NextG Communications R&D Gaps Report

Nada Golmie

NIST Fellow
Communications Technology Laboratory

National Institute of Standards and Technology
U.S. Department of Commerce

CTL Communications Technology Laboratory

NEXTG COMMUNICATIONS R&D GAPS REPORT

- Describes 100+ technology gaps impacting NextG communications systems related to:
  - Hardware & Higher Frequency Research
  - Spectrum Science
  - Joint Communications & Sensing
  - AI, ML, Data Privacy
  - Non-Terrestrial Networks
  - Sustainability and Energy Efficiency

- Data sourced from stakeholder working group meetings, interviews, market research

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Hardware & Higher Frequencies

Designing hardware for higher frequency spectrum improves network capacity and coverage, but requires new components and innovative measurement / modeling techniques.

Hardware & High Frequency gaps:

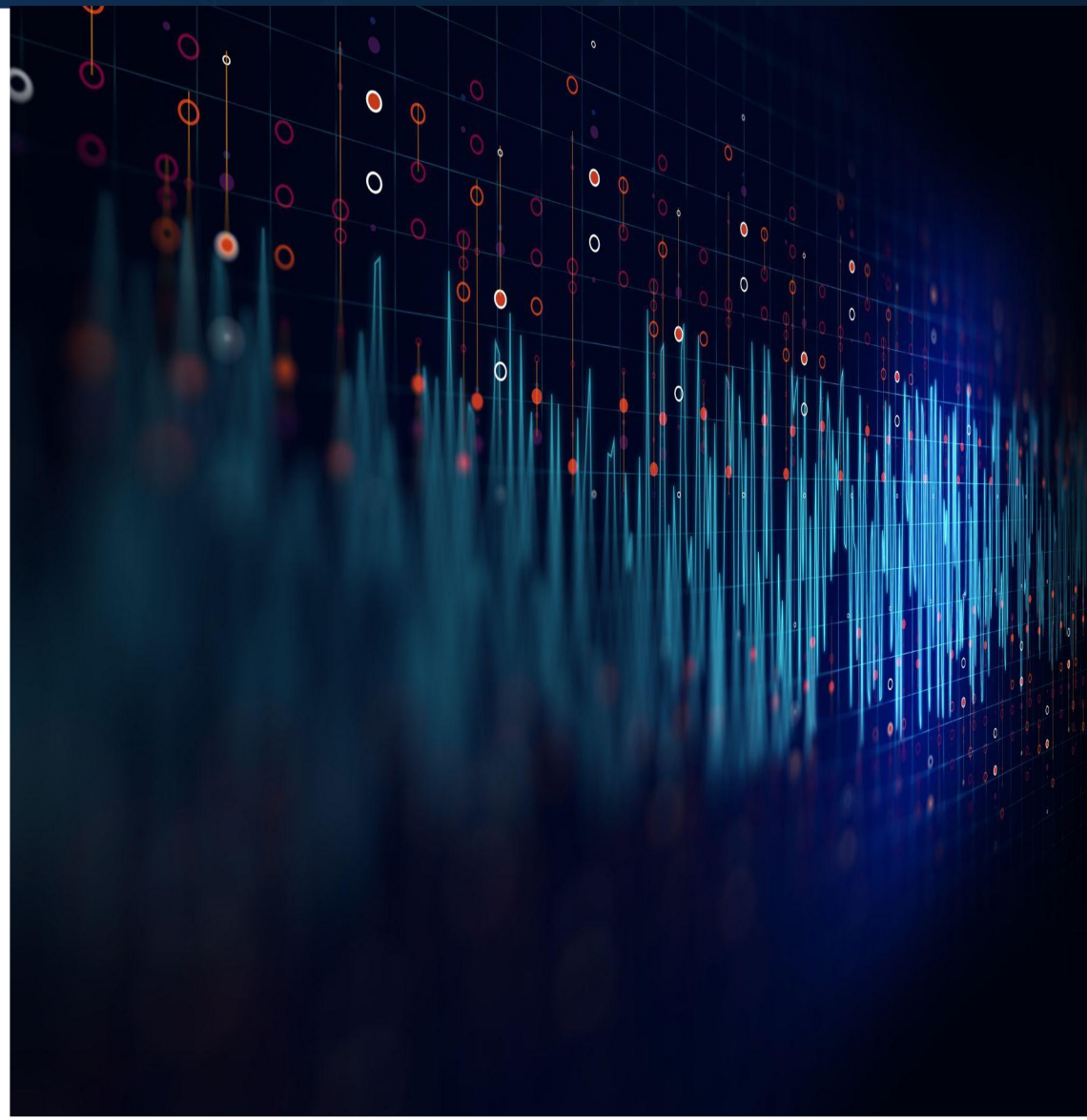
- Need to develop new antenna architectures and components with new materials
- Need to develop tunable Large Intelligent Surfaces and programmable antennas.
- Need to overcome form factor, energy consumption, cost, and processing constraints associated with mmWave deployments

Spectrum Science

More efficient methods to share and manage radio spectrum will help deliver the higher speed and data rates required for NextG applications.

Spectrum Science gaps:

- Improved propagation models focused on interference rather than coverage
- Need to evaluate and develop better spectrum sharing techniques
- NextG needs to be “Sharing Native”



Joint Communications & Sensing

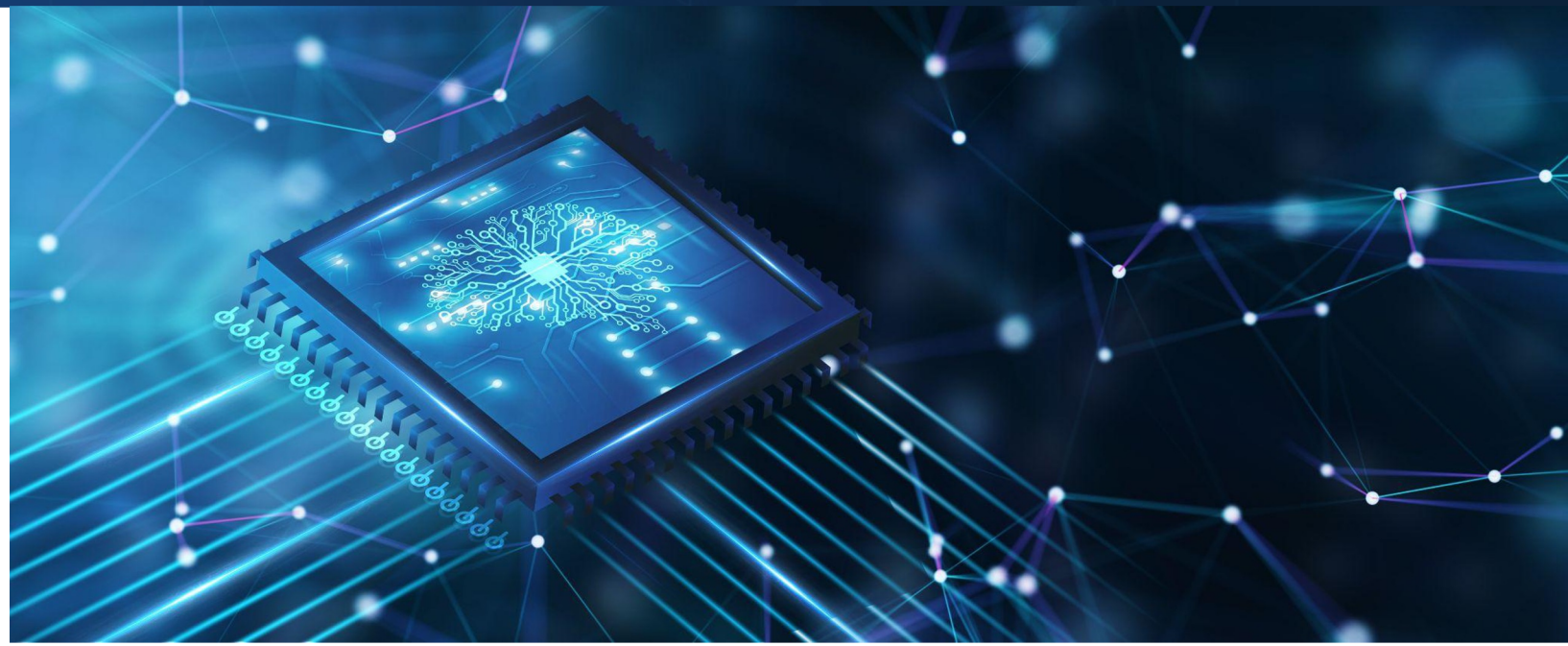
Integrating radio sensing capabilities into communication networks may enable more efficient management of devices and data, but new hardware, architectures, protocols, and standards may be needed.

Joint Communications & Sensing gaps:

- Need to design communication channel estimation signals to double as sensing signals
- Utilize sensing data to improve augmented reality, virtual reality, and metaverse interactions
- Need to use sensing information as part of network configuration and tuning, including side information from other sensing systems

Artificial Intelligence and Machine Learning

Wireless communications systems require native AI and ML capabilities at every network layer to improve efficiency, accuracy, and performance.



Artificial Intelligence and Machine Learning gaps:

- Need to equip single and multi processing blocks with machine learning capabilities to support an AI-native air interfaces
- Need to enhance AI/ML computations over resource-constrained and dynamically varying wireless networks

Data Availability, Use, and Privacy

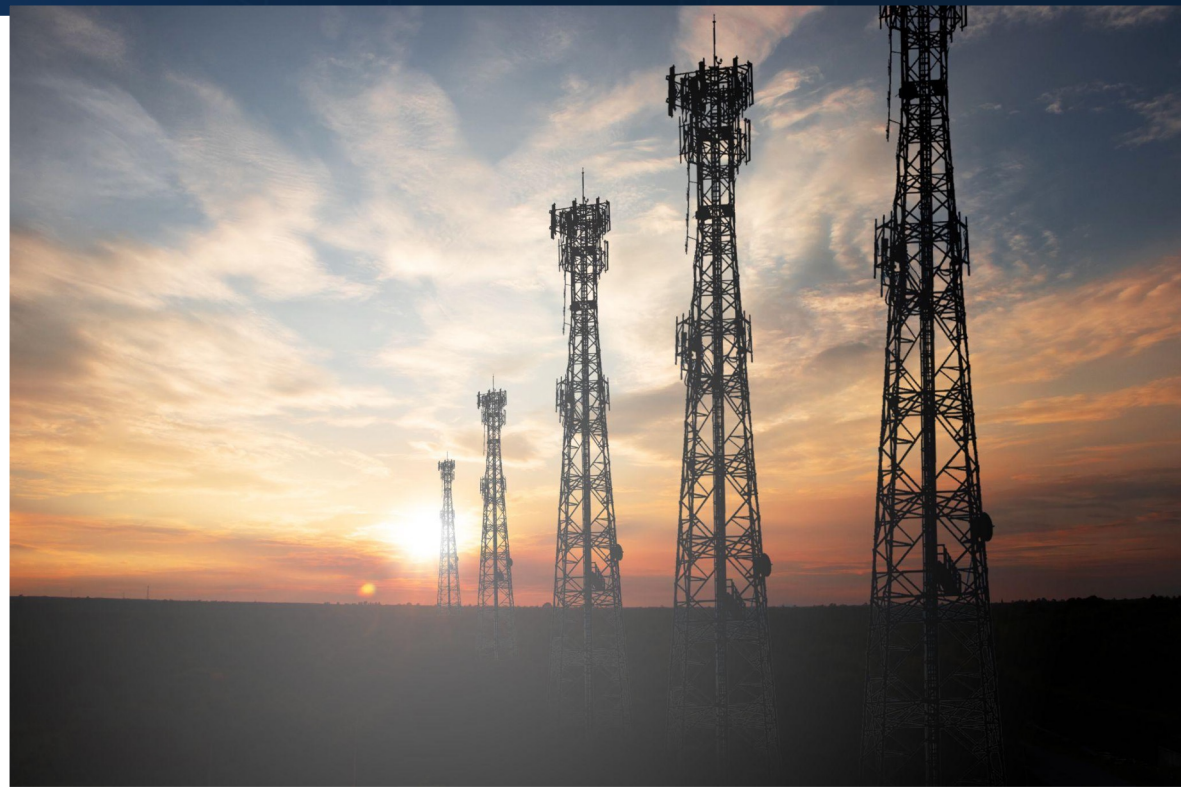
The proliferation of data-intensive applications requires updated rules and technologies to manage and analyze information while maintaining user privacy.

Data Availability, Use, and Privacy gaps:

- Need to develop confidential computing and privacy engineering capabilities
- Need to enhance data availability through replication for machine learning failures
- Need to increase trust and confidence in data
- Need to develop frameworks for encrypting data during analytical processing

NextG Network Architectures

Future networks require more flexible, interoperable architectures to support the increased diversity of NextG applications and devices, and offer more cost-effective services.



NextG Network Architecture gaps:

- Need to enable user equipment to communicate directly in short range, using device-to-device (D2D) communication protocols
- Need to integrate and accelerate the development of Open Radio Access Networks (OpenRAN)

Non-Terrestrial Networks

Non-terrestrial networks (NTN), offer global, cost-effective, and high-capacity connectivity in a three-dimensional architecture that integrates with terrestrial infrastructures.

Non-Terrestrial Network gaps:

- Need to decrease Round Trip Time (RTT) in non-terrestrial networks
- Need to design smart sensors for positioning and monitoring
- Need for multi-layer system integration

Sustainable and Energy-Efficient Networks

NextG communication systems need to prioritize energy efficient design to balance network performance and sustainability.

Sustainability and Energy-Efficiency gaps:

- Need to develop energy consumption models and metrics for NextG systems
- Need to improve coordination between the converging energy and telecommunications industry for better grid / utility management

Thank you!

Questions?

nada.golmie@nist.gov