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THE CASE FOR WIRELESS TRANSMISSION

WIDEBAND CHANNELS

FROM MACROECONOMICS TO STANDARDIZATION

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Introduction

Nowadays connectivity needs to be viewed as a critical resource, without which the economic and social prosperity of nations are at risk. The limiting factor to the provision of high-capacity connectivity is bandwidth. Regulators have the power to unleash growth in GDP and the population's general well-being by allowing wideband channels.

To assist regulators in their decision-making, international institutes such as the CEPT, ETSI and ITU have made it their mission to provide valuable technological guidance. After having thoroughly tested the potential adverse effects of widechannel bandwidth, these technology experts have put our minds to rest and strongly recommend the implementation of these wider channel sizes.

The need for these wider bands can be seen around the world, as they allow the provision of required capacity quickly and cost-effectively. The first steps in the implementation of wider channels are now being taken, and they should serve as a model for other industry players worldwide.

1. WIDEBAND MICROWAVE REGULATION AS CATALYST FOR ECONOMIC GROWTH

Adam Smith, considered the father of modern economics, identified three "factors of production," namely *land, labor and capital*, in his famous work "An Inquiry into the Nature and Causes of the Wealth of Nations." It is understandable why at the onset of the industrial revolution Smith's focus for a nation's growth was on these three critical resources.

While recognizing the importance of Smith's revolutionary concept "the division of labor" and emphasis on "free trade", which are still very relevant today, I want to place the focus somewhere else. As an economist I argue that in today's age of digitalization, we should acknowledge a new essential resource without which the wealth of nations is in real danger. This critical resource is *connectivity*.

1.1. THE NEED FOR CONNECTIVITY – EVERYWHERE AND ALWAYS

Businesses, governmental organizations and private people alike need connectivity – and lots of it. Talk of 5G, IoT, widespread automation and smart houses/cities is heard everywhere. Unlimited data and always being connected have become basic needs for all.

Lately, the COVID-19 pandemic has sparked a boost in capacity demand with surging digitalization in all areas of our lives. Online schooling, academic studies and professional training now take place virtually. Due to pressures on the medical sector, with more patients needing treatment with too little available human resources, the rising use of telemedicine can be seen; this includes areas which before COVID-19 were thought impossible, such as emotional and mental welfare.

In recent years governments have started to move more and more services online. Due to the pandemic, state leaders quickly adopted a wide range of technological solutions to ensure the safety and health of their nations. All these critical services call for higher, reliable, fast and secure capacity.

More people now work from home, meaning business meetings, exhibitions and showrooms are moving to the virtual space, with more businesses increasingly offering online shopping platforms and web training. Recruitment processes, with the need for interviews and professional assessment centers, are being carried out in the virtual arena as well. And even before the pandemic businesses shifted towards automation across their entire supply chains, which again calls for more capacity.

Some industries, such as agriculture, aquaculture and oil drilling, rely on real-time mission-critical data to improve productivity, reduce costs and increase yields, irrespective of any pandemic. Certain sectors will, in fact, only survive if they increase their efficiency by adopting digital solutions.

Those of us working from home know very well how the quality of our internet connection impacts our productivity – and frustration – levels. And while stuck at home, even when we are not working, we still use a lot of capacity for entertainment purposes, including a surge in online sporting products and services, besides gaming and video streaming.

And then there is the broad consensus regarding the need to close the digital divide and connect the unconnected, which has become a far more pressing matter since COVID-19. The unconnected are deprived of adequate schooling, which has a direct impact on their future employment chances and contribution to the economy. Where there are connectivity gaps, the provision of suitable medical treatment cannot be guaranteed. This again has severe secondary effects in terms of higher medical costs due to a worsening in a patient's condition, potential comorbidities, and the disablement of someone who could have been an effective contributor to their country's GDP.

Organizations will not go where they cannot operate efficiently and grow. Connectivity gaps are a real barrier to entry for businesses and eliminate employment opportunities in underserved areas before they have a chance of being created. The virtual world also enables more competition, following Adam Smith's notion of free trade to enhance a nation's well-being, irrespective of where a business is physically located.

1.2. FIBER EVERYWHERE? WHAT ABOUT FIBER GAPS?

Given the above, it is clear that capacity providers, such as telcos or carriers of carriers, play a critical role in ensuring the economic well-being of any country. Many connectivity suppliers follow the "fiber everywhere" approach, aware that once optical fibers are in the ground there is basically no limit to the capacity they can transmit reliably. However, optical fiber is not feasible in all cases. The costs of rolling out fiber are huge, placing immense CAPEX pressures on providers. It takes a long time to obtain digging permits and then lay fiber in the ground. In urban areas, setting up yet another building site is often simply not possible, and rural areas require very costly investments to reach a relatively low number of paying customers.

Here microwave technology comes to the rescue. Microwave equipment sits on towers, roof tops or street poles that often already exist. In cases where site acquisition is necessary, it usually takes less time than obtaining digging permits.

Besides these bureaucratic advantages, more important is that today's advanced microwave technology is reliable, flexible and delivers high capacity while taking up little space. With as little as two small radios easily mounted on any existing tower, up to 8 Gbps can be provided in the 6-42 GHz range with five-nines reliability, given we have available bandwidth of 224 MHz and the use of XPIC technology.

The limiting factor is bandwidth. A typical radio can transmit 1 Gbps at a 56 MHz bandwidth channel. The maximum that most countries allow today is channel bandwidth of 112 MHz, hence, practically a maximum of 4 Gbps can be transmitted under current regulatory restrictions.

1.3. THE CASE FOR WIDER BANDWIDTH

The case for wider bandwidth, such as 224 MHz channels, is strong and simple. Wideband channels enable the transmission of more capacity without the need for more equipment. It means operators can provide double the capacity without investing more CAPEX or OPEX, losing valuable time, or risking network downtime. Moreover, wider bandwidth lowers the

barrier of entry for connectivity providers, who will then have a real business case for entering the market in areas previously not economically viable for them. This will increase competition, translating into lower prices and better services for consumers.

A wider channel means mission-critical data can be transferred reliably, and businesses can ensure their long-term growth and compete in the global marketplace. With wider bandwidth, high capacity can be carried at relatively low costs to even the farthest and hardest-to-reach regions, enabling higher growth, reduced unemployment levels, and higher levels of national health. Wider bandwidth expands educational opportunities, shaping tomorrows workforce and ensuring future GDP growth. Subscribers can receive the additional capacity they need for their wide range of applications at the quality they expect, and 5G can happen even in the most remote areas – fast.

In summation, wider bandwidth allows for the increased and faster provision of the critical resource *connectivity*, and therefore is a catalyst for the wealth of nations. Regulators hold the key to success. In order to unlock the opportunity for increased economic growth and social welfare, wideband channels need to be approved.

At this point the question arises as to what is technically possible and feasible. Which channel size should and could practically be used for wireless transmission? To help regulators, institutes such as the CEPT, ETSI and ITU have made it their mission to provide valuable technological guidance, which we will look at in the next section.

2. TECHNICAL STANDARDS FOR WIDECHANNEL BANDS

2.1. WHAT WE *CAN* DO AND WHAT WE *SHOULD* DO

Bandwidth is limited, no matter whether we are transmitting in millimeter wave or microwave frequencies. The two main limitations to bandwidth are related to technology and regulation. Policymakers and regulators need to strike a fine balance between what is possible and what is feasible. On the one hand, they must enable businesses, government organizations and private people to enjoy the maximum transmission capacity that is technologically possible. The wider the channel, the more capacity can be delivered. On the other hand, they need to make sure that there are no unwanted side effects, such as interferences within or across different spectrum bands, caused by allowing too wide a bandwidth.

As established above, connectivity is a resource. As with any other resource, regulators quite rightly request that we maximize the use of currently available capacity before requesting wider channels. One way to maximize spectral efficiency for point-to-point wireless connectivity is to use both vertical and horizontal polarization by means of XPIC technology. Other technologies used to increase spectral efficiency are 4x4 LoS MIMO, Advanced Frequency Reuse, and the aggregation of multiple carriers from different bands into a single connection (i.e. multiband). Advanced microwave technology enables all these features for a large range of spectrum and bandwidth channels.

In its report on microwave and millimeter wave for 5G transport, ETSI makes a strong argument for the need for wider channel bandwidth. ETSI describes wider channel bandwidth as one of the fundamentals for allowing the higher capacity needed to fulfill all 5G requirements. But why not simply use more of the narrower channels? Why do regulators need to go through the

trouble of allowing wider channels when it is possible to simply use two adjacent channels to provide the same amount of capacity?

Under current regulations, two narrow channels assume the use of two modems and two RF transmission flows. This means double the amount of hardware needed and, depending on national regulations, an increase in spectrum costs. If we scale this up to the number of required links, it quickly becomes apparent that this proves to be a real barrier to entry for capacity providers in urban and rural areas. Moreover, there are negative secondary effects on economic growth and social welfare, as discussed above.

2.2. EXPERT RECOMMENDATIONS

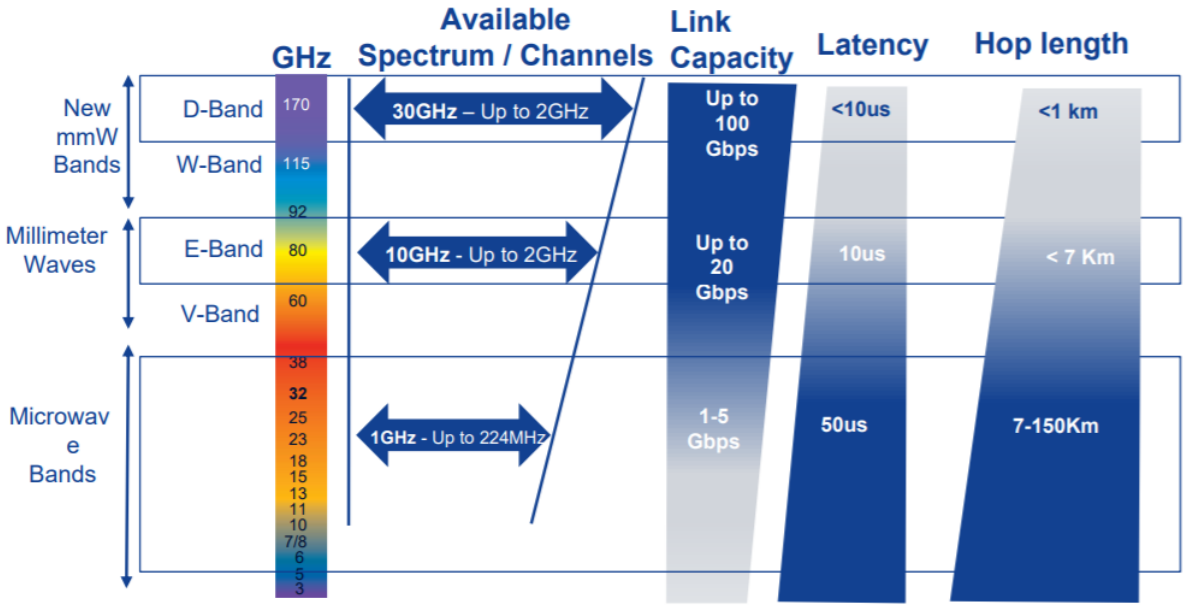
In its report on wide channels (updated 01/2020), the ECC (of CEPT) showed that there is no reason to worry about interference issues when using a wider channel vis-à-vis two narrow channels. Testing for worst-case scenarios, the ECC concluded that not only do wider channels *not* pose a threat for in-band interreference, but also no major problem is expected regarding adjacent narrower bands, as feared. In that same report the ECC refers to spectral efficiency, stating that using one channel of double the size allows the transmission of more capacity compared to when two half-sized channels were used. The reason for that is that there is some interreference when two narrower channels are used simultaneously. This interference is erased when using one wider channel. So, in this case 1+1 is, in fact, more than 2. Widechannel bandwidth actually *increases* spectral efficiency.

The ECC recommendation for maximum channel bandwidth is listed in the table below:

Band	Duplex spacing	Old max channel width	New max channel width	ECC recommendation
11 GHz	530 MHz 490 MHz	56 MHz 56 MHz	112 MHz 112 MHz	REC 12-06 E
18 GHz	1010 MHz	110 MHz	220 MHz	REC 12-03 E
23 GHz	1008 MHz	112 MHz	224 MHz	T/R 13-02
28 GHz	1008 MHz	112 MHz	224 MHz	T/R 13-02
32 GHz	812 MHz	112 MHz	224 MHz	REC (01)02
38 GHz	1260 MHz	112 MHz	224 MHz	T/R 12-01 E

Source: Sharing and compatibility implications of high capacity P-P systems using a single channel instead of two adjacent channels with the same total bandwidth SE19(19)035A05, updated 01/2020

The call for wide channel bandwidth can be heard around the world and not just in Europe. In its workshop on the Evolution of Fixed Services for wireless backhaul of IMT 2020/5G last year, the ITU also recommended wider bands of 112 MHz and 224 MHz for microwave bands. The aim is to provide 1-5 Gbps over a hop length of anything between 7km and 150km. Widechannel bandwidth is viewed by the ITU as critical for addressing forthcoming 5G use cases (see diagram below).



Source: Evolution of Fixed Services for wireless backhaul of IMT 2020 / 5G, ITU-R Workshop Geneva, 29.04.2019

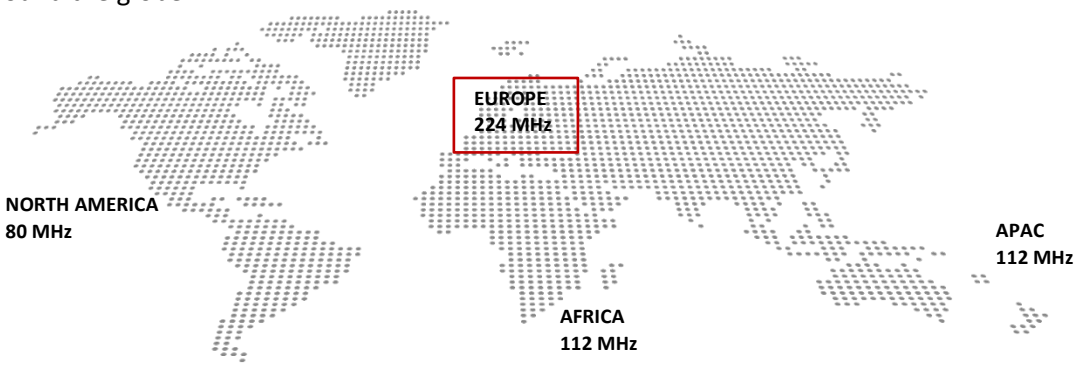
To sum up, everyone needs more capacity, which delivers economic, social and personal benefits. One of the most significant – and easiest – ways to provide more connectivity in a secure, speedy and cost-effective manner is by widening the channels through which the bits and bytes travel. Listening to technology experts, who have thoroughly tested all scenarios to make sure there are no adverse consequences, we understand that widechannel bandwidth is exactly what is needed to increase capacity in a quick and cost-effective fashion.

The need for these wider bands can be seen around the world, as they allow the provision of required capacity quickly and cost-effectively. In the next section we will look at the situation of channel sizes around the world, and then turn to some specific examples of what some countries are doing to implement these wider channels.

3. USE CASES

3.1. VIEW OF BANDWIDTH SIZES AROUND THE WORLD

Bandwidth size varies greatly worldwide. The reason for the implementation of different channels sizes at a national level depends on many factors, such as the need for data usage and spectrum availability. The map below shows the maximum bandwidth used in different regions around the globe.



Maximum bandwidth in selected regions

As is apparent from the above map, Europe currently is the clear leader in terms of channel size. For that reason, we will turn to one example of how the need for more capacity motivates a Nordic operator to cooperate with local regulators to speed up the implementation of wideband channels.

3.2. THE NORDICS – MOBILE DATA USAGE POWERHOUSE OF THE WORLD

The Nordic countries, home to well-known mobile communication hosting companies such as Ericsson, Nokia and Spotify, are traditionally very early technology adaptors. These countries are thought of as the mobile data usage powerhouses of the world. Not surprisingly, initial steps to implement wide channels are being made there.

Pragmatic regulators in the region are supporting and working closely with local operators to enable them to provide connectivity, which will lead to the subsequent societal benefits discussed earlier. One country in particular is spearheading this development. Its national regulator understands the importance of 5G for the whole nation, and it believes that operators must be given the tools to offer true 5G services without bottlenecks.

Specifically, a leading local operator is considered the driving force behind the promotion of 224 MHz channels – not only nationally but worldwide. The reason for this vested interest in wider channels lies in that operator's value promise to its customers to provide the best customer experience. It defines the best experience for a mobile customer as smooth, uninterrupted connectivity everywhere, always and at great value. A strong driving force is its desire to enable fixed wireless access (FWA) and enhance mobile broadband (eMBB) services. Like in other countries all over the world, with the spread of COVID-19 end-users there have realized that their existing slow-speed DSL connections are no longer efficient enough, and increasingly are moving to FWA.

In addition to bridging the digital divide, the need to connecting all residents in rural and urban areas calls for higher capacity, even in the most remote areas. Making the strategic investment in deploying an agile, future-proof and upgradeable access network without bottlenecks is a proven key to success. With such a network, offering competitive services and meeting end-customers' endless hunger for more bandwidth is easily made from the central office. OPEX and CAPEX can thus be diverted into increasing profitability instead of spent on costly site visits and time-consuming forklift upgrades.

The most efficient way to provide the required capacity for all of this is by widening channel size. Without wider channels, offering enhanced 5G services will become much harder, if not impossible. This is especially true for areas where fiber deployment is uneconomical or simply impossible due to geographic and other environmental conditions. As with other Nordic countries, here, too, there are vast stretches of land with very low population density whose residents still require connectivity.

To stay ahead in very competitive market operators in the Nordic countries have driven the process of allowing and implementing wide 224 MHz channels. To further excel the process, operators have provided national regulators with beneficial supporting materials and technical background information.

And the efforts have yielded fruits: in Finland and Sweden 224 MHz channels are expected to be allowed by the end of 2020. As a result, the Nordic region is staying at the technological forefront, making it possible for new unicorns to emerge, and to bridge the digital divide.

4. CONCLUSIONS

Undoubtably, higher connectivity is the catalyst for business growth and improved social welfare. Governments and industries are looking to close digital gaps, connect the unconnected, and increasingly provide more digital services. These trends skyrocketed even further as COVID-19 hit the world and created this "new normal" with growing demand for remote services, with people increasingly meeting and working virtually.

Microwave transmission can provide capacity even to the most remote places more quickly than laying optical fiber in the ground. The most effective, cost-efficient and fastest way to provide more and reliable connectivity is by widening channel sizes, thereby allowing more capacity to travel faster.

National regulators need to find the golden middle between allowing operators to provide required capacity to enable huge benefits for society as a whole, while preventing adverse effects such as frequency interferences. This is where institutions such as ETSI and the FCC provide valuable information, as they thoroughly test these important aspects. Based on their detailed research, these expert institutions have put regulators' worries to rest and highly recommended the opening of wider channel sizes.

The demand for larger bandwidth can be seen around the globe, with Europe spearheading the quest for wider channels. The Nordic countries are leading the way in viewing widechannel bands as a key driver of 5G and its accompanying societal benefits. Lessons learned in the Nordic countries should be applied worldwide wherever possible.