



# RESOURCES

- I. American National Standards Institute: U.S. Standards System Overview
- II. Federal Communications Commission: Spectrum Management Overview
- III. Qualcomm: New Trends of IoT and Applications in Industry
- IV. GSA: Private Mobile Networks: Executive Summary
- V. Additional Resources from Partners

I.  
American National Standards Institute: U.S.  
Standards System Overview

# American National Standards Institute

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## United States Standards System

An Introduction



Last updated: 2021

# Key Terms



## ◆ Standards

- **Market-driven** product and service specifications (e.g., technical requirements, management systems, etc.)

## ◆ Regulations

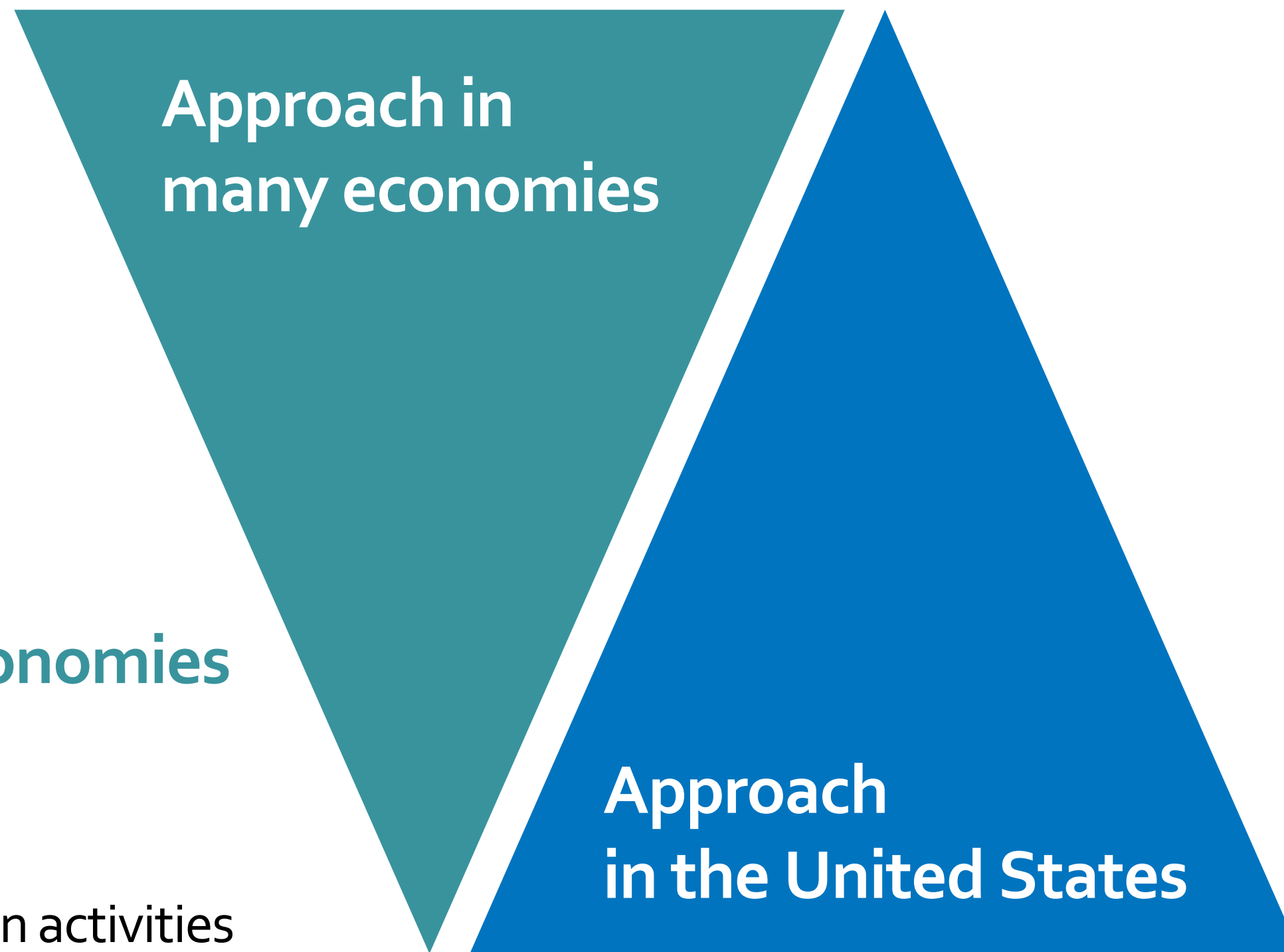
- **Mandatory** technical specifications, which may include particular standards or conformity assessment procedures

## ◆ Conformity Assessment

- **Processes and systems** used to verify the compliance of a product, person, process or system to either a standard or a regulation (e.g., testing, certification)

# U.S. Standardization System

comparison with many other economies



**Many other economies**  
*Top Down*

Standards bodies  
drive standardization activities

**United States**  
*Bottom Up*

Standards users drive  
standardization activities

# U.S. Standardization System

## comparison with many other economies

- ◆ Emphasizes private-sector **standards solutions**
- ◆ Relies on private-sector **compliance verification** (conformity assessment) for both regulatory and non-regulatory functions
- ◆ Provides a strong voice and greater authority to standards users and individual stakeholders



# U.S. Standardization System

## a market-driven approach

- ◆ In the U.S. alone, there are more than 100,000 standards
- ◆ These documents are being developed by:
  - hundreds of standards developing organizations (SDOs)
  - over 500 consortia
  - thousands of committees
- ◆ Over 13,000 approved American National Standards

# U.S. Standards System

## guiding principles

- ◆ Standards should meet societal and market needs and should not be developed to act as barriers to trade
- ◆ The U.S. endorses the globally accepted standardization principles of the World Trade Organization Technical Barriers to Trade Agreement
  - Transparency
  - Openness
  - Impartiality
  - Effectiveness and relevance
  - Consensus
  - Performance-based
  - Coherence
  - Due process
  - Technical Assistance
  - Flexible
  - Timely
  - Balanced

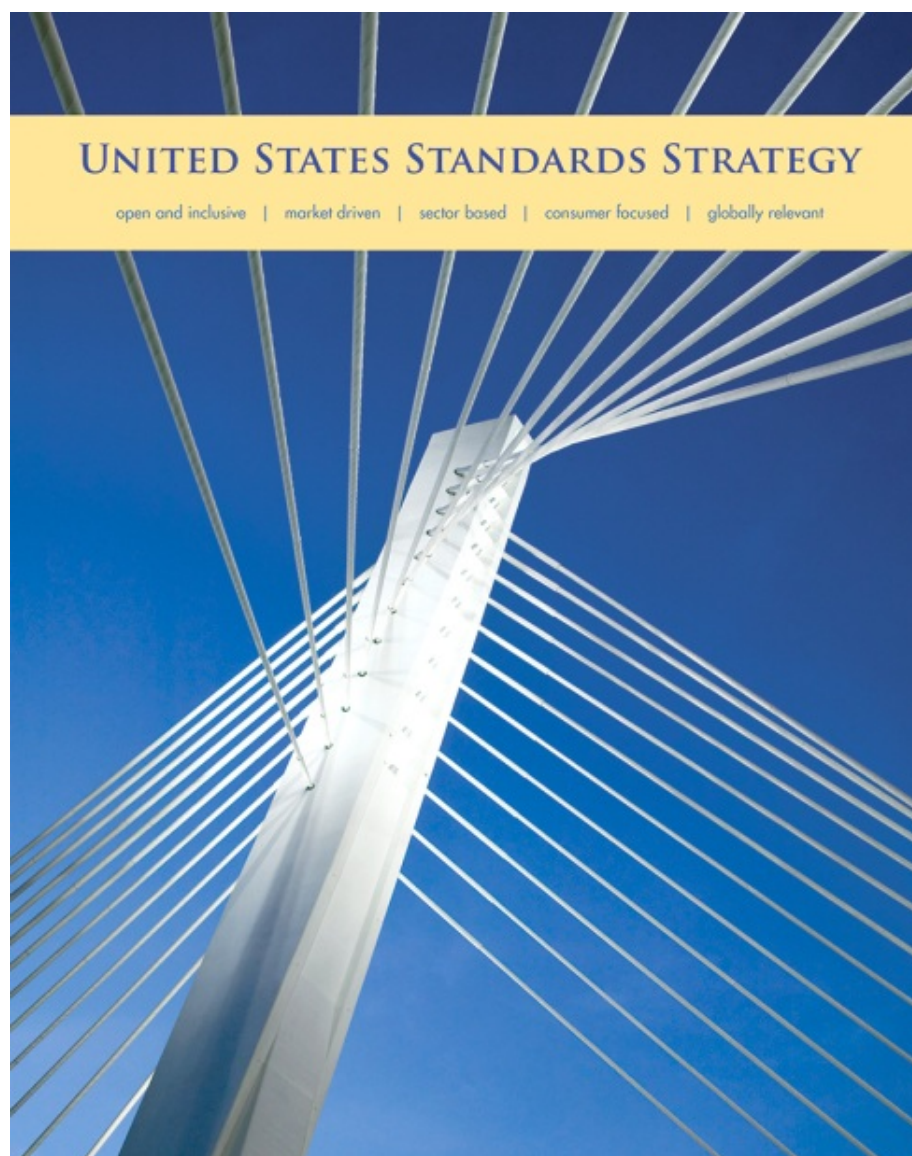




# U.S. Standards and Conformity Assessment System

reliable – flexible – responsive

- ◆ Market driven
- ◆ Flexible and sector-based
- ◆ Industry-led and government-supported



This system is designed to . . .

- ◆ Support a broad range of stakeholder engagement
- ◆ Address emerging priorities and new technologies
- ◆ Allow stakeholders to find the solutions that best fit their respective needs

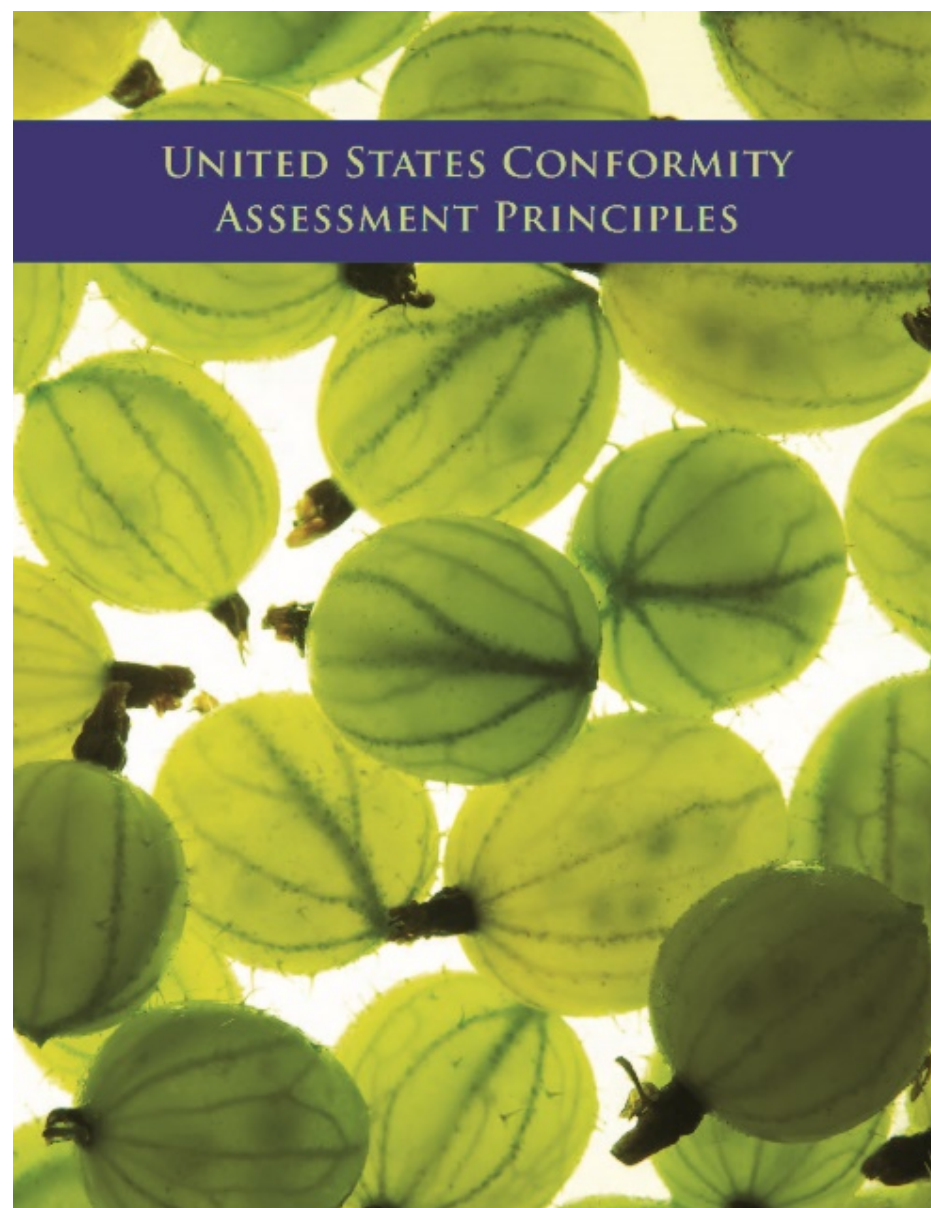
As defined in the *United States Standards Strategy*

[www.us-standards-strategy.org](http://www.us-standards-strategy.org)

# U.S. Standards and Conformity Assessment System

reliable – flexible – responsive

- ◆ The *United States Conformity Assessment Principles* (USCAP) explains key aspects of compliance verification.



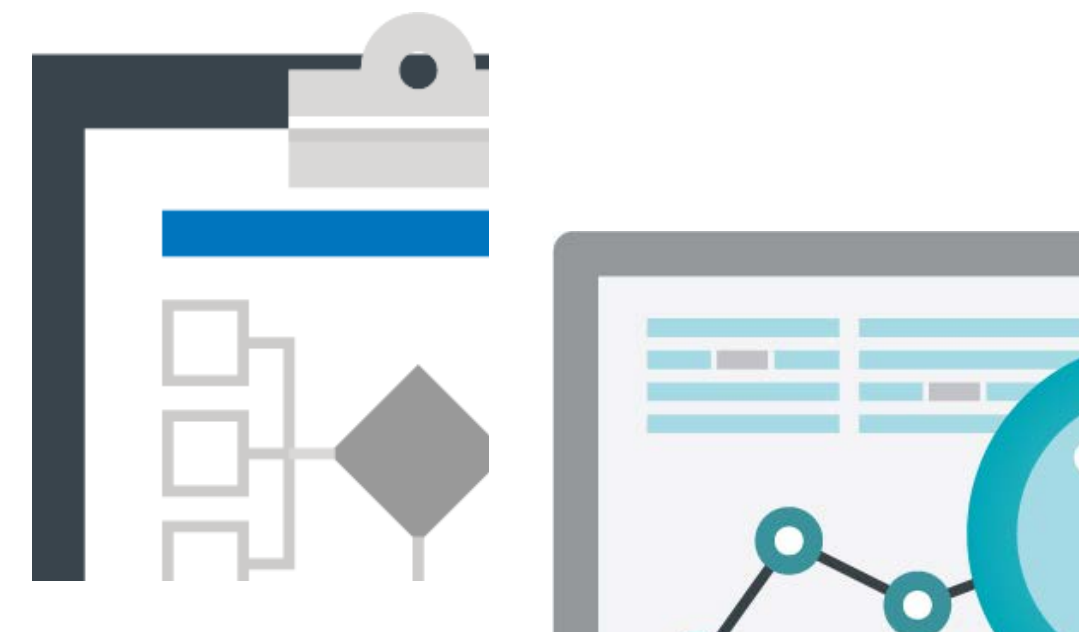
The USCAP is a guidance document that can be considered in conjunction with the *United States Standards Strategy*.

United States Conformity Assessment Principles

[www.ansi.org/uscap](http://www.ansi.org/uscap)

# U.S. Conformity Assessment System

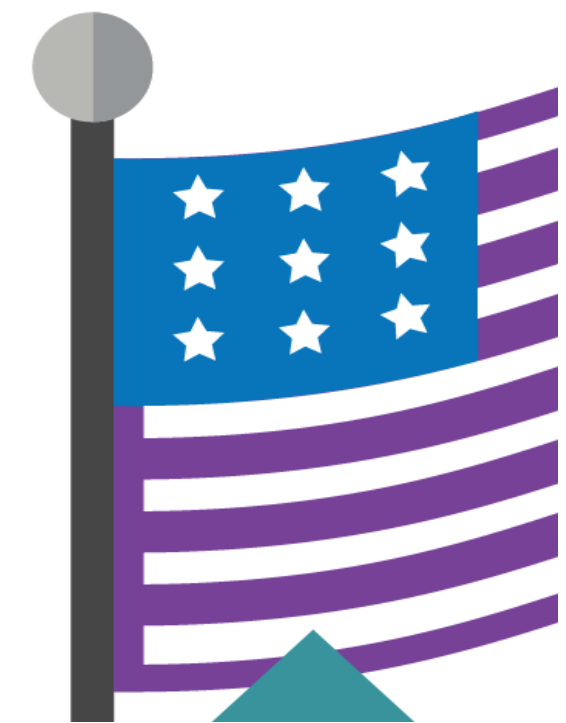
- ◆ Standards are just good ideas unless products, processes, systems, and personnel conform to them.
- ◆ The U.S. conformity assessment system – much like the standards system – evolved in a decentralized manner.
  - Conformity assessment activities are not centrally organized
  - Approaches vary among sectors



# U.S. Standards & Conformity Assessment System

## the public-private partnership

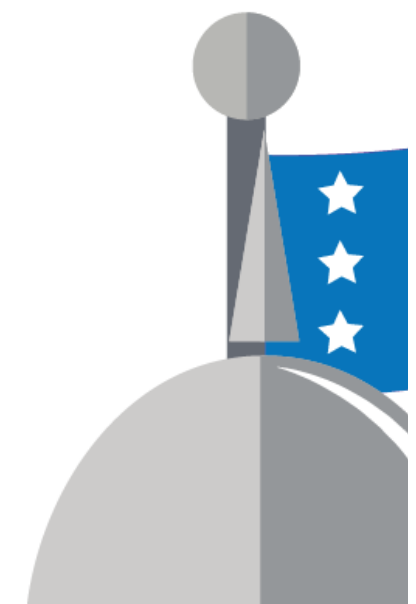
- ◆ Activities are a mix of government (regulatory programs) and private sector (market-based programs)
- ◆ The system relies on private-sector mechanisms to achieve both non-regulatory and regulatory conformance
- ◆ Designed to provide more confidence in the quality of the product, service, or system by consumers, the public, and employers



# U.S. Standards & Conformity Assessment System

## the public-private partnership

- ◆ No single government agency has control over standards
  - Each agency determines which standards meet its needs
- ◆ **National Technology Transfer and Advancement Act (NTTAA)** —  
Public Law 104-113
  - Encourages each government agency to seek existing private-sector standards that are appropriate for its purpose and mission



# U.S. Standards & Conformity Assessment System

the public-private partnership



- ◆ NIST has the legal responsibility of implementing the NTTAA
- ◆ Coordinates the standards activities of Federal agencies
- ◆ Sets legal metrology standards
- ◆ Accredits Laboratories



# U.S. Standards System

different tools for globally relevant standards



National Participation (one country one vote)	Direct Participation	Consortia
<ul style="list-style-type: none"><li>◆ Treaty Organizations</li><li>◆ Non-Treaty Organizations</li></ul>	<ul style="list-style-type: none"><li>◆ Nationally Accepted</li><li>◆ Internationally Accepted</li></ul>	
<p><u>Examples</u></p> <p>ISO, IEC, ITU, CODEX, etc.</p>	<p><u>Examples</u></p> <p>ASTM International, ASME, SAE, etc.</p>	<p><u>Examples</u></p> <p>W3C, Open Geospatial Consortium, etc.</p>

# About ANSI







- ◆ **The American National Standards Institute coordinates standards, conformity assessment, and related activities in the United States of America.**
- ◆ **Founded in 1918, ANSI is a private, non-profit organization.**
- ◆ **ANSI is not a government agency or a standards developer.**





- ◆ Represents U.S. globally
- ◆ Ensures integrity of the standards and conformity assessment system
- ◆ Offers neutral forum
- ◆ Accredits standards developers and accepts standards as American National Standards
- ◆ Bridge between U.S. public and private sectors



# Snapshot: ANSI International, Regional, and Bilateral Activities





ANSI represents and serves the diverse interests of more than **270,000 companies and organizations** and **30 million professionals** worldwide.

- ◆ Standards Developers
- ◆ Government
- ◆ Manufacturing
- ◆ Trade Associations
- ◆ Professional Societies
- ◆ Consumer Representatives
- ◆ Service Organizations
- ◆ Labor Interests
- ◆ Academia
- ◆ Individuals... and more

# Domestic Standards Program



# U.S. Standardization System

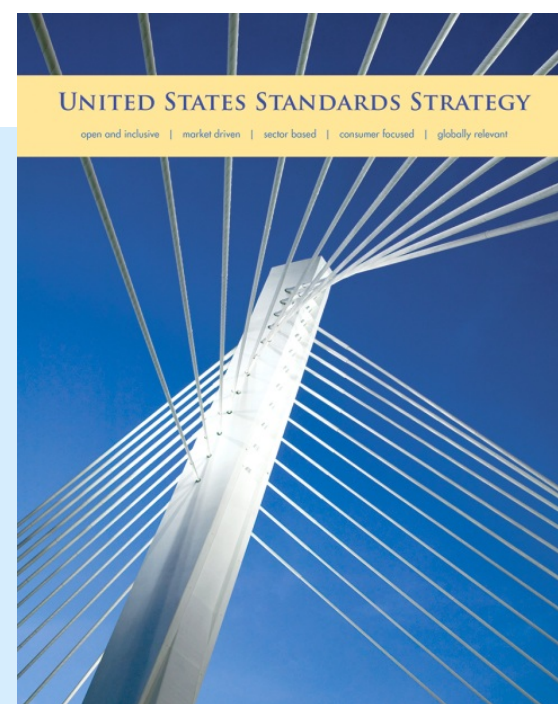
## ANSI-accredited SDOs and U.S. TAGs

- ◆ ANSI accreditation of SDOs and U.S. TAGs promotes alignment with the WTO's Internationally Recognized Principles for Standards Development

ANSI *Essential Requirements* for the development of American National Standards

World Trade Organization Technical Barriers to Trade Agreement

Referenced in the United States Standards Strategy



Openness  
Transparency  
Due Process  
Consensus

Referenced in the WTO TBT Committee Second Triennial Review – Annex 4

# U.S. Standardization System

examples of ANSI-accredited SDOs and U.S. TAGs

ASTM  
International



IEEE



National Fire  
Protection  
Association



IAPMO



AAMI



Health Level  
Seven



American  
Society of  
Mechanical  
Engineers



NSF  
International



UL



American  
Society  
of Civil  
Engineers



Building  
Institutional  
Furniture  
Manufacturers  
Association



International  
Code Council

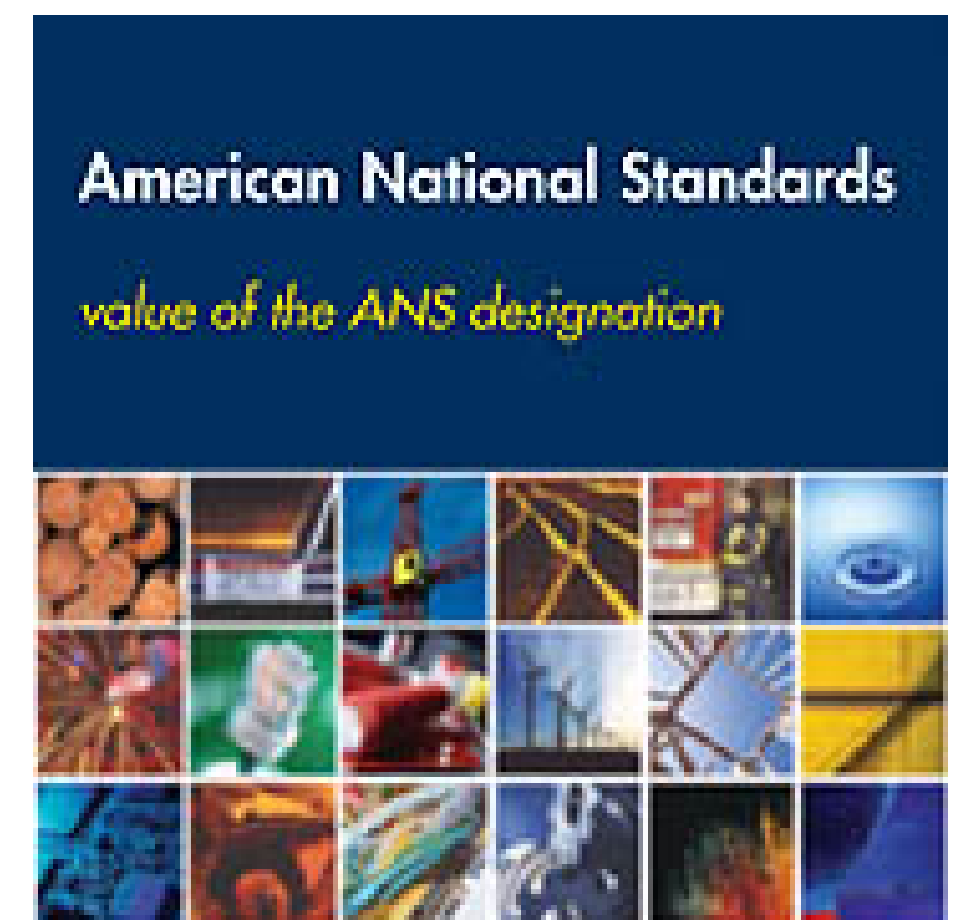


And more than 200 additional organizations

# American National Standards (ANS)

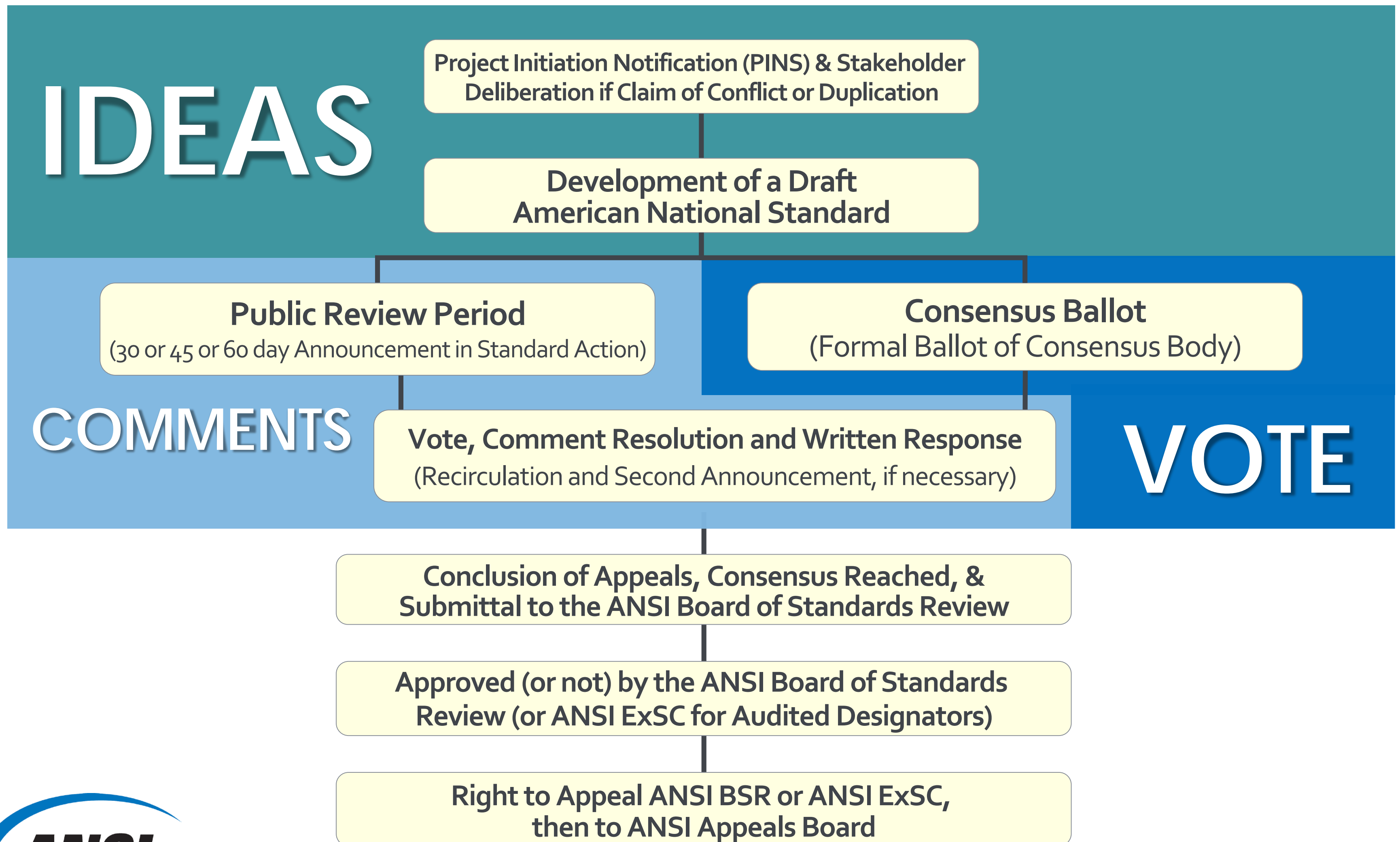
- ◆ Currently there are approximately 240 ANSI-accredited standards developers (ASD)
  - Only ASDs may submit standards for approval as ANS
  - Not all standards developed by these organizations are submitted for consideration as ANS
  - There are approximately 11,000 ANS
  - All ASDs are subject to ANSI's neutral third-party oversight including a routine audit of ANS and an annual compliance review of accredited procedures

Learn more: [www.ansi.org/ansvalue](http://www.ansi.org/ansvalue)





# ANS Development Process [ansi.org/anskeysteps](https://ansi.org/anskeysteps)



# International and Regional Participation



# The U.S. will...

## **Adopt**

International Standards as American National Standards (where they meet the needs of the user community)

## **Submit**

American National Standards for adoption as regional or International Standards

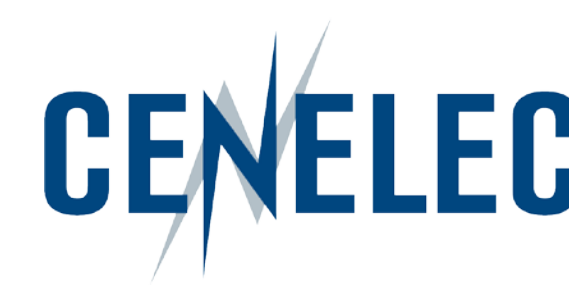
## **Ensure that**

U.S. positions (policy and technical) are accepted by international and regional standards organizations



# ANSI's Representation of U.S. Interests

- ◆ U.S. member of ISO
- ◆ U.S. member of the IEC, via ANSI's U.S. National Committee
- ◆ a U.S. member of IAF and ILAC
- ◆ member of regional forums in the Pacific Rim and the Americas
- ◆ liaison with groups in Europe, Africa and the Middle East
- ◆ bilateral agreements with other national standards bodies



# U.S. Technical Advisory Groups (TAGs)

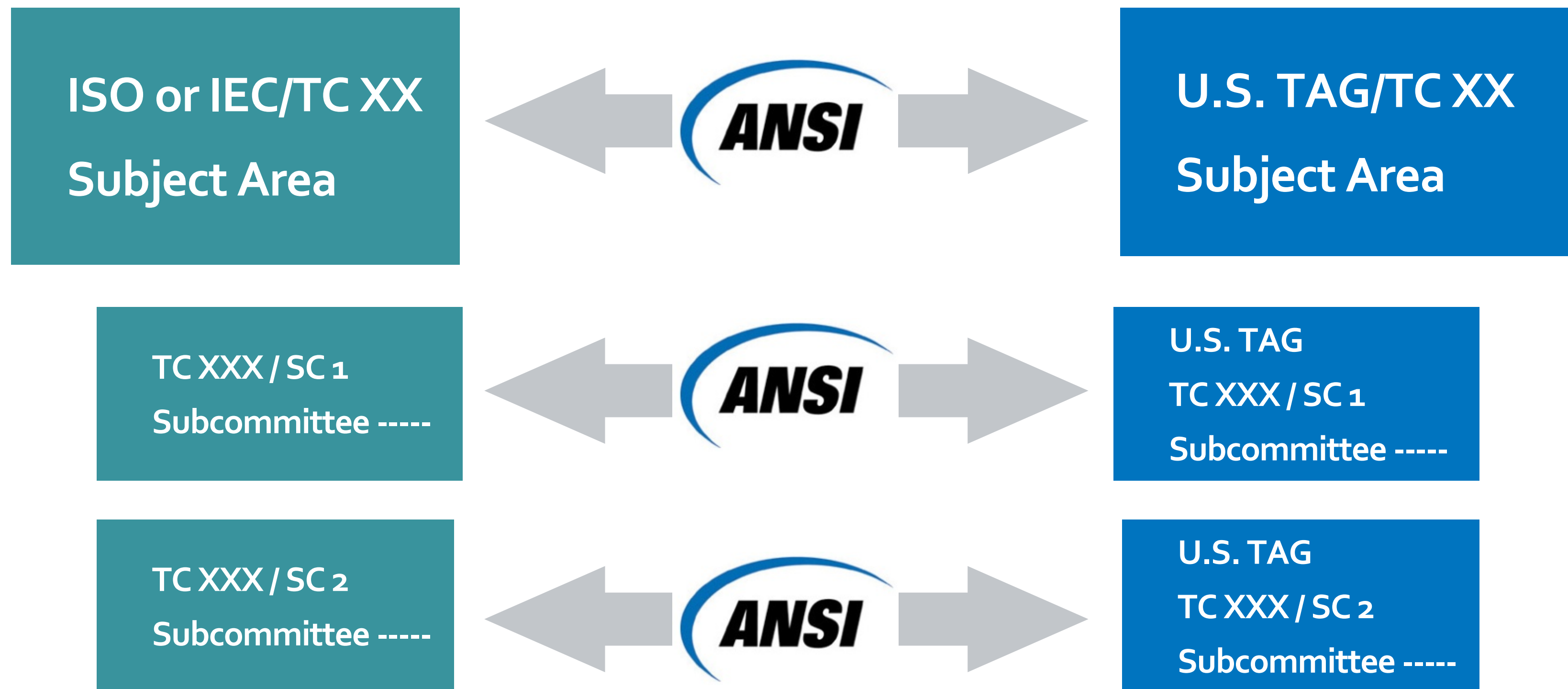
- ◆ ANSI sets policy for U.S. TAGs because the Institute is the official U.S. member of ISO; ANSI's U.S. National Committee (USNC) is the official U.S. member of IEC.
- ◆ U.S. TAGs to ISO committees are accredited by ANSI and must follow the Institute's cardinal principles, similar to Accredited Standards Developers.
- ◆ U.S. TAGs to IEC committees are appointed by the USNC Technical Management committee (TMC) and must meet a set of established criteria for fairness and openness.
- ◆ ANSI pays total dues for U.S. membership in ISO and IEC and represents the U.S. in regional and global forums.



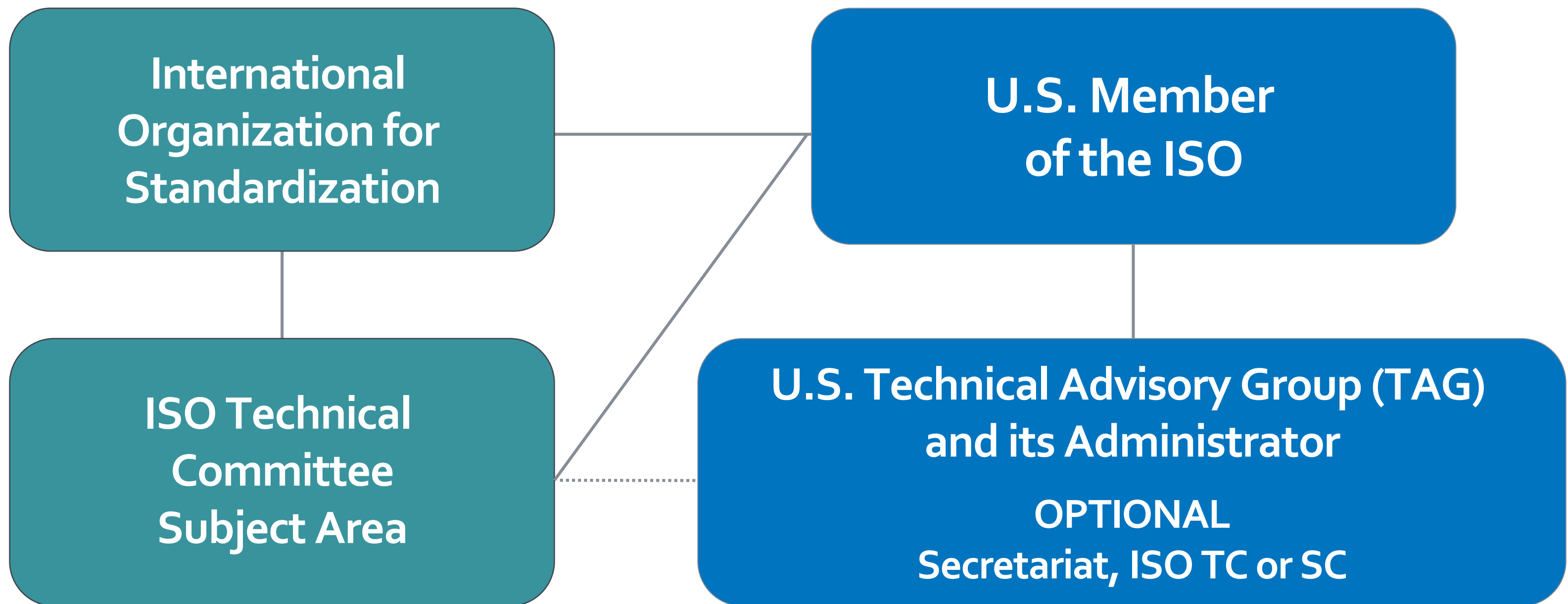
# U.S. Technical Advisory Groups (TAGs)

ISO Technical Committee

ANSI-Accredited or USNC/IEC Approved  
U.S. Technical Advisory Group



# ISO Example: Organizational Relationships



# ANSI's U.S. National Committee (USNC) of the IEC



- ◆ International Electrotechnical Commission (IEC)  
Geneva, Switzerland
  - Comprised of 60 National Committees (member nations)
- ◆ U.S. National Committee (USNC), a committee of ANSI
  - One of 6 permanent members of the Council Board of 15
  - One of 7 members of the Standardization Management Board
  - Participates in 92% of total IEC Technical Committees/Subcommittees



# U.S. Member Body of the ISO



- ◆ International Organization for Standardization (ISO)  
Geneva, Switzerland
  - Comprised of 163 National Standards Bodies/Members
- ◆ ANSI is one of
  - 6 permanent members to the ISO Council of 20
  - 6 permanent members to the Technical Management Board of 15
- ◆ ANSI and its members
  - Participate in nearly 80% of total ISO Technical Committees and Subcommittees



# ANSI Membership in IAF



- ◆ International Accreditation Forum ([www.iaf.nu](http://www.iaf.nu))
  - ANSI a founding member and 1st Chair (1993)
  - Legally incorporated in U.S. (1998)
- ◆ Global association of 66 accreditors from 59 countries
  - Other members: 4 regional Accreditation Cooperations; 17 NGOs; 4 observer organizations
- ◆ Objective: “Certified Once – Accepted Everywhere”
- ◆ Key Concepts:
  - Acceptance, Confidence, Consensus, Cooperation, International Trade

# ANSI's Web-Based Information Tools



- ◆ **ANSI Online** – [www.ansi.org](http://www.ansi.org)  
News and information about the Institute
- ◆ **ANSI Webstore** – [webstore.ansi.org](http://webstore.ansi.org)  
E-commerce site for real-time electronic publication sales and subscriptions
- ◆ **Standards Boost Business** – [www.standardsboostbusiness.org](http://www.standardsboostbusiness.org)  
Resources highlighting the value of standards activities for U.S. companies
- ◆ **StandardsPortal** – [www.standardsportal.org](http://www.standardsportal.org)  
A standardization resource for global trade
- ◆ **Standards Learn** – [www.standardslearn.org](http://www.standardslearn.org)  
Standards education: learning in your own space and at your own pace

II.  
Federal Communications Commission: Spectrum  
Management Overview

# The Federal Communications Commission: Spectrum Management Overview

Thomas Sullivan  
Bureau Chief, International Bureau  
Federal Communications Commission

August 2021



“The promise of 5G means new and improved services and applications for consumers and businesses alike. This means not only faster download speeds, but also enabling digital tools we can’t even imagine yet. We need to deliver the 5G that the American people were promised. That means a 5G that is fast, secure, resilient, and—most importantly—available across the country.”

- Acting Chairwoman Rosenworcel, February 23, 2021

5G Requires  
An Integrated  
Multi-  
Dimensional,  
Multi-Faceted  
All-Encompassing  
Approach

- Spectrum
- Technology
- Security
- Infrastructure
- Funding

# Light-Touch Regulatory Approach

- Goal: **facilitate an enabling environment in which market-driven, industry-led innovation can thrive** (“virtuous cycle of innovation”).
- Key elements:
  - Regulatory flexibility
  - Technological neutrality
  - Consumer choice
  - Transparency
- A light touch approach does *not* mean a lack of government action where needed.
  - When no rational business incentives exist in the market, it is the FCC’s responsibility to step in to encourage and incentivize investment and deployment.
  - Example: universal service.



# US Mobile Industry Numbers (Source: CTIA 2021 Annual Survey)

**300**  
MILLION

Americans covered by 5G

**108x**  
INCREASE

in mobile traffic since 2010

**\$601**  
BILLION

total U.S. wireless investment

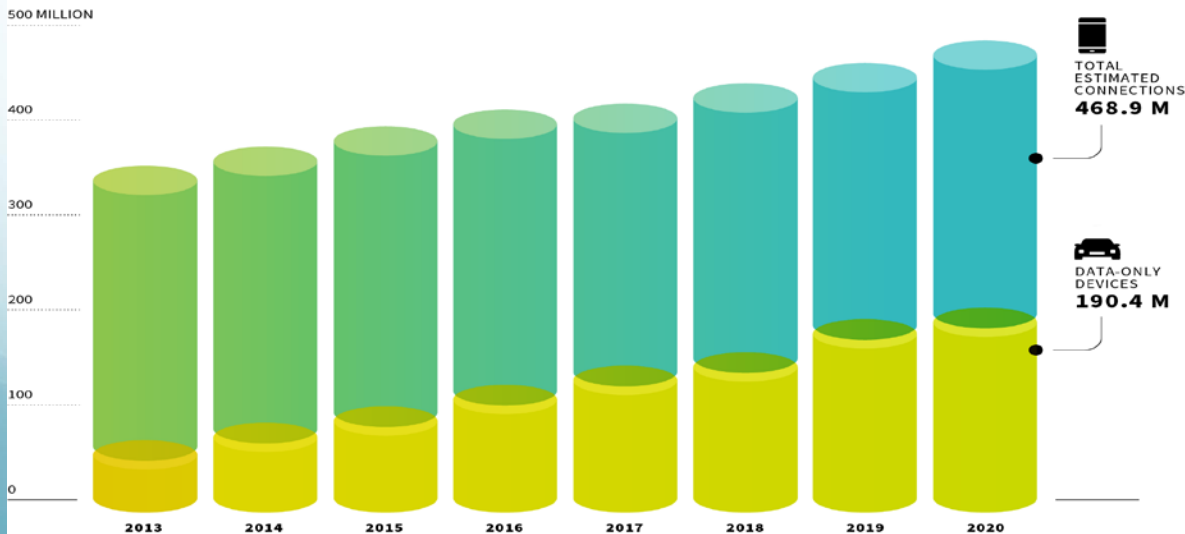
**41%**

Data-only devices' share  
of all estimated devices

**67,871**  
2-YEAR GROWTH

in cell sites is more than 2011-2018  
growth combined

## NUMBER OF WIRELESS CONNECTIONS



# Spectrum in the U.S. for 5G use

## ***High-band:***

24 GHz Band (24.25 – 24.45; 25.25 -25.75 GHz)

28 GHz Band (27.5 GHz – 28.35 GHz)

Upper 37 GHz Band (37.6-38.6 GHz)

39 GHz Band (38.6-40 GHz)

47 GHz Band ((47.2-48.2 GHz)

Working to free up spectrum in the 26 and 42 GHz bands

## ***Mid-band:***

2.5 GHz Band (auction planning in progress)

3.5 GHz Band

3.7-3.98 GHz Band

## ***Low-band:***

600 MHz Band

800 MHz Band

900 MHz Bands

## ***Unlicensed:***

Creating opportunities for Wi-Fi in the 6 GHz, 61-71 GHz and above 95 GHz bands

# High-Band Spectrum

The U.S. has made approximately 5 gigahertz of mmW spectrum available for licensed, terrestrial wireless services:

- Flexible-use service rules (permitting fixed or mobile operations) with exclusive-use geographic licensing:
  - **24 GHz** band (24.25-24.45 GHz, 24.75-25.25 GHz) – seven, 100-megahertz blocks, PEAs;
  - **28 GHz** band (27.5-28.35 GHz) – two, 425-megahertz blocks, counties;
  - **Upper 37 GHz** band (37.6-38.6 GHz) – ten, 100-megahertz blocks, PEAs;
  - **39 GHz** band (38.6-40 GHz) – 14, 100-megahertz blocks, PEAs; and
  - **47 GHz** band (47.2-48.2 GHz) – ten, 100-megahertz blocks, PEAs.
  - The FCC auctioned licenses in these five bands over the past 1½ years with over \$10 billion auction revenues. Incumbent licensees in these bands are permitted to operate under the new flexible-service rules without obtaining new licenses.
- The FCC has pending proceedings examining other bands for flexible-use, terrestrial licenses, including the **26 GHz band** (25.25-27.5 GHz), the **42 GHz** band (42-42.5 GHz), and the **50 GHz** band (50.4-52.6 GHz).
- In the Lower **37 GHz** band (37-37.6 GHz), the FCC established a licensing framework for sharing between commercial and Federal government users. The FCC currently is developing service rules for this band in a pending proceeding.



# 3.5 GHz CBRS (Mid-Band)

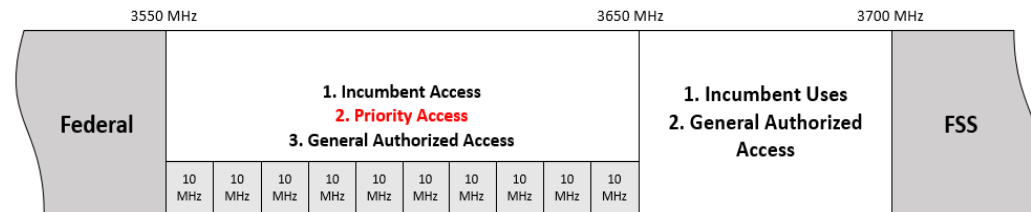
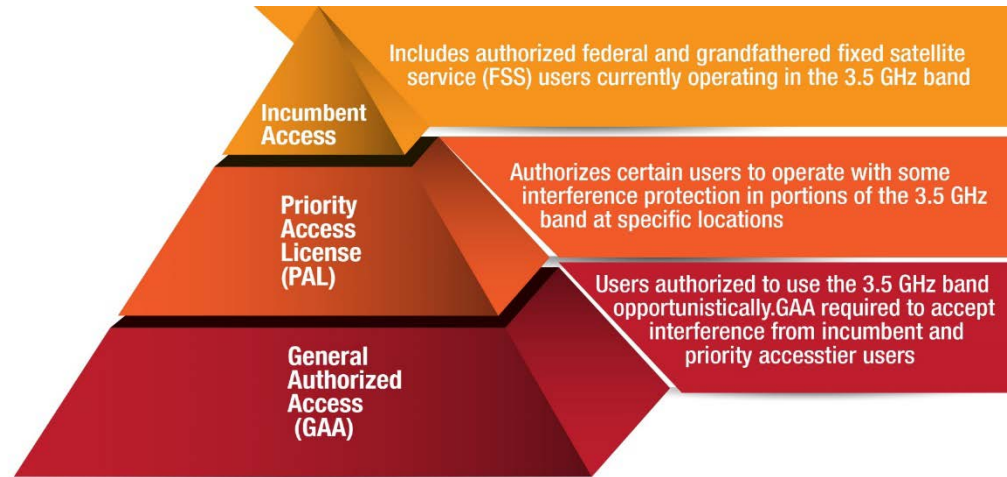
In October 2018, the FCC adopted updated rules for the shared use of the 3.5 GHz (3.55-3.7 GHz) band, known as the Citizens Broadband Radio Service (CBRS).

The CBRS band uses a dynamic sharing model to enable sharing between naval radars, satellite users, future PAL users like 5G, and future GAA quasi-licensed users.

CBRS dynamic sharing relies on a Spectrum Access System (SAS) database linked to sensors providing Environmental Sensing Capability (ESC).

Commercial deployment has started.

**Auction 105** offered 22,631 Priority Access Licenses (PALs) in the 3550-3650 MHz band. The auction completed August 25, 2020 with gross proceeds totaling \$4.543b



Each PAL is a 10 MHz channel in the 3550-3650 MHz band.  
No more than seven PALs will be issued in any county.  
A licensee can aggregate up to four PALs channels in one county.

# 3.7-4.2 GHz C-Band (Mid-Band)



## March 2020 - rules adopted in the *3.7 GHz Report and Order*

- Spectrum made available for new wireless uses while also accommodating incumbent Fixed Satellite Service (FSS) and Fixed Service (FS) operations in the band.
- 280 megahertz (3.7-3.98 GHz) available for mobile use.
- 20 megahertz (3.98-4.0 GHz) will serve as a guard band.
- 200 megahertz (4.0-4.2 GHz) to accommodate existing satellite operations.

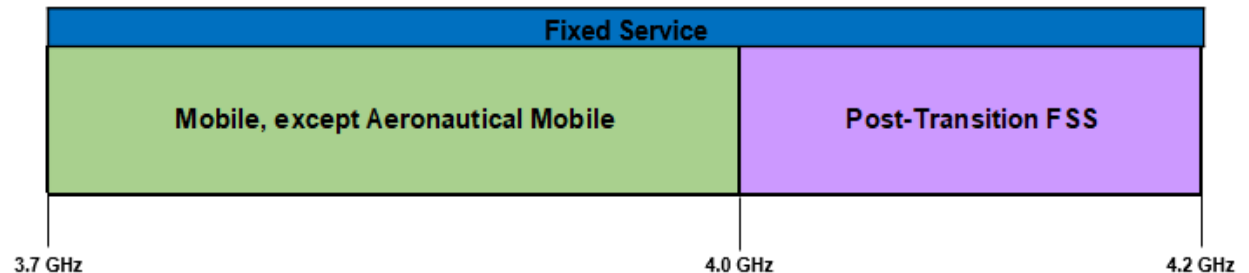
## Auction completed February 17, 2021 with \$ 81.2b in gross proceeds

## Accelerated relocation option selected by all satellite operators

- Lowest 100-megahertz in 46 of top 50 markets to transition by December 5, 2021
- Remaining markets and spectrum to transition by December 5, 2023

## Technical rules adopted to protect satellite operations

- In-band and out-of-band PFD limits
- Filters required for all earth stations





## 3.1-3.55 GHz Band (Mid-Band)

- 1<sup>st</sup> Report and Order – September 30, 2020
  - Removed non-federal secondary radiolocation and amateur allocations from the band
- 2<sup>nd</sup> Report and Order – March 17, 2021: 100 megahertz available for flexible use throughout the contiguous United States; Auction planning underway.
  - Creates coordinate regime for non-federal and federal users by adopting Cooperative Planning Areas and Periodic Use Areas and establishing coordination procedures;
  - Adopts a band plan and technical, licensing, and competitive bidding rules;
  - Requires non-federal radiolocation operators to sunset operations within 180 days after the grant of new flexible-use licenses and provide for reimbursement of reasonable relocation costs; and
  - Requires amateur operators to cease operations in the 3.45 GHz band within 90 days of the public notice announcing the close of the auction; allows those operations to continue in the 3.3-3.45 GHz band pending future Commission action in that spectrum.

# 2.5 GHz Band (Mid-Band)

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The 2.5 GHz band (2496 -2690 MHz) is the **single largest band of contiguous spectrum below 3 GHz managed by the FCC.**

In the U.S., the 2.5 GHz is licensed mainly to the educational broadcast service (EBS). Some EBS licensees have leased their spectrum to U.S. mobile operators like Sprint.

**The FCC recently modernized its regulatory framework for the 2.5 GHz band,** giving incumbent entities more flexibility in how they use this spectrum.

Also provided opportunities for access to unused spectrum by Tribal entities through a **Rural Tribal Priority Window.**

Future auction planned

# Unlicensed Spectrum

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**FCC rules provide for operation of low power radio transmitters without the need for the user to obtain a license.**

- These unlicensed devices may not cause harmful interference and must accept any interference received.

**Unlicensed devices are not “allocated” spectrum.**

- Operate in former “junk bands” (915 MHz, 2.4 GHz, 5.8 GHz).
- Restricted from operating in public safety or low signal bands.

**License-exempt (unlicensed, but not “unauthorized”) → rules minimize likelihood of interference by:**

- Identifying permissible frequencies.
- Limiting power to very low levels.
- Requiring equipment authorization.





## Unlicensed in the 6 GHz

The Commission also took action in April of this year to increase the supply of unlicensed spectrum, making 1200 megahertz of spectrum in the 6 GHz band available for unlicensed use.

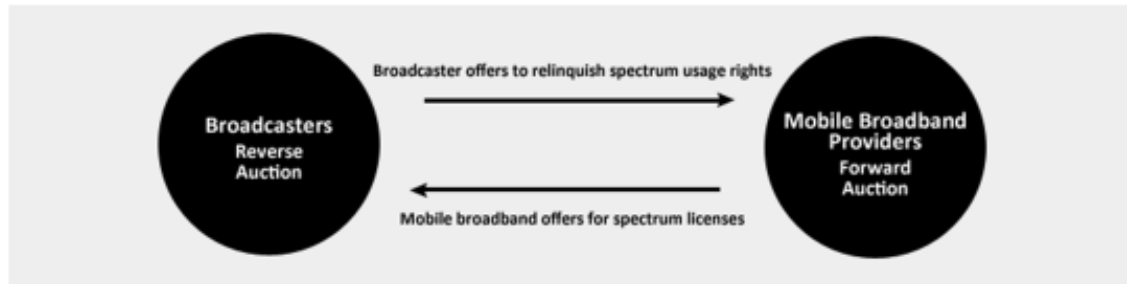
The rules will usher in Wi-Fi 6, the next generation of Wi-fi, will help improve rural connectivity and will play a major role in the growth of the Internet of Things.

Unlicensed devices will share this spectrum with incumbent licensed services under rules designed to protect the licensed services from harmful interference and enable both unlicensed and licensed operations.

Device Class	Operating Bands	Maximum EIRP	Maximum EIRP Power Spectral Density
Standard-Power Access Point (AFC Controlled)	U-NII-5 (5.925-6.425 GHz) U-NII-7 (6.525-6.875 GHz)	36 dBm	23 dBm/MHz
Client Connected to Standard-Power Access Point		30 dBm	17 dBm/MHz
Low-Power Access Point (indoor only)	U-NII-5 (5.925-6.425 GHz) U-NII-6 (6.425-6.525 GHz)	30 dBm	5 dBm/MHz
Client Connected to Low-Power Access Point	U-NII-7 (6.525-6.875 GHz) U-NII-8 (6.875-7.125 GHz)	24 dBm	-1 dBm/MHz

# 600 MHz

In April 2017, the FCC concluded its **Broadcast Incentive Auction**, repurposing 84 megahertz of television spectrum for mobile broadband use.



The 39-month transition period for repacking the band was recently completed in July 2020.

All 2,775 wireless licenses in the 600 MHz band have been granted to forward auction winners, many of whom have already commenced operations and are [using 600 MHz spectrum as the foundation for 5G networks](#).

# Unlicensed Low-Band Spectrum (TV White Spaces)

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Due to the better propagation characteristics of low-band spectrum, unlicensed white space devices can provide a vital link to providing broadband services, particularly in rural and underserved areas.

**The FCC allows unlicensed white space devices to operate in the TV bands at locations where frequencies are not in use by licensed services.**

To prevent harmful interference, the FCC has established technical rules for white space devices operating in the 600 MHz band.

White space device operation relies on a database to determine what spectrum is available for use at the device's location (databases administered by private entities selected by the FCC).

White space devices must report precise location information to the database (via geo-location capability) to ensure that the database, in turn, provides them with accurate spectrum availability information.



# Wireless Infrastructure Overview

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New construction of wireless communications facilities or collocation on an existing structure requires:

- State or local approval; and
- Compliance with FCC environmental and historic preservation rules.

Since 2017, the FCC has taken steps to **accelerate deployment of wireless facilities** by removing regulatory barriers to infrastructure deployment. These actions included:

1. **Streamlining** the wireless infrastructure siting review process;
2. Addressing the conduct of some **state & local governments** that needlessly slowed down & increased the costs of wireless infrastructure deployments;
3. Modernizing Federal **historic preservation & environmental** reviews of wireless deployments.



# 5G Network Security



In the United States, many agencies have important responsibilities when it comes to ensuring the safety of our networks, and the FCC is playing its part:

- ✓ **Supply chain integrity:** The FCC prohibits the use of universal service funding to purchase equipment or services from any company that poses a national security threat to the integrity of U.S. communications networks or the communications supply chain.
- ✓ **Open Radio Access Networks (ORAN):** Software-centric approach drives innovation, supply-chain diversity and increased security.
- ✓ **The FCC adopted a Notice of Inquiry to promote Open Access Networks (Open RAN)**

III.  
Qualcomm:  
New Trends of IoT and  
Applications in Industry

August 2021

USTDA 5G workshop

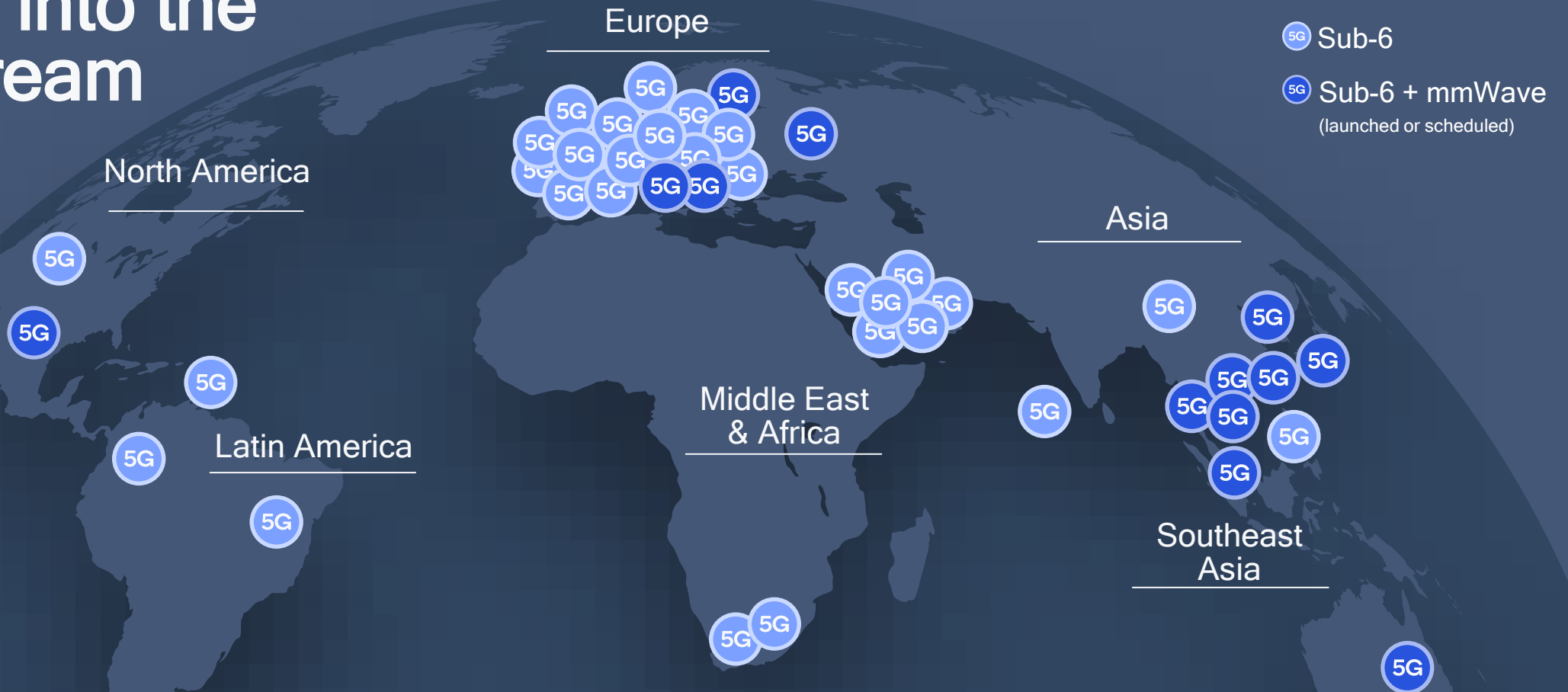
@qualcomm

Qualcomm

# New trends of IoT and applications in industry

Alex Orange, Snr. Director, Government Affairs

# 5G commercialization moving into the mainstream



**60+**

Countries with 5G commercially deployed

**165+**

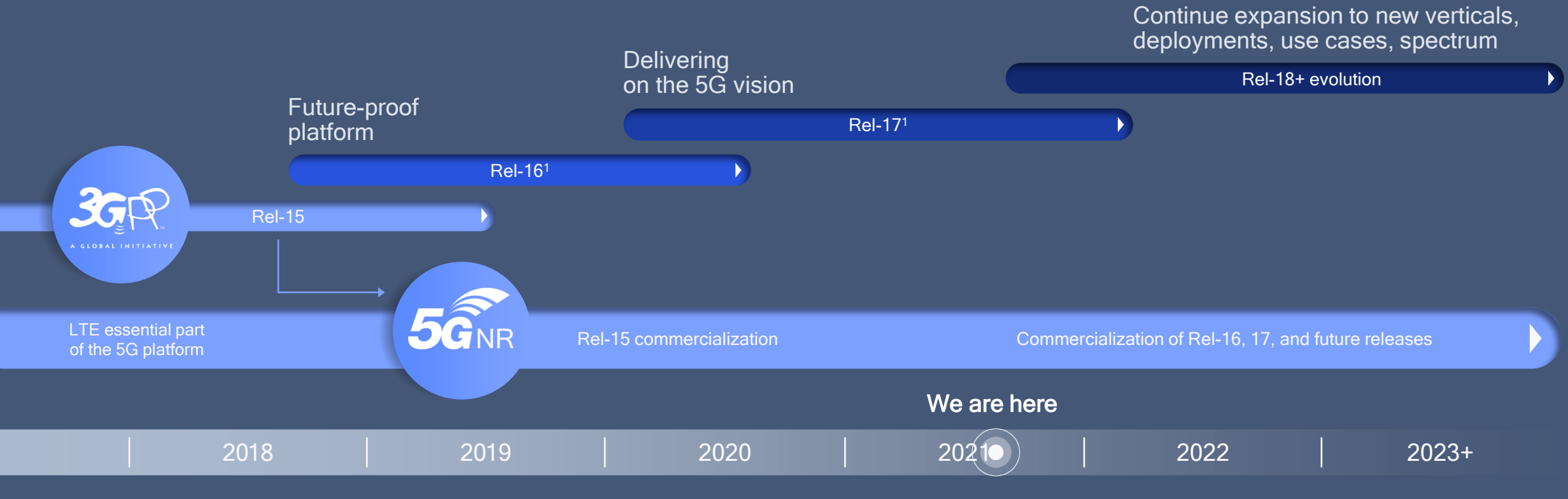
Mobile operators with commercial live 5G networks

**500M**

5G handsets expected to ship in 2021



# Driving the 5G technology evolution



## Rel-15 eMBB focus

- 5G NR foundation
- Smartphones, FWA, PC
- Expanding to venues, enterprises

## Rel-16 industry expansion

- eURLLC and TSN for IIoT
- NR in unlicensed (NR-U)
- Positioning
- 5G V2X sidelink multicast
- In-band eMTC/NB-IoT

## Rel-17+ long-term expansion

- Lower complexity NR-Light
- Boundless extended reality (XR)
- Higher precision positioning and more...



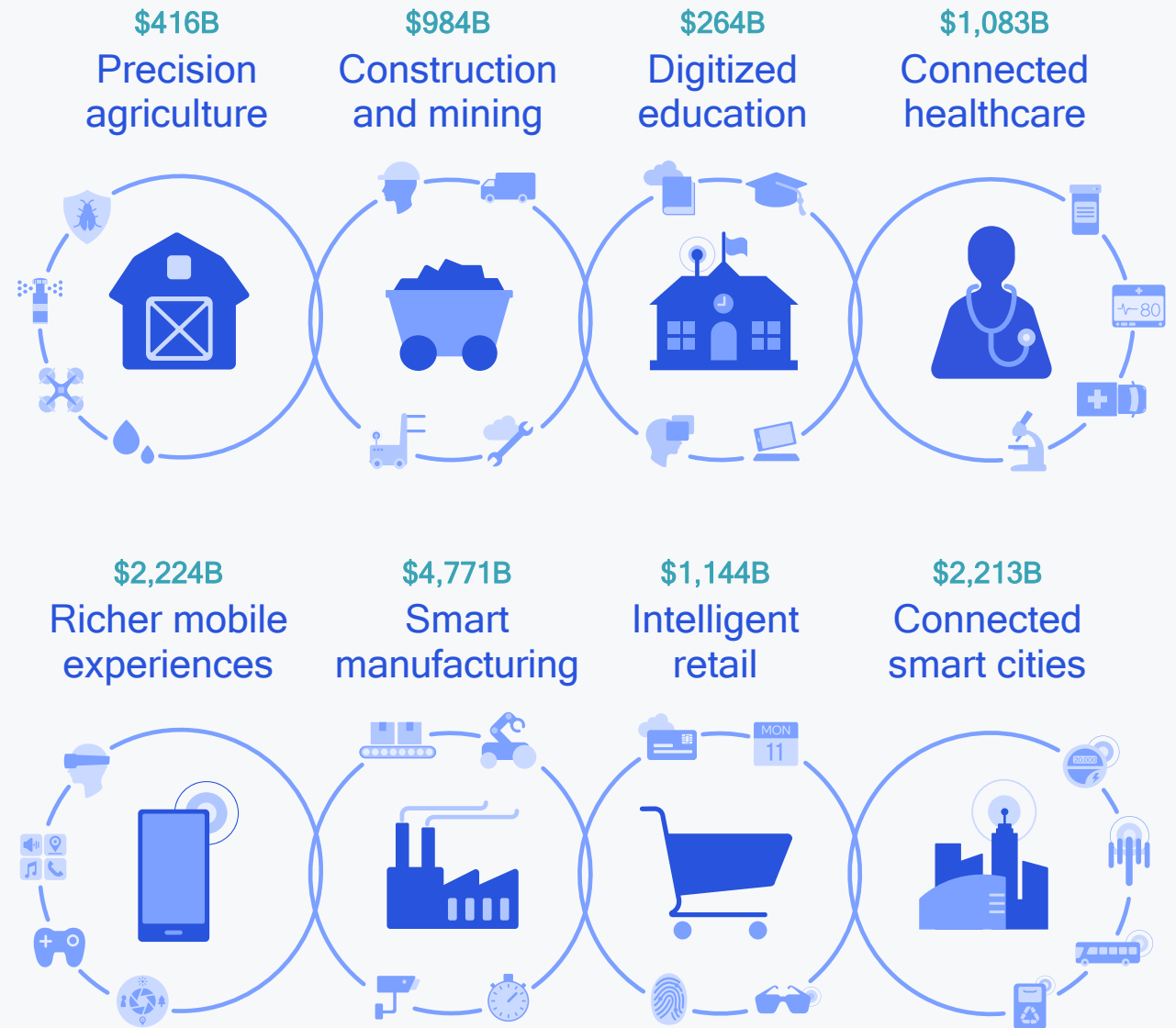
# 5G will expand the mobile ecosystem to new industries

Powering the digital economy

# \$13.1

# Trillion

In global economic value by 2035\*



\* The 5G Economy in a Post-COVID-19 Era - an independent study from IHS Markit, commissioned by Qualcomm Technologies, Inc.

Container ports



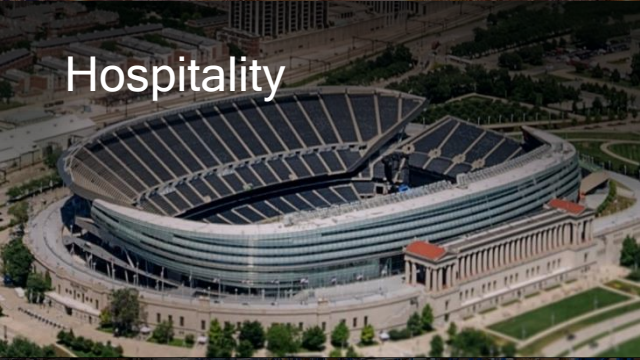
Oil refineries



Manufacturing



Hospitality



Mines



Warehouse



Airports



Hospitals



# 5G private networks will expand the market

Wide range of industries from manufacturing and seaports to venues and enterprise

## >\$3.5B

global private LTE/5G market size by 2026 <sup>1</sup>

## 18% CAGR

1. Mobile Experts, "Private LTE/5G 2021" (Feb. 2021)

## Enhanced mobile broadband

## Massive IoT

# 5G

### Computer Vision



**Security camera**  
Latency: 50ms  
Availability: 99.9%  
Rate: Mbps

### Sensors



**Process Monitoring**  
Latency: 100 ms  
Availability: 99.99%  
Rate: kbps

### Head mounted display



#### Augmented Reality

Latency: 10 ms  
Availability: 99.9%  
Rate: Gbps-Mbps

### Handheld terminal



#### Safety functions

Latency: 10 ms  
Availability: 99.9999%  
Rate: Mbps-kbps

## Ultra reliable low latency

### Automated guided vehicle (AGV)



#### Co-operative driving

Latency: 20ms  
Availability: 99.9999%  
Rate: Mbps

### Wireless edge analytics



### Industrial robot



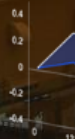
#### Motion control

Latency: 1 ms  
Availability: 99.9999%  
Rate: Mbps-kbps

# Emerging dedicated private networks for targeted needs

Shipping logs

Trip times



Cargo loads



Local management for low latency and protection of sensitive data

Real-time inventory

- Lumber
- Hardware
- Technology
- Manufacturing
- Produce
- Automotive
- Earth/Soil
- Retail

AR-guided execution

Reliable robotic control

UHD surveillance

Reliable, autonomous AGVs

On-premise compute and storage  
Updating

Real-time asset tracking

At port (Days)



Location



Spools shipped



Camera



Capacity



On-device intelligence

5G NR  
Private network

Seamless interworking with public network

# Driving the next industrial revolution with flexible manufacturing




5G  
private network



Smart UHD  
surveillance



Process  
monitoring sensors




On-premise  
edge analytics  
and data storage



5G  
private network



Process  
monitoring sensors



Wireless modular  
equipment



Factory  
automation



AGV tracking  
control system

Spools shipped

Precise indoor positioning

Capacity



AR guided  
belt repair

Conveyor belt repair steps

Performance

Maintenance schedule

Arm lubricants

Capacity


HMI interface



Autonomous  
guided vehicle



Predictive  
maintenance



Robot #018  
Digital twin

5G cloud connection

Production metrics

Transfer speed

8.5

2.3 Gbps

Performance

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
77	34	65	52	76	84	85	79	93	100	89	91	



UHD surveillance cameras



Autonomous guided vehicle



Shelf sensors



Monitoring sensors



**Real-time asset tracking**

At port (Days): **2**

Location:

Cases shipped:

Capacity:

Camera:



Perishable item tracking



Automated asset routing



5G

private network

**AGV control and insights**

Executing task 14 of 65

Battery life: 82%

Route history:



Identify precise cargo location

# Enabling smarter warehouses



# 5G NR URLLC for new mission- critical services

A platform for tomorrow's more  
autonomous world

Ultra-low 1 ms e2e latency

Faster, more flexible frame structure; also new non-orthogonal uplink access

High reliability targeting  $10^{-5}$  BLER<sup>1</sup>

Ultra reliable transmissions that can be time multiplexed with nominal traffic through puncturing

High availability

Simultaneous links to both 5G and LTE for failure tolerance and extreme mobility

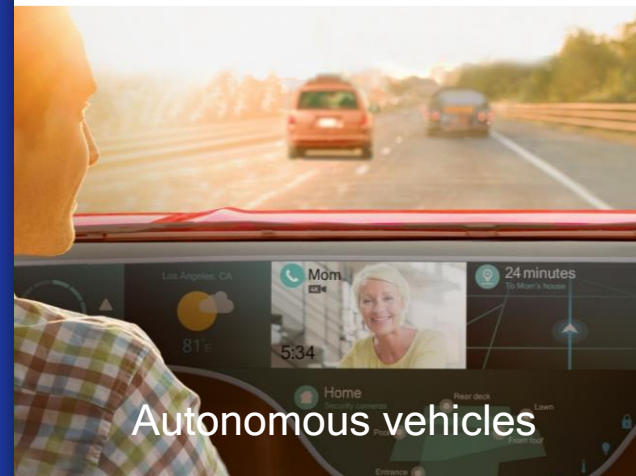
<sup>1</sup> Block Error Rate



Aviation and public safety



Industrial automation



Autonomous vehicles



Remote medicine



Robotics



Smart grid/energy



# 5G Standalone realizes the full potential of 5G for the Industrial IoT

Support the broadest range of devices and use cases, including eMBB, low-complexity IoT, XR, and mission critical apps

## Standalone private networks

Build independent private networks with multiple options for security credentials and optional public network fallback to meet custom needs

Use mmWave, sub-7 GHz, unlicensed bands with NR-U, or multiple bands with 5G SA carrier aggregation

## NR-Light devices

Densify wireless IoT connectivity with reduced capacity 5G NR-Light devices for longer battery life and greater cost-effectiveness

## Time sensitive networking

Cut the wires between industrial nodes with deterministic 5G TSN latency for more efficient and responsive industrial operations

**5G**  
**Standalone**

## Network slicing

Secure mission-critical data flows from heavy best-effort traffic with end-to-end resource reservations for network slices

## MEC and URLLC

Host delay-sensitive application servers on edge compute resources collocated with 5G vRAN for the lowest latency and the highest data integrity

## Precise positioning

Leverage 5G communication infrastructure for centimeter-level positioning indoors and outdoors



# Global snapshot of spectrum optimized for industrial IoT / vertical / private network use – local licensing or sharing

USA



- 3.5 GHz CBRS, exclusive & shared licenses, deployments in 2H19
- 37 - 37.6 GHz shared spectrum/local licenses, under evaluation

Germany



- 3.7 - 3.8 GHz
- 24.25 - 27.5 GHz, local licenses, expected Q4 2020
- Local licenses. Assignment complete; available 2H 2019

U.K.



- 3.8 - 4.2 GHz
- 24.25 - 26.5 GHz, local licenses, applications open since end of 2019
- Local licenses (50 meters square); regulator database; decision formalized; applications invited from end 2019

Sweden



- 3.72 - 3.8 GHz, in consultations

Finland



- Sub-licensing of 3.4 - 3.8 GHz
- Local permission via operator lease; assignment complete

Netherlands



- 3.5 GHz for local industrial use; 3.7 - 3.8 GHz (in consultations); 2.3 - 2.4 GHz (licensed shared access online booking system)
- 3.5 GHz for local industrial use; however, users may need to move to 3.7 - 3.8 GHz, if allocated; 2.3 GHz approved for PMSE

France



- 2.6 GHz, regulator database & approval. Up to 40 MHz approved for Professional Mobile Radio

Czech Republic



- 3.4 - 3.44 GHz for private networks

Brazil



- 3.7 - 3.8 GHz, under consideration
- 27.5 - 27.9 GHz, allocation completed

Chile



- 3.75 - 3.8 GHz, allocation completed at end of 2019

Australia



- 24.25 - 27.5 GHz and 27.5 - 29.5 GHz for local licensing
- 3.7 - 4.0 GHz for local area wireless broadband licensing in 2022

New Zealand



- Licenses in 2575 - 2620 MHz may be assigned for localized use

Malaysia



- 26.5 - 28.1 GHz will be assigned for the deployment of local/private networks

Singapore



- Each operator has acquired 800 MHz of 26/28 GHz spectrum to deploy local networks

Hong Kong



- 24.25 - 28.35 (400 MHz) available for local licenses

Japan



- Phase 1: 2,575 - 2,595 MHz (NSA anchor) and 28.2 - 28.3 GHz; local licenses, legislated in December 2019
- Phase 2: 1888.5 - 1916.6 MHz (NSA anchor), 4.6 - 4.9 GHz (4.6 - 4.8 GHz indoor only, 4.8 - 4.9 GHz outdoor possible) & 28.3 - 29.1 GHz (150 MHz outdoor; total 250 MHz 28.2 - 28.45 MHz); local license. Legislation in 4Q20. Uplink heavy TDD config. using semi-sync allowed in sub-6 & 28 GHz

South Korea



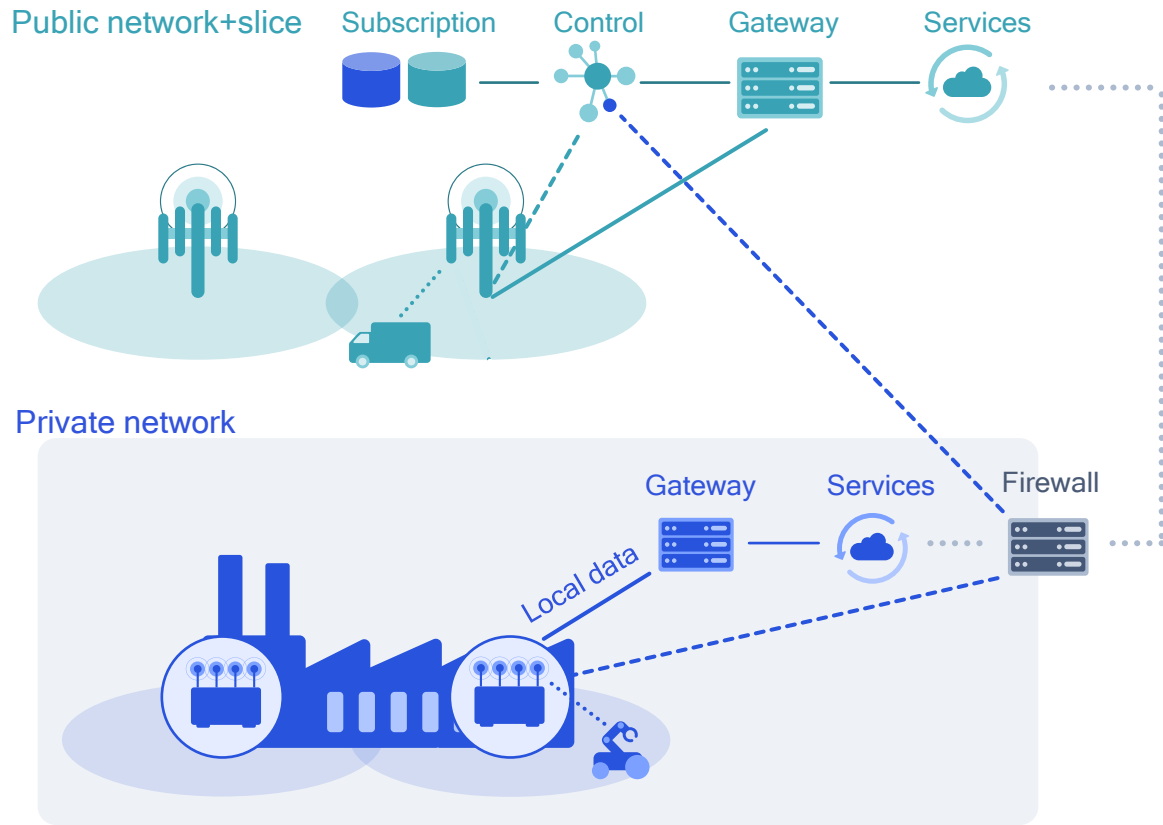
- 28.9 - 29.5 GHz and 4.72 - 4.82 GHz for 5G specialized local applications in 1H21

Taiwan

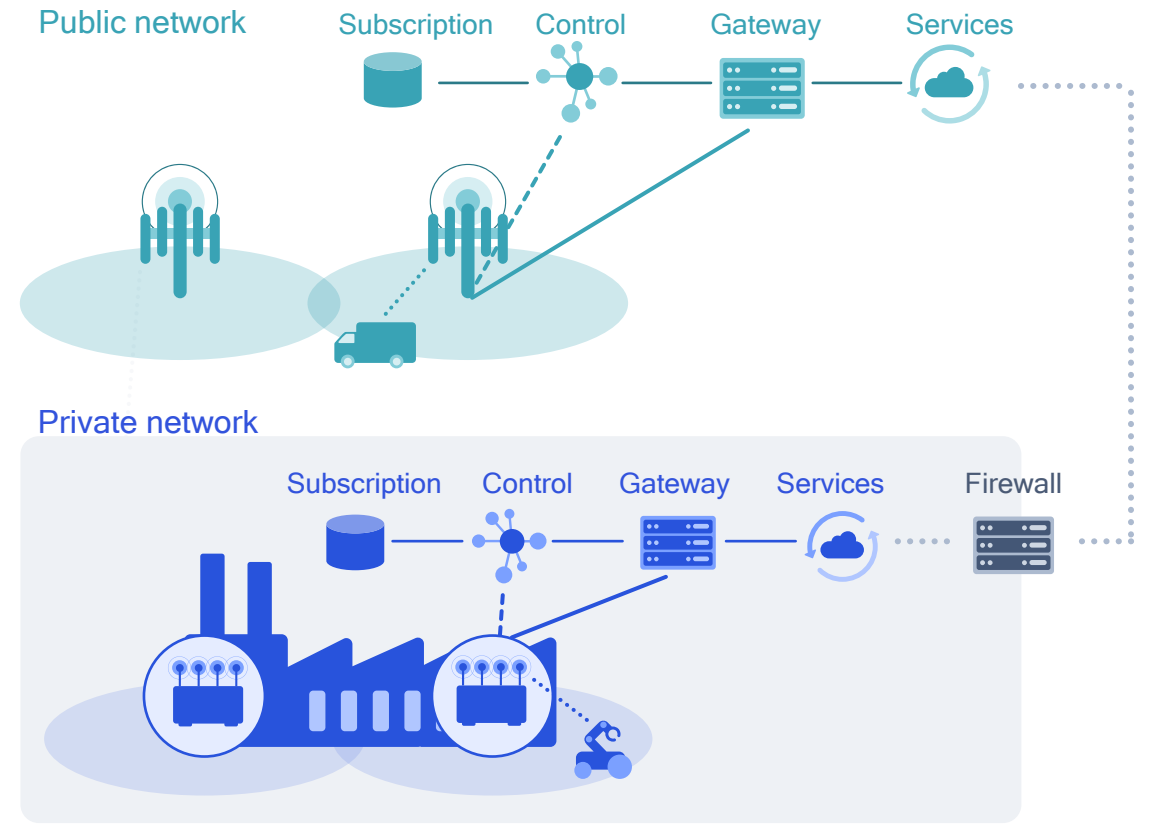


- 4.8 - 4.9 GHz for 5G local private and enterprise licenses

# Integrated private network



# Independent private network<sup>1</sup>



1) Mobility between private and public networks can still be supported via dual subscriptions

Multiple private network architectures for flexible deployments



# 5G private networks poised for growth

Growing momentum with early commercial deployments

A vibrant, global ecosystem led by 5G-ACIA, ready to scale

Comprehensive support for 5G private networks in 3GPP Rel-16

## General Motors, Honeywell

19 Nov. 2020

**Verizon Business deploys 5G Ultra Wideband indoors at General Motors and Honeywell**

<https://www.verizon.com/about/news/verizon-5g-ultra-wideband-general-motors-honeywell>

## Toyota

23 Jun. 2020

**Toyota to assess 5G private network in Japanese manufacturing center**

<https://www.lightreading.com/private-networks/toyota-to-assess-5g-private-network-in-japanese-manufacturing-center/d/d-id/761904>

## Deutsche Messe

18 Feb. 2021

**Deutsche Telekom to build 'a million square metres' of private 5G at Hanover Fairground**

<https://enterpriseinsights.com/20210217/channels/news/deutsche-telekom-to-build-private-5g-at-hannover-fair>

## Ford

25 Jun. 2020

**How Ford and Vodafone are creating the 5G 'factory of the future'**

<https://newscentre.vodafone.co.uk/news/how-ford-and-vodafone-are-creating-the-5g-factory-of-the-future/>

## Associated British Ports

1 Apr. 2021

**Verizon signs its first European Private 5G deal with Associated British Ports**

<https://www.verizon.com/about/news/verizon-european-private-5g-deal-associated-british-ports>

## Group ADP, Hub One & Air France

10 Jul. 2020

**ADP Group company Hub One, gets 10 year licence to operate 4 & 5G mobile network covering Paris-Charles de Gaulle, Paris-Orly and Paris-Le Bourget airports.**

<https://www.air101.co.uk/2020/02/adp-group-company-hub-one-gets-10-year.html>

## Yangquan Coal Industry

3 Jun. 2020

**China goes deep, with 5G network in coal mine**

<http://www.chinadaily.com.cn/a/202006/03/WS5ed78e2da310a8b24115aad1.html>

## ASE

18 Aug. 2020

**Chunghwa Telecom, ASE and Qualcomm Jointly Introduce Made-in-Taiwan Small Cell Base Stations for the First 5G mmWave Smart Factory in Taiwan**

[https://ase.aseglobal.com/en/press\\_room/content/5g\\_smart\\_factory\\_en](https://ase.aseglobal.com/en/press_room/content/5g_smart_factory_en)

## 5G-Alliance for Connected Industries and Automation (5G-ACIA)

Ensure the best possible applicability of 5G technology for connected industries, in particular the manufacturing and process industries

Manufacturing and process operators

Technology providers

Network operators





Spectrum advocacy

Collaboration with global industry bodies

<https://www.5g-acia.org/>



# Thank you

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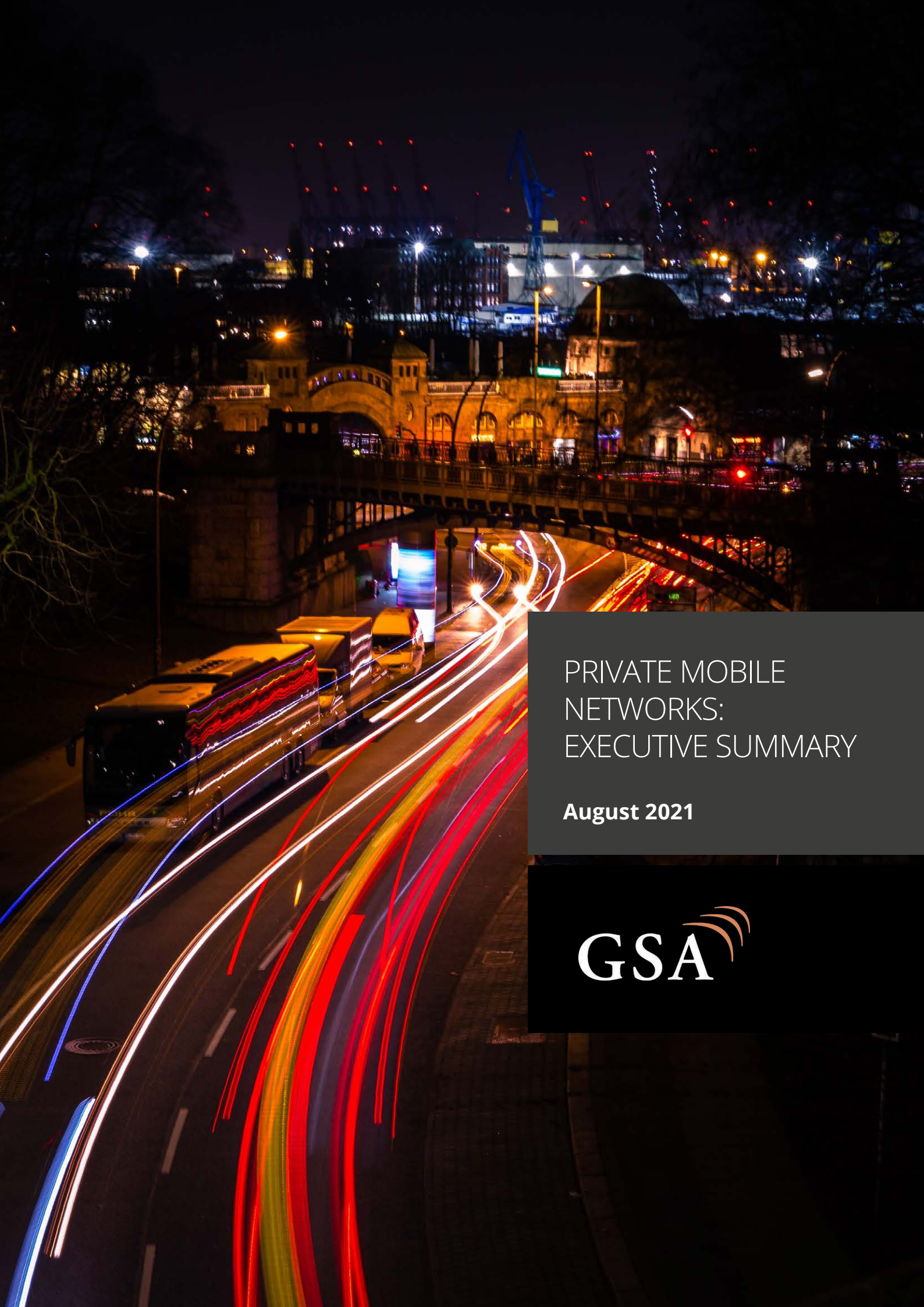
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IV.  
GSA:  
Private Mobile Networks:  
Executive Summary



PRIVATE MOBILE  
NETWORKS:  
EXECUTIVE SUMMARY

**August 2021**

**GSA** 

## Private Mobile Networks– Market Status Update

### Introduction

The demand for private mobile networks based on LTE (and increasingly 5G) technologies is being driven by the spiralling data, security, digitisation and enterprise mobility requirements of modern business and government entities. Organisations of all types are combining connected systems with big data and analytics to transform operations, increase automation and efficiency or deliver new services to their users. Wireless networking with LTE or 5G enables these transformations to take place even in the most dynamic, remote or highly secure environments, while offering the scale benefits of a technology that has already been deployed worldwide.

The arrival of LTE-Advanced systems delivered a step change in network capacity and throughput, while 5G networks have brought improved density (support for larger numbers of users or devices), even greater capacity, as well as dramatic improvements to latency that enable use of mobile technology for time-critical applications.

In addition to companies looking to develop their own private mobile networks for the first time, there is a large base of potential customers who currently operate LMR/PMR private networks based on technologies such as TETRA, P25 and DMR. These customers are demanding critical broadband services that are simply not available from alternative technologies and consequently, private mobile networks based on LTE and 5G have the potential to eventually replace much of this market.

The exact number of existing private mobile network deployments is hard to determine, as details are not often made public. In order to improve information about this market, GSA is now maintaining a database of private LTE and 5G networks worldwide.

GSA has identified 45 countries/territories with private network deployments based on LTE or 5G or LTE or where 5G-suitable private network spectrum licences have been assigned. In addition, there are private mobile network installations in various offshore locations serving the oil and gas industries, as well as on ships.

The database catalogues specific information about 370 companies known to be deploying LTE or 5G private mobile networks, or known

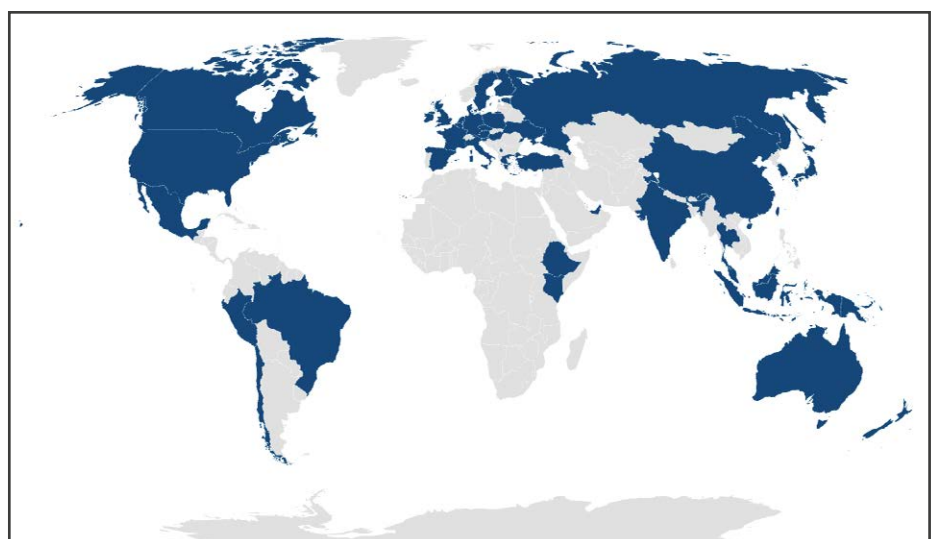
to have been granted a licence suitable for the deployment of a private LTE or 5G network (but excluding those that have deployed alternative technologies) – up from 311 catalogued organisations in the last issue.

### Private mobile networks – players and market statistics

The private mobile networks market is home to a wide range of service providers, including equipment/technology vendors, mobile network operators, systems integrators

and the private network end-users (who sometimes take responsibility for installing or operating their own infrastructure). GSA has counted nearly 50 equipment vendors that have been involved in the supply of equipment for private mobile networks based on LTE or 5G. In addition, it has identified 68 public network operators (counting national operators within the same group as distinct entities) involved with projects, so it is clear

**Figure 1: Countries/territories with identified private network deployments (pilot and commercial)**





end-users are not all breaking ties with existing mobile services providers.

GSA has been able to categorise 370 private mobile network deployments (up from 311 in our last issue), which as Figure 1 shows, are being deployed all around the world.

LAN deployments continue to outnumber WAN deployments and we would expect this disparity to continue, as there are many more potential users of smaller local networks than large regional or nationwide ones.

When information is not available about the nature of a deployment, or it is not clear if the organisation has started to use its licence, where possible, GSA uses information about the type of organisation, its activities and the coverage or scale of an awarded licence to classify it as a probable LAN or a probable WAN. In some cases, no determination is possible, in which case the classification 'To be confirmed' is used. Note that some deployments have been reclassified since the last issue of this paper to reflect new data.

LTE is used in 64% of the catalogued private mobile network deployments for which GSA has data. Perhaps surprisingly, 5G is also being deployed (or planned for deployment) in 44% of those networks.

It is not always evident whether a private mobile network deployment is intended as a pilot project only or whether a full production network is being deployed, as the end-users/contracted vendors do not always make that information available. What GSA's data suggests however, is that over 84% of identified LTE deployments are production deployments. (Note: some private mobile network projects involve both LTE and 5G.)

As we build our database, GSA's data still suggests that manufacturing is an early adopter of local area private mobile networks with 79 identified companies holding suitable licences or involved in known pilots or deployments of LANs or probable LANs (up from 51 at the start of 2021). Mining follows second, with ports also actively trialling/deploying local area private mobile networks. Meanwhile the data suggests that utilities, police/security/public safety/defence, communications/IT and rail are the biggest users of wide area private mobile networks. Companies in the communications/IT sector are key investors in private mobile networks, though

Figure 2: Private mobile network deployments by type, LAN vs WAN (base 370 networks)

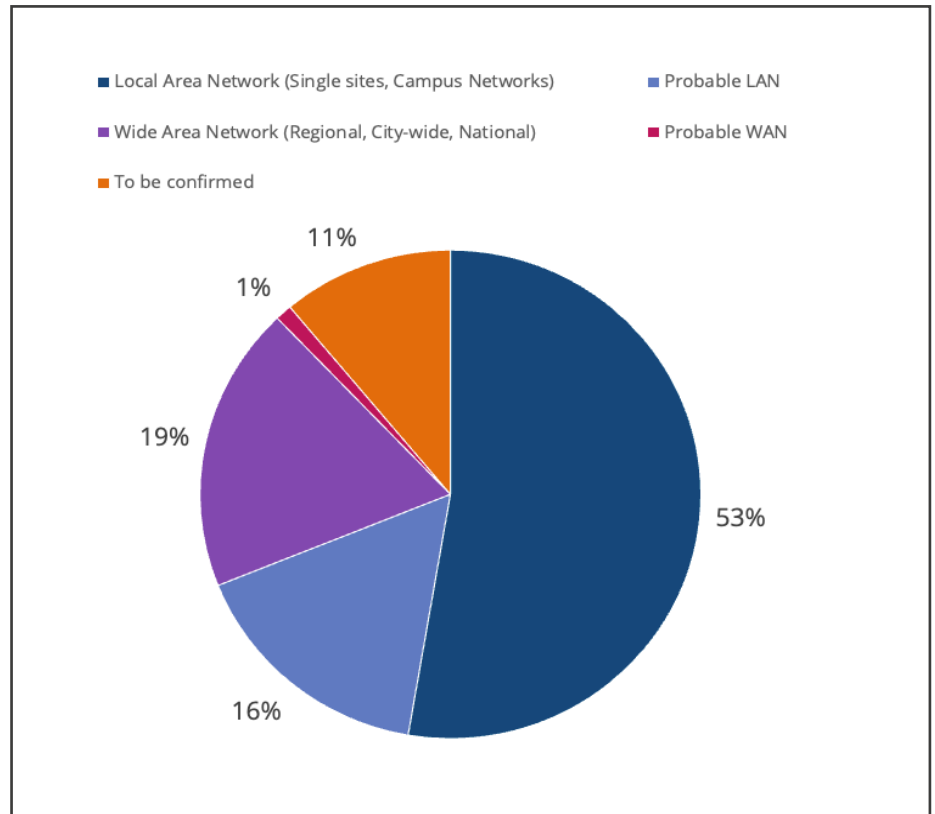
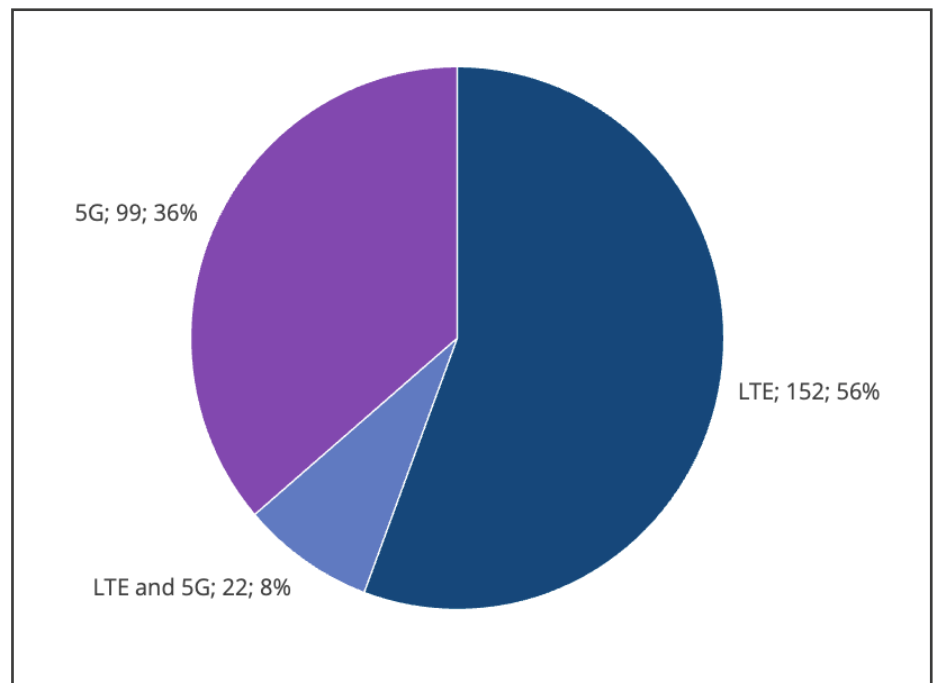


Figure 3: Private network deployments by technology (base with identified private network deployments, pilot and commercial 273 networks)



<sup>1</sup> Where organisations have subsidiaries in different countries/territories each licensed to deploy or deploying their own networks, each subsidiary is counted separately.

data is not always available to determine whether their activities encompass local or wide area applications (their licences, often held covering multiple locations, could potentially be used for multiple LAN deployments for separate clients or for wide area deployments). What is clear, though, is that after manufacturing, communications/IT companies are the second biggest group of licence holders enabling some sort of LTE/5G network deployment. (Note that some network types have been reclassified since the last issue of this paper.)

Looking in more depth at the manufacturing sector, the automotive subsector is an early leader in terms of private network investment and adoption. Automotive companies account for over a quarter (25.3%) of the 79 identified manufacturing companies holding suitable licences or involved in known pilots or deployments.

Nearly 61% of the companies involved in manufacturing are already at the production deployment stage.

### Summary

A wide range of market participants is actively engaged in developing and delivering solutions for private mobile networks. With so much opportunity and so many regulators planning initiatives to make spectrum available for LTE and 5G private usage, we can expect significant market evolution in the next couple of years. GSA will be publishing further statistical updates covering the private mobile sector during 2021.

Figure 4: Private network deployments by status: pilot project or production deployment (base 370 networks)

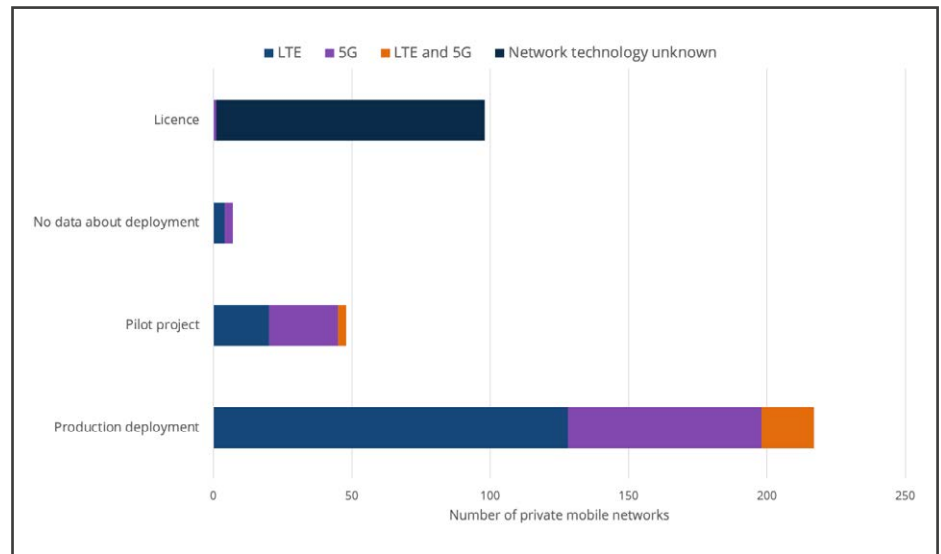


Figure 5: Number of identified private mobile network deployments by sector: commercial or trial; deploying and deployed (base 370 networks)

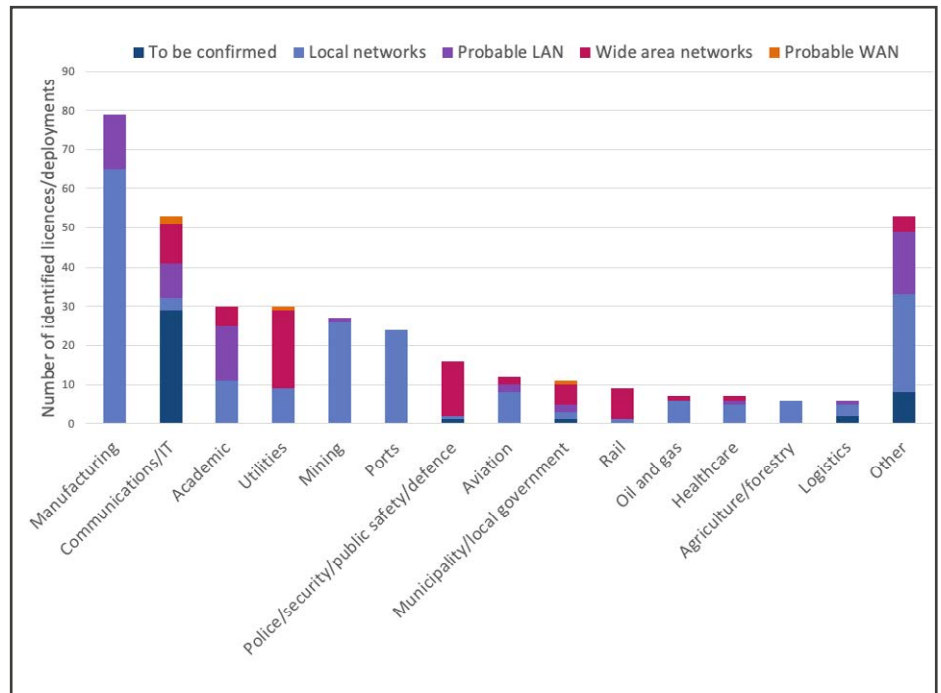
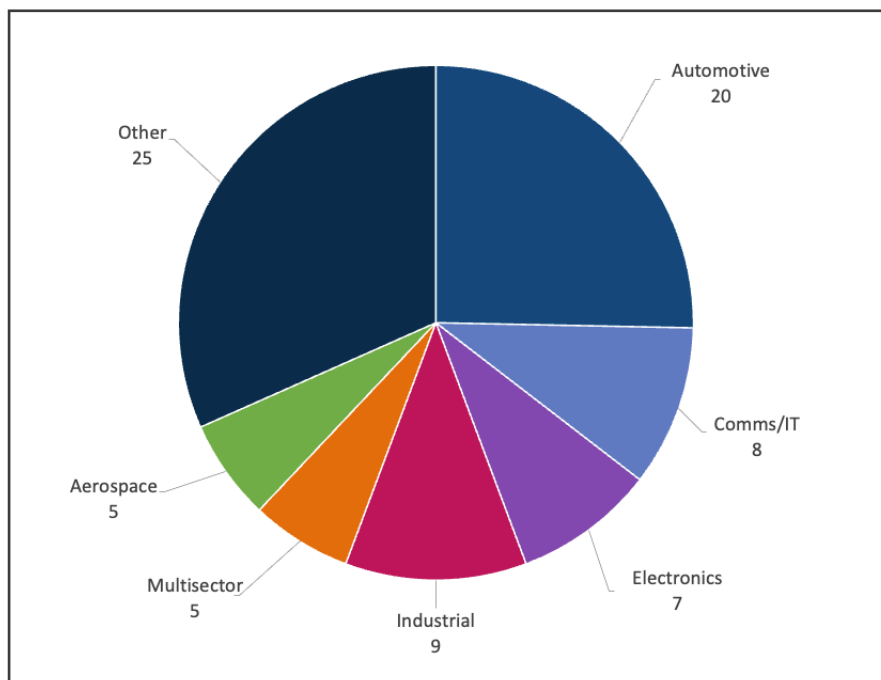




Figure 6: Breakdown of manufacturing investors (licence holders and those deploying networks) by sector (base 79 networks)



Annex 1 - Identified Private Mobile Network Licensees and Operators, by Country/Territory is available in the Member Report.

# ABOUT GSA

GSA is the voice of the global mobile ecosystem and has been representing mobile suppliers since 1998.

## **GSA GAMBoD Database**

Reports are based on data contained in the GSA GAMBoD databases which is a resource available to GSA Members and Associates. Companies and policy makers can subscribe as a GSA Associate to the database to gain insights into the source data behind reports for their own research purposes.

Discounted annual subscription are available to regulators, government agencies and mobile operators.

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V.  
Additional Resources from Partners

## Palo Alto Networks

- Examples of Palo Alto Networks partnership with the US National Institute of Standards and Technology (NIST) on 5G:
  - Our blog: [A Secure 5G: US Cyber Center of Excellence Selects Palo Alto Networks](#) (blog)
  - NIST site: <https://www.nccoe.nist.gov/projects/building-blocks/5g-cybersecurity>
  - NIST SPECIAL PUBLICATION 1800-33A: <https://www.nccoe.nist.gov/sites/default/files/library/sp1800/nist-5G-sp1800-33a-preliminary-draft.pdf> (we are listed on line 81 as a collaborator)
- A blog detailing GSMA's reference document, FS-37 "GTP-U Security", for security in the data plane. Leonid Burakovsky of Palo Alto Networks was an editor of this document.
  - <https://www.gsma.com/aboutus/workinggroups/are-we-prepared-to-deal-with-the-impact-of-cyber-threats-on-5g>
  - *The FULL GSMA FS-37 technical document is only available to GSMA members: but four Vietnamese operators are members of GSMA: Mobifone, VNPT, Vietnamobile, and Viettel- ALL can access it through their membership.*
- Two Palo Alto Networks position papers for government policymakers- our policy recommendations on what they should do to promote 5G security:
  - Securing Mobile Network Infrastructures: The Need for Constant Real-Time Visibility and Enforcement (April 2020, 3 pp) <https://www.paloaltonetworks.com/resources/whitepapers/securing-mobile-network-infrastructures.html>
  - A Comprehensive Approach to Securing 5G Networks and Data (September 2020, 6 pp) - Paper linked from blog <https://blog.paloaltonetworks.com/2020/09/securing-5g-networks-and-data/>
- Some of our 5G blogs generally:
  - Palo Alto Networks Launches Industry's First 5G-Native Security Offering <https://blog.paloaltonetworks.com/2020/11/5g-native-security/>
  - Top 5 5G Security Considerations for Enterprises <https://blog.paloaltonetworks.com/2020/09/netsec-top-5-5g-security-considerations/>
  - Tapping the True Potential of the 5G Digital Economy <https://blog.paloaltonetworks.com/2020/02/network-5g-digital-economy/>
  - How Federal Agencies Can Prepare for Secure 5G Adoption <https://www.paloaltonetworks.com/blog/2021/08/federal-agencies-secure-5g-adoption/>

## ATIS

- The set ATIS technology related white papers are listed here:
  - <https://www.atis.org/whitepapers/>
- Smart Cities Technology Roadmap
  - <https://www.atis.org/resources/smart-cities-technology-roadmap/>
- Smart Cities Data Sharing Framework
  - <https://www.atis.org/resources/data-sharing-framework-for-smart-cities/>
- Securing IoT devices and services

- <https://www.atis.org/resources/securing-internet-of-things-iot-services-involving-network-operators/>
- 5G Specifications and 3GPP North American Needs
  - <https://www.atis.org/resources/5g-specifications-in-3gpp-north-american-needs-for-the-5g-future/>
- Network Slicing and IoT
  - <https://www.atis.org/resources/iot-categorization-exploring-the-need-for-standardizing-additional-network-slices/>
- 5G Neutral Host Solutions
  - <https://www.atis.org/resources/neutral-host-solutions-for-5g-multi-operator-deployments-in-managed-spaces/>
- Multi-Network Enterprise Solutions and 5G Networks
  - <https://www.atis.org/resources/multi-network-enterprise-solutions/>

## National Institute of Standards and Technology (NIST)

- Cybersecurity Framework: Helping organizations to better understand and improve their management of cybersecurity risk
  - Main Site: <https://www.nist.gov/cyberframework>
  - International Resources (including translations and adaptations): <https://www.nist.gov/cyberframework/international-resources>
- National Cybersecurity Center of Excellence (NCCoE): Each project results in a freely available NIST Cybersecurity Practice Guide (Special Publication series 1800), which includes information and instructions organizations can use to implement an example solution for themselves. Organizations that want to adopt similar solutions can use products from our collaborating vendors, or products with similar characteristics that fit their budgets and IT infrastructure.
  - <https://www.nccoe.nist.gov>
  - 5G Security Project: <https://www.nccoe.nist.gov/projects/building-blocks/5g-cybersecurity>

## Intel

To the extent you need material on ORAN, some is available on the Open RAN Policy Coalition website. For example, the attached infographic is helpful.

- <https://www.openranpolicy.org/wp-content/uploads/2020/11/Open-RAN-Infographic-FINAL.pdf>

Information on O-RAN Alliance specifications and use cases are available at:

- <https://www.o-ran.org/>

5G Use Cases:

- <https://www.intel.com/content/www/us/en/wireless-network/5g-use-cases-applications.html>