OGC | Open Grid Computing, Austin, TX

LDMS Version 4.3 Tutorial Part 1: Basics https://github.com/ovis-hpc/ovis

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Tutorial Format (Basic)

Overview of the Lightweight Distributed Metric Service (LDMS) (9 slides)

- Overview of the LDMS framework
- LDMS architecture description

Setup (3 slides)

- Environment setup description and verification
- Introduction to support programs and helper scripts for use in lab work

Hands-on exercises, instructor walk through, and facilitated student exploration:

Configuring and deploying a distributed monitoring system with storage

- **Exercise 1:** Configuring and Running Samplers (37 slides – ~20 min)
  - Sampler startup and local and remote verification
  - Intro to ldmsd_controller and ldms_ls
- **Exercise 2:** Configure Aggregators (13 slides – ~20 min)
  - Aggregation startup and verification using local samplers
  - Aggregation of all other attendees' (remote) samplers
- **Exercise 3:** Aggregating From Remote Hosts: Building a Distributed Monitoring System (4 slides – if time permits)
- **Exercise 4:** Dynamic Configurations and Resilience (4 slides - if time permits)
- **Exercise 5:** Storing Data In CSV Format (11 slides - ~20 min)

LDMS Overview

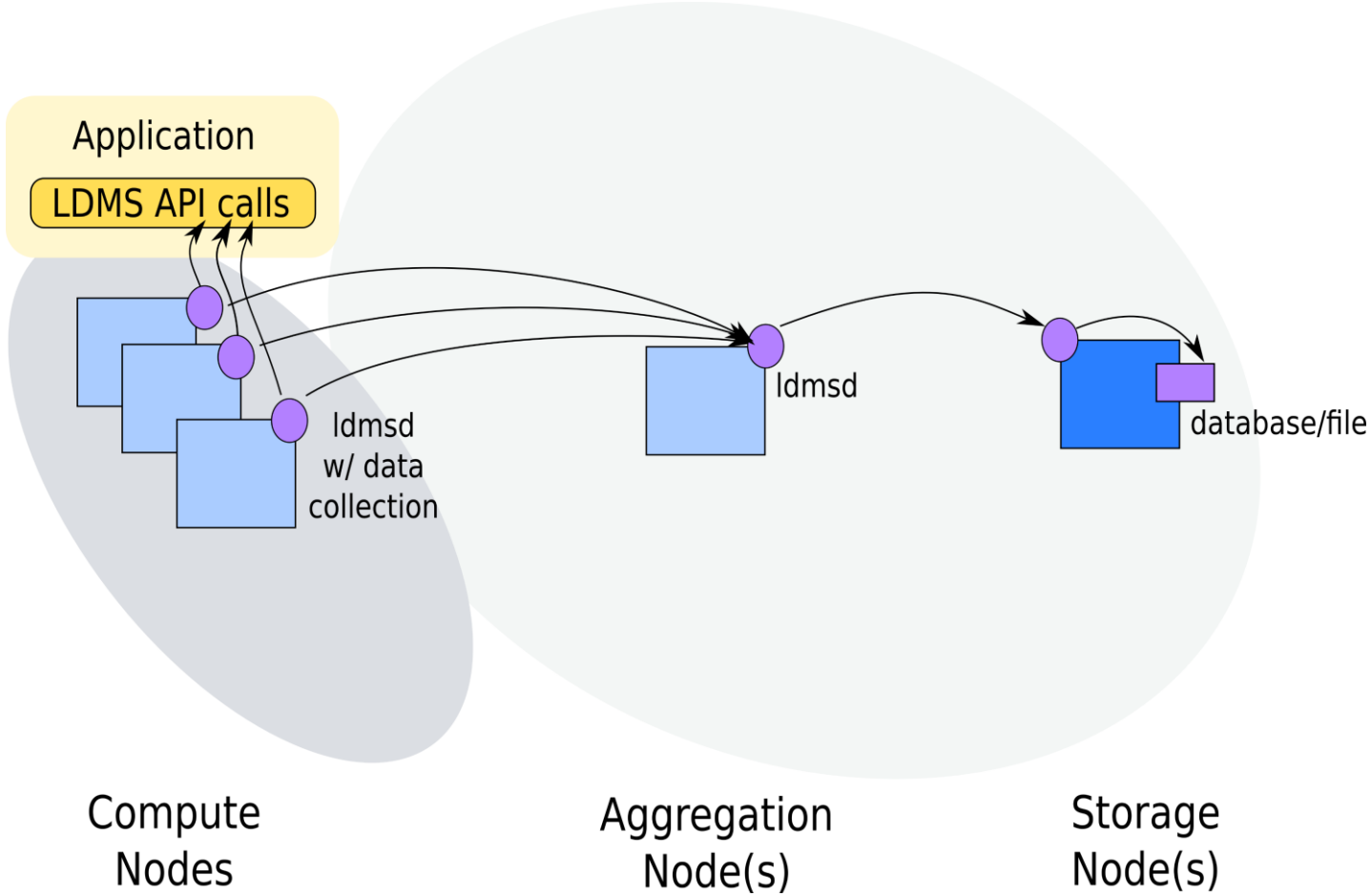
What is the Lightweight Distributed Metric Service (LDMS)?

- Daemon based data collection
  - Plugin architecture
  - Sample and transport numeric data
  - Transmit information published to publish/subscribe API
- Transport and aggregate data
- Store data

Typical use cases for information “stored” by LDMS

- Identify application execution behaviors
- Identify applications memory (and other resource) utilization behaviors
- Identify network congestion
- Determine over-provisioned resources
- Identify heavy Lustre users

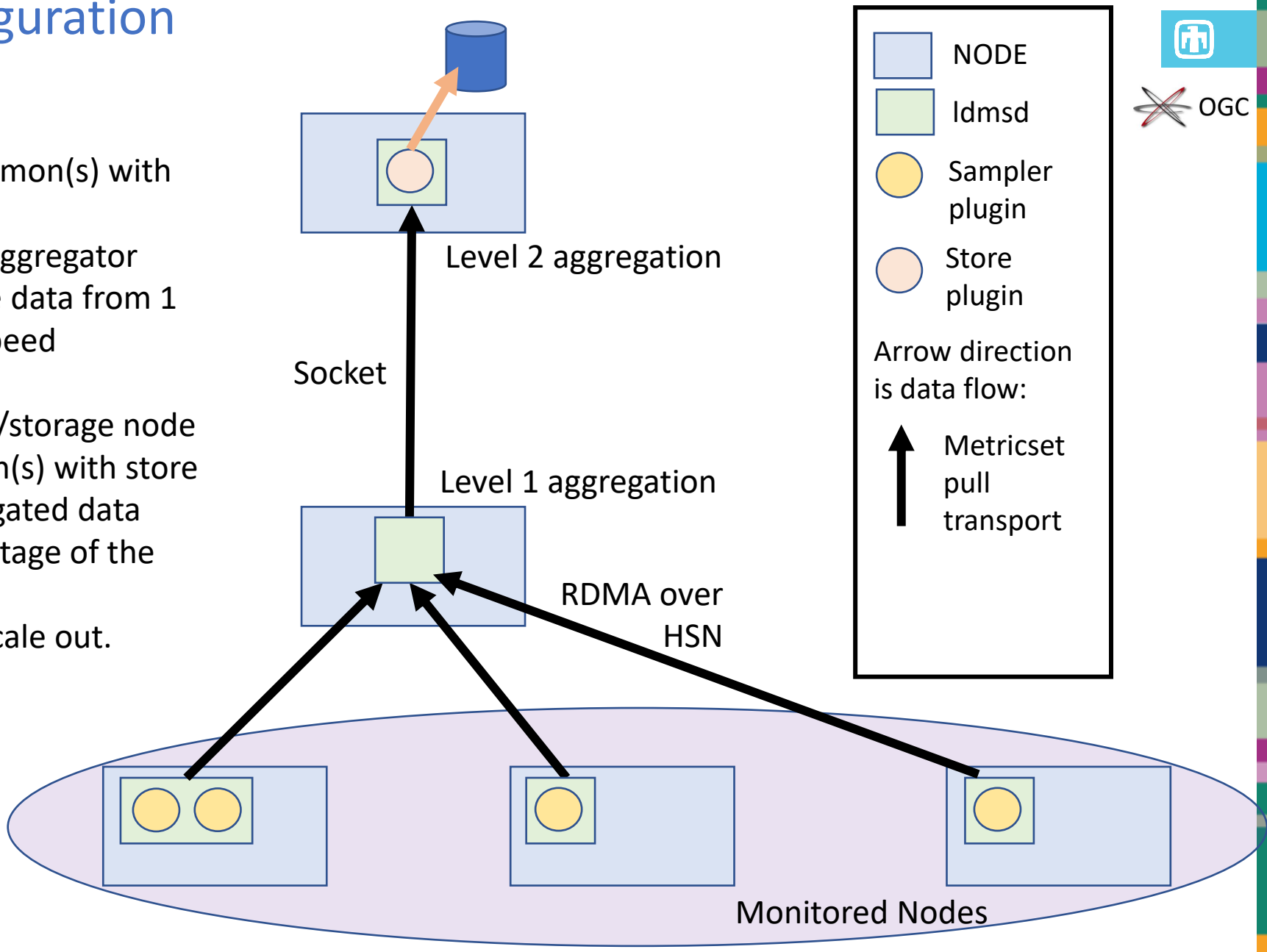
Lightweight Distributed Metric Service (LDMS) High Level Overview



* Only the current data is retained on-node

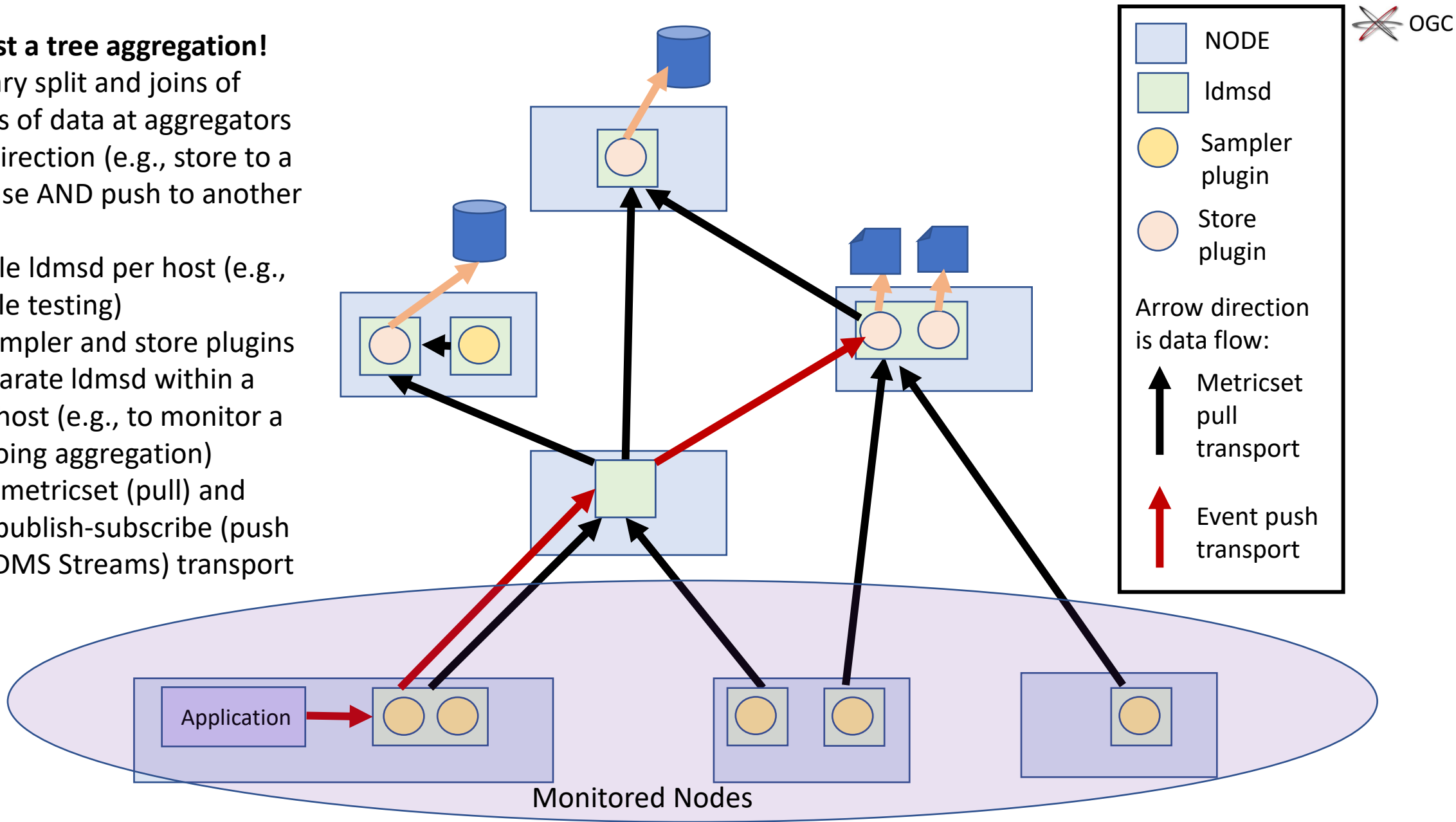
Common Simple Configuration

- Setup:
  - Compute Nodes have ldms daemon(s) with one or more sampler plugins
  - Cluster service nodes have L1 aggregator ldms daemon(s). Aggregate the data from 1 or more nodes over the high speed transport. No plugins.
  - Off cluster monitoring/analysis/storage node has L2 aggregator ldms daemon(s) with store plugin(s). Writes out the aggregated data
  - Mixed transports to take advantage of the HSN
- This topology can be replicated to scale out. Examples:
  - Replicate per “Scalable Unit”
  - Note that fan-in of ~thousands to one are possible

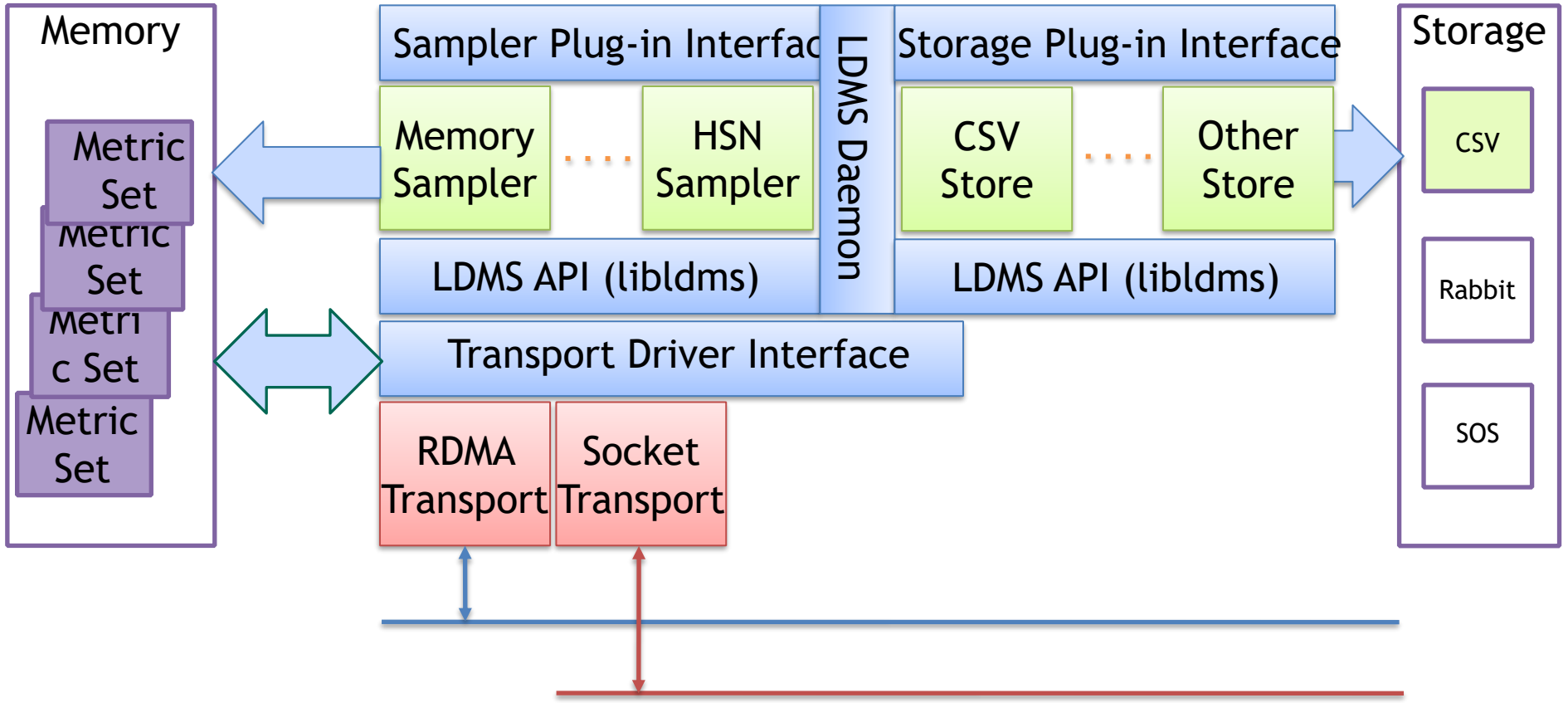


Anything is possible!

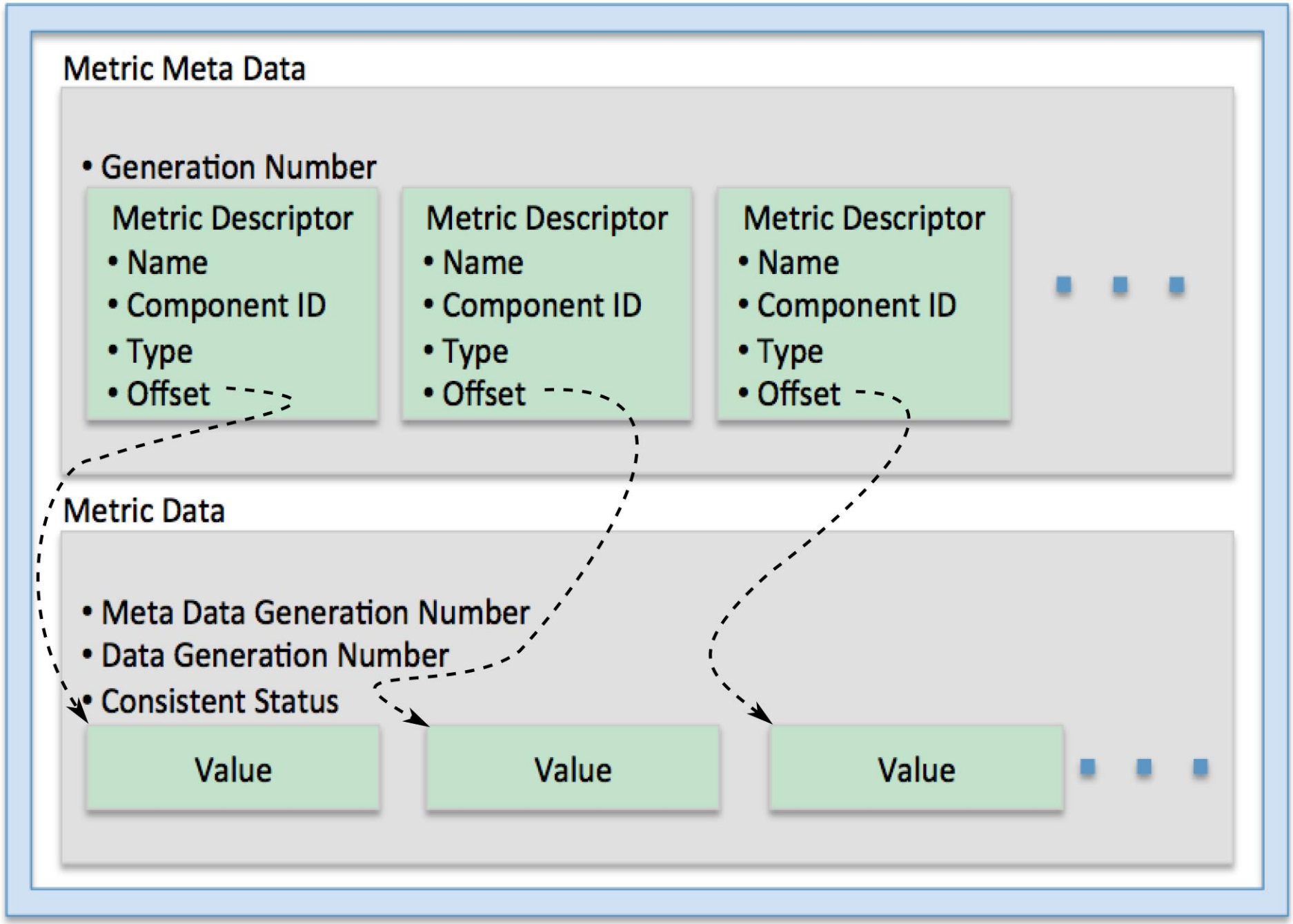
- **Not just a tree aggregation!** Arbitrary split and joins of subsets of data at aggregators for redirection (e.g., store to a database AND push to another ldmsd)
- Multiple ldmsd per host (e.g., for scale testing)
- Run sampler and store plugins on separate ldmsd within a single host (e.g., to monitor a host doing aggregation)
- Mixed metricset (pull) and event publish-subscribe (push over LDMS Streams) transport



LDMS Plugin Architecture



Metric Set Memory



- Meta-data only transferred upon initialization or change – this reduces both CPU and network burden
- Separation of data and meta-data blocks enables efficient RDMA transfer of data

Resources

Documentation (Building, Using)
- https://github.com/ovis-hpc/ovis-wiki/wiki

Source Code
- https://github.com/ovis-hpc/ovis
- git clone https://github.com/ovis-hpc/ovis.git
- git branch –a # Will show all available branches
- git branch -a | grep "\-4.3” # Will show all version 4.3 branches
- git checkout –b OVIS-4.3.<x> origin/OVIS-4.3.<x> # Will check out branch origin/OVIS-4.3.<x> under the name OVIS-4.3.<x>
- git branch # Will show currently checked out branch

Publications:
- https://ovis.ca.sandia.gov

How you can contribute
- Post an issue at: https://github.com/ovis-hpc/ovis/issues

Support
- **Bug reporting and questions:** Post an issue at: https://github.com/ovis-hpc/ovis/issues
- **Development services:** contact tom@ogc.us
- **Support services:** contact tom@ogc.us, ldms@sandia.gov

Supported platforms and networks

Linux support

- Rhel 6 - 8
- SLES 11 - 15
- Ubuntu

Vendor hardware platforms running supported software

- Cray XE6, XK and XC
- Generic Linux clusters
- IBM P8 & P9 (both big and little endian)

Transports

- Socket
- Cray ugni – Aries & Gemini
- RDMA – Infiniband, iWarp, libfabric

Build dependencies

Typical compute node environment

- Autoconf >=2.63, automake, libtool (collectively called autotools)
- OpenSSH-devel
- libpapi-devel for papi and syspapi samplers
- libpfm-devel for syspapi sampler
- libfabric-devel if applicable transport available

End use hosts (monitor cluster, special aggregation hosts, etc.)

- Python 3.x
- Doxygen for documentation
- Cython needed for SOS
  - Get from pip
- libcurl & libcurl-devel if using influx_store
- flex and bison including devel versions
- etcd if using Maestro

LDMS Installation methods

Manually build and install using autoconf and automake

Build and install RPMs

Note1: For this tutorial, LDMS is pre-installed on student VMs in /opt/ovis

Note2: We will be building and installing to local directories and will use the pre-installed software for all other exercises

Setup

Getting started: Log in and set up your environment

We will be using containers hosted at Open Grid Computing

Place the key files (e.g. user<#>_id_rsa and user<#>_id_rsa.pub) into the ~/.ssh/ directory.

Add the following entries to ~/.ssh/config

```
Host ldmscon2021
    Hostname ogc.us
    Port 65422
    User user64  # <------------------------ Change to the assigned username
    IdentityFile ~/.ssh/user64_id_rsa  # <---- Change to the assigned key file
    IdentitiesOnly yes
```

```
$ ssh ldmscon2021
```

You will want at least 2 terminal windows up for the tutorial

Directory structure

VMs include source code, scripts and configuration files for every exercise, helper mini-applications for use in the exercises

Directory structure:

/home/<user>/tutorial/exercises/ldms/	# Location of exercise related directories
/home/<user>/tutorial/exercises/ldms/conf/E*/	# Exercise configuration files
/home/<user>/tutorial/exercises/ldms/data/	# LDMS data
/home/<user>/tutorial/exercises/ldms/ env/	# Scripts to configure environment variables
/home/<user>/tutorial/exercises/ldms/scripts/E*/	# Helper scripts for deploying LDMS daemons
/home/<user>/tutorial/exercises/ldms/logs/	# Place to write log files
/home/<user>/tutorial/exercises/ldms/run/	# symlink to /tmp/run – place to write pid files

Getting started: Set up and verify your environment

Source your environment configuration file (ldms-env.sh):

```
$ source ldms-env.sh
```

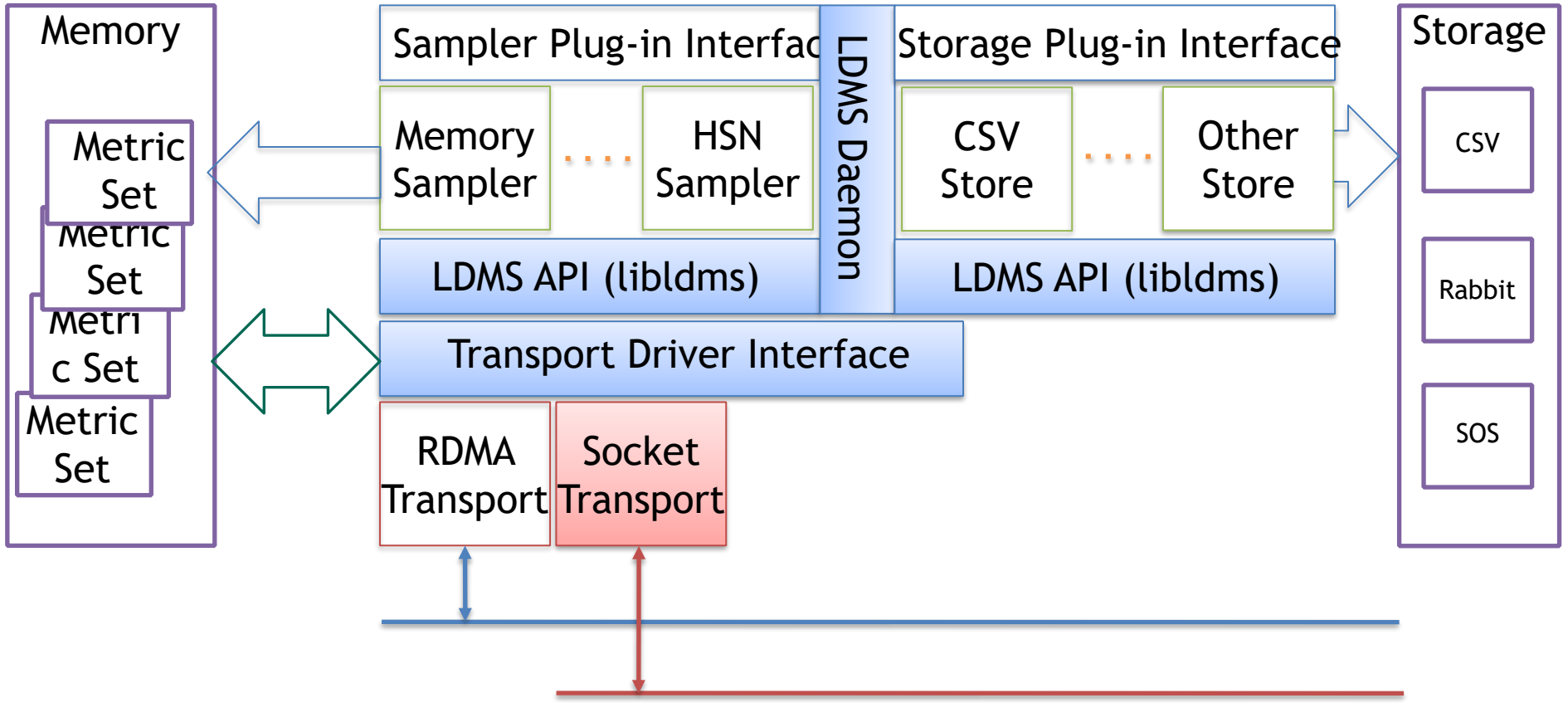
Contents of ldms-env.sh:

```
#!/bin/bash
TOP=/opt/ovis
export LD_LIBRARY_PATH=$TOP/lib64/:$LD_LIBRARY_PATH
export LDMSD_PLUGIN_LIBPATH=$TOP/lib64/ovis-ldms
export ZAP_LIBPATH=$TOP/lib64/ovis-ldms
export PYTHONPATH=$TOP/lib/python3.6/site-packages/:$PYTHONPATH
export PATH=$TOP/sbin:$TOP/bin:$PATH
```

*A live example of these commands can be found here:
Verify Environment Variables

Exercise 1: Configuring and Running Samplers

LDMS Plugin Architecture



Start and Check Status of a LDMS Daemon

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Exercise Goals:

Basic LDMS daemon startup and configuration flags/args

- Manual and run-time configuration options
- Output options
  - Log files and verbosity levels
- man pages
  - man ldmsd – displays ldmsd man pages
  - man ldmsd_controller – displays “ldmsd_controller” man pages

Use of ldms_ls utility as a diagnostic tool

- man pages
  - man ldms_ls – displays ldms_ls man pages

Start a LDMS daemon

- Start ldmsd with minimum configuration

```
$ ldmsd -x sock:10001 -l
/home/<user>/ldmscon2021/basic/exercises/ldms/logs/sampler1.log
```

-x: transport : listening port

-l: Specify the log file path and name(this is not strictly necessary)

Commands should be **written** in the command prompt window. Copy and paste may introduce non-printing characters and unexpected results

Check ldmsd Running Status

- Using ps

```
$ps auxw | grep ldmsd | grep -v grep
```

- Returns something like:

```
"ovis_pu+  3582  0.0  0.1 401604  2204 ?        Ssl  12:51   0:00 ldmsd
-x sock:10001" if running
```

- Returns: blank line if not running

- Using ldms_ls

```
$ldms_ls -h localhost -x sock -p 10001
```

- Returns: "Connection failed/rejected." if ldmsd specified does not exist or authentication fails
- Returns: blank line if the ldmsd specified exists but has no metric sets configured

- Also check network port for listener

```
$netstat -an | grep 10001 OR $ss -ln | grep 10001
```

```
tcp      0      0 0.0.0.0:10001  0.0.0.0:*    LISTEN
```

- Check out the log file. This can be used to find clues when troubleshooting.

```
$ cat /home/<user>/ldmscon2021/basic/exercises/ldms/logs/sampler1.log
```

EXAMPLE: Start and Check LDMS Daemon

Please see the Start and Check an LDMS daemon to view a video example of Exercise 1 (slides 19-22).

Manually Configure a Sampler Plugin

Exercise Goals:

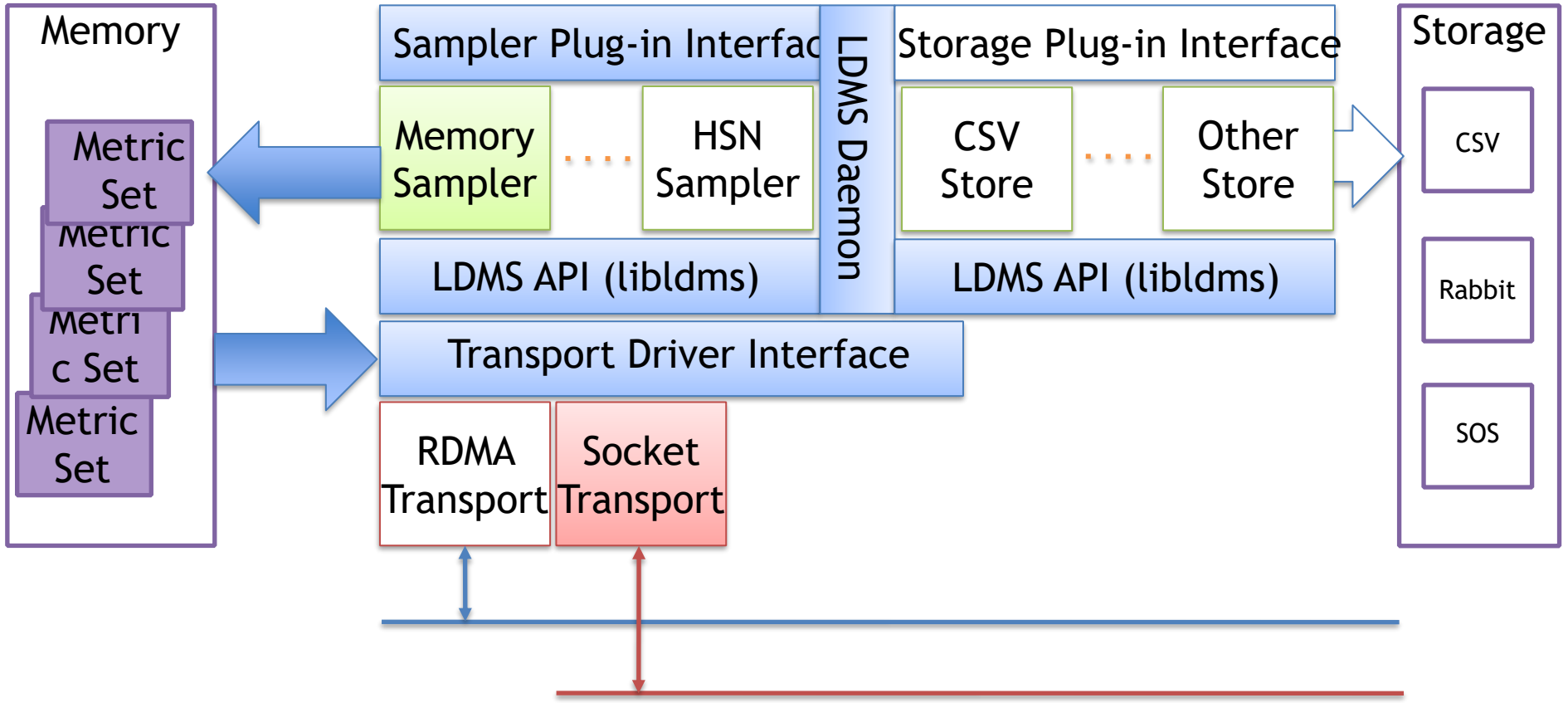
Basic sampler plugin operation

- Manual dynamic configuration using the “ldmsd_controller” utility
- Static configuration using a configuration file
- man pages
  - man Plugin_meminfo – opens meminfo plugin man pages
  - man Plugin_vmstat – opens vmstat plugin man pages

Use of ldms_ls utility as a diagnostic tool

- man pages
  - man ldms_ls – opens ldms_ls man pages

LDMS Plugin Architecture



Configuring a LDMS Daemon Sampler Plugin

Goals:

Load a sampler plugin

Configure loaded sampler plugin

- Give the set name (instance)
- Give the node name (producer)
- Give the component ID
- Plugin-specific arguments

Start sampler plugin with a particular sampling **interval** and **offset**

Interactive Configuration Using The ldmsd_controller

Connect to your ldmsd using the “ldmsd_controller” utility

```
$ldmsd_controller --host localhost --xprt sock --port 10001
```

```
Welcome to the LDMSD control processor
sock:localhost:10001> help
```

Note 1: The prompt tells you <transport>:<hostname>:<port>

Note 2: You can use “quit” or Ctrl-d to **exit** or Ctrl-c to **kill** the ldmsd_controller

*An example of running these commands can be found here: LDMSD Controller Interface Video

Load and Configure the “meminfo” Sampler Using the ldmsd_controller

- Load the “meminfo” sampler plugin:

```
sock:localhost:10001> load name=meminfo
```

- Configure the “meminfo” sampler plugin:

```
sock:localhost:10001> config name=meminfo producer=<$HOSTNAME>
instance=<$HOSTNAME>/meminfo component_id=<host number>
```

producer: By convention set to host name (can be any string). Source of the ldms data.
Instance: By convention set to producer/<sampler name> (unique string). Uniquely identifies the metric set (e.g. where and what type of data is being produced).
component_id: By convention some unique numeric identifier (any uint_64). Another unique identifier for faster comparison (e.g. number)

Query Current Sets Using “ldms_ls”

- Use ldms_ls to query the sets currently available on an LDMS daemon

```
$ldms_ls -h localhost -x sock -p 10001
```

```
node-1/meminfo
```

Get The Set Meta-Data Before Starting The "meminfo" Sampler Plugin Using -v Flag


```
$ldms_ls -h localhost -x sock -p 10001 -v node-1/meminfo
```

```
Schema          Instance                                    Flags  Msize  Dsize  UID    GID
   Perm                    Update          Duration            Info
--------------- ------------------------                    ------ ------       ------  -
----- ------   ----------              ----------------- ---------------- --------

meminfo      node-1/meminfo              L    1952     416    596  742    -
rwxrwxrwx         0.000000      0.000000       "updt_hint_us"="1000000:0"

--------------- ------------------------                     ------ ------     ------  -
-----  ------   ----------              ----------------- ---------------- --------

Total Sets: 1, Meta Data (kB): 1.95, Data (kB) 0.42, Memory (kB): 2.37
```

NOTE: The "node-1/meminfo" is optional. Leaving it off will display the meta-data for all metric sets resident on this LDMS daemon.

EXAMPLE: Interactive Configuration Using The ldmsd_controller

Please see Configuration Using LDMSD Controller Interface to view a video example of Exercise 1 (slides 24-30).

Query Current Metric Values Before Starting The "meminfo" Sampler Plugin using -l flag


```
$ldms_ls -x sock -p 10001 -l node-1/meminfo
```

```
ovis-demo-01/meminfo: inconsistent, last update: Wed Dec 31 17:00:00 1969 -0700 [0us]
M u64        component_id                 62
D u64        job_id                       0
D u64        app_id                       0
D u64        MemTotal                     0
D u64        MemFree                      0
D u64        MemAvailable                 0
D u64        Buffers                      0
D u64        Cached                       0
D u64        SwapCached                   0
D u64        Active                       0
D u64        Inactive                     0
D u64        Active(anon)                 0
D u64        Inactive(anon)               0
```

- *Set is "inconsistent"*
- *Values have not yet been collected*

NOTE: The "ovis-demo-01/meminfo" is optional. Leaving it off will display the data for all metric sets resident on this LDMS daemon.

Start The “meminfo” Sampler Plugin Using the ldmsd_controller

- Start the “meminfo” sampler with a 1 second (1,000,000us) interval

```
sock:localhost:10001> start name=meminfo interval=1000000 offset=0
```

- This starts the sampler updating the metric values every 1,000,000 micro-seconds = 1 second

Note 1: “interval” defines the number of micro-seconds between successive samples

Note 2: “offset” defines micro-seconds after the second

Query Current Metric Values After Starting The "meminfo" Sampler Plugin

```
$ ldms_ls -x sock -p 10001 -l node-1/meminfo
```

ovis-demo-01/meminfo: consistent, last update: Tue Oct 08 17:52:45 2019 -0600 [2058us]

M u64	component_id	62
D u64	job_id	0
D u64	app_id	0
D u64	MemTotal	131899768
D u64	MemFree	129843340
D u64	MemAvailable	129364708
D u64	Buffers	20076
D u64	Cached	458024
D u64	SwapCached	0
D u64	Active	184380
D u64	Inactive	393140
D u64	Active(anon)	125324
D u64	Inactive(anon)	284684

- *Set is "consistent"*
- *Values are being collected*

Check Source (/proc/meminfo) For Reference


```
$cat /proc/meminfo
```

MemTotal:	131899768 kB
MemFree:	129828892 kB
MemAvailable:	129350280 kB
Buffers:	20076 kB
Cached:	458076 kB
SwapCached:	0 kB
Active:	184380 kB
Inactive:	393064 kB
Active(anon):	125324 kB
Inactive(anon):	284680 kB
Active(file):	59128 kB

EXAMPLE: “meminfo” Sampler Plugin

Please see Meminfo Sampler Daemon to view a video example of Exercise 1 (slides 32-35).

Change The Sampling Interval

- Using ldmsd_controller, stop the plugin:

```
sock:localhost:10001> stop name=meminfo
```

Note: Querying with ldms_ls will show that the sampler is not updating

Note: We are still using the same sampler daemon from earlier. It should not be killed yet.

- Restart the plugin with a different (5 sec) interval:

```
sock:localhost:10001> start name=meminfo interval=5000000 offset=0
```

Note: Querying with ldms_ls will show that the metric set is now updating only every five seconds

(More on dynamic configuration and resilience in Exercise 3)

EXAMPLE: Change Sample Interval

Please see Change Sample Interval for Meminfo to view a video example of Exercise 1 (slide 37).

Kill Currently Running Daemons

- Kill all of your ldmsd in preparation for the next section

```
$killall ldmsd
```

- Kill a particular ldmsd

```
$ps auxw | grep ldmsd | grep -v grep
ovis_pu+  3582  0.0  0.1 401604  2204 ?        Ssl  12:51   0:00 ldmsd -x
sock:10001 -S samplerd.sock
$kill 3582
```

- Check to make sure it is dead

```
$ps auxw | grep ldmsd | grep -v grep
```

Start a ldmsd and Configure a Sampler Plugin Using a Configuration File

- Syntax is identical to that used for manual configuration
- Examine the sample configuration file for the meminfo example:

```
$cat ~/ldmscon2021/basic/…/conf/E1/simple_sampler.conf
```

- Alternatively create this file with the content shown below and filling in appropriate information for <>:

```
load name=meminfo
config name=meminfo producer=<$HOSTNAME> instance=<$HOSTNAME>/meminfo
component_id=<host number>
start name=meminfo interval=1000000 offset=0
```

- Run an ldmsd using this configuration file (argument after the –c flag). Modify <user> to your user name.

```
$ldmsd -x sock:10001
-l /home/<user>/…/logs/sampler1.log
-c /home/<user>/…/conf/E1/simple_sampler.conf
```

Query The Metric Values: The "meminfo" Sampler Is Configured And Running

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```
$ ldms_ls -x sock -p 10001 -l node-1/meminfo
```

node-1/meminfo: consistent, last update: Tue Oct 08 17:52:45 2019 -0600 [2058us]

M u64	component_id	62
D u64	job_id	0
D u64	app_id	0
D u64	MemTotal	131899768
D u64	MemFree	129843340
D u64	MemAvailable	129364708
D u64	Buffers	20076
D u64	Cached	458024
D u64	SwapCached	0
D u64	Active	184380
D u64	Inactive	393140
D u64	Active(anon)	125324
D u64	Inactive(anon)	284684

- *Set is "consistent"*
- *Values are being collected*

Multiple Sampler Plugins Running on a Single ldmsd

- Edit and uncomment the lines for the vmstat plugin in simple_sampler.conf then kill and restart your ldmsd using -c.
- Alternatively modify your previously created file with the additional contents:

```
load name=vmstat
config name=vmstat producer=<hostname> instance=<hostname>/vmstat
component_id=<hostnum>
start name=vmstat interval=1000000 offset=0
```

- Query the ldmsd using ldms_ls:

```
$ldms_ls -h localhost -x sock -p 10001
node-1/vmstat
node-1/meminfo
```

EXAMPLE: Multiple Sampler Plugins

Please see Multiple Plugin Sampler Daemon to view a video example of Exercise 1 (slides 39-42).

Configuration Methods Summary

- Dynamic/manual configuration using ldmsd_controller
  - ldmsd_controller is a Python script that can connect to a ldmsd via a configured network socket (supports command completion)
- Static configuration via configuration file
  - Configuration file – loaded at ldmsd run time

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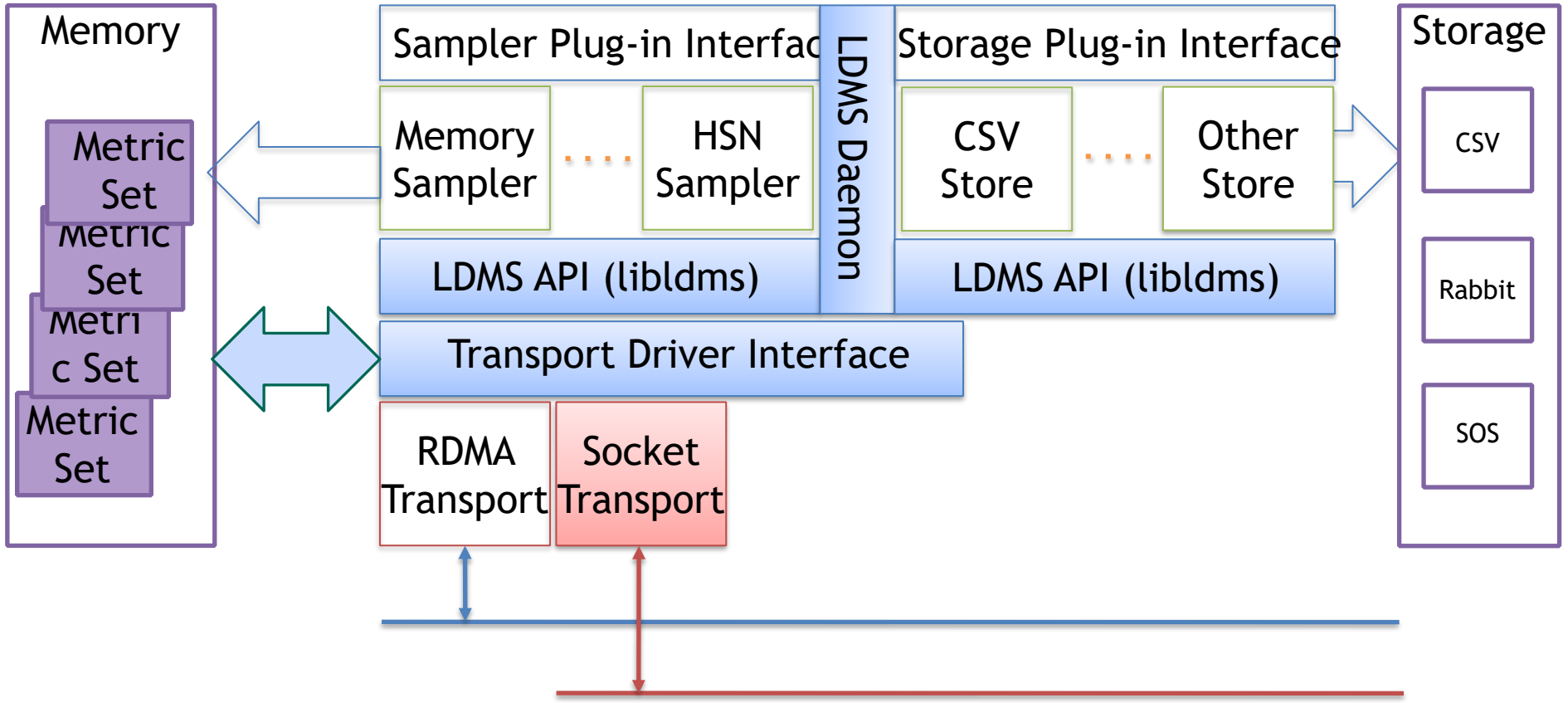
Exercise 2: Configure LDMS Aggregators

LDMS Plugin Architecture



Configure a LDMS Daemon (ldmsd) to Aggregate Metric Set(s)

Goals:

- Add list of connections to a ldmsd (connections to sampler ldmsd(s))
- Start the connections
- Create an “update policy”
  - Define an “update policy” update period and offset
  - Define which sets an update policy refers to (or all)
- Start the “update policy”

Start a ldmsd That Will Be Used For Aggregation

- (Re)start the sampler ldmsd from the previous exercise (can keep both meminfo and vmstat) using a configuration file
- Start a new aggregator ldmsd with minimum configuration:

```
$ldmsd -x sock:20001 -l ~/ldmscon2021/basic/exercises/ldms/logs/agg1.log
```

-x: Transport **:** listening port

-l: Specify the log file path and name (this is not strictly necessary)

NOTE: We are using **10001** for our sampler and port **20001** for our aggregator.

Interactive Aggregator Configuration Using the ldmsd_controller

- Set up “ldmsd_controller” connection to the aggregator over socket

```
$ldmsd_controller --host localhost --port 20001
Welcome to the LDMSD control processor
sock:localhost:20002>
```

Simple Aggregator Producer Configuration

- Configure the aggregator to aggregate from your sampler daemon (listening on port 10001)

```
sock:localhost:20001> prdcr_add name=prdcr1 host=$HOSTNAME port=10001
xprt=sock type=active interval=20000000
sock:localhost:20001> prdcr_start name=prdcr1
```

name: policy tag (this is just a string)

host: hostname of the sampler daemon that this aggregator is connecting to (e.g., node-1)

port: Port the sampler daemon listens on

xprt: Transport the sampler daemon listens on

type: Choose “active” (aggregator will initiate the connection with the sampler)

interval: Re-connect interval (set to 20 seconds) (*This is **NOT the update interval**)*

Check Aggregator Status

(**after producer** (prdcr) is started but **before** the **updater** (updtr) is started)

```
sock:localhost:20001> status
```

```
Name        Type        Interval    Offset      Libpath
----------- ----------- ----------- ----------- -----------
Name            Host            Port        Transport   State
--------------- --------------- ----------- ----------- -----------
prdcr1          node-1      10001       sock        CONNECTED
  node-1/meminfo meminfo
  node-1/vmstat  vmstat
Name            Interval    Offset      Mode            State
--------------- ----------- ----------- --------------- -----------
Name            Container       Schema          Plugin          State
--------------- --------------- --------------- --------------- -----------
```

Query Current Metric Values On The Aggregator


```
$ldms_ls -h localhost -x sock -p 20001 -l


$
```

Note: While status (previous slide) shows that the aggregator knows what sets the producer has, the ldms_ls query returns nothing because there is no update policy associated with the connected prdcr and the sets have not yet been created and populated with data at the aggregator.

EXAMPLE: Simple Aggregator Producer Configuration

Please see the simple Aggregator Producer Configuration to view a video example of Exercise 2 (slides 48-52).

Configure and Start Aggregator Updater Policy

- Configure the aggregator to update the “meminfo” set

```
sock:localhost:20001> updtr_add name=updtr1 interval=1000000 offset=200000
sock:localhost:20001> updtr_prdcr_add name=updtr1 regex=.*
sock:localhost:20001> updtr_start name=updtr1
```

name: policy tag (string)

interval: update (pull) interval (in usec)

- Example: interval=1000000 means pull data from associated prdcr every 1 seconds

offset: Target (in us) from <epoc sec>.000000

- Example: offset=200000 means aggregate every <interval> seconds at 200ms into the second.
  - To prevent pulling when sampler is updating.

regex: regular expression to match the target producers tag(s)

- prdcr1 in this case (see slide 50)

Check Aggregator Status

(**after** starting **both** producer (prdcr) and updater (updtr) policies)


```
sock:localhost:20001> status
```

```
Name        Type        Interval    Offset      Libpath
----------- ----------- ----------- ----------- -----------
Name            Host            Port        Transport   State
--------------- --------------- ----------- ----------- -----------
prdcr1          node-1          10001       sock        CONNECTED
   node-1/meminfo meminfo         READY
   node-1/vmstat  vmstat          READY
Name            Interval    Offset      Mode            State
--------------- ----------- ----------- --------------- -----------
updtr1          1000000     0           Pull            RUNNING
   prdcr1          node-1                 10001 sock        CONNECTED
Name            Container       Schema          Plugin          State
--------------- --------------- --------------- --------------- -----------
```

Query Current Metric Values On The Aggregator


```
$ldms_ls -h localhost -x sock -p 20001 -l node-1/meminfo
```

node-1/meminfo: consistent, last update: Wed Oct 09 18:30:49 2021 -0600 [2093us]

M u64	component_id	62
D u64	job_id	0
D u64	app_id	0
D u64	MemTotal	131899768
D u64	MemFree	129834752
D u64	MemAvailable	129356628
D u64	Buffers	20228
D u64	Cached	458892
D u64	SwapCached	0
D u64	Active	196708
D u64	Inactive	393768
D u64	Active(anon)	137336

EXAMPLE: Simple Aggregator Updater Configuration

Please see Aggregator Updater Configuration to view a video example of Exercise 2 (slides 54-56).

Start Aggregator ldmsd Using a Configuration File

- A ldmsd for performing aggregation can also be started using a configuration file in the same manner as a ldmsd for sampling (see slide 40)
- Configuration file syntax is identical to that used for manual configuration
- Check out your sample configuration file:

```
$cat ~/ldmscon2021/basic/exercises/ldms/conf/E2/simple_agg.conf
```

Alternatively create a conf file in this directory and populate it with the contents below:

```
prdcr_add name=prdcr1 host=$HOSTNAME port=10001 xprt=sock type=active interval=20000000
prdcr_start name=prdcr1
updtr_add name=updtr1 interval=1000000 offset=200000
updtr_prdcr_add name=updtr1 regex=.*
updtr_start name=update_all
```

- Kill your aggregator ldmsd and restart it using this configuration file

```
$ldmsd -x sock:20001 -l ~/ldmscon2021/basic/exercises/ldms/logs/aggd.log
-c ~/ldmscon2021/basic/exercises/ldms/conf/E2/simple_agg.conf
```

Query Current Metric Values On The Aggregator


```
$ldms_ls -x sock -p 20001 -l ovis-demo-01/meminfo
```

Ovis-demo-01/meminfo: consistent, last update: Wed Oct 09 18:30:49 2019 -0600 [2093us]

M u64	component_id	62
D u64	job_id	0
D u64	app_id	0
D u64	MemTotal	131899768
D u64	MemFree	129834752
D u64	MemAvailable	129356628
D u64	Buffers	20228
D u64	Cached	458892
D u64	SwapCached	0
D u64	Active	196708
D u64	Inactive	393768

EXAMPLE: Simple Aggregator with Configuration File

Please see Aggregator With Configuration File to view a video example of Exercise 2 (slides 58-59).

Exercise 3: Aggregating From Remote Hosts: Building a Distributed Monitoring System

Aggregate From Other Student Samplers

- Kill your current aggregator ldmsd
- Edit /home/<user>/exercises/ldms/conf/E3/agg.conf: Remove # for nodes you want to aggregate from

```
$cat /home/<user>/exercises/ldms/conf/E3/agg.conf
```

```
prdcr_add name=prdcr1 type=active host=node-1 port=10001 xprt=sock interval=20000000
#prdcr_add name=prdcr2 type=active host=node-2 port=10001 xprt=sock interval=20000000
#prdcr_add name=prdcr3 type=active host=node-64 port=10001 xprt=sock interval=20000000

prdcr_start_regex regex=.*                          # START (connect to) ALL PRODUCERS

updtr_add name=updtr1 interval=1000000 offset=200000    # UPDATE AT 1 SECOND INTERVALS
updtr_prdcr_add name=updtr1 regex=.*                        # DO THIS ON ALL PRODUCERS
updtr_match_add name=updtr1 match=schema regex=meminfo      # RESTRICT TO SETS WITH schema=meminfo
updtr_start name=updtr1                             # START UPDATER with POLICY "updtr1"

updtr_add name=updtr2 interval=2000000 offset=200000    # UPDATE AT 2 SECOND INTERVALS
updtr_prdcr_add name=updtr2 regex=.*                        # DO THIS ON ALL PRODUCERS
updtr_match_add name=updtr2 match=schema regex=vmstat       # RESTRICT TO SETS WITH schema=vmstat
updtr_start name=updtr2                             # START UPDATER with POLICY "updtr2"
```

Aggregate From Other Student Samplers (cont'd)

- Restart ldmsd using your edited configuration file

```
$ldmsd -x sock:20001 -l /home/<user>/exercises/ldms/log/aggd.log
-c /home/<user>/exercises/ldms/conf/E3/agg.conf
```

Alternatively create this file by copying the content from the previous slide at the end of the file.

LDMS supports complex topologies:

- Multiple ldmsd (aggregators) can pull from the same ldmsd (sampler or aggregator)
- Can daisy chain aggregators
  - Hierarchical
  - Support both fan-in and fan-out topologies

Check Aggregator Status


```
sock:localhost:20001> status
Name       Type       Interval   Offset     Libpath
---------- ---------- ---------- ---------- ----------
Name         Host         Port       Transport   State
------------ ------------ ---------- ---------- ----------
prdcr1       node-1       10001      sock        CONNECTED
  node-1/meminfo meminfo                        READY
  node-1/vmstat  vmstat                         READY
prdcr2       node-2       10001      sock        CONNECTED
  node-2/meminfo meminfo                        READY
  node-2/vmstat  vmstat                         READY
prdcr3       node-3       10001      sock        DISCONNECTED
Name         Interval   Offset     Mode         State
------------ ---------- ---------- ------------ ----------
updtr1       1000000    200000     Pull         RUNNING
  prdcr1       node-1           10001 sock      CONNECTED
  prdcr2       node-2           10001 sock      CONNECTED
  prdcr3       node-3           10001 sock      DISCONNECTED
Name         Container      Schema         Plugin         State
------------ ---------- ---------- ---------- ----------
```

EXAMPLE: Aggregate From Other Student Samplers

Please see Aggregate From Multiple VMs to view a similar video example of Exercise 3.

Exercise 4: Basic Dynamic Configurations and Resilience

Basic Dynamic Configuration Changes

Exercise Goals:

- Explore dynamic configuration options
  - Sampler daemons (from Exercise 1 - slide 37)
    - Stopping sampler plugins
    - Starting sampler plugins with different intervals
  - Aggregator daemons
    - Automatic detection of new metric sets on connected sampler ldmsd
    - Stopping producer (prdcr) and updater (updtr) policies
    - Changing updater intervals

Dynamically Changing a Sampler Plugin's Interval Parameters (Exercise 1 - slide 37)

- Using ldmsd_controller, stop the plugin:

```
sock:localhost:10001> stop name=meminfo
```

Note: Querying with ldms_ls will show that the sampler has stopped

- Restart the plugin with a different interval:

```
sock:localhost:10001> start name=meminfo interval=5000000 offset=0
```

Note: Querying with ldms_ls will show that the metric set is now updating only every five seconds

Dynamic Changes and Aggregator Robustness

On-the-fly changes in samplers will be discovered by the aggregating ldmsd

- **Exercise** – one student will add the vmstat sampler, using ldmsd_controller, to their running sampler ldmsd.
  - All others will see it, using ldms_ls, appear in their aggregators which are pulling from that sampler.
- **Exercise** – one student will first stop their meminfo sampler, using ldmsd_controller, on their running sampler ldmsd and then remove (term) their meminfo sampler
  - All others will see, using ldms_ls, that the timestamp in that student's metric set ceases to update
  - Upon removal all other students will see that metric set disappear from their list of metric sets
- **Exercise** – the same student will restart their meminfo sampler, using ldmsd_controller, on their running ldmsd.
  - All others will see, using ldms_ls, that the timestamp in that student's metric set resumes updating.

Note: updtr policies may preclude updating new metric sets e.g., match=schema regex=vmstat would not match a new schema "foo"

Dynamic Changes and Robustness (cont'd)

Samplers and Aggregators can be started in any order

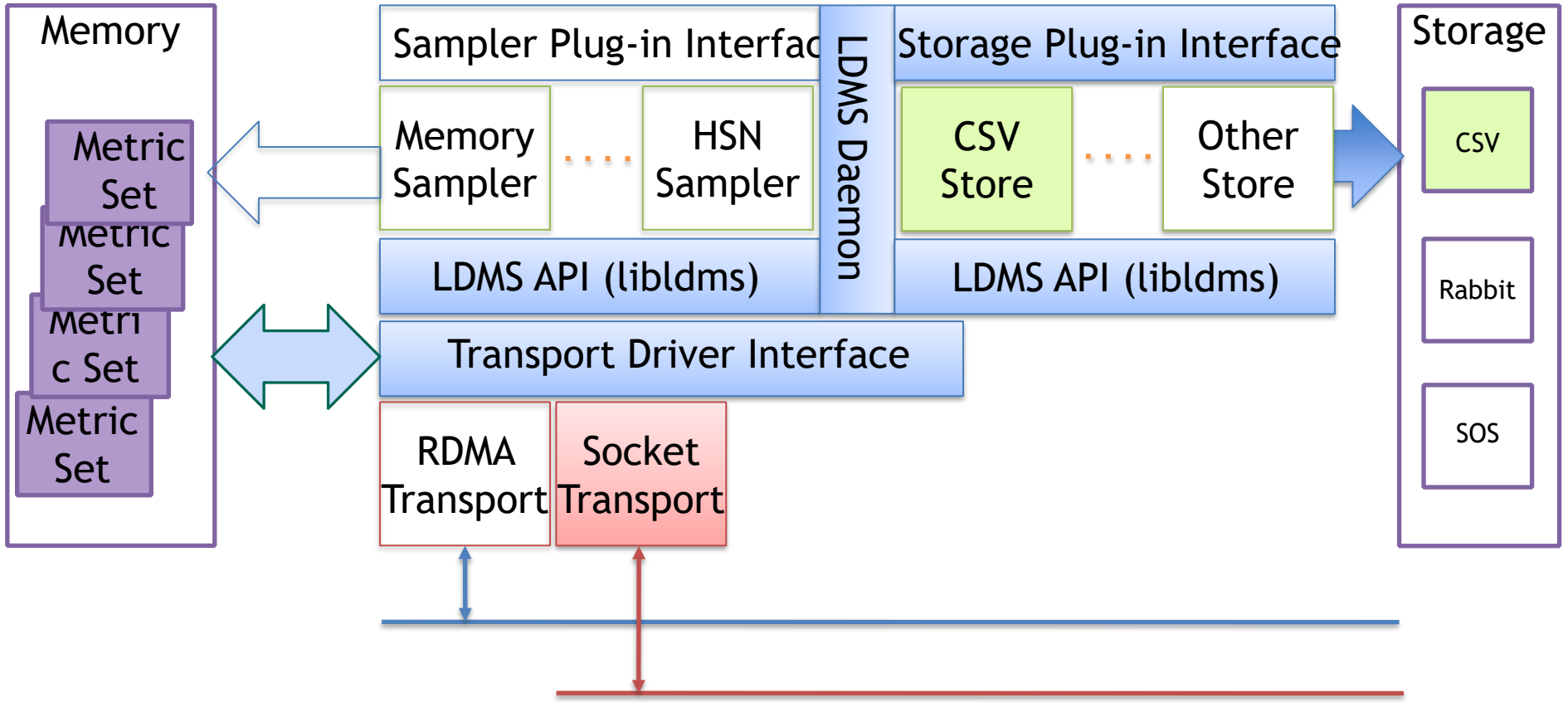
- **Exercise** – Use your modified configuration files to start the aggregator ldmsd before starting the sampler ldmsd
  - Use ldms_ls to convince yourself that, whether a sampler ldmsd is started before or after an aggregator ldmsd, you are able to see the data generated at the sampler ldmsd on the aggregator ldmsd when both are running

LDMS collection and transport are robust to Samplers and Aggregators being killed and restarted

- **Exercise** – one student will kill their sampler ldmsd. All other students will see from ldms_ls timestamp that the student's metric set is removed from the list.
- **Exercise** – the same student will restart their sampler ldmsd. All other students will see from ldms_ls timestamp that the metric set reappears and resumes updating (after up to the producer reconnect interval of 20 seconds).
- **Exercise** – Each student will stop and re-start their aggregator ldmsd and verify, using ldms_ls, that they are able to see appropriate data.

Exercise 5: Storing Data In CSV Format

LDMS Plugin Architecture



Storing Data: CSV Store Plugin

Goals:

- Configure an aggregator ldmsd with a CSV store plugin using ldmsd_controller
- Configure an aggregator ldmsd with a CSV store plugin using a configuration file
- Minimal store options (don't buffer data)
- **Note:** The scripts/E1 – E5 directories contain scripts to start ldmsd using associated configuration files

Example output from the "meminfo" sampler:

#Time,Time_usec,ProducerName,component_id,job_id,MemTotal,MemFree,MemAvailable,Buffers,Cached,SwapCached,Active,Inactive,Active(anon),Inactive(anon),Active(file),Inactive(file),Unevictable,Mlocked,SwapTotal,SwapFree,Dirty,Writeback,AnonPages,Mapped,Shmem,Slab,SReclaimable,SUnreclaim,KernelStack,PageTables,NFS_Unstable,Bounce,WritebackTmp,CommitLimit,Committed_AS,VmallocTotal,VmallocUsed,VmallocChunk,HardwareCorrupted,AnonHugePages,HugePages_Total,HugePages_Free,HugePages_Rsvd,HugePages_Surp,Hugepagesize,DirectMap4k,DirectMap2M

1487105964.002482,2482,node-3,3,
0,1884188,571028,1688632,0,1212004,6108,104536,1122496,8276,8580,96260,1113916,0,0,839676,793956,420,0,10552,24812,1796,52124,40104,12020,1792,3280,0,0,0,1781768,387984,34359738367,7216,34359728128,0,2048,0,0,0,0,2048,47040,2050048

1487105963.002583,2583,node-10,10,
0,1884188,1665280,1671132,948,107512,0,71540,80920,44128,8308,27412,72612,0,0,839676,839676,0,0,44000,22264,8436,35680,24304,11376,1600,2940,0,0,0,1781768,296444,34359738367,7216,34359728128,0,6144,0,0,0,0,2048,34752,2062336

1487105963.001964,1964,node-12,12,
0,1884188,1623168,1644996,948,129700,0,89312,101956,60788,8332,28524,93624,0,0,839676,839676,0,0,60620,23912,8500,36456,24608,11848,1872,4364,0,0,0,1781768,403252,34359738367,7216,34359728128,0,16384,0,0,0,0,2048,44992,2052096

CSV Store: Manual Aggregator Configuration

- Configure the aggregator to **store** the "meminfo" set to a **CSV** file using ldmsd_controller
  - Create a directory for the CSV data
  - Load the store_csv plugin
  - Configure the plugin

```
$ldmsd_controller --host localhost --port 20001
```

```
sock:localhost:20001> load name=store_csv
sock:localhost:20001> config name=store_csv \
path=/home/user1/ldmscon2021/basic/exercises/ldms/data/ buffer=0
```

name: plugin name

path: Path to the base directory for the csv file container. This directory must exist prior to loading this configuration or daemon will throw an error and terminate.

buffer: '0' to disable buffering # USE WITH CAUTION as this will limit performance as scale increases!

man page:

```
$man Plugin_store_csv
```

opens store_csv plugin man pages

CSV Store: Cont.

- Check status

```
sock:localhost:20001> status
Name       Type       Interval    Offset      Libpath
---------- ---------- ----------- ----------- ----------
csv        store          1000000           0 /opt/ovis/lib64/ovis-ldms/libstore_csv.so
Name          Host          Port       Transport    State
------------- ------------- ---------- ---------- ----------
prdcr1        node-1           10001 sock       CONNECTED
  node-1/meminfo  meminfo       READY
  node-1/vmstat   vmstat        READY
Name          Interval:Offset  Auto   Mode         State
------------- ---------------- ------ ------------ ----------
updtr1        1.0s:200.0ms     false  Pull         RUNNING
  prdcr1        node-1           10001 sock       CONNECTED
Name          Container      Schema         Plugin         flush(sec)      State
------------- -------------- -------------- -------------- ----------- ----------
```

CSV Store: Cont.

- Configure the aggregator to **store** the “meminfo” set to a csv file.

```
sock:localhost:20001> strgp_add name=meminfo-store_csv plugin=store_csv
container=memory_metrics schema=meminfo
```

name: storage policy tag

plugin: store plugin used for storing metric set data

container: the storage backend container name. For csv, this is the directory where the output file will go. This will be created.

schema: metric set schema to be stored

CSV Store: Cont.

- Check status

```
sock:localhost:20001> status
```

```
Name       Type       Interval    Offset      Libpath
---------- ---------- ----------- ----------- ----------
csv        store          1000000           0 /opt/ovis/lib64/ovis-ldms/libstore_csv.so
Name           Host           Port       Transport    State
-------------- -------------- ---------- ---------- ----------
prdcr1         node-1              10001 sock       CONNECTED
  node-1/meminfo  meminfo        READY
  node-1/vmstat   vmstat         READY
Name           Interval:Offset  Auto   Mode         State
-------------- ---------------- ------ ------------ ----------
updtr1         1.0s:200.0ms     false  Pull         RUNNING
  prdcr1         node-1              10001 sock       CONNECTED
Name           Container      Schema         Plugin         flush(sec)      State
-------------- -------------- -------------- -------------- ----------- ----------------
meminfo-store_csv memory_metrics   meminfo        store_csv      0.000000        STOPPED
  producers:
  metrics:
```

CSV Store: Continued

- Start meminfo-store_csv policy

```
sock:localhost:20001> strgp_start name=meminfo-store_csv
```

name: storage policy tag

CSV Store: Cont.

- Check status

```
sock:localhost:20001> status
```

```
Name       Type       Interval    Offset      Libpath
---------- ---------- ----------- ----------- ----------
csv        store          1000000           0 /opt/ovis/lib64/ovis-ldms/libstore_csv.so
Name           Host           Port       Transport    State
-------------- -------------- ---------- ---------- ----------
prdcr1         node-1             10001 sock       CONNECTED
  node-1/meminfo  meminfo        READY
  node-1/vmstat   vmstat         READY
Name           Interval:Offset  Auto   Mode         State
-------------- ---------------- ------ ------------ ----------
updtr1         1.0s:200.0ms     false  Pull         RUNNING
  prdcr1         node-1             10001 sock       CONNECTED
Name           Container      Schema         Plugin         flush(sec)      State
-------------- -------------- -------------- -------------- ----------- ----------
meminfo-store_csv memory_metrics   meminfo        store_csv      0.000000        RUNNING
  producers:
  metrics: component_id job_id app_id MemTotal MemFree MemAvailable Buffers Cached SwapCached Active …
```

Examining The CSV File

- **Exercise:** Check the CSV file

```
$head /home/user1/ldmscon2021/basic/exercises/ldms/data/memory_metrics/meminfo
$tail -f /home/user1/ldmscon2021/basic/exercises/ldms/data/memory_metrics/meminfo
```

- If aggregating from others' vm's, you will see multiple hosts in the output

EXAMPLE: CSV Store - Manual Aggregator Configuration

Please see Manual CSV Store to view a video example of Exercise 5 (slides 74-80).

CSV Store: Start and Configure Aggregator Using a Configuration File

- View store relevant part of configuration file at:
  /home/<user>/ldmscon2021/basic/exercises/ldms/conf/E5/agg_store_csv.conf

```
load name=store_csv
config name=store_csv path=/home/user1/ldmscon2021/basic/exercises/ldms/data
buffer=0


strgp_add name=meminfo-store_csv plugin=store_csv container=memory_metrics
schema=meminfo
strgp_start name=meminfo-store_csv


strgp_add name=vmstat-store_csv plugin=store_csv container=memory_metrics
schema=vmstat
strgp_start name=vmstat-store_csv
```

- **Note** that this configuration file also stores the **vmstat metric set** in memory_metrics
- Restart your aggregator using:
  /home/<user>/ldmscon2021/basic/exercises/ldms/conf/E5/agg_store_csv.conf
- "tail –f" each of meminfo and vmstat to see metrics being stored

EXAMPLE: CSV Store - Start and Configure Aggregator Using a Configuration File

Please see CSV Store Using Configuration File to view a video example of Exercise 5 (slide 82).

Basics End