

Search Head Clustering Basics To Best Practices

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Agenda

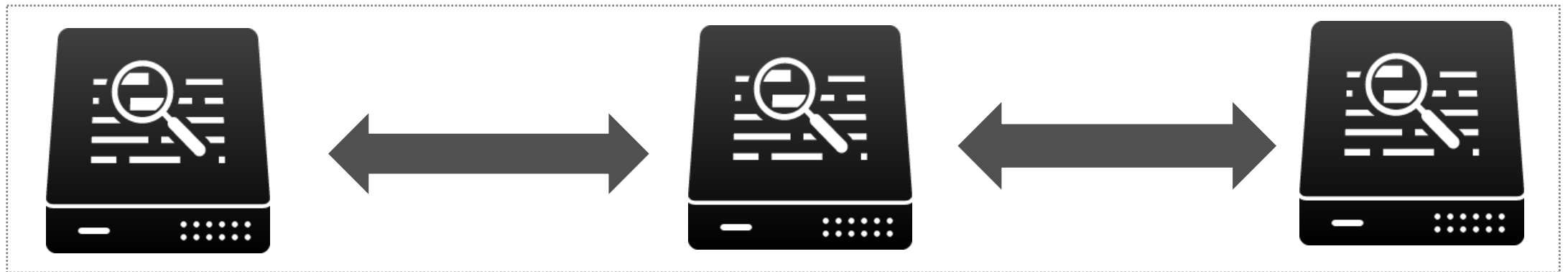
- ▶ What is Search Head Clustering?
- ▶ Clustering Internals
- ▶ Distributed Scheduling
- ▶ Configuration Management
- ▶ Bundle Replication
- ▶ What's New in SHC

Search Head Clustering Overview

What is Search Head Clustering?

Search Head Clustering

Ability to group search heads into a cluster in order to provide
Highly Available and Scalable search services



**MISSION
CRITICAL
ENTERPRISE**

Business Benefits of SHC

Horizontal Scaling

Consistent User Experience

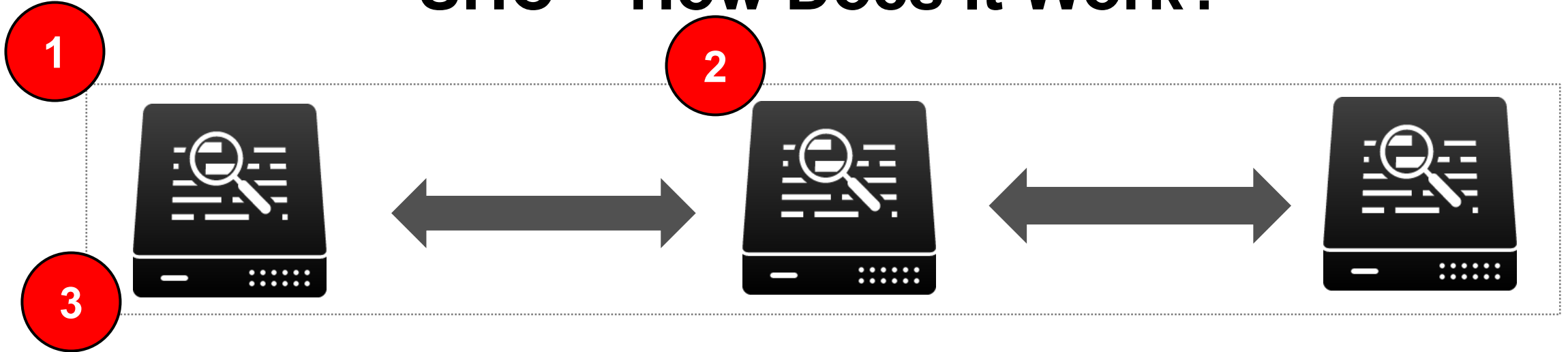
Always-on Search Services

Easy to add / manage premium contents (apps)

Clustering Internals

How does SHC work?

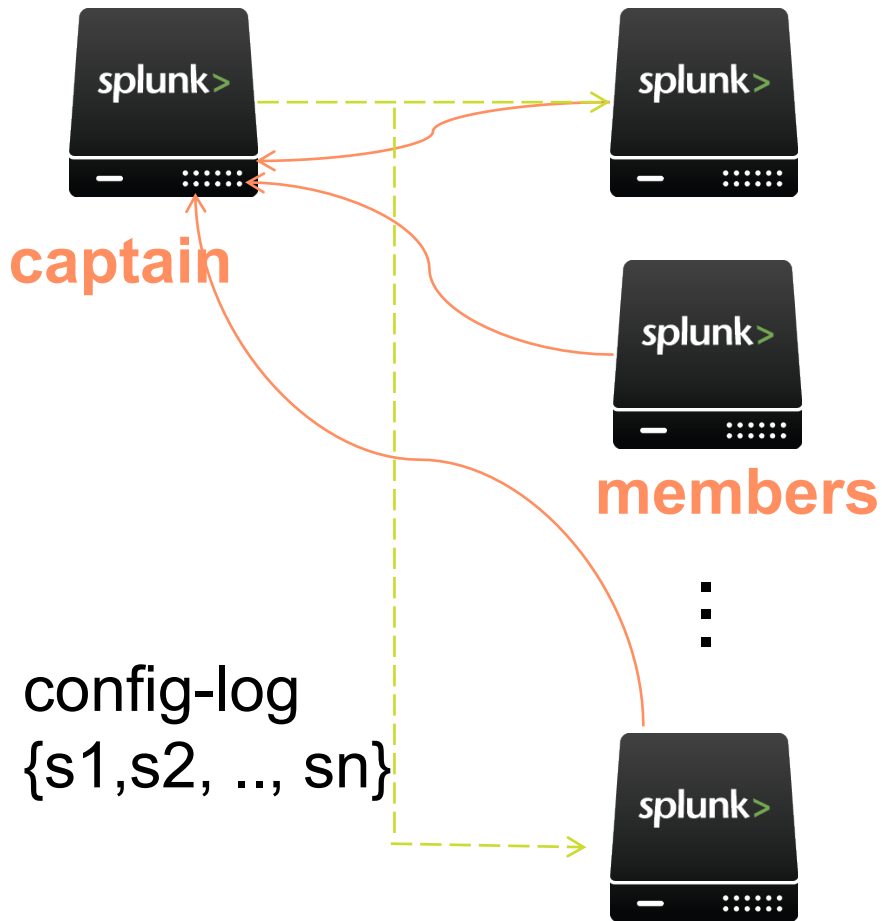
SHC – How Does It Work?



1. Group search heads into a cluster (Horizontal scaling)
2. Captain gets elected dynamically (No Single point failure)
3. User created reports/dashboards automatically replicated to other search heads (Consistent Configuration)

130.60.4 - - [07/Jan 18:10:57:153] "GET /category.screen?category_id=GIFTS&SESSIONID=5D5SLAFF10ADFF10 HTTP 1.1" 404 720 "http://buttercup-shopping.com/cart.do?action=view&itemId=EST-6&product_id=F1-SW-03" "Mozilla/5.0 (Macintosh; Intel Mac OS X 11_0_0; rv:53.0) Gecko/20100101 Firefox/53.0" 128.241.220.82 - - [07/Jan 18:10:57:123] "GET /product.screen?product_id=FL-DSH-01&SESSIONID=5D5SL7FF6ADFF9 HTTP 1.1" 404 3322 "http://buttercup-shopping.com/cart.do?action=purchase&itemId=EST-26&product_id=K9-CW-01" "Mozilla/5.0 (Macintosh; Intel Mac OS X 11_0_0; rv:53.0) Gecko/20100101 Firefox/53.0" 317 27.160.0.0 - - [07/Jan 18:10:56:156] "GET /oldlink?item_id=EST-26&SESSIONID=5D5SL9FF1ADFF3 HTTP 1.1" 200 1318 "http://buttercup-shopping.com/cart.do?action=changequantity&itemId=EST-18&product_id=AV-CB-01&SESSIONID=5D5SL8FF3ADFF9 HTTP 1.1" 200 2423 "http://buttercup-shopping.com/cart.do?action=purchase&itemId=EST-26&product_id=K9-CW-01" "Mozilla/5.0 (Macintosh; Intel Mac OS X 11_0_0; rv:53.0) Gecko/20100101 Firefox/53.0" 130.60.4 - - [07/Jan 18:10:57:153] "GET /category.screen?category_id=GIFTS&SESSIONID=5D5SLAFF10ADFF10 HTTP 1.1" 404 720 "http://buttercup-shopping.com/cart.do?action=view&itemId=EST-6&product_id=F1-SW-03" "Mozilla/5.0 (Macintosh; Intel Mac OS X 11_0_0; rv:53.0) Gecko/20100101 Firefox/53.0" 128.241.220.82 - - [07/Jan 18:10:57:123] "GET /product.screen?product_id=FL-DSH-01&SESSIONID=5D5SL7FF6ADFF9 HTTP 1.1" 404 3322 "http://buttercup-shopping.com/cart.do?action=purchase&itemId=EST-26&product_id=K9-CW-01" "Mozilla/5.0 (Macintosh; Intel Mac OS X 11_0_0; rv:53.0) Gecko/20100101 Firefox/53.0" 317 27.160.0.0 - - [07/Jan 18:10:56:156] "GET /oldlink?item_id=EST-26&SESSIONID=5D5SL9FF1ADFF3 HTTP 1.1" 200 1318 "http://buttercup-shopping.com/cart.do?action=changequantity&itemId=EST-18&product_id=AV-CB-01&SESSIONID=5D5SL8FF3ADFF9 HTTP 1.1" 200 2423 "http://buttercup-shopping.com/cart.do?action=purchase&itemId=EST-26&product_id=K9-CW-01" "Mozilla/5.0 (Macintosh; Intel Mac OS X 11_0_0; rv:53.0) Gecko/20100101 Firefox/53.0"

Search Head Cluster Bring Up



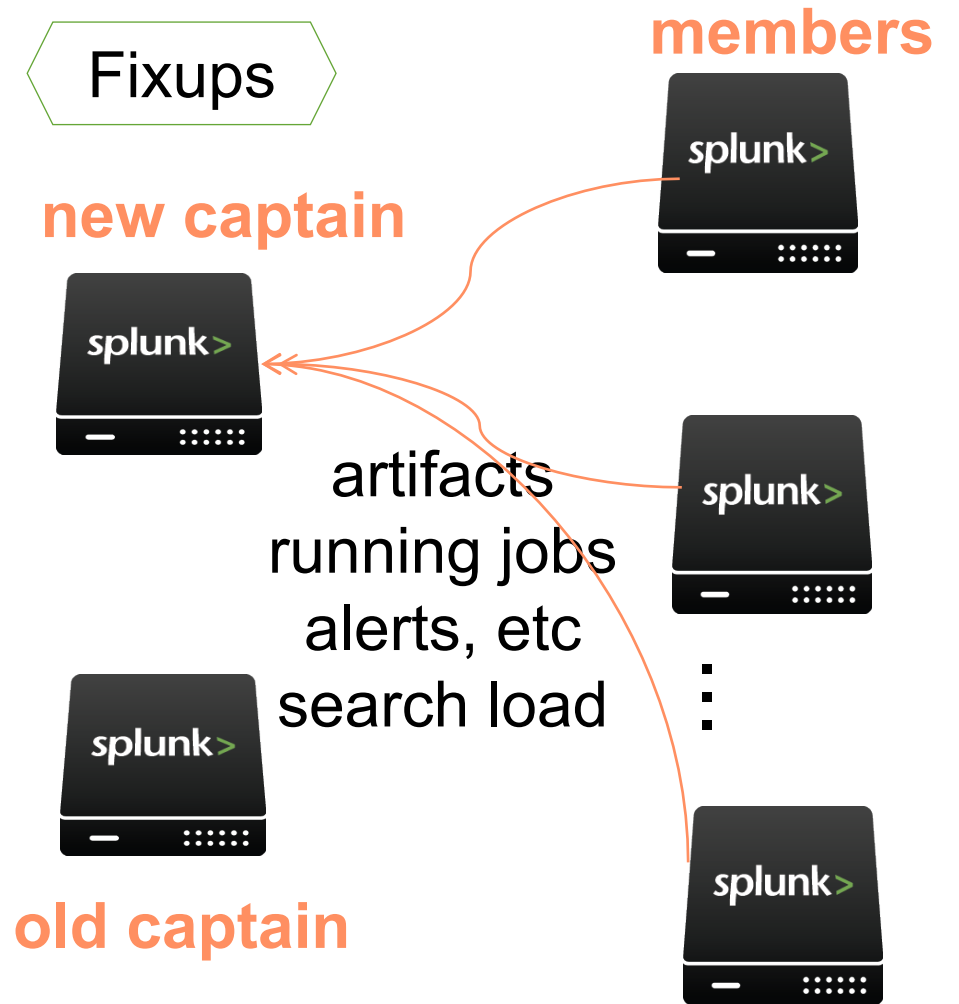
1. Bootstrap captain
2. Bring-up members
3. Captain establishes authority
4. Members join/register
5. CLI based cluster scale/shrink

Dynamic Captain & Auto Failover

► Raft Consensus Protocol from Stanford

- Diego Ongaro & John Ousterhout

► SHC uses RAFT for LE and Auto Failover



Controlling Captaincy

- ▶ Captain Switching should be extremely rare
- ▶ Repair a problem by transfer captain without restarts!!!
- ▶ Rolling-restart from the captain maintains the node as captain after restarts
- ▶ Captain preference added for members
- ▶ Disaster Recovery using static captaincy

Best Practices

- ▶ Add only fresh instances, if a node is re-purposed use “*splunk clean all*”
- ▶ High availability requires a minimum of 3 members
- ▶ All search heads on homogenous hardware and at same version
- ▶ Number of instances $\geq$ replication_factor
- ▶ Admin needs to manually do “*splunk remove shcluster-member*” on captain to remove a dead node
- ▶ Multi-site clusters to have majority nodes at one site

Distributed Scheduling

How jobs are scheduled in SHC?

Job Scheduling

- ▶ Auto-failover – New captain becomes scheduler
- ▶ `captain_is_adhoc_searchhead` knob to reduce captain load
- ▶ Captain updates RA/DM summaries on indexers.
- ▶ Scheduler limits honored across the cluster
- ▶ Real time scheduled searches run one instance across cluster
- ▶ Centralized user quota Management*

High Availability Of Search Results

- ▶ Artifacts are replicated across the SH members
- ▶ Adhoc searches are **not** replicated
- ▶ At least replication_factor number of nodes should be in UP state for enforcing replication policy
- ▶ Replicated directory starts with “rsa_<sid>” in the dispatch directory
- ▶ Captain orchestrates reaping of search artifacts from dispatch directory of all members
- ▶ An artifact is served based on availability from (1) itself, (2) search originating node, (3) captain

Configuration Management

How are dynamic changes to SHC kept consistent?

Configuration Files

► Goals

- Consistent user experience across all search heads
- Changes made on one member are reflected on all members

► Types of Configuration Files

- custom user content
 - reports
 - dashboards
- search-time knowledge
 - field extractions
 - event types
 - macros
- system configurations
 - inputs, forwarding, authentication

Configuration Changes

- ▶ Users customize **search and UI configurations** via UI/CLI/REST
 - save report
 - add panel to dashboards
 - create field extraction
- ▶ Administrators modify **system configurations**

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128.241.220.82 - - [07/Jan 18:10:57:123] "GET /product.screen?product_id=FL-DSH-01&JSESSIONID=5D35L7FF6ADFF0 HTTP 1.1" 404 3322 "http://buttercup-shopping.com/category.screen?category_id=GIFTS"
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Search And UI Configurations

- ▶ **Goal:** Eventual Consistency
- ▶ Changes to search and UI configurations are replicated across the search head cluster automatically

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125.17 14.14.14.14 - - [07/Jan 18:10:55:187] "GET /category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3 HTTP 1.1" 200 3885 "http://buttercup-shopping.com/category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3"
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125.17 14.14.14.14 - - [07/Jan 18:10:55:189] "GET /category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3 HTTP 1.1" 200 3885 "http://buttercup-shopping.com/category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3"
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125.17 14.14.14.14 - - [07/Jan 18:10:55:193] "GET /category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3 HTTP 1.1" 200 3885 "http://buttercup-shopping.com/category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3"
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125.17 14.14.14.14 - - [07/Jan 18:10:55:195] "GET /category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3 HTTP 1.1" 200 3885 "http://buttercup-shopping.com/category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3"
125.17 14.14.14.14 - - [07/Jan 18:10:55:196] "GET /category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3 HTTP 1.1" 200 3885 "http://buttercup-shopping.com/category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3"
125.17 14.14.14.14 - - [07/Jan 18:10:55:197] "GET /category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3 HTTP 1.1" 200 3885 "http://buttercup-shopping.com/category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3"
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125.17 14.14.14.14 - - [07/Jan 18:10:55:199] "GET /category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3 HTTP 1.1" 200 3885 "http://buttercup-shopping.com/category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3"
125.17 14.14.14.14 - - [07/Jan 18:10:56:000] "GET /category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3 HTTP 1.1" 200 3885 "http://buttercup-shopping.com/category.screen?category_id=FLOWERS&JSESSIONID=5D5SL8FF1ADFF3"

Conf Replication - Workflow

splunk> App: Search & Reporting

Search Pivot Reports Alerts Search & Reporting

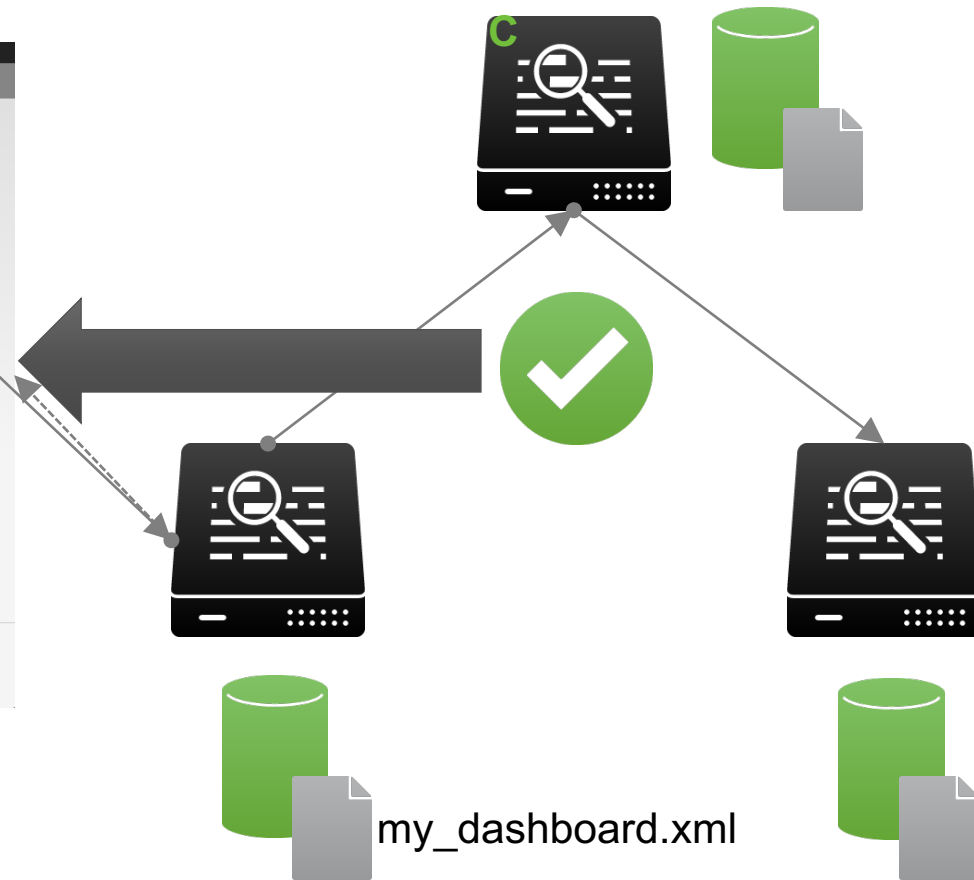
my dashboard

my panel

#	Time	Event
>	9/16/14 3:06:03.917 PM	09-16-2014 15:06:03.917 -0700 ERROR DistributedPeerManagerHeartbeat - Failed to get server info from peer =http://localhost:3601, response code=404
>	9/16/14 3:06:03.907 PM	09-16-2014 15:06:03.907 -0700 WARN DistributedPeerManagerHeartbeat - Unable to get server info from peer : http://localhost:3035 due to: Connection refused
>	9/16/14 3:05:03.863 PM	09-16-2014 15:05:03.863 -0700 ERROR DistributedPeerManagerHeartbeat - Failed to get server info from peer =http://localhost:3601, response code=404
>	9/16/14 3:05:03.848 PM	09-16-2014 15:05:03.848 -0700 WARN DistributedPeerManagerHeartbeat - Unable to get server info from peer : http://localhost:3035 due to: Connection refused
>	9/16/14 3:04:03.795 PM	09-16-2014 15:04:03.795 -0700 ERROR DistributedPeerManagerHeartbeat - Failed to get server info from peer =http://localhost:3601, response code=404
>	9/16/14 3:04:03.787 PM	09-16-2014 15:04:03.787 -0700 WARN DistributedPeerManagerHeartbeat - Unable to get server info from peer : http://localhost:3035 due to: Connection refused
>	9/16/14 3:03:03.735 PM	09-16-2014 15:03:03.735 -0700 ERROR DistributedPeerManagerHeartbeat - Failed to get server info from peer =http://localhost:3601, response code=404
>	9/16/14 3:03:03.726 PM	09-16-2014 15:03:03.726 -0700 WARN DistributedPeerManagerHeartbeat - Unable to get server info from peer : http://localhost:3035 due to: Connection refused
>	9/16/14 3:02:03.680 PM	09-16-2014 15:02:03.680 -0700 ERROR DistributedPeerManagerHeartbeat - Failed to get server info from peer =http://localhost:3601, response code=404
>	9/16/14 3:02:03.671 PM	09-16-2014 15:02:03.671 -0700 WARN DistributedPeerManagerHeartbeat - Unable to get server info from peer : http://localhost:3035 due to: Connection refused

« prev 1 2 3 4 next »

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Conf Replication – Progress Check

- ▶ captain keeps track of the conf replication progress of each SHC member

https://localhost:11089

18bc830e3087301900bdf2a30dc1a67bf8
318ced: Tue Jul 19 15:32:56 2016

https://localhost:8089

18bc830e3087301900bdf2a30dc1a67bf8
318ced: Tue Jul 19 15:32:52 2016

https://localhost:8189

dc4a991d168ae746f27979212253d6fb95
9fc92c: Fri Jul 1 13:51:05 2016

https://localhost:9089

CaptainDummyOpId: Tue Jul 19
15:32:09 2016

Bundle Replication

How are system-wide changes kept consistent?

System Configurations

- ▶ Recall: only changes to search and UI configurations are replicated across the search head cluster automatically
- ▶ Changes to **system configurations** are **not** replicated automatically because of their high potential impact
- ▶ How are system configurations kept consistent, then?

Configuration Deployment

- ▶ Deployer: a single, well-controlled instance outside of the cluster
- ▶ Configurations should be tested on dev/QA instances prior to deploy



```
130.60.4 - - [07/Jan 18:10:57:153] "GET /category.screen?category_id=GIFTS&JSESSIONID=5D5SLAFF10ADFF10 HTTP 1.1" 404 720 "http://buttercup-shopping.com/cart.do?action=view&itemId=EST-6&product_id=F1-SW-03"
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itemId=EST-16&product_id=RP-LI-02" 468 125.17 14. "screen?category_id=FLOWERS&JSESSIONID=5D5SLFF1ADFF3 HTTP 1.1" 200 3885 "http://buttercup-shopping.com/cart.do?action=remove&itemId=EST-SURPRISE&product_id=AV-CB-01"
http://buttercup-shopping.com/cart.do?action=purchase&itemId=EST-26&product_id=AV-CB-01" 200 3885 "http://buttercup-shopping.com/cart.do?action=changequantity&itemId=EST-18&product_id=AV-CB-01"
http://buttercup-shopping.com/cart.do?action=purchase&itemId=EST-26&product_id=AV-CB-01" 200 3885 "http://buttercup-shopping.com/cart.do?action=changequantity&itemId=EST-18&product_id=AV-CB-01"
```

Bundle Push

1

All apps and config are shipped to the SHs in the initial deployer push



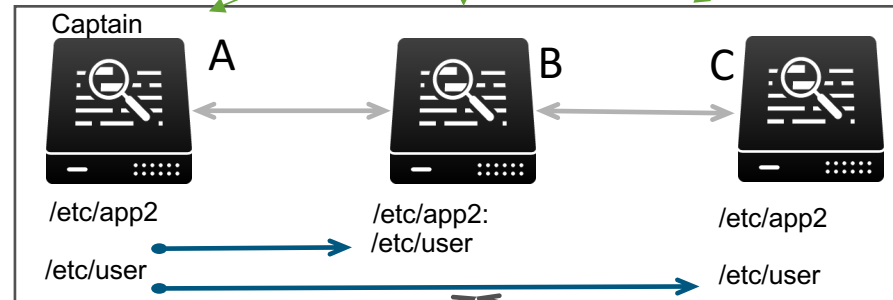
/etc/shcluster/app1: No Changes
/etc/shcluster/app2: Updated
/etc/shcluster/user: Updated

2

Only updated apps and updated user config is pushed on subsequent bundle push

3

App configuration is propagated to all SHC members

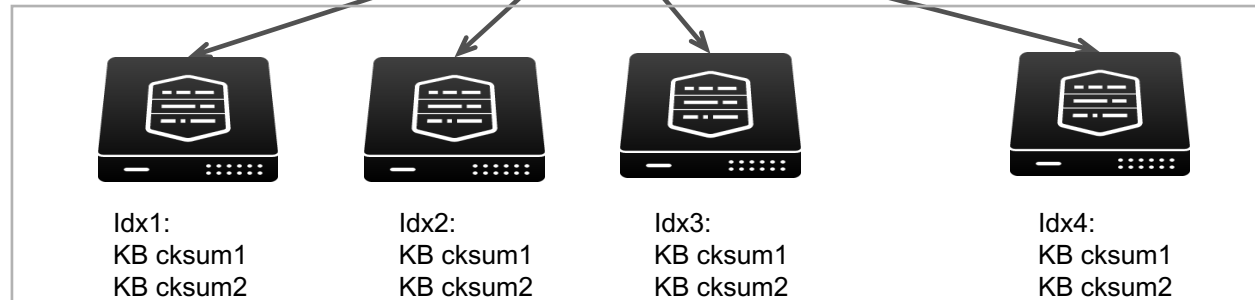


4

User configuration is sent to the captain and then replicated to remaining SHC members

5

Periodically, captain checks for new bundles and propagates the bundles to the indexers



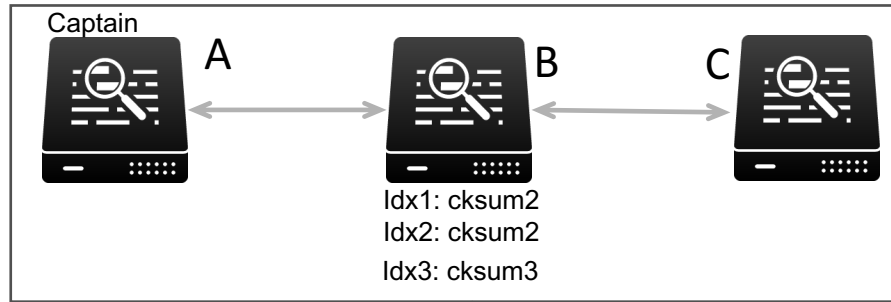
Bundle Replication

1

Each bundle push includes a KB cksum, when it is sent to the indexers

3

Captains delegates a scheduled search on SH B



2

SH periodically contacts CM to grab generation and peer set information. It tracks/reads async the latest common knowledge bundle across the peers

4

SH B determines the latest KB shared across peers (cksum2)

5

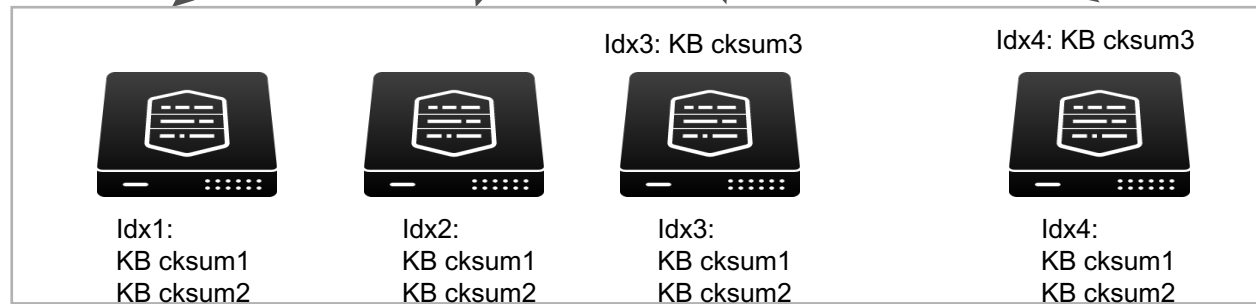
- If indexers do not have a common bundle
 - Best Effort Search uses common bundle across the the largest subset of indexers and excludes the other indexers
 - Otherwise – a synchronous bundle replication is kicked off prior to search

7

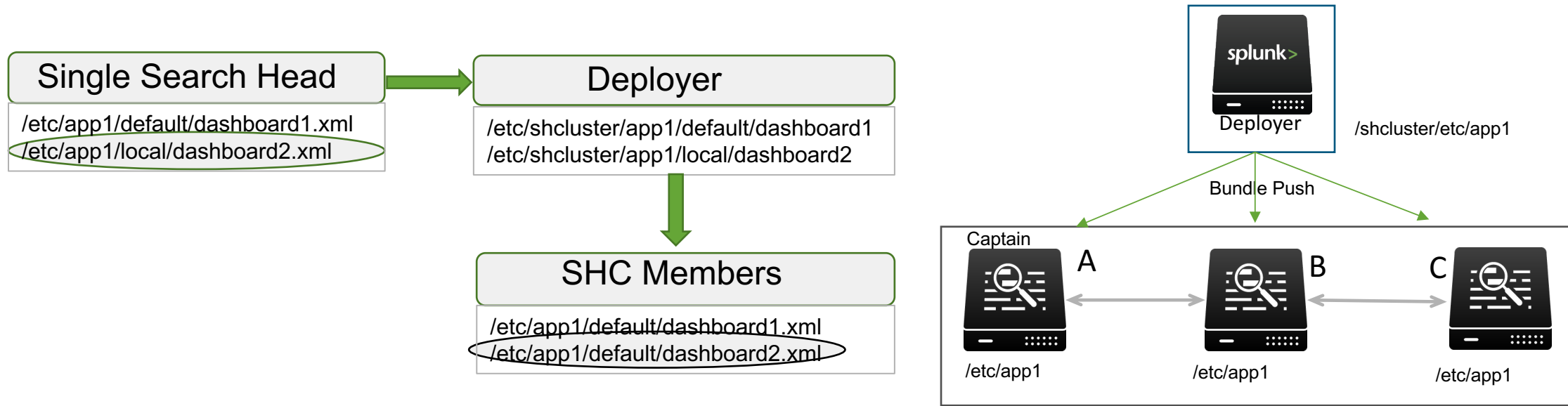
Indexers use the knowledge bundle (ckum2) included in search request

6

Search request is issued with common bundle checksum (cksum2)



SH->SHC Migration



- ▶ Deployer merges default and local app configuration during migration
- ▶ Post migration, users cannot perform certain operations on app settings like delete, move or unshare since default settings are immutable by a user
- ▶ Tip: Exclude default (ex: search) apps during migration to avoid overwrite. Migrate any custom settings in default apps by moving them to a new app

Recent Additions

What's New in SHC?

SHC Health Checker

Goal: Improve diagnosability with actionable information

- ▶ High level cluster health assessment
- ▶ Display node status
 - Captain/member
 - Heartbeat status
 - Uptime
 - Local unpublished conf changes
- ▶ Determine conf replication baseline consistency
- ▶ Expose search concurrency limits (running/capacity)

Conf Replication - Health Check

Monitoring Console

Overview | Instances | Indexing | Search | Resource Usage | Forwarders | Settings | Run a Search

Search Head Clustering: Status and Configuration

Search Head Cluster: goblinsSHC [Hide Filters](#)

Health Check

There are members in this cluster that do not share a common baseline. Action may be required. [click to see more details](#). [Learn More](#)

Select views: All Snapshot Historical

Snapshots

Search Concurrency (Running/Limit)

Ad hoc + Scheduled (4 Running)		Scheduled (4 Running)		
0/66 Historical	4/66 Real-time	0/22 Historical	4/22 Real-time	0/10 Summarization

[Click to see more details.](#)
Search concurrency limits can be set in `limits.conf`. [Learn More](#)

Status

2 Members

Instance	Role	Status	Last Heartbeat Sent to Captain	Configuration Baseline Consistency	Number of Unpublished Changes	Artifact Count
svdev-fedora14-009-search-head-3	Captain	Up	07/15/2016 10:22:47 -0700	1/3	0	0
svdev-fedora14-03-search-head-2	Member	Up	07/15/2016 10:22:50 -0700	1/3	missing common baseline with the captain: https://svdev-fedora14-009.sv.splunk.com:8089	0

[Click on instance name to see more details.](#)
[Click on configuration baseline ratio to see more details about configuration replication. Learn More](#)

Configuration Baseline Consistency for: svdev-fedora14-009-search-head-3

Shares Common Baseline With	Does Not Share Common Baseline With	No Response From
svdev-fedora14-009-search-head-3	svdev-fedora14-03-search-head-2	https://svdev-fedora14-02.sv.splunk.com:8089

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Resilient Conf Replication

- ▶ Higher resiliency to ensure continuous replication of knowledge objects across the SHC members
 - Conf replication failures when JSON string exceeds 512KB
 - Long file path (>255 characters) leading to snapshot creation failure
 - Large lookups files may block configuration push from the members
 - Accelerated baseline match using bloom filters to find the common baseline

- ▶ Intelligent captain selection
 - Prevent out-of-sync SHC member from becoming captain

Bundle Push/Replication Improvements

- ▶ Delta bundle push to indexers on lookup deletes at runtime
 - Trigger delta bundle replication when conf objects are deleted
- ▶ Deployer directs first bundle push to the Captain node
 - Pushing to captain enables faster bundle push down to the indexers
- ▶ Replicate option for lookup replication across SHC members
 - **replicate = true|false** in transforms.conf
 - True: lookup table is replicated to indexers,
 - False: lookup table is only replicated within SHC and not to the indexers
 - Avoids limitation of not replicating outputcsv (used to capture search results)
 - Use outputlookup to create a new csv file and replicate to SH and indexers as needed
 - Target usecase is ETracker tables, that are replicated to only to SHC members
- ▶ Support MV fields in outputlookup

SHC Manager UI

- ▶ New SHC UI available from any of the SHC members
- ▶ Enabled only in SHC environments
- ▶ Enables admins to run cluster operations (rolling restart, captain transfer)
- ▶ More functionality to come in upcoming releases

Search Head Clustering

Monitor and take action on your search head cluster. [Learn more](#)

Begin Rolling Restart

3 Members

filter

Actions

Captain is Node2

20 per page ▾

Name ^	Actions	Status ▾	Role ▾	Last heartbeat sent to captain ▾
mkt-centos7x64-002.sv.splunk.com		Up	Captain	3/31/2017, 4:31:44 PM
mkt-centos7x64-003.sv.splunk.com	Transfer Captain	Up	Member	3/31/2017, 4:31:42 PM
mkt-centos7x64-001.sv.splunk.com	Transfer Captain	Up	Member	3/31/2017, 4:31:45 PM

Key Takeaways

1. SHC provides always-on search services and consistent user experience
2. Enable SHC for horizontal scalability
3. Recent additions: SHC health check (6.5), Increased conf replication resiliency (6.6), SHC manager UI (6.6)

Thank You

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