5G

ZTE中兴

Driving the Convergence of the Physical and Digital Worlds

White Paper on
Next Generation Mobile Technology

Contents

5G

1 THE 5G FUTURE

With rising adoption of mobile networks and smart devices globally, more and more people now have the ability to access electronic information and interact with computing systems. This trend will accelerate in the future, as 5G revolutionizes how humans acquire, manage and engage with information. User experience and satisfaction will be fundamental in driving innovation and convergence of 5G devices, networks and services. Businesses and industries, in addition to the general public, will embrace 5G services, which will be carried on networks with greater intelligence, user-friendliness and versatility, combining the best characteristics of cellular and wireless local networks. Increasingly, humans will have their lives touched by 5G, which will form part of the fabric of the future world together with other successful technologies.

5G will be a fundamental pillar of the “M-ICT” era envisioned by ZTE, when ubiquitous mobility empowers innovations in all walks of life, transforming education, healthcare, industry, government, transportation, finance and technology, welding together the physical and digital worlds.

2 TECHNOLOGY VISION

Research on 5G will be focused on user experience, rather than simply increasing network capacity. A far broader range of interconnected information services and applications will be supported by 5G, as networks develop new capabilities to serve greater societal and business needs, in addition to those of individual consumers. Three themes will be central to the 5G landscape: service ubiquity, vast meshes of inter-connections, and a more energy-efficient future.

2.1 Service ubiquity

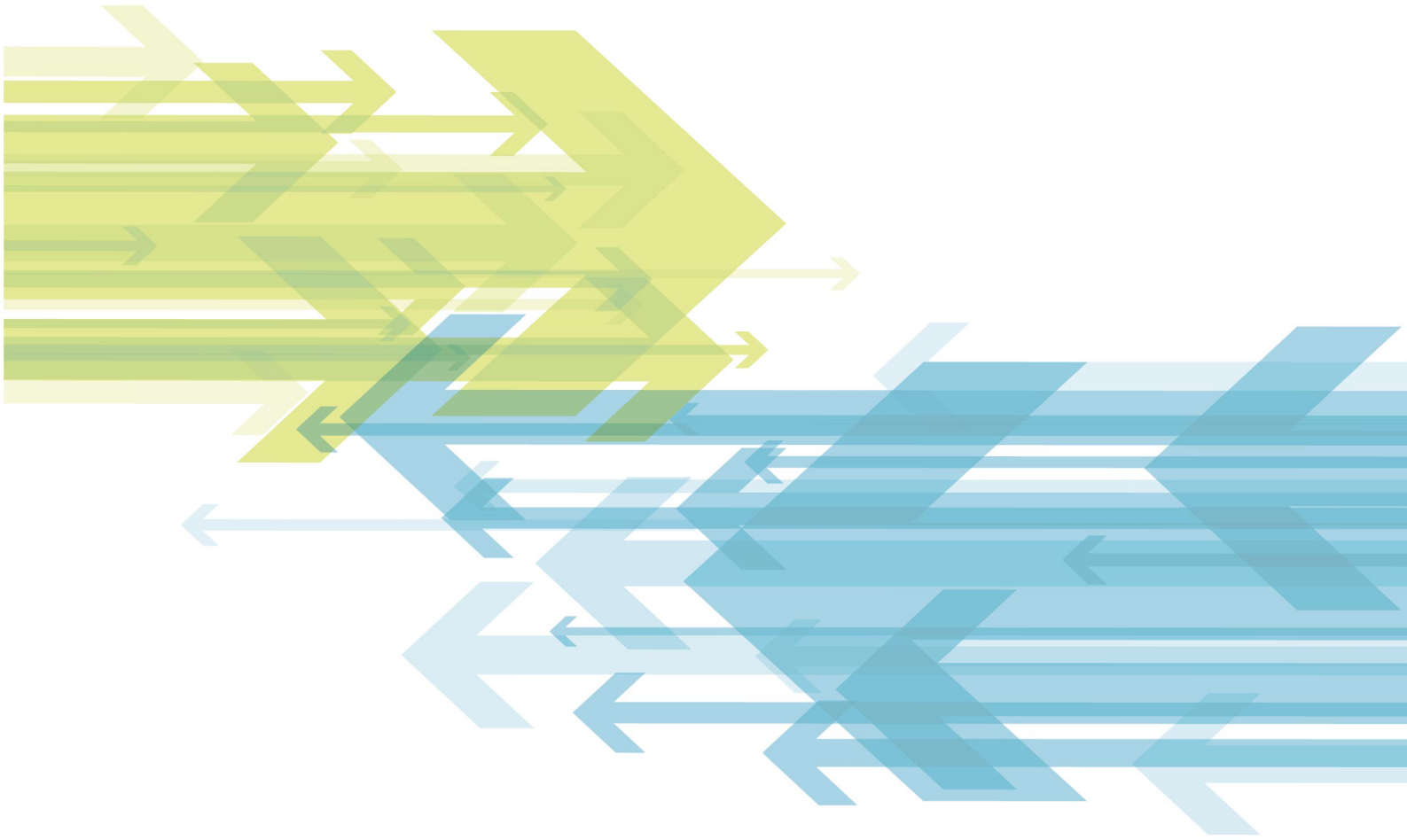
In order to deliver improved user experience, 5G researchers need to develop new user-centric service provisioning models that are informed by usage and service patterns. Acquiring deeper insights about users will enable researchers to formulate key performance indicators (KPIs) for 5G networks that will drive order-of-magnitude improvements in network capacity, bandwidth maintenance, peak data rate, latency reduction and high-accuracy indoor location monitoring. Large-scale enhancement in network performance is essential to support the age of service ubiquity promised by 5G, when users will expect consistent on-demand access to services including office applications, social networking tools, e-commerce and online financial services platforms.

2.2 Vast meshes of inter-connections

5G networks will become not only a means to connecting individual users, but will also connect people to devices as well as establish machine-to-machine connections at high data speeds. In the age of 5G, the physical world will be closely approximated by the corresponding digital sphere, engaging and interlocking with each other through rapid transfers of information. The digital mapping of the physical world will be achieved as the characteristics and functionality of different industry verticals such as retail, healthcare, education, entertainment, transportation and finance are more deeply integrated into 5G networks. As a key enabling infrastructure for everyday life, supporting vast meshes of inter-connections far exceeding networks of today, 5G must be highly robust and stable, presenting complex challenges to researchers.

2.3 A more energy-efficient future

To support the development of 5G technology, major advances in energy efficiency will be essential. The deployment of high-density network infrastructure to enable service ubiquity and vast meshes of inter-connections will entail massive power consumption at the infrastructure level. Terminal devices, which are the essential mediators of user experience, acting as the interfaces to the 5G network for humans and machines, will also need to be more power-efficient. In the future, as devices adopt new material designs and incorporate new cognitive, media and entertainment features, the need to lower power consumption will become more acute. The demands for increased energy efficiency at both the infrastructure and device levels will mandate changes in system architecture and re-optimization in design.



3 TECHNICAL FACTORS

To realize the 5G future, researchers need to address four major technical factors.

1. Massive traffic volumes
2. Transition to an intelligent cloud architecture
3. Deep Convergence of networks and services
4. Networks with configurable capabilities

3.1 Massive traffic volumes

To develop networks capable of carrying the massive volumes of traffic that will be generated by 5G applications and devices, researchers need to focus on three areas: efficiency of radio links, spectrum expansion and management, and cell site density.

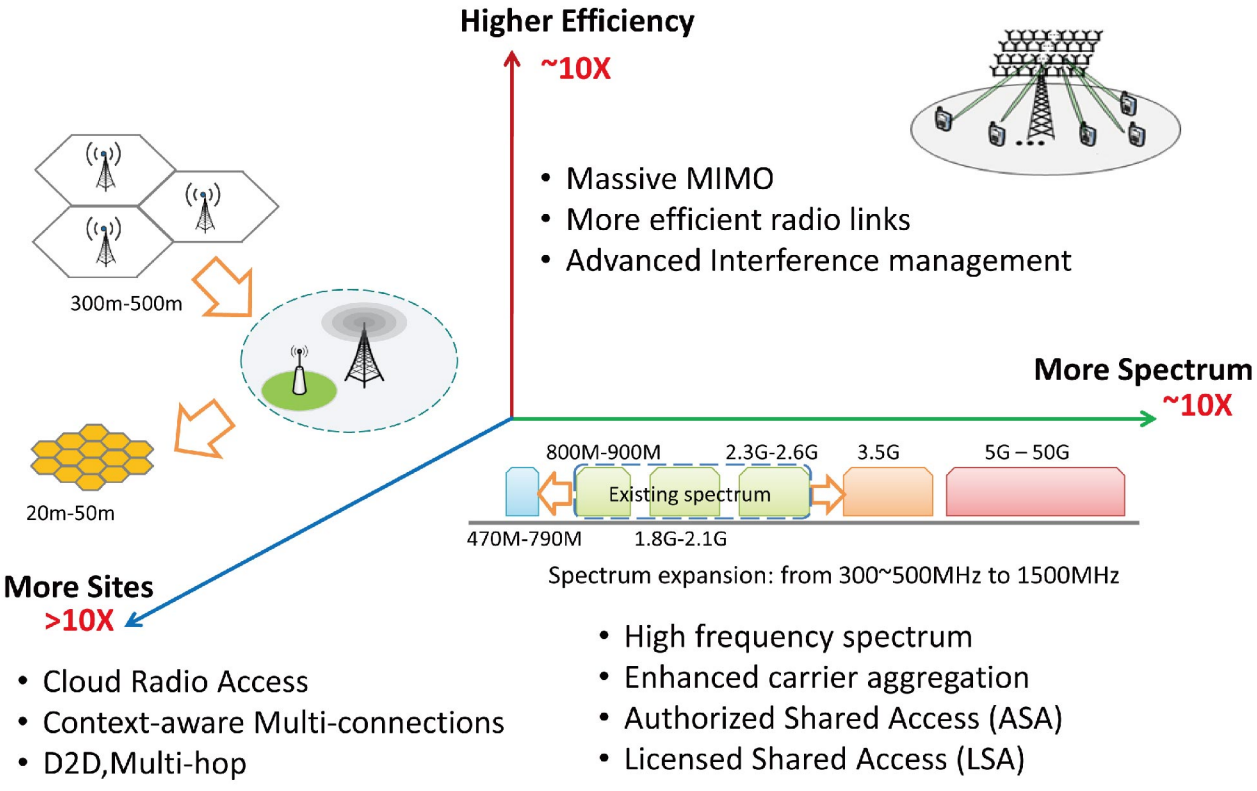


Figure 1: Breakthrough in three different dimensions

3.1.1 Efficiency of radio links

In the quest for improved efficiency on radio links, current research efforts have focused on new coding and modulation schemas, multiple access techniques, in addition to receivers.

In the field of coding and modulation, techniques including nonlinear multiple-user pre-coding, joint modulation and coding, physical network coding and advanced physical layer adaptation are being tested.

In the area of multiple access, major research efforts include NOMA (non-orthogonal multiple access) and FTN (Faster-Than-Nyquist).

Research on receivers have focused on the development of new waveforms that support MIMO (multiple-input and multiple-output), and the full duplex technique with shortened TTI (transmission time interval) radio links.

In addition, new techniques such as software-defined air interface are expected to enable multi- RAT (radio-access technologies) and multi-spectrum deployments in future. Research on improving efficiency of radio links are expected to yield significant gains in the transmission performance of wireless networks in the future.

3.1.2 Spectrum expansion and management

It is possible to deploy 5G services on a widened range of spectrum, including frequencies above 3GHz and sub-millimeter wavelengths, which are capable of supporting data rates exceeding 1 gigabits per second for indoor users of hotspots.

Consensus needs to be reached among regulatory authorities and the telecommunications industry internationally on spectrum utilization, and possible re-assignment, in order to ensure that sufficient spectrum resources are allocated to support the development of 5G.

In addition, intelligent and dynamic spectrum management technology may allow 5G to operate in a greater range of frequencies, including unassigned spectrum.

3.1.3 Cell site density

To support high-bandwidth requirements, the mobile broadband data transmission capabilities of 5G networks need to be strengthened. Through an ultra-dense network topology, with the deployment of combinations of macro cells, micro cells, pico cells and small cells, together with evolved wireless local area networks (WLAN) technologies, networks that can support ultra-large traffic volumes can be realized.

3.2 Transition to an intelligent cloud architecture

In the transition towards 5G, network architecture will more closely resemble the cloud structure, acquiring greater intelligence. By enabling seamless connections between people and human-machine interactions, 5G creates a new digital ecosystem in which any person or machine could be the originator, and consumer of information, driving accelerated growth in network traffic. The transition to a more intelligent cloud architecture will help 5G networks manage these challenges.

3.2.1 Cloud coordination of network access

5G networks will be heterogeneous, comprising of new network components as well as existing systems and assets. A cloud architecture will coordinate the disparate types of network resources, managing inter-RAT, inter-frequency and inter-site radio access and interference cancellation to deliver improved network performance at the cell edge. Cloud coordination and control enable operators to manage their existing networks and 5G in an integrated way, helping to realize savings in capital expenditure and operating expenses.

3.2.2 More horizontal architecture

5G networks will have a more horizontal architecture for improved commercial viability and agility. Technologies such as virtualization and software-defined network (SDN) can be deployed to reduce the complexity of 5G networks and optimize them horizontally. With an enhanced RAN (radio access network) function, and a simplified gateway, 5G networks will have a centralized control plane and a streamlined user plane, and the structure allows operators to focus on developing value-added services, and implement programs such as big data analytics.

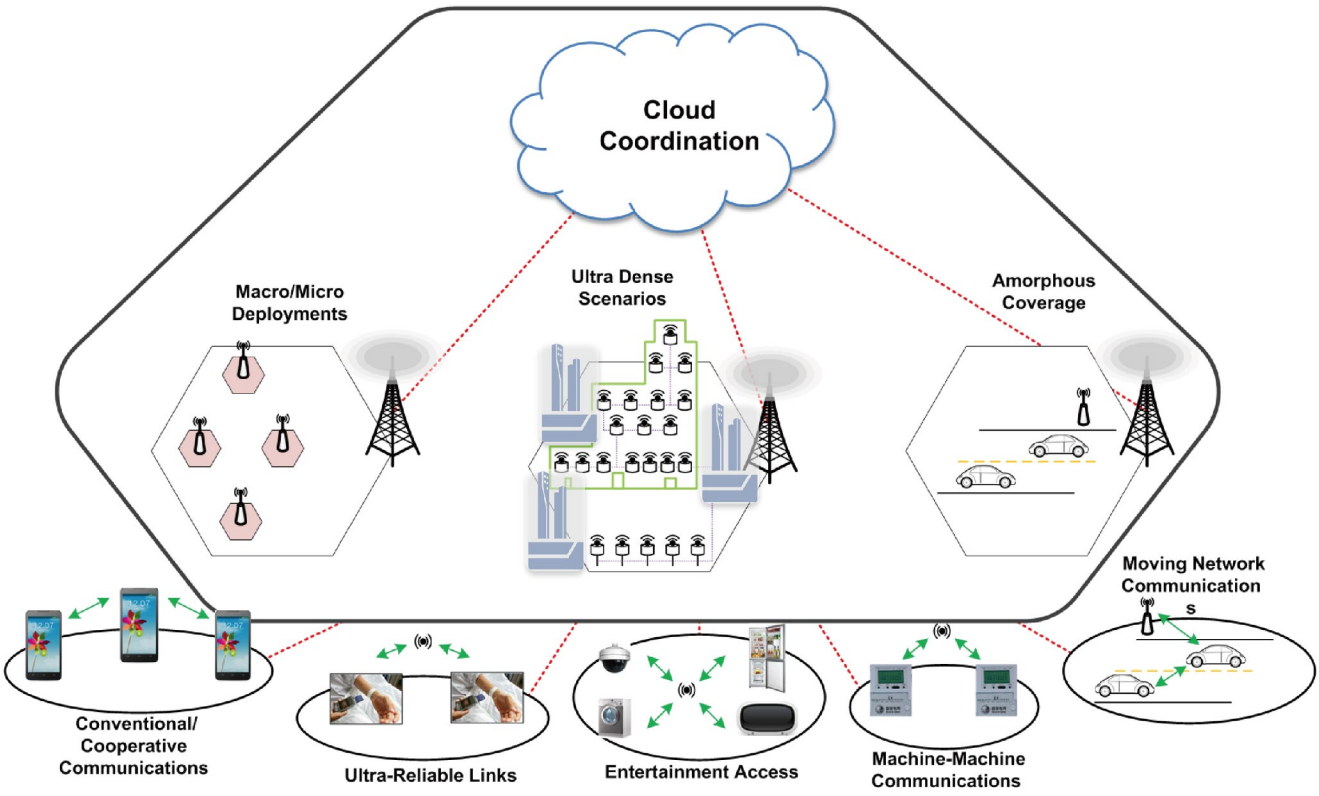


Figure 2: Cloud Based Radio Access

3.2.3 Multi-RAT convergence

5G networks need to provide a unified architecture for support of multiple radio-access technologies, including new high-speed wireless local area networks and short-range transmission. Research should be focused on multi-RAT convergence, intelligent management and universal process platforms modeled on a cloud architecture.

3.2.4 Latency reduction

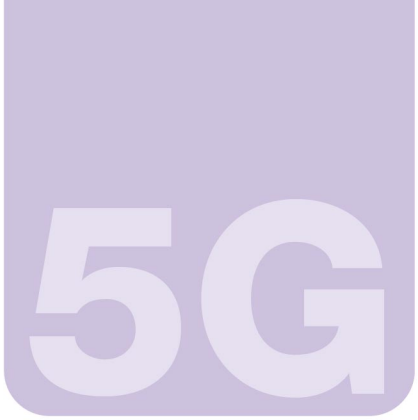
Reducing latency is one of the primary ways of improving user experience. Techniques and strategies including pre-scheduling, local gateway and local breakout, local server and local cache, shortened TTI, faster decoding and processing, and QoS (quality of service) controls can be deployed to reduce latency by cutting network delay, backhaul delay, radio access delay and terminal delay.

3.3 Deep convergence of services and networks

Multimedia content such as high-definition video are extremely popular among mobile users, but they currently place severe strains on mobile networks. In the age of 5G, such content can be delivered to users by the network itself, and not only downloadable on remote cloud servers. Technologies that drive the convergence of services and networks will greatly improve user experience, while lowering capital expenditure and operating expenses for operators.

3.4 Networks with configurable capabilities

In the age of 5G, a unified and open platform will be the basis of service provisioning for users. Capabilities of the 5G networks such as bandwidth, QoS and latency will be configurable, allowing third-party developers to create increasingly customized applications, giving users access to a wider range of services.



4 COLLABORATION

5G will act not only as a driver for the development of the information and communications industry, but will also provide impetus to deeper integration between the technology world with other industry verticals. To deliver the best user experience, the telecommunications industry needs to collaborate with other industry verticals in order to develop an in-depth understanding of how 5G can serve the needs of different sectors of the economy.

In the development of 5G, close attention should be paid to the needs of telecommunications operators in network construction, operations and maintenance. Collaboration between operators and technology providers will provide the foundation for 5G to deliver the promise of service ubiquity and superior user experience.

The formidable technology challenges presented by 5G also offer the opportunity for businesses to collaborate with academic institutions. International bodies including the International Telecommunication Union (ITU), the Next Generation Mobile Networks Alliance (NGMN), the 3rd Generation Partnership Project (3GPP) and the Institute of Electrical and Electronics Engineers (IEEE) are key forums for defining the technology standards of 5G and for the exchange of up-to-date information. In their efforts to contribute to the development of 5G, the telecommunications industry and academic institutions should leverage these important repositories of knowledge.

5 CONCLUSION

Innovation and convergence of 5G devices, networks and services will be driven by a user-centric approach, promising to deliver super broadband network capabilities and vast meshes of inter-connections to consumers and organizations, realizing the vision of service ubiquity and superior user experience. 5G will also provide impetus for improved power efficiency to be attained at the network infrastructure and device levels.

5G will be deeply integrated with Mobile Internet networks in the M-ICT era, transitioning to a cloud architecture and acquiring greater intelligence to drive convergence of networks and services, delivering a superior user experience to consumers and organizations.

6 Glossary

5G	5th Generation Mobile Communication System
M-ICT	Mobile-Information & Communication Technology
MIMO	Multi Input and Multi Output
QoS	Quality of Service
RAT	Radio Access Technology
RAN	Radio Access Network

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