FIFTH GENERATION (5G) TECHNOLOGY FOR ALBANIA

A STRATEGIC PLAN

For

AUTORITETI I KOMUNIKIMEVE ELEKTRONIKE DHE POSTARE

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1 EXECUTIVE SUMMARY

Albania's Electronic and Postal Communications Authority (AKEP) is the regulatory body in the field of electronic communications and postal service, which supervises the regulatory framework defined by Law No. 9918, dated 19.05.2008 "On electronic communications in the Republic of Albania," as amended by the law on the postal service and development policies, set by the Council of Ministers.

AKEP exercises its functions following the principle of legality, per the law and other normative acts, and under national sectoral policies for the development of electronic communications and international agreements in the field of electronic communications, to which the Republic of Albania is a party. AKEP considers the relevant recommendations and decisions of the European Commission and the Body of European Regulators for Electronic Communications (BEREC). This Strategic Plan is also consistent with the recommendations regarding 5G found in the European Union's, *"Roadmap for Lowering Roaming Charges Between the EU and WB, dated September 2021".*

AKEP promotes efficient competition for the provision of electronic communications networks and services, associated facilities, and other services:

- to enable every category of users of electronic communications services, including users with disabilities, to have maximum benefits from access to electronic communications services in terms of price and quality choice.
- to protect the interests of users of electronic communications services, to protect the personal data and privacy of users.
- to protect the interests of public safety.
- to ensure free and effective competition in the electronic communications sector.
- to ensure the integrity and security of public electronic communications networks.
- To promote efficient investments in electronic communications infrastructure and new technological developments for a high quality of their products.
- to promote the fruitful use of frequencies and digital series as finite resources.
- to ensure non-discrimination and equality in the treatment of providers of electronic communications networks and services.

At the direction of the Prime Minister and the Albanian Parliament, AKEP must prepare a complete plan and assessment for "Preparation of Albania and its Operators for 5G Starting from 2022" (hereinafter the "Plan"). As a result, AKEP commissioned the development of this Plan, including an assessment where technology, safety, affordability, and capability aspects were considered. Importantly, the assessment also considered the Albanian Operators' views on the measures to be taken to encourage investment in 5G for the future.

Around the world, governments, academia and industry have concluded that 5G will significantly impact the digital sector and the economy. The EU considers the successful launch of 5G as crucial for economic development and the competitiveness and productivity of the economy. Therefore, the European Union (EU) is taking the lead in providing sufficient

spectrum for the successful launch and development of 5G. Albania intends to take the lead for our entire region.

This Plan outlines a process for granting usage rights as objective and transparent as possible for the benefit of Albanian consumers and the Albanian economy, the creation of a competitive market in Albania, and the effective use of spectrum and the fulfillment of regulatory objectives.

Implementation of the Plan will be managed under the leadership of AKEP, with participation and coordination with numerous Albanian departments and agencies. Albania's telecom Operators have provided significant input into this Plan and will be instrumental to the overall success of the 5G implementation across Albania. This Plan encompasses four focus areas, as described below.

Focus Area One: Facilitate Albania's 5G Spectrum Auction

The Government of Albania, through AKEP, has a unique opportunity to implement 5G strategies for the country and its residents in an efficient manner that incorporates lessons learned from other 5G rollouts in the EU. To facilitate this, an auction of spectrum licenses to interested parties – such as Albania's Operators – provides the investment funding needed to improve/prepare Albania's telecommunications infrastructure for a secure 5G implementation. Outside of the spectrum licensed/set aside for appropriate government, educational, and emergency/first responder organizations, spectrum auctions more effectively assign licenses than either comparative hearings or lotteries. The auction approach is intended to award the licenses to those who will use them most effectively and have been proven to reduce the average time from initial application to license grant to less than one year, with Albania's citizens receiving the direct financial benefit from the award of licenses.

In parallel to a spectrum auction, AKEP must support new technologies to make better use of existing spectrum and free up frequencies, such as the use of duplexes that allow radio equipment to transmit and to receive signals at the same frequency, and spectrum sharing and grouping of technologies that allow for the use of the same spectrum by several users through allocation mechanisms. Spectrum allocation mechanisms can guarantee efficient allocation at some point but do not guarantee that such allocation remains effective if there are changes in technology or terms of supply and demand.

In support of future spectrum auctions, this Plan describes/recommends the use of best practices in Europe for spectrum awarding procedures and collaboration with other EU Regulators regarding their recent spectrum auctions / experience is also recommended. These recommendations also support the recent Memorandum of Understanding between Albania and the United States signed by Prime Minister Rama and Secretary of State Blinken in June 2021.

Focus Area Two: Recommend/Enact Legislative Actions to Support 5G Rollout

Planning for and implementing new technology such as 5G inherently requires new operating strategies for the government and telecom industries, new regulations and tools for monitoring performance and measuring success, and a transparent process that encourages investments for the future. This means Albanian laws, regulations, and processes need to be reviewed to support the goal of a successful 5G rollout across Albania. This Plan identifies and makes recommendations on legislative actions that will help facilitate the rollout. In addition, this Plan will identify potential "special actions" and "streamlined processes" that the Albanian government may consider enhancing the success of the spectrum auction, encourage telecom Operator investments, and minimize cumbersome/time-consuming processes while still maintaining diligent review for effective and safe implementation of 5G technology throughout Albania.

Focus Area Three: Promote Operator Deployment of 5G

This Focus Area will address two major requirements of the plan: (1) the observations and recommendations of the Albanian telecom Operators as they consider making investments in 5G; and (2) the role the Government should play in encouraging those investments and in informing the Albanian public about the benefits of 5G through a focused marketing campaign.

This Plan confidently assumes that Albania's telecom Operators will develop their own marketing and advertising campaigns to support their 5G capabilities and offerings. However, 5G is a new technology that represents change, and change is more readily accepted with transparent communications regarding its benefits to the country and each citizen. On occasion, social media has provided false and misleading information on 5G, which may cause hesitancy in adopting this valuable technology. A broad and effective marketing campaign on how 5G can benefit Albanian society and what it means for them now and in the future can eliminate hesitancy, benefit the Operator's (and Government's) ability to "sell" 5G products and services, and in turn encourage investments and meaningful spectrum auction results for Albania. This is especially important with a 5G rollout. It represents a paradigm shift in technology that focuses primarily on enterprise and government applications versus wholly focused on the consumer as with 4G/3G/2G. 5G can become the data backbone for many traditional fiber or cable solutions such as electric utilities, government communications, and military communications within NATO. This was not fully understood in many Western countries as they began their 5G strategic planning, but their lesson-learned are reflected in this Plan.

Focus Area Four: Assess and Address Risks and Other Considerations to 5G Rollout

Inherent in the implementation of any new technology, this Plan assumes and addresses several potential risks. These risks can come in many forms, such as incomplete or unsatisfactory spectrum auction results; availability of systems/components or trusted network supply chains; access to buildings/structures for antenna; vulnerabilities in secure 5G networks from non-Clean Network suppliers; and financial/technical limitations of telecom Operators to implement true 5G.

This Plan also addresses other factors that must be considered, such as the geographical and environmental impacts, the current state /recommended state of fiber deployment (backbone) in support of 5G, and the tools and advisory services needed for implementing and monitoring 5G.

In summary, the implementation of 5G in Albania should ensure the creation of a national eco-system for wireless connectivity that will focus on significant increases in the quality of user experience, not only within the context of increased speed, reliability, and reduced communication latency but also by significantly expanding the number of offered services and creating new opportunities for Albanian citizens.

2 INTRODUCTION

It is expected that the future economic and social development of EU member states – and Albania itself – will be enhanced by the development of new wireless technologies and increased digitalization in everyday activities. New 5G technology development will overcome the existing wireless networks' capabilities and result in communications services available from anywhere, at any time, with significantly faster data rates. 5G technology is already spreading worldwide, and its continued development will likely be driven by new market needs. Albania must also engage with the world in the development of new technologies and support the operators of electronic communication networks/services (Operators) in the development and implementation of new innovative services.

The support provided to the Operators by the relevant Albanian institutions should be proactive and cooperative for the investment dynamics to support new generation networks such as 5G. Prerequisites, such as changes in the relevant regulations and application approval processes will enable the efficient and rapid construction and implementation of new 5G networks. Once implemented, 5G networks have been shown to provide:

- Increased speed of up to 10 Gbps.
- Latency (delay) is lower than 1ms.
- 1000-fold increased bandwidth.
- 100-fold more connected devices.
- 99.99% availability; and
- 100% coverage.

However, in addition to the significant improvements in speed, reliability and throughput, the main benefits of 5G that go beyond the boundaries of traditional electronic communications lie in the evolution of the new business models, infrastructure partnerships, and range of service increases. The vertical industry partnerships that can be established through 5G are multi-layered, ranging from simple sharing of infrastructure to integrating partners into a system with a software-oriented architecture. This creates value to an organization, including transparent and comprehensive availability, consistent quality of service, personalization of services, and highly reliable communications.

The range of services that can be radically innovated and offered through 5G architecture is the main incentive for the development on behalf of every industry sector. The mobile-connected society and the complete digital infrastructure offered by 5G are drivers for the development of modern industry and economic growth. 5G technology is expected to be applied in the automotive industry, public safety, healthcare, financial sector, utilities, high-tech manufacturing, internet/digital homes, media/games, etc.

As noted above, 5G has the potential to support millions of devices at ultrafast speeds and become a transformation enabler for people in Albania and around the world. For example:

- Improvements through 5G technology can help make life better. For example, significant advances in autonomous vehicle technology are possible with 5G, creating the potential for people to have new personal and professional freedom levels. Connected appliances can help automate tasks around the house, which can improve personal convenience and help those who need assistance with everyday tasks.
- 5G can power technology further beyond what current mobile technology permits. Thanks to its speed and bandwidth, 5G promises to make significant improvements in virtual reality, augmented reality, and artificial intelligence, creating opportunities to connect people far beyond what current cellular technology allows.
- Access to 5G technology promises to improve the safety and security of mission-critical services received today. Opportunities include smart cities with 5G in public spaces, the potential for remote surgery, better traffic control, and many other applications that depend on nearly instantaneous response time.
- Unlike previous generations, 5G benefits two distinct customer groups: (1) consumers with expanded applications, new business opportunities, lightning-fast downloads, and educational opportunities; and (2) enterprise, government, and military data/communication application customers. In other words, 5G becomes a critical data/communication backbone for the government, military and industry like copper and fiber did in previous generations.

2.1 AKEPs Objectives for 5G

AKEP has undertaken partnerships to standardize, per the rule of law and legal obligations for network security and user privacy protection, the approach and the means to obtain secure networks and technologies in the framework of the future implementation of next-generation technologies and networks. To ensure the conditions for these efforts, AKEP has worked and continues to work with the Ministry of Infrastructure and Energy (MIE), Audiovisual Media Authority (AMA), International Telecommunications Union (ITU), and other international experts to vacate the 700 MHz broadband which will be exclusively used for digital purposes.

AKEP's objectives are:

- Driving investments focused on sustainable digital development, improved service quality and guaranteeing consumer rights.
- Making the electronic communications and postal services sector more dynamic through fair and accessible competition in the market.
- Promoting national assets, frequency bands, and their efficient use in the framework of next-generation technologies.
- Standardizing network security and reliability of electronic communication services through safe providers and technologies.
- Increasingly closer harmonizing with regulatory and functional independence requirements, following the EU standards.

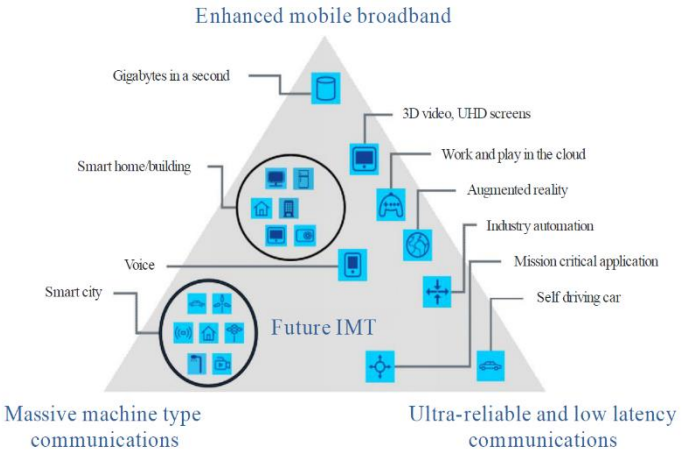
2.2 TECHNICAL OVERVIEW OF 5G TECHNOLOGY

The term 5G describes the next generation of mobile communications, following 4G, which offers much more capability than previous generations. Instead of the traditional approach of improving the utilization of the radio frequency spectrum, 5G drives the need for developing new radio interfaces that use higher frequencies, specific user applications such as Internet of Things (IoT), or specific features (e.g., low latency) that go much farther than what is currently supported by 4G.

However, 5G not only drives the development of a new radio interface, but its ecosystem includes all aspects of the network. Its design converges today's access mechanisms and their advanced future versions, including cable connections and all-new access networks that are yet to be developed. This means that 5G will work in a highly heterogeneous environment that is characterized by multiple types of access technologies, multi-layer networks, different types of devices, different types of user interaction, etc. Formally defined, 5G is an end-to-end ecosystem that provides a fully mobile and connected society. This ecosystem supports creating more value for customers and service providers through existing and new examples of use, offered with consistent user experience, and defined with the help of sustainable business models. Designed as a flexible system, 5G can provide much higher performance with optimized network usage by using modular networking functions that can be applied and scaled as needed. All different application types can be supported with 5G in an agile and cost-effective manner.

According to ITU, three main scenarios of using 5G technology have been identified, according to which the development of specific services with specific requirements depends upon the industry (sector) where they will be identified:

- **mMTC–Massive Machine Type Communications**. A larger number of connected devices with different service quality requirements. The goal is to respond with an exponential increase in the density of connected devices
- **eMBB-Enhanced Mobile Broadband.** Connections for mobile broadband at ultra-high speeds (indoor and outdoor) with uniform quality of service
- **URLLC-Ultra-reliable and Low Latency Communications.** This scenario has unique requirements, such as latency, to ensure increased response speed.



Typical uses of 5G include:

- Broadband access in densely populated environments
  - Examples: Ubiquitous video, smart offices, cloud services, high-resolution video sharing
- Broadband access everywhere
  - Examples: More than 50 Mbps anywhere, ultra-cheap networks
- High user mobility
  - Examples: High-speed trains, remote calculations, mobile hot spots, 3D drone links
- Massive IoT
  - Examples: Smart carrying devices, sensor networks, mobile video surveillance
- Extreme communications in real-time
  - Examples: Tactile Internet
- Emergency communications
  - Examples: Natural disasters
- Ultra-reliable communications
  - Examples: Automated traffic and driving control, collaborative robots, e-health, remote operations, drone control, public safety
- Broadcasting services
  - Examples: News and information in real-time, local cell-level services, regional services, national services

Introducing 5G will help meet the growing demands of digital radio infrastructures' capacity, bandwidth, availability, and latency. In order to meet these requirements, to ensure coverage in rural areas, and to provide for high-capacity applications, enough radio frequencies will be required.

For example, favorable propagation conditions in rural areas will require low frequencies (below 1 GHz). In contrast to lower ones, the frequency in slightly higher bands (for example, in the 3.5 GHz band) offers a larger frequency range and provides the capacity for higher data rates available on many devices. The frequencies in very high bands (above 24 GHz) will also be needed to offer substantial bandwidth and large-capacity services. However, unlike low frequencies, coverage is minimal, making these networks limited to local areas.

However, the implementation of high-speed data services (up to 20 Gbit/s) requires allocating additional radio frequency bands for mobile communications that will allow a radio communication channel band of several hundred MHz or even GHz. Radio frequencies above 24 GHz (millimeter range) are very suitable for this purpose. AKEP should monitor the identification of harmonized radio frequency bands at the European level and support the compliance for radio frequency bands declared by the World Radio-communication Conference (WRC) as 5G candidates.

2.3 SUPPORTING THE IMPACT OF 5G ON THE MARKET

It is expected that many sectors, starting from everyday life, to transport, finance, healthcare, creativity, manufacturing, public services, and others, will be directly impacted by the new opportunities offered by the 5G ecosystem. Therefore, it is strategically essential for the Government of Albania to support the establishment of consortia of various partners that will include the telecommunication operators who will offer infrastructure, representatives of vertical markets who will define the services and end-users, companies who will develop new innovative services, and the representatives of the academia who will support research, testing, and analysis activities for the implementation success.

During implementation, the Government of Albania should begin talking with the vertically positioned sectors, industry, and telecommunications operators to the following end:

- Sign a Memorandum of Understanding for 5G development and digital transformation in all spheres of society using 5G technology.
- Consider possible financing of projects through which the potential 5G features will be demonstrated and tested, thus allowing the development of new services.
- Support the increase of the level of digital skills within the industry, as well as among Albanian citizens.

2.4 IMPROVEMENTS BETWEEN PREVIOUS GENERATIONS OF MOBILE NETWORKS AND 5G

4G has driven significant development in Albania's network and communication sector. However as noted earlier, AKEP has an immediate need to develop a 4G/5G evolution strategy and roadmap that provides the steps necessary to deliver a 5G capability/ecosystem that meets Albania's technical, legislative, and security requirements for citizens, visitors, government, and other national economic and sociological needs. All mobile networks contain differences with each other, as does 5G:

- Services can be deployed faster and easier.
- More connected devices can be added to Albanian networks, and "bring your own device" can become a reality.
- True edge processing.
- Orders of magnitude increase in data volume.
- Lower latency percentage.
- Higher reliability through Service Level Agreements can be developed and maintained with the new 5G network.

Around the world, as 5G has been transitioned into operation, users have begun to realize the value and benefits of 5G:

- **Generational Leap in Digital Critical Infrastructure Security.** To achieve and maintain maximum information security protection for 5G applications and services, including the network edge, a detailed 5G Open Security Framework will be needed to

support the development, verification, validation, deployment, and operation of critical applications and underlying services. By creating this framework, the Government of Albania will enable secure 5G infrastructure, services, and applications that enables continuous validation of 5G, specific use cases for the deployment of 5G systems in critical domains, and advanced techniques such as secure virtualization and zero-trust methods to address the security of 5G systems. The talent and expertise needed to develop and continually validate this framework will take – and attract – high level engineering and software development professionals, to Albania.

- **Economic (GDP)**. The European Union argues that 5G will significantly impact the digital sector and the economy. Especially against the background of slow deployment of 4G and related services, the successful launch of 5G in the EU is considered crucial for economic development and the economy's competitiveness and productivity. A robust 5G network will bring significant direct benefits with more data, more devices, increased speed, and a better network experience for businesses and individuals. Also, 5G will promote broad societal benefits, including improved cost competitiveness for Albanian companies, and improved health and safety delivery.

- **Health and Medicine:** Advanced capability from 5G will drive improvements in telemedicine delivery along with new applications, tools, and equipment for the health industry. In addition, 5G technology will support the mission-critical applications required for the regulatory evaluation of critical medical devices.

- **Digital Government:** Digital transformation will be essential to advance the workings of the government. Government priorities, including higher citizen engagement, improved productivity, and more robust economic growth, will increasingly depend on digital technology. 5G can deliver significant value to public services, include public education and training, government facility management, defense, blue-light services, smart city initiatives, public healthcare, and public transport.

- **Administrative Organizations:** Priority should be given to deepening existing public-private partnerships throughout Albania's Government. Enabling access to a nationwide set of diverse administrative organizations can allow Albania's industry, academia, and government to focus resources on technology enhancement, developing solutions, and addressing necessary market needs, faster.

- **Populace:** The benefits that 5G will bring to society in the coming decade are genuinely revolutionary. In addition to the accelerated speeds that individual consumers will see, laying the infrastructure for 5G will enable civilization-changing smart technologies and an unlimited number of device connections. 5G will enable blossoming technologies that rely on connectivity to the internet to go widespread, from connected self-driving cars to smart plugs, lights, cameras, thermostats, healthcare monitoring devices, and more.

- **Connectivity:** With 5G, high amounts of data can be transmitted more efficiently, which means 5G is expected to deliver faster download speeds, real-time responses, and enhanced connectivity, giving businesses and consumers the potential to experience new, innovative technologies. 5G will promote a truly connected and safer Albania, and fuel innovation.

- **Driving Retention of Albania's Best and Brightest:** The application possibilities from 5G are endless, from the development of life-saving health monitors to train platforms that will tell you how many free seats there are in each carriage of the approaching train. Technology developed with 5G as its backbone enables Albania's best and brightest citizens – now and in the future – to be a part of an Albanian technology wave, committed to staying in Albania to help the country realize 5G's full value.

2.5 PRIVATE / SECURE 5G NETWORKS

Private 5G will likely become the preferred choice for many of the world's businesses, especially for industrial environments such as manufacturing plants, logistics centers, and ports. A mobile private 5G network, as the name suggests, is a local area network that utilizes 5G technology as its communication medium to build and create a 'private' network.

Since private 4G LTE networks are already commercial and in extensive use, deploying private 5G networks is an expectation that will allow manufacturers to eliminate the tethered limitations of ethernet cables that litter their factory floors and connect the machines wirelessly to the cloud. The network's capacity, and number of wireless devices connected to the network will be considerably higher once a 5G network is deployed.

In addition to private networks described above, many 5G applications upon which Albanian citizens will depend must be safe, secure, fast and reliable. As examples, secure 5G networks will be required for:

- **Intelligent Mobility:** Automated and connected driving will make road traffic safer and improve traffic flow so that resources are conserved, and harmful emissions are reduced. Intelligent mobility also offers opportunities to optimize parking management, for example, through automated parking display systems.

- **Smart Grids:** 5G allows the connection of consumers, producers, and network operators to create intelligent, decentralized energy systems that communicate with each other in real-time and can be combined into virtual power stations in the future. 5G supported smart grids can support the introduction and use of new technological developments, such as electrically powered vehicles and the charging stations required for this or smart home applications. At the same time, the safety of the future energy infrastructure will depend significantly on the security of the communication infrastructure. From this mutual interdependence arises the necessity to create an overall resilient system of communication and energy and develop new application

technologies in the energy sectors building upon it. 5G will facilitate intelligent building services, such as smart metering, the control of heating systems, or the monitoring of supply infrastructures such as water, sewage, or ventilation systems.

- **eHealth**: Telemedicine will revolutionize the relationship between doctor and patient and enable better medical care in all areas of Albania. The live involvement of specialists in virtual clinics and the transfer of patient data to the clinic, will create a generally more efficient emergency medical aid. Digitization has already reached the healthcare sector and medicine in all its functional areas, so secure 5G will improve the provision of quality medical care while securing the privacy of each patient's health information.

- **Education:** Learning experiences are already being changed by digital learning environments. 5G driven enhancements such as augmented and virtual reality in the educational sector and future media will dramatically increase the demand for mobile broadband capacities. Interactive participation in teaching sessions with multi-media applications (e.g., distance learning, etc.) is becoming more popular, and 5G allows completely new experiences in this area. The increased use of digital teaching styles will further facilitate the trend towards individualization of teaching, independent of location and time. Nevertheless, the more teaching becomes individualized, the more individual privacy must be a priority, so the security of 5G learning applications becomes essential.

- **Smart Cities**: The procedures for awarding research projects on application areas for the new mobile technology standard must include the users. Furthermore, topics such as acceptance and system integration must be addressed as significant issues. The topic "smart cities" is particularly suited for the development and testing of new digital technologies, because in this broad application area, the effects of 5G on the urban mobility, environment, energy, IT, and safety areas as well as system integration can be researched across the different application fields.

- **Secure 5G for the Government and the Military**: In a world where cyber threats and ransomware actions are exponentially increasing in numbers and complexity, effective cyber-protection will be required for the Albanian Government, the Ministry of Defense. As demonstrated by other 5G users around the world, secure 5G technology around a government complex or a military base, will enable a "bubble" of wireless network protection if supplemented by secure encryption and protection software.

- **Public Safety**: First responders to fires and other emergencies can employ secure 5G network resources to retrieve building maps to identify access points, riser taps for fire hoses, elevator command and control, structural drawings and other data for rapid, informed decision making. Firefighters can use 5G-enabled drones for search and rescue operations, or to monitor hot spots near a structural fire to prevent them from spreading. The same technology can be used to map wildfire containment strategies

during heavy fire seasons. The same technology can also be used to track firefighters using sensors implanted in their clothing.

3 FACILITATE AN ALBANIAN 5G SPECTRUM AUCTION

3.1 WHAT IS A SPECTRUM AUCTION, AND WHY IS IT NECESSARY?

Simply stated, a spectrum auction is an online auction sponsored by a government that auctions licenses (the government retains ownership of the spectrum) for commercial use. It is typically designed for commercial telecommunications operators such as mobile phone companies and satellite providers. More recently, there has been a trend for the Internet of Things (IOT) operators to purchase licenses in a spectrum auction. The proceeds of the spectrum license auction go to the government sponsoring the auction. With the advent of 4G and 5G, the worth of spectrum as a country's digital infrastructure has skyrocketed.

For example, in the United States, the Federal Communications Commission (FCC) has conducted auctions of licenses for electromagnetic spectrum since 1994. There are also several European examples of auctions, such as the most recent Swiss auction, which parallels Albania's 5G goals. These auctions are open to any eligible company or individual that applies, provides upfront payment, and is found to be a qualified bidder by the Commission. The auctions are conducted electronically and are accessible over the internet.

The proceeds from the auction facilitate two essential purposes. First, it allows incumbents in the auctioned spectrum to be rapidly paid to move their capabilities to a new frequency facilitating an efficient move to another band for the incumbent. Secondly, it allows a significant amount of capital from the auction proceeds that the government can use for infrastructure improvement or for use in the general treasury.

Through comparative results of nearly three decades, the EU Regulators and FCC have found that spectrum auctions assign licenses more effectively than either comparative hearings or lotteries. The auction approach is intended to award the licenses to those who will use them most effectively. Additionally as an example, the FCC has reduced the average time from initial application to license grant to less than one year by using auctions. The public receives direct financial benefits from the award of licenses. Albania has the added opportunity of having an unencumbered spectrum in both mid-band and millimeter-wave bands, allowing rapid use after an auction is complete.

Auction proceeds need to exceed the cost of an incumbent's cost to move to another band; otherwise, it becomes a "failed auction" and needs to be repeated in the future. Each band is different, with some having high costs to move incumbents while others with minimal incumbents have little overhead required to make an auction "successful." It should be noted that the capital markets have become mature in supporting commercial companies interested in purchasing spectrum licenses. Spectrum licenses have become their capital market, with some claiming an analogy to the bitcoin market. Especially in the 4G/5G markets, spectrum licenses have become assets like physical property.

It should be noted that in the EU's *"Roadmap for Lowering Roaming Charges Between the EU and WB, dated September 2021,"* Western Balkans (WB) economies are encouraged to enhance the deployment of 5G networks by ensuring the availability of a substantial amount

of radio spectrum, consistent with market demand, as soon as possible. It notes that WB economies should ensure that the management of spectrum promotes high-quality connectivity for businesses and citizens, thereby generating benefits for the economy and society as a whole in terms of accessibility, equal opportunity and inclusivity. It goes on to say that WB economies should develop, or update if necessary, relevant domestic spectrum roadmaps or action plans related to the future 5G spectrum releases, and establish a strong coordination process among the economies for spectrum assignment in order to avoid interference problems that were noticed in the region in the past. This Plan reflects these recommendations.

3.2 How Spectrum Auctions Work

The typical structure of a spectrum auction is called a **Simultaneous Multi-Round (SMR)** auction. This means that all the available licenses are auctioned simultaneously. The bidding on these licenses is broken into rounds of set, predetermined length. There is no set limit of rounds. The auction only stops when there is a round with no new bids. This can take weeks, even months (typically ~4 weeks).

Since all licenses are available for bidding simultaneously, a separate function can be built into the system called **Package Bidding**. This allows a bidder to select a group of licenses to bid on as a single "package." This is especially useful if a telecommunications company is trying to establish a nationwide service using a specific radio frequency. Bidding during rounds is confidential, but all bids are made public at the end of the round. Since this is a multi-round system, bidders use this information to adjust their maximum bids or reconsider which licenses are most important. At the start of the next round, the minimum bid is set at ten percent higher than the **Provisional Winning Bid (PWB)**, the highest bid from the previous round.

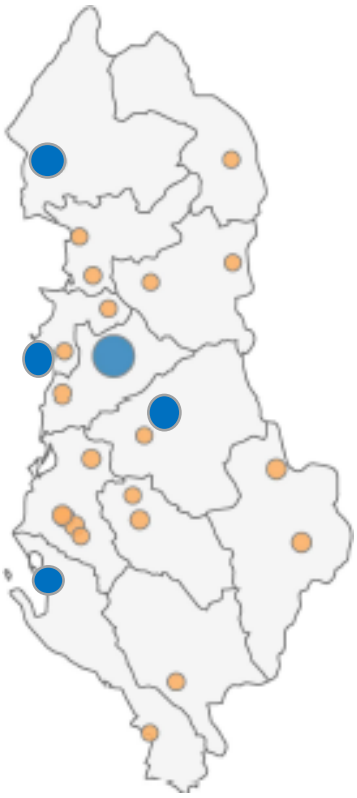
3.2.1 What is Actually Sold at Auctions?

During spectrum auctions, the government sells individual licenses to use specific frequencies of the available electromagnetic spectrum. Each license gives the license holder the right to use the spectrum freely if they adhere to all government broadcaster and operator guidelines and standards. If not, a license can be revoked. The auction system is only used when two or more commercial organizations want to buy the same piece of spectrum.

License duration can vary. Most countries use 10-15 years for the duration of licenses. This allows 5G deployment and customer adoption with enough time to recoup their investment in both the license cost and equipment deployment. It is also recommended that minimum equipment deployment timeframe and level of service are specified in license agreements. This is especially important with longer license agreements as it provides an expected level of service and the required speed of deployment to retain the license for the duration specified. An excellent example of the level of service would be a minimum service threshold of 50 Mbps download/25Mbps upload with an objective service level of 100Mbps download/100Mpbs upload. This provides a service transition from a combined 5G/4G network transitioning to a stand-alone 5G network.

Typically, when a government plans an auction, it breaks the licenses down into regions corresponding to different economic or metropolitan areas. The largest regions are called Economic Area Groupings (EAG). For example, six EAGs were covering all 50 states and territories in the most recent US auction. Smaller regions are called Major Economic Areas (MEA). Other important license regions are Cellular Market Areas (CMA) and Regional Economic Area Groupings (REAG). Regardless of country size, breakdowns of the various economic areas allow a proper spectrum grouping for MEAs and appropriate pricing.

Note: This Plan recommends AKEP create 5 MEAs – Tirana, Durres, Elbasan, Shkoder and Vlore.



When planning an auction, the government sells licenses in blocks. Each block corresponds to two factors: the number of frequencies being licensed and the number of different sectors in which they're being offered.

Note: Interest has already been given to AKEP from Albania's three main Operators that they prefer a mix low, mid-band and millimeter wave band spectrum, divided into 10 MHz bands for low band, a range of 20 to 100 MHz for the mid-band, and a range of 100 to 200 MHz for the millimeter wave band. This Plan recommends AKEP and the Operators work together in the pre-auction phases to refine Operator preferences for an optimum auction outcome.

3.2.2 What Qualifies Bidders for Auctions?

Typically, any public or private organization, business, or individual can apply to become a qualified bidder on a government spectrum auction.

All accepted bidders receive an information packet from the respective governmental agency with additional details about the auction, including a list of the licenses that'll be auctioned. All bidders must then make an upfront payment that serves as a refundable deposit, securing them a place in the auction.

The amount of the upfront payment depends on how many licenses the organization wants to bid upon. Each license is assigned a fixed number of bidding units. To be eligible to bid on the license, the organization must buy the required number of bidding units. If an organization wants to bid on multiple units, the upfront payment must cover the total amount of bidding units for all the licenses they are interested in.

3.3 SUCCESSFUL AUCTION DESIGNS

3.3.1 Simultaneous Multiple-Round (SMR) Auctions

In a simultaneous multiple-round (SMR) auction, all licenses are available for bidding throughout the auction, thus the term "simultaneous." Unlike most auctions in which bidding

is continuous, SMR auctions have discrete, successive rounds, with the length of each round announced in advance by the government.

After each round closes, round results are processed and made public. Only then do bidders learn about the bids placed by other bidders. This provides information about the value of the licenses to all bidders and increases the likelihood that the licenses will be assigned to the bidders who value them the most. The period between auction rounds also allows bidders to take stock of and perhaps adjust their bidding strategies. In an SMR auction, there is no preset number of rounds. Bidding continues, round after round, until a round occurs in which all bidder activity ceases. That round becomes the closing round of the auction.

3.3.2 Package Bidding

The government's SMR auction design can be modified to allow combination or "package" bidding. With package bidding, bidders may place bids on groups of licenses as well as on individual licenses. This approach allows bidders to express better the value of any synergies (benefits from combining complementary items) among licenses and avoid the risk of winning only part of the desired set. This has been an essential aspect for industry and significantly increases the value of the spectrum.

In general, package bidding is appropriate when there are strong similarities among licenses for some bidders, and the pattern of those similarities varies among bidders. Under these circumstances, package bidding yields an efficient outcome, ensuring that licenses are sold to those bidders who value them the most. The capital markets also recognize this and are more willing to increase loans to the industry as they see the return on investment as quite high and low risk. Package bidding procedures are also designed to allow the auction to proceed at an appropriate pace, encourage straightforward bidding, and permit bidders to employ flexible backup strategies.

3.4 Spectrum Auctions Setups and Timelines

The following sections describe a recommended approach for an Albanian spectrum auction. Figure 3.4 provides a flow chart for this approach.

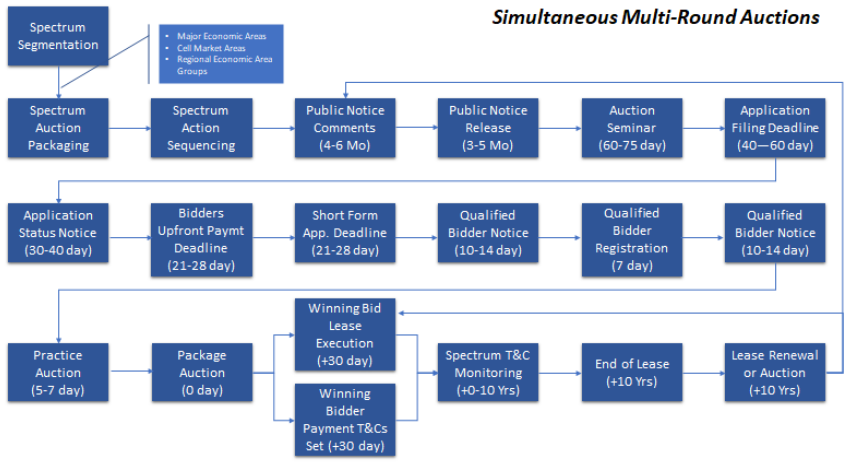


Figure 3.4 Auction Flow Chart

3.4.1 Public Notice for Comment

(Approximately 4-6 months before the auction) Typically, a public notice is released according to local laws and allows companies to consider joining the auction. The public notice includes requests for comments on auction procedures such as activity rules, upfront payment amounts, minimum opening bids, and/or reserve prices. This allows the government to change, delete or add rules as necessary following the public comment.

3.4.2 Procedures Public Notice

(Approximately 3-5 months before the auction) Public notice is released, providing potential participants with the procedures, terms, and conditions for the auction event.

3.4.3 Seminar

(Approximately 60-75 days before the auction) A free pre-auction seminar is conducted for potential participants to introduce them to the auction rules and process. The bidding software is demonstrated, and participants can get questions answered.

3.4.4 Application Filing Deadline

(Approximately 45-60 days before the auction) This is the first deadline faced by potential participants. A formal application that must be filed electronically collects basic information, including the applicant's ownership structure and the licenses on which it wants to bid during the auction. If an individual or company does not submit its short-form application by the established deadline, it will not participate in the auction.

3.4.5 Application Status Public Notice

(Approximately 30-40 days before the auction). After the deadline for filing, staff reviews all timely-filed short-form applications and deems them accepted, incomplete, or rejected. This public notice announces the status of the applications. AKEP would then send the public notice to each applicant in a typically two-day express mailing package. For applicants whose filings have been deemed incomplete, a letter is included that explains the reasons for the "incomplete" designation. This letter also includes the name of a government contact person if the applicant requires further explanation.

3.4.6 Upfront Payment Deadline

(Approximately 3-4 weeks before the auction) Potential bidders must submit a refundable deposit used to purchase the eligibility (bidding units) required to place bids in the auction.

3.4.7 Short-Form Application Resubmission Deadline

(Approximately 3-4 weeks before the auction) Auction applications deemed "incomplete" must be refiled by this deadline, which often coincides with the upfront payment deadline.

3.4.8 Qualified Bidders Public Notice

(Approximately 10-14 days before the auction) This public notice lists the bidders qualified to participate in the auction, each bidder's AKEP Registration Number, and its claimed bidding credit eligibility. This public notice also lists each bidder's bidding unit eligibility and which items it selected on its auction application for some auctions. The public notice also contains information about the mock auction, the bidding schedule for the first day of the auction, and other auction-specific details. AKEP would send this public notice to each applicant in a typically two-day express mail package along with registration materials as listed below.

3.4.9 Qualified Bidders Registration

(Approximately seven days before the auction) Immediately following the release of the Qualified Bidders Public Notice, the bidder registration process begins. Two, two-day express mailings are sent to the contact person identified on the short-form application. These mailings include the Qualified Bidders Public Notice, RSA SecurID cards (cyber protection) for logging into the Integrated Spectrum Auction System (ISAS), the Auction Bidder Line phone number, and other materials needed to participate in the auction.

3.4.10 Mock Auction

(Approximately 5-7 days before the auction) To ensure bidders understand the auction process, AKEP would conduct a mock auction as a service to qualified bidders. The mock auction allows bidders to familiarize themselves with the bidding process and become comfortable with the rules and conduct of the auction. This is a significant event for both governments and industries. This team recommends that AKEP consider two mock auctions three days apart to ensure the first Albanian auction goes smoothly.

3.4.11 Auction Begins

This process provides a smooth transition to an auction where both the government and bidders are fully understanding of the process and comfortable with using the auction tools.

3.5 Other Spectrum Auction Considerations

Public tender procedures will be conducted per law no. 9918, dated 19.05.2008, and will be monitored for transparency in legality through the detailed logs kept by AKEP under the supervision of the Ministry of Infrastructure and Energy.

Note: In addition, this Plan recommends AKEP consider the use of the detailed forms, applications and processes utilized by the FCC, and/or the rules/application documents utilized by the Swiss Federal Department of the Environment, Transport, Energy and Communications for the licensing of 5G mobile radio technology.

3.5.1 Pre and Post Auction

At the level of the European Conference on Posts and Telecommunications (CEPT), which includes administrations from 48 countries including Albania, it has already been decided that Europe should analyze the following radio frequency bands 24.25-27.5 GHz, 31.8-33.4 GHz, and 40.5-43.5 GHz. The Radio Spectrum Policy Group (RSPG), the advisory body of the EU for radio frequency issues, and the EU Radio Spectrum Committee (RSC) aim to harmonize the 24.25-27.5 GHz (26 GHz) band in Europe. The goal is to use this 5G pioneering band as early as possible. Therefore, compatibility checks and negotiations with existing users in this range and users in the adjacent bands that must be protected have already begun.

The radio frequency band 3.4-3.8 GHz will also play an important role in introducing 5G. In this radio frequency band, there is a good chance that operators providing mobile electronic communications networks/services will be able to use channels up to 100 MHz wide, so this range can generally be used for data-intensive applications in smaller cells, for example, in urban areas. Albania has a significant advantage in that the mid-band spectrum is unencumbered with other users.

In addition, due to favorable propagation conditions, the 700 MHz frequencies will provide the opportunity for network operators to develop comprehensive 5G coverage early, especially in rural mountainous regions, based on their existing network infrastructure.

A precondition for the promotion of 5G networks is to provide a sufficient and adequate radio frequency spectrum as early as possible to stimulate investments, innovation, and competition in the development of 5G services.

To enable the earliest possible use of 5G technology in Albania, it is important to provide test radio frequencies in a timely manner and frequencies for commercial use.

In support of pre- and post-auction efforts, it is recommended that AKEP take the following actions:

- AKEP will launch bilateral talks with representatives from Albania on the possible signing of a Memorandum of Understanding on the avoidance of unwanted harmful interference in the radio frequency bands when implementing mobile communications (especially 5G).

- AKEP, in cooperation with the Ministry of Infrastructure and Energy and the Operators, will launch a public debate on the amount of the one-time fee for the use of radio frequencies for the introduction of 5G.

- AKEP, in cooperation with the Operators, will launch a public debate on the amount of the annual fee for the use of radio frequencies, per the new proposed EU Directive on Electronic Communications.

- AKEP, in cooperation with the Ministry of Infrastructure and Energy and the Operators, will launch a public hearing on the duration of the authorization for the use of radio frequencies, per the new proposed EU Directive on Electronic Communications, which will result in respective amendments of the Law of Electronic Communications (LEC).

- AKEP will harmonize the spectrum within CEPT and implement it in the national regulation during 2022. Before this, re-planning certain broadcasting bands and allocation for the land mobile service must be conducted.

- AKEP will make changes, ex officio, in the 694-790 MHz band channels operators use to provide digital television services (DVB-T) to free the 694-790 MHz radio frequency band.

- The tender procedure for granting authorizations for the use of radio frequencies for the 694-790 MHz band must be planned for an announcement by the second half of 2022.

3.5.2 Auction Procurement

The primary procedure followed by AKEP regarding the public tender will be the "Open Procedure," in which all interested subjects can make a valid tender offer that will be selected based on price and established technical criteria. When the technical criteria and policy development objectives require it, the tender will be implemented under the "Competitive Procedure," where the interested applying subject will be selected based on the established technical criteria. Regardless of the procedure utilized, the application will include the supporting documentation as follows:

- notification form, instructions for the candidates, offer form, general qualification / competition criteria, offer insurance form, winning notification form, candidate disqualification form, winner publishing form.
- specific information on:
    - frequency/frequencies definition and the value of those mentioned above.
    - general authorization as well as the individual authorization regarding the frequency usage.
    - both the notification and registration.
    - the numeration.
    - information on the market of Electronic Communication in the Republic of Albania.
    - general information on Albania, and payment methods regarding individual authorization.

For a valid public procurement procedure, the tender order should include the object of the tender, the minister-approved procedure type, payment method, and the composition of the document preparation unit in charge.

Before conducting the procedure, AKEP has the obligation of publishing the planned procedure, in international publishing and, when necessary, twice in a national newspaper and via mail, fax, e-mail, etc., and on the official AKEP website.

Note: This Plan encourages competition, so consideration should be given to inviting Operators outside Albania to submit bids for spectrum licenses in the auction(s).

3.5.3 Payment Method

The application of payment by installments procedure for an individual authorization is approved by the Ministry in cases when the application of such a method accelerates the investments for the offer of services in the interest of the public and benefiting competitiveness. In some cases, the Ministry should consider installment terms longer than one year if that assists an Operator in making the investment in 5G faster than they otherwise could have afforded.

3.5.4 Application Process/Criteria

A candidate or applicant is eligible to compete in the tender process after verifying that:

- the applicant is a joint-stock company or a juridical entity following the legislation of their registration country, registered in the competent authorities of their headquarters.
- can make offers and collaboration of investors with the scope of achieving the tender transaction through an emerging company.
- is not in liquidation process and has the necessary payment capabilities and are not in any process that may interrupt the conduction of business.
- cannot be priory trialed and found guilty of fraud, money laundering, corruption, and any role in a criminal organization.
- cannot have an unpaid debt to the Albanian state and are not in an insolvency process.

All the criteria mentioned above must be verified with official documentation not older than thirty (30) days. For foreign applicants, a declaration from the applicant will suffice, and if deemed necessary, AKEP will require assistance from the applicants' respective authorities. The lack of any of the abovementioned requirements may result in the disqualification of the applicant.

The potential applicant then qualifies for the tender procedure after having met the conditions as follows, which AKEP deems necessary for as long as they comply with the nature and size of the individual authorization of the tender and non-discriminatory:

- The applicant must certify their knowledge of electronic communication and experience on a case-by-case basis depending on the frequency/frequencies to be tendered, the technologies operating in that band, for the process of the procurement and their technical abilities.

- The applicant must submit an extension and configuration plan of the network that will be developed and operate the tendered frequency/frequencies.
- The applicant shall include a plan of the service as well as service quality to be offered through the network that will operate the object of the tender on a case-by-case basis and the applicant should insure the usage of the frequency/frequencies in compliance with the ITU & CEPT recommendations and standards.
- The candidate must ensure their financial capabilities to accomplish the tender operation through all the necessary documentation as well as their legal capability to undertake such a process.

The application with the above-mentioned documentation must be delivered in hard copy and accompanied by a declaration from the applicant that will fulfill the abovementioned criteria if selected.

The potential applicant can request an explanation by AKEP if the request is received five (5) days before the final deadline. AKEP is obliged to reply within three (3) days from the request's receipt and shall reply to all participants in the procedure without identifying the requestor. The deadline for submitting offers is no less than forty-five (45) days from the date when the tender was published.

AKEP will disqualify any application that does not meet minimum requirements, includes fraudulent documentation, or are from subjects excluded by public procurement procedures as per governing law.

AKEP reserves the right to withdraw from the procedure in cases of public benefit always by implementing a transparent and open approach by notifying the applicants and publishing the reasons for the procedure annulment within five (5) days of the decision.

As per payment instructions, the offers that include an installment payment method must consider that the minimal first-year installment is 20% of the offer price.

The application can be delivered in hard copy, personally or by mail, signed and sealed as instructed. The applicant will be provided with a submission certificate designating the delivery of the application and the date and time. All application costs are not reimbursable and offers made after the deadline will be resent unopened to the applicants.

AKEP requires all the applicants to have a refundable insurance deposit not greater than 2-3% of the minimal monetary value of the frequency. If the payment method is through installments, the minimal offers are minimally thirty (30) days ahead of the proposed payment.

The offer valuation commission will open the offers while keeping logs and establish a date of publication of its decision, not later than thirty (30) days from the offer opening moment. The commission will notify the applicants of any arithmetic errors in their calculations and input the correct information.

An offer will not be accepted if the applicant will not acknowledge the arithmetic error, the offer doesn't meet the specified criteria, or when the applicant is ineligible for the application process as specified above.

3.5.5 Procedure Completion

If two or more offers have the same number of evaluated points, the winner will be decided in a public lottery. The applicants have the right to issue a formal complaint towards AKEP within five (5) days of receiving notifications. AKEP then has five (5) days to review the complaint.

The criteria used in evaluating the "Open Procedure" are the offer value and technical requirements. The criteria used in the evaluation of the "Competitive Procedure" are the technical requirements.

3.5.6 Notification of Winning Application and Authorization

After the exhaustion of the claim period, AKEP will officially notify the winner and publish the notification on the official website. AKEP and the winning applicant will then sign the tender contract no later than ten (10) days without surpassing the tender deadline as instructed in the documents.

The individual authorization comes into power after the winner has fulfilled all the financial obligations, or in the case of payment by installments, after the first installment payment. The payment calendar is included in terms of individual authorization. Suppose the winner cannot deliver the individual authorization. In that case, AKEP will seize the insurance and proceed into granting the rights to the second winning applicant or withdrawing from the procedure thoroughly. Any Individual Authorization issued before the end of the deadline is null and void.

3.5.7 Administrative Review

Any claim forwarded to the Managing Board of AKEP must be made within five (5) days of receiving notice regarding the claim issue. Upon receiving a claim, AKEP will suspend the process until the resolution of the claim and decide within the legally established deadline. If AKEP does not resolve the claim within five (5) days, the claiming applicant will address the competent Minister within fifteen (15) days from the date of the claim being first delivered to AKEP. Upon receiving the claim, the Minister suspends the process until a resolution can be achieved with a maximal deadline of twenty (20) days.

3.5.8 Determining/reporting results, resultant actions

AKEP must protect the privacy of the participants' bids. Before an auction, each bidder must submit an upfront payment that determines its bidding eligibility. During each auction round, each bidder is required to bid on a specified portion of its maximum eligibility. If a bidder does not meet this requirement, it uses an activity rule waiver (if available) or loses eligibility. Round results are released within approximately 15 minutes after each round closes. They are available for download, both to bidders and to the general public.

3.5.9 Additonal information

The primary goal of the allocations and autcions procedure reccomanded in this document, is therefore to achieve an efficient use of spectrum, innovation, competition, legal certainty, connectivity and rapid nationwide coverage for the population and economy with high-quality communication infrastructure.

AKEP is expressly committed to a strategic and innovation-friendly objective of frequency issuing procedure, and therefore to economically justifiable auction/tender designs.

The main aim of this document is not giving details of concrete awarding procedures to maximise revenues from auctions. These points should be defined within the framework of the appropriate tender/auction document at the time of issuing the frequencies.

Awarding frequencies in the 700 MHz, 3.4-3.8 GHz, 26 GHZ bands are scheduled for this year and the next. Moreover, additional frequency bands for 5G are already identified on International and Europioan level from CEPT/ECC Decisions. As soon as there is clarity regarding the availability of such additional bands, Albania will make these bands available, through other ducumentation.

4 IN ORDER TO FURTHER INCREASE THE PREDICTABILITY ON PARTICIPANTS IN THE ENTIRE AWARD PROCEDURE, THE TENDER/AUCTION DOCUMENT WILL CONTAIN CONCRETE RULES AND LEGAL REQUIREMENTS, FOR DETERMINING THE HIGHEST BIDS, INCLUDING PRICE/FEE, COVERAGE OBLIGATION AND OTHER CRITERIA, WHICH SHOULD BE DEFINED IN THE APPROPRIATE TENDER/AUCTION DOCUMANTION.RECOMMENDED LEGISLATIVE AND AKEP ACTIONS TO SUPPORT 5G ROLLOUT

4.1 REGULATION CHANGES

Provided below are recommended amendments and supplements to the applicable laws that are of interest to electronic communications Operators and should be considered in order to streamline the procedures for obtaining the approvals/decisions necessary for the construction of the telecommunications infrastructure, such as:

- Simplification of the procedure for obtaining approvals for building base stations at greenfield sites (towers on land).
- More detailed clarification of the obligations in the procedure for obtaining a decision for rooftop deployment of base stations (towers on buildings).
- Amendments to the procedure for obtaining an approval/decision for deploying the line infrastructure (fiber optic cables, power lines).
- Construction of infrastructure of public interest (telecommunications, electricity, gas, water supply, etc.) should be regulated in a separate law on construction of infrastructure of public interest or be placed in a separate section in the Infrastructure/Construction Law.
- Amendments to the Law on Public Roads to enable the construction of a telecommunications infrastructure along the roads and within a protected belt.

- Harmonization of the draft amendments to the Construction Law with other laws that are affected and involved in the procedure for obtaining decisions/approvals for construction of a telecommunications infrastructure.

Note: Albania's three main Operators have provided a comprehensive list of recommendations regarding legislative and process modifications that could benefit their acquisition of spectrum and more importantly, their implementation of 5G throughout Albania. Many of their recommendations fall into the areas addressed in this section of the Plan, but many are tactical in nature and worth consideration. This Plan recommends that AKEP set up a Working Group with Albania's three main Operators to discuss their recommendations in more detail to arrive at a reasonable and actionable approach.

In support of regulatory and procedural changes requested/required, the following measures are recommended:

- The Government of Albania should consider establishing an inter-ministerial working group(s) for mutual harmonization and amendment of the laws and bylaws related to construction and electronic communications, considering the proposals submitted by Operators and the measures outlined in this Plan. Representatives from the energy sector should participate in the working group.
- AKEP and other parties involved should initiate talks to ensure:
    - Joint use of the existing physical infrastructure.
    - Streamlining the coordination of construction works, which should take 1-2 months.
    - Use of free optical fibers from aggregation linking to the development of 5G. Consider procedures that will enable quick and simple acquisition of approvals to construct electronic communication networks, particularly for deploying fiber-optic infrastructure and base stations for the new 5G network.
    - Deployment of 5G equipment on existing lighting poles, at bus stops, transmission line towers, etc.
    - Deployment of small-size and low output equipment.

4.2 SPECIFIC RECOMMENDATIONS

It is recommended that the following specific law amendments be considered to enhance 5G implementation for the Government and the Operators.

4.2.1 Law NR.9918, Article 1

In Article 1, "Scope of the Law," this Plan suggests that the scope of this law is not only to promote competition, efficient infrastructure through the principle of technological neutrality in electronic communications, and to ensure the right and adequate services in the territory of the Republic of Albania, but to also provide regulatory support for efficient deployment. AKEP should also provide support to mitigate municipality delays due to new poles, handing

additional equipment on existing poles, and supporting the rapid deployment of each spectrum band.

4.2.2 Law NR.9918, Article 8

In Article 8(a), "AKEP Competencies," the current law states that to meet the purpose and the regulatory objectives under this law, AKEP shall have the following competencies: "to supervise, control and monitor the activities Quality of Service, upload and download, latency, packet loss, etc. the activities of electronic communications networks operators and providers in compliance with this Law, and other by-acts serving to the implementation of this law."

It is important to note that AKEP should consider partnering with citizens, government agencies, and corporations as volunteers to test upload and download speeds for fixed broadband by conducting automated, direct measurements of service delivered.

AKEP should also consider providing a mobile broadband application using smartphone-based technology to collect anonymized broadband performance data from volunteers participating in the collaborative crowdsourcing initiative. This data is collected to help inform consumers, industry, and policymakers on ways to improve mobile broadband performance nationwide. Users can also use the app to test their mobile broadband service on demand.

Article 8(b) states: "To regulate access and interconnection between electronic communications networks in compliance with stipulations of this law, by-legal acts for its implementation, and to ensure that the undertakings are not discriminatory, and they have equal opportunities and transparent, objective and fair conditions."

If an incumbent lacks the incentive to interconnect, AKEP may need to mandate the technical aspects of interconnection, upon which other carriers will depend. For example, AKEP may need to set deadlines within which the incumbent must respond to a request for interconnection and provide the actual interconnection facilities. Similarly, AKEP may need to require the incumbent to make space available within its central offices so that other carriers can install the equipment necessary for physical interconnection.

Regarding monitoring compliance with interconnection agreements, the Plan recommends that AKEP shall oversee each interconnection agreement reached and Operator compliance in order to address issues such as:

- Delays in providing interconnection:
- Delayed response to a request for interconnection orders.
- Once orders are acknowledged, delay in provisioning the interconnection.
- Preferential treatment of own affiliates' requests over competitors' requests.
- Refusal to provide adequate information concerning the network.
- Disputes over technical conditions.
- Denying interconnection is possible at a requested point.

- Demanding excessive compensation for network changes that may be required to provide interconnection or charging for changes not directly related to interconnection.
- Denying competitors physical access to networks when required to provide service.
- Disputes around interconnect billing and settlements.

To alleviate these issues, AKEP can require the incumbent carrier to provide interconnecting carriers with data on the types and amount of traffic exchanged to reduce billing disputes. Similarly, imposing performance measures and performance reporting requirements on the incumbent can help the regulator detect discrimination.

It is recommended that AKEP define, develop and deliver a series of performance measures in the provision of interconnection. When operators fail to perform adequately, AKEP should be within its purview to take appropriate action.

For the frequencies use, the civil users shall pay a tariff as stipulated in the legislation in force in the Republic of Albania. The level of the tariff shall reflect the need to ensure an optimal use of the radio frequencies as an ultimate resource and should be justified in an objective, transparent, non-discriminatory and proportionate way with respect to their purpose.

Article 8 (e) states: "To cooperate with the Minister on preparation of the National Radio-frequencies Plan; To prepare the Radio-frequency Usage Plan and to administer the radio-frequencies bands assigned for civil purposes, public or private usage, except the frequency band assigned for the radio and television broadcasting, which are administered by NRTC."

This Plan suggests that it is necessary to keep in mind whether the plan for each frequency group be accessible publicly.

Article 8 (h) states: "To conduct the coordination of radio-frequency allocation and use with the administrations of neighboring and other countries, related to the part of the spectrum it administers."

This Plan recommends that AKEP host a yearly or bi-annually multi-lateral spectrum coordination meeting with surrounding countries such as Greece, Montenegro and North Macedonia. These meetings should include 700MHz, and 5G developing interconnection policies between each country.

Article 8 (m) states: "To manage and administer the Universal Service Fund (USF)"

This Plan suggests that the Albanian Government invests to the USF in order to establish a 5G fund to connect to rural Albania.

Article 8 (nj) states: "to create, maintain and update an electronic database from the electronic communications sector and ensure that that data/information are made available to the public in compliance with the rules on public informing and keeping of confidentiality."

Instead of a database, this Plan recommends the use of an interactive GIS solution accessible anywhere, yet still follows all confidentiality requirements.

Article 8 (v): "defines the measure for the tariffs and maximum prices regulation that can be applied in a certain series of numbers used for the value-added services, premium in order to protect the clients."

This Plan suggests a focus on tariff investigations. This provides the ability to institute an investigation of any tariff before or after it becomes effective. Investigations can be instituted on AKEP's initiative or in response to a complaint filed by a carrier or consumer.

4.2.3 Law NR.9918, Chapter VII, Radio Frequency Spectrum, Article 62 in AKEP Competencies

This Plan recommends the addition of another essential competency: advocating the transparent, fair, economically resourceful, and effective spectrum management policies while regulating the efficient and adequate use of the spectrum. AKEP also considers all aspects of using this spectrum to avoid harmful interference and the possibility of imposing technical restrictions to safeguard the public interest.

Article 62 (6) states: "The management of the spectrum shall ensure that all the types of the technologies used for the electronic communications services and all types of electronic communications service may be used in the radio frequency bands specified in the National Frequency Plan, available for the electronic communication services.

Regarding the National Frequency Plan, this Plan notes that it is essential to state that AKEP will maintain an accessible national frequency plan with frequency assignment data to encourage openness and facilitate the development of new radio systems. This includes public consultations on proposed changes to national frequency allocation plans and on spectrum management decisions likely to affect service providers to allow interested parties to participate in the decision-making process.

This Article also states that after five years from the entry into force of this law, AKEP shall take the measures to reassess all the remaining authorizations according to the requirements of point 5 of this law.

AKEP ensures fair competition concerning the execution of the requirements of this law. The reassessment of authorizations according to the requirements of this law does not mean the granting of a new authorization.

4.2.4 Law NR.9918, Article 63, National Radio Frequency Plan

This Plan recommends the following: AKEP shall maintain and provide accurate data pinpointing where broadband and cellular service is available and where it is not available. The broadband/cellular maps shall be provided to service providers and other government agencies to make decisions about where service is needed and how to fund the expansion. AKEP is in

the process of updating its current maps with more detailed and precise information on the availability of fixed and mobile broadband and services. This will give the AKEP, industry, state, local and entities, and consumers the tools they need to improve the accuracy of existing maps.

4.2.5 Law NR.9918, Article 64, Plan for Radio Frequencies Utilization

This Plan recommends the following: Article 64 (8) states: Compliance and Enforcement; lighting and marking of radio transmitting towers, unauthorized construction and operation of communications facilities, and an ability to monitor the airwaves to determine if harmful interference is occurring. It also requires a system for assessing penalties on licensees not complying with regulations. The regulator must take into consideration its country's financial, legal, and political constraints, and assess what can be done given limited resources. Once new spectrum is allocated to a provider or individual (Article 65) and systems are in operation, AKEP will verify that these licensees obey the law.

Within the last bullet, this Plan recommends considering how the investment in these new technologies can create an easier way for inspectors to verify compliance or not, including poles. A suggestion would be having a tag for each device that can be read by the inspector faster and less manually.

4.2.6 Law NR.9918, Article 65, Radio Frequencies Use

This Plan suggests the removal of bullet 5: "Specific radio frequencies may be used without authorization per the provisions made under this Law and comply with the international rules and obligations accepted by the Republic of Albania."

Any spectrum not allocated can be used to advance education, business, research and development, or other verticals, and should be managed by AKEP. AKEP can either create a spectrum access system to manage the unused MHz range within each GHz allocation or approve a set of providers to provide a SAS capability.

4.2.7 Law NR.9918, Article 66, Allocation of the Frequencies

This Plan suggests the removal of the article. While determining the frequencies that can be used under the general authorization and issuance of individual authorizations for the frequencies used, AKEP considers that the frequencies are a national asset with economic, social, and cultural value. Allocation of frequencies from AKEP is made according to the principle of objectiveness and transparency, proportionality, and non-discrimination respecting the international agreements where Albania adheres, radio regulations of ITU, and in compliance with the regulatory objectives determined in article 7 of this law.

This should also be managed under a Spectrum Access System (SAS) capability – the SAS will give AKEP more visibility, transparency, and control, including temporary use and potential tariffing.

4.2.8 Law NR.9918, Article 67, Individual Authorization Issuance Procedures

Article 67 (1) states: "When the radio frequencies use is not subject to the general authorization according to point 5 of article 65 of this law or subject to a public competition according to articles 68 and 69 of this law, AKEP shall issues the individual authorization according to the procedures established in this law. If AKEP receives different applications for individual authorizations in the same frequency band, it examines them according to their order of submission."

This Plan suggests that this Article be altered in order to support the creation of an AKEP SAS Program.

Article 67 (2) states: "Where no individual authorization is needed for the use of radio frequencies, according to point 5, Article 65, AKEP shall define in the general authorization the conditions for the use of radio frequencies."

This Plan suggests that this Article be removed. AKEP manages all spectrum, not military, and if it is an un-utilized spectrum, it is managed by the SAS. Issuance of radio frequencies shall be done in compliance with the definitions in the National Radio-frequencies Plan and Plan for Radio-frequencies Utilization on a non-discriminating, transparent and objective basis.

4.3 USER'S RIGHTS

An essential part of change strategy is the implied contract between providers and subscribers wherein the subscribers/user anticipate being better off due to the implemented technical change as in 5G. Albanian Law No.9918 / 2008 [Chapter XI] contains provisions for protecting the rights of electronic communications users and obligations for network and service providers regarding transparency and disclosure of information as in subscriber contracts, subscriber registration, personal data protection, quality of services, billing, etc. According to the provisions of the law, AKEP has adopted the framework Regulations Nos. 31, 29, and 27. This Plan acknowledges that as enhanced capabilities inherent in a 5G National Infrastructure push forward, AKEP should consider developing a unified regulation act clearly defining, subscriber, user, and operator, which will govern the current and emerging 5G Capabilities.

5 PROMOTE OPERATOR DEPLOYMENT OF 5G

Critical to the development and the eventual execution of the Plan is the input of Albania's Operators, so AKEP invited and met with each of the three primary Operators to inform them on the development of this Plan. These meetings were followed by a detailed questionnaire sent to the Operators, with the intent to:

- learn as much as possible about the internal plans already under consideration for 5G rollout; and
- give the Operators the unique opportunity to provide input on how they prefer the rollout to occur, what changes to Albanian legislation/regulations/processes might assist the Operators in rolling out 5G, and how the Plan could be developed best to support the Operator's investment in 5G.

This Section of the Plan provides generalized, summary thoughts, issues or recommendations from the Operators, followed by this Plan's responses, observations and/or clarifications, highlighted in text boxes below the Operator's input.

5.1 OPERATOR ECONOMIC VIABILITY OBSERVATIONS

Some Operators observe that Albanian performance indicators, Gross Domestic Product (GDP), revenues of Mobile Network Operators (MNOs), Average Revenue Per User (ARPU), etc., are lower than in other EU countries. Concretely, the Albanian mobile market is relatively small (low population density), where the Operator's current revenue is declining year by year (decreased by 9% in 2020 over the year 2019). The Perception is ARPU figures are low, nearly three times lesser than the E.U. average (GSM Association Source: EU AVG 14.74 €/user/month vs. AL 4.58 €/user/month for 2020). Therefore:

- There is concern that the end-user subscription may not generate the revenue necessary to make 5G economically viable.
- The investment and operational expenses required from the Operators are significant and include (but not only):
    - one-off payment fee for granting with 5G license authorization,
    - investment for deploying 5G as per the authorization conditions,
    - paying an annual fee (i.e., 80 MHz in 3.4-3.8 estimated payment at least 200 K Euro/year)
    - Considering the latest practice in renewal authorization for 900/1800 MHz frequency band, it's essential that the Government, when setting a minimal price, focus on reaching the digital connectivity goals rather than seeing minimal/reserve price as a means of state revenue maximizing. That means that the interest in the long-term socio-economic benefits from 5G broadband development should overpass the Government's short-term interest in state revenue maximization.

- There is concern that high auction pricing may diminish the Operators' ability to have the necessary capital needed to develop the required 5G technical infrastructure.
- Some Operators expressed that since a 5G network infrastructure in Albania would have a significant contribution to more effective governance, the State should be willing to contribute monies to the investment in the needed infrastructure.
- Some Operators expressed the position that a reduction in the radio communication tax fees (state budget fee) of at least 40% from the current level would enhance the probability of economic success.
- Operators recommended the Government consider implementing fiscal mechanisms for stimulating investing in remote/rural areas.
- Requested AKEP consider the possibility to pay in installments over at least five years.
- Some Operators noted Albanian rural villages have a very high cost of development with no feasibility, subvention/grants by the EU through the Albanian Government to speed up that process. Therefore, 5G in rural areas will require a long time to develop.
- They noted that fiber optic connectivity is the preferred option to guarantee the lowest latency, one of the most important features of 5G. E-band microwave can be used as an alternative in areas where fiber is prohibitive, provided that E-band spectrum costs are significantly decreased to a viable annual fee.
- They noted deployment of 5G services will increase the need for data transfer to and from antennae, implying more extensive use of microwave links. They believe annual remuneration of the State for these links is considered very high.

Plan Response: The Operator's comments on economic viability on the surface appear to under-appreciate the expanded market 5G offers in terms of Business-to-Business and System-to-System connectivity that 5G's higher bandwidth offers. This Plan attempts to provide more information on the greater benefits of 5G for the Operator's consideration.

5.2 Operator Incentives and Policies Observations

Some Operators recommended that the Government of Albania consider the following:

- Enact a legal and regulatory framework to allocate the frequencies to Operators through the administrative procedure and not necessarily subject to auction.
- Develop legal instruments to ensure all Operators are granted the same bandwidth where 5G operates in all spectrums.
- Actual legislation for permits should exclude from application the built permits for telecommunication infrastructure
- Enable more effective infrastructure development by removing the build permit procedure for small (micro) cells and enacting only a notification procedure to local administration entities.

- Define clear rules to ensure access to physical communications infrastructure located on buildings so Operators can reach rooftops for more effective antenna deployment.
- Operators should have the right to access other industries' physical communications infrastructure at reasonable prices and not higher than telecom Operator offers for access to their network.
- Simplifying the government procedures to reduce the cost price for certificates for non-ionizing communications radiation.
- Review the legislative framework where necessary before public authorities make the 5G spectrum available.

Plan Response: As to the process for allocation of spectrum, the Spectrum Auction process defined in Section 3 above has been determined to be the fairest and most beneficial method.

The Operators are seeking procedural and regulatory relief to enhance their ability to rapidly implement the infrastructure needed to achieve the objective of this 5G Strategic effort. AKEP, in cooperation with Parliament and Ministries, will consider many of these recommendations in order to facilitate implementation of 5G faster.

This relief is also recommended by the EU in its, "Roadmap for Lowering Roaming Charges Between the EU and WB, dated September 2021." In their recommendations under "Improve the Business Environment", Measures 4.2 and 4.4 offer AKEP the opportunity to integrate their 5G goals with the EU's effort to harmonize the implementation of 5G through activities to better the business processes in Albania that can facilitate the rapid growth in 5G implementation.

It goes on to say, "When implementing some of the best practices from this segment, WB economies should take account of the specifics of their domestic markets and possible legal and regulatory constraints that may require certain adaptations of the relevant measures to the regulatory provisions of each WB economy relating to the permit granting procedures. And "WB economies are encouraged to ensure that all reasonable requests for access to physical infrastructure owned or controlled by public bodies or entities, which are suitable for hosting very high capacity networks, are met. It is understood that there could also be some exceptions when placing infrastructure in protected areas governed by special rules. If the relevant physical infrastructure is owned or controlled by municipalities, WB governments should promote this practice amongst local authorities. WB economies should explore best practices from the EU in implementing this measure and share experience at regional level to align practices."

5.3 Operator's Asset Management Observations

The 5G implementation effort must be conducted through open communication and cooperative, information-sharing relationships based on the facts of the effort. The sharing model should include antenna, pole, electricity, frequency, and telco equipment and shall be under regulatory assurance and support among Operators. The consensus is that the Operators will conduct technology topology and marketing studies in 2022 and 2023, with infrastructure investment between 2024 and 2025.

Plan Response: The 5G implementation should also apply an integrated systems engineering perspective as the basis for oversight to limit the amount of spectrum available for each undertaking, avoid excessive accumulation of rights of use of spectrum, or avoid distortions of competition in line with the principles of E.U. regulatory framework.

5.4 Operator Legacy 2G Observations

The Operators believe that the primary issues that will need to be understood and overseen by AKEP are regarding the use and the potential interconnections between 2G/3G/4G/5G.

They note that because they have many customers whose phones only support 2G networks, or because of the presence of sensors that work over 2G, there is no plan to eliminate 2G networks soon. An Operator has not yet set a firm date but plans to terminate 2G as a voice service not earlier than 2024. This will strongly depend on the replacement of 2G-only terminals by specific market segments. For M2M applications, 2G layer could be available even longer due to respective demand and modem/CPE replacement or upgrade to latest technologies by Business-to-Business (B2B) customers.

Plan Response: The critical proven vulnerability of 2G and 3G has been amplified using 'smart' devices on these networks, and has provided the opportunity to exploit their inherent network weaknesses digitally. The Plan recommends that the overall AKEP strategy should require as part of the auction process, the sunset of 2G no later than 12 months after 4/5G coverage has been implemented in a Major Economic Area. The Plan recommends the sunset of 3G to be completed no later than 24 months after 4/5G coverage has been implemented in a Major Economic Area. The sunsetting of 2G and 3G are essential to maintaining the integrity and cybersecurity posture of the Albanian telecommunications networks and to prevent ransomware events against national assets and national provider companies. Additionally, a small percentage of the spectrum auction could accelerate/subsidize the 5G implementation through some form of equipment discount or subsidy assistance to Albanian 2G/3G legacy users.

Additional Plan Recommendations Regarding 2G/3G's Cybersecurity Issues:

2G/2.5G GPRS Tunneling Protocol (GTP) is a current 2G technology connecting various network interfaces, enabling mobile users to roam seamlessly between networks of different generations. The protocol was developed in tandem with General Packet Radio Service (GPRS), the packet-oriented mobile data standard integrated into GSM (G2) that allows mobile networks to transmit IP to external networks (i.e., the internet). GPRS is the mobile communications service that enables Short Message Service (SMS), Multimedia Messaging Service (MMS), Instant Messaging (IM), Wireless Application Protocol (WAP), peer-to-peer, smartphone internet apps, and more.

As we see in Albania, multi-generational mobile networks are being requested to be maintained for years to come. These GTP networks were not designed with security in mind and are very lightly protected because, before smartphones, there were virtually no cyber security attack surfaces within mobile networks. The technologies were proprietary and difficult to penetrate, resulting in secure network infrastructures where trust was assumed within what was then a closed industry. As the industry progressed to IP-based technology, the need for secure network interfaces using GTP grew exponentially. Lacking encryption and sender authentication, GTP did not provide the secure environment needed to achieve the desired outcome.

As 5G grows in accessibility and its ability to integrate the latest in Artificial Intelligence/Machine Learning (AI/ML), Internet of Things (IoT), slicing, and new/future advanced security enhancements, it is essential to account for 2G/3G networks within Albania and the roaming requirements between countries. Additionally, AKEP should add to the National Frequency Plan (NFP) a section containing the current status and location of 2G/3G usage and equipment and work with the Service Providers (S.P.) to develop a transition plan and timing for timing EOL.

As for now, Albania will need to work with these older networks, which means that GTP will still be relevant in Albania's 5G world, as it remains the primary protocol for user-plane and control-plane traffic. As with all previous generations, 5G introduces new standards. However, new network technologies such as 5G do not replace the previous ones; instead, they overlap. So, if earlier generations remain operative, old mobile signaling protocols and their accompanying vulnerabilities will threaten networks. Today's mobile threats stem from traditional IP-based threats within 4G/LTE networks combined with legacy 2G and 3G technologies. As 5G continues to grow, overlapped with 3G and 4G, a wealth of new services and technologies will lead to an ever-expanding attack surface.

Additionally, GTP is a critical technology in the EU for mobile roaming, and changes in EU regulations eliminated international roaming charges. Combine this with the explosive growth in the number of devices, applications, and traveling subscribers has led to skyrocketing roaming traffic. GTP is the primary protocol for exchanging user and control data between serving and packet gateways within the mobile core, enabling packet networks to signal and carry data between devices and apps. GTP connects the local (home) and visited network when

it comes to roaming, allowing subscribers to shift between networks quickly. Its extensive use between mobile networks (e.g., roaming) makes GTP an attractive attack surface.

In the past, attacking mobile networks required sophisticated tools and mastery of little-known protocols used for routing voice calls. The onset of I.P. within 4G changed everything and allowed attackers to leverage available internet hacking tools they were already familiar with to launch attacks on mobile networks became as easy as hacking any device connected to the internet.

Because of the many vulnerabilities in the protocol's specifications, GTP became a prime attack target. The protocol **does not support encryption**, so, among other pieces of sensitive information, international mobile subscriber identity (IMSI), integrity session keys, and user data are sent in cleartext. Also lacking is integrity protection, which leaves the door open for cyber attackers to hack GTP messages and corrupt signaling commands, alter user data, and redirect their mobile billing charges onto unwitting victims. Lastly, the protocol lacks any means for authenticating senders, making it impossible to tell legitimate subscribers from imposters.

All in all, these GTP vulnerabilities make it easier for attackers to gain access to critical network and subscriber information, including critical identifiers such as the Tunnel Endpoint Identifier (TEID) — a pathway into the network's mobile core assigned by the GPRS Tunneling Protocol (GTP) and the Temporary Mobile Subscriber Identity (TMSI). Using such information, impersonators can gain access to the IMSI of legitimate subscribers, drop subscriber communications or overwhelm the network with bot-transmitted messages to instigate a DDoS attack.

In partnership with the Operators, AKEP may want to develop a division partly funded by service providers that addresses past, current and present 2G/3G/4G/5G cyber challenges within fixed and mobile broadband. This would be a great opportunity to partner with the United States Department of State and CISA (https://www.cisa.gov/). Staying in front of new attack surfaces and in partnership with the US, AKEP can provide users, Operators, government agencies, and businesses with notifications, responses, and action around new cyber vulnerabilities, including:

- Zero-Day
- Eavesdropping
- Denial of Service (DoS)
- Fraud
- Rogue Base Stations – Man in the Middle
- Malicious Peers
- Roaming IoT
- Identity Mapping attacks
- Web Site Fingerprinting attacks
- DNS Redirection attacks
- Authentication Synchronization Failure attacks

- Traceability attacks
- Numb attacks
- Authentication Relay attacks
- Paging Channel Hijacking attacks
- Stealthy Kickoff attacks
- Panic attacks
- Energy Depletion attacks
- Detach/Downgrade attacks

5.5 DYNAMIC SPECTRUM SHARING (DSS)

DSS is an advanced feature that enables both 4G and 5G to deploy and co-exist in the same carrier simultaneously. The concept does not include sharing with other Internet Service Providers (ISP). DSS could be partially used in the future strategy to complement specific areas where the n78 band is not present.

An Operator is interested in using Dynamic Spectrum Sharing of the existing 2G/3G/4G band they possess. Another Operator is not interested in sharing with any ISP current spectrum. Although there are no plans currently, another Operator is considering working and contacting its competitors for all kinds of sharing models. Their expectation from the regulatory effort is that sharing models like antennas, poles, electricity, frequency, and telecom equipment shall be under regulatory assurance and support among Operators.

***Plan Response**: As part of the final design solution for 5G in Albania, the Plan recommends that DSS should be employed as appropriate to ensure the effective national implementation consistent with the overall strategic goals of 5G and a robust national infrastructure.*

5.6 BACKBONE DISCUSSION

Fiber connectivity is the preferred option as it guarantees the lowest latency, one of the most important features of 5G. E-band microwave can be used as an alternative in areas where fiber is prohibitive, provided that E-band spectrum cost will significantly decrease to a convenient annual fee. However, there is a belief that the focus should not limit itself to existing public infrastructure, especially with backbone networks, which are also of primary importance to deploying high-speed networks across the country.

The Operators indicate they may use mainly fiber optics for backhauling of 5G sites. Still, considering the difficulties of laying fiber for too many sites, as 5G network will require, other millimeter wave connections at millimetric bands such as E or V bands will be of significant interest. They note the proposed 5G plan should include revising the law and regulation related to tariffs to be paid yearly for such use. Operators plan to use their fiber backbone for 5G, where most base stations are already connected with fiber.

The Operators particularly underline the need to strengthen and effectively enforce the framework for infrastructure sharing for non-governmental agencies, and an Operator indicates a need to access the Albanian Telecommunication Union's (ATU) dark fiber, which has increased the dark fiber by 137 km in 2018 and has 750 km of dark fiber access. They also indicate there may be an opportunity for fiber from Albania's Transmission System Operator (OST). OST, in 2017, implemented a new telecommunication network system based on Dense Wavelength-division Multiplexing (DWDM) technology. This network is projected and foreseen to provide high communication capacities for OST services and the telecommunication market in Albania, including the neighboring countries. Currently, there is 2000 km of OPGW in the OST transmission system.

Plan Response: This Plan recommends a National Giga-Backhaul Optical Infrastructure Network (NBON) be funded and implemented by the Government of Albania. This recommendation is described in more detail below in Section 6.3.3. Doing so will address the Operator's concerns, yet at the same time increase the return on investment for spectrum auction purchases and effectively assist in a faster 5G rollout.

5.7 OPERATOR INVESTMENT/INPUTS

In one Operator's view, a 5G investment cannot be started earlier than 2023 due to the Government-led process, a public review period, and the finalization of changes to laws or regulations. In addition, as noted in section 5.1 above, the Operators must be confident in their return in order to invest. They note they have invested significantly in 4G/4G+ technology, in all respective spectrum bands within the last 2-3 years, and they believe there is still a possibility to cover the local demands for mobile broadband and individual use cases, at least for the next 2-3 coming years. Nevertheless, the consensus is that the Operators have set aside 2022-2023 for technical trials and marketing studies, with significant investments in 2024 and 2025. They assess that the process will take time. 5G, being an intensive investment and disrupting technology, will probably need more time to deploy than 4G. For significant areas/cities, approximately 12 months post auction, depending on coverage obligations that will be set.

Plan Response: The Operators' suggested timelines will significantly delay actual progress on developing a national 5G infrastructure, resulting in the final implementation after the 5G capabilities have been replaced by 6G or a follow-on version. Instead, and especially if the Albanian Government invests in the NBON, there are ample and sufficient examples of western 5G implementations that will enable auction winners to effectively and efficiently implement 5G within 12 months after a frequency has been unincumbered.

Additional Plan Thoughts Regarding 5G Timing:

To their credit, the Operator's business plans for 5G include other "non-consumer slices" of the spectrum to go after other markets, which include, but are not limited to:

- *Healthcare Sector*
- *Agriculture Sector*
- *Construction Sector*
- *Education Sector*
- *Energy and Utility Sectors*
- *Entertainment & Food Sector*
- *Finance & Insurance Sector*
- *Health Care Sector*
- *Industrial Internet of Things (IoT) Sector*
- *Information Services Sector*
- *Manufacturing Sector*
- *Oil, Gas, and Mining Sectors*
- *Professional Services Sector*
- *Public Sector*
- *Real Estate Sector*
- *Trade Sector*
- *Transportation, Logistics, & Warehousing Sector*

The Operator community has a correct belief that the fundamental value-added proposition for 5G economic development will be found in enterprise customers. Given the application of next-generation technology, this Plan believes their appetite for 5G will grow significantly over the next decade. They see significant potential for 5G in business, utilities, manufacturing, and public service applications. The Boston Consulting Group conducted research entitled "5G Promises Massive Job and GDP Growth in the U.S." by Enrique Duarte Melo, Antonio Varas, Heinz Bernold, and Xinchen Gu, in collaboration with CTIA, February 2021. According to the report, "5G will unlock benefits across the US and will reach broadly into densely populated cities and communities with lower population densities. Over time the regional effects of 5G will be far-reaching as innovation enables new use cases across all industries, from agriculture to manufacturing to health care."

In addition, the EU, in its "Roadmap for Lowering Roaming Charges Between the EU and WB," offers ideas on developing investment incentives which could help accelerate Operator implementation of 5G in Albania. Many of these are recommended in this Plan, and include:

- **Promoting adequate reserve prices which reflect the minimum levels of fees for the rights of use of radio spectrum**

- When using a benchmarking exercise as input, prices should be adjusted to consider the economy specific circumstances, such as population, license duration and coverage obligations, among others.

- **Providing in a non-discriminatory manner the possibility that fees for rights of use of radio spectrum are paid in instalments within the period of those rights**
  - The possibility to pay the award fees in installments makes operators have more free capital to direct to investments. This would have a positive effect on the speed of the network rollout and coverage. Furthermore, this possibility does not harm the public interest, since the revenue will be the same as in one-off case and interest rates may be included to consider the real value of the postponed payments.
- **Combining financial incentives with obligations or formal commitments to accelerate or to expand high-quality wireless coverage**
  - Linking financial incentives in spectrum awarding process with coverage, timing and/or quality obligations helps mobile operators having more funds for infrastructure rollout. By imposing obligations that go beyond the level provided in auction, the kind of guarantee that operators invest those funds into coverage is obtained. There are various possibilities to link the financial incentives and related obligations in spectrum award process, e.g.:
    - ambitious coverage obligations to all or certain spectrum blocks with financial incentive matrix clearly set out in the award rules;
    - a reverse auction in which the forward auction worked like a normal auction and in the reverse auction bidders are able to receive discounts on their award fees by bidding on the coverage of specific areas;
    - a reduction of the reserve price in exchange for increased coverage requirements.

  However, it should be noted that improving coverage in some cases may be achieved by market and competition drivers which are deemed to force Operators to accelerate and expand their coverage. Therefore, it will not be necessary in all cases to compensate the coverage obligation with a financial incentive.
- **Providing, subject to competition law, the possibility for the sharing of passive and active infrastructure, as well as for joint rollout of infrastructure that relies on the use of radio spectrum.**
  - Providing holders of spectrum rights with the possibility to share infrastructure without distorting competition. Special attention should be paid to promoting this possibility, especially in rural areas where deployment is desirable and the investment case more difficult.

5.8 PROMOTING AWARENESS AND OPPORTUNITIES ABOUT THE BENEFITS OF 5G

The implementation of 5G nationally will offer practical applications to many economic sectors as discussed in this Plan. The ability to exploit those opportunities will depend on the willingness and readiness of the Albanian society to adopt 5G, both users and businesses. All parties involved must develop the capacity, knowledge, and skillsets to drive innovative uses and applications for 5G. Such an endeavor calls for a robust Albanian Government capacity and skills development program promoting awareness of the benefits and opportunities inherent in 5G. Various Albanian Government / AKEP initiatives can achieve this objective and involve a significant "5G Campaign" across the country.

5.8.1 Nationwide Marketing / Advertising Campaign

This Plan recommends the development of a nationwide marketing campaign, led by the Albanian Government and senior elected officials. Coordination of the campaign with the Operators will be valuable. It is recommended that the Government issue a tender to seek the professional expertise of a well-known Albanian marketing / advertising firm to help create the messaging, delivery methodology, and other aspects of the campaign in order to increase success.

5.8.2 5G Events

This Plan recommends organized 5G events to provide informational opportunities for commercial and public key stakeholders. Such events should focus on 5G's capabilities to expand the national commercial base where application use cases from other implementations can be presented.

5.8.3 5G Dialog Forum

To strengthen the level of discussion, a "5G Dialog Forum" might be created. It could support the active exchange and networking between the telecommunications sector and vertical industries, benefiting from 5G M2M and B2B opportunities. The Forum establishes the potential and current state of the development of 5G for the various vertical integrated industries. The Forum acts as a door opener for companies to participate actively in developing 5G projects.

5.8.4 Skills Development

The implementation of 5G will also generate a need for a structured skills development program. The needed skills, as a minimum, should address 5G applications development, radio and network technologies & maintenance, deployment and regulatory norms, and 5G entrepreneurship to exploit the 5G inherent capabilities. The target audience would include university faculty, commercial engineering staff, administrators and address the skill development and retooling of the domestic workforce engaged in development, manufacturing, deployment, and maintenance of 5G solutions.

5.9 ECONOMIC REFERENCES

Empirical data on the economic advantages created by 5G is widely available and highly positive. Examples include:

- U.S. Wireless Industry Contributes $475 Billion Annually to America's Economy and Supports 4.7 Million Jobs, According to New Report, Accenture, April 5, 2018, at https://newsroom.accenture.com/news/us-wireless-industry-contributes-475-billion-annually-to-americas-economy-and-supports-4-7-million-jobs-according-to-new-report.htm.
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6 ASSESS AND ADDRESS RISKS AND OTHER CONSIDERATIONS TO 5G INFRASTRUCTURE ROLLOUT

6.1 CHALLENGES FOR 5G IMPLEMENTATION IN ALBANIA

To support 5G implementation, the current market in Albania indicates several challenges that need to be addressed or regulated. Operators and the Government are expected to invest in two key areas:

1. **Infrastructure investments.** Mainly to build a denser fiber optic network infrastructure, thus ensuring 5G connectivity of base stations, and to fund their installation. The next generation of 5G wireless networks will support applications requiring high speeds. One of the solutions, in this case, is to allow a higher density of base stations by deploying small cells.

2. **Investments in service innovation.** To stimulate the emergence of new 5G services. This includes reviewing and building upon the body of evidence through which potential 5G features have been demonstrated and tested, thus allowing new services for Albanian applications. With over 100 countries deploying 5G, the technology has become mainstream. However, applications to fully leverage 5G capability are still being developed and unique characteristics for individual regions.

The implementation of 5G architecture mainly depends on the small cell deployment capabilities and their interconnection to the core system using a high-bandwidth network infrastructure based on fiber optic technology. This process is currently painstaking due to various complications arising in finding sites for new base stations, obtaining a license for their deployment, and the procedures that must be followed when installing the cable network infrastructure.

From this viewpoint, it is necessary to provide facilitation for the Operators, as follows:

- When sourcing sites for new base stations, it is necessary to facilitate the conditions for deployment of the appropriate equipment
    - the need for sites should also be considered when planning the construction of new facilities, that is, to envisage the possibility of deploying base stations on top of constructed facilities
- Reducing the costs of deploying network infrastructure
    - new facilities must be constructed with a mandatory installed fiber-optic infrastructure

To utilize most of the options offered by 5G architecture and attract as many as possible end-users, thus involving a wide range of quality-of-service requirements, net neutrality implications must be considered at network-layer, enabling defining a set of layers with different quality of service intended for various applications. In addition, the defined net neutrality rules should follow the norms prescribed by the EU.

For the development of 5G networks and services, support is needed from AKEP and other government organizations, as follows:

- Develop general and administrative procedures that will enable quick and easy acquisition of approvals to construct the new 5G network.
- Because of this, there will be a need to deploy base stations in places where the current legislation does not allow it (e.g., roads, installing equipment on existing lighting poles, bus stops, transmission line towers, etc.). Accordingly, it is necessary to adapt the relevant laws to enable the deployment of 5G equipment on top of such facilities and the deployment of fiber-optics thereto.
- Regulating the deployment of small-size and low output equipment for the mobile network should follow the regulations for installing urban equipment (without an approval/decision) and via a straightforward and quick procedure.
- When building new 5G networks, the possibility of shared use and avoidance of building parallel networks by business users in the so-called "Campus Networks" in large industrial compounds, hospitals, and other institutions should be considered.

6.2 ESTABLISHING A NATIONAL TELECOMS LAB

To evaluate these challenges and address the implementation plans required from this Plan, it is recommended that AKEP establish a National Telecoms Lab. The Lab will serve as a hub for telecommunication R&D activity across Albania and deliver a wide range of benefits that will mitigate risk, enable and accelerate diversification through new market entrants and interoperable deployment methods. It will create a unique testing environment for Operators and suppliers to match their requirements and specifications to assess the technical performance and security of equipment in representative networks – this could be particularly beneficial for new and emerging suppliers, offering them a unique opportunity to demonstrate their viability. This facility will also play a major role in setting best practices for open-interface network deployment and uplift in telecoms skills and specialism in Albania.

The Lab will independently test network equipment security, resilience, and performance under various conditions – providing access to a representative, operational examples of Albania's critical next-generation telecommunications networks. The lab will be a bookable, accessible research facility, allowing academia, subject matter experts, critical industries, and government teams to research, test, and learn about security on Albania's existing and future networks.

Specifically, the Lab will:

- provide a place to undertake security research into telecommunications security, enabling operators, vendors, Government, academia, and other entities to overcome security challenges.
- create a secure operating environment to manage commercial and national security sensitivities.

- enable vendors and operators to understand and test how their technology can meet the Government's telecommunication security framework technically, potentially reducing their costs of doing so.
- support supply chain diversification by providing new vendors with access to environments to demonstrate interoperability and security capabilities.
- allow for end-to-end security research to be conducted against networks that represent real-world Albania deployments, with research being targeted to the reality of network deployments seen in Albania today.
- provide security scrutiny over a broad range of telecom technologies, including legacy, current, and future systems likely to be used in our fixed and mobile infrastructure.
- support the development of telecommunications and telecommunications security skills, creating a national cadre of valuable and experienced resources.

The Lab should include a SmartRAN Open Network Interoperability Center (SONIC), proposed between AKEP and other agencies / entities for testing interoperability and integration of open networking solutions, starting with Open RAN.

SONIC will demonstrate and foster an open disaggregated network ecosystem in Albania of large and small suppliers along with the telecoms industry, helping to develop a supply chain with multiple suppliers for each element in the technology stack. In addition, it will enable Albania's suppliers to maximize their part in the new supply chain as part of an international effort. This will enable Government and AKEP to better understand the technology readiness, maturity, and challenges of Open RAN to inform technology roadmaps and strategies.

Specifically, the Center will:

- Provide innovative companies with a neutral environment to come together to test and demonstrate solutions.
- Facilitate interoperability testing with organizations involved in standards development.
- Support and link small and large companies to collaborate in a rapidly technologically changing landscape.
- Operate at a pre-commercial stage at technology readiness.

6.3 INFRASTRUCTURE

6.3.1 Fiber Optic Infrastructure

It is clearly emphasized that in each scenario, 5G will require a significant backhauling capacity, which will result in a considerable number of connections in the domain of fiber optic networks. Although in many remote areas it may be possible to use fixed wireless links for backhauling, the need to transport data at higher speeds will require access to fiber-optic networks as a vital element for 5G introduction, especially in scenarios and at sites where small cells with high capacity will be used. Even though most of the investment is needed to introduce new fiber optic network resources and 5G, it should be ensured that the private sector and the Government encourage a range of initiatives and activities to increase accessibility fiber-optic

infrastructures. An example of this is determining the so-called white zones (zones without any commercial interest for constructing an electronic communications network), obtained through an appropriate mapping procedure.

6.3.2 Sharing Infrastructure

Sharing the infrastructure under concisely defined competition rules may be an efficient and cost-effective way of introducing and implementing 5G telecommunications infrastructure, especially in areas where it is not cost-effective to introduce several competing network infrastructures. However, at the same time, the need for protection and guarantee of Operator's investment interests should be considered. In general, sharing of infrastructure can be divided into two categories, passive or active sharing.

Passive sharing is generally defined as sharing space or physical infrastructure that does not require active operational coordination between network operators. For example, sharing a location for a base station or an antenna tower represents a form of passive sharing. Active sharing is an approach when operators share an active telecommunications infrastructure. For example, sharing an access network or national roaming are a specific implementation of active sharing.

The Ministry of Infrastructure and Energy, in cooperation with AKEP, should work with the Operators to identify the unnecessary obstacles for sharing the existing telecommunications infrastructure. In addition, this cooperation would develop a more stable and robust sharing framework, which would significantly accelerate and facilitate the implementation of 5G in Albania.

6.3.3 A National Giga-Backhaul Optical Infrastructure Network (NBON)

A strong backhaul network is a crucial requirement to meet high throughput and low latency expectations from 5G/next-generation technology and facilitate connection of base stations via fiber optic. To achieve this goal, this Plan recommends the creation of a National Giga-Backhaul Optical Infrastructure Network (NBON), funded by the Government.

Deploying a NBON in Albania will provide numerous benefits across the country and, over time drive new business and job creation. Figure 6.3.3-1 is an example of an NBON Fiber Network deployed across the country utilizing Tirana as the central hub deploying a ring network topology. Each ring will include multiple cores deployed on each ring throughout the city utilizing the second topology called a star network.

This ring will be a self-healing network using dual rings, the red ring being primary and the blue ring being secondary.

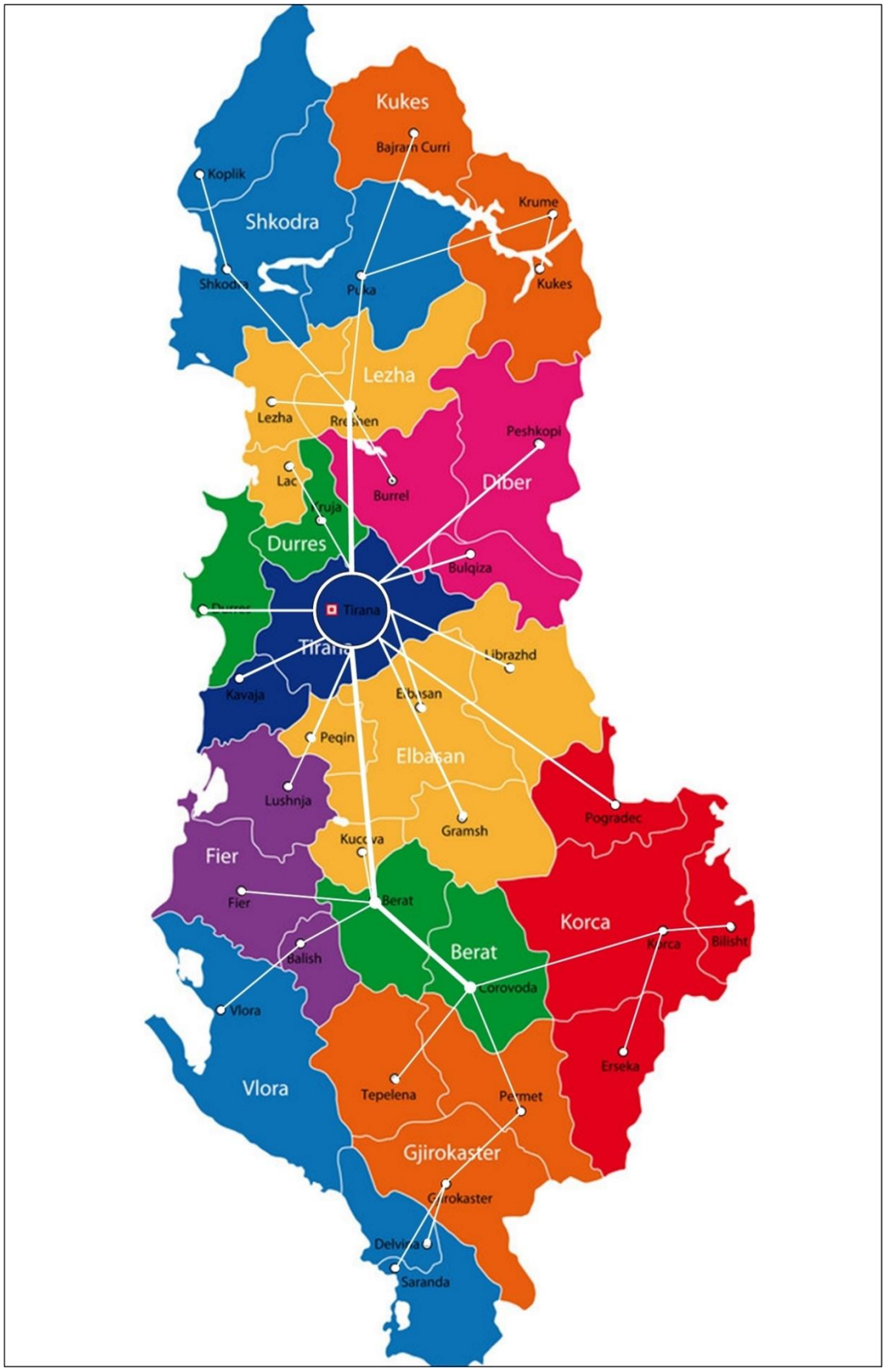

Figure 6.3.3-1 Albania NBON utilizing Fiber Ring Topology in Tirana, & Star Topology to all Counties

The NBON is also envisioned to provide new capabilities for all vertical markets, and job opportunities for Albanian citizens. For example:

- The NBON fiber ring could become an internet POP for high-speed access around the world. This also would include connection to submarine cables shown below in Figure 6.3.3-2, reflecting the fiber ring in Tirana with a direct connection to Durres and then anywhere around the world.

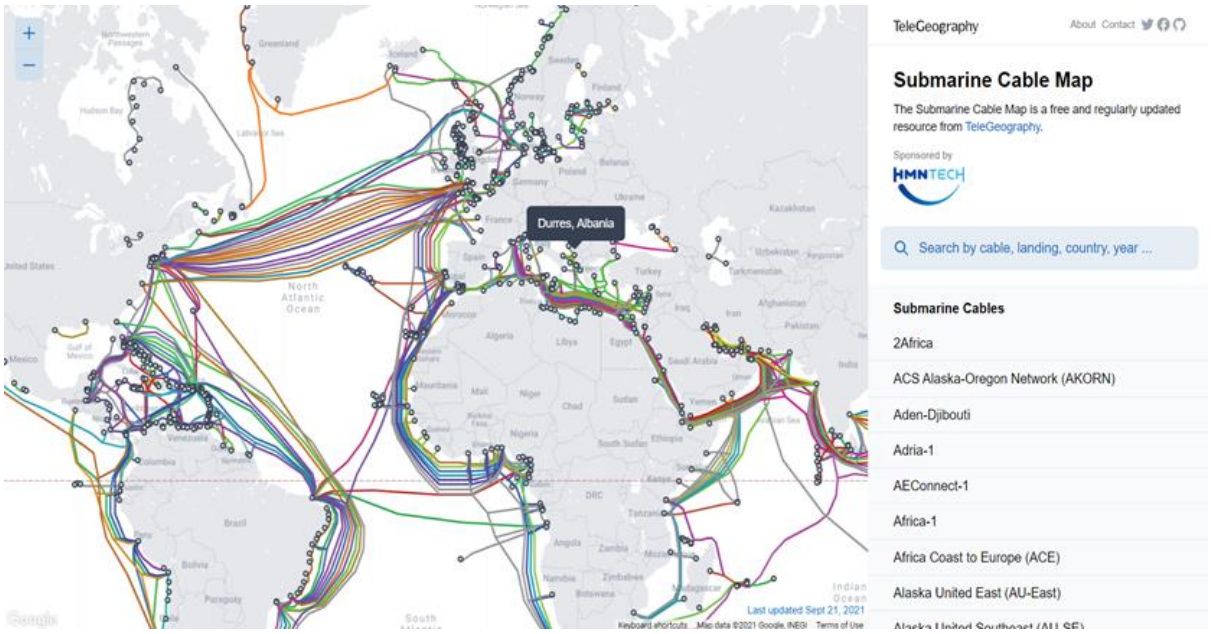

Figure 6.3.3-2 Submarine Cable Map, Direct Connection in Durres

- This new NBON network infrastructure could support the potential deployment of an Amazon World Services' datacenter or a Microsoft Azure datacenter to support this region.
- The NBON could drive new business into areas outside of Tirana.
- It could also drive new, modern farming methods across the country, including the use and demonstration of agricultural autonomy.
- It could create new opportunities for research and development utilizing public and private universities to advance in areas of medicine, high-performance computing, applied & theoretical physics, etc.
- It could lead to the conceptual idea of directly connecting off the star topology to CERN in Switzerland in order to expand research and development in Tirana.
- It would certainly create information technology jobs across the country for operation and maintenance of the NBON.
- And it could potentially create "green" jobs to expand the smart grid including a combination of solar, wind, and other power generating technologies.

With technical support, AKEP could create a complete solution utilizing software defined networking (SDN). SDN technology is an approach to network management that enables

dynamic, programmatically efficient network configuration in order to improve network performance and monitoring, making it more like cloud computing than traditional network management SDN is meant to address the fact that the static architecture of traditional networks is decentralized and complex while current networks require more flexibility and easy troubleshooting. SDN attempts to centralize network intelligence in one network component by disassociating the forwarding process of network packets (data plane) from the routing process (control plane). The control plane consists of one or more controllers, which are considered the brain of the SDN network where the whole intelligence is incorporated.

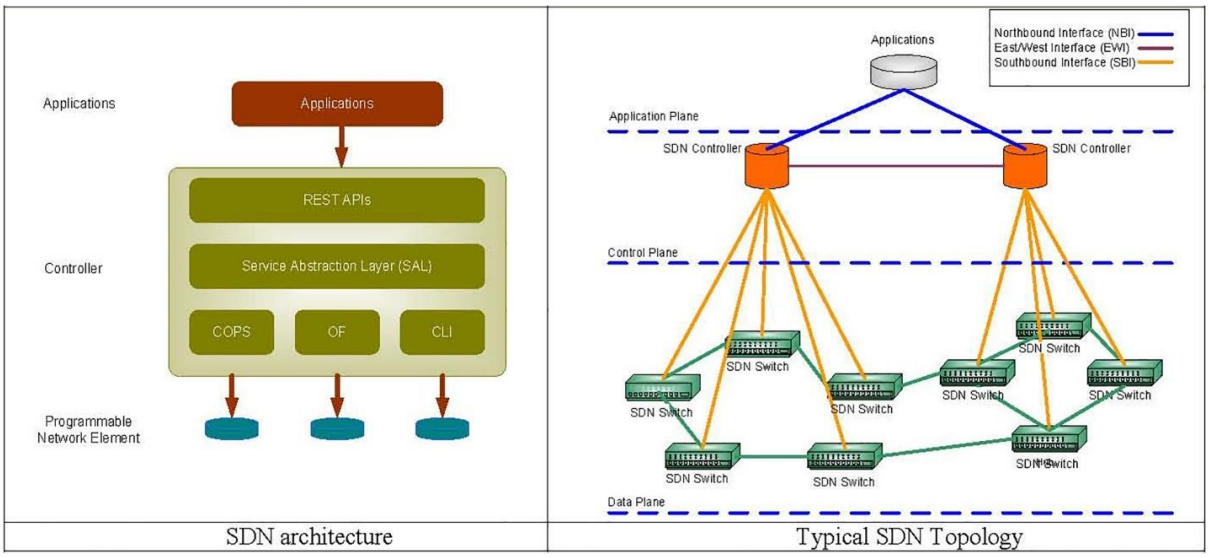

Figure 6.3.3-3 Software Defined Networking Network Management

To support the NBON initiative, the following actions are recommended:

- AKEP and the MIE will begin drafting the NBON Feasibility Study.
- The Government of Albania should review, comment and then adopt the NBON Feasibility Study.
- MIE shall announce public calls for selecting a project designer to draft the necessary construction projects for each region in the country.
- MIE shall obtain all necessary permits, consents, and approvals for the construction of the NBON.
- MIE shall announce the public calls for the selection of companies to build the NBON.

6.3.4 Laying the Cable Installations When Constructing or Reconstructing Roads

In order to avoid incurring duplicate / rework costs in the future when constructing new or reconstructing the existing roads in the country, it is essential to set up cable installations, i.e., underground ducts (pipes) and cable shafts, used to install and protect the electronic communication cables (especially the fiber optic cables). It is of particular importance to ensure the coordination of the construction works when deploying the cable installations, per the Law

on Electronic Communications, so that the Operators can plan their future investments in a timely manner.

This will not only avoid duplication of networks, but it will also ensure competition development, cost savings, better working conditions, which as a result, will provide better services to the citizens at affordable prices. This can be particularly important for the construction and development of NBON and the development of new technologies, such as 5G.

Laying the underground cable ducting should be done during the construction or reconstruction of the existing roads under the local self-government's jurisdiction. For that purpose, amendments and supplementations to the laws and bylaws related to the construction of public roads are necessary.

To support this initiative, the following actions are recommended:

- MIE and AKEP and the other competent public institutions, upon adopting the NBON, should commence a procedure to amend the existing laws and bylaws to ensure the obligation to lay underground cable ducting when constructing new or reconstructing the existing roads.
- When constructing new or reconstructing the existing roads in the country that are under the jurisdiction of the local self-government, cable installations, i.e., underground ducts (pipes) and cable shafts, must be set up, which will be used for the installation and protection of the electronic communication cables (especially the fiber optic cables).

6.4 5G MICRO-CELL STRATEGY

5G networks will differ from the previous generations of mobile networks as it will comprise various mobile cells where small cells will be a leading type. Traditional macrocells will still be required to provide comprehensive coverage outside the urban environment. However, urban areas will need to significantly increase the number of small cells [microcells] to sustain high-capacity requirements. Microcells allow for cost-effective deployments; equipment costs are generally lower than for macrocells. The number of cells can be optimized to provide additional capacity in locations most needed to support business and end-users. The size of the microcells is equivalent to or smaller than a regular Wi-Fi router. It is essential to note that the microcells are very important in B2B and M2M applications. They provide the needed level of location fidelity, enabling remote devices to perform delicate maneuvers and movements in close environments.

The mobile industry believes processes could be standardized and streamlined to reduce the time to approve and activate the microcells to just a few weeks. That would accelerate the needed coverage density needed to support the anticipated 5G demand growth and significantly reduce the administrative costs on both public and private sides.

As mentioned above, microcells are like Wi-Fi access points (routers) – similar in size, weight, and similar function only difference is that both are using different technology. Based on the technological neutrality principle, the same framework shall apply without regard to the technology, i.e., as in the case of Wi-Fi access points, no specific planning permissions should be required to roll out small cells. As a result of multiple consultations with the relevant authorities and industry players, strategy foresees an action to streamline the process of small cells deployment and aligning it with other similar deployment cases, i.e., to add small cells to the list and a written statement deposited to the responsible development authority, together with the project of work, drafted and signed under the responsibility of licensed professionals, is the only sufficient document for starting of construction works. The same can be applied for rooftop sites, considering the small volume of civil work needed.

It should be noted that according to the Albanian construction framework, Wi-Fi deployment does not require building permits.

6.5 Creating A Diverse And Trusted Telecoms Supply Market

Albania's Operators must have/develop trusted suppliers, as noted by the Clear Path Memorandum of Understanding signed between the United States and Albania.

Successfully achieving that vision will depend on:

- The Operator's willingness to work with incumbent suppliers but challenge their market power. Measures will need to be taken to address barriers to entry, such as aggressive commercial practices, closed interfaces, and control over standards-setting bodies.

- The Operator's encouragement for new suppliers into their supply chain - i.e., offering full open interfaces between service providers and private LTE/5G networks.

- The accelerated development and deployment of next-generation technologies that enable interoperable and open-interface solutions, supported by enabling global standards, allowing operators to utilize equipment from multiple suppliers in their network. This will challenge incumbent supplier lock-in and promote choice and flexibility for operators.

- Investment in research and development to support new and emerging suppliers recognizes that the radio access network market is dynamic and relies on significant research and development costs.

- Incentivizing Operators to diversify, recognizing that radio access equipment accounts for most mobile operators' network equipment costs in the current market. While a more diverse supply market should lead to greater price competition, operators are likely to require encouragement to integrate equipment from new suppliers into their networks ahead of the natural refresh cycle. Operators will also need to be confident

that new suppliers conform in practice to the open, interoperable standards and that any initial concerns around performance, reliability, and efficiency are addressed.

6.5.1 Development of Criteria for Trusted Suppliers

This Plan recommends that AKEP commission the creation and implementation of an organization – internal or external – chartered to provide a set of comprehensive services including certification of personnel, products, facilities, processes and systems to applicable standards and requirements. AKEP and its chartered organization (e.g. Albanian Trusted Supplier Certification Company/Department) can help identify and close regulatory gaps, confirm compliance, and maintain certifications.

Facility Certification. AKEP's chartered organization will be uniquely positioned to evaluate operational adherence to all regulations and standards for datacenters connected to the NBON. They can review plans, perform on-site evaluations to verify compliance with installation codes, conduct vital checks for critical safety issues, and assess the performance of building products and components. Their facility certification offerings should include digital security services and supplier audits, as well as device testing.

Datacenter Certification. To mitigate the risk of a widespread outage, cloud/datacenter providers need to address the most common causes of outages, which include human errors, software issues, network downtime, hardware failure with corresponding failure of high availability architecture, and, of course, data centers. Mass adoption of cloud computing has created a significant new risk: the potential to affect large numbers of companies and individuals in the event of a cloud services provider data center, infrastructure or network failure. Establishing an AKEP Data Center Certification Program addresses the continued reliability of key components of critical data center infrastructure by integrating the multiple disciplines of electrical, mechanical, security, life safety, building automation and telecom to create a comprehensive service.

The chartered organization can address the fire, life safety and security aspect of data centers, and evaluate the electrical, mechanical, telecommunications and building automation systems. AKEP is widely regarded as a thought leader by influencers in the data center engineering, colocation and hyperscale center industries.

The AKEP Data Center Certification Program should provide services for the full spectrum of data center consumers — from small, public cloud users to large Fortune 1000 entities with diverse hybrid information technology implementations. The program should incorporate six critical components that can be attributable to data center outages:

- Concurrent maintainability
- Reliability
- Security
- Sustainability
- Commissioning

- Safety

Product Certification. AKEP-approved certifications demonstrate that products have been tested to applicable standards prior to use on the NBON. AKEP's recognized regulatory expertise provides critical credibility to authorities and the marketplace. With an AKEP-approved certification, suppliers can bring their products to market more efficiently, and clearly differentiate them on crowded shelves.

This Plan envisions AKEP's process for certification of a product in generally four steps:

- Application (including testing of the product).
- Evaluation (does the test data indicate that the product meets qualification criteria?)
- Decision (does a second review of the product application concur with the evaluation?)
- Surveillance (does the product in the marketplace continue to meet qualification criteria?)

Using trusted suppliers helps focus the national research efforts to advance and sustain Albania's leadership in 5G technologies and secure the national 5G infrastructure. Establishing a trusted supplier certification organization / process will help address a significant risk to the 5G network and assist Albania in the compliance of the Clean Path MoU.

6.5.2 The Importance of Interoperability

In recent years, increased network interoperability has become an essential topic within the telecommunications industry, particularly with introducing 5G networks and their broader range of potential applications. Interoperability is a critical requirement for the successful diversification of telecoms networks. It will counter vendor lock-in by reducing the risk and cost of adding new suppliers' equipment to networks.

Interoperability is also a consideration when looking at the telecoms market from a network design, regulatory, or consumer perspective. Indeed, from a consumer point of view, interoperability is often the default, with mobile handsets working seamlessly across infrastructure providers and as barriers to switching are increasingly reduced. This same approach, if applied to infrastructure deployment, could rapidly accelerate diversification.

The consideration in this strategy is solely focused on network design and the technical application and implementation of interoperability. Here interoperability can be generally understood as the ability of two or more networks, systems, devices, applications, or components to communicate and deliver competitive performance. Within the access network, this refers to the interworking of services over multi-vendor inter-connections where equipment from different suppliers can be integrated into one network.

While the emergence of software-defined networks, virtualized network functions, and disaggregated supply chains – brought about by 5G – has increased the demand and potential for interoperable solutions, interoperability is not a new concept within the telecoms supply

market. However, previous attempts to define, standardize and implement interoperability have been hindered due to technical complexity and a lack of willingness on behalf of suppliers as they seek to protect their commercial interests. This has resulted in the use of proprietary specifications that have exacerbated supplier lock-in.

Interoperability could enable market diversification by giving operators the confidence to diversify their supply chains and utilize equipment from multiple suppliers. However, this will require reassurance that the equipment will integrate seamlessly with little risk to performance, efficiency, and the end-user experience.

Greater interoperability will also free operators from vendor lock-in. Increased network compartmentalization could also enable new and emerging market entrants to interface with incumbent suppliers and differentiate themselves by offering new and specialized services.

Together this will offer network operators greater flexibility and choice to select the best equipment available from different suppliers based on performance and prices, driving up quality, innovation, and resilience. At the same time, suppliers will be able to design and develop equipment with the confidence that their equipment can be integrated across networks without creating tailored or proprietary solutions.

Establishing interoperability as the default will require the buy-in and engagement of industry (suppliers and network operators), transparent and collaborative standards-setting, and establishing R&D and testing facilities to provide assurance and feedback from representative or 'live' networks.

Within the industry, there is a recognition of the importance and value of interoperability. This has led to a range of initiatives and the development of technical applications of interoperability, such as Open RAN. The Government is committed to supporting these and other emerging deployment methods that align with our aim to open the market to increased competition, innovation, and diversity.

6.6 SPECTRUM SLICING/USER REQUIREMENTS

6.6.1 Overview of What Slicing Means Related to 5G – the Fundamentals

A network slice is defined as a logical (virtual) network customized to serve a defined business purpose or customer, consisting of an end-to-end composition of all the varied network resources required to satisfy the specific performance and economic needs of that service class or customer application.

Slicing is not a new concept. Virtual network capabilities have been part of packet networking for decades. However, 5G deployments will extend this virtualization to an end-end/top-to-bottom functional scope and imbed slicing as a core functioning part of the network. The benefits include internal service provider network management uses; the ability to differentiate broad classes of services that require specific characteristics or resource parameters; providing a virtual service provider network across another physical network operator; providing

customers the ability to customize a virtual network to support their operations; traffic splitting across 5G, 4G and Wi-Fi networks, etc. Operators will utilize slicing to optimize network management from core to customer.

To support defining a flexible platform that will involve the integration of different vertically positioned industries, thus responding to each industry's technological and business requirements, 5G must support the concept of network slicing.

Network slices representing the logical traffic division throughout the network for which specific rules and requirements may be defined should be designed from an end-to-end perspective and may potentially pass across several technology domains (e.g., core, backhaul, and access network), and administrative domains (e.g., various mobile network operators). Therefore, management and orchestration functions should be available at the slice level through the central configuration of all elements across which the slice extends. This way, the same infrastructure for different services with different requirements, i.e., the convergence of applications offered through the 5G network, is provided. An example thereof may be the co-existence of user-oriented and machine-oriented applications with entirely different functional and performance requirements from the 5G network. The creation of network slices allows defining specialized telecommunication services for each vertical sector by offering so-called client-oriented network slices/layers created according to the client's requirements. These requirements for establishing a new network slice should be automatically translated into network resources orchestration to provide the required features.

Network slicing is a foundational concept for 5G wireless networks and can be utilized in many ways. It is helpful to differentiate between a few salient levels of usage of network slicing, which is also likely to map to phases of adoption:

- Network Slicing can be used for operational purposes by a single network operator to differentiate characteristics and resources for different broad classes of services
- Network slicing can be used by a service provider seeking to establish a virtual service provider network over the infrastructure of a physical network operator
- Network slicing can allow individual end customers (enterprises) to customize a virtual network for their operations and consume these network resources more dynamically like today’s cloud services (i.e., dynamically varying scale or for temporary needs).

In its initial incarnation, network slicing is more likely to be instantiated, like the provisioning of VLAN or VPN services for business customers. Over time, network slicing will allow Operators to introduce greater programmability for service differentiation. It will eventually be used to handle large usage scenarios such as massive IoT. As end-end network orchestration solutions mature, network slicing will handle inter-relationships between disparate network topologies and multiple business interfaces in an automated and transparent manner.

6.7 CRITICAL ASPECTS / CHARACTERISTICS THAT ENABLES MODERN 5G AND BEYOND

6.7.1 Open RAN

Open RAN introduces an open standard for developing Radio Access Network technology, meaning that all suppliers could develop interoperable products and components. It enables operators to deploy equipment from multiple suppliers in the same configuration – utilizing software and virtual solutions – allowing them to choose the best equipment suppliers for a particular RAN component to suit their deployment requirements or needs.

Full open RAN is still several years from deployment. However, it is critically important to define the interfaces in today's network that should be interoperable between a service provider and 4G LTE/5G Private Networks. Failure to do this will create complex barriers and high costs when implementing Open RAN. This also allows an almost seamless transition to 6G and 7G.

Open RAN can be expected to have several positive impacts on the market barriers currently affecting supply chain diversity, including for example:

- Reduced switching costs and futureproofing by enabling operators to more easily switch between and integrate new suppliers due to the open interface basis of the solution. As a result, operators could save on capital expenditure by adding suppliers without incurring the costs associated with replacing or refreshing legacy equipment when looking to integrate a new supplier.

- It enables disaggregation of both the hardware and software in the access network, allowing operators to pick and choose from a range of suppliers. This will also enhance opportunities for and competitiveness of new market entrants who offer specialist or innovative services.

- Scalable and agile deployment due to the critical role software will play at the center of the network, offering operators the ability to roll out more timely updates and adjust capacity and coverage outcomes as required.

While Open RAN promises to unlock the supplier lock-in across today's market, some challenges will need to be overcome, including the need to manage the introduction of additional 'touch points' across the network architecture from a security and resilience perspective and new challenges in system integration. The technology is also relatively nascent and requires further research and development to ensure that it can match the performance, efficiency, and robustness of traditional network architecture.

6.7.2 Open RAN Will Drive Competition, Innovation, and Network Vendor Diversity

Open RAN will facilitate competition, innovation, and network diversity in three fundamental ways: (1) increased modularity in the network architecture enables more participation across a varied set of vendors, (2) this modularity also prevents vendor "lock-in" by enabling carriers

to upgrade their networks more rapidly as innovative features become available for components over time, and (3) the ability to upgrade more quickly – especially when paired with the speed and agility of virtualization – can engender a virtuous cycle for innovation and adoption wherein architecture can be tailored more nimbly to function and network management can more effectively navigate evolving architectures.

Enabling more participation. The additional modularity in network design will help grow the suppliers' market and lower the barrier to entry for new participants. Because Open RAN constitutes a fundamentally open architecture, it opens the ecosystem to new suppliers, increasing the diversity of RAN solutions. Network operators will have the option to choose from a variety of suppliers, creating the opportunity for network solution vendors to offer standardized solutions to many operators instead of developing unique, one-off solutions for individual operators. The greater availability of such standardized equipment would, in turn, drive down the costs of network components, permit the entry of new market players and expand the existing market by increasing the number of competitors that network operators can turn to when they procure RAN elements. Network operators would also be afforded more flexibility for configuring their networks in an open architecture design. Open RAN will allow operators to customize the RAN to provide new services and applications to specific users such as enterprise customers and do so more quickly than in a closed model where network operators must work with their existing vendors to develop and deliver the feature.

Preventing vendor lock-in. By standardizing or "opening" what are today essentially vendor-specific protocols and interfaces that connect the various subcomponents in the RAN, networks can be deployed with a more modular design without being dependent on a single supplier. Developing, standardizing, and validating open interfaces allows reliable interoperability across different market players and provides network operators with greater options to mix equipment from different suppliers in the same RAN and other network layers and utilize multi-vendor deployments. This ability to mix and match with different suppliers providing different network components can increase competition by preventing "vendor lock" where proprietary or semi-proprietary implementations of RAN components inhibit competition among suppliers. Modularity allows network operators to use multiple vendors without being locked into a single source because there is more interoperability. With interoperability, operators can slowly move from one vendor to another over time rather than flash cutting from one vendor to the next. This modularity also allows an operator to use equipment from different vendors in parallel to avoid reliance on a single source.

Creating a virtuous innovation cycle to reduce costs. Previously noted that the RAN is currently the most expensive and most restrictive part of the network. According to some estimates, the RAN accounts for 65-to-70 percent of the total cost of network ownership. Increasing competition, innovation, and network vendor diversity can create a virtuous cycle to reduce the costs of deploying and operating a network and potentially speed the ability to build out 5G networks in urban and rural environments.

6.7.3 Open RAN Improvements That Benefit Network Management and Innovation

In addition to these benefits, Open RAN also provides or otherwise leverages technological improvements. For example, Open RAN architectures often focus on leveraging the advantages of the parallel migration toward software-based networks and virtualization that allow for more functionality and increased use cases.

A software-based network moves the network functions to the software that exists on general purpose servers found in every cloud data center instead of traditional environments wherein network operators have deployed purpose-built physical equipment to support network functions. This programmable RAN infrastructure lowers costs and simplifies the roll-out of new features and functions at distributed RAN locations at the network's edge. Moreover, open interfaces enable these new network features and functions to operate on any vendor's hardware without having to send out engineers and technicians as frequently to perform vendor-specific integration, as is standard practice today.

The management interfaces of RAN equipment standardized by the O-RAN Alliance enable consistent and automated operation of RAN in a vendor-independent fashion. Thus, Open RAN will complement efforts to replace much of the time-consuming and manual work of maintaining, upgrading, and optimizing networks with light-touch, centrally managed, automated computing processes.

More generally, as we move into the innovations of a 5G-powered world, exactly which innovations and capabilities will arise will only become apparent with experience over time. Likewise, Open RAN provides foundational capabilities that network owners and operators will leverage in a myriad presently unforeseen ways as new needs emerge. As an example, in a previous technological advance, the boost of consumer speeds in 4G LTE led to broadband video services on mobile devices that were not widely predicted during the 4G standard-setting process.

Similarly, industrial and enterprise use of the new capabilities unlocked by 5G and Open RAN are promising. Still, it is unclear which specific use cases made possible by these new capabilities will prove most impactful in the drive to unlock a new wave of American innovation and competitiveness. This underscores the importance of the U.S. government investing in advanced wireless testbeds that will drive an understanding of the potential use cases and streamline the development and deployment of Open RAN, including future features and functionality.

6.8 NETWORK FUNCTIONAL VIRTUALIZATION (NFV)

In addition to SDN described in section 6.3.3, it is important to implement Network Functional Virtualization (NFV). SDN and NFV will play a key role in the migration of Operators from 4G to 5G networks, allowing for easy and fast scaling. With the help of resource virtualization and implementation of a software-defined, programmable network, operators may offer a solution where each client can own and manage its network slice through a set of well-known

APIs (Application Programming Interface). Using the defined API functions, each client may define the slice features (topology, quality of service, etc.) based on its specific requirements. Therefore, to support the future development of 5G services, operators need to implement SDN and NFV technologies and provide uniform, well-defined access to these capabilities to ensure transparent cooperation between the telecommunications provider and the end service provider.

6.9 NETWORK EDGE COMPUTING

In addition to these options, provision of reduced latency, reduced core traffic, and streamlining of the central infrastructure is possible only with the implementation of Mobile Edge Computing (MEC) solutions that provide computing resources at the network edge, next to the base stations. In this way, moving the computing and storage capabilities close to the network edge, rather than the traditional approach of using a remote data center, provides seamless implementation of specific significant 5G pilot examples, such as autonomous driving and other data-intensive examples.

To this end, Operators need to develop a strategy for deploying these additional computing nodes by minimizing costs and raising the quality of the user experience. The size, location, and configuration of this equipment depends on the use and demand.

6.10 IDENTIFY, DEVELOP AND ANALYZE CORE SECURITY PRINCIPLES FOR 5G INFRASTRUCTURE

5G network involves addressing Albania's economic and national security risks during the development and deployment of 5G infrastructure worldwide. As a part of this effort, Albania should identify the incentives and policies necessary to close identified security gaps in close coordination with the private sector and through the continuous evaluation of commercial, security, and technological developments in 5G networks. A related activity is identifying policies that can ensure the economic viability of Albania's domestic industrial base in coordination with the private sector through listening sessions and reviews of best practices. This element of the implementation plan will also involve more intense engagement with the owners and operators of private sector communications infrastructure, systems equipment developers, and other critical infrastructure owners and operators. The engagements will involve sharing information on 5G and future generation wireless communications systems and infrastructure equipment.

Malicious, illegal, and harmful actions in the digital sphere do not only come as attacks. They do not only aim at defrauding, theft, or obtaining confidential elements. Being organized and coordinated by powerful actors, structured in difficult to track formats, and outside any effective judicial jurisdiction or democratic control, these actions may be preliminarily configured to be part of the systems, technologies, and networks we use daily. They become interfaces for collecting, stocking, treating, and using personal, commercial, intellectual property, national security, or alliance and strategic partnership interaction data. As such, they are a tremendous global threat, putting national sovereignty, the functioning of the rule of law,

guaranteeing fundamental rights and the protection of citizens' interest, the principles of free and fair competition, and public security at significant risk. The long-term risk they pose concerning the reliability of a democratic digital society increases many folds when efforts are made to reach everywhere possible through next-generation technologies and networks, especially 5G.

In addition, Regulation No. 37, dated 29.10.2015, charges AKEP with the mission to set a series of obligations for undertakings, putting in place adequate technical and organizational means and methods to ensure the security of public communication networks the services provided through them. These means should ensure a security level commensurate with the risk present and should avoid security incidents or mitigate the impact or consequences of these incidents should they occur. Other obligations in this aspect are the following:

- Implementing the appropriate technical and organizational measures to ensure public communication networks' integrity while also ensuring uninterrupted service provision.'
- Managing and protecting the equipment and systems employed to store public communication systems and/or services user data.
- Ensuring an adequate level of protection and safety regarding the potential and foreseen risks.

6.11 ENVIRONMENTAL IMPACTS

6.11.1 The Effects of the 5G Mobile Phone Standard on Greenhouse Gas Emissions

In a study conducted by a team of researchers from the University of Zurich and EMPA, the team concluded that, with an assumed eightfold increase in future data traffic, 5G technology will be more efficient and enable innovative applications, such as flexible working, a smart grid or precision agriculture, thereby helping to reduce CO2 emissions.

The study examined the energy and material flows for the construction and operation of the infrastructure of a 5G network and thus possible (new) applications up to the year 2030. The results of the study show that the expansion of the 5G network and the new equipment required for new applications on the 5G network should cause environmental pollution in the order of 0.18 megatons of CO2 equivalents in 2030. On the other hand, new applications also offer a savings potential of up to 2.1 megatons of CO2 equivalents.

One reason for the climate-friendly CO2 savings is the greater energy efficiency of 5G technology. The 5G network in 2030 should cause around 85% fewer emissions per unit of data transported than today's mobile phone network. In addition, there are indirect savings from new uses, such as smart grids or new applications in agriculture with more targeted use of fertilizers and pesticides. Likewise, the faster, more reliable and (in terms of quantity) much larger data transmission that are conducted, enable and support flexible working, which in return reduces commuter traffic and business travel due to the fact that virtual collaboration can be carried out more efficiently in the 5G network, according to the Empa researcher.

Additional reductions in greenhouse gas emissions can be achieved through new technologies that will only emerge with the expansion of 5G networks, such as autonomous driving, tele-surgery and intelligent buildings.

With the study, Hischier points out, a basis for future political decisions is now in place, which shows that the spread of 5G technology has environmental benefits. "Technological developments, if applied in a smart way, are a major contributor to further reducing our CO2 emissions." After all, the 5G network promotes and enables promising technologies, which in turn meets the future needs of society and helps achieve sustainability goals.

6.11.2 Exposure of Humans to Radiofrequency Electromagnetic Fields

In a study conducted by the World Health Organization (WHO), electromagnetic fields (EMF) of all frequencies are one of the fastest and growing environmental influences. WHO notes that currently a vast majority of the populations are exposed to a different degree of EMF, and in the future we will observe an increase in the level increase as technology advances.

When it comes to human exposure, the exposure is limited to radio frequency only EMF (RF EMF). The exposure level differs from one country to another. In the scenario that there is no limitation of RF EMF exposure ITU recommends that International Commission on Non-Ionizing Radiation Protection (ICNIRP) limits should be used. ICNIRP is formally recognized and the ICNIRP limits are endorsed by WHO. To date, WHO, the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) of the EU and ICNIRP have concluded that exposure related to wireless networks and their use does not lead to adverse effects for public health if it is below the limits recommended by the ICNIRP.

In Albania RF EMF is established in Law 10 469, date 13.10.2011[1]. Decision no 843 date 3.12.2014 transposes the directive of EU 2013/35 / EC of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (20th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and repealing Directive 2004/40/EC).[2] RF EMF limits established in Albania are in line with ICNIRP limits.

6.12 TOOLS AND ADVISORY SERVICES FOR THE IMPLEMENTATION OF 5G

In support of 5G implementation, AKEP will be required to upgrade / acquire appropriate frequency monitoring capability, tools and applications. For example, spectrum analyzers will be needed – generally one for each frequency set and deployed in each county. The antenna output should be monitored around the borders of Albania. In order to reduce costs, other 5G implementations included a “volunteer” program whereby individuals around the county, using

[1] http://www.ishp.gov.al/multimedia/zmr/rrezatimet_jojonizuese/ligje/l_nr_10469_date_13_10_2011.pdf

[2]Directive2013/35/EU
https://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:179:0001:0021:EN:PDF

an app, can monitor frequency usage throughout the country. AKEP should also consider the use of a cyber reporting service to assist in cyber security assurance in the network.

7 CONCLUSIONS

The following conclusions summarize the key aspects / recommendations of the Plan:

- AKEP, has a unique opportunity to implement 5G strategies for the country and its residents in an efficient manner that incorporates lessons learned from other 5G rollouts in the EU and the US. In order to facilitate this, an auction of spectrum licenses to interested parties – such as Albania's Operators – provides the investment funding needed to improve and/or prepare Albania's telecommunications infrastructure for a secure 5G implementation.
- Albanian laws, regulations, and processes need to be reviewed to support the goal of a successful 5G rollout across Albania. One key element of this Plan was to identify and make recommendations on legislative actions that will help facilitate the rollout. In addition, this Plan identified potential "special actions" and "streamlined processes" that the Albanian government may consider enhancing the success of the spectrum auction, encourage telecom Operator investments, and minimize cumbersome / time-consuming processes while still maintaining diligent review for effective and safe implementation of 5G technology throughout Albania.
- The new 5G technology development in Albania will overcome the existing wireless networks' capabilities to develop communications services available from anywhere, at any time, and significantly faster data rates which is expected to be globally widespread, and its development will be aligned with the new market needs. Albania should engage in global activities to provide the necessary prerequisites for the development of new technologies and support the operators of electronic communication networks/services. These prerequisites provided to the Operators shall be significant for the investment dynamics in new generation networks.
- The 5G network represents an investment in the potential for opening new markets and the opportunities to foster development in numerous fields, ranging from smart agriculture to smart factories. Significant advances in autonomous vehicle technology are possible with 5G, creating the potential for people to have new personal and professional freedom levels. 5G will drive significant improvements in virtual reality, augmented reality and artificial intelligence, creating opportunities to connect people far beyond what current cellular technology allows.
- The Operators have a clear understanding of the traditional commercial uses of 5G, but need to more fully recognize the enterprise, government and military applicability of 5G to the market. In addition, the Operators must recognize the risks of delaying the sunset of 2G/3G. The vulnerability of 2G and 3G has significant cyber risks, which has been further amplified using 'smart' devices on these networks, which in turn has provided the opportunity to exploit their inherent network weaknesses digitally. As part of the overall AKEP strategy and auction process, strong consideration should be given to the sunset of 2G/3G capability no later than 12 months after 5G coverage has been fully implemented in Major Economic Areas.

- A strong backhaul network is a crucial requirement to meet high throughput and low latency expectations from 5G/next-generation technology and facilitate connection of base stations via fiber optic. To achieve this goal, this Plan recommends the creation of a National Giga-Backhaul Optical Infrastructure Network (NBON), funded by the Government. The Government's investment in the NBON will be justified, as deploying a NBON in Albania will improve the return on investment in 5G for the Operators, thereby encouraging them to implement 5G faster. It will also provide numerous benefits across the country and, over time drive new business and job creation in Albania.
- This Plan recommends that AKEP commission the creation and implementation of an organization – internal or external – chartered to provide a set of comprehensive services in support of Trusted Network Suppliers including certification of personnel, products, facilities, processes and systems to applicable standards and requirements. AKEP and its chartered organization can help identify and close regulatory gaps, confirm compliance, and maintain certifications.
- To evaluate these challenges and address the implementation plans required from this Plan, it is recommended that AKEP establish a National Telecoms Lab. The Lab will serve as a hub for telecommunication R&D activity across Albania and deliver a wide range of benefits that will mitigate risk, enable and accelerate diversification through new market entrants and interoperable deployment methods. It will create a unique testing environment for Operators and suppliers to match their requirements and specifications to assess the technical performance and security of equipment in representative networks – this could be particularly beneficial for new and emerging suppliers, offering them a unique opportunity to demonstrate their viability.
- As recommended by the EU's *"Roadmap for Lowering Roaming Charges Between the EU and WB"*, dated September 2021, AKEP should consider establishing a Broadband Competence Office (BCO) or similar advisory single point of contact (SPOC) for broadband and 5G investments in Albania.
- Finally, the implementation of 5G nationally will offer practical applications to many economic sectors as discussed in this Plan. The ability to exploit those opportunities will depend on the willingness and readiness of the Albanian society to adopt 5G, both users and businesses. Such an endeavor calls for a robust Albanian Government capacity and skills development program promoting awareness of the benefits and opportunities inherent in 5G. Various Albanian Government / AKEP initiatives can achieve this objective and involve a significant "5G Campaign" across the country.

8 ACRONYM DEFINITIONS

- AI: Artificial Intelligence
- AKEP: Albania's Electronic and Postal Communications Authority
- API: Application Programming Interface
- ARPU: Average Revenue Per User
- ATLAS: Abbreviated Test Language for All Systems
- ATU: Albanian Telecommunication Union
- B2B: Business-to-Business
- BCO: Broadband Competence Office (BCO)
- BEREC: Body of European Regulators for Electronic Communications
- CEPT: European Conference on Posts and Telecommunications
- CISA: Certified Information Systems Auditor
- CMA: Cellular Market Areas
- CPE: Customer-Provided Equipment
- CTIA: Cellular Telecommunications and Internet Association
- Db: Database
- DDoS: Distributed Denial of Service
- DNS: Domain Name System
- Dos: Denial of Service
- DSS: Dynamic Spectrum Sharing
- DVB-T: Digital Television Services
- DWDM: Dense Wavelength-Division Multiplexing
- EAG: Economic Area Groupings
- eCPRI: Enhanced Common Public Radio Interface
- eMBB: Enhanced Mobile Broadband
- EOL: End of Life
- EPC: Electronic Product Code
- ETSI: European Telecommunications Standards Institute
- EU: European Union
- FCC: United States Federal Communications Commission
- Gbit/s: GigaBytes per second
- GDP: Gross Domestic Product
- GHz: Gigahertz
- GIS: Geographic Information System
- GPRS: General Packet Radio Service
- GSM: Global System for Mobile Communication
- GTP: GRPS Tunneling Protocol
- I.M.: Instant Messaging

- IMS: IP Multimedia Subsystem
- IMSI: International Mobile Subsidier Identity
- IMT-2020: International Mobile Telecommunications
- IoT: Internet of Things
- IP: Internet Protocol
- ISAS: Integrated Spectrum Auction System
- ISP: Internet Service Providers
- ITU: International Telecommunication Union
- LEC: Law of Electronic Communications
- LTE: Long Term Evolution
- M2M: Machine-to-Machine
- Mbps: Megabits per second
- MEA: Major Economic Areas
- MEC: Mobile Edge Computing
- MHz: Megahertz
- MIE: Ministry of Infrastructure and Energy
- ML: Machine Learning
- MMS: Multimedia Messaging Service
- mMTC: Massive Machine Type Communications
- MNO: Mobile Network Operator
- MNOs: Mobile Network Operators
- MPN: Mobile Private Networks
- M.W.: Micro-Watt
- NDUDM: User Data Management
- NBON: National Backhaul Optical Infrastructure/Network
- NFP: National Frequency Plan
- NGA: Non-Governmental Agency
- NRTC: National Rural Telecommunications Cooperative
- NFV: Network Functional Virtualization
- OpenRAN: Open Radio Access Network
- OPGW: Optical Ground Wire
- OST: Albania Transmission System Operator
- PWB: Provisional Winning Bid
- QoS: Quality of Service
- R&D: Research and Development
- RAN: Radio Access Network
- REAG: Regional Economic Area Groupings
- RSA: Rivest–Shamir–Adleman [Public Key Cryptosystems]
- S.A.: Stand Alone [Mobile Network]
- SAS: Spectrum Auction System
- SmartRAN: Smart Radio Access Network
- SMEs: Small and Mid-Size Enterprises
- SPOC: Single Point of Contact

- RSC: EU Radio Spectrum Committee
- S.P.: Service Providers
- SDN: Software-Defined Networking
- SMR: Simultaneous Multiple-Round
- SMS: Short Message Service
- SONIC: SmartRAN Open Network Interoperability Center
- TEID: Tunnel Endpoint Identifier
- TMSI: Temporary Mobile Subscriber Identity
- UK: United Kingdom
- UL: Underwriters Laboratory
- URLLC: Ultra-reliable and Low Latency Communications
- USF: Universal Service Fund
- VLAN: Virtual Local Area Networks
- VPN: Virtual Private Network
- WAN: Wide Area Network
- WAP: Wireless Application Protocol
- WB: Western Balkans
- WRC: World Radio-communication Conference