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6G vision and requirements – have we reached a consensus?

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5G networks deployment progresses fast in many countries and most of the mobile operators around the world already provide some type of 5G service to their customers. According to Ericson Mobility Report, during 2022, the number of 5G subscribers exceeded the 1 billion milestone, while it is expected to grow to 5 billion by 2028, further enhancing the expectations that 5G will become the fastest adopted mobile radio technology in history (3.5 billion 5G subscribers and 60% population 5G coverage are forecast by the end of 2026).

5G has still a long way to go before it reaches its full potential, but the discussion on 6G has already started. This comes as no surprise as extensive research and development as regards the technical aspects, the use cases and the business models is needed, as well as decisions about standardization and spectrum allocation.

For the next 10 minutes, I would like to invite you into briefly reviewing 5G-6G intersection points, but also in taking a step back and consider the radio access and mobile technology dynamics as well as the broader IT and socio-economics trends that will shape our 6G future, to better envision, understand and, why not (?), even plan ahead for 6G.

THE 6G PARTS THAT WE CAN TAKE FOR GRANTED

5G introduced **two radical changes** as far as our radio access planning and overall radio network architecture is concerned. Namely:

1. It introduced and embraced mmWave band use, and
2. -to some extend as a result of its mmWave use introduction- asked us to move away from our 'big mast'/macro-cells thinking, promoting instead the use of smaller base stations in spatially ultra-dense deployments.

In 5G radio infrastructure, the focus shifts towards mmWave enabled microcells (serving 200 users) and picocells (serving 50-60 users) which are to be deployed densely within residential and commercial areas.

These two changes, we can now take for granted, will be the basis our 6G networks will be built upon as well, and the better we deploy 5G infrastructure along these lines today, the more 6G value we are introducing into them – **so the better we protect our investments.**

The operation of very low power, small-cell RANs (mostly in the micro and pico-cell sense), will be important for **decreasing** power consumption and avoid quickly saturating cells servicing many users, a factor that would lead to degraded performance and poor user experience.

So, beyond delivering higher speeds, and maybe even more importantly, the use of mmWave micro and pico-cells is also enabling us to reduce the transmitted power (at radio level) by roughly four times -since 5G already-, and network overall power consumption by 80 - 90%, allowing the development of 'greener' cells/base stations, which could even operate on renewable energy, collected at the point of use - with the help of a small power storage system.

There is clearly no turning point back from that network architecture, and even beyond higher speeds **and** lower power consumption, while also **contrary** to popular belief, carefully planning the use of mmWave micro and pico-cells can also contribute in creating **safer** EMF environments.

Through the use of mmWave bands and small cells we can:

1. Deploy radio networks with small cell antennas having their radiation lobes along street plane alone, making all non-street plane areas effectively a zero EMF zone, while

2. Through utilizing MIMO beam steering techniques we can make sure that, even for the people moving along a street, EMF emissions will be directional towards the actual radio link user and not uniformly to anyone in the vicinity of

So summarizing 6G radio technology in one sentence I would say that: mmWave bands and hyper-dense small, micro and pico-cells will be for sure the foundations 6G radio technology will build upon.

It is also certain that 6G multi-gigabit links will have to utilize frequency bands above 26GHz -above 100-Gigahertz to Terahertz bands are currently discussed- and even though for the technical part we can always rely on the wonderous semiconductor industry for getting the proper pieces of silicon in place, and on time for using these frequencies, there are some critical action points remaining for policy planners, decision makers and telecom regulators. These action points are:

a. The Development of friendly spectrum licensing procedures, with reasonable spectrum valuation and reserve prices, assignment of contiguous blocks of spectrum and limited (if possible, no) coverage obligations.

b. The provision of easy licensing of mmWave base stations and small (micro/pico) cells with appropriate frameworks for handling passive infrastructure access and rights of way.

c. The support of infrastructure sharing initiatives as an important tool for reducing deployment times, costs and environmental nuisance given the base station densities expected for small-cell deployment.

LOOKING FOR THE WHY's

By summarizing 6G Radio tech in a few sentences and presenting our action points in bullets by no means I am suggesting that any of that is easy to do technically or that will naturally occur in the policy and regulatory domains unless decision makers fully grasp and get inspired by how 6G (and future G's) align and converge with other, broader, IT and socio-economic trends, so I think this summit is extremely important, relevant and just perfectly timed, since it gives us the opportunity to discuss about exactly these issues

It is extremely important because it bares the weight of 6G **'vision'**, which practically means that it bares the weight of explaining the **'why's'** of 6G, but also asks for the **requirements**, so it's ambitious enough too, to outline the blue-prints of transforming the **'why's'** into **'how's'**.

Having dealt with the **'how's'** already, we can now, as promised, take a step back and consider the **'why's'**

So, **why** 6G?

Interpreting Radio Access Network evolutionary generations as purely technical ones gives us little insight on the why's, and only leave us a strictly technical set of benchmarks to measure and understand progress, with the most recognizable of these benchmarks been: **speed**.

Higher speeds as a 'why' seemed to work 'ok' for transitioning from 3G to 4G and for as long Radio-Access Networks were unable to deliver the experience Fixed-Access Networks did. For 5G, 'speed' became a much less convincing 'why' and most probably, it will be a totally non-convincing 'why' for 6G.

We need a different viewing angle to understand the benefits late 5G and early 6G generations will bring along. My proposal about choosing a different viewing angle to use is: using the **services and functionalities** angle

Since even late 2G, Radio-Access (or Cellular) networks progress rode the trends of Internet access becoming mainstream and mobile phones becoming the portable, multi-functional computers we call "smartphones".

The kind of functionality our RANs offer since then and up until now, is mostly internet access connectivity services. Our RANs provide batch, best-effort access to information. Light-weight web browsing during the earlier days and heavyweight content consumption today. Still though, there is nothing critical we, even today, trust on our RANs no matter how strange that sounds. If you think about it, you still get your keys and your credit-card leaving home every morning, additionally to your phone, or at least in principle you accept the 'risk' coupled with not doing so.

For new services and functionalities to surface, this needs to change and this is the most important '6G why'.

Internet connectivity speeds run their course as 'selling point' strategy. They will of course continue to be important, but in a less profound, 'utility-like' manner, and our next set of mobile applications will not need such batch, best-effort services but new, real-time, guaranteed ones.

The highest-potential such 6G applications, in socio-economic-impact, will undoubtedly be the autonomous driving and smart city related ones.

Is any meaningful degree of autonomous driving even an option in a batch, best-effort network, or can key city-scale utilities be trusted in a network of that type?

So why 6G?

Because network continuity, latency, predictability, reliability and RESILIENCE, need to become network service options, and not only that. They need to become measurable, transparent and accessible network service options in providing **next-generation RAN services to build next-generation applications**.

6G will not be about new speeds – it will be about new services. It will be about providing the needed network fabric that will bring these new services to life, that will make them possible.

This apparently 'simple change', from Speed-Focus to Quality of Services focus, will bring sea changes in our economies and societies. It will challenge the status-quo and will shake the foundational business models of everyone in the multi-trillion-dollar ICT world, telecom operators and web 2.0 companies alike. It will also bring governments and regulators before important decisions with the most important of them be the preservation of net neutrality.

A great sign towards things coming is the difficulty in reaching a consensus in Europe on the very simple fact that: all types of networks need to be net-neutrality preserving, but not all net-neutrality preserving networks are of just one type.

Translating all that back to 6G network architecture, I would dare to say that 6G hyper-dense type of network architecture will be more about reliably picking-up low-powered Smart-City IoT radios, due to high proximity, to make our cities smarter, safer and more efficient, and less about beaming 10Gbps of data on a single mobile device.

I would dare to say that 6G hyper-dense micro/pico cell-based deployment, will be more about promoting 'always connected' connectivity, lowering latency and advancing predictability, and less about 'just' supporting mmWave propagation.

We are currently only scratching the surface of this tectonic shift from 'speed focused' to 'QoS focused' Radio Access Networks.

Our networks will become fully software defined and 6G will probably be the first generation to accomplish that. That will be 6G biggest 'why'. By becoming software defined our networks will not only have IP level connections brought up and tore down no demand. They will have physical layer deep, quality-of-service related features created and disposed on demand, delivering a diverse set of network fabrics for new applications to thrive on – real-time and guaranteed.

..and to handle these network operations complexity, 6G networks will most probably be run by AI. Not it the -exotic- Artificial General Intelligence sense, but in the practical Machine Learning sense that will allow insight on extremely multi-dimensional datasets, which we now perceive as chaotic, like how competing QoS will co-exist in bandwidth-constrained channels – but I will leave this last part to discuss on another opportunity.

Thank you very much for your time and please remember: **6G will not be about new speeds – it will be about new services. It will be our first fully Software Defined RAN, across all network layers, so definitely critical having**.