Latest Trends in Communication

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Abstract: If humans are the only internet users of the future, then the total user base might conceivably double, but is unlikely to go beyond two billion active users in the near future. On the other hand, if "things" become active internet users on behalf of humans, then the number of active connections could be measured in terms of tens or hundreds of billions. The internet and other data transmission services (e.g. SMS, MMS), initially the purview of the developed world, are also gaining market share in developing economies, boosting information and communication access and increasing demand for bandwidth. With Internet of things, it is expected that there will be 300 billion things connected to network by 2025. There will be Tsunami of data to meet the demands of internet of things and other smart phone applications. INTERNET began in the late 1960s as a link between handfuls of university computer centers. In the 1970s and 1980s, the use of the Internet was dominated by e-mail and file transfer, and the number of users was counted in thousands. In the 1990s, web browsing became dominant and users were denominated in millions. The Internet as we know it today will radically change over the next decade. As of the end of 2015, there were some 3.36 billion internet users worldwide. Moreover, mobile phones, of which there were over 2 billion at the end of 2015, are being used more and more as devices for internet access. This creates new applications and services hitherto unknown, through both 2G systems and a growing subscriber base for IMT-2000 (3G) systems.
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Today, we are heading into a new era of ubiquity, where the "users" of the internet will be counted in billions and where humans may become the minority as generators and receivers of traffic Instead, most of the traffic will flow between devices and all kinds of "things", thereby creating a much wider and more complex "Internet of Things".

INTRODUCTION

The Trends in Communications can be classified into three parts:
1) Trends in Communications technologies
2) Trends in Data management
3) Trends in Operators

perspective to meet the challenges with minimum costs and manage the networks efficiently.

First we will take up the communication technologies. As we all know the communication can be People to people: This has been the trend since the civilization started as people were communicating with each other with different means of communications.
The evolution of wireless technology, from the pioneering 1G to the groundbreaking 5G, has reshaped the way we connect, communicate, and interact with the world. The need for 1G, the first generation of wireless communication, arose from the desire for mobility and instant connectivity, liberating us from the constraints of fixed landlines. As technology progressed, each subsequent generation, like 2G, 3G, and 4G, brought improved data speeds and capabilities, expanding our horizons beyond voice calls into the realms of data services and the internet. Now, we stand on the cusp of the 6G era, where innovation is set to unlock unparalleled possibilities.
6G promises not only lightning-fast data transmission but also groundbreaking applications such as human digital twins, holographic communication, and extended reality experiences that engage all our senses. It is a technological frontier where AI, millimeter-wave channels, and visible light communication converge to redefine how we connect, communicate, and even perceive the world. In this article, we delve into the past, present, and future of wireless technology, exploring its profound impact on

diverse sectors, from healthcare to agriculture, and envisioning the transformative potential of 6G.

Access Technologies

In people-to- people communication, the speech is transmitted through the network called Access Network. There have been fixed phones, which are location based and were identified by the address or place where the phone is installed. In seventies came the wireless technology that was analogue as below:

- TACS: Total Access Communication System. This was working in UK in the frequency band 890-915 MHz and 935-960 MHz
- NMT Nordic Mobile Telephone (Europe) This was developed in the frequency band of 453-457.5 MHz and 953-960 MHZ
- AMPS: Advanced Mobile Phone System 824-849 MHz and 869-894 MHz.

All these technologies being analogue, there were difficulties of capacity and quality of speech and interference issues. This was First generation of mobile system called 1st Generation.

Mobile phones were invented to address issues with immobile telephones. They offered the advantage of portability, enabling people to communicate on the go. Mobile phones enhanced accessibility by allowing users to receive calls wherever they were. They revolutionized communication by using wireless networks, eliminating the need for physical wires. The convenience of mobile phones meant you could communicate instantly without the need for a nearby landline. They proved invaluable in emergency situations, allowing for quick response and reporting. In the business world, mobile phones increased productivity by keeping professionals connected while on the move. Personal relationships were strengthened as mobile phones made long-distance communication easy. Technological advances, such as smaller components, were critical in making mobile phones compact and practical. They continue to evolve, offering a wide range of features and services beyond voice communication.

Evolution In Technologies

1. First Generation – 1G

- Origin: The result of various technological developments and contributions from many individuals and companies. Motorola was a prominent early player.
- Technology: Used analog technology.
- Purpose: Primarily designed for basic voice calls; did not support data services.
- Timeline: The 1G era began around the 1980s.
- Data Speeds: Very limited, with average data rates much lower than 14.4 kbps, typically around 2.4 kbps or lower. This was sufficient for voice calls but inadequate for internet use.
- Internet Access: 1G networks did not support internet connections as we know them today.
- Primary Design: Primarily designed for voice communication. Internet access became feasible with later generations.

2. Second Generation (2G):

- Deployment: Began to be deployed in the early 1990s and continued into the late 1990s.
- Key Feature: Introduced digital signal processing for voice encoding and transmission. This improved voice quality and allowed for more efficient use of the radio spectrum.
- Data Speeds: Typically ranged from 9.6 kbps to 64 kbps. The 14.4 kbps speed was part of the higher end of its data capabilities.
- Standard: The Global System for Mobile Communications (GSM) standard was a key development.
- Enhancements: Further improvements like 2.5G (GPRS) and 2.75G (EDGE) increased data transfer rates and allowed for limited internet access.
- SIM Cards: 2G was the first generation of mobile networks to use SIM cards (Subscriber Identity Module), which allowed users to easily switch between different mobile devices while keeping the same phone number and account.
- Multiple Access Technologies: 2G networks were mainly based on TDMA (Time Division Multiple Access) technology. CDMA (Code Division Multiple Access) was primarily associated with 2G networks in the United States and used different technologies to manage multiple users on the same frequency bands.

3. Third Generation -3G:

- Deployment: Commercially deployed before 2004, continuing to evolve and be in use well beyond 2010.

- Data Speeds: 3G networks aimed to provide data speeds of around 384 kbps to 2 Mbps, with later revisions offering even higher speeds.
- Key Innovation: Introduced video calling services, allowing users to make video calls using mobile devices.
- Technology Basis: Primarily based on WCDMA (Wideband Code Division Multiple Access) and CDMA2000 (1xRTT and EV-DO) standards, not EDGE (which was a 2G technology).
- Network Architecture: 3G networks primarily used packet switching for both the air interface and the core network, supporting efficient data transmission and services like internet Browse and email.
- Challenges: Despite significant improvements, 3G had limitations including higher power consumption compared to 2G, and challenges with network coverage, especially in rural areas. The cost of spectrum for 3G licenses also varied widely by country.

4. Fourth Generation (4G):

- Deployment: Development and deployment occurred throughout the mid-2000s and continued well beyond 2010.
- Data Speeds: Aimed to provide data speeds ranging from 100 Mbps to 1 Gbps, significantly higher than 3G.
- Technology Basis: Primarily LTE (Long-Term Evolution) and WiMAX. These technologies provided high-speed data connections and efficient use of the wireless spectrum.
- Network Architecture: 4G networks were designed to offer a seamless combination of various access technologies, including broadband, Local Area Network (LAN), Metropolitan Area Network (MAN), and Wide Area Network (WAN).
- IP-Based Architecture: 4G networks adopted an all-IP (Internet Protocol) architecture, making them better suited for a wide range of data services and internet access.
- Services Supported: Enabled a wide range of services, including high-speed internet access, video streaming, and support for various connected devices.
- IoT and Wearables: Wearables and IoT (Internet of Things) devices became more prevalent with 4G.
- MIMO Technology: Multi-Input Multi-Output (MIMO) technology was a key component, using multiple antennas on both the transmitting and receiving ends to improve data throughput and network performance.

5. Fifth Generation – 5G:

- Development & Adoption: Started in countries like the United States, South Korea, and China.
- Data Speeds: Offers significantly higher data speeds than 4G, ranging from 1 Gbps to 10 Gbps, depending on specific network deployment and frequency bands.
- Core Technologies: Based on new and advanced radio technologies, including:
  mm Wave (millimeter-wave) spectrum: For high bandwidth.
- Massive MIMO: Advanced signal processing techniques using many antennas.
- OFDM (Orthogonal Frequency Division Multiplexing): For efficient data transmission.
- MC-CDMA (Multi-Carrier Code Division Multiple Access): In some implementations, to enhance data transmission reliability.
- Network Infrastructure: IPv6 is an integral part of the 5G network infrastructure, crucial for accommodating the rapidly increasing number of connected devices.

Connectivity Types

1. Intelligent Connectivity:

The Future of AI in Communication Networks. The integration of Artificial Intelligence (AI) in communication networks, termed "Intelligent Connectivity," is poised to revolutionize the field. AI has already significantly advanced 5G capabilities, transforming network dynamics from rigid hardware-based systems to flexible, software-defined architectures. This shift has improved network efficiency and performance. Looking ahead, the development of 6G networks will further leverage AI, aiming for massive, heterogeneous, and diverse communication environments. "Intelligent Connectivity" in the 6G era is characterized by:

- Intellectualization of Connecting Units: Enhancing the intelligence of terminal devices and network architecture.
- Need for Intelligent Management: Effectively managing the increasingly massive and complex 6G network.

Overall, AI is deemed crucial for the continued growth and evolution of communication technology, particularly as we transition towards 6G.

2. Deep Connectivity:

This concept emphasizes optimizing coverage for both indoor and outdoor cellular systems by integrating various access technologies (5G, IoT, Everything) and utilizing base stations (BS) or wireless nodes. It aims for a human-centric, collaborative communication paradigm, driving expansion in IoT and the "Internet of Everything" (IoE). Key requirements include expanded activity space, deeper perceptual interaction, data mining, and deep access.

3. Holographic Connectivity:

A major 5G requirement, this involves high-throughput applications to transform AR/VR experiences. It enables mobile wireless AR/VR, potentially evolving into multimedia, holographic interaction, and high-fidelity AR/VR-based communication. The goal is to achieve full holographic interactivity.

4. Ubiquitous Connectivity:

Beyond "anytime, anywhere" connectivity, this envisions widespread network access for people and devices in IoT, expanding the scope of space and information exchange. It necessitates technologies like high-range communication, intelligent remote-control equipment, autonomous robots, and human activity space exploration. This feature is crucial for addressing the increasing demand for network access in 2030-2040 and will be a defining characteristic of 6G, with a focus on "intelligent connectivity" in a real sense.

In essence, these concepts highlight the evolving demands for more pervasive, intelligent, and immersive communication experiences, shaping the trajectory of 6G and beyond.

Potential Application

Potential Application and future scope of some latest trends in communication like 6G technology and IOT as follows:

1. Human Digital Twin :

The fusion of bioscience, materials science, and bio-electronic medicine, coupled with 6G technology, has the power to reshape healthcare profoundly. It enables the creation of digital replicas of the human body These digital twins integrate data from MRI, CT scans, ultrasound, and biochemical tests, providing a holistic view of an individual's well-being. This isn't limited to detecting diseases; it offers a detailed overview of one's overall health.

2. Holographic Communication:

People might communicate in a more lifelike manner through holographic avatars, making remote interactions more personal. A Holographic Society in 6G could revolutionize healthcare and remote work. Doctors could examine patients remotely with more precision using holographic medical imaging, and remote workers might have holographic office setups for more realistic collaboration. Holography could be integrated into education and training. Imagine students dissecting holographic frogs in biology class or mechanics repairing holographic engines for training purposes.

3. Extended Reality:

Extended Reality (XR) is a term that encompasses various technologies that merge the physical and virtual worlds. It is an umbrella term that includes Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR). is expected to undergo significant advancements, especially when based on holographic communication. While 5G largely focuses on visual and auditory immersion, 6G, with the support of holographic communication, aims to mobilize all human senses. This means not only sight and hearing but also touch, smell, taste, and even emotions can be simulated .

4. Visible Light Communication (VLC):

Visible Light Communication (VLC) is a promising technology for 6G networks, with established practical applications in areas like indoor localization and Vehicle-AdHoc Networks (VANET).

Its key advantages include:

- High Bandwidth: Allows for better tolerance to interference compared to Radio Frequency (RF) communication.
- Suitability for Crowded Environments: Ideal for challenging signal environments where 6G networks are expected to operate.

Despite its benefits, VLC is susceptible to security threats such as eavesdropping, Denial of Service (DoS) attacks, jamming, and node compromise. Therefore, robust security measures will be crucial to protect VLC communications within 6G networks.

CONCLUSION

Latest trends in communication paint a picture of a future where networks are not just faster, but also smarter, more pervasive, and more intuitive. The convergence of AI, advanced connectivity paradigms, and a renewed focus on human needs and security will collectively shape a dynamic and exciting era of communication, offering unprecedented opportunities for innovation and connection while demanding careful consideration of ethical and societal implications.

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