SC20

Atlanta, GA | more than hpc.

SCinet DTN-as-a-Service Developments

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Building upon prior SCinet DTNaaS XNet work

- The project is intended to deliver Data Transfer Node software and hardware platform as a prototype service to support the SC SCinet community

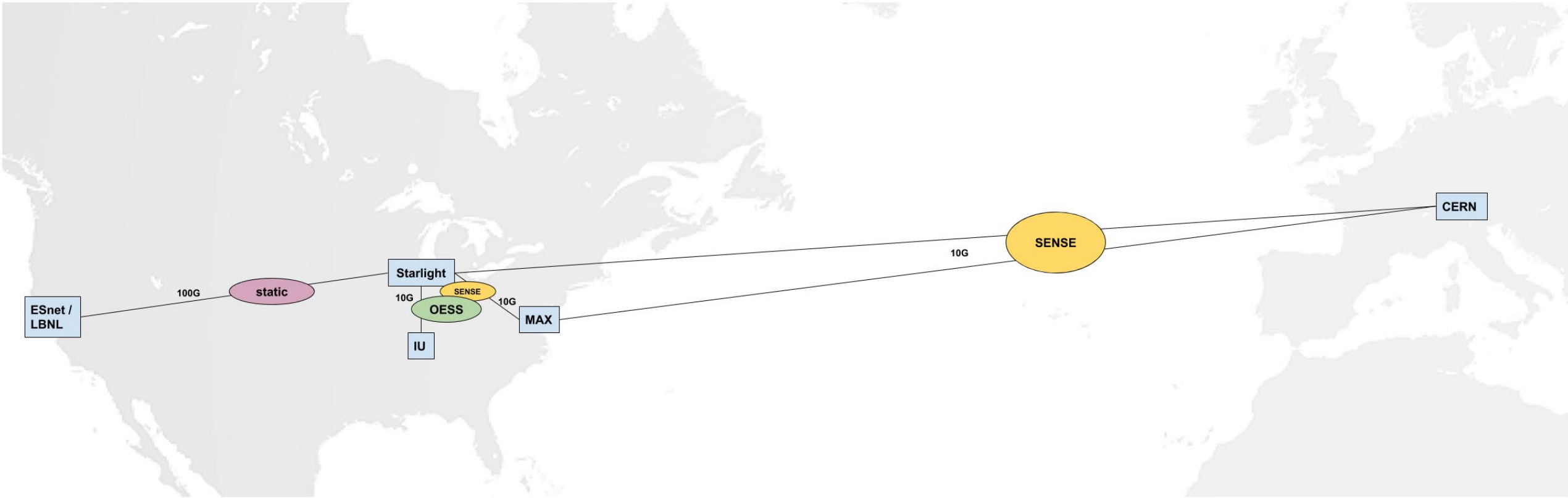
- Multi-year XNet experiment, beginning in 2017
  - In recent years deployed with Kubernetes, NVMe-oF, and 400G LAN/WAN
  - 2019 INDIS paper [1]
  - Efforts to continue SCinet DTNaaS for SC20 and beyond
  - Part 2 of this talk will describe details on history and broader work

- After SC19, a tentative plan to provide DTNaaS as a SCinet capability was formed
  - SC20 architecture began the year considering support of DTNs/compute in strawman
  - COVID pandemic changed the equation

[1] S. Yu, *et al.*, "SCinet DTN-as-a-Service Framework," in *2019 IEEE/ACM Innovating the Network for Data-Intensive Science (INDIS)*, Denver, CO, USA, 2019 pp. 1-8.

Gathering resources for a remote DTNaaS testing environment

- DTNs on ESnet testbed, Starlight, IU, MAX, CERN/SURFnet
- Make use of dynamic path provisioning: SENSE and OESS (also some static vlans)
- Some logistical challenges impeded progress early on

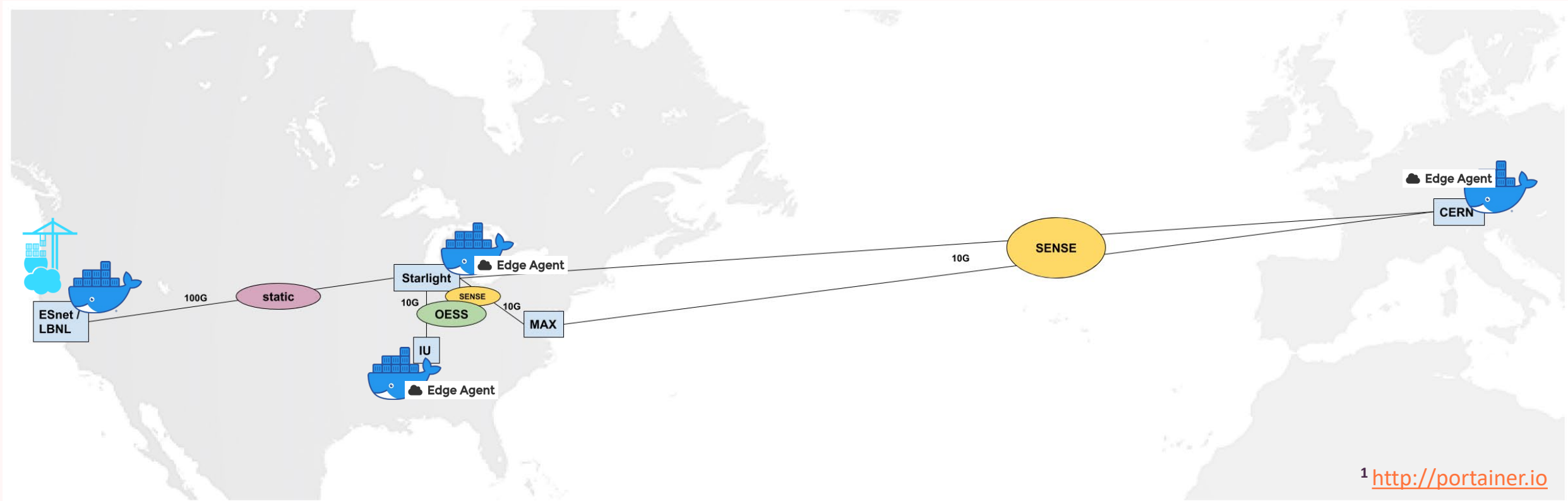


SC20 Goals from a SCinet/XNet perspective

- Develop additional tooling to manage local and distributed containers
  - New prototype provisioning framework with minimal setup overhead
  - API, CLI for service allocation and management
- Understand the performance of different available container networks on hosts
  - Single networking namespace impractical if hosting multiple services
- Investigate use of RDMA/RoCE support for container-based DTNs
- Continue NVMe-oF evaluation
  - Explore NVMe over RDMA (RoCEv2) in addition to TCP

Portainer[1] as an endpoint manager

- Thin layer for Docker and/or Kubernetes management
  - Idea is to simplify deployment and explicitly control container interface specifics
  - Many K8s CNIs are beginning to fully support these capabilities as well
- WebUI and RESTful API for endpoint control, exposes Docker Engine API



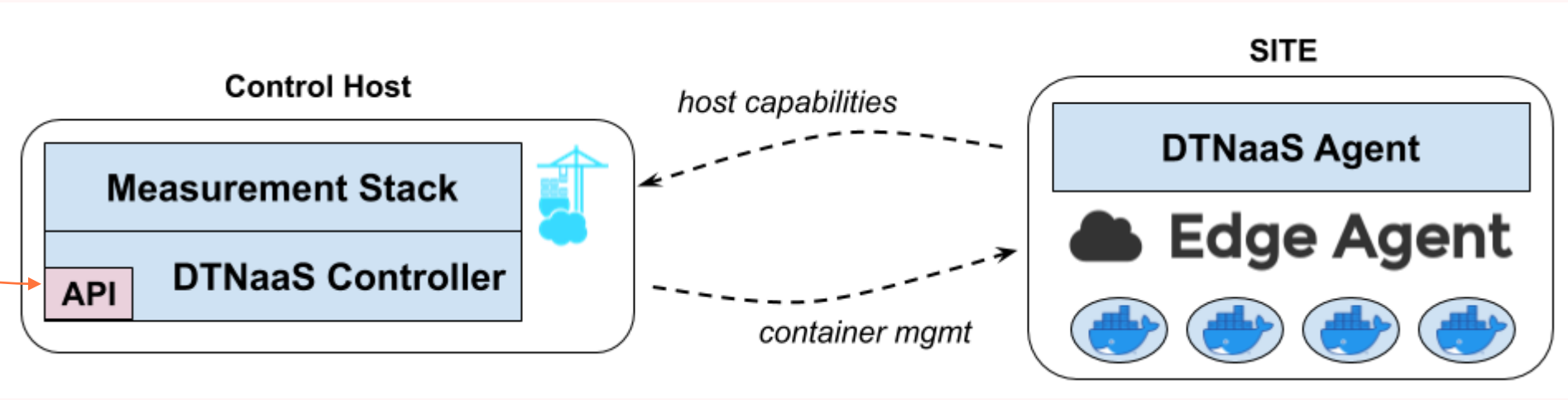
[1] http://portainer.io

DTNaaS controller and agent

- Stateful service that interacts with Portainer API to allocate and control containers
  - Uses profiles to manage control and data port ranges
  - Support RDMA/Infiniband support via SR-IOV virtual function profiles
  - Volumes, devices, limits, and capabilities
- DTNaaS Agent runs on each endpoint and exposes system details
  - Interfaces, CPUs, memory, block devices, NUMA mappings, etc.

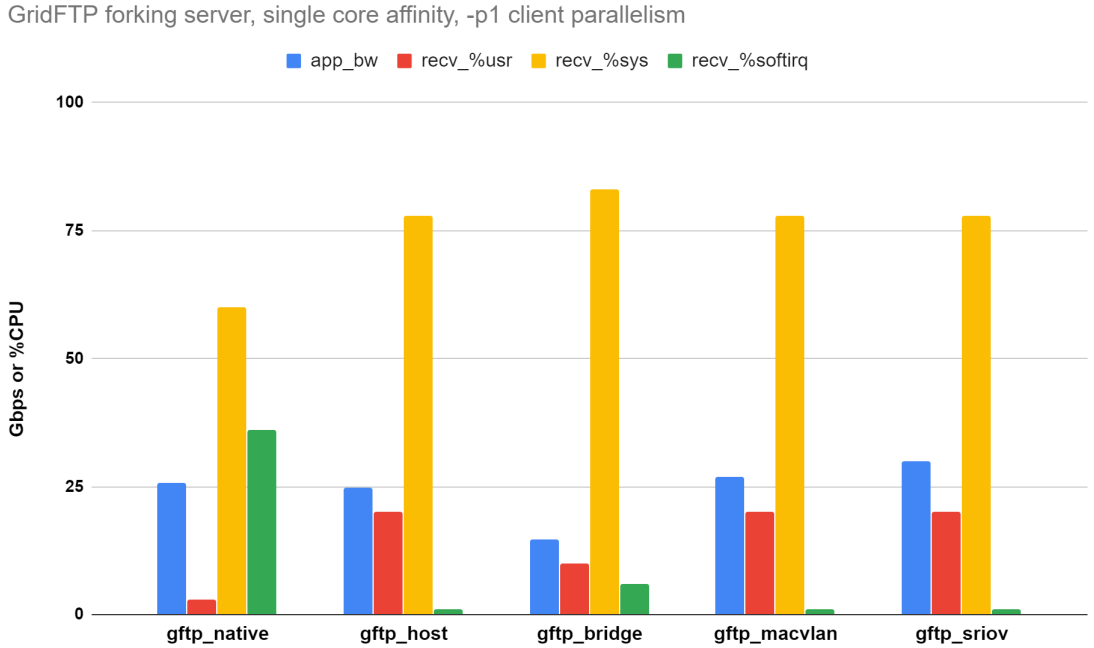
```
lbnl-rdma

volumes: { /nvme/data, mode: rw }
devices: [ rdma_cm, uverbs ]
limits: [ memlock:-1 ]
data_nets: [star222]
ctrl_port_range: [ 12000,12019 ]
data_port_range: [50100, 50199]
```

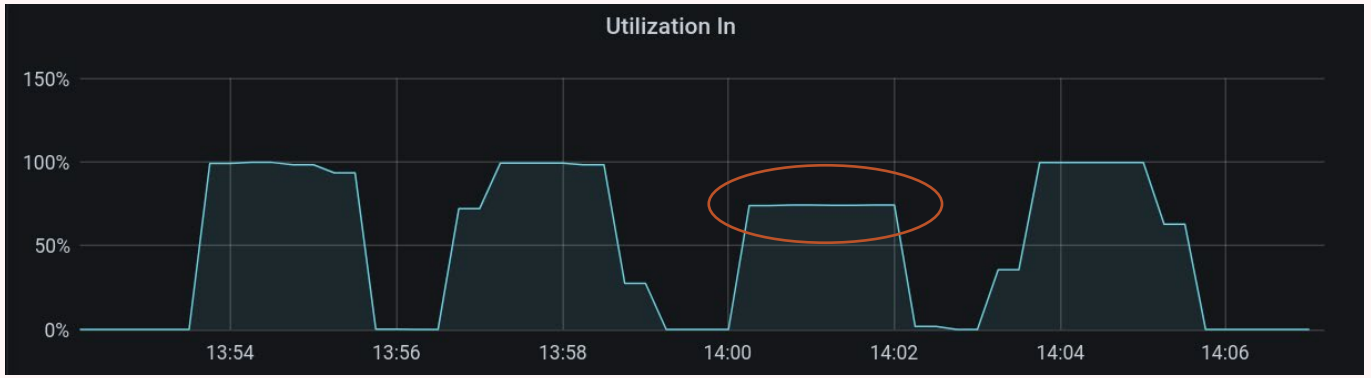


Container networking performance

- A number of container network attachments are supported and available
  - Host namespace, bridge, macvlan, ipvlan, sr-iov, etc.
  - Which works best for high-performance networking in each deployment?
- Relatively easy to achieve matching performance with well-understood tuning params
  - E.g., container execution mapped to appropriate NUMA nodes for cores and memory



native system *container host net* *container bridge net* *container macvlan/sriov net*



100G links, GridFTP, forking server, 5 clients with -p4 parallelism

DTNaaS Client and CLI

- Admin interfaces for DevOps management
  - Client library and CLI could be easily adapted for user access

```
dtncli> cd active
dtncli> ls
4: STARTED      (['nersc-tbn-6', 'nersc-tbn-7'], dtnaas/ofed)
8: STARTED      (['starlight-dtn', 'surf-dtn-ppc'], dtnaas/gct:latest)
11: STOPPED     (['nersc-tbn-7', 'starlight-dtn'], dtnaas/ofed:latest)
dtncli> cd 8
dtncli> ls
uuid: 136939c0-880f-41d7-9146-b877264d83c7
user: admin
state: STARTED
allocations
services
request
dtncli> cd services
dtncli> ls
starlight-dtn
surf-dtn-ppc
dtncli> cd surf-dtn-ppc
dtncli> ls
mgmt_net
data_net
data_net_name: net3989
data_ipv4: 192.168.4.179
data_vfmac
container_user: dtnaas
ctrl_port: 30001
ctrl_host: 192.91.245.27
docker_kwargs
image: dtnaas/gct:latest
profile: surf
errors
container_id: 385308b62066e4704240454e80f865618ea2d506120fcc6ae4bc71e98c083d04
```

View active sessions

```
dtncli> transfer starlight-dtn:/data/1T surf-dtn-ppc:/data/1T gridftp
Found suitable existing session 8
Starting transfer for starlight-dtn -> surf-dtn-ppc using transfer type gridftp
dtncli> show transfers
1:      (starlight-dtn -> surf-dtn-ppc [gridftp])
dtncli> show transfers log 1
Dest:   sshftp://dtnaas@192.91.245.27:30001//data/
  1T
Connecting to sshftp://dtnaas@165.124.33.182:30000//data/1T ...
Connecting to sshftp://dtnaas@192.91.245.27:30001//data/1T ...
   3967287296 bytes       756.70 MB/sec avg       756.70 MB/sec inst
dtncli>
dtncli>
dtncli> show transfers log 1
Dest:   sshftp://dtnaas@192.91.245.27:30001//data/
  1T
Connecting to sshftp://dtnaas@165.124.33.182:30000//data/1T ...
Connecting to sshftp://dtnaas@192.91.245.27:30001//data/1T ...
   9537847296 bytes       909.60 MB/sec avg      1062.50 MB/sec inst
dtncli>
```

Manage transfers

DTNaaS Client and CLI

Create new sessions across DTN endpoints using profiles

```
dtncli> session create nersc-tbn-7,starlight-dtn image dtnaas/ofed:latest profile star-rdma
Initialized new session with id "12"
dtncli> ls
4: STARTED      (['nersc-tbn-6', 'nersc-tbn-7'], dtnaas/ofed)
8: STARTED      (['starlight-dtn', 'surf-dtn-ppc'], dtnaas/gct:latest)
12: INITIALIZED (['nersc-tbn-7', 'starlight-dtn'], dtnaas/ofed:latest)
dtncli> cd 12
dtncli> ls
uuid: 6ef87984-8cfd-4482-ac06-0774ed8af7cd
user: admin
state: INITIALIZED
allocations
services
request
dtncli> cd services
dtncli> ls
nersc-tbn-7
starlight-dtn
dtncli> cd starlight-dtn
dtncli> ls
mgmt_net
data_net
data_net_name: star222
data_ipv4: 192.168.2.64
data_vfmac: ce:92:ff:ff:fe:9a:ce:c8
container_user: dtnaas
ctrl_port: 30001
ctrl_host: 165.124.33.182
docker_kwargs
image: dtnaas/ofed:latest
profile: star-rdma
errors
container_id: 646f8bfcf576021776b816a638a28b98a6174f7e872be92587ad1abffdb51c25
```

Supports multiple transfer/test types

```
dtncli> ls
4: STARTED      (['nersc-tbn-6', 'nersc-tbn-7'], dtnaas/ofed)
8: STARTED      (['starlight-dtn', 'surf-dtn-ppc'], dtnaas/gct:latest)
12: INITIALIZED (['nersc-tbn-7', 'starlight-dtn'], dtnaas/ofed:latest)
dtncli> session start 12
Starting session "12"
dtncli>
dtncli> ls
4: STARTED      (['nersc-tbn-6', 'nersc-tbn-7'], dtnaas/ofed)
8: STARTED      (['starlight-dtn', 'surf-dtn-ppc'], dtnaas/gct:latest)
12: STARTED     (['nersc-tbn-7', 'starlight-dtn'], dtnaas/ofed:latest)
dtncli> transfer nersc-tbn-7:/data/1T starlight-dtn:/data/1T_2 rdma
Found suitable existing session 12
Starting transfer for nersc-tbn-7 -> starlight-dtn using transfer type rdma
dtncli>
dtncli> show transfers
1:      (starlight-dtn -> surf-dtn-ppc [gridftp])
2:      (nersc-tbn-7 -> starlight-dtn [rdma])
dtncli> show transfers log 2
75: | port=18515 | ib_port=1 | tx_depth=16 | sl=0 | duplex=0 | cma=1 |
Created SLAB buffer with SIZE: 2147483648 PARTITIONS: 4
Metadata exchange complete
[0.0-2.0 sec]         16.64 GB        66.57 Gb/s
[2.0-4.0 sec]         18.25 GB        73.01 Gb/s
dtncli> show transfers log 2
[0.0-2.0 sec]         16.64 GB        66.57 Gb/s
[2.0-4.0 sec]         18.25 GB        73.01 Gb/s
[4.0-6.0 sec]         18.25 GB        73.01 Gb/s
[6.0-8.0 sec]         18.25 GB        73.01 Gb/s
[8.0-10.0 sec]        18.25 GB        73.01 Gb/s
dtncli> show transfers log 2 src
[2.0-4.0 sec]         18.25 GB        73.01 Gb/s
[4.0-6.0 sec]         18.25 GB        73.01 Gb/s
[6.0-8.0 sec]         18.25 GB        73.01 Gb/s
[8.0-10.0 sec]        18.25 GB        73.01 Gb/s
[10.0-12.0 sec]       18.25 GB        73.01 Gb/s
dtncli>
```