KEYSIGHT

AI and Machine Learning in the Path to 6G

From optimization to AI-native networks

Why 6G Matters

Every wireless generation has transformed how we live and work. While 5G opened doors to smart factories and connected healthcare, it left promises unfulfilled—particularly in delivering ultra-reliable, low-latency performance at scale.

5G's Reality Check

Powerful capabilities but with AI as an afterthought, creating patchwork optimization

6G's Promise

AI-native networks designed from the ground up for intelligence and adaptability

The Goal

Smarter, adaptive, resilient networks that evolve in real-time

Today's Agenda

01

Setting the Stage

Understanding the leap from 5G limitations to 6G's AI-native vision

02

AI in the RAN

Three-part framework for transforming wireless infrastructure

03

Research Frontiers

AI-native interfaces including channel estimation, and digital twins

04

Implementation Challenges

Real-world obstacles and strategic solutions

05

Key Takeaways

Insights for your wireless R&D initiatives

5G Limitations vs 6G Vision

5G Architecture	6G Vision
AI Add-On Approach Intelligence layered onto existing systems as an afterthought	**AI-Native Design** Intelligence embedded throughout every layer from day one
Patchwork Optimization Isolated functions optimized independently, lacking system-wide coordination	**End-to-End Intelligence** Coordinated optimization across physical layer, core network, and devices
Limited Adaptability Fixed rules struggle with dynamic network conditions and complex scenarios	**Real-Time Adaptation** Self-driving network grid that learns and evolves continuously

Think of 5G as a highway with smart traffic lights at busy intersections—helpful but limited. 6G is a fully autonomous transportation grid where every element communicates and adapts in real time.

5G Limitations vs 6G Vision

5G: Smart Traffic Lights on the Highway

6G: The Self-Driving Network Revolution

Why AI is Core to 6G

1 Tbps

Data Speeds

Terabit-per-second performance requirements

<1 ms

Latency Target

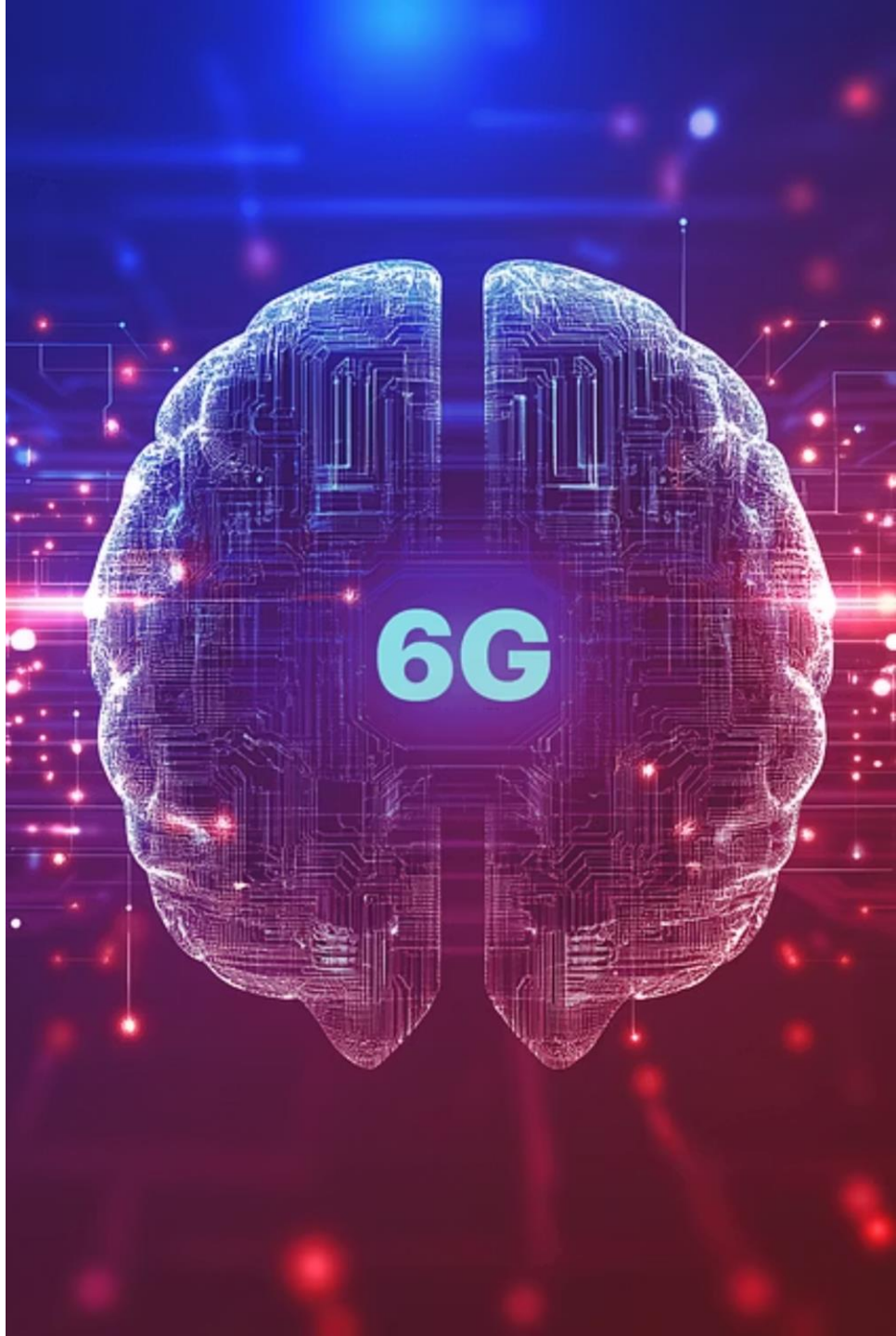
Sub-millisecond response times for critical applications

100B+

Connected Devices

Massive IoT ecosystem requiring intelligent orchestration

Such demands exceed AI-aided and human-designed control capabilities. AI provides the essential adaptability and automation to manage this complexity.



AI and the RAN

The RAN transforms from fixed architectures with pre-defined rules into an adaptive system in a three-part framework:

AI-for-RAN

Optimization Focus: Efficient spectrum allocation, reduced power consumption, and lower operational costs

Like a city grid dynamically rerouting traffic to prevent congestion

AI-and-RAN

Infrastructure Convergence: Real-time resource allocation and coordinated infrastructure utilization

Adjusting capacity dynamically for stadium crowds or emergency situations

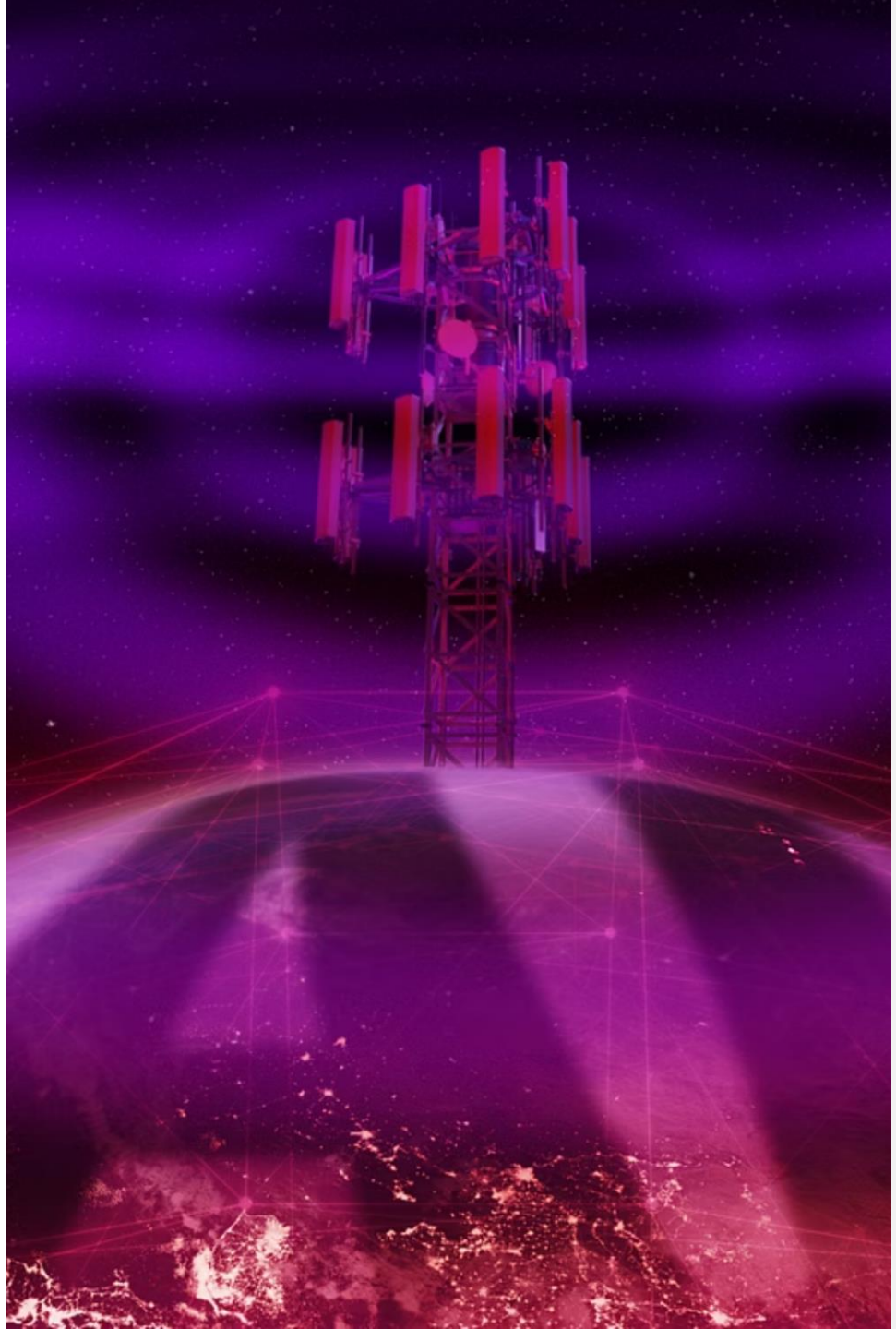
AI-on-RAN

New Service Frontier: Edge-native AI services including real-time AR and ultra-reliable robotics control

Intelligence embedded directly at the network edge for instant response

Research Frontiers

Where AI Meets the Future of Wireless



AI-Native Air Interfaces

1

Traditional Design

Human-engineered blocks using mathematical models and fixed protocols

2

AI-Designed Systems

Intelligent transceivers that continuously optimize modulation and coding

Air interfaces—the communication rules between devices and networks—are evolving beyond human design limitations. AI is already replacing individual receiver components, with the long-term vision of fully AI-designed transceivers that adapt to exact channel conditions in real-time.

Early implementations show AI replacing traditional receiver blocks with measurable performance gains in dynamic environments.

Channel Estimation & Feedback

As 6G moves into higher frequencies, signals become increasingly fragile and susceptible to environmental disruption.

The Challenge

Higher frequencies create signals easily disrupted by obstacles, weather patterns, and device mobility

AI Solution

Real-time pattern learning and dynamic channel estimation adaptation

Result

Reliable connections maintained even in complex, rapidly changing environments

Traditional models struggle with these dynamic conditions, but AI transforms uncertainty into intelligent adaptation.

Digital Twins

As virtual replicas of real networks, digital twins allow engineers to simulate thousands of scenarios ahead of time—urban canyons, rural expanses, high-speed trains—before network deployment.

Virtual Replicas

Pre-deployment testing of network designs and configurations.

Stress-Test Scenarios

Simulate extreme conditions and unexpected events without real-world risk.

Train AI Models

Generate synthetic data to train AI, filling gaps where real-world measurements are scarce.

AI-driven digital twins transform uncertainty into intelligent adaptation, acting as a dynamic "flight simulator for networks" that learns and evolves continuously.

Energy & Sustainability

Telecom networks are major energy consumers. The industry is designing 6G to be fundamentally sustainable, integrating energy efficiency as a core principle. AI will be crucial in achieving this.

→ AI-driven Scheduling

Optimizing network operations based on real-time demand, allowing infrastructure to enter low-power modes during off-peak hours.

→ Smart Power Modes

Dynamic power adjustments for base stations and network components, reducing energy consumption without compromising performance.

→ Greener Networks

Overall reduction in carbon footprint by enabling intelligent beam shaping and energy harvesting integration.

Think of it like an intelligent climate control system for a vast interconnected grid—but applied at the scale of global networks, ensuring resilience while minimizing environmental impact.

Challenges Ahead

Of course, none of this comes without its own set of significant challenges.

Data Scarcity

Wireless environments lack clean datasets, making robust model training difficult.

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AI networks face real-world unpredictability—validation must go beyond lab tests.

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Compute & Energy Constraints

AI boosts networks but drains power—efficiency is critical.

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Security & Privacy

AI creates new attack risks—strong data sovereignty and encryption are paramount.

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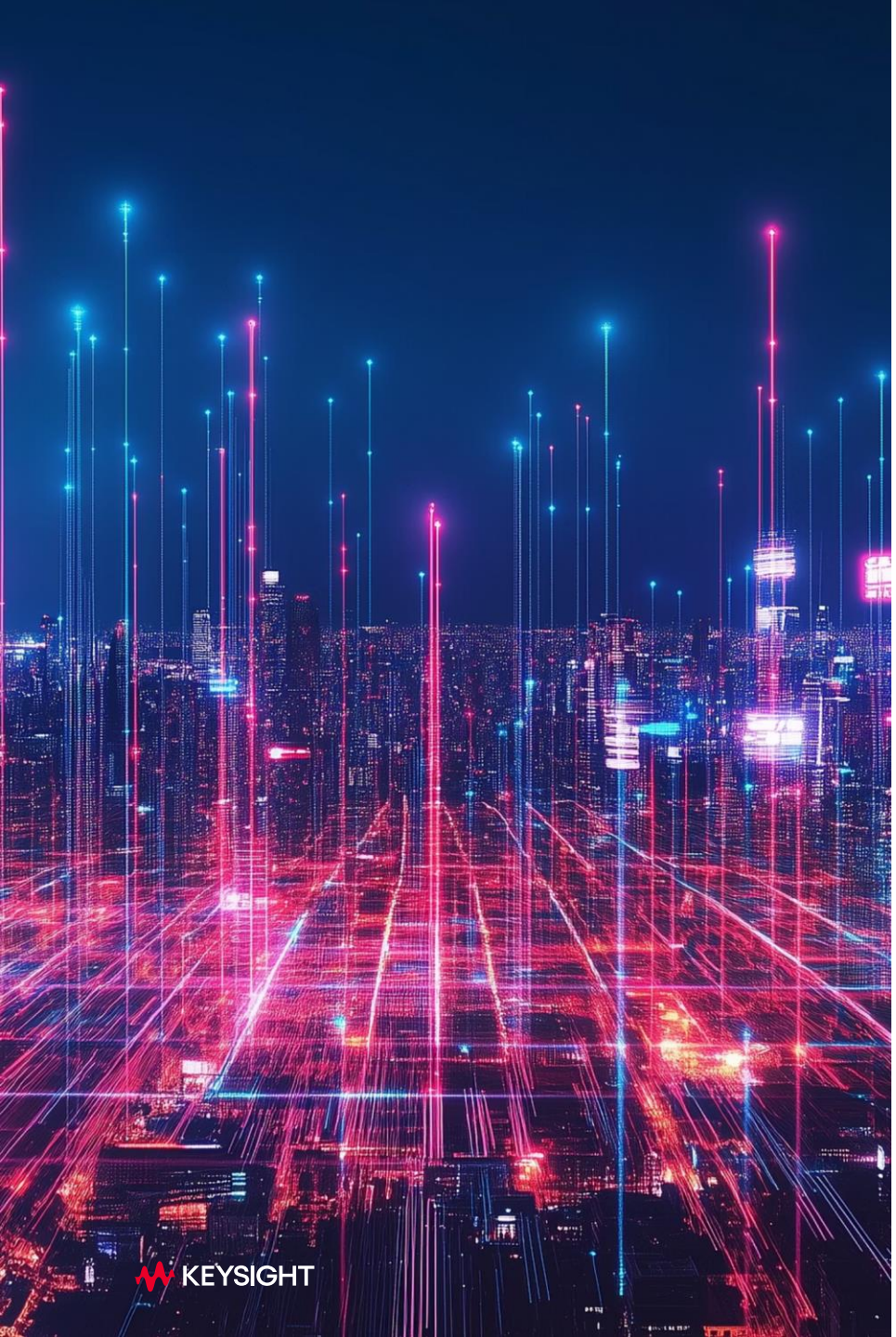
For researchers, challenges are opportunities to push wireless innovation.



Key Takeaways

Paradigm Shift

6G represents a fundamental move from AI add-ons to AI-native network architecture

RAN Transformation

Three-tier AI integration: optimization, convergence, and new services

Technical Readiness

AI-native air interfaces and digital twins are where breakthroughs will happen

Strategic Imperative

Organizations must begin AI-native research today to compete in the 6G era

The future of wireless is intelligent by design. The question isn't whether AI will transform 6G—it's how quickly we can make that transformation happen.

> “The path to 6G is still being written, and AI is holding the pen.”

Together, as engineers, researchers, and innovators, we have the chance to shape networks that aren’t just faster, but smarter, more sustainable, and more human-centric.

Join the full session, “AI/ML Algorithm Design and Testing toward 6G,” for a deeper dive into testing challenges and breakthroughs ahead.