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PERSPECTIVE TRENDS OF TELECOMMUNICATION NETWORKS DEVELOPMENT BASED ON IMT-2030 CONCEPT

Triska N.R.
Educational and Scientific Institute of Telecommunication Systems,
Igor Sikorsky Kyiv Polytechnic Institute, Ukraine
E-mail: ntriska@ukr.net

ПЕРСПЕКТИВНІ НАПРЯМКИ РОЗВИТКУ ТЕЛЕКОМУНІКАЦІЙНИХ МЕРЕЖ НА ЗАСАДАХ КОНЦЕПЦІЇ IMT-2030

Розглянуто перспективні напрямки розбудови сучасних телекомунікацій в контексті подальшого розвитку та впровадження базової концепції мобільного зв'язку – IMT. На основі програмних документів ITU-T проаналізовано основні засади розвитку сучасних та майбутніх телекомунікаційних систем на період до 2030 року (концепція IMT-2030). Відзначено важливість адаптації нових технологій та технічних рішень до існуючої інфраструктури телекомунікаційних мереж, а також необхідність забезпечення точної синхронізації для багатьох сучасних та майбутніх застосувань.

Ever-increasing demand for infocommunication services in very different fields of modern business and social life leads to the development of new technical concepts and solutions. As people communicate in high-definition video and gain more user experience with virtual reality, cloud gaming etc., the need for more bandwidth is growing. High-speed, low-latency device-to-device (D2D) interaction is also a very promising trend, especially for industrial processes automation and Internet of Things (IoT). New digital realities strongly influence the ways of learning, understanding and memorizing in different fields of science. It is important to note the steadily increasing role of users in the IT & Telecom market development: now the user experience shapes the technologies for personalized needs [1, 2].

On the other hand, new technical solutions should provide the sustainable interaction with existing resources and processes. So the role of standardization in the new technologies deployment is really important.

During the last decade the telecommunications development has been based on the IMT (International Mobile Telecommunications) concept defining the mobile broadband systems and corresponding network infrastructure. It reflects the ever-increasing role of mobile communications in the modern world. The emerging demand for new mobile services is one of the main driving factors in IT &Telecom now. IMT concept went through several stages of development (IMT-2000, IMT-Advanced, IMT-2020) and now the next stage – IMT-2030 – is actively discussed. So the development and standardization of IMT-2030 deployment scenarios will be in focus of telecom industry for the next years. The IMT-2020/2030 standardization activities are coordinated by the corresponding International Communication Union sectors – ITU-R (radio technologies and interfaces) and ITU-T (network architecture, transport network, synchronization).

The capabilities of IMT systems are being continuously updated in line with user trends and technological developments. The current IMT-2020 concept (based on 5G mobile telecommunications standards) has introduced some promising technologies such enhanced mobile broadband (eMBB), ultra-reliable low-latency communications (URLLC) and massive machine-type communications (mMTC). Besides significantly enhancing the data rate and mobility provided in IMT-Advanced, IMT-2020 has introduced new advantages such as spectrum efficiency, latency, reliability, connection density, energy efficiency etc. to support emerging usage scenarios and applications.

IMT-2030 is expected to provide a revolutionary new user experience with connection speeds in the Terabits/s range per user and a whole new array of sensory information such as touch, taste and smell. New services and application trends for IMT towards 2030 and beyond are summarized in [1] and includes:

– Enabling services that help to steer communities and countries towards reaching the United Nations' Sustainable Development Goals (UN-SDGs);

– Customization of user experience based on the user-centric resource orchestration models;

– Community-driven networks and public–private partnerships as new models for future service provisioning;

– Development of products and technologies that innovate to zero will be promoted; for example, zero-waste and zero-emission technologies.

– Increasing role of artificial intelligence (AI) in different industry and social applications. The goal is to provide the access of AI to everyone, every business, every service anywhere anytime.

– The trend towards higher data rates will continue: peak data rates may approach Tera bits per second (Tbit/s) indoors, requiring large available bandwidths giving rise to (sub-) Tera hertz (THz) communications.

The technical base for implementation of the abovementioned tasks is being formed now. The three basic usage scenarios proposed for IMT-2020 – eMBB, mMTC and URLLC – will still remain relevant. At the same time, new promising use cases and applications (digital twin, cyber-physical systems, "mixed reality" – MR, industrial/service robots etc.) will require to develop and implement the various new technologies and solutions.

For example, the different solutions are proposed to enhance the radio interface such as advanced modulation, coding and multiple access schemes, advanced antenna technologies (e.g. E-MIMO) and holographic radio [1].

Extreme MIMO (E-MIMO) is further development of massive MIMO, which is widely deployed in IMT-2020 systems. It can be achieved by exploiting much larger antenna array, using new materials, applying new deployments and new tools, etc.

Holographic radio (HR**)** can be applied in some promising use cases, such as high-precision positioning and perception, smart factory and immersive media. It utilizes the spatially continuous electromagnetic aperture and interference exploitation to enable spatial multiplexing and spectral multiplexing with pixelated ultra-high resolution. HR can make use of all available spatial dimensions to achieve

benefits in terms of flexibility, spectral efficiency, delay, power consumption and complexity.

The important aspect of IMT-2020 (and future IMT-2030) systems deployment is the effective adaptation of the existing transport network infrastructure to new technical requirements [2, 3]. The main aspects of such adaptation has been summarized in ITU-T Recommendation G.8300 “Characteristics of transport networks to support IMT-2020/5G” [4] which defines:

- Relationship of 5G network architecture to transport network architecture;
- Operations, administration, and maintenance (OAM) requirements;
- Timing performance and time/synchronization distribution architecture;
- Survivability mechanisms.

All these issues will remain relevant as new solutions based on IMT-2030 concept are introduced. The use of data and algorithms such as artificial intelligence (AI) will play an important role, and technological complementarities are required to ensure that the technology innovations complement each other [1].

One of the most important aspects of new telecommunication technologies deployment has traditionally been synchronization issues [2, 3]. The precise synchronization will remain critical for many new application such as time-sensitive networking for automated vehicles, controlling robots in smart factories, high-precision positioning. Industrial devices, processes and future haptic applications will require strict timing synchronization with tight requirements for jitter. It should be considered in the respective ITU-T standards and in the new generations of synchronization equipment.

It is generally expected that IMT-2030-based networks will connect many devices, processes and humans to a global information grid cognitively, thereby offering new opportunities for various verticals. Future applications could allow users to feel material objects in holographic form, taste food samples in a kind of virtual reality, and even smell samples thanks to innovative digital scent technologies. But a lot of work should be done from the research & development to standardization and deployment of new technical decisions. All these activities should consider the need to adapt the new technologies, networks architectures as well as management and OAM tools with the existing network infrastructure.

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