FEATURES IN EVOLUTION OF MOBILE CELLULAR SYSTEMS
Design of Access, Metro and Core Networks

Wireless Networks are broadly divided into 2 categories, Wireless-LAN and Cellular System. While Wireless-LAN is mostly restricted to smaller areas, Cellular Systems cover larger areas and provide access to much large user base. Cellular Networks have come a long since they were first launched in 1979, from being used to voice communication to providing host of services like video streaming, gaming, video conferencing etc.

The 1st Cellular Network was launched in Japan in 1979 by Nippon Telegraph & Telephone. This was based on analog signals and provided basic voice call services. This mobile network had various issues like poor voice quality and call drops. Moreover, due to its analog nature, calls were not encrypted, and anyone could tap into the call using simple radio receiver. During 1980's, this kind of network was deployed all over America and Europe.

During the 1990's, seconds generation of cellular networks (2G) emerged. 2G uses digital signals instead of analog and was a revolution in cellular systems. Digital signals provided various features and enhancement like encryption, international roaming, noise tolerance, flexible frequency bands and enhanced voice clarity. There were 2 major 2G technologies, GSM and CDMA. GSM became the most widely used cellular network providing 90% coverage world-wide. 2G networks introduced a host of features along with enhancement in voice quality. A new form of communication, SMS – Short Message Service was added to these networks. It also provided Data and MMS – Multimedia Messaging Service along with voice communication with speed up to 30-35 kbps. Later GSM was enhanced and GPRS – General Packet Radio Service (2.5G) was introduced with data speed of 110 kbps. It was an always-on data service and the users did not need to use dial-up to access data. In 2003, another update introduced EDGE – Enhanced Data rates for GSM Evolution (2.75G) with speed up to 300 kbps.

In the early 2000's, the next generation of cellular networks was launched – 3G. With growing demand of data traffic caused by various multimedia and web services, 3G was focused on enhanced data rates. Due to enhanced data rates, 3G networks supported real time video calling. This was the first mobile broadband network and used packet switching for data transmission. UMTS – Universal Mobile Telecommunications System was the first 3G variant and was based in Wideband CDMA and provided speed up to 384 kbps. There were 2 enhancements to 3G networks, HSPA and HSPA+ providing download speed of 14.4 Mbps and 42 Mbps respectively.

In late 2000's, fourth generation mobile network was introduced and termed as 4G/LTE – Long Term Evolution. 4G is different from 2G and 3G as it did not have any circuit switched core network component. It supported download speed up to 100 Mbps. Earlier 4G users have to fallback to 2G or 3G for voice communication. Later, VoLTE – Voice over LTE was

introduced to make phone calls over IP network. An enhancement of LTE, LTE-Advanced was introduced that offers download speed up to 1 Gbps. This was true 4G network according to ITU requirements.

The next generation network, i.e. 5G is development phase and has been deployed in some areas under phase 1 deployment where 5G gNodeBs are attached to 4G core networks. 5G is fueled by IoT Applications and M2M connections which require ultra-low latency for real time connectivity. According to IMT-2020 requirements, 5G networks should offer peak download speed up to 20 Gbps.

Generation	Network	Download Speed	Remarks
1G	AMPS, NMT	-	Analog Voice only
2G	GSM	35 Kbps	Digital Signals, SMS, MMS, Data
	GPRS	110 Kbps	
	EDGE	300 Kbps	
3G	UMTS	384 Kbps	Multimedia Streaming, Video Calls
	HSPA	14.4 Mbps	
	HSPA+	42 Mbps	
4G	LTE	100 Mbps	Packet Switched, 2G/3G Fallback or VoLTE
	LTE-A	1 Gbps	
5G	5G NR	20 Gbps	IoT, Ultra Low Latency

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