Embedded Intelligence: Innovative Outcomes with Edge Cloud

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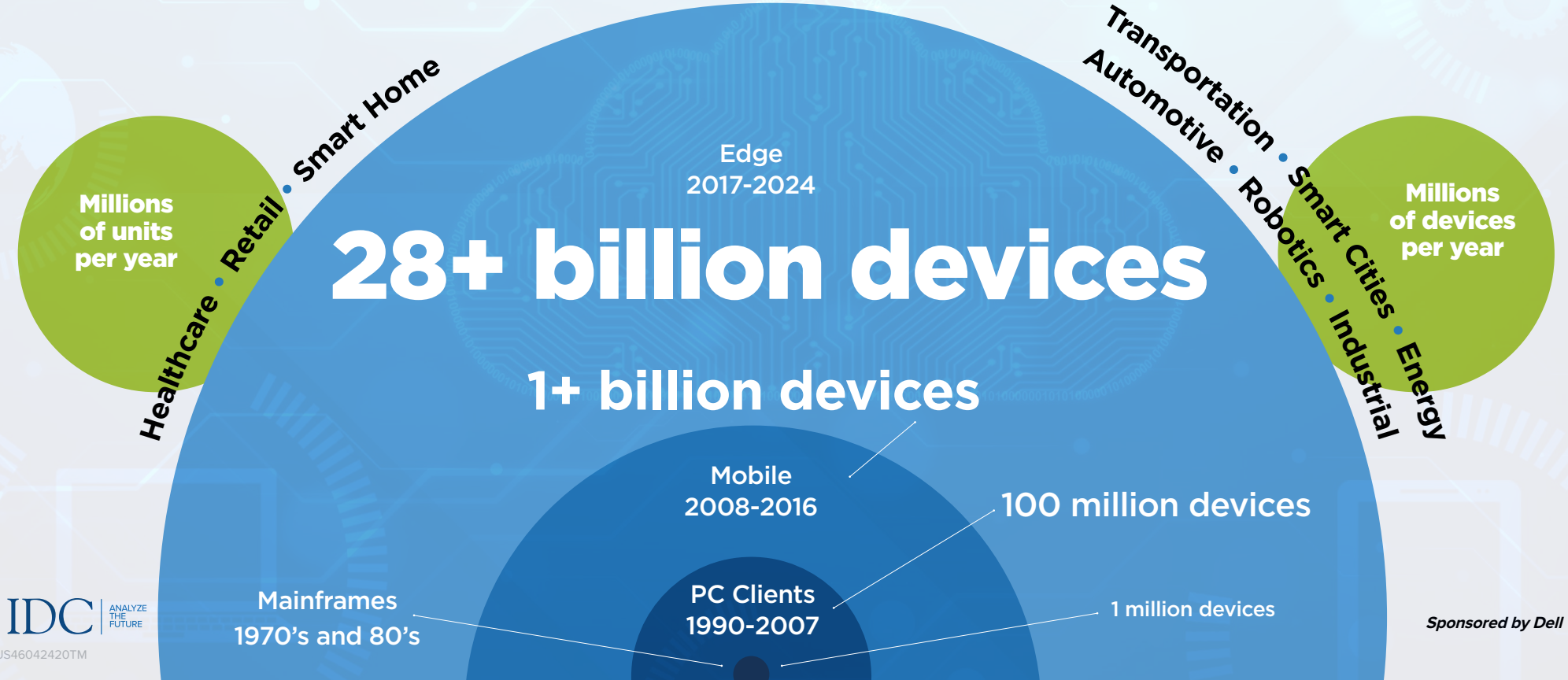
The Rise of the Edge Is a Catalyst for Explosive Intelligence Growth

45 years of evolution in computing gives way to the rise of billions of embedded intelligent systems over the next 4 years.



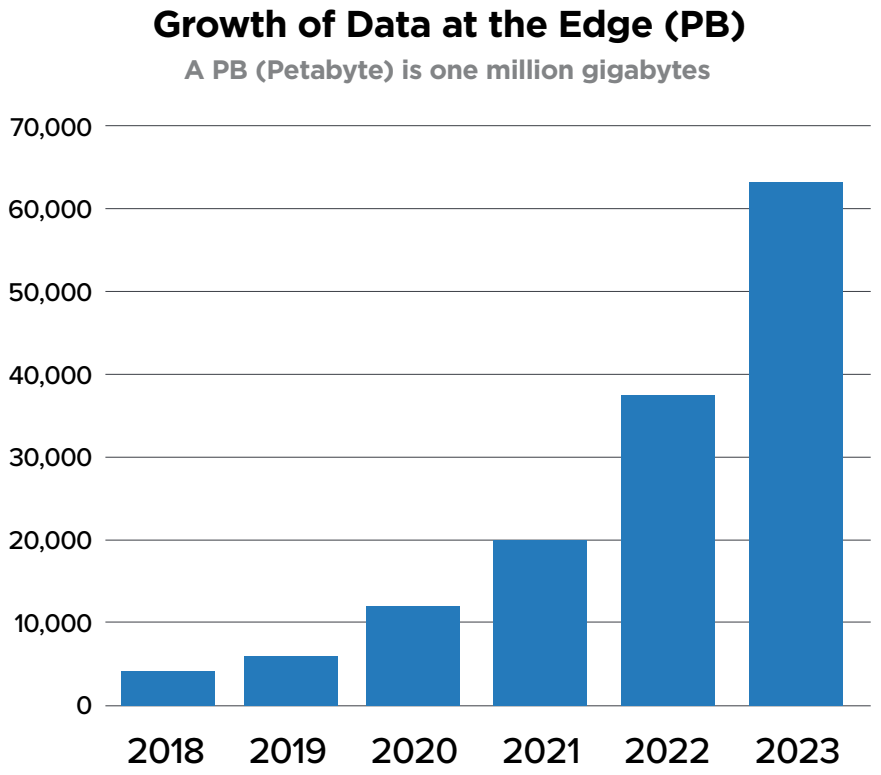
Market Landscape

By 2023, edge devices will be creating over 60,000 PB of data that will need to be converted to information with the help of the edge cloud.

MORE THAN 100 ZB OF DATA

WILL BE CREATED ANNUALLY ACROSS THE WORLD, THREE TIMES MORE THAN EXISTS TODAY.

- Data created at the edge will grow 6 times faster than that of other systems (CAGR 2018-2023 is 78%).
- Hardware and computing architectures will be optimized to address AI inferencing and low latency in local applications where data is created.
- 28 billion embedded intelligent systems will be shipping annually at the edge.
- **Intelligent, AI-enabled systems will account for 41% of all edge system volumes.**



Intelligent Edge Systems vs. Embedded Systems

Flexible intelligent edge systems eclipse fixed-function embedded systems.

Intelligent edge systems are improving outcomes for organizations and consumers by making instantaneous, autonomous, or semi-autonomous decisions independent of the datacenter and private or public clouds.

Compared to embedded systems, intelligent edge systems are designed with more compute and sensors to enable analytics, artificial intelligence inferencing, and natural user interfaces. Also, unlike fixed-function embedded systems, intelligent edge systems can change their behavior and provide new functionality over time based on programming instructions sent to them from the edge cloud.

Comparison of Embedded Systems and Intelligence Edge Systems

Embedded Systems	Micro-controller	Real-time operating system	Machine-oriented user interface	Telemetry data	Sensor, one kind of connectivity
Intelligent Edge Systems	Microprocessor system on chip	High-level OS	Human-machine interface or natural user interface	Larger data sets or machine learning	Multiple kinds of connectivity

Emerging Use Cases

Examples of engaging customers and evolving operations through embedded intelligence and edge cloud.

Automotive

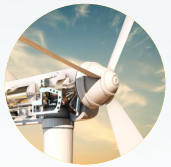
- Line detection and ranging (LiDAR)
- Central driver assist
- Visual systems

Computing

- 3D printer production
- High speed inkjet printer
- Thin client

Consumer

- Gaming consoles
- Casino gaming system
- Consumer drone



Energy

- Grid analysis & transmission control
- Command and control
- Wind turbine control

Healthcare

- Computing tomography (CT) scan
- Picture archiving and communications system (PACS)
- Magnetic resonance imaging (MRI)

Manufacturing

- Semiconductor manufacturing equipment
- Industrial robots
- Inventory management

Retail

- Loss prevention solutions
- Inventory management solutions
- Customer experience solutions

Smart City

- Intelligent traffic management
- Smart parking
- Safety and security systems

Source: Embedded and Intelligent Systems Processor Market Model, December 2019

How Intelligent Edge Devices Work Together through the Edge Cloud

Insightful results

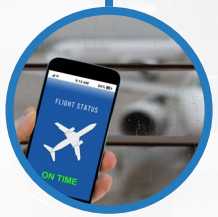
- Intelligent edge devices collect data and provide services to users, corporations, or municipalities.
- The edge cloud aggregates data from local intelligent edge devices and uses the combined data to improve behavior models.
- Intelligent edge devices then receive updated behavior models (instructions) from the edge cloud.
- The result is better than could be achieved with only data from a single set of devices.

Example

A smart phone carried by a consumer provides significantly more value than would a traditional wired or cellular phone. The user could load an app offered by the airport to identify available services, wait times at security lines, and other value-added services.

When joined to an airport's WiFi (free when the app is installed), the phone becomes part of the network. Facial recognition cameras can identify the user and can connect the user's identity with his/her location (tracked accurately through the user's phone-mapping function, or beaconing technology, or WiFi location tracking).

Through the edge cloud, the airport's intelligent systems can offer personalized services to the customer ("When you come to the airport, we notice you always buy a latte. Do you want us to prepare one so it's ready for pickup as you walk by? Yes/no/customize").



The system could then also enhance more critical experiences, such as by tracking the user's location against the impending departure of their plane. If the user hasn't yet arrived at the airport, the system could offer a rebooking feature and alert the gate staff to release the seat. If the user is in a slow security line, the system could offer access to a high-priority security lane. Or if they're walking around the airport away from their assigned gate, the system could alert the user that their flight is boarding so they don't miss their flight. No more generic overhead announcements; now users can be called or texted directly with the details they need to know immediately.

Disrupt or Be Disrupted

Expectations from deploying intelligent edge devices:

"Improve processes across all key functional business areas with systems that leverage machine learning and ingest large amounts of data."

—Director Data Government, Security, and Compliance, Cloud Service Provider

"Move to a shared digital infrastructure with empowerment on premises."

— Enterprise Solutions Owner (ESO) Director, SaaS Provider

"Increase customer satisfaction and retention by leveraging technology as close to the product process as possible."

—Director, Automotive Manufacturing Supplier

"Personalize products and services with real-time data from sales, design, and production enhancements."

—Chief Technology Architect, Consumer Appliance Manufacturer

"Maximize safety and increase productivity at every layer of our process."

—IT Director at Discrete Manufacturing Company

"Reinvigorate and disrupt our existing business model for sustainability."

—Senior Solutions Architect at Food and Logistics Company

"Significantly reduce costs as we implement edge systems throughout our organization."

—Computational Modeling Manager, Global Chemical Company

Critical Lessons Learned from Early Implementations

- Rapidly expanding use cases for embedded intelligence are leading to a flurry of new internal stakeholders interacting with IT. These new stakeholders require implementation and support to address edge-specific constraints introduced by their use cases—for example, requirements for low latency, tight data security, or autonomous operations. Investing in people, processes, and the underlying technologies used throughout the company's private, public, and edge clouds will help you prepare for these new demands.
- Learning implementation-by-implementation results in fragmented and expensive data controls and data silos. Invest in the right data framework now to maintain control of and maximize the usefulness of your data across projects.
- Initial implementations of embedded intelligence may not account for the volume, distribution, and value of data that comes from an edge implementation. That data needs to be secured from theft, tampering, and accidental loss.
- Embedded intelligence is solving problems in revolutionary ways, many beyond line of sight. Explore technologies and infrastructure that will evolve and scale to help you differentiate your organization's currrent line of sight. Many organizations will find that a consumption-based acquisition model will fit their needs best, given the uncertainty of future needs.

Finding the Right Partner

The best partner is one who has trusted expertise and a broad technology portfolio to help you across these domains:

- Leverage and protect your data by aligning the business and IT on intelligent edge device use cases and requirements
- Design and implement your IT environment to support these use cases
- Architect for flexibility at scale, including compute, storage, networking, and data protection across public, private and edge clouds
- Provide flexible IT consumption models that match the requirements of your business.