Agenda
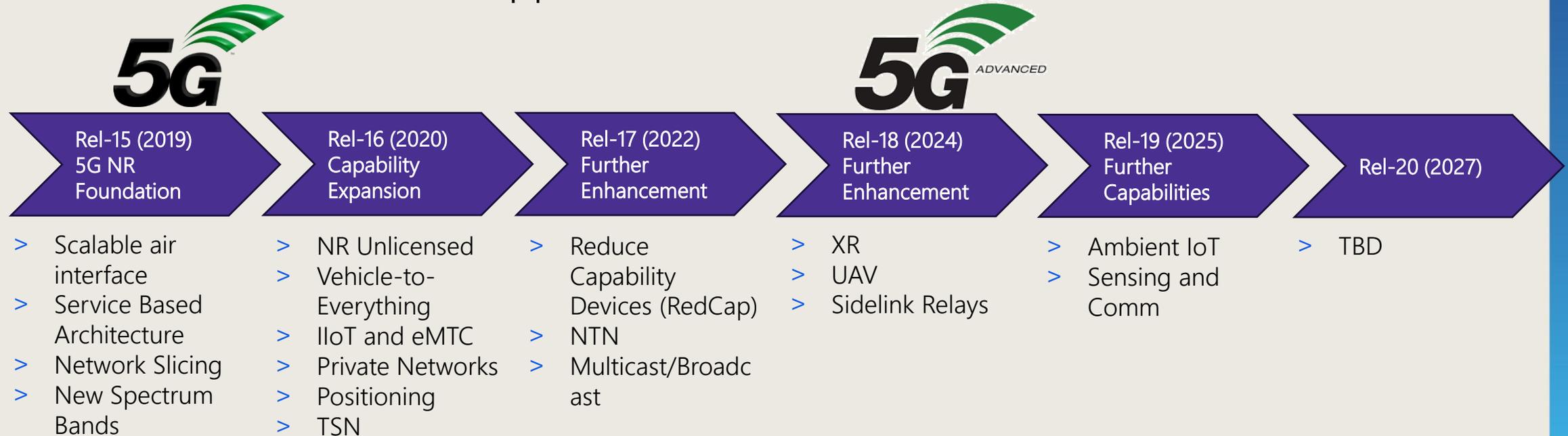
☐ Views on Mobile Support for Vertical Industries

☐ Efforts on Verticals (Whitepaper, Workshop)

☐ Summary of Vertical Workshops held in Feb 2025

☐ Strategic Initiatives within NGA

5G Support of Vertical Industries

- ❑ One of 5G goals is to bring faster and more responsive communication services to enterprise/verticals markets, offering
  - ❑ Differentiated and guaranteed capabilities: QoS, availability, cost, etc.
  - ❑ Seamless Connectivity: mobility with service continuity and ubiquitous coverage
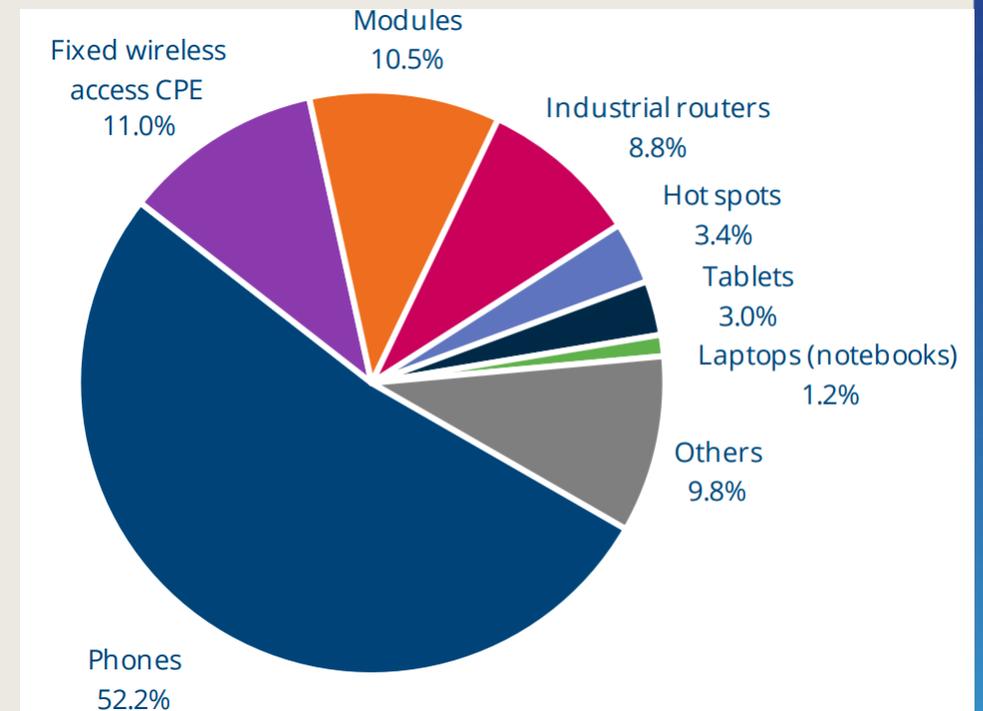- ❑ Continuous feature support for verticals across releases

Rel-15 (2019) 5G NR Foundation	Rel-16 (2020) Capability Expansion	Rel-17 (2022) Further Enhancement	Rel-18 (2024) Further Enhancement	Rel-19 (2025) Further Capabilities	Rel-20 (2027)
> Scalable air interface > Service Based Architecture > Network Slicing > New Spectrum Bands	> NR Unlicensed > Vehicle-to-Everything > IIoT and eMTC > Private Networks > Positioning > TSN	> Reduce Capability Devices (RedCap) > NTN > Multicast/Broadcast	> XR > UAV > Sidelink Relays	> Ambient IoT > Sensing and Comm	> TBD

Note: Dates are end dates that protocol is stable, see https://www.3gpp.org/specifications-technologies/releases

Challenges

- ❑ What is Lacking?
  - ❑ Devices, network solutions, and APIs that satisfy a broad range of vertical market needs
    - ❑ Cost/complexity improvement needed
    - ❑ Solutions have not reached the market base, despite already existing in standards
    - ❑ Consumer smartphone connectivity has historically been prioritized over other devices
  - ❑ Better mutual understanding of vertical and telco value chains
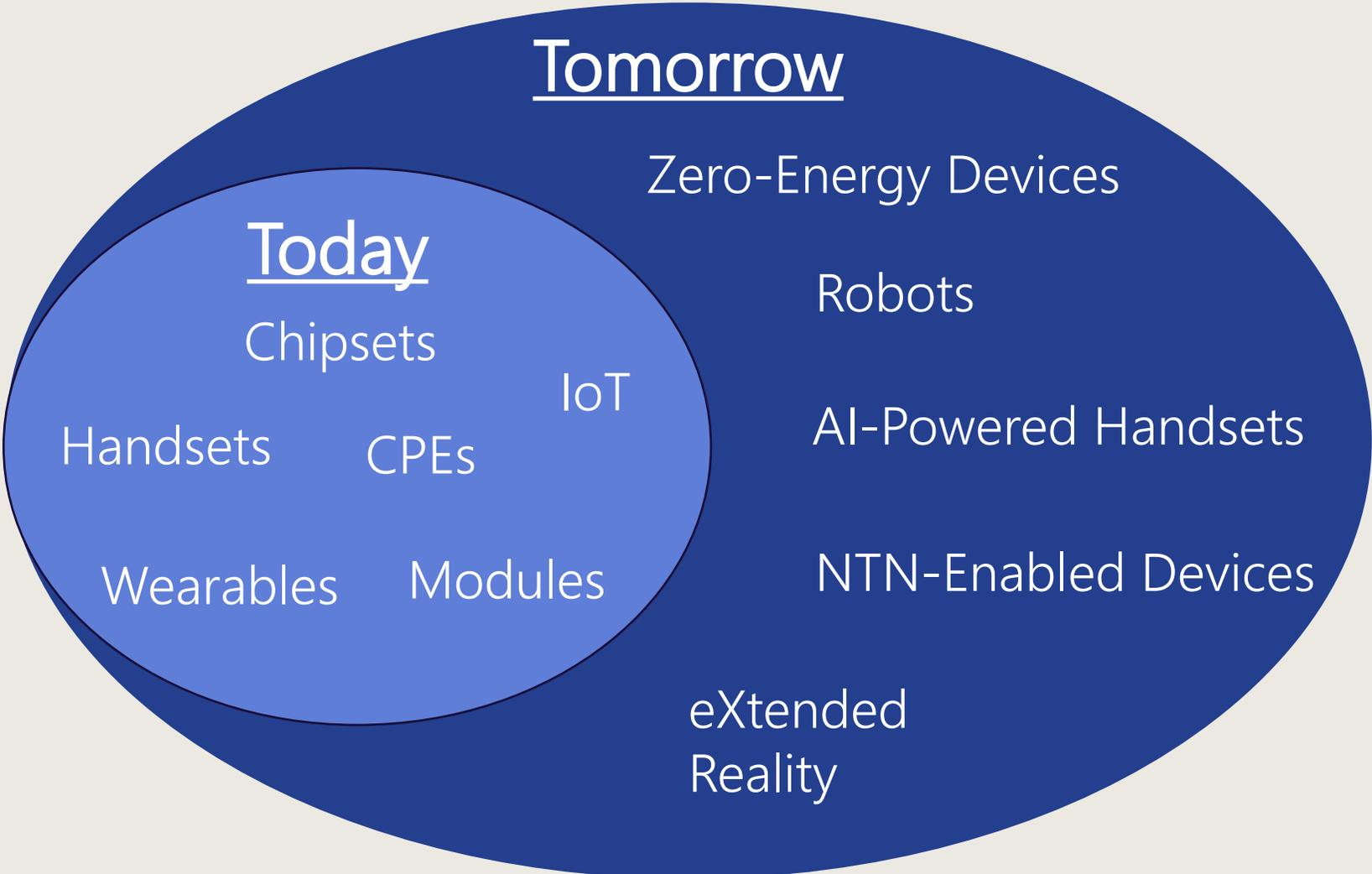   - ❑ Collaboration and division of responsibility between vendors, vertical players and CSPs
- ❑ Other Potential Barriers
  - ❑ Complexity
  - ❑ Coverage
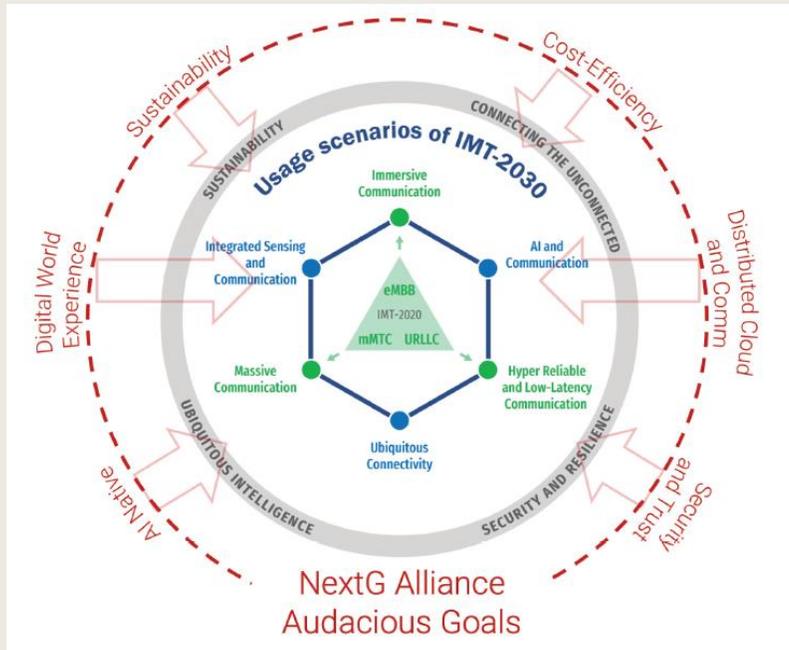 - ❑ Longevity of Devices
  - ❑ Time to Market
  - ❑ Business Case and Models

Pie chart with the following segments:
- Phones 52.2%
- Fixed wireless access CPE 11.0%
- Modules 10.5%
- Industrial routers 8.8%
- Hot spots 3.4%
- Tablets 3.0%
- Laptops (notebooks) 1.2%
- Others 9.8%

Source: GSA, "5G Market Snapshot", September 2024

Device Ecosystem Opportunity

North American Representative Use Cases

ITU-R IMT-2030 Usage Scenarios and Overarching Design Principles, and their alignment to NGA Audacious Goals

Representative Use Cases to Drive Priorities

Multi-Sensory XR

Fixed Wireless Access

ITS/Connected Vehicles

Smart Factory

Low Power Wide Area (LPWA)

Personalized User Experiences

Robots

Digital Twins

Short Range Massive Sensors (Ambient IoT)
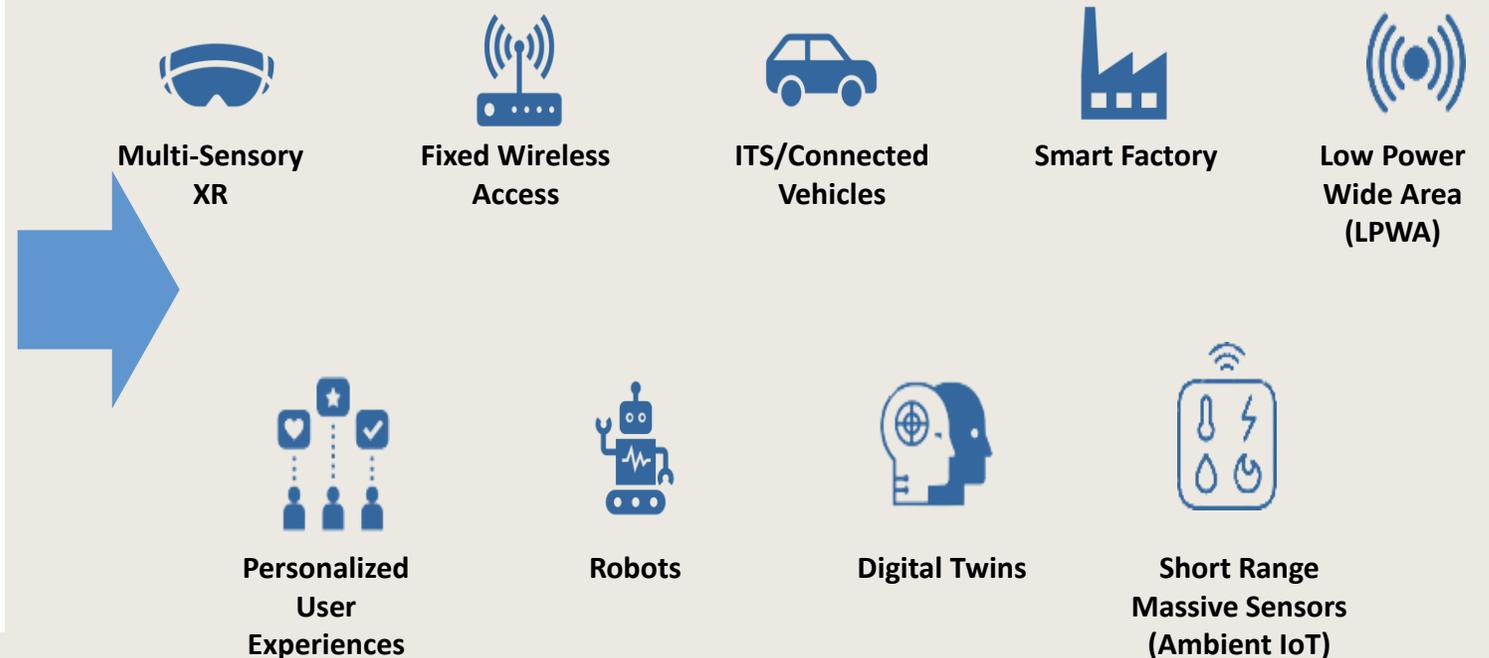
# 3GPP Workshops on 6G – Some Vertical Views

Vertical Org	Use Cases	Requirements / Capabilities
5GAA - Auto	Real-time situational awareness monitoring (e.g. 360 deg) Intelligent ADS Enhanced in-vehicle experience	Secure, reliable, resilient, low-latency, high-mobility, location accuracy Sustainability, dependable, and trusted TN & NTN, Sensing
5G-ACIA - Industrial	5G use cases are also applicable for 6G: Industry automation, Flex manufacturing, etc.	Dependable / Resilient, Maintainable, Sustainability, NPN, ISAC, Digital Twin, Native-AI
5G-MAG – Media	XR and Immersive Streaming and Content Production Content Delivery Media > 2D	Coverage, Latency, Data Rate, spectral efficiency, Area traffic capacity Security & Resiliency, Sustainability
GSOA – Satellites	Immersive / Ubiquitous: Direct conn. to UEs indoor/in car, eMBB to vehicles, UAV, trains, aircrafts JSAC, Wide area IOT, Content/Media distribution, Loc/Positioning	Data Rate, Positioning, Coverage, Reliability, Latency, Conn. Density
TCCA – Public Safety	"Trust" use cases: Guaranteed MC Services, Coverage (ultra-rural), Ad-Hoc NW, MC roaming Failure recovery, GNSS-resilience, EM threats, Quantum-safe	General (Trust) capabilities: Traffic Management NW Interop, Resilience, Robustness, Security

NOTE: This table is a summary of the contributions from vertical organizations (3GPP MRP) into the SA1 IMT-2030 WS and the TSG 6G WS

NGA's 6G Roadmap for Vertical Industries

May 2023

6G Roadmap for Vertical Industries
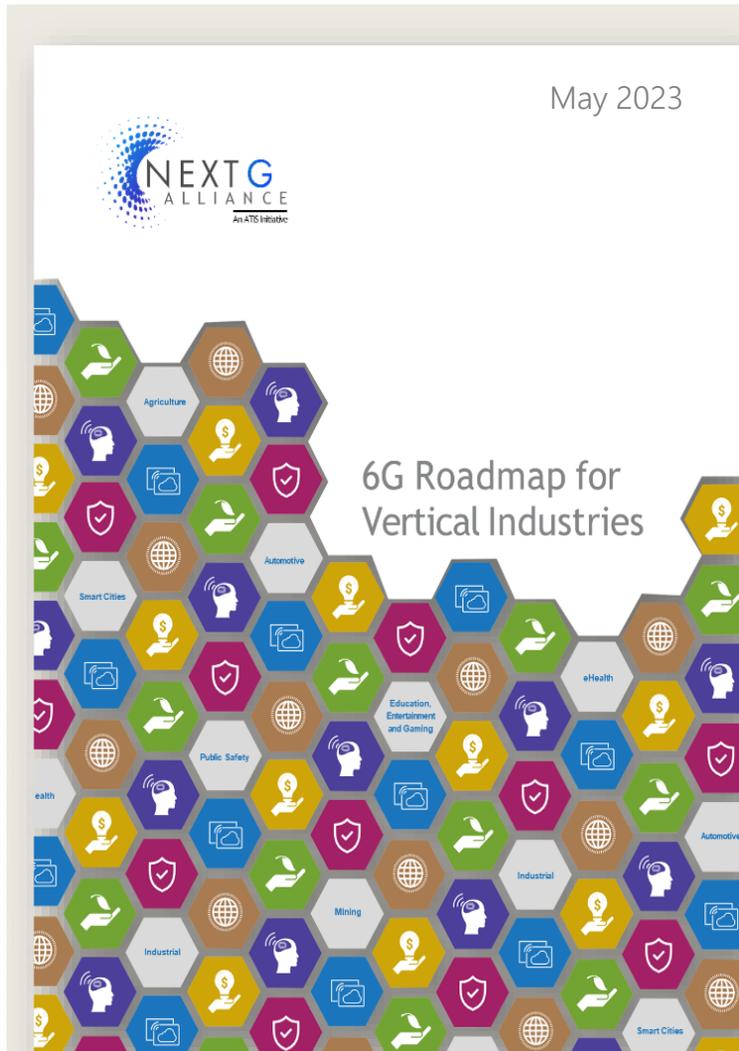
Agriculture

Automotive

Education, Gaming and Entertainment

eHealth

Industrial IoT
(included Utilities)

Mining

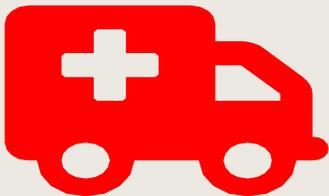Public Safety

Smart Cities
(included Utilities)

What we did:

- Research into vertical industry dynamics & societal needs
- Develop insights into industry needs and enabling application
- Characterize vertical industry needs as a basis for action

Survey Insights from Public Safety

- Applications
  - Next Gen mission critical communication
  - AR headsets and glasses
  - Networked robots and UAVs
  - Connected ambulances

- Key Technologies Needs
  - Coverage technologies for limitless connectivity all "geographies" – land, maritime, aerial, satellite
  - Ultra 3D positioning for indoor and outdoor
  - AR/XR and video feeds, capable for heads-up display
  - AL/ML based situational awareness for risk identification
  - Highly reliable and secure communications

Survey Insights from Agriculture

- ❑ Applications
  - ❑ High precision irrigation and fertilizer treatments
  - ❑ Massive sensing and remote actuation
  - ❑ Movement between farming and road infrastructure
  - ❑ Robotics

- ❑ Key Technologies Needs
  - ❑ Improved data collection and processing are critical (sensor connectivity, edge computing)
  - ❑ Combination of low latency and high reliability is critical for autonomous vehicles (e.g., tractors)
  - ❑ Connectivity for low energy sensors
  - ❑ Peer-to-peer communications
  - ❑ Scalable latency
  - ❑ Communications across mobile and NTN

Survey Insights from Utilities

Derived in part from applicable material from Industrial IoT section of Roadmap Report
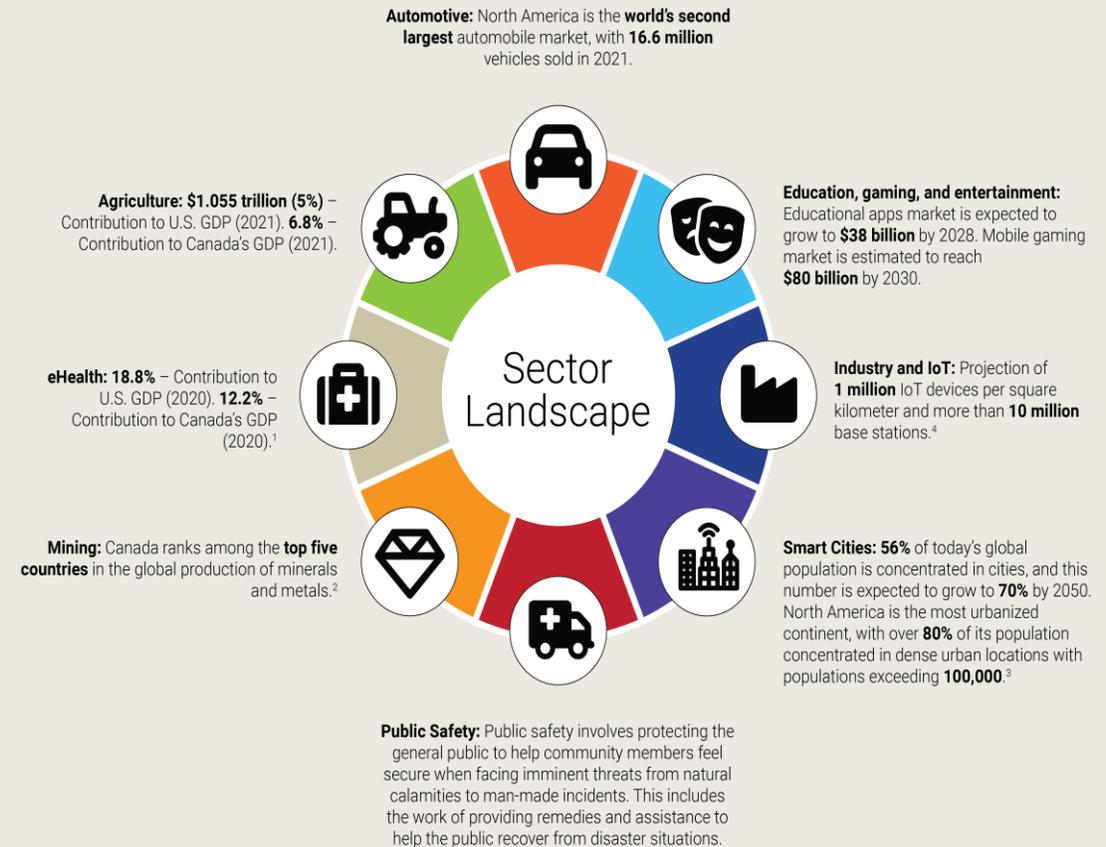
- ❑ Applications
  - ❑ Sensing and control of transmission and distribution
  - ❑ Consumption (Smart Meters, EV Charging)
  - ❑ Smart building & smart homes
  - ❑ Communication to technicians in field

- ❑ Key Technologies Needs
  - ❑ More granular sensing for smart building and cities to optimize use of resources
  - ❑ AI-Native network to improve deployment, management and operation of network and device functions
  - ❑ Distributed computing to move data processing across edge cloud and device edge
  - ❑ Private networks
  - ❑ Group communications (MCC)
  - ❑ Distributed cloud and virtualization

Key Findings

- Ecosystem readiness is as critical as technical standards – synchronizing development roadmap and understanding
- Vertical industries expressed two main needs: one related to connectivity and the second to technology to enable new services.
- The range and diversity of vertical industry interests span a mix of evolutionary and revolutionary capabilities

Automotive: North America is the **world's second largest** automobile market, with **16.6 million** vehicles sold in 2021.

Agriculture: $1.055 trillion (5%) – Contribution to U.S. GDP (2021). **6.8%** – Contribution to Canada's GDP (2021).

Education, gaming, and entertainment: Educational apps market is expected to grow to **$38 billion** by 2028. Mobile gaming market is estimated to reach **$80 billion** by 2030.

eHealth: 18.8% – Contribution to U.S. GDP (2020). **12.2%** – Contribution to Canada's GDP (2020).[1]

Industry and IoT: Projection of **1 million** IoT devices per square kilometer and more than **10 million** base stations.[4]

Mining: Canada ranks among the **top five countries** in the global production of minerals and metals.[2]

Smart Cities: 56% of today's global population is concentrated in cities, and this number is expected to grow to **70%** by 2050. North America is the most urbanized continent, with over **80%** of its population concentrated in dense urban locations with populations exceeding **100,000**.[3]

Public Safety: Public safety involves protecting the general public to help community members feel secure when facing imminent threats from natural calamities to man-made incidents. This includes the work of providing remedies and assistance to help the public recover from disaster situations.

Sector Landscape

NGA 6G Applications KPI Database

- A dynamic and evolving resource designed to support the global standards community in defining and refining key performance indicators (KPIs) for 6G networks

- 100+ Applications

- 20+ Application Groups

- 50+ KPIs
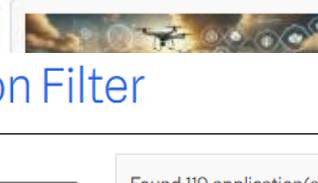https://6gkpi.atis.org/

Application Groups

Agriculture 4.0

Asset Management

Digital Twins

Distributed Sensing and Communications

Entertainment

Extended Reality (XR)

Fixed Wireless

Application Filter

Application Group:
- Select -

DL E2E Packet Latency:
- Select -

UL E2E Packet Latency:
- Select -

E2E Packet Jitter:
- Select -

DL User Experience Data Rate (Mbps):
- Select -

UL User Experience Data Rate (Mbps):
- Select -

Communication Service Availability:

Found 119 application(s)

Fixed Wireless Access (1)

Use Cases: FWA as a Service; Bridging the Digital Divide; Exploit Underused Spectrum; Smart Factory

Agriculture 4.0 (6)

Livestock Monitoring

Smart Irrigation

Smart Fertilization

Smart Pest Control and Early Disease Detection

Vertical Industries Workshop

- ❑ Details
  - ❑ F2F Event, February 25-26, Washington DC
  - ❑ Presentations: [NGA Verticals Workshop](#)
  - ❑ ~50 people (NGA + Verticals industries)
- ❑ Objectives
  - ❑ How to cooperate and create Value together
  - ❑ Understand specific needs of verticals and identify common requirements for telecom investment
  - ❑ Bring requirements and roadmap to NGA working groups and discussions to drive deeper support

Public Safety

Agriculture

Telecom Investment
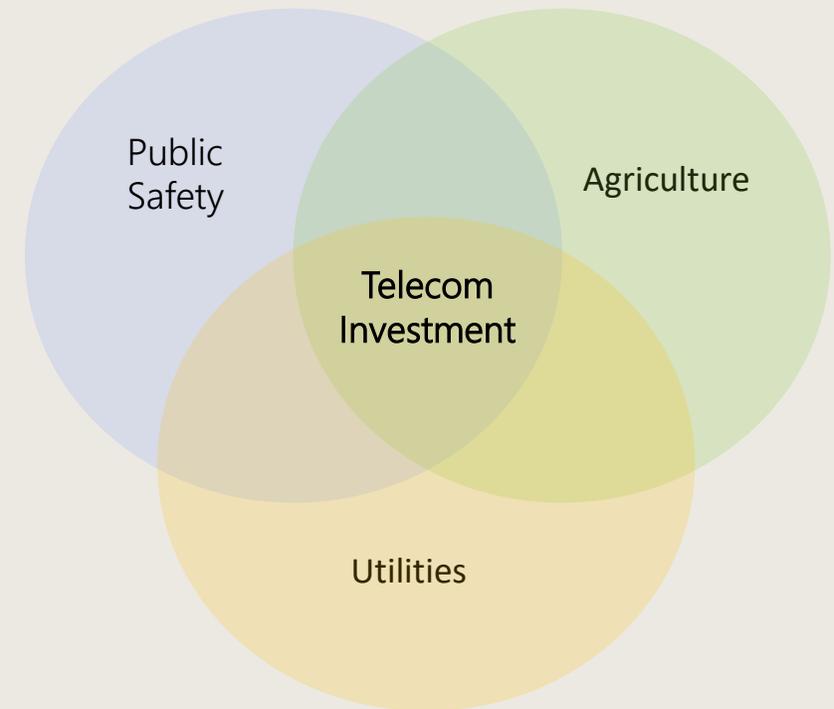
Utilities

Example Take-Aways

- Utilities
  - Uses cases: smart metering, protective relaying, and distributed automation
  - Advanced Metering Infrastructure (AMI) 2.0 capabilities
  - Investment is drive by regulators, not ARPU. Requirement to service last customer at the end of the line
- Agriculture
  - Use cases: Sensor Data and Autonomous Machinery
  - Challenges: Coverage, Cost and Complexity
- Public Safety
  - Key use cases are video calling w/ 911, in-vehicle connectivity, etc.
  - Challenges: Off-network connectivity (side-link), coverage, uplink speed
- Common Themes
  - Connectivity and Coverage not sufficient today
  - High device density needed for all three verticals (e.g., sensor networks)
  - Barriers to adoption: 3GPP Complexity, Expertise and Awareness is limited in verticals.
  - Specialized device for verticals is limited (e.g., ruggedness, ability to integrate with tractors, energy efficiency, etc.)

Activities in NextG Alliance

1 Whitepapers

6G Library – Next G Alliance

31 Whitepapers published

2 NGA's PPP Proposal/NSF

Recent meetings with leadership from NSF TIP (Technology Innovation and Partnerships) has invited the development of a partnership proposal. The proposal is under discussion.

3 NTIA / DoD

NTIA Administrator Alan Davidson announced a RFC on "Advancement of 6G Telecommunications Technology." NGA responded to this RFC .
NGA responded to DoD's ISAC "Dear Colleagues Letter"

4 New Reports and Initiatives

Initiative with NIST on JCAS and Communication channel studies at midband and mmWave band. Channels sounders provided by NIST, Keysight, Ericsson, NYU, Nokia, AT&T and Anritsu. 1st phase report published in July 2024 and 2nd phase report due on May 2025.
Initiative on "Gaps and Priorities" at NRWG identifying the applications, technology and spectrum for the first release of 6G. Published.
Cross WG effort on "JCAS Readiness" and "AI/ML Readiness". JCAS readiness report will be published in May 2025

5 Vertical Industries

Published Verticals WP in 2023
Vertical Workshop on 3 Verticals held in Feb 2025
Continuing our initiatives on 3 Verticals : Agriculture, Public Safety and Utilities

6 Global Collaboration

NGA influences ITU-R work on an ongoing basis through key contributions.
TTC EU-US position paper published, presented to USG WH and EU ministry.
Workshop held with Korea 6G Forum.
Remote workshop with Bharat 6G
 Workshop with Japan's XGMF.
 NGA expected to spear head US collaboration with all regional alliances
NGA invited for many national and global conferences and Workshops. NGA presented at SA1 Use case workshop in March 2024.

NEXT G ALLIANCE
An ATIS Initiative

Summary

❑ Recommended Use Case Priorities, Technologies and Research Actions are aligned to NGA Vision and North American Needs

❑ Identified and studied eight Verticals for 6G North American Needs

    ❑ Workshop held focusing on Agriculture, Public Safety and Utilities

❑ The success of 6G will require collaboration across governments, industries, and academia

    ❑ Collaboration with XGMF, Bharat 6G, Korea 6G Forum, 6G-IA

❑ Effort on JCAS Readiness, AI/ML Readiness and Vertical Industries underway

❑ NGA is key contributor towards IMT-2030

Survey Insights from Automotive

Alignment of Roadmaps across Automotive and 6G critical due to the long development cycles of each

> Applications
>> V2V and V2P safety improvement and awareness
>> Autonomous, coordinated and remote driving
>> Real-time 360° situational awareness

> Key Technologies Needs
>> Joint Communications and Sensing
>> Distributed Compute and Communications
>> Heterogeneous Networks (NTN, Mesh, etc.)

Survey Insights from Smart Cities

- > Applications
  - > Urbanization density and access to resources
  - > Zero energy IoT devices
  - > AI-driven data decision-making
  - > Government-provided playing fields for 6G innovation

- > Key Technologies Needs
  - > Sensing technologies utilizing ML to analyze and predict
  - > AI-driven decisions to allocate resources
  - > Resilient networks to assure privacy and security
  - > Massive connectivity of IoT devices

Survey Insights from eHealth

> Applications
>> Home-based patient care
>> Remote surgery and scanning
>> AI-enabled patient digital twin
>> Ambient assisted living

> Key Technologies Needs
>> In-facility and remote connectivity
>> 3D devices, systems and imaging
>> Cognitive systems supporting DWE
>> Trustworthy AI
>> Micro-networks surrounding patient

Survey Insights from Mining

> Applications
>> Extreme connectivity
>> Tele-operation for hazardous environments
>> Use of digital twin replicas
>> High precision accuracy and tracking

> Key Technologies Needs
>> Trusted connectivity
>> JCAS
>> Integrated AI
>> Distributed sensing and communications
>> Data-driven distributed intelligence
>> Energy efficiency and environmental sustainability technologies

Survey Insights from Education, Gaming, Entertainment

> Applications
> > Leveraging EGE innovation for education
> > Metaverse experiences
> > Immersive knowledge and learning
> > Hologram receivers

> Key Technologies Needs
> > Open standards and open source are critical to enable metaverse inter-operability
> > Distributed Compute and Communications is critical to offload processing from resource constrained HMDs
> > Testbeds are needed to enable interoperability of metaverse

Survey Insights from Industrial IoT

> Applications
> > Factories of the future
> > AI-managed automatic guided vehicles
> > Massive sensors to manage environment and resources

> Key Technologies Needs
> > Distributed cloud and virtualization
> > Flexible compute resources
> > Physical sensors updating digital twins, JCAS
> > Trustworthy networks and systems

3GPP WS on 6G – Inputs from Vertical Orgs

3GPP SA1 WS on IMT-2030 Use cases (May 2024)

> Inputs from Vertical Orgs (3GPP MRP):

SWS-240005	Automotive (5GAA)
SWS-240006	Industry (5G-ACIA)
SWS-240007	Multimedia (5GMAG)
SWS-240008	Satellite (GSOA)
SWS-240009	Public Safety (TCCA)
SWS-240010	Wireless Broadband (WBA)

> Informative 3GPP summary: SWS-240025

3GPP RAN/SA WS on 6G (March 2025)

> Inputs from Vertical Orgs:

6GWS-250142	5GAA input to 3GPP workshop on 6G
6GWS-250214	5G-ACIA Considerations on 6G
6GWS-250137	5G MAG: General views & priorities
6GWS-250164	GSOA: NTN and Satellite 5G Arch
6GWS-250155	TCCA 6G priorties
6GWS-250223	EUTC Considerations on 6G

> Informative 3GPP summary: 6GWS-250243

Note: the table above includes a sub-set of inputs related to verticals