Bringing strategy and technology together to lead the opportunities of the future

Nishant Batra
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Lay the path for Nokia’s future technology innovation
Identify the most promising areas for new value creation
Key trends shaping the world of 2030
Driving requirements for the ecosystem and the network

Socioeconomic & geopolitical
- Deglobalization
- Cybersecurity
- State-driven innovation
- Sustainability

Technology
- Metaverse
  - XR
  - 5G
  - 6G
  - AI/ML
  - Blockchain

Cloud
Web3

User needs
- Industry
- Enterprise
- Consumer
- Developer
- Evolved experiences
- Digital-first
- Service-optimized connectivity
- New purchasing priorities
We have a clear and definitive vision of the metaverse opportunities.
Concepts of ‘Human Augmentation’ and ‘Digital-Physical Fusion’ frame this vision.

**Metaverse enablers**

<table>
<thead>
<tr>
<th>Human Augmentation</th>
<th>Digital-Physical Fusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handhelds</td>
<td>Basic, organization-level digital twins</td>
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<tr>
<td>VR HMDs</td>
<td>Smart sensor networks</td>
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<tr>
<td>Tethered AR glasses</td>
<td>Persistent virtual worlds &amp; objects</td>
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<tr>
<td>Haptic-enabled remote control</td>
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<tr>
<td>Connected bio-medical implants</td>
<td>Complex, enterprise-wide digital twins</td>
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<tr>
<td>Industrial exoskeletons</td>
<td>Ecosystem interoperability</td>
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<tr>
<td>Ergonomic, untethered XR glasses</td>
<td>Interactive 3D digital twins</td>
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<tr>
<td>XR interoperability</td>
<td>6G network sensing</td>
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</table>

**Metaverse opportunities**

- **Consumer Metaverse**
- **Enterprise Metaverse** (IT-centric)
- **Industrial Metaverse** (OT-centric)

Nokia well ahead of the current ‘meta-hype’: based on Nokia Bell Labs research over 5+ years.
Industry is expected to lead metaverse commercialization

**Consumer Metaverse**
Virtual spaces revenue (global markets)\(^1\)

- Consumer appeal driven
- Reliant on trends and network effect
- Fragmented monetization, with growth from ~2026

**Enterprise Metaverse**
Immersive collaboration and related cloud revenue (global markets)\(^2\)

- Business value driven
- Solution & device innovation
- Good monetization potential, with growth from ~2025

**Industrial Metaverse**
Digital twin & simulation and industrial XR HMD shipment revenue (global markets)\(^3\)

- Operational results driven
- Industrial automation focus
- High monetization potential, with early traction

**Metaverse usage could exceed time spent on OTT video by 2028**\(^4\)

**Metaverse could drive up to 9x higher bandwidth consumption in enterprise data usage by 2030**\(^5\)

**Metaverse could drive up to 100x growth in bandwidth consumed by industrial applications delivered from on-premise and edge networks by 2030**\(^6\)

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1. ABI Research: 2022 Consumer Metaverse Market Update, June 2022
2. ABI Research: Enterprise Metaverse: Future of Work, March 2022
4. Bell Labs Consulting: Spectrum study done for a US mobile operator
5. Bell Labs Consulting: Studies on enterprise & industrial services demand growth 2021-2030 (disruptive scenarios)
Customer and service requirements for metaverse
... will be different than today’s
The network will be key to realizing those opportunities ... requiring transformed capabilities and versatile integrations.
Driving the 2030 metaverse value chain
Example: Consumer Metaverse – Immersive Gaming

New network capabilities
- Ubiquity & accessibility
- Security & privacy focus
- Industry-specific optimization
- Performance, resiliency & agility
- Intent-based autonomy
- Enhanced symmetrical capacity
- Sustainability & efficiency
- Distributed, flexible service instantiation
- Sensing, positioning and context

Multi-party value ecosystem
Open ecosystem - Innovation & value creation through partnership

- Hyperscalers: Multipurpose edge cloud
- CSPs: Optimized, adaptive premium connectivity
- Gaming enthusiasts: Gaming solution providers & developers
- Gaming enthusiasts: Gaming solution providers & developers

Example: Consumer Metaverse – Immersive Gaming
Driving the 2030 metaverse value chain
Example: Enterprise Metaverse – XR for Education

New network capabilities
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Multi-party value ecosystem
Open ecosystem - Innovation & value creation through partnership

Private campus networks & solution platforms
- Ubiquitous, adaptive, high-capacity connectivity, optimized for XR devices
- Network-as-Code APIs
- CSPs
- Education authorities & institutes
- Education solution providers

Example: Enterprise Metaverse – XR for Education
Driving the 2030 metaverse value chain
Example: Industrial Metaverse – Real-time Digital Twin for factory operations

New network capabilities

- Intent-based autonomy
- Enhanced symmetrical capacity
- Sustainability & efficiency
- Distributed, flexible service instantiation
- Sensing, positioning and context
- Performance, resiliency & agility
- Industry-specific optimization
- Ubiquity & accessibility
- Security & privacy focus

Multi-party value ecosystem
Open ecosystem - Innovation & value creation through partnership

- Specialized dedicated networks & platforms; Process optimization solutions (Network-as-Code-enriched)
- Partners: Integrators, OEMs, etc.
- Digital twin solutions for mission-critical factory operations (Network-as-Code-enriched)
- Industrial organizations

Sensing, positioning and context
Security & privacy focus
Ubiquity & accessibility
Performance, resiliency & agility
Industry-specific optimization
Intent-based autonomy
Enhanced symmetrical capacity
Sustainability & efficiency
Distributed, flexible service instantiation
Digital twin solutions for mission-critical factory operations (Network-as-Code-enriched)
Nokia’s differentiating role and capabilities in the metaverse value chain

<table>
<thead>
<tr>
<th><strong>Consumability</strong></th>
<th>Nokia technology becomes easy to consume</th>
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<tbody>
<tr>
<td><strong>Software</strong></td>
<td>Handling the complexity</td>
</tr>
<tr>
<td><strong>AI</strong></td>
<td>Embracing AI/ML through the stack</td>
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<tr>
<td><strong>Security</strong></td>
<td>Foundational to critical networks</td>
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<tr>
<td><strong>Semiconductor</strong></td>
<td>System-on-Chip remains critical</td>
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<tr>
<td><strong>Sustainability</strong></td>
<td>Minimize footprint, maximize handprint</td>
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<tr>
<td><strong>Innovation</strong></td>
<td>Creating the future. The basis for everything.</td>
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Nokia’s transversal technology strategy drives our company portfolio

Cognizant wireless
- Extreme mMIMO
- 5G-Advanced, 6G
- EasyMesh WiFi
- Private networks

Adaptive fabric
- Coherent routing
- 800G and beyond
- 25G PON
- Adaptive cloud networks

Bell Labs Core Research
- Network architecture
- Systems
- Devices

Nokia Standards
- Industry ecosystem and standardization enablement

Bell Labs Solutions Research
- System architecture & solution design
- AI & algorithms
- Software & data systems

Frictionless networking & Multi-cloud
- Network as code
- Software as a service
- SA core
- Digital automation cloud

Applications & devices
- Audio visual
- Sensors
- IOT
- AR/VR devices
- Bio-wearables
Bringing our vision of the metaverse to life

Collaboration is key

The metaverse will be created by an ecosystem of partners, working together to bridge industries and fuse the digital and physical.

Network is the heart of the metaverse ecosystem

Nokia as a critical partner

Strongly positioned to build the network and drive the collaborative advantages of the metaverse value chain.