Applying Container Technology to the Virtualized Ground System

GSAW 2017 “Looking Beyond the Horizon”

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Introduction

RT Logic Virtualized Ground System (VGS) *“The Big Picture”*

- vFEP (Virtual Front-End Processor) Application
- Using hardware (H/W) virtualization with virtual machines (VM’s)

Comparing H/W Virtualization (VM’s) to Containers

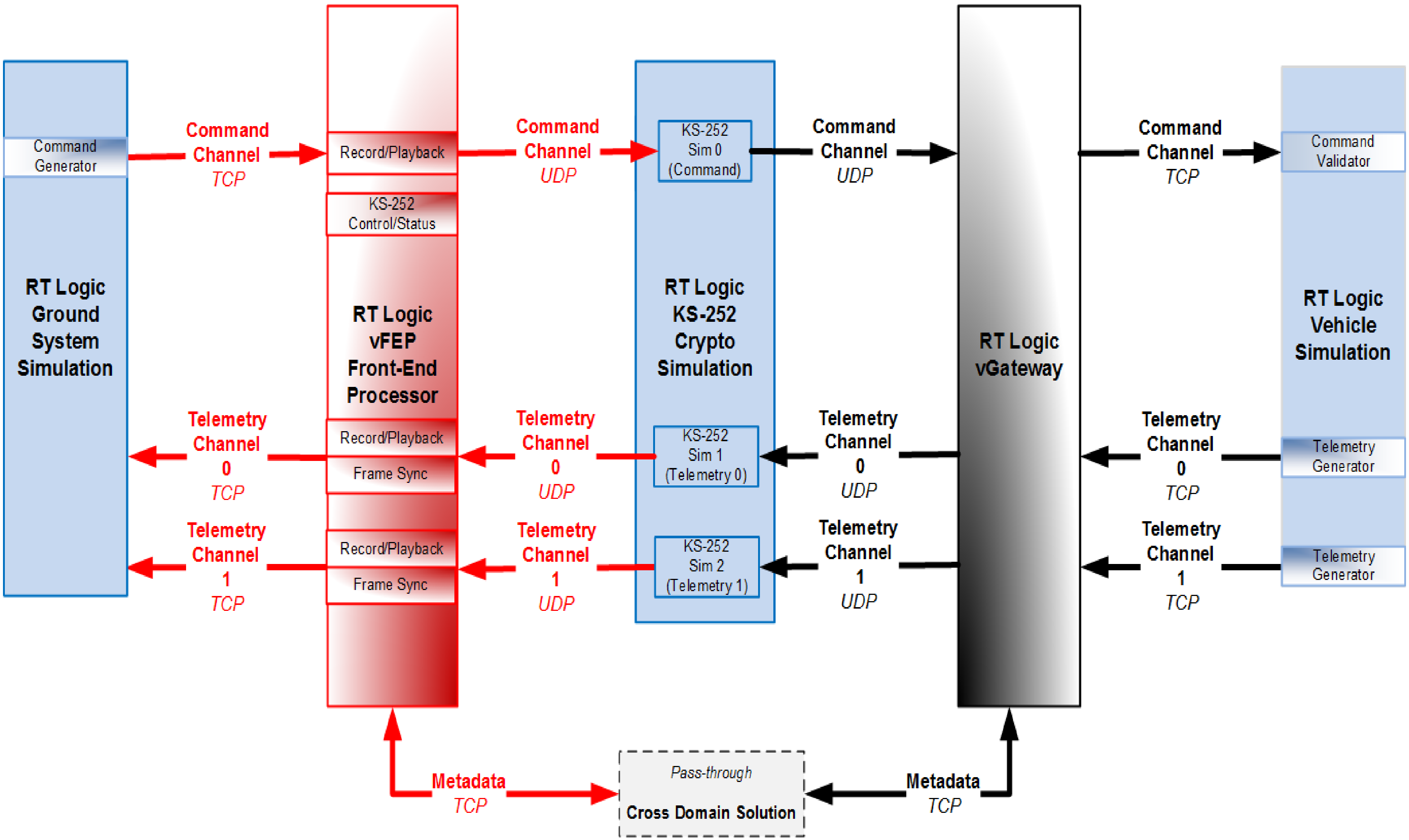
Applying a container technology *“Its Go Time!”*

- Making the transition into containers
- Building/deploying/running Docker containers
- Automation
- Container isolation and monitoring
  - How isolated are containers?
  - Monitoring the Docker Engine and containers

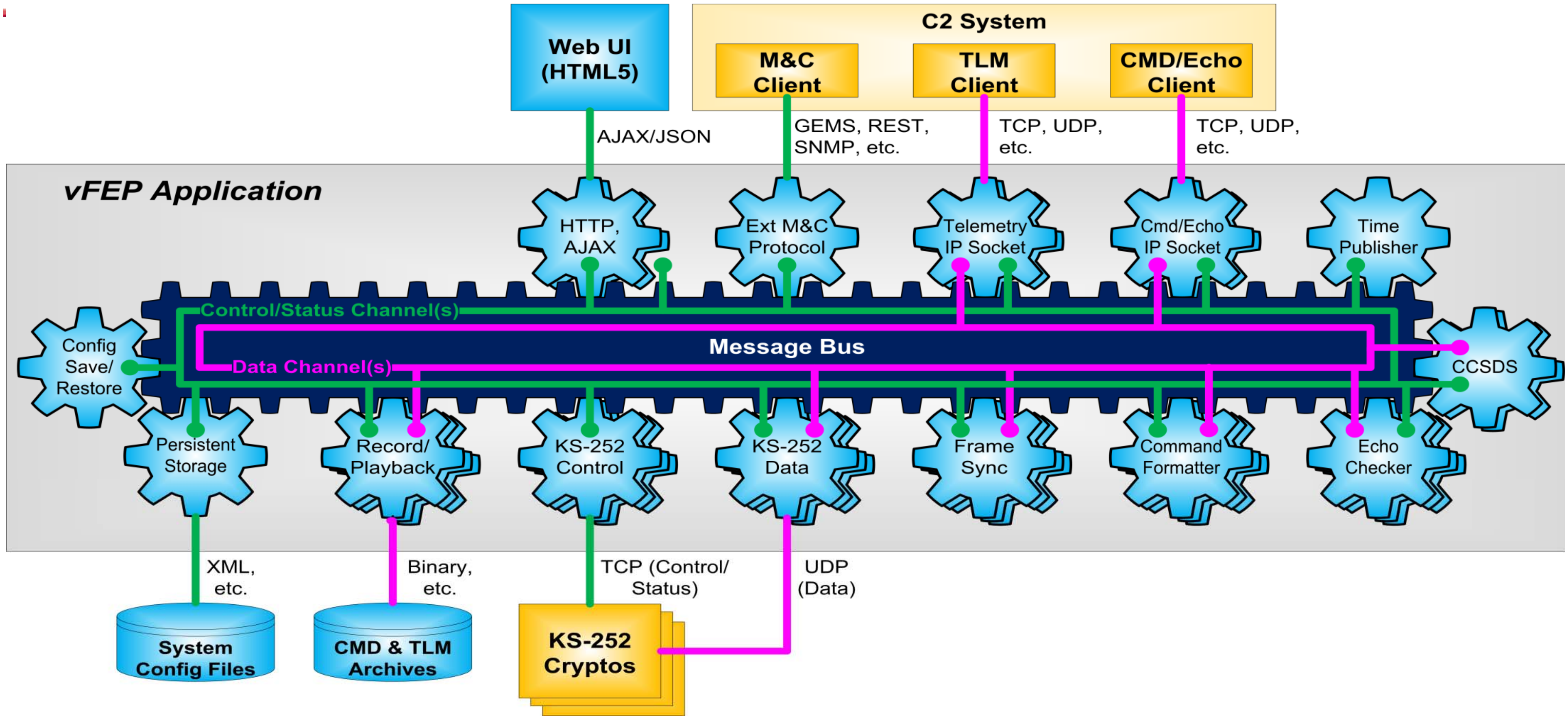
Summary

Questions?

"The Big Picture" Virtualized Ground System

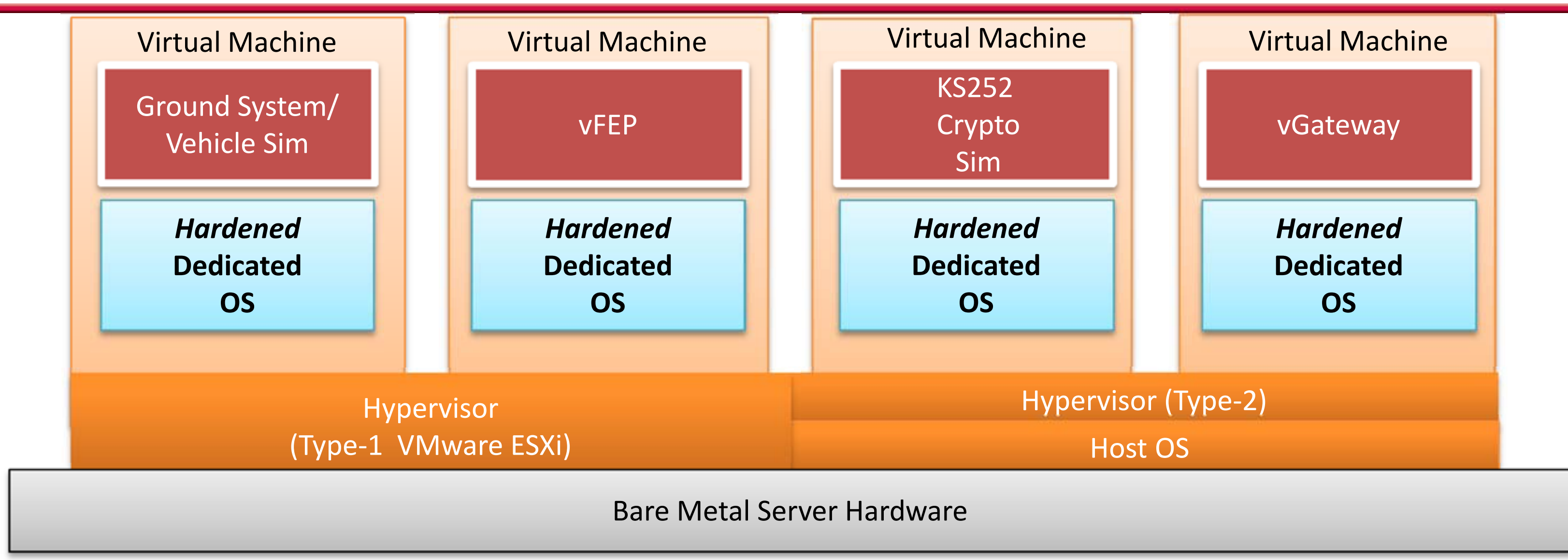


vFEP Taking a look inside



- 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, SNMP)

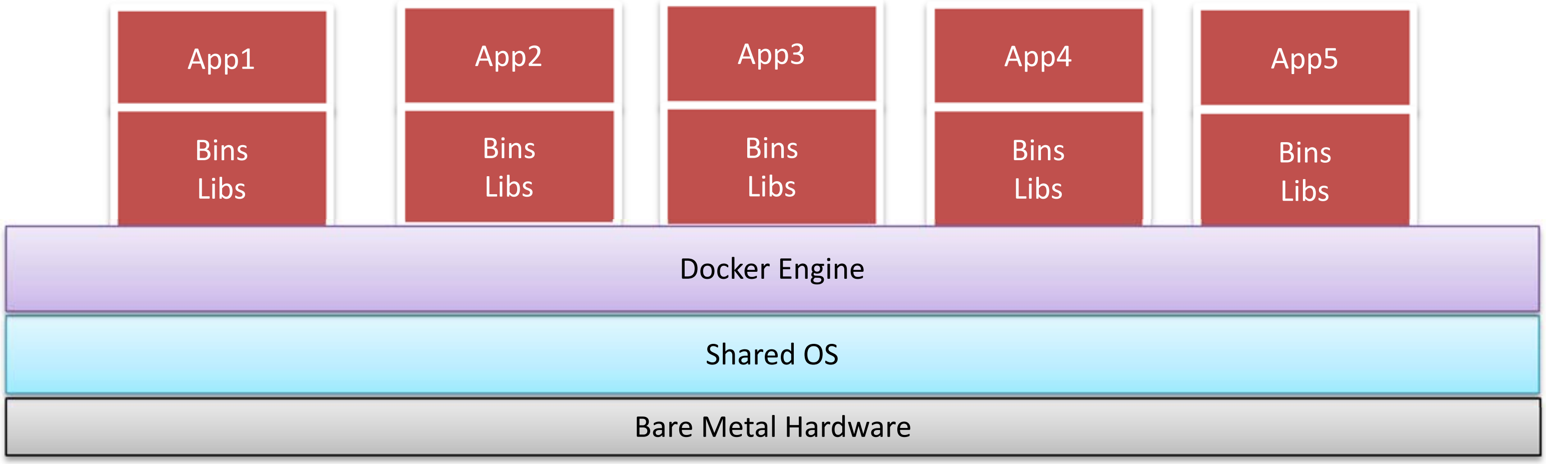
Hardware Virtualization
Virtual Machines



Quick look at VGS VM's and how we use them

- Applications installed and configured on individual VMs
  - Dedicated OS
  - Application ISO images mounted and installed
  - Command and telemetry channels *interactively* user configured
  - Firewall (iptables) and service configuration (lifetime management)
- Things are ***really good now*** but could they be ***even better***?
  - Hardware sharing, Snapshots, vMotion, VM templates, Application isolation, OVA's, Secure, Stable, Scalable

Containers



Quick look at containers. How do they differ from VM's?

- Shared OS across containers
  - Containers are more resource efficient (only use what they need when they need it)
    - More containers running on less Bare Metal Hardware
  - Extremely fast to start
  - Extremely lightweight
  - Docker Engine OS (kernel) and container compatibility required
  - Failures/cycling of the Docker Engine-OS-H/W can be more impactful
- Capable of running directly on Bare Metal Hardware

Containers (SaaS) and the 12 Factor App

- Methodology leveraged to produce *"good"* containers
  https://12factor.net/

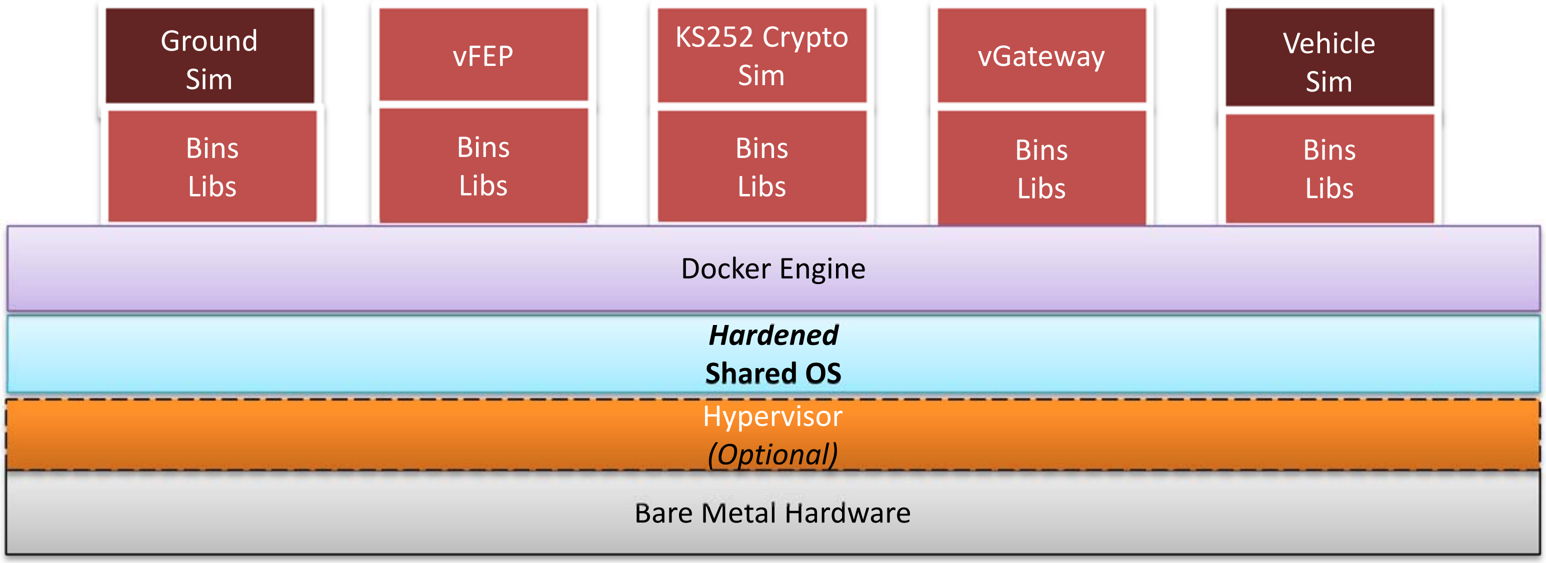
  I. Codebase *(single purpose, one code base/application versioned independently)*
  II. Dependencies *(be explicit)*
  III. Configuration and code separation
  IV. Backing services (think resources)
  V. Build/release/run *(separation)*
  VI. Processes (*stateless, non-sharing)*
  VII. Port binding
  VIII. Concurrency
  IX. Disposability *(lightweight, fast startup, graceful shutdown*)
  X. Dev/prod parity *(keep as similar as possible)*
  XI. Logs
  XII. Admin processes

Transitioning into Containers cont'd

VGS changes related to how we install/configure/run applications

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

Transitioning into Containers cont'd



VGS deployment with Docker containers

- Split the GSVeh Simulator into two containers
- Same configuration as before
  - One command channel and two telemetry channels
- Configured Docker version 1.12 and 1.13 environments
  - Optionally running our Docker Engines in VM's

Docker Files for Docker Image Builds

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, and logs.
  - Defined a *(single)* ENTRYPOINT to execute each container
- Removal of internal service lifetime configuration
  - Now managed with the container lifetime

Docker Compose
Build/Deploy/Run Automation

Initially images are built and containers are run manually

- Built images from instructions in `Dockerfile(s)`
  - `docker build -t="gsaw/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 gsaw/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

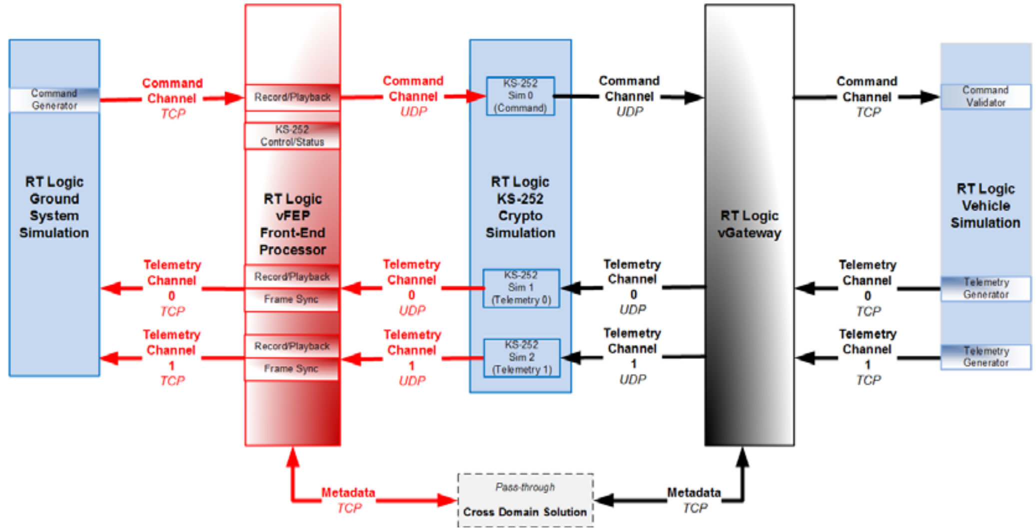
Virtual Ground System Operational !!!

Build/Deploy/Test Automation

Jenkins

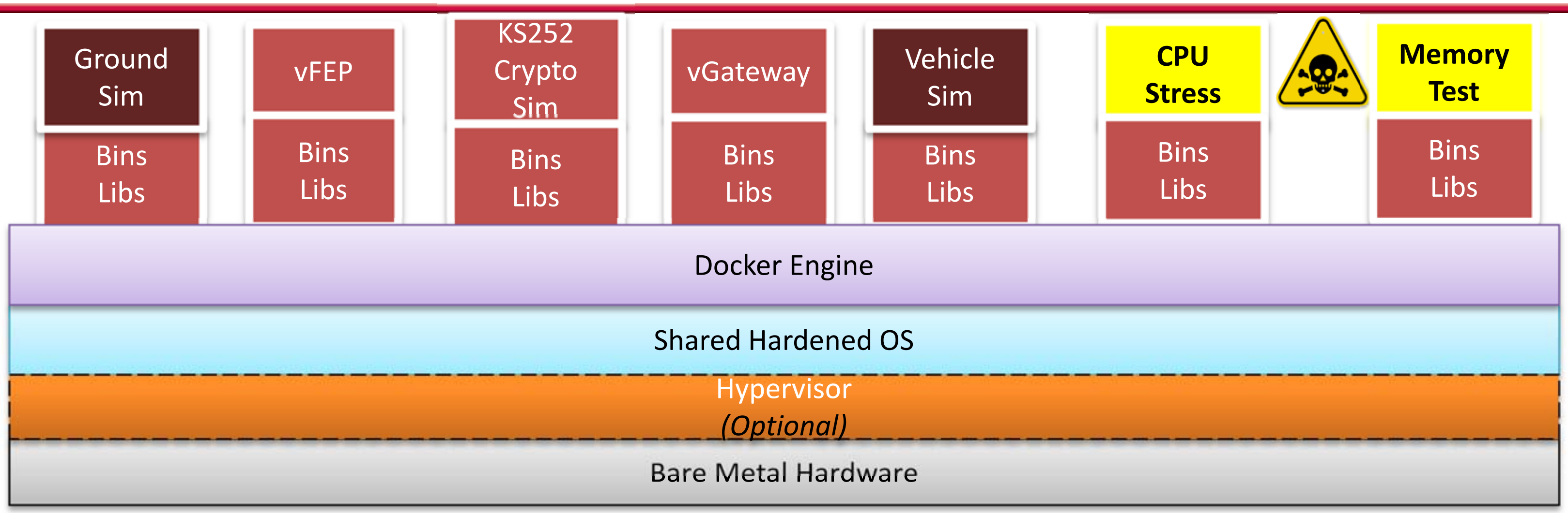
(A)
Nightly
Product Builds

(B)
Nightly
Docker/Compose
Builds



(C)
Virtualized Ground System
Operational!!!

Container Isolation



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

- CPU Stress container example run:
  - `docker run -it --rm --network=vsc_network --name=cpu_stress  gsaw/cpu_stress:1.0.0`
- Memory Test (limit memory_test container to 50meg)

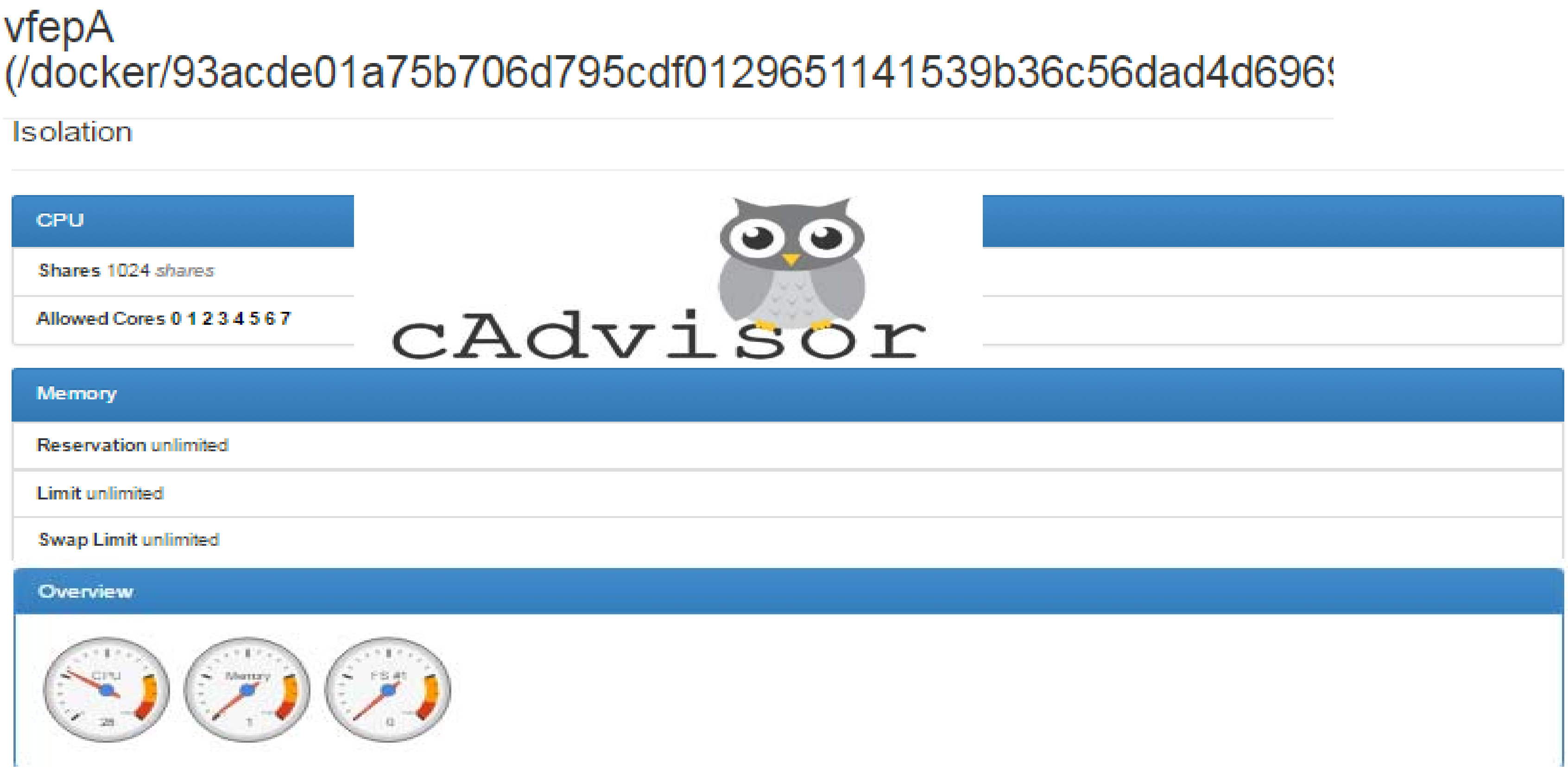
– Verify the VGS maintains the normal operational state
- Undisturbed by "*bad*" containers sharing same Docker Engine/OS

– Can I see what's really going on in this container environment?

Monitoring Docker with 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`**



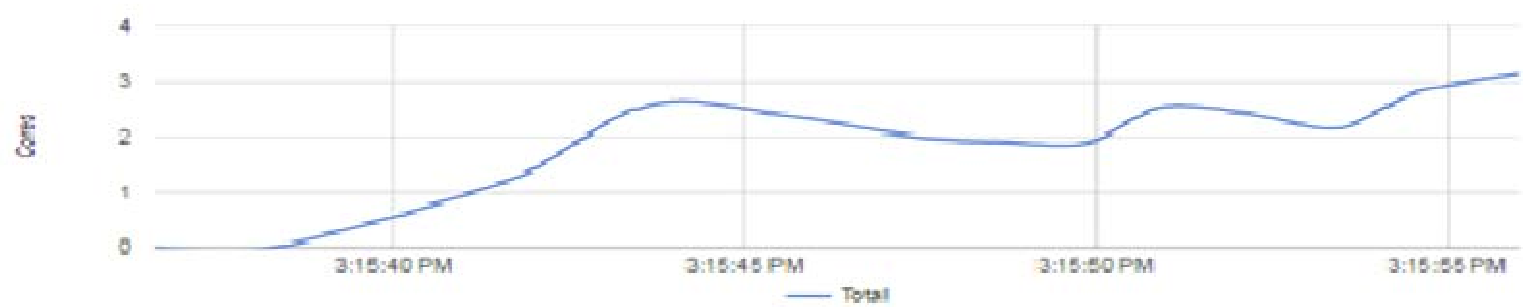
CPU Monitoring with cAdvisor

Processes

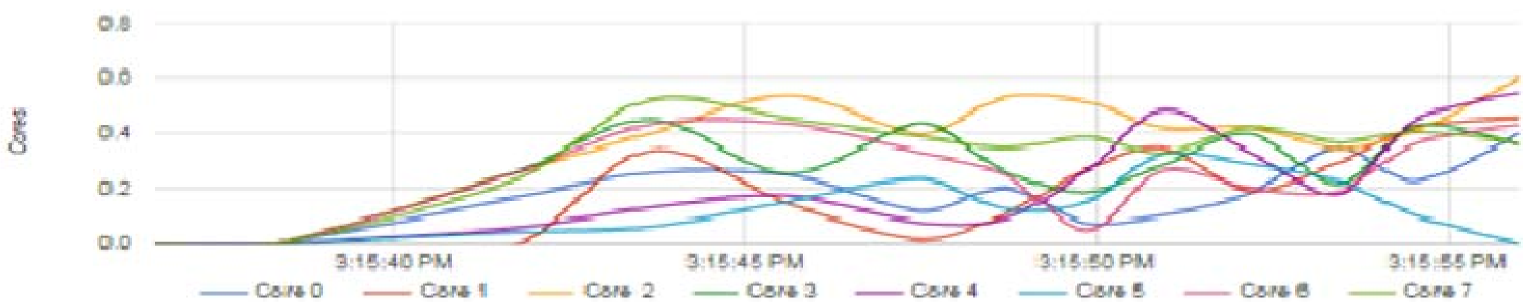
User	PID	PPID	Start Time	CPU %	MEM %	RSS	Virtual Size	Status	Running Time	Command
root	16,169	16,152	15:15	1.40	0.00	1.31 MiB	11.09 MiB	Ss+	00:00:00	cpu_stress.sh
root	16,218	16,169	15:15	0.00	0.00	308.00 KiB	4.03 MiB	S+	00:00:00	sleep

CPU

Total Usage



Usage per Core



Usage Breakdown

RT LOGIC technology that connects

Summary

Container Benefits

- Application scalability
- Lightweight
  - Very fast startup, smaller size, easy to distribute
- Cost reductions
  - Increase of 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

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

Summary

Container History and Maturity

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

Container Standards

- https://www.opencontainers.org/

Thanks for Attending
GSAW 2017

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