

**WHITE PAPER ON**

# **5G APPLICATIONS**

**FOR BANKING AND FINANCIAL SECTOR IN INDIA**

5G



**Institute for Development and Research in  
Banking Technology**  
(Established by Reserve Bank of India)

# INDEX

<b>1.</b>	<b>Introduction</b>	<b>02</b>
1.1	Why 5G	03
1.2	Why 5G for India	05
1.3	Why 5G for Banking, Financial Services and Insurance (BFSI)	05
1.4	Why 5G for BFSI in India	07
1.5	The Objective of this White Paper	07
<b>2</b>	<b>Architecture and Security in 5G</b>	<b>08</b>
2.1	Generations of Mobile Telecom Networks	08
2.2	Architectural Principles of 5G	09
2.3	New Features to Enable Vertical Applications	12
2.4	Deployment Architecture of 5G	13
2.5	The Lifecycle of a Vertical Use Case in 5G	14
<b>3</b>	<b>Key 5G Technologies for BFSI</b>	<b>16</b>
3.1	Generic Technologies – Key Enablers of 5G	16
3.2	Network Slicing - Beyond Brick-and-Mortar Based Branches	21
3.3	Other 5G Technologies and BFSI	23
3.4	Security in 5G	25
<b>4</b>	<b>BFSI Use Cases for 5G in India</b>	<b>29</b>
4.1	Incremental Impacts from 5G	29
4.2	Newer Use Cases for BFSI from 5G	32
4.3	BFSI Providing 5G Infrastructure and Services to other Verticals	35
<b>Glossary</b>		<b>36</b>
<b>References</b>		<b>39</b>

## RACING TOWARDS 2020 – YEAR OF 5G

**M**OBILE technology has been marching ahead very rapidly since early 1980s when the 1G technology provided analog based voice for the human to human interaction. Then onwards, a new generation technology came into existence almost every ten years, providing better features and functionalities. While in 2010s the 4G ushered in the merger of Internet and telecom networks with core network as an all IP network, cyber world had started moving in directions of virtualization, cyber-physical systems, service-oriented architecture and so forth during the period. To meet the emerging requirements, there has been considerable work around the development of the next generation network – 5G. With announcements and promises that the Tokyo Olympics in 2020 would be the arena not only for high profile athletes but also for the splash of 5G networks, the world seems to be moving closer to the realization of 5G.

The 5G network is likely to encompass not just the Internet but all the resources connected to it. In such a scenario it is essential that there is a greater preparedness from both the service providers and consumers regarding the principles, architecture and features of the new technology. Such preparedness will help all concerned to design, develop and deploy appropriate applications that can be used efficiently and effectively. It is often felt that a similar preparedness by various sectors could have helped a greater success of 4G.

This white paper would be a step towards preparedness of the banking, financial services and insurance (BFSI) sector, which has very high reliance



on communication technology for all its activities. To ensure that the white paper covers all relevant aspects of the technology and its use in the BFSI sector in India, a team comprising of bankers, academicians, telecom service providers, telecom hardware providers, system integrators and FinTechs has been formed for this initiative. Faculty and senior domain experts from IDRBT continuously interacted with all of them in preparation of this white paper. The paper is a result of the dedicated work of all the team members.

The paper, in addition to presenting the principles, architecture and features of 5G, compiles a few use cases for the use of 5G by BFSI. It also addresses the security concerns, generally associated with financial transactions on such networks. We believe that the white paper, with its use cases for BFSI, will serve as a good resource for all concerned with 5G, especially while designing sector-specific requirements.

**Date:** April 12, 2019

**Place:** Hyderabad

  
**(Dr. A. S. Ramasastry)**  
Director, IDRBT

# 1. INTRODUCTION

THE evolution of mobile communication has a significant impact on our daily lives and the way we perform everyday tasks. The industry witnessed a new mobile generation ever since the introduction of 1G in the 1980s. 2G started to roll out in 1990 and gave the consumers voice calling and text messaging. 3G was first implemented in 2001 and paved the way for using the Internet on mobile phones, picture sharing, and Bluetooth. The 3G network, a breakthrough in communications, provided the speed of up to 21.1 Mbps. In 3G, the signals are received from the nearest phone tower and are used for phone calls, messaging and data. 4G offers lower latency (time taken for a packet of data to move from one point to another), broadband speed on mobile phones, and is supposed to be at least 5x faster than 3G. 4G can offer download speeds of up to 100 Mbps, enables social media, video streaming, and makes it easier to order food or a taxi with a few clicks through mobile apps. Carriers also upgraded their 4G networks with higher speeds, using Gigabit Long-Term-Evolution (LTE) technology, which boasted download speed. Pucks, dongles and laptop cards were prevalent during early 4G LTE rollout, since it was the easiest and cheapest way to release a device to support the next-generation wireless service.

5G is a system designed to meet the requirements of IMT-2020<sup>[1]</sup> set by the International Telecommunication Union (ITU-R) specification M.2083. Third Generation Partnership Project (3GPP) is a standards body that coordinated the development of fourth generation (LTE) working with researchers, OEMs, service providers, governments and other stakeholders on various task forces related to 5G. ITU is about to firm up spectrum bands and standards in consultation with 3GPP for the rollout of 5G by October 2019. Experts expect an explosion of customer premises equipment (CPE) as 5G devices followed by inbuilt support in newer mobile devices and terminals. According to the Groupe Speciale Mobile Association (GSMA), to qualify for 5G, a connection should meet these eight criteria<sup>[2]</sup> as compared to 4G networks:

- ★ Peak data rate – A target of 20 Gbps downlink rate and uplink of 10 Gbps
- ★ Less than one-millisecond end-to-end round-trip delay
- ★ Thousand-time increase in bandwidth per unit area (goal of 1000 (Mbit/s)/m<sup>2</sup>)
- ★ Ten to hundred times increase in the number of connected devices
- ★ (Perception of) 99.999 percent network availability including at mobility speed of 500 Km/h
- ★ (Perception of) 100 percent coverage
- ★ 90 percent reduction in network energy usage (ten times improvement)
- ★ Support for up to ten-year battery life for low power, machine-type devices

Fig. 1 provides a pictorial representation for enhancements targeted by 5G networks.

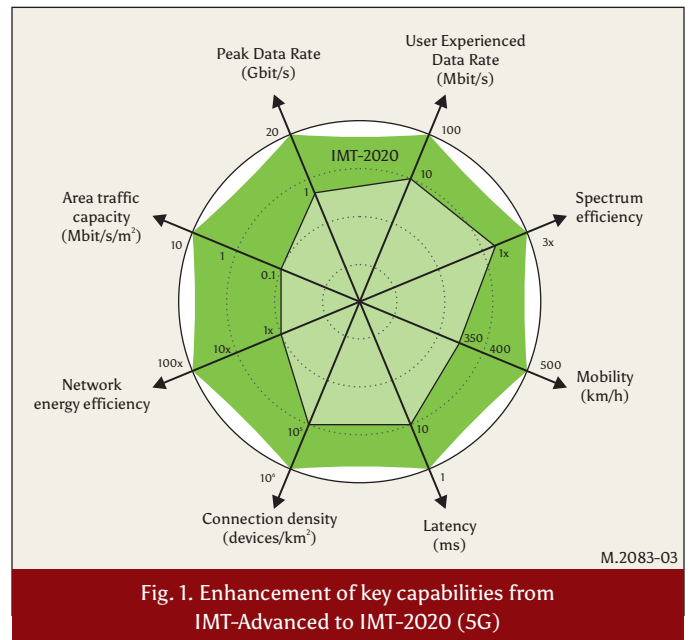


Fig. 1. Enhancement of key capabilities from IMT-Advanced to IMT-2020 (5G)

To meet these goals, 5G will also use high-frequency airwaves, often referred to as millimeter wave spectrum, and deploy a lot more "small cells" or compact boxes that broadcast and carry cellular signals.

## 1.1 Why 5G

5G is intended to provide more traffic volume, support many more diverse devices and service requirements, offer better quality of experience (QoE) for the users and better affordability by further reducing costs. It will provide faster and reliable access along with the capability to connect trillions of Internet of Things (IoT) devices. This transformation to 5G will also transform human lives, economy, jobs, and industries. 5G mobile services promise to connect millions of devices, reduce power consumption, provide higher security, reduce latency, and improved support for augmented/virtual reality (AR/VR) experience. 5G will enable secure connectivity between devices other than smartphones, such as sensors, vehicles, robots, and drones.

With 5G, minimum latency could be one millisecond (compared to 50 milliseconds for 4G). The data speeds could be 50-100x faster with 5G. Reduced latency and high throughput with 5G would enable infinitely large amounts of data flowing on the network, ushering in an era of ultra-reliable communication. A full DVD of a movie can be downloaded in less than half-a-minute using 5G networks. The 5G network can handle millions of IoT devices and enable machine-to-machine (M2M) communication, and not just smartphones. This would enable much more intelligence in the system along with higher data speeds.

While there has been a huge growth in pervasive computing scenarios using IoT and smart devices, the enhanced capabilities of 5G will ensure a fully connected world. Next Generation Mobile Network's 5G white paper<sup>[9]</sup> states that 5G connections will be based on user experience, system performance, enhanced services, business models and management & operations. 5G will also use massive Multiple-Input Multiple-Output (MIMO) to improve network capacity and reduce error rates, thus improving the quality of service (QoS).

Telecom operators are keen to get 5G spectrum for an edge in new digital services such as powering the IoT, better home automation, industrial automation and deployment of autonomous vehicles. 5G networks will enable wider adoption of blockchain, artificial intelligence, deep machine learning and possibly quantum computing. 5G will be delivered by deploying secure, flexible networks that operate at the edge by virtualizing the network and deploying cloud technology and mobile edge computing (MEC). MEC is the key technology to enable low latencies and security in short-term and bring machine-learning based intelligence to wireless networks.

The committee, on Digital Economic Policy, of Organization for Economic Cooperation and Development expects an increase in Gross Domestic Product, increased employment and faster digitization with 5G implementation. The Fig. 2 below depicts the three primary technology features that define the 5G use cases.

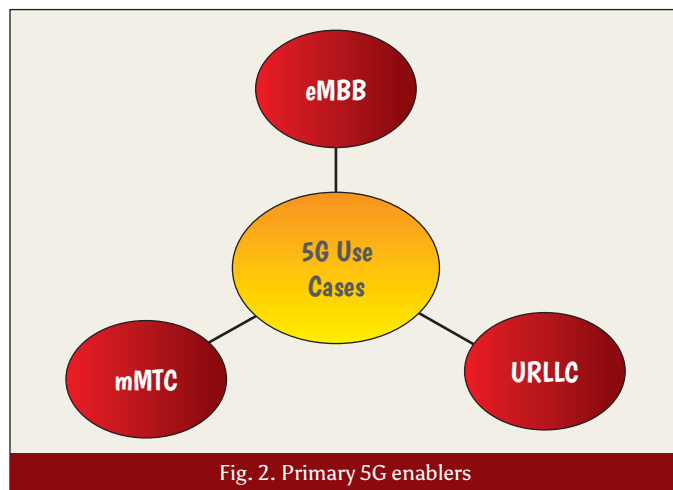


Fig. 2. Primary 5G enablers

### (i) Enhanced Mobile Broadband (eMBB):

Enhanced Mobile Broadband will be an evolution to 4G mobile broadband services like multi-media content, audio and data services. The eMBB usage scenario will come with new application areas and requirements. It will deliver very high traffic capacity, enhanced connectivity, higher user mobility and support wide-area coverage.

## (ii) Ultra-Reliable and Low Latency Communications (URLLC):

URLLC is a new use case category, which has strict requirements for capabilities such as throughput, latency and availability. Some examples of latency-sensitive applications include factory automation, autonomous driving, remote medical surgery and applications such as payment transfer in banking sector. Faster transactions, lower latency, quick acknowledgments, can enhance the ability to handle a large number of such payments over a network as each transaction can be finished faster. Faster acknowledgment is also important from the user's perspective. Faster and more enhanced security can now be done at the network level. For example, a biometric/facial recognition that is done on the device can be moved to the cloud. This will avoid any tampering at the device level, and the cloud could provide more secure authentication. This would also prevent snooping attacks on devices and provide security if the device is lost.

## (iii) Massive Machine Type Communications (mMTC):

Massive Machine Type Communications use case targets the cost-efficient and robust connection of billions of heterogeneous devices without overloading the network. The devices are required to transmit a relatively low volume of non-delay-sensitive data, while ensuring very long battery life. As the number of smart devices scale, the network should handle the load. Faster and more enhanced M2M communication would enhance peer-2-peer payments, while authentication may still be done at the network level to avoid fraudulent transactions.

Based on the use cases, 3GPP Technical Report 38.913<sup>[4]</sup> recommended Indoor hotspot, Dense urban, Rural, Urban macro, Extreme long-distance coverage in low density areas, Urban coverage for massive connection, Highway scenario, Urban grid for connected car, Commercial air-to-ground scenario, Light aircraft scenario, Satellite extension to terrestrial, as key 5G deployment scenarios. 5G would

also offer native support to all spectrum types – licensed, shared, unlicensed, and spectrum bands (low, medium, high), a wide range of deployment models including traditional macro-cells, hotspots, and new ways to connect (device-to-device, multi-hop mesh).

### 1.1.1 The economic impact of 5G

As per an Information Handling Services Markit, 5G economic impact study <sup>[5]</sup>, 5G mobile value chain alone can generate up to \$3.5 Trillion in revenues by 2035 and support up to 22 Million jobs. A report on “The guide to capturing the 5G industry digitalization business potential” <sup>[6]</sup>, a sequel to “5G Business potential” report <sup>[7]</sup> suggests operators could grow revenues between 12-36% (revenue of \$204-\$619 Billion) to their current forecast service revenue of \$1.7 Trillion in 2026. This would mean a 13.6% annual growth against current operator service revenue growth targeted at 1.5%.

The report examined over 400 industry digitalization use cases across ten key sectors - energy and utilities, BFSI, manufacturing, public safety, healthcare, public transport, media and entertainment, retail and agriculture, that would benefit from digital transformation with 5G. As per Industry Business Impact of 5G report <sup>[8]</sup>, the major drivers for participants in taking the next step to 5G from a strategic perspective are:

- ★ Create a first-mover advantage (73%)
- ★ Position themselves as an industry innovator (54%)
- ★ Leverage digital transformation enablers (53%)
- ★ Build a solid base for IoT (46%).

The use cases identified into clusters covered 90% of addressable 5G business potential. The use cases around real-time automation forms the largest cluster with a revenue potential of US \$ 113 billion by 2026 followed by 96 billion for video services.

## 1.2 Why 5G for India

India is one of the few countries with extensive LTE coverage (4G connectivity). This has led to the largest mobile data consumption in the world. To build on this LTE growth, 5G provides the perfect roadmap for new applications and service roll out. Indian telecom is also under pressure on tariffs and narrowing margins in the recent years and domestic banks are increasingly hesitant to further lend to the operators. Adoption of newer and disruptive technology such as 5G is expected to provide impetus to the operating models of the providers.

India is getting ready to implement the 5G networks by 2020 to speed up its “Digital India” and “Make in India” initiatives and to keep pace with the global technology adoption. 5G will enable higher productivity with connected devices like smartphones, smartwatches, other smart wearables, Artificial Intelligence (AI)-powered devices, and connected cars. The 5G-enabled digitization revenue is estimated to be at \$25.9 billion by 2026 and 5G-enabled industry revenue is expected to add around \$13 billion to operator revenue<sup>[9]</sup>. 5G will improve the Internet speed and the quality of network in India and will enable the digital transformation of services in the areas of healthcare, education, entertainment, agriculture and manufacturing.

The “Make in India” initiative is expected to provide low-cost and high quality 5G mobile devices and telecom equipment. India will be one of the biggest IoT user base and the telecom players can partner with government, private and MSME sectors for developing IoT solutions. Also, related ancillary industries that provide service platform, delivery model, logistics support, and other niche services

have opportunities to innovate and scale to the upcoming needs. The government-sponsored Jan-dhan Aadhaar Mobile (JAM) and other programmes to transform agriculture and healthcare would be able to deliver faster and smoother in rural areas with rolling out of 5G services.

## 1.3 Why 5G for Banking, Financial Services and Insurance (BFSI)

Gartner report, 2018<sup>[10]</sup> cites IoT Communications, Video as Tier-1 use cases and Fixed Wireline Access, High performance Edge Analytics, Location tracking, AR/VR intensive videos and holograms, smart city, image recognition, blockchain, public safety/emergency radio, autonomous vehicles, non-critical sensors and real-time rendering as Tier-2 use cases of 5G. BFSI would benefit from most of these use cases. BFSI would also serve as the backbone for other industries to adapt/implement these use cases.

Mobility has already been a game changer in BFSI and has heralded the rise of the 'omni-digital' customers who use only their smartphones, tablets and PCs for transactions. 5G is expected to force banks to relook at digital banking both for internal operations and customer engagements. Banking is expected to become omni-channel with operations extending to newer channels including 5G smartphones, wearables, IoT devices and Virtual Reality. 5G connectivity can enable real-time mobile transactions, shortening settlement cycles and removing latencies.

5G would impact key industries including media and entertainment, automotive, public transport, healthcare, and energy and utilities. IoT is expected to play a larger role in day-to-day lives and change the way companies interact with customers.

If URLLC 5G becomes an affordable alternative for business broadband (rather than laying fiber), the enterprise market including BFSI will be the real opportunity. It is paramount to stay prepared, understanding the shifts in the market, technology, and competitive landscape as-they-happen, hence BFSI should focus their effort on 5G.

Digitization benefited a few industries more than it did others; 30% of the industries (e.g. financial services) reaped 70% benefits of industrialization, improving their growth rate over 70%, about four times more than other industries. While the financial services industry has benefitted disproportionately from earlier industrialization waves, there still is substantial scope for the financial services industry to further benefit in the current Industry 4.0 and 5G wave.

The key use cases of 5G in BFSI will include

- ★ Financial inclusion through the globally integrated financial supply chain
  - ★ Enhanced ATMs with more features like AR/VR to interact with bank officials directly
  - ★ Virtual and augmented reality enabling richer customer experiences at lower costs for BFSI
  - ★ Analytics for risk prevention and regulatory compliance to:
    - Prevent fraud and crime
    - Predict and analyze cyber-security threats
    - Implement affordable and higher assurance Identity verification
    - Investigate and prosecute criminals/enforce law
  - ★ Big-data Analytics for enhancing the customer experience
- ★ Exclusive network slicing for improved QoS and Security for BFSI services in general and the payment infrastructure in particular
  - ★ 5G coupled with Blockchain and other technical innovations will also impact in
    - Capital markets for automated trade lifecycle
    - Cross-border payments
    - Automated payments through high speed moving vehicles on road and possibly in air or space
    - Improving digital identity
    - Customer and employee loyalty and rewards
    - Smart self-regulating contracts
    - Mobile as the main channel for banking, enabling common banking transactions on the go, trading and settlement management cycles.
    - Mobile as credit/debit cards
    - Mobile as digital identity
    - Enable digital deposits, payments and P2P lending (Including micro financing)
    - Wearables and smart home devices enabling voice based services (for example, extension beyond “Alexa please clear my bills”)
    - Virtual personalized services
    - IoT devices (providing user lifestyle inputs, car driving tendencies etc. for loan interest rates) leading to better asset and mortgage management.



## 1.4 Why 5G for BFSI in India

While drivers and use cases for 5G adoption are common worldwide, specific to India, the BFSI sector needs 5G for applying Artificial Intelligence (AI) and for enabling Government of India's social inclusion agenda. As per the findings of NASSCOM-Cybermedia research<sup>[11]</sup>, BFSI sector in India would be a great beneficiary from applying AI in the areas of

- ★ Fraud detection and prevention tools and chatbot/voicebots for customer support
- ★ Automating back-end business processes to reduce human errors and improve the turnaround time
- ★ Marketing to track consumer behaviour so as to offer customized products
- ★ Security and compliance.

All these AI use cases deal with mountains of data that need speed and low latency of 5G.

The government of India has called for diverse solutions to solve the challenge of Financial inclusion of 1.3 billion Indians to drive access, inclusion, connectivity, opportunity, and accountability. India is quickly progressing on financial inclusion journey with more than 1.2 billion digital identities based on Aadhaar, 330 million new bank accounts, use of eMarketer GEM, 1500 times rise in digital transactions in the last two-and-half years using RuPay and BHIM UPI with more than 128 banks connected to Unified Payments Interface (UPI).

India has also recently participated in the launch of API Exchange (APIX), an online marketplace and sandbox for FinTech focused APIs. APIX is the world's first cross-border, open architecture platform to

improve financial inclusion. APIX is developed by ASEAN Financial Innovation Network (AFIN) to connect financial service providers to FinTech businesses. AFIN is an initiative by International finance corporation (IFC), Monetary Authority of Singapore (MAS) and ASEAN Bankers Association (ABA) aiming to expand the access and use of financial services.

## 1.5 The Objective of this White Paper

The document provides an understanding of 5G technology and architecture, security and use cases that are relevant to BFSI sector. The document can be a reference for Chief Digital Officers, CIO/IT-Heads, Chief Information Security Officers and other stakeholders as a preparation to the new revolution in Digital world. The document helps in understanding the enhancements and advancements over existing wireless technologies, that BFSI sector can use for remodelling their current business practices. The BFSI sector including FinTechs can prototype or enhance the discussed use cases. BFSI sector specific inputs on security, latency and reliability can also be taken up while firming the 5G specifications. The document will also be a stepping stone used for setting up 5G use case lab for BFSI at IDRBT.

It may be noted that this white paper does not cover core technology aspects from telecom service providers perspective. For examples, aspects like migrating a 4G network to 5G, or co-existence between the two is beyond the scope.

## 2. ARCHITECTURE AND SECURITY IN 5G

### 2.1 Generations of Mobile Telecom Networks

Early telecom networks (plain old telephone systems) were primarily wired in nature. Radio technologies were used for communication since the late 19th century. First complete, commercially successful wireless telegraphy was demonstrated by Guglielmo Marconi in 1894, which subsequently evolved into two-way telegraphy. Voice was carried on radio sets, primarily by police and defense personnel in the first-half of the twentieth century. Handheld radio receivers, frequently carried as back-packs, were extensively used in second world war. Mobile telephones for consumers started as car-based

phones and subsequently, became portable phones in the late 1970s.

Fig. 3, below provides an overview of the major generations of telecom networks.<sup>[13]</sup>

The first generation analog cellular networks were deployed around 1980 in Nordic countries, Japan and Americas. The deployments in USA were driven by research at Bell Systems and Motorola, leading to Advanced Mobile Phone Systems (AMPS). It used analog signals and was commonly referred to as 1G mobile network. It supported data rate up to 2.4kbps<sup>[14]</sup>.

Digital encoding of voice for communication was the advent of 2G networks and devices in the 1990s. There

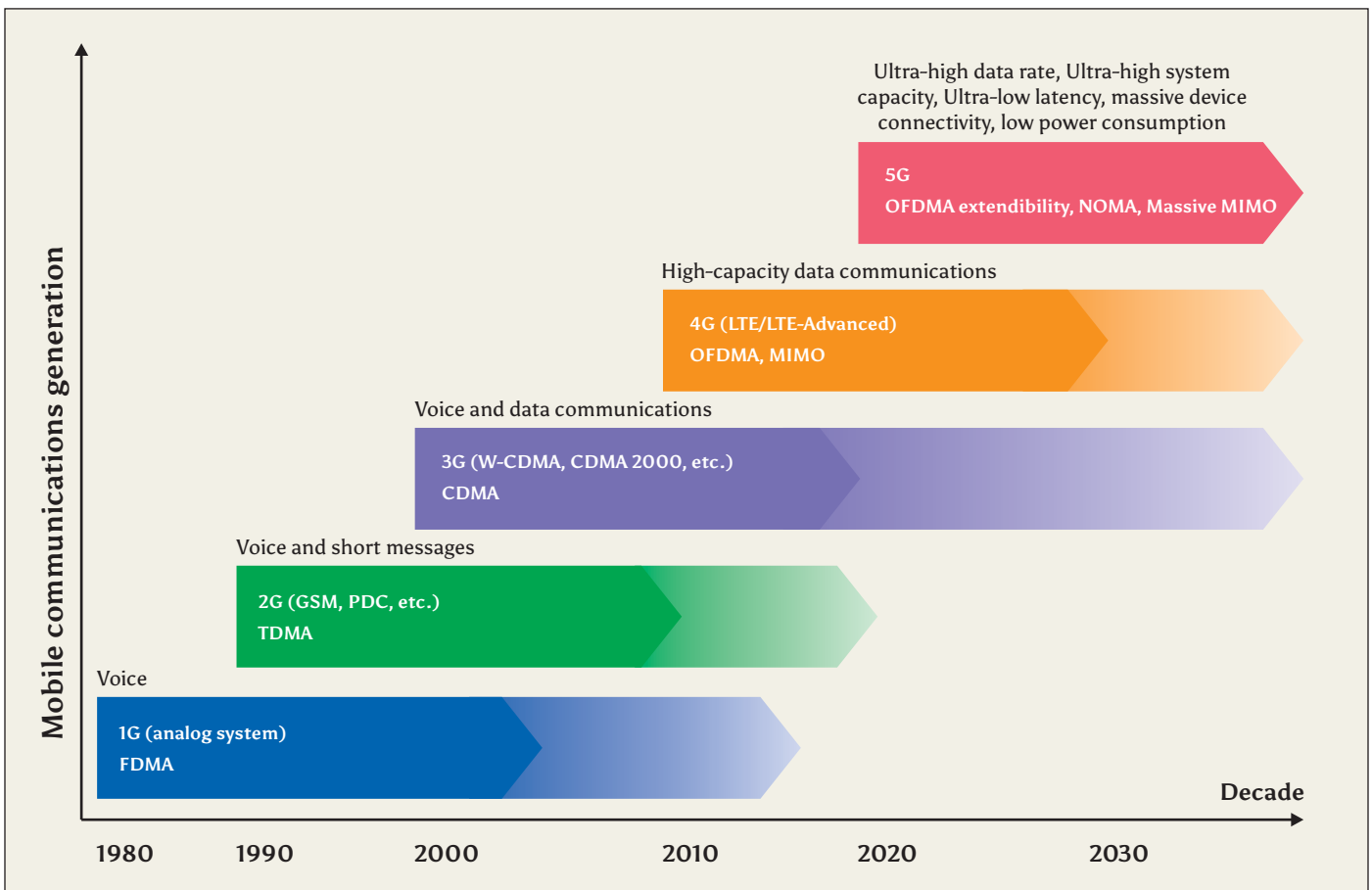


Fig. 3. Evolution of Wireless Telecom Networks (Ref. NTTDOCOMO vol17\_4)

were significant differences in digital networks for Europe (GSM) and USA (CDMA). Though these networks were primarily for voice-based communication, they allowed data rates up to 64kbps. Subsequent enhancements as 2.5G and 2.75G included technologies like CDMA2000 1X (IS-2000), General Packet Radio Services (GPRS), Enhanced Data rates for GSM Evolution (EDGE), that allowed higher data communication speeds.

In the late 1990s, 3GPP was launched as a joint initiative of Nortel Networks and AT&T Wireless. Subsequently, many organizations joined this effort. In early 2000, its role evolved to facilitate the interoperability between the US and European markets.

3G networks attempted to make IP over wireless networks as one of the primary goals and started utilizing packet switching instead of circuit switching for data transmission. The first set of commercial trials were done in the early 2000s and allowed data rates of 2mbps. Subsequent 3G+ enhancements allowed data speeds of 14 Mbps.

Data communication became the primary scenario for 4G networks. It eliminated circuit switching of 3G networks and is commonly referred to as an all-IP network. LTE provided higher speeds by using newer radio technologies on both the base stations and the user terminals. It also offered a significant enhancement on the core network by implementing data routing over pure IP networks.

While the early evolution was from analog to digital, and subsequently from circuit switched to all-IP network, these generations assumed humans to be the end-point for data connectivity. 5G networks aim to provide ubiquitous and pervasive connectivity (including M2M), enabling various services as well as provide a framework for sharing the infrastructure. In addition to enhancements at radio levels, it extends the telecom networks by adding aspects of software-defined networks, virtualized environments to support a multitude of services with shared resources and programmability to respond to change in resource needs.

## 2.2 Architectural Principles of 5G

The requirements for the 5G Mobile Technology is defined by ITU standards under the focus group, IMT-2020 under ITU-R Working Party 5D. The goal of this technology standard is to enable seamlessly connected society by 2020 timeframe and beyond. As the IMT standards evolved from IMT-2000 (3G) to IMT-Advanced (4G), the network converged to provide packet switched data services making the network an all IP network. In the 4G system, voice became an application on this all IP network rather than network having a separate circuit switched core. IMT-2020 or 5G network is taking it to the next stage of evolution by enabling communication not only for people-to-people (P2P) but also for people- to-machine (P2M) and M2M. This transformation paves the way for the applications to make the best use of the 5G network to enhance efficiency and user experience. This transformational promise of 5G is the primary reason for the excitement across all the industry segments including BFSI.

The architecture of 5G is designed to provide flexibility to support different usage scenarios (Refer page 02, Fig. 1). The key guiding principles for the design of 5G architecture are listed below<sup>[15]</sup>

- ★ Separate User Plane (UP) functions from Control Plane (CP) functions, allowing independent scalability, evolution and flexible deployments
- ★ Modularize function design to enable flexible and efficient network slicing.
- ★ Wherever applicable, define procedures (i.e. the set of interactions between network functions) as services, so that their re-use is possible.
- ★ Enable each Network Function (NF) to interact with other NF directly if required.
- ★ Minimize dependencies between the Access Network (AN) and the Core Network (CN).
- ★ Support a unified authentication framework.
- ★ Support "stateless" Network Functions (NFs), where the "compute" resource is de-coupled from the "storage" resource.

- ★ Support capability exposure
- ★ Support concurrent access to local and centralized services. To support low latency services and access to local data networks, UP functions can be deployed close to the Access Network.
- ★ Support roaming with both Home routed traffic as well as Local breakout traffic

Key network functions identified to support this architecture<sup>[45]</sup> include:

- ★ Authentication Server Function (AUSF)
- ★ Unified Data Management (UDM)
- ★ Access and Mobility management Function (AMF)
- ★ Unified Data Repository (UDR)
- ★ Data Network (DN), e.g. operator services, Internet access or 3<sup>rd</sup> party services
- ★ User Plane Function (UPF)
- ★ Unstructured Data Storage Function (UDSF)
- ★ Application Function (AF)
- ★ Network Exposure Function (NEF)
- ★ User Equipment (UE)
- ★ Network Repository Function (NRF)
- ★ (Radio) Access Network ((R)AN)
- ★ Network Slice Selection Function (NSSF)
- ★ 5G-Equipment Identity Register (5G-EIR)
- ★ Policy Control Function (PCF)
- ★ Security Edge Protection Proxy (SEPP)
- ★ Session Management Function (SMF)
- ★ Network Data Analytics Function (NWDAF)

The introduction of a new NF in this architecture is simple owing to the fundamental change in the architectural construct.

5G architecture fundamentally is a service-based architecture (SBA) that doesn't need a reference point-based implementation. As a result, a new NF can subscribe to a set of existing information to produce and publish a set of outputs that can be consumed by other NFs and the service consumers. This flexibility makes the architecture attractive by bringing the network and applications together, to deliver greater value to the business.

### 2.2.1 Key differences compared to earlier generations

5G system differentiates itself from 4G and earlier generation networks for not only evolving the radio network performance parameters but also for greatly increasing end-to-end (E2E) flexibility, enabled largely by the “softwarization” of the network. Softwarization is powered by technologies like Software Defined Network (SDN), Network Function Virtualization (NFV) and Cloud computing. The flexibility will also enable the use of existing access technologies along with new radio access technology introduced by the 5G system. For realization of a use case, one can specify the access technology to be used with the provision to use multiple access technologies based on service scenarios. Thus, the use-case realization is possible with easy incorporation of new features, provisioning the infrastructure in a cost-effective manner and enhancing network capacity and geographic coverage dynamically based on demand.

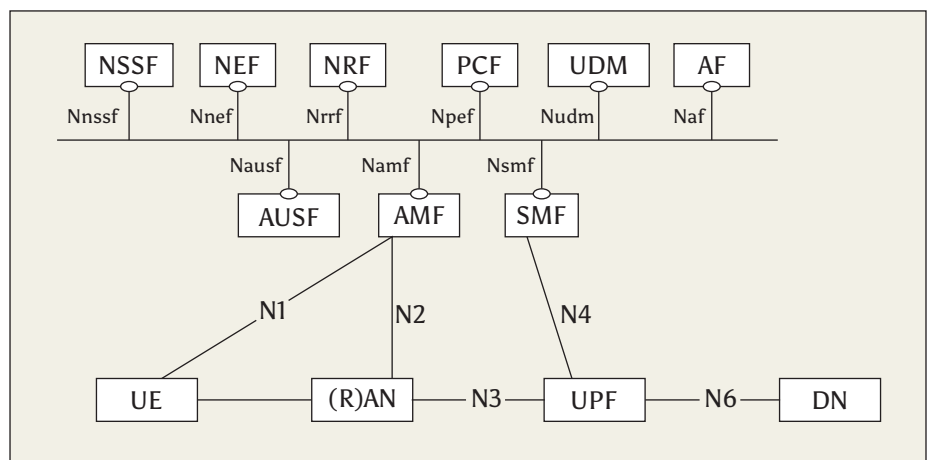


Fig. 4: Service-based Architecture (Source 23.501)

In 5G, with SBA, each network node performs very specialized functions and provides specific services to all other nodes. This modularity allows flexibility in design, reduced dependencies between different nodes and efficient network slicing. Besides, the control plane and data plane functions are demarcated very clearly in 5G. This allows Control and Data planes to scale and evolve independently of each other.

In summary, the flexibility of the network will enable new capabilities like network slicing, exposure of network capabilities, resource optimization, automation of vertical applications, autonomic decision making through cognitive information processing, on-demand network provisioning, E2E quality of service assurance, assurance of end-user data rate, enhanced security, provision of distributed network architecture with Edge computing, energy efficiency, etc.

From the services perspective, for BFSI, the key network capability could be simplified with the three fundamental requirements - discussed in the previous section:

- ★ User experience data rate: Enhanced mobile broadband (eMBB)
- ★ Reliable and low latency: Ultra Reliable Low Latency Communication (URLLC)
- ★ Connection density. Virtual: massive Machine Type Communication (mMTC)

The 5G usage scenarios as summarized in the ITU-R requirement M.2083<sup>[15]</sup> are represented below (Fig.5).

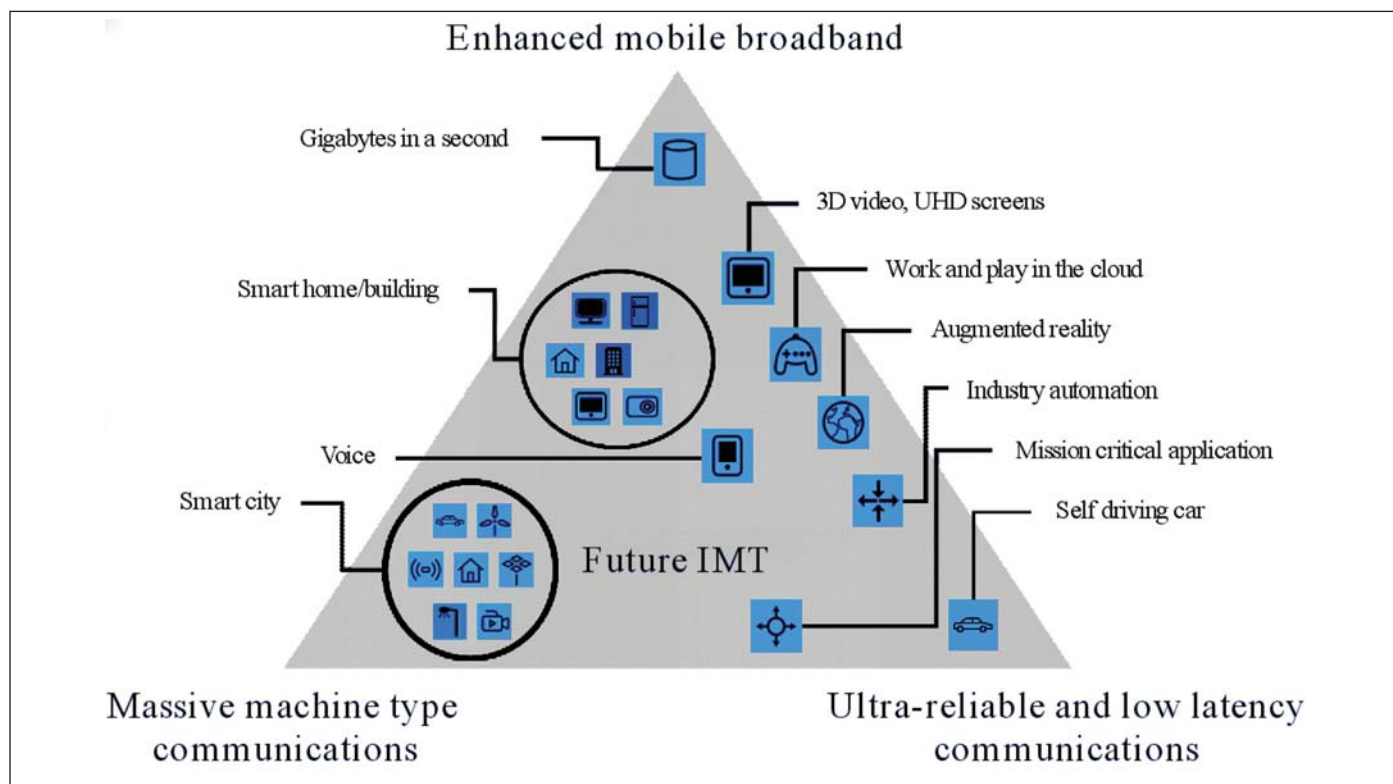


Fig. 5. Usage scenarios for 5G

## 2.3 New Features to Enable Vertical Applications

Five key technology trends that will drive the 5G platforms are<sup>[16,17,18]</sup>

### (i) Network Slicing

Network slicing is a feature that refers to logically partitioning the network into multiple isolated SBAs to support different service requirements. Each network slice comprises of specifically configured NFs, applications, and underlying infrastructure that are bundled together to meet the requirements of different verticals.

### (ii) Network Programmability

All the NFs and the underlying infrastructure should be programmable to optimize the use of physical resources and to automate network maintenance and management. This will also help in automating deployment or dynamic configuration of network resources depending on traffic pattern and user demand.

### (iii) Network Function Virtualization (NFV)

NFV is a way of design that decouples network functions from dedicated hardware by moving these functions to virtual machines. By decoupling NFs from dedicated network devices, both operating and capital expenses are reduced significantly. It also enables faster scaling of the network and introducing new services quickly without having to introduce additional dedicated hardware. NFV is a key enabler for network slicing too.

### (iv) Edge Computing (EC)

EC aims to reduce network latency and optimize resource usage by shifting computing, data analytics, and storage from external servers to the edge of a mobile network. It can be a cloud server running at the edge of a mobile network that provides IT and cloud computing capabilities to application developers and content providers with real-time radio network information.

### (v) Network Capability Exposure

5G network supports Network capability exposure through NEF. This enables the vertical applications to specify the custom requirement of the application through a set of connectivity and infrastructure requirements by invoking the Northbound Network API using the Common API Framework (CAPIF). For example, a BFSI application providing AR/VR based virtual banking services could ask the network to provide the following:

- ★ 50Mbps user experience bandwidth during the active service usage period, best effort otherwise, but not less than 10Mbps
- ★ 50ms latency during the active service usage period, best effort otherwise
- ★ Edge computing resources for hosting Edge application for caching of 1000 concurrent AR/VR sessions (e.g. intelligent cache controller application requiring 4 virtual cores, 16GB RAM and 1TB storage).

The network service (NS) orchestrator would provide the capabilities specified by the application by decomposing the requirements into specific NS, NFs, and Virtualized Resources layer and provisioning the same.

Compared to earlier generations, 5G also allows for additional capabilities<sup>[16]</sup>

- ★ **Service Deployment Time:** Programmability implies that orchestrations for new service can be done in order of seconds.
- ★ **Data Volume:** Faster speed of the network and the fact that they are being built for multimedia platforms imply that the volume of data handled by such systems will be huge.
- ★ **Autonomy:** Building upon Internet design principles, various subsystems will be autonomous, while exporting and consuming functionalities with other sub-systems.

- ★ **Security:** The distributed nature of the 5G deployments imply that the security aspects should be designed from the beginning.
- ★ **Identity:** When dealing with multiple sub-systems, as well as having the capability to handle billions of devices, identity management will be much more comprehensive in nature.

## 2.4 Deployment Architecture of 5G

Fig. 6, below captures the architecture for various services enabled by 5G networks and resources<sup>[19]</sup>. At the resource layer, in addition to presently captured resources, we may have humanoids, cameras, digital-video-recorders and ATMs, next-gen-branches from the perspective of BFSI. Specific 5G slice (possibly spanning across multiple operators) would be created

for different use-cases that need isolated access and control. Service level orchestrator controls the access to physical resources and QoS for the network slices that enable the rich user experiences.

The architecture itself is recursive, in the sense that certain pattern can replace parts of itself. E.g. physical resources (like traffic lights and video cameras) managed by municipal systems using their own slice in 5G networks can be exposed as virtual resources to other entities such as national or state level emergency response teams. Just as a recursive service that replaces parts of its functionality, a recursive 5G architecture allows for it to be instantiated and linked repeatedly. While the lowest level in the recursive implementation typically has physical resources, it will expose virtual resources to

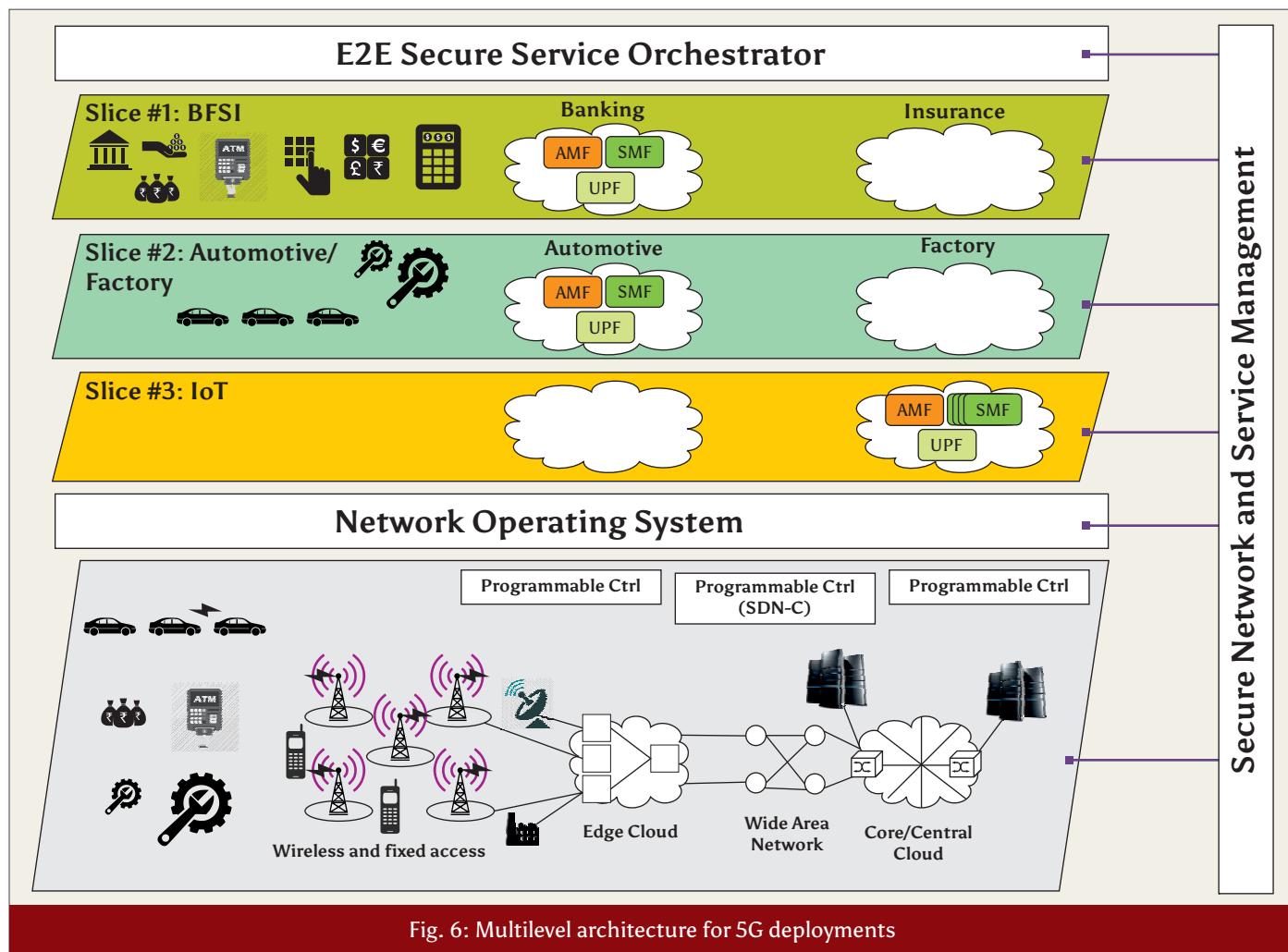


Fig. 6: Multilevel architecture for 5G deployments

higher levels in the recursion. This allows for ease of management, flexible deployments and elasticity.

The secure network and service management is a significant challenge, when we are looking at large scale distributed and autonomous systems. 5G-PPP Working Group on “Network Management and QoS” attempts to provide solutions in this space. The Matilda project<sup>[20]</sup> aims to provide end-to-end services operational framework. It targets to cover the lifecycle of design, development, and orchestration of both applications and services over programmable 5G infrastructure. It relies on a unified programmability model and abstracts the control interfaces for modular designs.

## 2.5 The Lifecycle of a Vertical Use Case in 5G Architecture

Softwarization has simplified creation, modification and deletion of NFs and NSs in an agile way. Let us look at the lifecycle of a client-server-based application, for example, Internet banking application. The client-server architecture is prevalent in a number of industry use cases (Fig. 7).

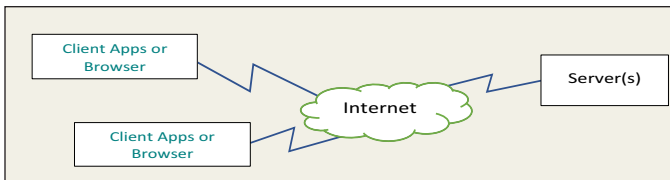


Fig. 7. Deployments for classical client-server Architectures

In this use case, the client, i.e., the end user has a network connection to the Internet and so does the online banking server. It is assumed that the network is already available, and both the client and server can interact with each other over the network. The application has no control over the network performance, and it can interact with the network layer only through the TCP/IP socket provided by the host operating system of the server and the client. Frequently the end-user should remember the address of the server(s) or the details are hardcoded in the custom client applications. Though DNS and similar mechanism allow for decoupling the actual

### (A) Identify service requirements

- \* Supported operating systems for hosting the server
- \* The connection speed, the latency
- \* Type of authentication, type of encryption
- \* Regulatory requirements
- \* Supported device types – e.g. PC(Windows/Linux), Smartphone (Android/iOS) etc.
- \* Application requirements – Native app or browser-based app.

### (B) Subscribe to a broadband network and connect the server to the same

### (C) Install the Server apps

- \* Choose a server (physical/virtual) with the right capacity and right OS based on the expected transaction volume and supported OS
- \* Install the server App with appropriate number of licenses
- \* Go live after necessary validation browser-based app.

### (D) Create client app and/or the web interface for web-based service

### (E) Distribute the client through an App store or publish the service URL

### (F) Launch the service

### (G) Start monitoring the server health and performance

### (H) Continue maintenance activities for planned upgrades, bug fixes and security patches

### (I) Phase out the service in the event of new technology availability

Fig. 8. Life cycle of service offering in legacy networks



address from the logical address, the changes to DNS entries take an order of minutes (or hours) to percolate through the network.

For rolling out this service, in a pre-5G deployment (legacy networks), the service provider, in this use case, the bank, will follow the steps in Fig. 8.

In 5G architecture, the above use case could be realized as a digital catalog item with **Design** and **Run** phases.

In the **design** phase, the complete functional requirements of the service are conceptualized and abstracted with a set of data models related to the NSs, NFs and Infrastructure (Compute, Storage, Networking). These requirements could be specified in a Topology and Orchestration Specification for Cloud Applications (TOSCA) template<sup>[21]</sup>.

Once the service catalog is created, the **run** phase can be fully automated based on a service policy to manage the lifecycle of the service. The service could be instantiated in the Run phase of the lifecycle based on the instantiation policy or through a one-click deployment option. In the run phase, the service can be instantiated, modified and terminated by a programmatic interface to the 5G network using the northbound APIs. The application can also be enhanced with the provision for the end user to configure the network requirement on demand.

For example, in an online banking app, a provision for virtual branch interaction could be made available where the bandwidth will be boosted to meet the services required. An example of intelligence for sensing the services requirement - When an AR/VR headset is attached; it can also be programmed in the client App, which can then automate the network requirements based on headset capability. The easiest way to simplify the network for the application would be to have a slice definition for the application. The Application can ask the network to configure and allocate the slice for that application through the NS descriptor. The application also has the provision to directly interact with the network through NEF to dynamically change the requirement as per the end user requirements during the in-service phase of the application.

5G also brings in the concept of runtime service assurance with the Self-organizing/optimizing Network (SON) feature. When integrated with the Application layer performance indicator, this feature can make the 5G enabled applications powerful and thus opens a new set of possibilities for transformation making the applications Self-Optimizing.

### 3. KEY 5G TECHNOLOGIES FOR BFSI

THE previous section discussed the evolution of telecom networks, leading to 5G. It also provided a high level overview of the technical innovations in 5G and its architecture to support various services on top of 5G. This section delves deeper into some of the technologies that are relevant for Banking, Financial and Insurance sectors. It first discusses the generic technologies that are key enablers for 5G deployments and thereafter delves deeper into a few of those that have a significant impact for BFSI.

Banks have been finding it difficult to deploy wireless technology, in a way to achieve a proper tradeoff between security (including authentication), convenience (ease of use for customers, partners and employees) and costs (both operational and capital). With its shared infrastructure including network connectivity, computer as well as a host of physical and virtual devices, 5G offers a comprehensive platform for FinTech and financial institutions to innovate. While some of the technical aspects will require a significant training time for the core design and development teams, the convenience for the wider team will be significantly higher.

#### 3.1 Generic Technologies – Key Enablers of 5G

Early discussions on 5G targeted the six key features as improvements over 4G<sup>[22,23]</sup>

- \* Network flexibility
- \* Providing more flexible mobility solutions
- \* Enhanced efficiency for short-bursts or small data communication
- \* Expanding context information known to the network
- \* Expanding integration and management
- \* Additional support for essential functions as fundamental attributes of the network layer.

For 5G to deliver on its promise, it will also need enabling technologies for deploying networks efficiently and flexibly. Some of the key technologies being incorporated are Millimeter Band spectrum, Network Function Virtualization (NFV), Network Slicing (NS), MIMO, SDN, Distributed or Edge Cloud Computing, support for heterogeneous devices (including IoT), Artificial Intelligence and Advanced Analytics.

5G technology also marks the coming together of Mobile Networks and Cloud computing platforms. An array of facilities is provided by the present generation of mobile service technologies, but still there are problems like lack of high bandwidth, heterogeneity of connected devices and lack of network availability. In 4G and earlier generations, the bandwidth available to devices maxes out at tens of Mbps. This is unsuitable for some scenarios like ultra-high definition video streaming (4K/8K). With the increase in the number of mobile users, the bandwidth & heterogeneity has grown as a major problem.

Mobile communication and its almost seamless connectivity to the Internet and other users for daily communication needs has been a significant game-changer over the last thirty years. As a natural progression, in future the users will be dependent on the mobiles and 5G services; this modern technology will further ease the use for the end users, which in addition to humans, will also include a variety of machines and sensors.

The 5G technologies (other than those at the physical layers, like MIMO and millimeter bands covered by 3GPP) will be standardized by other SDOs like IETF, IEEE and ad-hoc industry groups. Taken together, these features will allow operators to deploy at lower cost points, develop differentiated business models and better manage the networks for performance and reliability.

### 3.1.1 Physical layer – 5G Radio

#### (i) Millimeter Waves (mmWave)

Mobile technologies from 1G to 4G have been deployed below the 3 GHz band, with less than 1 GHz band being the favored due to higher coverage areas. Millimeter wave generally corresponds to the radio spectrum between 30 GHz to 300 GHz, with wavelength between one and ten millimeters. One of the key advantages of millimeter wave communication technology was the availability of large amount of spectral bandwidth. The bandwidth available in the 70 GHz and 80 GHz bands, a total of 10 GHz, is more than the sum total of all other licensed spectra available for wireless communication.

With such wide bandwidth available, millimeter wave wireless links can achieve capacities as high as 10 Gbps full duplex, which is unlikely to be matched by any lower frequency RF wireless technologies. An advantage in these high-frequency bands is the availability of wider bandwidth channels. However, in these bands, the cell sizes also drop to less than 200 meters and may require line-of-sight with directional antennas to achieve high data rates.

#### (ii) Massive MIMO

MIMO technology uses multiple transmitters and receivers to transfer more data at the same time. It takes advantage of a radio-wave phenomenon called multipath where transmitted information bounces off walls, and other objects, reaching the receiving antenna multiple times via different angles and at slightly different times. Multiple Input Multiple Output (MIMO) wireless multiplies data rates by using multiple antennas both at the transmitter and the receiver to enable ‘Spatial Multiplexing’ that creates parallel data streams equal to the number of antennas. The technique requires special encoding of signals at the transmitter and corresponding decoding of the entangled signals at the receiver.

MIMO, therefore, effectively multiplies the radio spectrum, a scarce and a very expensive resource. 5G networks are moving to millimeter band spectrum will

allow the use of a much larger number of antennas. This will boost MIMO leverage by hundred times or more in the next few years. Though MIMO is already used by 4G networks, with 5G, the number of transmitters and receivers are expected to increase manifold, thus providing speeds of the order of tens of Gbps.

#### (iii) Small Cells to Support High Node Density

5G deployments will allow for micro and nano cells to support extremely high node densities. Smaller cells will allow more devices to connect. Since these base stations will use lower power, it will reduce interference, hence allowing a higher level of frequency reuse. These deployments will be environment-friendly.

#### (iv) Flexible Beam Forming

Beam-forming is a signal processing technique applied in the areas of radar, sonar, seismology and wireless communications. It can be used for a myriad of purposes, such as detecting the presence of a signal, estimating the direction of arrival, and enhancing the desired signal from its measurements corrupted by noise. Beam-forming is a traffic-signaling system for cellular base station and it reduces interference for nearby users in the process.

This technology had been used in earlier generations where-in coupled with MIMO, a single tower could create beams in different directions to handle the varied number of users that are expected in the area covered by the beam. With 5G and SDN enhancements to base-stations, it will be possible to programmatically control the beams and the frequency bands allocated to it.

#### (v) Low Mobility Large Cell (LMLC)

The present generation of telecom networks is less profitable to operate in rural areas due to low Average Revenue Per Unit (ARPU). While the key focus of 5G has been on high-density small cells, for developing countries like India, it’s important to cater to rural scenarios. LMLC targets to reduce the operational and capital expenditure for deployments of 5G in rural scenarios.

### (vi) Fixed Wireless Access (FWA)

FWA will be primarily used as a replacement for wired/optical connectivity to static endpoints (e.g. a physical branch of banks, or between base-stations), driven by line-of-sight requirements. As technology evolves, even higher speeds are foreseen. Using millimeter wave technology and massive MIMO + Beamforming, it will be possible to match the optical and copper-based links used by the current deployments.

### (vii) Cognitive sensing and co-existence with other physical layer networks

5G RAN is designed to encourage co-existence with other radio networks. Cognitive sensing for efficient bandwidth usage will be possible in such deployments.

It will also support integration with Wi-Fi networks. Wi-Fi networks are public and shared, and more prone to attacks. Using the 5G-WiFi integration, it may be tracked when the physical communication happened on Wi-Fi but the authentication happens at the core network of 5G. This feature enhances the reliability of such inter-technology communication.

This technology will also allow better network coverage in 5G systems. It will be possible for devices in low signal areas (e.g. within lift or in the basement) to reach the base-station via another device that has a better signal strength.

### (viii) 5G Private Networks

As the number of connected devices and the data generated in financial enterprises increases, it is expected that organizations would want to control their own networking environment. This can help the enterprise to easily customize and/or optimize the network as well as monetise the enterprise data that is generated. The key motivators for banks to look at the possibility of “private networks” are the following:

- ★ Coverage and capacity concerns in large financial organizations: Enterprises can hope to better engineer the network to meet their specific performance needs, e.g., specify uplink

and downlink configuration as necessary, dictate access policies, determine specific user/device rights, traffic prioritization, etc.

- ★ Deploy the network to meet specific challenging physical environments (e.g., warehouse or oil/gas facility, rural areas with specific micro financing potential etc). This can include robustness to recover from failure, implement for specific reliability and latency considerations, which would be hard to ask for in a public network.
- ★ Data security and control: Financial organizations can control the security of the data and ensure that sensitive information doesn't leave the premises; this is an essential requirement for many banks and financial institutions nowadays. Companies can also hope to better use the generated data by controlling the type of analytics to run on the generated data.

## 3.1.2 Softwarization of network and resources

### (i) Network Function Virtualization (NFV)

NFV deals with a separation of software instances from hardware platforms. The main idea behind the NFV is that virtualized network functions are implemented through software virtualization techniques and run on commodity hardware (i.e. industry-standard servers, storage, and switches). Some of the common network functions that may be virtualized include functionalities like switches, Network Address Translation (NAT), firewalls, load-balancers, Secure Socket Layer (SSL)/Virtual Private Network (VPN) end-points, gateways (for multitude of web-services, multimedia streaming, tunneling), DPI, AAA servers etc.<sup>[14]</sup>

Software running on high-performance computing server farms will implement many functions of a wireless infrastructure like the physical and medium access layers that were earlier implemented by dedicated hardware/semiconductors. NFV will bring enormous savings and flexibility in rolling out 5G wireless networks.

## (ii) SDN

SDN is a network architecture based on the idea of decoupling the control and data planes. In traditional IP networks, routers were placed at confluence points to route or switch the flow of packets to ultimately reach the destination node. The associated routing table was based on local knowledge of link congestion (identified in-band with data flow), which may vary from time to time and the routing logic was determined by the IP address of the destination node.

In the SDN based decoupled architecture, the SDN controller directly talks to routers and switches (over a dedicated connection, isolated from data flow) and populates the forwarding information within them. The routing of payload or other networks specific functionality is achieved using the information populated by the controller. The routing and forwarding strategies can be more flexible than IP address of the destination node leading to more efficient routing.

When coupled with virtualization, SDN provides a significant improvement in terms of agility for deployment and effective resource utilisation. This technology is already utilized in modern data-centers. With 5G architecture, it's possible to have the complete network resources connected to it, implemented as an SDN, which can be a complete game-changer.

## (iii) Cloud Computing

Cloud computing is a model of provisioning resources to the user as a pay-per-use methodology through the Internet. The resources may be at the infrastructure level such as networks, compute-server and storage or may be high-level applications and services.

4G and earlier networks have allowed the end-devices to access cloud computing resources. But these older networks did not work with cloud infrastructure and could not optimize the service delivery for the same. With SDN support by the 5G network and its ability to optimize services delivered by the cloud platforms, the network will be able to offer significantly enhanced experiences for end-user.

## (iv) Edge/Fog Computing

Traditional cloud computing offers many economic advantages from centralizing compute server functions particularly by sharing of resources. However, these server farms are often deployed at remote locations where the cost of power and cooling are economically advantageous, which also means that applications that need a rapid response/low latency are disadvantaged. Edge computing locates the shared compute resources much closer to the service endpoints like 5G base stations or NFV servers.

As opposed to massively centralized data-centers of today, 5G networks will allow installation of computing and storage nodes in the proximity of the data source (typically, close to the edge of service provider network), to optimize the user experience. While content distribution networks (CDNs) are already doing it, a pervasive and standards-based approach of edge computing support will foster better user interactions with reduced latency and enhanced power and communication efficiency for portable devices.

Fog computing refers to the gateways and compute systems that are placed in a distributed manner between the centralized data centers (legacy cloud infrastructure) and the edge of the network (near data source).

## (v) Network Slicing

Network slicing is a technology that allows a network operator to provide dedicated virtual resources (including network) with the functionality required for service to be delivered to the end user over a common network infrastructure. This form of virtual network architecture builds upon the principles of Software Defined Networking (SDN) and Network Functions Virtualization (NFV) that are common for fixed networks. SDN and NFV deliver greater network flexibility by allowing traditional network architectures to be partitioned into virtual elements that can be linked (also through software).

Since network slicing is a technology which allows

network operators to build multiple virtual networks on a shared infrastructure; it will enable operators to create pre-defined, differing levels of services to different enterprises, enabling them to customize their own operations. This allows better utilization of the resources on the network while providing dedicated (and possibly isolated) capacity for various technologies and applications.

Network slicing with programming support on 5G architecture will allow a tailored set of functions to optimize the use of the network for each device or a set of devices in a secure manner. Only the required functionality and resources can be assembled in a network slice, such that device can find and use the network, in an efficient and secure manner. Some of the resources can have gateway functionality to securely communicate beyond the slice with the core network.

A service can be simple in a manner that it requires only access to a single slice—for example, a garden watering system with soil moisture sensors and few controllers for water pumps and valves – can use a radio interface to exchange very small, infrequent messages. That Radio access network (RAN) attaches the devices to a simple, efficient authentication process that results in the device being connected to a single core network slice that handles these communications over an isolated network with required quality of service, based on the SLA requested for creating the network slice. The connected functionality provides all that the application needs to accomplish its work, without the overhead of unneeded functions and features

### **3.1.3 Enhanced device support**

#### **(i) Heterogeneous devices**

Early work on 5G observed that 4G networks were optimized for mobile devices, primarily smartphones and tablets, used by people. In such deployments, significant effort and enhancement of functionality are needed to support a very small M2M device. 5G systems will be capable of supporting a diverse set of devices in an efficient manner. It would be possible to

configure the devices that may be resource constrained.

Hence, the 5G system is designed to efficiently support a variety of devices, from the extremely small devices like smart dust to sense information, to the most powerful high-performance servers for running deep analytics. Other than supporting multiple physical layer connectivity, 5G systems are also designed to support the unique needs of each of these heterogeneous devices and the services that are delivered using them.

#### **(ii) IoT**

IoT refers to the objects that have sensors or actuators attached, can exchange information through the Internet, where its data can be processed and analyzed for decision making. These objects can be of varied size and shapes and may include mobility. While earlier generations of telecom networks expected humans to be present at least on one endpoint (e.g. humans at both endpoints for a voice/video call; and humans at one endpoint for applications like YouTube and Facebook), 5G is designed to support massive M2M communication.

Creating an architecture that allows machines to talk to each other, and to humans in a secure, reliable and quick manner, will help enable a wide range of verticals, varying from healthcare, to smart homes, smart industries and smart cities. While a range of IoT solutions exists today, 5G will provide simpler interoperability using standardization and enhance the security for the deployments.

#### **(iii) WSN (Wireless Sensor Networks)**

WSN can be considered as a subset of IoT, wherein the devices sense and generate information but do not implement the actuation and control part. The WSN may consist of a number of sensor nodes, collecting information from the environment for the specific use case and communicating with the neighboring sensor nodes using wireless medium. Some of these sensor nodes may not have full TCP/IP stack running on them as they are resource constrained (e.g. portable with

small batteries). In the past they have used gateway devices to communicate with other systems on the Internet.

With the 5G features such as device-to-device communication and communication support for non 5G RAN, WSN nodes will find better support in 5G networks.

#### (iv) Light-weight Cryptography

Many of the devices connecting to the 5G networks will not be able to handle full PKI implementations. For instance, they may not have enough storage space or network bandwidth to store multiple root-certificates or revocation lists. Various lightweight crypto schemes are being explored for such devices, especially for low-security (low-assurance) needs.

### 3.1.4 Converged Collaborative Network Infrastructure

#### (I) Contribution and Delivery Network for Video Feeds

OTT players like Netflix, Amazon Prime, YouTube and Apple TV+ service have implemented CDN to provide the excellent user experience. 5G networks will create a platform for content contribution apart from content distribution. It will be possible to stream content from all public video cameras in a town in a privacy-preserving manner. Such scenarios will be of

huge benefit for public safety, transportation, environmental monitoring, and law enforcement.

#### (ii) Artificial Intelligence / Advanced Analytics

The number and variety of 5G links will increase by 100x over those supported in current 2G, 3G and 4G networks. This will complicate network management, anomaly / fault detection and optimization. The role of machine learning and advanced analytics will vastly increase in 5G networks to handle this complexity.

Moreover, the collaborative nature of the architecture will foster the development of these services in a modular, secure and privacy preserving manner.

### 3.2 Network Slicing - Beyond Brick-and-Mortar Based Branches

The Fig. 9 covers the ten broad industry verticals that will benefit from 5G<sup>[24]</sup> and maps the six key characters of the network slice to support them.

With a possible exception of “hazard and maintenance sensing”, all other clusters apply for financial services use cases. It should be noted that all six characters of network slice are required for most of the BFSI use cases.

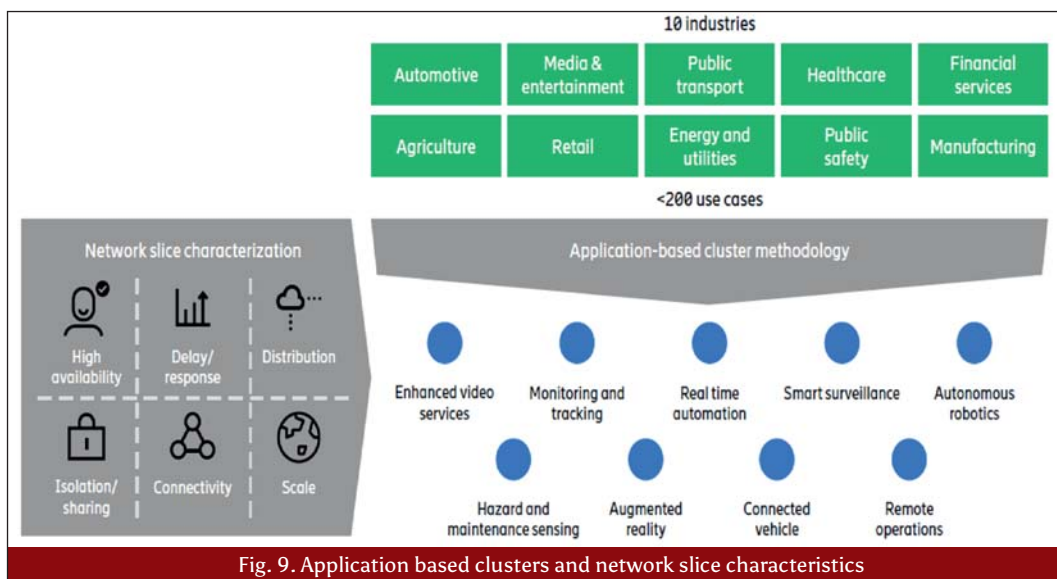


Fig. 9. Application based clusters and network slice characteristics

With the current trend of developments in technology space, imagining a financial services firm to transform an ATM into a full-service branch powered by video conferencing over a 5G fixed wireless connection, and usage of VR bots in the branch is not a fantasy anymore. 5G's expectation to offer the requisite bandwidth and low latency will be fundamental to mobile VR experiences. Further, extending augmented VR beyond gaming, BFSI can offer customers varied experiences including virtual telepresence. For example, 5G will make it possible to remotely operate physical lockers. Though the physical layer connectivity will play a key trend, network slicing will be the key technology to enable a secure, shared infrastructure for such scenarios.

Network slicing will be a key enabler for BFSI since each slice can be isolated, providing higher reliability, higher security and QoS to avoid data loss. These slices can be deployed at a global level or can be hierarchical in nature. For example, in the hierarchy of

slices, each branch of the bank can be a separate slice, serviced by multiple network service providers for fault tolerance. A couple of gateway nodes for the branch can be a part of the regional slice. The same hierarchy can continue from regional to zonal, from zonal to country and from country to planet levels. Note that the service level agreements will be different for slices as a different hierarchy.

The slices provide isolation at multiple levels as shown in Fig. 10<sup>[25]</sup>. Depending on the level of resilience and global reach required, the slices may be created at different levels. For a slice to span across the world (the whole of the earth), it may be at L5 so that it can work with multiple service providers across the continents.

Today, at the branch level, we generally run an isolated network at L0. With 5G, it may be possible to create a virtual slice, which internally uses two or more L1 slices from a different service provider. A

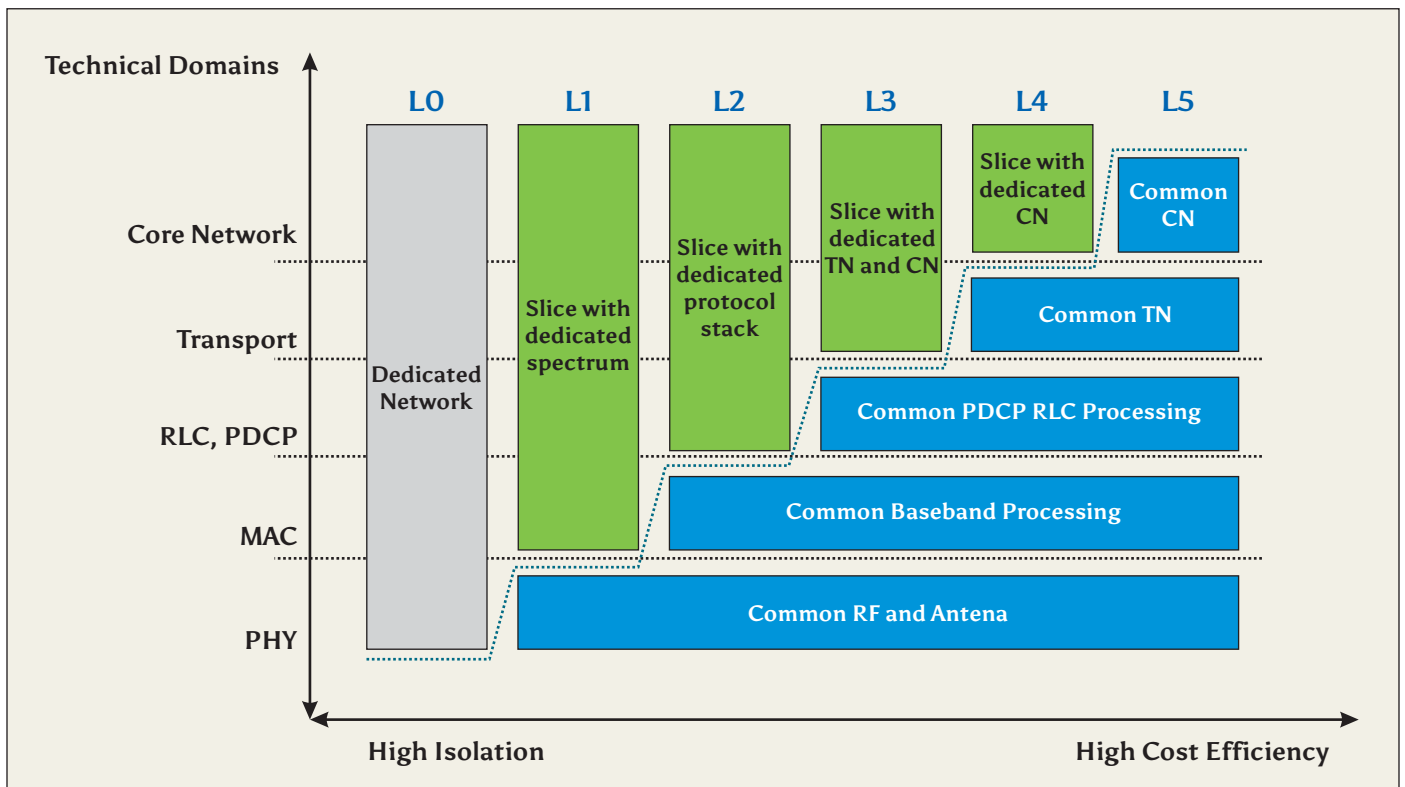


Fig. 10. Different levels of network isolation



virtual branch that supports mobility (say within a train), may require L4 or L5 level of slicing support to ensure that the mobility across service providers is properly handled.

As discussed in the prior section, the customizable features of network slice capabilities include data speed, quality (loss and jitter), latency, reliability, security, associated services, and resources depending on the layer at which the slice is offered. The capabilities are provided based on a Service Level Agreement (SLA) between the service provider and the consumer utilizing the slice. With the softwarization of the 5G deployment, in future, it may be possible to dynamically change the SLA for cost, performance or other reasons. Since the network slice is a virtual concept, it can span across multiple parts of the network (e.g. access network, core network and transport network) and could be deployed across multiple operators. A request for network slice can also explicitly mention the dedicated and/or shared resources and their QoS, e.g. in terms of processing power (CPU/GPU), storage, and communication bandwidth, etc.

### 3.3 Other 5G Technologies and BFSI

The advancement in information technology has resulted in explosive growth in banking technology like smart ATMs, extensive Internet and mobile banking offerings, which were traditionally offered by physical branches. With online banking and mobile banking, for many of the low assurance services, BFSI have adopted technology to go beyond the physical branches. They have engaged with FinTech providers in transforming customer engagement. FinTechs have helped in various fields such as: upgrading and migrating services, retaining existing customers and acquiring new ones.

5G promises to provide additional tools to aids such efforts, as well as create an environment for innovations. In addition to bringing significantly improved experiences for consumers, 5G will provide a wide range of opportunities for newer commercial applications as well as in improving the processes

within these industries.

BFSI entities are already challenged by the changing communication preferences of newer generation customers. They cannot afford to wait for the 5G picture to clear up, before moving to these platforms. There are primarily three technology trends that will benefit BFSI:

- ★ Firstly, a secure and privacy-preserving mobile wireless 5G Closed User Group (CUG) for BFSI to extend security beyond the brick-and-mortar based branches. This will be enabled primarily by technologies like Slicing, SDNs, Edge and Cloud computing, and NFV. The technology trends for the same is covered in the prior section
- ★ Second technology trend will be around M2M and machine-to-human communication features enabling micro-transactions and improving compliance and trust. Some of this sensed information (including video feed) will allow additional data analytics opportunities. It will also extend VR far beyond gaming where users could attend sporting events and concerts via their VR headsets capturing live experiences
- ★ Finally, the secure and open standards-based collaborative nature of 5G architecture will enable cross-domain opportunities offering newer services with multiple stakeholders.

#### 3.3.1 Smart Sensing and Micro-payments

Smart sensing and micro-payments offer a dedicated slice for the payments industry with higher QoS and more security. This is similar to public safety applications being handled separately. Building on WSN and IoT, smart meters can be equipped with UPI-enabled interfaces, and bills can automatically be paid/generated.

In pockets, this technology is already being attempted, especially at power grid and solar power generation levels. With software-defined services coupled with WSN and IoT, newer use cases could be deployed for BFSI. For instance, a financed vehicle running in a fleet of Ola or Uber could generate

micropayments towards servicing the loan for each trip that they undertake.

#### **(i) Micro-payments and negotiable offerings**

An established 5G network will enhance the possibility of micro-payments - a notion of paying exactly according to what is used, rather than the inelegant way we pay now with discrete plans. For example, drivers pay for a car parking space, or a tourist pays for an entry ticket for a museum, or a customer pays-for Wi-Fi hotspot for a set amount of time or set quota in size of downloads, rather than exactly how often and how long they have used the resource. With the massive deployments of sensors and devices in 5G-era, coupled with its real-time connection to the cloud; a real-time micro-payment could become very big business. As an extension, it could be possible for a person in urgent need (for say parking close to a hospital or bank), to make a counteroffer in a manner that the owner of the currently parked vehicle creates a space for him/her to park their vehicle. These policies could be set on devices (e.g. car's entertainment console) with minimal user interaction. Additional revenue can be generated by BFSI for such transactions.

#### **(ii) Smart devices and interplay with service providers**

Smart meters can be equipped with UPI-enabled interfaces, and bills can be automatically generated and paid. As the number of smart devices scale, the network should be able to handle the load.

Rather than monthly billing, some of the services can also have additional features like time-of-day or seasonal billing, wherein the charges can be higher during peak load (e.g. for water supply in summer or electrical power supply when the demand on the grid is high), while usage during off-peak hours is subsidized.

Faster and enhanced M2M communication will enable P2P payments, while authentication may still be done at the network level to avoid fraudulent transactions. The BFSI can utilize it for reducing their operational

expenses. The reduced cost-per-transaction may further expand the market to newer domains.

#### **(iii) Drones and Vehicle mounted cameras**

One of the heterogeneous devices and service for 5G involves usage of drones and other vehicle-mounted cameras. In addition to handling video streams while the nodes are mobile, the 5G ecosystem allows use cases like surveying of land/building records (for loan processing) or agricultural output including weather-related damage (for handling insurance claims). When coupled with geo-tagging and 3D surveying, these innovations will improve system efficiency while reducing fraudulent claims.

### **3.3.2 Collaborative platform**

#### **(i) Advanced Analytics**

The 5G architecture provides enhancements for advanced analytics across multiple domains, in a privacy-preserving manner. While significant analytics will be used by BFSI for streamlining their business processes and IT infrastructure, analytics features will percolate down to services offered by the BFSI as well.

For example, it will be possible for a BFSI to create an automated bundled offering wherein the customer opens some of the private information (e.g. vehicle location and usage details, for a vehicle purchased on loan) to receive financial benefits. This additional information can subsequently be utilized for behavioral, fiscal and social analysis to design new products that could be offered to customers or to reduce the risk by better analysis of the current loans.

#### **(ii) Smart Surveillance**

Cameras installed near the ATMs can be used for purposes like video recording, real-time identification of customers, face authentication, and identifying customer's mood while accessing services. Though current networks connecting the ATMs may not be suitable for these applications, the 5G network speeds would make such applications possible.

### 3.4 Security in 5G

Network Service Providers give preference to the activity of launching their products into the market and how good they are in terms of speed and efficiency of the product/service launch. The security of their product and service offerings takes a back seat. It has been shown time and again throughout the history that whenever computing power, bandwidth, connectivity, etc. are enhanced, it opens a new frontier, providing an opportunity for hackers and attackers to exploit against.

Some of the most publicized examples include cloud, mobile apps and IoT devices that are part of the system. Video cameras that are classified as a consumer gadget were the root cause of the largest Distributed Denial of Service (DDoS) attack seen by humankind. It has been established that the cloud can be exploited by hackers for taking control of a number of systems towards perpetual attempt of brute-force attacks over networks.

5G Security concerns at the most fundamental level, encounter issues in the authorization, confidentiality, data integrity/security, availability and authentication. These are not new concerns when we look at technologies of previous generations and were very much important issues.

Purdue University uncovered gaping holes in 4G LTE security<sup>[30]</sup>. It outlined crucial procedures of attaching, detaching and paging that is an integral part of the 4G LTE protocol and demonstrated as to how they are exploitable and can be compromised. This entails serious lapses in 4G LTE security.

It is anybody's call that 5G expectations include better, robust and stringent security policies vis-à-vis 4G and earlier generations with regard to various aspects of cellular networks.

It may, however, need to be kept in mind that the new protocol and specifications of 5G have legacy issues with 4G and previous generations. Those vulnerabilities of older generations continue to be vulnerabilities in 5G. In addition, as of now there is no

formal structured specification that is verifiable in a standardized way. Hence, new vulnerabilities deeply underneath are likely to be present in 5G, when the security policies are formalized. Another important point is the threat due to a network downgrade attack, a clear case of vulnerabilities of earlier generations getting exploited.

By using side-channel attacks, it is easy to have unauthorized access to sensitive information in (for example) International Mobile Subscriber Identity (IMSI). It will allow actors with malicious intent to intercept phone calls as well as geographical location tracking of the users. Since in 5G at the initial connection setup phase, there is no authentication of the base station, it will result in a downgrade to 4G or 3G of the customer's network by the hacker. Now the hacker can employ known attacks in 3G or 4G.

In the IoT context, 5G is expected to be a gamechanger and revolutionize innovation. It is said that 5G is capable of supporting billions of sensors and devices. It will obviously increase exponentially the threat vectors for IoT. In IoT space, security by design is more of an exception than a rule and each of the category of IoT devices from pacemaker (and such other medical devices) to connected gadgets and toys to smart-home appliances (such as a refrigerator that orders food when stocks go below some threshold) is shown to be brimming full with vulnerabilities.

Takeover of industrial installations and video cameras is amply demonstrated by cyber hackers. In 2016, incidence of hugely successful DDoS attack, millions of IoT devices were compromised. It resulted in the crash of Spotify, Reddit, The New York Times and Twitter. The culprits were botnets with names like Reaper, Mirai, etc.

Insecurely connected devices, with industrial controls, vulnerable cameras, and such other IoT consumer gadgets were found to have a weak interface in their underbelly, which was easily exploitable. This has been repeatedly demonstrated by using tools such as Shodan - a search engine.

### 3.4.1 Challenges in Security Architecture

5G networks allow entry of new mobile players in the market, their design and creation of new innovative services, and marketing of groundbreaking business models for their success. It is expected that such advanced networks will lead to highly efficient and economical promotion of a number of services, with synergy across differentiated vertical markets that can cater to diverse requirements of security and service. This may also result in exponential growth in number of factors.

Some of the critical technologies used include network slicing, network softwarization, network function virtualization, software-defined networking, etc. Ongoing research in security architecture makes use of technologies that were present in earlier generations of security architectures. However, the objective is to improvise, enhance, extend, boost these technologies to encompass and cater to demand of 5G landscape.

This can be achieved by use of new tools for modeling of the systems from the security perspective, with the ultimate goal of mastering security functions and mechanisms, which help and complement the implementations of security controls for given security objectives. Additional challenges in the 5G security design are due to high-level security aspects whose genesis is in the deployment of a huge number of IoT devices and network softwarization in the 5G architecture.

Many of the rules in 3G and 4G are essential for 5G security too. We look at the five major points:

- ★ **Threats prevention:** Majority of security incidents boil down to basic issues contributing to it. They can be minimized by use of firewalls for network protection and comprehensive access controls. Use of intrusion detection and prevention tools will help in mitigating 5G basic threats to security
- ★ **The strategy towards halting and hitting advanced malware:** The idea is to use something beyond the signature-based tools so as to identify and isolate attacks that are modeled and architected to dodge basic filters. Alternate strategies can include behavior-based checks on endpoints and sandbox deployments. As soon as a threat is detected, on priority, all instances of the threat on the network need to be identified and eliminated
- ★ **Anomalies identification:** Techniques such as big data, machine learning, packet capture, analytics, etc., need to be used to identify threats that were not detected by basic filters. These techniques when incorporated in routers and switches become integral and very effective, as it transforms these devices towards sensors for 5G security
- ★ **DNS intelligence:** DNS activity monitoring and protection against malware
- ★ **The principal aim of threat intelligence:** Organizations that do profiling of cybercriminals are in better position to comprehend wicked designs of attackers and cybercriminals. Threat intelligence should be attempted from diverse and multiple sources.

### 3.4.2 Various aspects of 5G Security:

The Fig. 11 below highlights the security aspects to be considered in implementing 5G networks.

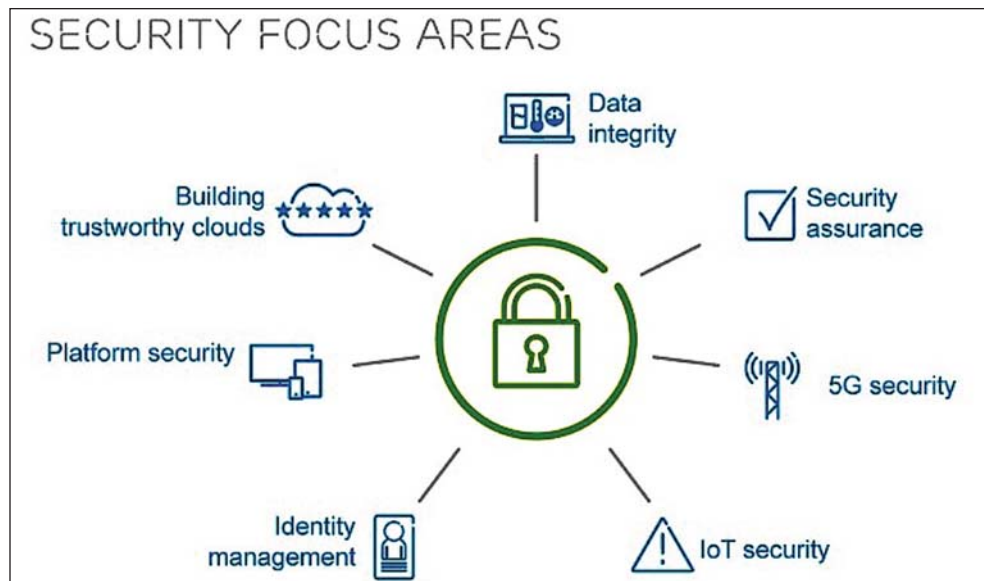


Fig. 11. Focus areas for security considerations in 5G implementation [Src: Ericsson/Meritec]

The massive MIMO technology has been shown to have good resistance to eavesdropping and jamming attacks because of the capability of forming very narrow beams towards the desired user (or from the desired user) using the massive arrays available. The same is possible using the mmWave systems wherein narrow beams can be formed using the mmWave antenna arrays. However, mmWave is a bigger challenge because of its propagation characteristics as it may get attenuated for a variety of reasons.

Enhanced physical layer security techniques over and above existing security mechanisms are crucial to ensure the success of the upcoming 5G wireless networks.

Standardized security mechanisms used in the wireless networks are well understood and their vulnerabilities have been well researched. So over and above these, we need something else that can make transmissions more secure. Physical layer security plays a key role in this space and enhances security. While something like this was not used for 4G; future advanced wireless technologies may use the same and improve the system performance. The existing LDPC and polar coding schemes have been designed in 5G with the aim of enhancing reliability in data transmission. However, they have not been designed with the goal of secrecy in mind. There is a rich literature on how to improve these existing channel coding schemes to improve the 5G system performance against any security eavesdropping attacks.

Several researchers have shown LTE 4G systems are susceptible to jamming and spoofing attacks predominantly because of the design of the pilot signals and always ON reference signals, which are used in the decoding of the LTE signals. Without these always ON signals, practically the LTE system is dead. For instance, CRS signals that are always ON and at the fixed location of the band of use, can be easily jammed rendering an LTE system useless. Furthermore, the synchronization signals are always at the center of the band of use and can be practically jammed. Different channels from control to data channels have been analyzed by researchers in Virginia Tech to show how vulnerable they are and how they can be attacked under limited jamming power considerations. They show that LTE systems are easy to be brought down<sup>[31]</sup>. For more reading, please see the IEEE Communications Magazine paper titled "LTE/LTE-A Jamming, Spoofing, and Sniffing: Threat Assessment and Mitigation". Some mitigation techniques have also been provided by the authors. However, considering LTE is already deployed and designed, these solutions, unfortunately, cannot be considered for the system design.

On the other hand, 5G systems, from the beginning have been designed to be highly flexible, no signal is always ON, the control channel locations, the synchronization signals, etc. can all be very flexible making the system more secure than the 4G systems. At least it should be understood that the flexibility provided in 5G NR design is such that more efforts are needed from the jammer/attacker perspective to bring down the 5G NR system. While synchronization signals may seem to be easier to attack in 5G NR, the possibility of sending multiple of such synch signal blocks can enhance the reliability of 5G NR systems more than 4G LTE systems. Therefore, it can be claimed at least from a physical layer perspective attack, the 5G systems are less vulnerable than LTE to jamming, mainly because of its dynamic and flexible design, and removal of sparse control channels like the PCFICH, which were present in LTE for easy attacks. Therefore, we can claim that we will be slightly safer in a 5G deployment.

### **3.4.3 Increased Home Control**

Home control is used for authentication of the device location when the device is roaming. It allows the home network to verify the device is in the serving network when the home network receives a request from a visited network.

### **3.4.4 Unified Authentication Framework**

In 5G networks, authentication will be access agnostic. The same authentication methods are used for both 3GPP and non-3GPP access networks (for example, 5G radio access and Wi-Fi access). Native support of Extensible Authentication Protocol (EAP) allows for new plug-in authentication methods to be added in the future, without impacting the serving networks.

### **3.4.5 Security Anchor Function (SEAF)**

5G introduces the concept of an anchor key, with the new function of the Security Anchor Function (SEAF). The SEAF allows for the re-authentication of the device when it moves between different access

networks, or even serving networks without having to run the full authentication method. This reduces the signaling load on the home network HSS during various mobility services. The SEAF and the AMF could be separated or co-located. In 3GPP Release 15, the SEAF functionality is co-located with the AMF.

### **3.4.6 Subscriber Identifier Privacy**

In 5G, a globally unique Subscriber Permanent Identifier (SUPI) is allocated for each subscriber. Examples for SUPI formats include the IMSI and Network Access Identifier (NAI). The SUPI is never disclosed over the air in the clear when a mobile device is establishing a connection. This is different from 3G and 4G networks, where the IMSI is disclosed when a device is going through an attach procedure (and another vulnerability in 3G and 4G networks) before the device is even able to authenticate with the new network.

Instead of disclosing the SUPI, a Subscription Concealed Identifier (SUCI) is used until the device (and network) is authenticated. Only then does the home network disclose the SUPI to the serving network. This procedure has been defined to prevent IMSI catchers (also known as false base stations, or Stingrays) from being able to retrieve the subscriber identity by forcing a device either to attach to the Rogue Base Station (RBS) or perform attachment process to operator's Base Station while sniffing the unencrypted traffic over the air.

### **3.4.7 Security Edge Protection Proxy (SEPP)**

To protect messages that are sent over the N32 interface, the 5G system architecture introduces Security Edge Protection Proxy (SEPP) as the entity sitting at the perimeter of the Public Land Mobile Network (PLMN).

## 4. BFSI USE CASES FOR 5G IN INDIA

INITIAL part of this section covers the incremental improvements from further digitization on account of 5G. Thereafter, it covers use-cases that will be enabled primarily by 5G. The additional role that existing BFSI infrastructure can play in the 5G deployments is also discussed.

### 4.1 Incremental Impacts from 5G

#### 4.1.1 5G to Enable Digital Transaction in Supply Chain and Financial Inclusion<sup>[26]</sup>

IMF plans to support programs to push 1 billion low-income population into middle-class by 2020. Technology has helped include over 2 billion low-income people globally with access to basic financial services – mobile banking, debit cards, mWallets. However, real financial inclusion needs participation from the entire supply chain. A connected financial supply chain (FSC), leveraging IoT and cloud computing can integrate manufacturers, distributors, retailers, shoppers including the ones in low-income groups. Such connected FSC will be the basic step for financial inclusion.

Benefits of connected FSC leveraging 5G include:

- ★ Enables replacement of cash transactions with financial instruments to economically uplift the unbanked population
- ★ Enables tracking of payments between unbanked population and FSC players
- ★ Enables tracking of wholesale operations, inventory, distribution, logistics and transfer of goods and services
- ★ Enables improved decisions on stocking, insurance, and replenishment of inventory
- ★ Enables a better understanding of consumer preferences and buying behaviors
- ★ Enables improved forecasting, demand planning and decisions

- ★ Enables planning of campaigns, promotions and discounts
- ★ Enables the ability to effectively use and forecast working capital
- ★ Enables banks to offer to lend for working capital finance and improve sales
- ★ Reduces the need for producing and transporting cash
- ★ Enables governments in implementing Anti-money Laundering, and increase tax.

Integrated FSC benefits various stakeholders. As per the World Economic Forum, the MSME sector contributes US\$34 Trillion to the economy of which \$19 Trillion is in cash. There is potential to bring this cash segment to the banked population with increased social inclusion and reduce the cost of cash handling, prevent theft and crime.

Integrated FSC incentivizes consumers to keep money in banks/mWallets with discounts and loyalty points for electronic purchases and reduced risk of keeping the cash. More electronic transactions enable stores to maintain inventory of the right products and help consumers meet the needs with fewer wasted trips.

#### 4.1.2 Using 5G to Enhance Risk Prevention and Regulatory Compliance<sup>[27]</sup>

With so much online business, there is increased data, residing in unstructured Big Data lakes. Companies that can analyze the structured and unstructured data together as a single dataset have an advantage. However, it means going beyond traditional enterprise data warehouse and business intelligence approaches. Considering the time taken to create a single dataset view, often the business requirements change.

The unstructured Big Data from the sources such as social media, weblogs, machine sensors, and mobile interactions with a varied source, type, size and format needs to be analyzed. Often one may need

data scientists to model, integrate, cleanse, prepare, analyze and visualize the data into Hadoop.

Analysis of Big Data is required to create accurate algorithms to spot the patterns and detect fraud and aggregate the information to make complex reporting speedier, analyze private and sensitive data for potential breach to compliance/regulations such as BASEL II/III, Anti-money laundering (AML), Know Your Customer (KYC) and many others.

### (i) Preventing Fraud and Crime

Fraud and crime analytics involve clustering, decision tree function, behavior and time series analysis, data profiling and accuracy calculations, data standardization, root-cause analysis, breach detection and fraud scoring to identify and prevent fraud and ensure regulatory compliance. Analyzing data can help reduce operating cost of fraud investigation, help prevent fraud, streamline compliance reporting, stop the fraudulent customers and protect damage to the brand.

Fraud detection and identifying compliance violations requires answers to questions like:

- ★ Whether someone is accessing data they should not be authorized to access
- ★ Where are the attempts to hack originating from
- ★ Types of customer behaviors that point to potential fraud
- ★ The list of customers who are into a very high-risk zone
- ★ Assessing customer risk before extending credit.

The potential outcomes of fraud and crime analytics include fraud and crime prevention, avoiding the cost of data breach, predicting security threats, reducing time to analyze data, lowering cost relating to fraud detection and prevention.

### (ii) Prediction and Analysis of Cyber-Security Threats

In order to predict and prevent the cybersecurity threats, the cyber-security firms need to analyze

where security threats could occur. Analyzing where the threat originated, regions where the traffic was generated, could predict where the next threat was likely to occur. This would help in reducing the risk of data breach. Data breach on average costs organizations \$5.5 Million.

### (iii) Identity Verification

Fraudulent transactions are growing at double the speed of online transactions. \$20 Billion worth transactions (about 9% of transactions carried out online) are fraudulent. Fear of fraud results in merchants rejecting the transactions on online media. Online identity verification can address this challenge by validating behavioral, transactional and social information, including individuals' social media profile to validate the individual making the transaction as well as the payment method used. A fool-proof identity verification results in an increase in trusted transactions and reduced fraud.

### (iv) Investigation and Prosecution of Criminals by Law Enforcement

Law enforcement agencies need to, on an ongoing basis, be able to identify individuals involved in criminal activity and be able to prevent upcoming criminal activities. Data from multiple sources need to be aggregated to be able to visualize human and crime relationships, identify how the criminal groups organize themselves, find out the relation between various criminal entities, etc.

### (v) Incentivizing compliance

Both BFSI and governments can provide incentives for people who use digital means (enabled by 5G) for their trade and finance. The incentives could be monetary or otherwise. For example, a roll-out of GST with e-way bill helps reduce revenue leakage, while allowing for faster transport of goods across the states in India.

### 4.1.3 Improve Customer Relationships and Customer Experience using 5G<sup>[27]</sup>

Banking and Financial Service Industry (BFSI) continues to face pressures to increase revenue and



grow the assets under management, while competition is increasing with many providers vying for the same consumer wallet share. BFSI industry needs to find new ways such as

- ★ Launch targeted marketing campaigns
- ★ Better understand consumer behavior and offer value-added products and service
- ★ Improve customer experience with the better understanding of causes of dissatisfaction and reduce customer churn.

By exploiting the features of 5G, BFSI can significantly improve the efficiency of the existing infrastructure (e.g. improve the branch efficiency).

Marketing teams need to engage in targeted marketing, which requires data on new types of customers. To improve revenue and reduce churn, sales and relationship teams need to understand customer behavior across various channels such as social media, websites, and customer call centers. To offer specific products, product teams need to know the customers better, identify customer needs and differentiate. Customers generate amounts of data, structured and unstructured, during their interactions with a variety of channels – social media, digital ads, email campaigns, product usage, and contact centers. Each time the customers click on online advertisements, call the contact center, use the account online to perform a transaction, and other interactions; such data can be turned into insights to help companies meet these objectives.

Data on client behavior patterns can be useful in multiple ways. In Wealth management advisory, client behavior (such as seeking information along with another advisor on the call, downloading certain forms from company portal) could indicate potential churn and movement of funds to another wealth advisory firm. Advance knowledge of this potential churn can help customer loyalty team to take proactive strategies to improve the service offered and prevent potential churn.

Businesses want customers to have uniform customer experience regardless of which channel they deal with. Often the websites get number of hits from automated Bots (with changed IP and Cookie) to find the data on pricing, etc. to help support pricing of competitors. If such hits are counted as real customers, the portal loses the ability to protect its confidential information on pricing, as well as wastes resources in handling bots that are not customers. Eliminating Bots helps free up servers for real customer traffic, resulting in improved customer experience, and preventing IT investments to accommodate Bots traffic.

Big data analytics and new BI platforms offer these capabilities but considering the amount of data existing in disparate systems, there is need to aggregate and carry out analysis such as clustering, path analysis, graph analysis, and advanced data mining and enable ingestion, enrichment, analysis and visualization of continuously evolving data. 5G networks come to an advantage to using more customer data in analysis from various sources and channels, correlate the analysis to projected outcomes to find new insights and take actions. All this can be done with a multi-fold reduction in analysis time.

#### **4.1.4 5G to enable Distributed ledger technologies (DLT) and Blockchain<sup>[28]</sup>**

Both permissioned and public blockchains can be ideal services to be deployed on 5G architecture. For BFSI in India, crypto-currency and public blockchain may not be a natural fit. Permissioned and federated DLT services can be offered on 5G networks in future for further innovation around the BFSI ecosystem.

##### **(i) Blockchain in capital markets**

Blockchain technology can be used to simplify and streamline trade process to create an automated trade lifecycle to make available same data about the trade to all parties involved. When integrated with 5G technology, it would reduce the cost of infrastructure, data management, transparency, processing cycle, reconciliation, and remove the brokers/middlemen.

## (ii) Blockchain for cross-border payments

Transferring money from one country to other takes a number of banks and currencies before the money is collected by the beneficiary. Services like Western Union is faster but expensive. Blockchain coupled with 5G can improve cross border payments by speeding up and simplifying the process, reducing the costs (from 5-20% down to 2-3%), removing the middlemen, and remittances and provide guaranteed, real-time transactions across borders.

## (iii) Blockchain to improve digital identity

Financial services like loans, mortgages, insurance require security for the financial institution to adhere to KYC process, which requires

- ★ in-person checking and/or official/government identity documents to be provided
- ★ users need to authenticate themselves each time they log in to the service
- ★ Authorization needs to be carried out to allow users to achieve what they intend to do.

The sequence of steps needs to be carried out for every new provider the users deal with. There are also privacy issues of web services and intermediaries having identity information stored.

Many of the identity management challenges in 5G can be addressed using DLT. Further 5G with its virtual slices provides an excellent platform to run Blockchain as services for different BFSI business networks.

## (iv) Blockchain for smart contracts

Blockchain can execute commercial transactions and agreements automatically (Smart Contract on blockchain) and enforces the obligations on all parties in a contract without adding the overhead of middleman. Smart contracts are programs that facilitate, verify and enforce the execution of an agreement emulating logic of contract clauses. Many types of contract clauses can be made self-executing and self-enforcing.

Smart-contract of Blockchain can simplify many of the multi-party interactions foreseen in 5G architecture. Furthermore, the slice-based deployments can provide a robust platform for conserving security and privacy for such deployments.

## 4.2 Newer Use Cases for BFSI from 5G

Following are some of the use cases where 5G will be a significant game-changer. Since machines will also be first class end-points for 5G, usage of robots and humanoids will be one of the most significant change. An exclusive network slice used by the BFSI will create isolated environments for wireless and mobile scenarios. In a way, this will allow all MPLS-based applications (including branch and ATM infra) to be connected wirelessly with some aspects of mobility as well. Native support for two-way multimedia communication will allow augmented virtual reality. Finally, support for drones, IoT and massive video streaming will also foster newer use-cases. For instance, lockers in physical branch can be remotely operated, including biometric authentication, without compromising on security and privacy, by bringing in the technical benefits of 5G for multimedia, AR, VR and IoT together.

### 4.2.1 Customer experiences beyond brick and mortar branches

Today Internet-based access to banking facility has become pervasive for most of the common banking needs. For the specific tasks that cannot be done over the Internet, the banking and financial companies are utilizing field agents for delivering services at the customer's doorstep. In rare scenarios (e.g. using safe deposit boxes, cash deposit / withdraw of high value, etc.) the customer still needs to visit the branch. The digitally illiterate customers also rely on physical branches. Despite the computerization of the branches, the cost of operating the branch is still significant.

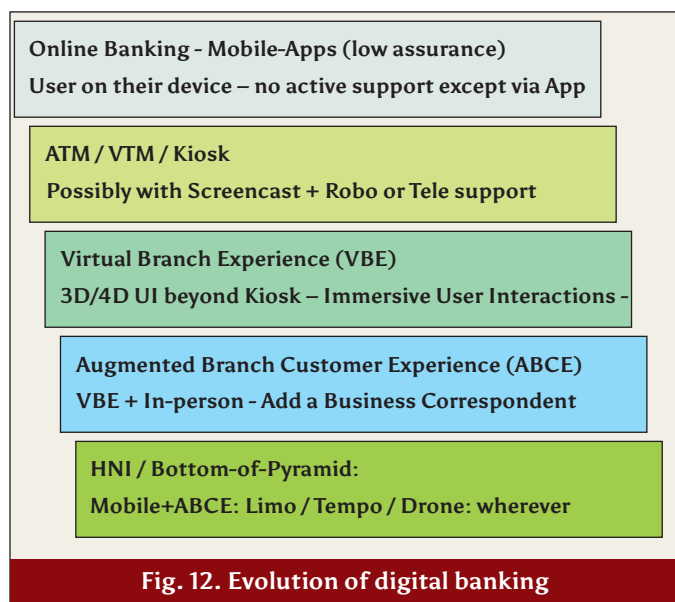
Bank branches are not as close to the end-customers as their mobile devices or computers. Online and mobile banking fulfills this gap. There are still

significant challenges:

- ★ User device not as trustworthy: Low Assurance services or delay for high assurance /high-value transaction
- ★ Two-factor authentication not enough in all scenarios
- ★ Some aspects of banking mandate physical contacts (e.g. in-person verification)
- ★ Impersonal: Technology may put off some of the HNI or people from the bottom of the pyramid
- ★ Lack of support for multiparty scenario: Online banking is still primarily a two party (bank and customer) scenario, though the banking portal allows controlled access to other parties and tools (e.g. trading platform, payment gateway etc.)

Virtual branch solutions that go beyond online banking exist today and complement the bank-employee to provide a better user experience. 5G will enable significantly superior experiences both within the branch as well as in customer’s vicinity.

The Fig. 12 below provides a possible evolution path for the banking industry:



Today, all banks have their apps for basic online banking needs. These apps run on customer's devices, which may be having malware or viruses and

hence only low assurance services are offered. Some high assurance services may be offered here with additional multi-factor authentication/authorization.

At the next level, banks are providing infrastructure like ATM or VTM or Kiosks where they can control the type of software that runs on the platform. This allows the next level of assurance in most cases.

Virtual branch experience (VBE)<sup>[29]</sup> using a dedicated setup can provide the customer with an experience similar to visiting a branch or even better than visiting the branch. These go beyond being a simple kiosk and may use physical space to allow interaction in the 3D realm. The environment may also include additional hardware elements like check-book printer, etc. to deliver most of the in-branch experience in a dedicated space in an automated manner. These branches may operate from small areas, including the lobby of a mall or hotel. In fact, some of this VBE infra can be white-label in nature. Depending on customer's interaction (e.g. use of a specific credit/debit card), the environment can take the avatar of the BFSI involved.

Augmented branch customer experience (ABCE) includes one or more BFSI employees as part of the virtual branch experience. The employee may be in physical proximity or utilize telepresence. Such setups will allow better utilization of human resources and encourage customers who are not cyber-savvy.

At the most innovative level, ABCE can support mobility. Thanks to enhanced security offered by 5G and the extreme mobility speeds being targeted, multiple new ways of offering BFSI services can be thought of. For example, as an executive rides an autonomous vehicle to go to work, her financial planner may join her in the car (either physically or virtually). The whole car ambiance may replicate the office ambiance of the financial planner and allow access to personal information without any impact on privacy and security. At the other extreme, a banking business correspondent driving a bi-cycle or a tempo may set up a mobile-ABCE using portable projectors and webcams in almost any place. This will allow the banks to reach remote corners of the world.

### 4.2.2 ATMs augmented with 5G

The ATM's currently installed throughout India provides different financial services to customers. The ATM's in India are connected through a National Financial Switch (NFS) offering services like Cash withdrawal, Balance inquiry, PIN change, Mini Statement and other value-added services. Most of the ATM's are stand-alone machines with very limited bandwidth only sufficient to exchange small payment related information. This limited bandwidth has been the bottleneck to upgrade the ATM's to smart ATM's. Now, with 5G network and a dedicated network slice for BFSI, the ATM's are transformed to smart ATM's which not only provide financial services but opens many business opportunities. We list some of the services provided by smart ATM and their network requirements:

- ★ Cash withdrawal and common ATM functions  
This is the primary functionality of the ATM and requires latency as per BFSI standards. This service doesn't require high bandwidth but demands low latency and also high end-to-end connectivity.
- ★ Advertisements  
Currently, ATM's are loaded with bank-related advertisements. However, these advertisements are loaded manually. Smart ATM's can leverage the 5G network capabilities to display dynamic advertisements.
- ★ Dynamic Updates  
ATM's require periodic updates for security reasons. Currently, these updates are installed manually and require high bandwidth to install updates online. As 5G promises high bandwidths, ATM's updates are installed online.

Present day ATMs rely on wired connectivity between ATM and banks core network. The encrypted traffic generally flows on MPLS links for privacy and security. With 5G, the wireless networks can augment or replace the wired networks, while providing similar quality, security and privacy.

Most of these ATMs also have multiple cameras. The costly wired links and poor bandwidth imply that these videos are frequently recorded locally and only backed up on a need basis. With 5G, it will be possible to utilize the programmable network to stream videos for live analysis. Many of the physical damage and financial losses can be observed in close to real time. This coupled with reactive policing will discourage miscreants from making mischief.

IoT features of the 5G network can also be used to monitor the health of ATMs environment including air-conditioner, UPS, lights, etc. When coupled with camera and motion detection system, the ATM environment can be programmatically controlled for significant energy savings.

### 4.2.3 5G Enabled Cash delivery and refill vans

Interbank cash transfers and ATM refills rely on cash delivery vans. Some of the solutions from Automotive vertical of 5G use cases can also be utilized for these delivery vans.

While the van itself may be autonomously driven in future, in the near term, using 5G technologies, the vans can be location tracked and immobilized if they deviate from the approved path. Moreover, the access to cash chest can be remotely authorized after analyzing the camera feed and location of the vehicle and nearby branches and ATMs. Given the distributed and autonomous nature of 5G architecture, such proactive implementations can be completely automated, even when the cash delivery systems are operated by third parties. In the short term, rather than complete automation, these solutions may involve human in the loop.

### 4.2.4 5G-IoT Enabled Insurance and Loan repayments

In the present days, the insurance companies are incentivizing people who are following best practices. For example, a good driver is offered discounted insurance if they commit to installing devices in the car that track the driving behavior. Similarly, a person who is physically active and healthy may be offered health

insurance at a significantly discounted rate if they are willing to share their health record during the policy period.

Loans sanctioned to purchase equipment or service can similarly be incentivized in a manner that the equipment is properly maintained and used. If the equipment is not used, there are chances of loan default, since the purchaser may not be able to generate revenue. Frequently IoT-based solutions can help measure all such compliance and trigger a warning of pending loan default, etc.

An IoT enabled 5G service will encourage multiple such scenarios. An added benefit related to this use case is the availability of massive amount of data for subsequent analysis (subject to privacy policies etc.).

#### **4.2.5 PoS and micro-transaction platforms empowered by 5G**

The point of sale terminal (POS) is used along with smart cards for the payment process. The problems with this system is that, it is very slow, less secure and time-consuming. To enable more security, the system will be using Cloud Storage. Also, the system will provide security using the One-Time-password (OTP), which is an automatically generated numeric string of characters.

#### **4.2.6 Drones for survey and tracking - benefits from 5G**

The Internet of Drones (IoD) is a layered network control architecture designed mainly for coordinating the access of unmanned aerial vehicles to controlled airspace and providing navigation services between locations referred to as nodes. The IoD provides generic services for various drone applications, such as package delivery, traffic surveillance, search and rescue, and more.

#### **4.2.7 Wireless connections to nearby data center**

For business continuity and disaster recovery, frequently a mix of off-site and near-site disaster

recovery deployments are used. Enhanced capabilities of 5G will allow connections to near DC.

### **4.3 BFSI Providing 5G Infrastructure and Services to other Verticals**

The recursive nature of 5G infrastructure allows BFSI to provide additional infrastructure and services to other verticals. As discussed in the preceding section, a fleet of vehicles can be financed and tracked to create a win-win situation spanning Automotive and BFSI sectors. Here we discuss some additional services and related use-cases.

#### **4.3.1 ATM and branches hosting the 5G base stations**

Since the ATM locations and branches already have physical presence coupled with power supply and some level of network connectivity, many of them can be used for small cell deployments. These locations already have UPS or back-up power sources that can be shared for combined usage.

Local small cell can in turn also offer a RAN slice for usage within the branch, manifesting the recursive nature of 5G architecture.

#### **4.3.2 Smart Surveillance - externally facing camera feeds exposed to other entities**

It has become difficult to monitor our workplaces and homes for security. Thus, there is an increased need for camera surveillance systems. By using these systems, it is possible to continuously monitor the workplaces and homes for security purposes and store it for future references.

#### **4.3.3 DVR for edge-based storage**

Many of the deployments for web-cameras include digital video recorders (DVR) that have massive storage capacity. In 5G deployments, it might be possible for banks to offer a service using these edge storage devices.

## GLOSSARY

3GPP	3rd Generation Partnership Project
AAA	Access, Authentication, Authorization
ABCE	Automated Branch Customer Experience
AF	Application Function
AFIN	ASEAN Financial Innovation Network
AI	Artificial Intelligence
AMF	Access & Mobility Management Function
AML	Anti Money Laundering
AMM	Access and Mobility Management
AMPS	Advanced Mobile Phone Systems
AN	Access Network
APIX	API Exchange
AR/VR	Augmented Reality/Virtual Reality
ATM	Automated Teller Machine
AUSF	Authentication Server Function
BCBS	BASEL Committee on Banking Supervision
BFSI	Banking, Financial Services and Insurance
BHIM	BHarat Interface for Money
CAPEX	Capital Expenditure
CAPIF	Common APIC Framework
CCAS	Comprehensive Capital Analysis and Review
CDMA	Code Division Multiple Access
CDN	Content Distribution Network

CN	Core Network
CP	Control Plane
CPE	Customer Premises Equipment
CPU	Central Processing Unit
DC	Data Center
CRS	Cell-Specific Reference Signal
DDoS	Distributed Denial of Service
DLT	Distributed Ledger Technologies
DN	Data Network
DVR	Digital Video Recorder
E2E	End-to-End
EAP	Extensible Authentication Protocol
EC	Edge Computing
EDGE	Enhanced Data rates for GSM Evolution
EIR	Equipment Identity Register
eMBB	Enhanced Mobile Broadband
FSC	Financial Supply Chain
FWA	Fixed Wireless Access
Gbps	Giga-bits per second
GEM	Graph EMbedding (for routing)
GPRS	General Packet Radio Services
GPU	Graphics processing Unit
GSM	Global System for Mobile communication

GSMA	Groupe Speciale Mobile Association
HSS	Home Subscriber Server
IEEE	Institution of Electronics and Electrical Engineers
IETF	Internet Engineering Task Force
IFC	International Finance Corporation
IHS	Information Handling Services
IMSI	International Mobile Subscriber Identity
IMT	International Mobile Telecommunications
IoD	Internet of Drones
IoT	Internet of Things
IP	Internet Protocol
ITU	International Telecom Union
JAM	Jandhan Aadhar Mobile
KYC	Know Your Customer
LDPC	Low Density Parity Check
LMLC	Low Mobility Large Cell
LTE	Long-Term Evolution
M2H	Machine to Human
M2M	Machine to Machine
Mbit/s	Megabit per second
MEC	Mobile Edge Computing
MIMO	Multiple-Input Multiple-Output

mMTC	Massive Machine Type Communications
MAS	Monetary Authority of Singapore
MSME	Micro, Small and Medium Enterprises
NAF	Network Authentication Function
NAI	Network Access Identifier
NAMF	Network Access and Mobility Management Function
NAT	Network Address Translation
NAUSF	Network Authentication Server Function
NWDAF	Network Data Analytics Function
NEF	Network Exposure Function
NF	Network Functions
NFV	Network Function Virtualization
NPF	Network Processing Function
NR	New Radio (5G)
NRF	Network Repository Function
NRRF	Number of Rx RF Chains
NS	Network Services
NSMF	Network Slice Management Function
NSSF	Network Slice Selection Function
NUDM	Network Unified Data Management
OEM	Original Equipment Manufacturer
OPEX	Operating Expenses

OTP	One Time Password
OTT	Over The Top
P2P	People to People
P2M	Person to Machine
PCF	Policy Control Function
PCFICH	Physical Control Format Indicator CHannel
PLMN	Public Land Mobile Network
POS	Point-of-Sale
PPP	Public Private Partnership
QoE	Quality of Experience
QoS	Quality of Service
RAN	Radio Access Network
RBS	Rouge Base Station
SBA	Service Based Architecture
SDN	Software Defined Network
SDO	Standards Developing Organizations
SEAF	Security Anchor Function
SEPP	Security Edge Protection Proxy
SLA	Service Level Agreement

SMF	Session Management Function
SSL	Secure Socket Layer
SUCI	Subscription Concealed Identifier
SUPI	Subscriber Permanent Identifier
TCP/IP	Transmission Control Protocol/Internet Protocol
TOSCA	Topology and Orchestration Specification for Cloud Applications
UDR	Unified Data Repository
UDM	Unified Data Management
UDSF	Unstructured Data Storage Function
UE	User Equipment
UP	User Plane
UPF	User Plane Function
UPI	Unified Payment Interface
UPS	Uninterrupted Power Supply
URLLC	Ultra-Reliable and Low Latency Communications
VPN	Virtual Private Network
VTM	Video Teller Machine
WSN	Wireless Sensor Networks



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