CPSL
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Real-Time Internet of Things

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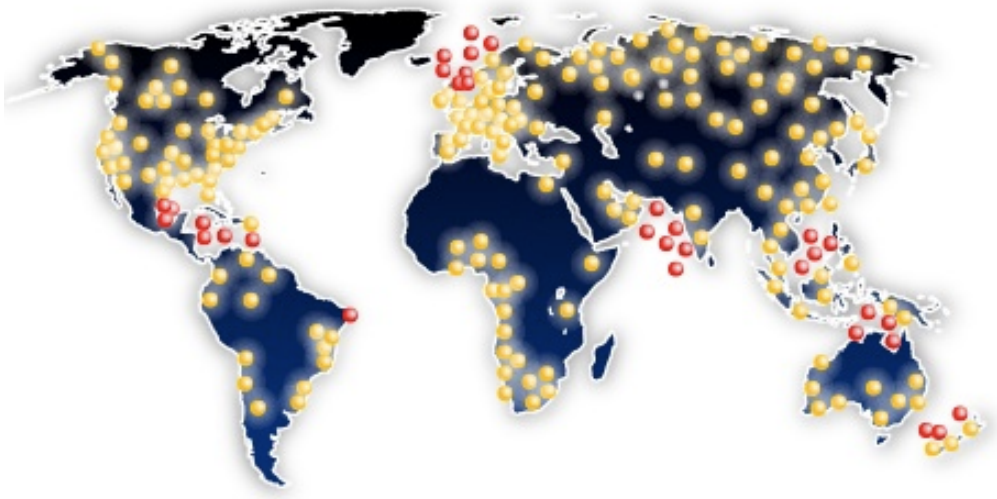
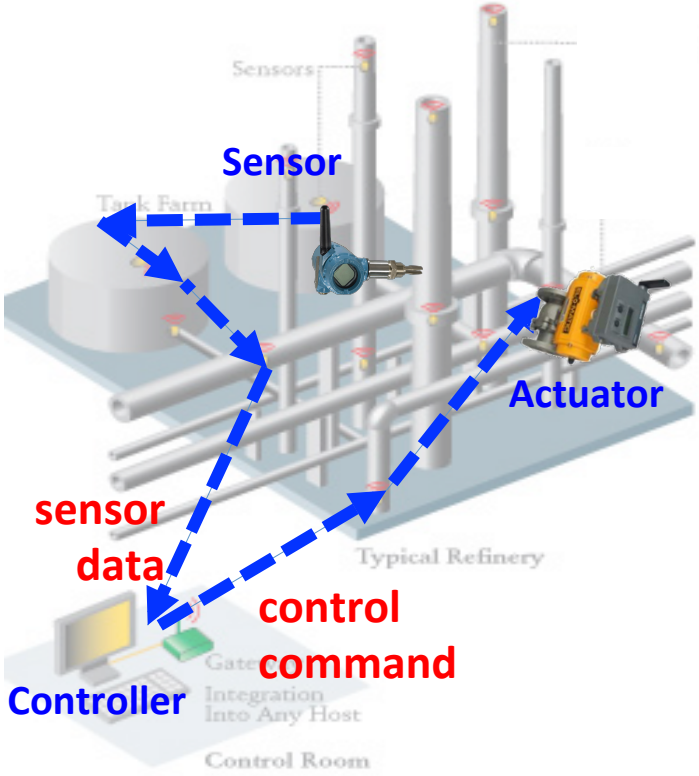
IoT-driven Control

- Smart manufacturing, transportation, grid, healthcare…
- Closed-loop control → latency bounds
- End-to-end: devices–wireless–**edge**–internet–**cloud**

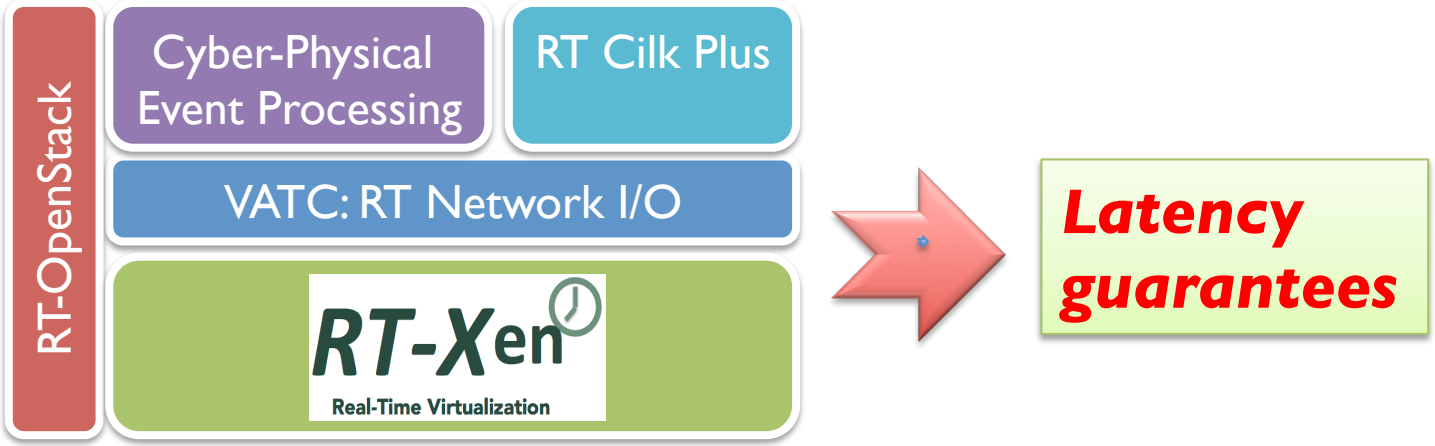


WirelessHART in Process Industries
[Courtesy: Emerson Process Management]

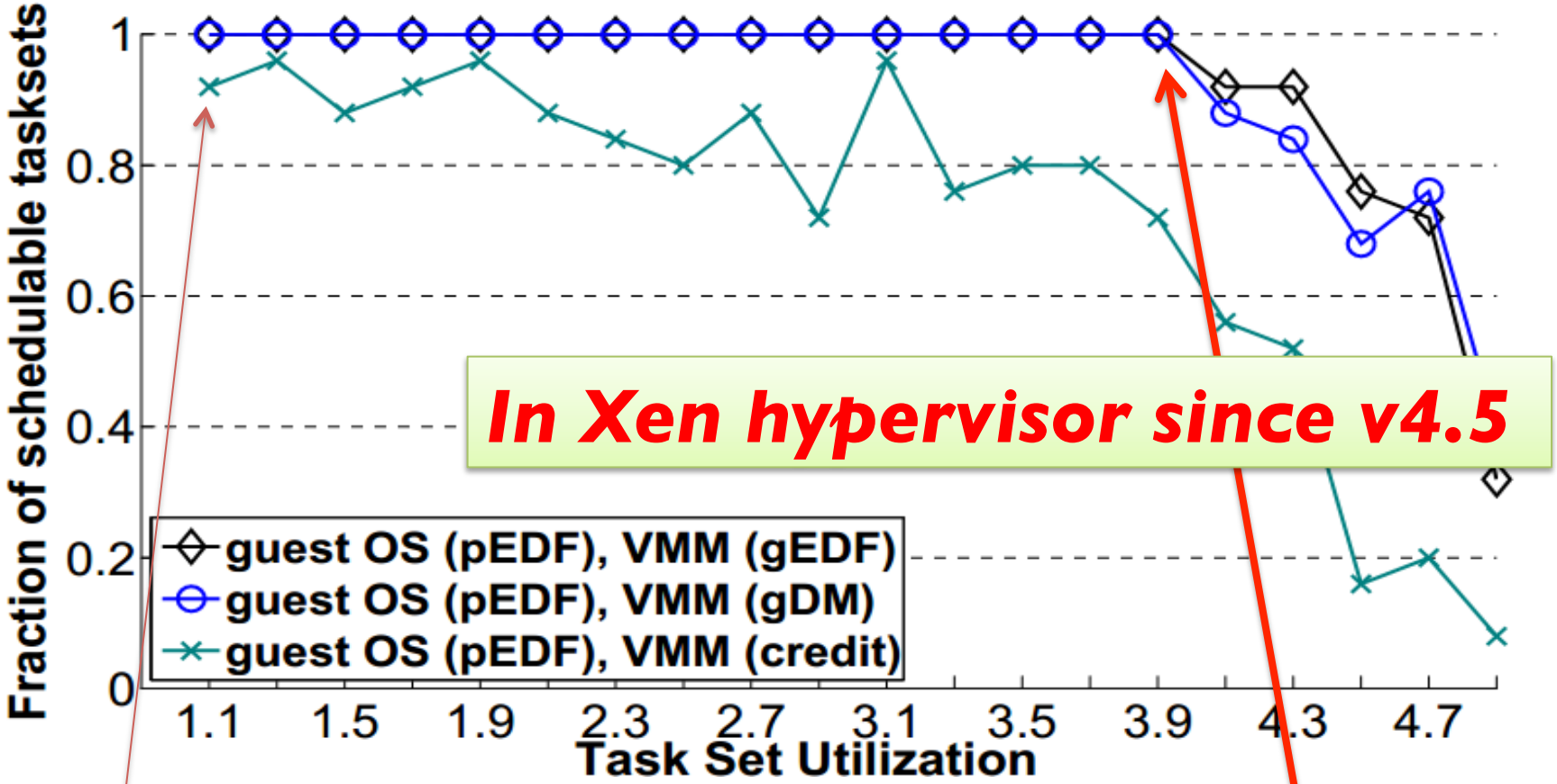


Towards Real-Time Edge/Cloud

- Support real-time applications in the cloud.
  - Latency guarantees for tasks running in virtual machines (VMs).
  - Real-time performance isolation between VMs.
  - Resource sharing between real-time and non-real-time VMs.
- Real-time cloud stack.
  - RT-Xen → real-time VM scheduling (included in Xen hypervisor)
  - VATC → real-time network I/O on a virtualized host.
  - RT-OpenStack → real-time cloud resource management.



RT-Xen vs. Xen



In Xen hypervisor since v4.5

- Xen (credit scheduler) misses deadlines at 22% of CPU capacity.
- RT-Xen delivers real-time performance at 78% of CPU capacity.

End-to-End Real-Time Challenges

- Orchestrate edge and cloud
- Analytics: machine learning, optimization, control…
- Wireless: real-time low power wide area networks
  - e.g., 5G, SNOW (Sensor Network Over White spaces)
- Along with everything else: scalability, reliability, security, resilient control…