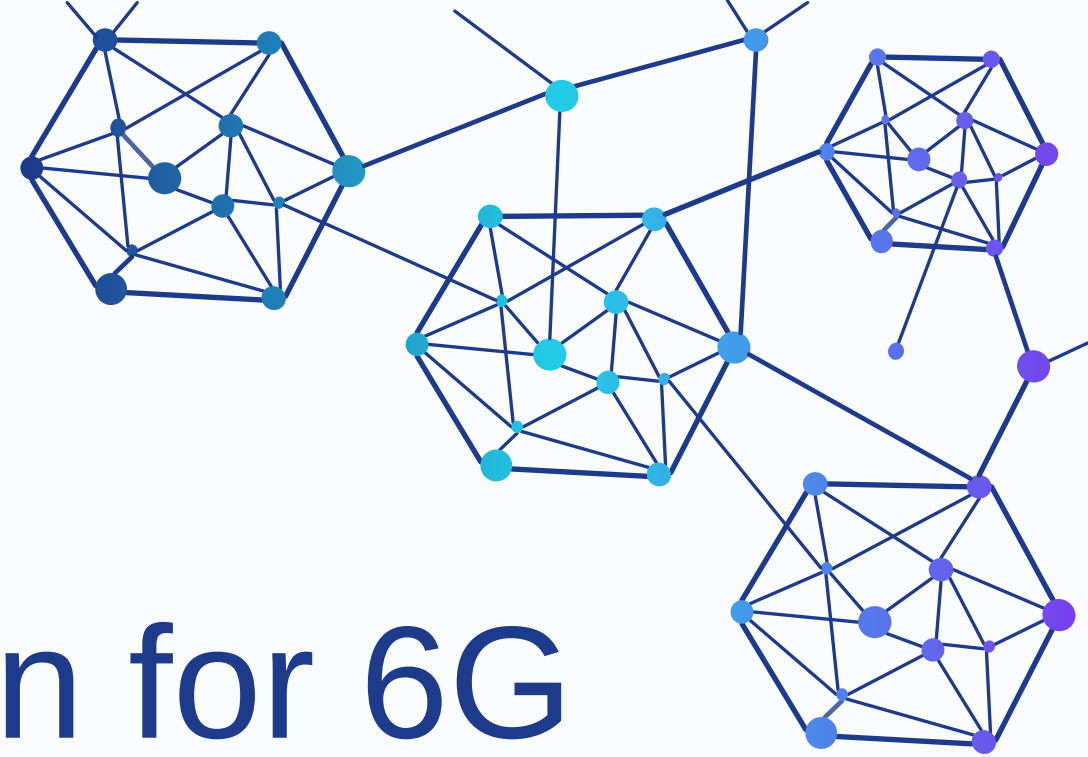


RAN Evolution for 6G

Prof. Rohit Budhiraja | IIT Kanpur

International Workshop on 6G Standardization

18th March 2026, Vigyan Bhavan, New Delhi

6G Goals

- Customer Experience

  Improved customer experience via high-quality services and ubiquitous coverage

- Efficiency

  Cost reduction via simplified systems and operations, with AI-driven automation

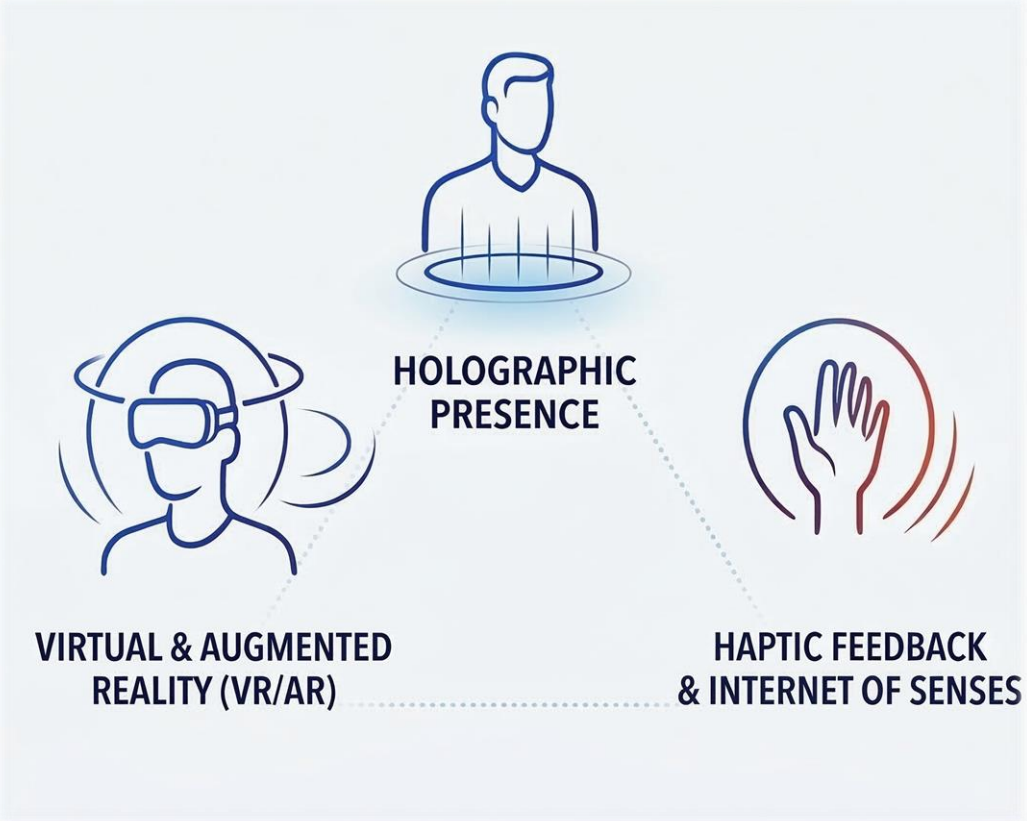
- Sustainability

  Includes energy efficiency, and contributing to global emissions targets

- Revenue Growth and monetization

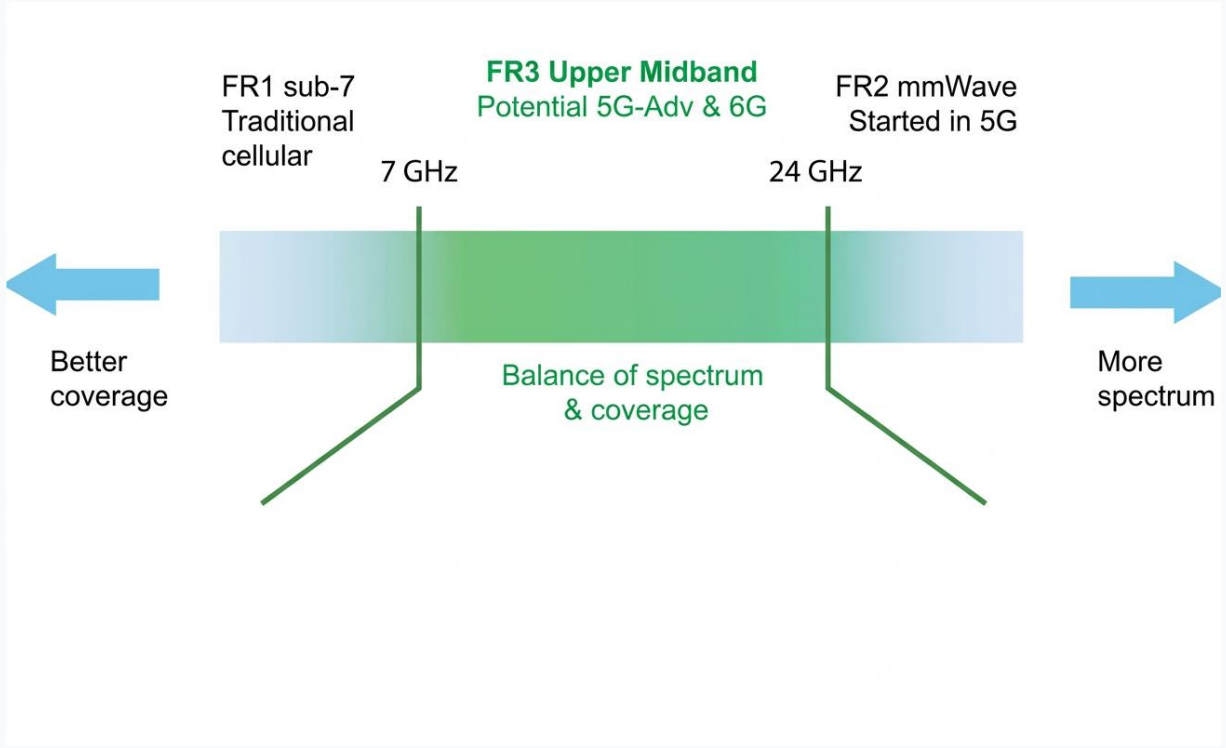
  Operators should be profitable

Immersive Communication



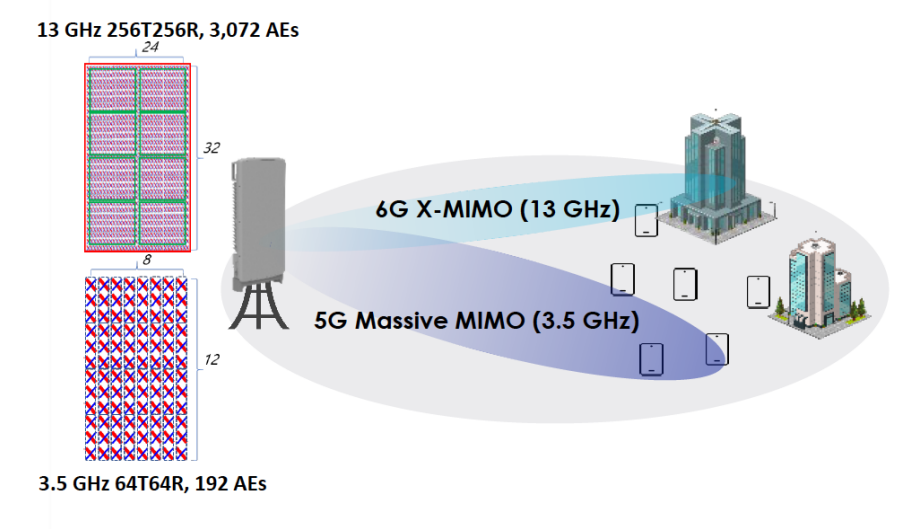
- 6G is to have peak data rates of:-
  - Downlink 36 Gbit/s.
  - Uplink 18 Gbit/s.
- 6G to support maximum
  - single carrier bandwidth of 400MHz
  - up to 600 MHz of aggregated bandwidth
- Enhanced Modulation and coding
  - DL 4K QAM
  - UL 1K QAM
- Enhanced duplexing flexibility
  - TDD, FDD, Sub-Band Full Duplex

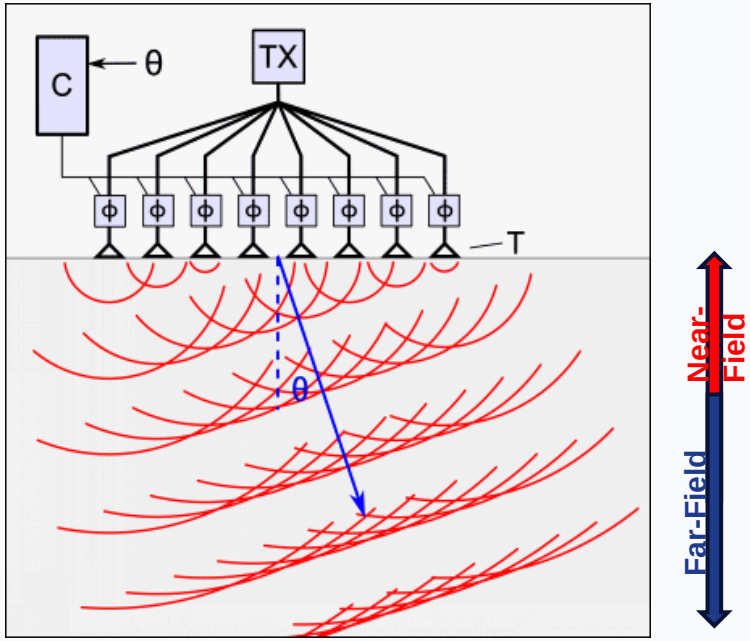
Immersive Communication - Spectrum



- Support for existing FR1 & FR2 spectrum to continue
  - Performance and efficiency enhancements needed
- Support for new spectrum in upper mid band critical
  - Desire for deployments based on existing mid band cell site grid
  - Evolution of multi-antenna technology

Immersive Communication – XL-MIMO

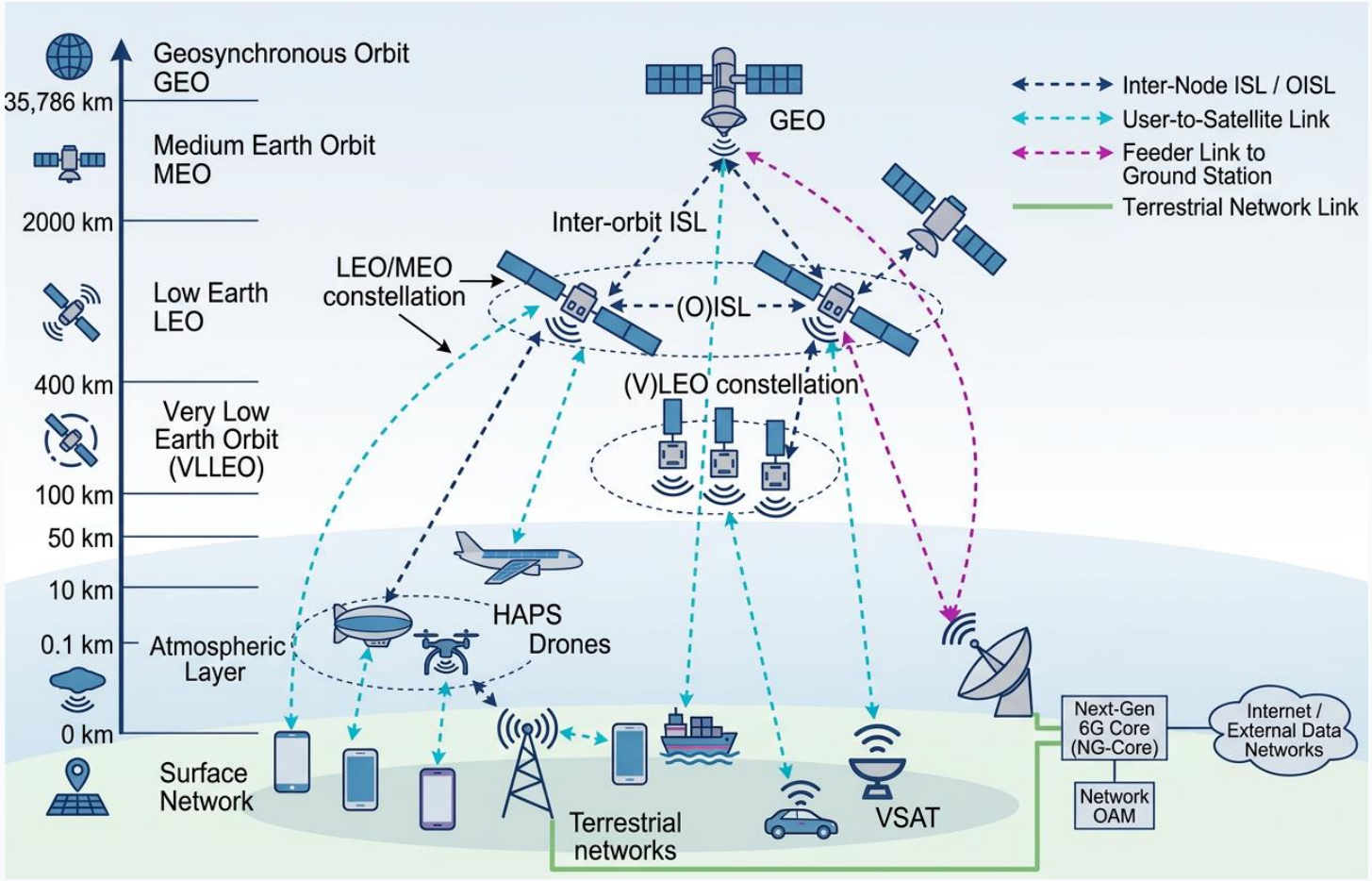




- Optimized pilots for large antenna arrays
  - >128 antenna ports e.g., **256/512**
- Unified Codebook for diverse mobility
  - Flexible codebook design for low- and high-mobility scenarios
- Efficient Beam Management & CSI Reporting
  - Improved beam tracking and feedback to reduce overhead and latency

Ubiquitous Coverage

- 6G RAN to inherently support Terrestrial Network + Non-Terrestrial Network
- Use satellite access to provide backhaul services to local area networks on aircraft, vessels



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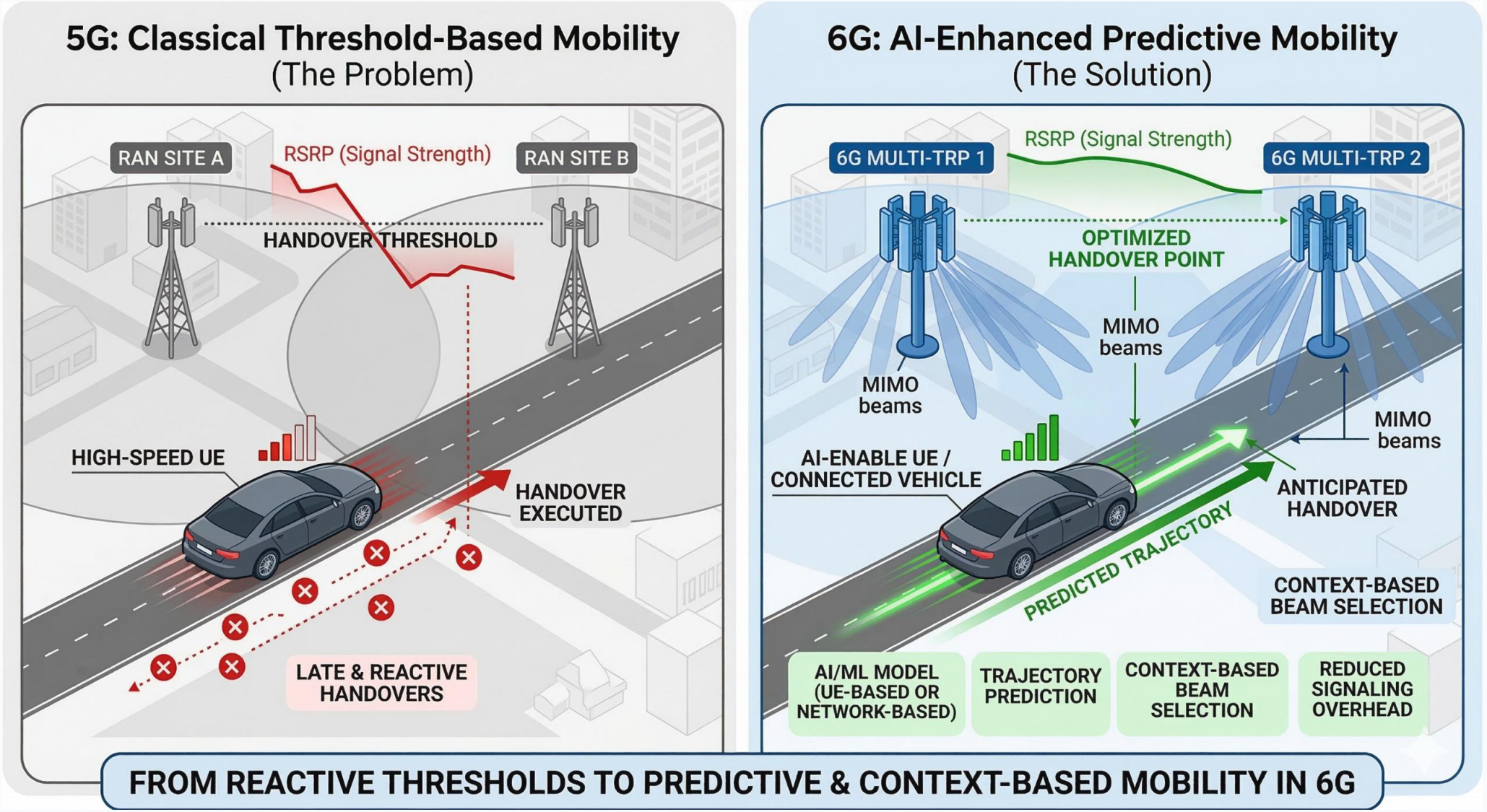
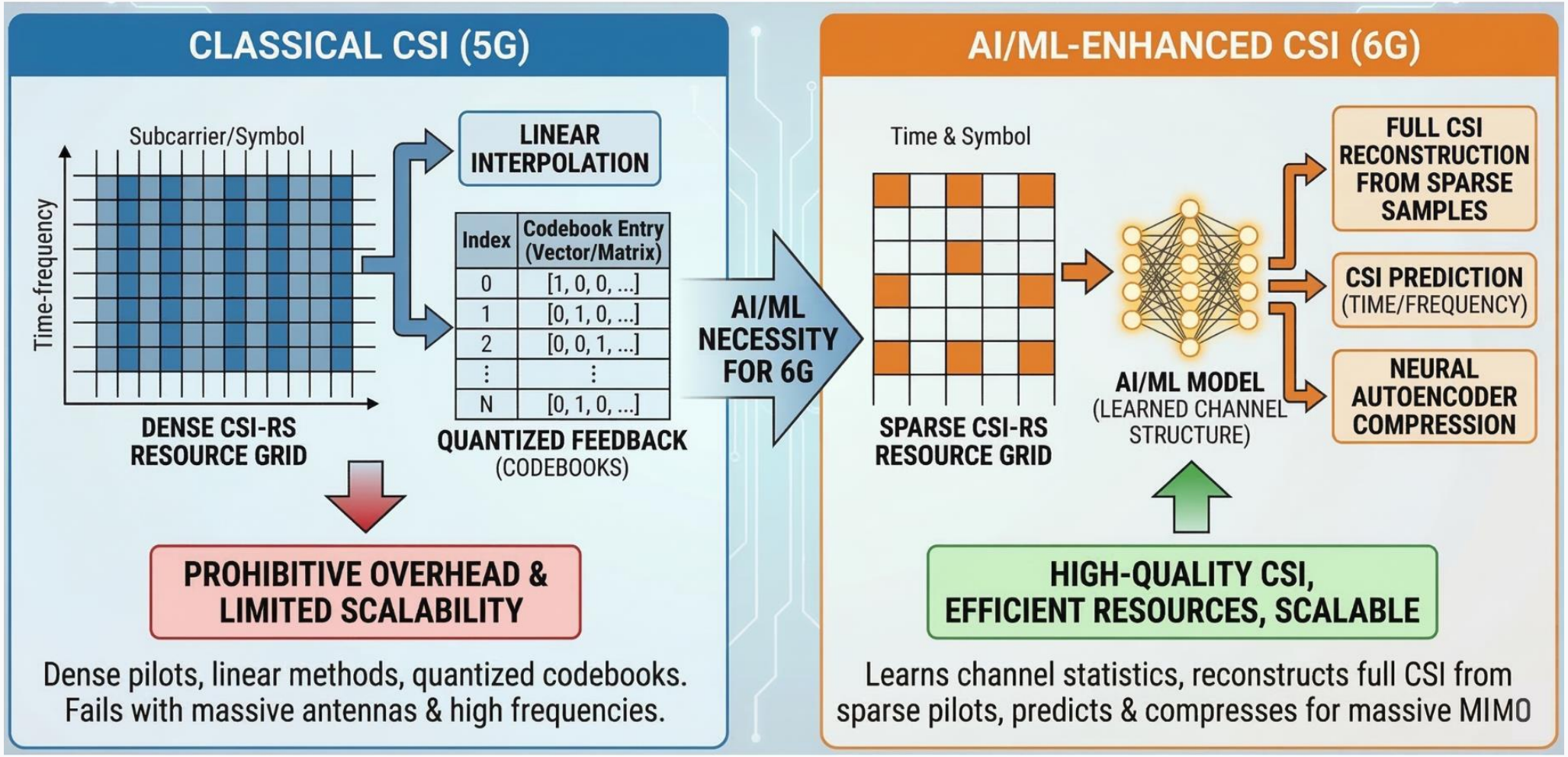
Efficient 6G Network With AI

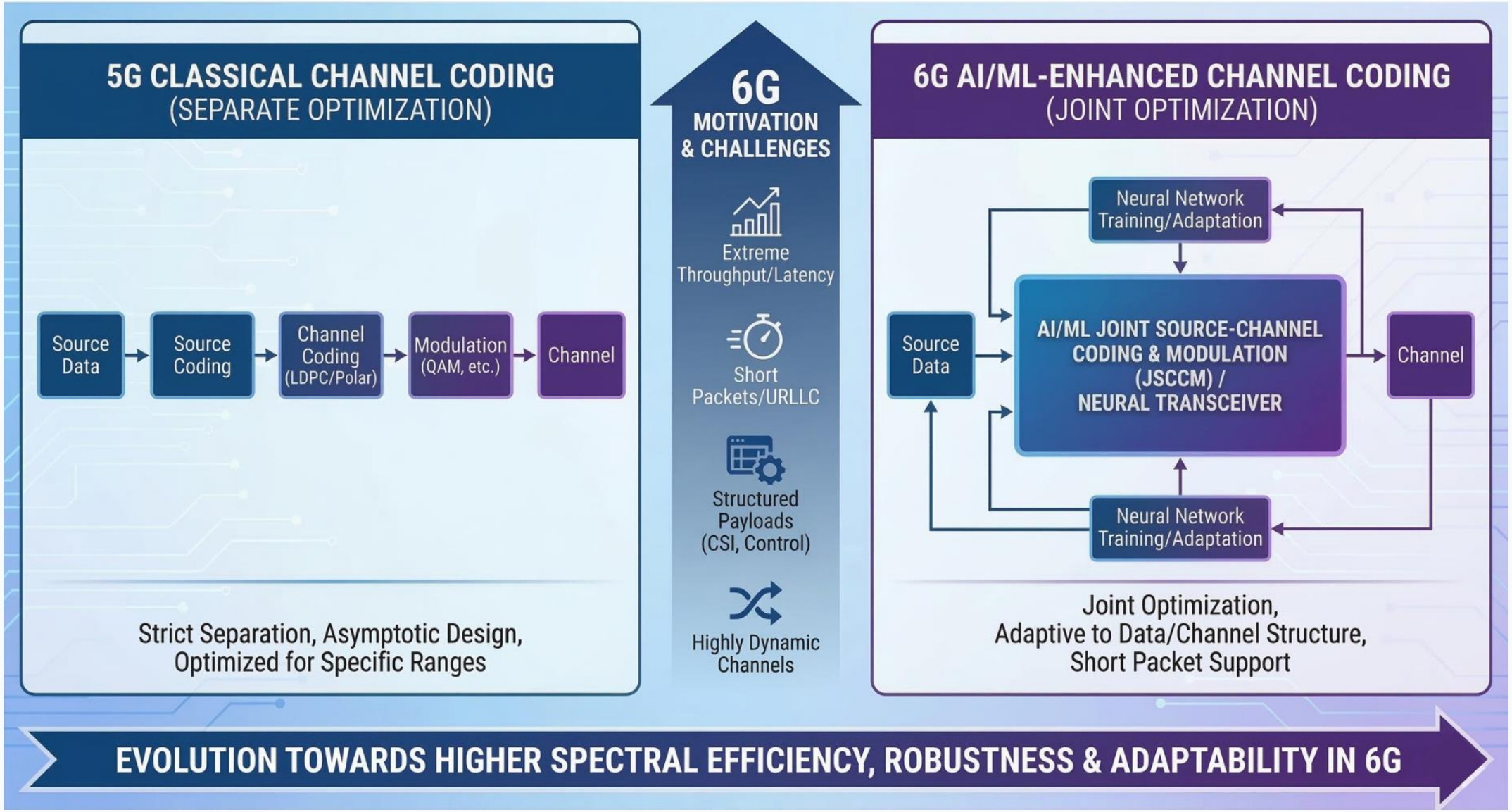


Efficient 6G Network With AI



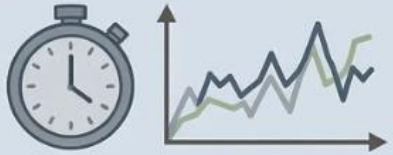
CSI-RS: Channel State Information Reference Signal

Efficient 6G Network With AI



Sustainable/Green 6G Network With AI

6G Energy Challenge: The Motivation



DYNAMIC TRAFFIC
(highly dynamic, variable)

NETWORK DENSIFICATION
(multi-cell, carriers)

DIVERSE SERVICES
(immersive/massive communication)

Traditional 5G Methods: **INSUFFICIENT.**

AI-Enhanced 6G Energy Solutions

TRAFFIC PATTERNS

USER MAP

SERVICE TYPE

- Deactivate antenna sub-arrays during low demand
- Spatially steer power only to active users

NETWORK ENERGY SAVING (NES)

Proactive Cell & Carrier Management

MASSIVE MIMO SLEEP

Spatial and Sub-array Disabling

UE POWER SAVING (UEPS)

Enhanced DTX/DRX & Signalling OH reduction

6G Goals

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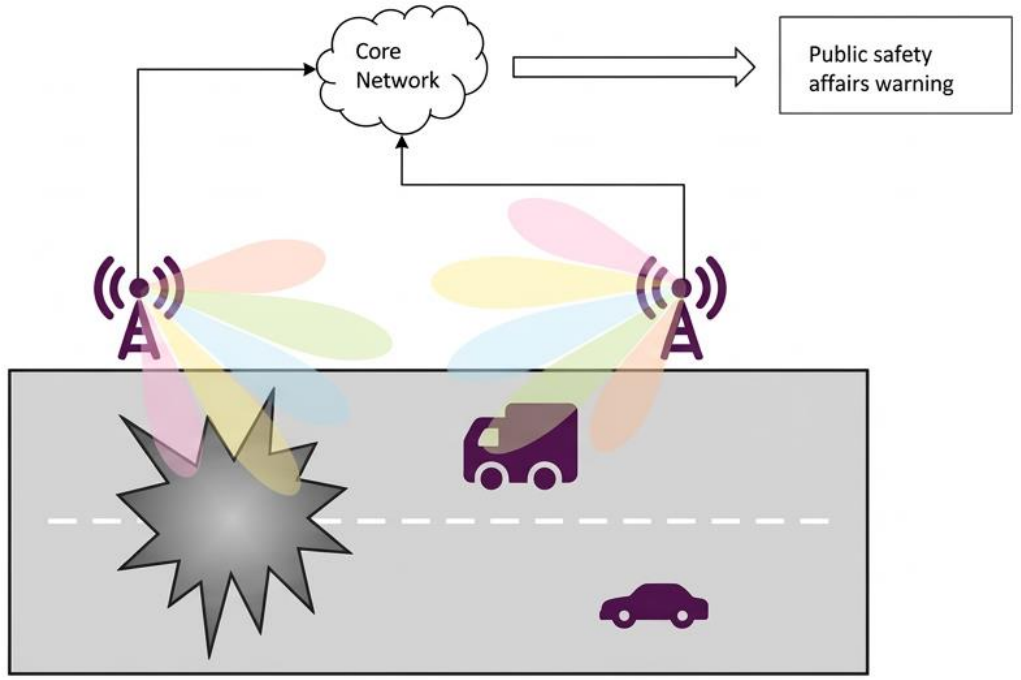
Massive Communication

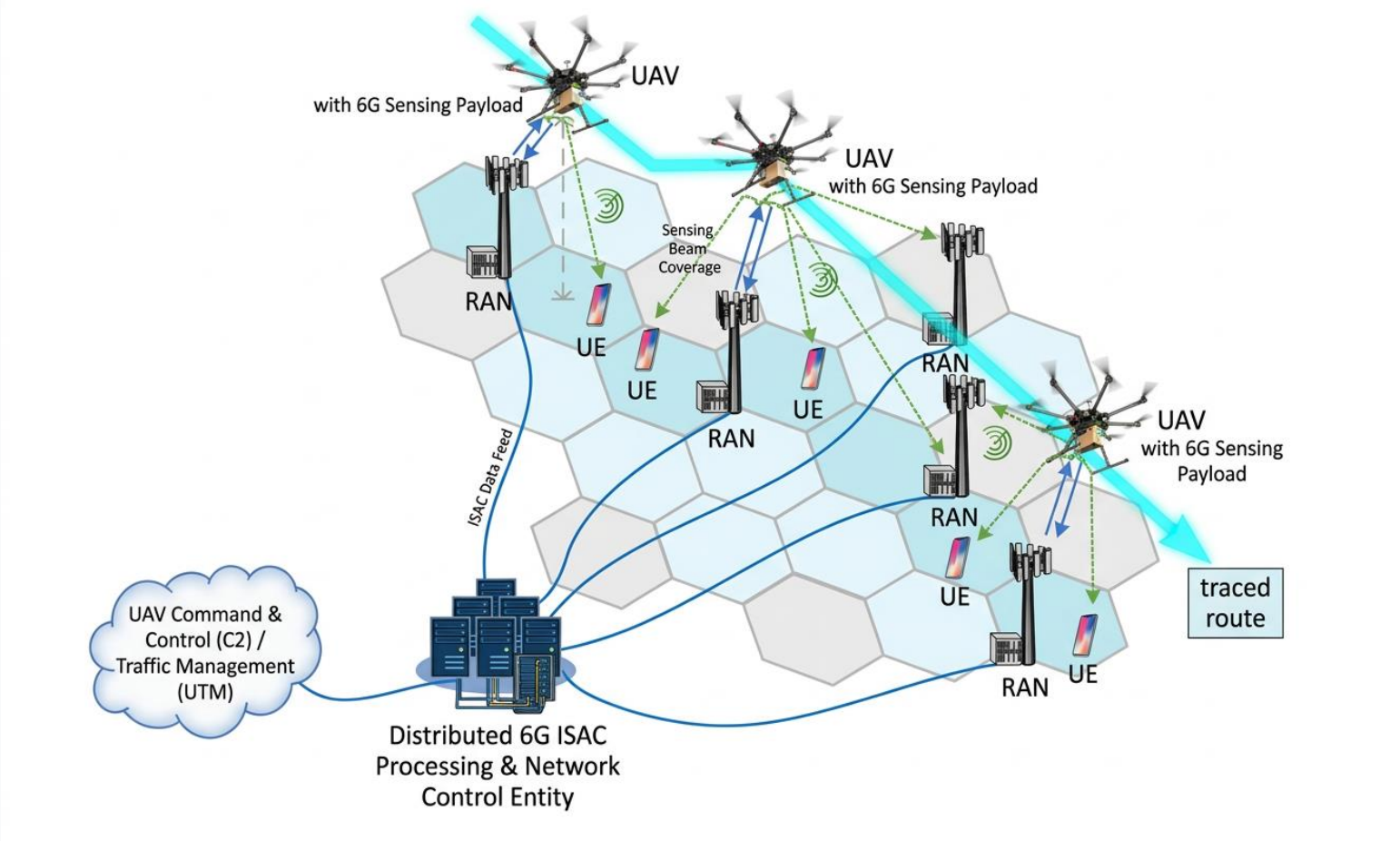
- 6G is envisioned to cater 10^6 devices per km^2 per IMT-2030 requirements
- Day-1 Versatility: Native support for diverse device types and traffic profiles
  - UEs, Fixed Wireless Access, Non Terrestrial Network
- 6G to support unified Framework with single, scalable design
  - Will eliminate technology fragmentation

Integrated Sensing and Communication: Use cases



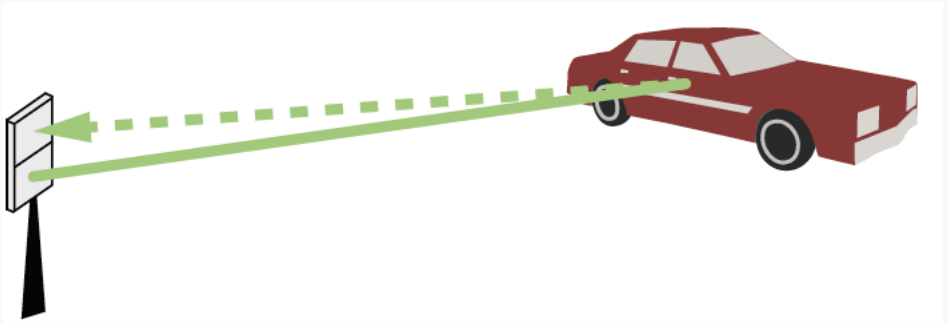
- 6G operator selects BS around or along road to sense infrastructure collapse
  - BSs monitors moving objects and also continuously assess road condition
  - Sensing signals emitted by BSs reach road surface and reflected back to BSs

Integrated Sensing and Communication: Use cases

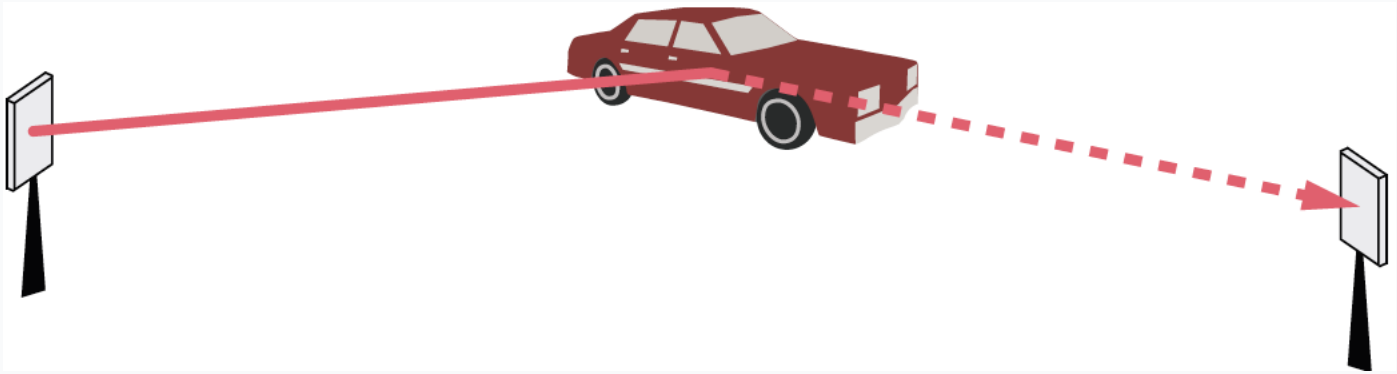


- 6G operator can provide UAV flight trajectory tracking services to third-party applicatior
  - UAV service operators, regulatory agencies
  - Uncrewed Aerial System Traffic Management systems

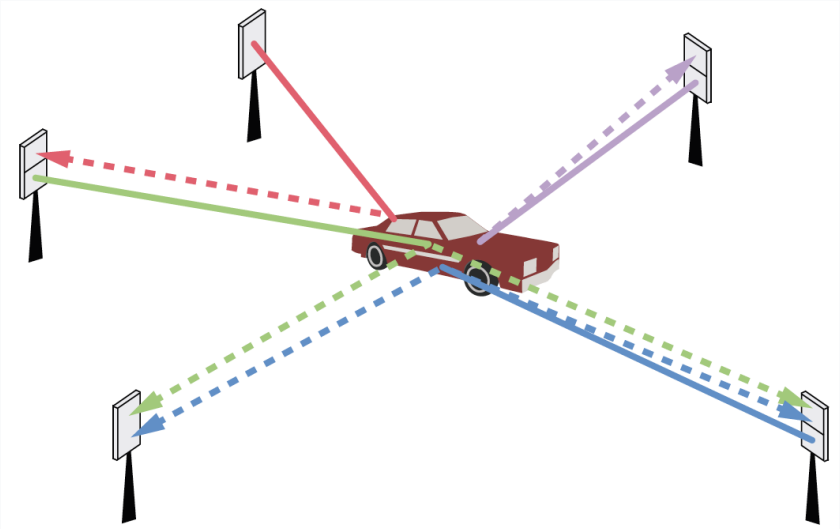
ISAC modes



Mono static sensing

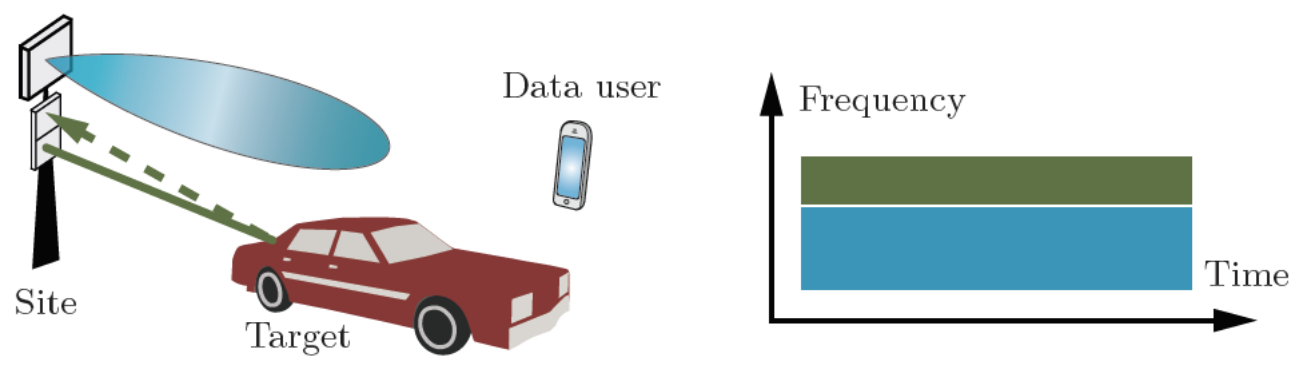


Bi static sensing

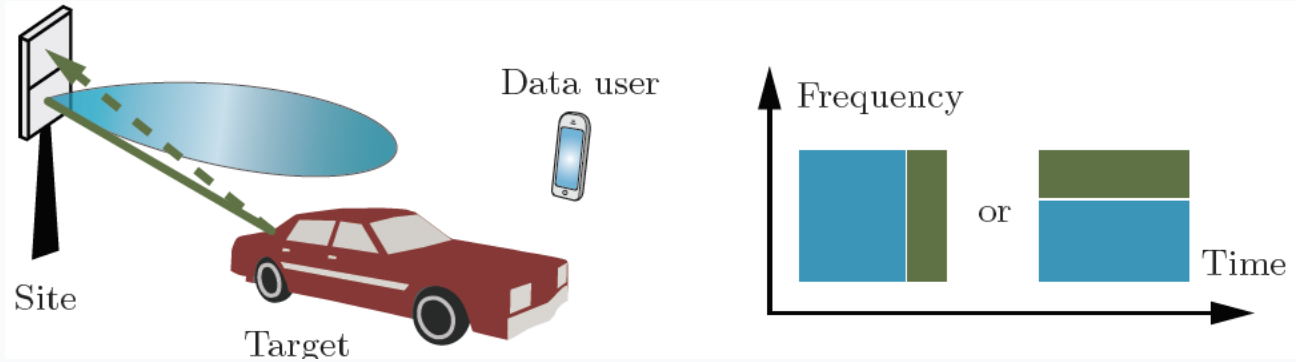


Multi static sensing

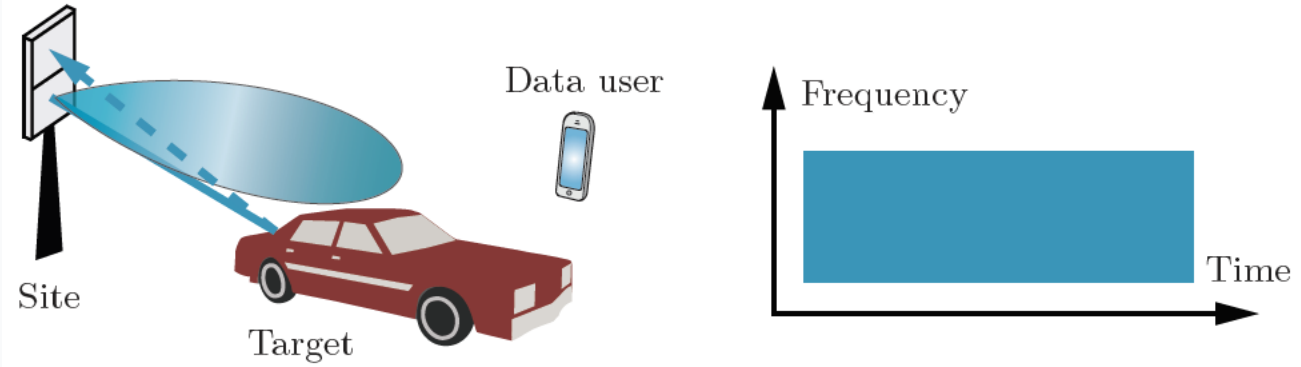
ISAC Hardware Options



First integration level: Site-sharing but separate hardware and frequency resources



Second integration level: Hardware sharing but orthogonal frequency resources



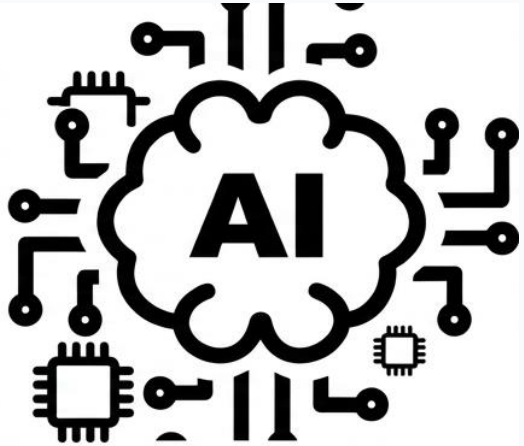
Third integration level: Hardware sharing and frequency resources

RAN Architecture

Summary: Key Technologies for 6G RAN

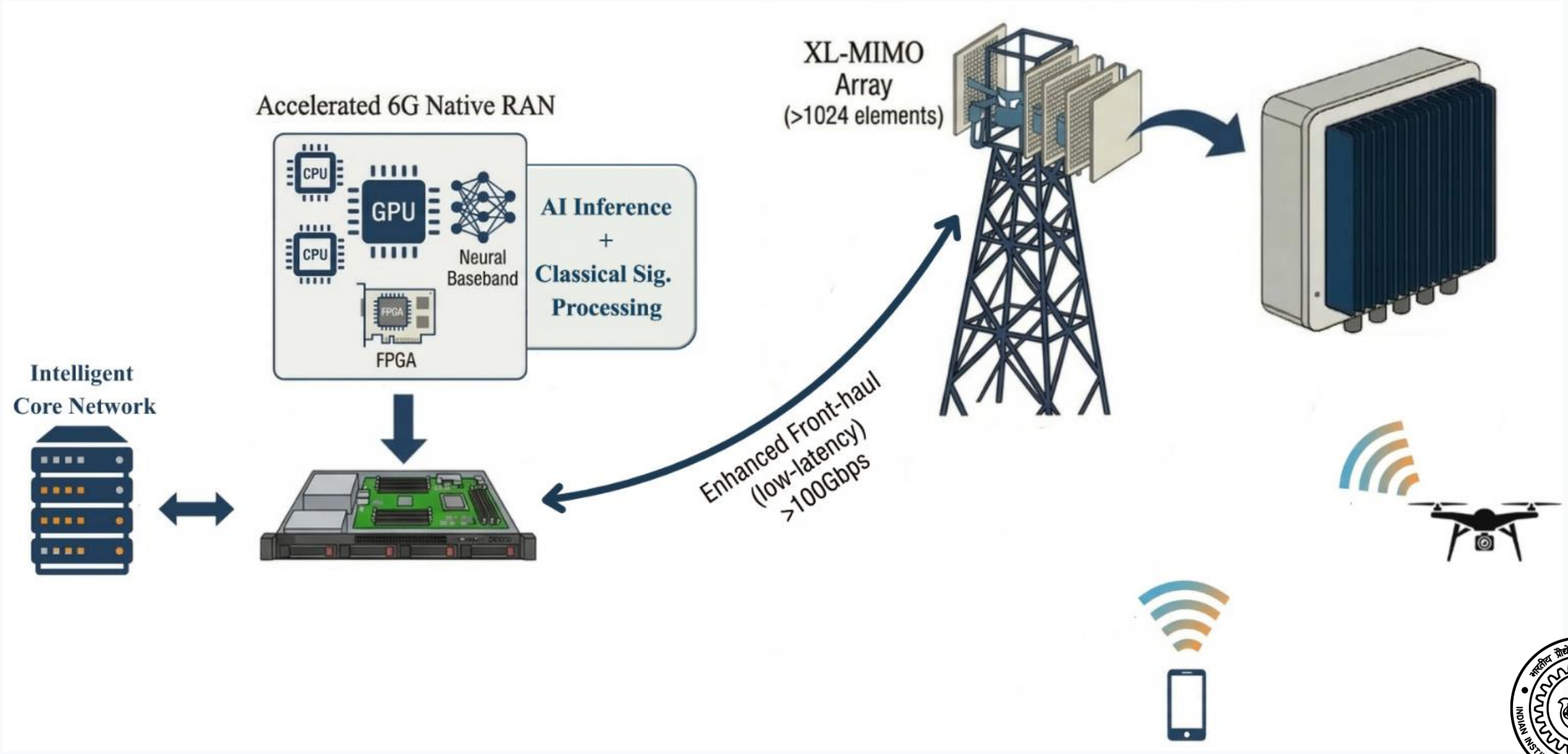
XL-MIMO

Sensing

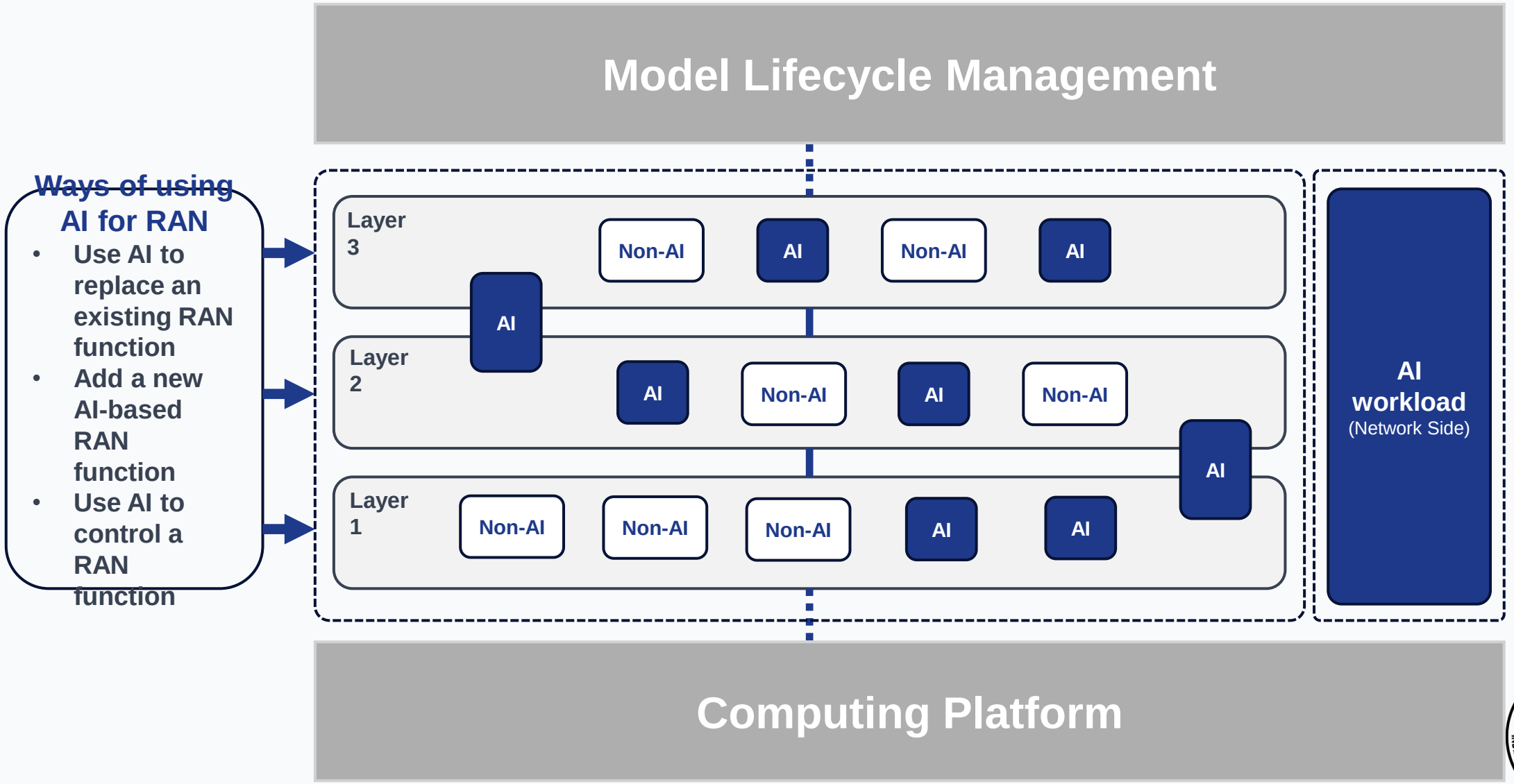


AI/ML

AI-Native ISAC RAN - Hardware



AI-Native ISAC RAN - Software



Conclusion

- Discussed how 6G RAN will evolve to
  - improve customer experience via high-quality services and ubiquitous coverage
  - enhance efficiency with AI-driven automation
  - increase energy efficiency
  - increase revenue growth and monetization
- Discussed potential 6G RAN architecture

Thank you