Standards for the Industrial Internet

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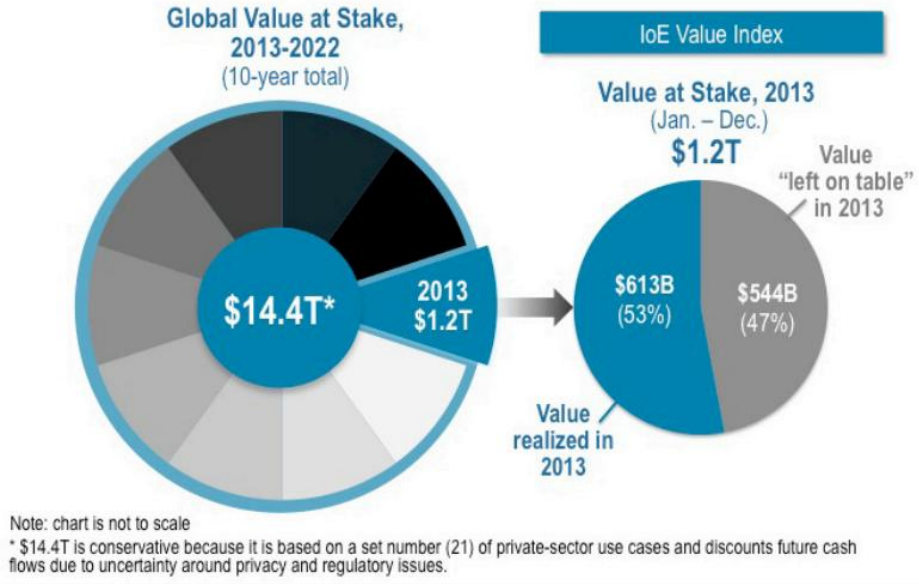
The Industrial Internet of (Every)thing

Converge Control Networks to IP

- Make IP operations more efficient
- Emulating existing Industrial protocols

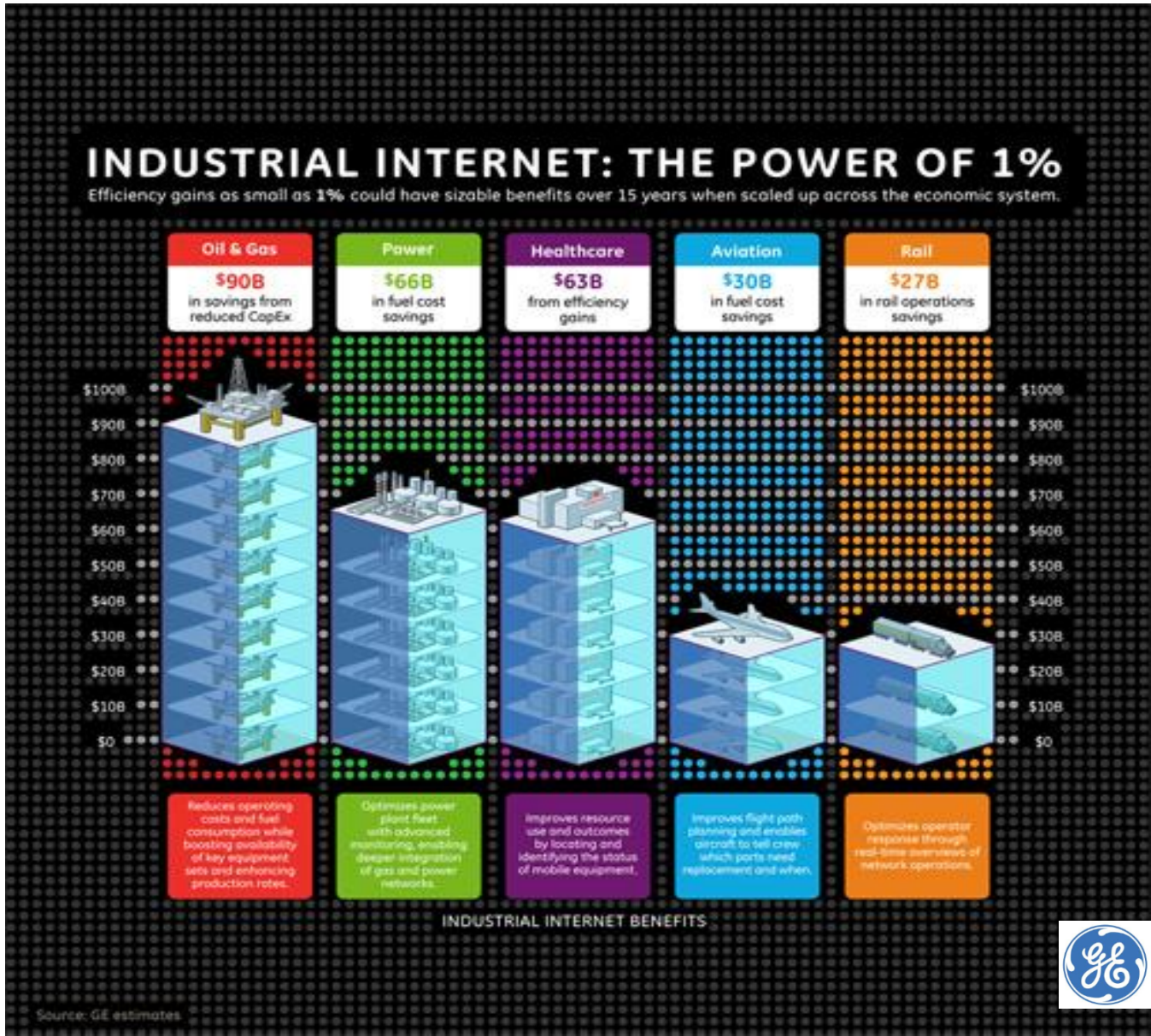
Beyond Control and Automation

- Optimize processes (by 1%?)
- Leveraging IT, Live big data and Analytics



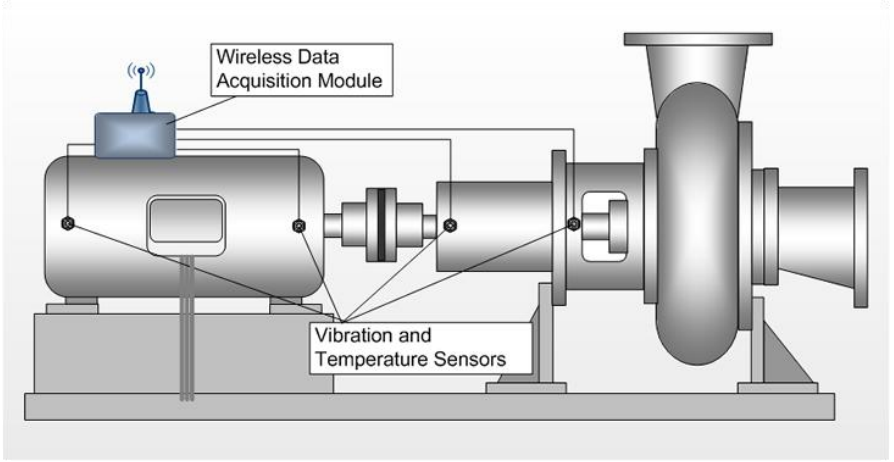
Note: chart is not to scale

* $14.4T is conservative because it is based on a set number (21) of private-sector use cases and discounts future cash flows due to uncertainty around privacy and regulatory issues.



Condition Monitoring and Large Scale Monitoring

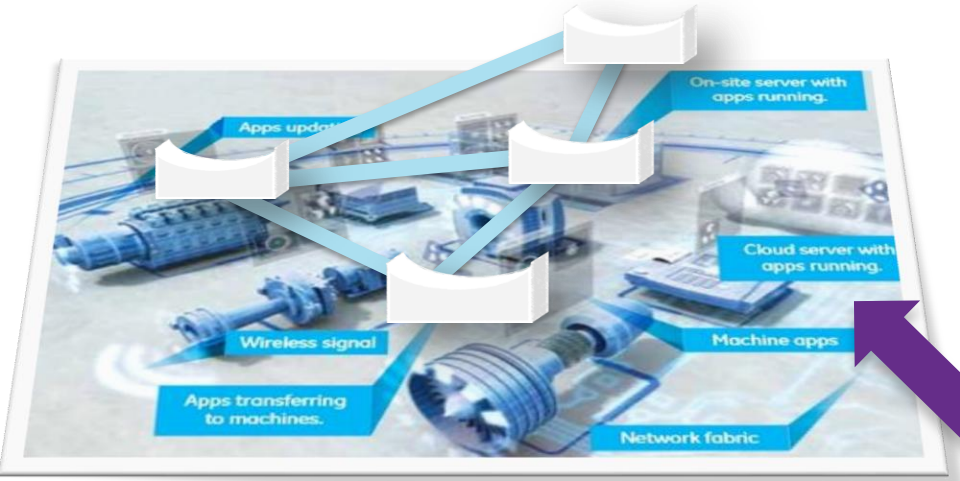
- Not Process Control but “Missing Measurements”
  - Reliability and availability are important, which implies
  - Scheduling and admission control
- Scalability
  - 10’s of thousands of new devices
- Deployment cost factor is key

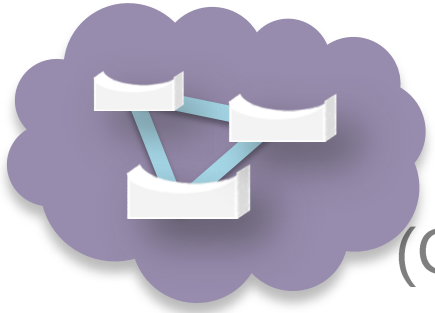


For Emerson this is the **second layer of automation**:

Typically missing are the measurements you need to monitor the condition of the equipment--temperature, pressure, flow and vibration readings you can use to improve site safety, prevent outages and product losses, and reduce maintenance costs of equipment such as pumps, heat exchangers, cooling towers, steam traps and relief valves.

Industrial Internet





SDN
(Controller)

Deterministic
Networking

Fog

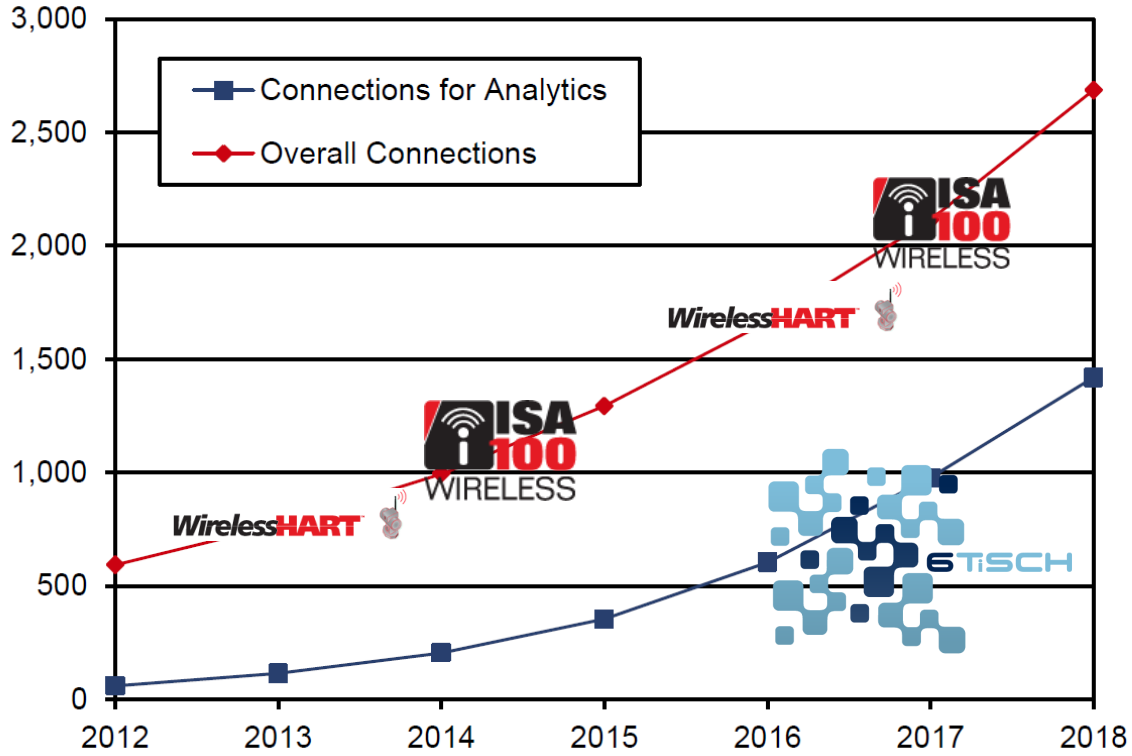
Clock
Synchronization

Enabling Trends

What is 6TiSCH?

- Radio Mesh: Range extension with **Spatial reuse** of the spectrum
- RPL-based Distributed Routing and Scheduling — Now
  - ⇒ Diagnostic to Learning Machines in cloud for **Industrial Internet**
  - ⇒ Leveraging IEEE/IETF standards (802.15.4, 6LoWPAN …)
  - ⇒ Separation of resources between deterministic and stochastic for co-existence with incumbent Wireless Industrial Standards
- Deterministic Centralized Routing and Scheduling — Later
  - ⇒ for Time-Sensitive IACS **Critical Control and Monitoring**
  - ⇒ Mission-critical data streams (control loops)
  - ⇒ Deterministic to local Fog for **Control Function Virtualization**
  - ⇒ And limitations (mobility, scalability)

What's missing in Process Control:



Everything is centrally computed.

This limits meshes to 10-100 nodes.

IP connectivity to the Fog or Cloud required for Machine Learning / CFV

A distributed scheduling and routing is needed to enable large scale monitoring for Industrial Internet over the shared medium

That's what **6TiSCH** adds to the picture

A pervasive problem: siloed proprietary solutions

“ Many utilities still rely on complex environments formed of multiple application-specific, proprietary networks. Information is siloed between operational areas.

This prevents utility operations from realizing the operational efficiency benefits, visibility, and functional integration of operational information across grid applications and data networks.

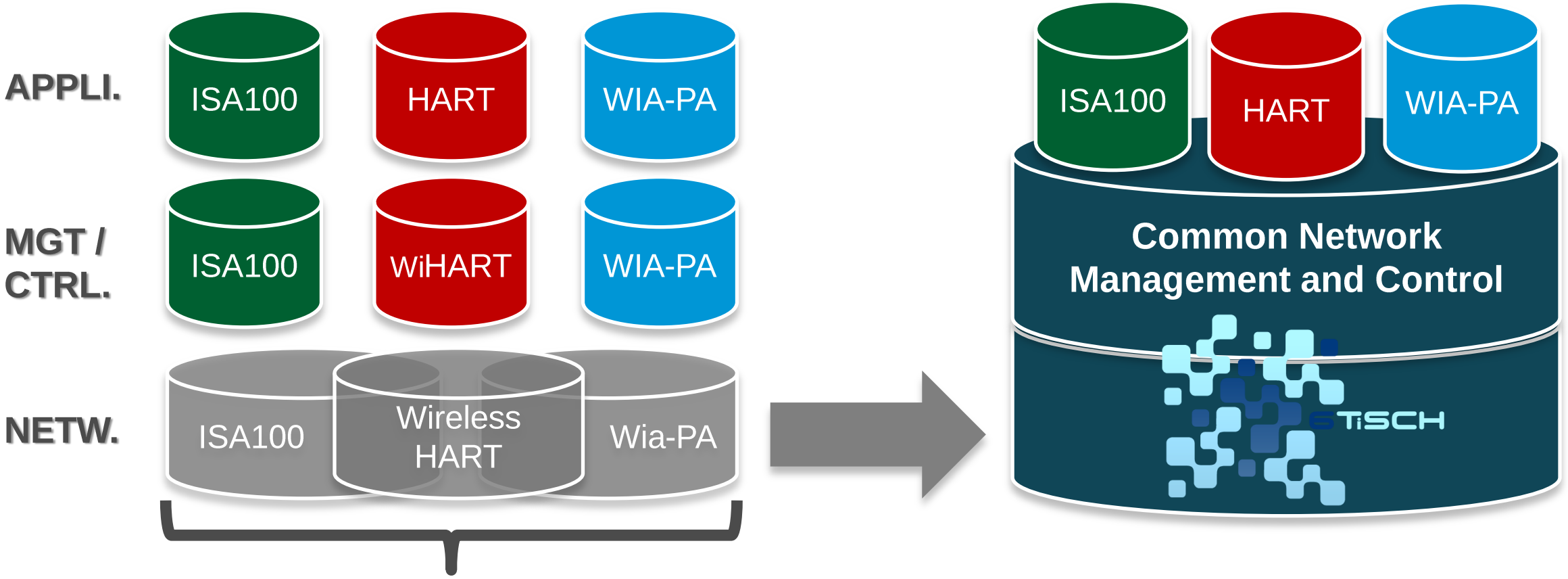
The key to modernizing grid telecommunications is to provide a common, adaptable, multi-service network infrastructure for the entire utility organization...”

draft-wetterwald-detnet-utilities-reqs

It’s the same story everywhere:

Scalability issues, limited service, high equipment costs (CAPEX) and undue operating costs (OPEX) for managing multiple incompatible products

The pervasive problem of silos



TRIPLE OPEX + interferences

Better Co-Existence

Key take aways

Operational technology (OT) is hardware and software that detects or causes a change through the direct monitoring and/or control of physical devices, processes and events in the enterprise.

Customers after next % point of operational optimization:

Requires collecting and processing of live “big data”, **huge amounts of missing measurements by widely distributed sensing and analytics capabilities**.

Achievable by combination of the best of IT and OT technologies together, forming the IT/OT convergence, aka **Industrial Internet.**

Architectural approach, standards, Industry adoption needed to embrace radical changes happening in IT networking technologies. Products are following.

Secured-by-default model required throughout network lifecycle.

6TiSCH extends Deterministic Wireless Industrial Networking technologies to also reach higher scales at lower costs (but then, guarantees as well).

Thank You !

How does IoT affect the design of the Internet?

- The any-to-any paradigm
  - Art: Any pair of global addresses can reach one another
  - IoT: Many devices of all sorts, no hotfixes
  - Corridors to the cloud?
- The end-to-end paradigm
  - Art: Intelligence at the edge, dumb routing nodes
  - Infinite bandwidth to all powerful clusters?
- The best-effort paradigm
  - Art: Stochastic packet distribution and RED
  - Can we make the whole Internet deterministic?

DetNet: Emulating a Serial Link over switched networks

- Clock for Flow Scheduling and Timely Delivery
- QoS beyond traditional Network QoS, for new level of guarantees for control traffic
- Hard bound latency. Easier to develop control applications with near-0 jitter.
- High ratio of critical flows for 1) traffic known a priori and 2) asynchronous.
- (often) Time Sharing physical resources with classical best-effort networking




The solution

- Clock synchronization on all the nodes, network, source and destination
- Zero congestion loss and assured end-to-end latency for fixed-bandwidth streams via:

  Centralized computation of network-wide deterministic paths

  New traffic shapers within and at the edge to protect the network

  Hardware for scheduled access to the media.