Cloud Based Computing for Machinery Control

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Shipboard HM&E Control Systems

- Navigation
- Damage Control
- Machinery Mgmt
- Power Gen Mgmt
- Navigation
- Stealth
- Thrust Ctrl
- Propulsion
- Thrust Ctrl
- Thrust Ctrl
- Cargo Mgmt
- Cargo Mgmt
- Ballast Mgmt
- Ballast Mgmt
- Habitability Mgmt
- Habitability Mgmt

- Life: ≥ 8 years
- Sub System Uptime: ≥ 99%
- Distributed
- Sub System can be standalone
- Mostly integrated for remote monitor/control
- I/O is tightly coupled with control
HM&E Control Architectures
HM&E Control Architecture Spectrum

Majority Today → Emerging (Hybrid) → Destination (Cloud)

Supervisory

Control

Device
HM&E Control Architectures

Destination (Cloud)

Majority Today
Analogy

- Tightly coupled I/O to control Real Time system examples
  - ABS
  - Fuel / Air mixture
  - Valve timing

- Integrate some standalone systems
  - Radar / optical road monitoring
  - Speed monitoring
  - Engine control
- Autonomous emergency brake boost
- GPS location E-911 transmission
- Green light for light pedal drivers

- Google Car that goes where you want to
  - Integrates the entire car systems via cloud of computing power

Majority Today
Emerging (Hybrid)
Destination (Cloud)
Why?

- Scalability
- No Single Point of Failure
- Object Oriented
- Speed on Demand
- New Compute Capabilities
- Modern High Level Languages

Scalability: + N Anytime

No Single Point of Failure

Object Oriented

Speed on Demand

New Compute Capabilities

Modern High Level Languages

350ms → 50ms

The whole (cloud) is greater than the sum of the parts
How?

Functionality of PLC Controller is replaced with a Cloud Service

All machinery control will be performed by the MCaaS running on top of a Cloud OS

The service provides all the necessary input/output variables and algorithms normally available in hardware

Challenges: Integration of network, cloud computing and machinery control
Cloud Based OS

- A Cloud OS is a control program running on a group of interconnected computers.

- Virtually unifies the different computers into a single integrated compute and storage resource.
Machinery Control Service

• With this approach, device control becomes scalable and can handle highly complex computational tasks
• Focused on the modularization of the control according to a granularity that reflects the runtime requirements in a distributed environment
• The total time of execution of any of the instances of MCaaS should be considered the “scan time” for the service
Components

CLOUD
- Cloud Controller
- Simple Storage Service
- Machinery Control Service

CLUSTER
- Cluster Controller
- Storage Controller

NODES
- Node Controller
  - VM
- Node Controller
  - VM
Conclusion

- Performance and availability scales with number of compute nodes
- Controller(s) location is independent and dynamic
Conclusion

• Reduce cost of commissioning, maintenance and operation
• The implementation and maintenance of highly complex algorithms becomes easier by using high level languages like Java and C++
• The maintenance of hardware, which includes firmware, physical defects and technical obsolescence, goes away