5G, IoT & IT'S RELEVANCE FOR THE ARMED FORCES

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By

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Introduction

1.   Fifth generation technology or 5G is the luminance we are all heading for in the technology space with its promising capabilities such as low latency and high data rates. 5G is going to transform the telecom industry across sectors like healthcare, agriculture, smart cities and surveillance. India plans to roll out 5G services for consumers by 2020. The movement of our society and much of the world from the industrial age to the information age has been hastened to a large extent by the liberalised availability of frequency spectrum. The same has had an impact on the Armed Forces, providing both opportunities and challenges to both friend and foe alike.   There is thus a need to write a paper on this topic of immense relevance. This paper puts forth the condensed wisdom of deliberations carried out by various speakers, during a Round Table Discussion (RTD) on the subject held on 16 May 2019. The paper is structured in seven sections to articulate the Government

Position Towards 5G&Understanding the Phased Rollout of 5G & IoT, the Present & Future Indian Telecom and Broadband Scenario, 5G, IoT and Recommended Use Cases for Defence, 5G and IoT Roadmap as per ITU, NDCP-18 &NFAP-19 and Its Relevance to 5G, IoT & the Armed Forces and the Cyber Security Implications of 5G& IoT.

Government Position Towards 5G

2.   As per the Telecom Secretary Aruna Sundararajan, India wants to lead in the upcoming 5G technology and wants to have its own IPR becoming a part of 5G in global standards. Department of Telecommunications (DoT) has invited incumbent telcos-Vodafone Idea, Bharti Airtel, Reliance Jio and Bharat Sanchar Nigam Limited (BSNL) in addition to network vendors such as Cisco, Ericsson, Samsung and Nokia to undertake 5G-based pilots on spectrum allocated for trial purposes for a certain period of time and showcase India-centric use cases by 2019. The DoT is yet to take a call on inviting Huawei to participate in the trials. A 5G Spectrum Policy Task Force, Govt of India, Chaired by Dr Abhay Karandikar was constituted and few important high level recommendations of this committee are that there are High Requirements for 5G Spectrum , for 3GPP "5G/New Radio" Bands. The Key Recommendations of the Spectrum Task Force have separately listed Recommendations for the Radio Access and Recommendations for the Wireless Backhaul

3.   **Geo-Technology: Force Multipliers Vs Force Substitutors**. It's extremely important to understand5G & IoT because unless people properly understand a technology, they will be unable to either apply it or exploit it optimally for reaping military benefits. We would thus be doing great injustice to this technology which the whole world is talking about. Countries that control the Geo-technology domain will control all the other three domains of Geo Strategy, Geo Politics and Geo Economics. The nations which control these other three domains control the world. In the emerging world order India has got a major role to play. Though India is a global player but it had not yet become a global leader. In

order to become a global leader, India needs to harness these latest technologies like 5G & IoT. There is a need to examine whether these technologies are only *Force Multipliers* as is widely believed because the problem with force multipliers is that they multiply forces also! In the present context with downsizing being the norm in the Army, it might not be possible to multiply forces.

4.   A better rather optimal solution would be if these technologies could be deployed to become **Force Substitutors,** as that would give better payoffs as it would have more impact, more effect and at a lesser cost. These options need to be examined. Every technology comes with new challenges and threats which need to be examined. On the issue of IIoT (Industrial IoT), while China has a rating of 7, India's score was only 3.5. Connected to this is that this factor will give 5 to 10% reduction in costs in operational optimisation, 10-40% savings in preventive maintenance and 20-50% cost reduction in inventory optimisation. So in overall one can reduce the cost of the industry at the production stage by upto 40% and increase the quality of the product by 40%. So it needs to be examined if in India we are we actually doing this type of IIoT in our country, especially in the defence sector. The defence sector was possibly still functioning at sub optimal levels considering that our Ordnance Factory Boards follow the oldest of procedures. All this needs to change if we have to find our rightful place under the sun in this new world order.

5.   **Triad of National Growth, National Security and Money**. A positive change in India is that as a nation we are changing over from being reactive to proactive. The UN has also complimented India a couple of weeks ago in the manner we have handled the Odhissa cyclone. The same is happening in the field of 5G also. 2020 is a vision that the government has kept for the nation and in May 2019, well before 5G is slated to happen, the Armed Forces have started talking about it and upon the relevance of 5G &IoT for the Armed Forces. Telecom business has three components- National Growth (which is talked about by everybody), National Security and the Money. Out of these three, a

nation can at best optimize only two aspects; a nation can grow with money or we can have money with national security (and forget about growth) or else a nation can choose to grow with money (and forget about national security). If however money is the driving factor for a nation then the other two attributes at times tend to get compromised/ neglected. It was however advisable that while doing so we should not throw caution to the winds as regards National Security.

6. The telecom transition during the last two decades, has been phenomenal, moving from the era of 1G, 2G, 3G & 4G. Though in the Armed Forces there are certain restrictions on carrying of smart phones, yet there is a pressing requirement of 5G for the Armed Forces because 5G is bigger than mobile phones; it's about Communications, Storage, Processing, Smart Cars, Smart Grids, Connected Homes, e-Health and of various apps which are for now beyond imagination. For all of these the soldier needs 5G speeds and data transfer capability. The futuristic soldier will wear at least six IP addresses; one each for monitoring the ration state, the ammo state, health, for AI, to get inputs from all sensors and one sensor to relay to the ops room so that that the commander sitting there sees & hears what all he does. The military has already catered for this for the future and as of now 78,555 satellites based equipment applications have been approved for procurement by the CCS.

7. **War: A National Effort Spearheaded by the Armed Forces**. During the Balakot mission as reported by the media, Indian aircraft crossed the border and dropped bombs at terrorist training camps. The air assets deployed for the mission, as per media included aircraft like Sukhoi, Mirage, interceptors, UAVs, AWACS, EW escort jammers, Air to Air Refuelers, smart munition and air to air missiles. To coordinate this massive air package, comprising of diverse platforms, a plethora of sensors/ communication equipment would have been used, some of which would have definitely been for High / Medium Power radios (HPR / MPR), Low Level Tracking/Weather Radars (LLTR / LLLWR), Search & Rescue Equipment (SRE), Commercial civil Radars, PAR, Area Radars

/ ECM / ELINT / COMINT / TCAS & for Identification Friend or Foe (IFF). When a mission like this happens, which gives reason for the nation to be proud, then it's a major national effort. Likewise the next day a wide range of missile systems were operating when a large No of aircraft from across the border were operating. It can be seen that so much activity took place over communication / sensor networks for only one mission, which was merely a preemptive non military strike. So the requirement of communication / sensor networks during war, to carry out number of such strikes can only be imagined. A similar effort would have possibly been put in by Pakistan also.

8.   In addition to these, hot lines between who is who of the two nations would have been established at the command and control centres besides the communication being carried out over AFCEL / IACCS / ICATS networks. The precision ammunition used by us (SPICE 2000) uses GPS tracking to home on to it's target. All this shows that Military Warfare is spectrum intensive. There is a requirement of frequency by the Armed Forces, across the complete EM spectrum ranging from 3 KHz to 3000 GHz. As per NFAP of 1982, the Armed Forces were the major users. This was however deliberately removed, possibly due to purely financial considerations. It needs to be emphasized that while the commercial departments grow and make money, space in EM spectrum must be left for national security. 5G India 2020 can happen alongside the requirements for the national security however in the absence national security, growth and making money will not be feasible and will at best be temporary.

Understanding Phased Rollout of 5G & IoT

9.   5G is being rolled out in three phases. In 2021, in the first phase of 5G, the Enhanced Mobile Broadband (**eMBB**) is set to roll out, which will give very high bandwidths; from the 1Gbps of 4G, upto 30 Gbps. In 2022, the second phase of 5G will come, which will include Massive Machine Type Communication (**MMTC**); this will cater for IoT. In the third phase of 5G Ultra Reliability Low latency Communication (**URLLC**).

Low Latency implies that the difference between the source and the destination, or between action and reaction, will be minimal; in 4G while it is 10 msec, in 5G it will be less than 1milli sec.5G will give very high density. Present density in 4G is that in one square km there are about one lakh cell towers; in 5G it's going to be one million. It will cater for situations where people are in very close proximity and there are a need for a large No of IP addresses. 5G is primarily being driven because there is a pull for this technology. People want anytime anywhere communication. There are over 800 Mn internet users in China, of which 98% access the internet from the mobile phones. Similar is the case in India. People also want to remain connected when travelling using the bullet train, which travels at speeds of 300 Kmph. People who are into gaming need the features of Augmented Reality / Virtual Reality (**AR/VR**). They also want high speeds with large bandwidths. Another application is driverless autonomous vehicles. Such vehicles will have radars and image sensors all around. It will need to sense the traffic lights and relay back information; it will possibly also be connected to a satellite and will be required to relay messages at very high speeds over the internet. All this can't be provided in 4G and these can only be provided by 5G. There is thus a pull coming from the users, from the enterprises & from the AR/VR community, from the Robotics/ AI community for this 5G technology.

10.   **Digital Highways of Development.** Previously, if a village wanted development and progress, people used to ask the Govt to build a road because the moment a road was built, it provided access to traders to whom the farmers could sell their produce, besides providing avenues for development of business and for growth of education & healthcare. The village thus used to develop and grow just because of the road connectivity. In the digital era, 5G is a type of a digital highway, which is required for development of business and for growth of education, healthcare and other infrastructure. 5G is not just about communications alone; it's in fact about improvement and growth in the fields of industry, automation, education, healthcare and other infrastructure- in fact the

list is endless. It's an end to end road for growth in various fields and IoT is very closely linked with it. IoT is already being used by many of us in our homes for various purposes eg Alexa, Security cameras and microphones connected by WiFi over the internet to enable remote monitoring of various activities, including the press of a doorbell. In an average American home there are seven such devices connected over the net, each having it's own IP address, which can be controlled remotely over the internet. In a few years 50 million devices are likely to be there.5G and IoT are thus very closely linked and there is a need to understand the environment and also as to why there is a pull for 5G.

11.   **Technology Aspect of 5G**. The technology part of 5G has to be understood correctly. 5G involves a mobile (ie a user equipment), there is an air interface from where it is connected to GNode B. The air interface in 4G LTE is called OFDMA and in 5G it is called GNode B. From the air interface, there is an Access network through which it goes to various gateways and finally goes to the Core network. The environment needs to understand what 5G is all about and to review the architecture and understand the technologies. The technologies are generally well understood, kind courtesy the Julian calendar because 1G came in 1980, 2G in 1990, 3G in 2000, 4G in 2010 and 5G is scheduled to be operational in 2020. In addition 1G was analog communication and was country specific. There was earlier AMPS in North America and TACS in UK Europe so one could not take the mobiles and use it elsewhere. 2G became GSM, 3G became UMTS, 4G used LTE and we have 5G round the corner. Along with the technology, the accessing techniques also kept changing. The first one was FDMA (Frequency Division Multiple Access), this gave way to TDMA (Time Division Multiple Access) and now it is Wideband CDMA (Code Division Multiple Access). So there are three issues regarding 5G ie - the technology, the architecture and understanding of 5G. There is a need to first understand what 5G is all about before one can talk of it's usage in general and then one can think about it's utilization in the Armed Forces.

12.   **Military Applications of 5G**. In the Army, under the project being progressed by the DGIS, there were a number of different systems like BSS, BMS, ADCNRS etc and for each of these systems a dedicated systems of intra communication had been planned. For that particular battle field system application. Now with 5G in place, it can take care of all the requirement of communication for various battle field systems/ applications. Due to the high speed and bandwidth offered by 5G, the need to have separate systems of intra communication for each of these military applications could be reconsidered. So the only aspect that merits consideration and deliberation here is that the frequency bands in which 5G operates (presently sub 6 GHz bands , primarily 3 GHz onwards at present), the distances become very less. This implies that a very large number of base stations would be required in a particular area, as compared to the present day set up. How this high density of BTS is to be set up in the battle field would be analysed by the domain experts from the Corps of Signals in the Army and other Subject Matter Experts (SMEs) in the other two services. The Tactical Communication System (TCS) of the Army is presently being reviewed and possibly a new Communication System for the Army, based on 5G would be considered to be evolved. The AFCELL of Air Force is based on CDMA technology is well established and may possibly merit an upgrade to 5G. For the Navy, while at sea, mobile communications is not a criticality or a priority and satellite communication actually meets the Navy's requirement. However for the Army, considering the large requirement of sensors, communications, systems and weapon platforms, 5G is the way ahead. The domain experts from Corps of Signals in the Army could consider analyzing in detail as to how 5G can be leveraged for both peace time& operational communications and other activities. 5G is the road for future and soon there would be 50 million devices connected over 5G.

Indian Telecom and Broadband Scenario – Present & Future

13.   India as a developing country requires some tools to provide services to it's people. Using a variety of tools available, a nation has

to provide education, health services, transportation, security etc to its citizens and all this is required to be done in an increasingly efficient manner. The resources at the behest of the country are limited and it has been understood at the highest echelons of the govt, that technology needs to be leveraged as a tool to provide development to the people. If the country is developed, the security naturally will improve. The security paradigm can't be ignored because if the economy is good, the security will be good, as then the nation will have the resources to pump into the Armed Forces to equip them with the kind of security tools/ systems that they require. There is of course the need to balance out the three variables of National Growth, National Security and Money. Balancing these three aspects is an important aspect which needs to be addressed.

14. The telecom policy is perhaps one of the most talked about topics in the newspapers and in the media. 2Mbps has been designated as the latest broadband speed. 5G is not merely about telecom; telecom will definitely be a means to get there but 5G is about using technology in the way one lives. The telecom industry is presently working with an Average Revenue Per User (ARPU) of Rs 70, which is equal to $1, which is actually a very low average revenue. The telecom companies are not actually earning enough revenue to be in a position to put in more capital as an investment for the roll out of 5G services. Private telecom players entered the field as the govt was not able to provide telecom services to fully meet the aspirations of the people of this country. So licenses were provided to the private TSPs to provide telecom services to the country. In a way, the private TSPs are working on behalf of the govt, having been given a license, to provide telecom services.

15. **Telecom Industry: Contribution to India**. Telecom sector provides 6.5% of the national GDP, which is substantial when compared to the contribution made by other major sectors like aviation, transportation, logistics or agriculture etc. Telecom is also among the highest contributor of FDI to the govt, having contributed INR 185,639 crores ~ $32 Bn in last two decades. This is because for every rupee earned by Telcos, 30 paise goes back to the govt. So if the telecom sector makes a loss, the govt

actually stands to lose, as TSPs are working on behalf of the govt. So it is incumbent upon the govt to have a healthy telecom sector. Telecom sector also contributes directly to 2.2 Mn employments and indirectly to 1.8 Mn jobs. It's a global challenge today that Internet Service Providers (ISPs) are eating into telecom revenues. The Over The Top (**OTT**) companies or the 'Fang' companies or the top 20 companies globally like Alibaba, Tensent, Facebook, Google and Amazon are all there in the SNP ratings but telecom companies have slipped a lot. It should be a cause of concern to the govt that while telecom sector gives revenue to the govt, these big companies are taking money out of the country and if the telecom sector goes down, then who will make investments in rolling out the network which will provide us 5G for development for the country.

16. **<u>Expert's Take on Spectrum Allocation</u>**. As per Stanford University Professor and chairman of the high-level 5G Forum, AJ Paulraj India's value for 5G is very high and the government should realise it and make spectrum as cheap as possible. The NDA government in tandem with Telecom Regulatory Authority of India (TRAI) is preparing for a mega spectrum auction of a total of 8,293 Mhz units including frequencies in the 3300-3600 Mhz band range used for 5G services. As per Cellular Operators' Association of India (COAI), the auction of 5G spectrum will happen around second half of 2019 as it would offer Telco's better visibility. The spectrum in India it seems is priced very high. Ultimately when a network is established/ rolled out, the inputs to the network are the cost of buying the raw material ie Spectrum and Right of Way (ROW) charges to be paid to the land owning agencies, for places where the BTS have to be established. All agencies involved want this money to be paid up-front. Due to this the amount of money available for buying the Radios or to put in the network shrinks, which is a challenge. The govt & TRAI must arrive at a fine balance between the revenue to be taken from TSPs and the support to be provided to them. Worldwide in Japan, Korea or in the US wherever 5G auctions have taken place, the price of the spectrum has been regulated and kept low so as to incentivize 5G. If the cost of the spectrum for 5G in India is kept high, the rollout of 5G could be slow.

17.   **Pan India Mobile Coverage**. The Pan India 2G/3G/4G Coverage, is as shown in Fig 1.1 below and the national telecom network in India can be accessed at the **Tarang Sanchaar** portal at "https:// tarangsanchaar. gov.in". It is a web portal for information sharing on Mobile Towers and Electromagnetic Frequency (EMF) Emission Compliance. It has been developed in Public Private Partnership (PPP) mode by Department of Telecommunications with Industry. Through the portal, public can access the following services:-

(a)   Locate mobile towers in vicinity of any locality - A public interface where an easy map-based search feature has been provided for viewing the mobile towers in vicinity of any locality.

(b)   Locate mobile towers with their EMF Safety Status based on your current location - For users who access through GPS enabled PC / Tablets / Mobiles.

(c)   EMF Measurement Request by Public - Any person can request for EMF emission measurement at a location by paying a nominal fee of Rs 4000/- online. The tests will be conducted by the local Telecom Enforcement Resource and Monitoring (TERM) field unit of DoT and the test report will be provided to the requestor.

(d)   Learning resources on EMF - The portal also has 'EMF Overview' and 'Learn' Sections, which provide numerous articles, booklets and videos, to further educate the citizens about EMF and coverage of telecom service.

(e)   Portal hosts technical details of over 20 lakh base stations (BTSs) spread across the country of all technologies (2G, 3G, 4G etc.) and of all Telecom Service Providers (TSPs).

Fig 1.1 : Pan India Mob Coverage

18.   During the last three years, from 8 lakh BTS's there are today 21 lakh BTS's, implying that the network has grown three times, which is very good because nowhere in the world has the telecom network expanded at this pace. 75% of the whole network is broadband. This is what will be used as a segue to make the transition into 5G. The type of radios which are being deployed for 5G are of two types - New Radio or NR, which is 5G compliant only and the other one is Non Stand Alone (ie NSA) which means that it will have 5G but one can fall back to 4G when 5G is not available. This is so that the investment in the equipment on ground is suitable enough to upgrade it to 5G.

19.   **Drop in AGR**. The Adjusted Gross Revenue (**AGR**) has however taken a serious dip. Due to competitive pressure, all telcos are offering very cheap data rates. Voice has in fact become free today and it is bundled with data and there are no voice only plans anymore. The telcos are thus taking money as a loan from banks, investing the same into the networks but are providing a service which is way below cost, with no means of recovering that money. The result is that the telecom sector is in a major debt and the govt has serious cause to worry about it. If they don't do that, then it will be difficult to roll out 5G. The flip side is that the data subscribers have gone up substantially and the wireless data users are getting speeds enhanced from the earlier 2Gbps to 8 Gbps. India today consumes more data than the US and China combined. What needs to be seen is how we are using this data and the networks ability to deliver this data. Where the telcos were earning 27 paise per min, they are now earning only 11 paise per min, which explains the debt part. The telecom sector is bleeding financially. Even in data realization the earnings have dropped from the earlier Rs 1.70 per Mb to Rs 1.02 per Mb. Thus the ability of Telco's to get back their investment has come down substantially. If this situation continues, it will be a serious challenge as the money to make investments to get 5G, is being put on the table by Telco's. The govt will of course logically put in investments in the defence and other national critical/ sensitive networks as the spectrum is available to them as administrative allocation but the aspect of making the overall rollout of 5G financially viable for the Telcos needs to be deliberated upon at the apex levels of governance.

20.   **NDCP: Translating Policy into Action**. The Mobile Data subscribers (in Crores) has substantially gone up over the last two years and stood at 43.6 Crores as on Dec 18. Likewise the Data Volumes also increased to reach 1313.2 Crores (GB) as on Dec 18. As a nation we have to rely on a variety of things in India for our developmental goals. As stated earlier, the ARPUs have dropped from 105 to 70, which is equal to $1. The least plan in the US is however a $40 plan. There is a need to rationalize a manner in which a nation designs it's business proposition to sustain a national requirement of a good digital network. While there

has been an announcement of the release of the National Telecom Policy (**NTP**) 2018 ie the National Digital Communications Policy **(NDCP**) 2018 — made public by the department of telecom on last year, the country is ready for the next generation of communications technologies such as 5G, artificial intelligence (AI), machine-to-machine .As a nation we have to rely on a variety of things in India for our developmental goals. The nation needs to take concrete steps on ground to ensure that the goals stated in NDCP 2018 are actually made to happen by translating the policy into actionable steps. The vision and intent is laudable but we need to walk the talk. Project implementation really needs a soul searching and improvement.

21.   As per Opensignal's survey, worldwide India ranks fifth in the availability of 4G, after Korea, Japan, USA and Taiwan. On the 4G availability in India's largest cities (ie presence of BTS's), tier 2 cities like Dhanbad, Ranchi and Srinagar figured at the top. Thus while the network is available at these cities, possibly due to a lesser population density there, as compared to metros, there is lesser data usage. However the moot point is that the ***network is available and can be upgraded*** to 5G once the resources for it are available.

22.   **Smart Phone and OTT Growth**. The growth of OTT is due to it's usage on either an IoT device or a smart phone and it's a success story in India. With the current networks and data speeds, the average speed in India is about 8Mbps. This speed is adequate to do a whole lot of activities like voice call, online gaming, browsing, HD Video streaming etc. However 5G will also facilitate 4K video streaming for which speeds of about 25 Mbps are required.4G speeds across India vary by upto a factor of 4.5x between peak and off-peak hours, with the lowest speeds being 2.2 Mbps and the highest going upto 21.6 Mbps. The average generally remains around 7Mbps, which is about adequate to do most of the things that need to be done by an average Indian.

23.   However once India moves into 5G and rolls out the new high capacity radios and network elements, then the pressure on 4G networks will be relieved. In the early deployments of 5G, which countries have

put out live 5G networks, are Fixed Wireless Access **(FWA)** and **eMBB**. FWA implies that if you have a fixed antenna, then instead of an optical fibre access (which is difficult to provide in a busy metro like Mumbai and Delhi, where digging up the ground to lay fibre is a challenge), there is a requirement to provide a fibre like capacity to the user. The network provided by the Indian Telecom Sector is in synch with a world class Mobile Broadband Infrastructure. The CTOs of Indian TSPs push through more bits/sec/hertz, than any other operator in the world.

24.   **5G: A Maze of BTS's**. One of the stated goals of the NDCP 2018 is to provide connectivity at 50Mbps to every citizen. If the current network of 21 lakh BTS's is giving us an average of 7 Mbps then by simple maths it implies that to provide 7 x 7Mbps (ie 49 ~ 50 Mbps), we would need 21x 7 lakh BTS's or 147 lakh BTS's. These large No of BTS have to be physically installed somewhere. 5G antennas will use massive MIMO technology, implying a large number of antennas can be put. With higher frequencies, range becomes shorter and BTS antennas have to virtually become part of street furniture. This needs to be provided by the govt and by the local municipal bodies. The ROW access to that kind of infrastructure needs to be provided to the TSPs by the govt. It's good to say that India will be there in 5G 2020, which is just six months away but we actually need to walk the talk to make it happen. The govt also needs to make the investment climate good enough so that investors come forth to help in providing the capital for rolling out the network.

25.   **Understanding 5G: Mobile Technology**. 5G is customer driven and is primarily due to the emergence of IoT and M2M communication. While 4G provides 100 Thousand connections per square km, peak data rates of 1Gbps, supports data traffic of upto 7.2Exabytes /month and a latency of 10 msec; 5G will provides One Million connections per square km, peak data rates of 20Gbps, will support data traffic of upto 50 Exabytes /month and a latency of less than 1 msec. 5G Network is envisaged to accommodate Apps & Services with different Latency, Reliability & Bandwidth. 5G is not only about broadband speeds, it is

but one of the basket of services. There are three main 5G Use Cases; eMBB – Enhanced Mobile Broadband, mMTC – Massive Machine Type Communications and uRLLC – Ultra-reliable and Low Latency Communications, which had been explained earlier. The range of services offered is actually a tradeoff between the three sides of the triangle depicted below in Fig 1.2. At the low end of the services, there is an application of an embedded/ underwater/ underground sensor whose battery has to last for a long period (10 years or so) and it has to be really cheap. At the other end we have uRLLC which is used for critical applications like an autonomous car. The range of services offered is as depicted below:-
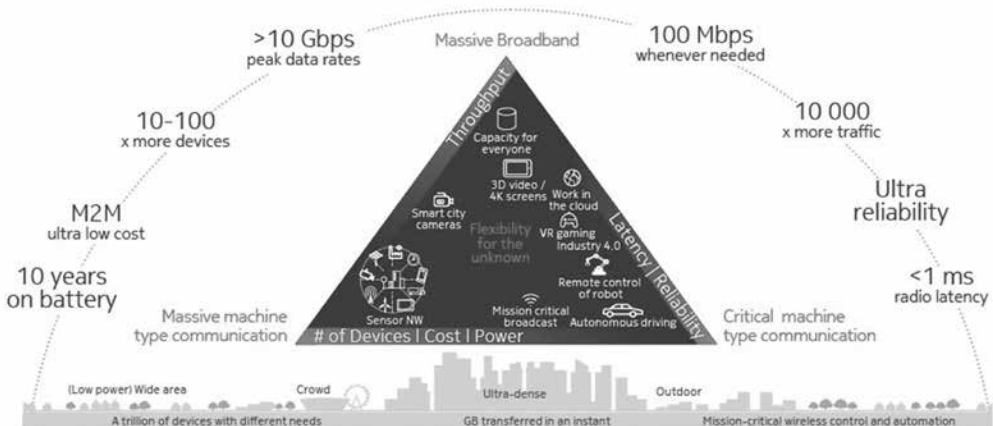
Fig 1.2 : Range of services offered by 5G

26.   In the India Mobile Congress (IMC) 2018, held in Oct 2018, in the Aerocity at New Delhi,some of the 5G use cases which were demonstrated to the environment were :-

   (a)   **Skyship & Facial Recognition (Samsung & RJIO):** 5G connected Skyship provides a real-time 4K HD quality 360 degree aerial view of Aerocity.

   (b)   **AR/VR Connected Car (Ericsson & RJIO):** advanced sensors on unmanned vehicles, a remotely driven car from

Aerocity, where the car is at IIT Delhi and a VR driven bus, where the bus is in Navi Mumbai.

(c)   **Drone flying on a 5G network (Ericsson & Airtel):** The drone will take surveillance pictures and also pick and drop a packet from point A to Point B.

(d)   **Manufacturing of Nokia 5GNR (New Radio);** Made in India for the World& being exported to 70 countries.

27.   Overall for India, as per the estimates put forward by KPMG, the cumulative economic impact of 5G in India by 2035 will be USD 1 Trillion. There are opportunities for using 5G in each and every sector in India, be it IoT sensors and networks, Connected Utilities, Smart cities Industrial automation, Autonomous robots, Public Asset management, Remote Delivery, Cloud Infrastructure or Intelligent Predictive Warehousing demand and supply control and Defence should not get left behind. Requisite expertise is available in the Armed Forces for leveraging various use cases for 5G and the same needs to be properly utilized.

28.   **5G Spectrum Status**. As per the COAI though every user has planned out a use case for the spectrum allocated to their respective organizations, yet nation may consider using latest techniques for making shared use of spectrum. One of these are Licensed Spectrum Access (LSA), which facilitates access for additional licensees in bands which are already in use by one or more incumbents. LSA is a concept to dynamically share this band, whenever and wherever it is unused by the incumbent users. There are methods to gainfully use the spectrum commercially in a non-operational period, with the condition that it would be made available to the govt for use during ops. Because global mobile industry and terrestrial communications is taking a huge leap so there is a great demand for spectrum. There is a major tradeoff between the broadcast, the mobile and the space segment.

29.   **5G Frequency Bands**. The 5G spectrum from 470 MHz onwards (ie broadcast band) is the sub 6GHz band and the frontier band for milli metre wave, when you actually need the eMBB is 28 GHz. The considerations on spectrum for 5G services rollout as per the NDCP 2018 are as listed below:-

(a)   **Immediate**.

(i)   Announce 700 MHz, 3.5 GHz, 26 GHz and 28 GHz as 5G bands.

(ii)   mm Wave bands be opened free for two years for trials and indigenous R&D

(b)   **Mid Term**.

(i)   Open 600 MHz, L Band, 31 GHz and 38 GHz bands for 5G

(ii)   38 GHs (37.0 to 43.5 GHz) band be opened free for two years for indigenous R&D.

(c)   **Long Term**. Study 3600-3700 MHz band for meeting mid-level 5G spectrum requirements.

30.   **Smart Cities**. On the aspect of smart cities, the question that is often asked is how smart is smart? These are like Centres of Excellence (C's of E) where it's difficult to quantify how excellent is excellent. Thus a datum level needs to be set for a smart city. The communication needs for a smart city or a smart cantonment also need to be quantified. There would be new revenue streams when 5G is rolled out. Globally, the number of active IoT connections is expected to reach 21.5 Bn whereas the Global IoT Market size is forecasted at 1600 Bn USD by 2024-25. In India, M2M/IOT is expected to reach 5 Bn connections by 2022. Some of these 5G applications which are tested commercially could be later adapted to meet the specific requirements of the Armed Forces. Security is an integral part of 5G and there are a lot of security focus areas in 5G

to include Identity Management, Platform Security, Building Trustworthy clouds, data Integrity, Security Assurance, 5G Security and IoT security. ***The Armed Forces must ensure that they are part of all discussion forums*** where 5G security aspects are being discussed, because if one is not discussing their specific security needs then they will end up buying whatever security is being provided. To the extent feasible, ***Armed Forces must ensure continuity of the person dealing with 5G and its security aspects,*** without linking it to the number of times he has been working in a particular appointment in the course of his duty. In the civil street, people who have been dealing with telecom standards have been there since last 20 years or so.

31.   Countries which have digitized their data across a common data format which can be used to run an AI engine are in the lead. While India has started off on a project called Digital Broadband Index of Readiness for various states, the Armed Forces could on similar lines consider steering a Digital Index of Readiness for various formations within their respective services. Only if the AF are digitized, will they be in a position to crunch numbers and provide services. This is a specialized area which requires continuity. The Armed Forces and HQ IDS would be well advised to nominate a Special Team in HQ IDS to track and work/train/ participate on future technologies events pertaining to 5G and provide continuity to the said team.

5G, IoT and Defence Connectivity and Recommended Use Cases for Defence

32.   **Background**. Mobile technology has made a leap every ~10 years. 1G provided analog voice and used AMPS, NMT, TACS. The 2G digital voices used D-AMPS, GSM, IS-95 (CDMA). 3G mobile broadband used WCDMA/HSPA+, CDMA 2000/EVDO. 4G provided faster and better MBB and uses LTE, LTE Advanced technology. In 2010 the auction for spectrum took place in India but by that time the technology had already become obsolete in the rest of the world. However luckily auction of spectrum for 4G was also carried out in India at the same

time. Though we were very late in implementing 3G, yet we were more or less in time for rolling out 4G. This spectrum was practically useable somewhere in 2014-2015, five years after the actual auction had taken place. The 4G growth in India has happened only during the last four years. Prior to that, there was hardly any 4G experience, possibly only in Kolkata. The just in time auction of spectrum for 4G was possible primarily due to defence services. The spectrum which is now being used by 4G was earlier being used by defence and some portion of it was also being used by commercial TSPs for providing 2G services. The complete process took four years and the moment it happened, TSPs could launch 4G services. The point evident from the above example is that when everyone gets aligned with the growth of the nation, the country gets benefitted.

33.   **Defence Specific Requirement**. When we talk about spectrum for 5G, the same thing is applicable here. There will however be a slight difference. Whatever technologies the defence is using for providing various services/ purposes, are not common commercially available technologies. When defence uses a particular spectrum band, and the same spectrum band is also used for commercial services, there is a requirement to put some guard band in between. This leads to wastage of a huge amount of spectrum, which can be otherwise put to better use if planned wisely. If Defence also starts using same set of technologies, which are commercially available technologies, then there would be no wastage of spectrum and spectrum can be utilized in a much better way and more effectively.

34.   **Security**. The stakeholders from the Armed Forces HQs (ie SHQs), need to actively participate in various deliberations that take place regarding finalization of security standards so that their concerns are addressed at the initial deliberation stage itself. 3GPP meetings are held regularly at COAI and various telecom standards are developed there. A group called SA 3 is doing the standards on 5G security standards, to ensure that security is built in by design into the radios and into the network elements. In that group there are people from US

Homeland security, British security etc but surprisingly no one from India is even there in the forum. So while Armed Forces may talk about security related issues within the closed confines of the SHQs, but if they are not represented at the high table where such decisions are taken then the in house deliberations are not of much use as it won't even get heard, let alone getting addressed. In India DoT is doing a lot of work on 5G security standards and compliance. Also, the Indian telecom sector being licensed, all companies follow some very strict security practices. All telco's have got SOPs and very good procedures are followed as can be seen by visiting the Airtel experience centre and the NOCC in NCR. In the Armed Forces, due to the rigid organizational requirement of time bound posting of officers after every 2-3 years, in the normal scheme of things, no officer will be able to keep up pace with the rapid changes taking place in the telecom sector, unless he has an inclination in this field. So the aspect of taking security as a service by the Armed Forces, for their networks, could be considered. The Armed Forces must ensure that they are part of all discussion forums where 5G security aspects are being discussed, because if one is not discussing their specific security needs then they will end up buying whatever security is being provided. To the extent feasible, Armed Forces must ensure continuity of the person dealing with 5G and its security & communication aspects. Requisite expertise exists in the Industry within India to provide security as a service. Requisite SLAs could be signed with the industry reps, to even include clauses of the 1923 Official Secrets Act and the same would be complied with by them.

35.   **5G Development Areas for Armed Forces to Focus**.   Each of the three use cases for 5G, offers avenues for the Armed Forces to utilize 5G, as tabulated & explained below:-

SNo	Use Case	Human To Human	Human To Machine	Machine To Machine
(a)	**eMBB**	VR/AR, Video Calling, Virtual Meetings	VR/AR, Fixed Wireless, UGH Video	Video Monitoring, Mobile Cloud Computing

(b)	mMTC	Wearables, Social Networking	Smart Homes, Smart Cities, Health care Monitoring	Smart Homes, Smart Cities, Vehicle to Infrastructure, Industrial Automation
(c)	uRLLC	Public safety	Remote Surgery, Vehicle to Pedestrian	Vehicle to Vehicle, Industrial Automation

36.   **5G Recommendations for Armed Forces**. Few recommendations/ suggestions / specific to the Armed Forces are as listed below:-

(a)   **Specify Needs**. Evaluate needs of Arms/Services; Combat/ Support Arms, Logistics, and Static Establishments for their service needs.

(b)   **Evaluate Potential**. 5G is from MTC to urLLC, how do these technologies map the needs for the above. Use of HAPS and Drones for deployment of NW elements??

(c)   **Exploit Digitisation**. Use Network Function Virtualisation (NFV) and SDN to customise network for specific needs of Armed Forces users and operational roles. Requires high level of digitization and is especially useful for doing remote surgery.

(d)   **Maximise Use of Available Data**. Create a data repository with a common Armed Forces **(AF)** data exchange, to enable Big Data Analytics for enabling enhancing combat effectiveness, predictions, optimising response timings. Could be of use to the logistics or to EME.

(e)   **Team Work**. Nominate a SPOC/Special Team in HQ IDS to track and work/train/participate on future technologies events. Establish a working relationship with Indian industry to build a mutually supportive relationship.

(f) **AF App Ecosystem**. Make an AF App ecosystem/agency for developing services the various users on the Armed Forces NWs, for use on wireless devices and small but rugged form factors, viz: Ninja Tool.

(g) **Spectrum Utilisation**. Rationalisation of various spectrum bands for access and backhaul for enhancing MBB coverage in the short time frame to provide fibre like capacity connectivity.

37. **Harmonization.** The range of EM spectrum varies from 300 KHz to 300 GHz. Spectrum has three distinct characteristics of Space, Time and Frequency. However when one is using a particular band of spectrum, there is a limitation that we can use only two of these three domains at any given point of time and place. Due to this reason and due to the fact that spectrum does not have boundaries, hence harmonization is a must. This not only necessitates harmonization to be carried out at a global scale, but also at the national level. This implies that if there is a place where the organization is using some kind of services in a particular set of spectrum band, the same band cannot be used by another user in the same locality. This is the biggest challenge for spectrum managers. WPC will face a major problem if defence is using a particular set of spectrum band and a TSP also starts using the same band for commercial purposes in the same locality. This leads to instances of interference, which need to be resolved.

38. **Path to IMT-2020**. Typically it takes time to make telecom standards, to plan and to build equipment accordingly and actually deploy that. It took about 15 years to develop 3G and deployment was after 2000. It was called IMT 2000. A vision document was created for 4G called IMT advanced, which took about 3 years and development took about 9 years, after which deployment started happening. For 5G, which is also called IMT 2020, there was a vision document which was created. The presence of the reps from India ensured that some of the interests of India were taken care of while formulating the said vision document. The formulation of this document took 4 years and in 2015

this document was finalized in the ITU and in 2020 it is slated to roll out. Few nations like Korea have already deployed 5G. Japan is moving ahead and got a very interesting thought process; they are putting a grid of 10 by 10 Kms with 5 eNodes at every 10 Kms square pan Japan.

39.   **Release 15-17 of IMT 2020**. IMT 2020 is what the various 5G technologies pertain to and 3GPP is the organization which is actually making standards for this. Release 15 of this was completed last year and standards which it finalized were Standalone (SA) radios for 5G and Non-Standalone (NSA) radios for 5G. In 2020, commercialization of Release -15 will take place. The devices that will come with Release -15 will facilitate eMBB deployments in both mm Wave and sub-6 GHz. In mm Wave, presently only one band is part of this which is 28 GHz band, which is the frontier band, which was spoken about earlier. Release -16 specifications will get frozen by next month. This will speak of the next level ie New 5G NR technologies to evolve and expand the 5G ecosystem. Release -17 is expected to be out by Dec 2019 and will start working on mMTC. It will address the expanded ecosystem: Industrial IoT, private network, 5G NR C-V2X, Integrated Access and Backhaul, unlicensed/shared spectrum, and continued eMBB evolution. This is the work going on in 5G and it is the right time for the Armed Forces to get involved in evolving standards for the same and especially security related work and in the IoT part of it.

40.   **5G, IoT & Defence**. The Indian Armed Forces have slightly different type of IoT requirements, on similar lines as is possibly applicable to the DoD of US and of other nations. The Defence Band existing with the Indian Armed Forces possibly needs to be given a holistic re-look to discard spectrum bands no longer required and include bands which would be required for 5G, as the same would be required for the Armed Forces. The standards available globally could also be looked at to meet the defence requirement. Different technologies of IMT-2020 like 3G, EVDO, LTE, LTE Advanced have been developed and defence is using some of these. Other than these there are few technologies which are already in use or have gone out of use like EVDO and CDMA. Defence

needs to identify the next best technology to which it should shift from the CDMA technology being presently being used. The Armed forces/ DoD of many other nations have a dedicated team of officers interacting with the vertical of the industry looking into these aspects. The Indian Defence Forces should also think on these lines and select a team of officers with requisite domain knowledge for preparing standards and to participate in discussions on future technologies events pertaining to 5G. In order to reap tangible results, Defence needs to provide continuity to the said team. Till now we were using CDMA/2G/3G technologies for a specific requirement. 3G spectrum was being used for voice communication and limited data capability. 5G is however not just a technology, it's a complete thought process to shape a way of life. 5G is all about connecting new industries and device, enabling new services & empowering new user experiences.

41.   **5G: Motivation and Drivers**. There is a wide basket of flavours that pulled 5G, which are listed as under and these find *close relationship with many operational requirements in the **Armed Forces***:-

> (a)   **eMBB (Enhanced Mobile Broadband)**. This provides extreme capacity (upto 10 Tbps per square Km), Extreme data rates (peak rates of Multi-Gbps & user experienced rates of 100 plus Mbps), Deep awareness (Discovery and optimization).

> (b)   **Massive Internet of Things**. This facilitates Deep coverage (to reach challenging locations), Ultra-low energy (ie >10 years of battery life), Ultra-high density (1 million nodes per square Km).

> (c)   **Mission Critical Control**. This is due to Ultra-high reliability (<1 out of 100 million packets lost), Ultra-low latency (As low as 1 millisecond) and Extreme user mobility.

42.   **5G NR Goals**. 5G New Radio (NR) is the global standard for a unified, more capable 5G wireless air interface. Different requirements listed in para 41 above need different frequency bands to operate and

the 5G New Radio is being designed to meet the same. Technology, equipment and devices will change as per the application envisaged. Few of the stated targets of IMT 2020 are Peak Data Rate of 20Gbps, User Experience Data Rate of 100Mbps, 3 times present Spectrum Efficiency, Latency of less than 1milli sec, Connection Density of million Devices/ square km, Network Energy Efficiency enhanced by 100 times , Area Traffic Capacity of 10Mbps/ square metre and Facilitates 500 Kmph Mobility.

43.   **Country Specific Requirements**. The requirement of 500 Kmph mobility is a typical requirement of High speed trains of China. The entire cell structure is designed in a linear fashion along the railway tracks. However on this aspect, India had a different specific requirement of Low Mobility Large Cell (**LMLC**) configuration for 5G technology. This was specific to the situation prevalent in rural India, where mobility is at times less than 10 Kmph but vast areas are required to be covered. The entire cell structure is designed in a manner so as to cover the vast areas of villages. The Indian proposal for LMLC has been approved by ITU to be included as mandatory evaluation standard for 5G.

44.   **Waveform and Frame Structure for 5G**.

(a)   **Scalable Numerology.** Typically LTE had 15 KHz pre set channels, which gave us a 1 msec inter frame with 15 KHz channel. 5G frame gives the option of 15/30/120 KHz. So converting into time domain we can club number of channels together to suit our specific requirement. To meet the surge requirement say downloading a video, the number of channels assigned to that application will go high and the bandwidth increases for that download. So no service is hampered and no channel is left unutilized. This also addresses the Doppler issues and delays the spread.

(b)   **Self Contained Slot**. In LTE, first the data was transmitted, receiver would receive it and send acknowledgment. So there were two different time frames happening and two different frames

were moving for that. When one side is ending acknowledgement, it would wait for the time slot to become available to send the transmission. However in 5G the same slot can be used for sending an acknowledgment and for sending or receiving data at different time frames, which is a part of dynamic TDD. Each 5G NR transmission is a modular transaction with the ability to independently decode slots and avoid static timing relationships across slots. By confining transmissions in time and frequency, the flexible design simplifies adding new 5G NR features/services in future — delivering a more forward-compatible design than previous generations.

(c)   **Dynamic TDD**. In LTE the UL/DL (Up Link/ Down Link) ratio is generally set at 1:2 or 1:3 but here in 5G it can be dynamically altered as per the situation. The system automatically handles it as per the network requirement. The 5G NR self-contained slot structure also delivers significantly lower latency than LTE thanks to support for fast UL/DL turn-around and scalable slot durations of e.g. 500 µs at 30 kHz tone spacing to 125 µs at 120 kHz tone spacing. This slot structure framework includes the opportunity for UL/DL scheduling, data, and acknowledgement to occur in the same slot. Beyond lower latency, this modular slot structure design enables more adaptive TDD UL/DL configuration, advanced reciprocity-based antenna techniques (e.g., downlink Massive MIMO steering based on fast uplink sounding) as well as additional use cases.

45.   **Carrier Spacing**. It efficiently address 5G diverse spectrum, deployments & services. The scaling reduces FFT (Fast Fourier Transform) processing complexity for wider bandwidths with reusable hardware. Few examples of Scalable 5G NR OFDM numerology are:-

(a)   Outdoor macro coverage e.g., FDD 700 MHz. Sub-Carrier spacing, e.g.15 kHz and Carrier bandwidth, e.g. 1,5,10 and 20 MHz.

(b)   Outdoor macro and small cell e.g., TDD 3-5 GHz.Sub-Carrier spacing, e.g.30 kHz and Carrier bandwidth, e.g. 100 MHz

(c)   Indoor wideband e.g., unlicensed 6 GHz. Sub-Carrier spacing, e.g.60 kHz and Carrier bandwidth, e.g. 160MHz

(d)   mmWave e.g., TDD 28 GHz. Sub-Carrier spacing, e.g.120 kHz and Carrier bandwidth, e.g. 400MHz.

46   **Scalable 5G NR Slot Duration For Diverse Latency/QoS.** Thus enhanced capacities available and same devices are doing all this. In terms of time domain each sub frame is of 1 msec, so as to be aligned with LTE and hence backward compatibility with LTE. We have 14 slots or 14 symbols in this, and we can use whatever part of that 14 slots for various requirements, each slot being of 125 micro seconds. Also mini slots exist in this for all together different purposes. 14 OFDM symbols per slot with mini-slot (of 2, 4, or 7 symbols are available) for shorter transmissions. This supports slot aggregation for data heavy transmissions and also facilitates efficient multiplexing of long and short transmissions. Thus same spectrum can provide IoT and eMBB at the same time.

47.   **Massive MIMO : Benefits**. Higher capacity is there due to MIMO technology ie there are a large No of antenna elements implying more simultaneous users. Thus leading to better spatial resolution. The coverage also increases due to beam forming and transmission diversity. Elevation Beam Forming (EBF) is carried out and is a fundamental requirement of massive MIMO and mm (Millimetric) waves.

48.   **5G : Simultaneous Access to Low, Mid and High Bands Needed**. The tabulated requirement of frequency spectrum, to include both licensed and unlicensed spectrum bands, for different applications of 5G is as under:-

SNo	Type of Service	Remarks	Freq Band
(a)	eMBB, URLLC	High-band above 6 GHz extremely high peak data rates	26 GHz, 28 GHz, 40 GHz, 60 GHz
(b)	eMBB, URLLC & mMTC	Mid-band above 2 GHz to around 6 GHz combination of both coverage and capacity	2.1 GHz, 2.3 GHz, 2.5 GHz, 3.4 GHz, 2.4 GHz, 5 GHz
(c)	Wide-area and deep indoor coverage (eMBB, URLLC & mMTC)	Low-band below around 2 GHz wide-area coverage and deep indoor services	600 MHz, 700 MHz

49.   **Military Requirements**. These are available in all fields of Command and Control like Security, Resilience/Survivability, Mobility, Radio Determination, Asymmetric Op Comn, Fire Control, Active/ Passive Surveillance and Time Critical/ Latency. Asymmetric Op Comn is of special relevance. Other applications are Edge Computing, Power Management, MIMO, Processing, Virtual Reality, Augmented Reality, Artificial Intelligence, Context Awareness, Peer to Peer, Small Cells, NFC and Face Recognition Radars. Using Virtual Reality, Augmented Reality, people sitting at Command HQs can actually feel to be part of the ops being carried out at a distant field location.

50.   **MTC (M2M/IoT) Technologies**. Various MTC (M2M/IoT) Technologies operate in different frequency bands. The same, along with the IEEE standards under which the said technology has been standardized and equipment for which is globally available are tabulated as under:-

SNo	Technology	IEEE/ ITU Standard	Distance	Frequency Bands
(a)	Bluetooth	IEEE 802.15.1	0-50 Mtrs	2.4 GHz
(b)	ZigBee/ 6Lo-WPAN	IEEE 802.15.4	0-100 Mtrs	869 MHz, 915 MHz, 2.4 GHz
(c)	Z-Wave	ITU-T-G.9959	0-20 Mtrs	868 MHz, 908 MHz, 921 MHz
(d)	Wireless N- Bus	EN 13757	0-1000 Mtrs	868 MHz
(e)	WiFi	IEEE 802.11a/g/n/ac/p	0-100 Mtrs	2.4 GHz, 5 GHz
(f)	WiGig	IEEE 802.11ad	0-20 Mtrs	60 GHz
(g)	WiFi	IEEE 802.11ah	0-1000 Mtrs	< 1 GHz
(h)	DASH7	ISO/IEC 18000-7	0-1000 Mtrs	433 MHz
(j)	Wavenis (wave2M)	Wave2M open standard group	0-100 Mtrs	433 MHz, 915 MHz, 8588 MHz
(k)	Zero-G Lite/ IEEE 802.22	Weightless SIG	0 - 10000 Mtrs	< 1 GHz
(l)	2G/3G/4G Cellular (MTC)		0-10000Mtrs	No separate spectrum band. Operates Across complete range of spectrum

51. **5G: Enabler of National Growth**. Listed in the table above are technologies developed as per different standards used in different parts of the world. So if the Defence uses these standardized technologies for which equipment is available then our procurement process in the military will be much faster. Even DRDO could use these same standards to develop equipment for the Defence.5G is a backbone technology for high speed, low latency telecom. It has extraordinarily low latency

allows services such as AR/VR and an immersive and tactile internet. 5G inverts classic paradigm of computational scarcity at the network's edge and computational abundance at the center. Edge computing facilitates AI, quantum computing and cryptography, facial recognition, etc. to be performed by mobile devices itself. 5G can serve as basis for internet-based IoT for every imaginable types of requirement and for many not yet imagined. 5G can be used as an instrument of international security policy of many developed countries. 5G is both an enabler and source of national economic growth and is likely to become a central element of nation's economic and military power, as can be seen in the deliberations on the subject between two major nations.

5G and IoT Roadmap as per ITU

52.   5G is the new mobile broadband technology that is in the early stages of development and deployments and likely to become the main mobile technology in the coming years. 5G has three main use cases ie Enhanced mobile broadband (**eMBB**), Massive machine type communications (**mMTC**) and Ultra-reliable and low latency communications (**URLLC**). While in 2G/3G/4G it was always about voice (and later about data) communication, yet in 5G for the first time it is getting into areas which are not simply about communications alone. The mMTC and URLLC are new areas, which imply that it will go into the IoT and machines, into the medical area, into the industrial field. 5G is thus an all-encompassing technology- it's not just a mobile technology and is thus likely to affect people from all walks of life- not merely Telecom Service Providers (TSPs). Industries, public safety, defence healthcare, municipalities etc all sectors will be affected by 5G.

53.   **ITU & 5G**. The ITU never refers to 5G; it's is in fact called IMT 2020. It was mooted in 2012 and it took seven years for it to mature to the state it is in. The radio being developed to be used for 5G is called 5G NR (New Radio). It moves away from LTE radio though it uses as the OFDMA for modulation. The technology development time cycle has got compressed. While it took 15 years for 3G technology to develop,

it was reduced to nine years in case of 4G. In 5G we are looking at developmental cycles of four to five years. A detailed development plan has been evolved in ITU staring from the stating the requirement, to workshops, submission of proposals and evaluation of same leading to consensus building and announcement of IMT 2020 after the 23rd meeting of ITU-5D. The meetings of ITU-5D is the place where actual decisions are taken as regards deciding the technology to be used and it's evaluation and it is very important for defence to participate in the same.

54.   **Flavors for 5G**. The technology related work being done at ITU is related to various updates released. The Release 15 was for First 5G NR Specs and work has been completed. It pertained to Licensed bands between 600MHz – 39 GHz, LTE-Anchored 5G (NSA), and Standalone (SA) 5G, Basic URLLC support, Massive MIMO, Flexible RAN architecture and Fulfills ITU IMT2020 criteria. Release 16 is towards the fuller 5G vision and is the first version where we will have full version of standalone 5G. The work on this has begun and should be over by 2020. It will actually eventually support V2X ie Video to anything, Autonomous driving, Enhanced MIMO, Support for Unlicensed bands, Factory automation and Support of higher bands (>52.6 GHz). The telecom sector has invested in LTE and is yet to recover their capex so it is not interested in investing for 5G. The investment for 5G is likely to come from the industrial or automation sector or from medical or robotics sector and from Defence. Release 16 puts across the complete flavor for 5G.

55.   **Defence & 5G**. In US, the DoD is actively participating in 5G use cases for defence. The security related work being done in 5G needs no emphasis. It is necessary to be there on the high table where deliberations are being done if one is to be taken seriously. The example of how India had to put in efforts to get it's LMLC proposal through is a shining example of what can be achieved through synergy of all stakeholders involved and hence early involvement of Defence is required. The 5G Scenarios provide amazingly fast speeds, great

service in a crowd, ubiquitous things communicating, best experience follows the user and user get super real-time ,reliable connections, high bit-rate, no delay and greater accessibility even in dense crowds and during mobility. 5G will support large number of use cases in all areas of day to day life. Lower frequency bands provide deep coverage inside tunnels/ underground/ in factories and higher frequency bands provide high bandwidth. The mid frequency bands will be the real work horse to provide basic services. The band 3.3- 3.4 GHz is the main workhorse band of 5G. All these could find major applications in Defence.

56.   **Frequency Bands for 5G**. Though being the forte of US and Europe, this time Asia has taken a lead in launch of 5G with it being inaugurated during the games in Korea. It will also be launched in Japan during the Rugby match in Sep 2019 and formal launch in Tokyo Olympics in July 2020. India till last year was counted as a leader in 5G and a High Level forum was also set up to write a spectrum report for 5G. Initial 5G Spectrum in most countries has been earmarked in the 3.4 to 3.7 GHz and 26-28 GHz and is tabulated below:-

S.No	Country	Mid Frequency Bands	High Frequency Bands	Commercial Time Plan
(a)	China	•3.3-3.6 and 4.8-5.0 GHz: release in 2019 • Consider 4.4-4.5 GHz	Consider 24.75-27.5 and 37-42.5 GHz bands for 5G	2020
(b)	Japan	• Release maximum 500 MHz from 3.6-4.2 and 4.4-4.9 GHz in 2019 Q1 • 3.4-3.6 GHz: already used for LTE	Release 27.0-29.5 GHz or a part in 2019Q1	2020
(c)	South Korea	3.42-3.7 GHz: auctioned in 2018	26.5-28.9 GHz: auctioned in 2018	2019
(d)	EU	3.4-3.8 GHz: auctions have started	Release (auction) of 24.25-27.5 GHz band (or a portion) auctions started	2020

| (e) | USA | • 3.55-3.7 GHz (CBRS)
 • Consider 3.7-4.2 GHz | • 27.5-28.35 and 39 GHz trials underway with commercial deployments in 2019
 • Auction additional 28 & 24 GHz in 2018 | 2019 |

57.   **Sharing of Spectrum**. In the LTE there is a 100msec delay but we now need only a 1msec delay, which 5G provides. Certain unlicensed LTE and new technologies can support higher data. 5G is all about sharing of spectrum when it is not being used by another user/ service. This is possible as shown in the Citizen Band Radio Service (**CBRS**). CBRS is from 3.5-3.7 GHz. Here FCC of US has advocated a 3 Tiered shared spectrum model being followed in USA, using a new sharing technology, where 150 MHz is shared spectrum without interrupting incumbents (the military radars- both ship based and ground based). There is a second category of users who have Premier Access Licenses (**PAL**) and a third category who have General Authorized Access (**GAA)**. Incumbents Have priority over PAL and GAA. PAL has priority over GAA. GAA can use any spectrum not used, must yield to PAL and Incumbents. This is possible using a database, through online monitoring and allocation using real time allocation to IP addresses. Spectrum Allocation System assigns Spectrum and Enterprise Applications, Custom BB LTE coverage and capacity for private networks is made possible using this system. A Hybrid licensing model (Licensed, Unlicensed) is followed here.

58.   **Types of IOT Technologies**. At present, there is an array of different technologies competing within the IOT space including Cellular IoT (CIOT) like LTE-M and NB-IOT as well as non-cellular technologies such as Sigfox, LoRa, etc. CIOT piggybacks on the same mobile networks as smartphones. Its infrastructural simplicity combined with the dawn of 5G, positions cellular IoT as a strong player in the connectivity space. It will use existing bands of cellular networks. It will facilitate auto switching off of receivers to enable a battery life of upto 10 years.

NDCP-18 & NFAP-19 & Its Relevance to 5G, IoT & the Armed Forces

59.   **National Digital Communication Policy (NDCP 2018)**. Spectrum is a very valuable natural resource which gets used but does not get consumed on being utilized. It is required to be shared by various services like Telecom, Space, Aeronautical and Defence amongst other users. NDCP 2018 is the National Digital Communication Policy. At times the same frequency band is shared by two or three services and the stakeholders rightly have their own service specific concerns. There are thus competing and conflicting demands on the same band of spectrum which is used by different services. There was a time when even to access a basic telephone, one was required to approach the ministry for priority allotment of the same. Now a stage has come when there are more than 2-3 mobiles in each family. This has been possible due to efficient use of frequency spectrum. The NDCP is very comprehensive document and has the following major goals at the national level:-

(a)   Identifying and making available new Spectrum bands for Access and Backhaul segments for timely deployment and growth of 5G networks.

(b)   Making available harmonized and contiguous spectrum required for deployment of next generation access technologies.

(c)   Further liberalizing the spectrum sharing, leasing and trading regime.

(d)   Enabling Light Touch licensing/ de-licensing of spectrum for broadband proliferation.

(e)   Promoting the co-use/ secondary use of spectrum.

60.   At the global level, the ITU has already carried out harmonization of the frequencies to be used for various services. These regulations are also applicable to India and India as a nation is committed to making available most of the globally accepted 5G spectrum bands available for commercial 5G technology in India. DoT is trying to harmonize

the spectrum requirements of different users and is trying to make a dedicated chunk of spectrum available for use. Defence has also been given a dedicated spectrum under the Defence Band.

61.   Vide NDCP, in order to synergize deployment and adoption of new and emerging technologies, a road map has been created and there are a number of initiatives taken by the govt, few of which are listed as under:-

>   (a)   Creating a roadmap for emerging technologies and its use in the communications sector, such as 5G, Artificial Intelligence, Robotics, Internet of Things, Cloud Computing and M2M.

>   (b)   Simplifying licensing and regulatory frameworks whilst ensuring appropriate security frameworks for IoT/ M2M / future services and network elements incorporating international best practices.

>   (c)   Earmarking adequate licensed and unlicensed spectrum for IoT/ M2M services.

>   (d)   Encouraging use of Open Application Program Interface (APIs) for emerging technologies

62.   WPC (Wireless Planning & Coordination) Wing of MoC already has a licensing approach and TRAI has recommended Light Touch Licensing regulations mechanism for E band and G band. A new licensing mechanism is being worked out 5G. There is no separate frequency band required for M2M and IoT services as these services can work in bands identified for mob services. A number of frequencies have been delicensed for Short Range Devices (**SRDs**) and Ultra Wide Band devices. Those frequencies can also be used for M2Mand IoT applications.

63.   **National Frequency Allocation Plan-2018 (NFAP-2018)**. Based on decisions taken in WRC 2015, the NFAP 2018 was formulated for the nation, after taking inputs from all stakeholders. This document

provides inputs as to which frequency band can be used for which service. It provides a broad regulatory framework, identifying which frequency bands are available for Cellular mobile service, Wi-fi, Sound and Television broadcasting, Radio navigation for aircrafts and ships, Defence and security communications, Disaster relief and emergency communications, Satellite communications and satellite-broadcasting and Amateur services. Besides this NFAP contains details of and provides allocation for 41 Radio-communication Services. The spectrum is divided into frequency bands and each band is allocated to one or more radio-communication services to provide effective access to frequencies.

64.   **Frequency Allocation**. The principle of designating a band for the use by specified radio-communication services is referred to as frequency allocation. A radio-communication service usually encompasses more than one application. For example, cellular mobile service (2G, 3G, 4G and to be introduced, 5G,), Wi-Fi, radio trunking, radio paging, walkie-talkies and several others come under the "**mobile**" service. Broadcasting includes sound broadcasting as well as television broadcasting. The use of the spectrum is not static, and that the introduction of ever new application of spectrum is determined by demands from citizens and the industry.

65.   **SRDs & UWB**. Short-range Devices (SRDs) and devices using Ultra-wideband (UWB) technology make use of the radio-frequency spectrum. SRDs and UWB-devices are fast assuming crucial importance to citizens, as well as to specialized public and private sectors (e.g., medical implants, ground-probing radars, the latter for use by security and utility agencies). Machine-to-Machine (**M2M**) communications and Internet of Things (**IoT**) largely depend upon SRDs and UWB-devices. M2M & IoT devices are, however, not considered as providing radio-communication services and are usually kept out of the purview of Radio Regulations. An Annexure has been added to NFAP-2018 for the frequencies in license exempt use for SRD & UWB devices. NFAP-18 doesn't list the various applications of any radio-communication service. In a few cases, however, applications of a radio-communication service

in specific frequency bands have been indicated in the India footnote to the Table of Frequency Allocation.

66.   Globally the following frequency bands, or parts thereof, have been identified for implementation of International Mobile Telecommunications **(IMT)**, as tabulated below. Part of the band 470-698 MHz would be made available for IMT once the current and future usage of the band 470-698 MHz by the broadcasting service is finalized. However as part of this 470-698 MHz band is also allocated for other central govt agencies, hence allocation of the same would require lot of inter-ministerial coordination. The frequency bands are:-

Ser No	Sl No as in NFAP	Band as mentioned in RR (Radio regulations) of ITU	Relevant RR Footnotes
(a)	1	450-470 MHz	5.286AA
(b)	6	470-585 MHz*	5.296A
(c)	7	585-610 MHz*	7
(d)	8	610-960 MHz	8
(e)	11	1427-1518 MHz	11
(f)	15	1710-2025 MHz	15
(g)	20	2025-2200 MHz	20
(h)	25	2300-2450 MHz	25
(j)	26	2500-2690 MHz	26
(k)	31	3300-3400 MHz	31
(l)	32	3400-3600 MHz	32

67.   The efforts previously made by the Defence to accommodate the national requirements in the 1710-2025 MHz band in India were appreciable. In the 2300-2450 MHz band, despite earmarking spectrum for 5G, the nation's strategic interests also need to be catered for as Defence has certain requirements in various bands, which need to be accommodated by WPC.

68.   **Frequency Bands Proposed For For 5G**. In August, 2018, the TRAI had made recommendations for further auction of spectrum in the frequency bands of 700 MHz, 800 MHz, 900 MHz,1 800 MHz, 2100 MHz, 2300 MHz,2 500 MHz,3300MHz and 3400 MHz bands.WRC 19 has a special agenda 1.13 for identifying spectrum for mobile services communication. The frequency bands 698-803 MHz, 3300-3600 MHz are being considered for IMT services and would be auctioned in the forthcoming auction. The frequencies bands being considered at ITU WRC-19, under Agenda Item (AI) 1.13 for IMT identification are - 24.25-27.5 GHz, 31.8-33.4 GHz, 37-43.5 GHz, 45.5-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz and 81-86 GHz. India is supporting the frequency bands 24.25-27.5 GHz and 37.0 to 43.5 GHz for IMT 2020 under the AI 1.13 of WRC-2019. Still there are certain contentious issues with opposition being raised by the satellite industry amongst others but WPC is confident of resolving the same.

69.   **Recommendation of High Level Forum for 5G**. A High level forum for 5G was created in India and few important recommendations of this forum are :-

>   (a)   **Access Bands**. The following bands were considered for Access:-
>
>>   (i)   617-803 MHz;
>>
>>   (ii)   1427-1518 MHz;
>>
>>   (iii) 3300-3700 MHz;
>>
>>   (iv)   24.25-27.5 GHz;
>>
>>   (v)   27.5-29.5 GHz;
>>
>>   (vi)   29.5-31.3 GHz;
>>
>>   (vii) 37-43.5 GHz;
>
>   (b)   **Backhaul Bands**. The following bands considered for backhaul:-

(i)   51-71 GHz;

(ii)   71-76/81-86 GHz

(c)   **5GHz WiFi Bands**. The following bands considered for 5GHz WiFi:-

(i)   5150-5350 MHz;

(ii)   5470-5725 MHz;

(iii)   5725-5825 MHz.

70.   **Telecom Gear Makers' Efforts Towards 5G**. Cisco, Samsung, Ericsson, Nokia, Intel and Sterlite Tech are likely to invest more than Rs 4,000 crore in India, in line with the goal to achieve a capital gain of $100 billion as per NDCP- 2018. Sterlite Tech will be an enabler of upcoming 5G technology rollout. Intel Corporation is planning to unveil dual capability 4G and 5G technology based System-on-Chip (SoC) for the device ecosystem in the 3300-3600 MHz frequency band in India, according to a highly-placed industry source. Ericsson, Reliance Jio and Samsung have been granted Trial licenses for 5G. Some pricing mechanisms and regulatory issues are being addressed before the move ahead for trials.

71.   **Defence Concerns**. The concerns of the defence regarding some important issues about frequency spectrum bands , have been conveyed in writing to the Telecom Secretary as some of those spectrum bands under contention have already been identified by the WPC for auction for 5G. Equipment which operates in these frequency bands under contention has already been bought by the Armed Forces and allocation of frequency spots for these equipment is required to be provided on priority. When the Defence Band was being culled out, few years back, a detailed study had been carried out by JCES, HQ IDS, regarding the spectrum used by the Federal band in the US, the Defence band of UK and what was required for India. In the US in the homeland, they had 24% reservation in the Federal band, 22% in the Defence band

of UK and in India we had 28% utilization. The Empowered Group of Ministers (EGoM), while carving out the Defence Band for Indian Armed Forces, had directed that there should be no sharing of spectrum which had been earmarked exclusively for Defence. This arrangement should not be unilaterally altered. The Defence Band was meant exclusively for use by the Armed Forces and should not be encroached upon.

72.   The Armed Forces requirements for providing national security would actually emerge when the balloon goes up during war and all the frequency spots, "*seemingly lying vacant",* would be utilized. It is important that now, during peace time these issues be resolved. It's not only in India where this frequency (earmarked for Defence), seems to be lying unutilized. Even in the US they have 24% reservation in the Federal band and they fight wars using the NATO band; thus in totality the spectrum reserved for US Armed Forces is 34%. As per the migration plan post promulgation of Def Band, defence and commercial users were to complete the migration into the respective parts of their frequency spectrum within 5 years. However due to procedural delays, the nationwide Optical Fibre network to be laid under project NFS , which was to be in place long back, has not yet materialized . Hence delay in completion of migration.It is reiterated that National Security is not merely the responsibility of the Armed Forces but it was equally the responsibility of all stakeholders including the WPC, MoC. As explained, had the NFS been established and had it been fully operational in 2012, as initially promised and planned, migration by commercial & defence users into the respective parts of their frequency spectrum would have been completed long back. Unfortunately the spectrum has been released by Defence but the network to facilitate the said migration is still not in place.

5G, IoT and It's Cyber Security Implications

73.   **Source Code Testing**. Any discussion about 5G will be incomplete without addressing it's security implications and closely linked to that are the unsubstantiated stories / allegations about the telecom equipment

being supplied by a foreign telecom company and the vulnerability of networks using the equipment supplied by the said firm. While it is important to have access to source code of the equipment under doubt, yet it is equally important to have a facility to be able to test the same for vulnerability. It is important to accept that the capability to detect (leave aside destroying) any vulnerability is very limited and is a niche field. There is a need to increase our capability of trusting the equipment provided by foreign vendors before we think of ways to exploit the same. Merely having a source code is thus of no use if are unable to exploit it.

74.   **Moot Issues to Deliberate Upon**. By 2025 there will be 5 Bn IoT devices but as per Chinese estimates, there will be 25 Bn new IoT devices which will be added on to 5G network and most of these will be sensors and not the ordinary communication protocol. Using an untrusted network equipment implies as a nation we are willing to share our data with a potential adversary. The data could be commercially exploited, leaving aside aspects of espionage and warfare. The aspect as to whether a potential adversary can actually weaponise 5G in cities needs to be considered. The day to day implications of allowing equipment from a potential adversary, in the core networks of 5G, also need to be addressed.

75.   **Futuristic Applications of 5G**. With 25 Bn new IoT devices and terrific speeds, 5G will be used for a vast variety of services like video streaming and holography etc. But 20 years later maybe the applications will change and a person could be moving around with 5-6 sensors and an autonomous vehicle would be having 25-30 sensors. High speeds, low latency and high bandwidth applications would be the norm. A humanoid, with assisted intelligence in the human mind, could also be a distinct possibility in future. Whatever applications that have been thought of at present for eg AR/VR/, Holographic calls, drones, self-driving cars etc are only current/ contemporary for next five years. Beyond that, the applications are limited only by imagination.

76.   **Long Term Implications: Monopolistic Tendency**. There is thus a need to think for the future because once the core network is established, an eco system will grow around it and at that time it will be very difficult to remove the suspect telecom equipment from the network. Initially one thought Google was only about Gmail or at best about a search engine. It now turns out that it's much bigger than that- it's in fact got a finger in each pie. Google has cloud, data, search engine, AI, Payment gateways; they have everything you can imagine in the world. So one cannot do away with Google today. Likewise is the case with Facebook which is now planning to branch into aerial balloon platforms also for communication services.

77.   Similar is the case with these technology companies. Once we allow them into our core networks, we will not be able to do without them and we will not be able to remove them. They have patents ready and will soon build an ecosystem around the device put in the network. People will pay money for using those patented devices, build applications and gadgets around them and soon the eco system will be ready which can't be replaced. Thus while a nation may presently be in a position to replace the equipment in the core network now but later on it will not be possible to replace the complete eco system. So a very conscious decision needs to be taken now in this regard. Few instances /reasons giving rise to misgivings/ reservations about using Huawei equipment, as reported in the media are the US indictment in early 2019, regarding sale of technology to Iran, the arrest of the daughter of the Huawei founder and CEO of Huawei in Canada, by the RCMP and allegations of transfer of IPR in an unauthorized manner to Chinese firms. If these allegations are found to be true, then possibly the aim appears to be to save money which would have otherwise been spent on R&D and develop and market products so cheap that it effectively wipes out any competition in the near foreseeable future.

78.   **5G : An Ecosystem of Gadgets.** It needs to understood that the routers of any firm which is suspect is not merely a piece of an isolated equipment as 5G is going to be an ecosystem of gadgets, sensors,

various OTT applications, applications, Operating systems etc. In that if we collect humongous amount of data, it is useless unless it can be made sense of and analysed. In 2010 Baidu had started discussing AI strategies and calls. However it was only in 2015 that Google discussed it's Machine Learning (**ML**) applications for the first time. So a clear leap of 5 years has been taken by the Chinese in AI and ML. Even today 70% of funding of all US companies in AI is coming from Angel Investors which possibly have either Chinese backing or Chinese collaboration.

79.   **Camera Surveillance**. The biggest camera surveillance systems regime in the world using AI and web cameras is reportedly being put up by China. Now it will shift to 5G platform. Even today Chinese claim that within 90 secs they can track any individual in China and a car can be tracked immediately in China. So it's a tough call to be taken regarding allowing any firm which is suspect to participate in fielding 5G in India and the decision makers would weigh all pros and cons on the subject. The middle path approach of banning such a firm in critical/ core / sensitive sectors like defence but permitting them in non sensitive areas is also fraught with consequences. The 25 Bn sensors deployed in this other so called non sensitive areas are also important. These sectors like power, electricity etc have the potential to be shut down if infected. So everything is linked. Data about people is being collected which will be mined in future.

80.   **Battle For Technological Dominance**. Snowden's leaks were possible because he had access to data systems, routers and cables ie the full ecosystem was available to them. Now in 5G, a particular technology firm has penetrated the smart phone market, the Chinese are building their own OS and OTT apps. They are in fact building a parallel system to the Google basket of services. This battle for technological dominance being waged between USA and China is not for the immediate present but it is for the future. Whoever controls those 25 Mn sensors will control 5G and whoever dominates 5G will dominate the intelligence empire for the next 50 years. It is all about Data, Data Colonization and about Intelligence. Militaries may not go to war but it's

all about data. When Dokhlam happened, India was looking for some actionable intelligence. Each nation is collecting this info about various nations but it won't be sending all this info back to it's homeland for processing and analysis. They will have some local stations to do this task ie Edge computing facilitated by 5G. Like the west has the group of 5 Eyes and Israel for sharing of intelligence, China too will build it's allies.

81.   **White Listing**. The approach of not deploying routers supplied by a company under scrutiny, in core/ critical networks is also counter-productive as at locations where these routers have not been installed give an indirect indication of being sensitive / important nodes ie a Red flag is raised. So if some hacker wishes to inflict damage, he exactly knows which router to target. So this approach of segregation is fraught with danger. There is thus a need to either ban this kind of suspect equipment or decide to put in requisite safeguards and live with it.

82.   **Maintenance Support**.   If we allow systems supplied by a company under scrutiny, then we will need to employ their maintenance engineers to maintain and upgrade their systems. At present it is possible to control the internet traffic to some extent. The moment we have the equipment from firms which are suspect and when 5G is fielded, then we have to install multiple nodes, then density and thus vulnerability will increase. If any one of the thousands of points/ nodes is compromised then due to the mesh network architecture, data will get transferred all over the network. The DNS logs will be transported and the complete browsing history of a nation will be available for interested parties to see.

83.   **Legal Point of View**. Article 7 of the National Intelligence act passed by China last year is very specific in asking all Chinese firms to cooperate with the govt ie national security agencies. Article 14 of this act mandates the companies to share data ie it's neither optional nor subject to judicial review in China. US has categorically stated that it wants it's Allies to keep Huawei out of sensitive infrastructure programmes over concerns that it will allow China to spy on West. US will not be putting out

any information on an untrusted network. So it implies that for nations wanting to have seamless connectivity with US systems and which use agreements (like COMCASSA), it will not be possible to have access to such information over networks having supposedly suspect equipment. As it will not be possible retrospectively to take out suspect equipment deployed in the core networks, thus a deliberate call needs to be taken now itself.

Conclusion

84.   **Electro Magnetic Fields**. In 5G due to the large number of towers that would be established there should be some study to be carried out on the effects of radiation and Electromagnetic Fields (**EMF**). EMF radiation concerns are reportedly unfounded as these radiations are only incident upon the body but are non-ionizing in nature. Though the EMF radiations are reportedly non-cancerous in nature and may at best cause RF burns and heating, yet Earth Exploration Satellite Service (**EESS**), which monitors the power flux density in a particular area, could be used to carry out this analysis. Studies carried out by international bodies have set EMF limits and safety norms and they are in compliance in India. A study also needs to be carried out of the number of Data Centres that would be required and the associated requirement of water and electricity for the same should be worked out. Being member nations of WTO banning a nation specific product may not be easy.

85.   **Dedicated 5G Network for Armed Forces**. 5G is all about use cases and it can be used to enhance op effectiveness. The feasibility of establishing a dedicated 5G cloud which can be made available only for the Armed Forces and it's security implications, merits deliberation. A dedicated 5G network, with 5G cloud and data centres could enable working on a paperless and automated environment, facilitating remote control. Such a system would need to be hack proof and there would be a need for separation of the commercial and military requirements. 5G will facilitate tracking and monitoring of the exact location of the person with a mobile device. So it is very important who has access to the data

base and controls it. It is recommended that a special cell be created within the Armed Forces to understand and utilize the 5G technology to enhance the understanding of the subject and leverage op effectiveness. Also participation by defence reps in meetings of SA-3 and in 3GPP should be encouraged.

86.   **Great Game in Digital Realm**. For 5G radios, the technology is either produced by ZTE or Huawei or Nokia or Ericson. Within the Armed Forces, in order to have plurality of OEMs there would be requirement to source equipment from all the major OEMs. China has filed the maximum number of patents and IPRs in development of 5G. The current situation and standoff between USA and China is akin to the *Great Game* being played out in digital realm- The technological ascendancy of the West is being challenged by the Orient. India as a rising nation has to find it's own space in the overall scheme of things and the policy makers need to take a deliberate call on development and education at relatively lower costs versus security or a mid-course tradeoff between the two.