

# APEX STANDARDS

6G Standardization and Research: Key Insights from 3GPP's Inaugural Workshop

Apex Standards researchers have prepared this summary to provide a structured overview of 3GPP's first 6G Workshop on March 10–11, 2025, in Incheon, Korea. Designed to accelerate the review process, it offers a forward-looking perspective on how 6G standards will take shape—empowering readers with strategic planning for market positioning, product development, IPR, and regulatory frameworks over 6G's new decade to span 2025 to 2035. With 230 contributions, this workshop defines anticipated features and must-haves from "Day 1." Although these visions often intertwine—at times overlapping and other times exhibiting nuanced differences—they cover a diverse range as part of consensus building. We have organized them into 30 topics, as illustrated in **CHART 1** (a hierarchical view), **CHART 2** (topics ranked by mention frequency), and **TABLES 1–4** on Page 2 (which cite the exact verbatim wording used by companies to describe each topic; a blank entry indicates that the company has not expressed a position on that topic).

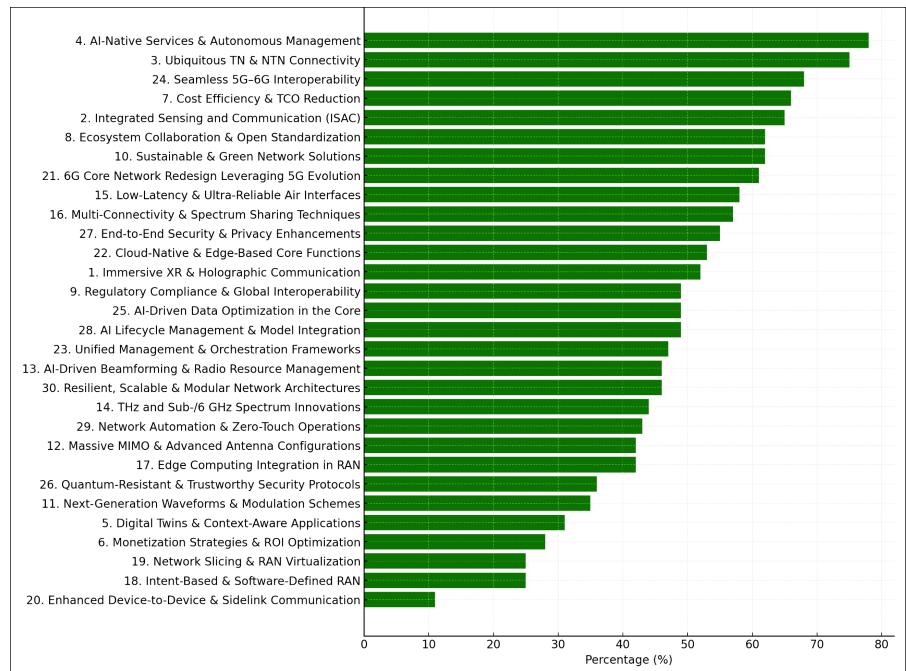
Additionally, we have prepared the mega PDF binder of all 230 contribution files—comprising 3,272 pages, fully indexed, bookmarked and keyword searchable—is available for download at:

<https://www.apexstandards.com/6gwsz.pdf>

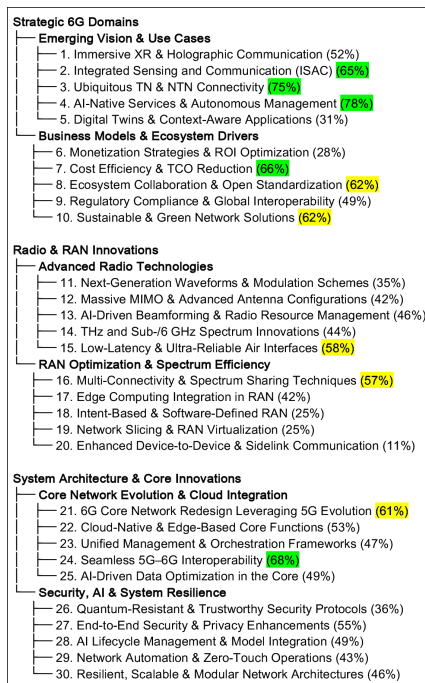
A static PDF version of the full company-by-topic breakdown table is offered to the public by courtesy:

<https://www.apexstandards.com/6gwsv.pdf>

The interactive web version and verbatim Excel table are offered to clients, with reserved bandwidth for invited guests or first-come, first-served access.



**CHART 2** ranks topics by mention frequency, sorted from the highest mentions as shown in **CHART 1**. AI will be central to the future of 6G, led by AI-Native Services (78%), followed by AI Data Optimization in Core (49%), AI Lifecycle Management (49%), AI Beamforming (46%), and AI Network Automation (43%). These trends highlight AI's expanding role in enabling intelligent, adaptive networks and automation, while also empowering other hot areas like Integrated Sensing (ISAC) and Digital Twins, even when not explicitly labeled under direct AI keywords.



**CHART 1** lists the hierarchical topics to be presented and discussed at the 6G Workshop. The topics highlighted in green represent the top 5 most mentioned areas—including AI, ISAC, cost efficiency, and 5G-6G interoperability. The topics highlighted in yellow rank 6<sup>th</sup> through 10<sup>th</sup>, including ecosystem collaboration and RAN innovations. The hottest topic is "AI-Native Services & Autonomous Management," mentioned in 78% of the contributions.

## To Where the Future Is

The workshop aims to define next-generation mobile technologies and builds on discussions from the 3GPP Stage 1 Workshop on IMT 2030 Use Cases, held from May 8–10, 2024, in Rotterdam, Netherlands. That event brought together the 3GPP community with regional and global research organizations, market partners (MRPs), operators' associations, and the ITU, laying the groundwork for 6G standardization [Ref Apex Standards C20003236].

### Key Strategic Domains in 6G Development

The workshop highlights emerging and converging views for 6G, with a strong focus on AI-Native Services & Autonomous Management, Ubiquitous TN & NTN Connectivity, and Integrated Sensing and Communication (ISAC). These areas emphasize AI-driven automation **TABLE 1**, seamless integration of terrestrial and non-terrestrial networks, and advanced sensing technologies. Complementing these are Immersive XR & Holographic Communication and Digital Twins & Context-Aware Applications **TABLE 2**, which explore new interaction paradigms through extended reality, virtual environments, and real-time digital modeling.

Beyond use cases, discussions also focus on business models and ecosystem drivers. Topics such as Cost Efficiency & Total Cost of Ownership (TCO) Reduction, Ecosystem Collaboration & Open Standardization, and Green Networks highlight both economic and environmental considerations in 6G deployment. Furthermore, Regulatory Compliance & Global Interoperability and Monetization Strategies & ROI Optimization address the need for alignment with global regulations and ensuring the economic sustainability of 6G networks.

## 6G Radio & RAN Innovations

The workshop explores radio access network (RAN) evolution across key areas. Topics include AI-Driven Beamforming, Multi-Connectivity & Spectrum Sharing, and Massive MIMO, all essential for improving spectral efficiency, network capacity, and adaptive connectivity. These tie to Low-Latency & Ultra-Reliable Air Interfaces, which support critical applications like industrial automation, real-time communications, and autonomous systems.

THz and Sub-6 GHz Spectrum Innovations focus on better frequency use, spectrum sharing, and new spectrum opportunities **TABLE 3**, along with Next-Generation Waveforms & Modulation Schemes for improved transmission reliability and efficiency.

Further network architecture advances include Edge Computing in RAN, Network Slicing & RAN Virtualization, and Intent-Based & Software-Defined RAN. These improve deployment flexibility, resource use, and Enhanced Device-to-Device & Sidelink Communication, strengthening connectivity in dense, remote, and latency-sensitive environments.

### System Architecture & Core Network Evolution

Core network evolution remains a key area of focus. Discussions center on Seamless 5G-6G Interoperability **TABLE 4**, 6G Core Network Redesign Leveraging 5G Evolution, and Cloud-Native & Edge-Based Core Functions, ensuring scalability, efficiency, and low-latency processing for next-generation networks. The topics of AI-Driven Data Optimization in the Core and Unified Management & Orchestration Frameworks further emphasize the role of automation and intelligent data handling in supporting dynamic network environments. ▶

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## Security and Resilience in 6G

Security and resilience are concerns in 6G standardization. Topics include End-to-End Security & Privacy Enhancements, Quantum-Resistant & Trustworthy Security Protocols, and AI Lifecycle Management & Model Integration. These initiatives aim to bolster system security against threats, including those posed by quantum computing and AI-driven attacks. Also, Network Automation & Zero-Touch Operations and the development of Resilient, Scalable & Modular Network Architectures are emphasized to ensure long-term reliability and self-sustaining security.

## Further into Avant-Garde 6G Research

Beyond the hot topics above, research continues to venture into avant-garde concepts around AI-native, and ubiquitous networks. Industry leaders see seamless integration of terrestrial and non-terrestrial (NTN) systems, which allows for semantic communication (Pengcheng Laboratory, 6GWS-250194) and full interoperability for reliable connectivity to further support global digital inclusion.

At RAN, innovations like advanced MIMO, cache-aided multi-user MIMO, and Zak-OTFS waveforms (Cohere, 6GWS-250233) work to boost throughput and reduce latency. Advanced duplexing is expected to meet high uplink data rate needs for metaverse and AI traffic. Samsung's 6GWS-250036 eSBFD (enhanced subband full duplex) shows this potential, while ZTE's mention in a new TDD spectrum (6GWS-250008) highlights further promises.

Other innovations include AI-driven beam management and modular RAN architectures that support XR and HD streaming, while keeping 5G compatibility. Core networks must become simpler, use AI, and improve security, as noted by Cisco (6GWS-250193).

Vertical industries need tailored solutions. Automotive, industrial, healthcare, and broadcast sectors demand low latency, high reliability, and long device lifecycles. Automotives seek TN/NTN integration and sidelink capabilities, while industrial IoT and XR require secure, energy-efficient networks. Sustainability remains key for cost-effective, eco-friendly systems. Multisensory communication, which goes beyond XR to include haptic, olfactory, and gustatory feedback, is also a focus. Samsung (6GWS-250036), Meta (6GWS-250183), and Lenovo (6GWS-250061) study how digitizing human senses could transform healthcare, education, and industrial training. KDDI (6GWS-250090) envisions 6G "killer services" delivering true five-sense experiences, hinting at **network intelligence** as a **sixth sense**. This marks 6G's shift from pursuing speed to offering an immersive, user-driven platform for next-gen applications.

## Future Outlook

Along the 6G Workshop, organizations can stay ahead through systematic review and timely tracking to refine innovation/IPR strategies, optimize product roadmaps, and strengthen market positioning. ■

**Disclaimer** This summary is based solely on TDoc data. For a precise interpretation, please refer to the actual in-person presentations in Incheon, Korea.

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TDoc	Title	Source	4. AI-Native Services & Autonomous Management
<a href="#">6GWS-250182</a>	Meta's Views on 6G Vision and Priorities	Meta USA	Agentic AI via XR Wearables
<a href="#">6GWS-250160</a>	Views on 6G Core	Huawei, HiSilicon	Agent-driven Autonomous Management
<a href="#">6GWS-250111</a>	Apple's Vision and Priorities for 6G RAN	Apple Inc	AI/ML supports offline training
<a href="#">6GWS-250226</a>	Philips view on 6G (SA)	Philips International B.V.	AIML to improve signal transmission and reception

TABLE 1 78% of companies describe Topic 4: "AI-Native Services and Autonomous Management" in distinctive terms. Nokia uses "ubiquitous connectivity" for global access via both terrestrial and non-terrestrial links. T-Mobile emphasizes "seamless NTN integration" and "AI data collection" to boost efficiency, while China Telecom employs a "task-driven AI management framework" for a practical approach. Philips states "Using RAN plus UE side AIML to improve signal transmission and reception," leveraging user equipment for edge processing. Apple's "offline training" hints at on-device learning via its dominating UE offerings (iPhones, iPads) for low-latency performance. Huawei and Meta use "agent-driven autonomous management" to distribute decisions, and Nvidia highlights "AI-driven computing infrastructure" based on its GPU leadership, while SK Telecom and Oppo favor "simple design" and "native integration."

TDoc	Title	Source	5. Digital Twins & Context-Aware Applications
<a href="#">6GWS-250019</a>	AT&T views on 6G studies in SA and CT WGs	AT&T	Digital twins and virtual world
<a href="#">6GWS-250227</a>	CBN's View for Broadcast on 6G RAN	CBN, China Broadnet	intelligent transportation, smart homes
<a href="#">6GWS-250083</a>	Overall vision & priorities for 6G	Ericsson	Massive Digital Twin

TABLE 2 31% mention Topic 5: "Digital Twin" for 6G as replicas of network environments. Nokia uses "Network Digital Twin Cloud-edge orchestration" to model network dynamics, while LG Electronics Inc. uses "ISAC-assisted Digital Twin" and "Digital Twin RF sensing on Real Twin" to sense and model real environments. VIavi uses digital twin (e.g., ray tracing) to mimic network behavior, T-Mobile uses digital twins for service experience, and AT&T plans "digital twins and virtual world" testing for operations. InterDigital uses "Enhanced UE context management" to boost user interactions, and Meta checks "context aware cross-layer design" to refine services. Ericsson coins "Massive Digital Twin", and Bosch and Siemens add a business focus to optimize network performance.

TDoc	Title	Source	14. THz and Sub-/6 GHz Spectrum Innovations
<a href="#">6GWS-250019</a>	AT&T views on 6G studies in SA and CT WGs	AT&T	Utilizes THz spectrum, ultra-wide bandwidths
<a href="#">6GWS-250227</a>	CBN's View for Broadcast on 6G RAN	CBN, China Broadnet	more frequency bands
<a href="#">6GWS-250083</a>	Overall vision & priorities for 6G	Ericsson	Sub-Terahertz (90...300 GHz)

TABLE 3 44% of contributions mention Topic 14: "THz and Sub-/6 GHz Spectrum Innovations." ZTE and Sanechips propose to "fully utilize new spectrum without the limitation of backward compatibility" and "support new spectrum in mid-band (U6GHz~7GHz)," suggesting a focus on flexible mid-band use for future 6G. Deutsche Telekom suggests achieving a "10% spectrum efficiency gain" to boost high-frequency performance, and T-Mobile USA proposes "Dynamic Spectrum Sharing in 7GHz." AT&T mentions plans to "utilize THz spectrum, ultra-wide bandwidths," while KT Corp proposes "Multi-Radio Spectrum Sharing." LG Uplus and the Indian Institute of Tech (IIT) propose support for the "6.425-7.125 GHz frequency range." Vestel proposes "THz-band monostatic sensing," InterDigital suggests leveraging "Sub-THz FR3 (6G)," and Sony proposes "new spectrum by enabling FR3 (especially in 7-15GHz)." Ericsson expands the horizon with "Sub-Terahertz (90...300 GHz)" though this remains distant from current spectrum use. These proposals reflect the ambitious expectations to secure and optimize spectrum across various bands for 6G connectivity.

TDoc	Title	Source	24. Seamless 5G-6G Interoperability
<a href="#">6GWS-250039</a>	SoftBank's vision & priorities for 6G core network	SoftBank Corp.	interworking and service continuity with 5G and also with 4G
<a href="#">6GWS-250110</a>	Apple's Vision and Priorities for Next Generation Wireless Communication	Apple Inc	interworking and migration between 5G and 6G

TABLE 4 68% of contributions mention Topic 24: "Seamless 5G-6G Interoperability," yet companies propose diverse focuses based on their priorities and infrastructures. Nokia emphasizes "seamless interworking with 5G" by leveraging its robust macro cell network to ensure a smooth transition. T-Mobile proposes comprehensive interoperability frameworks that enable efficient migration and support emerging 6G services. AT&T and Huawei advocate for integrated, AI-driven core network to reduce complexity. ZTE and Sanechips propose ensuring "comparable coverage and service continuity with a fast fallback from 6G to 5G" if necessary, while SoftBank stresses 6G interworking across 5G and even 4G. Thales suggests a 6G RAT on satellite networks that supports existing 5G RAT for migration purposes. These varied proposals stem from differences in strategic interests, regulatory environments, and the need to balance innovation with reliable legacy support.