Next G Alliance Overview and Research Priorities on 6G Technologies

NEXT G ALLIANCE
An ATIS Initiative

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Opening Thoughts

NEXT G ALLIANCE
An ATIS Initiative

How will future 6G applications impact my life?

What is the 6G killer app?

Will 6G be evolutionary or revolutionary?

What are the key industries that will benefit?

How will consumers benefit from 6G?

How will 6G enable the metaverse?

Application Classes and 6G Advantages

Everyday Living

Service robots for home assistance

Indoor/outdoor delivery services

Intelligent travel assistance

Experience

Real-time interactive gaming

MR entertainment

MR-powered classrooms

XR-enriched transportation

Critical Roles

Digital twins

Robotics for hazardous conditions

Remote surgery, therapy & monitoring

Manufacturing & agriculture

Societal Goals

Digital equity

Cultural and civic participation

Public safety

Sustainable society

Change How We Live

Home-based patient care

Remote surgery
and medical scanning

AI-enabled patient digital twin

Ambient assisted living

Connected ambulances

V2x safety improvement and
awareness

Autonomous, coordinated and
remote driving

Real-time 360° situational
awareness

Leveraging innovation for
education

Metaverse experiences

Immersive knowledge and
learning

Hologram receivers

Next Gen mission critical
communications

AR headsets and glasses

Networked robots and
UAVs

Change How We Work

Factories of the future

AI-managed automatic guided vehicles

Massive sensors to manage environment and resources

High precision irrigation and fertilizer treatments

Massive sensing and remote actuation

Ubiquitous outdoor coverage with mobility between terrestrial and NTN modes

Extreme connectivity

Tele-operation for hazardous environments

Use of digital twin replicas

High precision accuracy and tracking

Urbanization density and access to resources

AI-driven data decision-making

NGA Overview

NGA – 6G Initiative

> ATIS formed Next G Alliance in late 2020

> "Roadmap to 6G" published February 2022 provides foundation for North American 6G vision and leadership

Next G Alliance Report:
Roadmap to 6G
February 2022

> Broad ecosystem of contributors

Next G Alliance Membership

Operators
Vendors
Hyperscalers
Academia
Government
Research Labs

> More than 800 experts across 100+ members

Foundational Goals

Next G Alliance Agenda

Private sector, academia and government collaborate to position North America as the global leader for Next G technologies.

North American Model for Success

A comprehensive model built on North American 6G technology developments, R&D needs, standards goals and market readiness.

6G Market Leadership

Strategies that will lead to rapid commercialization and adoption of Next G technologies across domestic and global markets.

North America's Six Audacious Goals

> Top priorities for North America's contribution and Next G leadership

> Collective set of goals serving as NGA's compass

> Addresses multiple stakeholder interests

Sustainability

Trust, Security, and Resilience

Digital World Experiences

AI-Native Wireless Solutions

Audacious Goals

Cost-Efficient Solutions

Distributed Cloud and Communications Systems

Founding and Full Members

Contributing Members

ANALOG DEVICES	Anritsu Advancing beyond	CableLabs®	CASE WESTERN RESERVE UNIVERSITY EST. 1826	cohere technologies	COMCAST	COMPAL	DEEPSIG
NTT docomo DOCOMO Innovations	FAU FLORIDA ATLANTIC UNIVERSITY	FIU FLORIDA INTERNATIONAL UNIVERSITY	FUJITSU	FUTUREWEI Technologies	GEORGE MASON UNIVERSITY	GEORGETOWN UNIVERSITY	HYUNDAI
imec	Institute for the Wireless Internet of Things at Northeastern University	INTELSAT	ITRI Industrial Technology Research Institute	APL JOHNS HOPKINS APPLIED PHYSICS LABORATORY	Mitacs	me mobile experience	motorola
MOTOROLA SOLUTIONS	muRata INNOVATOR IN ELECTRONICS	NC STATE UNIVERSITY	Northwestern University	NYU WIRELESS	ofinno	OLD DOMINION UNIVERSITY	Peraton LABS
PSBN Innovation Alliance	PURDUE UNIVERSITY	QORVO	ROHDE&SCHWARZ Make ideas real	Schneider Electric	SPREADTRUM	STEVENS INSTITUTE of TECHNOLOGY THE INNOVATION UNIVERSITY	SUNY POLY
TDK	Tektronix®	TERADYNE	UCDAVIS	University of Manitoba	UNIVERSITY OF MARYLAND	UNIVERSITY OF NOTRE DAME	VDI
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Government Members
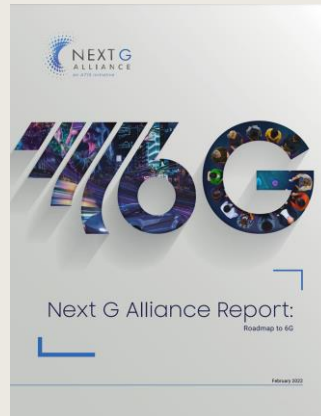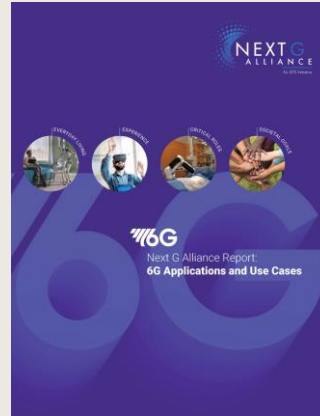
Next G Alliance Reports

The Path
Toward
Sustainable
6G

Roadmap
to 6G

6G
Applications
and
Use Cases

6G
Technologies

6G Distributed
Cloud and
Communicati
ons System

6G Trust,
Security, and
Resilience

Research Priorities – 6G Technologies

Realizing the Next Generation of 6G Radio Systems and Devices

Advanced MIMO and High Frequency Bands

To build upon and extend the 5G multiple-input and multiple-output (MIMO) framework and leverage the abundance of spectrum at mmWave, sub-THz (100 GHz to 300 GHz) and THz (300 GHz to 3 THz) frequencies can enable new use cases such as holographic services.

- XR, THz interconnects, data center inter-rack connectivity
- IAB, high positioning accuracy, critical medical communication, non-invasive health monitoring
- Smart vehicle keys, peer-to-peer SOS messaging, device-to-device based mesh networking, swarm communications

New areas of mmWave/THz/sub-THz communications would further extend North American leadership into the next generation and help usher wireless communications into the Tbps regime.
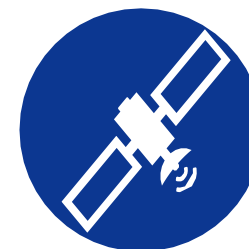
6G Air Interfaces

Radio technologies for new topologies and networking such as User Equipment (UE) cooperative communication, Non-Terrestrial Network (NTN), and mesh networking will support new types of connectivity.

- Coexistence of TN with NTN
- Full duplex, mmWave, cmWave, and subTHz deployments

Air interface enablement for distributed computing and intelligence is a key enabler for incorporating mobile device computing into the 6G wide-area cloud and allowing efficient computing and workload distribution.

Joint Communications and Sensing (JCAS)

JCAS is envisioned as a key technology for 6G communication systems to improve mutual performance with coordinated operation of communications and sensing.

- Coexistence for spectrum sharing, hardware reuse, and interference management
- Visualization of the environment among many sensing nodes
- Physical layer should be capable of detailed sensing for characterization and pass the details in real-time

Tradeoffs between sensing and communication performance, channel modeling for sensing, waveform- beamforming design, co-existence, cooperation and co- design between sensing and communication.
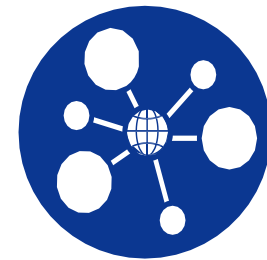
Spectrum Sharing

To alleviate bandwidth availability constraints for public and private networks advanced spectrum sharing approaches can also be employed when allocation of exclusively licensed spectrum is not feasible.

- New techniques that approach performance of exclusively licensed spectrum
- (Near) real-time sharing
- Expanded and efficient sharing
- Mechanisms for exchange for federal and commercial stakeholders

Develop techniques that improve spectrum-sharing efficiency and predictability of radio resources of 6G use in a manner that they approach the performance of exclusively licensed spectrum.
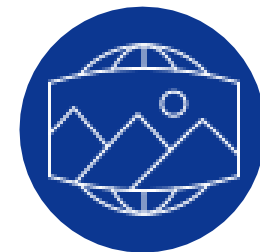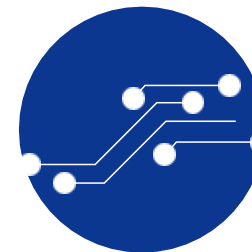
Component Technologies

Semiconductors are the enablers of digital wireless communications. Information and signal processing occur in digital, analog, and Radio Frequency (RF) domains.

- Semiconductor technology, circuits and sub-systems, antenna, packaging and testing, and holographic technologies

6G will require advanced 3D display technology (holographic capability) and continued advancements in semiconductor packaging, antennas and RF components.

Natively Integrating AI/ML into Networks, Systems, and Devices
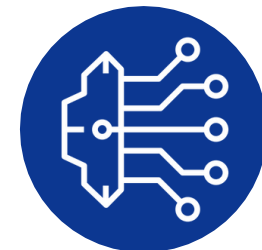
AI Native Interface

Integrating native AI/ML into the design of an air interface for 6G systems will facilitate joint optimization of network and device operations, and autonomous network operation.

- Adopting a data-driven approach to facilitate autonomous network operation and optimization
- Adapting to changing environment
- Stringent 6G performance requirements

AI-based air interface design and air interface enablement for distributed computing
and intelligence will allow end-to-end native AI and true convergence of communication and computing.

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Mechanisms for AI/ML Performance Evaluation

Establishing mechanisms for AI/ML performance evaluation with relevant parameters and KPIs, with the goal of making AI/ML approaches explainable and accountable.

- Establishing mechanisms for performance evaluation with relevant parameters and Key Performance Indicators (KPIs)
- Unified framework for collecting relevant datasets
- AI/ML power consumption models

Enhancements to the service management and orchestration framework, data management frameworks, and intelligent network control and automation frameworks.
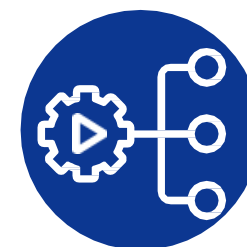
AI/ML Integration

Identifying and handling issues introduced by AI/ML native integration into systems, components, and devices.

- Issues such as additional overhead, resource requirement and power consumption

Lifecycle management in areas related to data preparation, modeling, AI operations, policy/intent enforcement, and enrichment of data collection.

Cognitive Systems and Extreme Automation

Cognitive systems and extreme automation for user-centric network, device and service, design and optimization.

- Cognitive systems and extreme automation for user-centric network, device, and service design and optimization
- Cognitive impact of Digital World Experiences (DWEs)

Achieve greater reliance on dynamic, automation capabilities across communications, computing, device, interface, service enabler, and spectrum resources.

Trustworthy AI

Explainable and ethical behavior from network-hosted AI models with auditing of service exposure to AI capabilities and privacy protection.

- Trustworthy AI/ML operation and inference
- Confidential computation and storage for proprietary AI models for network clouds

Application of AI/ML to services such as user authentication, access control, anomaly detection, and attack detection.

Transforming Systems to Fully Leverage/Enable Distributed Cloud and Communications

Distributed Cloud Platform

Reconsidering the boundaries of the network to include the edge and the cloud domains and to allow for joint optimizations across multiple domains belonging to different stakeholders.

- Service discovery, chaining, coordination, and automation
- Interplay between communication and computing functions
- Limitations due to dynamic environments
- Heterogeneity of the computing environment and the 6G infrastructure

Evaluate design approaches to assess the right level of coupling between communication and computing for optimized scalability, complexity, and performance of distributed cloud platforms.

Air Interface for Distributed Cloud

Air interface features to enable distributed computing services and smart resource management in 6G, and address specific computing workload requirements.

- Enabling intelligence across device and network
- Smart resource management in 6G system
- Computing workload requirements and cooperative tasks
- Joint optimization of compute model/data

Enabling distributed computing services and smart resource management in 6G systems including joint computing resource control and communication resource control.
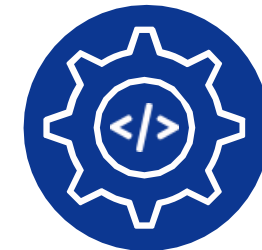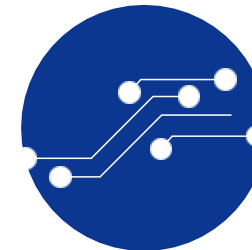
Network Disaggregation

Deconstruction of monolithic networking systems into separate components or subsystems, allowing selective integration of these components according to differing requirements, technology choices, or different vendor origin.

- Hardware (H/W) and Software (S/W) with increasing role for open H/W and S/W platforms
- Separation of control, management, and user/data plane functions
- Radio access into components that implement discrete functions at different network layers

Applying network disaggregation at a foundational level enables physical separation, such as geo-distributed deployments across sites and proper placing algorithms to determine optimal hosting cloud for components.
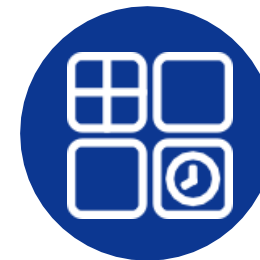
Enhancements to Application Frameworks

6G system will require a rich ecosystem of 6G application services integrating with the 6G core network and 6G radio access network.

- Changes in user policies and allocation of network resources
- On-demand Quality of Experience (QoE) provisioning based on application requirements
- Automated and accountable management and user visibility of services
- End-to-end trust, security, and data privacy

Methods to support dynamic changes in user policy and allocation of network resources for a variety of sensing applications, specialized subnetworks and functions that exchange metrics.

Achieving Trustworthy, Secure and Resilient Solutions for North America
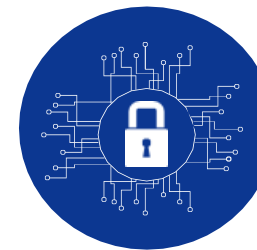
Security By Design

For 6G, it is critical to incorporate data privacy and security aspects natively into the system architecture and HW/SW design.

- Quantum security and post-quantum cryptographic techniques
- Joint optimization of compute model/data
- Realization of zero-trust principles for 6G security with real-time anomaly/threat detection and automated threat mitigation

Achieve secure chain of trust across each system component using various design techniques.

Trustworthy Networks and Devices

Confidence in the ability that a system performs as expected in the face of environmental disturbances, impairments, errors, faults, and attacks.

- Enhanced network observability for network performance management and resource provisioning
- Storage and processing solutions for identity management
- Analyzing workflows for key security metrics
- Defining threat detection and response in cloud-based identifiers

Creating a robust network infrastructure to support enhanced monitoring of service metrics and threat detection using secured datasets and data driven techniques.

Resilient Infrastructure

Meet the increasing need to harden infrastructure against catastrophic events, including extreme weather, and how to deploy temporary coverage in the event of emergencies.

- Near zero energy devices powered by energy harvested from ambient energy sources to support a diverse set of commercial, industrial, and defense applications
- Hardening 6G infrastructure against extreme weather events, and how to deploy temporary coverage in the event of emergencies

Innovative approaches to detecting and mitigating anomalies or disturbances and the development of near-zero energy communications and zero energy devices.

User-Centric Privacy

Improving the security of identities, privacy, data, and protocol stack, including decentralized trust approaches.
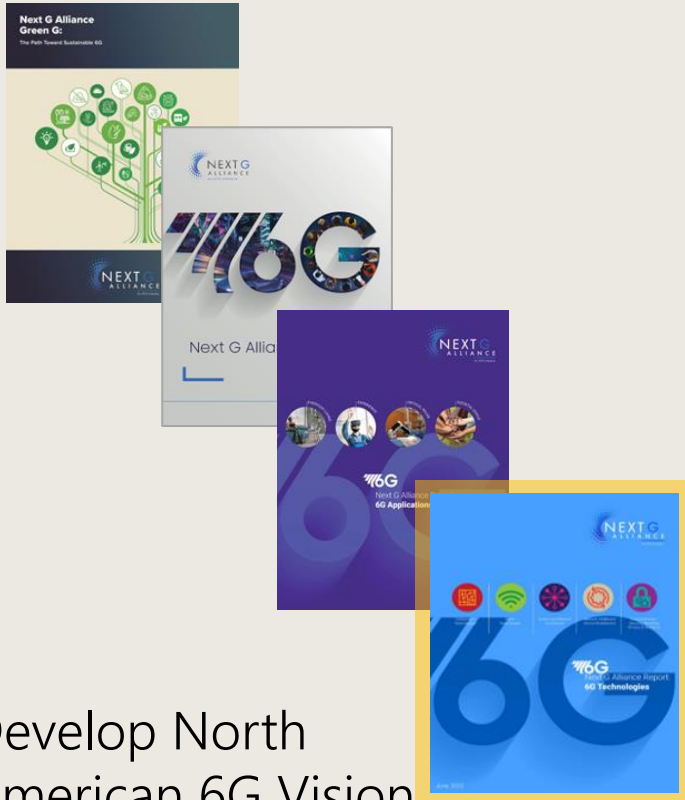
- Understanding of privacy concerns and proper technology to facilitate secure collaboration between entities
- Improved security of identities, privacy, data, and protocol stacks

Assessing 6G-enabled technology-based approaches to privacy that assure greater user control and are well-aligned with existing and future legal/regulatory privacy frameworks.
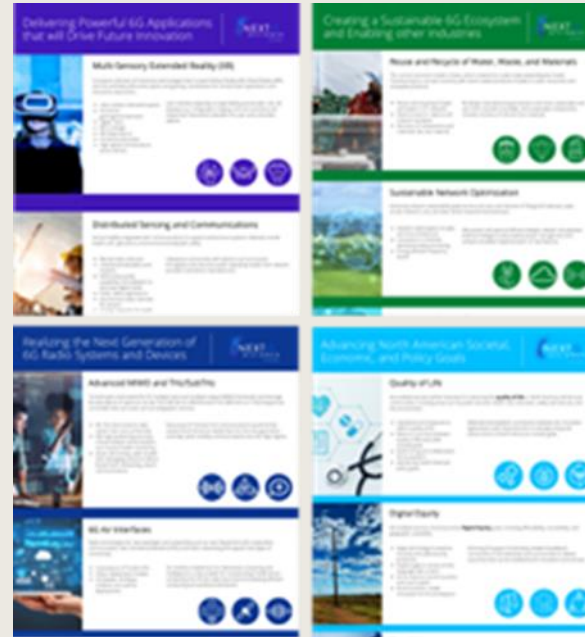
Closing Remark

The Journey to 6G

Develop North
American 6G Vision

https://www.nextgalliance.org/research-priorities/

Align on a collective set
of 6G Research Priorities

*Create 6G Public Private
Partnership for Next Frontier
of Innovation and Investment*

North American Voice
to 6G Global Activities

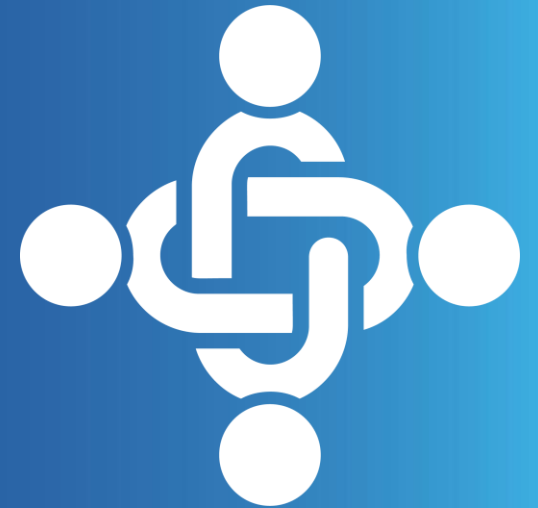Established collaboration relationships with global 6G partners

Contributions to ITU-R IMT-2030 covering North American vision

Collaboration is the Key to Success

NGA is progressing an action-oriented agenda:

> Foundational documents lead to recommended priorities and actions

> Prioritization of 6G research aligned to NGA vision and North American needs

> Increasing the velocity of 6G research and collaboration across the ecosystem

> Holistic approach that leverages research outcomes to promote
  new opportunities (e.g., jobs of the future, education, innovation, and future
  societal needs).

North American 6G leadership through collaboration across government, industry, and academia