Container Based Virtualization Applied

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Introduction

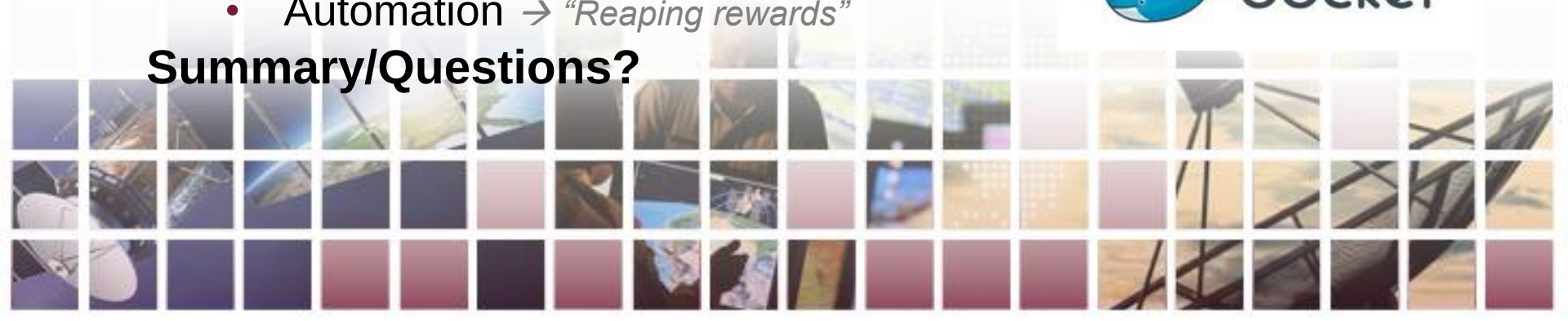
Virtualized Ground System (VGS) → *"The Big Picture"*

- vFEP (Virtual Front-End Processor) → *"Quick look inside"*
- H/W Virtualization with Virtual Machines (VM's)
- OS Virtualization with Containers → *"Let's compare"*

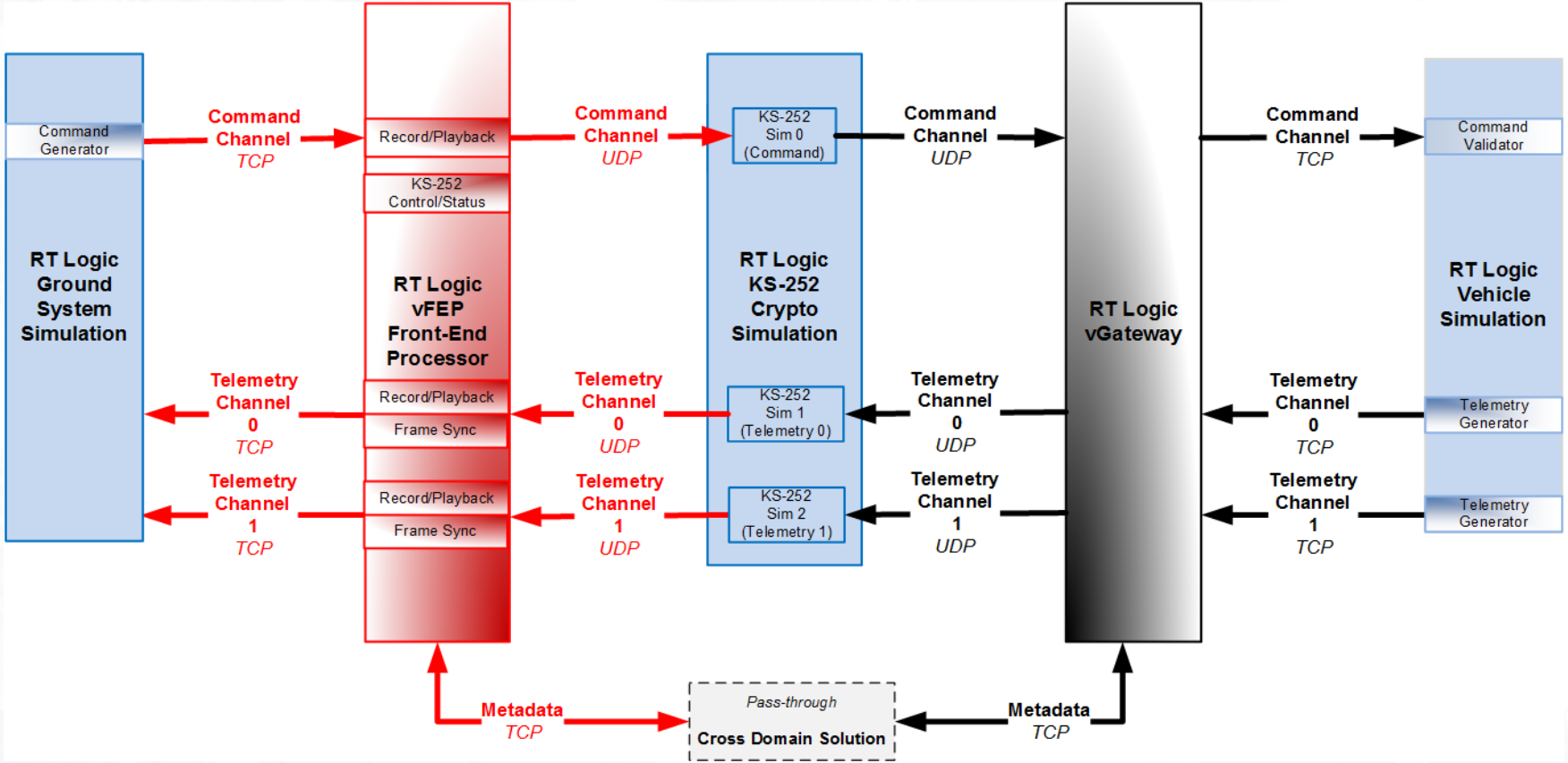
Container Technology Applied

- Making the transition → *"Approach taken"*
- Building/deploying/running Docker containers
  - Container isolation and monitoring
- Automation → *"Reaping rewards"*

Summary/Questions?



Virtualized Ground System (VGS)



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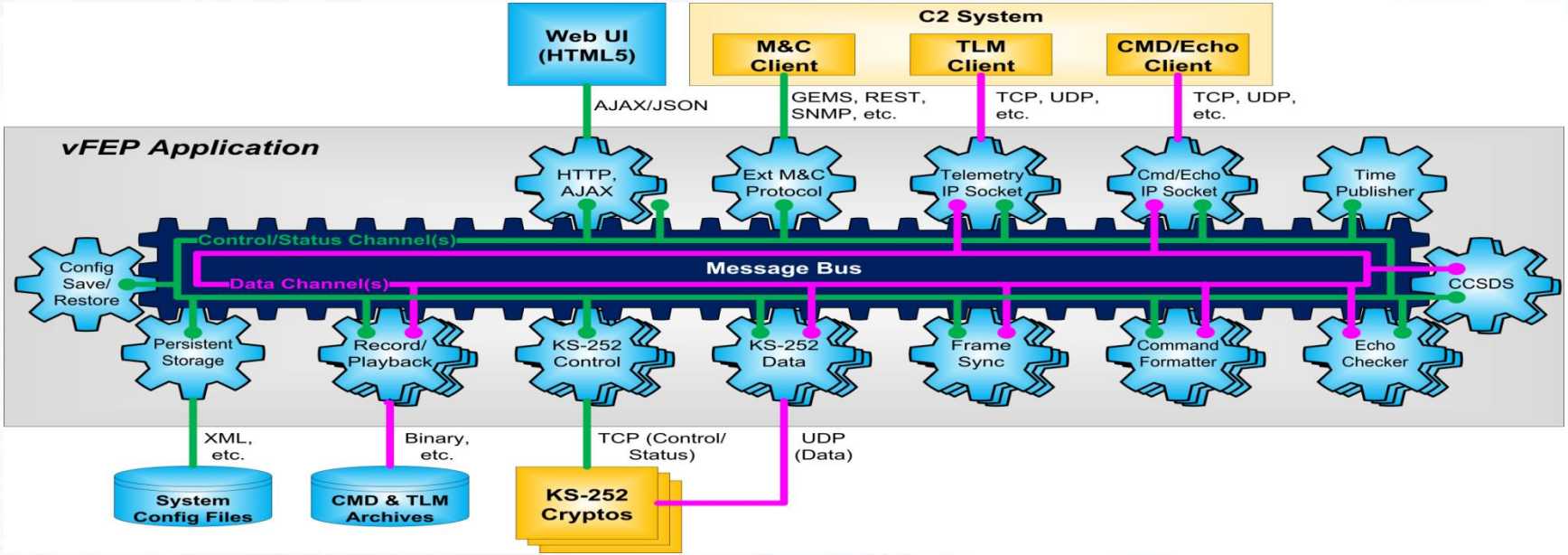
vFEP "Quick look inside"



- Publish/Subscribe message bus architecture
  - ✓ (loosely-coupled components, independently versioned)
- Highly configurable, extensible, scalable, secure and efficient
  - ✓ Auto-created user interface and auto-generated documentation
- Extensive API Support (GEMS, REST XML/JSON)

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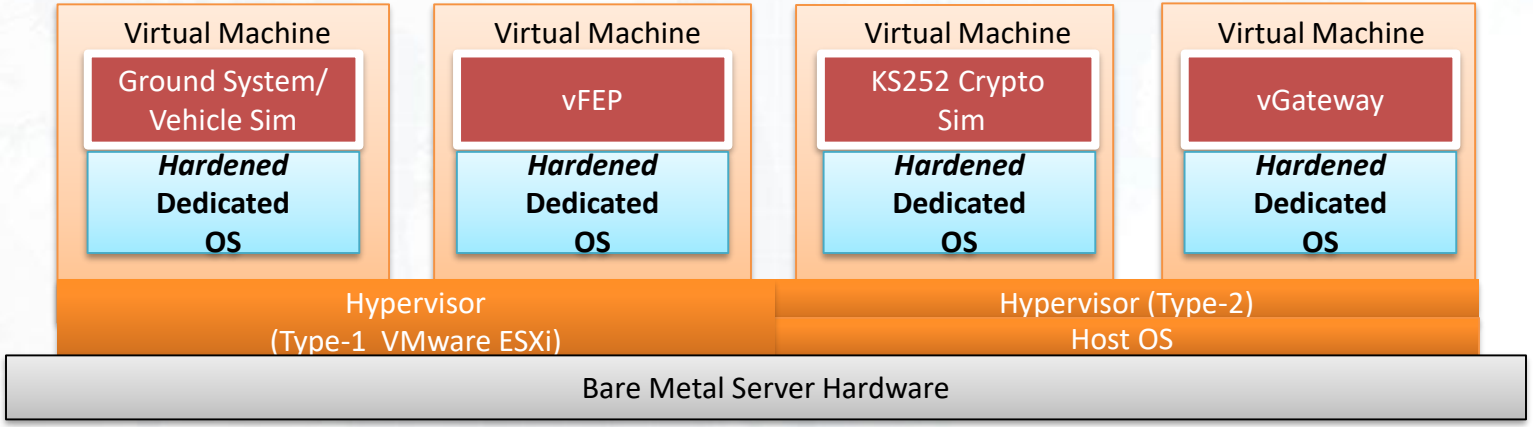
Hardware Virtualization – Virtual Machines



Applications installed and configured on individual VMs

- ***Hardened Dedicated OS***
- Application ISO images *mounted* and installed
- Command and telemetry channels *interactively* user configured

Things are ***really good now*** … could they be ***even better***?

- Hardware sharing, Snapshots, vMotion, VM templates, ***Isolation***, OVA's, Secure, Stable, Scalable

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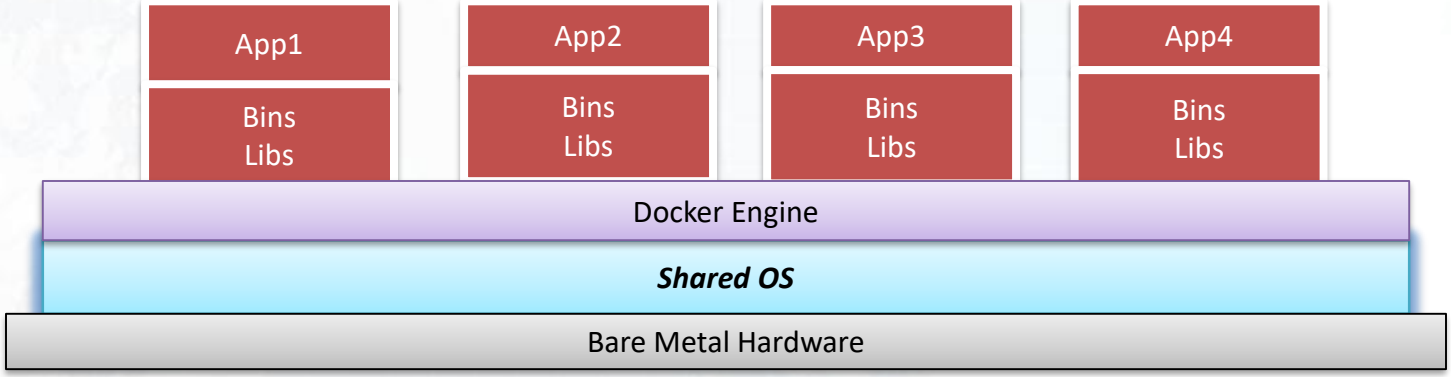
Operating System Virtualization - Containers



Containers: How do they differ from VM's?

- ***Shared OS*** *for* containers
  - \+ More resource efficient (only use what they need when they need it)
  - \+ Extremely lightweight, fast to start
  - \+ Capable of running directly on Bare Metal H/W, less H/W required
    - \+ No Hypervisor required - OS Kernel/Container compatibility required
  - \- Failures/cycling of the Docker Engine-OS-H/W are more impactful

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Transitioning into Containers

Methodology leveraged to produce/evaluate *"good"* containers

https://12factor.net/ *"The 12 Factor Application"*

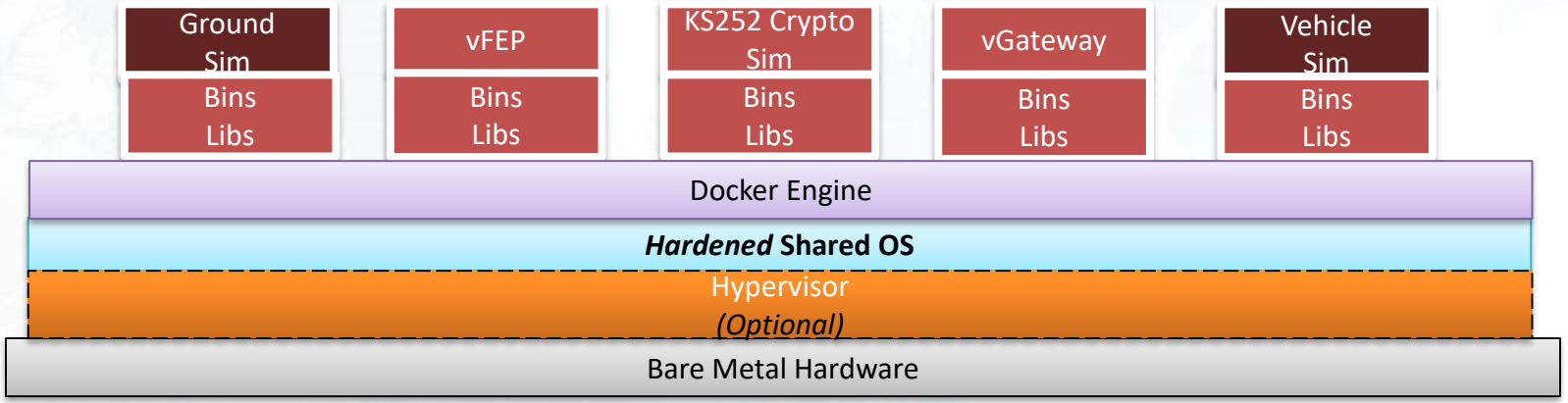
I. Codebase *(single purpose)*
II. Dependencies *(be explicit)*
III. Configuration and code separation
IV. Backing services *(think resources)*
V. Build/release/run *(separation)*
VI. Processes *(stateless, non-sharing)*
VII. Port binding
VIII. Concurrency
IX. Disposability *(easily replaceable)*
X. Dev/prod parity *(similarity)*
XI. Logs
XII. Admin processes

Transitioning into Containers cont'd

Changes to how we install/configure/deploy/run applications

- GSVeh Simulator *(single purpose)*
  - ✓ Multiple applications (Ground System and Vehicle Simulation)
- Don't store data within a container *(backing services and disposable)*
  - ✓ vFEP Recording/Playback of command and telemetry data
  - ✓ Storing configuration files
- Application lifetime
  - ✓ Lifetime management no longer controlled internally
- Interactive application configuration and deployment
  - ✓ Eliminate ISO mounts for application installation
  - ✓ Need to automate image building and the deployment of containers

VGS deployment with Containers



Split GSVeh Simulator into two containers

Running the Docker Engine on a ***single*** **Hardened Shared OS**

Configured Docker version 1.12 and 1.13 environments

- Optionally running the Docker Engine/Host OS in a VM
  - Leveraging both H/W and OS Virtualization Technologies
  - Increased capabilities/flexibility

Docker files create Docker images

Creating Docker images, what needed to be done?

- ***Images*** are used to ***create*** *immutable* ***container instances***
- ***Dockerfiles*** contain the ***instructions*** needed to ***build each image***
  - Build images FROM a *(lightweight)* initial image
  - Extensive use of LABELs to support image/container traceability
  - COPY/RUN used to install and configure each application
  - Explicit EXPOSE for container to container communication
  - Defined VOLUMEs as storage for record/playback of command and telemetry data, configuration files
  - Defined a *(single)* ENTRYPOINT to execute each container
- Removal of internal service lifetime configuration
  - Now managed with the container lifetime

Building images/running containers

Initially images are built and containers are run manually

- Built images from instructions in Dockerfile(s)
  - `docker build -t="vgs/vfep:1.0.1" .`
- Create the VGS network
  - `docker network create --driver bridge vgs_network`
- Run a container from an image as a daemon on the docker host
  - `docker run -d -p 30010:30001 --net=vgs_network --name vfepA vgs/vfep:1.0.1`

Equivalent using Docker Compose

- Define a single `docker-compose.yml` service definition file
- Single command: `docker-compose up`
  - Builds images "*if necessary*", creates a container network, deploys and runs all containers

Virtual Ground System Operational !!!

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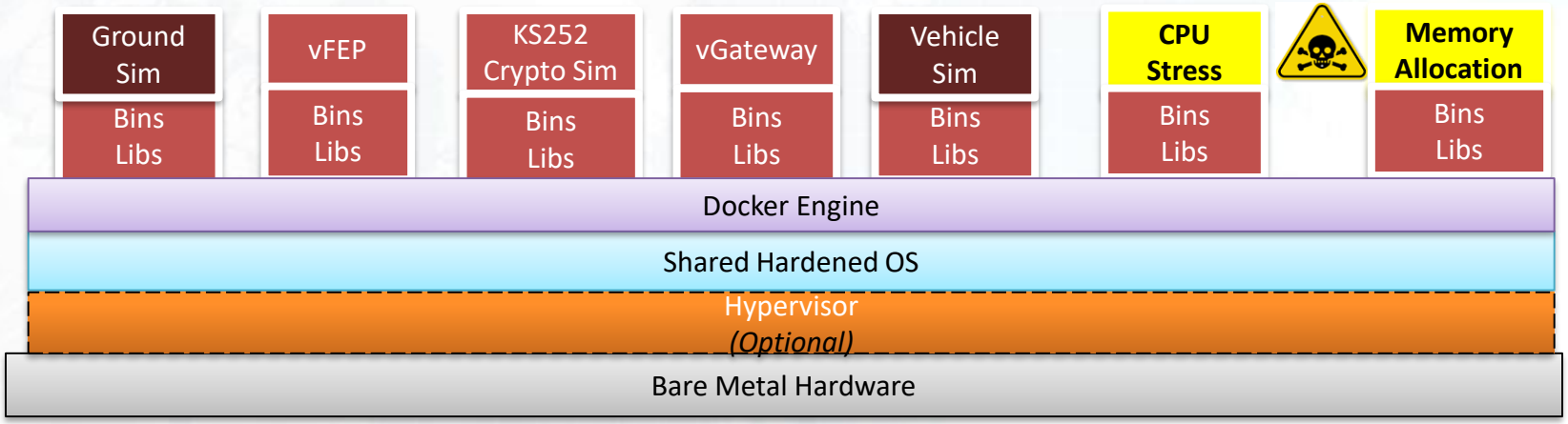
Container Isolation



Running "*bad*" *disruptive* containers in the VGS

- CPU Stress container
- Memory Allocation container

Verify the VGS maintains a normal operational state

✓ Undisturbed by *"bad"* containers sharing the same Docker Engine/OS

What's really going on in the container environment?

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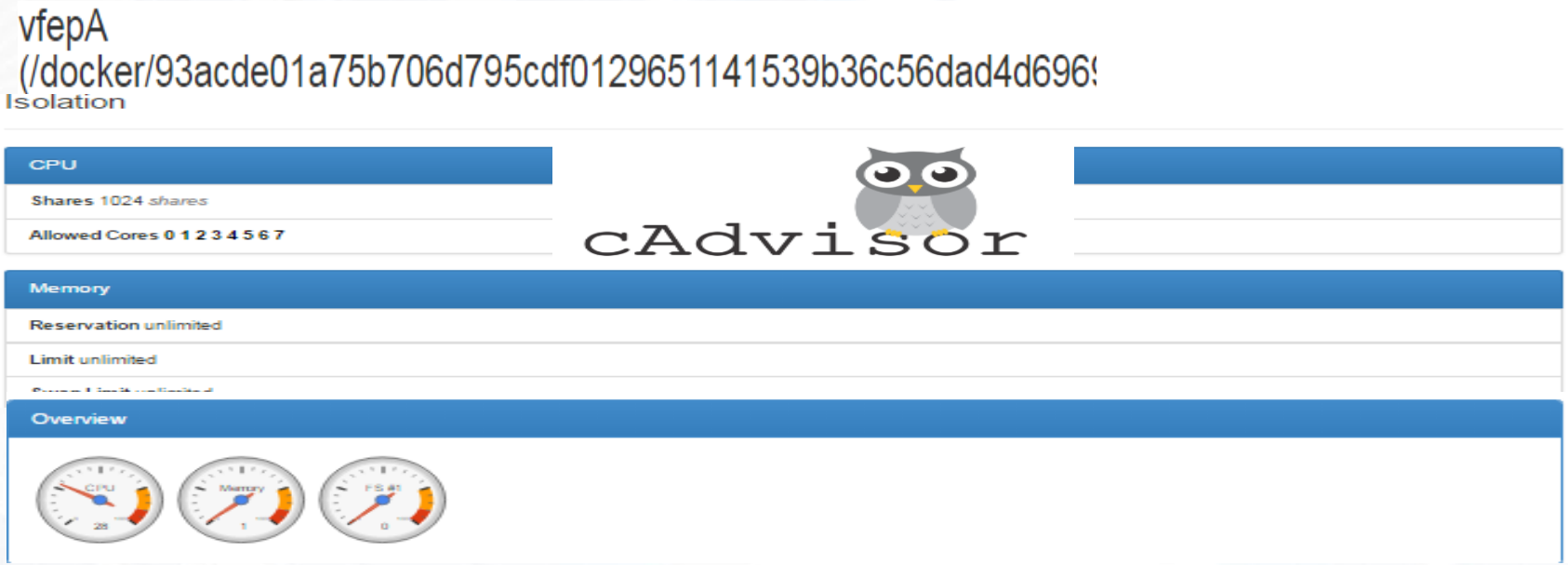
Monitoring the environment (cAdvisor)

View/monitor the Docker Engine and images/containers

- Insight into resource limitations/utilization and performance
  - `docker run … --publish=8080:8080 --detach=true name=`**`cadvisor  google/cadvisor:latest`**



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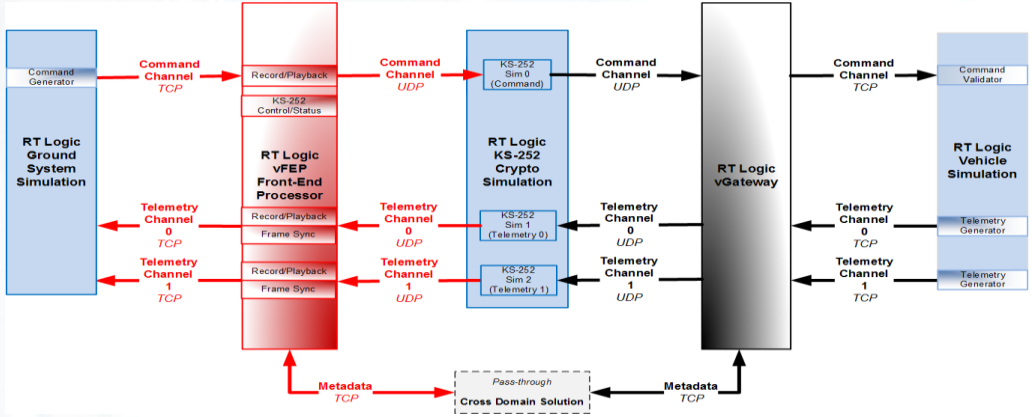
Build/Deploy/Test Automation with Containers

Jenkins

(A)
On-Demand & Nightly
Product Builds

(B)
On-Demand & Nightly
Docker Builds



(C)
Ground System Operational!!!

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Summary

Container Benefits

- Application scalability
- Lightweight
  - Very fast startup, smaller in size, easily updated/distributed
- Cost reductions
  - More workloads running on less H/W
  - Less OS's to license/manage/patch/update
- Containers are properly isolated from one another
  - Perfect mechanism to support end-user/customer extensibility
- Facilitates troubleshooting/debugging
- More opportunities for automation in dev/test environments

Summary

Container Security

- Smaller footprints (fewer OS's) means a smaller attack surface
- Vulnerabilities are inevitable
  - Visible image/container metadata – be careful
  - Image manipulation/injection concerns

Container History and Maturity

- Containers date back prior to 2009 - Linux Containers (LXC)
  - https://content.pivotal.io/infographics/moments-in-container-history
- Windows containers a reality
- Docker transition from versions 1.12 to 1.13 was seamless
- Competition coming from rkt on CoreOS
  - https://coreos.com/rkt

Summary/Questions

Container standards

- Open Container Initiative
  - https://www.opencontainers.org
- Open industry standards
  - Container Formats
  - Runtime

Questions?

Thank You