New Paradigms in Edge Computing for IoT

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Why the interest in “Things” out at the “Edge” of the IoT?
The Rise of Smart and Connected “Things” at the Edge

Source: BI Intelligence Estimates, National Instruments
Pent up insights are embodied in “Things”

New sources of data and insight → “things”

People, devices, nature, buildings - “Things” - have always embodied interesting and valuable data. Consider how the healthcare professional relies on the data expressed from the patient (the Thing), such as body temperature and blood pressure. When this data is captured, keen insights into the patient’s health are derived, conclusions made, and actions taken. And so it is with many other Things in our world today. Untapped insights are pent up in many Things, and can extracted via IoT systems and solutions.
The Things are out at the “Edge”

The “Edge” is a place. It’s where the Things reside, and are sometimes the Thing itself. The edge can be a manufacturing floor, a power plant, an airplane, automobile, train, windfarm, street crossing, medical facility, crop fields, oil fields, baseball fields, buildings, boats ... The Edge is simply NOT the data center or cloud.

New, optimized IoT solutions and services – out at the Edge - are needed to capture, process, and derive value from Things data.

- The Things embody new insights...

The 3 Types of Insight from the IoT:

- Business
- Engineering
- Scientific
Why compute at the Edge?
“Things” Data is Big and “Big Data” is not just in datacenter

“Things” Data

- Can be Big Data, derived from the physical analog world
- Is usually sourced from nature, people, electrical and mechanical devices, environment, and objects
- Is mostly sensor acquired and digitized via A/D conversion

T.M.S. Bradicich, PhD
Why NOT Send All Things Data to The Data Center or Cloud?

IDC believes over 40% of all the data captured at the Edge will be processed at the Edge. This is because there are at least 7 reasons NOT to send all the big IoT data all the way to the data center/cloud:

**AVOIDANCE of:**

1) **LATENCY**: Latency in data transfer reduces “time-to-insight” from the data, which slows “time-to-action” for businesses and protracted responses to the data.

2) **BANDWIDTH**: Using available but limited NW bandwidth then prevents other business critical uses of said NW bandwidth.

3) **COST**: Sending data incurs IT and bandwidth costs.

4) **SECURITY**: Transferring data by definition exposes data to security threats.

5) **DUPLICATION**: Complexity and cost of storage and other assets must be duplicated to accommodate the data if sent to a data center/cloud

6) **CORRUPTION**: Data transmission, especially large amounts across large distances, can incur delays associated with correction/recovery, dropped data, etc.

7) **COMPLIANCE**: Region and country compliance issues can complicate data transfer across borders and long distances.
Extracting the data and controlling the “Things” at the “Edge”

Stage 1: Sensors/Actuators (wired, wireless)
- Primarily analog data sources
- Devices, machines, people, tools, cars, animals, clothes, toys, environment, buildings, etc.

Stage 2: Internet Gateways, Data Acquisition Systems
- (data aggregation, A/D, measurement, control)

Stage 3: Edge IT (analytics, pre-processing)

Stage 4: Data Center / Cloud (analytics, management, archive)

The “Things”

SW Stacks:
- Data Flow: Control Flow:

End-to-End, Proactive, Defense-in-depth Security
Open, Extensive, Partner driven Ecosystem
Advise, Transform, Integrate, Operate, Manage Services

Visualization

T.M.S. Bradicich, PhD
Over the decades, HPE has developed many IT and embedded electronics assets. Today, HPE is bringing these world class competencies to the IoT Edge, with the Edgeline Systems family. In sum, the EL1000 and EL4000 create a new product category: “Converged IoT Systems”. HPE is converging three crucial capabilities for efficient IoT solutions:

1) Deep compute (Stage 3/4)
2) Deep data capture and ingest (Stage 2)
3) Enterprise class systems and device management
HPE Edgeline – The Full Portfolio

- Multiple functions in one box
- Open industry standards
- Environmentally ruggedized

Compute at the edge, accelerate insight™

T.M.S. Bradicich, PhD
HPE Moonshot and Edgeline IoT Systems – 2016
EL10 and EL20

• First output of Intel partnership
• Sit at the network edge
• Enables customers to securely aggregate, analyze data in real-time
• Insight and Control

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<th>HPE EL10</th>
<th>HPE EL20</th>
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<tbody>
<tr>
<td></td>
<td>A rugged price/performance-optimized edge gateway designed for entry level deployments</td>
<td>A rugged performance-optimized edge gateway with additional features for higher compute capabilities designed for more demanding high volume deployments</td>
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</table>
HPE Edgeline Converged Edge Systems – 2017

**HPE Edgeline EL 1000**
- Wall or Shelf mountable
- One hot-pluggable deep compute engine – up to 16 Intel Xeon cores
- Two Mini-PCI Express slots for connectivity options
- 2 Option Slots - PCIe or Robust I/O for the IoT

**HPE Edgeline EL 4000**
- Rackable and Wall mountable
- Up to Four hot-pluggable deep compute engines – up to 64 Intel Xeon cores
- One 40Gb Pass-thru or One 10Gb un-managed switch.
- Up to 4 Option Slots (1 per compute engine) - PCIe or Robust I/O for the IoT
HPE Edgeline EL4000, EL1000 Expansion Options

Infiniband, More 10Gb network, RAID controllers, Fiber Channel, PCIe accelerators...

- HP IB FDR/EN 40 Gb 2P 544+ QSFP Adapter
- Infiniband
- More 10GbE
- HP Ethernet 10Gb 2-port 560SFP+ Adapter
- HP Ethernet 10Gb 2-port 561T Adapter
- HP Ethernet 10Gb 2-port 546FLR-SFP+ Adapter
- RAID cards
- HP Smart Array P441/4GB FBWC 12Gb 2-ports Ext SAS Controller
- SFF HDD options for additional storage
- Inference at the Edge
- NVIDIA Tesla P4
- GPUs
- For Application offload or bump-in-the-wire processing
- Nallatech 385 A Arria 10 /1150
- FPGA Accelerators*
- Up to 2 PCIe Gen3x8 shared links for FH/HL cards
- Up to 4 PCIe Gen3x8 links for FH/HL cards - 1 per cartridge
- Moonshot Cartridges x2
- Moonshot Cartridges x2 (FH, HL)
- PCIe cards x2 (FH, HL)
- PCIe cards x2 (FH, HL)
- PCIe cards x2 (FH, HL)
- Inference at the Edge
- Up to 2 PCIe Gen3x8 shared links for FH/HL cards

For Application offload or bump-in-the-wire processing

Hewlett Packard Enterprise
Modular Capability for Every Application

**DAQ and Control**
- Multifunction I/O
- FPGA
- Digital I/O
- Analog Input / Output
- Vision and Motion
- Counter / Timer / Clock
- Sensor Measurements
- Reconfigurable I/O
- Signal Conditioning

**Instruments**
- Oscilloscopes
- High-Speed Digital I/O
- Digital Multimeters
- Signal Generators
- Switching
- RF Analyzers & Generators
- Power Supplies
- Dynamic Signal Analyzers
- Source Measurement Units

**Interfaces**
- GPIB, USB, LAN
- RS232 / RS485
- CAN, LIN, FlexRay
- Avionics Buses
- I2C/SPI
- Boundary Scan / JTAG
- DeviceNet, PROFIBUS
- SCSI, Ethernet
- VXI - VME

NI Offers 600+ PXI Products
And there are over 1500 PXI modules from 70+ vendors in the market today

Shared with permission from National Instruments
HPE Edgeline EL4000, EL1000 I/O card options – Deep Data Ingest

PXI/PXIe card options. Converging scientific instrumentation and streaming analytics.

- Edgeline systems are a new product category: Industry first
  - Enable connectivity with previously isolated scientific equipment
  - Have sufficient compute cores (Moonshot cartridges) for real-time post-processing (condition monitoring, analytics)
    - Example: 1 m510 cartridge links to 4 PXIe cards in EL4000. The remaining 3 cartridges run a distributed analytics stack for live-processing acquired data. Enables real-time control.

Up to 4 PXI/PXIe Gen3x8 links – configurable to one or more hosts

Up to 2 PXI/PXIe Gen3x8 links – to Moonshot host

Shared with permission from National Instruments
Why use an Edgeline “Converged IoT System” at the Edge?
Where is the Edge?

IT Edge

Use Case Examples
- **Media Delivery, CDN**
- **Edge** network analysis
- **Video** analytics
- **NFV** edge applications
- **Brach level VDI**
- **Wayfinding** (Aruba Meridian)

Industrial IoT Edge

Use Case Examples
- **Manufacturing automation** efficiency improvements
- **Refinery** asset tracking and safety applications
- **Digital Oil Field** with enhanced analytics
- **Smart Grid** optimization and control
- **Preventive maintenance** in O&G/mfg
- **Control Systems** integration & automation

Mobile IOT (Telco & Media)
Campus, Branch Office and Retail
Manufacturing
Oil & Gas
Energy & Utilities
Defense and Intelligence
Transportation & Automotive
There Are Many Other Types of Intelligent “Edges” . . .

HPE Edgeline Intelligent Edge Workspace Appliance

EL4000

HPE Edgeline Converged Edge Systems

Temperature, shock, vibration hardened

Edge Mobile Workspace
Remote data and app access anywhere, anytime, on any device

Industry’s first Dedicated Workspace Appliances for mid market and branch

Workspace Application Stack (Citrix)

VM
Container
Docker/Kubernetes

CTIX

USX SDS
vSphere/Xen
KVM/Azure

Distribution
Telco,
Media,
Comms

Campus,
Branch,
& Retail

IT Edges

HPE Edgeline Intelligent Edge Workspace Appliance
There Are Many Other Types of Intelligent “Edges” . . .

HPE Edgeline Intelligent Edge Media / Comms Solutions

HPE Edgeline Converged Edge Systems

Temperature, shock, vibration hardened

Proven solutions with many industry ISV partners

Distributed Telco, Media, Comms

Campus, Branch, & Retail

HPE Edgeline Intelligent Edge Media / Comms Solutions

EL1000 EL4000

HPE Edgeline Converged Edge Systems

Media Streaming
multiscreen content delivery

Live Sources

Live/Linear Outputs

IT Edges

IPTV & OTT
Web
Mobile
**Auto Manufacturing – Management Simplicity Improves Efficiency**

**Assembly Line Efficiency Improvements**

- **Converged** Compute, 12x CAN bus interfaces, advanced management
- **Increased uptime and security** with elimination of sneaker-net updates
- **Fully automated** system deployment improves factory efficiencies
- **Modern platform** with support for rapid deployment of new applications
Distributed 5G Research Testbed

**Stage 1**
- Sensors & Actuators
- The Things
  - Passengers and Autonomous Vehicles
  - Telemetry and Control
  - Video/Audio Streaming

**Stage 2**
- Data Aggregation & Control
- Edge Services (SDR, CDN, etc)

**Stage 3**
- Edge Analytics
- Converged RF and compute distributed at the edge, software-defined radio evolves with 5G standard

**Stage 4**
- Data Center / Cloud

- Distributed HPE Edgeline EL4000 & National Instruments PXI RF Basestations
- High performance compute in small, low power NEBs form factor enables new low latency, high bandwidth service delivery and control applications
Industrial IoT project to transform operations through automation by leveraging:

- Edge to Core real-time analytics
- Digitization to automate paperwork process
Real Time Monitoring and Root Cause Analysis (Flowserve)

**Stage 1**
FlowServe Pump

**Stage 2**
Data Acquisition & Pre-processing
- NI cRIO

**Stage 3**
Edge Analytics (ThingWorx)
- HPE EL1000

**Stage 4**
Cloud or DC
- ThingWorx

Real Time Augmented Reality App

**Root Cause Analysis, Corrective Action Process, and augmented reality for service support**

PTC Dashboard (Control Room)
AI Enabled Smart Cities with Real-Time Video Analytics

By 2020 Surveillance camera capture 30 billion images/second; 100 trillion images/hour
Video Analytics at the Edge for AI Cities

Video analytics performance

![Graph showing video analytics performance](image)

40X efficient vs. CPU, 8X efficient vs. FPGA

![Graph showing efficiency comparison](image)
How can we get started with Edgeline Systems?
HPE Global IoT Discovery Labs

- More than show and tell, and more than a customer experience center
- Working lab for customer and partner IoT solutions building in real time
- Test and pre-validation of Edgeline system and end-to-end IoT solutions
- On-site access or secure remote access
Thank you!

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To learn more about Hewlett Packard Labs, visit: http://www.labs.hpe.com
# HPE Edgeline EL4000 and EL1000 Converged Edge Systems

- Unprecedented Edge Compute with Integrated Deep Data Ingest and Control
- Datacenter-Class Security and Management
- Engineered to fit into Harsh Edge Environments

<table>
<thead>
<tr>
<th>EL4000</th>
<th>EL1000</th>
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<tbody>
<tr>
<td><strong>Compute</strong></td>
<td>Up to (4) Intel based m510 [4x16c] or m710x [4c+GPU] high density servers</td>
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<tr>
<td><strong>Dimensions</strong></td>
<td>1U , 23” Deep, 17” wide, reversible rack mount with slide rails</td>
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<tr>
<td><strong>I/O</strong></td>
<td>One x8 PCI-E slot per server (four total)&lt;br&gt;- Or - Four assignable x8 PXI-E slots</td>
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<tr>
<td><strong>Network</strong></td>
<td>2 port 10GbE pass through per cartridge (dual, combined QSFP)&lt;br&gt;- Or – Aggregated 2 port 10GbE SFP+ uplinks (Layer 2 switch)</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>Onboard server cartridge storage up to 4x 4TB total&lt;br&gt;External storage via PCI-E or iSCSI</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>N+1 redundant fans</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td>Extended operating temp 0-55 deg C&lt;br&gt;95% non-condensing Humidity</td>
</tr>
<tr>
<td><strong>Power Input</strong></td>
<td>95-265 VAC or -48 VDC input, 1+1 redundant power, high efficiency</td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td>HPE iLO4 enterprise-class aggregated to single management RJ45</td>
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## HPE High Density ProLiant Servers

- Choice of compute
- Remotely managed via iLo
- Energy efficient
- Integrated GPU (m710x)

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<tr>
<th>HPE ProLiant m510</th>
<th>HPE ProLiant m710x</th>
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| **SoC** | Intel® Xeon® D1587 16 core, 1.7GHz, 24MB L3 cache  
- Or -  Xeon® D1548 8 core, 2.0GHz, 12MB L3 cache | Intel® Xeon® E3-1585L 4 core, 3.0GHz, 8MB L3 cache with 128MB eDRAM (L4 cache) |
| **Graphics** | iLO4 Remote Console | Integrated Intel® Iris™ Pro Graphics P580 with 72 execution units  
- And - iLO4 Remote Console |
| **Memory** | (4) DDR4 SDRAM (2133/2400MHz) (8GB, 16GB, 32GB) with ECC protection  
Maximum Configuration 128GB (4x32GB) | (4) DDR4 SO-DIMMs (2133MHz) (8GB, 16GB) with ECC protection  
Maximum Configuration 64GB (4x16GB) |
| **NIC** | Mellanox Connect-X3, Dual 10GbE RDMA NIC | Mellanox Connect-X3, Dual 10GbE RDMA NIC |
| **Management** | HPE iLO4 Enterprise-class | HPE iLO4 Enterprise-class |
| **Onboard Storage** | Three (3) m.2 Modules  
(1) - SATA m.2 (2242) – 64GB, 120GB, or 240GB  
(2) – x4 NVMe m.2 (2280): 256GB, 512GB, or 1024GB | Five (5) m.2 Modules  
(1) - SATA m.2 (2242) – 64GB, 120GB, or 240GB  
(4) – x4 NVMe m.2 (2280): 256GB, 512GB, or 1024GB |
| **OS** | Ubuntu, RHEL, SLES, Windows Server, CentOS | Ubuntu, RHEL, SUSE, SLES, Windows Server, Windows client, CentOS, Xenserver |
| **Workload** | All Purpose Compute Workhorse for vRAN and other MEC applications, CDN, content caching, IoT and more! | Just in Time Transcoding [JITT], remote visualization, CDN, content caching, video surveillance, Big Data analytics, and more |
Resources

- **HPE.com/info/Edgeline**
  - Showcasing the Edgeline family line of products and resources

- **HPE.com/IoT**
  - Access additional resources from HPE about the Internet of Things: case studies, white papers, videos, etc.

- **@HPE_IoT**
  - Follow and engage with us in live conversations around #IoT

- **HPE.com/blog/IoT**
  - Cut through the noise to learn what our HPE IoT experts and customers are saying about the latest IoT industry news and experiences with IoT deployments

**White papers**

- [Become a data-driven organization with IoT](#)
- [Securing the Internet of Things - Explore security and privacy in an interconnected world](#)