The World Bank

Assessment of the Digital Market in Croatia

Final Report

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

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LIST OF ACRONYMS

ABBREVIATION	MEANING
ADSL	Asymmetric Digital Subscriber Line
AE	Active Ethernet
AI	Artificial Intelligence
AIOTI	Alliance for Internet of Things Innovation
AZTN	Agency for the Protection of Market Competition
BCO	Broadband Competence Office
BEREC	Body of European Regulators for Electronic Communications
BIDP	Broadband infrastructure development plan
CAFP	Competent Authority for the Framework Program
CAGR	Compound Annual Growth Rate
CEBF	Connecting Europe Broadband Fund
CF	Cohesion Fund
CPS	Carrier Pre-Selection
CRM	Customer Relationship Management
CROAI	Croatian AI Association
CS	Carrier Selection
DAE	Digital Agenda for Europe
DG COMP	Directorate-General for Competition
DGU	State Geodetic Administration
DESI	Digital Economy and Society Index
DPN	Special Purpose Company Form
DSLAM	Digital Subscriber Line Access Multiplexer
DURA	Dubrovnik's local development agency
DVBT	Digital Video Broadcasting Terrestrial
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
ECA	Electronic Communications Act
ECI	Electronic Communications Infrastructure
EEA	European Economic Area
EECC	European Electronic Communications Code
EGS	European Gigabit Society
EMFF	European Maritime and Fisheries Fund
ERDF	European Regional Development Fund
ESF	European Social Fund
ESIF	European Structural and Investments Funds

ABBREVIATION	MEANING
EU	European Union
FLAP	Frankfurt-London-Amsterdam-Paris
FMS	Fixed-to-Mobile Substitutions
FTTH	Fiber to the Home
FTTP	Fiber to the Premise
GDP	Gross Domestic Product
GIS	Geographic Information System
GNI	Gross National Income
GPON	Gigabit Passive Optical Networks
GSM	Global System for Mobile Communications
GSMA	Global System for Mobile Communications Association
HAKOM	Croatian Regulatory Authority for Network Industries
HRK	Croatian Kuna
HT	Hrvatski (Croatian) Telekom
ICT	Information and Communications Technology
IEC	International Electrotechnical Commission
IGO	Intergovernmental Organization
IoT	Internet of Things
IPTV	Internet Protocol Television
IRMO	Institute for Development and International Relations
ISO	International Organization for Standardization
LLU	Local Loop Unbundling
LTE	Long-Term Evolution
M2M	Machine to Machine
MNO	Mobile Network Operator
MRRFEU	Ministry of Regional Development and EU Funds
MST	Margin Squeeze Test
MSTI	Ministry of the Sea, Transport and Infrastructure
MUX	Multiplexer
MVG	Music, Video, and Games
MVNO	Mobile Virtual Network Operator
NDS	National Development Strategy
NGA	Next Generation Access
NP	National Plan
NP-BBI	National Program for the Development of Backhaul Broadband Infrastructure
NPV	Net Present Value
NRA	National Regulatory Authority
OECD	Organisation for Economic Co-operation and Development
OLT	Optical Line Terminal

ABBREVIATION	MEANING
ONP	National Framework Program for the Development of Broadband Infrastructure in Areas Lacking Sufficient Commercial Interest for Investment
OPCC	Operational Program "Competitiveness and Cohesion"
OTT	Over the Top
PON	Passive Optical Networks
PPP	Public-Private Partnership
PSI	Public Sector Information
RF	Radio Frequency
RIO	Referent Interconnection Offer
RLLO	Referent Leased Line Offer
RUNE	Rural Networks
RUO	Referent Unbundling Offer
RWBA	Referent Wholesale Broadband Access
SCIS	Smart Cities Information System
SDM	Subscriber Data Management
SEA	Strategic Environmental Assessment
SIM	Subscriber Identity Module
SIP	Single Information Point
SLA	Service Level Agreement
SMP	Significant Market Power
STEM	Science, Technology, Engineering, and Math
SWOT	Strengths Weaknesses Opportunities Threats
TV	Television
UMTS	Universal Mobile Telecommunications System
UN	United Nations
USF	Universal Service Fund
VDSL	Very High-Speed Digital Subscriber Line
VHCN	Very High-Capacity Networks
WiMax	Worldwide Interoperability for Microwave Access
WLR	Wholesale Line Rental

Executive Summary

INTRODUCTION AND OBJECTIVES

With a view to supporting Croatia's continued efforts to advance its digital transformation, this report contains the findings of a comprehensive study of the digital sector in Croatia. In this study, the digital sector is defined as the internet (fixed and mobile), telephony (fixed and mobile), and pay TV markets.[1] The study examines indicators of Croatia's performance relative to a set of peer countries and the European Union (EU) average, with an emphasis on fixed and mobile broadband services as foundational elements of the digital transformation. To complete the assessment, other related factors, such as human capital, the integration of digital technology into the economy, and digital public services, are also considered at a higher level. The study then identifies specific gaps pertaining to digital infrastructure as well as the regulations and policies needed for a vibrant and competitive digital sector. On the opportunities side, the study assesses the relevance of encouraging the development of four emerging technologies in Croatia: the Internet of Things (IoT); artificial intelligence (AI); data centers and cloud services; and smart cities. The report concludes with high-level strategic and actionable recommendations drawn from the analysis. In light of the three national disasters that have recently affected Croatia, namely, the Zagreb earthquake in March 2020, the December earthquakes that struck the Sisak-Moslavina County, and the outbreak of COVID-19, this report also highlights the role that digital infrastructure and services could play in strengthening Croatia's resilience to such crises.

DIGITAL SECTOR PERFORMANCE

In order to more fully identify gaps and growth opportunities for Croatia's digital sector, the following countries were selected to make up a peer group for the purpose of comparison: Bulgaria, Estonia, Greece, Hungary, Latvia, Lithuania, Poland, Portugal, Romania, and Slovakia.

Overall performance

The size of the information and communications technology (ICT) service sector in Croatia in terms of percentage contribution to GDP is around 4 percent (corresponding to roughly €1.3 billion in 2019), which is in the middle of the 3–5 percent range in which the overwhelming majority of EU countries fall. The composition of the ICT sector in terms of revenue is still predominantly made up of telephony services (as opposed to broadband internet services), which suggests that the digital market in Croatia is not fully mature. Yet, mobile broadband revenues grew at a cumulative average growth rate (CAGR) of 13 percent (compared to 3 percent for fixed broadband) between 2014 and 2019.

According to the five categories compiled by Digital Economy and Society Index (DESI), Croatia underperforms compared to both EU and peer group averages in terms of connectivity and digital public

1 The pay TV market is relevant for this assessment, given the relative importance of "convergent" offers within the broadband market (e.g., telephony + internet + TV offers) and the related impact on competition dynamics between market players,

services, but displays a better performance in internet use, human capital, and integration of digital technology. However, Croatia belongs to a group of countries that, despite a weak digital performance, are arguably improving more rapidly. In other words, Croatia belongs to a set of countries that could be termed "lagging fast movers": their DESIs are below the EU average, but their rate of improvement is above it (see figures below). This report focuses primarily on the connectivity aspects from an infrastructure and policy point of view, which are discussed below.

FIGURE ES1.
Croatia, Peer Group, and EU average Digital Economy and Society Index (DESI) Performance. 2019

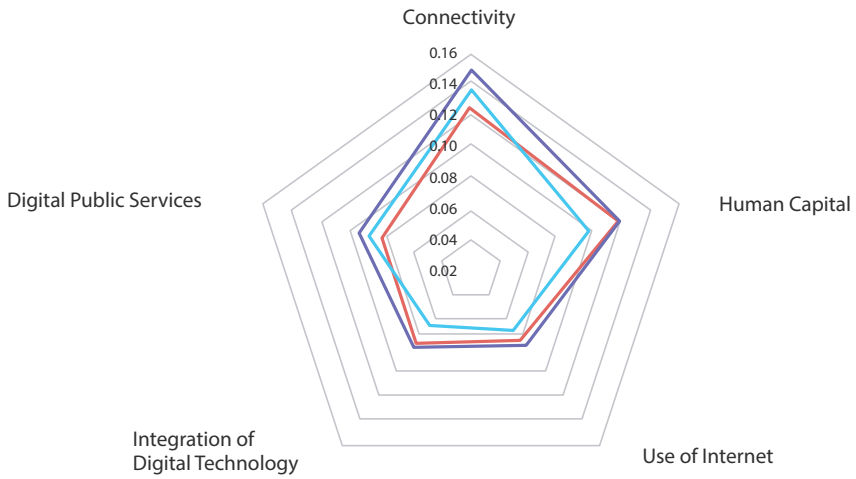
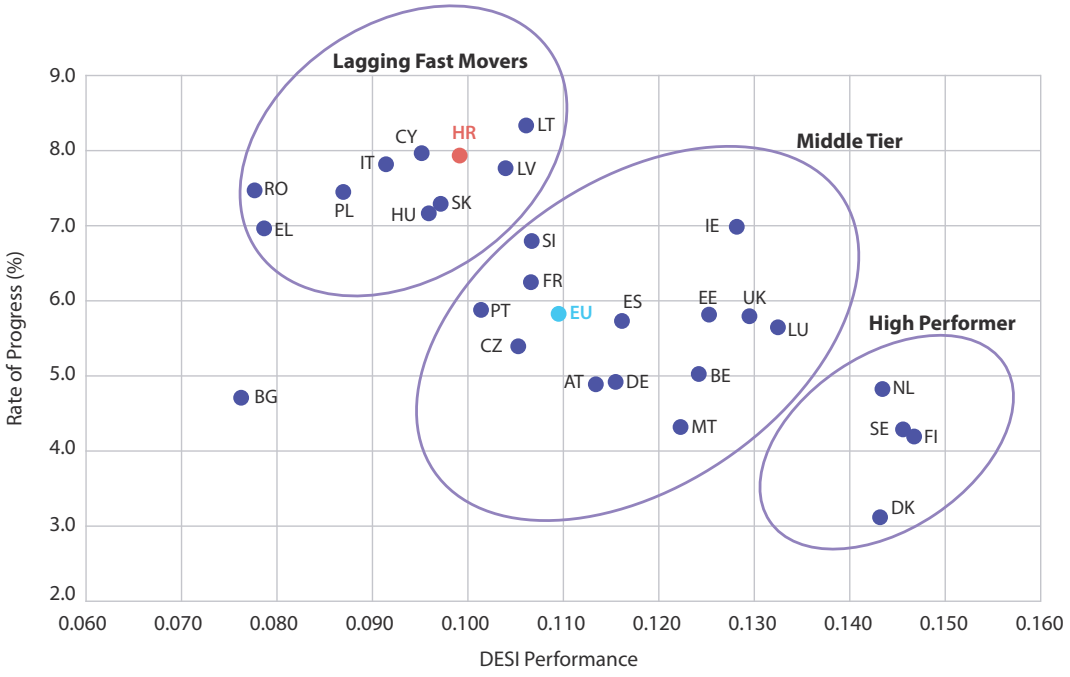


FIGURE ES2.
EU Member States' DESI for 2019 and Rate of Improvement since 2015



Source: Salience Consulting, based on Eurostat data.

Accessibility, Affordability and Usage

Croatia outperforms its income-based peer group and the EU average in terms of fixed broadband coverage,[2] but in terms of *fast* fixed broadband services,[3] Croatia's comparative performance is significantly lower than both sets of averages in actual take-up (despite the fact that coverage is close to the EU average and even exceeds its peer average). With respect to *ultrafast* broadband,[4] Croatia is below the peer group and EU averages for both coverage and take-up; many peer group members have leapfrogged the EU average in ultrafast broadband, but Croatia is not among them.

There is significant disparity between the urban (city of Zagreb) and the tourist areas on the one hand, and the interior rural areas on the other. Although Croatia has made progress in recent years in terms of take-up of fast fixed broadband service (at least 30 Mbps download), urban take-up is still more than twice that of rural take-up. Overall, Croatia performs particularly badly with respect to rural penetration in comparison to other EU countries and remains far from the 100 percent EU household take-up target for 2020.

In terms of mobile broadband, Croatia's coverage is in line with EU and peer group averages: as much as 94.4 percent of the populated areas in the country receive 4G service. Take-up, however, is comparatively lower, with only 84 data subscriptions for every 100 persons compared to 96 in the EU generally and 98 in the peer group. 5G-enabled technology was introduced in Croatia in 2018,[5] and consistent with the 5G EU Action Plan,[6] the government selected the city of Osijek in early 2020 for focused efforts to become the nation's first "5G city."[7] 5G deployments globally are still in an early stage of development, with the device ecosystem expected to facilitate true commercialization only in another one–two years; it is thus difficult to fully assess Croatia's performance in this area in absolute terms or relative to that of other countries.

Although affordability is unlikely to explain all of Croatia's underperformance in terms of fixed broadband take-up, it remains a significant factor, and Croatia's fixed broadband prices do appear to be high relative to its peers and to Croatian incomes. The analysis of mobile pricing suggests a more positive picture, as mobile prices appear affordable relative to household income and compared to EU and peer group averages.

Croatia has a relatively low usage level compared to the EU average and its peer group, which is reflected in a relatively low percentage of internet users (72.7 percent in Croatia compared to 74.6 percent for the peer group and 83.1 percent for the EU). In terms of what the internet is actually used for, Croatian usage more or less tracks with its peer group, which in turn, in comparison to the EU on average, is higher for news (91 percent), social networks (72 percent), and video calling (70 percent) but lower for banking (44 percent), shopping (34 percent), and video-on-demand (27 percent). The significant underperformance of Croatia relative to the EU average in terms of banking and shopping online may be more reflective of the lack of complementary infrastructure in those sectors than usage itself.

2 Percentage of households passed by the various "fixed" broadband technologies.

3 "Fast" fixed broadband technologies are defined by fixed technologies capable of providing at least a 30 Mbps download.

4 Ultrafast" fixed broadband technologies are defined by fixed technologies capable of providing at least a 100 Mbps download.

5 See L. Simmonds, "Croatian Telecom First to Bring 5G Technology to Croatia," *Total Croatia News*, July 9, 2018, https://www.total-croatia-news.com/news/29649-croatian-telecom-first-to-bring-5g-technology-to-croatia.

6 See EC, "5G for Europe: an Action Plan" (Brussels: European Commission, 2016), https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=1713.

7 See C. Dziadul, "Osijek to be First Croatian 5G City," *Broadband TV News*, January 26, 2020, https://www.broadbandtvnews.com/2020/01/26/osijek-to-be-first-croatian-5g-city/.

Competition Policies and Regulations

Although the Croatian regulatory framework is fully aligned with the EU framework in its core provisions, some aspects of its implementation in practice (i.e., the non-harmonization of different laws) could be seen as a possible inhibitor to broadband development.

The level of competition in the mobile telephony and broadband market appears to be adequate, but when it comes to the fixed broadband market, the same conclusion cannot be drawn. This is due to the fact that there was strong consolidation in the fixed broadband market structure several years ago, resulting in the current market domination of Hrvatski (Croatian) Telekom (HT) and A1 as the only two convergent network operators offering a full range of services (fixed, mobile, broadband, and pay TV). This strongly affects the coverage and take-up of fast broadband services, which are limited by the restricted competitive forces in the market. At the same time, there are some direct regulatory barriers limiting the ability of competition to emerge, such as provisions in the Electronic Media Act that present an obstacle to Telemach's (previously Tele2) entry into the pay TV market and thus to its becoming a third convergent network operator.

Although wholesale markets are fully regulated in line with EU recommendations, market data indicate that there are some possible challenges in the ex ante regulation that prevent market development.[8] When it comes to spectrum, the current frequency allocation between the operators present on the market appears not balanced in the lower spectrum bands in absolute terms, something that could affect competition in the future.

In addition to these conclusions, in their replies to the data request, operators highlighted a wide variety of problems affecting the market. These include the high costs imposed by state bodies (land access, rights of way, spectrum fees), overcomplicated procedures affecting network deployment (construction regulation, spatial planning, etc.), and ineffective wholesale regulations.

Public interventions

Private investment can typically be relied upon to deliver needed infrastructure when it is commercially justified. But given the weak performance in fixed infrastructure rollout and take-up in several less economically relevant areas, the public sector has begun to play a greater role in development in Croatia through both EU and national initiatives. EU policies and funding should thus play a critical role in the structural reform and development agenda in Croatia. However, this has proven to be a key challenge for all stakeholders, primarily the central administration, which is struggling with implementation.

Over half of EU funding is channeled through the five European Structural and Investment Funds (ESIF). They are jointly managed by the European Commission and the EU member states. The purpose of these funds is to invest in job creation and a sustainable and healthy economy and environment for the European area. The overall ESIF allocation to Croatia for the 2014–20 period was €10.7 billion.[9]

The implementation of ESIF in Croatia has been slow. Although dedicated funds have been contracted at a relatively high rate, the payments made have been very low. The usage of funds (absorption rate) at the end of November 2019 across ESIF was between 27 and 46 percent (with an average of 32 percent). To understand the reasons for this poor performance, the report examined four significant public initiatives directed toward the development of the digital sector: 1) the National Framework

8 The first points to the quality of wholesale access regulation, as market data suggest that the number of unbundled lines is decreasing while wholesale bitstream access service stagnates. The second is the possibility that margin squeeze regulation does not prevent HT from exploiting its dominant position at the expense of competitors.

9 This allocation comes from five funds: the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund (CF), the European Agricultural Fund for Rural Development (EAFRD), and the European Maritime and Fisheries Fund (EMFF).

Program for the Development of Broadband Infrastructure (ONP); 2) the National Program for the Development of Broadband Backhaul Infrastructure (NP-BBI); 3) the Croatian Regulatory Authority for Network Industries' (HAKOM) Program for the Development of Internet and Broadband Access; and 4) the RUNE (Rural Networks) Project.

The analysis of these initiatives identified several reasons for this relatively poor performance: 1) a lack of ownership and coordination from public bodies, and a lack of resources for implementing projects; 2) a state aid process that is overly complicated and lengthy, with, for instance, processing delays in publishing the public calls for tender; 3) inappropriate parameters for state aid projects, such as a threshold for a private share in investment set too high and a maximum amount of funding per project set too low; and 4) public-private partnership (PPP) law issues.

INHIBITORS TO DIGITAL MARKET DEVELOPMENT

The analysis has identified several inhibitors to sectoral development that have been categorized in four distinct groups and analyzed in terms of their relative impact on the development of the sector. A list of the analyzed inhibitors is given below.

TABLE ES1. Inhibitors to Broadband Development

CATEGORIES	INHIBITORS	IMPACT
Governance and public investment	No strong ownership of the digital transformation agenda at the institutional level	HIGH
	A state aid process that is too complicated and lengthy	LOW
	Excessive delays in the tendering process of major programs	HIGH
	The threshold for private share in investment set too high for rural areas	LOW
	The maximum amount of funding per project set too low to fund large projects	LOW
	Lack of resources and experience for implementing some large projects	MEDIUM
	Issues in the law on public-private partnerships (PPPs)	LOW
Market structure and competition	Fixed broadband service prices too high relative to incomes	HIGH
	Highly consolidated fixed markets	HIGH
	The Electronic Media Act restricting development of the market	HIGH
	Limitations in the current wholesale regulations	MEDIUM
Land access or usage, construction, and rights of way	High fees for land access (rights of way)	MEDIUM
	Some local spatial plans with prohibitive requirements for fixed and mobile infrastructure	HIGH
	Construction regulations for building electronic communications infrastructure (ECI) (both line and mobile infrastructure) that do not ensure fast and cost-effective deployment	HIGH
	Concerns over the legality of legacy fixed infrastructure due to lack of permits (property rights issues)	HIGH
	EU Directive on measures to reduce the cost of deploying high-speed electronic communications networks transposed into national legislation but not functional in practice	HIGH
Spectrum	Spectrum fees	N/A
	Spectrum imbalance among mobile network operators (MNOs)	N/A
	Interference from neighboring countries and 5G spectrum assignments	HIGH

OPPORTUNITIES IN EMERGING DIGITAL TECHNOLOGIES

On the opportunities side, the report analyzes four emerging global trends and their specific applicability in Croatia: 1) the IoT, 2) AI, 3) data centers and cloud services, and 4) smart cities:

- IoT: there is not much development of the IoT in Croatia, nor is there a cluster or body leading on this issue that could clearly be identified at present. Some operators reported that one of the inhibitors is the lack of low band spectrum, which is crucial for IoT devices.
- AI: Croatia is already plugged into some of the European initiatives[10] on Artificial Intelligence (AI) and has made some progress in developing the sector through the Croatian AI Association (CROAI) initiative. However, its members and activities are at the moment quite limited.[11]
- Data centers and cloud services: Croatia has been doing relatively well in this sector, given that its cloud services adoption rate is above the EU average. The domestic data centers have been well positioned to serve the national market, and this trend is expected to continue. There were no specific factors that would make Croatia stand out as a favorable data center location for the big global players: connectivity is mainly through terrestrial links, and there are no major subsea cable routes, no large EU-wide internet exchanges, and no specific climate energy advantages. Therefore, in the short to medium term, Croatia is not seen as an attractive option for hyperscale data center investment.
- Smart cities: Croatia has had several interesting local initiatives based on the enthusiasm of local officials and the research community. However, there is no common state governance on smart city development or common deployment strategy.

Supporting these emerging technologies would give a boost to the overall development of the digital sector in Croatia and generate additional direct and indirect economic and social benefits, including:

- Job creation, for example, in the form of application developers related to IoT and catering to Croatia's specific small and medium-sized enterprise (SME) requirements and/or smart city application developer jobs
- Regeneration of certain parts of the country by establishing large-scale or disaster recovery data centers in areas that have historically high unemployment rates
- Development of technology-related manufacturing for street furniture and other physical objects that are part of the smart city ecosystem (smart metering, smart traffic lights, smart signs, and so on)

SWOT ANALYSIS OF THE DIGITAL SECTOR

The conclusions of the analysis of the digital sector in Croatia can be summarized in a strengths, weaknesses, opportunities, and threats (SWOT) table, as per below.

10 For instance, AI4EU

11 A. Momcilovic, "Use of Artificial Intelligence: Comparing Croatia with Other Countries' Strategies," Total Croatia News, January 25, 2020, https://www.total-croatia-news.com/business/41051-ai-croatia.

TABLE ES2.
Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis

Strengths	Weaknesses
Competition – Satisfying level of competition in mobile telephony and broadband markets – Satisfying fixed network and fixed services competition in densely populated urban areas – Steady increase of bundled services **Mobile services** – Satisfying level of mobile broadband take-up, affordability, and coverage – Excellent mobile network infrastructure – National Action Plan for the usage of the 470–790 MHz frequency band already published **Resilience** – Resilient and scalable digital infrastructure and services in case of crisis like COVID-19	**Governance and state aid projects** – Inadequate ownership and coordination from public bodies and a scarcity of resources for implementing projects – Slow implementation (compared to other EU countries) and inappropriate design (i.e. not fully conducive to private participation) of state aid projects **Market structure** – Overall market structure characterized by strong consolidation in recent years that could restrict market dynamism in the coming years – Lack of third convergent network operator that could boost competition, with the market currently dominated by HT and A1 offering a full range of services (fixed, mobile, broadband, pay TV) – No full or light MVNO present in the market – Fixed broadband market essentially a duopoly **Prices** – Fixed broadband prices are high relative to Croatian incomes, which negatively affects demand side **Broadband coverage and take-up** – Fixed broadband coverage varies greatly between urban and coastal counties on the one hand and rural and interior counties on the other – In terms of *fast* broadband, take-up of these services is significantly lower in Croatia than the EU and peer group averages. – Croatia is below both the peer group and EU averages for both coverage and take-up of *ultrafast* broadband
Opportunities	**Threats**
New services and technologies – Increase in user demand for broadband access services due to the development of new digital public services – Roaming and tourism – Developed IT industry – Implementation of 5G – Public opinion in post-COVID period that digital networks were one of the main enablers of "normal" life during the pandemic – Some opportunities to develop niche industries in emerging technologies (Internet of Things, Artificial Intelligence, Cloud services, Smart Cities, etc.) **Regulatory framework** – National telecom regulatory framework is fully aligned with the EU regulatory framework in terms of the core provisions, which means that all the relevant EU directives have been transposed into national legislation – Government plan of introducing new Electronic Communications Act that will deal with some problems on the market (e.g. provisions to facilitate network deployments, strengthen market competition, and improve the spectrum policy) – Possibility of using EU best regulatory practices and experiences (BEREC, NRAs, etc.) in order to deal with problems on the market	**Governance** – Slow decision making on the state level as regards the telecom sector – Low absorption of EU funds for digital infrastructure development – Inadequate coordination among state bodies **Regulatory framework** – Provisions in Electronic Media Act limit Telemach's ability to become a third convergent network operator – Implementation of the national regulatory framework in practice lacks compatibility with several laws (e.g., construction regulations) – Construction regulations for building digital infrastructures (both line and mobile infrastructure) do not ensure fast and cost-effective deployment – Questionable impact of the current wholesale access regulation on competition – Non-legality of some of the already built infrastructure – Lack of regulatory predictability in practice (e.g., tax system, spectrum fees, different regulations covering deployment of the network, etc.) as well as unjustified delays in making key decisions on using EU funds **Deployment and operational costs** – High costs of network deployment for the operators (land access, rights of way, etc.) – Possible high cost of spectrum that could limit investments in new technologies **Spectrum** – Interference from neighboring countries that could affect 5G implementation – Spectrum imbalance among MNOs

RECOMMENDATIONS FOR FURTHER SECTOR DEVELOPMENT

A number of key recommendations have been identified based on the analysis of the market and sector inhibitors, as well as on the opportunities available in emerging technologies. Foundational reforms are highlighted in blue in the table below.

TABLE ES3.
Recommendations

THEMES	OBJECTIVES	RECOMMENDATIONS
Governance and public investment	**Establish ownership of the digital agenda** to lead a coordinated effort among institutions for the digital transformation of the country. **Foster investments in the digital agenda** by i) increasing EU funds absorption and efficacy and ii) maximizing private sector participation.	Rec.#1: Strengthen the institutional organization around the digital transformation agenda. Rec.#2: Create rules and guidelines that will obligate all stakeholders to act more quickly and efficiently in the decision-making process related to EU funds. Rec.#3: Create rules and guidelines that simplify the state aid procedures related to the telecom sector. Rec.#4: Simplify the law on public-private partnerships.
Market structure and competition	**Promote competition and market entry** through revised wholesale regulations and policies to improve the affordability of digital services and to foster innovation,	Rec.#5: Review and adapt wholesale regulations (including the margin squeeze test rules) and encourage the entrance of a third convergent market player. Rec.#6: Evaluate possible modifications to the Electronic Media Act to support effective competition, with the addition of safeguards to competition if needed.
Land access or usage, construction, and rights of way	**Reduce the costs and facilitate the deployment of telecommunications networks** to improve the accessibility and affordability of digital services.	Rec.#7: Adopt a uniform legislative solution that would equally refer to all different types of linear infrastructure. Rec.#8: Adopt a national spatial development plan for Electronic Communications Infrastructures Rec.#9: Amend the existing construction regulations or adopt special regulations in the construction and physical planning of Electronic Communications Infrastructures. Rec.#10: Adopt a law on the legalization of legacy fixed and mobile infrastructure. Rec.#11: Impose stricter inspection and supervision of the implementation of the Law on Measures to Reduce the Cost of Deploying High Speed Electronic Communications Networks
Spectrum	**Ensure that spectrum, a scarce public resource, is properly allocated and priced** to promote competition, quality of service (e.g., rural coverage), cost efficiency, and innovation (e.g., 5G rollout).	Rec.#12: Define spectrum auction rules to safeguard market competition, ensuring that spectrum assignment does not harm competition. Rec.#13: Undertake an independent comparative analysis and a benchmarking of the level of spectrum fees in EU member states. Rec.#14: Undertake additional diplomatic efforts to minimize the impact of cross-border interference on 5G development in Croatia.
Emerging technologies	**Exploit the opportunities offered by innovative digital technologies** to generate economic and social benefits	Rec.#15: Foster a government initiative to consult with the industry on the specific needs of large corporates and SMEs in terms of Internet of Things . Rec.#16: Encourage the government to make a greater effort to obtain the cooperation of other telecom and IT sector members in the field of Artificial Intellingence and to stimulate further developments and initiatives. Rec.#17: Conduct a government study to explore any uniqueness or activities that could be found to attract bigger international players of the data centers and cloud services market to Croatia. Rec.#18: Encourage state coordination in providing more focused knowledge support and technical assistance on smart cities projects.

Note: Foundational reforms are highlighted in purple

COVID-19 AND OTHER DISASTERS: RESILENCE AND RECOVERY

Resilience of telecommunications networks to supply and demand shocks

Telecom networks have shown remarkable resilience to the far-reaching COVID-19 crisis and the damaging earthquakes in March and December 2020. These crises had a variety of impacts on operators, such as closing points of sale, disrupting the supply chain, increasing the resources needed for customer care, and so on, but the overall impact was limited.

In addition, as a consequence of full or partial lockdowns, there has been a massive shift in traffic from offices, schools, and universities to the home. Work from home via video conferencing, online education for schools and universities, extensive use of online services, and increased use of video streaming and gaming have resulted in unprecedented growth in network usage. Yet, in Croatia, HAKOM and the operators have confirmed that congestion has generally not been a problem.

Agenda for Action to contend with the effects of the crisis

The COVID-19 pandemic and the resulting restrictions have highlighted the importance of communications and connectivity and with that, of digital networks. The Broadband Commission for Sustainable Development has developed an Agenda for Action to mitigate the impact of the pandemic and ease the immediate adverse effects on economies and societies. Croatian policy makers should examine the Commission's short- and mid-term Agenda for Action to contend with the effects of the crisis:

- The short-term agenda is based on three different pillars: 1) Resilient connectivity (e.g., ensure connectivity and network continuity, increase bandwidth capacity and network resilience and security, provide vital/emergency services, streamline customs procedures and classify network equipment as essential infrastructure, etc.); 2) Affordable access (e.g., identify solutions for liquidity and financial shortages; offer special tariffs for related health, education, humanitarian, and emergency workers/services; rely on Universal Service Funds; etc.); 3) Safe use of online services for informed and educated societies (e.g., make available safe and secured digital platforms and open source software for health, education, food security, and financial and governmental services; promote quality education and information content and services; enhance policies against disinformation and increase transparency; provide online training and safe digital tools to parents and teachers to keep children safer online; use AI to support medical institutions; support norms and provide resources to educational and media institutions, etc.)

– The medium–term agenda includes a set of high-level actions requiring more coordination among national and international stakeholders: 1) Acceleration and implementation of digital cooperation and digital strategies and policies; 2) Elevation to the G20 level of resilient broadband networks as a basic right; 3) Implementation of agile and flexible regulatory measures to support an inclusive and competitive digital environment; 4) Adoption of strategies aimed at promoting universal connectivity by mobilizing public and private funding and investment; 5) Implementation of streamlined actions and partnerships to promote the expansion of broadband connectivity, digital services, and digital inclusiveness to unconnected communities and populations; 6) Promotion of the ongoing importance of connectivity for education, access to information, and online user empowerment though media and information literacy; 7) Highlighting of areas where connectivity is playing a key role in the COVID-19 pandemic response and widespread dissemination of these stories to help build better and more resilient societies; 8) Identification of major partners for public financing of connectivity to vital services, including schools, and actions to attract institutional finance investors looking for a compelling market opportunity.

1. Introduction and Objectives

1. Introduction and Objectives

With a view to supporting Croatia's continued efforts to advance its digital infrastructure, this report contains the findings of a comprehensive study of the digital sector in Croatia. In this study, the digital sector is defined as the telephony (fixed and mobile), internet (fixed and mobile), and pay TV markets.[12] The study examines indicators of Croatia's performance relative to a set of peer countries and the European Union (EU) average, with an emphasis on fixed and mobile broadband services. To complete the assessment, other related factors, such as human capital, the integration of digital technology into the economy, and digital public services, are also considered. The study identifies specific gaps pertaining to digital infrastructure itself and examines the relevant government policy reforms needed for a vibrant and competitive digital sector. In addition, the study assesses the relevance of encouraging the development of four emerging technologies in Croatia: the Internet of Things (IoT); artificial intelligence (AI); data centers and cloud services; and smart cities. The report concludes with high-level strategic and actionable recommendations drawn from the analysis.

As a specific addition to the study, in light of the two national disasters that have recently affected Croatia, namely, the Zagreb earthquake in March 2020 and the outbreak of COVID-19 at roughly the same time, a separate section of this report highlights the role that digital infrastructure and services could play in strengthening the resilience of Croatia to such crises.

At the beginning of the study, a data request was sent to a variety of stakeholders, including the Ministry of the Sea, Transport and Infrastructure (MSTI), the Croatian Regulatory Authority for Network Industries (HAKOM), and local operators Hrvatski Telekom (HT), A1, Telemach, and Transmitters and Communications (OIV), a state-owned company. All of them responded to the data request, and most complemented their submission with telephone interviews.

12 The pay TV market is pertinent to this assessment, given the relative importance of "convergent" offers within the broadband market (e.g., telephony + internet + TV offers) and the related impact on competition dynamics between market players.

2. Croatian Digital Sector Performance

2. CROATIAN DIGITAL SECTOR INDICATORS

2. Croatian Digital Sector Performance

2.1. INTRODUCTION

In this section, the performance of Croatia's digital market is examined in absolute terms and relative to other European countries, particularly the attributes of its fixed and mobile broadband markets in comparison to a set of selected peer countries and the EU average. To complete the assessment, other measures of the Croatian digital economy are then presented, particularly those that make use of Eurostat's indicators that produce the Digital Economy and Society Index (DESI). The chapter concludes with observations that help to inform the rest of the report.

The economic performance of the country is a key factor in determining the relative performance of the digital sector, given the very direct relationship between economic development and income distribution and digital services usage. The general economic context of Croatia is discussed in detail in Annex 5, but key points are summarized below.

From an economic point of view, Croatia is among the least developed of the EU member states. In terms of GDP per capita, Croatia is toward the bottom of the scale. GDP per capita figures were used to identify a group of 10 countries that, along with Croatia, form a lower-income peer group for more pertinent comparisons in the rest of this chapter. The thresholds of €20,000 unadjusted GDP per capita and €25,000 purchasing power adjusted were selected to form Croatia's peer group, which includes 10 countries in addition to Croatia, namely, Bulgaria, Estonia, Greece, Hungary, Latvia, Lithuania, Poland, Portugal, Romania and Slovakia.

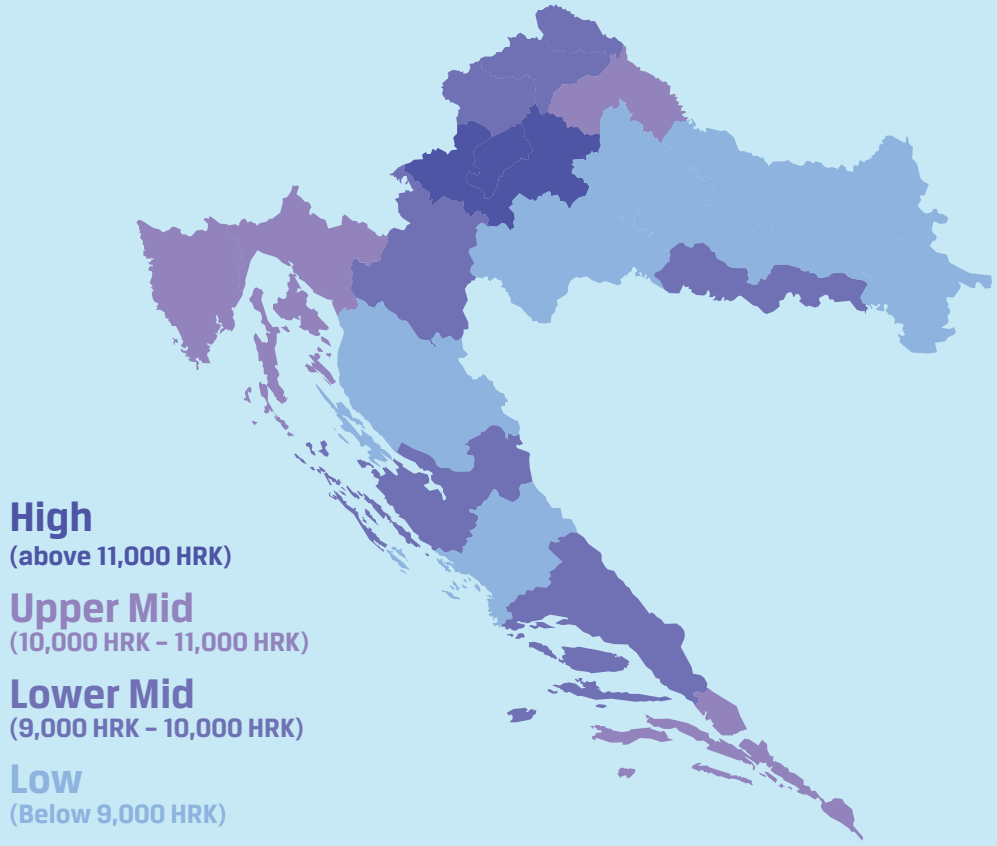
Another important measure of economic well-being for the purposes of assessing the affordability of broadband is income distribution. There are a number of ways of measuring income distribution, but three publicly available EU-wide measures of income inequality (discussed in Annex 5) are 1) the income quintile share ratio, 2) the Gini coefficient, and 3) the at-risk-of-poverty rate. Croatia's income quintile share ratio is 5, which is more equal than most of its lower-income EU peers and more or less the same as the EU ratio overall.

Croatia's relative position with the Gini coefficient is virtually unchanged in comparison to the income quintile share ratio. With respect to the at-risk-of-poverty rate,[13] it can be seen that almost 20 percent of Croatia's population is at risk of poverty. This is a significantly greater share of the population than in the EU overall. One of the main implications here, if broadband is truly believed to be a necessity for all, is that particular attention will need to be given to the issue of affordability in Croatia. Finally, there are sharp regional disparities among the counties in Croatia, as illustrated in the figure below. Estimates of household income for 2017 range from 8,025 kuna (US$1,260) per month in the county of Virovitica-Podravina to 13,238 kuna (US$20,800) in the county of Zagreb.[14]

13 The at-risk-of-poverty rate is the percentage of the population that earn a level of income—a threshold—that is significantly lower than that of the population as a whole, such that it can lead to poverty. The EU defines this threshold as 60 percent of median equivalized disposable income. For details, see EC, "Glossary: At-Risk-of-Poverty Rate," https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:At-risk-of-poverty_rate.

14 According to the Croatian Statistical Office.

FIGURE 1.
Estimated Monthly Household Income in 2017

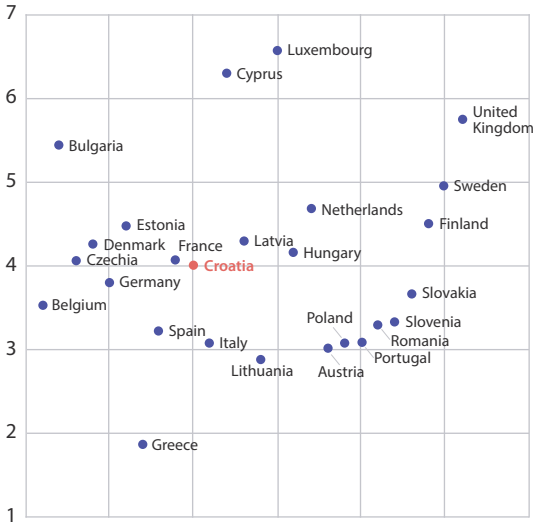


Source: Salience Consulting, based on data from the Croatian Statistical Office.

2.2. SIZE OF THE BROADBAND MARKET

The size of the information and communications technology (ICT) service sector in Croatia in terms of percentage contribution to GDP is around 4 percent, which is in the middle of the 3–5 percent range in which the overwhelming majority of the EU countries fall (see the figure below).

FIGURE 2.
ICT Services as % of GDP, 2017



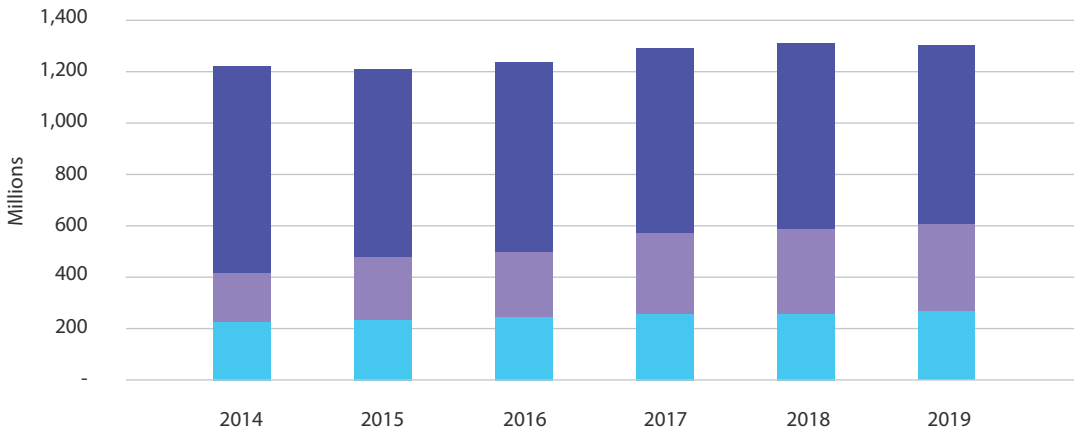
Note: This is percentage of GDP calculated as value added at factor cost as a percentage of total national value added at factor cost. These figures do not include ICT equipment manufacturing but services only.
Source: Based on Eurostat data.

As shown in the figure 3, the composition of the ICT sector in terms of revenue is still predominantly made up of non-broadband services (mobile narrowband, in particular, as will be discussed further in Chapter 3) but will eventually be overcome by broadband service revenue. Mobile broadband revenues have grown more rapidly than fixed broadband at a cumulative average growth rate (CAGR) of 13 percent (compared to 3 percent for fixed broadband) and surpassed fixed broadband in 2015.

Although mobile broadband revenues and traffic growth exceed that of fixed broadband, fixed networks still carry far more traffic, as demonstrated in the figure 4.

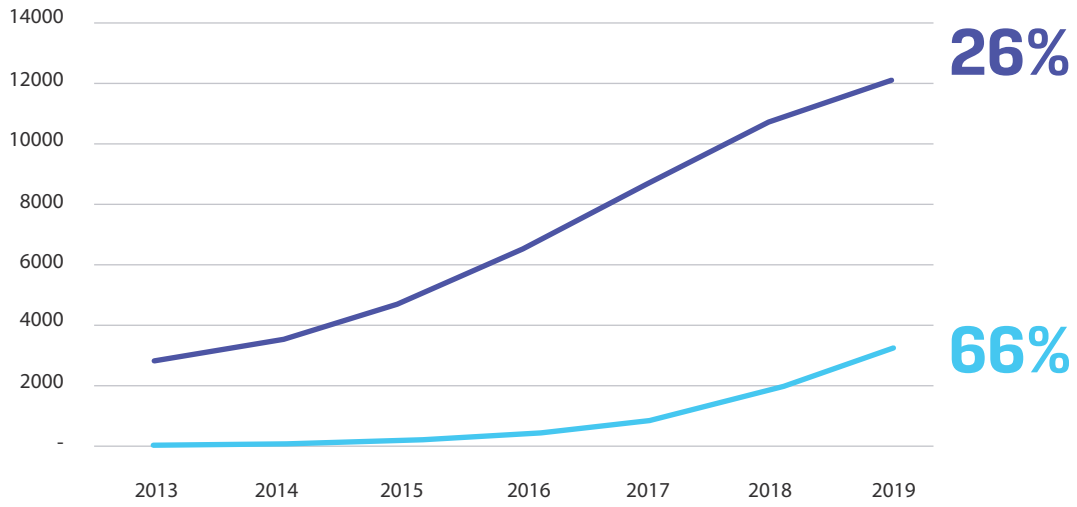
Croatia's performance in each of these aggregate broadband markets is examined next.

FIGURE 3.
Revenues and Growth of the Croatian Telecommunications Market, 2014–19, in million euros



Note: Non-broadband telecommunications include both fixed and mobile narrowband and some television services (see Chapter 3 for more details).
Source: Based on data from HAKOM.

FIGURE 4.
Annual Petabytes of Data Downloaded in Croatia, 2013–19



Source: Based on data from HAKOM.

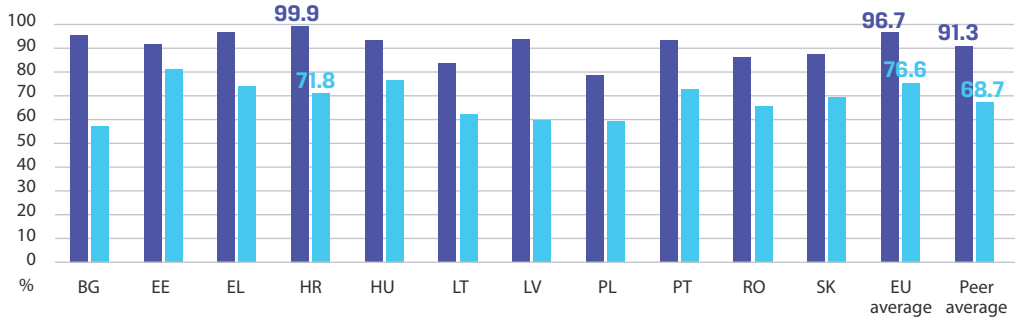
2.2.1. Fixed broadband market

2.2.1.1. National comparisons

Croatia outperforms its income-based peer group and the EU average in terms of fixed broadband coverage. Here, fixed broadband coverage is defined as the percentage of households passed by the various "fixed" broadband technologies: asymmetric digital subscriber line (ADSL),[15] cable, fiber to the premises (FTTP),[16] or WiMax[17] networks. In terms of take-up (households effectively subscribing to a service), Croatia exceeds its peer average but not the EU average.

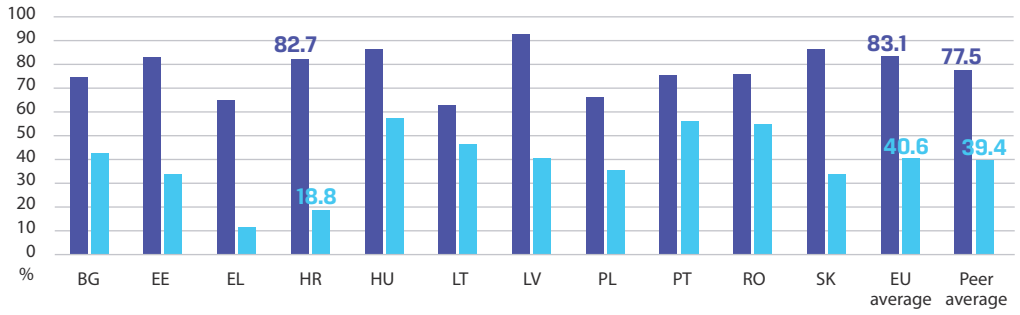
In terms of fast fixed broadband services, Croatia's comparative performance is lower. "Fast" fixed broadband technologies are defined by fixed technologies capable of providing at least a 30 Mbps download: FTTP, DOCSIS 3.X,[18] and very high-speed digital subscriber line (VDSL).[19] Coverage of fast broadband in Croatia is close to the EU average and exceeds its peer average, but actual take-up of these services is significantly lower than both the EU and peer group averages.

FIGURE 5.
Fixed Broadband Coverage and Take-Up, % of households, 2019



Source: Based on Eurostat data.

FIGURE 6.
Fast (at least 30 Mbps download) Broadband Coverage and Take-Up, % of households, 2019



Source: Based on Eurostat data.

15 ADSL is a type of DSL broadband communications technology used for connecting to the internet. ADSL allows more data to be sent over existing copper telephone lines (POTS) compared to traditional modem lines.

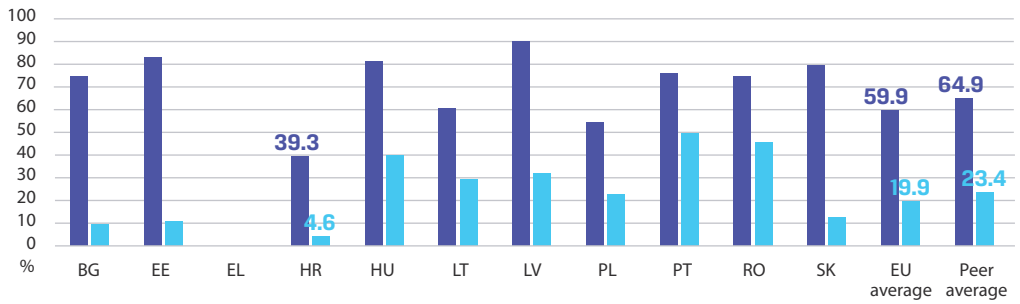
16 FTTP means either fiber-to-the-home or fiber-to-the-business.

17 WiMax (Worldwide Interoperability for Microwave Access) is based on wireless technology and has the ability to provide service even in areas that are difficult for wired infrastructure to reach and also to overcome the physical limitations of traditional wired infrastructure.

18 DOCSIS (Data Over Cable Service Interface Specification) is the standard used in cable internet technology that allows the transfer of data over cable lines. Since the first version of cable internet was introduced in 1997, there have been several updates to the technology leading up to today, when DOCSIS 3.1 is the best on the market.

19 VDSL is a DSL technology that provides a faster data transfer rate than ADSL and ADSL2+ technologies. VDSL is capable of providing services like high-definition television and video-on-demand, along with internet access.

FIGURE 7.
Ultrafast (at least 100 Mbps download) Broadband Coverage and Take-Up, % of households, 2019



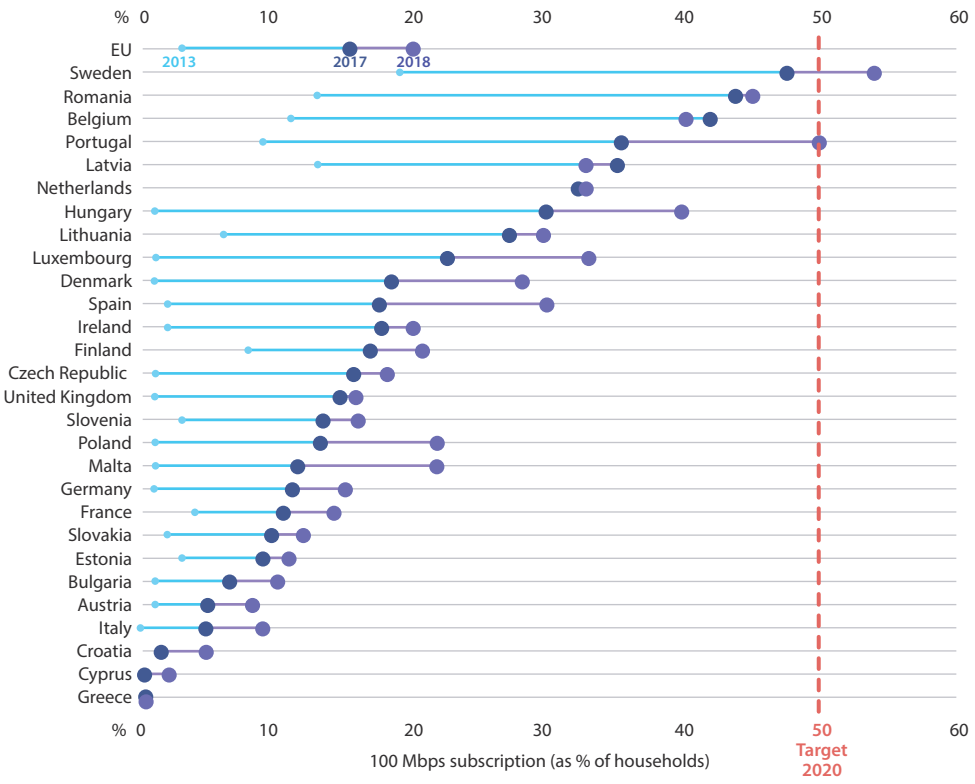
Source: Based on Eurostat data.

With respect to *ultrafast* broadband, Croatia is below both the peer group and EU averages for both coverage and take-up. "Ultrafast" fixed broadband technologies are defined by fixed technologies capable of providing at least a 100 Mbps download: FTTP and DOCSIS 3x. It should be noted that many peer group members have leapfrogged the EU average in ultrafast broadband, but Croatia is not among them.

In 2016, the European Commission (EC) set the following broadband targets to be achieved by 2020:
- 100 percent of European households to have access to at least 30 Mbps (fast broadband)
- 50 percent of European households to have access to at least 100 Mbps (ultrafast broadband)

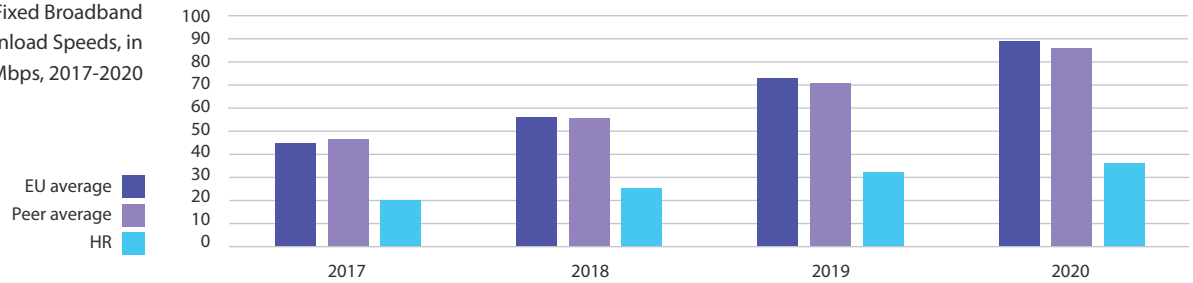
The figure below underscores the slow progress Croatia has made recently with respect to ultrafast broadband. It also highlights how far Croatia is from the EU 2020 target of 50 percent of households.

FIGURE 8.
Progress on EU 2020 Target for Take-Up of Ultrafast Broadband, 2017–18



Source: Based on Eurostat data.

FIGURE 9.
Fixed Broadband Download Speeds, in Mbps, 2017-2020



Note: Measurement taken in March of each year, except for 2020, for which January data were used.
Source: Based on Ookla data.

Croatian underperformance in fixed broadband is corroborated by Speedtest.net by Ookla[20] measures of broadband speed over the past several years, which show download speeds of less than half the EU and peer group averages. There should be some caution that Ookla data are flawed, as the company does not sample across a representative population of users. Thus, although most Croatian households do not use next generation access (NGA), Ookla shows an average download speed higher than 30 Mbps. However, assuming that Ookla measures are similarly biased in every EU market, it provides further evidence of the underperformance of Croatia compared to the EU and peer groups averages.

2.2.1.2. Regional comparisons

A map of fixed broadband shows the disparity between the urban (city of Zagreb) and the tourist areas (Splitsko-dalmatinska, Istarska, Dubrovačko-neretvanska, Šibensko-kninska, Zadarska, and Primorsko-goranska) on the one hand, where fixed broadband take-up is 29 percent or above, compared to the interior rural areas on the other.

20 Speedtest.net by Ookla is a web service that provides free analysis of internet access performance metrics, such as connection data rate and latency.

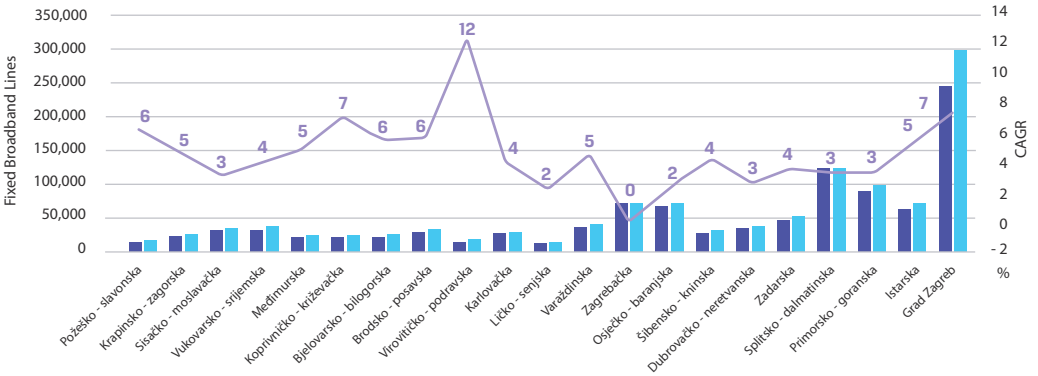
FIGURE 10.
Fixed Broadband Density (take-up as a percentage of population) per county

Over the 2016–19 period, fixed broadband take-up grew in the single digits. The exception was Virovitičko-podravska, which started from such a small base that its results cannot be considered unusual.

The figure 12. demonstrates the geographic disparity in the context of EU comparators. Although Croatia has made progress in recent years in terms of take-up of fast fixed broadband service (at least 30 Mbps download), the following shortcomings are visible:

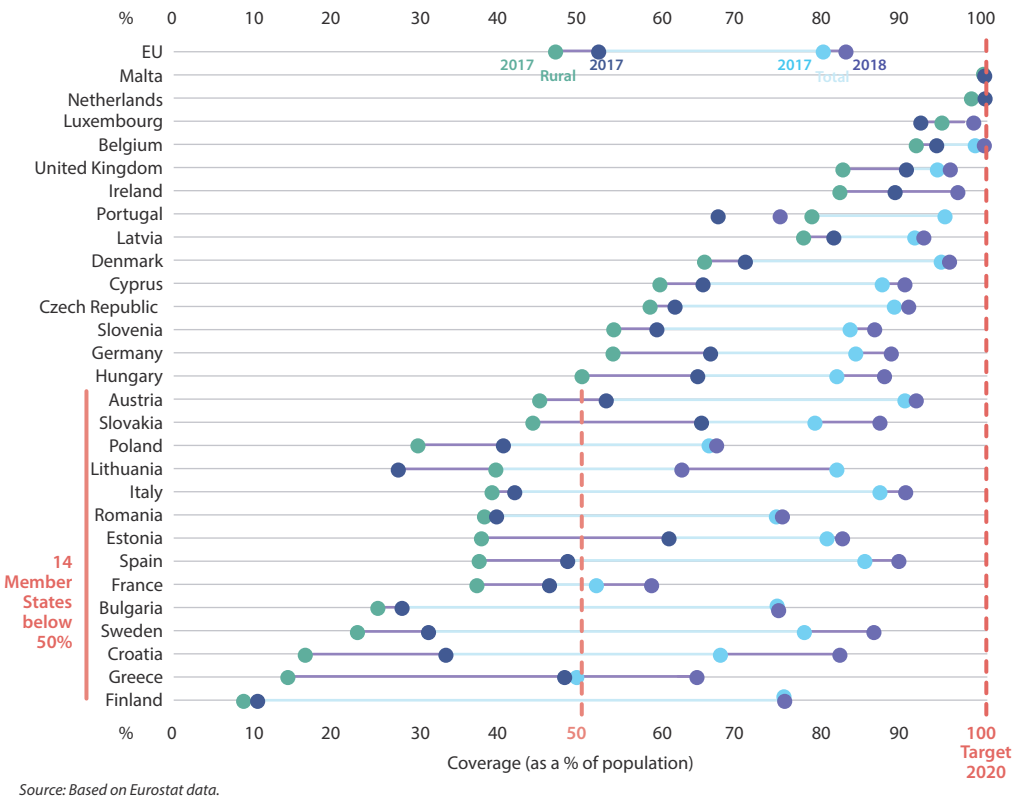
- Urban take-up is still more than twice that of rural take-up.
- Croatia performs particularly badly with respect to rural penetration in comparison to other EU countries.
- Croatia is still far from the 100 percent EU household take-up target for 2020.

FIGURE 11.
Fixed Broadband Connections and CAGR, by district, 2016–19



Note: 2016 data are from the second quarter and 2019 from the fourth quarter, so the CAGR may be slightly exaggerated.
Source: Based on HAKOM data.

FIGURE 12.
Evolution of EU Rural and Urban Fast Broadband Density, 2017–18



Source: Based on Eurostat data.

2.2.2. Mobile broadband market

Introduced commercially in 2001, the goals set out for third generation (3G) mobile communications were to facilitate greater voice and data capacity, support a wider range of applications, and increase data transmission at a lower cost. 3G increased the efficiency of the frequency spectrum by improving audio compression for more simultaneous calls in the same frequency range (see section 2.2.2.2 for more technical details).

Introduced in 2009, 4G allows the use of digital media (video streaming, online shopping, online video games) without the frequent frustration stemming from a slow internet connection. The main difference between 3G and 4G is the data rate: a 4G connection ranges from 100 Mbps per second to 1 Gbps per second.

Testing and implementation of 5G worldwide began in 2019. Compared to previous generations, 5G network capabilities can offer much more, with a main focus on IoT connectivity (5G networks will significantly optimize communication between IoT devices), low latency (1–10 ms compared to 10–30 ms for 4G and 100–500 ms for 3G), and high speeds (downloading a movie will be a matter of seconds rather than hours/minutes when compared to previous generations).

Data rate is one of the main differences between 3G, 4G, and 5G. With speeds of up to 10 Gbps, 5G is set to be as much as 10 times faster than 4G. In addition, 4G is more spectrally efficient than 3G, just as 5G is more spectrally efficient than 4G. Each generation delivers more data per hertz than the previous one. 3G works at frequencies of up to 2.1 GHz, 4G at up to 2.5 GHz, and 5G at up to 95 GHz.

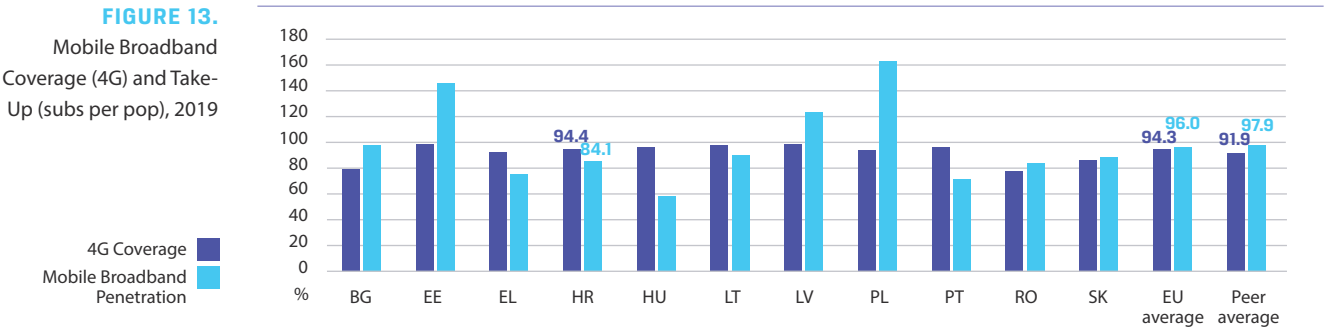
2.2.2.1. National comparisons

In Croatia, 3G services were first introduced by A1 in April 2006, followed by HT in November 2006 and then Telemach. HT and A1 both launched 4G services on the same day in March 2012. HT was the first operator to test 5G network capabilities in 2019.

In terms of mobile broadband, Croatia's coverage is in line with EU and peer group averages. As much as 94.4 percent of the populated areas in the country receive 4G service. Take-up, however, is comparatively lower, with only 84 data subscriptions for every 100 persons as compared to 96 in the EU generally and 98 in the peer group. However, this ratio may be impacted by the way Eurostat measures 4G take-up: since not all service providers in Croatia offer 4G to the same extent across the nation, "take-up" is necessarily lower than it would be if all subscribers were able to choose the network service with the greatest 4G coverage.

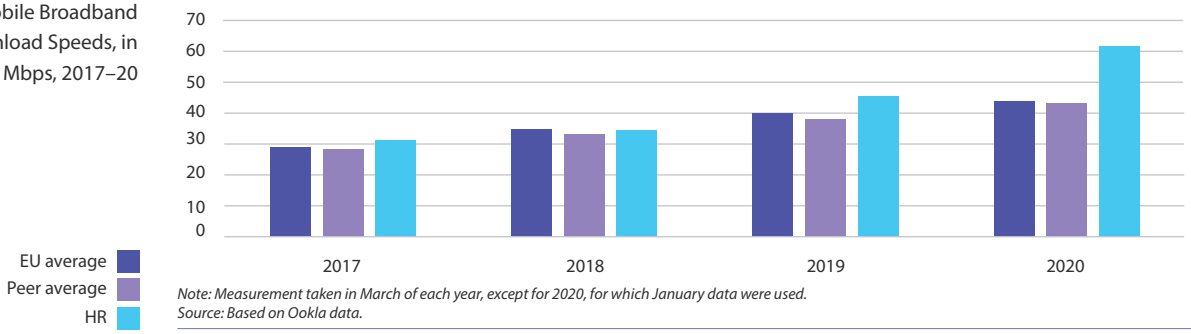
Eurostat doesn't provide data on mobile broadband speed. As discussed above, Ookla data are flawed in that its sample is not representative of the entire population of users. However, assuming a similar bias across EU markets and over time, Ookla data suggest that Croatia's mobile download speeds may compare favorably to other EU markets—and they have doubled over the past few years.

FIGURE 13.
Mobile Broadband Coverage (4G) and Take-Up (subs per pop), 2019



Source: Based on Eurostat data.

FIGURE 14 .
Mobile Broadband Download Speeds, in Mbps, 2017–20



Note: Measurement taken in March of each year, except for 2020, for which January data were used.
Source: Based on Ookla data.

2.2.2.2. 5G readiness

Based on the definition of the Global System for Mobile Communications Association (GSMA), radio spectrum is used to carry information wirelessly for a vast number of everyday services, ranging from television and radio broadcasting, mobile phones, and Wi-Fi to communications systems for emergency services, baby monitors, GPS, and radar. The key ingredient for faster wireless services that can support the rising tide of data is more spectrum, but it is a scarce resource that is already heavily encumbered. Radio spectrum is divided into frequency bands, which are then allocated to certain services.

All wireless communications signals travel over the air via radio frequency, that is, spectrum. The national regulatory bodies grant licenses to mobile network operators (MNOs) to use frequency bands for each mobile generation (2G, 3G, 4G, and 5G). Every MNO has its own spectrum band dedicated by the national telecom regulatory body. MNOs cannot transmit wireless signals over the same frequencies in the same markets at the same time.

Spectrum bands have different characteristics, which makes them suitable for different purposes. In general, low-frequency transmissions can travel greater distances before losing their integrity, and they can pass through dense objects more easily. Less data can be transmitted over these radio waves, however. Higher-frequency transmissions carry more data but are poorer at penetrating obstacles.

HAKOM assigns spectrum bands to the mobile operators. Different spectrum bands are allocated for the use of different technologies (global system for mobile communications [GSM], universal mobile telecommunications system [UMTS], 4G, 5G). Eurostat measures "5G readiness" in terms of the amount of spectrum within specified ranges planned to be assigned and ready for 5G use by the end of 2020. The 5G spectrum ranges considered are within the 700 MHz (703–733 MHz and 758–788 MHz), 3.6 GHz (3400–3800 MHz) and 26 GHz (1000 MHz within 24250–27500 MHz) bands. In the EU's most recent publication dated 2019, only 11 EU countries had qualified as "5G ready," and only two of those (Hungary and Latvia) were in Croatia's peer group.

That said, 5G-enabled technology was introduced in Croatia in 2018,[21] and consistent with the 5G EU Action Plan,[22] the government selected the city of Osijek in early 2020 for focused efforts to become the nation's first "5G city."[23]

21 See L. Simmonds, "Croatian Telecom First to Bring 5G Technology to Croatia," *Total Croatia News*, July 9, 2018, https://www.total-croatia-news.com/news/29649-croatian-telecom-first-to-bring-5g-technology-to-croatia.

22 See EC, "5G for Europe: an Action Plan" (Brussels: European Commission, 2016), https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=17131.

23 See C. Dziadul, "Osijek to be First Croatian 5G City," *Broadband TV News*, January 26, 2020, https://www.broadbandtvnews.com/2020/01/26/osijek-to-be-first-croatian-5g-city/.

5G deployments globally are still in an early stage of development, with the device ecosystem only expected to facilitate true commercialization in another one–two years. It is thus difficult to assess Croatia's performance in this area in absolute terms or relative to that of other countries. The challenges to 5G deployment in Croatia are discussed in more detail in Chapter 3.

2.2.2.3. Regional comparisons

Subscriber data are not available by district, but coverage maps of the mobile operators underscore that 4G coverage is extensive but not equally available from all service providers.

FIGURE 15.
T-Mobile Coverage by Technology, 2020

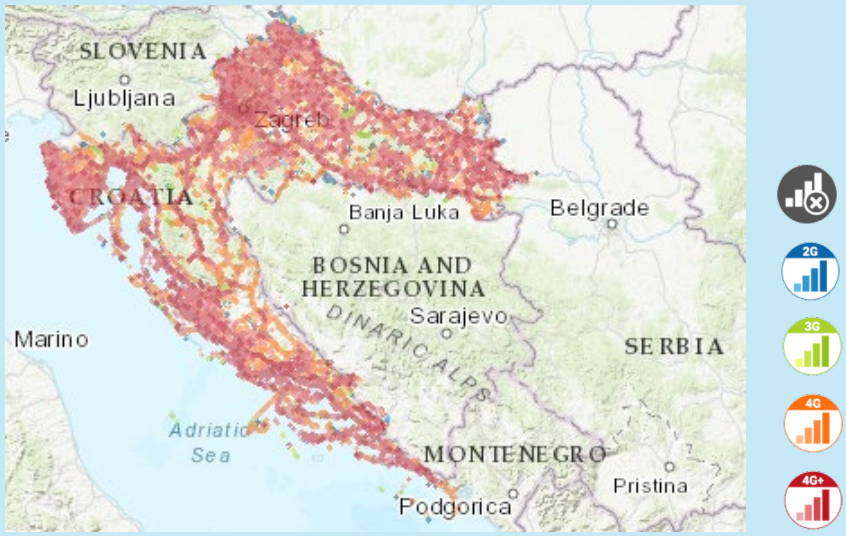
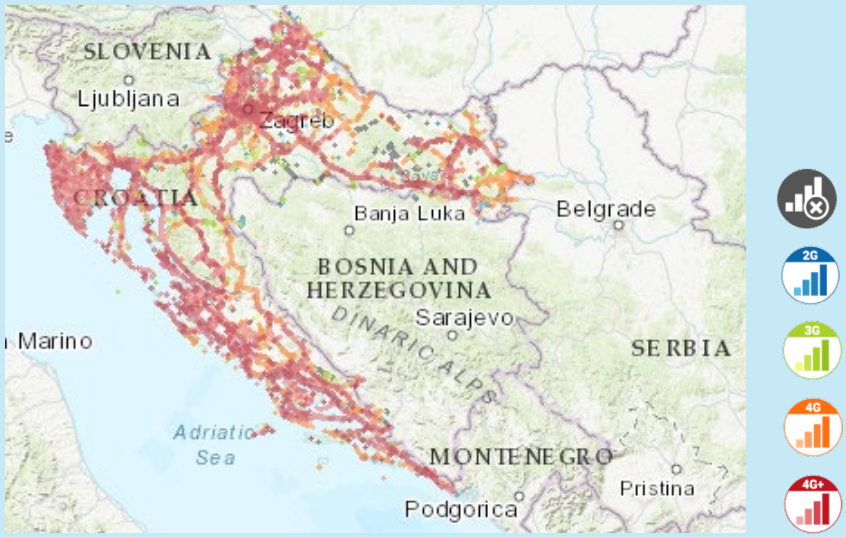


FIGURE 16.
A1 Coverage by Technology, 2020



Source: nperf (see https://www.nperf.com/en/map/HR/-/-./signal/).

FIGURE 17.
Telemach Coverage by Technology, 2020

Source: nperf (see https://www.nperf.com/en/map/HR/-/-./signal/).

2.3. AFFORDABILITY OF BROADBAND SERVICES

The table below provides a comparison between the residential "fixed" bundle packages (broadband internet, fixed phone, and TV) from the main broadband providers currently on the market in Croatia. All benchmarked packages are for a fast broadband service (between 30 and 100 Mbps). They fall within the €32–€48 range, with similar terms and conditions.

TABLE 1.
Offers for Bundle Packages (Internet, Fixed TV, and Telephony) from the Main Broadband Players in Croatia (data from June 8, 2020)

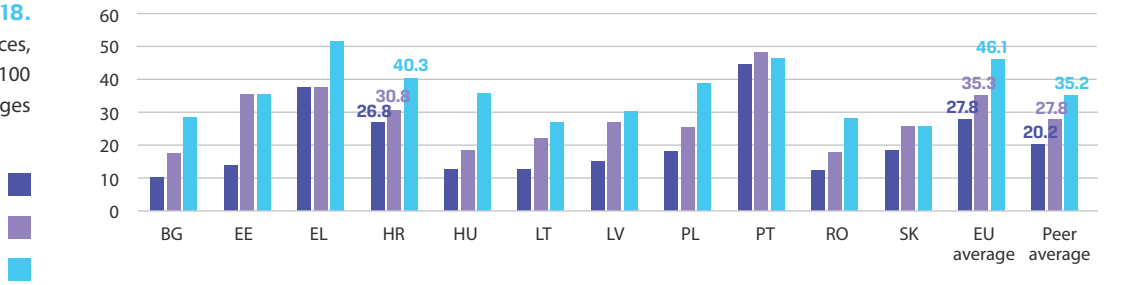
	HT	A1	Optima	Iskon
Download speed	Up to 100 Mbps	49 Mbps–70 Mbps	Up to 60 Mbps	Depends on subscriber's location (up to 100 Mbps)
Unlimited internet traffic (yes/no)	Yes	Yes	Yes	Yes
Number of TV programs	100+	120	100+	100
Fixed phone	Unlimited calls to fixed and mobile	Unlimited calls to fixed and mobile	Unlimited calls to fixed network	Unlimited calls to fixed network
Price kn HRK	359kn/monthly	249kn/monthly	265kn/monthly	253.9kn/monthly
Price in euros	€47.47	€32.93	€35	€33.57
Contract commitment	24 months	24 months	24 months	24 months

Note: All prices are value added tax (VAT) inclusive.

To assess the hypothesis that affordability explains underperformance in fixed broadband service, several elements can be examined.

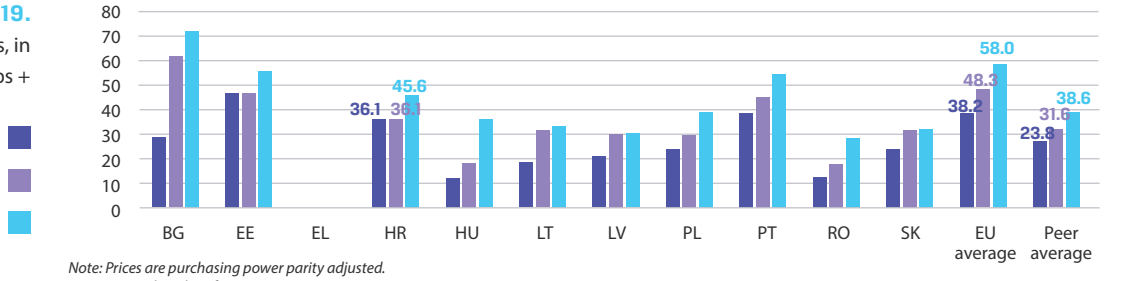
First, comparative fixed and mobile broadband prices are considered. The figures below regarding fixed broadband prices show purchasing power parity–adjusted euro prices for stand-alone internet access, double play (internet + fixed telephony), and triple play (internet + fixed telephony + TV) as of 2018, according to the empirica database. Croatian prices are below average EU prices but somewhat above

FIGURE 18.
Fixed Broadband Prices, in EUR, 2018, 30–100 Mbps packages



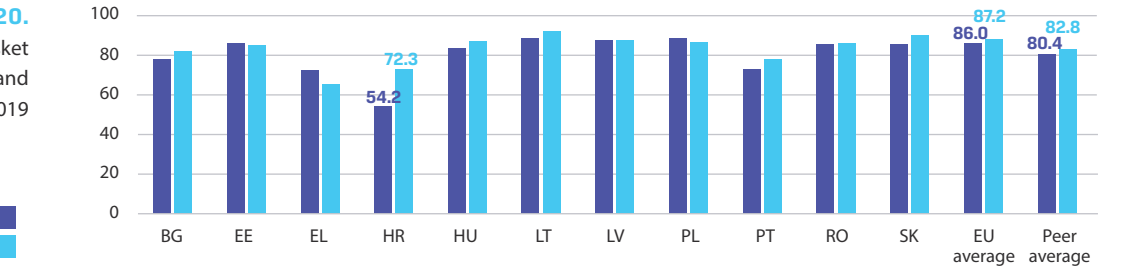
Notes: It is not clear why empirica data show lower prices for triple play than double play in Portugal. Prices are purchasing power parity adjusted.
Source: Based on empirica data.

FIGURE 19.
Fixed Broadband Prices, in EUR, 2018, 200 Mbps +



Note: Prices are purchasing power parity adjusted.
Source: Based on data from empirica

FIGURE 20.
Broadband Price Basket Score (between 0 and 100), 2016 and 2019



Source: Based on Eurostat data.

the peer average. Thus, affordability does not appear to explain the lower take-up and usage in Croatia compared to the EU. It may, however, explain the underperformance compared to its peer group. Among these packages, stand-alone internet pricing is relatively more expensive. For 30–100 Mbps packages, stand-alone internet was 33 percent higher in Croatia than the peer group average, though it was only 14 percent higher for triple play. A similar pattern is observed for 200 Mbps+ packages.

For an idea of trends over time, the figure below presents Eurostat's Broadband Price Index for 2016 and 2019.[24] The figure shows that although Croatian prices compare unfavorably to both EU and peer group averages, they have become more affordable over time in absolute and relative terms.

24 The index is a composite, combining the affordability of 12 representative broadband packages relative to household income. The higher the index, the more affordable the fixed broadband services. The baskets include three speed categories (12–30 Mbps, 30–100 Mbps, and at least 100 Mbps) and four types of products (stand-alone internet, internet + TV, internet + fixed telephony, and internet + fixed telephony + TV).

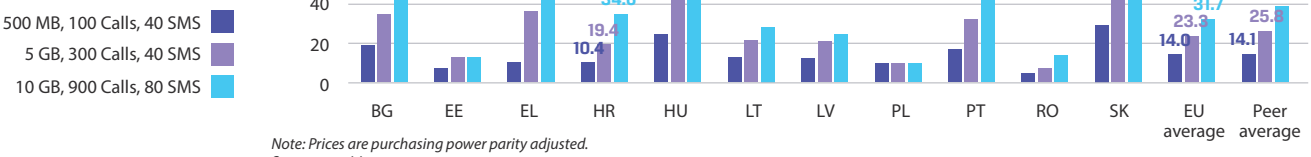
FIGURE 21.
Correlation between Broadband Density and Household Income in Croatia's Counties, 2017

Note: Household income was estimated on the basis of household composition, average salaries, unemployment, the number of retirees, and pension payments by county from the Croatian Statistical Office.
Sources: HAKOM; Salience Consulting.

Second, Croatian regional data are considered to assess whether affordability explains the relative lack of take-up across Croatian counties. In the figure below, estimated household income is compared to fixed broadband penetration in 2017. According to these data, 25 percent of the variation of penetration is explained by household income. Thus, although significant, affordability does not appear to be the primary variable in take-up among Croatian counties.

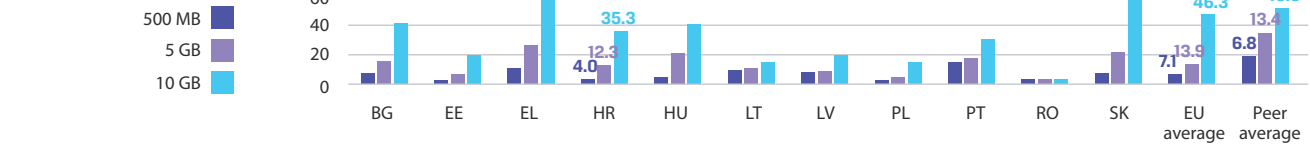
Finally, mobile broadband pricing is considered. The figure below shows that Croatian prices tend to be significantly lower than in the EU in general and in its peer group.

FIGURE 22.
Mobile Voice + Data Packages, in EUR, 2019



Note: Prices are purchasing power parity adjusted.
Source: empirica.

FIGURE 23.
Mobile Data Package Prices, in EUR, 2019



Note: Prices are purchasing power parity adjusted.
Source: empirica.

By way of conclusion, there is evidence of an affordability issue in Croatia with respect to fixed broadband pricing. Croatia's fixed broadband prices do appear to be high relative to its peers. Although affordability is unlikely to explain all of Croatia's underperformance in terms of fixed broadband take-up, it remains a significant factor. The analysis of mobile pricing, as other areas of mobile performance, suggests a more positive picture for mobile broadband services. Mobile prices appear affordable relative to household income and in comparison to EU and peer group averages.

2.4. OTHER DIGITAL INDICATORS

In this section, other indicators of the Croatian digital market are examined. In particular, relevant Eurostat data are presented on the four areas that do not directly relate to infrastructure but form components of the DESI:

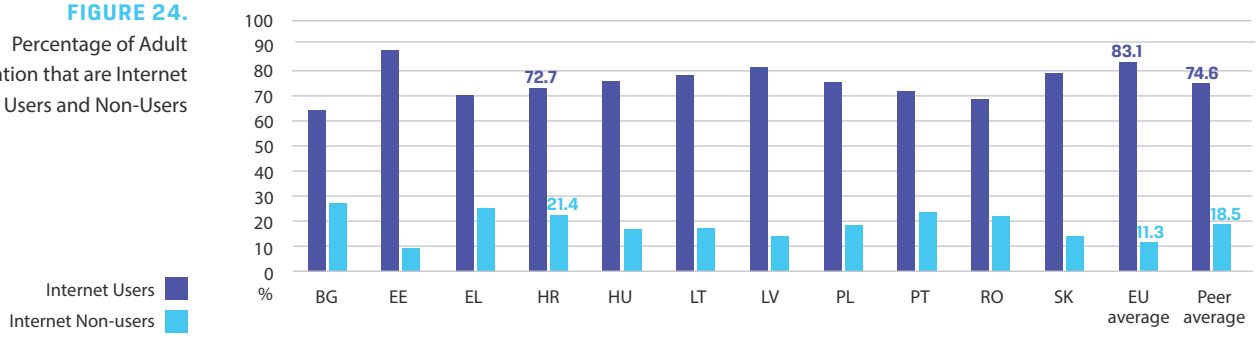
- Internet use
- Human capital
- Integration of digital technology
- Digital public services

2.4.1. Internet use

The figure below provides data on the percentage of people who use the internet at least once a week ("use" is defined as activity that is carried out online) and those who never use the internet. Croatia has relatively low usage level compared to the EU average and its peer group, which is reflected in a relatively low percentage of internet users and high percentage of non-users.[25]

Internet usage in Croatia has substantially improved since 2010, but a notable gender gap remains. In 2017, the percentage of men and women ages 25–54 using the internet was 88 and 81 percent, respectively, compared to the EU average of 92 percent for both genders. The percentage of men and women ages 55–74 using the internet was 46 and 28 percent, respectively, compared to the EU averages of 67 and 62 percent.[26] Annex 6 presents the comprehensive "Women in Digital Scoreboard," published by the European Commission in 2020.

FIGURE 24.
Percentage of Adult Population that are Internet Users and Non-Users



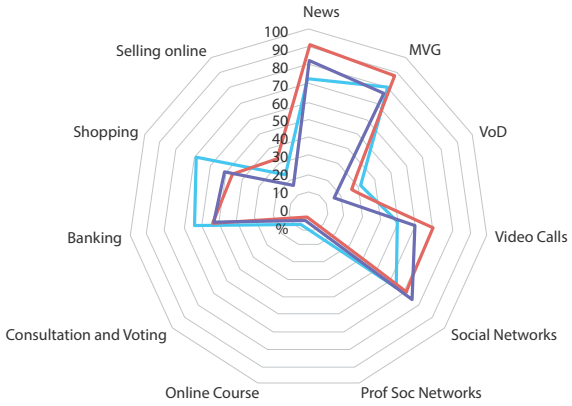
Note: Prices are purchasing power parity adjusted.
Source: empirica.

25 Note that the percentage of users and non-users does not add up to 100 because of the definition of users, which requires usage of at least once a week.

26 The data are from Eurostat.

In terms of what the internet is actually used for, the figure below indicates that Croatian usage more or less tracks with its peer group, which in turn, in comparison to the EU on average, is higher for news, social networks, and video calling but lower for banking, shopping, and video-on-demand. The significant underperformance of Croatia relative to the EU average in terms of banking and shopping online may be more reflective of the lack of complementary infrastructure in those sectors than ICT usage itself.

FIGURE 25.
Percentage of Internet Users Using the Internet for Selected Activities, 2019

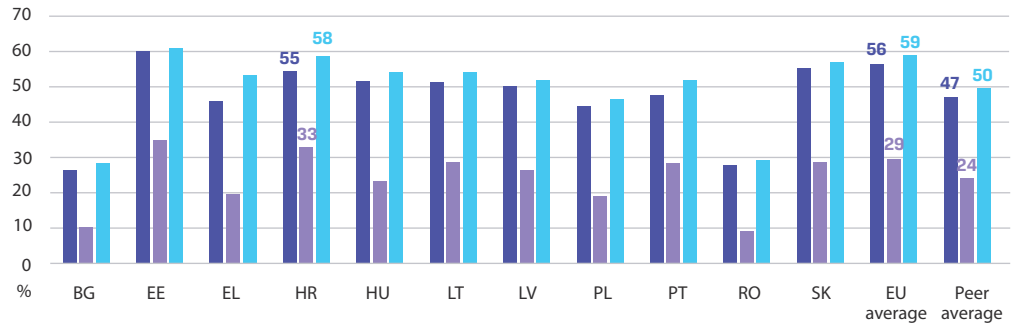


Note: "MVG" is music, videos, and games.
Source: Based on Eurostat data.

2.4.2. Human capital

DESI considers the human capital aspects in the digital sector in terms of user skills and ICT specialists. As indicated below, Croatia performs well within the EU average and above its peer group average in terms of user skills. Here, "basic" and "advanced" digital skills are the percentage of individuals aged 16–74 who have performed a selected set of activities on the internet in the four specific areas (identifying, retrieving, organizing, and analyzing information; communication; problem solving; and content creation) in the three months previous to the survey.[27] "Basic software skills" refer to the percentage of individuals aged 16–74 who have carried out basic software activities, such as performed word processing; used advanced spreadsheet functions; created a presentation or document integrating text, pictures, tables, or charts; or written code in a programming language.

FIGURE 26.
Percentage of Individuals with Basic Digital, Advanced Digital, and Basic Software Skills, 2017

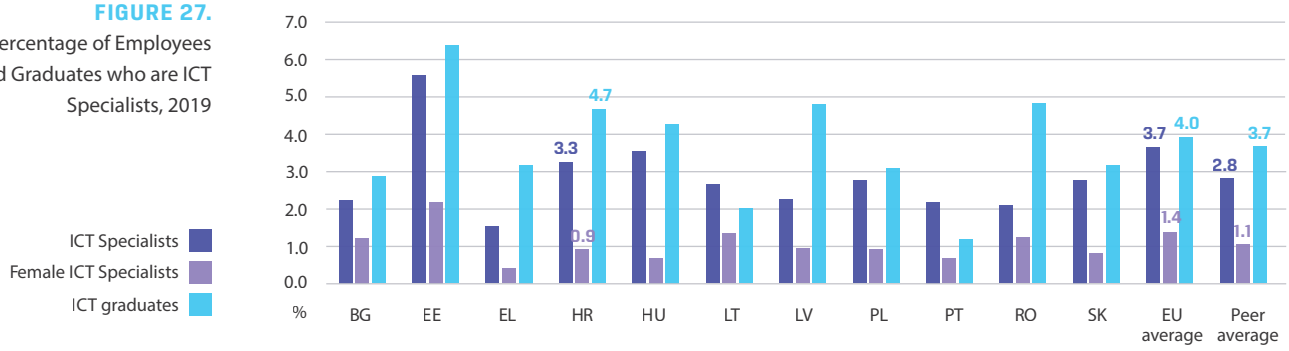


Source: Based on Eurostat data.

27 As Eurostat further describes it, "It is assumed that individuals having performed certain activities have the corresponding skills; therefore the indicator can be considered as a proxy of the digital competences and skills of individuals." See Eurostat, "Individuals Who Have Basic or Above Basic Overall Digital Skills by Sex," https://ec.europa.eu/eurostat/web/products-datasets/product?code=tepsr_sp410.

The figure below shows that in terms of employed specialists, Croatia has a mixed record. It seems to perform well relative to its peer group average, with the notable exception of female specialists. It is possible that Croatia is set to improve its relative standing in terms of specialists, as it is currently generating a relatively higher number of ICT graduates.

FIGURE 27.
Percentage of Employees and Graduates who are ICT Specialists, 2019



Source: Based on Eurostat data.

As noted in a recent report[28] from the World Bank, despite the fact that women in Croatia achieve more education than their male peers, their representation in the STEM (science, technology, engineering, and math) fields that offer higher remuneration is lower. Gender equity in STEM is linked to better labor market opportunities for women, raising a country's productivity and growth. Although Croatian women graduating from all fields of tertiary education outnumber their male counterparts by about 49 percent, this overall gain is translated into all sectors of the labor market except ICT, engineering, services (personal, transport, environmental, security), and manufacturing. Cultural norms about gender roles and femininity likely influence the subjects Croatian women decide to pursue in tertiary education, often steering them away from certain technical fields.

2.4.3. Integration of digital technology

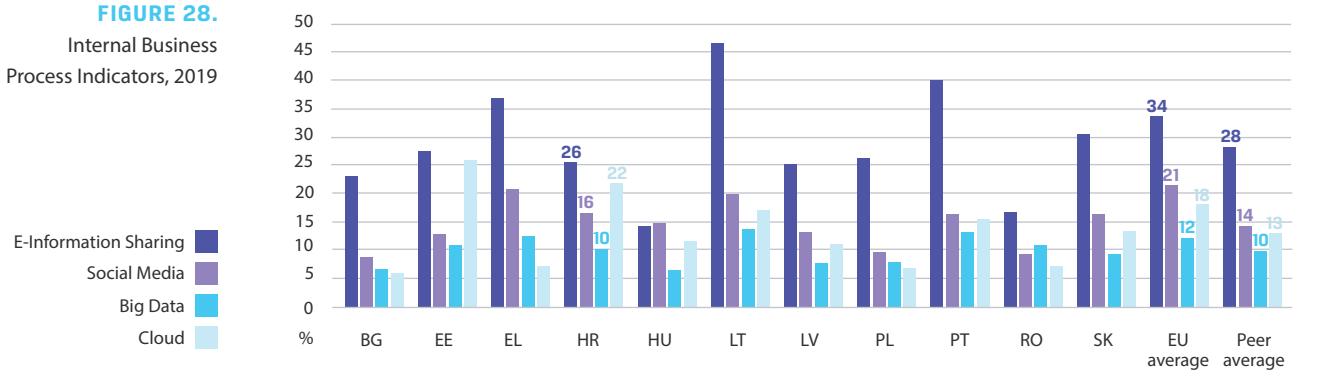
The EU measures the integration of digital technology in the business community with two sets of indicators: ICT as part of the internal business process and e-commerce. With respect to the internal business process, the EU considers four dimensions:

1. Electronic information sharing, or the percentage of businesses that use enterprise resource planning software
2. Social media, or the percentage of businesses that use two or more of the following: social networks, enterprise blogs, multimedia content sharing websites, or wiki-based knowledge sharing tools
3. Big data, or the percentage of businesses that use big data from any data source
4. Cloud, or the percentage of businesses that purchase at least one of the following cloud computing services: hosting of a database, accounting software applications, customer relationship management (CRM) software, or computing power

As the figure 28. indicates, Croatia's performance in terms of the integration of ICT into the internal business process is mixed. For example, electronic information sharing appears underdeveloped, whereas cloud usage is relatively high. The other measures seem to track with both EU and peer group usage.

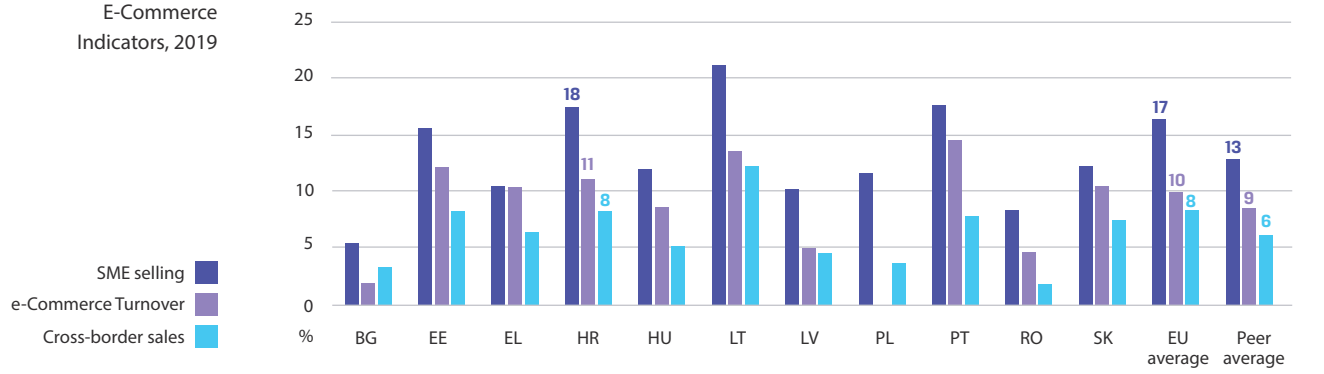
28 World Bank, "Investing in Opportunities for All – Croatia Country Gender Assessment" (Washington, DC: World Bank, 2019).

FIGURE 28.
Internal Business Process Indicators, 2019



Source: Based on Eurostat data.

FIGURE 29.
E-Commerce Indicators, 2019



Source: Based on Eurostat data.

With respect to e-commerce, Eurostat measures three dimensions:

1. Small and medium-sized enterprise (SME) sales, or the percentage of SMEs with at least 1 percent of turnover sold online
2. e-commerce turnover, or the percentage of SME sales from e-commerce
3. Cross-border sales, or the percentage of SMEs with cross-border e-commerce sales

Croatia outperforms its peer group in terms of e-commerce and is in line with the EU average overall.

2.4.4. Digital public services

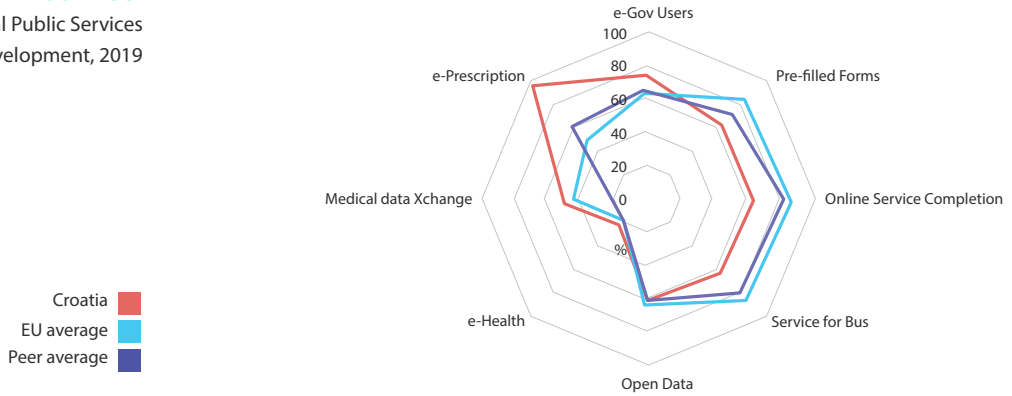
Eurostat measures the extent of digitization in public services with eight indicators:

1. E-government users, or the percentage of adults who submitted forms to public authorities over the internet within the previous year
2. Pre-filled forms, or the percentage of data that is pre-filled in public services' online forms
3. Online service completion, or the share of administrative steps related to major life events (birth of a child, new residence, etc.) that can be conducted online
4. Digital public services for businesses, or the share of public services needed for starting and conducting a business that is available online

5. Open data, which is a composite indicator of a) the extent to which open data policy conforms to the Public Sector Information (PSI) Directive, b) the impact of open data, and c) the characteristics of the national data portal
6. E-health, or the percentage of adults who use health care services provided online without having to go the hospital or a doctor's office
7. Medical data exchange, or the percentage of general practitioners who exchange medical data with hospitals and doctors electronically
8. E-prescription, or the percentage of general practitioners who use electronic prescriptions

Croatia exhibits a mixed performance with respect to digitizing public services. Whereas its peer group tracks the average EU experience quite closely, Croatia appears to outperform on the digitization of health care services but to underperform on the digitization of general public administration.

FIGURE 30.
Digital Public Services Development, 2019



Source: Based on Eurostat data.

JUSTICE FOR BUSINESS PROJECT

In March 2020, the World Bank Board of Executive Directors approved a loan to the Republic of Croatia for the Justice for Business Project in the amount of €100 million (US$110.3 million equivalent) aimed at improving business regulatory procedures and justice service standards for businesses and citizens.

The project will rely on the use of electronic services to speed up response times and integrate case management systems across different courts. It depends heavily on digital technologies and includes in particular activities related to:

- Implementing and expanding a single digital window to enable a one-stop-shop online registration of and key changes to limited liability companies
- Publishing online and consolidating licensing requirements to start a business activity and digitalizing selected license procedures
- Fully implementing the E-Dozvola platform, an online platform for construction permits
- Increasing the uptake level of electronic online services in the justice sector, both internally by justice sector operators (e.g., judges, staff, prosecutors) as well as by external users (citizens, businesses and lawyers representing their clients)
- Reducing the disposition time to issue judicial decisions in cases before the commercial courts by maximizing the utilization of ICT tools, in addition to other means

2.5. CONCLUSIONS

In terms of overall performance, and according to the five categories compiled by DESI (connectivity, internet use, human capital, integration of digital technology, and digital public services), Croatia underperforms compared to both EU and peer group averages in terms of connectivity and digital public services. However, it displays a better performance in terms of internet use, human capital, and integration of digital technology (see the figure and table below).

That said, Croatia belongs to a group of countries that, despite a weak digital performance, are arguably improving more rapidly. In other words, Croatia belongs to a set of countries that could be termed "lagging fast movers": their DESIs are below the EU average, but their rate of improvement is above it (see figure 32.).

FIGURE 31.
Croatia, Peer Group, and EU average DESI Performance. 2019

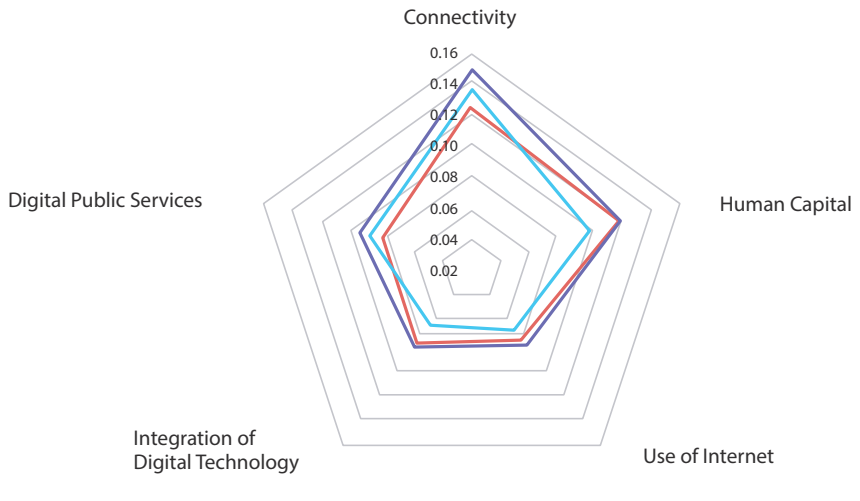


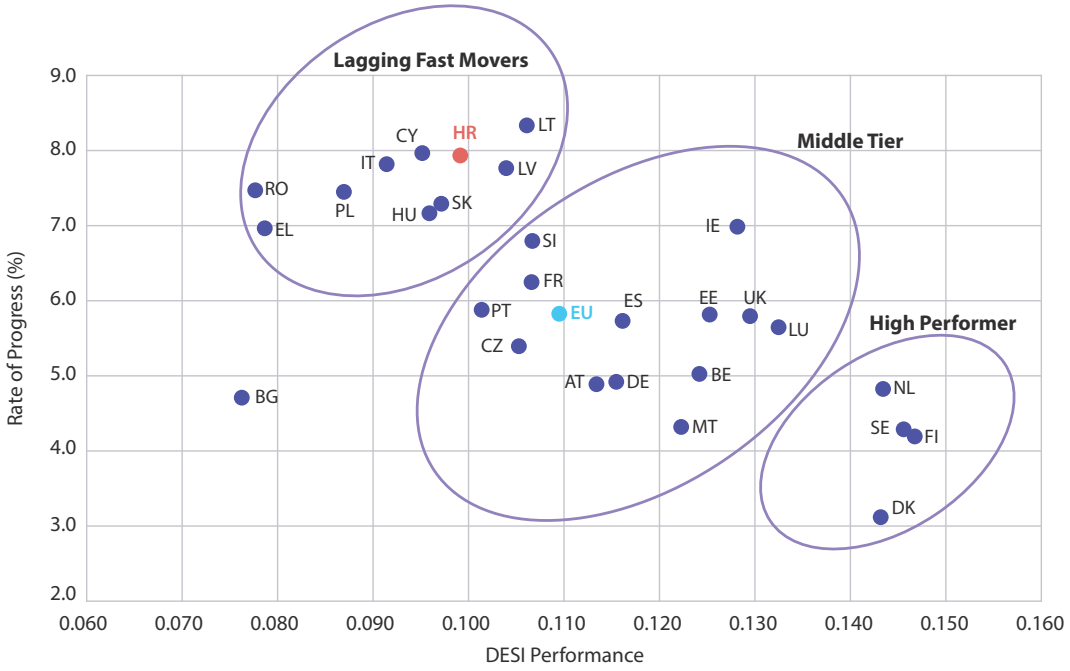
TABLE 2.
Croatia: Relative DESI Performance

DESI Component	Relative to Peer Group Average	Relative to EU Average
Connectivity	Underperforms	Underperforms
Human Capital	Outperforms	Tracks
Use of Internet	Outperforms	Underperforms
Integration of Digital Technology	Outperforms	Underperforms
Digital Public Services	Underperforms	Underperforms

The major conclusions that emerge from this chapter are:

1. In terms of fixed broadband performance:
   - On fast broadband (capable of providing at least a 30 Mbps download), take-up of these services is significantly lower in Croatia than the EU and peer group averages.
   - With respect to ultrafast broadband, Croatia is below both its peer group and the EU average for both coverage and take-up. Many peer group members have leapfrogged the EU average in ultrafast broadband, but Croatia is not among them.
   - Fixed broadband coverage varies greatly between urban and coastal counties on the one hand and rural and interior counties on the other.

FIGURE 32.
EU Member States' DESI for 2019 and Rate of Improvement since 2015



Source: Salience Consulting, based on Eurostat data.

2. Although affordability does not explain all of the underperformance in the take-up of fixed broadband, it appears to be a significant issue. Fixed broadband prices are high relative to Croatian incomes.
3. There are no obvious problems with respect to current mobile broadband take-up, affordability, or coverage, except that perhaps there is an imbalance in 4G coverage among the service providers.
4. There is evidence that Croatia is lagging behind in 5G readiness, along with others in its peer group.
5. Croatia has a relatively low usage level of digital services compared to EU and peer group averages, which is reflected in a relatively low percentage of internet users and high percentage of non-users.[29] This is likely linked to the lower fixed broadband take-up levels.
6. Croatia generally performs well or tracks in terms of other digital indicators, such as the number of ICT specialists and graduates and the integration of digital technology.
7. Croatia has a mixed performance with respect to digitizing public services. Whereas its peer group tracks the average EU experience quite closely, Croatia appears to outperform on the digitization of health care services but underperform on the digitization of general public administration.

29 Again, the percentage of users and non-users does not add up to 100 because of the definition of users, which requires usage of at least once a week.

3. Croatia's Digital Sector: Market Structure, Competition, Policies, and Regulations

3. CROATIA'S DIGITAL SECTOR: MARKET STRUCTURE, COMPETITION, POLICIES, AND REGULATIONS

3. Croatia's Digital Sector: Market Structure, Competition, Policies, and Regulations

3.1. DIGITAL SECTOR MARKETS

According to the official data on market revenues published by HAKOM,[30] the digital sector in Croatia can be categorized into five electronic communications services:

- fixed voice telephony
- mobile voice telephony
- fixed internet access – fixed broadband
- mobile internet access – mobile broadband
- pay TV

The total revenue of all electronic communications services provided in Croatia in 2018 was 11,541 million HRK (US$1,794 million). The share of each above-mentioned service in the total market revenue is shown below.

FIGURE 33.
Market Share of Different Services in Total Revenue

Source: HAKOM Annual Activity Report for 2018.

30 Published by HAKOM in its Annual Activity Report for 2018.

In the following sections, the structure of each electronic communications market will be presented in terms of the main players, their market shares, and any particular important information for the market in question.[31]

The overall market is served by five main operators (in terms of revenues generated):
1. Hrvatski Telekom (HT) d.d. – HT (51 percent owned by Deutsch Telekom)
2. A1 d.o.o. (a member of the A1 Telekom Austria Group)
3. Telemach d.o.o. (previously Tele2, a member of the United Group)
4. Iskon Internet d.d. (owned by HT)
5. Optima Telekom d.d. (managed by HT, based on a decision of the Agency for the Protection of Market Competition [AZTN][32])

Each operates on different electronic communications markets (as indicated in figure 33) and provides a full range of services on the market in which they operate. Some of these companies or their affiliates (e.g., Combis, a member of the HT Group), in addition to electronic communications services, provide system integration services (system solutions and the development and integration of ICT solutions), in this way providing more comprehensive business solutions tailored to the specific customer requirements.

Despite the presence of other players, due to consolidation in recent years, the overall Croatian telecommunications market is currently dominated by HT and A1, as they are the only two convergent fixed and mobile network operators that also provide pay TV services.

It should be noted that HT has only temporary management rights over Optima Telekom lasting until July 2021 (HT has initiated the sales process for its shares of Optima). HT is obligated to follow strict rules on the temporary management of Optima Telekom determined by AZTN, thus preventing unwanted influence on Optima's business operations and protecting its market value. Although this report aggregates the figures of Optima Telekom and Iskon Internet to those of HT, after July 2021, HT will no longer have temporary management rights over Optima Telekom, which will in turn modify the market structure. As of September 2019, Optima Telekom had a market share of roughly 11 percent in the broadband market.

3.1.1. Fixed voice telephony

This market is characterized by decreasing revenues. From end-2015 until end-2018, total fixed telephony revenue decreased by roughly 30 percent, and in the same period, the market share of the fixed voice telephony market in total market revenue declined by approximately 35 percent. The number and duration of minutes of fixed voice calls on the market is decreasing year by year as well.

Four main players are active in this market:
- HT
- A1
- Optima Telekom
- Iskon Internet

HT, together with the two other operators under its control, is the dominant player in this market, with a market share of roughly 76 percent at the end of 2018.[33]

31 The data on market shares that will be shown in the following sections are the last available from various sources (HAKOM market surveys, HAKOM annual reports, EU DESI report, etc.).

32 The decision is explained in more detail in further sections.

33 Data from the DESI Report for 2019 (https://ec.europa.eu/digital-single-market/en/desi).

HT provides services through its own nationwide access network, while other operators provide services through a combination of their own access networks and regulated access products (carrier pre-selection [CPS], local loop unbundling [LLU],[34] and bitstream access[35] with a private virtual channel for voice [VoIP]). Usage of the CPS service is trending down, in that volumes decreased by around 10 percent from December 2018 to December 2019, while demand for LLU and bitstream access remains strong, thus enabling alternative operators to provide bundled services to their own end users.

3.1.2. Mobile voice telephony

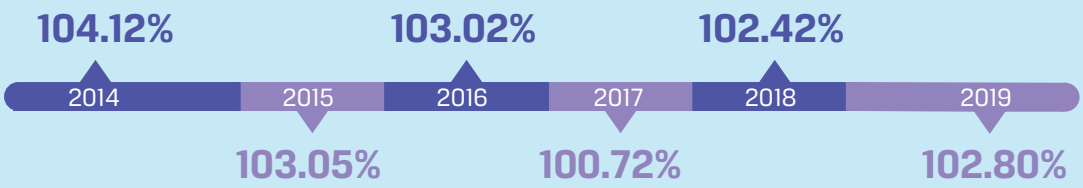
Mobile telephony penetration (in terms of the number of SIM cards per 100 inhabitants) was 102.8 at the end of 2019. The trend in SIM penetration in the last six years is shown below.

The mobile voice market is characterized by relatively stable revenues of around 4.3 billion HRK (€560 million) per year. The number of SMS (texts) sent decreases each year, while the number of minutes of calls on the market has increased. Of particular importance for the Croatian market is the amount of roaming traffic.[36] The large net inbound tourist volume creates a significant net roaming revenue stream for Croatian operators.

There are currently three players operating on the mobile voice telephony market:
- HT
- A1
- Telemach

All three players are MNOs, which means that they provide their services through their own mobile network infrastructure throughout Croatia. In terms of subscriber market shares, HT holds 46 percent of the market, while A1 holds 35 percent and Telemach 19 percent. There are no full or light mobile virtual network operators[37] (MVNOs) present in the market, but both A1 and HT sell services under alternative brands:
- Tomato as a second brand of A1
- Bon as a second brand of HT

FIGURE 34.
Mobile Services Penetration



Source: HAKOM quarterly reports.

34 Local loop unbundling is an electronic communication service in which a physical wire line (twisted metal pair) connects the end connection point of the telecommunications network in the subscriber's area with the connection on the main distributor (local exchange or remote subscriber stage). The operator that provides the service to the subscriber is allowed to use the entire frequency spectrum of the local loop (twisted metal pairs). The service is explained in more detail in Annex 2.

35 Bitstream access is an electronic communication service in which the network of the operator providing the service is connected to the network of the operator that is using the service in order to provide electronic communication service, regardless of whether it is access technology based on a copper pair, a hybrid solution (that includes both copper pair and fiber optic cable), or fiber optic cable. The service is explained in more detail in Annex 2.

36 This involves making phone calls, sending SMS (texts), and going online with a mobile device from another country to Croatia.

37 A mobile virtual network operator (MVNO) is a mobile communications services provider that does not own the wireless network infrastructure with which it provides services to its customers; instead, an MVNO enters into a business agreement with a mobile network operator to obtain access to its network at wholesale rates, then independently resells its services on the retail market to end users.

The third MNO, Telemach, which entered the market in 2005, was recently acquired by United Group, a regional player operating in the fixed, mobile, pay TV, and media markets in the region (Bosnia and Herzegovina, Croatia, Montenegro, North Macedonia, Serbia, and Slovenia).

3.1.3. Fixed broadband internet

As Chapter 2 indicated, the challenges that Croatia faces in terms of broadband service performance are largely found in fixed network provision and take-up. Therefore, in this section, the characteristics of the fixed broadband market will be analyzed in more depth in comparison to other markets.

In this particular market, there are currently four main players:
- HT
- A1
- Iskon Internet
- Optima Telekom

Given that Iskon and Optima are under the control of HT, as discussed earlier, the market is essentially a duopoly. HT, together with the two other operators under its control, is the dominant player in this particular market, with a market share of around 69 percent at the end of 2018.[38] It should be noted that HT disputes that figure, arguing that 1) HT has only temporary management rights over Optima Telekom lasting until July 2021, hence Optima Telekom's market shares should not be added to those of HT, and 2) connections related to fixed-to-mobile substitutions (FMS) should be integrated into the calculation of the fixed broadband market.[39] HT estimates that FMS represented a 20 percent market share in the fixed broadband market in the second quarter of 2020. Under these assumptions, the share of HT (including Iskon Internet only) would represent approximately 50 percent of the fixed broadband market, changing the perspective of its dominance over the market.

The Croatian fixed broadband market is served primarily by HT's access network, which has evolved from a national copper telephony network covering the vast majority of the households in Croatia to one increasingly of fiber: fiber-to-the-curb (FTTC), fiber-to-the-building (FTTB), point-to-point fiber-to-the-business, and fiber-to-the-home (FTTH) as a gigabit passive optical network (GPON), as well as point-to-point FTTH access networks. Apart from HT's network, there is A1's DOCSIS 3.X cable network (sold under the B.net brand and formerly owned by the B.net cable operator) and a growing number of local fiber optic (FTTH) networks, both deployed only in densely populated parts of Croatia. A1 generally relies on HT's wholesale network for customer access in less densely populated areas as discussed in figure 35.

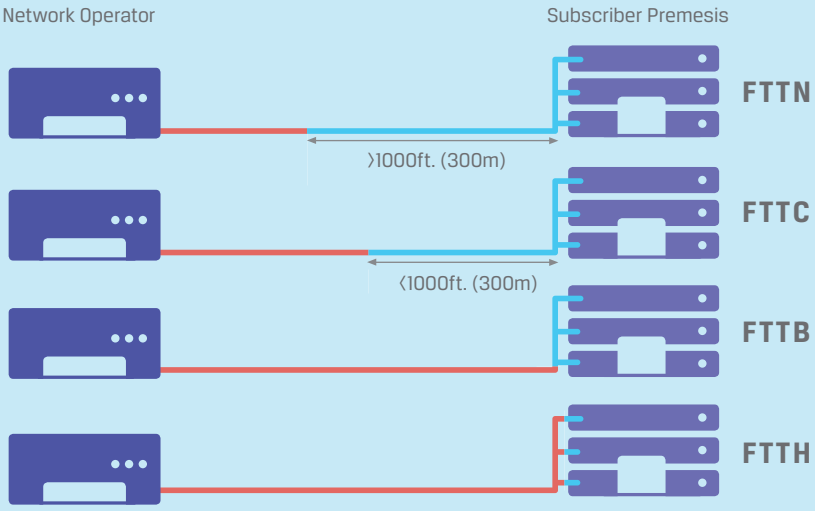
The figure 35 illustrates the different types of FTTx technologies.

Fixed broadband services in Croatia are provided through different infrastructures, technologies, and/or access network architectures. In the process of an analysis of the wholesale markets of local access and central access provided at a fixed location, HAKOM determined that fixed broadband services in

38 Data from DESI Report 2019. It is not clear whether this market share is defined in terms of subscribers or revenue. Clarification is being sought from HAKOM.

39 In its recent market analysis of wholesale fixed bitstream access market (2019), HAKOM did not include FMS connections in the scope of the retail fixed broadband access market in Croatia, stating that FMS does not present a functional substitute for fixed broadband access. HT believes that this conclusion is contrary to market realities, since FMS provides fast-speed internet access in areas where other technologies are not available.

FIGURE 35.
Different Types of FTTx Technologies



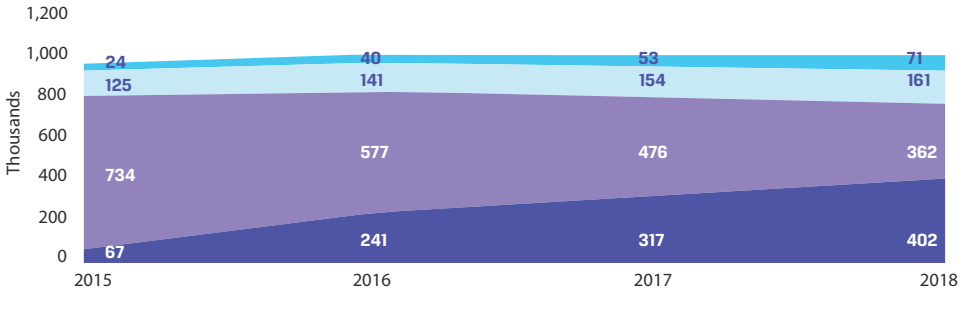
Note: FTTN is usually considered to be an increase in ADSL (copper) throughput (20 Mbps) and FTTC is usually considered to be a byword for VDSL.

Croatia provided through the following technologies are substitutes and therefore part of the same fixed broadband market:

- ADSL
- VDSL
- FTTB/FTTH P2MP GPON and FTTH P2P
- Cable networks (DOCSIS 3.X)

The share of each of these technologies in the access network is shown below. Although the competition implications of migrating from ADSL to VDSL and then to FTTB/H are not in the scope of this report, it is important to note that this migration (which seems to be a simple technicality that helps to increase the available bandwidth for end users) has tremendous implications for market dynamics. The impact would be on the viability of wholesale products, which in turn drives the ability of alternative operators to compete with the historic operator and thus the performance of the retail market. It also raises complex questions as to whether an operator beneficiary of state aid (e.g., a subsidy) can comply with the "open access" requirement.

FIGURE 36.
Number of Fixed Broadband Lines by Technology in Croatia, 2015–18



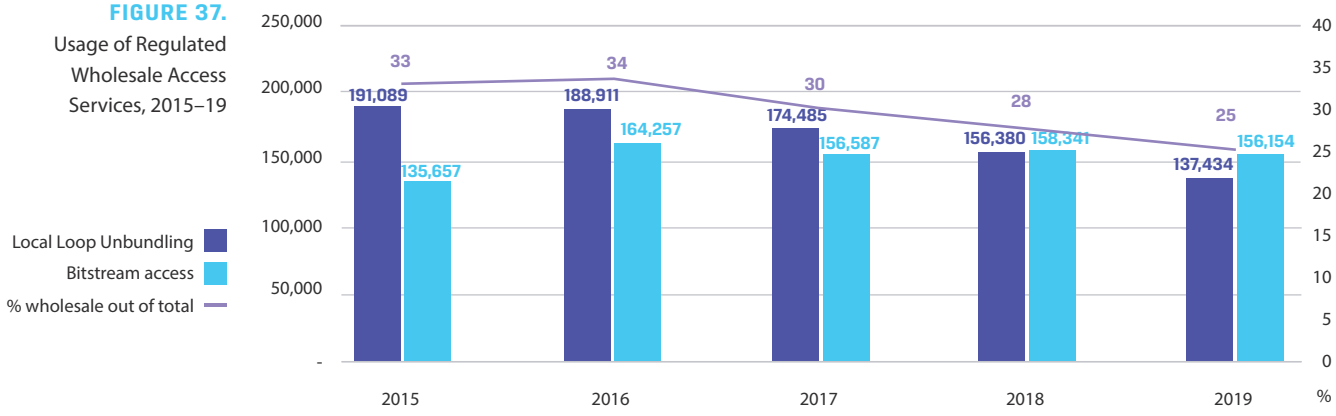
Source: HAKOM Annual Activity Report for 2018.

Starting in 2005, the introduction of the wholesale LLU service and other related regulations enabled competition to emerge in the retail market. HT's wholesale access services are regularly used by all the other operators. A1 utilizes its own cable access network and local fiber optic (FTTH) networks throughout densely populated parts of Croatia but still relies on HT's unbundled local loops and bit-stream access in other areas. LLU is mandated on all of HT's copper pairs except where VDSL2 vectoring technology is used. Bitstream access is mandated on all of HT's infrastructure copper pair and FTTH at all levels: i) local (optical line terminal [OLT]/ digital subscriber line access multiplexer [DSLAM]); ii) regional (IP/Ethernet); and iii) national (IP/Ethernet).

The trend of using LLU and bitstream access services is seen in the figure 37, and more details can be found in Annex 2.

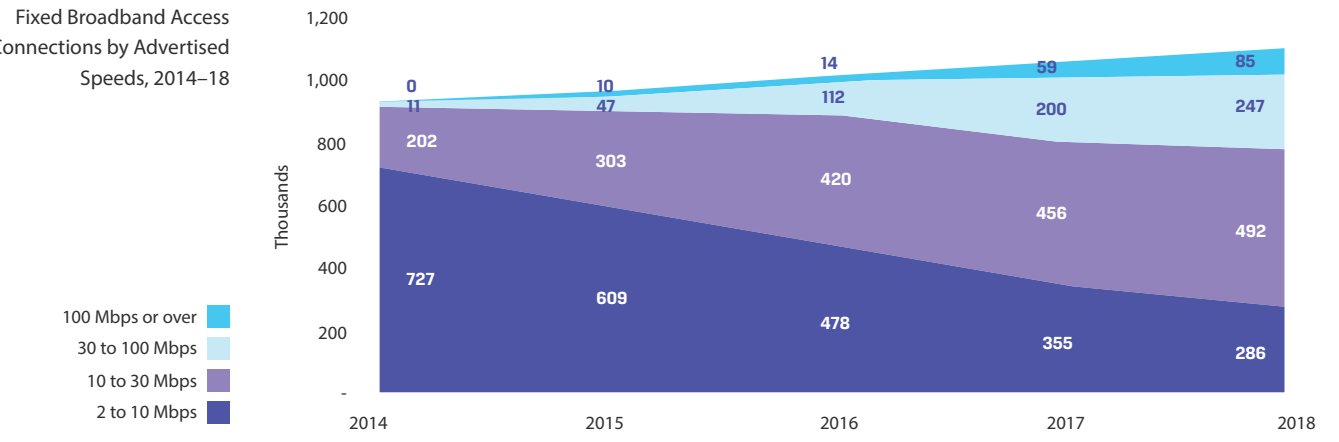
End users' contracted broadband access download speed shows the state of the infrastructure as well as the demand side of the market in terms of the usage of the available services.

FIGURE 37.
Usage of Regulated Wholesale Access Services, 2015–19



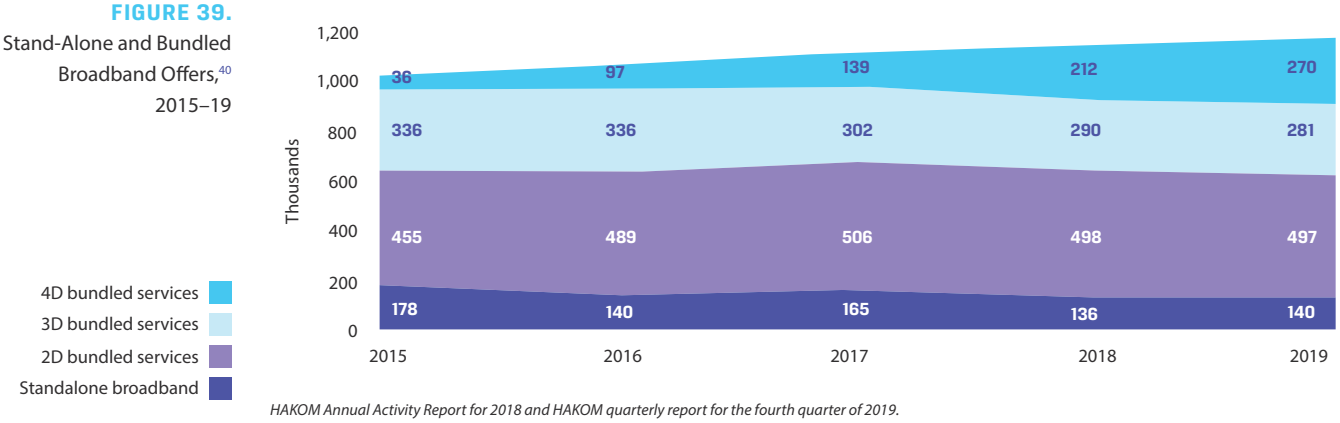
Source: HAKOM market surveys.

FIGURE 38.
Fixed Broadband Access Connections by Advertised Speeds, 2014–18



Source: Annual Activity Report for 2018.

FIGURE 39.
Stand-Alone and Bundled Broadband Offers,[40] 2015–19



HAKOM Annual Activity Report for 2018 and HAKOM quarterly report for the fourth quarter of 2019.

Finally, the approach from operators and the demand from end users on bundled services are important elements in fully understanding the structure of the fixed broadband market. When it comes to bundled services, the figure below demonstrates that most of the connections of broadband access, roughly 90 percent, are provided in bundled offers. The fact that end users consider the bundle to be the service, rather than each of the constituent products, has important competitive implications. The other trend that could be observed is that the number of 4D bundles has been increasing at the expense of the other two (2D and 3D) over the past two years.

Several providers have recently started to deploy fiber access networks that are compliant with HAKOM's bylaw on fiber distribution networks.[41] These include vertically integrated fixed broadband providers HT and A1, some smaller operators (such as Pro Ping), and the wholesale-only operator RUNE (which stands for Rural Networks).[42] RUNE currently accounts for a small area of coverage but has ambitions to expand significantly over the next few years. Furthermore, it is expected that the National Framework Program for the Development of Broadband Infrastructure in Areas Lacking Sufficient Commercial Interest for Investments (known by its Croatian acronym, ONP) will make new local access networks possible that would not have been built on a purely commercial basis.[43] More details on RUNE and ONP are provided in Chapter 4.

40 Different services (fixed voice, fixed broadband, mobile [voice and broadband], and pay TV) are usually bundled together. 2D refers to the combination of two out of three services (fixed voice, fixed broadband, and/or pay TV); 3D refers to the three following services (fixed voice, fixed broadband, and pay TV); and 4D refers to the four services (fixed voice, fixed broadband, mobile [voice and broadband], and pay TV).

41 See: https://www.hakom.hr/UserDocsImages/2014/propisi_pravilnici_zakoni/Pravilnik%20o%20svjetlovodnim%20distribucijskim%20mrezama-20140507.pdf (in Croatian).

42 The RUNE case will be discussed in greater detail in section 5 and Annex 1.

43 The ONP case will be discussed in greater detail in section 5 and Annex 1.

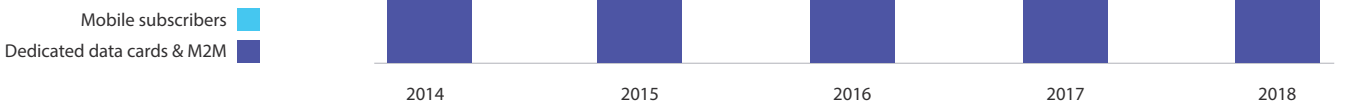
44 M2M means that machine-to-machine communication is used for automated data transmission and measurement between mechanical and electronic devices. The two machines "communicate" or exchange data without human interface or interaction.

45 Prepaid and post-paid cards for internet data only, excluding voice and SMS. These cards can be inserted into a laptop with a USB stick for internet access.

3.1.4. Mobile broadband internet

The penetration of mobile broadband (including machine to machine [M2M][44] and dedicated data cards)[45] in terms of the number of SIMs used to access broadband service per 100 inhabitants was 82 at the end of 2018. The trend over the past six years is shown in the figure below.

FIGURE 40.
Mobile Broadband Subscribers and Penetration, as % of 100 inhabitants, 2014–18



Source: HAKOM market indicators.

This market is characterized by a steady increase in revenue, which rose at a CAGR of 13 percent from end-2015 to end-2018, as well as by an increase of its market share in total market revenue by approximately 30 percent in the same period. Apart from that, as can be seen in the figure above, the number of subscribers per 100 people increases each year.

As noted above, roaming is particularly important in Croatia. In fact, data roaming has more of an impact than voice in terms of revenue and investments due to the volumes involved. It should be noted that, in line with Regulation (EU) 2017/1128 of the European Parliament and the European Council of June 14, 2017, on the cross-border portability of online content services in the internal market, there is an obligation for the cross-border portability of online content, which includes roaming by an end user. Thus, though there is fair-use criterion in force in terms of retail broadband roaming prices, the right of end users to access their contracted content services when abroad indicates that even more capacity is needed to meet roaming demand.

The same three MNOs that operate on the mobile voice telephony market operate also on the mobile broadband market. All the operators provide services throughout the territory of Croatia. As discussed in Chapter 2, each has different coverage performance with respect to 4G. According to the DESI Report for 2019, Croatia has 4G coverage (as an average of operators) for 94 percent of households, which is on the level of the EU average.

In terms of market competition and the convergent services and operators, it is worth stating that two operators do not offer flat rate price schemes. However, one of them (Telemach), which is not present on the fixed market, offers a flat rate mobile broadband tariff that can be seen as an attempt to compete in the fixed broadband market with wireless services. This strategy could gain more importance with the introduction of 5G, given the comparable performances of both services, and therewith the ability of mobile networks to offer throughput heretofore possible only on fixed networks.

44 M2M means that machine-to-machine communication is used for automated data transmission and measurement between mechanical and electronic devices. The two machines "communicate" or exchange data without human interface or interaction.

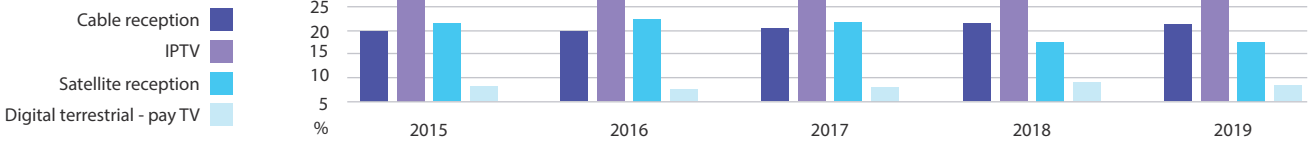
45 Prepaid and post-paid cards for internet data only, excluding voice and SMS. These cards can be inserted into a laptop with a USB stick for internet access.

3.1.5. Pay TV services

The pay TV market is characterized by platform competition, which means that competing providers of pay TV services offer them over different technological platforms, including:
- internet protocol television (IPTV) (through copper or FTTx infrastructure)
- cable TV
- pay TV terrestrial
- satellite

The figure below illustrates that IPTV is by far the most widespread. IPTV and cable TV have gained shares at the expense of satellite TV in recent years.

FIGURE 41.
Pay TV Platforms: Market Share



Source: HAKOM quarterly reports.

The major operators on this market are:
- HT, offering pay TV on three platforms, mostly IPTV, terrestrial pay TV (through Evo-TV), and satellite
- A1, offering pay TV on IPTV and cable platforms
- Iskon Internet, providing IPTV
- Optima Telekom, providing IPTV
- Total TV, providing satellite TV

Telemach, although bought by a convergent operator, United Group, currently cannot enter the pay TV market. This is due to the provision in Articles 61 and 79 of the Electronic Media Act, which state that the Electronic Media Council cannot issue a license for the satellite, internet, or cable transmission of audio-visual and/or radio programs or other permissible ways of transmission to affiliates of media service providers. As United Group also owns other television broadcasters and media service providers referred to in Articles 61 and 79, Telemach is prevented from offering digital television service. This issue was highlighted by Telemach as a regulatory hurdle to market development.

However, the pay TV market is characterized by exclusive deals for content and thus has differentiated offerings on the market. As an example, with respect to sports, a key content driver, HT owns exclusive TV rights to the Europa league and Arena sport (for Serie A and Ligue 1), and A1 owns exclusive rights to the Champions league. Both show the respective content exclusively on their platforms. The other exclusive TV rights for other important leagues are as follows:
- Bundesliga – Eurosport (provided through OTT)
- Laliga - Sportklub (United Group) (provided on almost all platforms)
- Premiership - Sportklub (United Group) (provided on almost all platforms)

This topic of the limitations arising from media affiliation and exclusivity is important to the overall fixed broadband market, given the large share of bundled services. This is discussed further below.

3.2. DIGITAL MARKET COMPETITION AND LIBERALIZATION ASSESSMENT

3.2.1. Historical context: market liberalization and consolidation in the past 20 years

The Croatian market was first liberalized in 1999 when A1 was granted a concession for the second GSM network in Croatia to compete with HT.

Market liberalization in the fixed services space began in 2005 in Croatia with the introduction of the first alternative market players, which launched operations utilizing the existing infrastructure of the dominant operator on a wholesale basis (carrier selection [CS]/CPS and LLU). At the same time, number portability in fixed and mobile networks was introduced as one of the main tools in the liberalization process.

Five new players entered the fixed services market in 2005. H1 Telekom and Optima Telekom were the first, with a focus on the residential market. Metronet next launched services on the fixed market, with a focus on business users by deploying direct fiber access connectivity. Iskon Internet and Amis Telekom also joined the fixed network services market that year, providing a full range of services.

Apart from Metronet, all of these new entrants based their business case and offerings on the usage of HT infrastructure and relevant wholesale access offers. Some operators had business cases based on national coverage and presence, while others (e.g., Amis Telekom) targeted only densely populated local areas due to their limited investment funds. Around the same time, B.net entered the market as a cable access provider, covering the biggest cities and expanding from its cable television networks into broadband services.

However, consolidation began soon after liberalization:

- The first acquisition took place in 2006, when HT bought a 100 percent share in the biggest alternative internet service provider at that time, Iskon Internet. Iskon Internet operates as an independent company, but since 2006 it has been a member of the HT Group and wholly owned by HT.
- In 2011, VIPnet (the predecessor of A1) acquired a 100 percent stake in B.net, the largest cable operator in Croatia at that time. Today, B.net is A1's brand for cable broadband access services.
- In June 2014, Croatian incumbent HT took over the management of alternative fixed network operator Optima Telekom following the completion of a pre-bankruptcy settlement procedure and the adoption and registration of decisions by the General Assembly of Optima Telekom. AZTN, upon reviewing the case, ruled that HT was allowed control of Optima Telekom for up to four years. On June 9, 2017, AZTN approved an extension of HT's management rights over Optima Telekom until July 10, 2021. According to the AZTN ruling, the incumbent needed to commence with the transparent, objective, and non-discriminatory sale of its shares in Optima in January 2020 via a competitive international call for tender, and preference would be given to a potential buyer that was not yet present in the Croatian market. In line with the AZTN ruling, HT announced that on January 31, 2020, it had started the sale process of its 17.41 percent stake in Optima Telekom.
- In October 2015, A1 (under its former name of VIPnet) merged with Amis Telekom.
- In 2017, Optima Telekom merged with H1 Telekom.
- In 2017, A1 (under its former name of VIPnet) acquired local alternative telecommunications operator Metronet.
- The latest acquisition took place in 2019 when pay TV provider Evo-TV (owned by Croatian Post), which provides services through terrestrial pay TV, was acquired by HT. With this acquisition, HT obtained the possibility of offering end users services that were not passed by broadband infrastructure capable of providing bundled broadband and pay TV services.

3.2.2. Current competition on the market

The current state of play on all the markets was elaborated on in detail in earlier sections. From what has been described above, it is clear that two main operators, HT and A1, hold commanding shares of all fixed markets and the market overall.

On fixed markets, the dominant operator HT faces serious infrastructure competition in the more densely populated (and economically viable) areas of Croatia but not throughout the whole country. The other operators have built their own infrastructure in urban and densely populated areas only but rely on purchased HT wholesale access services (LLU and bitstream access) to fill the gaps in urban areas and generally to service non-urban areas. In total, the current situation for competition in the national fixed broadband market is unsatisfactory. The history of multi-players was brief and was quickly followed by a consolidation that left only two major players on the market.

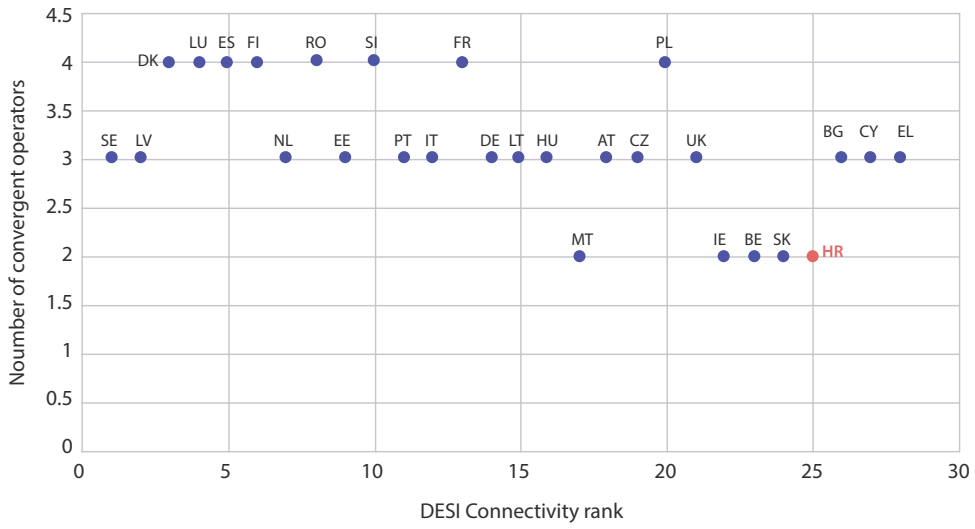
The present situation does not appear to provide competitive incentives for investment in NGA networks, at least not throughout the entire territory of Croatia. This is partly demonstrated by the significant digital divide between the regions (urban and rural), which in turn, has required state aid schemes (discussed in detail in Chapter 4) to close that gap.

Telemach was launched in 2005, breaking the duopoly in the mobile market that had existed before that time. As a third player on the mobile market, Telemach has at least a 19 percent market share in terms of subscribers, which results in a satisfying level of competition in which none of the present operators are capable of acting independently of its actual or potential competitors, consumers, buyers, or suppliers.

With regard to the overall market, there are two convergent network operators: HT and A1. With the entry of a third player, there might be an opportunity to introduce further competition and investment in the market, similar to the experience in the market.

In the figure below, it can be seen that markets with more than two convergent network operators offering a full range of services (voice, broadband, and pay TV) generally achieve better ranking for connectivity in the DESI, which suggests a clear correlation between competition and penetration in the market.

FIGURE 42. Number of Convergent Operators vs DESI Connectivity Rank



Keeping in mind that there has been a steady increase in bundled packages quarter over quarter, it is quite likely that it will not be possible to have full competition without a third convergent operator. In line with this, the DESI Report for 2019 stated that: "The entry of a strong new operator could increase competition, bringing benefits such as greater choice for users, price declines, and improvements in quality, just as the entry of TELEMACH Croatia to the mobile market did."

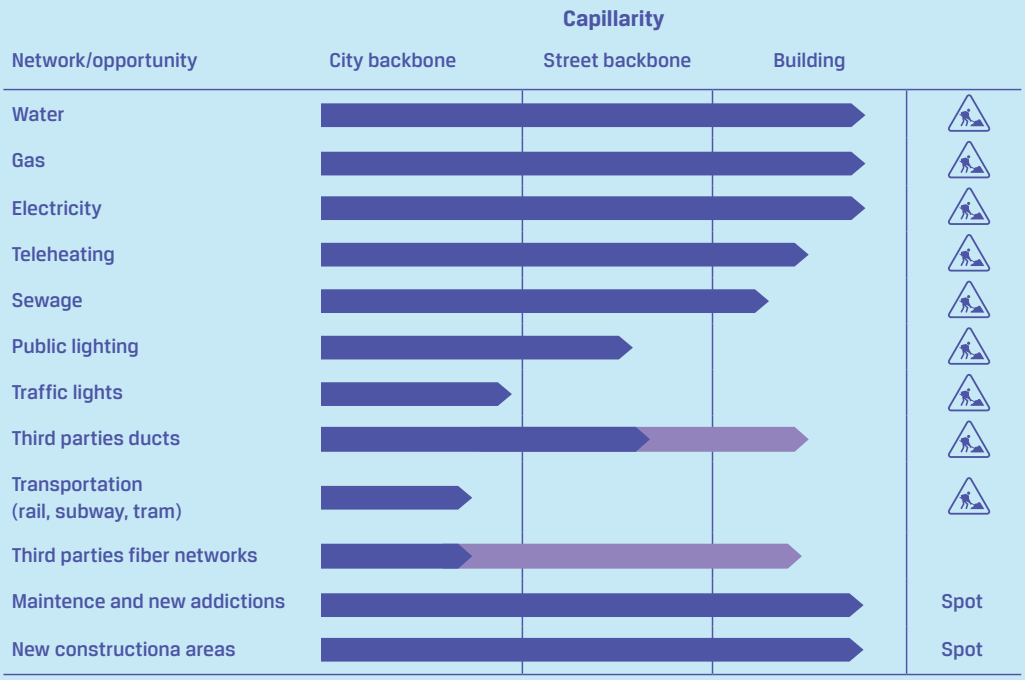
3.2.3. Cross-sectoral infrastructure development

Several years ago, policy makers around the world began recognizing the value of cross-sector infrastructure sharing as a means of lowering deployment costs and market entry barriers. Utilities have linear networks similar in structure to traditional telecommunications networks and often have an interest in developing their own private national or regional telecommunications systems. This means that not only do many utilities have specific infrastructure that could be shared for rolling out broadband facilities, such as ducts and poles, but they may be interested in rolling out capacity themselves or in partnership with telephone companies.

The opportunities for such infrastructure sharing will vary among utilities, as their horizontal (across geographies) and "capillarity" (down to customers) reach will vary. Thus, for example, the configuration of natural gas lines and railways connectivity will be different from one country to another, providing greater or lesser complementarities relevant to broadband rollout. Utilities, by their very nature, deploy assets closer to possible subscribers, potentially providing more opportunities for infrastructure sharing as the figure below demonstrates.

Significant as well is a country's policy, legal, and regulatory framework, which can facilitate or inhibit partnership and coordination across linear networks.

FIGURE 43. Infrastructure-Sharing Opportunities



Sources: Based on G. B. Amendola and L. M. Pupillo, "The Economics of Next Generation Access Networks and Regulatory Governance: Towards Geographic Patterns of Regulation," Communications and Strategies 69, no. 1 (2008); and World Bank, "Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps" (Washington, DC: World Bank, 2019).

The commercial models through which infrastructure sharing takes place are diverse and may be summarized as:

1. **Hosting**, in which utilities host third-party telecommunications equipment by authorizing a telephone company to install its own telecommunications facilities on their infrastructure. This is the most traditional means of infrastructure sharing and includes, for example, leasing space on power poles.
2. **Joint development**, in which utilities and telephone companies coordinate in planning and constructing or refurbishing infrastructure. This form of infrastructure sharing has been a major component of the EU's Directive on Broadband Infrastructure Cost Reduction (discussed in section 3.4.1.3 on Symmetric Regulation).
3. **Joint venture**, in which the utility contributes existing infrastructure, including excess fiber, to a venture to provide commercial telecommunications services on a profit-sharing basis.
4. **Utility-run business**, in which the utility provides broadband services to end users or dark fiber and condition capacity to telephone companies on their own networks. Examples of this are captured in the figure below.

FIGURE 44. Examples of Utilities Providing Broadband Services to End Users or Offering Dark Fiber to Other Telephone Companies

	United States	Ireland	Norway	Italy	New Zeland	Basel, Switzerland	Bavaria, Germany	Denmark
Utility	epb	ESB	36-utility partnership	enel	Northpower	IWB	SW//M	14-utility partnership
Fiber Venture	EPB Fiber	SIRO	Altibox	Open Fiber	Northpower Fiber	IWB Net	M-Net	WAOO
Trigger for FTTX	Business diversification Public Funding	Market Opportunity National policy	Business diversification	National policy Public funding	National policy Public funding	National policy Market Opportunity	Business diversification	Business diversification
Business Model	Retail	Wholesale	Retail	Wholesale	Wholesale	Wholesale Retail (B2B)	Wholesale Retail	Retail

Source: World Bank, "Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps" (Washington, DC: World Bank, 2019).

One can find examples of traditional hosting and coordination in Croatia, and the implementation of EU directives is likely to force more coordination and planning among utilities.

Croatia has distinguished itself through a hybrid of the third and fourth models. The state-owned company OIV provides the national infrastructure for the transmission of television and radio signals in Croatia. In February 2014, it was given the excess telecommunications capacity of state-owned entities, such as public highways, gas pipelines, and power companies, to commercialize and manage.

Furthermore, as discussed in this report, OIV was designated in 2017 to design, build, and operate a backhaul network, which will be used based on an open access model and will ultimately provide useful investment and competition in the market for the core and backhaul network. This initiative will indirectly have a strong impact on the development of fast broadband access networks. Thus, OIV acts as both a joint venture with utilities as well as a self-standing business entity providing network services. This is the only known example of this type of collaboration in Croatia.

It is unlikely that either utilities or OIV will have the incentive, in the near term, to expand effectively into competitive retail markets.

3.3. LEGAL AND REGULATORY FRAMEWORK FOR DIGITAL INFRASTRUCTURE

3.3.1. Croatia's regulatory framework

The Croatian telecom regulatory framework is composed of the following primary legislation:
- Electronic Communications Act (ECA) (OG 73/08, 90/11, 133/12, 80/13, 71/14, and 72/17)
- Act on Measures to Reduce the Cost of Deploying High-Speed Electronic Communications Networks (OG 121/16)

The five central EU directives mentioned in Annex 6 have been transposed into Croatian legislation through the ECA, which, among other stipulations, prescribes the rights and obligations under which electronic communications networks and services are provided. By applying the provisions of the ECA, HAKOM ensures the conditions for effective competition to provide a level playing field for all operators active in the electronic communications markets.

Apart from creating the conditions for effective competition, the ECA deals with the following areas: electronic communications infrastructure (ECI), rights of way, spectrum management, universal service, end-user rights, numbering, market analysis, and so on. All of these topics are fully in line with the EU regulatory framework, as all directives have been transposed into national legislation. The ECA will be amended in line with Directive 2018/1972 in the near future (see below).

Determination of the relevant markets subject to ex ante regulation is conducted in accordance with Article 53 of the ECA, with the application of a valid EC recommendation on the specific markets. The relevant recommendation currently contains four markets subject to ex ante regulation: wholesale call termination on fixed networks, wholesale call termination on mobile networks, wholesale access provided on fixed networks, and high-quality access provided on fixed networks. HAKOM is able to regulate these four markets on an ex ante basis without having to prove that all criteria of the "three-criteria test" are met simultaneously. The three criteria are:
1. the presence of high and non-transitory entry barriers, whether of a structural, legal, or regulatory nature
2. a market structure that does not tend toward effective competition within the relevant time horizon
3. the application of the competition law alone would not adequately address the market failure(s) concerned

However, in accordance with Article 53 (2) of the ECA, HAKOM may determine by decision that other relevant markets specific to the area of electronic communications networks and services in Croatia are subject to ex ante regulation if the three criteria are simultaneously met in those markets.

In addition, the Croatian regulatory framework consists of secondary legislation (bylaws, ordinances, etc.) that cover various relevant topics, of which the most important are:
- Ordinance on addressing and numbering (OG 85/12, 67/13, and 129/15)
- Ordinance on the manner and conditions for the provision of electronic communications networks and services (OG 154/11, 149/13, 82/14, and 24/15)
- Ordinance on the manner and conditions for the determination of zones of electronic communications and associated facilities, of protected zones and radio corridors, and of the obligations of construction work or building investors (OG 42/09)
- Ordinance on the manner and conditions for access to and shared use of electronic communications infrastructure and other associated facilities (OG 136/11)
- Ordinance on radio frequency spectrum allocation (OG 107/13)
- Ordinance on the special conditions for the installation and use of radio stations
- Ordinance on Right-of-Way Certificates and Payment of Fees for the Right of Way (OG 152/11)
- Ordinance on number portability
- Ordinance on optical fiber distribution networks (OG 57/14)
- Ordinance on technical requirements for cable ducts

- Ordinance on universal services in electronic communications (OG 146/12)
- Ordinance on the conditions of assignment and use of the radio frequency spectrum

Other legal provisions that are neither primary legislation dealing with the electronic communications sector nor secondary legislation issued by HAKOM but still affect the sector include:

- Law on the Regulation of Property Rights for the Construction of Infrastructure Buildings (OG 80/11)
- Regulation on Criteria for the Development of Electronic Communications Infrastructure and Other Associated Facilities (OG 131/2012, 92/2015)
- Law on Roads (OG 84/11, 22/13, 54/13, 48/13, 92/14)

These laws and regulations are related to such issues as the administration needed to build and plan the networks (including spatial plans), the way land access fees are charged to private and state-owned companies, and so on. The numerous provisions in these laws and regulations are highlighted as inhibitors to investment by stakeholders in their replies to the data request.

3.3.2. Possible future development of the Croatian regulatory framework and related strategies

The information presented in this section was provided by the MSTI.

Future steps are covered by the following documents, though It should be noted that the COVID-19 crisis will have an impact on their implementation:

1) **New Electronic Communications Act (ECA).** This act, which transposes into the legal order of the Republic of Croatia the provisions of Directive (EU) 2018/1972 of the European Parliament and of the Council of December 11, 2018, establishing the EECC, is already drafted. The new ECA will, among other goals, implement an internal market in electronic communications networks and services that results in: the deployment and take-up of very high-capacity networks (VHCNs), the interoperability of electronic communications services, effective market competition, the security protection of networks and services, an increase in affordability, and access to infrastructure and services. The new ECA will change the legal framework in the field of electronic communications by adopting measures to encourage investments in VHCNs through clear provisions on geographical surveys of network deployments (Article 22 EECC), strengthened market competition, and a more consistent internal market approach to spectrum policy, which is particularly important to the introduction of 5G. public. A consultation on ECA started in the fourth quarter of 2020, and its adoption by the Parliament is scheduled for the first quarter of 2021.

2) **Broadband Strategy 2016–20.** The main objectives of the current national broadband strategy—National Broadband Strategy 2016–20 and associated programs (ONP and the National Program for the Development of Backhaul Broadband Infrastructure [NP-BBI])—are aligned with the Digital Agenda for Europe (DAE) objectives, which establish internet speeds of above 30 Mbps for all inhabitants by 2020, as well as internet connections above 100 Mbps for at least 50 percent of households by that same year. The main strategic programs and actions related to broadband connectivity in Croatia will not be implemented fully or even partially by the end of 2020.

   However, the current National Broadband Strategy is not aligned with the objectives of the European Gigabit Society (EGS), the complement to the DAE. Croatia will have to push its strategic objectives toward EGS 2025, which defines 100 Mbps as a minimum download speed that should be available to all residential customers by that year.
   The implementation of the National Broadband Strategy has not been successful due to a number of delays that are related, but not limited, to the following:
   - The fulfillment of the Strategy's objectives was primarily dependent on the implementation of state aid programs initiated under the Operational Program Competitiveness and Cohesion

(OPCC) 2014–20. Since these programs are only at the beginning of implementation, the objectives of the Strategy will certainly not be met by the end of 2020.
- The ONP has still not been implemented.
- Late enforcement of the Broadband Cost Reduction Directive, which was transposed into the national legal system after a one-year delay, by the Act on Measures to Reduce the Cost of Deploying High-speed Electronic Communications Networks (OG 121/16).

3) **National Plan for Broadband Development in the Republic of Croatia for 2021–2027 (NP).** This plan has been drafted. Public consultation on the NP was planned for the fourth quarter of 2020, before its adoption. The NP represents a continuity of the government's policy on strategic planning for broadband development in Croatia, and its priority policies include:
   - ensuring the necessary prerequisites for the deployment of VHCNs[46] throughout whole territory of the Republic of Croatia
   - ensuring the necessary preconditions for the introduction of 5G networks
   - supporting the introduction of VHCNs in areas where it is not possible to ensure their availability under the usual market conditions

   Defining new strategic goals and amending the measures and activities of the existing Strategy is conditioned by the rapid changes in the electronic communications market, the need to develop new standards and technologies, and the desire to follow the EU among the leading economies in the application of ICT, compliant with the highest environmental standards.

   A Strategic Environmental Assessment (SEA) procedure for the NP must also be prepared, which is currently in its final stage of preparation, with public consultation to be conducted along with the NP.

   The NP envisages specific objectives to achieve the following goals:
   - VHCN access for all households
   - VHCN access for public use
   - introduction of 5G networks in urban areas along major terrestrial transport paths
   - introduction of 5G networks in rural areas.

   The measures foreseen in the NP will essentially focus on removing regulatory and administrative obstacles to commercial initiatives and creating an enabling environment for investment in VHCNs.

   The implementation of the NP's objectives involves the following activities/measures:
   - promoting cost reduction for deploying VHCNs
   - improving and harmonizing the legislative framework regarding planning and construction of VHCNs
   - informing and educating the public on electromagnetic fields
   - supporting the introduction of 5G networks

4) **Program for Support of Digital Connectivity (hereinafter, "the Program").** The Program, which is intended to support the deployment of very high-capacity electronic communications networks and infrastructure that enable gigabit connectivity, will be drafted by the government. Part of the Program will include a national state aid scheme for the deployment of VHCN infrastructure, which will likely require a state aid notification to the Directorate-General for Competition (DG COMP).

46 VHCNs, including FTTP and fiber backhaul to mobile base stations to support 5G services, will be needed to meet the demand for high-speed communications and access to the internet for video and other data-rich applications. See BEREC, "Study on the Determinants of Investment in VHCN: a System Dynamics Approach" (Riga: Body of European Regulators for Electronic Communications, 2019), https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/8933-study-on-the-determinants-of-investment-in-vhcn-8211-a-system-dynamics-approach.

The drafting of the Program is planned to start immediately after the adoption of the NP and to be completed by the second quarter of 2022.

The objective of the Program is to ensure that all citizens and entrepreneurs nationwide have access to the same level, state-of-the-art digital society services. The uniform availability of gigabit connectivity is a basic prerequisite for the further social and economic development of Croatia as well as the transition to a digital society and economy. The Program is envisaged to facilitate individual projects at the local or regional level by public authorities or operators and will focus on areas where market failure has been demonstrated or where there is no commercial interest in investing in VHCN infrastructure.

The Program will assess the investment gaps and define the necessary public interventions, based on sustainable models. In order to achieve the stated goals, the Program will also adjust the forms of financial assistance to the market failures identified, using different forms of financing, which include EU funds and other financial instruments.

Thus, the Program will address the significant gaps in the availability of broadband access between urban and rural areas of Croatia in order to close them. It will also create the preconditions for the further development of digital services that require very high speeds, capacity, and transmission reliability, thereby contributing to balanced regional development more broadly.

5) **Broadband Competence Office (BCO) within HAKOM.** The formal status of the BCO will be defined by the new ECA. The main function of the BCO is to identify and remove market failures that affect broadband coverage by:
   - enhancing the efficiency and effectiveness of broadband investments
   - providing professional and administrative assistance to public authorities in the planning, implementation, and monitoring of the projects
   - providing advice and assistance to citizens and businesses about broadband deployment (coverage mapping, quality of service and penetration, future investment plans, etc.)
   - supporting the aggregation of demand for high-capacity broadband networks
   - supporting coordination with the relevant authorities
   - promoting the use of financial instruments
   - supporting the implementation of a digital single market by effectively and efficiently accelerating public investment in broadband

The BCO supports Croatia's ministries and authorities in charge of the planning and implementation of NGA network strategies, along with the municipalities and other public bodies (local, regional, and national) responsible for the funding and deployment of broadband. It also supports project promoters, telecom operators, utilities, user groups, and any other entity seeking guidance on the planning and execution of broadband projects using a variety of business and investment models and financing structures, as well as citizens, enterprises. and other bodies that wish to be informed about broadband developments, national or regional plans for broadband connectivity, and EU support available in their area.

3.3.3. Comparison of Croatia's policies and regulatory framework with EU best practices

As mentioned in the two previous sections, all the relevant EU directives have been transposed into Croatian legislation and the implementation of the EECC's provisions will be transposed into the new ECA in the near future.

Although market conditions and findings differ among the member states, it should be emphasized that EU rules (Article 7 and Article 7a of the Electronic Communications Framework Directive – 2002/21/EC) require that the NRAs conduct national and EU consultations on the draft regulatory measures they

intend to take prior to their adoption. These consultations should comprise the definition and analysis of relevant markets, the designation of operator(s) with SMP, and the proposed imposition or removal of regulatory remedies on providers of telecom networks or services.

Both Article 7 and 7a procedures consist of the following steps:
- If the Commission considers that a draft measure notified by an NRA is contrary to community law or creates a barrier to the single market, it begins an in-depth review lasting up to three months.
- After an in-depth investigation, in close cooperation with BEREC, the Commission may:
  - withdraw its reservations if its serious doubts are no longer justified
  - issue a "veto" decision requiring the NRA to withdraw its proposals when a notified draft measure defines a relevant market or designates/does not designate an SMP operator
  - issue a recommendation asking the NRA to amend or withdraw a measure if it relates to the remedies. If the NRA decides to go forward with its proposal and not comply with the recommendation without a thorough reasoned justification, the Commission may consider further legal steps, including possible infringement proceedings.

The new rules also enable the Commission to adopt further harmonization measures in the form of recommendations or legally binding decisions if divergences in the regulatory approaches of national regulators, including remedies, persist across the EU in the longer term, as occurred with access conditions to broadband networks and termination rates.

In conclusion, the Croatian regulatory framework is fully aligned with the EU framework in terms of its core provisions, which means that all the relevant EU directives have been transposed into national legislation, as likely will any new ones. When it comes to market analysis and ex ante regulation, which are specific to the telecom sector, differences in regulation among member states usually arise from different market circumstances, but the whole process of market analysis is still based on the same standards and procedures in all EU member states.

The section below presents more information on how the implementation of the regulatory framework in practice (non-harmonization of different laws) represents one of the key inhibitors to broadband development.

3.4. REGULATION

3.4.1. Ex ante regulation

3.4.1.1. Regulatory authority

HAKOM is a national regulatory body for electronic communications and postal and railway services. HAKOM is an independent and non-profit legal entity, reporting to the Croatian Parliament and the government. It is governed by a collegial body, the Council, headed by a president.

HAKOM performs regulatory and other tasks as a public authority in accordance with related laws. These include the ECA, the Law on Measures to Reduce the Cost of Deploying High Speed Electronic Communications Networks, the Postal Services Act, the Law on the Regulation of the Railway Services Market and the Protection of the Rights of Passengers in Rail Traffic, and the Law on Railways. HAKOM has inspection authority and is competent to resolve individual disputes between end users and service providers in all three regulated network activities.

3.4.1.2. Asymmetric regulation

HAKOM performs an analysis of markets susceptible to ex ante[47] regulation. The legal framework on which it is based is described in section 3.3.1.

HAKOM currently regulates seven markets as markets susceptible to ex ante regulation on which operators have been found to possess SMP, and regulatory obligations on those operators have been imposed. The regulated markets, operators with SMP, and regulatory obligations are as follows:

From the list above, it can be seen that just one retail market is currently regulated. All the other regulated markets are wholesale markets. Thus, HAKOM follows the philosophy embedded in the EU regulatory framework that the wholesale level should be regulated in order to ensure competition at the retail level.

On top of the standard wholesale regulation, in some of these markets, HAKOM imposed a regulation in 2014 related to the application of the ex ante margin squeeze test (MST) on the dominant operator. All the details of the MST's requirements are defined in the Methodology of the Margin Squeeze Test published by HAKOM in 2014 and updated in 2016 and November 2019.

One operator stated in its reply to the data request that despite the adoption of the MST methodology and the introduction of the MST, the HT Group's share of the fixed broadband internet market has remained high and stable, reaching 74 percent at the end of 2018. Considering the HT Group's high share of the market, according to that operator, the question is whether the MST as designed or implemented currently fulfills its purpose. This is to say, the share of users of other operators in the market is relatively low, suggesting that the current way of applying the MST does not provide sufficient margin between the wholesale and retail prices of the HT Group, which prevents other operators from effec-

TABLE 3.
SMP Regulation in Croatian Electronic Communications Markets

MARKET	SMP OPERATORS	REGULATORY OBLIGATIONS
Access to the public telephone network at a fixed location for residential and non-residential customers	HT, Iskon, and Optima	Access obligation, non-discrimination, transparency, price control and cost accounting, and accounting separation
Call origination on the public telephone network provided at a fixed location	HT	Access obligation, non-discrimination, transparency, price control and cost accounting, and accounting separation.
Call termination on individual public telephone networks provided at a fixed location	All fixed voice operators with their own network	Access obligation, non-discrimination, transparency, price control and cost accounting, and accounting separation (for other operators except HT, without accounting separation)
Wholesale local access provided at a fixed location	HT	Access obligation, non-discrimination, transparency, price control and cost accounting, and accounting separation.
Wholesale central access provided at a fixed location for mass-market products	HT	Access obligation, non-discrimination, transparency, price control and cost accounting, and accounting separation.
Wholesale high-quality access provided at a fixed location	HT	Access obligation, non-discrimination, transparency, price control and cost accounting, and accounting separation.
Wholesale voice call termination on individual mobile networks	All fixed voice operators with their own network	Access obligation, non-discrimination, transparency, and price control and cost accounting.

47 Ex ante regulation is when the telecom regulatory body carries out an assessment of all relevant markets to determine whether dominance/SMP exists. If so, the regulator then imposes remedies on the operators where it sees a future potential for market abuse.

tively replicating HT Group packages with HT wholesale inputs. On the other hand, HT Group notes that wholesale fees, combined with a strict MST, create sufficient profit margins for other operators to enter the market with competitive offers, since Optima and Iskon both offer low-end retail prices, although with HT wholesale infrastructure and subject to the MST, and both remain profitable.

According to HAKOM, this issue will be addressed through amendments to the November 2019 methodology.

3.4.1.3. Symmetric regulation

In addition to regulations imposed only on SMP operators, certain regulatory obligations are binding on all operators in the market, irrespective of their size and market power.

The services regulated by symmetric regulation are as follows:

- **Access to physical telecom infrastructure (e.g., ducts, masts, poles, etc.).** Pursuant to the ECA (Article 30, par. 2), access to physical telecom infrastructure is mandatory on a symmetrical basis. Access to other utilities' infrastructure is mandated by the Act on Measures to Reduce the Cost of Deploying High-Speed Electronic Communications Networks (OG 121/16), transposing the Broadband Cost Reduction Directive (Directive 2014/61/EU).
- **Access to in-building infrastructure.** The provisions of the Broadband Cost Reduction Directive were transposed and enforced by the Act on Measures to Reduce the Cost of Deploying High-Speed Electronic Communications Networks (OG 121/16), which came into force at the end of 2016, and by the Act on Amendments to the Electronic Communications Act (OG 72/17), which came into force in July 2017. Article: 24.a, 24.b) also impose an obligation to share in-building infrastructure.
- **Access to and usage of the fiber distribution network.** Pursuant to HAKOM's bylaw, all operators building fiber distribution networks should facilitate access to all parties that indicate an interest in it. To enable parties to express interest, according to Article 8 of the bylaw, an investor who plans to set up a fiber distribution network in a specific area/territory is obligated to announce an intention before the start of construction.
- **Net neutrality[48] rules.** Pursuant to Regulation (EU) 2015/2120 of the European Parliament and of the Council of November 25, 2015, laying down measures concerning open internet access, net neutrality rules disallow blocking, throttling, and discrimination against internet traffic by internet service providers in the EU. It applies to all market players.
- **International roaming.** Based on the same Regulation (EU) 2015/2120, the rules on wholesale and retail roaming are imposed on all three MNOs in Croatia.
- **Number portability.[49]** Pursuant to the ECA (Article 76, par. 2), number portability is mandatory for all fixed and mobile operators. It was implemented at the beginning of the process of liberalization, and it is still an important enabler of competition in the market.

According to the provisions of the Broadband Cost Reduction Directive (Directive 2014/61/EU), enforced by the Act on Measures to Reduce the Cost of Deploying High-Speed Electronic Communications Networks (OG 121/16) and the Act on Amendments to the Electronic Communications Act (OG 72/17), the additional following decisions/measures were applied:

1. A single information point (SIP) for coordinating civil works has been established, and its role has been assigned to the State Geodetic Administration (DGU) (https://dgu.gov.hr/).

48 End users have the right to access and distribute all content on the internet, via any terminal equipment, regardless of the location of the content provider.

49 Number portability allows the subscriber of publicly available telephone services, at the subscriber's request, to keep the number that was assigned to the subscriber irrespective of a change of operator.

2. The process for coordinating civil works has been defined and implemented. All network operators that perform civil works are obligated to provide information to the SIP on their construction. Any interested party can access the information.
3. The process of granting permits for civil works has been outlined in the Construction Act.

According to the information provided by the MSTI and HAKOM, all three of the above-mentioned measures function in practice. However, operators have voiced concerns about the usability of the SIP system due to the incompleteness and/or inaccuracy of data records.

The study, "Analysis of the Effects of Implemented Measures and Activities from the Action Plan of the Strategy for Broadband Development in the Republic of Croatia 2016–2020," which was prepared by BDO Consulting and the Institute for Development and International Relations (IRMO) in May 2018, evaluated the implementation of the Strategy for the MSTI and concluded:

> *The adoption and implementation of the Act on measures for reducing the costs of deploying high-speed electronic communications networks represent one of the implementation measures of the existing Strategy. The analysis … revealed serious difficulties in the implementation of this measure, as well as the related Act. By reviewing all available material and communicating with competent state institutions and operators, it was determined that the difficulties of implementation of the Act are not caused by its provisions being lacking or flawed, but for the lack of its implementation in practice. Regardless, it must be pointed out that there is a notable lack of a clear and unambiguous obligation of a specific state body regarding overarching monitoring of the effects of the Act and informing the stakeholders, as well as educating the subjects of the relevant Act, especially network operators, on its provisions and obligations, especially network operators. It is also a consequence of the situation in which the scope of the Act appoints responsibilities for its implementation to several public bodies (MSTI, HAKOM, MGIPU, DGU).*

3.4.2. End users

The protection of end users is one of the pillars of HAKOM's activities as regulator. It implies a set of powers that include all the levers of regulation: licensee obligations, inspection powers, dispute resolution, and recommendations. HAKOM resolves disputes between end users and operators of electronic communications services on bill complaints, the quality of service, or a breach of terms of the subscription contract. After the procedure of resolving complaints with the operator has been completed, and on the basis of the Commission's proposal for the protection of end users' rights,[50] HAKOM makes a decision. The decision is binding on the operator and the user, though an administrative dispute can be initiated against it. Dispute resolution has proven to be an indispensable part of regulation, as it results in exact information on everything that needs to be changed, improved, or in extreme cases, prohibited in relations with consumers. HAKOM provides information and advice to end users and helps them understand the terms and conditions of provided public communications services, with a focus on protecting against potential abuse.

3.4.3. Spectrum management and 5G roadmap

3.4.3.1. Frequency allocation between MNOs

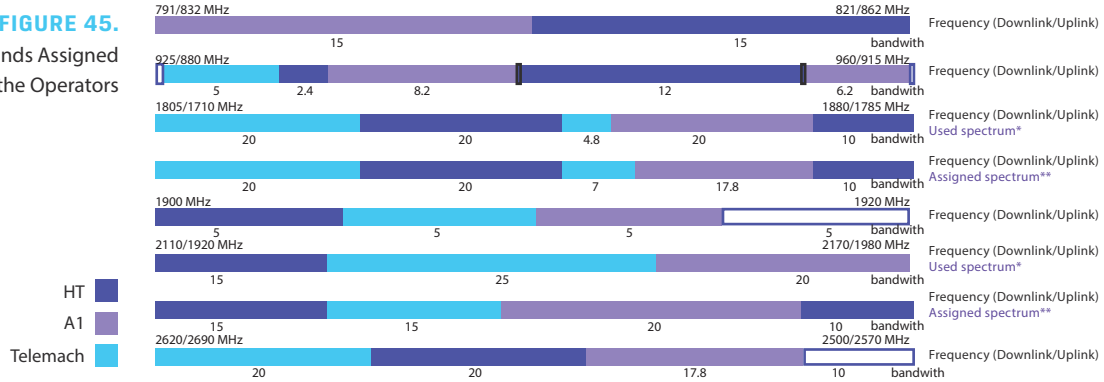
The radio frequency (RF) spectrum is an indispensable resource for MNOs' business operations. At the same time, the spectrum is scarce, so its assignment plays a great role in market and competition development.

50 The Commission for the Protection of End Users Rights is an advisory body acting at HAKOM and consists of representatives of the Alliance of Consumer Associations.

The last operator that entered the market, Telemach, stated in its reply to the data request that the frequency allocation between the operators present on the market is not balanced, as the other two operators (HT and A1) hold greater allocations suitable for 4G and 5G, especially in the lower spectrum bands. Nevertheless, it appears that the spectrum imbalance is linked to Telemach's business decisions during spectrum acquisition processes between 2009 and 2018, in which spectrum caps were imposed only on HT.

Licenses for the use of the RF spectrum issued to MNOs are technologically neutral, which means that they are free to use technologies of their own choosing for mobile communications (GSM, UMTS, or long-term evolution [LTE]) even in the previously assigned bands.

FIGURE 45.
Spectrum Bands Assigned by HAKOM to the Operators



**Used spectrum: after the assignment of frequency blocks according to an agreement between the operators.*
***Assigned spectrum: spectrum assigned according to the licenses issued for the use of the RF spectrum.*
Source: Based on HAKOM data.

From the figure above, it appears that the current frequency allocation among the operators present on the market is not balanced in the lower spectrum bands. However, a comparison of the amount of spectrum assigned to an operator is not enough to conclude whether the imbalance in spectrum allocation is a real threat to the market, as the amounts of spectrum should be compared while taking into account the relative market shares in terms of subscribers, which is a key driver for spectrum needs (in addition to coverage). When considering the market shares of operators, the spectrum appears relatively balanced. As spectrum is a scarce resource of great importance for current and future competition and market development, the issue will be addressed further in Chapter 5.

3.4.3.2. 5G roadmap

The National Action Plan for the use of the 470–790 MHz frequency band was published on May 8, 2020 (https://vlada.gov.hr/UserDocsImages/2016/Sjednice/2020/Svibanj/229%20sjednica%20VRH/229%20-%2028.pdf). Public consultation on the future award of the 700 MHz, 1500 MHz, 3.6 GHz, and 26 GHz bands in Croatia was held between October 18, 2019, and January 20, 2020. Interest was expressed in all the bands, and HAKOM was planning an auction in the third or fourth quarter of 2020. There are several factors that may complicate the implementation of these 5G pioneer bands.

In the continental part of Croatia, clearance of the 700 MHz band is planned to take until April 2021, and in the Adriatic part of the country, until October 2021. The main reasons for this two-track approach are:

– The band will not be cleared, at least not in the Adriatic area, until the existing pay TV multiplexers (MUXs) using the 700 MHz band are able to migrate to the channels below 694 MHz due to the present interference from Italy (i.e., Italian broadcasters are using Croatian GE'06 channels).

- TV operation in the 700 MHz band exists in some neighboring countries outside of the EU.
- The licenses for existing pay TV MUXs, which use some channels in the 700 MHz band, are valid until October 2021.

Regarding the 3.4 GHz band, 70 MHz in the lowest part of the band (3400–3470 MHz) will not be available in part of north Croatia until November 2023 due to existing fixed wireless access (FWA) licenses. The rest of the band is available in line with Commission Decision (EU) 2019/235. The whole 26 GHz band is also clear and available.

However, the current coronavirus pandemic has changed the situation significantly, and delays can be expected globally due to the *force majeure*, regardless of the considerations listed above. In Croatia, the transition of digital terrestrial television to DVB-T2/HEVC and the release of the 700 MHz band for mobile services had not been concluded by June 30, 2020, due to the pandemic and has been postponed until autumn 2020. Additionally, the earthquake that hit Zagreb on March 22, 2020, made the transition even more complicated in this area. For these reasons, telecom operators have changed their position and requested a postponement of the auction for 5G bands until 2021.

Considering this request, HAKOM has proposed auctioning 5G bands together with bands currently in use for 2G, 3G, and 4G. Existing licenses for 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, and 2600 MHz expire in 2024, and postponing the auction for 5G bands brings these dates closer together. Therefore, public consultation on auctioning 5G bands together with 2G, 3G, and 4G was held between June 26 and July 15, 2020. Taking into account stakeholders' responses, HAKOM plans to auction 5G bands by the end of June 2021. Auction for 2G, 3G, and 4G bands is planned for 2022.

According to the new plan published in July 2020, the transition of digital terrestrial television to DVB-T2/HEVC will happen from October 27 to November 12, 2020. On August 26, 2020, the new license for pay TV MUXs was issued, valid until the end of 2030. Clearance of the 700 MHz band will be done during the DVB-T2 transition.

The Republic of Croatia will request a delay with respect to Article 1 and the annex to EU Decision 2017/899, which states that by June 30, 2020, member states shall allow the use of the 694–790 MHz ("700 MHz") frequency band for terrestrial systems capable of providing wireless broadband electronic communications services only under harmonized technical conditions established by the Commission pursuant to Article 4 of Decision No 676/2002/EC. The decision allows member states to delay authorization of the use of the 700 MHz frequency band for up to two years on the basis of one or more of the duly justified reasons set out in the annex to the Decision.

As mentioned earlier, following a government decision on January 23, 2020, Osijek was designated as the first major city in Croatia in which a 5G network will be built by December 31, 2020, and put into commercial operation soon thereafter. Postponing the auction for 5G bands will probably delay commercial operation until 2021, although there is a possibility that this goal could be achieved using other bands (e.g., 2100 or 2600 MHz). The frequency bands currently used for 2G, 3G, and 4G have been harmonized at the European level with the prescribed technical conditions to enable their use for 5G. In order to enable the implementation of 5G in the already awarded frequency bands, HAKOM launched public consultations on amendments to the allocation plans for the 800 MHz, 900 MHz/1800 MHz, 2100 MHz, and 2600 MHz bands on September 17, 2020. As mentioned, licenses for the use of the RF spectrum issued to MNOs are technologically neutral, and with the above-mentioned amendments, it will be possible to use these bands also for 5G on a commercial basis.

3.4.4. Transparency

Consistent with international best practices, various types of information useful to the public, operators, and state bodies are publicly available on an interactive geographic information system (GIS) portal on HAKOM's website (http://mapiranje.hakom.hr/en-US/), including on the following topics:

- availability of broadband access
- consolidated coverage plan of mobile communications operators
- areas of intended deployment (construction) of the fiber optic distribution network
- broadband access speeds experienced by end users
- radio stations
- measured levels of electromagnetic emissions
- statistics on the digital market, including the number and type of broadband connections

3.5. CONCLUSIONS

Although the Croatian regulatory framework is fully aligned with the EU framework in terms of its core provisions, some aspects of its implementation in practice (i.e., the non-harmonization of different laws) could be seen as a possible inhibitor to broadband development.

The level of competition in the mobile voice and broadband market appears to be adequate, but when it comes to the fixed broadband market, the same conclusion cannot be drawn. This is due to the fact that there was strong consolidation in the fixed broadband market structure several years ago, resulting in the current market domination of HT and A1 as the only two convergent network operators offering a full range of services (fixed, mobile, broadband, and pay TV). This strongly affects the coverage and take-up of fast broadband services, which cannot be increased due to the lack of competitive forces in the market.

At the same time, there are some direct regulatory barriers limiting the ability of competition to emerge. One example is the provisions in the Electronic Media Act that present an obstacle to Telemach's entry into the pay TV market and thus to its becoming a third convergent network operator that could confront the dominance of the other two players.

Although the wholesale markets are fully regulated in line with EU recommendations, market data indicate that there are some possible challenges in the ex ante regulation that prevent market development. The first points to the quality of wholesale access regulation, as market data suggest that the number of unbundled lines is decreasing while wholesale bitstream access service stagnates. The second is the possibility that margin squeeze regulation does not prevent HT from exploiting its dominant position at the expense of competitors.

When it comes to spectrum, the current frequency allocation between the operators present on the market does not appear to be balanced in the lower spectrum bands in absolute terms, something that could affect competition in future.

In addition to these conclusions, in their replies to the data request, operators highlighted a wide variety of problems affecting the market. These include the high costs imposed by state bodies (land access, rights of way, spectrum fees), overcomplicated procedures affecting network deployment (construction regulation, spatial planning, etc.), ineffective wholesale regulation, and an imbalance in the allocation of spectrum to MNOs.

All of the recognized problems will be addressed in greater detail in Chapter 5.

4. Market Intervention and Access to Funds

4. MARKET INTERVENTION AND ACCESS TO FUNDS

4. Market Intervention and Access to Funds

4.1. INTRODUCTION

In this section, the public attempt to increase investment in underserved areas is examined. Private investment can typically be relied upon to deliver needed infrastructure when it is commercially justified. HT, its affiliates, and A1 have deployed high-speed networks in the more densely populated (and economically viable) parts of Croatia. More recently, HAKOM's bylaw on fiber distribution networks has enabled more operators to become involved. Still, these are generally purely commercial efforts with private funding.[51] Estimates suggest that in the past seven years, there were 446 privately funded fixed broadband infrastructure projects[52] in Croatia.

Given the weak performance in fixed infrastructure rollout and take-up, the public sector has begun to play a greater role in development. In this chapter, public sector (EU and national state) initiatives are discussed, including their performance in delivering on objectives over the past several years.

4.2. MAJOR INITIATIVES

The following table provides a summary of the main initiatives on developing broadband infrastructure in the past few years in Croatia.

TABLE 4.
Main initiatives on Broadband Development in Croatia

	National Framework Program for the Development of Broadband Infrastructure (ONP)	National Program for the Development of Broadband Backhaul Infrastructure (NP-BBI)	HAKOM's Program for the Development of Internet and Broadband Access	RUNE Project
Objective of the project	NGA networks countrywide in white NGA areas, with a symmetric 100 Mbit/s NGA access with either FTTx or advanced wireless technological solutions, covering a minimum of 78% of private end users, minimum of 83% of business end users, and minimum of 100% of public end users.	Construction of a publicly owned, passive next generation network (NGN) backhaul infrastructure (ducts, dark fiber, and colocation facilities) from major Croatian settlements toward smaller settlements in rural and suburban areas.	Build broadband infrastructure in areas of special national concern, (hilly and mountainous areas and islands), for targeted users, such as schools, health care institutions, and fire stations.	RUNE's goal is to provide connectivity to a new fiber access network with speeds of 1 Gbps in areas that are currently not covered by fiber optic infrastructure.

continue

51 An exception here is RUNE, where the project is funded by the Connecting Europe Broadband Fund (CEBF). For more information, see Annex 1.

52 For more information, see the HAKOM website at http://mapiranje.hakom.hr/hr-HR/SvjetlovodnaMreza.

	National Framework Program for the Development of Broadband Infrastructure (ONP)	National Program for the Development of Broadband Backhaul Infrastructure (NP-BBI)	HAKOM's Program for the Development of Internet and Broadband Access	RUNE Project
Funding	The overall estimated budget is €252 million, of which €117.2 million will be funded by the European Regional Development Fund (ERDF) and the rest by private funds. €92 million have been allocated to fund the selected projects.	The overall estimated budget is €101.4 million, of which €86.2 million will be funded by the ERDF and the remaining €15.2 million by national funds.	€6.6 million	€250 million
Start of the program	Mar. 2014 ONP published	Jan. 2015 NP-BBI published	2011	2019
Expected implementation by	End of 2023	End of 2023	Jul. 2018	N/A
Current status of the project	*Ongoing* 21 projects were selected: 16 projects with a private design-build-operate (DBO) investment model (HT was selected for 13 projects and A1 for 3) and 5 projects with a public DBO investment model.	*Ongoing* Currently in process of Major Project Application with the EC	The project was finished on time.	*Ongoing*
Target	The selected 21 projects cover 126 municipalities with 904,000 inhabitants and approximately 26,000 housing units in "white" areas.	Connect at least 350 central administrative settlements in municipalities located in white and grey NGN areas	35,000 users	340,000 households
Concerns/ remarks	It has been 6 years since the beginning of the program and the deployment of the network has not started yet.	It has been 5 years since the beginning of the program and the deployment of the network has not started yet. It is expected that program implementation will start by the end of 2020.	The speed test has proved that contracted speed has been achieved. It can be concluded that the project has fulfilled its goals.	The project has been going quite well with no substantial barriers reported. In Dec. 2019, the first customers in Croatia and Slovenia were connected. In Mar. 2020, the first node of the RUNE optical network was successfully connected, providing optical signals to households in 8 surrounding municipalities.

More details on each of these major initiatives can be found in Annex 1.

4.3. COMPARING OUTCOMES TO THE ORIGINAL PLANS AND ASSESSING THE MARKET IMPACT

The following charts show a comparison between the initial plans and the actual outcomes of selected state aid projects.

From the figure 46., it can be clearly seen that although the execution of the project was slow from the very start, considerable time (i.e., more than three years) was lost for no apparent reason between state aid approval by the EC and publication of the public call. The first six grant agreements, with a total value of HRK 270.6 million, were awarded on July 31, 2020.

FIGURE 46.
Timeline of the ONP

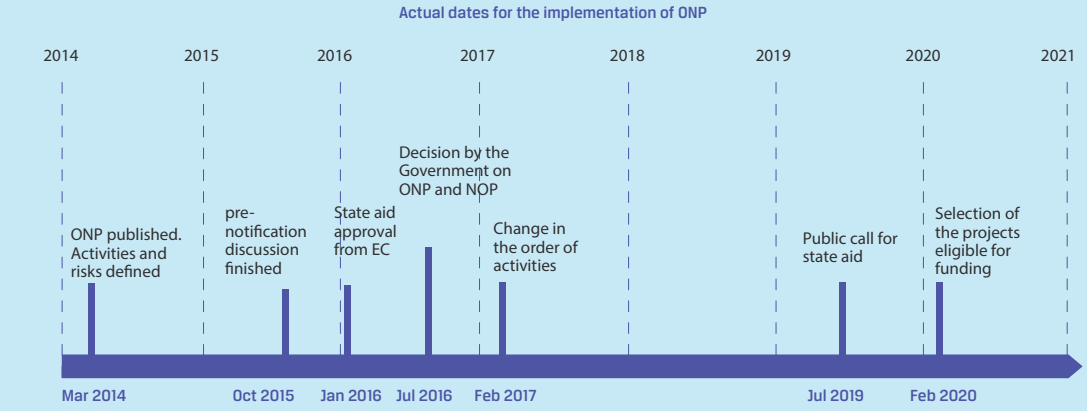
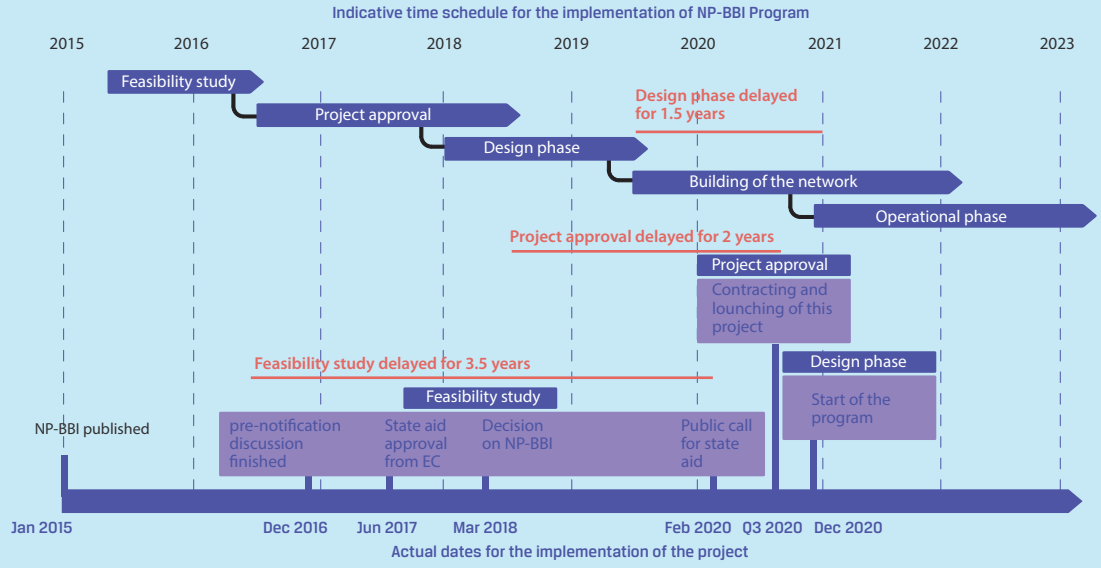


FIGURE 47.
Timeline of the NP-BBI

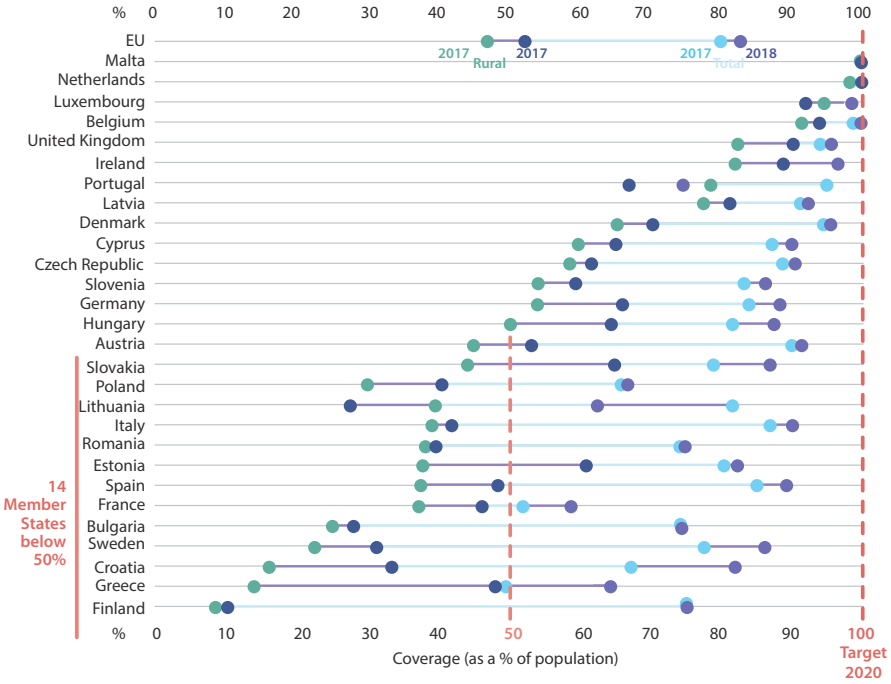


As with the ONP, the original plan compared to the actual implementation of the NP-BBI shows significant delays in the execution of the project, which affects the final termination date.

In the following two figures, the comparative results of EU member states in terms of rural coverage with an NGA speed of 30 Mbit/s are shown. It should be emphasized that both projects (ONP and NP-BBI) deal with the coverage of white areas (predominantly rural).

From the chart above, Croatia appears to be among the worst performers in NGA rural broadband in the EU. Croatia has made some improvements in coverage in rural areas thanks to state aid programs, but delays in the process caused by slow administration continue to negatively affect the coverage of rural areas and the benefits of end users.

FIGURE 48.
Mbps Coverage in Rural Areas Compared to Total Coverage in 2017 and 2018



Source: Based on Eurostat data.

4.4. CROATIA'S USE OF EU FUNDS FOR DIGITAL DEVELOPMENT

4.4.1. European Structural and Investments Funds available to Croatia

Over half of EU funding is channeled through the five European Structural and Investment Funds (ESIF). They are jointly managed by the EC and the EU member states. The purpose of these funds is to invest in job creation and a sustainable and healthy economy and environment for the European area. The ESIF are:

- European Regional Development Fund (ERDF) promotes balanced development in the different regions of the EU.
- European Social Fund (ESF) supports employment-related projects throughout Europe and invests in Europe's human capital: its workers, young people, and those seeking a job.
- Cohesion Fund (CF) finances transport and environment projects in countries where the gross national income (GNI) per inhabitant is less than 90 percent of the EU average. In 2014–20, these were Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, and Slovenia.
- European Agricultural Fund for Rural Development (EAFRD) focuses on resolving the particular challenges facing the EU's rural areas.
- European Maritime and Fisheries Fund (EMFF) helps fishermen to adopt sustainable fishing practices and coastal communities to diversify their economies, improving the quality of life along European coasts.

The overall allocation of €10.7 billion of ESIF 2014–20 for Croatia comes from these five funds programmed through four national Operational Programs (OPs):

- OPCC (€6.83 billion from the ERDF and the CF)
- OP Efficient Human Resources (€1.58 billion from the ESF)
- Rural Development Program (€2 billion from the EAFRD)
- OP Maritime and Fisheries (€0.25 billion from the EMFF)

In addition, there are funds from a number of small Territorial Cooperation Programs.

TABLE 5. ESIF 2014–20 Allocations for Croatia

European Structural and Investment Fund	Allocation (EUR bn)
European Fund for Regional Development (EFRD)	4.32
Cohesion Fund (CF)	2.51
European Social Fund (ESF)	1.58
European Agricultural Fund for Rural Development (EAFRD)	2.03
European Maritime and Fisheries Fund (EMFF)	0.25
TOTAL	**10.69**

TABLE 6. Operational Programs Overview

Program	EUR bn
OPCC (ERDF + CF)	8.03
OP Efficient Human Resources (ESF)	1.85
Rural Development Program (EAFRD)	2.38
OP Maritime and Fisheries (EMFF)	0.34
TOTAL	**12.60**[53]

Source: www.strukturnifondovi.hr.

Allocations are divided into annual amounts that must be spent within two or three years, depending on the country. This rule is known as the "N+2 or N+3" rule, with N being the start year when the money is allocated. Any of that annual amount that is not claimed by the member state within that period is automatically deducted from its allocation and goes back into the overall EU budget. For the 2014–20 period, Croatia negotiated an N+3 rule, meaning that the country has until 2023 to withdraw the funds.

4.4.2. Croatia's use of ESIF 2014–20

The implementation of ESIF in Croatia is slow. Although dedicated funds have been contracted at a relatively high rate, the payments made are very low. The usage of funds (absorption rate) at the end of November 2019 across ESIF was nearly 30 percent. More recent data are provided below. All ESIF OPs in Croatia are underperforming; the Rural Development Program is the most successful and the OPCC the least.

TABLE 7. ESIF Implementation in Croatia as of January 31, 2020

Program	Allocation EUR	Published Calls EUR	Contracted EUR	% Contracted	Paid to Beneficiaries EUR	% Paid to Beneficiaries
Competitiveness and Cohesion	6,831,255,232	7,411,821,336	6,446,079,047	94.36%	1,846,074,190	27.02%
Efficient Human Resources	1,617,328,125	1,505,759,483	1,183,333,613	73.00%	557,098,090	34.37%
Rural Development	2,026,222,500	1,982,731,358	1,588,904,821	78.42%	935,009,476	46.15%
Maritime Affairs and Fisheries	252,643,138	172,184,157	133,862,176	52.98%	70,081,546	27.74%
TOTAL	10,727,448,995	11,072,496,334	9,352,179,657	87.18%	3,408,263,302	31.77%

Source: www.strukturnifondovi.hr.

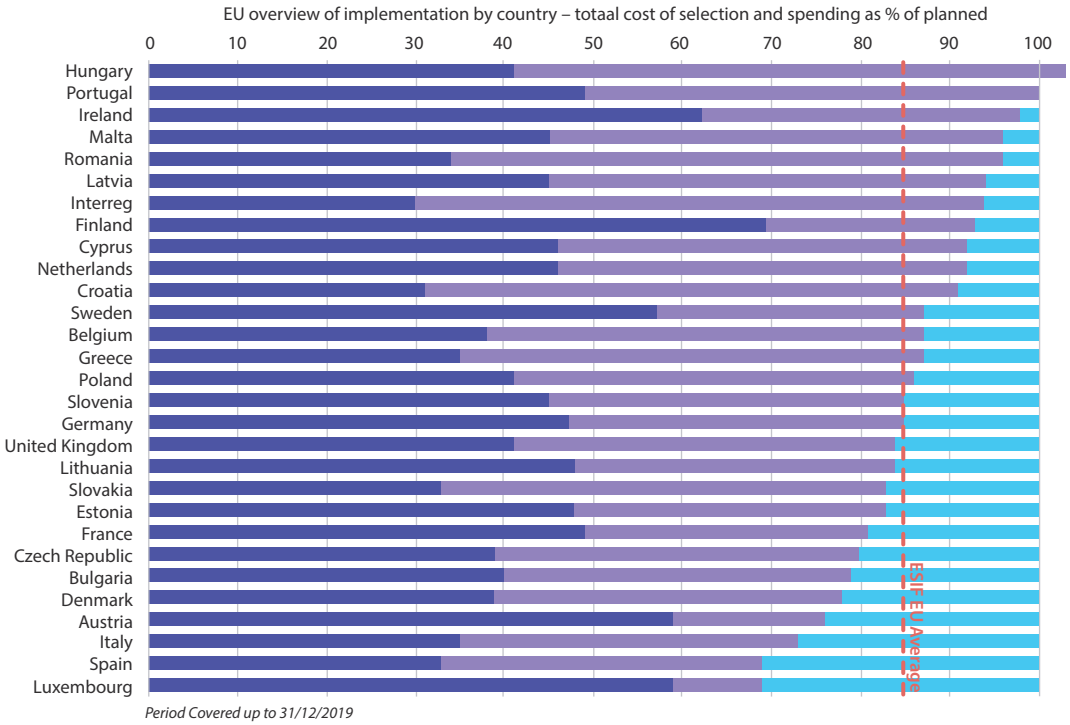
53 This Includes co-financing from the state budget.

Comparison of results with other EU member states

4.4.3.

EU policies and funding should play a critical role in the structural reform and development agenda in Croatia. However, this has proven to be a key challenge for all stakeholders, primarily the central administration, which is struggling with implementation. The current period of EU funds, 2014–20, is the first in which Croatia has participated entirely as a member state. Compared to other EU member states, for the period until end-December 2019 (the last available cohesion data), Croatia was the worst performer (Croatia 31 percent, Slovakia 33 percent, and Spain 33 percent) with regard to the amount paid to beneficiaries.

FIGURE 49.
EU Overview of Implementation by Member States: Total Cost of Selection and Spending as % of Planned (period covering until end-December 2019)



Source: https://cohesiondata.ec.europa.eu/overview.

4.5. CONCLUSIONS

Croatia's relatively low performance in ESIF implementation is a missed opportunity for the digital sector, with consequences for the country's digital divide that can only increase if it is not addressed with public support. Based on discussions with stakeholders, several reasons have emerged to explain this relatively poor performance:

- A lack of ownership and coordination within public bodies, and a lack of resources to implement projects
- A state aid process that is overly complicated and lengthy, with, for instance, processing delays in publishing the public calls for tender
- Inappropriate parameters for state aid projects, such as an overly high threshold for a private share in investment and an unduly low maximum amount of funding per project
- Private-public partnership (PPP) law issues

These are examined in more detail in Chapter 5.

5. Inhibitors to Broadband Development in Croatia

5. INHIBITORS TO BROADBAND DEVELOPMENT IN CROATIA

5. Inhibitors to Broadband Development in Croatia

In Chapter 2, the major shortcomings of the Croatian digital market were identified:

1. The take-up of fast fixed broadband services is significantly lower in Croatia than the EU and peer group averages.
2. Croatia is below both averages for both coverage and take-up of ultrafast broadband.
3. Fixed broadband coverage varies greatly between urban and coastal counties on the one hand and rural and interior counties on the other.
4. Although affordability does not explain all the underperformance in take-up in fixed broadband, it appears to be a significant factor. Fixed broadband prices are high relative to Croatian incomes.
5. Croatia has a relatively low usage level of digital services compared to EU and peer group averages, which is reflected in a comparatively low percentage of internet users and high percentage of non-users. This is likely linked to the lower fixed broadband take-up levels.
6. There is evidence that Croatia is lagging behind in 5G readiness, as are others in its peer group.
7. Croatia has a mixed performance with respect to digitizing public services. Whereas its peer group tracks the average EU experience quite closely, Croatia appears to outperform on the digitization of health care services but underperform on the digitization of general public administration.

In Chapter 3, the analysis of the market structure, competition, and regulations led to the following conclusions:

1. There has been strong consolidation in the overall fixed broadband market structure in recent years, which means that the market is currently dominated by HT and A1 as the only two convergent network operators offering a full range of services (fixed, mobile, broadband, and pay TV).
2. Coverage and take-up of fast broadband services would benefit from increased competition by means of a third convergent network operator offering a full range of services.
3. Certain provisions in the Electronic Media Act function as an entry barrier to the pay TV market, preventing Telemach from becoming a third convergent network operator.
4. The level of wholesale access to LLU service is decreasing, while access to wholesale bitstream service is stagnating, which raises the question of the quality of wholesale access regulation.
5. There is a possibility that margin squeeze regulation is not preventing HT from exploiting its dominant position at the expense of competitors.
6. The implementation of the regulatory framework in practice (non-harmonization of different laws) is the main inhibitor to market development.
7. In their replies to the data request, operators offered their views on the wide variety of problems affecting the market. These include the high costs imposed by state bodies (land access, rights of way, spectrum fees), overcomplicated procedures hindering network deployment (construction regulation, spatial planning, etc.), the limitations of the wholesale regulation, and an apparent imbalance in the allocation of spectrum to MNOs.

In Chapter 4, Croatia's performance in terms of market interventions and access to funds was examined. Discussions with stakeholders highlighted the following issues:

1. A lack of ownership and coordination from public bodies, and a lack of resources for implementing projects

2. A state aid process that is overly complicated and lengthy, with. for instance. processing delays in publishing the public calls for tender
3. Inappropriate parameters for state aid projects, such as an overly high threshold for a private share in investment and an unduly low maximum amount of funding per project
4. PPP law issues

In this chapter, potential inhibitors are examined to determine if there is evidence behind them. The chapter summarizes only those inhibitors with confirmed evidence and impact on the market, or inhibitors without definitive evidence but that deserve further evaluation given their potential impact on market development. Inhibitors that have no supporting evidence and low impact on the market have been excluded. It should also be noted that the government plans to introduce a new ECA to deal with some of the problems with the broadband market. Thus, this chapter analyzes only those inhibitors that will not be covered and remedied by the amendments to the ECA. As per the summary table below, the inhibitors have been divided into five categories: affordability; land access or usage, construction, and rights of way; public investment (EU state aid, etc.); market structure and competition; and spectrum.

Summary of Categories and Potential Inhibitors

CATEGORIES	INHIBITORS
Governance and public investment (EU state aid, etc.)	**1.** No strong ownership of the digital transformation agenda at the institutional level **2.** A state aid process too complicated and lengthy **3.** Excessive delays in the tendering process of major programs **4.** The threshold for private share in investment set too high for rural areas **5.** The maximum amount of funding per project set too low to fund large projects **6.** Lack of resources and experience for implementing some large projects **7.** Issues in the law on public-private partnerships (PPPs)
Market structure and competition	**8.** Fixed broadband service prices too high relative to incomes **9.** Highly consolidated fixed markets **10.** The Electronic Media Act restricting the development of the market **11.** Limitations in the current wholesale regulations
Land access or usage, construction, and rights of way	**12.** High fees for land access (rights of way) **13.** Some local spatial plans with prohibitive requirements for fixed and mobile infrastructure **14.** Construction regulations for building ECI (both line and mobile infrastructure) that do not ensure fast and cost-effective deployment **15.** Concerns over the legality of legacy fixed infrastructure due to lack of permits (property rights issues) **16.** EU Directive on measures to reduce the cost of deploying high-speed electronic communications networks transposed into national legislation but not functional in practice
Spectrum	**17.** Spectrum fees **18.** Spectrum imbalance among MNOs **19.** Interference from neighboring countries and 5G spectrum assignments

In the rest of this chapter, the evidence to support each potential inhibitor is examined, its impact is assessed, and potential solutions are suggested when relevant. The potential solutions are explored in more detail in Chapter 8.

5.1. GOVERNANCE AND PUBLIC INVESTMENT (EU STATE AID, ETC.)

5.1.1. No strong ownership of the digital transformation agenda at the institutional level

Inhibitor	No strong ownership of the digital transformation agenda at the institutional level
Description	– A country's digital transformation agenda relies on deep technical expertise, strong coordination among public entities in view of the cross-sectoral scope involved, and tight collaboration between the government and the private sector, given that the digital agenda is driven mainly by the private sector (telecommunications operators, content providers, IT firms, etc.).
Evidence or material collected	– In Croatia, ICT matters are led by the MSTI. The digital agenda is therefore only a subset of the very large portfolio of this ministry. Most of the technical expertise remains with HAKOM, which prevents the strong ownership of digital initiatives at a ministerial level, including in particular the ones related to public investments using EU funds in the digital sector, which are led by the Ministry of Regional Development and EU Funds (MRRFEU). In addition, a Central Office for the Development of a Digital Society has been established under the prime minister, but with limited resources and without the political weight of a proper ministry. – This diffuse ownership among the MSTI, MRRFEU, Ministry of Economy, HAKOM, and central office for a digital society is not conducive to a coordinated and forceful approach to the digital transformation of the country. – In many countries, given the considerable importance of this agenda, a dedicated ministry is typically in charge of the digital transformation, with a portfolio ranging from ICT to the digital economy or digital transformation. For instance, among the peer group there is the Ministry of Digital Affairs in Poland, the Ministry for the Economy and Digital Transition in Portugal, the Ministry of Digital Governance in Greece, the Ministry of Economic Affairs and Communications in Estonia, and the Ministry of Transport, Information Technology and Communications in Bulgaria. – Although such institutional arrangements are not a prerequisite, discussions with stakeholders suggest that many difficulties and delays experienced in the use of EU state aid could be avoided with a different institutional setup in the sector.
Impact assessment	– **HIGH IMPACT**, as any ambitious digital transformation agenda requires strong political ownership and the ability to lead, mobilize, and coordinate all the stakeholders around a common vision. This agenda goes well beyond the management of state aid to encompass also the creation of a policy and regulatory environment for the digital sector, a taxation regime, and more broadly, the "ease of doing business" in the sector, among other measures. This inhibitor can be seen therefore as a direct or indirect contributing factor to many other inhibitors discussed in this section.
Potential solutions	– Create a ministry dedicated to the digital economy, including telecommunications, electronic media, and EU funds for digital programs.

Digital Transformation Agenda: the Case of Estonia

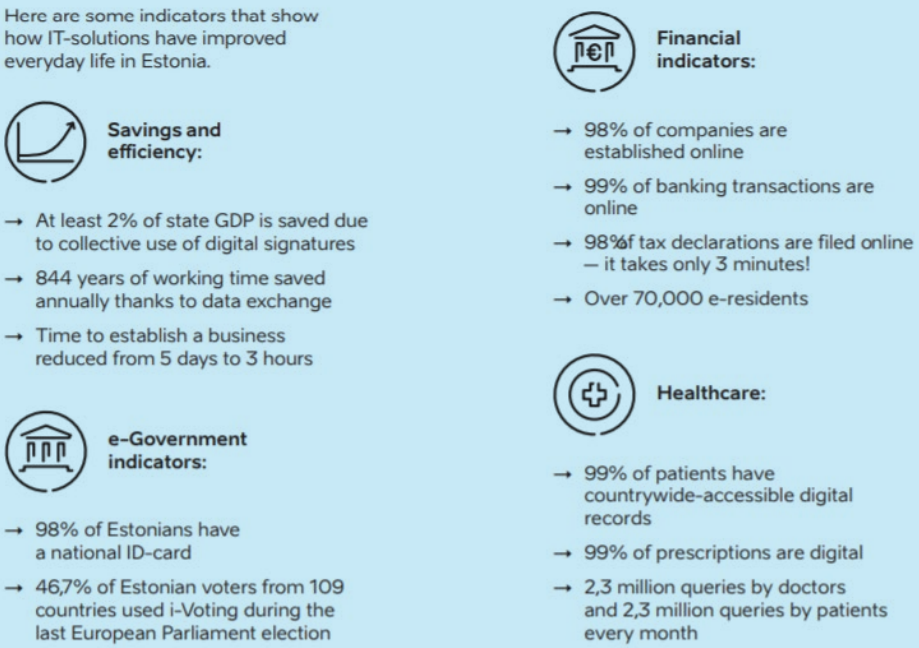
Estonia is considered to be one of the most advanced digital societies globally, thanks to a forward-looking vision for the digital sector implemented over the past two decades.

Building on the key enablers of digital identification, payments, and connectivity, Estonia has built most notably a government interoperability platform known as the X-Road, allowing the secured transmission of information across government entities, breaking up the silos of ministries, and enabling efficient integrated service delivery to citizens and businesses.

The principles of Estonian e-governance are as follows:

- Decentralization – There is no central database, and every stakeholder, whether a government department, ministry, or business, can choose its own system.
- Interconnectivity – All system elements exchange data securely and work smoothly together.
- Integrity – Data exchanges, M2M communications, data at rest, and log files are, thanks to blockchain technology, independent and fully accountable.
- Open platform – Any institution may use the infrastructure, which works as an open source X-Road data exchange platform.
- No legacy – There are continuous legal changes and organic improvements to the technology and the laws.
- Once-only – Data are collected only once by an institution, eliminating duplicated data and bureaucracy.
- Transparency – Citizens have the right to see their personal information and to verify how it is used by the government via log files.

As a result, 99 percent of public services are now available online at all times, and Estonia has reached an unprecedented level of transparency in governance. For example, the government uses the e-Cabinet system to pass laws, while citizens use the i-Voting system. Thanks to digital signatures, Estonia annually saves 2 percent of GDP. Some of the impact indicators are presented below.



Source: https://e-estonia.com/.

5.1.2. A state aid process too complicated and lengthy

Inhibitor	A state aid process too complicated and lengthy
Description	– The method of allocating funds to access projects appears overly complicated (including public consultation), resulting in substantial delays in implementation. – Local government (municipality, city, or group of municipalities/cities) has to create a "broadband infrastructure development plan" (BIDP), based on which it can either look for a partner telecom/vendor to build and operate the network (Model A: private design-build-operate [DBO]), build on its own and operate the network (Model B: public DBO, though it can only do passive network and lease fiber to other operators), or have a PPP model (Model C), which would require the use of very complicated PPP regulation that is unlikely to be implemented. – HAKOM is charged with the function of the Competent Authority for the Framework Program (CAFP). A municipality or group of municipalities (called a "cluster") send their BIDPs for a check to HAKOM, at which time there is a public consultation in which all interested parties can participate.
Evidence or material collected	– The scheme of the process is shown in Chapter 4. – Most of the problems and the biggest delays occurred as a result of governmental/ministerial decisions and not on the project level.
Impact assessment	– **LOW IMPACT**, as it was recognized that the main problems stemmed from government procedures.
Potential solutions	– Possibly simplifying the procedures that do not compromise the quality of the project or the EU's requirements

5.1.3. Excessive delays in the tendering process of major programs

Inhibitor	Excessive delays in the tendering process of major programs
Description	– It has been six years since the beginning of the project (document was sent to the EC in 2014), and no construction work has started yet. – Out of the 11 phases and activities in the preparation and implementation of the projects set out within the National Framework Program, all selected projects are now in phase 7, "Project budget, application for co-financing from EU funds," which means that four more phases remain, including building the network. – The ONP officially entered into force in July 2016 by a government decision that was based on a decision of the EC (from January 2016) not to raise objections to the aid on the grounds that it is compatible with the internal market pursuant to Article 107(3)I of the Treaty on the Functioning of the European Union. – The public call for state aid was announced by the Ministry of Regional Development and EU Funds in July 2019.
Evidence or material collected	– Much time has been lost, as seen in Chapter 4, waiting for the announcement of the first public call. – In the May 2018 study by BDO and IRMO, on implementing measure 8: Implementation of the National Framework Program for the development of broadband access infrastructure, it was concluded: "Nevertheless, it bears mentioning that the second activity within this measure – Implementation of broadband access infrastructure development for NGN networks in 'white' areas has not yet begun and is significantly delayed in relation to the set time frames, which is why this part of the measure can currently be assessed as ineffective and having no effect. Considering the extent of the delay, there is also a possibility that the available OPCC resources will not be used on time, which may result in additional need for national co-funding."
Impact assessment	– **HIGH IMPACT**, on the speed of the process, investments made, and absorption of EU funds
Potential solutions	– Creating guidelines that will obligate the government to be more rapid in the decision-making process related to EU funds.

5.1.4. The threshold for private share in investment set too high for rural areas

Inhibitor	The threshold for private share in investment set too high for rural areas
Description	– There is a view that the project success rate would have been higher if the private investment share had been less—44% is the minimum share of private investors/operators within "investment model A" as defined by the MRRFEU selection criteria, and the outcome of that is a lower success rate (only 21 out of 71 proposed projects are going ahead). – According to one operator, there is a risk that approximately €24 million for NGA networks from the currently available broadband allocation will remain unspent, and consequently, the next programming period will have at least a 6% decrease in total available funding for broadband due, in part, to poor absorption and contracting dynamics.
Evidence or material collected	– Some operators claimed that this was the reason that there was a lower success rate among projects to be financed by EU funds.
Impact assessment	– **LOW IMPACT** – Fewer viable cases for private investment – Unspent money
Potential solutions	– Change in the rules in the next round of the state aid programs

5.1.5. The maximum amount of funding per project set too low to fund large projects

Inhibitor	The maximum amount of funding per project set too low to fund large projects
Description	– There is a view that projects covering larger areas and able to achieve more economies of scale were prevented due to the low maximum amount of funding per project. – According to one operator, there is a risk that approximately €24 million for NGA networks from the currently available broadband allocation will remain unspent, and consequently, the next programming period will have at least a 6% decrease in total available funding for broadband due, in part, to poor absorption and contracting dynamics.
Evidence or material collected	– The outcome could have been the same in terms of the number of projects but could have covered more area if a higher amount of funding had been possible.
Impact assessment	– **LOW IMPACT** – Only smaller projects are to be funded. – With a higher amount of funding, the larger projects could have been funded and economies of scale achieved. – Unspent money
Potential solutions	– Change in the rules in the next round of the state aid programs

5.1.6. Lack of resources and experience for implementing some large projects

Inhibitor	Lack of resources and experience for implementing some large projects
Description	– The backhaul program (NP-BBI) aims to construct a publicly owned, passive NGN backhaul infrastructure, i.e., ducts, dark fiber, and colocation facilities. Thus, the program aims to support the development of uniform NGN backhaul at the national level, in parallel with the implementation of a national program for broadband access infrastructure promoting NGA networks. – Implementation of the scheme and the design, building, and operation of the backhaul network will be managed by the public undertaking "Odašiljači i veze d.o.o." (Transmitters and Communications Ltd.; OIV), fully controlled and owned by the state. – There could be a possible lack of available resources and experience on the part of OIV in this kind of project and network development, as it deals mostly with wireless communications and may lack the necessary resources.
Evidence or material collected	– The main business activities of OIV are, inter alia, providing access and shared use of ECI and associated facilities; leasing electronic communications networks and lines; and offering analog FM radio broadcasting, digital television terrestrial broadcasting (DVBT), satellite services, private mobile network services, multimedia services, and professional engineering services. – According to the NP-BBI program, OIV will create a separate organizational unit to manage the implementation of the scheme. – OIV's role will be to manage the whole scheme on behalf of the government. This includes the development of infrastructure and the management of the resulting infrastructure within the operational phase (e.g., selection of operators willing to lease fibers, managing a database of the infrastructure, managing and supervising the maintenance of the infrastructure), whereas related maintenance and repair services will be tendered out.
Impact assessment	– **MEDIUM IMPACT**, in terms of lacking experience and resources for this kind of project, which could result in delays in project execution
Potential solutions	– As the decision is already made, the only feasible solution could be to ensure that all the resources needed for OIV and other stakeholders to execute this project are made available.

5.1.7. Issues in the law on public-private partnerships (PPPs)

Inhibitor	Issues in the law on public-private partnerships (PPPs)
Description	– Possible issues with PPP law that could affect its use in practice – Complexity of the law and its inadequacy in reconciling the interests of public and private partners
Evidence or material collected	– The PPP law is in force, but implementation is extremely demanding and is not facilitating partnerships. – There is a clear lack of projects based on PPP in practice. – Not one project in the ONP was based on model C (a PPP). – NP-BBI was also not based on a PPP. – One operator stated that according to the PPP model, the procedures for project preparation and implementation are more complex than other investment models. That includes additional administrative steps, e.g., approval of the Ministry of Finance and "double administration" (passive fixed network infrastructure as part of the PPP and the rest of the NGA network (all remaining passive and active elements as well as mobile networks and frequencies) that are out of the scope of the PPP. Additionally, setting a Special Purpose Company Form (DPN) for each PPP project increases the risk of effective realization of the PPP. Taking account of all the obstacles that can jeopardize the project timeline leads to the realization that a PPP is not an attractive model for applying for EU funds.
Impact assessment	– **LOW IMPACT.** It has not influenced the level of funding and investments in the sector, as there are no projects based on the PPP model.
Potential solutions	– Simplification of the PPP law in order to make it more implementable

5.2. MARKET STRUCTURE AND COMPETITION

5.2.1. Fixed broadband service prices too high relative to incomes

Inhibitor	Fixed broadband service prices too high relative to incomes
Description	– As described in Chapter 2, according to the DESI broadband price index indicator and empirical data, Croatia is among the worst performers in terms of the affordability of fixed broadband prices and their share in average household income. – High prices relative to income, among other things, affects the take-up rate of NGA fixed broadband services. – This inhibitor may be related to the level of competition and costs of deployment of the network, in addition to low average income.
Evidence or material collected	– See figures 18, 19, and 20.
Impact assessment	– **LOW IMPACT,** as affordability is significant but may not be the sole or primary reason for the lower take-up.
Potential solutions	– As stated in the description, since this inhibitor is strongly related to the level of competition, cost of network deployments, and average income, the potential solutions could range from encouraging competition and lowering network deployment costs to stimulating an increase in the average income of the end user.

5.2.2. Highly consolidated fixed markets

Inhibitor	Highly consolidated fixed markets
Description	– On the fixed broadband and the bundled services markets, there are two strong market players: HT and A1. These operators are capable, to a considerable extent, of acting independently of their actual or potential competitors, consumers, buyers, or suppliers. – Some of the stakeholders stated that the market had characteristics of a duopoly. Moreover, with the increase in the importance of bundled services, operators that are convergent (fixed and mobile) have more opportunities to contract end users.
Evidence or material collected	– The mobile services markets are experiencing the highest growth. In the DESI index, in terms of coverage and take-up, the best results currently are related to mobile networks. – According to the broadband price index in fixed networks, Croatia is among the worst performers, while in the mobile broadband price index, Croatia falls in the group of "relatively inexpensive countries." – The common denominator of both of the above comments is the healthy competition that takes place in mobile markets.
Impact assessment	– **LOW IMPACT** as regards market development, investment, and benefits for end users
Potential solutions	– Encourage the entrance of a third convergent market player

5.2.3. The Electronic Media Act restricting the development of the market

Inhibitor	The Electronic Media Act restricting the development of the market
Description	– Telemach is prevented from entering the fixed market and offering IPTV services.
Evidence or material collected	– In Article 79 of the Electronic Media Act (OG 153/09, 84/11, 94/13 and 136/13), it states that the Electronic Media Council cannot issue a license for the satellite, internet, or cable transmission of an audiovisual and/or radio program, or other permissible ways of transmission, to affiliates of media service providers. As United Group also owns other television broadcasters and media service providers referred to in Article 79 of the Electronic Media Act, Telemach is prevented from offering digital television services (distribution of audiovisual services under Article 61). – Telemach states that no other EU member state has such prohibition. There are several that have provisions that put some obligations on certain providers, but they do not wholly prohibit them from entering the pay TV market and becoming convergent operators. – Moreover, two convergent operators bought exclusive TV rights: A1 for the Champions League (https://www.uefa.com/uefachampionsleague/news/0253-0d82037aaedd-f371c464f919-1000--where-to-watch-the-action/) and HT for the Europa League (https://www.uefa.com/uefaeuropaleague/news/0255-0e98c81243a0-8146fd07b94a-1000--where-to-watch-the-games/). Arguably, A1 and HT have achieved contractually what the Electronic Media Act was trying to prevent through its barriers to affiliated enterprises. [54] – However, the United Group, to which Telemach belongs, has a strong market presence and market power not only in the media but also on the content markets in Croatia. As a result, giving Telemach the ability to bundle its telecommunications offers with its media and content offers would put it in a very strong position, especially if HT and A1 are not given the possibility of acquiring content from the United Group, or at unfavorable conditions. In this regard, HAKOM published decisions that did not impose any remedies on the merger between Telemach and United Group, due to the existence of Article 61 in the Electronic Media Act, and did not consider it a barrier to entry but instead as a gatekeeper from any form of possible abuse of United Group due to its market power in the related markets.[55] In addition, it should be noted that the Electronic Media Act does not prevent Telemach from buying exclusive TV rights, as A1 and HT did with TV rights to soccer games, provided that it contracts a third party for the production of the content (as did A1 and HT).
Impact assessment	– **HIGH IMPACT,** since barring operators from offering IPTV services is not necessarily the most effective means of dealing with a potential market failure that directly impacts the level of competition on the fixed retail broadband market. Moreover, when the development of the bundles is taken into account, this kind of market barrier can influence the level of investment and the prices and benefits for end users. The market that is most competitive (mobile services) has the highest growth rates in terms of revenue, and this competition-induced growth is lost to the fixed segment due to these barriers.
Potential solutions	– Evaluation of the provisions of the existing Electronic Media Act that prevent? an increase in market competition in the segment of bundled offers. The changes could range from simply deleting the relevant provision to replacing it with some lighter touch safeguards or obligations on certain providers to address the concerns. In any event, any modification to the Electronic Media Act should also include clauses that would protect other market players from any abuse of market power in general and in this instance, from Telemach/United Group (such as proposing content under excessive pricing or any other discriminatory terms and conditions that would give Telemach prevailing market power).

54 A1 and HT legally circumvented the provisions of the Electronic Media Act by contracting a third party for the content, hence not distributing content as one legal entity.

55 See http://www.aztn.hr/aztn-ocijenio-dopustenom-koncentraciju-poduzetnika-slovenia-broadbanda-i-tele2/ and http://www.aztn.hr/ea/wp-content/uploads/2020/03/UPI-034-032019-02009.pdf.

5.2.4. Limitations in the current wholesale regulations

Inhibitor	Limitations in the current wholesale regulations
Description	– Looking at the current market structure and competition, the market does not appear to be regulated effectively. In particular, the market share of the HT Group in terms of subscribers raises the question of whether the MST and other wholesale regulations as currently implemented are fulfilling their purpose. HT's market share has been stable and high since wholesale regulation was implemented some years ago. – The wholesale prices of HT as the incumbent could be an additional barrier to market development. – One operator is of the opinion that with such wholesale offers and prices (especially the wholesale regulated price of FTTH), there is no operator in the fixed segment market that can effectively compete with HT, which represents a barrier to any new market entrant.
Evidence or material collected	– There are almost no alternative operators existing in the market. – In figure 37, it can be seen that the number of LLU lines has decreased since 2015 while the number of bitstream lines has remained stable, which suggests that the increase in broadband penetration in the past five years has not come from wholesale service but through new infrastructure or via the old one but with HT's end users. – On the other hand, wholesale products are defined by HAKOM based on a bottom-up cost model, and HT highlights that its LLU fees (€5.56) are among the lowest in Europe and below the EU average (€7.94). HT also mentions that the changes to the MST rules imposed by HAKOM in 2019 resulted in one of the most restrictive MST approaches in Europe. Finally, HT suggests that the decrease in LLU lines is linked in fact to the increase in FMS offers and not to the ineffective wholesale regulation.
Impact assessment	– **MEDIUM IMPACT,** due to the fact that it influences only that part of the market in which other infrastructure cannot be economically replicated
Potential solutions	– Possible revision of all wholesale prices and MST rules

5.3. LAND ACCESS OR USAGE, CONSTRUCTION, AND RIGHTS OF WAY

5.3.1. High fees for land access (rights of way)

Inhibitor	High fees for land access (rights of way)
Description	– The right-of-way fee regime (use of land for telecommunications infrastructure) is regulated by a HAKOM ordinance. The fees are different for different types of land: urban, agricultural, forests, etc. – The current regulation could have a negative impact on investments in the telecom sector. The burden on HT, based only on the right-of-way fee for the use of public municipal land, amounts to almost HRK 180 million per year (statement of HT). – In addition, the right-of-way mechanism tends to be discriminatory in two ways: - only telecommunications operators are charged, and other linear infrastructures (e.g., electric, gas, water, etc.) are excluded. - state-owned companies (i.e., OIV, HEP, Janaf, etc.) are excluded from paying for the use of public roads and for the use of all other types of public land. – An additional complexity is that political stakeholders understand the problem, but the fees provide income for local governments and any potential reduction will impact municipal budgets.

continue

Inhibitor	High fees for land access (rights of way)
Description	– For the use of public roads, a special fee is prescribed and determined by the central government, but public road managers (county road authorities) ignore this determination and, at their own discretion, require HT to pay a right-of-way fee that is multiples higher than the government's rate, which leads to the payment of various fees for the use of the same public land (public roads) (roughly 1/3 of total ECI is located on public roads, according to HT). – For the use of public roads, a special fee is prescribed and determined by the central government, but public road managers (county road authorities) ignore this determination and, at their own discretion, require HT to pay a right-of-way fee that is multiples higher than the government's rate, which leads to the payment of various fees for the use of the same public land (public roads) (roughly 1/3 of total ECI is located on public roads, according to HT).
Evidence or material collecte	**Right of way fees** – In the 2018 study, *"Analitičke odrednice naknade za ppro puta za elektroničku komunikacijsku infrastrukturu"* (Analytical Determinants of the Rights-of-Way Fee for Electronic Communications Infrastructure"), the Institute of Economics in Zagreb concluded that out of 33 European countries analyzed, 25 either do not charge a fee for the right of way through public land, or the fee is related to the land's market value and/or a reduction in market value due to the needs of the ECI. – The study also concluded that Croatia is the only European country that determines the fee for right of way through private land in an ordinance. In most countries (20 out of 33), the right-of-way fee over privately owned real estate is determined by agreement between the real estate owner and the telecommunications network provider. – The same study found that the potential share of the rights-of-way and easement fees in HT operating revenues is up to 6% (HT gave the same figure during interviews), while telecommunications companies in the region allocate between 0.3 and 1.6% of annual revenues. – However, there is no demonstrated evidence that decreasing right-of-way fees would directly translate into increased investments in digital infrastructure. **Discrimination** – HAKOM's ordinance on rights of way (https://narodne-novine.nn.hr/clanci/sluzbeni/2011_12_152_3151.html) refers only to the ECI, which means that only telecommunications operators are charged. – In Article 86, paragraphs, 2 and 3 of the Law on Roads (https://www.zakon.hr/z/244/Zakon-o-cestama), it states that the fees for the acquisition of easements and construction rights on public roads shall not be paid when this right is acquired by publicly owned/stated owned companies/institutions.
Evidence or material collecte	– In Article 4 of the Law on the Regulation of Property Rights for the Construction of Infrastructure Buildings (https://www.zakon.hr/z/482/Zakon-o-ure%C4%91ivanju-imovinskopravnih-odnosa-u-svrhu-izgradnje-infrastrukturnih-gra%C4%91evina), it states that fees for the acquisition of property rights, easements, and construction rights shall not be paid when this right is acquired by public or state-owned entities, or from each other, for the construction of infrastructure buildings on their land. – It also states that legal entities owned and/or founded by the Republic of Croatia that manage infrastructure buildings owned by the Republic of Croatia shall not pay a fee for acquiring ownership rights, easements, and construction rights to other legal entities owned by the Republic of Croatia and legal entities whose founder is the Republic of Croatia, which manages the land owned by the Republic of Croatia on which the infrastructure buildings are built.
Impact assessment	– **MEDIUM IMPACT** on the ability of private telecom companies to deploy substantial telecom infrastructure, which could hinder investments.
Potential solutions	– A potential solution might be to eliminate the discrimination between public and private entities. In this way, the burden could be evenly distributed across all linear infrastructures and both private and public companies. Therewith, fees could be reduced on private telecommunications entities with no—or even a positive—impact on municipal revenues.

continue

Inhibitor	High fees for land access (rights of way)
Potential solutions	– An additional solution is to prohibit public road managers from setting the fees they charge to telecom operators and requiring them to charge only the fee determined by the government. – An overall solution could be the adoption of uniform legislation (a law on linear infrastructure) that is equally applicable to all types of linear infrastructure (gas, water, electricity, telecommunications, etc.) to regulate in a non-discriminatory manner all rights and obligations related to infrastructure and evenly distribute the burden on all pipe owners and linear infrastructure operators, regardless of whether they are private entrepreneurs or public law entities, so that all pay the same fees for the same category of real estate/public land.

5.3.2. Some local spatial plans with prohibitive requirements for fixed and mobile infrastructure

Inhibitor	Some local spatial plans with prohibitive requirements for fixed and mobile infrastructure
Description	– Spatial planning and construction of ECI in Croatia is defined through a series of laws and regulations that are, to a large extent, not adapted to the specific conditions for building line infrastructure such as ECI. This makes it impossible to carry out ECI construction projects quickly and efficiently. – Spatial plans (responsibility of local authorities) in some local municipalities are not aligned with the relevant regulation on the development of ECI, with restrictions imposed by local governments that are much greater than those at the national level. Many local authorities refuse to harmonize with the national regulation. – Through their spatial planning documents, illegal restrictions and obligations are imposed on operators when constructing ECI such as rooftop antennas, even though the government's regulation specifically stipulates that ECI should not be addressed in those documents. – Spatial plans ignore the existence of the regulation, despite administrative court judgments, according to which spatial plans should comply with the regulation. – The problem is already impacting network performance, and the issue might escalate with 5G's requirements for the densification of base stations. – Discrepancy in state and local regulations, together with differing interpretations, make ECI building very uncertain. The lengthy process at the local level prevents the faster development of mobile and fixed networks.
Evidence or material collected	– Regulation on criteria for the development of ECI (https://narodne-novine.nn.hr/clanci/sluzbeni/2012_11_131_2798.html) Article 5, paragraph 9 of the regulation states that rooftop antennas that are placed on existing buildings are not included in the spatial plans. – Operators claim that through their spatial planning documents, local authorities impose illegal restrictions and obligations on operators when constructing ECI such as rooftop antennas, even though the government's decision stipulates that they should not be included in those documents. – Operators also claim that there is a conflict between the government's regulation and construction laws and corresponding bylaws that allow municipalities to restrict infrastructure building by local spatial plans. – The same issue was recognized in the study, "Analysis of the Effects of Implemented Measures and Activities from the Action Plan of the Strategy for Broadband Development in the Republic of Croatia 2016–2020," prepared by BDO and IRMO in May 2018, which evaluated the implementation of the Strategy for the MSTI (page 92).
Impact assessment	– **HIGH IMPACT,** in terms of significant restrictions in network expansion and lower network performance
Potential solutions	– A potential solution might be to design a national spatial development plan that covers the entire country and could be adopted after a comprehensive and transparent public consultation process. This would align development throughout the whole country. – The government's decision on criteria for the development of ECI and other associated facilities has to be directly applicable in case local spatial plans are not in compliance.

5.3.3. Construction regulations for building ECI (both fixed and mobile infrastructure) that do not ensure fast and cost-effective deployment

Inhibitor	**Construction regulations for building ECI (both fixed and mobile infrastructure) that do not ensure fast and cost-effective deployment**
Description	– The operators interviewed defined a number of problems they currently face. The most important ones are: – General conditions for deploying ECI (both fixed and mobile infrastructure) do not ensure fast and cost-effective deployment since: - basic elements of fixed ECI are not recognized legally, leading to the inconsistent application of legislation in practice. - exceptions from the requirement to obtain permits for specific elements of ECI are not recognized (such as rooftop antennas). - mini- and micro-trench technology is not recognized as a technical construction standard for which a building permit is not required. - administrative procedures for obtaining the different permits are too long and complex and the administrative fees are too high. – Construction costs represent 80% of all deployment costs of new ECI, and the construction process is extremely complex because it requires compliance with spatial planning documents, resolution of property and legal rights with different landowners, and the acquisition of construction and usage permits from competent state and local administration bodies. – In addition, coordinated investments in municipal infrastructure, according to the principle of construction-integrated infrastructure, have not been implemented in practice. Individual operators of various types of line infrastructure continue to build line infrastructure independently for their own purposes, even when dealing with the same type of infrastructure (e.g., ECI).
Evidence or material collected	– Most of the above-described problems were recognized in the BDO/IRMO study of May 2018. – In Chapter 3 of the study, BDO and IRMO made several proposals on ways to amend objectives, priorities, measures, and activities in order to improve the implementation of the broadband strategy. As the study was done in May 2018, and given that the operators interviewed still highlight the same issues, it can be concluded that no improvements have been made since then.
Impact assessment	– **HIGH IMPACT,** related to significant problems in the speed of network development and investments made
Potential solutions	– Amend the existing construction regulations or adopt special regulations in the construction and physical planning of ECI, with the aim of simplifying and shortening the administrative procedures related to issuing building permits; recognizing mini- and micro–trench technology as a technical standard for construction for which a building permit is not required; and enabling coordinated investments in integrated infrastructure, among other objectives, in order to secure a faster and more efficient ECI construction process.

5.3.4. Concerns over the legality of legacy fixed infrastructure due to lack of permits (property rights issues)

Inhibitor	**Concerns over the legality of legacy fixed infrastructure due to lack of permits (property rights issues)**
Description	– Permits to construct new, or to build on top of existing, infrastructure require evidence of property ownership. – The lack of permits poses a problem to EU funding for all operators (HT, OIV) for the aggregation network program. – In 2019 there was an initiative for the legalization of fixed infrastructure, including telecom, through a special law on legalization, but it failed.
Evidence or material collected	– Not all permits for all infrastructure have been obtained. This was not a problem when HT was a state entity and EU funding was not an issue.
Impact assessment	– **HIGH IMPACT,** in terms of the possible duplication of infrastructure as existing infrastructure cannot be upgraded
Potential solutions	– To adopt a law on the legalization of legacy fixed and mobile infrastructure

5.3.5. EU Directive on measures to reduce the cost of deploying high-speed electronic communications networks transposed into national legislation, but not functional in practice

Inhibitor	**EU Directive on measures to reduce the cost of deploying high-speed electronic communications networks transposed into national legislation, but not functional in practice**
Description	– Operators claim that though Directive 2014/61/EU has been transposed into Croatian legislation through the Law on Measures to Reduce the Cost of Deploying High-Speed Electronic Communications Networks and through amendments to the ECA, no improvement has been made in practice thus far to stimulate faster and more cost-effective deployment of high-speed electronic communications networks. – Coordinated investments in municipal infrastructure, according to the principle of construction-integrated infrastructure, have not been implemented in practice. Individual operators of various types of line infrastructure continue to build line infrastructure independently for their own purposes, even when dealing with the same type of infrastructure (e.g., ECI). – One operator stated that a SIP, the creation of which derives from Directive 2014/61/EU by the DGU, has not yet been implemented. All network operators that perform civil works are obligated to provide information to the SIP on their works. Any interested party can access the information. – Contrarily, the MSTI and HAKOM are of the opinion that the SIP has been established and that the coordination of civil works has been implemented. HAKOM, however, acknowledges that actual use by operators is still limited. The process of granting civil works permits is being implemented in accordance with the Building Act.
Evidence or material collected	– If a SIP has been established, it is likely that there is a problem of feeding the data from construction companies into the system, which could explain why operators contend that the SIP is not functioning. – According to interviews with stakeholders, it can be concluded that the provisions of the directive, and its functioning in practice, are not fit for purpose at the current time. – The May 2018 study by BDO and IRMO concluded that: *The adoption and implementation of the Law on measures for reducing the costs of deploying high-speed electronic communications networks represent one of the implementation measures of the existing Strategy. The analysis … revealed serious difficulties in the implementation of this measure, as well as the related Law. By reviewing all available material and communicating with competent state institutions and operators, it was determined that the difficulties of implementation of the Law are not caused by its provisions being lacking or flawed, but for the lack of its implementation in practice. Regardless, it must be pointed out that there is a notable lack of a clear and unambiguous obligation of a specific state body regarding overarching monitoring of the effects of the Law and informing the stakeholders, as well as educating the subjects of the relevant Law, especially network operators, on its provisions and obligations, especially network operators. It is also a consequence of the situation in which the scope of the Law appoints responsibilities for its implementation to several public bodies (MSTI, HAKOM, MGIPU, DGU).* – In the same study, it was advised that the Law on Measures to Reduce the Costs of Deploying High-Speed Electronic Communications Networks should be retained, but with additional activities introduced.
Impact assessment	– **HIGH IMPACT,** as construction costs (digging, civil works, etc.) make up roughly 80% of the total cost
Potential solutions	– Providing information on the provisions and obligations in the law to the relevant persons, in particular to network operators – Monitoring and reporting on key performance indicators of the functioning of the law/system (e.g., number of contracts concluded, quantity of infrastructure (in km) provided to the SIP, etc.) – Possibly instituting stricter inspection and supervision of the law's implementation

5.4. SPECTRUM

5.4.1. Spectrum fees

Inhibitor	High spectrum fees
Description	– Total annual fees for the use of RF spectrum in Croatia are considered very high by some operators, but the authorities have taken steps to decrease these fees in the past few years. – By adopting an ordinance on amendments to the ordinance on the payment of fees for the right to use addresses, numbers, and RF spectrum (OG 126/17) of December 19, 2017, the existing RF spectrum fee to be paid by mobile operators was reduced by one-third (for all three mobile communications operators) to a total amount of roughly HRK 182 million per year. – In June 2018, the MSTI adopted the new ordinance on amendments to the ordinance on the payment of fees for the right to use addresses, numbers, and RF spectrum (OG 55/18) in order to remove the existing barriers to investment in the mobile network market and to continue to increase the investment potential of the public mobile network operators. These amendments comprise: - A one-off fee for the use of RF spectrum for public mobile networks, amounting to HRK 150 million (a total of HRK 450 million for all three operators), was abolished, thus removing the existing barrier to investment for operators in the radio spectrum that was required for introducing and developing 5G technologies and services in the Republic of Croatia. - The annual fee for the part of the RF spectrum (1900 MHz–1920 MHz) that public mobile network operators do not use due to technological limitations was abolished (a total of HRK 12 million per year for all three operators). - A mechanism was introduced to apply uniformly the annual fee for the use of unused RF spectrum to all operators of public mobile networks in the Republic of Croatia. – In June 2020, the MSTI adopted the new ordinance on amendments to the ordinance on the payment of fees for the right to use addresses, numbers, and RF spectrum (OG 73/20) in order to implement measure 15 of the Action Plan for the Reduction of Non-Tax and Parafiscal Charges 2020, adopted by the government of the Republic of Croatia on May 7, 2020, as one of the commitments undertaken by Croatia within the European Semester and the National Reform Programme. The ordinance reduces the annual fee for the use of unpaired RF spectrum to 50% of the existing amount in order to provide relief to all public mobile network operators of approximately HRK 99.8 million annually. – The ordinance also provides a mechanism whereby the effect of the said reduction of the annual fee will be applied equally to all operators in the ensuing years of validity of their licenses for the use of radio spectrum by recognizing their right to a refund of the difference between the amounts of the fee paid for the last billing period according to previously valid regulations and the amount of that fee determined by this ordinance.
Evidence or material collected	– The 2017 GSMA study, "Effective Spectrum Pricing in Europe: Policies to Support Better Quality and More Affordable Mobile Services" (https://www.gsma.com/spectrum/wp-content/uploads/2018/12/Effective-Spectrum-Pricing-in-Europe.pdf), compared reserve prices for the 800 Mhz band and showed that Croatian prices were higher in relative terms. But this analysis does not take into account the recent and significant changes that have since been introduced.
Impact assessment	– Possibly **HIGH IMPACT**, but more evidence is needed on spectrum fees compared to the EU, given the potential high impact on the market
Potential solutions	– Significant reductions in the annual state budget and annual HAKOM fees, but only after a thorough analysis of the current level of spectrum fees in EU member states

5.4.2. Spectrum imbalance among MNOs

Inhibitor	Spectrum imbalance among MNOs
Description	– The imbalance in frequency allocation in low bands for 4G and 5G spectrum between Telemach and the other two players (HT and A1) could affect competition in the provision of 5G services. – Telemach believes it is limited in its ability to offer any IoT-based solution due to the lack of low band spectrum, which is crucial for deep indoor/underground smart metering use cases.
Evidence or material collected	– Chapter 3 shows that Telemach lacks the spectrum in low band and that it is in a less favorable position in terms of market potential compared to the other two players. – On the other hand, the spectrum imbalance is a consequence of Telemach's business decisions, resulting in a situation in which regulatory remedies are typically not appropriate as they could distort fair market competition. In addition, the quantity of spectrum available to an operator has to be commensurate to its subscriber base to ensure a satisfactory quality of service; in this regard, the allocation of spectrum relative to the subscriber market shares does not appear unreasonable. – In addition, IoT-based solutions can also be used in other spectrum bands, such as 900/1800 MHz bands, or the unlicensed spectrum.[56]
Impact assessment	– Possibly **HIGH IMPACT**, but more evidence is needed on the potential risks of the spectrum imbalance among MNOs on future market developments, the competitive environment, and the proper introduction of 5G services
Potential solutions	– Possible refarming. Any solution should ensure that it does not distort competition dynamics.

5.4.3. Impact of the interference from neighboring countries on 5G spectrum assignments

Inhibitor	Impact of the interference from neighboring countries on 5G spectrum assignmentst
Description	– There are several implementation risks identified in the national roadmap for the use of the 470–790 MHz frequency band. In the continental part of Croatia, clearance of the 700 MHz band is not planned until April 2021 and in the Adriatic part, until October 2021. Some of the main reasons are related to neighboring countries: - The band will not be cleared, at least in the Adriatic area, until the existing pay TV MUXs using the 700 MHz band are able to migrate to the channels below 694 MHz due to the present interference from Italy (i.e., Italian broadcasters are using Croatian GE'06 channels) - TV operation in the 700 MHz band in some countries outside the EU
Evidence or material collected	– There is a history of issues with Italian interference across the Adriatic Sea, mainly felt during the analog TV switchover (first digital dividend). – The plans for a second digital dividend among Croatia's non-EU neighbors are not satisfactory and do not have to comply with EU rules and deadlines as Croatia does. This was the case with the analog TV switchover (first digital dividend) in the border areas of Croatia.
Impact assessment	– Possible **HIGH IMPAC**T on 5G introduction, development, and implementation
Potential solutions	– Further diplomatic efforts, as well as additional actions by international organizations (e.g., the International Telecommunication Union (ITU)

56 Refer to documents published by HAKOM during the Public consultation on future award of bands 700 MHz, 1500 MHz, 3.6 GHz and 26 GHz and Public consultation on future award of bands 700 MHz, 800 MHz, 900 MHz, 3.6 GHz and 26 GHz

6. Specific Opportunities in Emerging Technologies

6. SPECIFIC OPPORTUNITIES IN EMERGING TECHNOLOGIES

6. Specific Opportunities in Emerging Technologies

6.1. INTRODUCTION

In this section, four emerging global trends and their specific applicability in Croatia are analyzed:
- the Internet of Things (IoT)
- artificial intelligence (AI)
- data centers and cloud services
- smart cities

For each of these, parallels are made between EU efforts in the particular domain and what Croatia has achieved or intends to achieve, and then specific recommendations are offered for further development.

6.2. INTERNET OF THINGS (IOT)

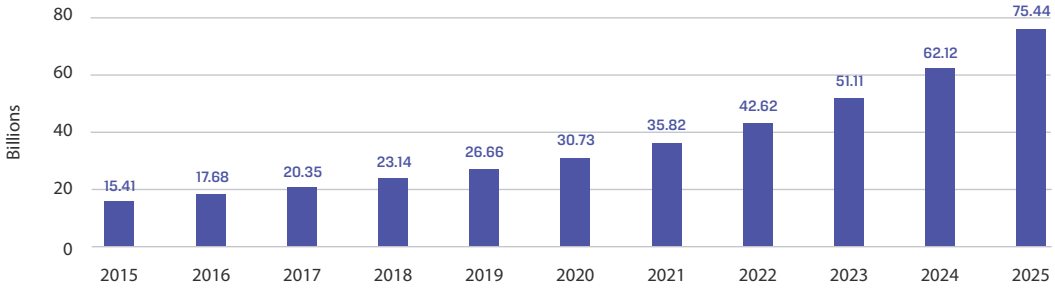
6.2.1. Technology introduction

According to the EC's definition, the IoT is about setting up new ecosystems that cut across vertical areas and create new markets for hardware (connected devices), software (IoT platforms and systems), and services (IoT applications).

The IoT is based on various disciplines and technologies, such as sensors, embedded systems, and assorted communications technologies. It requires a specific configuration for object identification and search, open/closed data sharing, lightweight communication protocols, a trade-off between local and network-based information processing, and back-end integration. It also requires specific considerations of data security (e.g., location-based profiling), liability (many service providers involved), seamless identification and authentication mechanisms (including those of persons/entities needed for managing contractual relations, attribution, and liability), and trust. All of these factors increase the complexity of the IoT ecosystem.

According to 2018 statistics, it was expected that the number of installed connected devices would double between 2015 and 2020 from 15 to 30 billion and continue to grow by nearly 2.5 times to 75 billion by 2025.

FIGURE 50.
IoT-Connected Devices Installed Worldwide from 2015 to 2025 (in billions)



6.2.2. Europe-wide initiatives

In March 2015, the Alliance for Internet of Things Innovation (AIOTI)[57] was launched by the EC to support the creation of an innovative and industry-driven European IoT ecosystem. The Commission is working closely with AIOTI and all IoT stakeholders and actors on the establishment of a competitive European IoT market and the creation of new business models.

In 2019, the EU conducted a comprehensive mapping overview of the geographic areas of the IOT innovation clusters operating within its borders, as well as their main specialization in the specific kind of IoT areas.[58] The study targets were: a smart living environment; smart farming and food security; wearables; smart cities and smart communities; smart mobility; smart environment and water management; and smart manufacturing. The study identified a number of clusters (see the figure below) in each EU country, with Spain in a leading position. However, no IOT clusters were identified in Croatia as can be seen from the map in figure 51.

The study also identified the rationales behind the establishment of the IoT clusters and concluded that most were created to respond to industrial and sectoral crises in specific geographic areas, often of large enterprises (such as Ericsson and Nokia). It further explained that in most cases, the clusters were driven by public-private partnerships (PPPs), but their sustainability does not rely on public funding. Clusters have the purpose of supporting specific industrial strategies, such as Industry 4.0; in some cases, they are established as part of EU, national, or regional research and innovation or development programs and initiatives, such as Horizon 2020 or the ESIF.

The study also noted that in several cases, large players promoted and supported cluster creation. They include large multinational companies and large research and technology organizations and are considered to be the natural counterparts to the government bodies and agencies engaged in their setup and support.

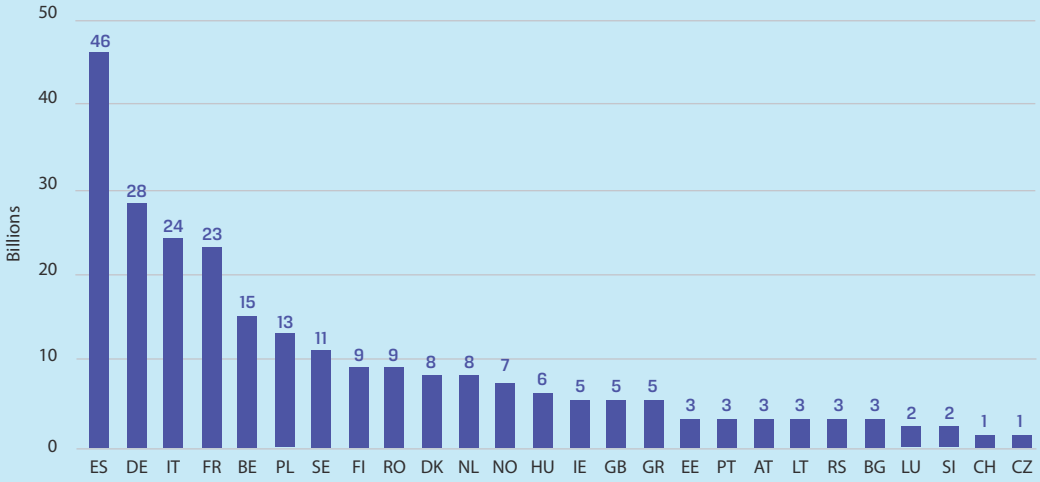
The examined case studies demonstrated that government bodies and administrations are key stakeholders and contributors, but they are not critical to the clusters' sustainability; in fact, the usual patterns of public financial support are often considered unsuitable to sustaining cluster missions.

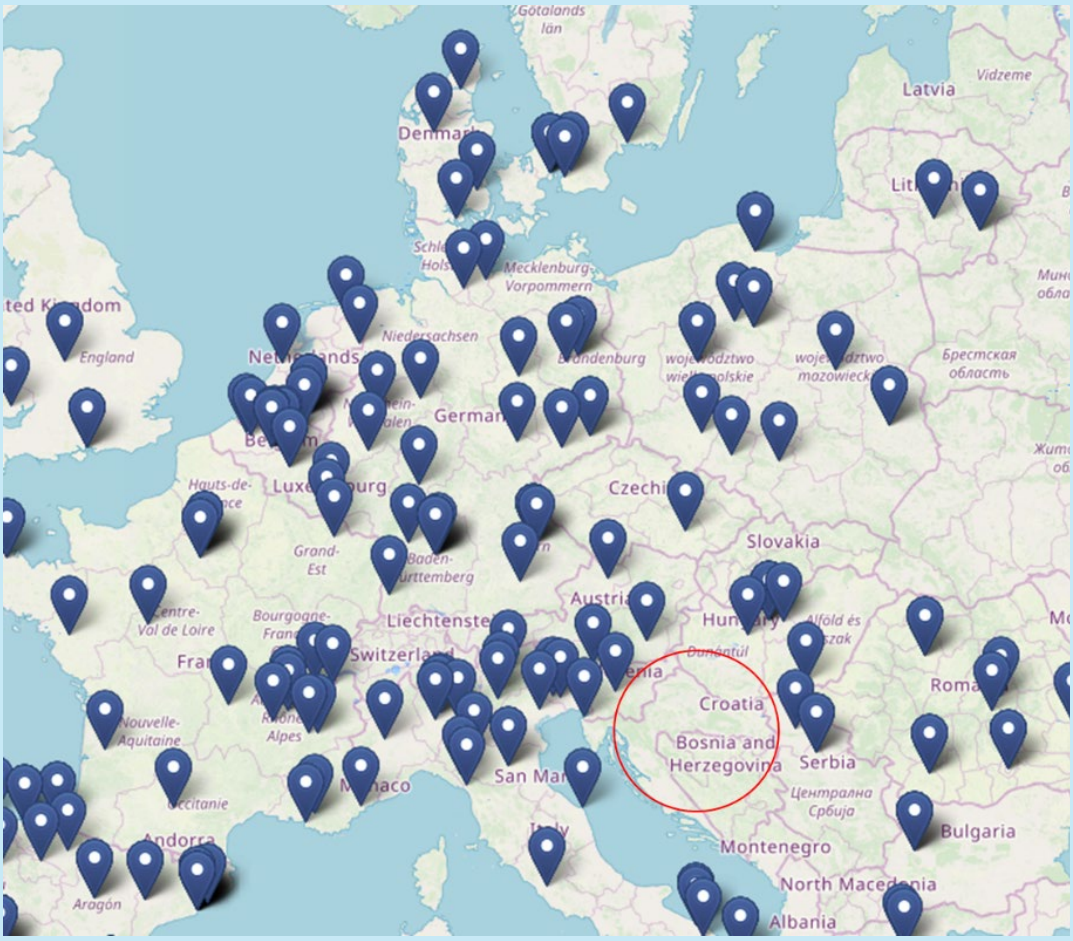
Another study looking at the barriers to IoT development in Europe identified as a key inhibitor the importance of promoting an interoperable IoT numbering space for universal object identification that transcends geographic limits and an open system for object identification and authentication. Some aspects of numbering were already addressed in the 2016 review of the EU's telecoms rules.

57 For more information, see https://aioti.eu/.

58 See EC, "Mapping Internet of Things Innovation Clusters in Europe," https://ec.europa.eu/digital-single-market/en/internet-of-things/clusters.

FIGURE 51.
Number of IoT Clusters per Country





Source: Eurostat.

6.2.3. Croatia-specific initiatives

Very little IoT development was identified in Croatia, though OIV is one of the few stakeholders that is currently developing such platforms. According to the feedback, OIV is developing a multipurpose IoT platform called OIV Smartino IoT. The platform is based on LoRaWAN technology and provides wireless monitoring and control services for water, gas, and electricity meters as well as sensors for air quality, smart buildings (temperature and humidity), parking, garbage cans, and street lighting control. Currently, the OIV Smartino IoT service is available in the largest Croatian cities ready for the implementation of smart city projects.

6.3. ARTIFICIAL INTELLIGENCE (AI)

6.3.1. Technology introduction

According to the EC definition, AI endows systems with the capability of analyzing their environment and making decisions with some degree of autonomy to achieve goals. Machine learning denotes the ability of a software/computer to learn from its environment or from a very large set of representative data, enabling systems to adapt their behavior to changing circumstances or to perform tasks for which they have not been explicitly programmed.

To build robust models at the core of AI-based systems, high-quality data are a key factor in improving performance. The Commission has adopted legislation to improve data sharing and open up more data for re-use, including public sector data as well as research and health data.

6.3.2. Europe-wide initiatives

The EC[59] has recently increased its annual investments in AI by 70 percent under the research and innovation program Horizon 2020. It will reach €1.5 billion for the period 2018–20 and will:
- connect and strengthen AI research centers across Europe
- support the development of an "AI-on-demand platform" that will provide access to relevant AI resources in the EU for all users
- support the development of AI applications in key sectors

The EU has also established AI4EU,[60] a consortium of 81 European academics, technology leaders, policy makers, companies, and businesses in AI, industries, and non-AI sectors. The project is funded by the European Horizon 2020 program. The consortium partners are shown in figure 52.

As published on their website, AI4EU is to distribute €3 million equity-free among individuals, start-ups, and SMEs. There will be two types of calls:
- **AI prototypes.** Under this call, AI4EU will select 25 individuals who could be researchers, students, or developers per open call. Beneficiaries can receive up to €30,000 and a four-month support program to develop prototypes based on AI resources. Two open calls will be launched, addressing five different challenges that will be owned by industrial partners, corporates, or other EU projects.
- **Tech transfer program.** AI4EU will select 20 scale-ups that could be financed up to €180,000 in equity-free cash, plus an online premium acceleration program. The setup will include mentoring from top entrepreneurs and C-levels, training, access to technology, and access to private and public investment, among other benefits.

59 See EC, "Artificial Intelligence," https://ec.europa.eu/digital-single-market/en/artificial-intelligence.

60 For more information, see https://www.ai4eu.eu/ai4eu-open-calls.

FIGURE 52.
Consortium Partners

The first AI prototype open call was scheduled to be launched in the first quarter of 2020 but was delayed as a consequence of the COVID-19 virus outbreak across Europe.

The EU has also appointed members to a High-Level Expert Group on Artificial Intelligence who will define some of the EU-wide policies on AI.

In its strategy on AI for Europe, the Commission offered to work with member states on a coordinated plan on AI by the end of 2018, with the aim of maximizing the impact of investments at the EU and national levels, encouraging synergies and cooperation across the EU, exchanging best practices, and collectively defining the way forward to ensure that the EU as a whole can compete globally. This proposal for a coordinated plan was built on the declaration of cooperation on AI that was launched in April 2018 on Digital Day and signed by all member states as well as Norway. It was endorsed by the European Council in June 2018.

6.3.3. Croatia-specific initiatives

Launched in February 2020, the Croatian AI Association (CROAI)[61] is a nongovernmental organization that connects many organizations and individuals working in the field of AI with a common vision and mission on how to use AI and what to develop and deploy as their own solutions. It should be noted that A1 is the only telecom member in this organization.

CROAI recently launched an AI-powered personal assistant called "Andrija"[62] that will help people become informed about the COVID-19 virus.

61 For more information, see https://www.croai.org/.

62 See https://andrija.ai/ (in Croatian).

6.4. DATA CENTERS AND CLOUD SERVICES

6.4.1. Technology introduction

Data centers are dedicated facilities that house computer systems and associated components. They are categorized by different Tiers (1–4): the higher the number the more reliable the setup and data redundancy. Due to the data boom currently being experienced on a global scale, data centers are increasingly important for the future, with a recent trend to move to hyperscale data centers supported by industry giants like Microsoft, Facebook, Amazon, and Google. Cloud services are usually connected to the data centers and offer an alternative model of data storage and processing on demand. Users can access their data and applications on the device of their choice over the internet.

6.4.2. Europe-wide initiatives

As both data centers and cloud computing have been a developing trend for a number of years, there are numerous EU initiatives and research on the subject.

One of the most important enablers of cloud computing was the Free Flow of Non-Personal Data Regulation, together with the General Data Protection Regulation, which established the unrestricted movement of all data across Europe. By May 30, 2021, all existing unjustified data localization restrictions must be removed. Thanks to this stipulation, companies will now be able to store and process their data anywhere on EU territory.

In the Horizon 2020 funding program, the EU invested roughly €300 million in projects related to cloud computing and software between 2014 and 2020.

Cloud-for-Europe (C4E) is a key piece in the European Cloud Computing Strategy executed between 2013 and 2017. The public sector initiative investigated the cloud procurement requirements of public organizations using pre-commercial procurement across Europe. It is a double partnership, with both public sector organizations and industry.

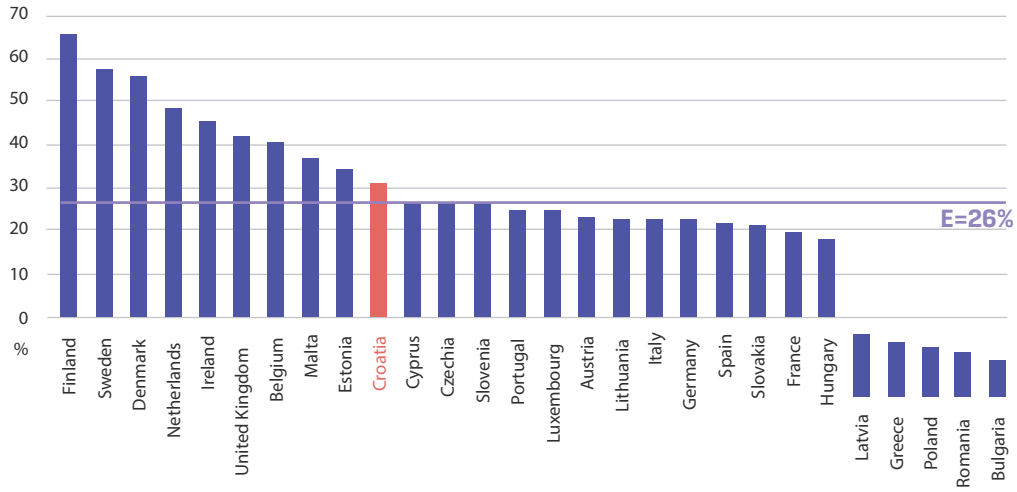
The top data center markets in Europe can be found where the largest internet exchanges reside—what are called the "FLAP markets," referring to Frankfurt, London, Amsterdam, and Paris. The London Internet Exchange, or LINX, DE-CIX in Germany, and AMS-IX in the Netherlands are all world-class peering exchanges with hundreds of the largest networks exchanging huge volumes of traffic.

6.4.3. Croatia-specific initiatives

According to a Eurostat survey in 2018, 31 percent of Croatian businesses with more than 10 employees were using cloud computing services, which is above the EU average of 26 percent.

The main Croatian data centers and characteristics are provided in the table 8.

FIGURE 53.
Use of Cloud Computing Service by Enterprises in EU Member States, 2018 (% of enterprises)



Source: Eurostat ICT usage in enterprises in 2018.

FIGURE 8.
Croatian Data Centers

Data Center	Owner	Characteristics
Altus Zagreb Data Center	Altus IT – first Croatian provider of carrier independent data center services, specialized in colocation, interconnection, and cloud services	50+ telecoms 50% telecoms Tier 1 820 m2 IT 2,000+ fibers 3 ISO certificates 3 geo redundancy links The Croatian Internet Exchange (CIX) = also present at Altus IT data center Power Redundancy: N+1
VIP Data Center	A1	Tier 3 standards, Expected location infrastructure availability of 99.982%
DC Selska	HT – Croatian Telecom	Tier 3 Microsoft Azure cloud Availability 99.982%, 1.6 hours permitted unannounced interruptions per year redundancy (N+1)
Jastebarsko	DataCross – specialist data center company	Tier 3 Service level agreement (SLA) availability 99.982% (Tier 3) 7300 m2 Two independent optical routes leading to two separate nodes in Zagreb Transmission capacity on each route 160 x 10 G
Zagreb DC	Croatian Web Hosting	Tier 3 28 total racks Power Redundancy: N+1 Cooling Redundancy: N+1
Megatrend		Offered services: colocation, dedicated hosting, disaster recovery hosting, virtual data center All data center procedures are certified according to ISO / IEC 9000: 2008, ISO / IEC 27001: 2013 and ISO / IEC 20000-1: 2011 All data center propulsion systems are multiple redundant (2N or better).

Source: https ://datacentercatalog.com/croatia-hrvatska.

In 2015, local media reported that Facebook was planning to build a large data center in Croatia, which, when complete, would be among the three largest in Europe and the only one outside the United States owned by the company.[63] However, no further information has become available on this initiative since the initial announcement. It should be noted that the data center was to be built by Emerson Croatia, which used to specialize in modular data centers; however, according to further announcements, Emerson exited this business in 2016.[64]

In 2019, HT doubled its capacity and modernized its Tier 3 data center in Selska in order to enable all users to move their businesses to the cloud. Its expansion is an integral part of the platform, "World of Better Opportunities," with which HT is realizing its corporate promise to accelerate the digitization of companies and cities as a key determinant of economic and social success in the coming period.

In addition, HT hosts Microsoft Azure Stack, which brings users all the benefits and advantages of the Azure public cloud.

6.5. SMART CITIES

6.5.1. Technology introduction

According to the definition in a 2017 study on the subject,[65] a smart city is an urban area that uses different types of electronic IoT sensors to collect data and then takes insights gained from that data to manage assets, resources, and services more efficiently. In other words, the data are used to improve operations across the city. This includes data collected from citizens, devices, buildings, and assets that are processed and analyzed to monitor and manage traffic and transportation systems, power plants, utilities, water supply networks, waste management, crime detection, information systems, schools, libraries, hospitals, and other community services.

6.5.2. Europe-wide initiatives

The EU has established the Smart Cities Information System (SCIS) to manage and support EU smart city projects.[66] According to its website, SCIS represents a knowledge platform to exchange data, experience, and know-how and to collaborate on the creation of smart cities, providing a high quality of life for citizens in a clean, energy efficient, and climate friendly urban environment. SCIS brings together project developers, cities, research institutions, industry, experts, and citizens from across Europe. It focuses on completed, ongoing, and future projects, mostly co-funded by the EC.

On its map (figure 54.) of Lighthouse projects, only Rijeka is mentioned as a smart city initiative in Croatia.

There is some information about an initiative on the island of Hvar related to the innovative integration of the renewable energy supply and energy efficiency in large communities.

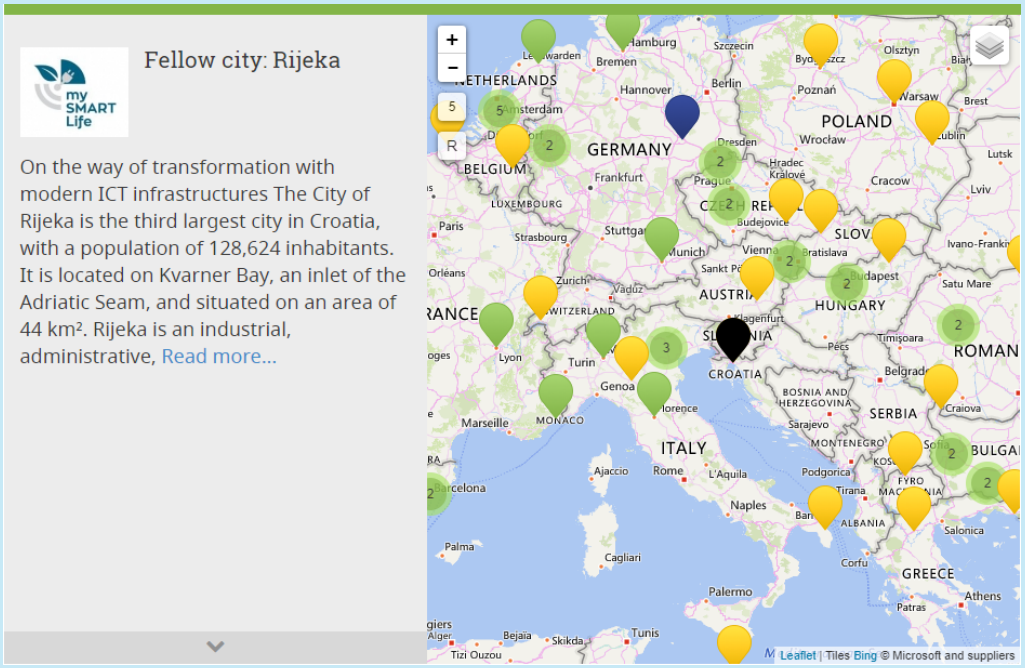
63 "Facebook to Build Data Centre I Croatia?" Croatia Week, May 15, 2015, https://www.croatiaweek.com/facebook-to-build-data-centre-in-croatia/.

64 Hannah Williams, "Emerson Exits Data Centre Business, New Owners Rebrand as Vertiv Hires a New CEO," *Computer Business Review*, December 2, 2016, https://www.cbronline.com/data-centre/emerson-exits-data-centre-business-new-owners-rebrand-vertiv-hire-new-ceo/.

65 D. McLaren and J. Agyeman, *Sharing Cities: A Case for Truly Smart and Sustainable Cities (Urban and Industrial Environments)* (Cambridge, MA: MIT Press, 2017).

66 See https://smartcities-infosystem.eu/.

FIGURE 54.
Rijeka Smart City Map



SCIS has executed a number of initiatives in the areas of energy, mobility and transport, and ICT. Some example initiatives are shown below:

FIGURE 55.
Examples of Smart City Initiatives by SCIS

An interesting example of an initiative is project ESPRESSO,[67] which focuses on the development of a conceptual smart city information framework based on open standards. This framework will consist of a smart city and a number of data provision and processing services to integrate relevant data, workflows, and procedures. The project will build this framework by identifying the applicable open standards, technologies, and information models that are currently in use or in development in various sectors.

67 Fabisch, "Citizen Focus Ambassador Cities Initiative Relaunch," Espresso, November 30, 2017, http://espresso.espresso-project.eu/.

6.5.2. Croatia-specific initiatives

A number of Croatian smart city–related initiatives have been identified:

Dubrovnik. This is a flagship smart city in Croatia, where a smart parking project worth HRK 3.2 million was implemented in July 2019. The technological enabler of its implementation was a consortium of partners led by HT. As part of the project, more than 1,900 parking spaces in the city have sensors installed that can detect if a car is located in a parking spot. They send this information through the NB-IoT network and are visible to drivers through a mobile app and 20 public displays, allowing them to locate vacant parking spaces faster and more easily, which contributes to a reduction in traffic jams. Not only is this the largest project in the smart cities segment in Croatia, but also—in terms of number of sensors and area coverage—it is one of the largest smart parking projects realized on the NB-IoT network in Europe.

Dubrovnik also has the first smart street in Croatia, developed in another partnership with HT. The street has a multifunctional sensor network installed with public lighting, a wireless high-speed internet connection, cameras that monitor traffic violations, smart parking with contactless payments, and environmental controls. All of these initiatives are part of a broader smart city strategy project called Smart City Dubrovnik. Dubrovnik's local development agency, DURA, coordinates the strategic approach by suggesting the implementation of smart technologies in mobility and infrastructure, economic development, and public administration management, thus improving the quality of life for citizens in Dubrovnik.

Zagreb. Zagreb has also taken great strides in its evolution toward a smart city. It developed a smart city strategic document that highlighted six key areas of the city's development: digital infrastructure, smart governance and citizen involvement, smart energy and utility management, education, the economy, and sustainable urban mobility. In addition to these projects, the city administration has invested in the digitization of a series of public services, such as: the Zagreb GEO Portal, an energy information system for the city of Zagreb, and ZagrebNow, a portal for the current status of city services, including road and traffic infrastructure, waste management, public transport, gas and water utilities, and others. City-owned utility companies, such as the gas distributor, Gradska plinara Zagreb (GPZ), have enabled online payment as well as consumption reporting mechanisms for citizens. Large infrastructure initiatives worth mentioning include an LED lighting project for converting city lights into smart LED technology that should be implemented by 2021. The city carried out a start-up factory contest for the tourism industry in 2018, focusing on smart city alternatives. Citizens are welcome to offer and comment on additional ideas that the city can consider for possible realization.

Koprivnica. This was the first city in the region to have obtained the International Organization for Standardization (ISO) certificate "37120: Sustainable Development – Indicators of City Services and Quality of Life," the so-called "Smart City Certificate," by evaluating quality-of-life factors in the city. Koprivnica also became the leading city in Croatia in terms of electronic mobility with a project that aims to address the absence of public transport, which is a consistent challenge for the country's small towns. The city works on implementing electric buses to alleviate the need for a cost-and-energy effective public transport system. Energy efficiency as a goal for the city is visible through various implemented projects, such as the already established car-sharing electric vehicles for city administration employees and businesses. Koprivnica also set up a public bicycle system that includes seven terminals with a total of 60 bicycles. One of the terminals is next to the railway station and provides an additional mode of public transport within the city.

Rijeka. This city boasts a flagship initiative, the Competence Center for Smart Cities in Rijeka, whose key activities combine innovative and developmental projects devoted to the implementation of a strategy for a smart, sustainable, and inclusive local community, active support to local administrative units on the introduction of smart city service components, and the establishment of scientific, technological, and organizational starting points for the application of integrated, intelligent technologies and business models for smart cities solutions. The project should result in 36 scalable and widely applicable innovative solutions for products or technologies that will improve everyday city processes and boost the quality of life for citizens. The project connects private and research (university) partners through cooperative initiatives to develop new and intelligent city-related products and services. HT is part of the partner consortium engaged in the implementation of the project, contributing in the areas of big data, smart mobility, smart infrastructure, and smart waste management.

Hvar. The SCIS-sponsored project on the island of Hvar is located approximately 40 kilometers off the Dalmatian coast.

The objective of Hvar was to make the energy supply 20 percent self-sufficient by 2020 by improving the energy efficiency of existing buildings and constructing new energy-efficient buildings as a primary measure. Altogether, 10 buildings were refurbished during the SOLUTION project (five private and five public, including three schools and two kindergartens), and four buildings were newly constructed.

6.6. CONCLUSIONS

In general, Croatia is performing relatively well in the adoption and exploitation of the emerging technologies analyzed here.

Concerning IoT, it can be concluded that there is not much development of IoT in Croatia, nor is there a cluster or body leading on this issue that could clearly be identified at present. Some operators reported that one of the inhibitors is the lack of low band spectrum, which is crucial for IoT devices. The government should take the initiative and consult with industry on the specific needs of large corporates and SMEs in terms of IoT. EU examples could be also studied to find a sustainable[68] model for the implementation of a Croatian cluster for IoT, similar to the ones identified in the EU study but specific enough to cater to Croatia's requirements (which additionally need to be identified).

Croatia appears to already be plugged into some of the European initiatives on AI and has made some progress in developing the sector through the CROAI initiative. However, its members and activities are at the moment quite limited. The government should therefore make more effort to get the other telecom and IT sector members on board and to stimulate further developments and initiatives.

Croatia has been doing relatively well in the data centers and cloud services sector, given that its cloud services adoption rate is above the EU average. The domestic data centers have been well positioned to serve the national market, and this trend is expected to continue. There were no specific factors that would make Croatia stand out as a favorable data center location for the big global players. Connectivity is mainly through terrestrial links, and there are no major subsea cable routes, no large EU-wide internet exchanges, and no specific climate energy advantages. Therefore, in the short to medium term, Croatia is not seen as an attractive option for hyperscale data center investment. The govern-

68 A. Momcilovic, "Use of Artificial Intelligence: Comparing Croatia with Other Countries' Strategies," Total Croatia News, January 25, 2020, https://www.total-croatia-news.com/business/41051-ai-croatia.

ment should explore any uniqueness or activities that could be found (such as government land use, tax levies) to attract bigger international players, even if only as a hub for the Western Balkans region.

Croatia has had several interesting local initiatives on smart cities, based on the enthusiasm of local officials and the research community. However, there is no common state governance on smart city development or common deployment strategy. It is recommended that the state coordinate in providing more focused knowledge support and technical assistance in certain areas, such as creating the necessary business justifications, if these projects are to be candidates for EU funding.

These and other related government initiatives will support the further development of the digital sector in Croatia and generate additional economic and social benefits. Other indirect benefits from the emerging technologies could lead to:

- job creation, for example, in the form of application developers related to IoT and catering to Croatia's specific SME requirements and/or smart city application developer jobs
- regeneration of certain parts of the country by establishing large-scale or disaster recovery data centers in areas that have historically high unemployment rates
- technology-related manufacturing for street furniture and other physical objects that are part of the smart city ecosystem (smart metering, smart traffic lights, smart signs, and so on)

There is also an opportunity to encourage the participation of women in these new fields, which could contribute to combating the gender wage gap and the gender gap in labor force participation. Women's high levels of tertiary education enrollment do not translate into higher levels of labor market participation, and in particular, Croatian women lag significantly behind men when it comes to graduation from most of the STEM fields. Overcoming this challenge would require policies and initiatives to raise interest and keep women progressively more involved in the STEM professions.

7. COVID-19 Resilience and Recovery

7. COVID-19 RESILIENCE AND RECOVERY

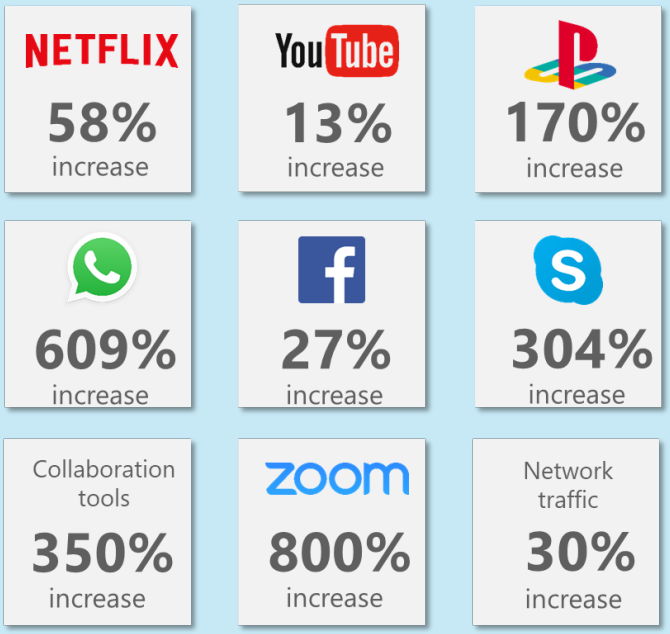
7.1. Short-Term Agenda

7.2. Medium-Term Agenda

7. COVID-19 Resilience and Recovery

The COVID-19 pandemic and the resulting restrictions have highlighted the importance of communications and connectivity and with that, of digital networks around the globe. In many countries, full or partial lockdowns have been applied to slow and stop the spread of the virus. As a consequence, there has been a massive shift of traffic from offices, schools, and universities to the home. Work from home via video conferencing, online education for schools and universities, extensive use of online services, and increased use of video streaming and gaming have resulted in unprecedented growth in network usage. There has never been a period of traffic growth like that which occurred in March 2020 in the whole history of the internet, with a growth of 30–60 percent in that month alone compared to traditional traffic growth of 30–45 percent annually.[69] Since March, Netflix traffic is up by 58 percent; YouTube by 13 percent; PlayStation by 170 percent; WhatsApp by 609 percent; Facebook by 27 percent; Skype by 304 percent; collaboration tools by 350 percent; Zoom traffic by 800 percent; and finally, Akamai[70] by 30 percent.

FIGURE 56.
Usage Increase Since the First Week of Lockdown



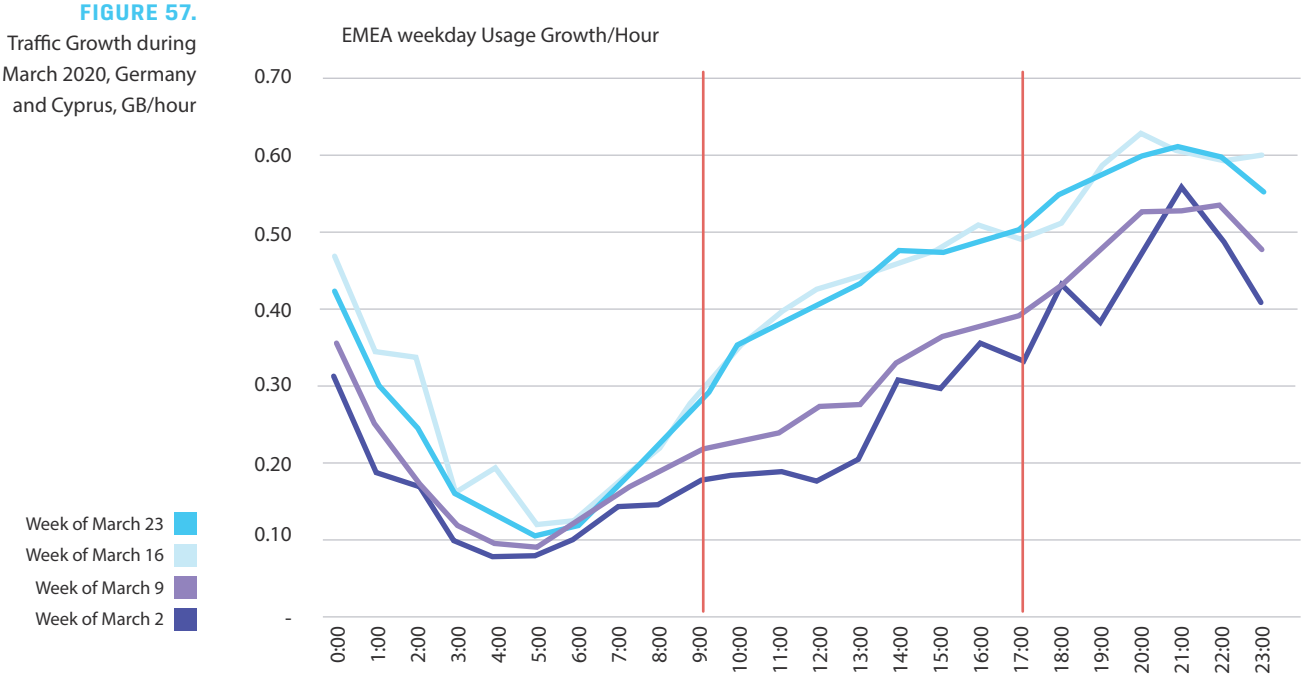
Source: Salience Consulting.

69 CommsDay Summit held April 6, 2020.

70 M. Kincaid, "Kentik Virtual Panel Series, Part 2: How Adamai, Uber and Verizon Media are Supporting Remote Work and Digital Experience," Kentik, April 22, 1010, https://www.kentik.com/blog/panel-series-part2-akamai-uber-verizon-media/.

Significantly, however, this increase in total traffic has mainly been during off-peak hours. Peak traffic volumes have reportedly been more on the order of 20–30 percent. This is to say that the demand increase has been expressed more in the extension of off-peak hours rather than an increase in peak-hour traffic (see the figure below for the example of Germany and Cyprus). This means that since networks are designed to offer more capacity during peak hours, in general, they have not had to significantly increase capacity to meet the new demand. In Croatia, HAKOM and the operators have confirmed that congestion has generally not been a problem.

FIGURE 57.
Traffic Growth during March 2020, Germany and Cyprus, GB/hour



Source: OpenVault.

The more significant impacts of the pandemic are outlined in the table below.

TABLE 9.
COVID-19 Impacts on Operators

Type	Description	Impact
Increased resources to customer care	Implementing staff expansions, remote and virtual agent strategies to deliver increased customer care amid escalating traffic to contact centers	Increased operating expenses (opex)
Internal initiatives to keep workforce running	Like other businesses, operators may face additional expense of enabling employees to work at home, get paid without work, etc.	Increase in opex
Promotions	Providing increased usage allowance, free time; waiving overdue payment fines, etc. to enable customers to use service more in times of need	Foregone revenue and/or increased costs with no return
Closing of Points of Sale (PoS)	Closing of PoS may mean a drop in device sales, top-up, and other revenue-generating activity	Drop in profit
Device sales cycle may be delayed	If new device introduction represents uplift in sales, then the delay will have a negative financial impact.	Lower net present value (NPV) of sales

continue

Type	Description	Impact
Short-term COVID-19-related investment	Operators may voluntarily or by mandate provide additional facilities for the health care sector (base stations at hospitals) to assist in the battle against the virus.	Increase in capital expenditure (capex) without return
Data tracking initiatives	As governments expand their capacity to fight the spread of the virus, they may require operators to assist in tracking certain sets consumers.	Increase in capex and opex, possibly without compensation
Other COVID-19-specific damage	There may be a variety of other impacts experienced in markets that have arisen specifically due to COVID-19. The attacks on cell sites due to false reports of the virus' connection to 5G are an example.	Remedial capex and opex and foregone revenue
General business turn-down	There will be short-, medium-, and potentially long-term revenue implications of the virus. COVID-19 will impact certain sectors more than others and therefore certain revenue streams disproportionately, e.g., roaming.	Profit may fall due to lower economic activity
Cash-flow financing	There may be specific costs associated with measures undertaken to cope with cash-flow issues.	Increased finance costs to overcome cash-flow issues
Loss of advertising revenue	Some operators with certain types of media offerings may be deprived of advertising revenue.	Reduction in revenue
Delay of return on planned investments	For a variety of reasons, investment plans may be delayed, resulting in the lowering of NPV of return.	NPV deltas of delayed investment
Supply chain disruptions	Operators may face increased costs or shortages due to equipment and labor supply volatility.	Increased capex, opex or foregone revenue
Policy choices by regulator	HAKOM has undertaken some actions to ease customer payment pressures (forbidden disconnection) or to release regulatory obligations (suspending MSTs), which may have an impact if the action is prolonged.	Various, depending on the policy and operator affected

Looking at another crisis, the earthquake in March 2020 had a limited impact on telecom operators. HAKOM reports that there were few consequences for fixed access networks, though there were many users affected by power outages in their homes and HT reported some minor issues associated with a disruption of power at a few base stations. The digital infrastructure has demonstrated strong resilience to both the COVID-19 crisis and the 2020 earthquake.

Given the scale and long-lasting consequences of the COVID-19 pandemic, the Broadband Commission for Sustainable Development has developed an Agenda for Action[71] to mitigate its impact and ease the immediate adverse effects on economies and societies. It is recommended that Croatian policy makers, including HAKOM, MSTI, and the operators, follow the Commission's short- and mid-term Agenda for Action to contend with the effects of the crisis, depending on how the situation evolves. In the section below, the agendas proposed by the Broadband Commission are summarized. Most of the agenda items are relevant to building resilience and handling the negative impacts of natural disasters, including earthquakes as well as pandemics.

71 Broadband Commission, "COVID-19 Crisis: Broadband Commission Agenda for Action for Faster and Better Recovery," https://broadbandcommission.org/Documents/Agenda_for_Action.pdf.

7.1. SHORT-TERM AGENDA

The Agenda for Action is based on three different pillars:
1. Resilient connectivity
2. Affordable access
3. Safe use of online services for informed and educated societies

Each pillar contains actions by stakeholder type. The Broadband Commission recommends that each stakeholder take the action and "commit to a common responsibility to collaborate, partner, and develop more sustainable models for preventive and post-crisis development."

TABLE 10. The Broadband Commission's Short-Term Agenda

RESILIENT CONNECTIVITY

Industry, private sector
- Ensure connectivity and network continuity, increase bandwidth capacity and network resilience and security, including for vulnerable populations.
- Manage capacity to ensure rational use of the network.
- Provide vital/emergency services to support the general population as well as emergency responders.
- Lease spare satellite transponder capacity at very nominal costs during an emergency.
- Provide temporary royalty-free software licenses for capacity augmentation and intellectual property rights for related vital service delivery.

Government, policy makers, regulators

Implement policy and regulatory actions to:
- Temporarily relieve network capacity constraints and keep networks running and operational (including by decreasing taxes and fees, offering wholesale services, temporarily freeing up additional spectrum that can be immediately deployed, sharing infrastructure, using existing resources from the Universal Service Fund [USF], promoting cross border roaming, etc.).
- Maintain internet access.
- Support urgent requirements to expand bandwidth and connectivity, inclusive of marginalized groups and vulnerable populations, including refugees.
- Streamline customs procedures and classify network equipment as essential infrastructure to ensure supply chain continuity.

United Nations (UN), intergovernmental organizations (IGOs), international financial institutions (IFIs)
- Mobilize expertise, foster better coordination and international technical support.

AFFORDABLE ACCESS

Industry, private sector
- Provide in-kind support through the donation of ICT services, cloud services, software, equipment, and end-user devices, and support working from home.
- Identify solutions for liquidity and financial shortages to ensure service continuity.
- Offer special tariffs for related health, education, humanitarian, and emergency workers/services.
- Offer free SMS and a zero rating for access to health, educational content, and government information services.

Government, policy makers, regulators

- Facilitate delivery of (and remove barriers to) industry commitments and general provision of ICT services.
- Use USF funding to support affordable access to health, education, humanitarian, and emergency services and people and communities with special needs.

UN, IGOs, IFIs

- Finance national digital connectivity initiatives, as well as electricity generation, transmission, and distribution vital to digital service provision.
- Create pricing strategies and financing/investment documents to help finance national connectivity in schools that can then be extended to health centers, emergency hubs, etc.

SAFE USE OF ONLINE SERVICES FOR INFORMED AND EDUCATED SOCIETIES

Industry, private sector

- Make available broadcasting capacity for education and health.
- Make available safe and secured digital platforms and open source software for health, education, food security, and financial and governmental services, including by sharing open-source digital public goods.
- Promote quality education and information content and services; enhance policies against disinformation and increase transparency.
- Provide online training and safe digital tools to parents and teachers to keep children safer online.
- Share data on a voluntary basis and use AI to perform analytics for prevention and monitoring purposes, ensuring data anonymization.
- Use AI to support medical institutions.

Government, policy makers, regulators

- Provide guidance to consumers and the general population in areas that include child online safety, data protection, and cybersecurity measures.
- Increase proactive publishing to promote access to information, support learning institutions to conduct distance classes, take actions to foster media and information literacy.

UN, IGOs, IFIs

- Promote and nurture innovative partnerships among organizations and with the private sector.
- Support norms and provide resources to educational and media institutions.
- Monitor and promote open educational resources; enhance online capacity building around issues relating to information and disinformation.

Source: Broadband Commission for Sustainable Development.

7.2. MEDIUM-TERM AGENDA

In the medium term, the Broadband Commission recommends a set of high-level actions requiring more coordination among national and international stakeholders. The figure below presents a medium-term agenda to be followed by the industry, policy makers, regulators, the United Nations (UN), intergovernmental organizations (IGOs), and international financial institutions (IFIs).

FIGURE 58. The Broadband Commission's Medium-Term Agenda

Source: Broadband Commission for Sustainable Development.

8. Conclusions and Recommendations

8. CONCLUSIONS AND RECOMMENDATIONS

8.1. SWOT Analysis of the Digital Sector
8.2. Recommendations on inhibitors and opportunities
8.3. Detailed Action Plan
8.4. Three-Year Plan 2020–23

8. Conclusions and Recommendations

In Chapters 2, 3 and 4, possible causes of, or hypotheses about, specific inhibitors explaining Croatia's underperformance were identified. Other hypotheses came from interviews with stakeholders (operators, the MSTI, and HAKOM). In Chapter 5, the potential inhibitors were examined in greater detail. For each inhibitor, the chapter examined the evidence to support it, assessed its impact, and suggested potential solutions. It was concluded that 19 inhibitors may represent real barriers to entry and growth as well as to effective investment, which suggests that these 19 inhibitors are the main reasons that the Croatian telecom sector lags behind its EU counterparts.

This chapter starts by summarizing the conclusions reached on the digital sector in a strengths, weaknesses, opportunities, and threats (SWOT) table. Conclusions on each group of inhibitors are then provided, together with high-level policy proposals and recommendations on how to address the identified inhibitors to market development in Croatia—that is, barriers to entry and growth and factors affecting development and investment in broadband more generally—as well as recommendations to leverage the opportunities identified in the emerging technologies.

8.1. SWOT ANALYSIS OF THE DIGITAL SECTOR

The table below summarizes this study's conclusions on the digital sector in Croatia in a SWOT table.

TABLE 11. Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis

Strengths	Weaknesses
Competition – Satisfying level of competition in mobile telephony and broadband markets – Satisfying fixed network and fixed services competition in densely populated urban areas – Steady increase of bundled services **Mobile services** – Satisfying level of mobile broadband take-up, affordability, and coverage – Excellent mobile network infrastructure – National Action Plan for the usage of the 470–790 MHz frequency band already published **Resilience** – Resilient and scalable digital infrastructure and services in case of crisis like COVID-19	**Governance and state aid projects** – Inadequate ownership and coordination from public bodies and a scarcity of resources for implementing projects – Slow implementation (compared to other EU countries) and inappropriate design (i.e. not fully conducive to private participation) of state aid projects **Market structure** – Overall market structure characterized by strong consolidation in recent years that could restrict market dynamism in the coming years – Lack of third convergent network operator that could boost competition, with the market currently dominated by HT and A1 offering a full range of services (fixed, mobile, broadband, pay TV) – No full or light MVNO present in the market – Fixed broadband market is essentially a duopoly **Prices** – Fixed broadband prices are high relative to Croatian incomes, which negatively affects demand side **Broadband coverage and take-up** – Fixed broadband coverage varies greatly between urban and coastal counties on the one hand and rural and interior counties on the other – In terms of *fast* broadband, take-up of these services is significantly lower in Croatia than the EU and peer group averages. – Croatia is below both the peer group and EU averages for both coverage and take-up of *ultrafast* broadband
Opportunities	**Threats**
New services and technologies – Increase in user demand for broadband access services due to the development of new digital public services – Roaming and tourism – Developed IT industry – Implementation of 5G – Public opinion in post-COVID period that digital networks were one of the main enablers of "normal" life during the pandemic – Some opportunities to develop niche industries in emerging technologies (IoT, AI, Cloud services, Smart Cities, etc.) **Regulatory framework** – Croatian telecom regulatory framework fully aligned with the EU regulatory framework in terms of the core provisions, which means that all the relevant EU directives have been transposed into national legislation – Government plan of introducing new ECA that will deal with some problems on the market (e.g. provisions to facilitate network deployments, strengthen market competition, and improve the spectrum policy) – Possibility of using EU best regulatory practices and experiences (BEREC, NRAs, etc.) in order to deal with problems on the market	**Governance** – Slow decision making on the state level as regards the telecom sector – Low absorption of EU funds for digital infrastructure development – Inadequate coordination among state bodies **Regulatory framework** – Provisions in Electronic Media Act limit Telemach's ability to become a third convergent network operator – Implementation of the national regulatory framework in practice lacks compatibility with several laws (e.g., construction regulations) – Construction regulations for building digital infrastructures (both line and mobile infrastructure) do not ensure fast and cost-effective deployment – Questionable impact of the current wholesale access regulation on competition – Non-legality of some of the already built infrastructure – Lack of regulatory predictability in practice (e.g., tax system, spectrum fees, different regulations covering deployment of the network, etc.) as well as unjustified delays in making key decisions on using EU funds **Deployment and operational costs** – High costs of network deployment for the operators (land access, rights of way, etc.) – Possible high cost of spectrum that could limit investments in new technologies **Spectrum** – Interference from neighboring countries that could affect 5G implementation – Spectrum imbalance among MNOs

8.2. RECOMMENDATIONS ON INHIBITORS AND OPPORTUNITIES

The table below summarizes the conclusions on the inhibitors to broadband development and 15 recommendations to address these issues.

TABLE 12A.
Conclusions and Recommendations for Each Group of Inhibitors

Category	Conclusions	Recommendations
Governance and public investment (EU state aid, etc.)	Most of the recognized inhibitors in this category were found to have a low impact on overall market development and investment, but still, the impact is negative. The common denominator is that all the recognized shortages have already occurred, so the damage was already done and cannot be fixed for the ongoing projects.	1) **Strengthen the institutional organization around the digital transformation agenda.** 2) **Create rules and guidelines that will obligate all stakeholders, including government, to act more quickly and efficiently in the decision-making process related to EU funds.** 3) **Create rules and guidelines that would simplify the state aid procedures related to the telecom sector.** 4) **Simplify the law on public-private partnerships.**
Market structure and competition	As was found in Chapter 3 and through stakeholder interviews, there are three recognized inhibitors related to market structure and competition that have a negative influence on market development and investment, two of which have a high negative impact. The recommendations should remedy these recognized problems and at the same time, fix the problems associated with affordability as well. It is quite important that there be no barriers to the development of healthy competition in the market, as competition itself could solve a number of other problems, such as affordability, need for state aid interventions, etc.	5) **Review wholesale regulations and encourage the entrance of a third convergent market player.** 6) **Evaluate the modifications to the Electronic Media Act.**
Land access or usage, construction, and rights of way	All five recognized inhibitors related to this group are seen as having a high negative impact on market development and investment. This means that resolving them could significantly boost investment, in terms of both lower costs and the less time and resources needed to undertake the investment.	7) **Adopt a uniform legislative solution (e.g., law on linear infrastructure) that would equally refer to all the different types of linear infrastructure (gas, water, electricity, telecommunications, etc.).** 8) **Adopt a national spatial development plan (and potentially spatial planning regulations ahead) for Electronic Communications Infrastructures.** 9) **Amend the existing construction regulations or adopt special regulations in the construction and physical planning of Electronic Communications Infrastructure.** 10) **Adopt a law on the legalization of legacy fixed and mobile infrastructure.** 11) **Impose stricter inspection and supervision of the implementation of the Law on Measures to Reduce the Cost of Deploying High-Speed Electronic Communications Networks.**
Spectrum	Chapter 5 outlined three main inhibitors in the spectrum area. Keeping in mind that fixed mobile substitution takes place and that the boundaries between fixed and mobile are increasingly blurred, spectrum, as a scarce resource, plays a great role in market and competition development. Thus, the availability of spectrum and access to it is of great importance, as is its price, as this affects operators' investment decisions, prices offered to end users, and the timeline in which the new technologies (e.g., 5G) will be introduced.	12) **Undertake an independent comparative analysis and a benchmarking of the level of spectrum fees in EU member states.** 13) **Undertake additional diplomatic efforts to minimize the impact of cross-border interference on 5G development in Croatia.** 14) **Define spectrum auction rules to ensure market competition.**

The table below summarizes the conclusions on the opportunities in various emerging technologies, together with four recommendations on ways to exploit these opportunities.

TABLE 12B.
Conclusions and Recommendations for Opportunities in Emerging Technologies

Category	Conclusions	Recommendations
IoT	There is not much development of IoT in Croatia, nor is there a cluster or body leading on this issue that could clearly be identified at present. Some operators reported that one of the inhibitors is the lack of low band spectrum, which is crucial for IoT devices.	15) **Foster a government initiative to consult with the industry on the specific needs of large corporates and small and medium-sized enterprises in terms of IoT.**
AI	Croatia is already plugged into some of the European initiatives on AI and has made some progress in developing the sector through the CROAI initiative. However, its members and activities are, at the moment, quite limited	16) **Encourage the government to make a greater effort to obtain the cooperation of other telecom and IT sector members in the field of AI and to stimulate further developments and initiatives.**
Data centers and cloud services	Croatia has been doing relatively well in this sector, given that its cloud services adoption rate is above the EU average. The domestic data centers have been well positioned to serve the national market, and this trend is expected to continue. There were no specific factors that would make Croatia stand out as a favorable data center location for the big global players: connectivity is mainly through terrestrial links, and there are no major subsea cable routes, no large EU-wide internet exchanges, and no specific climate energy advantages. Therefore, in the short to medium term, Croatia is not seen as an attractive option for hyperscale data center investment.	17) **Conduct a government study to explore any uniqueness or activities that could be found (such as government land use, tax levies) to attract bigger international players of the data centers and cloud services market to Croatia, even if only as a hub for the Western Balkans region.**
Smart cities	Croatia has had several interesting local initiatives based on the enthusiasm of local officials and the research community. However, there is no common state governance on smart city development or common deployment strategy.	18) **Encourage state coordination in providing more focused knowledge support and technical assistance on smart cities projects, such as by creating the necessary business justifications if these projects are candidates for EU funding.**

8.3. DETAILED ACTION PLAN

In the tables below, a description of each recommendation outlined above is presented, as well as the activities needed to implement it, the body in charge of implementation, and an indicative deadline.

8.3.1. Governance and public investment (EU state aid, etc.)

Recommendation	Objectives	Planned activities
1. Strengthen the institutional organization around the digital transformation agenda.	– Improving the ownership and implementation of public initiatives in the digital sector – Strengthening the coordination between the public stakeholders and private market players in the digital sector	– Evaluate the relevance of creating a ministry dedicated to the digital economy that would include telecommunications, electronic media, and EU funds for digital programs. – Ensure the proper staffing of this ministry with relevant experts, including folding back the Central Office for a Digital Society.
2. Create rules and guidelines that will obligate all stakeholders, including government, to act more quickly and efficiently in the decision-making process related to EU funds.	– Better absorption of EU funds and avoidance of past problems with EU-funded state aid projects	– Drafting rules and guidelines on procedures and timelines when dealing with strategic decisions related to EU funds – Consulting with the relevant ministries and state bodies – Adopting the rules and guidelines
3. Create rules and guidelines that would simplify the state aid procedures related to the telecom sector.	– Simplifying procedures on the project level but at the same time not jeopardizing project quality or EU requirements – Simplifying and enabling the execution of projects, and tailoring the rules and guidelines for different telecom projects in order to facilitate more worthy projects to qualify for EU funds	– Assessment of the most optimal threshold level for a private share in investment in the next possible round of state aid projects – Assessment of the maximum amount of funding level per project for the next possible round of state aid projects – Assessment of the resources needed by project holders in order to execute the project – Drafting of overall rules and guidelines for the next round of state aid projects in order to simplify the procedures related to the telecom sector – Consultation with the relevant ministries and state bodies – Adoption of the new rules and guidelines
4. Simplify the law on public-private partnerships.	– To make it more implementable for different telecom projects	– Collecting the views of different stakeholders on deficiencies in the PPP law – Drafting changes to the PPP law to overcome the barriers to its better implementation in practice – Launching broad public consultation on the impact of the changes on different areas and sectors so that all stakeholders can take part – Putting the law through parliamentary procedure and adopting it

8.3.2. Market structure and competition

Recommendation	Objectives	Planned activities
5. Review wholesale regulations and encourage the entrance of a third convergent market player.	– Improving wholesale regulation – Improving MST rules – Removing all possible barriers to entry	– Undertaking an analysis of the impact of wholesale regulation and the MST on the lack of growth in the use of wholesale services and market competition in the past few years – Analyzing the development of retail prices in the past few years – Launching public consultations on the results of that analysis – Based on the results of the public consultation and evidence provided by interested parties, launching the formal procedure of re-evaluating wholesale prices and MST rules – Removing all possible barriers to entry (related to all other defined recommendations)
6. Evaluate the modifications to the Electronic Media Act.	– Removing the barriers to market entry and effective competition – Implementing safeguards for competition if needed, but not preventing market entry	– Thoroughly evaluating possible modifications to the Electronic Media Act and their potential effects on the telecom and media markets, given the market power of telecommunications operators and media/content groups in these intertwined markets – Drafting the changes to the Electronic Media Act. if relevant – Launching broad public consultation on the impact of the changes on the market – Putting the changes to the Act through parliamentary procedure and adopting the amended Act, if relevant

8.3.3. Land access or usage, construction, and rights of way

Recommendation	Objectives	Planned activities
7. Adopt a uniform legislative solution (e.g., a law on linear infrastructure) that would equally refer to all different types of linear infrastructure (gas, water, electricity, telecommunications, etc.).	– Lowering the burden of high fees for land access, which negatively affects investments – This legislative solution should regulate, in a non-discriminatory manner, all rights and obligations related to infrastructure and evenly distribute the burden on linear infrastructure operators, regardless of whether they are private entrepreneurs or public law entities, so that all pay the same fees for the same category of real estate/public land used.	– Transferring the competences of changing the rights-of-way fees from HAKOM to government by changing Article 29 of the Law on Electronic Communications – Making a comparative analysis of similar charges in the EU or comparable charges in Croatia (the study, "Analytical Determinants of the Rights of Way Fee for Electronic Communications Infrastructure," by the Institute of Economics in Zagreb could be used as a reference for the benchmarking of fees). – Reducing rights-of-way fees in line with comparative values in other EU countries or in line with other similar charges in Croatia, provided that provisions can be established ensuring that this reduction would not simply displace this taxation to other items that would also impede the development of the sector

Recommendation	Objectives	Planned activities
		– Drafting a law on linear infrastructure by all related ministries dealing with this topic (Ministry of Construction and Physical Planning, Ministry of the State Property, Ministry of Justice, Ministry of the Sea, Transport and Infrastructure, Ministry of Finance, etc.), including provisions that will change the way the fees are charged and collected and that prohibit discrimination among providers in terms of proprietorship (public/state or private) – Launching broad public consultation on the impact of the changes on different areas and sectors so that all stakeholders can take part – Putting the law through parliamentary procedure and adopting it
8. **Adopt a national spatial development plan (and potentially spatial planning regulations in the future) for Electronic Communications Infrastructures.**	– A national spatial development plan would prevent local authorities from implementing local spatial plans that are not in line with current legal provisions and that negatively influence the deployment of telecom networks. – It would help ensure that development would be aligned throughout the whole country. – Until this plan comes into force, spatial planning regulations could be a step forward. In addition, the application of the government's decision on criteria for the development of electronic communications infrastructure and other associated facilities should be ensured by amending the Law on Construction.	– Drafting the plan with all related stakeholders – Launching a comprehensive and transparent public consultation process so that all stakeholders can take part – Adopting a national spatial development plan – In parallel, adopting targeted spatial planning regulations to prevent a legal deadlock
9. **Amend the existing construction regulations or adopt special regulations in the construction and physical planning of electronic communications infrastructure.**	– Removing barriers; simplifying and shortening administrative procedures related to issuing building permits; recognizing mini- and micro-trench technology as a technical standard for construction for which a building permit is not required; ensuring that coordinated investments in integrated infrastructure really happen, etc., in order to secure a faster and more efficient ECI construction process	– Drafting changes to the existing laws or drafting a new uniform legislative solution in the construction and physical planning of ECI by all related ministries dealing with this topic (Ministry of Construction and Physical Planning, Ministry of the Sea, Transport, and Infrastructure, etc.) – Launching broad public consultation on the impact of the changes in the existing laws/new uniform law so that all stakeholders can take part – Putting the changes to the existing laws/new uniform law through parliamentary procedure and adopting them
10. **Adopt a law on the legalization of infrastructure.**	– In general, these laws are comparable to laws dealing with the legalization of private buildings and houses, except that field infrastructure is linear and passes through multiple land parcels with different impacts on the environment.	– Drafting the law with all related ministries dealing with this topic (Ministry of Construction and Physical Planning, Ministry of the State Property, Ministry of Justice, Ministry of the Sea, Transport and Infrastructure, Ministry of Finance, etc.) – Launching broad public consultation on the impact of the law on the economy and investments so that all stakeholders can take part – Putting the law through parliamentary procedure and adopting it

Recommendation	Objectives	Planned activities
11. Impose stricter inspection and supervision of the implementation of the Law on Measures to Reduce the Cost of Deploying High-Speed Electronic Communications Networks.	– Informing different persons of their obligations deriving from the law and monitoring their compliance	– Giving information on the law's provisions and obligations to the relevant entities (e.g., network operators) – Monitoring and reporting on key performance indicators of the functioning of the law/system (e.g., number of the contracts concluded, quantity of the infrastructure (in km) provided to the SIP, etc.) – Developing a detailed inspection plan to supervise the implementation of the law and sharing it with all interested parties – Acting according to the inspection plan

8.3.4. Spectrum

Recommendation	Objectives	Planned activities
12. Define spectrum auction rules to ensure market competition.	– Ensuring that spectrum assignment does not harm market competition, which, in mobile markets, has proven to have an excellent impact on end-user benefits	– Analyzing the best way of ensuring market competition deriving from spectrum usage. – Setting up a draft model and parameters of the announced public auction of the spectrum bands 700 MHz, 3.6G Hz, and 26 GHz, taking into consideration the expiration of the current licenses for the spectrum bands 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, and 2600 MHz in 2024 and its impact on possible assignment methods that would be aimed at preserving market competition – Launching public consultations on the model and parameters of the public auction and the conditions of the RF spectrum use to be allocated – Making a final decision on the model and parameters of the public auction and the conditions of the RF spectrum use to be allocated
13. Undertake an independent comparative analysis and a benchmarking of the level of spectrum fees in EU member states.	– The analysis should be used to calculate the weighted average level of the fees in EU member states.	– Calculating the fees in EU member states – If the calculated weighted average level is lower than in Croatia, assessing the impact of lowering the fees on market performance – Launching public consultations on lowering the fees – Implementing the new fees through changes in the ordinance on payment of fees for the right to use addresses, numbers, and RF spectrum
14. Undertake additional diplomatic efforts to minimize the impact of cross-border interference on 5G development in Croatia.	– To ensure the full usage of 5G frequencies in Croatia	– Bilateral diplomatic activities toward neighboring countries with the goal of minimizing the interference on 5G development in Croatia – Activities through international organizations (e.g. ITU, Radio Spectrum Policy Group) with the goal of minimizing the impact of interference on 5G development in Croatia

8.3.5. Emerging Technologies

Recommendation	Objectives	Planned activities
15. **Foster a government initiative to consult with the industry on the specific needs of large corporates and small and medium-sized enterprises in terms of IoT.**	– Job creation, for example, in the form of application developers related to IoT and catering to Croatia's specific SME requirements and/or smart city application developer jobs – Efforts to increase women's access to higher-wage occupations, building on their high levels of tertiary education – Regeneration of certain parts of the country by investing in specialized digital infrastructure, for instance, establishing large-scale or disaster recovery data centers in areas that have historically high unemployment rates – Development of technology-related manufacturing, for instance, street furniture and other physical objects that are part of the smart city ecosystem (smart metering, smart traffic lights, smart signs, and so on)	– Establishing one or several government-led task force(s) dedicated to leveraging emerging technologies – Supporting the creation of industry alliances and fostering collaboration between telecoms and IT market players around emerging technologies – Launching consultation processes with the industry on needs in terms of IoT, AI, cloud services, etc. – Conducting a study to 1) explore possible initiatives to attract large international players to invest in Croatia's emerging technologies and 2) encourage research and development among local market players in these fields – Studying EU examples to find a sustainable model for the implementation of a Croatian cluster for IoT similar to those in the EU but specific enough to cater to Croatian requirements (which additionally need to be identified)
16. **Encourage the government to make a greater effort to obtain the cooperation of other telecom and IT sector members in the field of AI and to stimulate further developments and initiatives.**		
17. **Conduct a government study to explore any uniqueness or activities that could be found (such as government land use, tax levies) to attract bigger international players of the data centers and cloud services market to Croatia, even if only as a hub for the Western Balkans region.**		
18. **Encourage state coordination in providing more focused knowledge support and technical assistance on smart cities projects, such as by creating the necessary business justifications if these projects are candidates for EU funding.**		

8.4. THREE-YEAR PLAN 2021–23

In the figure below, a detailed three-year action plan (2021–23) is presented, with an indicative timeline for each activity to be undertaken in order to implement the defined recommendations. Recommendations related to emerging technologies are not included in this table.

FIGURE 59. Three-Year Action Plan (2021–23) with an Indicative Timeline for Each Activity

Work Flow	Work item	Description	Q1 Y1	Q2 Y1	Q3 Y1	Q4 Y1	Q1 Y2	Q2 Y2	Q3 Y2	Q4 Y2	Q1 Y3	Q2 Y3	Q3 Y3	Q4 Y3	Q1 Y4	Q2 Y4
R1: Strengthen the institutional organization around the digital transformation agenda	R1/ A1:	Evaluate the relevance of creating a ministry dedicated to the digital economy														
	R1/ A2:	Ensure the proper staffing of this ministry with relevant experts, including folding back the Central Office for a Digital Society														
R2: Creating rules and guidelines for faster and more efficient decision-making process for EU funds	R2/ A1:	Drafting the rules and guidelines on procedures and timelines when dealing with strategical decisions related with EU funds														
	R2/ A2:	Consultation with relevant Ministries and State Bodies														
	R2/ A3:	Adoption of the rules and guidelines														
R3: Creating rules and guidelines that would simplify the state-aid procedures related to telecom sector	R3/ A1:	Assessment of the most optimal level of threshold for private share in investment for the next round of state-aid projects														
	R3/ A2:	Assessment of the most optimal level of maximum amount of funding per project for the next round of state-aid projects														
	R3/ A3:	Assessment of the resources needed by project holders in order to execute the project														
	R3/ A4:	Drafting the overall rules and guidelines for the next round of state-aid projects in order to simplify the state-aid procedures														
	R3/ A5:	Consultation with relevant Ministries and State Bodies														
	R3/ A6:	Adoption of the new rules and guidelines														
R4: Simplification of the PPP Law	R4/ A1:	Collecting the views of different stakeholders on shortages of PPP Law														
	R4/ A2:	Drafting the changes of PPP Law that should overcome the barriers for its better implementation in practice														
	R4/ A3:	Launching broad public consultation on the impact of the changes on different areas and sectors														
	R4/ A4:	Putting the Law in parliamentary procedure and adoption of the Law														
R5: Review wholesale regulations and encourage the entrance of the third convergent market player	R5/ A1:	Undertaking analysis of the impact of the wholesale regulation and MST on the lack of growth in usage of WS services														
	R5/ A2:	Analysis of the development of the retail prices in last few years														
	R5/ A3:	Launching of public consultations on results of those analysis														
	R5/ A4:	Based on the results of the public consultations launching of the formal procedure of re-evaluating WS prices and MST rules														
R6: Evaluate modifications of the Electronic Media Act	R6/ A1:	Evaluate and draft changes of the provisions of the Electronic Media Act														
	R6/ A2:	(If relevant) Launching broad public consultation on the impact of the changes on the market														
	R6/ A3:	(If relevant) Putting the changes of the Act in the parliamentary procedure and adoption of the changed Act														

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Work Flow	Work item	Description	Q1 Y1	Q2 Y1	Q3 Y1	Q4 Y1	Q1 Y2	Q2 Y2	Q3 Y2	Q4 Y2	Q1 Y3	Q2 Y3	Q3 Y3	Q4 Y3	Q1 Y4	Q2 Y4
R7: Adoption of a uniform legislative solution that would equally refer to all different types of linear infrastructure	R7/ A1:	Transferring competences of changing the level of the rights of way fees from HAKOM to Government														
	R7/ A2:	Making of comparative analysis of similar charges in EU or other similar charges in Croatia														
	R7/ A3:	Reduction of the level of rights of way fees in line with comparative values in other EU countries														
	R7/A4:	Drafting the Law on linear infrastructure by all related Ministries dealing with this topic														
	R7/A5:	Launching broad public consultation on the impact of the changes on different areas and sectors														
	R7/A6:	Putting the Law in the parliamentary procedure and adoption of the Law														
R8: Adoption of the National spatial development plan	R8/ A1:	Drafting the plan with all related stakeholders														
	R8/ A2:	Launching comprehensive and transparent public consultation process so that all stakeholders could take part in it														
	R8/ A3:	Adoption of the National spatial development plan														
R9: Amending the existing construction regulations or adopting special regulations	R9/ A1:	Drafting the changes in the existing Laws or drafting the new uniform legislative solution														
	R9/ A2:	Launching broad public consultation on the impact of the changes in the existing Laws/new uniform Law														
	R9/ A3:	Putting the changes in the existing Laws/new uniform Law in the parliamentary procedure and adoption of the changes														
R10: Adoption of the Law on legalization of infrastructure	R10/ A1:	Drafting the Law with all related Ministries dealing with this topic														
	R10/ A2:	Launching broad public consultation on the impact of the Law on the economy and investments														
	R10/ A3:	Putting the Law in the parliamentary procedure and adoption of the Law														
R11: Imposing stricter inspection and supervision of the implementation of the Law for reducing the cost of deploying high speed networks	R11/ A1:	Giving information about provisions and obligations from the Law to its obliged entitites														
	R11/ A2:	Monitoring and reporting on key performance indicators of the functioning of the Law/system														
	R11/ A3:	Implementing the detailed inspection plan for supervision of the implementation of the Law														
	R11/ A4:	Acting according the inspection plan														
R12: Defining of the spectrum auction rules that will ensure market competition	R12/ A1:	Analysing which would be the best way of ensuring market competition deriving from the spectrum usage														
	R12/ A2:	Set up draft model and parameters of the announced public auction of the spectrum bands of 700MHz, 3,6GHz and 26GHz														
	R12/ A3:	Launching public consultation on the model and parameters of the public auction and conditions of use of the radio spectrum														
	R12/ A4:	Final decision on the model and parameters of the public auction and the conditions of use of the radio frequency spectrum														

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Work Flow	Work item	Description	Q1 Y1	Q2 Y1	Q3 Y1	Q4 Y1	Q1 Y2	Q2 Y2	Q3 Y2	Q4 Y2	Q1 Y3	Q2 Y3	Q3 Y3	Q4 Y3	Q1 Y4	Q2 Y4
R13: Undertaking the independent analysis and benchmarking for spectrum fees in EU member states	R13/ A1:	Calculation of the fees in EU member states														
	R13/ A2:	If the calculated weighted average level is lower than in Croatia, assessing the impact of lowering the fees on market performance														
	R13/ A3:	Launching of public consultations of lowering the fees														
	R13/ A4:	Implementation of the new fees and payment of fees for the right to use of addresses, numbers and radio frequency spectrum														
R14: Minimize impact of the cross border interferences on 5G	R14/ A1:	Bilateral diplomatic activities with neighbouring countries for minimizing impact of the interferences on 5G in Croatia														
	R14/ A2:	Activities through the international organizations (e.g. ITU) for minimizing impact of the interferences on 5G in Croatia.														

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ANNEXES

ANNEX 1. MAJOR PUBLIC INITIATIVES
ANNEX 2. LLU AND BSA SERVICES
ANNEX 3. MAIN WHOLESALE SERVICES AND REFERENCE OFFERS OF THE REGULATED OPERATORS

ANNEX 1. Major Public Initiatives

NATIONAL FRAMEWORK PROGRAM FOR THE DEVELOPMENT OF BROADBAND INFRASTRUCTURE (ONP)

– General information about the program

The National Framework Program for the Development of Broadband Infrastructure in Areas Lacking Sufficient Commercial Interest for Investments, referred to by its Croatian acronym ONP, is a national state aid scheme that aims to promote the development of next generation access (NGA) networks in Croatia. In line with the Europe 2020 strategy for more growth, the Digital Agenda for Europe (DAE), and the Croatian broadband strategy, Croatia aims to gradually deploy NGA networks countrywide in white NGA areas,[72] with a download speed of at least 40 Mbit/s and an upload speed of at least 5 Mbit/s. However, different, and more ambitious requirements were defined in the selection criteria for project proposals according to the specific objectives of the Operational Program Competitiveness and Cohesion (OPCC) 2014–20, which were the part of the public call for proposals and the selection of operators for the development of NGA networks in these areas. One of the key selection criteria was for each selected operator to cover a minimum of 78 percent of private end users, a minimum of 83 percent of business end users, and minimum of 100 percent of public end users by symmetric 100 Mbit/s NGA access with either fiber to the x (FTTx) or advanced wireless technological solutions. By this additional requirement, the possibility of deploying any non-future-proof technology was eliminated.

The ONP covers NGA networks and is one of two programs for high-speed broadband development in Croatia with the approval of the European Commission (EC) until 2023. The other is a next generation network (NGN) backhaul scheme that will be implemented in parallel during the same time period.

The ONP provides three basic groups of investment models for implementation:
- Model A – private design-build-operate (DBO) model,
- Model B – public DBO model
- Model C – public-private partnership (PPP)

The ONP does not preclude the application of other investment models in projects in addition to those mentioned above. In that sense, all projects in which other investment models are planned will also be analyzed through the preparatory stages and final approval of the Broadband Infrastructure Development Plan (BIDP), and all the relevant "structural rules" will be defined, depending on the planned investment model. These structural rules include:
- the obligation to apply the wholesale business model
- the application of the public procurement process to the selection of operators of a private partner in a construction project, network operation, and/or management

72 These are areas in which there currently is no NGA broadband infrastructure in place or none is planned to be developed in the next three years.

- the obligation to apply a clawback procedure to return inappropriately allocated funds (mandatory only for the projects in which the aid awarded exceeded €10 million)
- the application of the relevant legislation on the PPP domain and/or concessions

In addition to these structural rules, the ONP also provides a formal framework for instructions and guidelines that will enable and facilitate the preparation and implementation of projects. It does not limit the selection of infrastructural and technological solutions that may be implemented in the projects (i.e., it follows the principle of technological neutrality), but the guidelines promote an optimum approach to the specification of projects, in accordance with current opportunities and future development needs at the local level.

The ONP was first published in March 2014 and officially entered into force in July 2016 by a government decision, based on a non-objection decision of the EC (from January 2016) pursuant to Article 107(3)(c) of the Treaty on the Functioning of the European Union.

- **Funding**

The overall estimated (maximum) budget of the ONP is €252 million, of which €117.2 million will be funded by the European Regional Development Fund (ERDF) and the rest by the private sector. It is expected that private funds will amount to €120 million during the implementation of the project. The annual budget is €31.5 million for the period 2016–23.

- **Status of the project, including opinions and comments of the stakeholders**

In 2019, the Croatian Regulatory Authority for Network Industries (HAKOM), as the competent authority for the ONP, approved 71 local broadband development plans. These 71 projects cover 443 municipalities with 2.68 million inhabitants. Approval of these projects was a prerequisite to the municipalities' applications to the public call for state aid announced by the Ministry of Regional Development and EU Funds (MRRFEU) in July 2019. The selection process is still ongoing and is divided into three phases. In the first phase, an expression of interest is made by the local municipalities. All 71 projects were approved by the MRRFEU as having made valid expressions of interest. In the second phase, project proposals are received from the municipalities. In this phase, 21 projects were selected: 16 with a private DBO investment model and five with a public DBO investment model. Out of the 16 projects with the private DBO model, Hrvatski Telekom (HT) was selected as the operator for 13 and A1 for three. In the third phase, only the applicants selected during the second phase submitted their project proposals for final approval by the MRRFEU. Evaluation of the pre-selected project proposals is currently in the final stage. These 21 projects cover 126 municipalities with 904,000 inhabitants. Assuming that final approval is received, the contracting and launching of all 21 selected projects are expected by the end of the second quarter of 2020.

As mentioned above, roughly €117.2 million is available for the implementation of the ONP from the ERDF. Of that, €92 million will cover these 21 projects.

- **Conclusion**

Considerable time elapsed between the beginning of the project (the document was sent to the EC in 2014) and the final, third stage (six years in total), and no construction has started yet. From the 11 phases and activities in the preparation and implementation of projects set within the Framework Program, all selected projects are now in phase 7, "*Project budget, application for the co-financing from the EU funds*," which means that four more phases remain, including building the network.

It is also worth emphasizing that one of the activities in the action plan for the implementation of the Broadband Strategy 2012–16 was Measure 8, called "*Implementation of the NGA broadband access projects in white areas*." The deadline for that activity was set at December 31, 2020. Apart from that, according to the EC, the program's time frame covers the period from Commission approval until December 31, 2023, the last date on which aid can be granted under the measure.

Given these deadlines, one could argue that the Croatian government still has time to act. However, examining what actually transpired indicates that the whole process has been burdened by administrative procedures, government decisions, and public consultations, all of which have resulted in a state of affairs in which, after six years, no network has been built. The whole process is presented in section 4.3.

As regards stakeholders' views, the reasons for the missed opportunities in the current funding period 2017–20 include:

- There was a lack of private sector involvement in the preparation and planning of strategic documents.
- The government's focus was on the public DBO investment model, but based on the ONP, only five out of 21 projects were selected with that model.
- The threshold for a private share in investment was set too high (at 44 percent), which reduced the potential number of projects that could have been EU-funded.
- The maximum amount of funding per project was set too low (at HRK 63.5 million), which prevented larger projects from being funded.
- The government delayed publishing the first public call for more than three years.
- Due to all of the above, there is a risk that approximately €24 million for NGA networks from the currently available broadband allocation will remain unspent, and consequently, the following programming period will have at least a 6 percent decrease in total available funding for broadband due in part to poor absorption and contracting dynamics.

NATIONAL PROGRAM FOR THE DEVELOPMENT OF BROADBAND BACKHAUL INFRASTRUCTURE (NP-BBI)

– General information about the program

The National Program for the Development of Broadband Backhaul Infrastructure (NP-BBI) in areas lacking sufficient commercial interest for investment is intended to be implemented in parallel to the ONP: from Commission approval until 2023. The NP-BBI aims to construct a publicly owned, passive NGN backhaul infrastructure, that is, ducts, dark fiber, and colocation facilities, from major Croatian settlements toward smaller settlements in rural and suburban areas that are currently not adequately covered by backhaul networks. The technology neutral character of the project's infrastructure will enable all operators in the market to implement their NGN backhaul networks and offer NGA services in smaller settlements. The same aggregation infrastructure will be used to connect 5G base stations with the core network of mobile network operators (MNOs).

The NP-BBI is complementary to the implementation of the ONP. It is intended to provide sufficient NGN backhaul capacity to serve the access networks in white NGA areas approved by the EC in State Aid SA.38626. It will not serve access networks in grey NGA areas. By 2023, an additional 25 percent of the Croatian population will have access through the ONP. Projections foresee 306,000 new NGA connections in 2023 and 340,000 in 2025. An analysis carried out for the Croatian authorities concludes that by 2021, a majority of backhaul links will require capacities higher than 1 Gbit/s (82.9 percent), in 2025 a majority of links will require capacities higher than 5 Gbit/s (58.9 percent), and in 2030 and 2035 half of the backhaul links will have to support capacities higher than 10 Gbit/s (47.6 and 51.7 percent, respectively). Achieving those levels will require the deployment of significant additional backhaul capacity.

The program covers the time period from Commission approval until December 31, 2023, which is the last date on which aid can be granted under the measure.

The NP-BBI and ONP jointly contribute directly to the achievement of DAE targets related to the availability of high-speed broadband access. The competent authority for managing the NP-BBI is the Ministry for

of Sea, Transport and Infrastructure (MSTI), Directorate-General for Strategic Planning and EU Funds. The preparation and technical implementation of the NP-BBI is the responsibility of Transmitters and Communications (OIV), a state-owned company designated to design, build, and operate a backhaul network that will be used based on an open access model. The planned length of the newly built backhaul network is roughly 5,000 kilometers, through both existing and new infrastructure (ducts). If there is space in the existing ducts, OIV will be leasing it (at cost-based prices), and if there is no space in the existing ducts, it will deploy its own. The primary goal is to have OIV offer wholesale dark fiber as well as duct space and colocation available to operators that will deploy their own active equipment.

The NP-BBI aims to develop NGN broadband backhaul infrastructure as a segment interconnecting NGA and national core networks. The program thus facilitates a reduction in the digital divide, providing broadband capacity in the backhaul network in those areas lacking sufficient commercial interest in building a network. Implementation of the NP-BBI is a prerequisite to the full implementation of the ONP and to the further development of new generations of electronic communications infrastructure (e.g., 5G) and electronic communications services, including the realization of NGA connections for public users.

Detailed analysis of the infrastructure requirements for these areas can be found in official NP-BBI and ONP documents at the following link: https://mmpi.gov.hr/promet/elektronicke-komunikacije-126/strateski-dokumenti-8279/8279.

There were two public consultations performed by the MSTI (in 2014 and 2016), and the result was that some of the target settlements from the initial program were removed after the operators claimed that they infrastructure already built there or that they intend to deploy it in the next three years. There will be another public consultation prior to the start of implementation of the program to cover the period until 2023. The total value of the project will depend on the results of the last public consultation.

The NP-BBI was first published in January 2015 and officially entered into force in March 2018 by a government decision, based on a non-objection decision of the EC (from June 2017) pursuant to Article 107(3)(c) of the Treaty on the Functioning of the European Union.

- **Funding**

  The overall estimated (maximum) budget of the program is €101.4 million, of which €86.2 million, or 85 percent, will be funded by the ERDF as a part of the OPCC in the financial time frame 2014–20, and the remaining €15.2 million, or 15 percent, by national funds. The annual budget of the scheme amounts to €14.5 million for the period 2017–23.

- **Status of the project, including opinions and comments of the stakeholders**

  The NP-BBI is currently in the process of Major Project Application with the EC, and it is expected that program implementation will start by the end of 2020. OIV, in coordination with JASPERS, prepared major project documentation: feasibility study, cost-benefit analysis, and Major Project Application. In November 2019, JASPERS received an Action Completion Note. It followed this with an application on call for state aid announced by the MRRFEU. Evaluation of the project is in the final phase, and an Independent Quality Report is expected to be received in the fourth quarter of 2020.

  Contracting and launching of this project are also expected in the fourth quarter. Although the project should be completed by the end of 2023, there is a risk that it will be extended beyond that year.

- **Conclusion**

  As with the ONP, it can be concluded that considerable time has elapsed between the beginning of the project (first decision) and this stage (roughly five years), and the project still has yet to start. Clearly, the process, involving administrative procedures, government decisions, and public consultations, is too time consuming. The whole process is presented in section 4.3.

Again, the deadlines set for these programs within the national strategy (action plan for the implementation of the Broadband Strategy 2012–16, Measure 9, "Development of the NGN Backhaul Network") of December 31, 2020, and the EC's relevant decision of December 31, 2023, the last date on which aid can be granted, suggest that Croatia is within the time frame envisaged for this project. However, it has been years since the program was developed and no network deployment has taken place.

Furthermore, as regards stakeholder views, one stakeholder is of the opinion that implementation of the NP-BBI has been seriously delayed, and it is not likely that the project will be contracted until the end of 2020, putting at risk the absorption of the available funds.

HAKOM'S PROGRAM FOR THE DEVELOPMENT OF INTERNET AND BROADBAND ACCESS

- **General information about the project**
  HAKOM's program for the development of the internet and broadband in the areas of special national concern, hilly and mountainous areas, and islands, which aimed to build the necessary broadband infrastructure for targeted users, such as schools, health care institutions, and fire stations, began in 2011 and was fully completed by final testing and verification in July 2018.

- **Funding**
  The funds came from unspent money from HAKOM's operations from previous years. A total of €6.6 million was allocated for the construction of broadband infrastructure.

- **Results of the project, including opinions and comments of the stakeholders**
  The project was fully completed by final testing and verification in July 2018. A total of €6.6 million was allocated to the construction of broadband infrastructure for 332 institutions (targeted users) across Croatia at a minimum speed of 30 Mbit/s to cover approximately 35,000 users. Program funds were part of state grants and, based on seven tenders, were divided between four operators: HT, A1, Pro-ping, and H1Telekom.

  According to the operator data, the service is currently being used by 225 targeted users, of which about 36 percent is through the wholesale service. An additional 11,100 users will be included in the newly built network.

- **Conclusion**
  This is the only publicly funded project of those reviewed that was finished on time and in which all the funds were spent and distributed. All the speeds were checked, and it was proved that the contracted speed is being provided. Thus, it can be concluded that the project fulfilled its goals, even as the level of funding was quite modest in comparison to the other projects.

RUNE PROJECT

- **General information about the project**
  RUNE (Rural Networks) is a new market entrant that started operating in 2019, aiming to provide ultrafast broadband fiber optic infrastructure to users in rural areas of Croatia and Slovenia. RUNE's goal is to assist local governments in achieving the DAE 2020 goals by providing connectivity to a new fiber optic access network that will deliver speeds in excess of 1 Gbps in areas that are currently not covered and where existing operators have no commercial interest in investing. RUNE is the first, and at this moment the only, international project at the European level connecting the territories of several member states through ultrafast broadband infrastructure. The business model of the network will be wholesale only.

RUNE is building a fiber-to-the-home (FTTH) access network for all potential users in the project scope. According to RUNE's announcements in Croatia, roughly 110,000 households will be covered over approximately the next three years, mostly in two Croatian regions: Primorsko-goranska and Istarska County.

During public consultations on projects from the ONP, RUNE announced a commercial interest in 62,482 addresses. Thus, it is expected that RUNE will build out to significantly more addresses than the company had committed to in public consultations. In order to speed up and simplify construction, RUNE will use all available existing infrastructure, such as distribution telecommunication ducts, power grids, or lighting poles, as far as possible in accordance with the legal and technical standards of each country, guided by the Law on Reduction Measures and the cost of setting up high-speed electronic communications networks.

The network is designed as an active infrastructure that allows access to broadband services through a fiber optic network based on hybrid passive technology (Active Ethernet [AE] and passive optical network [PON]), including aggregation links between access nodes, which guarantees service providers access to the largest number of end users at the least cost.

– **Funding**
The project is financed by the Connecting Europe Broadband Fund (CEBF), which is a private equity platform supporting Gigabit Society objectives by promoting broadband investment in unserved areas (see https://www.cebfund.eu/).

The fund's investors include the EC, EIB, national promotional banks, and private investors. RUNE is the first project in Europe funded by the CEBF and addresses the problem of scarce broadband infrastructure in rural areas by using private equity instruments without public grants. It is also the first investment platform for the support of broadband infrastructure within the European Fund for Strategic Investment.

– **Status of the project, including opinions and comments of the stakeholders**
The project is ongoing, with civil works just getting started.

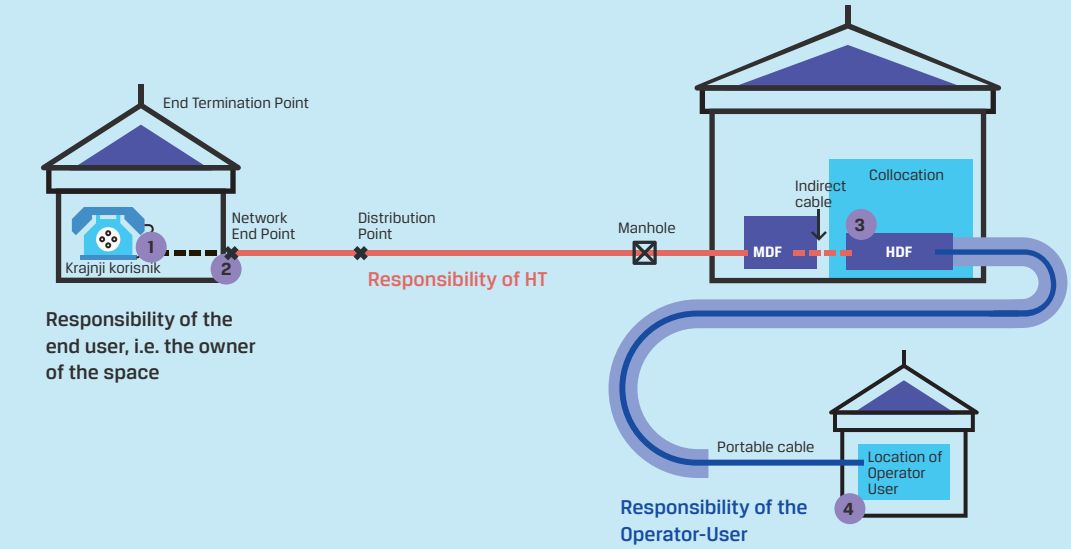
– **Conclusion**
As of this writing, the project was going quite well, with no substantial barriers reported.

ANNEX 2.
LLU and BSA Services

Croatia's telecom industry possesses significant market power (SMP) for wholesale local access provided at a fixed location. Based on this, Hrvatski Telekom (HT) has published a reference offer for local loop unbundling (LLU) as a wholesale service, indicating that other operators (that do not have their own network) can use HT's network to provide services to their customers.

The figure below gives an illustrative overview of LLU as a wholesale service offered by HT to other operators (operator users).

FIGURE A2.1.
Local Loop Unbundling as a Wholesale Service

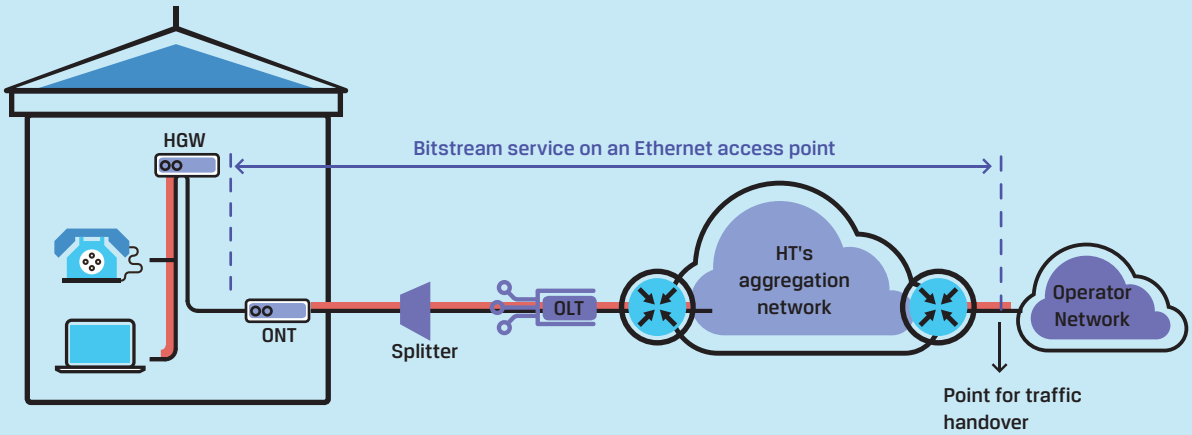


Source: HT's Reference Offer for local loop unbundling.

72 These are areas in which there currently is no NGA broadband infrastructure in place or none is planned to be developed in the next three years.

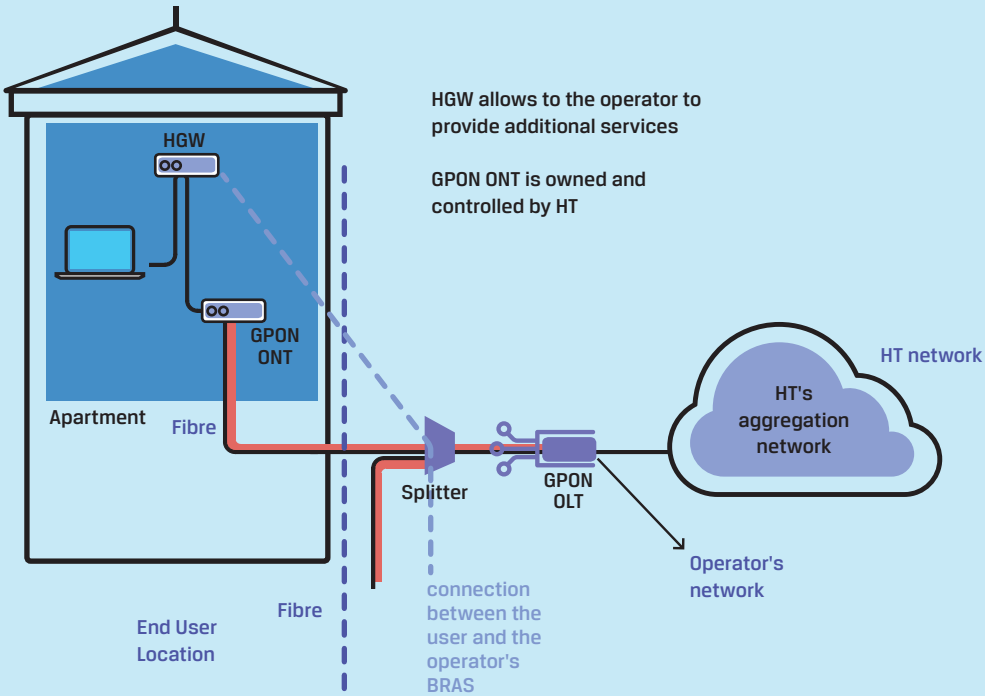
HT also has an SMP position on the market for wholesale central access provided at a fixed location for mass market products. Based on this, HT has an obligation to publish a reference offer for bitstream access. The figures below describe the different variations in the network in terms of providing bitstream access as a wholesale service to other operators.

FIGURE A2.2.
Wholesale Broadband Access to Provide Ethernet-Level Internet Service When Accessed via the FTTH Solution



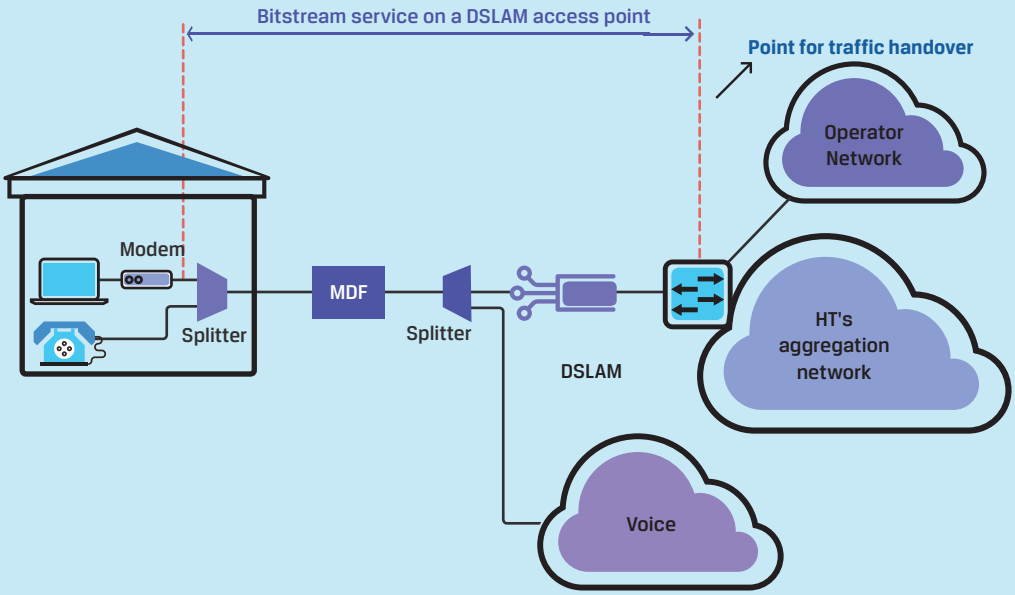
Source: HT's Reference Offer for bitstream access.

FIGURE A2.3.
Realization of Wholesale Broadband Access Service for Internet Service Based on FTTH Solution at OLT Level*



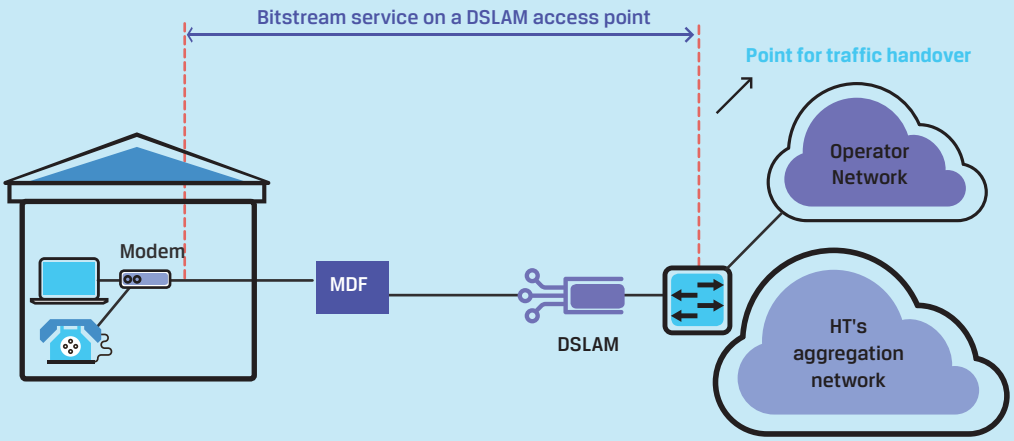
**FTTH stands for fiber to the home; OLT is optical line terminal.*
Source: HT's Reference Offer for Bitstream access.

FIGURE A2.4.
Wholesale Broadband Access for the Provision of Internet Service at the DSLAM* Level When the End User has Basic Access (voice connection) to the Network through HT Service



*Digital subscriber line access multiplexer.
Source: HT's Reference Offer for bitstream access

FIGURE A2.5.
Wholesale Broadband Access for the Provision of Internet Service at the DSLAM Level When the End User has Basic Access (voice connection) to the Network through the Service of the Operator-User



Source: HT's Reference Offer for bitstream access.

ANNEX 3. Main Wholesale Services and Reference Offers of the Regulated Operators

The following wholesale services derive from ex ante regulated markets and are the result of asymmetric regulation. All of them are published by regulated operators under the following names:

- Wholesale line rental (WLR) – "*Standardna ponuda Hrvatskog Telekoma d.d. za usluge najma korisničke linije (u primjeni od 01.01.2020.)*"
- Fixed origination (CS/CPS) – RIO fixed – "*Standardna ponuda za usluge međupovezivanja Hrvatskog Telekoma d.d. (u primjeni od 01.01.2020.)*"
- Fixed termination – RIO fixed – "*Standardna ponuda za usluge međupovezivanja Hrvatskog Telekoma d.d. (u primjeni od 01.01.2020.)*"
- LLU and fibre unbundling in case of FttH P2P – RUO – "*Standardna ponuda Hrvatskog telekoma d.d. za uslugu izdvojenog pristupa lokalnoj petlji*"
- BSA on different levels local (OLT/DSLAM) regional (IP/Ethernet) national (IP/Ethernet) – RWBA – "Standardna ponuda Hrvatskog telekoma d.d. za uslugu veleprodajnog širokopojasnog pristupa"
- Leased lines – RLLO – "*Standardna ponuda Hrvatskog telekoma d.d. za iznajmljene elektroničke komunikacijske vodove*"
- Mobile termination – RIO mobile – "*Standardna ponuda međupovezivanja u pokretnoj elektroničkoj komunikacijskoj mreži (u primjeni od 01.01.2020.)-HT; Standardna ponuda za usluge međupovezivanja u javnoj pokretnoj komunikacijskoj mreži A1 Hrvatska d.o.o.; Standardna ponuda za usluge međupovezivanja u pokretnoj mreži Tele2 d.o.o.*"

Reference offers deriving from symmetric regulation are as follows:

- Access to ducts and manholes – RDA – *"Standardna ponuda Hrvatskog Telekoma d.d. o načinu i uvjetima pristupa i zajedničkog korištenja elektroničke komunikacijske infrastrukture i povezane opreme (kabelske kanalizacije) Hrvatskog Telekoma d.d."*
- Access to local node/exchange – RSDM – *"Standardna ponuda Hrvatskog telekoma d.d. za uslugu pristupa pasivnoj pristupnoj svjetlovodnoj mreži na lokaciji distribucijskog čvora za svjetlovodne distribucijske mreže"*

All of the above-mentioned reference offers are accessible on the following link: https://www.hakom.hr/default.aspx?id=328.

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