SNIA CSTI | CLOUD STORAGE TECHNOLOGIES

5G Industrial Private Networks and Edge Data Pipelines

Live Webcast

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Today's Presenters

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HPE

SNIA-at-a-Glance

180
industry leading organizations

2,500
active contributing members

50,000
IT end users & storage pros worldwide

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Educate vendors and users on cloud storage, data services and orchestration

Support & promote business models and architectures: OpenStack, Software Defined Storage, Kubernetes, Object Storage

Understand Hyperscaler requirements Incorporate them into standards and programs

Collaborate with other industry associations

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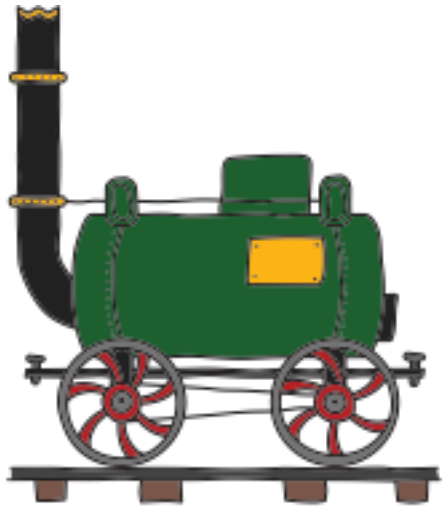
Agenda

- Current state of the industry
- How the Industrial Edge is being transformed
- 5G and Time-Sensitive Networking (TSN)
- The convergence of high-performance wireless connectivity and AI creates new data-intensive use cases
- The right data pipeline layer provides persistent, trustworthy storage from edge to cloud

The Industrial Edge

Mukund Shenoy

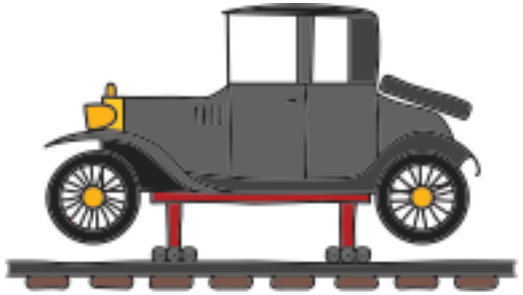
Industrial Revolutions – a Historical Perspective



Industry 1.0

The Industrial Revolution begins. Mechanization of manufacturing with the introduction of steam and water power

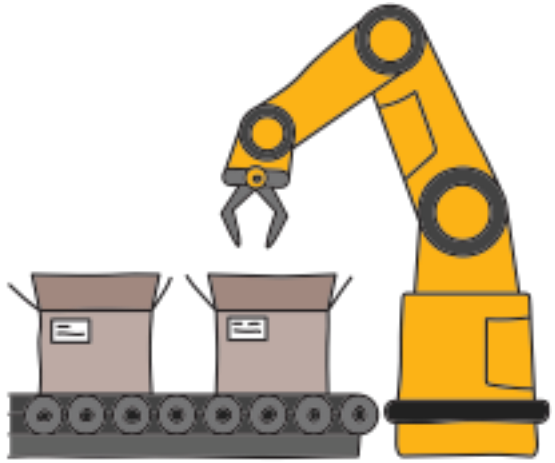
End of 18th Century



Industry 2.0

Mass production assembly lines using electrical power

Start of 20th Century



Industry 3.0

Automated production using electronics, programmable logic controllers (PLC), IT systems and robotics

Start of 1970s

Industry 4.0

The 'Smart Factory'. Autonomous decision making of cyber physical systems using machine learning and Big Data analysis. Interoperability through IoT and cloud technology.

Today

Current State of Industrial Automation

Automation Systems in Today's Factory

- Data Center
- Factory Server
- Industrial PC
- Laptops
- Cameras
- Human Machine Interface (HMI)
- Robots
- Programmable Logic Controllers (PLC)
- Remote IO

Enterprise Resource Planning (ERP)

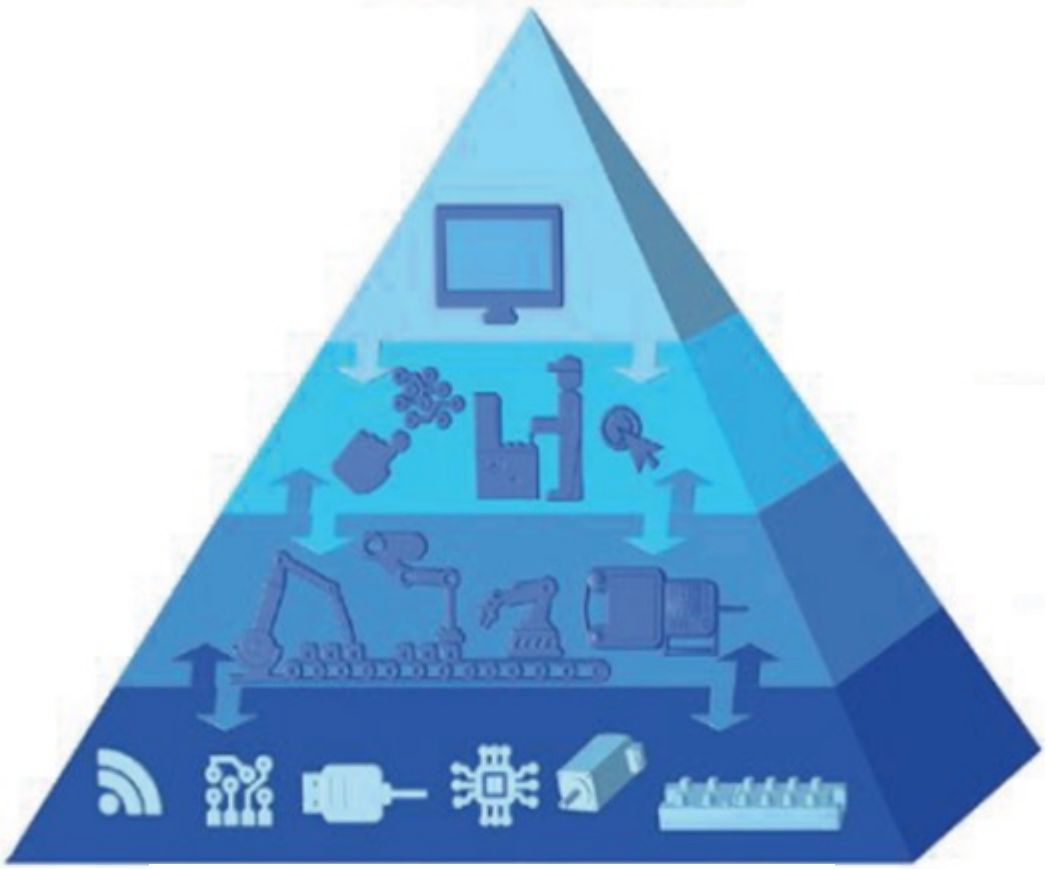
Mfg. Execution System (MES)

Supervisory Control (SCADA)

Machine Control / PLC

Field Level IO

Industry 3.0

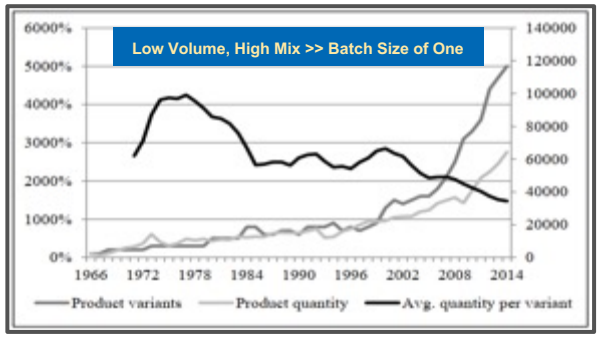


Automation Pyramid

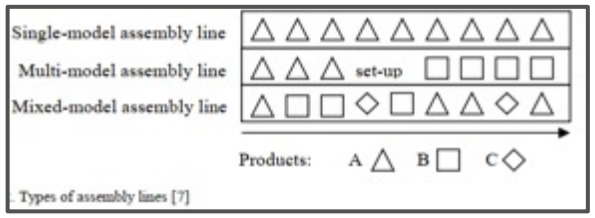
Shortfalls: Trapped Data, Hierarchical Controls, leads to inflexibility and slow response to supply-demand changes

Vision and Drivers of Industry 4.0| A Case Study

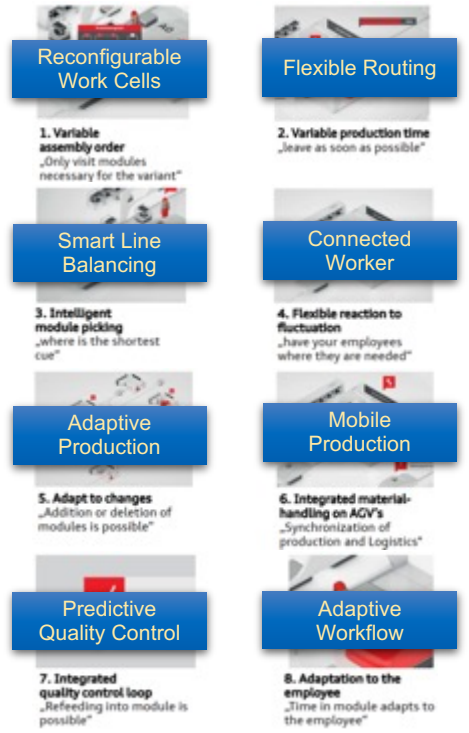
Manufacturing Complexity is Significantly Increasing



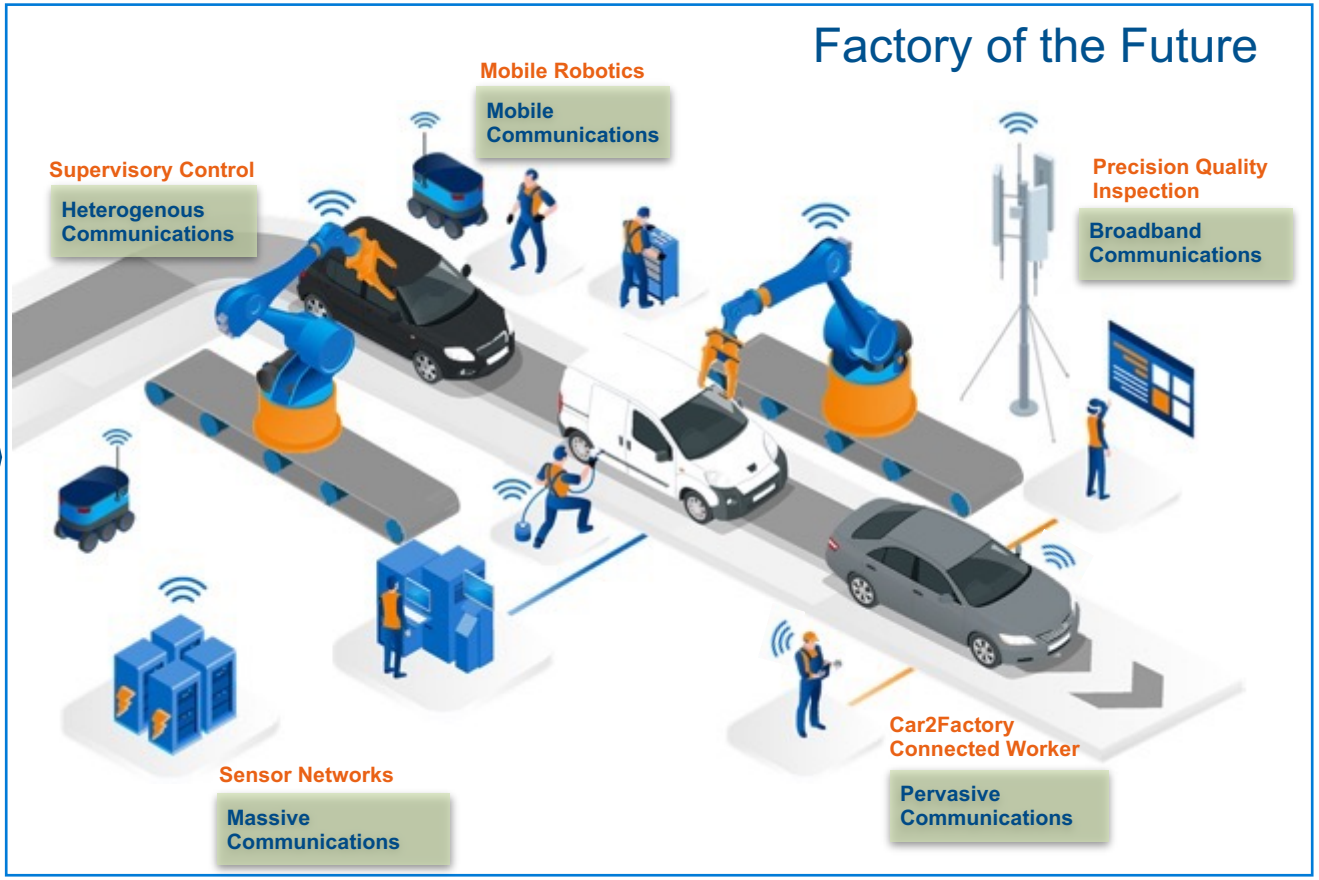
Today's Production Systems cannot handle the complexity



8 Principles of Modular Assembly

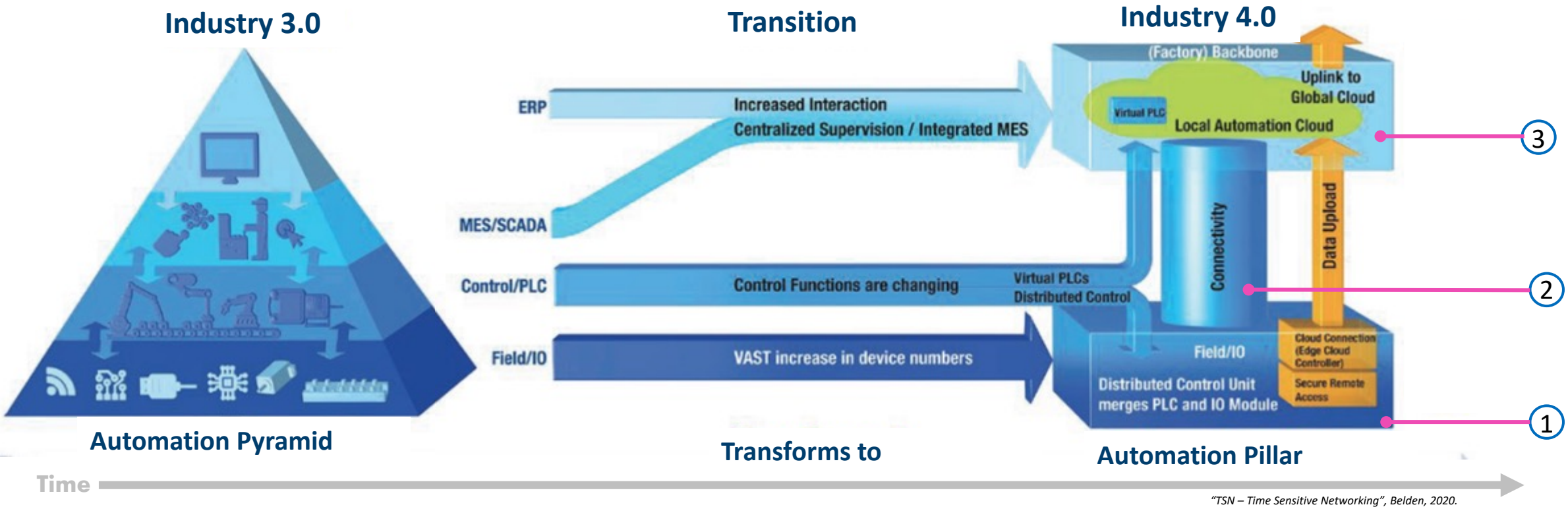


Wolfgang Kern, et al, "Alternatives to assembly line production in the automotive industry"



"The factory of the future is modular. Interconnection allows a central "brain" orchestrating the self organizing production process." - A leading Automotive Manufacturer

Industrial Automation Transformation



"TSN – Time Sensitive Networking", Belden, 2020.

1 **IoT Devices**
Security, Safety, Massive numbers, Time sensitive, High volume data

2 **High Performance Connectivity**
Ultra reliable, High data throughput, Low latency, Wireless Networking

3 **On-Prem Edge**
Distributed, deterministic, orchestrated workloads

TSN – Time Sensitive Networking", Belden, 2020.

Confluence of Enabling Technologies

5G Networks

5G infuses wireless networks with **speed, reliability and scale to meet emerging use cases**

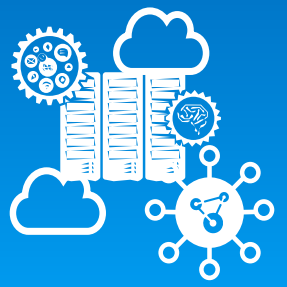
AI & Machine Learning

AI and federated machine learning **leverage new capabilities from the edge to the cloud to improve efficiencies**

Industrial IoT

Wireless now provides flexibility and efficiency for **smart factories that require high reliability & low latency control**

Edge to Cloud

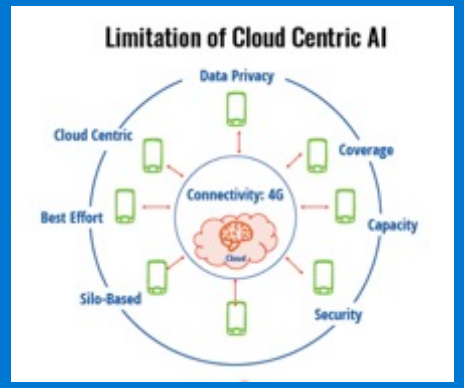


Cloudification & Edge improve responsiveness as the **network becomes distributed, scalable and programmable**

Convergence of Compute and Comms for Distributed Intelligence

Mobile & Cloud

Video explosion, social media, smart connected consumer devices, sharing economy models



4G + Wi-Fi 5

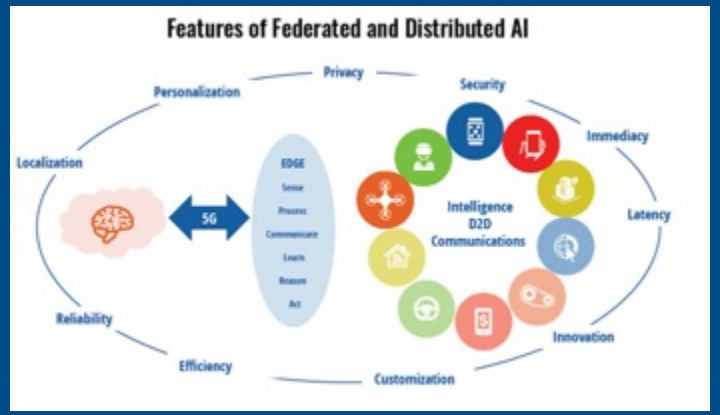
Mobile Broadband, smartphone & app marketplaces

2010s

- Wireless enables high-bandwidth and Ultra-reliable, real-time connectivity
- Interaction loops between people, things exponentially increase
- Workload requirements become dynamic & application-controlled
- New spectrum & deployment models enable new local ecosystems
- Networks fundamentally alter design; become distributed computers

Distributed Intelligence

Resources distributed & orchestrated across end-to-end compute fabric



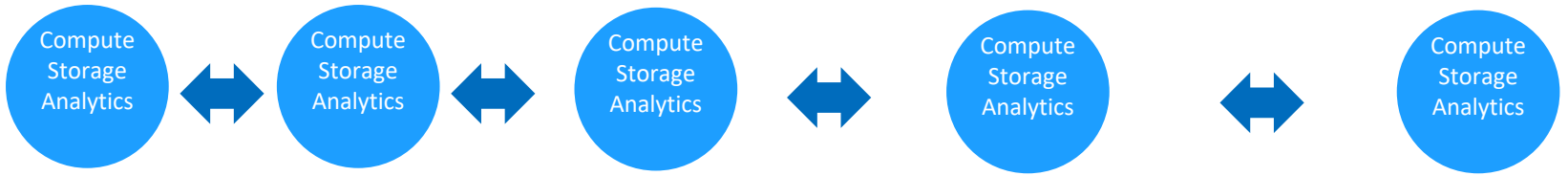
5G + Wi-Fi 6E, 7…

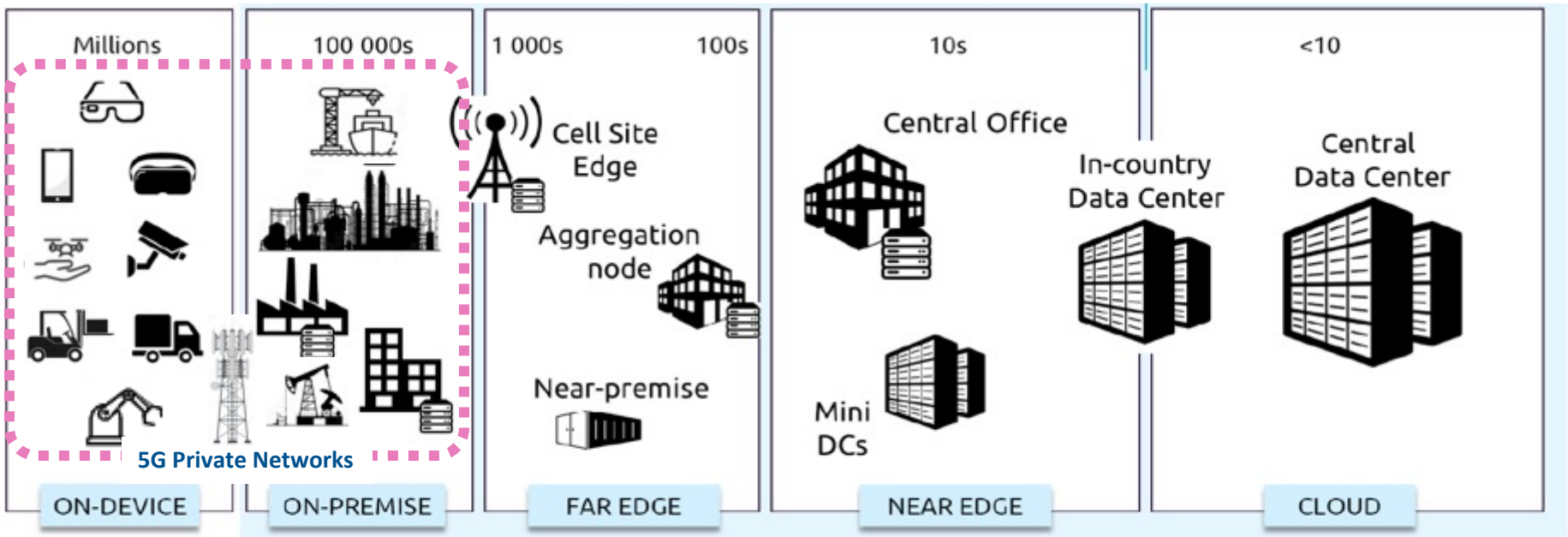
Extreme throughput, low latency, reliability, node density & IoT capacity

2020 & Beyond

5G and AI: Autonomous Decision Making at the Edge, ABI Research

Distributed Edge: The IoT to Cloud Compute Continuum





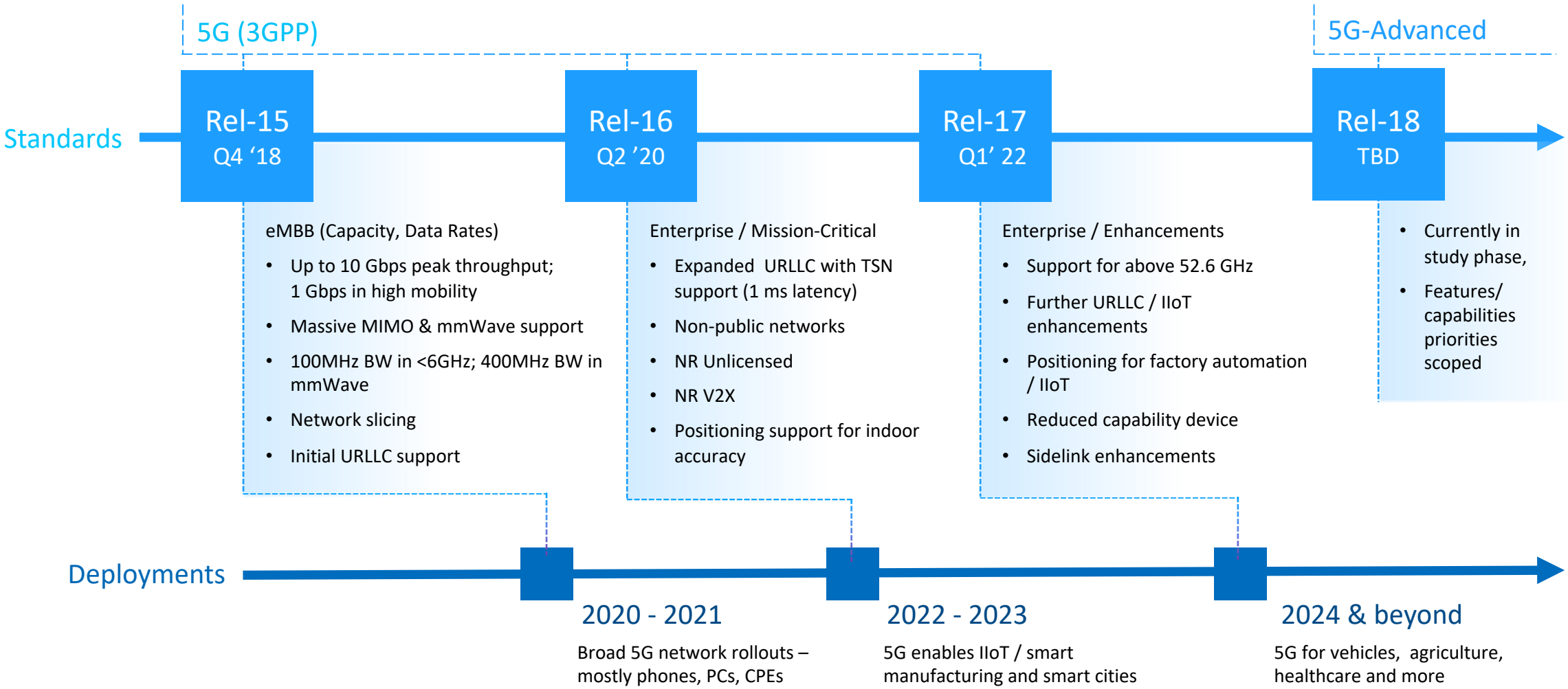
* Latency does not depend only on distance. Other factors influencing latency are a) access technology (latency in 5G or FTTH much lower than in 4G), b) transport topology and technology, c) core network configuration (user plane location, breakout point), d) network optimization (traffic prioritization, bandwidth allocation, Edge node selection).

European industrial technology roadmap for the next generation cloud-edge offering

Industrial Use Cases for 5G Private Networks

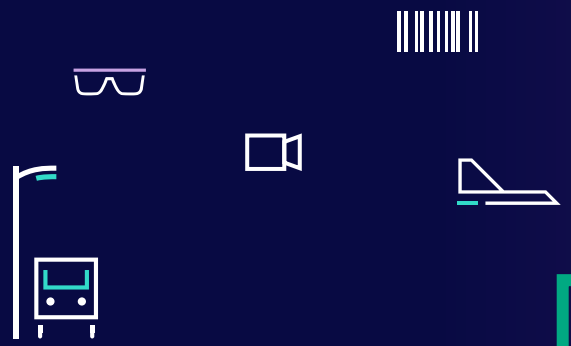
Potential Use Case		Example Application	Comms & Compute Requirement	Edge to Cloud
	Guided and Autonomous Vehicles (AGV, AMR)	Material Handling in indoor and outdoor warehouses and factory floors, Collaborating Robots	**Comms:** Mobility, Seamless handover, and Reliability **Compute:** Centralized control of AGV swarms, on-device sensor fusion, native 5G precise locationing	• ERP/Warehouse mgmt. Integration • On-prem AGV fleet management
	Visual Quality Inspection	Incoming , In-line, Outgoing inspection; ML based *Predictive* Quality Inspection to optimize production	**Comms:** High and consistent data throughput **Compute:** Real time distributed inferencing, product and process data contextualization	• ML Model training using data across global production lines
	Augmented Reality (AR)	Connected Worker, Remote equipment & facility maintenance, Worker training	**Comms:** High and consistent data throughput, Mobility, Reliability **Compute:** Rendition and augmentation at distributed edge	• Equipment Supplier remote maintenance capability
	Wireless Sensor Networks	Building automation and Remote operation command center applications	**Comms:** Reliably support massive number of end devices/sensors **Compute:** Sensor Fusion, Aggregation, distributed analytics	• Local versus facility wide operation decisions

Evolution of 5G Transformational Capabilities



Implications to Enterprise Storage
Persistent, Trustworthy Storage & Secure Data Pipeline

Glyn Bowden



55B

devices will be connected worldwide by 2022[1]

Edge Data

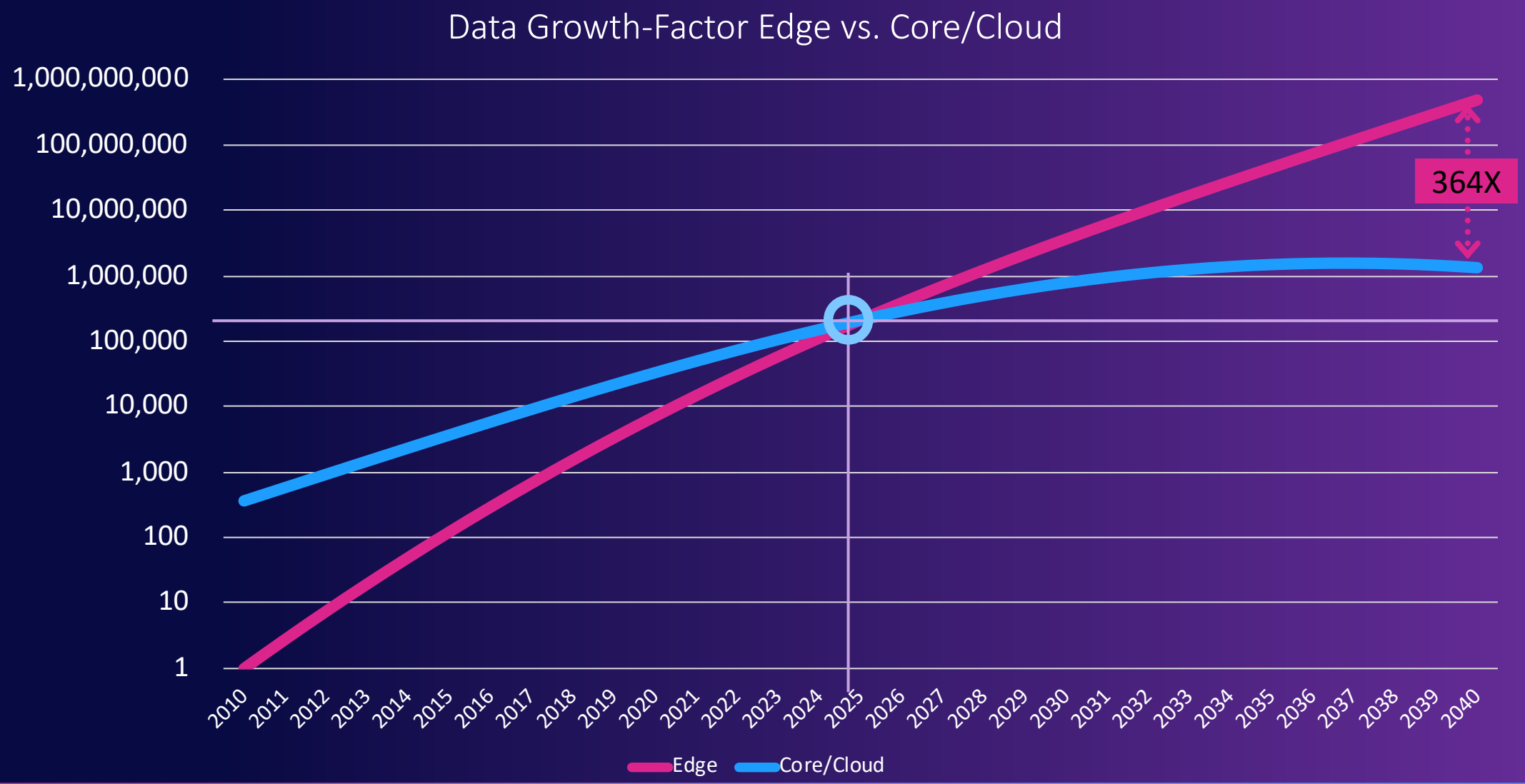
Drives the Next Level of Transformation

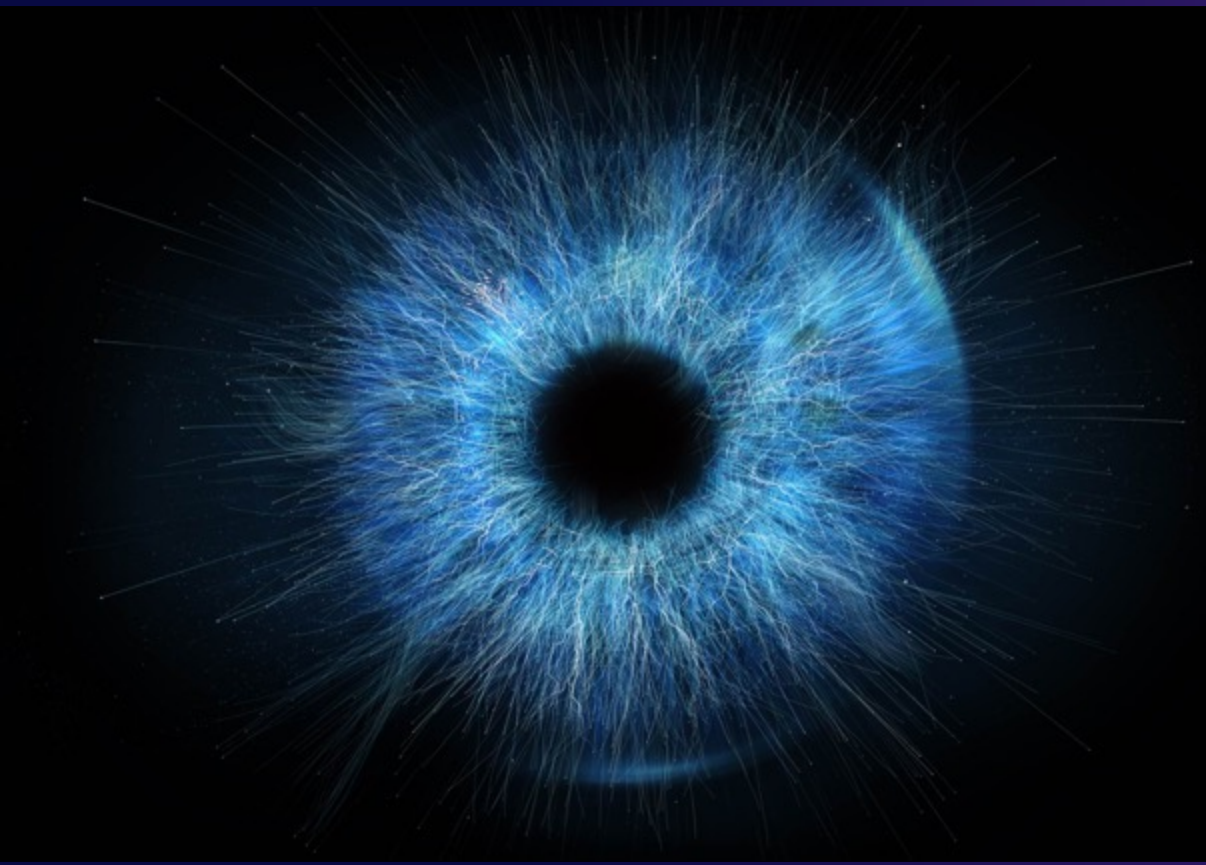
50%

of data will be created and processed at the edge outside the traditional data center or cloud[2]

1 Source: IDC
2 Source: Gartner

EDGE Tipping Point Only 4 Years Away



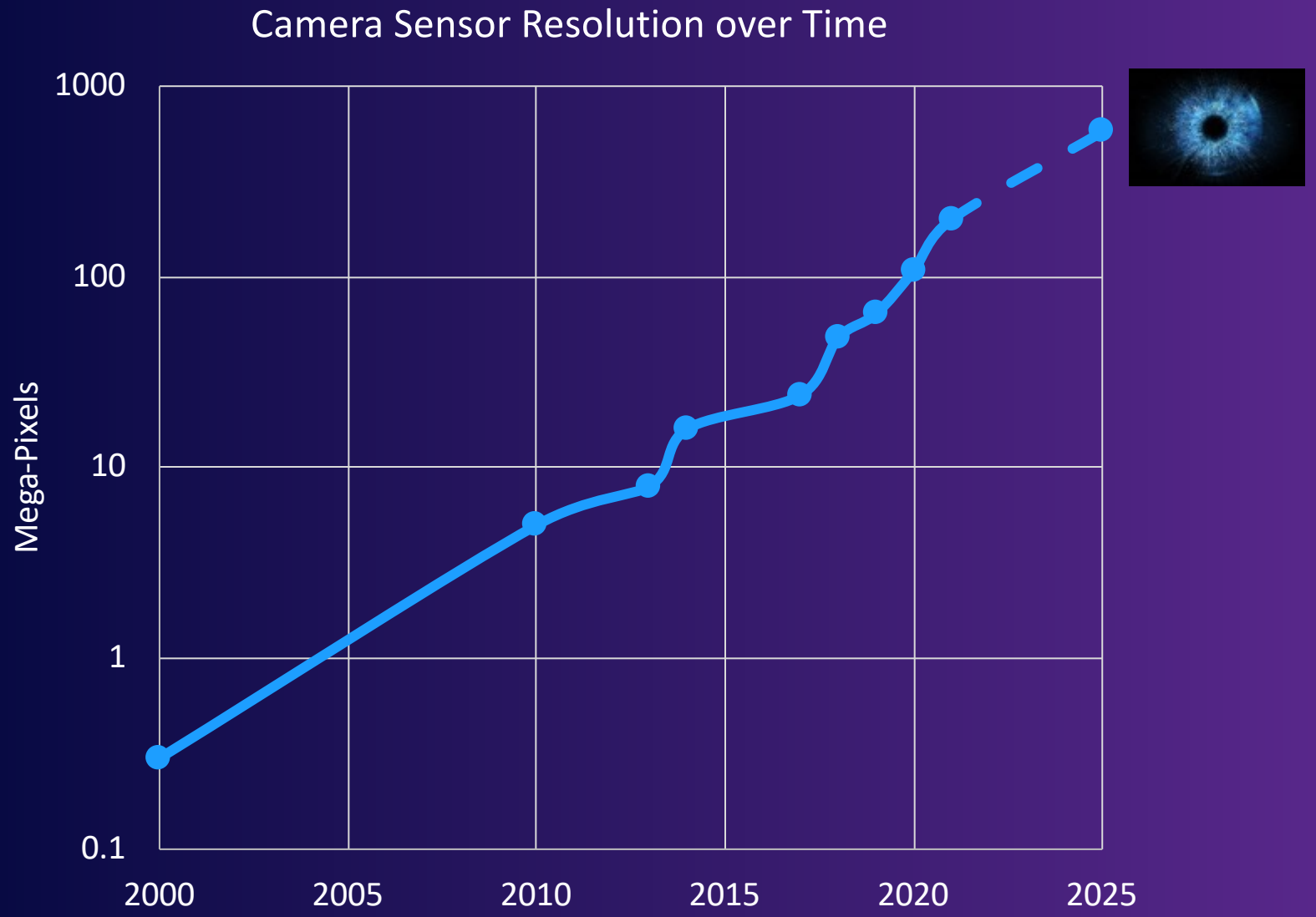


HUMAN EYE

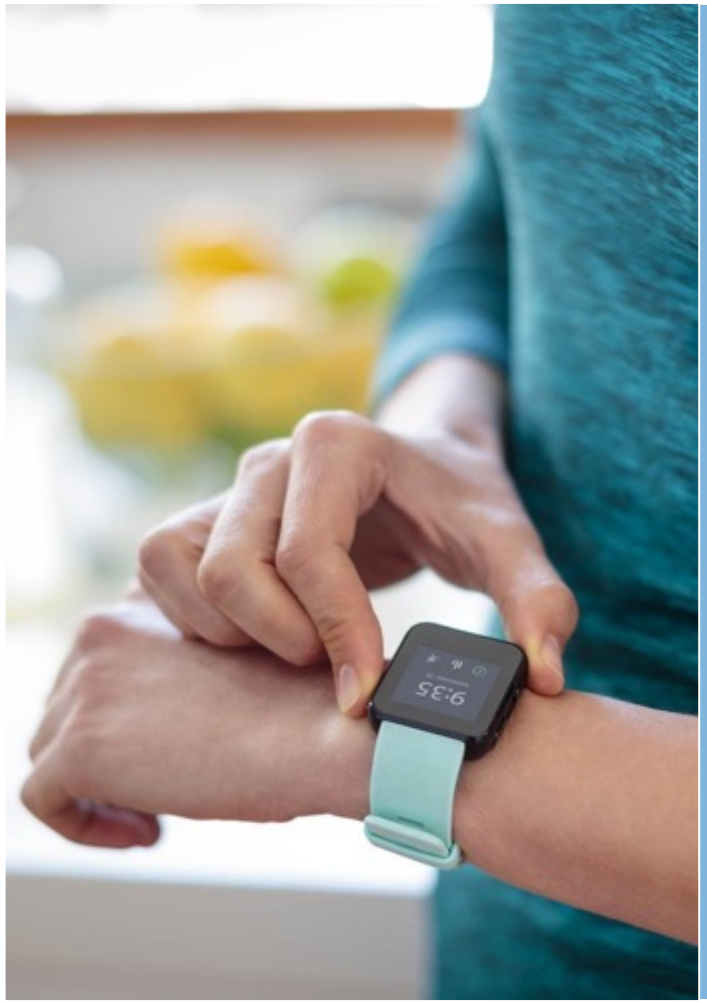
Single image: 5–15 megapixels

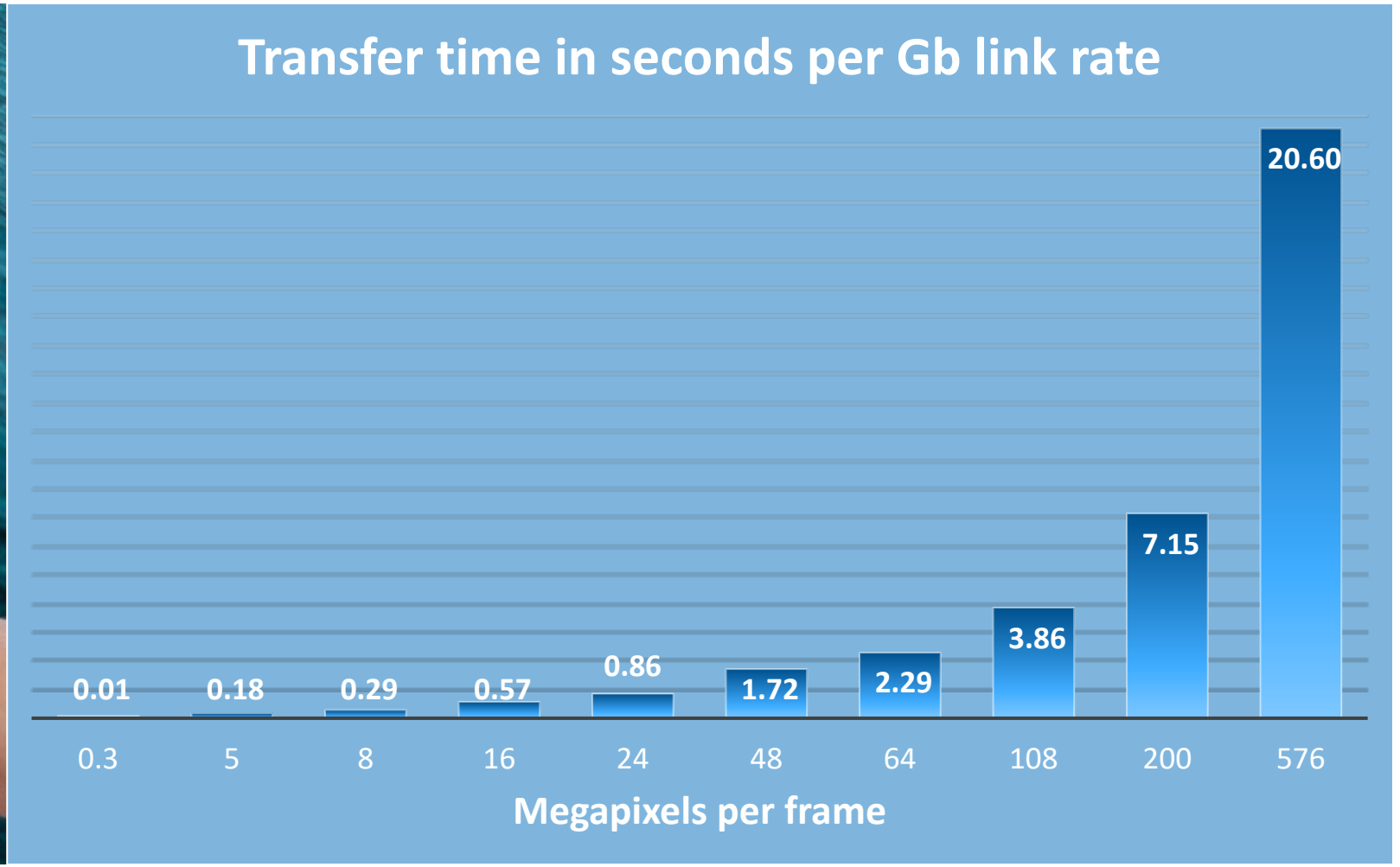
Maximum: 576 megapixels

Consumer Demand Drives Sensor Innovation

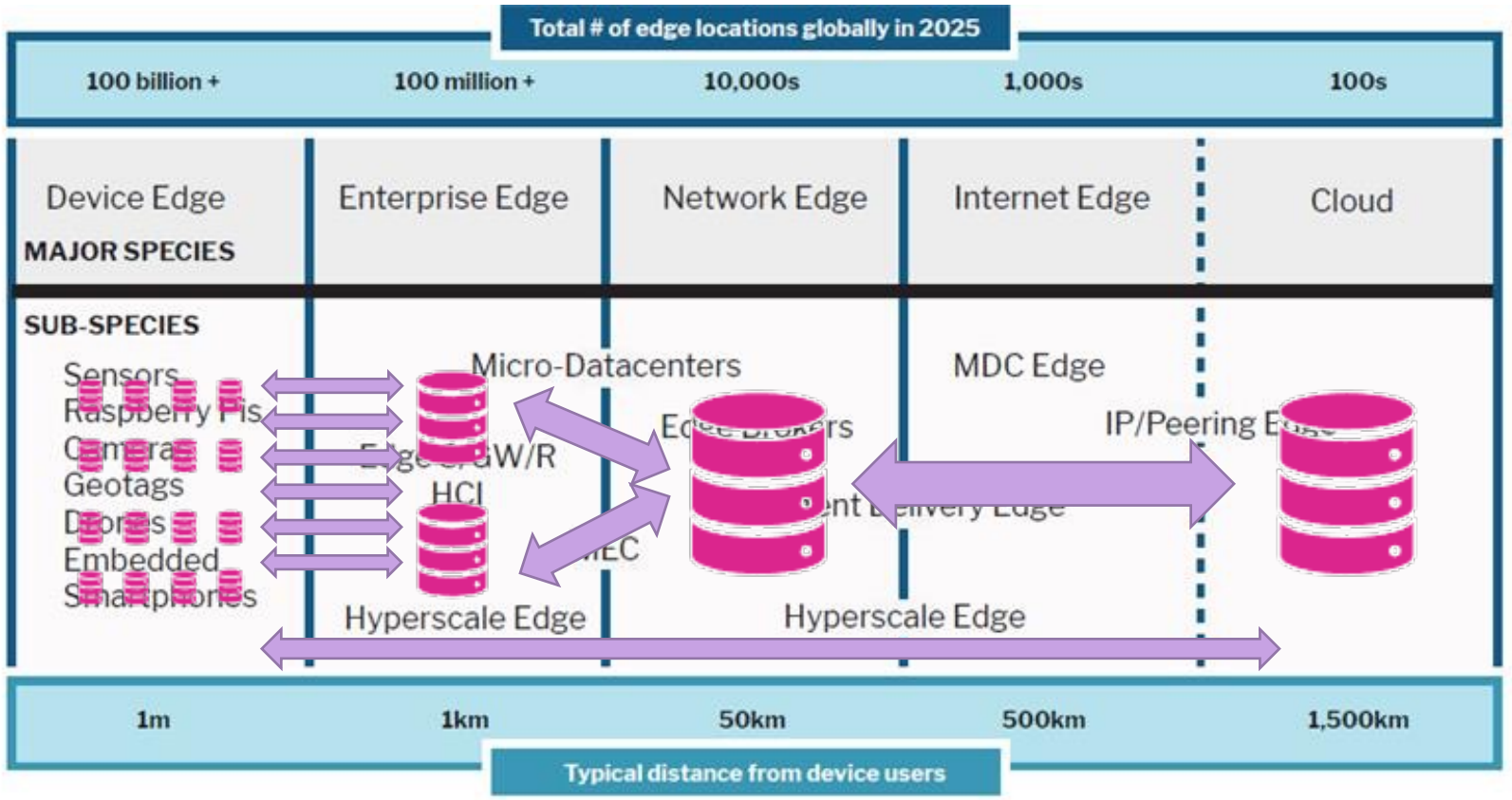


Higher Fidelity Means Greater Data Gravity





Migration of Storage to the Edge



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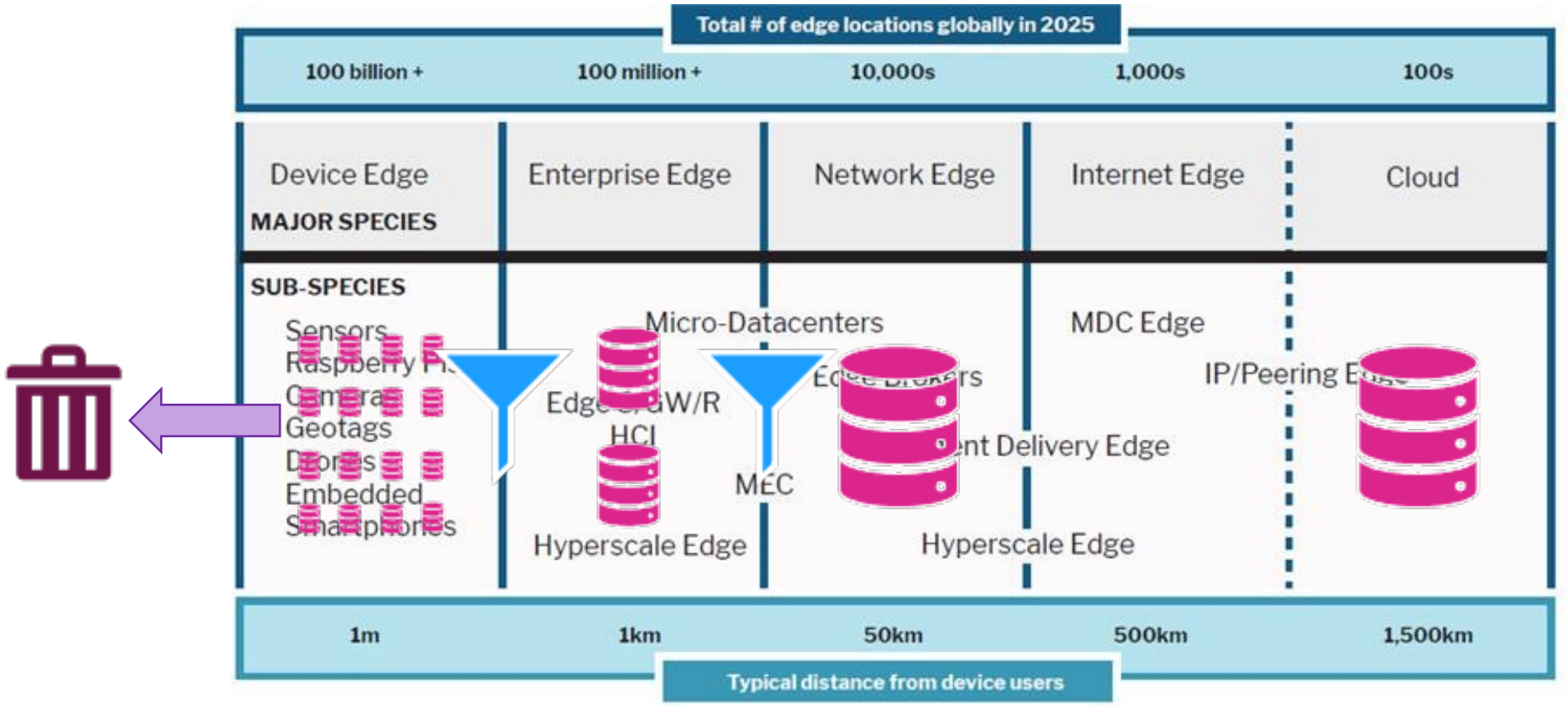
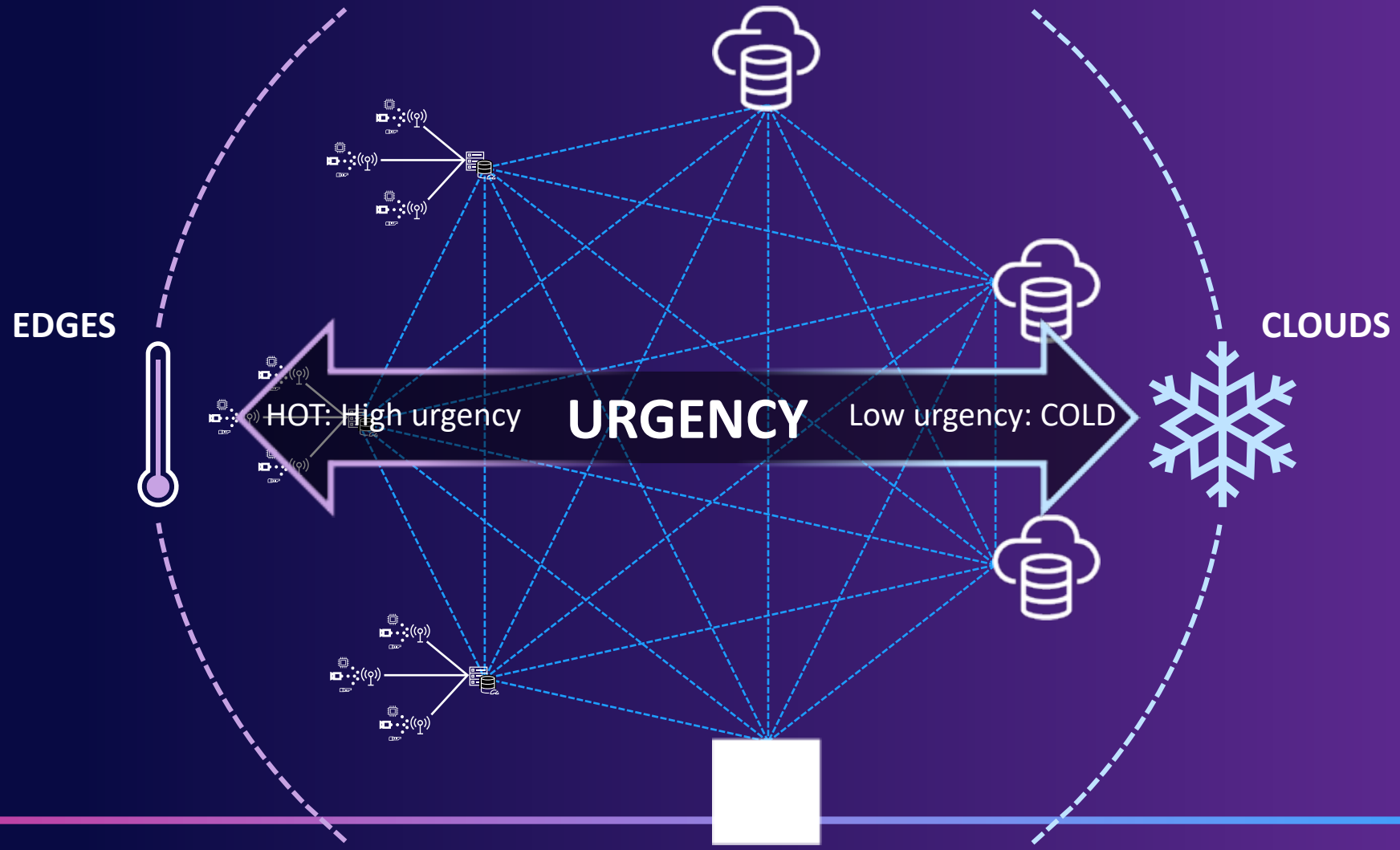


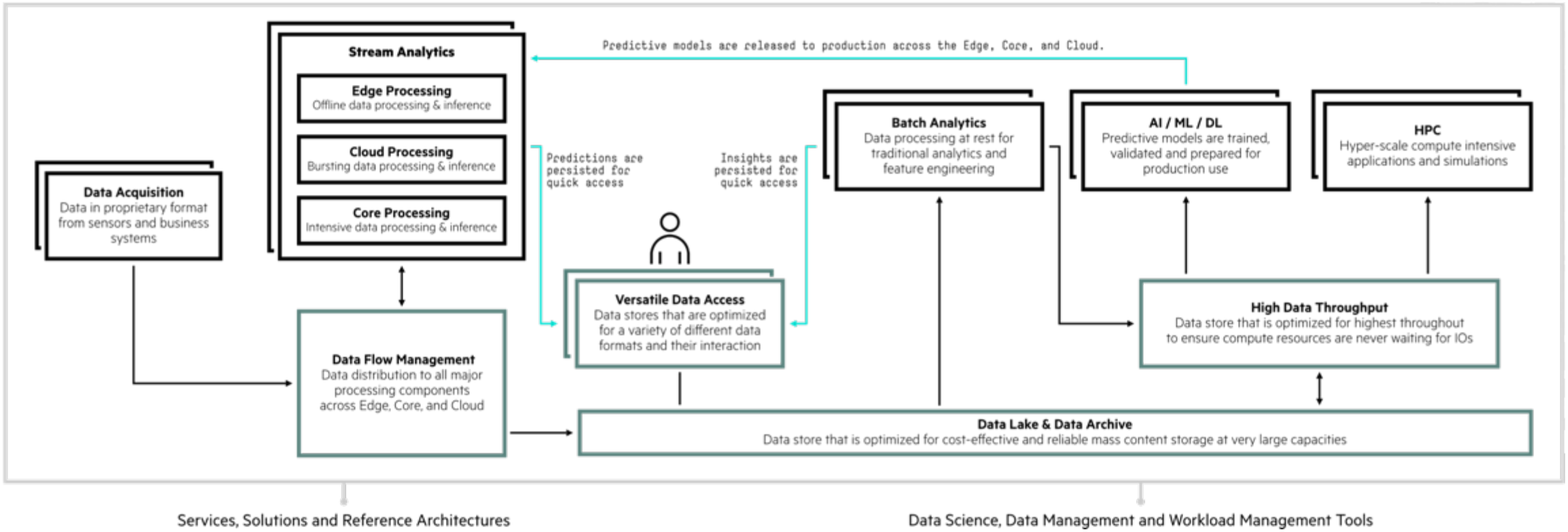
HOT EDGE – COLD CLOUD

Edge-to-cloud data placement is differentiated by data urgency



Edge Data Pipeline

- A typical workflow



In Summary…

- 5G Increases our opportunities and capabilities to work at the edge
- Command and control can now be more remote than before
- Sensor and generated data are still growing faster than our ability to ship that data!
- Storage and data strategy MUST include the edge!

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