Secure Multiparty Computation Sprint 4

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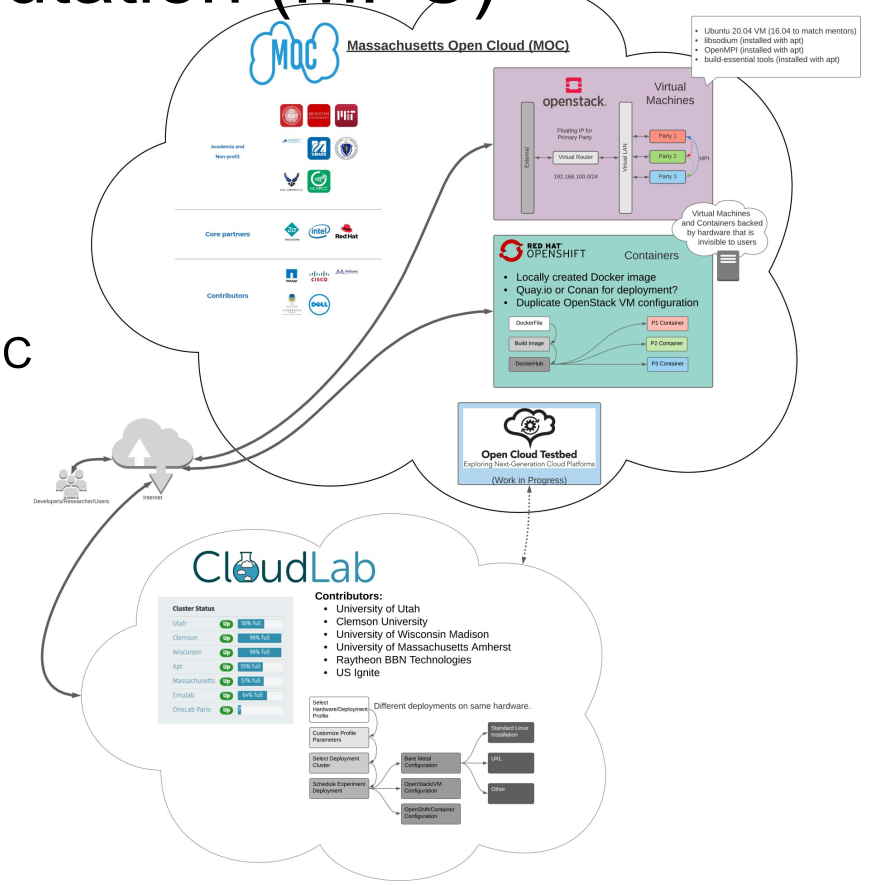
Presentation Outline

- Project Recap
- Project Goals & Sprint 4 Stories/Tasks
- Work Accomplished & Information Learned
  - Bare-Metal → CloudLab Testing
  - Containers → Docker/OpenShift
- Project Organization Assessment (Burndown)
- Sprint 5 goals (Mentor priorities)

Recap of Multi-Party Computation (MPC)

- MPC enables...
  - Shared Computation on Private Data
  - Protects the Privacy of Data
  - Mutually Agreed Computation
- Our mentors…
  - Are using three party Secret Sharing MPC
  - Perform Relational Queries with MPC
  - Keep all parts secure vs. splitting into secure and insecure steps
- Our mission…
  - Profile this new MPC library
  - Identify bottlenecks
  - Compare deployment scenarios and find the best performance


Massachusetts Open Cloud (MOC)
Academia and Non-profit
Core partners
Contributors
openstack.
Virtual Machines
External
Floating IP for Primary Party
Virtual Router
192.168.100.0/24
Virtual LAN
Party 1
Party 2
Party 3
MPI
Virtual Machines and Containers backed by hardware that is invisible to users
RED HAT OPENSHIFT
Containers
DockerFile
Build Image
DockerHub
P1 Container
P2 Container
P3 Container
Open Cloud Testbed
Exploring Next-Generation Cloud Platforms
(Work in Progress)
Developers/Researcher/Users
Internet
CloudLab
Select Hardware/Deployment Profile
Customize Profile Parameters
Select Deployment Cluster
Schedule Experiment Deployment
Bare Metal Configuration
OpenStack/VM Configuration
OpenShift/Container Configuration
Standard Linux Installation
UKL
Other

- Ubuntu 20.04 VM (16.04 to match mentors)
- libsodium (installed with apt)
- OpenMPI (installed with apt)
- build-essential tools (installed with apt)

- Locally created Docker image
- Quay.io or Conan for deployment?
- Duplicate OpenStack VM configuration

Cluster Status

Utah	Up	58% full
Clemson	Up	96% full
Wisconsin	Up	96% full
Apt	Up	55% full
Massachusetts	Up	57% full
Emulab	Up	64% full
OneLab Paris	Up	7

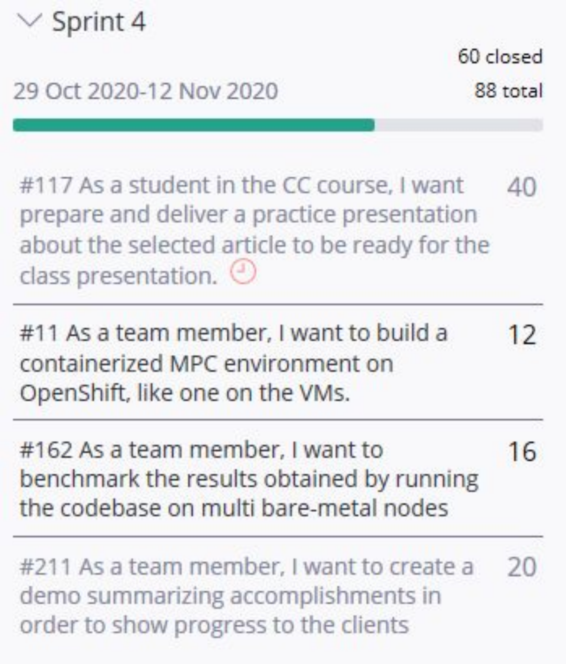
Contributors:

- University of Utah
- Clemson University
- University of Wisconsin Madison
- University of Massachusetts Amherst
- Raytheon BBN Technologies
- US Ignite

Different deployments on same hardware.

Project Goals & Sprint 4 Stories/Tasks

- Presentation
  - Finalize SmartNIC presentation
- CloudLab
  - Geni-lib automation
  - Bare metal testing
- Containers
  - Debug OpenMPI on Docker
  - Docker/Docker-compose work
  - Status with OpenShift (kompose)



Sprint 4

29 Oct 2020-12 Nov 2020 — 60 closed, 88 total

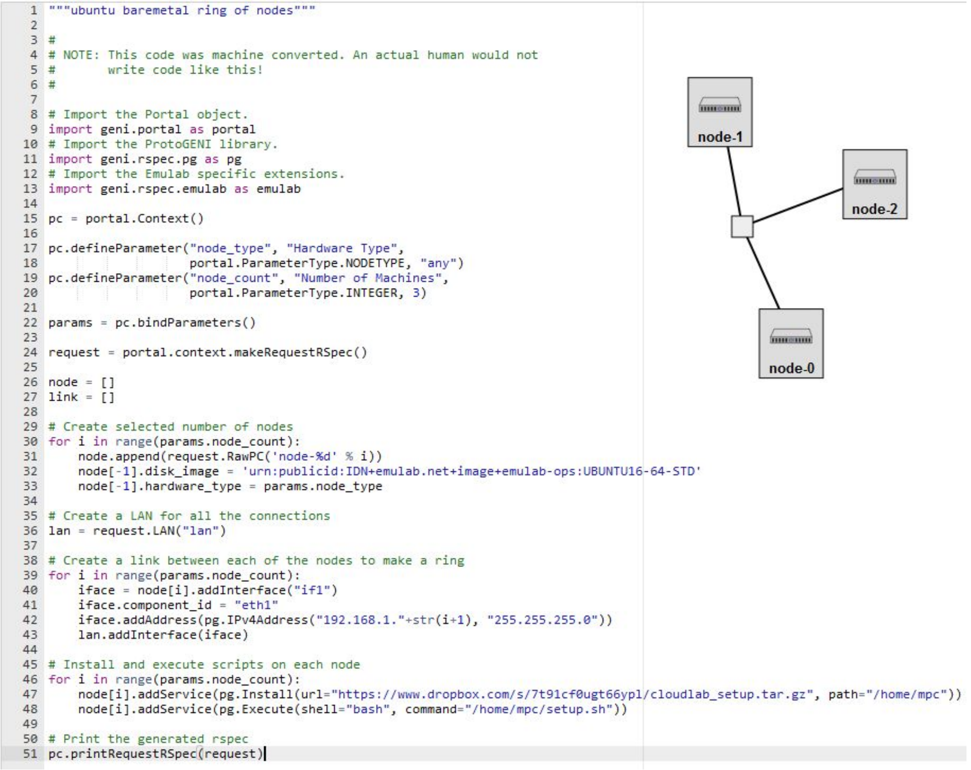
#117 As a student in the CC course, I want prepare and deliver a practice presentation about the selected article to be ready for the class presentation.	40
#11 As a team member, I want to build a containerized MPC environment on OpenShift, like one on the VMs.	12
#162 As a team member, I want to benchmark the results obtained by running the codebase on multi bare-metal nodes	16
#211 As a team member, I want to create a demo summarizing accomplishments in order to show progress to the clients	20

Bare-Metal Testing

CloudLab, geni-lib scripts, data collection, ...

CloudLab: Geni-lib Automation

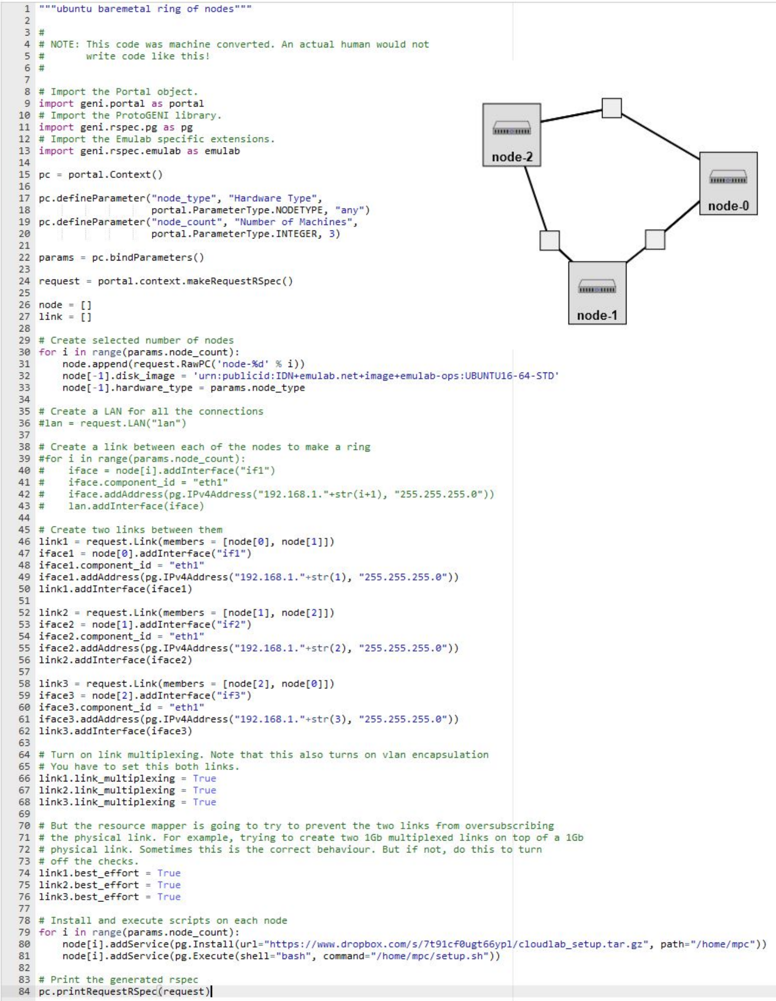
- LAN vs Link
- Static IP
- Setup
  - Dependencies
  - MPC Code duplicate
    - geni.rspec.pg.Install
- Remaining Issue:
  - geni.rspec.pg.Execute



```
"""ubuntu baremetal ring of nodes"""

#
# NOTE: This code was machine converted. An actual human would not
#       write code like this!
#

# Import the Portal object.
import geni.portal as portal
# Import the ProtoGENI library.
import geni.rspec.pg as pg
# Import the Emulab specific extensions.
import geni.rspec.emulab as emulab

pc = portal.Context()

pc.defineParameter("node_type", "Hardware Type",
                   portal.ParameterType.NODETYPE, "any")
pc.defineParameter("node_count", "Number of Machines",
                   portal.ParameterType.INTEGER, 3)

params = pc.bindParameters()

request = portal.context.makeRequestRSpec()

node = []
link = []

# Create selected number of nodes
for i in range(params.node_count):
    node.append(request.RawPC('node-%d' % i))
    node[-1].disk_image = 'urn:publicid:IDN+emulab.net+image+emulab-ops:UBUNTU16-64-STD'
    node[-1].hardware_type = params.node_type

# Create a LAN for all the connections
lan = request.LAN("lan")

# Create a link between each of the nodes to make a ring
for i in range(params.node_count):
    iface = node[i].addInterface("if1")
    iface.component_id = "eth1"
    iface.addAddress(pg.IPv4Address("192.168.1."+str(i+1), "255.255.255.0"))
    lan.addInterface(iface)

# Install and execute scripts on each node
for i in range(params.node_count):
    node[i].addService(pg.Install(url="https://www.dropbox.com/s/7t91cf0ugt66ypl/cloudlab_setup.tar.gz", path="/home/mpc"))
    node[i].addService(pg.Execute(shell="bash", command="/home/mpc/setup.sh"))

# Print the generated rspec
pc.printRequestRSpec(request)
```

CloudLab: Geni-lib Further Tweaks

- Modifications
  - Link multiplexing
  - Best Effort
- Issues with Ring Topology
  - Couldn't map to hardware
- Current Status: Still WIP



```python
"""ubuntu baremetal ring of nodes"""

#
# NOTE: This code was machine converted. An actual human would not
#       write code like this!
#

# Import the Portal object.
import geni.portal as portal
# Import the ProtoGENI library.
import geni.rspec.pg as pg
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params = pc.bindParameters()

request = portal.context.makeRequestRSpec()

node = []
link = []

# Create selected number of nodes
for i in range(params.node_count):
    node.append(request.RawPC('node-%d' % i))
    node[-1].disk_image = 'urn:publicid:IDN+emulab.net+image+emulab-ops:UBUNTU16-64-STD'
    node[-1].hardware_type = params.node_type

# Create a LAN for all the connections
#lan = request.LAN("lan")

# Create a link between each of the nodes to make a ring
#for i in range(params.node_count):
#    iface = node[i].addInterface("if1")
#    iface.component_id = "eth1"
#    iface.addAddress(pg.IPv4Address("192.168.1."+str(i+1), "255.255.255.0"))
#    lan.addInterface(iface)

# Create two links between them
link1 = request.Link(members = [node[0], node[1]])
iface1 = node[0].addInterface("if1")
iface1.component_id = "eth1"
iface1.addAddress(pg.IPv4Address("192.168.1."+str(1), "255.255.255.0"))
link1.addInterface(iface1)

link2 = request.Link(members = [node[1], node[2]])
iface2 = node[1].addInterface("if2")
iface2.component_id = "eth1"
iface2.addAddress(pg.IPv4Address("192.168.1."+str(2), "255.255.255.0"))
link2.addInterface(iface2)

link3 = request.Link(members = [node[2], node[0]])
iface3 = node[2].addInterface("if3")
iface3.component_id = "eth1"
iface3.addAddress(pg.IPv4Address("192.168.1."+str(3), "255.255.255.0"))
link3.addInterface(iface3)

# Turn on link multiplexing. Note that this also turns on vlan encapsulation
# You have to set this both links.
link1.link_multiplexing = True
link2.link_multiplexing = True
link3.link_multiplexing = True

# But the resource mapper is going to try to prevent the two links from oversubscribing
# the physical link. For example, trying to create two 1Gb multiplexed links on top of a 1Gb
# physical link. Sometimes this is the correct behaviour. But if not, do this to turn
# off the checks.
link1.best_effort = True
link2.best_effort = True
link3.best_effort = True

# Install and execute scripts on each node
for i in range(params.node_count):
    node[i].addService(pg.Install(url="https://www.dropbox.com/s/7t91cf0ugt66ypl/cloudlab_setup.tar.gz", path="/home/mpc"))
    node[i].addService(pg.Execute(shell="bash", command="/home/mpc/setup.sh"))

# Print the generated rspec
pc.printRequestRSpec(request)
```
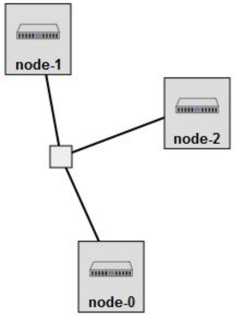
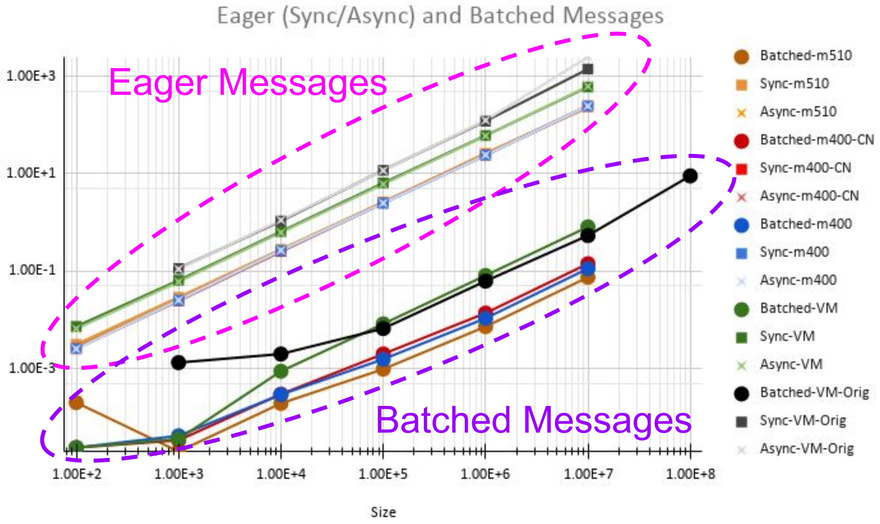

Boston University CS & ECE

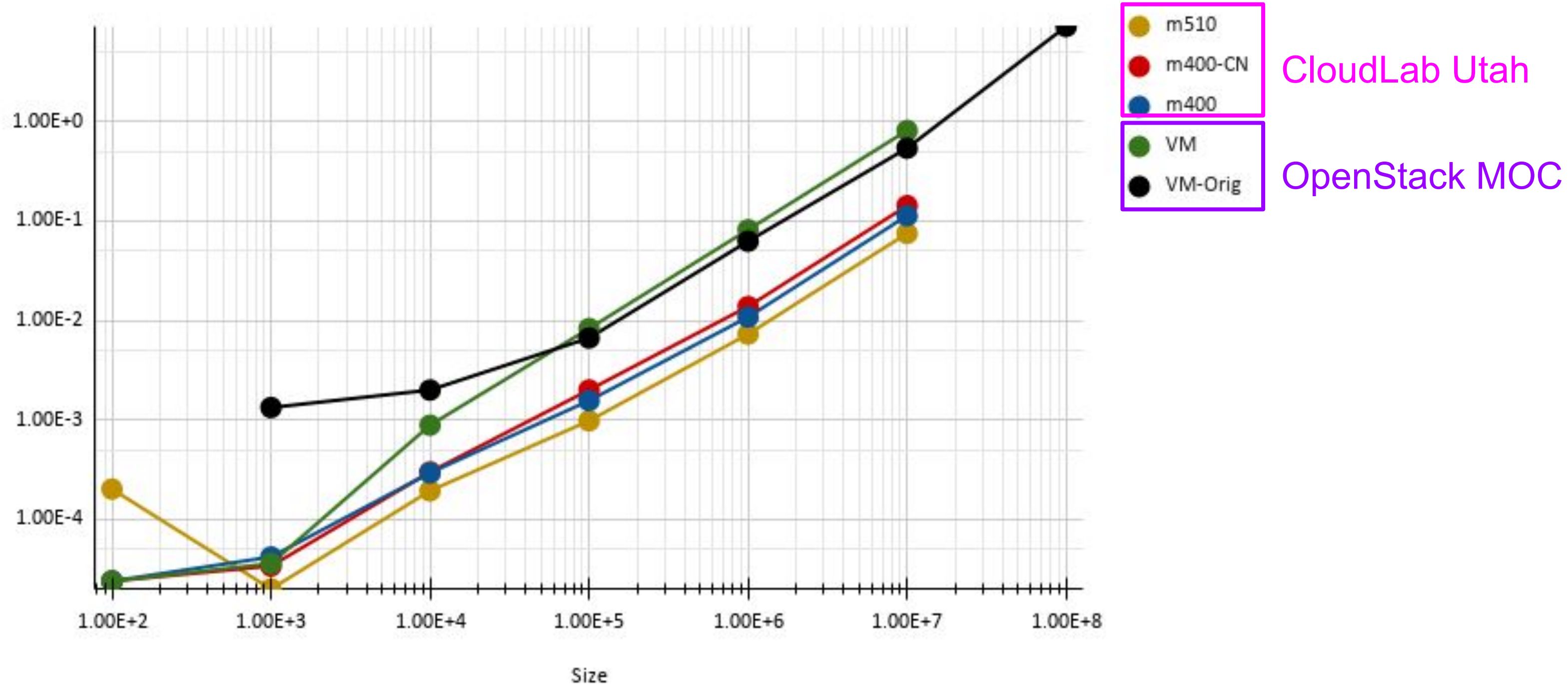
CloudLab Testing

- Shared Control Network
  - Hardware
    - m400 (ARM)
- LAN topology
  - Hardware
    - m510 (x86_64)
    - m400 (ARM)





Batched Messages - Different Deployments

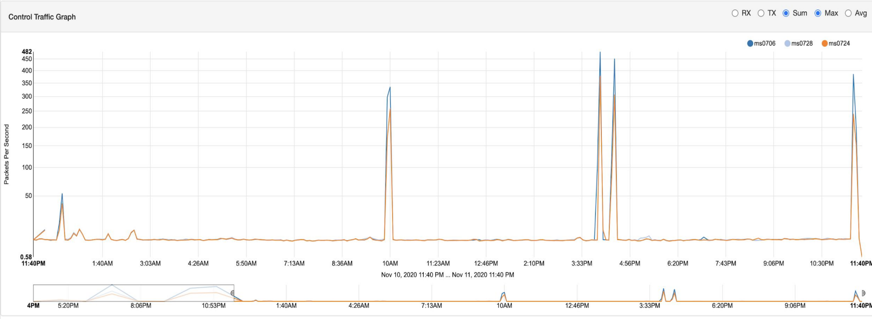


CloudLab Utah

OpenStack MOC

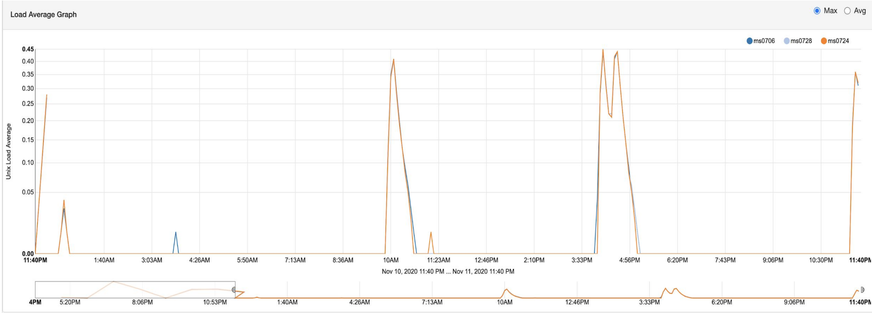
Observations

- News tests are using new Ubuntu image (14.04.1 → 16.04.01)
- When running 10M size test, performance varies might because of the time period. Test gets stuck in peak-hours and function normally in early morning EST.
- Experiments of smaller sizes are not restricted by time period.



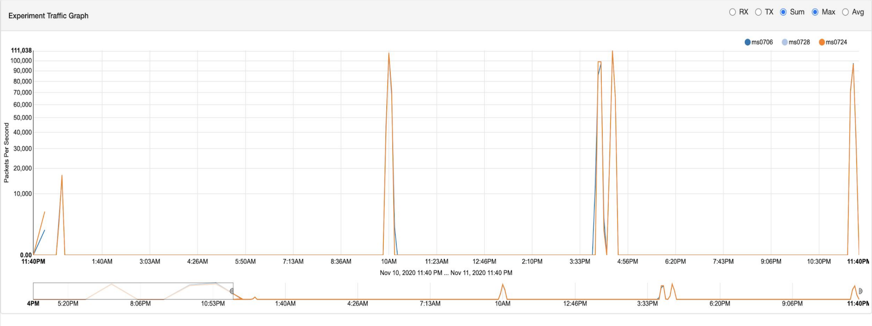
Control Traffic Graph

○ RX ○ TX ● Sum ● Max ○ Avg



Load Average Graph

● Max ○ Avg



Experiment Traffic Graph

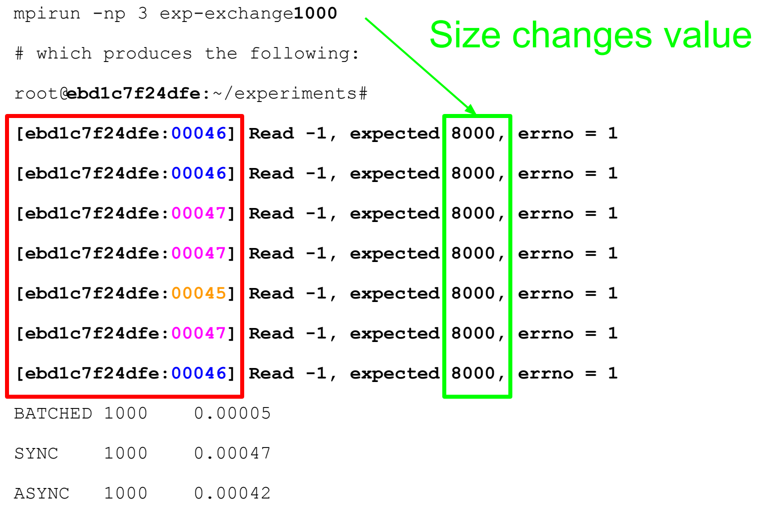
○ RX ○ TX ● Sum ● Max ○ Avg

Working with Containers

Docker, docker-compose, OpenShift, ...

MPC in Docker Container Debugging...

- Running tests.sh → OK
- Running exp-exchange
  - Issue with size greater than 505… ex: with 1000
  - Cryptic message…
- Determine source…
  - Some clues but overall meaning still unclear

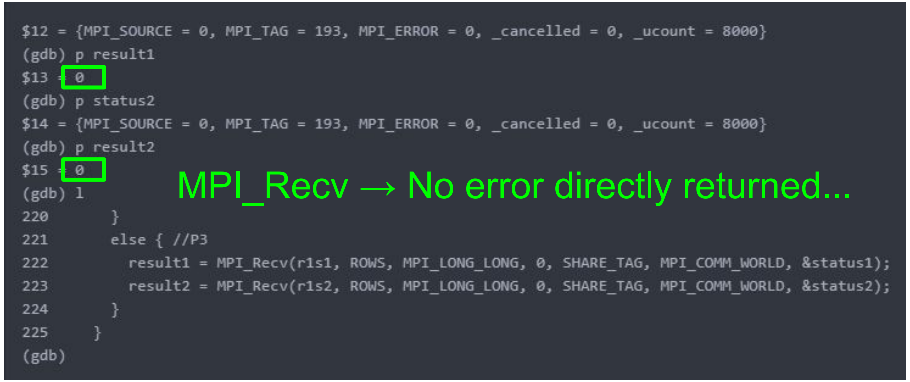


```
mpirun -np 3 exp-exchange1000

# which produces the following:

root@ebd1c7f24dfe:~/experiments#

[ebd1c7f24dfe:00046] Read -1, expected 8000, errno = 1

[ebd1c7f24dfe:00046] Read -1, expected 8000, errno = 1

[ebd1c7f24dfe:00047] Read -1, expected 8000, errno = 1

[ebd1c7f24dfe:00047] Read -1, expected 8000, errno = 1

[ebd1c7f24dfe:00045] Read -1, expected 8000, errno = 1

[ebd1c7f24dfe:00047] Read -1, expected 8000, errno = 1

[ebd1c7f24dfe:00046] Read -1, expected 8000, errno = 1

BATCHED 1000      0.00005

SYNC    1000      0.00047

ASYNC   1000      0.00042
```

Size changes value

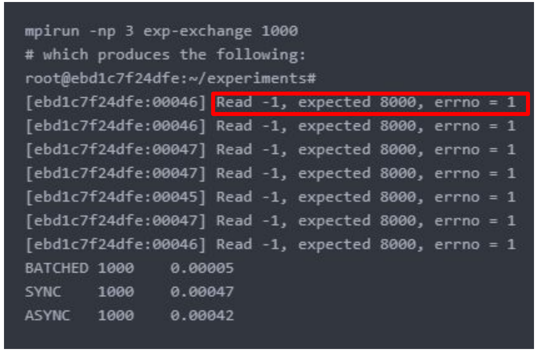
[Hostname:PID]

OpenMPI Debugging Continued...



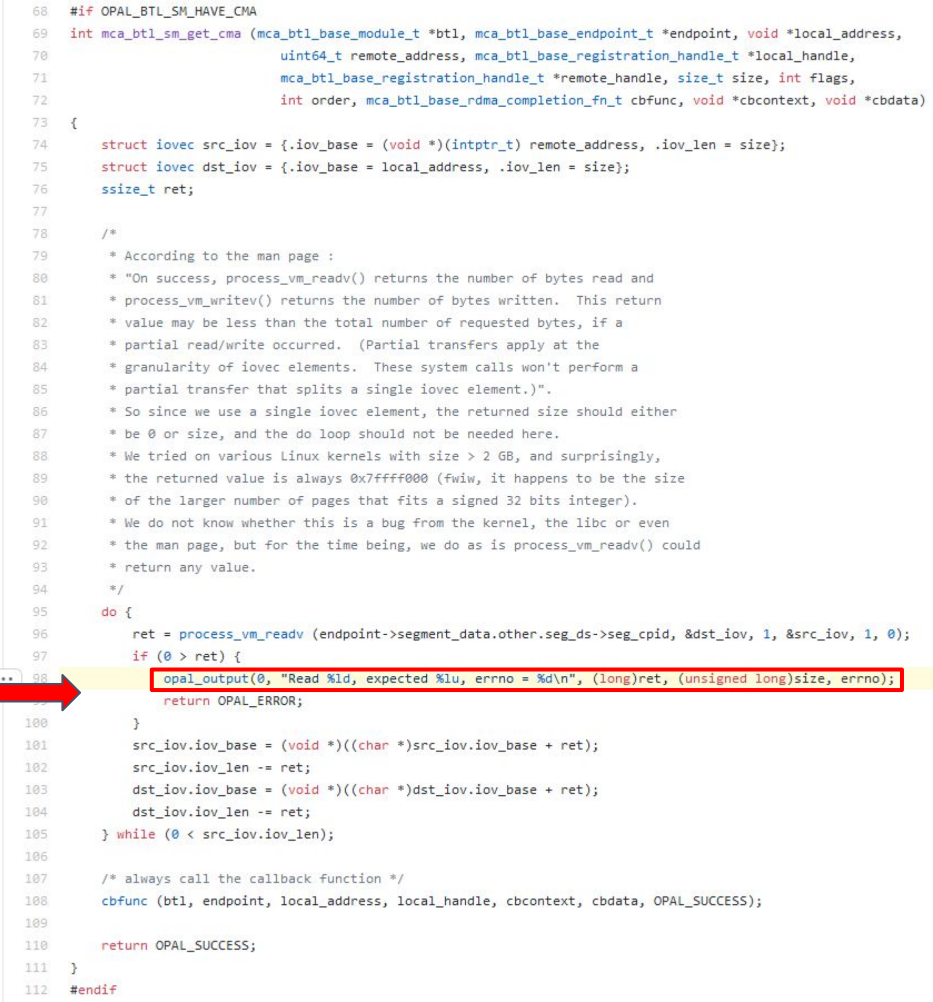
```
$12 = {MPI_SOURCE = 0, MPI_TAG = 193, MPI_ERROR = 0, _cancelled = 0, _ucount = 8000}
(gdb) p result1
$13 = 0
(gdb) p status2
$14 = {MPI_SOURCE = 0, MPI_TAG = 193, MPI_ERROR = 0, _cancelled = 0, _ucount = 8000}
(gdb) p result2
$15 = 0
(gdb) l
220         }
221         else { //P3
222           result1 = MPI_Recv(r1s1, ROWS, MPI_LONG_LONG, 0, SHARE_TAG, MPI_COMM_WORLD, &status1);
223           result2 = MPI_Recv(r1s2, ROWS, MPI_LONG_LONG, 0, SHARE_TAG, MPI_COMM_WORLD, &status2);
224         }
225       }
(gdb)
```

MPI_Recv → No error directly returned...



```
mpirun -np 3 exp-exchange 1000
# which produces the following:
root@ebd1c7f24dfe:~/experiments#
[ebd1c7f24dfe:00046] Read -1, expected 8000, errno = 1
[ebd1c7f24dfe:00046] Read -1, expected 8000, errno = 1
[ebd1c7f24dfe:00047] Read -1, expected 8000, errno = 1
[ebd1c7f24dfe:00047] Read -1, expected 8000, errno = 1
[ebd1c7f24dfe:00045] Read -1, expected 8000, errno = 1
[ebd1c7f24dfe:00047] Read -1, expected 8000, errno = 1
[ebd1c7f24dfe:00046] Read -1, expected 8000, errno = 1
BATCHED 1000    0.00005
SYNC    1000    0.00047
ASYNC   1000    0.00042
```

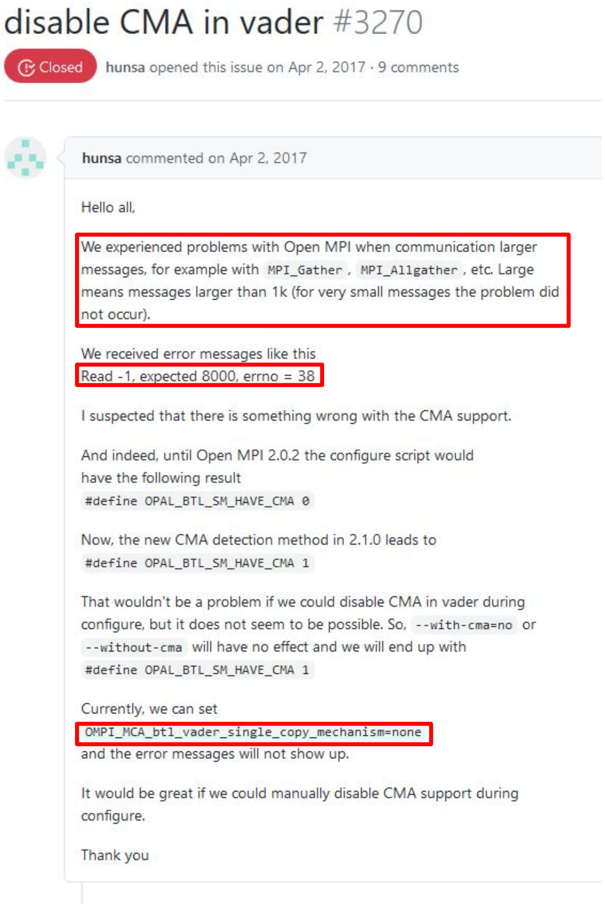
Looking for matching message pattern on github...



```
#if OPAL_BTL_SM_HAVE_CMA
int mca_btl_sm_get_cma (mca_btl_base_module_t *btl, mca_btl_base_endpoint_t *endpoint, void *local_address,
                        uint64_t remote_address, mca_btl_base_registration_handle_t *local_handle,
                        mca_btl_base_registration_handle_t *remote_handle, size_t size, int flags,
                        int order, mca_btl_base_rdma_completion_fn_t cbfunc, void *cbcontext, void *cbdata)
{
    struct iovec src_iov = {.iov_base = (void *)(intptr_t) remote_address, .iov_len = size};
    struct iovec dst_iov = {.iov_base = local_address, .iov_len = size};
    ssize_t ret;

    /*
     * According to the man page :
     * "On success, process_vm_readv() returns the number of bytes read and
     * process_vm_writev() returns the number of bytes written.  This return
     * value may be less than the total number of requested bytes, if a
     * partial read/write occurred.  (Partial transfers apply at the
     * granularity of iovec elements.  These system calls won't perform a
     * partial transfer that splits a single iovec element.)".
     * So since we use a single iovec element, the returned size should either
     * be 0 or size, and the do loop should not be needed here.
     * We tried on various Linux kernels with size > 2 GB, and surprisingly,
     * the returned value is always 0x7ffff000 (fwiw, it happens to be the size
     * of the larger number of pages that fits a signed 32 bits integer).
     * We do not know whether this is a bug from the kernel, the libc or even
     * the man page, but for the time being, we do as is process_vm_readv() could
     * return any value.
     */
    do {
        ret = process_vm_readv (endpoint->segment_data.other.seg_ds->seg_cpid, &dst_iov, 1, &src_iov, 1, 0);
        if (0 > ret) {
            opal_output(0, "Read %ld, expected %lu, errno = %d\n", (long)ret, (unsigned long)size, errno);
            return OPAL_ERROR;
        }
        src_iov.iov_base = (void *)((char *)src_iov.iov_base + ret);
        src_iov.iov_len -= ret;
        dst_iov.iov_base = (void *)((char *)dst_iov.iov_base + ret);
        dst_iov.iov_len -= ret;
    } while (0 < src_iov.iov_len);

    /* always call the callback function */
    cbfunc (btl, endpoint, local_address, local_handle, cbcontext, cbdata, OPAL_SUCCESS);

    return OPAL_SUCCESS;
}
#endif
```

OpenMPI Debugging Resolution

- Issue for messages larger than ~1k
- Shared memory Byte Transport Layer (BTL)
  - “Sm” was the original version
  - “Vader” is the current version
- CMA (Cross Memory Attach)
  - Kernel support required for “Zero copy” mechanism
- Bypass with parameter
  - mpirun --mca btl_vader_single_copy_mechanism none -np 3 exp-exchange 1000



disable CMA in vader #3270

Closed **hunsa** opened this issue on Apr 2, 2017 · 9 comments

hunsa commented on Apr 2, 2017

Hello all,

We experienced problems with Open MPI when communication larger messages, for example with `MPI_Gather`, `MPI_Allgather`, etc. Large means messages larger than 1k (for very small messages the problem did not occur).

We received error messages like this

```
Read -1, expected 8000, errno = 38
```

I suspected that there is something wrong with the CMA support.

And indeed, until Open MPI 2.0.2 the configure script would have the following result

```
#define OPAL_BTL_SM_HAVE_CMA 0
```

Now, the new CMA detection method in 2.1.0 leads to

```
#define OPAL_BTL_SM_HAVE_CMA 1
```

That wouldn't be a problem if we could disable CMA in vader during configure, but it does not seem to be possible. So, `--with-cma=no` or `--without-cma` will have no effect and we will end up with

```
#define OPAL_BTL_SM_HAVE_CMA 1
```

Currently, we can set

```
OMPI_MCA_btl_vader_single_copy_mechanism=none
```

and the error messages will not show up.

It would be great if we could manually disable CMA support during configure.

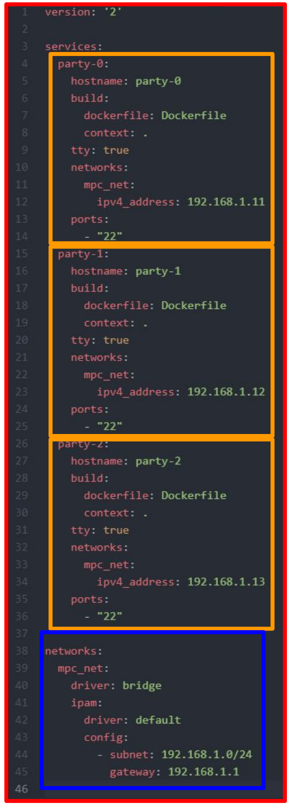
Thank you

Working with Docker and docker-compose

- docker-compose.yml
  - Define topology
  - Multiple “services” each a container based on Dockerfile
  - Virtual network for communication
- Build Configuration
  - docker-compose build
- Launch Three Containers
  - docker-compose up

- Dockerfile
  - Install dependencies
  - Configure non-root user
  - Configure ssh
  - Build MPC code
- Build Image
  - docker build -t mpc .
- Launch Single Container
  - docker run --name mpc -it mpc /bin/bash

Container Configuration Hierarchy

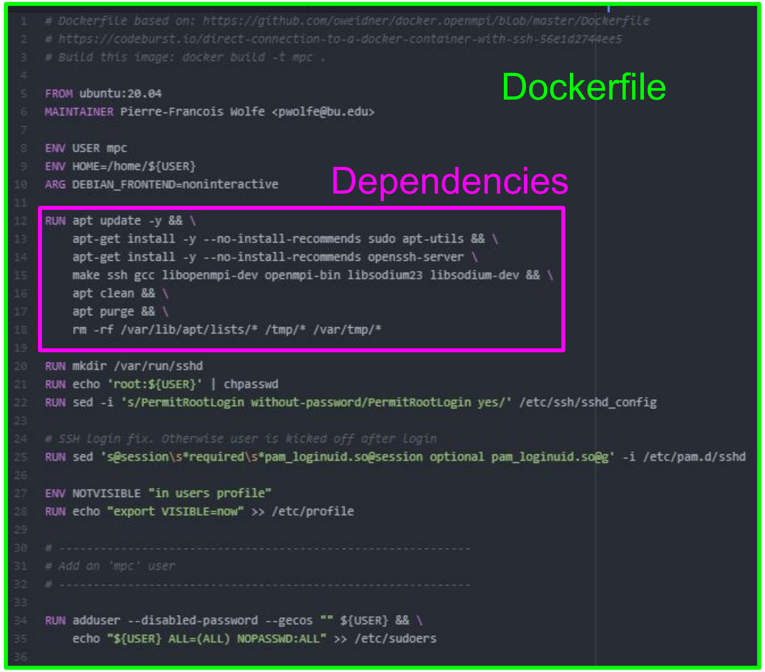


docker-compose

Three containers

Network Config.

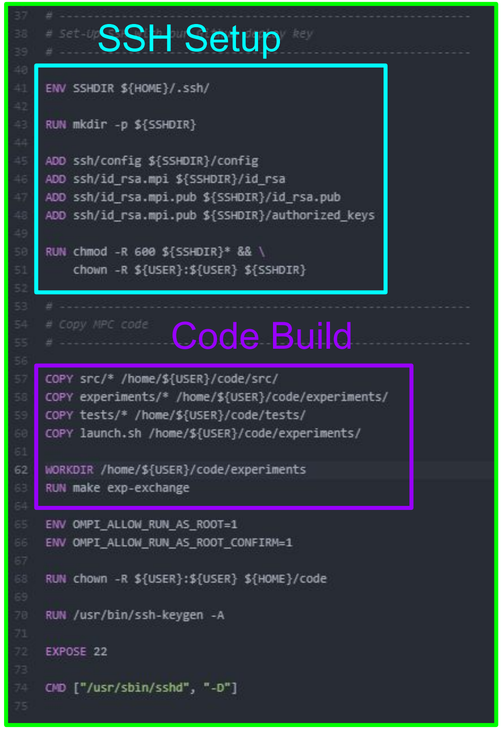
```
version: '2'

services:
  party-0:
    hostname: party-0
    build:
      dockerfile: Dockerfile
      context: .
    tty: true
    networks:
      mpc_net:
        ipv4_address: 192.168.1.11
    ports:
      - "22"
  party-1:
    hostname: party-1
    build:
      dockerfile: Dockerfile
      context: .
    tty: true
    networks:
      mpc_net:
        ipv4_address: 192.168.1.12
    ports:
      - "22"
  party-2:
    hostname: party-2
    build:
      dockerfile: Dockerfile
      context: .
    tty: true
    networks:
      mpc_net:
        ipv4_address: 192.168.1.13
    ports:
      - "22"

networks:
  mpc_net:
    driver: bridge
    ipam:
      driver: default
      config:
        - subnet: 192.168.1.0/24
          gateway: 192.168.1.1

```



Dockerfile

Dependencies

```
# Dockerfile based on: https://github.com/oweidner/docker.openmpi/blob/master/Dockerfile
# https://codeburst.io/direct-connection-to-a-docker-container-with-ssh-56e1d2744ee5
# Build this image: docker build -t mpc .

FROM ubuntu:20.04
MAINTAINER Pierre-Francois Wolfe <pwolfe@bu.edu>

ENV USER mpc
ENV HOME=/home/${USER}
ARG DEBIAN_FRONTEND=noninteractive

RUN apt update -y && \
    apt-get install -y --no-install-recommends sudo apt-utils && \
    apt-get install -y --no-install-recommends openssh-server \
    make ssh gcc libopenmpi-dev openmpi-bin libsodium23 libsodium-dev && \
    apt clean && \
    apt purge && \
    rm -rf /var/lib/apt/lists/* /tmp/* /var/tmp/*

RUN mkdir /var/run/sshd
RUN echo 'root:${USER}' | chpasswd
RUN sed -i 's/PermitRootLogin without-password/PermitRootLogin yes/' /etc/ssh/sshd_config

# SSH login fix. Otherwise user is kicked off after login
RUN sed 's@session\s*required\s*pam_loginuid.so@session optional pam_loginuid.so@g' -i /etc/pam.d/sshd

ENV NOTVISIBLE "in users profile"
RUN echo "export VISIBLE=now" >> /etc/profile

# ------------------------------------------------------------
# Add an 'mpc' user
# ------------------------------------------------------------

RUN adduser --disabled-password --gecos "" ${USER} && \
    echo "${USER} ALL=(ALL) NOPASSWD:ALL" >> /etc/sudoers

```



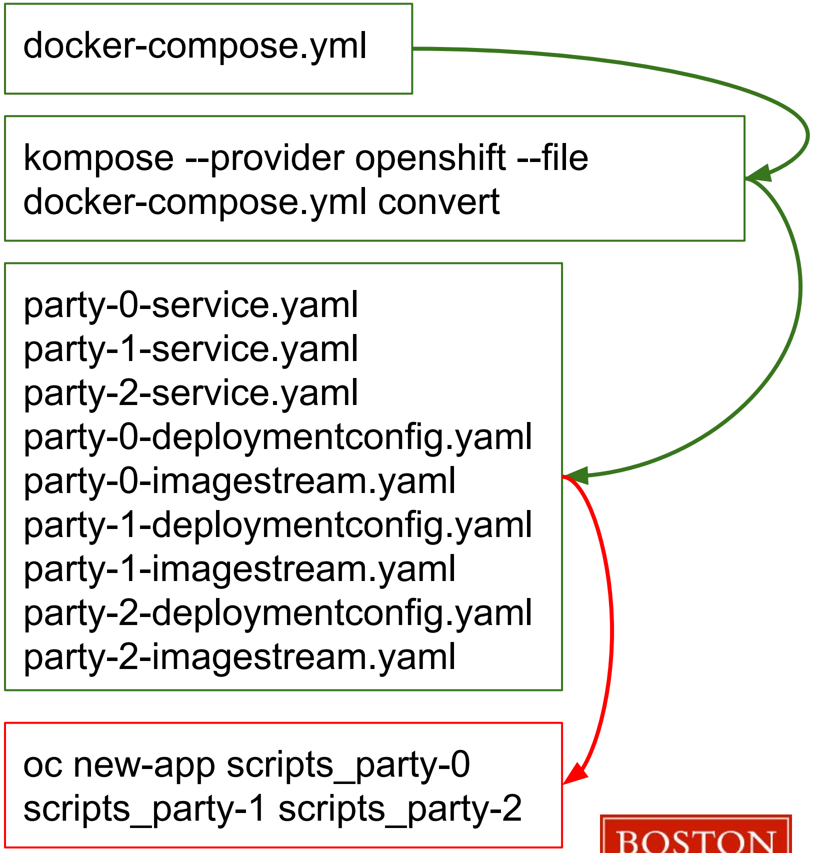
SSH Setup

Code Build

```
# ------------------------------------------------------------
# Set-Up SSH with our Github deploy key
# ------------------------------------------------------------

ENV SSHDIR ${HOME}/.ssh/

RUN mkdir -p ${SSHDIR}

ADD ssh/config ${SSHDIR}/config
ADD ssh/id_rsa.mpi ${SSHDIR}/id_rsa
ADD ssh/id_rsa.mpi.pub ${SSHDIR}/id_rsa.pub
ADD ssh/id_rsa.mpi.pub ${SSHDIR}/authorized_keys

RUN chmod -R 600 ${SSHDIR}* && \
    chown -R ${USER}:${USER} ${SSHDIR}

# ------------------------------------------------------------
# Copy MPC code
# ------------------------------------------------------------

COPY src/* /home/${USER}/code/src/
COPY experiments/* /home/${USER}/code/experiments/
COPY tests/* /home/${USER}/code/tests/
COPY launch.sh /home/${USER}/code/experiments/

WORKDIR /home/${USER}/code/experiments
RUN make exp-exchange

ENV OMPI_ALLOW_RUN_AS_ROOT=1
ENV OMPI_ALLOW_RUN_AS_ROOT_CONFIRM=1

RUN chown -R ${USER}:${USER} ${HOME}/code

RUN /usr/bin/ssh-keygen -A

EXPOSE 22

CMD ["/usr/sbin/sshd", "-D"]

```

Docker-compose to OpenShift

- Current (local)
  - docker-compose
    - Docker Containers
- In Progress
  - OpenShift (MOC)
    - Kubernetes
      - Docker Containers
- Conversion Tool
  - Kubernetes Kompose



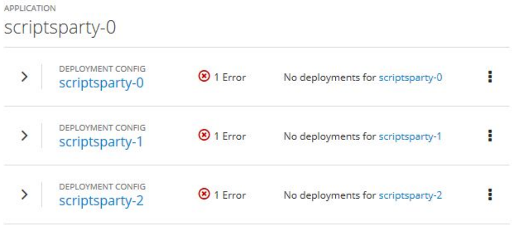
docker-compose.yml

kompose --provider openshift --file docker-compose.yml convert

party-0-service.yaml
party-1-service.yaml
party-2-service.yaml
party-0-deploymentconfig.yaml
party-0-imagestream.yaml
party-1-deploymentconfig.yaml
party-1-imagestream.yaml
party-2-deploymentconfig.yaml
party-2-imagestream.yaml

oc new-app scripts_party-0 scripts_party-1 scripts_party-2

Launching on OpenShift WIP

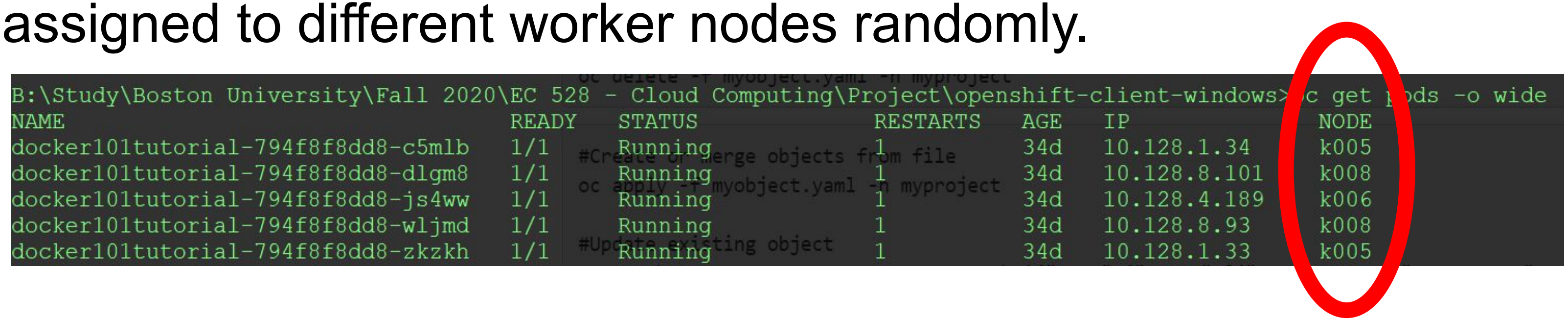


APPLICATION
scriptsparty-0

DEPLOYMENT CONFIG scriptsparty-0	⊗ 1 Error	No deployments for scriptsparty-0	⋮
DEPLOYMENT CONFIG scriptsparty-1	⊗ 1 Error	No deployments for scriptsparty-1	⋮
DEPLOYMENT CONFIG scriptsparty-2	⊗ 1 Error	No deployments for scriptsparty-2	⋮

OpenShift - Deploying Pods on Specific Nodes

When deploying multiple pods of same application, pods get assigned to different worker nodes randomly.



```
B:\Study\Boston University\Fall 2020\EC 528 - Cloud Computing\Project\openshift-client-windows>oc get pods -o wide
NAME                               READY   STATUS              RESTARTS   AGE   IP             NODE
docker101tutorial-794f8f8dd8-c5mlb   1/1     Running             1          34d   10.128.1.34    k005
docker101tutorial-794f8f8dd8-dlgm8   1/1     Running             1          34d   10.128.8.101   k008
docker101tutorial-794f8f8dd8-js4ww   1/1     Running             1          34d   10.128.4.189   k006
docker101tutorial-794f8f8dd8-wljmd   1/1     Running             1          34d   10.128.8.93    k008
docker101tutorial-794f8f8dd8-zkzkh   1/1     Running             1          34d   10.128.1.33    k005
```

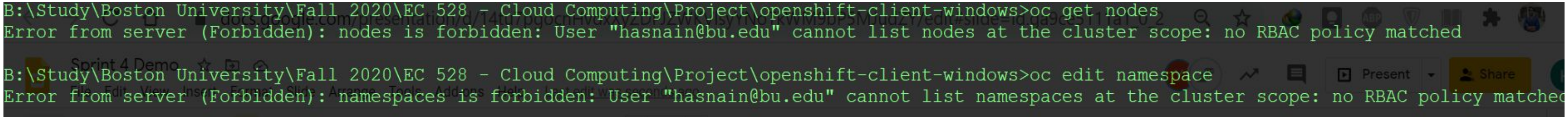
Running all MPC parties pods on the same nodes may have different latencies/computation delays as is the case otherwise.

OpenShift - Deploying Pods on Specific Nodes

Tried specifying what nodes to place pods on.

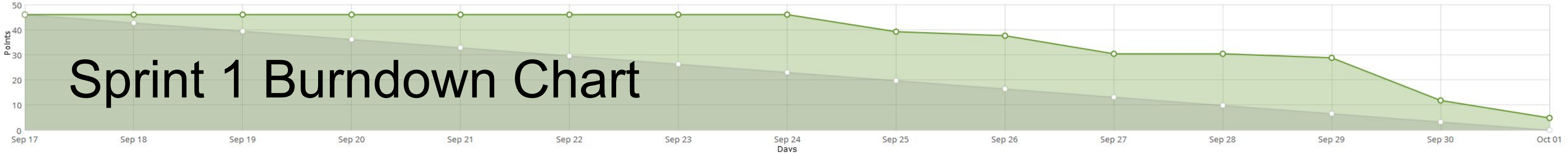
Failed → Most documentation for this is for OpenShift 3, while the latest version we're using is OpenShift 4.

An authorization error is encountered: Admin access / elevated rights needed !

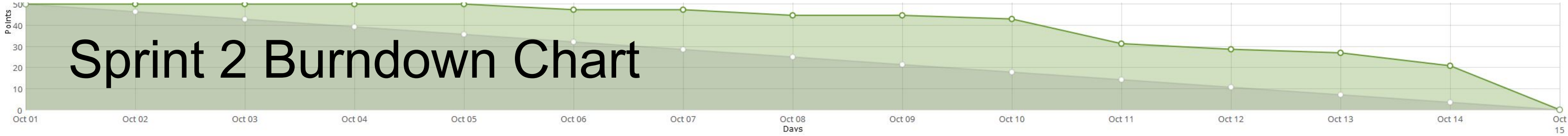


```
B:\Study\Boston University\Fall 2020\EC 528 - Cloud Computing\Project\openshift-client-windows>oc get nodes
Error from server (Forbidden): nodes is forbidden: User "hasnain@bu.edu" cannot list nodes at the cluster scope: no RBAC policy matched

B:\Study\Boston University\Fall 2020\EC 528 - Cloud Computing\Project\openshift-client-windows>oc edit namespace
Error from server (Forbidden): namespaces is forbidden: User "hasnain@bu.edu" cannot list namespaces at the cluster scope: no RBAC policy matche
```

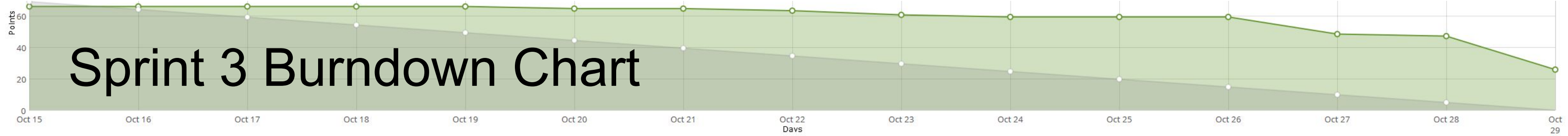
Sprint Demo



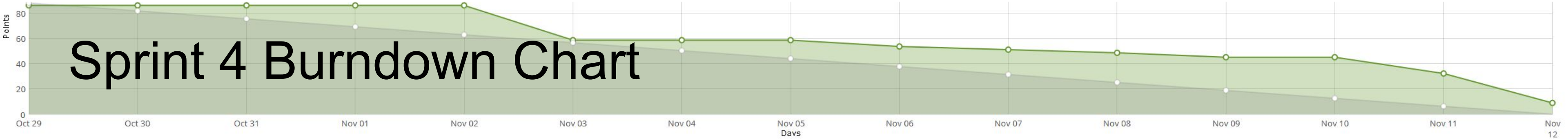
Sprint 1 Burndown Chart



Sprint 2 Burndown Chart



Sprint 3 Burndown Chart



Sprint 4 Burndown Chart

Sprint 5 - Some Known Stories

- As a researcher, I want to use a comprehensive test suite across all deployments...
  - Exp-exchange: iterate over message size, transaction size, other MPI options...
  - Add score-p wrapper toggle (and use some MPI tools for insights)
  - Push all changes to test setups (CloudLab *.tar.gz, rebuild Docker, rsync to VMs)
- As a researcher, I want to deploy final tests to each environment of interest.
  - Docker containers on OpenShift (finish debugging)
  - Revisit existing VM setup on OpenStack
  - Ring topology on CloudLab (if possible, otherwise LAN)
- As a researcher, I want to compare the same tests run on different platforms.
  - Conclusions about best performance of tested methods
  - Documentation and any other insights

Thank you

...any questions?