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Sixth Sense: The First Look at 6G

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While 5G rolls out, the research community is already thinking about its successor. The technological goals for 6G are ambitious, with huge advances in speed and capacity matched by tough requirements for reliability, security and energy efficiency that will benefit a wide range of industrial applications. As with previous generations, the key to a thriving 6G ecosystem will be unified technical standards that accelerate commercial returns on billions of dollars of R&D investment.

As a rule of thumb, we've grown accustomed to a roughly ten-year gap between the arrival of successive mobile generations. It's just over a decade since the first commercial 4G networks fired up in Scandinavia, while 5G made its debut in 2019 with initial deployments in South Korea and the US.

It is tempting to presume this is a pattern that will be repeated with 6G. But on the evidence of a globally orchestrated research effort—and huge investments already being made by academia, governments and private companies—6G may buck this historic trend and become a reality well before the end of this decade.

Evolving by leaps and bounds

Before looking at what 6G will offer, and the journey getting there, it is worth looking at changing attitudes towards mobile technology. Until now, each new generation has offered demonstrable advantages over its predecessor. Incremental improvements in speed and user experience have provided a clear value proposition for network operators to market to their customers. Around the turn of the millennium, 3G brought always-on Internet connectivity to the mobile space. This was a mind-blowing proposition for consumers making the leap from dial-up to fixed broadband.

Ten years later, 4G made smartphones the default choice for consuming video-rich content and social media. These are the user behaviors that effectively define our current mobile experience.

Ask today's consumers what 5G brings to the party and it's harder to get a clear answer. There is an implicit understanding that it is somehow 'faster' than 4G. But that's not instantly demonstrable through services like web browsing, instant messaging and video conferencing that are already adequate for most consumer and business needs.

Where 5G already shines—and provides a strong hint of the R&D investment focus for subsequent generations—are use cases geared to B2B vertical markets. From factory automation to driverless vehicles, this is the arena where robust, secure real-time machine-to-machine connections on a massive scale are the enablers for future business value. Accordingly, it is this same direction of travel that the ICT industry ecosystem is following with 6G.

Emerging metrics for 6G

The initial KPIs set by academia and industry for 6G are lofty. Throughput speed is the obvious headline metric, with peak data rates targeted in the 100 Gbps to 1 Tbps range. As well as raw speed, latency will be of critical importance in real-time applications like robotic surgery that will demand sub-millisecond roundtrip times as well as ultra-low jitter.

With new use cases for 6G, we'll see vastly greater device densities. Imagine wireless M2M connections replacing hundreds of thousands of cables in a large factory or industrial plant. We are already used to social media apps and vehicle satnavs that can pinpoint our physical location with an accuracy of a few meters. The shorter wavelength of frequencies in the terahertz range will refine the positioning accuracy of 6G devices to just a few centimeters. This capability will enable the introduction of services such as advanced vehicular anti-collision, high-precision manufacturing and remote-control systems.

6G challenges

One of the biggest challenges that the 6G research community is already grappling with is energy efficiency, a goal that has traditionally been at odds with greaterprocessing power and system performance. 6G will also see a proliferation of applications for autonomous devices—like a sensing station in the Antarctic or on a remote oil platform—where unattended operation with a 20-year battery life might be required.

Meeting these objectives will demand an order of magnitude improvement in energy efficiency to meet many organizations' own sustainability targets. This in turn requires energy efficiency to be an inherent part of 6G system design from the outset. Among other measures, this will be achieved by minimizing protocols and message flows, leaving devices in a dormant state for as long as possible and only activating them when absolutely necessary. What's more, 6G's extreme frugality and reduced carbon footprint will be partnered by stringent goals for reliability in mission-critical environments where system failure is not an option.

While 5G is already quantum secure by design, 6G will directly address the challenges of an expanding and ever-changing threat landscape. Billions of connected devices—together with the

valuable data they generate and share—are a tempting hunting ground for hackers and cybercriminals to exploit. In ETSI we have recently published standards (EN 303 645) to ensure the cybersecurity of today's connected consumer devices. Accordingly, efforts to reinforce system security, trust and user privacy will remain a prime focus of our future 6G work.

Some of the building blocks for 6G, such as network virtualization and edge computing, are already a feature of today's 5G systems. These are enshrined in technical specifications created by ETSI and 3GPP, the standards body that unites us with six other telecommunication standardization organizations and more than 700 member companies worldwide. Others, including innovative radio propagation techniques, intelligent and neuromorphic systems, quantum computing and advanced nano-scale technologies, are still in their comparative infancy.

Building on 5G

The tangible value of technological standardization is demonstrated by the staggering success of previous and current mobile generations. Serving billions of customers, this thriving global market has been made possible by the open standards developed and curated by 3GPP members. By guaranteeing seamless interoperability between devices, applications and services, these standards offer certainty for everybody in the ICT ecosystem—from vendors and operators to end users—while accelerating time to market and eliminating costly, time-consuming technology fragmentation.

It is well evidenced that standardized commercial products make a significant contribution to the overall economy and citizens' quality of life, as demonstrated by a recent report by GMSA that shows 5G will contribute $2.2 trillion to the global economy over the next fifteen years. What's more, a study conducted for the European Commission anticipates that 5G-related investments by EU member states will create 2.3 million jobs in Europe alone. The vast range of as-yet unrealized markets and applications enabled by 6G suggests that its own socioeconomic impact will be equally profound.

Standardization is sometimes perceived as an opaque, self-contained world that is hard for scientific researchers to access and engage with. At ETSI, our own work has always been enriched by close links with the R&D and academic communities. Accordingly, we offer a range of tools and resources to make researchers aware of our activities and needs.

Today, universities and research institutes represent 13 percent of our 900-strong membership—the highest representation in ETSI's 30-year history. Our focus in ETSI is on strengthening the close links that already exist with these communities. In turn, this provides a continuous pathway from pure research all the way through to our own pre-standardization activities. It is this joined-up dialogue that ensures the most exciting cutting-edge innovation will be captured in tomorrow's 6G standards, allowing the industry to meet challenging targets that customers in the not-too-distant future will benefit from directly.