6G

WBA Vision Statement

Source: Wireless Broadband Alliance
Authors: WBA
Issue Date: January 2025
Version: 1.0.0
Status: Industry Release

For other publications, visit our website here
To participate in further projects, contact pmo@wballiance.com

About the Wireless Broadband Alliance

Wireless Broadband Alliance (WBA) is the global organization that connects people with the latest Wi-Fi initiatives. Founded in 2003, the vision of the WBA is to drive seamless, interoperable service experiences via Wi-Fi within the global wireless ecosystem. WBA's mission is to enable collaboration between service providers, technology companies, cities, regulators and organizations to achieve that vision.

WBA undertakes programs and activities to address business and technical challenges, while exploring opportunities for its member companies. These initiatives encompass standards development, industry guidelines, trials, certification, and advocacy. Its key programs include NextGen Wi-Fi, OpenRoaming, 5G, IoT, Smart Cities, Testing & Interoperability and Policy & Regulatory Affairs, with Member-led Work Groups dedicated to resolving standards and technical issues to promote end-to-end services and accelerate business opportunities.

Membership in the WBA includes major operators, service providers, enterprises, hardware and software vendors, and other prominent companies that support the ecosystems from around the world. The WBA Board comprises influential organizations such as Airties, AT&T, Boingo Wireless, Boldyn Networks Broadcom, BT, Charter Communications, Cisco Systems, Comcast, HFCL, Intel, Reliance Jio, Telecom Deutschland and Turk Telekom.

For the complete list of current WBA members, click here.

Follow Wireless Broadband Alliance:

www.twitter.com/wballiance

www.facebook.com/WirelessBroadbandAlliance

www.linkedin.com/company/2919934/

Undertakings and Limitation of Liability

This Document and all the information contained in this Document is provided on an 'as is' basis without warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of merchantability, fitness for particular purpose, or non-infringement.

In addition, the WBA (and all other organizations who may have contributed to this document) makes no representations or warranties about the accuracy, completeness, or suitability for any purpose of the information. The information may contain technical inaccuracies or typographical errors. All liabilities of the WBA (and all other organizations who may have contributed to this document) howsoever arising for any such inaccuracies, errors, incompleteness, suitability, merchantability, fitness, and non-infringement are expressly excluded to the fullest extent permitted by law. None of the contributors make any representation or offer to license any of their intellectual property rights to the other, or to any third party. Nothing in this information or communication shall be relied on by any recipient.

The WBA also disclaims any responsibility for identifying the existence of or for evaluating the applicability of any claimed copyrights, patents, patent applications, or other intellectual property rights, and will take no position on the validity or scope of any such rights. The WBA takes no position regarding the validity or scope of any intellectual property or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any effort to identify any such rights.

Neither the WBA nor any of the other organizations who may have contributed to this document will be liable for loss or damage arising out of or in connection with the use of this information. This is a comprehensive limitation of liability that applies to all damages of any kind, including (without limitation) compensatory, direct, indirect, or consequential damages, loss of data, income or profit, loss of or damage to property and claims of third parties.

Table of Contents

Executive Summary 5

1. Wireless Convergence State-of-the-art 6

2. Industry Needs 7

2.1 Pressing Customer and Industry Requirements 7

2.2 Commercial Model 8

3. Analysis of Multi-Access & Agnostic Services 9

3.1 Technical considerations 9

3.2 Ubiquitous Connectivity as the Optimal End-to-End Solution 10

4. Industry Recommendations 12

4.1 Actionable Next Steps 13

Executive Summary

The Wireless Broadband Alliance (WBA) envisions a transformative role for 6G, with ubiquitous connectivity comprising Wi-Fi, cellular, non-terrestrial networks, IoT LPWANs, and other wireless technologies at its core. This positions 6G as a critical enabler of seamless connectivity, addressing real-world challenges and aligning with practical, high-impact use cases. To build on these premises, WBA vision key points are:

1. Ubiquitous connectivity for all: Advocate for a wireless ecosystem where wireless networks collaborate rather than compete. This environment ensures uninterrupted experiences for users, regardless of environment, urban, rural or indoors.
2. Practical solutions for industry challenges: 6G should prioritize resolving industry pain points such as fragmented user experiences, costly network implementations, and inconsistent coverage. Realistic, scalable models that leverage Wi-Fi and cellular, and other wireless technologies, to address these issues effectively.
3. Cost and operational efficiency: Operators must balance increasing data demands with operational/energy efficiency to ensure sustainability. Wi-Fi's cost-effectiveness can complement 6G to reduce CAPEX and operational costs.
4. Targeted applications for impact: Unlike 5G's broad focus, 6G should concentrate on practical verticals like healthcare, smart cities, and industrial automation. These areas benefit most from reliable, low-latency, and seamless connectivity.
5. Global collaboration and standardization: Importance of industry-wide collaboration, aligning Wi-Fi, cellular, among other technologies advancements through standards bodies like 3GPP, IEEE and IETF to avoid fragmentation and ensure interoperability.

Being a leading organization advocating for convergence over the years, the WBA has built a solid foundation. The actionable steps it seeks to promote for broad industry alignment are:

- Advocate for simplified, cross-network policies that focus on user experience.
- Develop frameworks for seamless identity management and access steering.
- Promote affordable and scalable solutions like OpenRoaming and neutral host models for network densification.
- Leverage AI to optimize network selection and reduce operational overhead.
- Establish innovation labs for real-world testing and vendor collaboration.

By centering its vision on densification, efficiency, and collaboration, the WBA aims to make 6G not just a technological leap but a practical solution for global connectivity challenges. This approach ensures that the 6G opportunity resonates beyond the technical community, appealing to policymakers, businesses, and end-users alike.

1. Wireless Convergence State-of-the-art

Wi-Fi and Cellular are the two most adopted wireless broadband technologies in the world, available in billions of devices and used daily by billions of users all around the world. Both technologies historically have been evolving, from the standards point of view, in independent paths, resulting in separate technical standards, architectures, and industry ecosystems. While the cellular standards organizations have made efforts to integrate these systems, and positive progress has been made, with converged solutions, like Wi-Fi Calling or SIM-based Wi-Fi authentication delivering great customer benefits, real-world adoption and implementation have lagged due to various factors. Several challenges have been identified:

- Harmonizing user experience across the value chain: The fragmented user experience, especially across different environments (home, office, public spaces), highlights the need for more effective convergence technologies. A seamless, cross-network experience is still difficult to achieve in part because of the gaps in integration between Wi-Fi and cellular ecosystems.
- Standards implementation and complexity: The complexity of existing 3GPP standards, such as non-3GPP access methods (notable specifications include ANDSF, URSP, ANDSP, N3IWF, ATSSS, and others[1]), has significantly increased the cost of network development and made assumptions on device compatibility. Vendors and operators face substantial challenges when working with these standards, which often require specialized equipment and expertise. This, in turn, drives up implementation costs across the board, leading to slower adoption and higher capital expenditure (CAPEX) for operators and market fragmentation.
- Cost drivers: Key contributors to rising costs include the requirement for an overlay of tunnel encapsulation and encryption, especially in scenarios where multi-connectivity approaches (Wi-Fi, cellular, IoT) need to operate seamlessly. For example, the complexity of handling policy steering between non-3GPP access and cellular networks under frameworks like new interfaces (N3IWF) significantly increases both development and maintenance costs for operators.
- Key learnings from cellular generations: Lessons learned from 4G/LTE and 5G deployments reveal that without full operator and device ecosystem buy-in, solutions for seamless connectivity fail to gain traction, prime examples are ANDSF or ATSSS. A reflection of this observation is the limited industry go-to-market initiatives, constrained by the lack of available equipment.

As operators and the industry approach 6G, there must be a clearer, more realistic perspective on the use cases that "6G cellular" can effectively enable. And what other technologies, such as Wi-Fi should deliver to 6G to increase the chances of success for those use cases. Wi-Fi will continue to play a critical

[1] 3GPP Standards: Access Network Discovery and Selection Function; User Equipment Route Selection Policy; Access Network Discovery and Selection Policy; Non-3GPP InterWorking Function; Access Traffic Steering, Switching, and Splitting

role in supporting certain use cases, such as XR/AR/VR and automotive, which remains underdeveloped within 5G due to limited demand and infrastructure challenges.

The layered complexity of the network, combined with the numerous network elements and interworking processes involved, has led to a substantial rise in operational expenses (OPEX) for network operators. This issue is further exacerbated by the duplication of certain functions across the architecture, which adds an additional layer of complexity that warrants reassessment. For instance, the advanced tunneling and multi-access solutions in ATSSS require considerable computational resources, and these costs are magnified when scaling up for widespread deployment, where latest data research from OpenSignal[2] on data consumption of smartphones in the US shows that 89% of all data is consumed over Wi-Fi. Further, ITU data[3] shows that fixed broadband accounts for 83% of all traffic

On the other hand, simpler technologies like Wi-Fi calling and SIM-based authentication with 802.1X have achieved significant market scale, driven by their lower complexity and costs, along with substantial improvements in user experience. These technologies provide a potential pathway for how more seamless 6G solutions might evolve with reduced technical overhead.

2. Industry Needs

2.1 Pressing Customer and Industry Requirements

Today's mobile users, both consumers and enterprises, demand a seamless experience across cellular and Wi-Fi. The lack of convergence often creates fragmented user experiences, with customers encountering different connectivity issues in various contexts (e.g., rural vs. urban, indoor vs. outdoor).

- Verticals: Industries such as healthcare, manufacturing, and transportation rely on mission-critical communication, particularly in private network deployments. Seamless handovers between public and private networks, as well as between indoor and outdoor coverage areas, are essential. Convergence wireless technologies can help provide smooth transitions across multiple access points. Examples include industrial settings that aim to provide enhanced indoor and outdoor sensor networks, as well as localized control for mobility and mission-critical applications.
- Complementing coverage and capacity: Leveraging Wi-Fi, NTN, and other wireless technologies in 6G and moving beyond 'non-3GPP access' technology offers significant benefits in bridging coverage gaps. There is an industry-wide need to prioritize better indoor and rural coverage. These areas pose unique challenges in terms of network performance and reliability. Converging Wi-Fi and 6G technologies provides an efficient solution to these coverage issues. These

[2] OpenSignal: https://www.opensignal.com/2024/10/31/wi-fi-drives-smartphone-data-consumption-in-the-us-but-trends-vary-across-operators
[3] ITU: https://www.itu.int/itu-d/reports/statistics/wp-content/uploads/sites/5/2023/11/Measuring-digital-development-Facts-and-figures-2023-E.pdf

synergies ensure affordable and consistent connectivity where traditional infrastructure is either too expensive or unreliable. Seamless transitions between Wi-Fi and cellular networks become crucial in these scenarios, allowing different network types to operate in harmony to meet demand.

- Spectrum considerations: Effective 6G deployment must account for spectrum availability. The convergence of wireless technologies will need to leverage both unlicensed, licensed and shared spectrum, to provide optimal coverage.
- Calling (Back-up solutions): In emergency scenarios, seamless handovers between Wi-Fi, Satellite and cellular networks are critical. Whether in rural areas or urban environments, users require uninterrupted call continuity, especially in critical situations where public safety depends on reliable connectivity.
- Data patterns and usage trends: Modern data consumption is primarily driven by video streaming and video calling, the majority of network traffic will continue to come from video services requiring high bandwidth and low latency. This highlights the need for cost-effective network densification and more energy-efficient technologies to manage the increasing data traffic load.
- Cost and energy efficiency: As data consumption grows, operators must focus on deploying networks that can manage both data growth and energy consumption in the most efficient way possible. Achieving this balance will be crucial for maintaining long-term profitability while meeting industry-wide sustainability goals. Instead of losing 99% of radio energy trying to serve indoor traffic from outdoor systems, 6G must recognize the efficiency benefits of serving indoor traffic from indoor radio systems, where Wi-Fi already dominates.

2.2 Commercial Model

To avoid repeating the shortcomings seen with 5G, 6G must adopt a more realistic perspective on use cases along with the ability for incremental 6G adoption. Pragmatic, high-impact areas such as healthcare, smart cities, and industrial automation could benefit significantly from the integration of Wi-Fi and cellular technologies, delivering immediate value through reliable, low-latency communications while achieving greater reliability, availability, and a seamless user experience.

- Complementary network solutions for coverage: A key lesson from 5G is that monetization models must factor in real-world coverage needs. The synergies between Wi-Fi, cellular-based mobile broadband, satellite and FWA will be particularly relevant for rural areas where traditional infrastructure investments may not make financial sense. Complementary solutions that bridge urban and rural areas will be crucial in reducing infrastructure costs and expanding coverage.

- Monetization and Return on Investment (RoI): Another key lesson from 5G is the challenge of monetization. Operators invested heavily in 5G but have often struggled to achieve a quick return on investment. There are examples of regions that after a decade still lack deployment of

5G and a clear RoI. As 6G planning progresses, it will be crucial to develop clear, sustainable monetization models from the outset. Operators must focus on consumer applications, particularly in video streaming and calling (the current major drivers of data growth), while integrating IoT solutions that create value for industrial verticals.

- Effectively address IoT: IoT is expected to play a key role in enabling new 6G use cases, particularly in sectors where seamless device connectivity and automation are critical. By leveraging ubiquitous connectivity for IoT device communication, industries can enhance performance in areas such as industrial automation (e.g. autonomous ground vehicles), smart cities (moving assets), and logistics (ports). This approach allows IoT devices to utilize the most appropriate network, Wi-Fi for localized, cost-efficient connectivity and 6G for wide-area. This may reduce operational costs, providing industries with a compelling return on investment.

Some early 5G rollouts did not realize the expected financial returns, and many are still waiting for RoI[4]. As 6G planning progresses, operators need to make financially sound choices that deliver clear returns. Historically, cellular infrastructure upgrades and capacity expansions are costly. In fact, every form of capacity expansion requires CAPEX investment. Operators are keen to evolve the way 6G gets deployed through software based features[5], but such aspirations are limited to 6G operation in existing spectrum, so leveraging cost-effective solutions like Wi-Fi offload as a supplement can help reduce overall expenditures, especially for converged deployments.

Reducing the RoI timeframe should be a priority, with a focus on use cases that drive user engagement and adoption rather than speculative or niche technologies. Properly managing the cost of deployment through optimized spectrum use, energy efficiency, and converged network solutions will be essential for long-term financial viability.

3. Analysis of Multi-Access & Agnostic Services

3.1 Technical considerations

The industry must evaluate which technical approaches best align with industry needs, including seamless access network selection, AI-driven traffic steering, and cross-network policy coordination. Several factors need to be prioritized for industry resolution:

- Challenges in implementing multi-access solutions: Despite technological advancements, the complexity and cost associated with tunneling, splitting, and steering between Wi-Fi and cellular networks have hindered widespread adoption. The business and technical barriers preventing

[4] ABI Research: https://www.prnewswire.co.uk/news-releases/feeble-roi-in-5g-network-security-market-feeling-sting-of-global-economic-slowdown-302282742.html
[5] NGMN 6G Position Statement: https://www.ngmn.org/wp-content/uploads/NGMN_6G_Position_Statement.pdf

agnostic, multi-access implementations remain significant. Effective solutions will need to ensure device ecosystem support, cost efficiency and lower energy consumption while delivering seamless experience to the end user. This is particularly important for handling scenarios such as voice traffic prioritization and Quality of Service (QoS) under different network conditions, where Wi-Fi and cellular handoffs must be efficient and reliable.

- Private networks and vertical integration: Private networks represent both a challenge and an opportunity for multi-access services. The demand for seamless connectivity between public and private environments, as well as between indoor and outdoor spaces, drives the need for better convergence technologies. However, the point to clarify here is that the industry requires alignment on cross-network policy, QoS integration, and device interoperability, not just specific to private networks but across all markets to ensure large-scale, cost-efficient production. Wi-Fi remains the most agnostic private network technology available, balancing the use of licensed and unlicensed spectrum, but the industry must address the handoff and connectivity challenges faced in real-world environments, particularly in cases like edge of cell operations and areas where quality of experience and service continuity (e.g. for real time communications) must remain consistent.

- Network architecture flexibility: Drawing lessons from Wi-Fi, where over 80% of traffic bypasses centralized gateways for direct Internet routing, 6G could adopt localized functions on its architecture and deployment to better align with Wi-Fi and enterprise networking. As an example, shifting from default tunneling with local exceptions to local routing with tunneling by exception could further support ITU M.2160's vision for seamless deep indoor coverage and ubiquitous connectivity, where Wi-Fi already excels in managing indoor traffic.

- Network equipment availability and vendor roadmap: The deployment of 6G networks depends heavily on the availability of network equipment aligned with vendor roadmaps. Faster proof-of-concept trials and go-to-market strategies require leveraging readily available, scalable, and cost-efficient multi-access solutions to meet growing demand. A key challenge lies in ensuring the production and affordability of such equipment, which will directly influence the pace and efficiency of 6G rollouts.

- Device readiness: In addition to network equipment, user devices (UEs) must also support the necessary capabilities for convergence. The development and widespread adoption of devices that can seamlessly integrate Wi-Fi and cellular connectivity will be critical in achieving the full potential of 6G in multi-access use cases.

3.2 Ubiquitous Connectivity as the Optimal End-to-End Solution

Converged services spanning cellular, Wi-Fi, non-terrestrial networks (NTN), and IoT LPWANs are essential to deliver a seamless experience. Ubiquitous connectivity allows for dynamic access selection and traffic routing across diverse networks.

The industry must evaluate which technical approaches best align with industry needs, including seamless access control, AI-driven network steering, and cross-network policy coordination. Several factors need to be prioritized for industry resolution.

Emerging use cases for convergence will enable Operators and vendors to align on new business models to enable access technology-agnostic services. Federated models for policy control, AI-driven network management, and shared infrastructure (e.g., neutral hosts, OpenRoaming) could facilitate adoption.

- Vertical industry demands: Vertical industries are increasingly seeking outcome-based solutions to achieve their business objectives. These solutions often demand consistent service quality and user experience across diverse access technologies and environments, including indoor, outdoor, rural, and other settings. The challenges of managing multiple access technologies become evident in edge cases, such as voice quality issues in parking lots or deep indoor locations, where network transitions can disrupt service. By enabling seamless integration and consistent performance across networks, convergence addresses these challenges. It helps prioritize critical services, such as voice, and minimizes the impact of network transitions, thereby enhancing the overall user experience.

- Edge computing: Globally, the anticipated growth in computing demands positions edge-targeted architectures as a pivotal component of 6G convergence, particularly in environments that support advanced use cases. By deploying computational resources closer to where data is generated, such as at the edge of the network, it can significantly reduce latency. Wi-Fi edge computing, in particular, can complement 6G's high-speed, low-latency connectivity by providing localized data processing, which enhances network performance and user experience. The combination of Wi-Fi edge computing and 6G will offer operators a more efficient, responsive, and scalable network environment.

- New use cases for convergence: The convergence of network access is not merely a technology goal but a practical necessity driven by emerging use cases requiring access via multiple network technologies. These include smart city infrastructure, industrial IoT, and advanced healthcare. For example, applications like autonomous vehicles require seamless access across Wi-Fi, 6G, and NTN for remote control or emergency communications. Mission-critical services during disaster recovery are also key. The adoption of access technology-agnostic solutions, such as OpenRoaming, allows devices to seamlessly select and authenticate between networks operated by different providers. This approach will accelerate adoption and enhance service delivery across industries.

Conceptually, seamless application experiences thrive on inter-network harmony, where internet technologies collaborate effectively without requiring full convergence. WBA's ability to fast-track technologies positions it to champion the introduction of a cross-network policy approach, leveraging IP signaling to enhance application experiences across cellular and Wi-Fi networks, and paving the way for user experience convergence.

4. Industry Recommendations

Better collaboration between cellular, Wi-Fi and other wireless technologies stakeholders, including operators, vendors, and vertical industry players, is crucial for the success of 6G. The Wi-Fi and cellular industry may come together to agree on unique position that foster this collaboration, particularly in alignment with 3GPP, IEEE, IETF and other standards bodies. Addressing fragmentation in the ecosystem should be a key priority to ensure successful outcomes:

- Balance between service requirements and technology-driven solutions: A key consideration is whether operators or vendors should lead convergence efforts. While equipment manufacturers, both cellular and Wi-Fi vendors, drive many innovations in their respective technologies, operators may be better positioned to take a holistic, technology-agnostic view of customer needs and their own challenges. Operators can bring balance to the ecosystem by ensuring that solutions are designed with customer challenges and real-world use cases in mind, avoiding a technology-driven approach that may overlook cross-network requirements. The ecosystem needs a balanced approach where operators lead in defining end-user requirements while vendors contribute with specialized technology.

- Strategic role of the Wi-Fi in 6G development: Industry alignment will be critical in the 6G standards process by ensuring that convergence, particularly involving relevant access technologies like Wi-Fi, plays a key role in how 6G meets customer needs. This includes promoting multi-stakeholder engagement to align technical specifications with real-world user needs and ensuring that 6G development focuses on interoperability between access technologies.

- Supporting innovation labs for 6G: Industry should support the creation of an "Innovation Lab" for 6G convergence to foster real-world convergence use cases and support vendor Proof of Concept (PoC) and prototype development. The objective of these labs would be to validate vendor innovations and produce viable industry solutions that address fragmentation, benefiting both operators and end customers. These efforts will ensure vendors across Wi-Fi, cellular, NTN, and other wireless networks can prototype solutions that work seamlessly together.

The roadmap to a seamless, always-best-connected experience lies in fostering collaboration across the wireless ecosystem. The WBA, by engaging stakeholders and pushing for standards that prioritize ubiquitous connectivity, is uniquely positioned to help drive forward the next generation of wireless networks ensuring that 6G standards are successful.

4.1 Actionable Next Steps

Actionable steps for the industry should prioritize:

1. Establishing a scalable framework: A scalable approach to identity management and policy control would streamline convergence and enable cross-network service delivery. The industry should work to enable a framework that would help operators manage multiple access technologies, ensuring smooth transitions between networks while maintaining policy consistency. It would also help integrate QoS prioritization, security, and service levels across technologies.

2. Ensuring consistent service levels: Ensuring consistent service levels across networks, including security, emergency access, and quality of experience (QoE), will be vital. The WBA should work with standards bodies to ensure that service continuity, particularly in emergency situations, is a central focus of 6G deployments. QoS and emergency services must address the application experience, which allows integration across Wi-Fi, cellular, and other access technologies to maintain high performance in critical scenarios.

3. Attaining cost-effective densification: The industry should work to make available a global testbed for the industry, focusing on leveraging OpenRoaming standards and neutral host models to enable dense network deployments at a lower cost. The testbed would allow industry players to collaborate on solutions for both 1) indoor scenarios where handovers and critical and 2) urban densification and cost-effective coverage in high-traffic areas.

4. Harnessing AI and shared data for access steering: The industry should explore the use of AI and shared data to optimize access steering and network selection across Wi-Fi, cellular, and other networks. A fundamental aspect to unlock is a data model comprising handset and platform provider for optimal training of the models. AI-driven network management can help operators dynamically allocate resources to improve user experience and reduce operational costs.

5. Driving location and sensing innovation: The industry should leverage current learnings to help with the development of location and sensing applications by using (anonymous) aggregated data from various access technologies. This would improve services such as indoor positioning, asset tracking, and environmental monitoring, leveraging both Wi-Fi and 6G capabilities. Whilst preserving privacy as a foundational element.

The WBA's work on 6G will continue through 2025, with the goal of releasing a proposed framework that drives alignment in key areas and enables end-to-end interoperability trials. This framework will aim to facilitate seamless integration across different networks and stakeholders, ensuring that 6G solutions are ready for real-world deployment.

For more information and learn how to engage: contactus@wballiance.com

Participant List

Company
AT&T
AirTies
Boingo Wireless
Boldyn Networks
Broadcom
BT
Charter
Cisco
Comcast
HFCL
Intel
Reliance Jio
Telekom Deutschland
Turk Telekom