Edge Computing and HPC

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Edge Computing and HPC

- **Edge computing: data-intensive computing performed entirely or mostly on/near data sources (e.g., IoT devices).**
  - Vs. sending all data to distant data centers or clouds
  - Main goal: fast (low-latency) local responsiveness
  - Computing ***on*** edge devices (e.g., vehicles, satellites)
  - Computing ***near*** edge devices (e.g., traffic sensors, "fog computing" clusters, HPC containers)
- **HPC has a limited but important role at the top of the edge-to-exascale food chain.**
  - Most edge data is small, transient and fine with local computing power
  - A small subset of edge data needs HPC, esp. for wide-area analysis and control (e.g., citywide traffic control, smart homes and power grids, cyber security)

- **Supercomputers aren't new to edge computing. Since the 1960s-1970s, governments have used HPC to:**
  - Monitor telecommunications traffic.
  - Forecast weather based on data from edge devices (sounding balloons and ground observations)
  - Analyze satellite data (not all edge computing is earthbound)

Memorable Quotes

"A supercomputer is a device for turning compute-bound problems into I/O-bound problems."
The late supercomputer architect Ken Batcher

1935-2019

"Edge computing is a device for turning I/O-bound problems into compute-bound problems."
Pete Beckman, Argonne National Laboratory

Advantages of Edge Computing

- **Faster responses to local events (latency)**
  - Traffic congestion, lawbreakers, severe storms
- **Lower costs (economics)**
  - Moving all data to clouds/data centers & storing it there could become prohibitively expensive
- **Higher autonomy & reliability**
  - Avoid multi-tenancy, multiple network connections
- **Greater privacy & security**
  - Avoid multi-tenancy, decide rules for local network
- **Scalability**
  - Easier to add small, inexpensive local units than to increase cloud and data center footprint.

Edge Computing & Cyber Security

ADVANTAGES OF EDGE COMPUTING FOR CYBER SECURITY

- Large amounts of data are more difficult to steal from many edge locations than from one central server
- Large amounts of computing power are more difficult to hijack for nefarious purposes (e.g., cryptocurrency mining)
- "Small data" processed at the edge is usually less mission-critical than the subset of edge data sent to central servers.
- Keeping most data at the edge makes central servers less likely to be attacked.

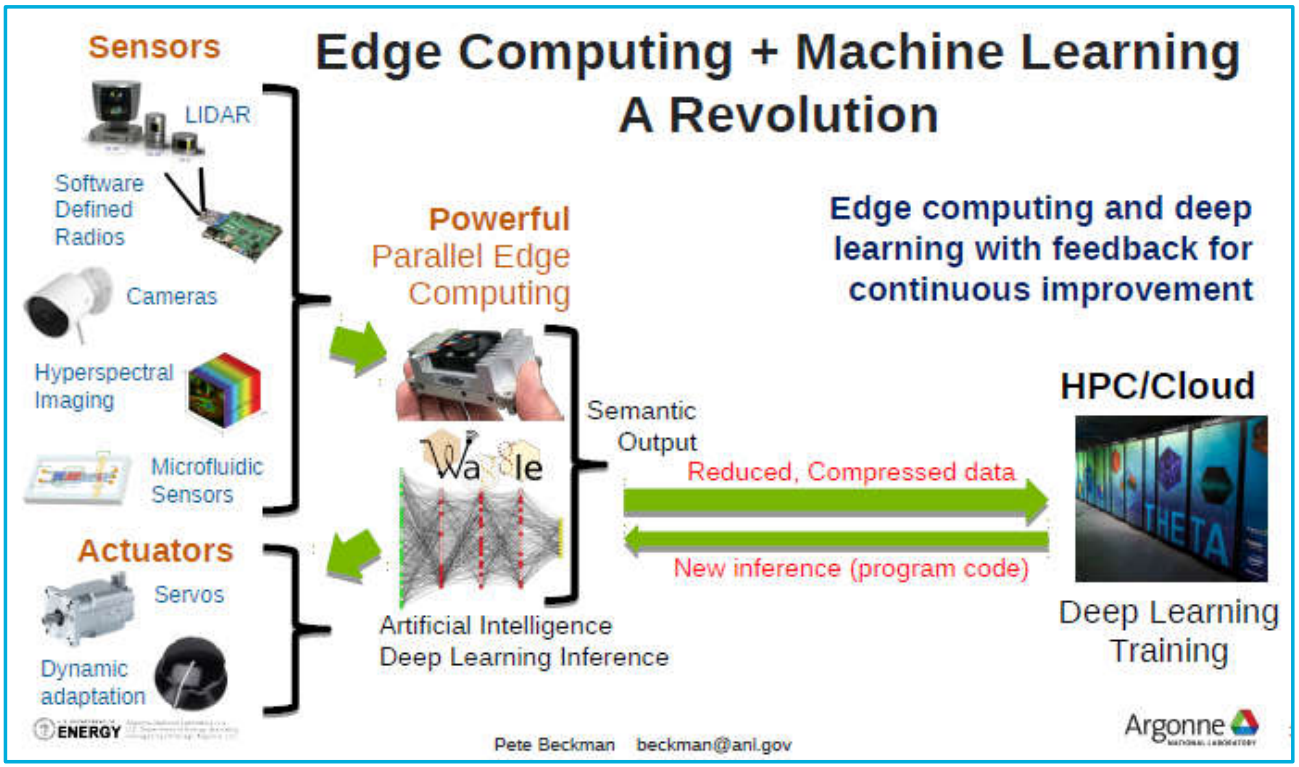
DISADVANTAGES OF EDGE COMPUTING FOR CYBER SECURITY

- Edge devices may not be designed with cyber security in mind.
- Commercial edge devices typically not tested for resilience to attacks, which is an important consideration for DoD.
- Visibility and control of edge locations via the network may be limited.
- Loopholes and vulnerabilities in edge security may provide network access to central servers.
- Edge devices may be physically small enough to steal or manipulate.

The “Waggle Project”

HPC for Traffic Management in Chicago*

The *Waggle Platform* is a research project at Argonne National Laboratory to design, develop, and deploy a novel wireless sensor platform with advanced edge computing capabilities to enable a new breed of sensor-driven environmental science and smart city research.



**One of multiple examples. A substantial portion of China’s Top500-topping Tianhe-1 supercomputer was used to manage traffic in Guanzhou.*

Many HPC-Supported Commercial Applications Involve Edge Computing

Most HPC Sites Already Run or Plan to Run At Least One of these Applications (2021 Hyperion Research global study)

Plans for HPDA/Big Data Application Types		
34) Are you running or planning to run any of these HPDA/big data application types?		
	Responses	Percent
None of the above	28	19.9%
Business intelligence	38	27.0%
Precision medicine	35	24.8%
Internet of things and/or edge computing	29	20.6%
Fraud or anomaly detection	27	19.1%
Cyber security	26	18.4%
Automated driving systems	22	15.6%
Smart cities	20	14.2%
Affinity marketing	9	6.4%
Other	29	20.6%
n = 141		
Source: Hyperion Research, 2021		