

---

# Telecom Operators' Business Model Innovation in a 5G World

---

Sriganesh K Rao and Ramjee Prasad

*Department of Business and Technology, Aarhus University, Herning, 7400,  
Denmark  
E-mail: Sriganesh.rao@hotmail.com; ramjee@btech.au.dk*

Received 30 January 2018; Accepted 27 February 2018;  
Publication 13 March 2018

## **Abstract**

Business models describe the rationale of how organizations create, deliver, and capture value. Evolving consumption patterns, advent of social media and emerging opportunities in new sectors fuelled by 5G Technologies, will render the current Business Models unviable and would create a need to innovate new Business Models. It is important for Telecom Operators to keep their business model innovation under continuous review. So, what business models should Telecom Operators consider? What opportunities does the future offer – and what threats?

This paper discusses the impact of 5G Technologies on Business Models – The need to plan highly cost-effective offerings that support exponential increase in network demand, higher data rates and volumes, lower latency and greater power efficiencies. It discusses as to how should Telecom Operators differentiate their businesses in 5G. The impact of Over-The-Top (OTT) player offerings on the Operators' Business Models are analysed in detail and the various Business Models that Operators could adopt to meet their strategic objectives are discussed.

**Keywords:** Business Models, Business Model Innovation, 5G Technologies, IoT/M2M, Over-The-Top (OTT).

## **1 Introduction**

This section describes the concept, definition and structure of Business Models. Further, the general principles of Business Model Innovation are described.

### **1.1 Business Models**

A business model is a company's plan on how it will generate revenues and make profit. It explains what products or services the business plans to manufacture and market, and how it plans to do so, including what expenses it will incur. A business model encompasses the addressed value potential, the customer interaction as well as the value creation model. The primary objective of a business model is to address a business opportunity in such a way that value is created both for the company and the customers it serves.

A business model lays out a step-by-step plan of action for profitably operating the business in a specific marketplace. The business model for automobile manufacturer is significantly different from the business model for a telecom operator, as an example. A business model describes the way how a company creates, delivers and captures value which is part of the overall business strategy [1].

To put together a good business model, we need to know the value proposition for the business. A value proposition is a straightforward statement of what a company offers in the form of goods or services that is of value to potential customers or clients, ideally in a way that differentiates the company from its competitors.

A business model should also include projected costs and sources of financing, the target customer base for the business, marketing strategy, competition, and projections of revenues and expenses. If possible, a business model should include any possible plans for partnering with other existing businesses. An example of this would be an advertising business that aims to establish an arrangement for referrals to and from a printing company.

Business Model design for a company, needs a good understanding of the following, amongst other things:

- What is the value proposition of the company i.e what products or services?
- What are the capabilities and the resources of the company?
- Who are the target customers?
- What customer problem or challenge is to be solved?

- What differentiated value are you offering?
- What are the costs models?
- How to you deliver the value to the end customer?
- What is the revenue model?
- What is the Profit model?

There are many different types of business models like the traditional direct sales, franchising, value added reseller, advertising based etc. The growth of Ecommerce, with the advent of Internet, has given rise to multiple new possibilities in business models like direct on-line selling and combination of physical presence with an online presence. Even if two companies are in the same industry segment, they may require different business models due to their individual advantages and disadvantages.

The fundamental structure of a Business Model involves

- Revenue potential target which considers the defined offerings (products/services), target customer segments and the vertical markets.
- Distribution channels through which the offerings are delivered to the end customer and defined payment structure.
- Customer relationship handling.
- Creation of value proposition i.e differentiation in offering the overall customer experience which is crucial for customer retention and sustainability of the business model.

If companies have to remain successful, they need to have an open eye towards the operating environment and innovate the business models, as necessary to stay competitive.

## **1.2 Business Model Innovation**

Business Model Innovation is the development of new, unique concepts supporting an organisation's financial viability, including its mission and the process for bringing those concepts to fruition. The primary goal of Business Model Innovation is to realize new revenue sources by improving product value and how products are delivered to customers. High speed Internet has made Business Model Innovation necessary, as technology has changed how companies operate and deliver value. This digital disruption has shortened business model lifecycles and made innovation key to financial success. Business have gone global and the global marketplace has further driven the need for Business Model Innovation, as companies have to address global challenges. Hence, companies have to Innovate business models to

stay competitive and foster growth in this highly competitive global market place. Business model innovation is about fundamentally rethinking about the business around the Customer need, then realigning company's resources, processes and profit formula with this new value proposition.

Business model innovation does not need new technologies or new markets, but the unique and innovative way the existing products are produced and delivered to the existing markets, which is very difficult for competitors to copy and replicate.

## **2 Trends in Telecom Operators Business**

Telecom Operators across the world are facing major challenges to the sustainability of their business models. They had typically grown on the back of the traditional voice and data services. Their current operations are becoming very complex, due to exponentially changing consumption patterns. The value is moving to a totally different market. The business models they had followed till now, will not work in future. Technology evolution is creating new opportunities in new market sectors. Technology developments are continuing to drive up demand and the development of new applications for mobile broadband. Telecom Operators have to remain vigilant and adapt quickly to disruptive changes. Many Operators have realized this and are updating their way of working to remain relevant in changing times. They are looking at innovating their business models to stay afloat and also profit from the new business opportunities enabled by disruptive technologies. They may have to adopt a combination of incremental innovation in certain areas while making disruptive innovation in select areas, to be able to best monetize the new opportunities.

### **2.1 Global Trends in Telecom Business**

The growth in telecom business, across the globe, is phenomenal. Details of the global mobile subscriptions, mobile data and video traffic, are given below [2].

- Mobile subscriptions are growing at around 4% year-on-year reaching globally 7.6 billion in Q1 2017. India grew the most in terms of net additions followed by China. The strong subscription growth in India was mainly due to an attractive LTE 'welcome offer' by one operator with free voice and data.

- Mobile broadband subscriptions are growing by around 25% year-on-year taking total global mobile broadband subscriptions to around 4.6 billion.
- LTE subscriptions reached 2.1 billion in Q1 2017.
- Mobile data traffic grew 12% quarter-on-quarter and around 70% year-on-year, while voice traffic growth was very slow. This growth is driven by increased smartphone subscriptions and average data volumes per subscription, fueled primarily by video content. The recent introduction of free data traffic offered in India has pushed up the global traffic heavily.
- 90% of the smartphone subscriptions are for 3G and 4G.
- By 2022, the number of smartphone subscriptions is forecast to reach 6.8 billion; almost all of these will be mobile broadband.
- Mobile video traffic is forecast to grow by around 50% annually through 2022.
- Video growth will be the largest at 50%. Video traffic dominates across devices.

India and China represent the fastest growing telecom markets. The Indian Government has set a target of 600 million broadband users by 2020 capable of a minimum of 2 mbps download speed and 100 mbps on demand [3].

Independent Over-The-Top (OTT) vendors are entering into traditional messaging, voice and video, which were forte of traditional operators. OTT communication services are increasingly bringing down the legacy voice and messaging revenues of mobile operators globally. OTT messaging has overtaken SMS globally as the most dominant form of messaging. International voice traffic is decreasing. The VoIP traffic contributes a significant fraction of international calls. The revenue lost by Telecom Operators globally due to OTT services, is increasing year-on-year [4].

Smartphone will emerge as the preferred medium of entertainment over TV, Theatres, Radio and newspapers. Mobile TV, powered by high speed connectivity, will dominate as it provides enhanced personal viewing experience anytime-anywhere access.

Voice revenue will decline and future growth will be in Data and Video.

## **2.2 Impact of Over-The-Top (OTT) services on Telecom Operator Business**

Over-The-Top services are the applications and services which are accessible over the internet and ride on top of Telecom Operator's networks offering

internet access services e.g. search engines, social networks, video and messaging services etc. The well-known OTT services are WhatsApp, Hike, Snapchat, Skype, YouTube, Viber, Facebook, E-Commerce sites like Amazon, online video games, Taxi aggregation services like Uber, etc.

Users can access these services directly online from any place, at any time, using a variety of internet connected consumer devices agnostic to how the connectivity is available i.e from a land phone, mobile or a computer. Conventional Telecom Operators offering connectivity only services like fixed or mobile telephony, are being impacted by these OTT services.

An OTT provider offers the above services without owning and operating a network or leasing network capacity from a Telecom Operator. Instead, they reach the users through global internet, by going “over-the-top” of Telecom Operator’s network. Services provided typically relate to media, entertainment and communications.

OTT players can access customers in the following different ways [4]:

1. Let us consider that a Telecom Operator has Internet Service Provider license and is providing last mile connectivity and bandwidth to the end user through fixed line or mobile, along with the conventional Voice service. So, a telecom pipe is created to connect the end user. The OTT player can offer its services on top of this telecom pipe.
2. A Cable Operator and a Wi-Fi operator provides the last mile connectivity and bandwidth to the end user, through a Wi-Fi hotspot to cable TV. Here, the OTT player can offer services over this bandwidth.

Here, the internet content and connectivity are separate, which enables the OTT player to deal directly with end users. The Telecom Operators are isolated from such transactions as they do not have any control over the content or the application. The move to all-IP architecture in LTE and 5G technology will further increase this delinking of delivery of services from the underlying network.

Telecom operator’s revenues are solely from the increased data usage for the internet connected customers for various applications. They do not get any other revenues. They are also not involved in planning, selling or enabling the OTT apps. On the other hand, OTT providers make use of the Operators infrastructure to reach their customers and offer products/services that make money for them and also compete with the traditional services offered by the Operator e.g. banking, e-commerce etc. Currently, the major sources of data traffic are Google, YouTube, WhatsApp, Facebook etc., which are capturing major traffic hours. OTT communications and OTT media are increasingly

playing a major role in internet domain. The declining price of Smartphones makes it easily affordable to large population and the digitalization of content facilitating easy delivery, has created explosive growth in online content.

The broadband networks setup by Telecom Operators are used as a platform by OTT players for development of new businesses. This creates a demand for faster broadband speed, which calls for more investments in network upgradation by Operators. The Operational Support Systems (OSS)/Business Support Systems (BSS) systems of Telecom Operators are also impacted as they have to support end-to-end telecom services. However, the Operators may not get return on their investments as they do not realize the profits which gets cannibalized by the OTT players.

Thus, we see that parasitic OTT services has made the traditional Telecom operator a “pure pipe” provider. The Telecom Operator whose network is utilized for delivering the OTT services, has no control, no rights for the content on these apps. Thus, it is evident that the Business Models of Telecom Operators are impacted by OTT players. The traditional income model of the operators, based on subscriptions and metered services, mainly voice and messaging, is failing.

The main challenge faced by Telecom Operators by the OTT players are that, they are offering voice and messaging services, traditionally provided only by Telecom operators. Thus, OTT players are competing with Telecom Operators without any investments in building networks. However, this is leading to increased data revenues for the Operators, but profitability is declining.

### **3 5G Evolution**

There has been a rapid evolution of radio technologies since the launch of analogue cellular systems in 1980s, termed as 1<sup>st</sup> Generation or simply 1G. Thereafter, digital wireless communication systems are consistently being evolved, one generation being advanced every decade.

The Second Generation (2G) happened in 1990s, primarily using the GSM standard and using digital transmission instead of analogue transmission, which had the benefit of lower battery power consumption. SMS text messaging was introduced.

The Third Generation (3G) came in 2000s, bring in high-speed IP data networking. Packet switching was used for data transmission as against circuit switching done earlier. This enabled media streaming of digital content to 3G handsets.

Fourth Generation (4G) in 2010s saw the growth of mobile broadband, with improvements in speed up to 10-fold over 3G and was an extension of 3G with higher bandwidth and services. Data transfer speed up to 100 Mbits/s downloads is possible in 4G Long Term Evolution [5].

Now we are progressing towards Fifth Generation (5G) in 2020. We are advancing towards more and more sophisticated and smarter technology. The features of 5G has the potential to change the meaning of mobile communications enabling revolution in connected society.

5G is more than just a generational step; it represents a fundamental transformation of the role that mobile technology plays in society. As demand for continuous connectivity grows, 5G is an opportunity to create an agile, purpose-built network tailored to the different needs of citizens and the economy. It is an opportunity for operators to move beyond connectivity and collaborate across sectors such as finance, transport, retail and health to deliver new, rich services. It is an opportunity for industry, society and individuals to advance their digital ambitions, with 5G a catalyst for innovation.

5G will naturally evolve from existing 4G networks, but will mark an inflection point in the future of communications, bringing instantaneous high-powered connectivity to billions of devices. It will be designed specifically for the way we want to live and provide a platform on which new digital services and business models can thrive. It will enable machines to communicate without human intervention in an Internet of Things capable of driving a near-endless array of services. It will facilitate safer, more efficient and cost-effective transport networks. It will offer improved access to medical treatment, reliably connecting patients and doctors all over the globe. From low-power, sensor-driven smart parking to holographic conference calls, 5G will enable richer, smarter and more convenient living and working. It is a giant step forward in the global race to digitize economies and societies [6].

5G can be described as a software-based communication network architecture [7], which can be dynamically programmed in order to provide the right control layer for a given application. This will facilitate new and diverse business use cases. 5G supports “network slicing”, which allows a Virtual Network Operator to define its own network architecture, enabling rapid roll out of scalable services at lower costs.

### **3.1 5G Features [8]**

- 10 Gb/s data rates to support ultra-high definition video and virtual reality applications.



- 10 to 100 times faster and have greater capacity than current 4G LTE networks. The increased speed and capacity will allow web pages, video, and other data to load faster on mobile devices, as well as enable various innovations such as remote surgery and smart cars that avoid collisions.
- Less than 1 mS latency to support real-time mobile control and vehicle-to-vehicle applications, Remote surgery, New applications in On-line gaming, Augmented reality etc.
- Seamless delivery of services across licensed and unlicensed spectrum.
- Always-on user experiences.
- several billions of applications and hundreds of billions of machines.
- Energy-per-bit usage should be reduced by a factor of 1,000 to improve upon connected device battery life.
- Network Slicing, which allows the physical 5G network to be split into different virtual networks to suit specific applications or customers.

### **3.2 Enablement of Diverse Use Cases**

The possibilities for 5G are many, but initially it is being designed to serve three very different use cases or market segments:

- Enhanced mobile broadband: High speeds measured in Gbps,
- Massive IoT: Low power consumption, low cost, and the use of low-frequency spectrum bands to provide broad and in-building coverage.
- Ultra-reliable communications: High reliability, high availability, and low latency down to 1ms end to end.

5G would enable new diverse use cases and applications like:

- Relaxed latency requirements – Remote meter reading for billing purposes.
- Strict latency requirements < 1mS – Process industry safety & control systems, real-time patient monitoring, Security & Video surveillance, real-time traffic light control, Two-way gaming, Virtual & Augmented reality etc.
- High levels of network reliability. – Electrical grids, industrial control, traffic, e-health and smart-city management.
- Relaxed level of network reliability – Temperature/moisture sensors @ home.
- High Volume of information – Remote video surveillance etc.
- Low volume of information – Cargo tracking in the shipping industry etc.
- Low device cost/low energy – Battery powered sensor networks.

## **4 Impact of 5G on Telecom Operators Business**

5G will bring multiple propositions to all customers and at the same time provides an enhanced and unique proposition tailored to each one of them. The definition of the customer is not limited to the consumers and the enterprises as in today's environment but also expand to include verticals and other partnerships.

5G will be enriching the mobile internet experience while at the same time opening up new possibilities, applications and services.

### **4.1 New Opportunities Created by 5G**

5G meets specific needs in many industries and as a network, can adapt to new domains such as Augmented and Virtual reality, Industries 4.0 and IoT [9]. Some of the applications which could be enabled by 5G are:

- Industries 4.0 requires very high level of connectivity in factories which are mainly wireline communications today. 5G will act as a single communication medium covering very remote locations and will cater to the automation of the process.
- Smart homes – residential and commercial areas can be connected wirelessly, even where fibre is not yet installed. The rich communication services offered by 5G would enable Home users to have realtime home security, home entertainment with virtual reality and UHD video services, healthcare and elderly care etc.
- Augmented and virtual reality enabled by 5G, can have applications in many areas like real-estate, hospitality and event management.
- In the Enterprise segment, the adoption of 5G will be faster as this offers the best business model where the revenues earned from these would be higher. Central business districts have a very large number of enterprise complexes and the 5G small cells can offer a good alternative for fibre which would be difficult to install.

5G will create new opportunities in new sectors, which had been ignored by Telecom Operators till now. The widespread deployments of wireless networks, coupled with an increased appreciation of the value of connectivity, have meant that opportunities for Telecom Operators have opened up in new sectors. Multiple operators are actively looking at opportunities in sectors such as healthcare, automotive, energy, and utilities. For e.g. BT has ventured into the smart metering area by setting up an alliance with two other companies under the brand name SmartReach [10].

Use cases enabled by 5G's ultra-reliable low latency communications and massive machine type communications, which involve sensor network and IoT, will take Operators to entirely new business segments and would be a key driver for Operators to design new Business models. The IoT market segment is new to many of the Operators and would offer a challenging Business Model Innovation to address these markets.

A broader range of use cases will evolve over time, along with implementation of supporting network technologies. The demands of numerous existing and new use cases can be fulfilled on evolved 4G (LTE) networks. As networks evolve, there will be even more opportunities to enhance the existing use cases, as well as to meet the demands of more new use cases when 5G is implemented.

The first commercial use of 5G is expected to be for enhanced mobile broadband (eMBB) and Fixed Wireless Access (FWA). Enhanced mobile broadband will provide very high system peak rates in the gigabit-per-second range, meeting the performance requirements of high-demand applications – such as augmented and virtual reality (AR/VR) and ultra-high-definition (UHD) video (4K/8K) – within a targeted coverage area. With 5G set to provide 10 to 100 times more capacity than 4G, it has the potential to enable cost-efficient FWA solutions on a massive scale.

Beyond enhanced mobile broadband, networks will be able to handle use cases with different demands on mobility, data rates, latency, reliability and device density. These cases will come from industries such as automotive, manufacturing, energy and utilities and healthcare.

Early 5G deployments are anticipated in several markets. In 2022, the number of 5G subscriptions is forecast to reach more than 500 million. A 5G subscription will require a device capable of supporting 5G services and use cases, and that is connected to a 5G-enabled network. Over time, 5G will enable a wide range of use cases for massive Internet of Things (IoT) and critical communication [11].

## **4.2 Role of Telecom Operator to Support 5G**

Mobile communication will be assumed to be always available as a lifeline, and serve as means for smart socio-economic well-being, smart services and processes, smart automated industries, and smart remote operations.

- Deliver faster connectivity, communication and content anywhere, anytime without any perceived delay, i.e Connectivity should be made available to customers anytime and anywhere.

- Services should be delivered with consistent experience across time, space, technology and devices used.
- Services should be made available on multiple devices and interfaces. User sessions have to be made portable from one device to another and should be transparent to the User. The interfaces may include touch/speech/facial/eyes recognition etc.
- They should support multiple interaction types- Multi-device interactions within smart user spaces and personal clouds with the user's ability to create, communicate, control, manage and share.
- They should provide full transparency and seamless connectivity for all customers regardless of wireless or fixed accesses i.e the support should be seamless across technologies.
- Provide a personalized and contextual services – i.e Services should be enhanced by contextual and personalised attributes to provide a personalized experience.
- Security and Privacy should be strictly supported.
- The network implemented should be highly reliable and resilient.
- The communication provided should be responsive and in real-time—to allow fast downloads to realtime multimedia and pervasive video, with ultra-high resolution, for personal interaction and peer-to-peer or multi-party.
- Carriers and service providers must prepare their networks for the scale and flexibility that is required to provide highly cost-effective solutions that support exponential increases in network demand, a wide variety of devices and applications, higher data rates, lower latency, and greater power efficiencies – all while maintaining a low cost per gigabit service model. The entire supply chain will be affected by this revolutionary development.
- Operators should implement technologies like edge computing and cloud Radio Access Network (RAN), pushing the network's computational processes closer to the end user, thus providing faster speeds and lower latency.
- Operators should implement network function virtualization (NFV) and software-defined networking (SDN) within their existing networks to support **network slicing**, in which the network dynamically adapts to support the different types of access traffic that's coming into it by assembling resources into a network slice that supports a specific application. One network view can be optimized for the specific requirements and cost objectives of massive IoT, while another could have the low latency

and high bandwidth necessary for connected cars, rather than having the network available to all applications all the time. This allows for a more efficient use of resources, which brings the cost per bit down and helps improve the business case for most applications.

- They should provide a network infrastructure which should be flexible and programmable to deliver large capacity to accommodate varying traffic demands and should be built on common platforms that adapt to any cloud based applications. They should offer advanced analytics to control and manage the entire network, with end-to-end security built in.

#### **4.3 Challenges Faced by Telecom Operators**

- The IoT sensor network would involve billions of devices which may not necessarily be SIM based. Telecom Operators will have to develop methods to authenticate such devices. This would involve large operational change [12].
- The business cases enabled by 5G, may necessitate to support vertical industries and this would involve a new set of partnerships to be established with different players in the ecosystem. Further, it may involve integrating partner's services into their own network, exposing their own specific network capabilities and infrastructure sharing.
- The network changes and the upgrades that the Operator has to do, involves a huge capital investments and technical resources.
- Work on 5G Standardization is still underway. Since technology is not proven, it would involve extensive trials before finalizing the networks.
- There is a massive increase in data traffic and revenue is either declining or not keeping up with growth in demand.
- Lower revenue per user in saturated markets,
- Having no accurate clarity on revenues, return on investments is very difficult to analyze. This may delay raising capital required for the network rollouts.

### **5 Impact of 5G on Telecom Operators' Business Model Innovation**

In this section, we will look at the evolution of the Telecom Operators' Business Models over a period of time, the current trends which create a necessity for their further innovation and the impact of 5G technologies in shaping the business models.

## **5.1 Telecom Business Model Evolution**

This section discusses the evolution of the business models adopted by Telecom Operators over a period of time. It traces the developments from a pure voice player to becoming a ‘Triple play’ player i.e delivering the triple service of voice, video and data and later their market expansion. Further, it discusses the outsourcing of certain functions like network to Original Equipment Manufacturers (OEM) and IT to System Integrators. Then, it looks at the advent of leasing bandwidth to Virtual Network Operator (VNO).

### **5.1.1 “Broadband business” model**

Telecom was basically a Dial-up Voice service business till about 20 years back. During 1999–2000, Cable operators started offering high speed wireline Broadband data service on Hybrid Fibre Co-axial (HFC) network along with their conventional cable video services. Telecom business was disrupted by this and large Telecom Operators, who had pure fibre infrastructure had to venture into installing HFC network and integrate their Voice, Data and Video services and offer a bundled offering. These providers were called as “Triple-Play” providers, because they provided all the three services – voice, video, high-speed data through a single cable coming into the customer premises through the HFC network. E.g., C&W Optus in Australia. Incumbent Telecom Operators, who did not have fibre infrastructure, started converting their existing infrastructure into Digital Subscriber Line (DSL) to offer Triple play services. E.g., BSNL in India. The Telecom Operators had to partner with Content/Video providers or build their own to offer the services.

Over the years to come, Broadband business model became predominant and grew rapidly, in Telecom Operator business, as they all had to offer broadband services along with their voice services. The main objective of this model was growth of subscriber numbers. This model was an evolution of the dial-up model, where the traditional voice customers were converted to Broadband which offered voice and data and in some cases, triple-play. This model has enabled both fixed and mobile broadband to reach the point of saturation in developed markets. The onset of 3G saw a growth in Mobile broadband, the business model of which was similar to the HFC/DSL model.

The success of this model came through the services operating over the top of the broadband network. The services included applications on the mobile phone being delivered from remote data centres in high speed through the broadband network. This model started as a flat rate model, went through an iteration of speed and finally moved to position of unlimited data plans.

Telecom Operators have made efforts to innovate across the three major dimensions, through a combination of market, channel, and network initiatives.

### **5.1.2 “Target expansion” model**

Target refers to the offerings (products/services), customer segments and the markets and this constituted the core value proposition of the Telecom Operators. They had begun to make changes to their core value proposition. Many of them had realized the need for expanding their footprint in order to tide over maturing home markets. For e.g. India's Bharti Airtel realized that competition in the Indian mobile market was growing rapidly, and in order to diversify, went ahead and acquired the African operations of Zain [13].

Similarly, operators had also entered completely new sectors and modified their offerings to address evolving business and consumer realities. Most of them had started off mobile broadband pricing plans on a flat rate model. However, once it started becoming clear to them that there was a challenge of monetization, they started moving onto tiered pricing based on downloads and even further by bandwidth offered.

### **5.1.3 “Outsourced managed services” model**

In this model, Telecom Operators outsourced significant parts of the network operations, which directly impacted their cost base, to equipment vendors. Multiple operators in India had outsourced network operations to vendors such as Ericsson and Alcatel-Lucent among others. Even the complicated Operation Support Systems/Business Support Systems, were outsourced to IT vendors like IBM.

The advantage of this model for the Operators was that they did not have to keep track of the technology changes and upgrade their networks and software applications frequently. They could just concentrate on the market, the offerings and customer acquisitions. The outsourcing model worked on stringent outcome based Service Level Agreements.

While Telecom Operators are innovating within the ambit of individual elements of the business model framework, there are larger trends with varying spans of influence that are impacting companies across multiple elements of this model. In the next section, we discuss some of these broader trends.

### **5.1.4 “Virtual Network Operator (VNO)” model**

Virtual Network Operators are extensions of the Telecom Operators who connect with their networks and deliver services to their own set of subscribers.

VNO does not own spectrum or access infrastructure, but provide telecom services by purchasing capacity from the Telecom Operator. VNOs play an important role in the telecom market by buying wholesale bulk minutes from the Telecom Operators and selling them to consumers at a discounted price. They create their own service delivery platform and handle customer service, billing and value-added services to their own subscribers.

The advantages for the Telecom Operators in this model are that they are able to sell a part of their wholesale business, without having to worry about customer acquisition, niche service offerings and customer management. They can have multiple VNOs. In this way, they were able to expand into niche markets very quickly.

## **5.2 Need for Telecom Operator's Business Model Innovation**

The operating environment for Telecom Operators is turning increasingly complex. Telecom operators who had grown on the back of traditional voice and data services are realizing that as consumption patterns are rapidly changing, value not only moves to other stages in the Telecom Operators value chain but also into completely different markets. Subsequently, their old business models are coming under increasing pressure and appear to be crumbling. They need to take a critical view of the rapidly changing scenario and take steps to ensure that they are in tune with the changing times.

Telecom Operators will have problems in profitability with their traditional services. The major issue would be the decline of their traditional fixed-line businesses and mobile voice business.

In Section 2.1, we have seen the global trends in telecom business. In Section 2.2, we have seen how the OTT services are affecting the Telecom Operator's business. To monetize the large opportunities promised by 5G, Telecom Operators have to enter into new domains necessitating changing their traditional ways of business operations to be in line with the requirements of the new domain. Since opportunities span across various domains, the key focus for the Telecom Operators is to ensure that they have a business model which is innovative and flexible to make them successful.

The coming of age of the digital consumer, a breakdown in current revenue streams, and emerging opportunities in new sectors are all playing a key role in ensuring that the business model of yesterday is becoming increasingly obsolete. Telecom Operators should consider taking steps to incrementally change their business models, while striving to adopt radical approaches in



select areas, and challenge traditionally accepted norms of where a Telecom Operators fits into the larger ecosystem.

### **5.3 5G Business Model Innovation Potential**

Some of the factors driving the potential for business model innovations for 5G are:

- The mobile broadband market in developed markets is at or approaching saturation and driven by revenues from consumers or consumer driven services offered to business. 5G will expand the addressed market into B2B applications – a scenario where the 5G network will improve or rationalize existing business processes with a digital/networked alternative. The potential efficiency improvement for these B2B applications brings very different businesses into play. Some of these can already be solved with 4G and can happen without business model innovations. But a larger number will leverage the 5G capabilities and characteristics with new business models.
- Network Slicing is a key enabler for new 5G services, which will enable operators to use their physical infrastructure to create ‘slices’ of their networks through virtualization technology and tailored to the needs of any industry, be it automotive, healthcare, logistics, retail or utilities. This will help transform various industries and new business models for the telecom industry. It will also help to handle the huge variety of 5G services with different requirements, thus lifting the networks’ productivity. Slicing requires a high degree of programmability which means a network can dynamically adjust to whatever it needs to do. Here, technologies such as Software Defined Networking (SDN) and Network Function Virtualization (NFV) can today help operators migrate many functions to the cloud, also preparing their OSS for the 5G era. In the process, this will immediately increase network productivity. This opens up a new opportunity in innovating their business models to monetize the opportunities [14].
- The pre-5G world will generate new applications and business models, such as location-finding services, multicast services, repetition on-demand and augmented reality. In the full 5G world, however, we will see additions like player-perspective gaming, augmented and virtual reality. This provides a huge potential for creating new targets with respect to the value proposition and also challenges in deciding on the offerings, markets and the partnership they have to forge. This creates a huge

potential for the Telecom Operator to shed their old business models and start innovating them to address future opportunities.

- The new opportunities created by 5G for the Telecom opportunities, as detailed on Section 4.1, creates a radical approach to future business.
- 5G is a technology evolution that enables Industries 4.0. To create new revenue streams from these opportunities the Telecom Operator should ensure to create good strategies to address the IoT applications and the right business models to ensure they are able to generate sustainable revenues from the services that they provide.
- 5G is ‘application aware’ and provides network as a service, enabling different profiles being used for different applications. This brings about a potential for application providers to pay for the network usage and bring out amazing user experience as an added incentive.

## **6 Telecom Operator’s Business Models in a 5G World**

Various business models that a Telecom Operator can adopt, is discussed here.

There are two main options for Telecom Operators

- Continue their core operations and/or
- Diversify into Digital services arena and transform themselves into a Digital Enterprise

Independent OTT vendors are entering into traditional messaging, voice, video, which were forte of traditional operators. OTT communication services increasingly cannibalizing legacy voice and messaging revenues of mobile operators globally.

We have seen in earlier sections on how the OTT services has impacted the Telecom Operators business. OTT messaging has overtaken SMS globally as the most dominant form of messaging. International voice traffic is decreasing. and the VoIP traffic is increasing. VoIP traffic contributes to a significant fraction of international calls. The revenue lost by Telecom Operators globally due to OTT services, is increasing year-on-year. With the increasing proliferation of Smart phones and OTT based voice and video calling services such as WhatsApp and Skype, regulated legacy voice services could lose significant market share.

With the above challenges that the Telecom Operators are facing, it is very important they relook at their existing Business Models and innovate to stay in the business. We will look at many of the possibilities that a Telecom Operators could adopt.

## **6.1 'Telecom Operator as Connectivity Provider' – Business Model**

Here the focus is on connectivity which is the core business of the Telecom Operator. The key factors for consideration are subscriber growth, Average Revenue Per User (ARPU) growth/Connectivity for IoT etc.

### **6.1.1 Basic connectivity model**

This is “Business as usual”, where the Operator continues as a connectivity provider. Basic connectivity involves best effort IP connectivity for retail and wholesale customers and this model is basically a projection of existing business models into the future. Here the Operator will continue with the traditional mindset of focussing on customer market share – voice/data/SMS. Operator will allow OTT players to monetize digital services but gain indirect upside from increase in data revenue and hence increase in ARPU due to OTT.

### **6.1.2 Enhanced connectivity model**

Enhanced connectivity models will be considered where IP connectivity with QoS and differentiated feature sets (e.g. latency, mobility) is made possible by 5G.

### **6.1.3 How will 5G affect this business model?**

The connectivity provider business model applies for both retail and wholesale commercial relations and offerings. It assumes that the customer and service provider are decoupled from the physical infrastructure and they are offered no configurability, and a very low level of configurability, respectively. The 5G system should enhance the efficiency of this model by enabling the operator to configure the data flow to use only necessary functions in the network, on demand and in a programmable manner, in order to optimize operational and management costs. This requires modular network architecture, having the capability to be exposed to the 5G provisioning/configuration system.

## **6.2 “Partnership” – Business Model**

Here, the various possibilities of partnering with an external entity is discussed. The partner could be a Virtual Network Operator or a 3<sup>rd</sup> party Application provider, who provides content. Further, we look at how 5G impacts this business model.

### **6.2.1 “Partner with virtual network operator” business model**

One of the operator’s key assets is infrastructure. Infrastructure usually is used by an operator to deliver own services to the end-customer. However, in this model, a part of the infrastructure can be sub-let to a third-party provider called as Virtual Network Operator. The advantages for the Telecom Operators in this model are that they are able to sell a part of their wholesale business, without having to worry about customer acquisition, niche service offerings and customer management. They can have multiple VNOs. In this way, they are able to expand into niche markets very quickly.

### **6.2.2 “Integrated partnership services” business model**

Here the Operator provides integrated service offering based on their own capabilities enriched by a Partners content and specific applications. The real-time asset provisioning feature makes this possible. Integrated streaming solutions can be an example here but even services such as payments are possible.

### **6.2.3 “Partner with 3<sup>rd</sup> parties/OTT” business Model**

Here, partners (3rd parties/OTTs) are empowered to directly make offers to the end customers enriched by the operator network or other value creation capabilities. Smart wearables with remote health monitoring are a good example. The customers buy clothes from a manufacturer and take benefit of the health monitoring feature offered by the 3rd party, enriched by the operator’s set of network and value creation capabilities.

Going forward, Telecom Operators should consider working closely with content owners in defining new models that best serve mutual interests while delivering the maximum value for the consumer. For consumers to be able to enjoy data-intensive content services on the Internet, Telecom Operators need to convince content providers on the need to consider the costs of building high-bandwidth data networks in their business models. In the future, Telecom Operators can work towards creating models where they agree with content players on a dedicated Quality of Service provisioning to ensure network asset monetization. Telecom Operators can consider experimenting with models where they not only charge consumers for access to network resources, but also potentially work with content providers to create dramatically different pricing models that move away from charges for data consumption.

#### **6.2.4 How 5G will affect the above partnership business model?**

The feature of 5G, high level requirement of allowing creation of different levels of relationship between operators and application/service providers, facilitates this business model. Exploiting flexibility, 5G should be able to support different levels of abstraction and business models as known today as well as allowing creation of completely new business models. The key requirement of this model is that Service providers should be able to configure and manage the service, while operators will have freedom to manage and evolve the network.

5G provides an abstraction layer as an interface, where all types of in-networking functionality can be exposed to the application layer functions and/or service providers based on a service level agreement. Application/Service provider will then be able to use sub-set of the network capabilities in a flexible, configurable and programmable manner, and to use network resources depending on their service preference and thus creating a separation from the Operator.

#### **6.3 Telecom Operator as a “Digital Services provider” Business Model’**

Here the Telecom Operator extends beyond providing the core connectivity services and transitions to digital services like offering TV/video content, Financial services and Smart homes. There is not much business in the core for Telecom Operators, with increasing Capex and stagnant revenues, as revenues are not going to increase in line with data growth. Just focussing on core would not be beneficial for Operators.

The advantages in this model are:

- Gain direct revenue upside by creating new revenue streams from digital Services – participate in the monetization of Digital Services.
- Re-positioning as an “Innovative Digital Age” service provider and remain relevant to changing consumer behaviour. – Gain from customer stickiness/lower churn.

Key points to consider while developing digital services business plan are:

- Given the scale of the core business, anything adding 5% to revenue should be considered a success.
- Many of the new services are lower margin than the core connectivity business and investment plans must recognize this,

- The new services will lead to indirect benefits to the core business such as reduction in churn, insulate core business from encroaching rivals like independent OTT etc.
- The gestation period is longer and this would impact 'return on investments'.

### **6.3.1 The options available to an operator to offer digital services**

The services offered by OTT player can be classified as Video led services and messaging led services. Video led services gives the maximum profits for a digital service provider.

The possible ways for a Telecom Operator to offer digital services are:

- Build their own applications
- Partner with an OTT provider

The digital services include video led services and messaging services.

#### **6.3.1.1 “Build own applications” model**

Here, they have to decide on the target customers, whether they serve only their subscribed customers or would give open access to anyone from any other carriers. In the walled garden approach, they build their key applications for their own customers. E.g. Reliance Jio in India. Here, the target market is limited and the Operator can offer differentiated services to its own customers.

On other hand, Open access market is larger, where Operators offers their services to anybody i.e carrier agnostic customers.

#### **6.3.1.2 “Partnership” model**

Here, the Telecom Operator does not build their key applications but they get their partner to build the applications. Here, time to market is very less I.e. they can partner with existing OTT application provider and investment is much lower. However, the disadvantage is that because of revenue sharing, the revenue will be very less when compared to the revenue obtained by OTT provider.

So, “Build your own application” and Open Access Model is always better for Operators in the longer run, as it can get much larger revenue due to large target market which is carrier agnostic. But this needs large investments, a change in organisation culture and longer time to markets.

However, the Telecom Operator needs to change the Business Model incrementally. Over the years, they have become large complex organisations with multiple layers. This can create barriers to innovation. They may take

a very long time to bring out a product, as they have to adhere to stringent process and work with multiple cross functional teams. In contrast OTT player is typically a startup and can develop products iteratively and very quickly. So, Telecom Operators should change the culture of the organisation, when they attempt such a development and bring in external expertise.

### **6.3.2 How 5G will affect the above “digital services provider” business model?**

All the features made available by 5G could enable the Telecom Operator's 'Digital Services Providers' business model. It opens up a world of new opportunities to be addressed in new vertical markets.

5G's modular network architecture provides programmability and flexibility to provision only necessary functions in the network.

5G enables the application partner/service provider to configure and manage the service, while the Operator will have the freedom to manage and develop the network.

Network slicing features provided by 5G, enable Operators to create 'slices' of their networks through virtualization technology which could be tailored to the needs of any vertical industry like automotive, healthcare, logistics, retail or utilities. This would enable Telecom Operators to be a full player in digital services across all vertical segments.

In the full 5G world, however, we will see additions like player-perspective gaming, augmented and virtual reality. This provides a huge potential for creating new targets with respect to the value proposition and also challenges in deciding on the offerings, markets and the partnership they have to forge. This creates a huge potential for the Telecom Operator to explore, build and offer their own suite of digital services.

Features like 5G's ultra-reliable low latency communications and massive machine type communications, which involve sensor network and IoT, will enable Operators to develop cutting edge applications to address multiple market segments. This opens up new avenues for Operators to develop digital applications to address Industries 4.0, Smart Cities, Smart homes, Healthcare, Utilities, Retail, Entertainment etc.

### **6.3.3 Business model framework**

It will be beneficial for the Operator to build its own digital services/OTT applications and provide Open access to all including both paying and non-paying subscribers of the service.

This could result in two revenue streams:

- Direct revenue from both self and other Operator subscribers
  - Subscription revenue – revenue from premium services which requires subscription
  - Advertisement revenue – Digital advertising revenue, typically structured on a per click/impression basis
  - In app purchases (Physical and virtual) – revenue from sales of physical (Ecommerce) or Virtual (like games etc.)
- Indirect revenue from own subscribers only
  - Increased Data users – Upsell non-data subscribers by bundling paid subscription along with data pack
  - Improved Customer retention – Reduce Customer Churn by differentiating through a digital services portfolio
  - Increased Data ARPU – Migrating customers to higher data bundles due to increased data consumption
  - Customer analytics – Monetization through selling customer analytics leveraging on customer data.

Unlike a pure OTT provider, Operator offering digital services gets Indirect revenue from its own subscriber base. This is an added advantage for the operator and a motivator to start its own digital services. Therefore, Operator gets both direct and indirect revenue when offering its own digital services.

On the Cost side, there are two cost elements.

- Direct Cost – Marketing, customer acquisition, content development/distribution, all other operational costs
- Indirect Cost – providing the voice and data services to indirect revenues.

The Cash flows would be (Direct + indirect) revenue – (Direct + indirect) costs.

Return on investments could be faster, if the Operator does not invest own Capex but launches Digital services on SaaS/Opex only platforms.

#### **6.3.4 “Operator-led video service” business model**

Video led services offers the best option for the Telecom Operator to enter into digital business.

Video is a high engagement and emotional service, especially in developing countries like India and China. As a high engagement service, it makes sense for an operator to build and control this service itself rather than



partnering with a 3<sup>rd</sup> party provider, as they can exercise greater control over user experience and product offering eg, optimizing the product for network quality as well as being able to bundle the product with core services. These are indirect benefits.

Also, licensing content is very complex, as they have to deal with Content cartels who hold a strong control in the video industry with players like Netflix and Amazon. Hence, owning content and thus managing the complexity in-house has its advantage in terms of ensuring business continuity, as well as provide potential scale benefits. Overall, this strategy helps in building a digital brand with targeted promotions and product bundling. This would transcend the Operator from a pure voice player to a Digital player.

It is more beneficial for Operator to Build their own Video app which is carrier agnostic, rather than partner with a third-party provider.

OTT video market is generally driven by advertising which gives more revenue than subscription revenue. An exponential increase in the market for OTT video services presents an opportunity for MNOs to derive additional revenues and strengthen their market positioning in the industry.

An operator driven video service will benefit from sizable indirect revenues from own customers, in addition to direct revenues (subscription revenue). Total revenue will consist of Direct revenue + Indirect revenue.

**Direct revenue:**

- Subscription revenues
  - Video apps – active users
  - Paid subscribers
  - Subscription charges
- Advertisement
- In-app purchase.

**Indirect Revenues:**

- Increased Mobile Broadband User base
- Churn reduction
- Increased Data ARPU

Content and Subscriber acquisition costs are two biggest cost components, with additional indirect (network) costs associated with indirect revenues.

It will be beneficial for Operators to acquire exclusive rights for some popular sports, events etc. For eg: The reach of IPL crossed 400 million in 2017.

Facebook, Airtel, Jio offered ~USD 500 million for acquiring 2016–22 digital rights for IPL.

Three Business Model possibilities are further available for Telecom Operator owned video services:

- 1) Build for Own customers
  - a. Moderate revenue potential – direct and indirect revenues from own customers
  - b. There will be direct and indirect costs for own customers
  - c. Payback period would be lower as no additional effort or costs required for customer acquisition. However, revenues would be limited as the service is limited to the subscribed customers only.
- 2) Build for Open access
  - a. High revenue potential – Direct revenues from own and other customers; indirect revenue from other customers.
  - b. Direct costs for own and other customers. Indirect costs for own customers only
  - c. Payback period could be higher as additional investments are needed for customer acquisition. However, net profits would be larger as more open users could be expected outside the subscribed users.
- 3) Partner with OTT provider
  - a. Low revenue potential. Only a share of partner’s revenue
  - b. No direct or indirect costs is involved
  - c. Here, costs are not involved and hence payback period is not applicable.

So, in the Operator led video service model, applications built in house for open access, has the highest revenues and profits and helps in building a brand for the Telecom Operator.

### **6.3.5 “Operator led messaging service” business model**

There is scope for multiple players in the messaging market but given high competition and network effect, adoption to a new service will be lower. There is room for multiple players as every user has 2–3 messaging apps on an average. It is highly competitive against popular global players like whatsapp, Line, Nimbuzz and Indian player Hike. These services are sticky in nature – Users will continue to use the services that will have the widest reach

with a majority of their friends. A new player in this space would already be 4–5 years behind these existing services in terms of market entry.

There is limited differentiation potential for standalone messaging service given no subscription charges and hence no bundling opportunity. So, a new entrant will not be able to ramp up quickly and become one of the top three global players.

The Operator led Messaging service maybe less viable as compared to a video service because of the network effect and strong competition from well established players such as WhatsApp, Hike, Line etc. who have been in the market for 3+ years. These services are sticky, like any social app, and users will continue using a service that has the widest reach amongst their social circle. Also, unlike video services, there are no subscription charges for messaging services and they cannot be bundled with data packs. Messaging apps will not lead to increase in data revenues given limited data usage on these apps. The main source of revenue could be from advertisements.

So, Operator led messaging service model may not be attractive as compared to video services.

## **7 Conclusions**

Carriers and service providers must prepare their networks for the scale and flexibility that is required to provide highly cost-effective solutions that support exponential increases in network demand, a wide variety of devices and applications, higher data rates, lower latency, and greater power efficiencies – all while maintaining a low cost per gigabit service model. The entire supply chain will be affected by this revolutionary development.

The classic broadband business model will be complemented with new models for 5G, centred around business rather than consumer proposition.

Business model innovation is perhaps the single biggest innovation 5G will bring to the market and Technological advances towards 5G along with greater industry consolidation, will transform network economics. Business models should focus on data and video market segments and should include greater industry collaboration with Network sharing.

Telecom Operators should move from providers of connectivity to aggregators and innovators of third-party offerings. Telecom Operators will need to continue to stretch the boundaries of what current revenue models allow. While they have traditionally followed Business-to-business and Business-to-consumer models, increasingly innovative Business-to-business-to-consumer models are more likely to be the norm in the future.

Operators should stop focussing only on Core business due to lack of revenue growth and should add digital services to their portfolio.

‘Build your own’ and ‘Open access’ Model is always better for Operators in the longer run as it provides the advantages of higher revenues due to large target market which is carrier agnostic.

‘Build your own’ video services are better than messaging services. An Operator driven Video service will benefit from sizable indirect revenues from own customers, in addition to direct revenues (subscription revenue).

Telecom Operators need to embark on a series of such changes in order to ensure that they can build upon their successes in delivering telecoms services. In the end, they will need to ensure that they continuously challenge established models if they are to truly innovate their business model.

The ability of operators to develop any of these business models will depend entirely on their individual circumstances and market conditions. Important is that they need to act now to consider which options will suit their business best in the “5G world”.

## References

- [1] [https://en.wikipedia.org/wiki/Business\\_model](https://en.wikipedia.org/wiki/Business_model)
- [2] Ericsson Mobility Report, June 2017.
- [3] National Telecom Policy 2012 of Government of India.
- [4] Telecom Regulatory Authority of India (2015). Consultation Paper on *Regulatory Framework for OTT Services*.
- [5] 1G,2G, 3G, 4G – The Evolution of Wireless Generations. Available at: <https://support.chinavasion.com/index.php?/Knowledgebase/Article/View/284/42/1g-2g-3g-4g—the-evolution-of-wireless-generations>
- [6] GSMA: The 5G ERA, 2017.
- [7] The Open Group blog – 5G technologies. Available at: <https://blog.open-group.org/category/interoperability-2/>
- [8] GSMA Intelligence – Understanding 5G. Available at: <https://www.gsmainelligence.com/>
- [9] Held, V. (2017). “Early 5G adoption is the winning business plans”.
- [10] ZDNET, British Gas, BT Push Ahead with Smart Meter Plans, October 2010.
- [11] Ericsson Mobility Report, 2017.
- [12] Fierce Wireless (2017). “5G- a look t Business Models eBook”.
- [13] Bharati Airtel’s company website.
- [14] Linder, P. (2017). Blog “5G Busines Model Innovation Potential”.

## **Biographies**



**Sriganesh Rao** received his B.E (Electronics) degree from Bangalore University (India) in 1980 and MTech (Electronics) degree from NITK, Surathkal (India) in 1983 followed by MBA (Technology Management) of Deakin University, Australia in 2000 with focus on International Telecommunication Management. He is currently pursuing PhD at the Department of Business and Technology, Aarhus University, Denmark.

He is an ICT Professional with over 34 years of global experience in leading complex technology projects in Australia and India, with rich background in Business Development, Engineering, Program Management and QA in Telecom, Government & Defence verticals across Embedded, Engineering Services, Testing and Manufacturing horizontals.

His experience spans across leading IT organizations like Tata Consultancy Services & IBM, Telecom Service Providers like TATA Teleservices & C&W OPTUS (Australia), Telecom OEMs like Bharat Electronics, United Telecoms & ERG (Australia) and Telecom OSS/BSS Providers like Alopa Networks. At present, he is with Tata Consultancy Services, Bangalore (India) working in Telecom domain. He has handled Business development and Pre-sales Solutioning in Telecom, Media & Entertainment, Government, Defence & Aerospace market segments and also led strategic initiatives in new technology areas –IPv6 and M2M/IoT for India business.

He is a Senior Member of IEEE, Senior Member of Australian Computer Society and Life Member of Computer Society of India. He is actively involved in M2M/IoT related initiatives of Professional bodies like IEEE, GISFI, TM Forum, ACS and TiE. As the Chairman for the Dept. of Telecom's (Govt of India) "M2M Gateway and Architecture" Workgroup and Member of its Joint Editorial Team on M2M Enablement in Remote Health Management, Power Sector, Intelligent Transport Systems and Safety & Surveillance Systems, he has contributed to the preparation of "National Telecom M2M Roadmap".

He continues as an active Member of the National Working Group of DoT's "IoT and its applications in Smart Cities".

His current interests include 5G, M2M, IoT, Smart Cities, Industries 4.0 and Business Model Innovation.



**Ramjee Prasad** received his M.Sc degree in 1970 and PhD in 1979 from Birla Institute of Technology, Mesra, India. Currently, he is the Professor of Future Technologies for Business Ecosystem Innovation (FT4BI) at the Department of Business Development and Technology of Aarhus University, Herning, Denmark.

He is the Founder President of the CTIF Global Capsule (CGC). He has been a Founding Director of the Center for TeleInFrastruktur (CTIF) since 2004. He is also the Founder Chairman of the Global ICT Standardization Forum for India (GISFI: [www.gisfi.org](http://www.gisfi.org)) established in 2009.

He was the Founder Chairman of the HERMES Partnership – a network of leading independent European research centres established in 1997, of which he is now the Honorary Chair. He is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) USA, the Institution of Electronics and Telecommunications Engineers (IETE) India, the Institution of Engineering Technology (IET) UK, Wireless World Research Forum (WWRF) and a Member of Netherlands Electronics and Radio Society (NERG) and the Danish Engineering Society (IDA).

He has received Ridderkorset af Dannebrogordenen (Knight of the Dannebrog) in 2010 from the Danish Queen for the internationalisation of top-class telecommunication research and education. He has been honoured by the University of Rome "Tor Vergata", Italy as a Distinguished Professor of the Department of Clinical Sciences and Translational Medicine in 2016.

He has published more than 30 books, 1000 plus journal and conference publications, more than 15 patents, over 100 PhD Graduates and larger number of Masters (over 250). Several of his students are today worldwide telecommunication leaders themselves.