

Before
INNOVATION, SCIENCE AND ECONOMIC DEVELOPMENT CANADA,
Spectrum Management and Telecommunications
Ottawa, ON K1A 0H5

In the Matter of

**Consultation on the Spectrum Outlook
2018-2022**

)
) **Canada Gazette, Part 1**
) **October 21, 2017**
) **Notice No. SLPB-006-17**
)

COMMENTS OF THE GLOBAL MOBILE SUPPLIERS ASSOCIATION (GSA)
February 16, 2018

General Comments:

The Global mobile Suppliers Association (GSA) represents the leading suppliers in the mobile industry and is progressively supporting mobile broadband development based on a harmonized and standards-based approaches. GSA promotes the 3GPP technology roadmap and represents companies across the worldwide mobile ecosystem engaged in the supply of infrastructure, semiconductors, test equipment, devices, applications and mobile support services. The GSA Executive Board members are Ericsson, Huawei, Intel, Nokia, Qualcomm and Samsung, covering close to 100% of all mobile network infrastructure deployments.

GSA welcomes this consultation and strongly supports this future-looking initiative taken by ISED and respectfully submits comments below.

Specific Comments:

Consultation Section 5.2 on commercial mobile contains questions Q2-Q4. The consultation's text contains these sections:

5.2.1 Subscribership

5.2.2 Traffic growth

5.2.3 Technology advancements for commercial mobile

5.2.4 Overall impact on commercial mobile spectrum requirements in Canada

ISED questions for this section:

Q2: Q2 –Do you agree with the above assessment on demand for commercial mobile services in the next few years? Is there additional information on demand, which is not covered above, that should be considered? If so, please explain in detail.

Q3: What new technology developments and/or usage trends are expected to address traffic pressures and spectrum demand for commercial mobile services? When are these technologies expected to become available?

Q4: Recognizing the trend of increasing commercial mobile traffic, what operational measures (e.g. densification, small cells or advanced traffic management) are being taken to respond to, and support, increasing traffic? To what extent are these measures effective?

GSA General RESPONSE TO/COMMENTS ON, SECTIONS 5.1 AND 5.2 OF THE SPECTRUM OUTLOOK CONSULTATION

In consideration of paragraphs 23¹ and 24² of the consultation, GSA concurs in general with the increase in data demand for the commercial mobile service as well as its impact on the spectrum requirements/needs of this service. Further, the increase in cellular traffic would lead to a larger increase in the backhaul traffic, with a consequent impact on the spectrum needs of backhaul (fixed service) as well.

Specifically, with respect to section 5.2, GSA notes that within the ITU, there have been several iterations of spectrum needs “calculations” over the past fifteen years. During the first iteration from approximately 2000 to 2003, the spectrum estimate provided in Report ITU-R [M.2023](#) and based on a methodology in Recommendation ITU-R [M.1390](#), proved to be low due to an incorrect forecast in the traffic demand that mobile networks were expected to face. This was remedied during the second iteration (2003-2007) when a conscious effort was made to derive a more accurate traffic demand which, in turn, would lead to a more precise estimate. Data was culled on the different types of applications, the amount of bits/bytes each application required, how many end-users would be transmitting such applications simultaneously and then calculating the spectrum requirements. The

¹ studies show that the volume of data to be carried over various networks is expected to increase between three- and six-fold by 2020 and that the most significant growth in demand for data will be for commercial mobile services, licence-exempt applications (largely Wi-Fi), satellite services and backhaul

² ISED recognizes that there are several variables that impact spectrum requirements (e.g. technology, traffic growth, network design), and that these can vary significantly for different networks, applications and services. Furthermore, traffic growth for some services and applications can impact the spectrum requirements of other services (e.g. demand for commercial mobile traffic can impact the demand for backhaul spectrum and due to commercial mobile off-loading, can impact the demand for licence-exempt spectrum)

three Reports (ITU-R [M.2072](#), [M.2074](#) and [M.2078](#)), based on a methodology developed in Recommendation ITU-R [M.1768](#), were made available to WRC-2007, as shown in Figure 1.

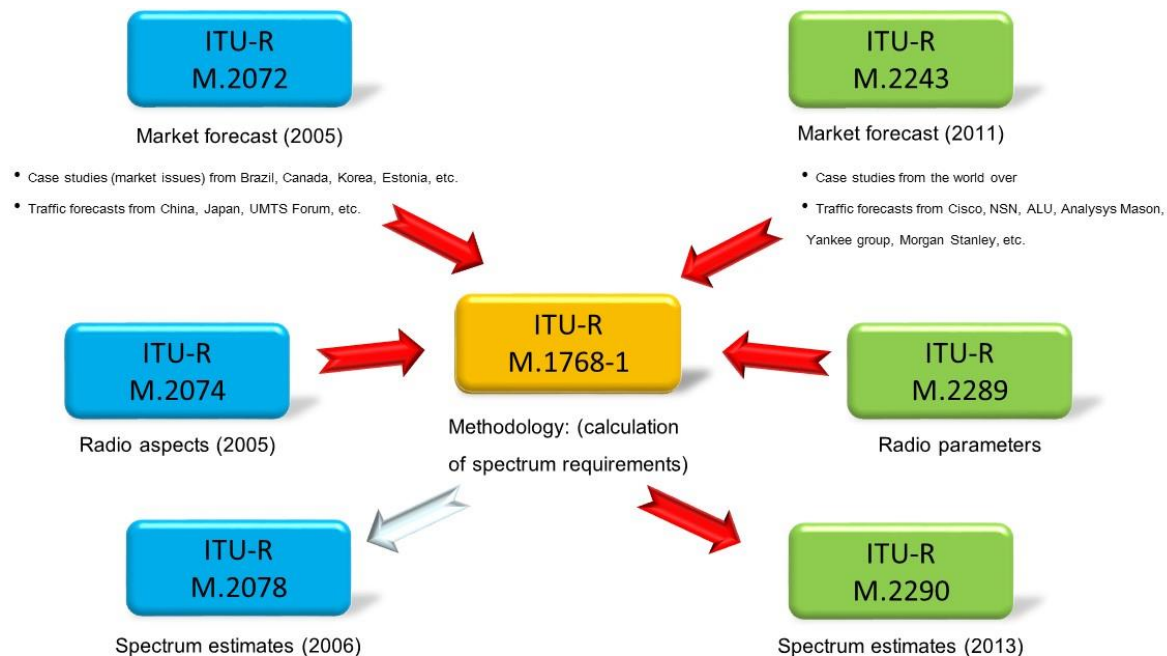


Figure 1: Showing the second iteration for the calculation of spectrum demands for IMT-2000 and IMT-Advanced.

With advances in radio technology, the methodology was updated (M.1768-1) and a new series of Reports (ITU-R [M.2243](#), [M.2289](#) and [M.2290](#)) was issued in time for WRC-2015 (see same Figure 1). Concurrently, since the IMT methodology “off-loaded” traffic carried by RLANs (or Wi-Fi networks), a separate Recommendation ITU-R [M.1651](#) was developed to calculate the spectrum requirements of “broadband nomadic wireless access systems” – as shown in Figure 2.

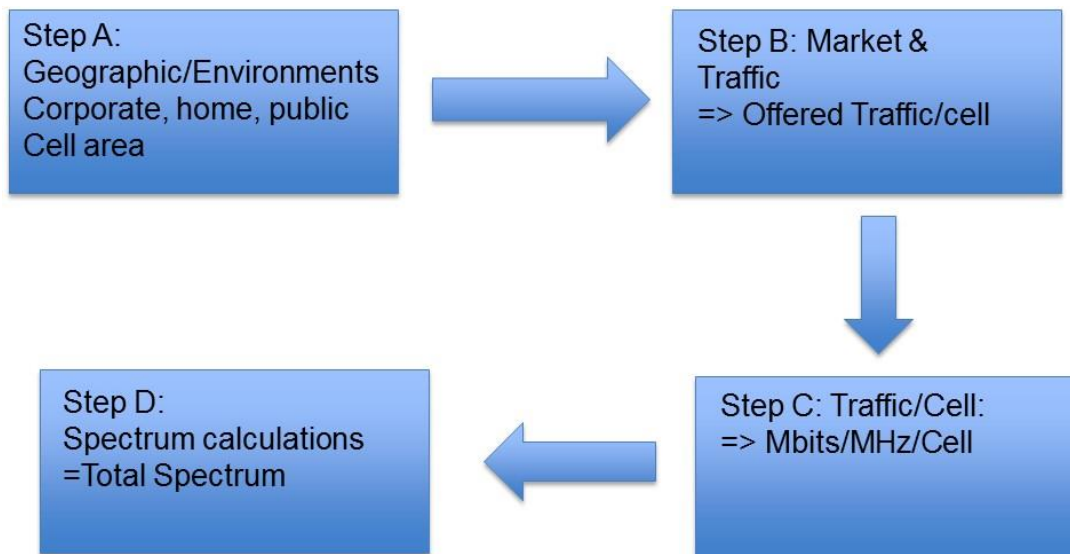


Figure 2: Showing the concurrent calculation of spectrum demands for RLANs (Wi-Fi networks).

This RLAN estimate was also made available to WRC-2015. The [Report of the CPM to WRC-15](#) summarizes these activities in Sections 1/1.1/3.1.1 and 1/1.1/3.1.2 for IMT and RLAN, respectively, while the different spectrum estimates for IMT-2000, IMT-Advanced and RLAN are shown in Table 1. It should be noted that the estimates for IMT (2000 and Advanced) and RLAN are independent of one another; this is a consequence of the RLAN traffic being “off-loaded” as mentioned earlier.

	IMT-2000 and IMT-Advanced	IMT-2000 and IMT-Advanced	RLAN
Lower bound (in MHz)	1280	1340	880
Upper bound (in MHz)	1720	1960	

Table 1: Showing the upper and lower bounds of the different spectrum estimates for IMT and RLAN.

With the radio having undergone a substantial makeover for IMT-2020, a third iteration in the derivation of a spectrum estimate for “5G” was necessitated. Though Report ITU-R [M.2370](#), estimating the traffic to be carried by IMT through the year 2030, was published in July 2015, a decision was taken by the mobile industry to base the spectrum “needs” on technical-performance requirements as set out in Recommendation ITU-R [M.2083](#) (so-called “Vision document”), rather than on traffic demand. This was due, in no small part, to the controversy that surrounded the spectrum estimates derived in the second iteration using the traffic-based methodology.

Further, the group within the ITU that developed the spectrum needs decided to *not* publish a detailed report on the methodology itself, but simply communicated the results and the process(es) by which the results were achieved through a liaison statement to the group which will use these results to perform sharing/co-existence studies. The ultimate objective is to convey the outcome of all of these studies to WRC-2019, where the decision on the bands to be identified for use by IMT-2020, will be taken. This is illustrated in Figure 3, where only the results based on the technical performance approach, are exhibited.

	Examples	Associated conditions for different examples (For details, please see the corresponding sections in the Annex A)	Spectrum needs in total (GHz)	Spectrum needs (GHz) per range
Technical performance-based approach (Type 1)	1	User experienced data rate of 1 Gbit/s with N simultaneously served users/devices at the cell-edge, e.g., Indoor	3.33 ($N=1$), 6.67 ($N=2$), 13.33 ($N=4$)	Not available
		User experienced data rate of 100 Mbits/s with N simultaneously served users/devices at the cell-edge, for wide area coverage	0.67 ($N=1$), 1.32 ($N=2$), 2.64 ($N=4$)	Not available
	2	eMBB Dense Urban	0.83-4.17	Not available
		eMBB Indoor Hotspot	3-15	Not available
	3	With a file transfer of 10 Mbits by a single user at cell-edge in 1 msec	33.33 GHz (one direction)	Not available
		With a file transfer of 1 Mbit by a single user at cell-edge in 1 msec	3.33 GHz (one direction)	
		With a file transfer of 0.1 Mbits by a single user at cell-edge in 1 msec	333 MHz (one direction)	

Figure 3: Showing the third iteration for the calculation of spectrum “needs” for IMT-2020.

One of the new calculations in this approach is to show the effect of latency and file-size on the spectrum requirement. As per Recommendation ITU-R M.2083, the user-plane latency requirement is as small as 1 msec in a specific usage scenario called “ultra-reliable-and-low-latency-communications – urLLC.” In such a scenario, as the file-size increases, the spectrum requirement also increases, but it is the magnitude of the increase (all other propagation factors remaining unchanged) which is somewhat surprising, if not disconcerting. Very low latency and very high reliability are demanding characteristics that could impose a corresponding burden on the spectrum need.

Current situation in two example countries (U.S. and Canada)

Table 2 shows the spectrum below and above 6 GHz available to cellular operation (IMT) in the US and Canada:

Below 6 GHz:	Comments
614-698 MHz = 84 MHz 698-806 MHz = 108 MHz 824-849/869-894 MHz = 50 MHz 1710-1755/2110-2155 MHz = 90 MHz 1755-1780/2155-2180 MHz = 50 MHz 2000-2020/2180-2200 MHz = 40 MHz 1850-1915/1930-1995 MHz = 130 MHz 2305-2320/2345-2360 MHz = 30 MHz 2496-2690 MHz = 194 MHz 3550-3700 MHz = 150 MHz Total 734 MHz	In the US, 20 MHz is licensed to Firstnet, a public safety broadband network and capacity may be used for commercial services if not in use by Firstnet. ITU-R Spectrum estimate: 1340 to 1920 MHz
Above 6 GHz US (2016/2017), Canada (decision pending):	
24.25-24.45 GHz = 200 MHz 24.75-25.25 GHz = 500 MHz 27.5-28.35 GHz = 850 MHz 37-40 GHz = 3000 MHz 47.2-48.2 GHz = 1000 MHz Total = 5550 MHz	ITU-R Spectrum needs (IMT-2020) in bands above 24.25 GHz: 0.83 to 15 GHz (depending on scenarios, see Figure 3)
Unlicensed 64-71 GHz = 7000 MHz	

Table 2: Showing the amount of spectrum identified for IMT in Canada and the US.

It is clear from this table that there is a shortfall in the amount of spectrum needed by IMT and that actually identified/used for it – at least in two countries. The amounts (shortfall) are as follows:

- 1) Below 6 GHz: between 610 and 1190 MHz
- 2) Above 6 GHz: 9.45 GHz, discounting the lower limit of 0.83 GHz and taking into account only licensed spectrum (as unlicensed implies any application can use it)

Table 3 shows the spectrum identified for RLANs in the US and Canada in the 5 GHz range³:

WAS⁴ (including) RLANs		
5150-5350 MHz	= 200 MHz	See FN 5.446A (Radio Regs) & RES 229 (WRC-12)
5470-5725 MHz	= 255 MHz	See FN 5.446A (Radio Regs) & RES 229 (WRC-12)
5725-5850/5850-5925 MHz	= 200 MHz	Under study in Region 2
Total	= 455 MHz	Spectrum estimate (RLANs): 880 MHz

Table 3: Showing the amount of spectrum identified for RLANs in Canada and the US.

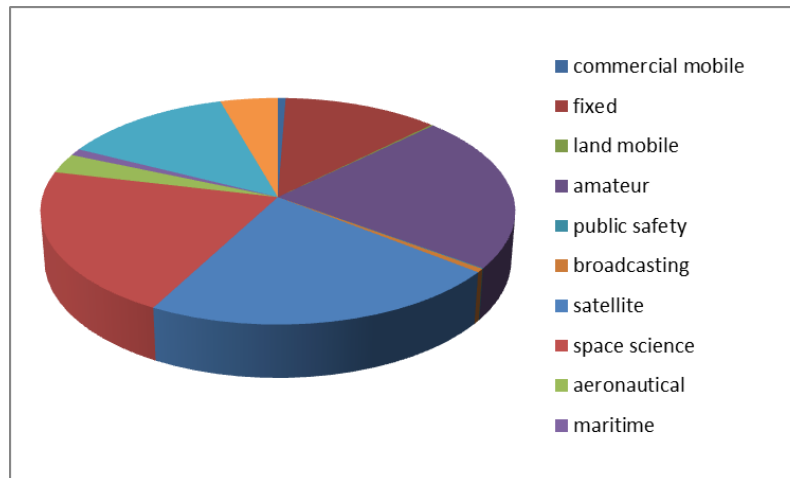


Figure 4: Spectrum allocations to services/identifications for applications in the bands 52 MHz – 38 GHz.

While it may be difficult to overcome the shortfall in spectrum identified for IMT and RLAN in the near-term, GSA would like to request that this be given due consideration while planning the spectrum outlook over the next few years. Indeed, if numbers from the [“Canadian Radio Spectrum Inventory – A 2010 Snapshot”](#) are taken into account, and the spectrum allocated to different services between roughly 52 MHz and 38 GHz studied⁵, it will be seen (Figure 4) that the commercial mobile service occupies a very thin slice of the pie⁶.

GSA RESPONSE TO Q2:

Q2 –Do you agree with the above assessment on demand for commercial mobile services in the next few years? Is there additional information on demand, which is not covered above, that should be considered? If so, please explain in detail.

Building on the global success of 4G and in recognition that demand continues to grow, leading global technology companies and standards organizations see the need to break past the limitations of 4G and design a new approach – a fifth generation (5G) of mobile broadband. 5G is needed to meet expected

³ Table 3 does not include other unlicensed spectrum such as 2.4 GHz and 902-928 MHz that, among other applications, are also used by RLANs.

⁴ Wireless Access Systems) – see “CCPII-2017-30-4356-1-16_i.doc”

⁵ Note that the total amount of spectrum is greater than the range (52 MHz to 38 GHz) due to dual allocations.

⁶ For exact definition of each service named in Figure 4, please refer to Canadian Radio Spectrum Inventory – A 2010 Snapshot, hyperlinked in the text above.

future demand and to fully realize the potential of new applications categories such as the Internet of Things (IoT).

The mobile network has experienced significant data traffic growth. Global mobile data traffic grew 63 percent in 2016. Global mobile data traffic reached 7.2 exabytes per month at the end of 2016, up from 4.4 exabytes per month at the end of 2015⁷ (One exabyte is equivalent to one billion gigabytes, and one thousand petabytes). IoT is expected to generate massive amounts of data that can be captured, analyzed and used for a variety of beneficial purposes. The combination of the capability of a 5G network with the expected reduction in the cost of devices is expected to lead to ubiquitous connectivity. Analysts estimate that 44 zettabytes of data will be generated by 2020 and 180 zettabytes by 2025. (Source: IDC MC/EDC, <https://www.emc.com/leadership/digital-universe/2014iview/executive-summary.htm> and <https://www.forbes.com/sites/michaelkanellos/2016/03/03/152000-smart-devices-every-minute-in-2025-idc-outlines-the-future-of-smart-things/#155966804b63>).

Subscribership

Mobile broadband technology has transformed economies and societies around the world, improving access to information, aiding productivity and facilitating commerce. As internet capable smartphones and affordable data services became available, the world has been placed, literally, in the hands of the consumer. This transformation is due to an array of radio access technologies and core network designs that were defined, created and perfected through industry collaboration within an open standards process as part of the Third Generation Partnership Project (3GPP).

Since the earliest deployments of cellular services, North America has been a key driver in the global advancement of mobile technologies. Recognizing early on the opportunity of mobile broadband, governments and companies have implemented policies and invented solutions that made it possible to lead in 3G and 4G LTE.

According to the GSMA's Mobile Economy report for 2017, North America will reach 300 million mobile subscribers in 2018, growing to 313 million or 84% penetration by 2020.

In fact, the U.S. and Canada are notable examples of markets where migration to next-generation devices and networks has been fast. Both were among the first countries in the world to reach 50% smartphone adoption and 4G/LTE adoption.

In Canada, over 28 million people subscribed to mobile services in 2017 with smartphone and 4G adoption at more than 75% and 4G services available to 97% of Canadians.

This adoption reinforces the commitment by companies and government to enable advanced wireless services which, in turn, ripples throughout the economy. As an example, the U.S. Cellular Telecommunications Industry Association (CTIA) estimated that licensed wireless service generates over \$400 billion in annual economic activity. Every wireless industry job results in another 6.5 people finding employment.

⁷ Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016–2021
<https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/mobile-white-paper-c11-520862.html>

As with 4G, there is an opportunity to continue global leadership in 5G. Currently, public and private investment in research and development (R&D) for 5G is underway to ensure that North American companies and service providers demonstrate early innovation in 5G.

GSA Response combining Q3 and Q4:

Q3 – What new technology developments and/or usage trends are expected to address traffic pressures and spectrum demand for commercial mobile services? When are these technologies expected to become available?

Q4 – Recognizing the trend of increasing commercial mobile traffic, what operational measures (e.g. densification, small cells or advanced traffic management) are being taken to respond to, and support, increasing traffic? To what extent are these measures effective?

Traffic growth

According to the GSMA, 5G adoption in North America is going to take place faster than in any other region of the world, with about half of connections on 5G networks residing in both the U.S. (190 million) and Canada (20 million) by 2025, compared to 30% adoption in Europe and key Asian markets (China, Japan and South Korea).

Technology advancements for commercial mobile

Ensuring leadership in the global 5G ecosystem requires early investment in a wide range of new technologies. Early work by North American companies--contributing within standards setting organizations such as 3GPP--includes prototypes to determine capability and use cases. Additionally, trials are underway with globally influential partners to ensure leadership and influence in this next generation of technology – a generation that is going to further transform economies and societies around the world.

As an example, a recent focus within 3GPP is work on the 5G New Radio (5G NR). According to global infrastructure provider Ericsson, 5G will encompass an evolution of today's 4G networks into 5G NR--a new, globally standardized, radio access technology. 5G NR will utilize the technology innovations identified by 3GPP for 5G (such as Massive MIMO) in support of the growing demand by users and devices and anticipated data traffic volumes. The mobile industry has actively worked through 3GPP as part of the standard organization's release-15 study items that were issued in December 2017. Through 3GPP, the industry is working to architect standard recommendations such as New Radio use of unlicensed spectrum, testing methods for new radio capability and methodology for the use of New Radio for vehicle to x (V2X) applications.

In addition to recent advancements in the radio, the 5G system will also include technology enablers such as:

Carrier Aggregation

Before the 4G technology was commercialized, it was already acknowledged to provide inadequate data rates, and any effort to increase the data rates would require either more spectrum or bandwidth. The solution developed by 3GPP LTE was called Carrier Aggregation: a combination of multiple bands in different regions of the spectrum, resulting in broad aggregated transmission. This Carrier Aggregation concept will continue in 5G technology, but in addition, the system will use spectrum that is available in the frequencies of tens and hundreds of gigahertz. Wireless systems operating on frequencies between around 20 to 100 GHz are commonly called millimeter wave (mmWave) systems.

mmWave Communications

With vast spectrum resources in the mmWave bands, enhanced mobile broadband services can be provided for 5G systems. However, the deployment of mmWave cellular Radio Access Network (RAN) faces challenges due to mmWave radio propagation characteristics such as high path loss, blockage and penetration loss. To address those challenges, a number of key techniques and system configurations such as dense deployment of small cells with joint wireless access and backhauling, adaptive directional beamforming and dynamic time division duplex can be applied.

Massive MIMO

When the number of antennas at the base station is increased to the range of hundreds to thousands of elements, the term massive multi-input/ multi-output (MIMO) is employed. Massive MIMO wireless systems, in general, allow increases to the network capacity in terms of higher data rates and higher number of users served. By adding multiple transceivers, the system can provide spatial diversity, and improve the received signal strength (for example, beamforming). Massive MIMO systems are also known by several names: Large-Scale Antenna Systems, Very Large MIMO, Hyper MIMO, and Full-Dimension MIMO.

The 5G technology includes both MMIO and the larger bandwidth typically available in mmWave frequencies. The combination of massive MIMO and high-bandwidth mmWave systems contributes significantly to fulfilling the 5G requirements of peak experienced data rate, area traffic capacity, and low latency.

5G Beamforming Functionality

One of the main advantages of 5G is the antenna beamforming capability. For devices deployed within metropolitan areas, devices will face many changes within the RF link environment, where numerous types of clutter (trees, cars, large buildings, humans, etc.) block the transmission path in both static and mobile states. An adaptive antenna with the capability to maintain a reliable RF link through a beamforming algorithm processes is a key for this functionality.

Network Slicing

Network slicing refers to the ability to create multiple logical instances on the same underlying network. The parameters for each network slice are optimized according to different criteria, and could possibly be used by different tenants or organizations. Network slices can be viewed as on-demand networks. Slicing may also include a fine-grained allocation of resources, such as compute, memory and disk space in addition to network separation. In this view the slice can represent a dynamic and logically independent application delivery infrastructure (IaaS). If an operator wishes, they could save costs by

sharing slice resources with a cost/risk study being conducted for each use case. However, the resources are always logically separated at the management layer. The intention of a 5G slice is to provide only the traffic treatment that is necessary for the use case, and to avoid all other unnecessary functionality. The flexibility behind the slice concept is a key enabler to both expand existing businesses and create new businesses.

Respectfully Submitted,

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