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5G Safety - Phase 1 Industrial survey, sub-phase IR.2

Misson-Critical Tehnologies in scope of 5GSafety

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Authors	Telekom Slovenije d.d., Iskratel, d.o.o., Kranj, Univerza v Ljubljani, Fakulteta za elektrotehniko, OSI d.o.o.
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ISKRATEL

1. Abstract

The smartphone market is a huge and complex market that will according to certain estimates include up to 3 billion active smartphone users by 2020, which undoubtedly brings along challenges for all stakeholders. Despite the fact that technologically advanced terminals are already available on the market, these terminals have many technological gaps and other weaknesses that stand out the most, however, when the terminal equipment is used in critical PPDR situations. The most significant disadvantages are:

- high dispersion of manufacturers of terminal equipment and operational systems;
- limited terminal battery autonomy;
- mobile signal and mobile data access coverage;
- frequent GPS errors in locating terminals and locating inside buildings;
- non-prioritization of urgent data calls;
- flooding of 112 applications at the terminal;
- questionable reliability and user-friendliness.

Data-enriched man-terminal interaction processes have been used in practice for quite some time, however, only the arrival of next generation networks in the coming years will render possible an even faster development of future technologies, such as:

- Augmented reality (AR);
- Virtual reality (VR);
- Mixed Reality (MR).
- Advanced personal virtual assistants.

Man-terminal interaction processes fall within demanding terminal tasks. This frequently involves processing multimedia material (image, video, audio), which usually requires process power at the terminal and higher RAM. Terminals for these types of interaction must have sufficient capacity in terms of processing and hardware performance in order to provide support to interaction processes, and applications must be designed so that their use is simple and intuitive in stressful and critical conditions – e.g. AR for urban navigation to the nearest defibrillator.

In the coming year, IoT technologies will be launched on the market in various areas, including PPDR. Already today, there are several different smoke, fire, collision sensors, IoT devices for communicating the exact location when playing outdoor sports and many other sensors for capturing safety, environmental, medical and other PPDR-related parameters. All these data can already contribute to or help improving our understanding of the situation on the field and in quickly responding to an event, and in certain scenarios they can even forecast and potentially prevent urgent events (e.g. detecting seismic shocks that precede earthquakes, timely detection of dangerous rising of water levels in flood risk areas, etc.). Low-power wide-area network (LPWAN) technologies represent the basis for the commercial usefulness of IoT solutions. Currently, the best-known technologies are ZigBee, LoRa, SigFox, Nwave, LTE-M and NB-IoT.

The transition between current and future PPDR systems will happen gradually, and in the meantime, hybrid networks, which entail the integration of current narrowband with broadband networks, will most likely be used. Hybrid networks enable group speech communication between narrowband network users, between broadband network users, between narrowband and broadband network users and dispatchers in operation centres. In addition to speech services, broadband network users also use applications for transferring videos and large data. At the same time, hybrid networks are expandable and enable use to several organisations of PPDR users. Standardized interfaces for connecting and the mutual operation of these networks are of key importance for the integration and coexistence of current and future systems. The manufacturers of equipment for critical networks are facing the challenge of coordinating the mutual connection of narrowband critical networks with broadband networks.

Technologies that are being used with PPDR are divided into categories depending on their data transfer capacity:

- narrowband (NB);
- wideband (WB);
- broadband (BB).

The needs of PPDR users for speech communication are met due to purpose development with current narrowband technologies (TETRA, TETRAPOL, P25 and DMR). These enable a wide range of speech-oriented services with limited data transfer options. In addition to the mentioned digital technologies, analogue systems, conventional as well as trunked (MPT1327), are sometimes also used, however, they are being increasingly replaced by digital systems. Narrowband technologies are suitable for smaller networks as well as for national networks which are being shared by several PPDR organizations in a particular area. In Europe, TETRA technology is used in most instances for national networks for PPDR use, and also TETRAPOL to a lesser extent.

The main limitations of narrowband PPDR technologies are:

- lack of capacity in case of an emergency;
- inability to transfer larger volumes of data;
- poor interoperability.

Mobile radio networks of service providers are intended for user coverage, the guiding principle of which is commercial interest. Service providers ensure coverage where users of mobile services are mainly located. Consequently, population coverage (based on addresses of residents) is very high, whereas areas that are not populated are commercially unattractive or the construction of base stations is impossible, for this reason these areas are poorly served or have no radio coverage at all. Areas which are currently commercially unattractive will need to have radio coverage in case of use of PPDR services. This can only be ensured by constructing new locations. Where this will not be possible, temporary base stations for ensuring radio coverage may be set up in case of emergency.

In order to ensure support to the operation of PPDR devices and services it is necessary to allocate a relevant radio spectrum for connecting PPDR devices. The radio spectrum for the operation of PPDR devices must ensure sufficient bandwidth and signal coverage. The spectrum must be coordinated at the state level and between EU member states. In this manner a significant advancement in the development of PPDR services at the international level, terminal equipment portability, higher quality and consequently lower prices will be ensured. At the same time the interoperability between EU states will be established, which will ensure a faster development of services and their extended use and the mobility of operation units in the EU territory.

In the first phase, 5G network will use the current LTE-A networks, upgraded with new functions (5G architecture) intended for 5G networks. The development and upgrade of portable systems and core networks is being carried out in parallel with the upgrade of base stations. The state announced a new auction of frequencies that will enable higher peak speeds and better user experience in the countryside (700 MHz band) and in cities (3.5 GHz).

With Regulation no. 2016/687, adopted on 28/ 4/ 2017, the European Commission provided a legal basis for the use of radio spectrum at 700 MHz. This regulation ensures:

- harmonized conditions for the operations of PPDR services at 700 MHz in a terrestrial wireless frequency spectrum in 703-733 MHz and 758-788 MHz frequency bands;
- simultaneous use of PPDR services with other terrestrial wireless broadband network services;
- use of PPDR services in individual member states;
- possible use of additional frequency bands for PPDR services based on the member state's decisions in bands 698-703 MHz, 733-736 MHz, 753-758 MHz and 788-791 MHz.

On 1/ 4/ 2019, the Ministry of Public Administration (MJU) submitted strategic orientations to the Agency for Communication Networks and Services (AKOS) with regard to allocating frequencies in the 700 MHz band monitored by AKOS. In allocating frequencies, AKOS should take into consideration the possibility of meeting the needs of users in the area of public safety, protection and rescuing (PPDR) using mobile communication services of commercial networks with the new generation of 5G technology.

Integrated circuits for terminals in the entire 700 MHz radiofrequency band already exist on the market, however, there is still not commercial equipment for base stations for band 68 available. For PPDR use the Agency proposed a spectrum in duplex slots in a protection band in the 700 MHz radiofrequency band, i.e. 2x5 MHz: 698-703 MHz / 753-758 MHz (3GPP band 68).

The strategy also specifies that with the development of LTE technologies (Release 12-14), PPDR could use LTE networks with its own infrastructure and in combination with the use of the public mobile infrastructure. The Agency explored the possibility of using duplex slots and protection bands in the 700 MHz band, which would mean 2x5 MHz and for purpose networks for ensuring M2M for the critical infrastructure 2x3 MHz (M2M) at a 700 MHz frequency band.

The architecture of the 5G core network enables virtualization by slots, consequently eliminating the need for physical sources. The key architectural novelty of the 5G network is the introduction of an analogous hierarchical approach of active central network elements between back-end systems and end users. The latter enables achieving low latency between endpoints.

The use of an allocated frequency spectrum exclusively for PPDR services in the initial phase enables the control over the use of capacities and ensures the Quality of Service (QoS) for individual users or services. In later phases, with the development of applications that will require high data transfer rates and/or short response times, the limitation of the allocated spectrum will result in overloading the radio interface in areas of increased use (extraordinary events). QoS for PPDR services in case of use of the entire frequency spectrum of public radio networks can be ensured by prioritizing traffic and with the option to roam in all mobile networks. The combination of the use of an allocated frequency spectrum for PPDR services with the simultaneous shared use (based on requirements) of commercial radio networks is also possible. With the introduction of 5G technologies, commercial networks will enable slicing, whereas ensuring QoS for PPDR services will be possible by introducing the dynamic allocation of radio sources for individual slices in the mobile network.

In order to use TETRA services, users of a broadband network use a regular smartphone with its own SIM 3GPP identity and with the TETRA purpose application installed on the smartphone with its own TETRA identity. The quality of service and its reliability depends on the implementation of the broadband network. From the point of view of the TETRA network user, an LTE network user is one of the TETRA network users who may use the same TETRA services and can be the member of the same TETRA groups. The LTE network can be commercial or private.

As part of technology research and methods of ensuring a suitable technological basis, we recognised areas that are essential for providing services within the framework of the proposed instruction examples. We identified critical areas in the technology segment, which can significantly impact the application implementation parameters (DPaaS) that will ensure the services for implementing instruction examples.

The main areas where we identified technological challenges are:

- Managing RTP traffic in order to provide speech services, video communication and recording.
- Recording events on the operating console.
- Implementing applications based on the principle of distributed applications.
- Using distributed data servers.
- Technological challenges in the implementation of hybrid communications.
- Challenges of dynamically determining the quality of 5G services.
- Integrating applications for residents in the WebRTC technology.

Data analytics are inherently complementary to other 5G technology trends, such as SDN (Software Defined Networking)/NFV (Network Functions Virtualization) and MEC (Multi-access Edge Computing). The limitations and technical challenges when using analytics in the 5G network are represented by mainly fast-changing data, support for application and network intelligence and safety along the entire path.

5G network will enable the mutual exchange of data between a wide range of different devices (sensors, devices, mobile devices, such as smartphones, tablets, etc.). In order for them to be safe and reliable, the applied safety mechanisms will have to be efficient and adaptive. Ensuring data privacy and comprehensiveness during the exchange will be based on the use of encryption and authentication mechanisms that are already in use today. This will be the IPSec protocol at the network level and the TLS protocol at the transport level. In order to ensure a higher level of safety of the keys that will be used for encryption and authentication, the use of purpose machine mechanisms from which keys cannot be exported, at the same time, however, they enable a more precise control over access to the keys themselves.

The two most important safety mechanisms for the protection of endpoints will thus remain antivirus protection against malicious software (AV) and personal firewall (FW) with which the access to sources on the devices themselves can be restricted. In cases where there will be required an even higher endpoint protection level, a functional upgrade will be possible using intrusion prevention systems (IPS) with which it will be possible prevent the exploitation of known vulnerabilities in the used software or configuration errors.

The key challenges in ensuring the safety of endpoints in 5G networks will thus be the relatively significant difference in software functionalities and in hardware performance, and the relatively long life span of certain devices. Cybernetic safety/protection against risks deriving mainly from the constant and global connectivity will have a decisive impact on the successfulness of the introduction of 5G networks. Due to the expected increase of the number of devices in 5G networks and the consequent increase of safety events, the use of tools for the automation and orchestration of safety functions will be of vital importance for effectively responding to such events. An important source of data for analysts in the safety-operation center, who mostly deal with responding to safety incidents, is represented by data on actual attacks and misuses.

The Network Operations Center (NOC) represents the integration and centralization of network control with the aim to:

- optimize operation and network maintenance;
- control over network interferences;
- detect and eliminate faults in the network faster;
- reduce downtime of individual network parts;
- reduce costs and loss of income;
- identify critical elements or points in the network and thus increase the network quality and availability.

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