Simplifying the shop Floor: Assembling the Software Defined Factory

Victor Abelairas,
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Software Defined Critical Infrastructure

Opportunity?

Threat?
## Why Now?

**Motivations for Change**

<table>
<thead>
<tr>
<th>Business Drivers</th>
<th>Technology Enablers</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Obsolescence cycle</td>
<td>▪ Internet of Things (IoT)</td>
</tr>
<tr>
<td>▪ Capital cost reduction pressure</td>
<td>▪ Virtualization</td>
</tr>
<tr>
<td>▪ Current systems limit or lag innovation</td>
<td>▪ Cloud</td>
</tr>
<tr>
<td>▪ Poor component interoperability</td>
<td>▪ Open platforms</td>
</tr>
<tr>
<td>▪ High integration, maintenance costs</td>
<td>▪ Analytics</td>
</tr>
<tr>
<td>▪ Insufficient system security model</td>
<td>▪ Proof points from adjacent industries</td>
</tr>
</tbody>
</table>
Two Catalysts for Change

- 2014: “Functional Characteristics” paper, presented to ARC Forum Feb ‘15
- 4Q15: Awarded contract to Lockheed Martin for early stage prototype development of an open control system
- Jan 2016: Issued press release and held Industry Day for suppliers
- Feb 2016: RFI submissions

- 2015: “Coalition of the Willing II”
- “… the Coalition of the Willing (COW II) project is a non-proprietary, multi-phased project to break down proprietary and operational siloes and to prove that enhanced operation can be achieved economically through use of a distributed intelligence platform”
The Shifting System Vision of ExxonMobil

The Century of the Controller

THE ASCENT OF AUTOMATION

The evolution of industrial control systems over a period of 100 years, beginning in 1920 and extending through 2020.

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The Shifting System Vision of ExxonMobil

Transition to the Cloud

OPEN SYSTEMS ARCHITECTURE

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We’ve seen similar transitions elsewhere …

**Avionics:** Certifiable architecture providing a common platform for multiple avionics functions with guaranteed performance and isolation.

**Telecom:** Virtualized server platform with six-nines availability, failure detection, system management, and highly optimized performance.
| Reliability and Availability | Fault tolerant to multiple software and hardware faults, no single point of failure  
|                            | Six-nines (99.9999%) network availability  
|                            | Minimal loss of service or data on failover  |
| Management                 | Software management: live patching and hitless upgrades  
|                            | VM management: fast and easy VM definition and creation  
|                            | OAMP feeds (operations administration, management and performance)  |
| Performance and Scalability| Hundreds of simultaneous VMs with high-performance virtual switching  
|                            | Provide high-performance services to VMs  
|                            | High-performance VM-to-VM networking with minimal core utilization  |
| Security                   | Encrypted AAA database (authentication, authorization, and accounting)  
|                            | Network-level authentication  
|                            | Data protection via encryption  |
Enterprise vs. Industrial-Grade

Each approach comes with mutually exclusive benefits

**Industrial Grade**
- **High cost of failure**
  - OEM/TEM business model
  - Infrastructure of “Pets”
  - Legacy/stateful apps
  - Seasoned developers
  - HA via platform infrastructure
  - Low cost of entry for ISVs
  - Regulatory constraints
  - QoS for pay-as-you-go pricing

- **Service uptime brings value**
  - Service continuity
  - Scheduled downtime
  - Resiliency
  - Security
  - Authentication
  - Optimum resource utilization
  - Predictable performance
  - Minimum OPEX and TCO

**Enterprise Grade**
- **Low cost of failure**
  - Open source/white box model
  - Infrastructure of “Cattle”
  - New/stateless apps
  - Millennial developers
  - Application-based HA
  - ISVs require HA skills
  - Best-effort reliability
  - Subscription pricing

- **Avionics**
- **Industrial**
- **Traditional telecom**

- **OTT**
- **Social media**
- **Consumer Cloud**
Controller Consolidation

Scenario #1 = IMA Architecture

Single virtualized hardware platform, applications replacing discrete nodes
Infrastructure Virtualization

Scenario #2 = NFV Architecture

Scaleable, resilient, virtual hardware platform, hosting control and compute functions.
Detail View: Titanium Server for Automation & Control

Titanium Server Software

IT SYSTEMS

Cross-Domain Virtual Functions

Control Node
Industrial Grade Cloud Management and Middleware
- VM High Availability Management
- OAMP
- Fault Management

Compute Node
- Industrial Grade KVM
- Virtual NICs
- DPDK
- KVM Real-Time Extensions
- Low Latency

Storage Node
Industrial Grade Storage Cluster
- Centralized or Local

Host any guest OS
- Add carrier grade storage cluster
- Add carrier grade cloud management and telco middleware functions
- Add carrier grade accelerated vSwitch
- Add critical real-time performance enhancements to KVM
- Based on standard open source components
## Ready for Software Defined Automation

The only commercial virtualization cloud that meets or exceeds the carrier grade standard

<table>
<thead>
<tr>
<th>Enterprise IT Platform Capability</th>
<th>Carrier Grade Cloud Requirements</th>
<th>Titanium Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection of failed VM</td>
<td>&gt; 1 minute</td>
<td>&lt; 1 s</td>
</tr>
<tr>
<td>Detection of failed compute node</td>
<td>&gt; 1 minute</td>
<td>~ 1 s</td>
</tr>
<tr>
<td>Recovery from control node failure</td>
<td>No support</td>
<td>&lt; 25 s</td>
</tr>
<tr>
<td>vSwitch performance</td>
<td>1–2 Gbps</td>
<td>Line rate with minimum core utilization</td>
</tr>
<tr>
<td>Network link failure detection</td>
<td>Depends on Linux distribution</td>
<td>50 ms</td>
</tr>
<tr>
<td>Live migration for DPDK-based VMs</td>
<td>No support</td>
<td>Full support</td>
</tr>
</tbody>
</table>

- No support: 500 ms
- Full support: 200 ms
- Line rate with single core (512 B/frame)
We are not standing still ...

- Critical Infrastructure Cloud Platform: Evolving Titanium Server product for industrial-specific capability

- Adding true real-time capability
  - TSN (Time Sensitive Networking) implementation from the edge to the application
  - Time Coordinated Compute (TCC)

- More scale

- Industrial orchestration enhancements: Edge to fog

- Security enhancements including Trusted Platform support

- New service layer capability: Docker, Bare Metal, Kubernetes, Cloud Foundry …