Response to RSPG Consultation on Draft RSPG Report on 6G Strategic vision

Dear RSPG members,

The partners in the 6G Future Network Services (6G FNS) program thank the RSPG for the opportunity to respond to its Consultation on the Draft RSPG Report on 6G Strategic vision. Our response focuses on a specific topic in the draft report: section 4.2 on the 6G usage scenarios and their implications on spectrum. This section refers to, among other things, the ITU-R IMT- 2030 diagrams on *Usage scenarios and overarching aspects* (the so-called Wheel diagram) and on *Capabilities* (the Palette diagram). In our response, we describe a complementary approach to explore the usage scenarios and capabilities for IMT-2030 that we are pursuing in 6G FNS. The 6G FNS approach can be characterized as bottom-up, driven by examining specific applications in industrial and societal sectors. These activities are led by innovative companies in their sector that see the need for specific performance improvements in 6G compared to 5G, aligned with their own vision on the further development of their sector value chain.

This response has been written by TNO[1]. It has been reviewed by Philips, Gomibo, Vialis, Comforest, PWXR, Fectar, DDS, KPN, Odido, Nokia and Ericsson, based on their experience and initial insights from the FNS program.

1. About 6G Future Network Services

Future Network Services (FNS) is a Dutch multi-year public-private program on 6G innovation and development. FNS works on specific and connected topics in 6G: intelligent radio components and antennas, intelligent networks, and leading applications in key sectors. This is further combined with work within the program aimed at strengthening the 6G ecosystem through a large-scale testbed and standardization. The program has three overall goals in 6G: sustainable economic earning power, European digital autonomy and sustainability.

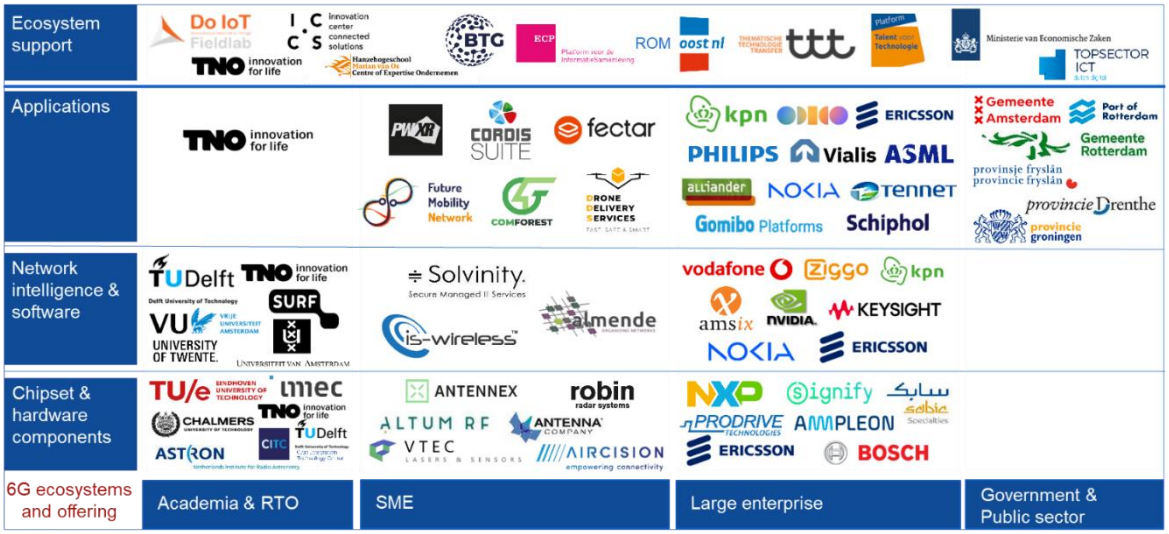

Figure 1. Participants in the Dutch public-private 6G FNS program.

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The program has over 60 participants from academia, knowledge institutes, SME, large enterprises and public sector. The program runs from 2024 to 2030, when the first version of 6G is expected to become available. The total budget allocated to the program is 315 MEuro.

2. Investigating 6G Leading Applications

Within 6G FNS, a dedicated program line on Leading Applications examines and develops specific leading 6G applications' around 30 organizations, representing different verticals. The research on each individual application is led by a private company, often an SME. The goal of the work on the leading applications is to derive coherent requirements and roadmaps for 6G, starting from the specifications already defined 5G. In this way, we explicitly include the application demand side in the steering of the 6G technology development. Also drawing on lessons from 5G, we believe this helps to promote the economic sustainability of the 6G ecosystem.

The selection of the leading applications and the companies involved has not been driven by the idea to pick 6G 'winners', as it would be naïve to assume anyone can do so. The selection was made with the aim to have A) a fair representation of different verticals and different requirements; B) a balanced mix of small & large companies; C) applications that vertical companies themselves have high expectations for, as the public-private program requires them to co-finance at least 50% of their research effort.

Figure 2. The eight Leading Applications in 6G FNS.

For each leading application, the vertical companies and typically one of the Dutch mobile network operators jointly develop a Proof Of Concept (PoC) to ensure hands-on collaboration between partners and steer clear of an overly theoretical or fragmented approach. Although PoCs are used to focus the 6G research, they also serve to leverage the full economic potential of 5G and 5G-Advanced in the applications. This helps to guide companies, policies and ecosystems to develop their view on feasible transitions to 6G.

Table 1 provides the prime reasoning behind the need for 6G for each leading application and how it maps to IMT-2030 and spectrum implications. The table also lists the company leading the research. In addition typically a vendor, mobile network operator and additional vertical companies and users do contribute.

For the initial view on spectrum the categories are structured as: 'Low' < 1 GHz for improvement coverage & resilience of the IMT network. Mid-band 1-15 GHz to allow capacity and introduction of new services on nationwide level, leveraging the rooftop / tower based network. 'High' > 26 GHz for capacity extension on hotspots, only new services in bounded geographic areas. indoor and market segments.

Leading application	**Research lead**	**SME**	**Why 6G**	**Mapping to IMT-2030**	**Initial view on spectrum**
Transport Hub	Drone Delivery Service	Y	Certified affordable seamless widespread 3D coverage & telemetry for UAV to improve logistics	3D Coverage Sensing & Positioning	Midband Spectrum (more capacity & beamforming to support ground & air)
XR retail	Fectar	Y	Support wayfinding and affordable AR glasses for mass market to improve retail sales	Area Capacity User Exp. Datarate	Midband spectrum (Sufficient capacity to offer nationwide service)
Exergaming	PWXR	Y	Improve experience and affordability for public locations by supporting body tracking & XR at scale	Area Capacity User Exp. Datarate	Midband spectrum (Sufficient capacity to offer nationwide service)
Grid Interactive Building	Comforest	Y	Support realtime local electricity grid and building balancing to reduce congestion and improve uptime	Resilience	Low spectrum (for resilience)
Wireless Intersection	Vialis	N	Improve safety and efficiency on intersections by improving detection of road users and autonomous vehicles	Sensing	Sensing capable spectrum (more stringent limitations on spectrum to allow sensing)
Wireless Factory	Cordis Suite	Y	Improve competitiveness of industry by change the functions of machines and allow communication inside of machine to move intelligence to the Edge	Latency & Jitter	Midband & High-band
Image Guided Therapy	Philips	N	Support Image Guided Therapy in a clinic with an 'office based setup' to allow centralization of compute)	User throughput Packetloss	Midband & Highband

Table 1. Leading application mapped to 6G and IMT2030

The annex to this response provides a detailed description of the leading applications and the determination of their requirement and KPIs. The research is ongoing: it has started at the beginning of 2024 and will continue with iterations in the application and the PoC towards the full 6G versions expected in 2030.

3. Why 6G

For several leading applications, our program has given us a preliminary view on crucial 6G KPIs and an initial view on the spectrum needed for them. For example, frictionless XR applications in retail and Exercise Gaming (Exergaming) in public and nomadic locations require a step change in KPIs compared to video. New companies (like PWXR and Fectar that are driving these use cases in FNS) flourish when these opportunities can be freely developed regardless of place and time so that they can be used without friction. This is similar to what 4G and 5G have done for streaming video.

Also in complex indoor environments (today only served by 4G and 5G through midband spectrum) the applications will become more demanding, calling for more advanced technologies. It will also demand higher spectrum. In the wireless factory application, the aim is to make factories and foundries more flexible and competitive by centralizing embedded software on a local edge. Image Guided Therapy can become more competitive and beneficial when e.g. very stringent frame loss (10^{-6}) and very high bandwidths in office-based clinics are supported.

We will continue to examine these and the other leading applications for their specific requirements with the aim to steer the 6G technology development and validate their feasibility and value in Proof Of Concepts.

4. Conclusion

The partners in FNS are working on a bottom-up, ecosystem-driven examination of use cases and capabilities for 6G, as a complement to the valued approach via the IMT-2030 Wheel and the Palette diagrams. In this way we believe we can address one of the lessons learned from the introduction of 5G: digital transformation requires an ecosystem and supporting policies – technology is only a part of this solution. The goal is the same: to promote that advanced applications can flourish on advanced mobile networking infrastructures. We see that on the (fragmented) applications side, there is still a lot of untapped potential for (future) European companies and society. The voice of the application side is fragmented over many parties, sectors and, as a result, less organized than the 5G and future 6G supply side. Still, the RSPG and national policies for spectrum are the foundation for applications as they contribute to the investment climate that enable a strong and stable digital single market that is competitive with other world regions.

5. Proposal for changes to draft report

The FNS partners believe it is beneficial to add following text at the end of section 4.2 of the draft report to capture the bottom-up insights from the application side:

Research from European projects (such as those in the Smart Networks and Services Joint Undertaking) and from national 6G projects provide further analysis of 6G usage scenarios in several sectors important for European citizens and businesses. As an example, the 6G Future Network Service project pursues a complementary approach, driven by examining specific applications in industrial and societal sectors. Based on the insights of innovative companies in their sector on the KPIs requirements by their applications, this bottom-up approach brings several observations that confirm and complement the more top-down analysis around the Wheel diagram and the Palette diagram:

- New use cases in energy grids (congestion management and protection) require reliable nationwide-area coverage, for which low-band spectrum (below 1 GHz) is essential.
- New use cases e.g. in exercise gaming, XR in retail, large-scale drone transport and traffic intersection safety need additional capacity in nationwide networks and for challenging indoor environments like factories and clinics.

Annex

A1.1 6G Wireless Factory (Cordis Suite)

To stay competitive in today's fast-paced global industrial landscape, factories in Europe have to constantly innovate and adapt to the ever-evolving market demands. The multiformity of their equipment only exacerbates the challenges. Typically, the machine pools are a mix of various makes and models, from modern to more than a decade old, fitted with a multitude of sensors, actuators and embedded systems from a range of suppliers. This makes maintenance and updates a daunting task during the equipment's long lifespan.

Figure 3 Testbed wireless factory on Brainport Industry Campus

Within the Future Network Services program, supported by the Dutch National Growth Fund, software development solutions provider Cordis Suite and telecom company KPN are spearheading a consortium to develop a vision for the factory of tomorrow. Together with semiconductor equipment giant ASML, industrial IoT and automation specialist Weidmüller and Eindhoven University of Technology and NXP they're exploring how 6G communication and a revolutionary centralized software architecture can help the European manufacturing industry lead the pace of change. At the Brainport Digital Factory, located on the Brainport Industries Campus (BIC) in Eindhoven, the Netherlands, a production line demonstrator has been implemented to show the initiative's advances toward fully wirelessly connected intelligent machines. The Eindhoven cluster was already recognized by the European Patent Office (EPO) to be the most innovative in the 4th Industrial Revolution in Europe.

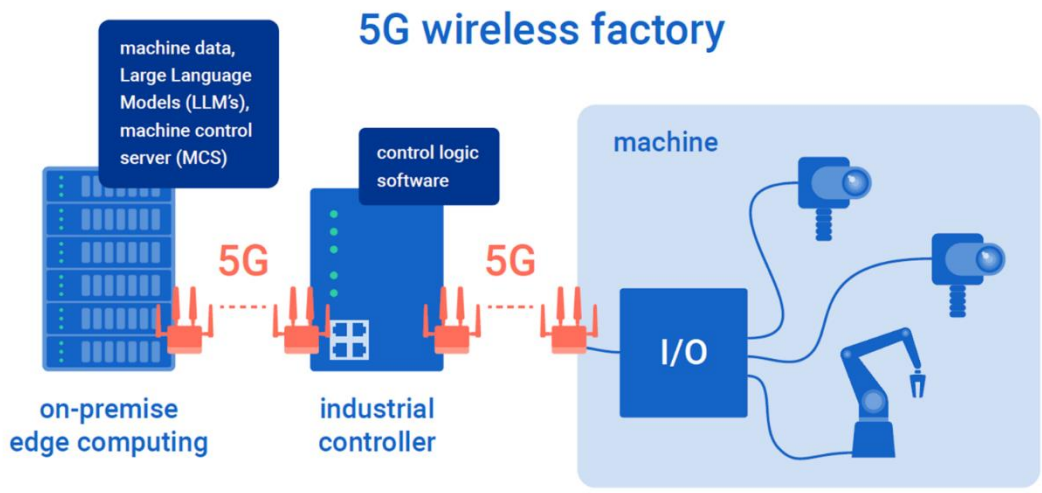

Figure 4. 5G wireless factory.

Why 6G?

In this work package, a completely new application of wireless connectivity is explored. 5G is targeted at the communication between the IT systems and machines in a factory, the operational technology (OT), taking the wireless connection **inside** the equipment to monitor and control the industrial assets, processes and events.

This collaboration will contribute to the development of the upcoming 6G technology by delivering the requirements to enable soft real-time factory automation and hard real-time motion control - ethercat, with latencies below 1 ms and very stringent synchronization / jitter targets. Higher frequencies in combination with protocol optimization (26GHz and higher) enable these lower latencies. The evolutionary (collaboration) approach in wireless factories will be key to achieve the necessary economies of scale in the higher frequencies (especially in 100GHz - SubTHz bands)

Simultaneously, at NXP and ecosystem partners, research and development is underway to craft an architecture and design a 6G base station capable of operating in potentially new frequency allocations such as 5-24 GHz and 100 GHz-THz bands. This work is intended to benefit the industrial IoT as well, as demonstrated by other FNS participants.

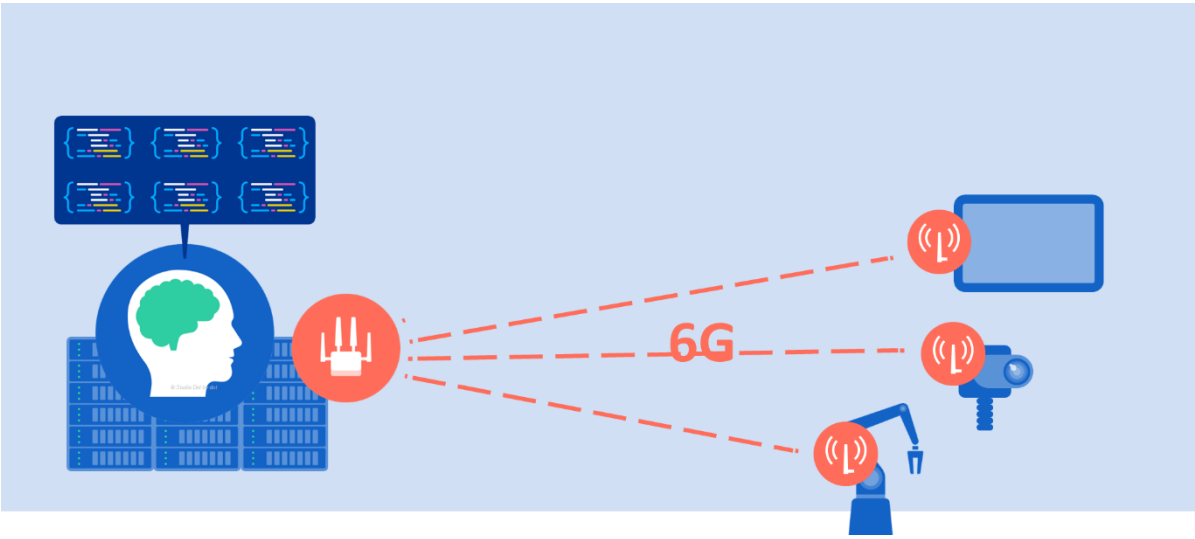

Figure 5. 6G Goes inside the machine.

With 6G connectivity going into the equipment, a new domain for cellular communication, the machine control can be simplified and the risk of errors reduced. By centrally combining and analyzing the machine data, production processes can be made substantially more efficient. In addition, the simpler technology, easier error detection and data-driven predictive maintenance will increase the uptime and time-to-repair of the production line. Finally, high-speed wireless communication makes factory floor layouts easier to rearrange when production processes change. As obsolete machines can be retrofitted with intelligent control, the technology is interesting for almost every factory.

The market potential is huge. According to Statistics Netherlands (CBS), the Dutch industry annually invests 10 billion euros in new production equipment. In Europe and the US, investments in industrial machinery amounted to 250 billion euros [EUROSTAT2022] and even 1 trillion euros [FRED2023], respectively, in 2020. With their large concentration of costly machinery and their ability to quickly implement new technology concepts, the high-tech, automotive and machinery sectors are expected to be the first to benefit.

A1.2 Image Guided Therapy (Philips)

The demand for imaged therapy is increasing due to the ageing population, clinical procedure innovation, and increased access to health care in Asia. Image Guided Therapy procedures offer significant benefits over open surgery. These advantages include smaller incisions, less trauma, faster recovery times and a lower probability of post-surgery infection. The global market is estimated between 4-7 BnE and to grow between 5-10% CAGR [MARKETIGT] during the upcoming decade. Within this market there is also a rise of office based special clinics, focusing on one day of image guided therapy surgery without stay-over in the clinic.

To capture the most important user and technical requirements, we have identified two use-cases: A) In an outpatient clinical treatment lab all medical equipment is connected through a mobile network. Quality metrics need to be met always to guarantee safe patient treatment. Advanced image processing of (live) surgery images, such as x-ray, ultrasound, etc, is performed in the cloud to leverage state of the art artificial intelligence algorithms. B) In a large hospital mobile medical equipment is wheeled into a clinical intervention room. The equipment connects to the operating environment through a local hotspot.

For further investigation, we selected the use case advanced spine surgery in an office based lab (ambulatory care). While the 6G setup will be relevant for many different medical interventions and care provider setups, this use case covers many relevant aspects, such as: a multitude of equipment, such as X-ray, ultrasound, vital signs monitoring and the need for advanced realtime combinations of the live and pre-operative information sources.

The office based setup is characterized by:

- A lack of a strong hospital IT department, leading to the need for service providers delivering this in a secure and reliable manner.
- It requires services, such as reporting, archiving, billing, secure sharing with other care providers.
- The ambulatory setup leads to the need for home monitoring for follow-up care.

Figure 6. Philips equipment to be used during Image Guided Therapy.

Why 6G?

The digital infrastructure of a medical system clearly requires high uptime and the ability to implement security patches even in live networks. More importantly, the bandwidth requirement for uncompressed 8K UHD at 25Hz (100 Gbps) exceeds what 5G can provide, hindering the advantages of more centralized computing environments for supporting real-time 3D rendering applications and AI. The need for loss-less data transfer in realtime drives bandwidth requirements. Loss-less is needed to ensure that clinical data for the surgeon remains identical. Furthermore, making the capabilities of centralized computing available to critical real-time acute clinical procedures, allows the use of state-of-art algorithms over the entire lifecycle of the medical equipment (typically around 15 years).

In addition to bandwidth also latency, jitter and packet loss are critical parameters to consider as safety measures in surgical settings. Jitter (the violation of latency requirements) should occur less than once in every million frames, and any violations must be kept below 100%.

A1.3 Transport Hub (Drone Delivery Service)

In the northern provinces of the Netherlands, which are relatively sparsely populated, there is an increasing demand for the delivery of essential goods to an ageing population and for facilitating productivity growth within the labor force. Maintaining access to essential services such as pharmacies and grocery stores is becoming more challenging. Furthermore, the productivity of maintenance engineers and veterinarians could be significantly enhanced by more efficient access to the right equipment on-site.

Drone Delivery Solutions for Remote Areas

Drone Delivery Services offers a cost-effective logistics solution to address these challenges, extending current delivery systems. To ensure the viability of this solution, three key conditions must be met:

- Leverage terrestrial mobile networks for safety and communication.
- Support for safe long-distance flights (Beyond Visual Line of Sight) in unsegregated airspace.
- Development of a unified market for certified 5G/6G drones and supporting software solutions.

The need for these services in northern Netherlands is part of a broader global trend, with the drone logistics market projected to grow to €64 billion by 2034, according to PwC [PWC2024].

Why 6G?

Our research focuses on reducing interference and improving handovers by leveraging advancements in beamforming. While the current 5G Standalone (SA) network has limitations in terms of capacity and interference for both ground and air users. 6G promises improvements in Coverage and mobility aspects to be enhanced and the need of uninterrupted coverage on the drone pathway.. With massive MIMO (Multiple Input, Multiple Output) technology and more adaptive beamforming, 6G will enable better coexistence between resilient ground and air coverage.

These advancements could also enhance drone localization and sensing capabilities, enabling detection of non-cooperative drones or GPS spoofing through terrestrial networks. For example, if the accuracy of a mobile system is within 50 meters in both X and Y coordinates 99.99% of the time, it could serve as a backup safety system for GPS. This would allow UAVs to remain within their designated flight corridors, ensuring safer operations.

As the drone logistics market expands between 2030 and 2040, especially with the advent of drone-based passenger transport, the need for increased air capacity will be critical.

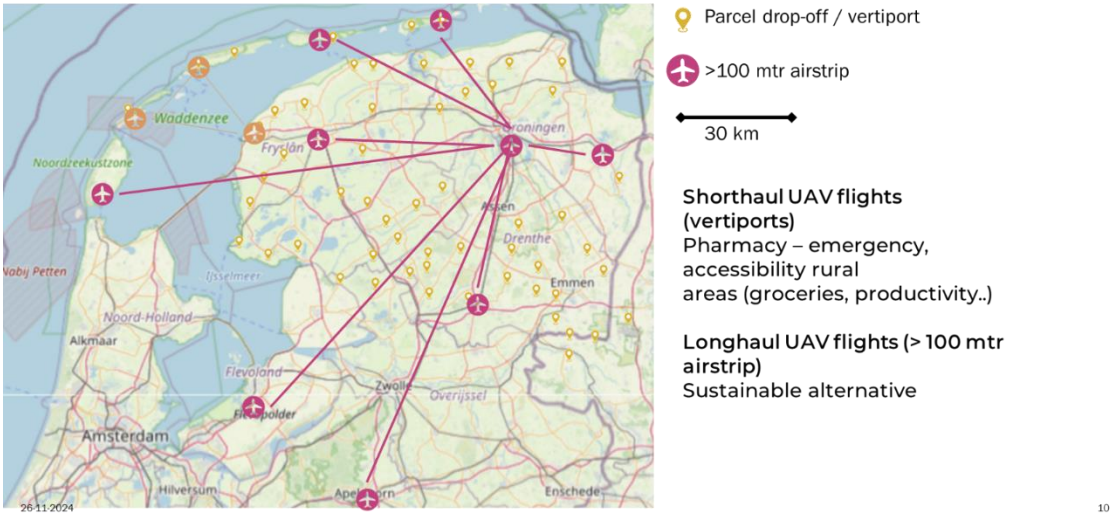

Figure 7: Vision UAV logistics infrastructure in 2035 North of Netherlands

The Dutch ecosystem prioritizes the use of existing high-end digital infrastructure to ensure the most cost-effective solution for the entire country. However, there are challenges related to the availability and national regulation of IMT/3GPP spectrum in the lower airspace (< 400 ft) particular for bands which support beamforming (3.5 GHz). This uncertainty limits investment opportunities for drone companies, regulators, operators, and software developers in the 5G SA ecosystem.

Additionally, any change in UAV user equipment or antenna configurations could trigger costly recertification processes. Therefore, providing stability and certainty regarding 3GPP spectrum use in this lower airspace is crucial for fostering a sustainable drone logistics market.

A1.4 XR retail (Fectar)

For younger generations, platforms like TikTok and video filters are an integral part of daily life. As this age group matures and becomes a key consumer demographic, their expectations will reshape the

customer journey in retail. The demand for Augmented Reality (AR) in the shopping experience — such as visualizing how a TV, refrigerator, or other products fit in a space or look in context — is naturally evolving, both at home and in physical stores.

As a result, the role of brick-and-mortar stores will also transform, shifting towards becoming hubs for digital experiences. Market projections indicate this trend could drive the market to exceed €500 billion by 2032 [Market.US].

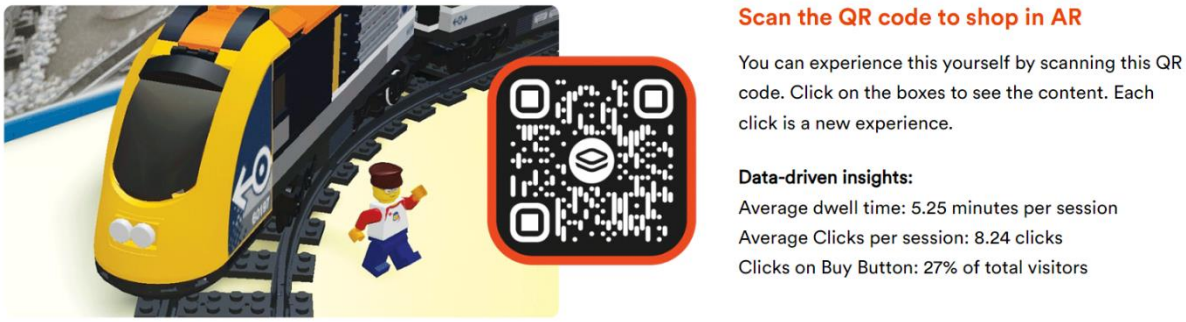

Figure 8. Example todays' implementation of AR in retail – still requiring QR codes.

The XR retail leading application is driven by Fectar, a cross-platform solution provider offering a unified XR experience. The goal is to make XR technology accessible to the mass market by delivering high-quality experiences while offloading processing to the cloud, thereby reducing the cost and weight of XR glasses.

Currently, massive investments are being made by companies like Apple, Meta, Magic Leap, and Unity, primarily aimed at developing content for the professional community, which will eventually enable mass adoption. However, as a result, the price, content availability, and mobile network infrastructure — including 5G capability — are not yet mainstream.

Despite these challenges, the long-term potential for XR technology and the role of networks remain significant. Like other digital platforms, Fectar sees a strong connection between XR experiences and retail sales. By focusing on Augmented Reality (AR) and Mixed Reality (MR), Fectar is positioning itself to take advantage of the broader applications of XR. These technologies offer wider usability compared to Virtual Reality (VR) and have lower technical requirements, such as minimizing motion sickness, for a better user experience.

Why 6G?

The mobility aspect that goes with XR applications for outdoor / nomadic commercial environments (not in the house) is the key what IMT offers nationwide. Additionally, 6G offers advanced localization and additional capacity - which will be essential for seamless 'wayfinding' in environments like shopping streets, even after walking 200 meters. With this technology, there will be no need to scan QR codes to align Augmented Reality (AR) content with the physical world or even the need for high-end (intrusive) camera's on the XR device. To enable mass adoption, it's crucial to develop XR content standards that align with pre-rendering in the digital infrastructure (GPU + network). This will ensure affordability and scalability.

The economics of achieving nationwide scale, while managing issues like jitter, latency, bandwidth, and fast positioning (including indoor localization), as well as orientation (Simultaneous Localization and Mapping – SLAM), are key to understanding the resources required for success.

Although much of the overall data traffic currently flows through WiFi, retail customers are almost always connected via mobile networks. This makes global integration more straightforward compared to the fragmented WiFi landscape. Several initiatives have been undertaken over the last decade to address this fragmentation from the user's perspective, but no guarantees can be made for the future. Therefore, improving delivery capabilities over IMT (International Mobile Telecommunications) networks remains crucial for effective XR experiences in shopping streets and stores.

XR should not go well above 50 milisecond latencies on experience level, but the issue is the affordability of the device and network to make it go widespread. In the next steps of our research, we will make a detailed investigation of the precise network requirement trade-off versus affordability (complexity of UE and network) for XR retail.

A1.5 Exergaming (PWXR)

The challenge addressed by the Active Esports Arena is the growing need to engage digitally native audiences in physical activity in an innovative and appealing way. Traditional sports and fitness activities often fail to capture the sustained interest of younger generations, who are more drawn to digital experiences. Additionally, many urban environments face social challenges, such as barriers to access and participation in fitness and recreational activities, particularly for disadvantaged communities. This underscores the need for inclusive, technology-driven solutions that promote physical fitness while fostering community and social inclusion.

Market Potential and Expansion Opportunities

The initial focus of the Active Esports Arena is on leisure, gaming, and sports, with XR centers located in urban areas where people can experience these applications on-site. The market for these immersive experiences in Europe is projected to reach €5.7 billion by 2025, driven by growing consumer demand. Beyond leisure, the broader XR market offers opportunities for expansion into sectors like training, education, and healthcare, with the global XR training and simulation market alone expected to reach €16 billion by 2028.

Inclusive Design for All Users

Exergaming is designed to be inclusive, with user-friendly interfaces, guided experiences for digital novices, and a strong focus on privacy by design. Simplified UX and targeted modules reduce complexity, making the application accessible to privacy-conscious, low-income, and digitally inexperienced users. By addressing these concerns, Exergaming ensures that everyone can benefit from the experience, regardless of their digital proficiency or background.

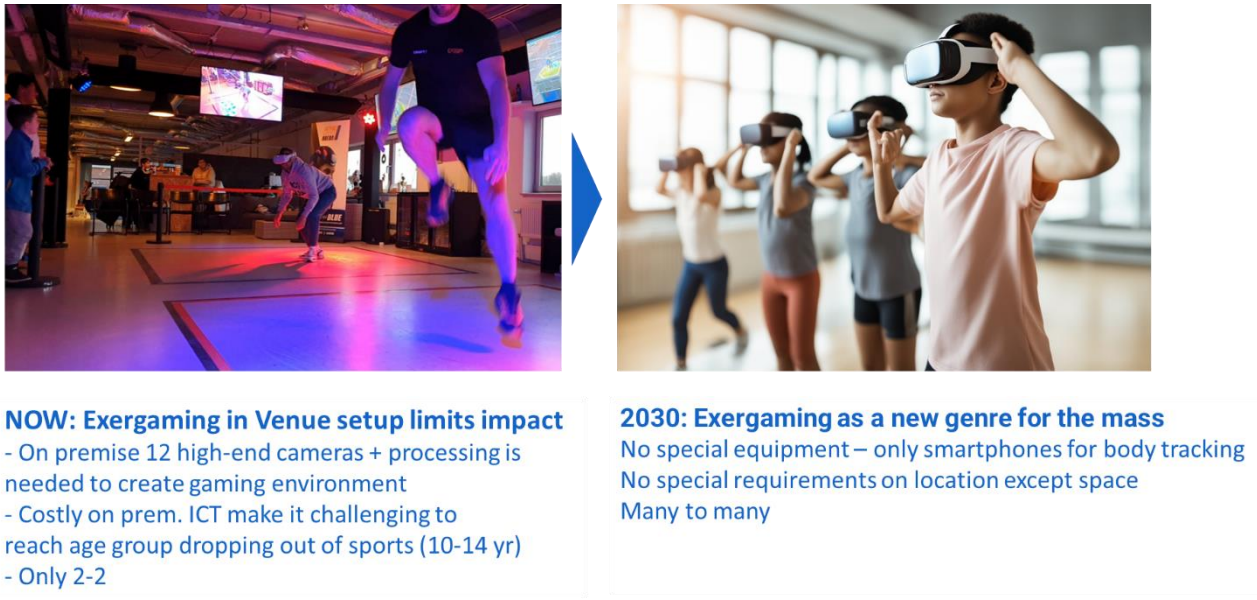

Figure 9 Exergaming today and evolution to 6G

Why 6G for Active Esports Arena (Exergaming)

The leading application within the Active Esports Arena connects up to 12 smartphones to 6G, leveraging its ultra-low latency, high bandwidth, and enhanced connectivity both indoor as outdoor. As long as you have space to move around Real-time full-body tracking, a core feature of the arena, directly benefits from 6G's capabilities. With 6G, the movements of multiple participants can be captured, processed, and reflected in the virtual environment instantly, enabling synchronized interactions without delays. This ensures that large groups can engage in interactive sports-gaming experiences, significantly enhancing immersion and user engagement.

6G's Role in Enhancing Accessibility and Social Inclusion

In this context, 6G not only provides the technical infrastructure for high-speed, responsive gameplay but also ensures that the arena is accessible to a diverse range of users, including those from socially disadvantaged backgrounds. The enhanced connectivity enables a scalable and inclusive platform, supporting remote access and connectivity that helps bridge digital divides in urban environments. This promotes social inclusion by offering technology-driven high-end fitness solutions that are accessible to all.

The Need for Increased Capacity in IMT2030

While IMT2020 has already achieved an area capacity of 10 Mbps/m², it has limitations in spectrum efficiency and compression compared to enhanced Mobile Broadband (eMBB), particularly for applications requiring low latency and affordable devices. To support the evolving demands of the Active Esports Arena, the area capacity in IMT2030 must be increased to accommodate these requirements, ensuring that low-latency, high-quality experiences can be delivered at scale.. In the next steps of our research, we will make a detailed investigation of the precise network requirement trade-off versus affordability (complexity) for exergaming.

A1.6 Grid Interactive Building

Comforest specializes in smart building management systems, a sector within the rapidly expanding European market. This growth is fueled by the EU's strong focus on sustainability, energy efficiency, and smart urban development.

Rapid Market Expansion Driven by EU Goals and Regulations

The European smart building market is growing quickly, driven by the EU's climate goals, stringent energy efficiency regulations (e.g., the Energy Performance of Buildings Directive), and increasing urbanization. Northern and Western Europe are leading adoption, with countries like Germany, the Netherlands, and Scandinavia seeing significant growth. The market is expected to reach a value of €30 billion by 2030, bolstered by government incentives, advanced infrastructure, and the integration of technologies like IoT, AI, and renewable energy systems. Key opportunities lie in retrofitting aging buildings, optimizing energy use, and aligning with Europe's green and digital transition.

Addressing Grid Congestion with Grid-Interactive Buildings

A major challenge facing Europe is grid congestion, as electricity grids struggle to handle the increased demand driven by electrification and renewable energy integration. Grid-Interactive Buildings (GIBs) can help address this issue by enabling demand-side energy management, peak shaving, and real-time balancing. These buildings enhance energy efficiency and reduce grid stress through features such as dynamic load adjustment, energy storage integration, and optimization of off-peak energy usage. Such solutions promote grid stability while complementing the broader objectives of the energy transition.

Behind-the-Meter Opportunities and European Market Integration

This solution is part of the emerging "behind-the-meter" opportunities within the European integrated single market (ACER). Active trading is already occurring at the European level across multiple markets. To ensure the stability of grid access, two critical factors must be addressed:

- Maintaining Physical Constraints: This requires the use of digital fuses to ensure that energy trade stays within the physical limits of the grid, while also mitigating potential threats from IoT vulnerabilities.
- Preventing Artificial Scarcity: Adherence to mandatory congestion management protocols is essential to maintain grid stability and avoid creating artificial energy shortages.

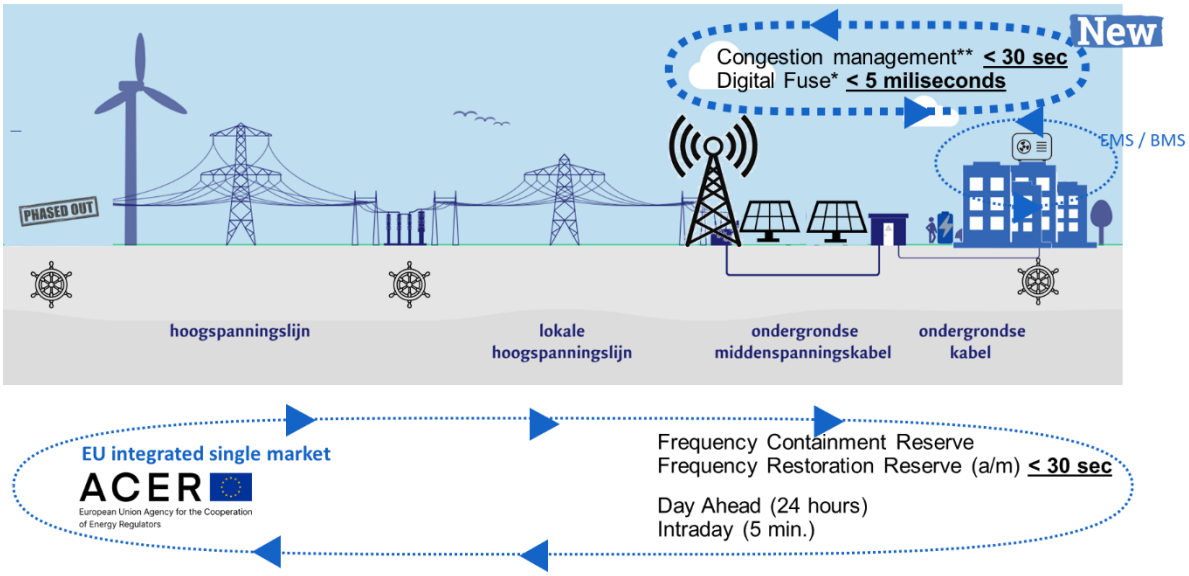

Figure 10. Emergence of new local balancing market in access grid & buildings.

Comforest's leading application, the smart building management system, is designed to optimize the use of scarce resources by focusing on energy efficiency and resource conservation. The system dynamically adjusts heating, lighting, and ventilation based on real-time conditions, ensuring that energy is only used when necessary and reducing unnecessary consumption. Through demand-side management, it helps reduce grid strain by shifting energy use to off-peak times, minimizing reliance on non-renewable energy sources. The system also monitors water usage, detecting leaks and optimizing consumption to reduce waste.

Why 6G in Grid Interactive Buildings?

In many cases, connecting buildings, transformers and foremost the many endpoints and smart meters in access grids through fiber is neither practical nor cost-effective. Especially when aiming for mass adoption, wireless solutions offer a more scalable and economical approach.

Resilience

To ensure continuous operation, resilience measures are embedded within the system. For example, in the event of a digital infrastructure failure, the smart indoor climate control system incorporates multiple safeguards. If a device or sensor disconnects, the system automatically switches to other available devices or sensors. The cloud continuously monitors and synchronizes all controllers, providing real-time alerts about missing or faulty devices.
Additionally, the control service includes built-in fallback mechanisms, ensuring the system can continue functioning even during data loss or communication failures between services or devices.

Complexity and Opportunity

Grid-Interactive Buildings (GIBs) add complexity and opportunity in the event of a blackstart. These buildings can continue to operate in "island mode," providing energy to their neighbors. However, to ensure a balanced blackstart, energy sources must be known, limited, and synchronized within a tolerance of 0.2 Hz. Also differential protection of individual lines / connections need to be done below 10 ms to reduce repair times in case of a line or connection failure. Connectivity will be crucial to maintain local energy balancing, resilience, and synchronization — capabilities that exceed what current 5G networks can support.

A1.7 Wireless Intersection

The Netherlands enjoys advanced road traffic management, with a particular focus on participant detection, thereby facilitating efficient and safe mobility. For our traffic lights to respond in an optimal manner to the demands of traffic, it is necessary for them to be able to detect traffic. This is currently achieved through the use of loops that are costly to maintain and located beneath the asphalt.

The deployment of 6G functionality for Joint Communications and Sensing (JCAS) offers a cost-effective solution for traffic detection. This approach provides more reliable information than traditional methods, including the ability to identify the type of vehicle, its speed, and its direction of travel. Furthermore, it offers the potential for real-time optimisation of traffic flow by transport type, which may lead to enhanced traffic safety, a reduction in the necessity for road works and, consequently, a reduction in CO2 emissions and travel time.

The Netherlands has roughly 5.500 Traffic Light Controller (TLC) controlled intersections. Assuming that 75% is complex and data driven, the attainable market for wireless detection is ~ 4.000 intersections. Not all intersections are traffic actuated, therefore 3.500 is a reasonable amount of intersections to be addressed by the solution. This translates to an economic value of ~50 Mio Eur on traffic detection without considering the economic values of vehicle lost hours based on road closers etc. For a sustainable business case, one needs to look not only at the Wireless Detection itself but also at the added value intersection awareness can bring for multiple mobility use cases in the future like: CCAM, Traffic Safety between vulnerable road users and heavy vehicles for instance, the ability to upload, download large data files (e.g. ROMO) to vehicles and new applications like providing information towards visual impaired on intersections.

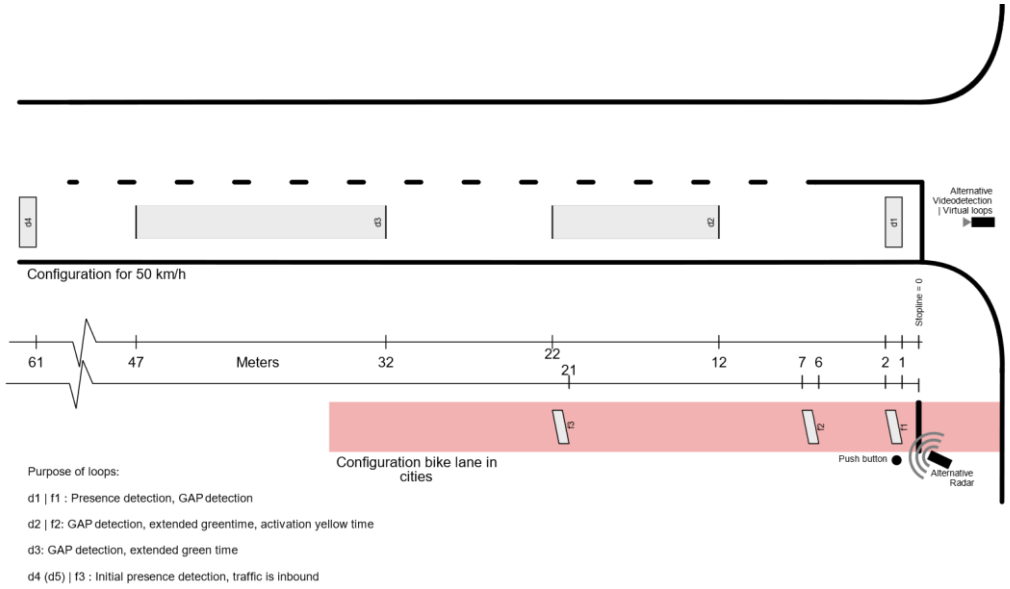

Figure 11 Challenge: Deploying sensing (radar) on an intersection

The application addresses the social demand for insights into all traffic modalities, ensuring inclusive detection of various modalities within a unified system. The data optimizes traffic at controlled intersections, aligning with government policy goals. This leads to more efficient, safer intersections and better protection for vulnerable road users.

Why 6G

The main environmental benefit of using 6G JCAS for wireless detection is the elimination of inductive loops in the tarmac, reducing both installation costs and air pollution from roadwork. Furthermore, improved traffic performance reduces the need for road closures. Today the application cycle time on intersections is 100ms, however already the trend is emerging to continuous floating data / decisionmaking. Meaning continuously decisions are made (rather than every 100ms) based on traffic data.

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