Are Opensource Cloud Technologies Ready for Enterprise Scale?

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IBM

Open Source Software Everywhere

Courtesy https://www.automotiveworld.com

Courtesy https://www.automotiveworld.com

Speaker Profile

IBM Cloud Engineering Guild Leader

Co-chair, Istio Performance Workgroup

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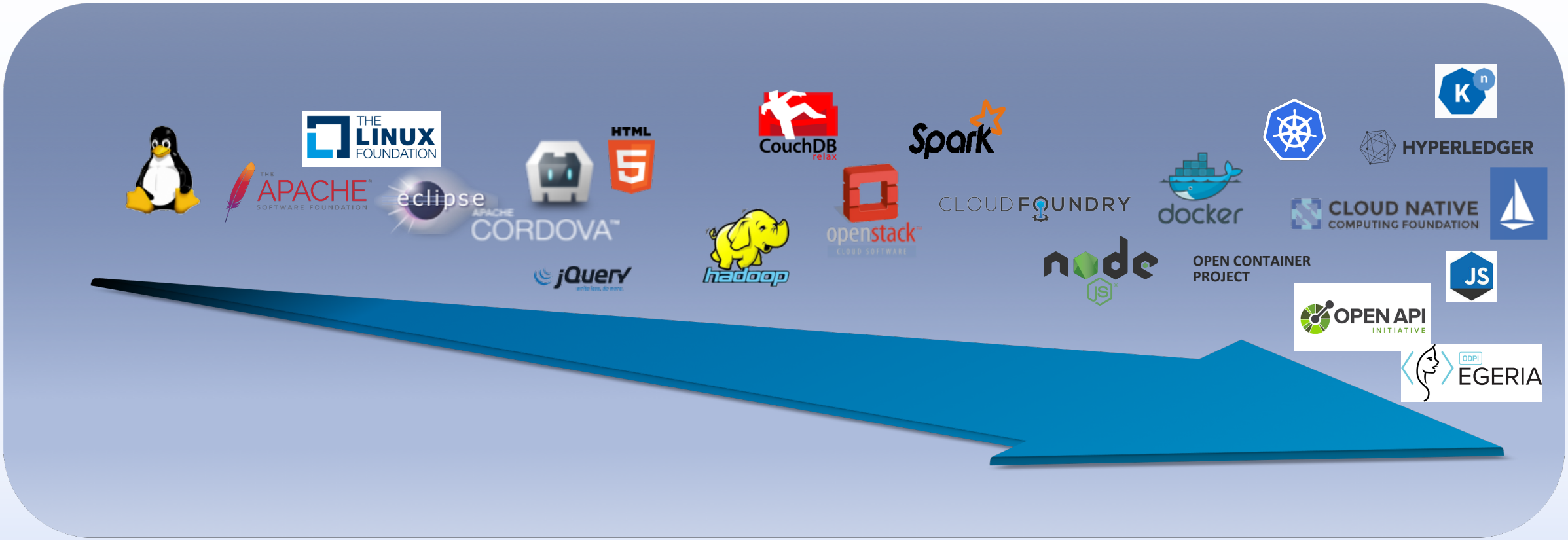
Open source allows developers to make a difference

Fueling most of the cloud platforms in the industry



Cloud Scale Stats from Multiple Industry Domains

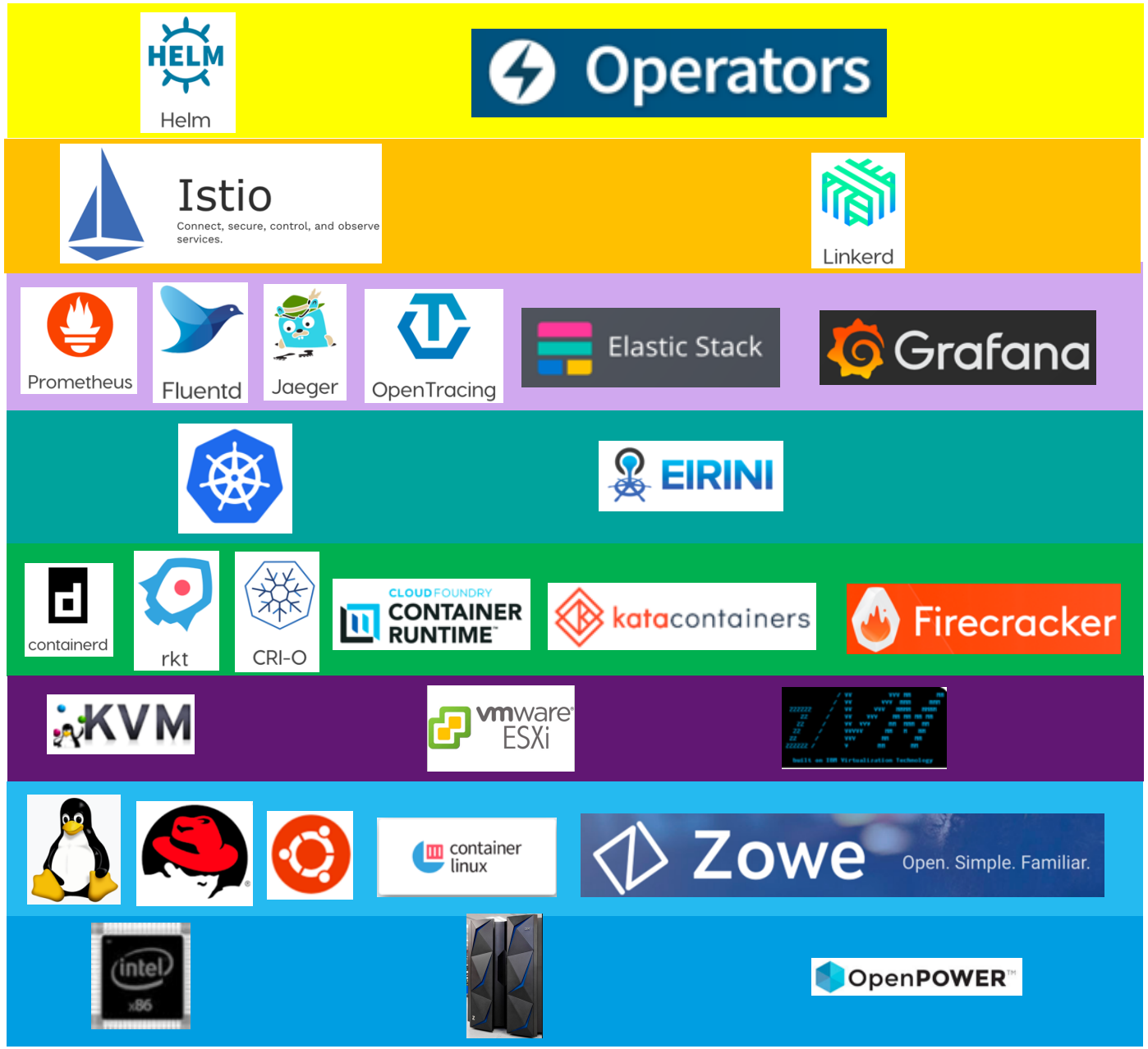
IBM Cloud

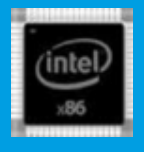
- ✓**Weather**
  - ✓Support 211M Video starts, 87k concurrent live stream views during a severe hurricane
- ✓**Healthcare**
  - ✓Support about 7 Million customers + Handling Millions of Immunization records for schools
- ✓**Banking**
  - ✓Retail Banking solutions with more than 6 Million customers + 50K Commercial Banking Customers
- ✓**Airlines**
  - ✓Support 6700 flights per day to over 350 destinations with web, mobile and kiosk to Cloud
- ✓**Car Rental**
  - ✓Support 500 Million total DB transactions per day
- ✓**Consumer Appliances**
  - ✓Support more than 2 Million Appliances with IoT API latency less than 500 ms

What are we going to talk in Today's Session?

- Opensource Frameworks in Cloud
- Kubernetes Safe Scheduler (SSX)
- Istio OSS Focus on Scale
- Other Open Community Initiatives
- Summary

Cloud Platform Architecture – Opensource Technologies





OpenPOWER™

Hardware

Persistent Memory CSI Plug-in

Device Plugins for Acceleration to Security and Compression

CPU Manager for Kubernetes

Node Tagging for Hardware Profiles

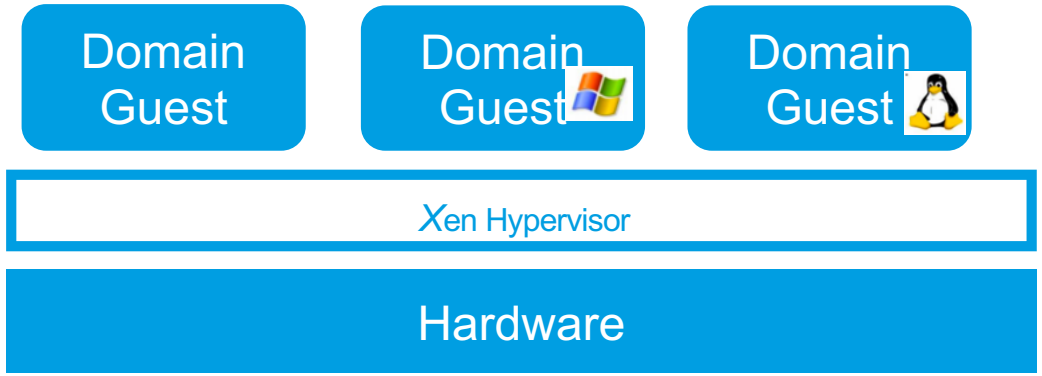
GPU Plugin for Kubernetes

- ❑ K8s API Server Scalability #1 – Exploit Hardware Acceleration
- ❑ Container Density #2 – Exploit low latency Persistence Memory
- ❑ Noisy Neighbor Problem #3 - Constraining Workloads to CPUs
- ❑ Hardware Centric Feature Identification #4 – Node Tagging

https://01.org/kubernetes/building-blocks

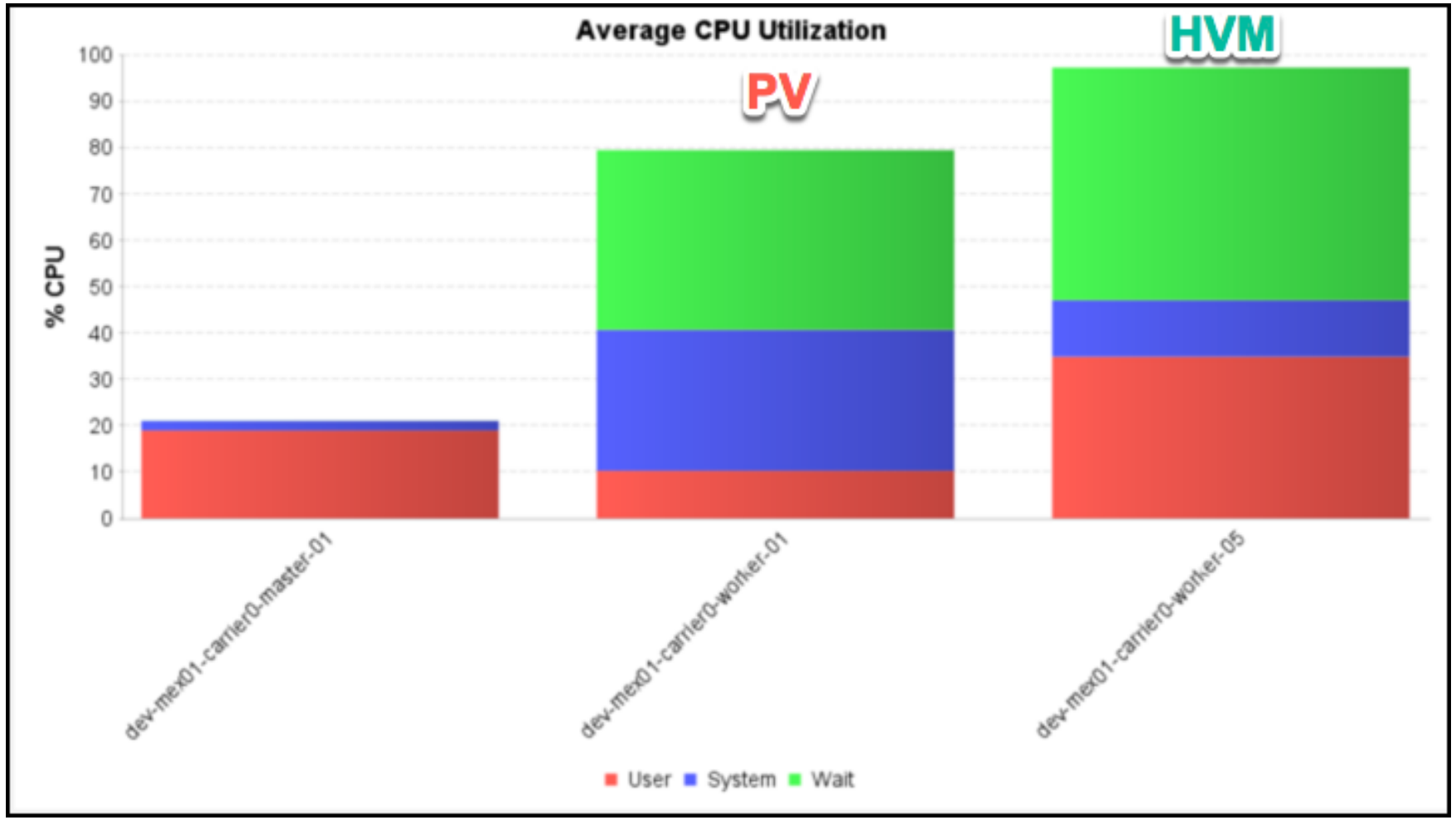
Virtualization

- Common Hypervisor is Xen Hypervisor on bare metal
- Common types of Virtualization on Xen are HVM (Hardware Virtual Machine) and PV (Paravirtualization)
- Virtual Machines run on top of Hypervisors
- Hypervisors take care of CPU Scheduling and Memory partitioning
- Hypervisor is unaware of Networking, external storage devices or common I/O functions



- Differences between various Virtualization Types (PV vs. HVM)
- HVM Guests will have less Kernel CPU Usage
- HVM also better for storage and network I/O
- Final choice is based on application usage needs

Virtualization Technology Impact



- Kernel CPU on HVM is only 1/3 that of PV VSI node saving significant CPU cycles
- For services like Cloud Foundry, HVM gives almost 7x more density packing almost 200 containers per cell

Container Runtimes

- Containerd has density advantages to Docker
- Kata Containers and micro-vms are gaining ground
- Nested Container architectures with few clouds
- Sidecars and Pod density considerations
- CPU sharing algorithms and noisy neighbor considerations

Test	Docker	Containerd
Maximum number of pods running without node occasionally going NotReady	400	475
Time for 400 pods to become ready (100 at a time)	11 mins	3 mins

https://www.opencontainers.org/

https://containerd.io/

Orchestration

- ❑ Default K8s Scheduler algorithm may result in unbalanced clusters
- ❑ Default K8s Scheduler depends on static request values
- ❑ Descheduler has many Issues
- ❑ What we need is a Rescheduler with dynamic cluster insights

- ❑ Smart Behavior through Extension
- ❑ Enhance Default Scheduler with Smart/Safe Scheduler
- ❑ Combination of K8s Extension and Node Annotator
- ❑ Support Over-commitment

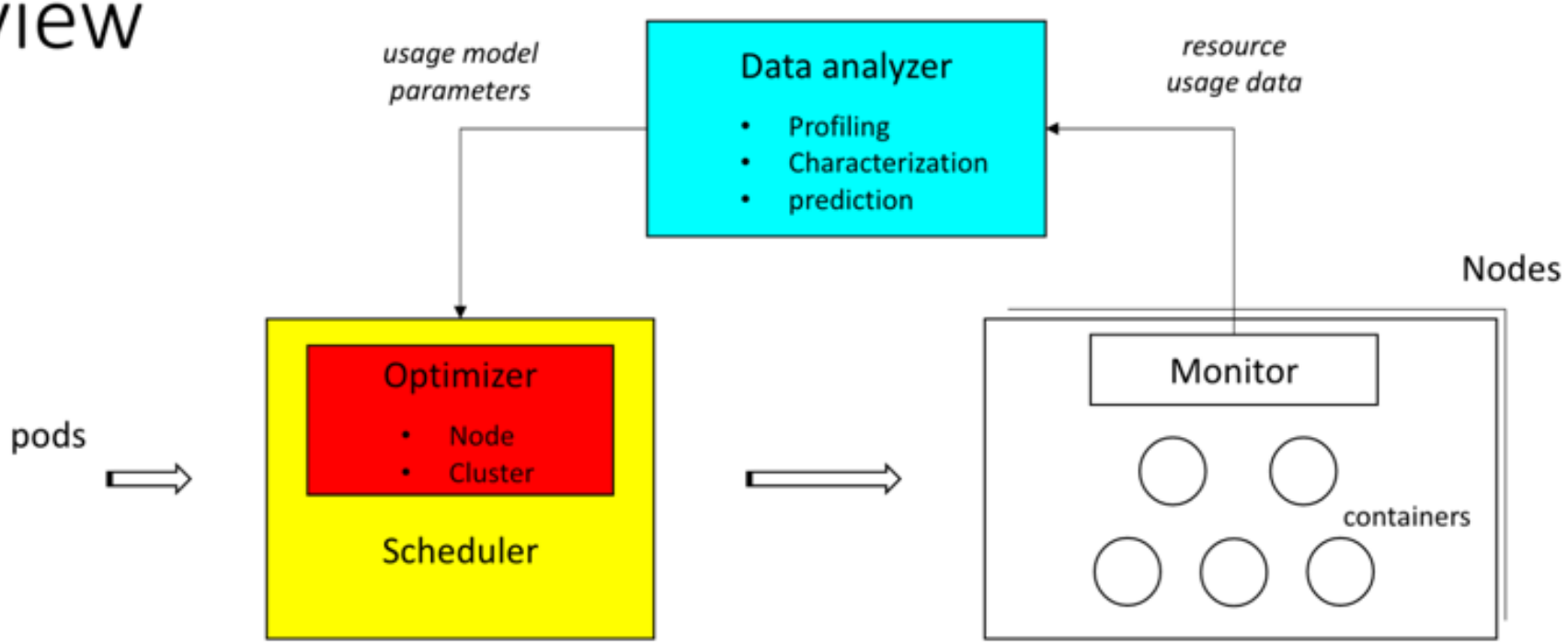
Safe K8s Scheduler (SSX) Design

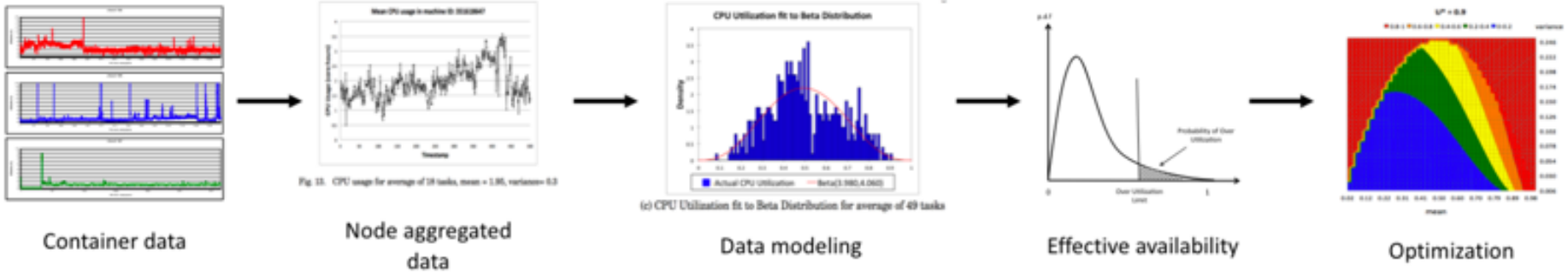
- SSX extends the predicates and priority functions of the default scheduler
- It supports Kubernetes 1.13.5
- Two priority functions are provided: 'safe-overload' and 'safe-balance'
  - The former orders nodes based on their calculated risk values
  - The latter orders nodes according to a combined measure of average and standard deviation of the available resources
  - Such a combined measure allows a trade-off between the average load and the variability in the load

https://github.com/IBM/kube-safe-scheduler

SSX Scheduler - Design

Overview

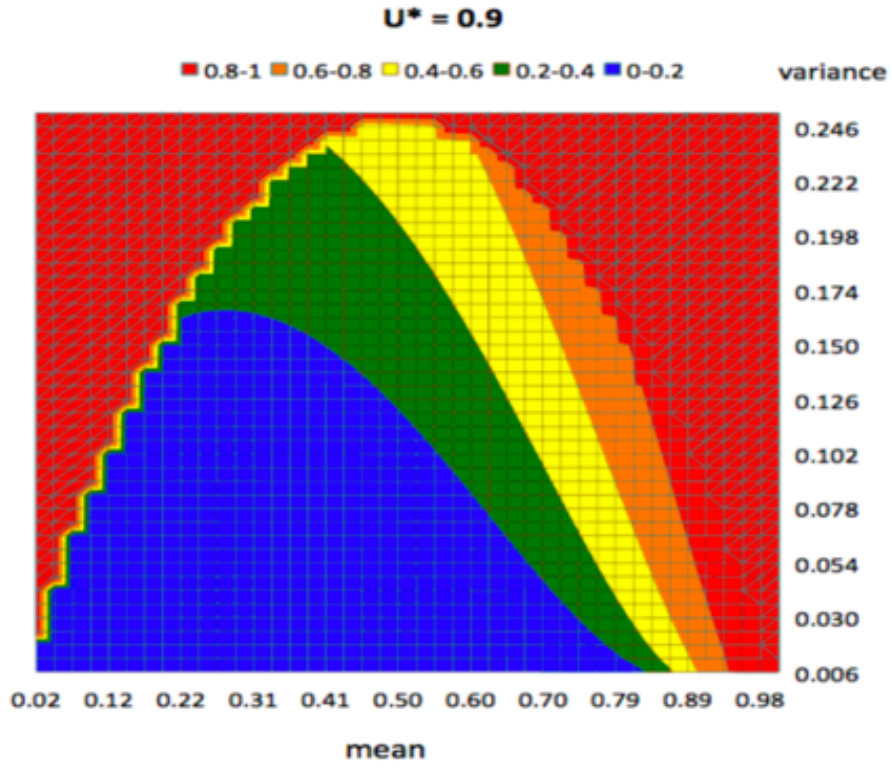




SSX Scheduler - Design

Over-subscription policy

- Set parameters
  - Load threshold (U*)
  - Overload probability (epsilon)
- Explore Mean-Variance (MV) space
- Select operating point
  - Low load: afford variability
  - Medium load: calculated variability
  - High load: limited variability
- Results in an effective resource availability metric to be used in a scheduling predicate



SSX Scheduler - Configuration

SSX may be configurable through the following environment variables:

```
SAFEUTILIZATION                integer to set the threshold utilization value
SAFEPERCENTILE                 integer to set the percentile acceptable value
SAFEFORECASTWEIGHT      integer to set weight percentage of forecast value
SAFEPRINTTABLE                 boolean to select detailed logging information
```

An example follows.

```
env:
          - name: SAFEUTILIZATION
            value: "90"
          - name: SAFEPERCENTILE
            value: "30"
          - name: SAFEFORECASTWEIGHT
            value: "20"
          - name: SAFEPRINTTABLE
            value: "false"
```

https://github.com/IBM/kube-safe-scheduler

Platform Services

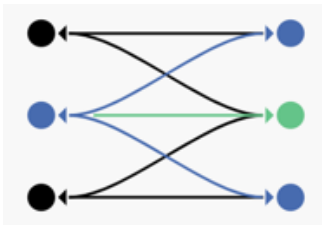
- Monitoring Service Scalability #1 – Prometheus operator with tuning knobs like scraping interval can help scale
- Tracing Scalability #2 – Jaeger operator with sampling can help
- Projects like Thanos can help provide global query view and merge data from Prometheus HA pairs with massive storage
- Exploiting faster persistent memory systems from latest processors can significantly help scale monitoring systems on cloud

https://prometheus.io/ https://grafana.com/ github.com/improbable-eng/thanos

Service Mesh

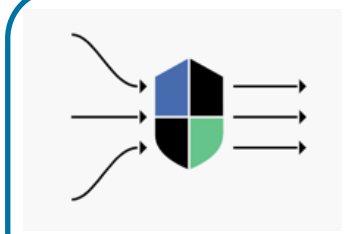
- Application Developer Productivity #1 – Significant improvements to application developer productivity
- Observability #2 – Best way to control large microservice meshes
- Managed Service Mesh #3 - Cloud Providers are providing managed service mesh taking out complexities and scale issues
- Self Consumption by Cloud Providers#4 – Many of the internal frameworks of cloud and many cloud services started using Service mesh

Istio Service Mesh – What is It?

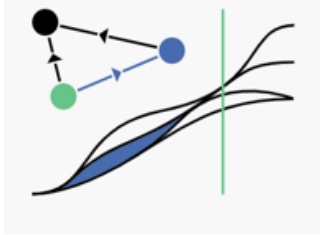


Connect

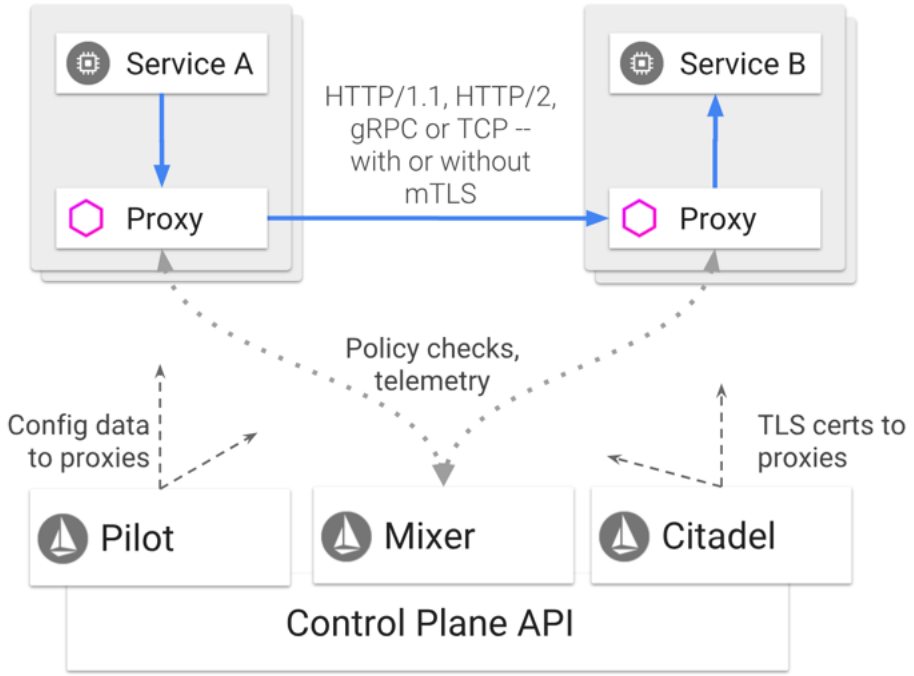
Secure



Control



Observe



https://istio.io/

Intelligent Routing
Load Balancing

Service to Service
Authentication
Certificate Management

Policy Enforcement
Authorization

Telemetry, Logging,
Visualization
Distributed Tracing

Istio Open Source Project – Architecting for Scale

- Istio
  - SWAT Team https://docs.google.com/document/d/1TiMmzbM5r9QlBfs79owBqiAZJgflMyXa3Zuev7xZKSc/edit#
  - SWAT Team Report https://docs.google.com/document/d/1ob9M2TfI5GS3_rqrEhWFIpVyfFVKPTE8N3YZpeiDJxw/edit#
  - Istio Performance and Scalability Optimization Issues on GH https://docs.google.com/document/d/17PfZkXGpiVk3qAQdnB_ASSIGvnV7ZKwH6RXBN3c8_so/edit
- Istio Community Regression Patrol Framework
  - Istio Code Quality https://ibmcloud-perf.istio.io/regpatrol/

Istio Performance Future Design Optimizations for Scale

#	Focus Area	Feature	Performance Benefits	Feature Design Details
1	Telemetry	• Sampling • New Control points	Significant reduction in Istio Control plane resource usage	• Sampling feature provides the ability to collect a specific sample set of telemetry data instead of collecting every metric • With new control features, end users will have ability to control metric collection either at the source or destination
2	Pilot	Dynamic load distribution	Uniform traffic distribution from proxies to Pilot replicas in the mesh	Grpc-lib centric more dynamic load balancing of traffic between Envoys and Pilot replicas
3	Proxy Sidecars	Improve network Bandwidth & resource reduction	• Reduce the container network costs by bypassing kernel with direct app to envoy through user space • Save memory copies and fragmentation • Set the correct worker threads	• Using eBPF save almost 60% BW costs • Need to set the correct Envoy worker thread count for multiple host environments either statically or dynamically
4	Buffer and Cache management	Externalize Buffer and Cache tuning at data plane	Improve the agility and density at data plane	With this feature end users have the ability to configure buffer and cache at data plane and control plane level
5	Envoy	Further perf improvements	Perf benefits to both side cars and Gateways	Currently with HTTP1.1 traffic, Envoy performs much slower than HAProxy (need to fix this)

Istio Performance Future Design Optimizations for Scale

#	Focus Area	Feature	Performance Benefits	Feature Design Details
6	InitContainer	• Cold Start	Required for Knative to reduce cold startup time	• Any init container adds significant cold-start time due to paying kubelet startup cost
7	Istio Proxy	Startup time	Required for Knative to reduce istio proxy startup time	We see a base of ~200ms cost of pushing envoy config down from pilot and more at scale. This is a significant portion of our cold start budget so we need a way to optimize this to near 0. Statically defining the northbound and other endpoints which our nodes can reach and not participating in the actual 'mesh' is an option

Content

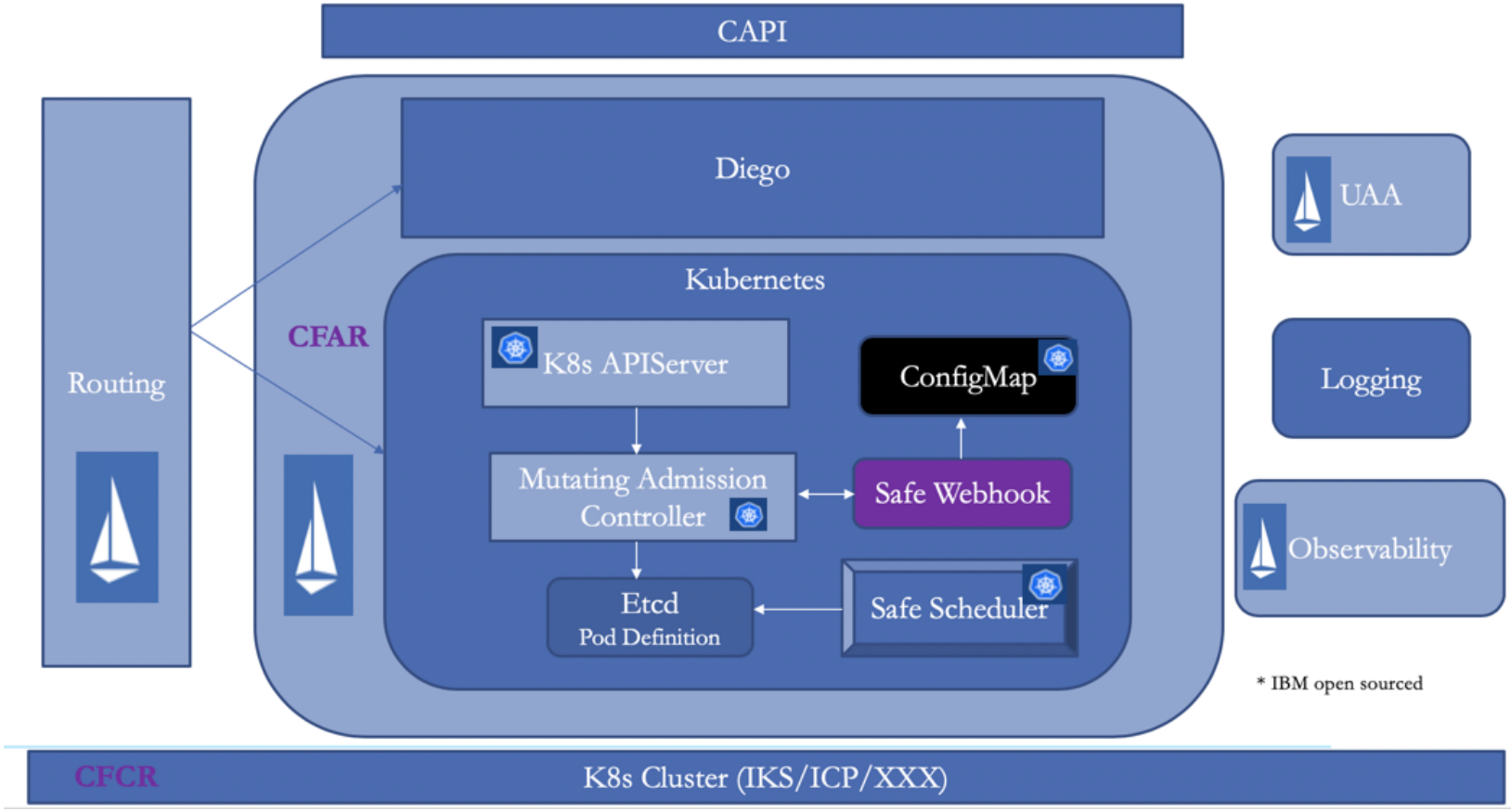
- Standardized packaging solutions through open source mechanisms
- Cloud Packs through Helm and Operators is becoming a standard way to deliver Content and services
- Operators provide the ability to automate common operational tasks through scripted controllers

https://operatorhub.io/

https://github.com/helm/helm

Frameworks Integration – Opensource Cloud Technologies

Frameworks Integration



https://www.cloudfoundry.org/project-eirini/ https://github.com/cloudfoundry/istio-release

OSS Frameworks Integration

- Cloud Foundry and Istio Integration
  - https://docs.google.com/document/d/1LgLY0g39fzpg1_4zTckbH1mOuuSKGvYwp2tkakoe9ys/edit#heading=h.tj1oxhcb47cj
- Cloud Foundry and Kubernetes Integration
  - **Project Eirini** https://github.com/JulzDiverse/scf/tree/eirini-scf-2.14.5

Key Takeaways from this Session

- **Open Source Cloud Technologies** are vetted for enterprise scale
- **SSX K8s Scheduler** will help enhance default K8s scheduler algorithm to safely balance clusters with over-commit
- **Istio Performance Workgroup** introduced a regression patrol framework to maintain code quality on a daily basis
- **Hardware Exploitation** will help reduce TCO for Cloud
- **Operating Systems** are getting optimized for containers
- **Operators** are becoming the common delivery mechanism for content for production use
- **Virtualization** technologies selection will impact container density

Thank You

Q&A

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