IBM Spectrum Scale: 
Use cases and (field) lessons learned with Kubernetes and OpenShift

Harald Seipp
Senior Technical Staff Member
Center of Excellence for Cloud Storage
The EMEA Storage Competence Center (ESCC) provides **Pre- to Post-Sales Storage services to assist you across IBM’s complete Storage portfolio (Hardware / Software / Solutions)** via:

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Skill Transfer, New Product Intro., Solution Enablement, Architectural Guidance

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Skill Enablement, Hands-On-Training, Implementation Assistance, Data Migration & Performance Tuning

**Development & Product Test Systems Lab**
Proof of Concept (PoC), Hands-on Product Training ...

**Product Field Engineering (PFE)**
Last level defect support

**Client Care**
Pro-active Customer Care Management
Outline

• Baseline
• Use Cases
  ➔ ADAS
  ➔ CSP
  ➔ Dev/Test
  ➔ Multi-cloud
• Topics clients ask for
  ➔ Unsupported platforms ;-) 
  ➔ Security / Multi-tenancy
  ➔ Heterogenous environments
• Summary
Baseline: Containers Everywhere

- **Multi-Cloud: On-premises and Public Clouds**
  - Elastic scheduling and auto-scaling
  - Improved resource utilization
  - Secure isolation and Multi-Tenancy
  - Portable and reproducible service
  - One-click Laptop to Supercomputer

- **Development, DevOps and continuous integration**
  - Re-use of applications and services
  - Simplify and accelerate application deployment

- **Microservices Architecture**
  - Programming language and technology stack independence
  - Faster and easier development
Baseline: Kubernetes Persistent Volumes

A Persistent Volume (PV) is a unit of storage that has been provisioned by an administrator or **dynamically** provisioned via a storage driver/plug-in.

A PersistentVolumeClaim (PVC) is a request for storage by a user. PVCs consume PV resources.

A Storage Class is pre-defined by the admin to dynamically provision PVs.
IBM Storage Enabler for Containers provides Kubernetes FlexVolume Drivers

IBM Spectrum Connect provides the Storage management API and Storage classes for IBM Block Storage

IBM persistent storage architecture 2017-2019
IBM persistent file storage architecture 2019+

Kubernetes cluster with CSI

- Kubernetes 1.13+
- CSI v1.1.0
- Operator-based install
- Stateless plugin
- CSI certification
- Full Open Source: https://github.com/IBM/ibm-spectrum-scale-csi
- Upgrade path from SEC to the new CSI plugin.
Multi-cluster support

Kubernetes Cluster with CSI

Master Node(s)

Infrastructure Node
External-Provisioner
CSI - Plugin
Scale Client

Infrastructure Node
External-Attacher
CSI - Plugin
Scale Client

Worker Node
Microservice A
CSI - Plugin
Scale Client

Worker Node
Microservice B
CSI - Plugin
Scale Client

Worker Node
CSI - Plugin
Scale Client

Scale GUI Server(s)

Spectrum Scale Client cluster

Spectrum Scale Storage cluster

High speed network
## SEC vs. CSI

<table>
<thead>
<tr>
<th>Feature</th>
<th>Storage Enabler for Containers</th>
<th>CSI Driver 1.0.x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static Provisioning</td>
<td>No K8s native static provisioning support, but there is way to use an existing fileset as a PV</td>
<td>Yes</td>
</tr>
<tr>
<td>Dynamic Provisioning</td>
<td>Fileset based (dependent and independent)</td>
<td>Lightweight (directory based) and fileset based (dependent and independent)</td>
</tr>
<tr>
<td>Multiple Filesystem Support</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Remote cluster mounts</td>
<td>Limited support</td>
<td>Yes</td>
</tr>
<tr>
<td>Deployment</td>
<td>Helm Chart</td>
<td>Operator</td>
</tr>
<tr>
<td>Spectrum Scale Version</td>
<td>5.0.0+</td>
<td>5.0.4.1+</td>
</tr>
<tr>
<td>Platform support</td>
<td>RHEL 7.x on x86_64, ppc64le, s390x</td>
<td>RHEL 7.x on x86_64</td>
</tr>
<tr>
<td>Kubernetes Version</td>
<td>1.10, 1.11, and 1.12</td>
<td>1.13+</td>
</tr>
<tr>
<td>Openshift Support</td>
<td>3.11 via RPQ only</td>
<td>4.2</td>
</tr>
<tr>
<td>Migration path from SEC to CSI</td>
<td>N/A</td>
<td>Manual offline migration</td>
</tr>
</tbody>
</table>
Use Cases
Spectrum Scale use case at automotive client

- Containerized platform to train and test the AI for an ADAS (Advanced Driver Assistance Systems) project
- High-bandwidth data ingest (double-digit TB per day) through Spectrum Scale/ESS
- Sophisticated cloud architecture (see next slide)
- Skilled admins and developers
Spectrum Scale use case at automotive client – cluster architecture

IBM Spectrum Scale / IBM Elastic Storage Server (ESS)
Spectrum Scale use case at automotive client – lessons learned

- To get the Spectrum Scale client up & running
  - Assigned an additional OpenStack network with a dedicated NIC to the VM
    - With OpenStack floating IP the Scale Cluster IP was not visible within VM
  - Adjusted OpenStack security groups to allow inbound traffic to the Spectrum Scale ports

- To ensure that persistent Pods are placed on the Spectrum Scale node(s)
  - Labeled the node and added a nodeSelector to the persistent Pod deployment configs
Spectrum Scale use case
at automotive client – lessons learned (cont.)

• Made Storage Enabler for Containers 2.0.0 work
  – Steps are now documented as solution blueprint

• Re-installed with SEC 2.1.0
  – SEC helm chart 1.0.1 requires container privilege adjustments for the deployment to succeed

• Existing data can be integrated though additional storage class for existing filesets
  – Created a PVC to re-use an existing Spectrum Scale fileset (ingest directory)
  – Ensure sufficient access rights for the container process
Spectrum Scale use case at CSP: AIaaS – lessons learned

- For the CSP, multi-tenant isolation and data management is more important than dynamic provisioning
  - Used (semi-)static provisioning to prevent Fileset sprawl
  - CSP pre-creates PVs/Filesets with own naming conventions
  - Better control of tenant-related services (Snapshots, Backup)

- Integration with 3-Tier concept
  - Through Fileset placement policies
  - One Kubernetes Storage Class per Tier
  - Leveraging CSI driver lightweight volumes

- CSI Driver works with IBM Cloud Private 3.2.1 on Power
  - No IBM CSI Driver Support here, CSP is supporting
Spectrum Scale use case
Dev/Test

Kubernetes Cluster with CSI

Master Node(s)

Infrastructure Node
CSI - Plugin
Scale Client

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Worker Node
Application
CSI - Plugin
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Application
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Kubernetes Cluster with CSI

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Static PV
(Read/Write)

Scale NSD Server

Static PV
(Read/Write)

Scale NSD Server

Scale NSD Server

Existing Directory
Spectrum Scale use case
Dev/Test – lessons learned

- Stronger isolation in Dev/Test clusters beyond Kubernetes namespace separation
  - Separate Kubernetes clusters with different cluster admins
  - Still single data plane wanted
    - With or without access to same data
Spectrum Scale use case
Multicloud

Home (on-prem)

- Master Node(s)
- Worker Nodes
  - Scale CSI - Driver
    - Filesystem1
      - Fileset1
        - Directory1
        - Directory2
      - Mongo DB
    - Scale GUI Server(s)
    - Scale NSD Servers

Cache (on-prem)

- Master Node(s)
  - Worker Nodes
    - Scale CSI - Driver
      - Filesystem1
        - Fileset1
          - Directory1
          - Directory2
        - Mongo DB
      - Sync PVs
      - Prefetch
    - Scale GUI Server(s)
    - Scale NSD Servers

Cache (cloud)

- Master Node(s)
  - Worker Nodes
    - Scale CSI - Driver
      - Filesystem1
        - Fileset1
          - Directory1
          - Directory2
        - Mongo DB
      - Sync PVs
      - Prefetch
Spectrum Scale use case
Multicloud – lessons learned

- To service workload on cloud
  - Single-writer (home site) only
  - Processed data should be pushed to separate file system

- For DR purposes
  - Only one workload container should be up at given time
  - Independent writer can be used, but monitor cloud data outgoing traffic (EGRESS)

- Can be used with Spectrum Scale on AWS automation
  - Requires (not-yet-supported) Spectrum Scale GUI
Topics clients ask for...
CSI driver unsupported platforms

- Operating Systems
  - Ubuntu 18.04.x
    - No issues probe testing with plain k8s

- Orchestration Platforms
  - IBM Cloud Private
    - See Cloud Service Provider use case
    - Cross-architecture (x86, Power, Z) support in a single k8s cluster
    - To get the CSI driver running
      - add `ibm-anyuid-hostaccess-psp` Pod Security Policy to ClusterRole CRs
  - Rancher
    - Sold as “plain k8s”, easy deployment & nice GUI
    - To get the CSI driver running
      - Remove the `type: Directory` specifier from the `gpfs-classic` hostPath mount of the `ibm-spectrum-scale-csi` daemonSet
      - Add a PodSecurityPolicy to the `ibm-spectrum-scale-csi` ClusterRole definitions when running Rancher with PSP enforcement

```yaml
apiVersion: policy/v1beta1
kind: PodSecurityPolicy
metadata:
  name: csi-psp
spec:
  requiredDropCapabilities:
    - NET_RAW
  privileged: false
  allowPrivilegeEscalation: false
  defaultAllowPrivilegeEscalation: false
  hostNetwork: true
  hostPorts:
    - min: 0
      max: 65535
  fsGroup:
    rule: RunAsAny
  runAsUser:
    rule: RunAsAny
  seLinux:
    rule: RunAsAny
  supplementalGroups:
    rule: RunAsAny
  volumes:
    - emptyDir
    - secret
    - persistentVolumeClaim
    - downwardAPI
    - configMap
    - projected
    - hostPath
```

- apiGroups: ['policy']
  resources: ['podsecuritypolicies']
  resourceNames: ['ibm-anyuid-hostaccess-psp']
  verbs: ['use']
- apiGroups: ['extensions']
  resources: ['podsecuritypolicies']
  resourceNames: ['ibm-anyuid-hostaccess-psp']
  verbs: ['use']

- hostPath:
  path: /gpfs/fs1
  type: Directory
  name: gpfs-classic

- apiGroups: ['policy']
  resourceNames: ['csi-psp']
  resources: ['podsecuritypolicies']
  verbs: ['use']
- apiGroups: ['extensions']
  resourceNames: ['csi-psp']
  resources: ['podsecuritypolicies']
  verbs: ['use']

---
Security / Multi-tenancy

- For maximum container security, consider OpenShift
  - Uses K8s RBAC plus Security Context Constraints (plus SELinux) to restrict container process security impact
- Kubernetes Administrator (kubeadmin) user can access all PVs
  - One could use RBAC/PSP or SCCs to create “less privileged admin” role
  - For strict isolation use separate Kubernetes clusters
    - Optionally use Kubernetes federation (v2!)

Extended Depth of Protection
Heterogenous environments

- Multi-platform
  - X86, IBM Power, IBM Z

- IBM Cloud Private supports multi-architecture clusters
  - IBM Storage Enabler for Containers supports all three platforms
  - Spectrum Scale supports all three platforms (Linux)

- OpenShift support for IBM Power and IBM Z is coming
  - Initial releases might have limitations regarding RHEL worker node and multi-architecture support
Summary and call to action

- Spectrum Scale provides tight Kubernetes and OpenShift integration through
  - IBM Storage Enabler for Containers (FlexVolume) for Kubernetes < 1.13 and OpenShift 3.x
  - IBM CSI drivers for Kubernetes 1.13 and later and OpenShift 4.x
- Use cases (ADAS, CSP, Dev/Test and more) are evolving
- Involve us (ATS / Lab Services)
  - To discuss your Spectrum Scale Container Platform use case
  - If you need help with IBM Storage Orchestration for Containers

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Thank you!

Please help us to improve Spectrum Scale with your feedback

• If you get a survey in your email or a popup from the GUI, please respond
• We read every single reply
Teilen Sie sich mit!

Nutzen Sie den Hashtag #IBMStorageDays auf LinkedIn, Twitter und Co. und berichten von unseren Vorträgen!

Let’s connect!

Bei Fragen einfach melden!

@haraldseipp

linkedin.com/in/harald-seipp-43458356
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Bookmarks

- IBM Spectrum Scale CSI Driver documentation:

- Storage Enabler for Containers documentation:
  https://www.ibm.com/support/knowledgecenter/SSCKLT_2.1.0/sec_kc_welcome.html

- IBM Spectrum Scale CSI Driver github:
  https://github.com/IBM/ibm-spectrum-scale-csi

- IBM Spectrum Scale CSI Driver video blogs:

- IBM Spectrum Scale CSI Driver at OperatorHub:
  https://operatorhub.io/operator/ibm-spectrum-scale-csi-operator

- Kubernetes CSI documentation:
  https://kubernetes-csi.github.io/docs/