



PERSONALITY TEST PROGRAMME 2019 (Current Affairs Interview Issues)

5G

Introduction

India's new National Digital Communications Policy (NDCP) presents a positive vision for the industry and country, with the **goal of creating the digital infrastructure that supports the next generation of digital services** and allows India to realise the true potential of the digital economy. Mobile has already played a central role in realising the ambitions of the Digital India initiative, and will also be central to realising the NDCP's goals to 'Connect India', 'Propel India' and 'Secure India'. In this context, **5G is envisaged to be the key catalyst that would fuel this growth**

Growth of Wireless Networks in India

- The **first mobile phone service** was launched in 1985 on a non-commercial basis, but it was only in 1995 that commercial service was started. Beginning 2007, the subscriber base rapidly increased reaching 560 million in 2009 and well over **a billion by 2017**.
- **Early deployment of mobile networks was based on 2G technology**, with **3G technology** entering service in 2010 and **4G in 2016**. All mobile services from 2G to 4G offered services based on increasingly advanced phones, with smart phones arriving about a decade ago.
- 2G and the early 3G networks primarily offered voice services, but beginning with **later 3G and now 4G technologies**, **the networks provide internet-based services like video, email, and social media**.

Definitions and Concepts:

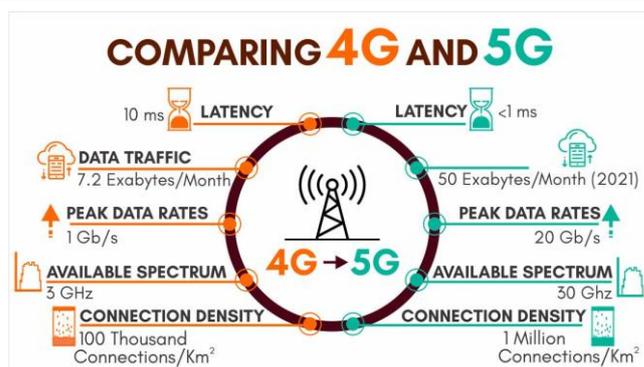
- **Bandwidth** commonly measured in bits/second is the maximum rate that information can be transferred
- **Throughput** is the actual rate that information is transferred
- **Latency** the delay between the sender and the receiver decoding it, this is mainly a function of the signals travel time, and processing time at any nodes the information traverses.
- **Use Case:** A use case is a software and system engineering term that describes how a user uses a system to accomplish a particular goal.
- A **test bed** is a platform for conducting rigorous, transparent, and replicable testing of scientific theories, computational tools, and new technologies.

How 5G reduces latency? Because communicating with a centralized computing and data repository takes time, the only way to save time (i.e. decrease latency) is to avoid using that centralized repository-which means moving big chunks of network's computing power to the edge of the network. The result is something called "**edge computing**," with architectures referred to as "edge cloud computing," which, in turn, uses things called "cloudlets" or sometimes called "fog computing." A key driver is mobile computing, which necessarily uses data at the edge.

- The **edge of the network is the part that's closer to the ultimate user**. By moving the data to the edge of the network, delays are cut down in two ways: First it reduces the distance between the user of the data and the place where it's stored (the repository), which reduces the time it takes data to move back and forth. Second, by keeping just the required data near the user, it is also reducing the amount of data that the server has to handle, which also speeds things up.

5G – The Next Generation Network

- 5G is a next generation mobile networks technology after 4G LTE networks using radio waves or radio frequency (RF) energy to transmit and receive data.
- It will provide **seamless coverage, high data rate, low latency, and highly reliable communications**.
- 5G technologies are entering into **services gradually, beginning in 2019** and is expected to be a full range of services by 2024.
- The final standard for 5G will be set up by the **International Telecommunications Union (ITU)**.



- 5G networks will use radio technology known as 5G NR (New Radio).
 - This allocates chunks of radio bands, some below 6GHz, and others above 24GHz (also known as mmWave).
 - In contrast, 4G LTE frequencies are much lower (Band 5 is around the 800MHz mark while Band 40 is around the 2300Mhz mark).
- 5G being the next generation of mobile networking standards, promises to deliver improved end user experience by offering new applications and services.
- It will increase energy efficiency, spectrum efficiency, network efficiency as well as efficiency of other systems.
- **Applications and Benefits of 5G:** 5G use cases can be categorized into three different use case classes namely enhanced Mobile Broadband (eMBB), massive Machine-Type Communication (mMTC), and Ultra-Reliable Low-Latency Communications (UR-LLC).

Table 2: Envisage use case mapped with key 5G characteristics

Enhanced Mobile Broadband (eMBB)	Ultra-Reliable and Low-Latency Communications (uRLLC)	Massive Machine Type Communications (mMTC)
Fixed Wireless Access service	Autonomous vehicles	Asset tracking and predictive maintenance
Enhanced in-building broadband service	Drones and robotic applications	Smart cities, buildings, and agriculture
Real-time augmented reality service	Health monitoring system / tele-health	Internet of Energy/Utility management
Real-time virtual and mixed reality service	Smart grid and metering	Industrial automation
Crowded or dense area service	Intelligent transportation	Smart logistics - advance telematics
Enhance digital signage	Factory automation	Smart grid and metering
High definition cloud gaming	Remote operation	Smart consumer wearables
Public Protection and Disaster Response (PPDR) Service	Self-driving car	Environment management
Massive Content Streaming service	Mission critical services - security & safety	Intelligent surveillance and video analytics
Remote surgery and examination	High definition real time gaming	Smart retail

Is India 5G Ready?

A. Prospects of 5G in India:

- According to GSMA intelligence (GSMAi), **208 million new subscribers will get connected in India by 2025**, accounting for a quarter of global and half of regional [Asia-Pacific (APAC)] new subscribers over 2017-2025 period.
- According to 5G HLF (High Level Forum), 5G is expected to be launched in India by 2020 and is predicted to create a **cumulative economic impact of \$1 trillion in India by 2035**.
 - Moreover, it will **unleash new business opportunities and bring substantial socioeconomic benefits** through increase in productivity, improvements in service delivery, optimum use of scarce resources as well as creation of new jobs.

B. Technology Enablers and Challenges:

- **Spectrum:** 5G needs a significant amount of new harmonised mobile spectrum within three key frequency ranges to deliver widespread coverage and support all use cases: sub-1 GHz, 1-6 GHz and above 6 GHz.
 - Currently, every country has differing spectrum allocations for 5G. Regulators in Europe and China aim to deploy commercial 5G networks in the 26GHz range by 2020 while South Korea has carried out a successful pre-commercial 5G trial using the range 26.5GHz to 29.5GHz. A **globally harmonised spectrum** would enable economies of scale and facilitate cross-border coordination and roaming for end users: a critical factor for the initial deployment of 5G.
 - **India's Position:** In India, spectrum is usually allocated by auction. **TRAI has proposed sale of 20 MHz blocks of 5G spectrum in the 3,300-3,600 MHz (3.3-3.6 GHz) band at a price of Rs 492 crore per MHz which is 375% higher than what operators in South Korea paid.**
 - ✓ **Challenge: Pricing will be a key consideration in the success of these auctions**, especially given the high debt levels, low Average Revenue Per User (ARPU) levels and poor profitability of the industry.
 - ✓ Also DoT has accepted ISRO's demand to reserve 26 GHz band primarily for satellite services which will make deployment of 5G challenging.

Spectrum is the lifeline for any wireless communication. **Low frequencies (less than 1 GHz)** provide wide area and deep indoor coverage across urban, suburban and rural areas and support IoT for low data rate applications. **Medium frequencies (1-6 GHz)** provide good coverage and high speeds.

High frequencies (above 6 GHz) offer real promise for the provision of very high data rates and high system capacity in dense deployments.

Technically, **spectrum is technology neutral** i.e. any spectrum band can be used for deploying any technology. However, while deciding the deployment of a technology, apart from the technical factors, development of eco-system plays a significant role.

- **Infrastructure Support for 5G:** The switch from 4G to 5G will be infrastructure intensive, which means mobile service providers will have to upgrade their underlying hardware countrywide in order to provide 5G speeds.
 - **Backhaul Infrastructure:** Backhaul is a network that connects **cells sites to central exchange**. The high throughput offered by 5G will result in high traffic on cellular networks which will need to be backhauled from mobile sites to an operator's core network (Central Exchange). This will lead to the **roll-out of fibre to most mobile sites** although there is also option to connect wirelessly through **millimeter wave spectrum** (70-80 GHz).

A **Cell Site** refers to the antenna equipment and ground equipment that is used to transmit cell phone signals to and from the mobile phone back to the receiver.

 - ✓ **Challenge: India lacks a strong backhaul to transition to 5G.** Nearly 75% of cell sites are connected through **microwave backhaul, while under 25% sites are connected through fibre**. The former has bandwidth issues as it uses traditional bands while the latter provides low latency and unlimited capacity (a prerequisite for 5G).

The backhaul infrastructure and technology for 5G will need to be strengthened in following manner

- **Higher capacity density:** For 5g, the mobile networks would need to be densified using **small cells**. The compact size and low power (consumption and radiated) make small cells suitable for street level, lamp pole and indoor deployment.

Small cells would help **deliver targeted cellular coverage and capacity**, indoors and outdoors. This will **also enable content and cloud services** to be delivered close to the user.

 - ✓ **Challenge:** Densification adds complexity to the network because it increases the number of cell borders, where interference and **handoffs (process of transferring an active call or data session from one base station (cellular tower) to another while roaming)** introduce the possibility of dropped connections. In a 5G world, networks will need to depend on intelligent, automatic spectrum allocation to maintain quality as well as speed. Wireline infrastructure will also require upgrades to provide adequate network.
- **Service and network virtualization:** Network virtualization is the process of consolidating hardware and software resources into a software-based, virtual network. Network virtualization is becoming increasingly important as mobile network operators (MNOs) seek to effectively manage their spectrum while maintaining their costs.
 - ✓ In the network core, 5G virtualization will use **network slicing** to support multiple virtual networks over one physical network infrastructure. **Network slicing** permits the logical separation of a network so that each slice provides unique connectivity-but all slices run on the same shared infrastructure. In this way, **5G virtualization** provides a new level of flexibility, allowing operators to-for example-devote a network slice to certain kinds of devices.

C. Financial Enablers and Challenges

- **Capital Investment Challenges:** With 5G spectrum and network densification needs, it is anticipated that industry might require an **additional investment of \$60-\$70 billion to seamlessly implement 5G networks**. In midst of **rising debt levels** and **market consolidation** activity, the telcos are seen to be constrained on capital expenditure.
- **Poor Financial Health of the Telecom Industry:** Despite being home to over one billion mobile subscribers, the Average Revenue Per User (ARPU) for telecom service providers has reduced from Rs 123 in 2015 to just Rs 69 by the end of the second quarter of 2018. The industry had a cumulative debt of Rs. 7.7 trillion in 2018.
- **High Tax burden:** Close to 30% of Telephone company's revenue goes to the Government in taxes and levies.
 - The **Import duty for equipment** such as base stations, optical transport gear, 4G LTE products, gateway controllers, carrier Ethernet switches etc., has further been increased to 20% in 2018.
 - **The DoT has sought a reduction in the goods and services tax (GST)** on telecom gear and services from 18% to 12%, a refund of utilised and/accumulated GST input tax credits and a cut in the Universal Services Obligation (USO) levy to 3% from current 5% level.

D. Electronic Equipment Manufacturing: Imports account for a whopping 90% of India's telecom equipment market. India's exports of telecom instruments in 2017-18 were worth USD 1,201.7 million, against imports of 21,847.92 million.

- The Telecom Regulatory Authority of India (TRAI) has recommended measures to **bring imports to 'net zero' by 2022, for both economic and security reasons**. However, it is widely acknowledged that equipment manufacturing holds a small share in the overall telecom business.

- E. **Right of Way (RoW) and lack of uniform policy framework:** Delays due to complex procedures across states, non-uniformity of levies along with administrative approvals impact telecom service providers in rolling-out Optical Fibre Cables (OFC) and telecom towers.
- F. **5G Market Readiness:** Though operators recognise the potential for 5G to transform aspects of the consumer and enterprise experience, they also have concerns around identifying specific business models and how much scope there is to monetise the new services that 5G will enable.
 - **India's scenario:** Various indicators suggest the **mobile ecosystem still needs to develop further** for India to be truly ready for 5G launches. These include the **relatively low levels of 4G adoption** across the Indian market as a whole, and **low network download speeds**. However, 4G adoption is accelerating rapidly and by 2025 will exceed averages globally and for developing markets. This highlights the importance of operators continuing to invest in the latest LTE network technologies, including network densification and additional fibre deployments, as building blocks for 5G.

Issues arising out of 5G technology adoption: The rise of new business architecture evolving through 5G networks are likely to present **new challenges to security and privacy protection**. As industries are expected to thrive on 5G and cloud-based ecosystem, it is expected to lead to promoting **huge number of interconnected devices**.

- **Digital Divide:** Because it requires density, **5G is feasible mainly for more populated areas**, where many antennas can be placed close together. This brings challenge of widening of the **digital divide by geography**. Rural areas where user density would be relatively low as compared to urban areas could be left out.
- **Ethical Concerns:** 5G has the power to change the world, and with that come massive responsibilities. **Two questions naturally arise:**
 - **How can we ensure 5G is benefiting the entire world?** If 5G is seen solely as a way to generate revenue, rather than a way to solve problems, then only a few will effectively benefit from the breakthrough technology. Applications such as **AI and Robotics could be used by few ahead in technology to leap forward their own dominance over the rest** who are lacking in such technology. Moreover, the adoption of **AI itself may have inherent biasness** with respect to gender, race, ethnicity etc. and fuel further discrimination.
 - **How can people's data be secure?** As 5G networks allow for a holistic connected life, consumers will expect their data to be protected at all costs. This is **especially true for India as India lacks a strong data protection policy and law**.
- **Cyber threat:** In 5G, the network has moved away from centralized, hardware-based switching to distributed, software-defined digital routing. Previous networks were hub-and-spoke designs in which everything came to hardware choke points where cyber hygiene could be practiced. In the 5G software defined network, however, that activity is pushed outward to a web of digital routers throughout the network, thus denying the potential for chokepoint inspection and control.
 - **India's critical infrastructures such as atomic power stations, power grid and government services etc. are very much prone to these threats.** It was manifested in **recent cyber attacks** on Kudankulam Nuclear Power Project as well as on ISRO.
- **National Security Challenge:** To adopt the 5G, **Indigenous manufacturing, on its own, is not a solution**. The entire manufacturing process is based on global supply chains and hence will affect not only national security, but foreign policy and its technological future. **The present case of Huawei manifests this challenge.**

Huawei case: Technologies such as 5G, AI, machine learning, autonomous systems, quantum computing etc. are rapidly emerging as the new **Technological Cold War** between US and China which has spread across the Globe now. The Chinese telecommunications company Huawei is under scrutiny around the globe. The **main reasons are**

- **Security Concerns:** It was found by an engineer who had earlier worked in PLA and is also a member of the Communist Party of China. It is claimed that Huawei has received state support at crucial points in its development.
- There is a **perceived security risk posed by Huawei** to countries it is operating in. Its is being alleged that its equipment are snooping into data and supply these to China. **For example, Vodafone had identified hidden backdoors** in the software that could have given Huawei unauthorised access to the carrier's fixed-line network in Italy.
- **Economic interests:** It is the **world's largest telecommunications equipment manufacturer**.
 - Huawei is widely acknowledged for reliable equipment, engaging customer service and lower pricing models. It's the lowest-cost provider (about 30% cheaper than Ericsson and Nokia) and the only provider of end-to-end solutions for national telecoms.
- **Stealing trade secrets:** US allege that Huawei Technologies Co., stole trade secrets from US business partners, including technology used by T-Mobile US Inc. to test smartphones.

5G technology in India: Steps taken

- **A 5G High Level Forum was set up by the Government in September 2017** to articulate the Vision for 5G in India and to recommend policy initiatives and action plans to realize this vision.
- The Government has **launched a program titled 'Building an End-to-End 5G Test Bed'**. The programme envisages close collaboration between the universities and startups and create an ecosystem that closely resembles a real-world 5G deployment.
 - Ericsson has installed the first public access 5G test bed at IIT Delhi in July 2018.
- **Several smaller academic R&D programs around 5G themes** have also been funded by DST and MEITY.
- In October 2019, Swedish telecom company Ericsson and American telecom equipment maker Qualcomm, collaborated to **demonstrate the first 5G video** call in the country at the India Mobile Congress (IMC) in Delhi.
- The **National Digital Communication Policy-2018** (NDCP-2018) also lays out the following objectives with respect to 5G services in India:
 - Enabling **Hi-speed internet, Internet of Things and M2M (Machine to machine)** by rollout of 5G technologies:
 - Implementing an **action plan for rollout of 5G applications** and services
 - **Enhancing the backhaul capacity** to support the development of next generation networks like 5G
 - Ensuring **availability of spectrum for 5G** in 6 GHz bands
 - **Reviewing industry practices with respect to traffic prioritization** to provide 5G enabled applications and services
 - Developing **framework for accelerated deployment of M2M services** while safeguarding security and interception for M2M devices

Way Forward

The **three priorities for India in 5G** are: **Deployment** – rolling out early, efficient and pervasive 5G networks to maximize the value offered by this new technology; **Technology** – building India's industrial and R&D capacity in the design and IP dimensions of 5G; and **Manufacturing** - expanding the manufacturing base in 5G for both semiconductor fabrication as well as assembly & test plants. In this regard, **the High-Level Forum on 5G made following recommendations-**

- **Spectrum Policy:** 5G spectrum be allocated as follows in three phases based on readiness of the various bands
 - For **wireless access**, licensed spectrum with an aggregate of 405 MHz + 137 MHz below 4 GHz and 5.25 GHz + 8.3 GHz below 45 GHz.
 - For **backhaul**, 14 GHz of unlicensed and 10 GHz of lightly licensed spectrum in the 57 to 86 GHz band.
 - For **WiFi**, opening additional bands of unlicensed spectrum in the 5 GHz band for outdoor use.
- **Regulatory Policy:** **Three expert committees on business, security and safety segments** be created to develop clear guidelines on regulatory policy that can be promulgated by the Government.
- **Education and Awareness Promotion Program:** The Committee recommends three initiatives - **Attract global 5G conference events to India, set up national 5G events and create a comprehensive skills** development program.
- **Participation in International Standards:** Telecom networks need standards to ensure interoperability and to avoid market fragmentation. Getting active in **global standards development eco-system** will open up a new realm of opportunities for India.
 - The Committee recommends **short term initiatives** like setting up '**Standards Project Teams**' to participate in standards activities. **For the longer term**, the Committee recommends a ten- year strategy for Information Technology Standards in India.
- **Technology Demonstration and Major Trials:** 5G trials will be an important learning opportunity for our Telecom Service Providers (TSP), academia and industry. The Committee recommends that the major global **Original Equipment Manufacturers be invited to conduct major 5G trials in India** in collaboration with local partners.
- **Implementation and Oversight:** Create a **5G Implementation Oversight Committee with participation from Government, Academia, Industry and R&D Labs** to supervise 5G program implementation and take corrective steps where necessary.
 - Create a **5G Program Office** within DoT, with a Program Lead and a supporting team **to coordinate all 5G implementation issues** among the three departments DoT, MeitY, DST.
- **Core Technology and Manufacturing:** Building India's capacity in core technology development (Design and IP) and manufacturing for 5G and more broadly for all Information Technologies needs a deep and long- term effort. However, the enabling measures of the report related to deployment are envisaged to trigger R&D and manufacturing aspects of 5G ecosystem as well considering India's market and innovation potential.



Conclusion

5G technology has the potential for ushering a major societal transformation in India by enabling a rapid expansion of the role of information technology across manufacturing, educational, healthcare, agricultural, financial and social sectors. India must embrace this opportunity by deploying 5G networks early, efficiently, and pervasively, as well as emerge as a significant innovator and technology supplier at the global level. Emphasis should be placed on 5G touching the lives of rural and weaker economic segments so as to make it a truly inclusive technology.

VISION IAS

Summary

- 5G is a 5th generation wireless communication technology using **radio waves** or radio frequency (RF) energy to transmit and receive data.
- Applications: **Driven by faster data rates** for access to multi-media content, services and data and low latency 5G technology is likely to bring to fruition a number of technologies, such as augmented reality, IoT and self-driving cars.

Is India 5G Ready?

- 5G in India has lot of prospects in terms of number of subscribers increasing, economic benefit and opening avenues for new businesses.
- But at the same, India needs to overcome the hurdles which are required for adoption of 5G in India like
 - India needs **expanded spectrum for 5G** network in which pricing will be key.
 - **India lacks a strong backhaul infrastructure to transition to 5G.**
 - It is anticipated that industry might require an **additional investment of USD 60 to 70 billion** to seamlessly implement 5G networks. In midst of **rising debt levels** and **market consolidation** activity, the telcos are seen to be constrained on capital expenditure.
 - India needs to **lowers its import of telecom instruments** and focus on electronic equipment manufacturing within India.

Issues arising out of 5G technology adoption

- As industries are expected to thrive on 5G and cloud-based ecosystem, it is expected to lead to promoting **huge number of interconnected devices**.
- This has its own consequences which includes **privacy concerns, national security issues as well as the ethical dilemma of technological divide and technological war**.
- Building a **new trust model secured with business continuity** will be one of the key essential drivers for enabling connected industries.

Steps taken

- **5G High Level Forum was set up in 2017** to articulate the **Vision for 5G** in India and to recommend policy initiatives and action plans to realize this vision.
- The Government has **launched a program titled 'Building an End-to-End 5G Test Bed'** envisaging close collaboration between the universities and startups and create an ecosystem that closely resembles a real-world 5G deployment.
- **Funding** to several smaller academic R&D programs around 5G themes by DST and MEITY.
- **National Digital Communication Policy-2018** which aims at enabling **hi-speed internet, Internet of Things and M2M (Machine to machine)** by rollout of 5G technologies:

Way forward

- Key priorities are
 - **Deployment** of early, efficient and pervasive 5G networks
 - **Technology** – building India's industrial and R&D capacity in the design and IP dimensions of 5G; and
 - **Manufacturing** - expanding the manufacturing base in 5G
- **Recommendations of the High-Level Forum on 5G:**
 - **Spectrum Policy** based on the recommendations of **international regulatory and standards bodies, availability of spectrum in the country**, co-existence with other domestic services and the need to align India with the global market place.
 - **Regulatory Policy:** Create **three expert committees on business, security and safety segments**.
 - Attract **global 5G conference events** to India, set up **national 5G events** and create a **comprehensive skill**.
 - Setting up of **Applications and Use Case Labs** providing functions like – interoperability testing for new applications, fostering innovation in 5G use cases etc.
 - Getting active in **global standards development eco-system** will open up a new realm of opportunities for India.
 - **Invite global Original Equipment Manufacturers to conduct major 5G trials in India** in collaboration with local partners.
 - Create a **5G Implementation Oversight Committee with participation from Government, Academia, Industry and R&D Labs** to supervise 5G program implementation.
 - Building India's **capacity in core technology development and manufacturing for 5G**.