Fermilab U.S. DEPARTMENT OF ENERGY | Office of Science

The BigData Express Project (BDE)

BDE Research Team

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BDE Research Team

- FNAL
  - Wenji Wu (PI)
  - Qiming Lu
  - Liang Zhang
  - Amy Jin
  - Sajith Sasidharan
  - Phil DeMar
- ORNL
  - Nageswara Rao
  - Gary Liu
  - Ryan Prout
- KISTI
  - Syed Asif Shah
  - Seo-Young Noh
  - Jin Kim

Note: KISTI and ESnet are unfunded project partners

BigData Express

- Collaborative effort by Fermilab and Oakridge National Laboratory
- Funded by DOE's office of Advanced Scientific Computing Research (ASCR)
- A three-year research project
  - Start: Oct 1, 2015
  - End: Sep 30, 2018
- http://bigdataexpress.fnal.gov
- Code repository
  - https://cdcvs.fnal.gov/redmine/projects/bigdata-express/repository/

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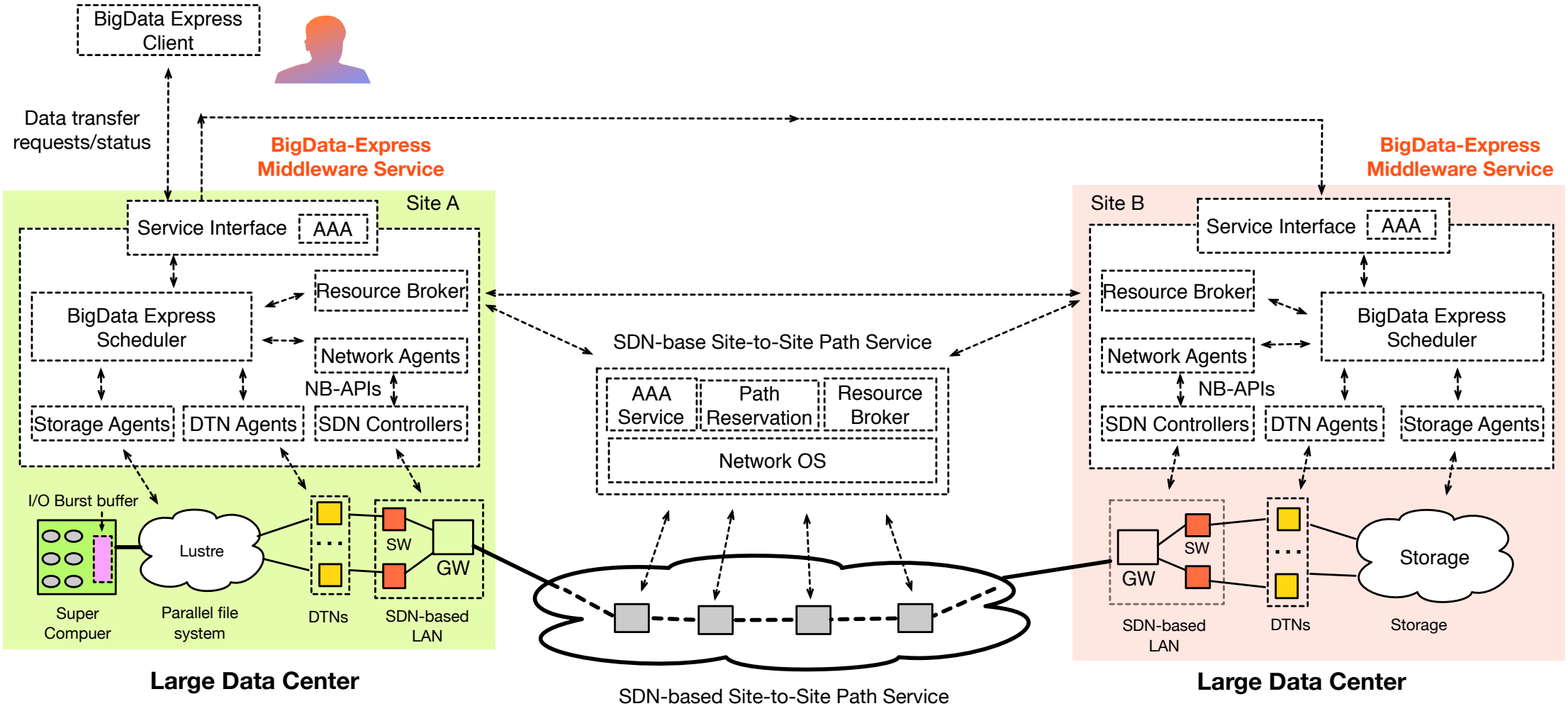
BigData Express Goal

- A distributed middleware system that will provide a schedulable, predictable, and high-performance data transfer service for the DOE’s large-scale science facilities and their collaborators.

Research problems to solve

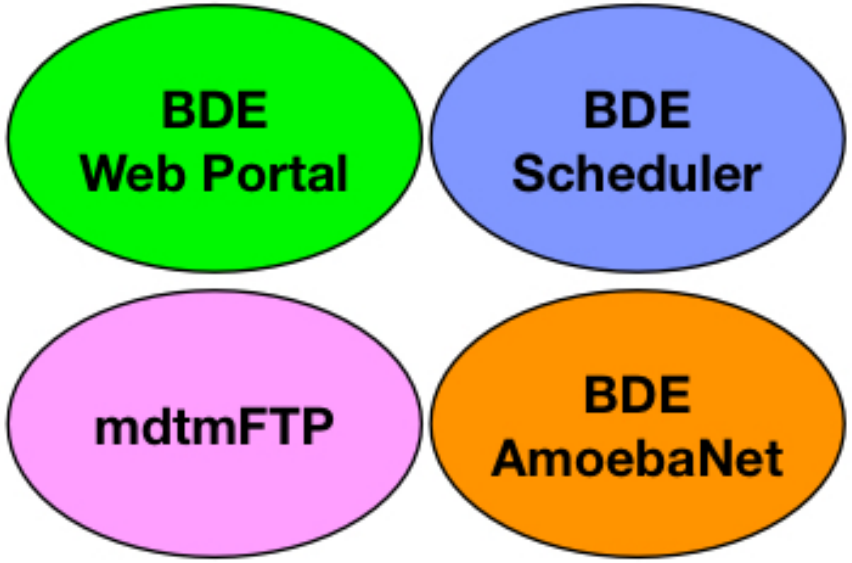
- Problem 1: Disjoint end-to-end data transfer loops
- Problem 2: Cross-interference between data transfers
- Problem 3: Existing data transfer tools and services are oblivious to user requirements
- Problem 4: Inefficiencies arise when existing data transfer tools are run on DTNs

BigData Express – Toward Schedulable, Predictable, and High-performance Data Transfer



BigData Express Components

- **BDE Web Portal**
  - A web portal that allows users to access BigData Express data transfer services
  - A distributed web application that allows BDE at different sites to coordinate and broker resources
- **BDE Scheduler**
  - DTN as a service
  - Co-scheduling of DTN, storage, and network
- **BDE AmoebaNet**
  - Network as a service
  - Allow applications to program networks at run-time for optimum performance
- **mdtmFTP**
  - a high-performance data transfer engine



Supports three types of data transfer

- Real-time data transfer
  - **BDE WebPortal + Scheduler + AmoebaNet + mdtmFTP**
- Deadline-bound data transfer
  - **BDE WebPortal + Scheduler + AmoebaNet + mdtmFTP**
- Best-effort data transfer
  - **BDE WebPortal + Scheduler + mdtmFTP**

BDE Web Portal

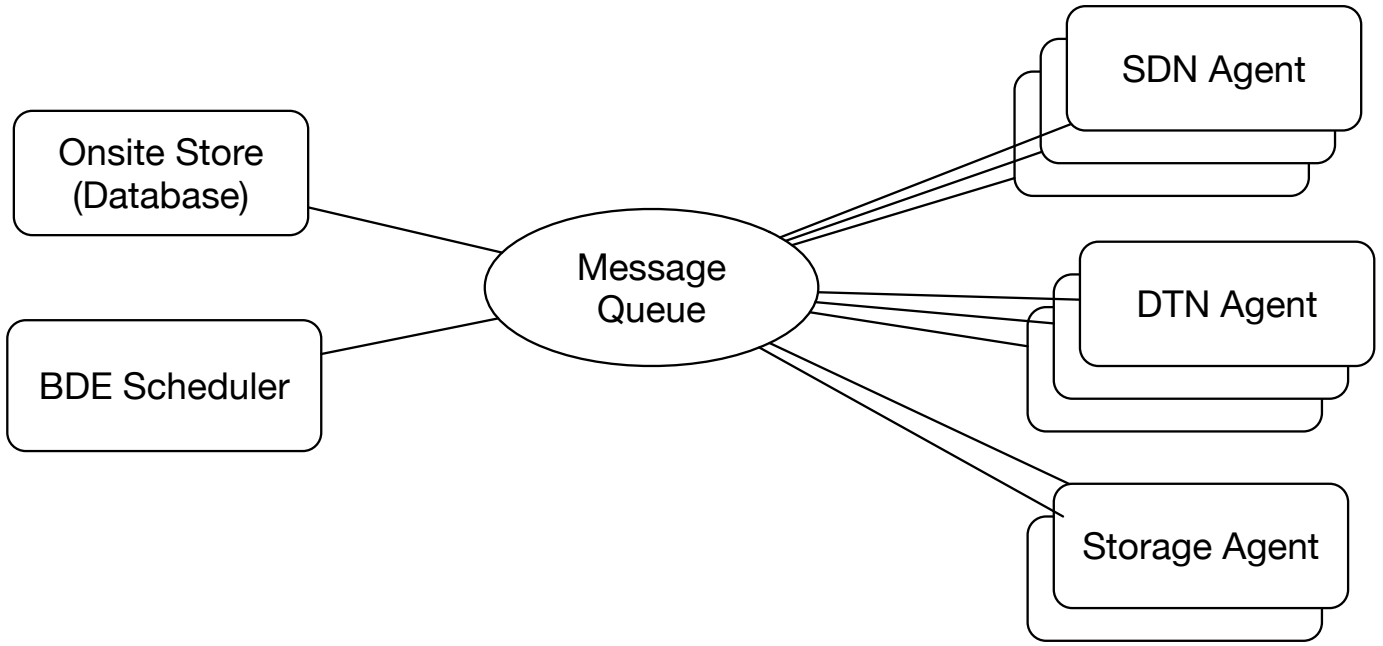
- Providing a visual interface to allow users to submit data transfer requests and obtain data transfer status
- Launching data transfer tasks on users/applications' behalves
- Providing HTTPS communication channels among BDE sites to support BDE mechanisms
- Allowing system admins to manage and monitor BDE sites
- A common single-point sign-on service - CILogon service – to obtain X.509 certificates for secure access to BDE sites
- http://bigdataexpress.fnal.gov/Releases.html

BDE Scheduler – Resource Management

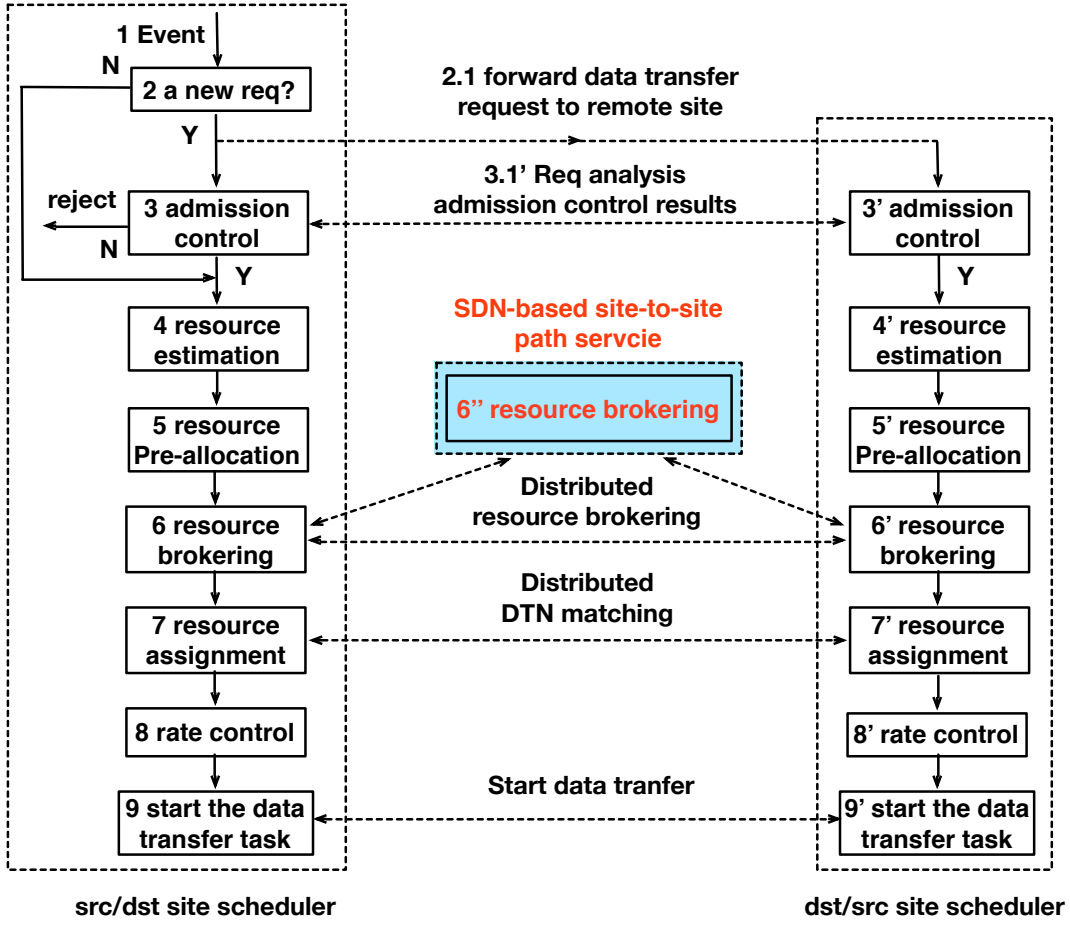
BDE scheduler manages site resources through various agents

- **DTN agents**
- **SDN agents**
- **Storage agents**

Use RabbitMQ as message bus to enable communication between BDE scheduler and agents



BDE Scheduler – Resource Orchestration



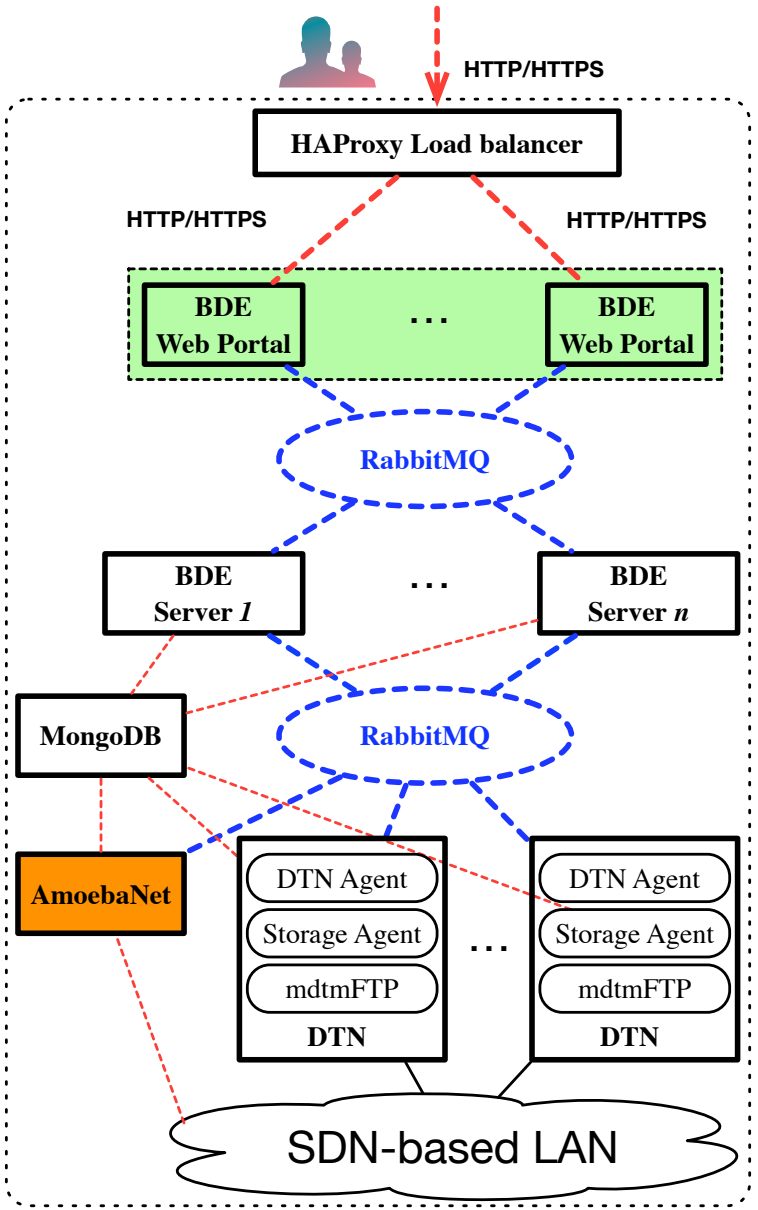
- Orchestrate resources at local sites
  - DTNs
  - Storage
  - Local network resources
- Negotiate resources with remote sites

AmoebaNet

- A SDN-enabled network service that provide “Application-aware” network
  - Allow application to program network at run-time for optimum performance
  - Network as a service
- Originally designed for BigData Express
- Can be independently deployed to support any applications
- Available at http://bigdataexpress.fnal.gov/Releases.html
- Docker release https://hub.docker.com/r/wenji/amoebanet/

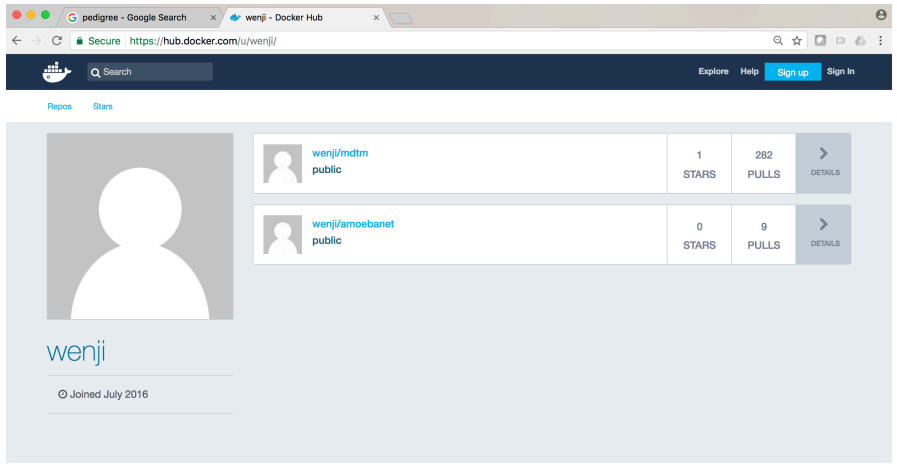
AmoebaNet

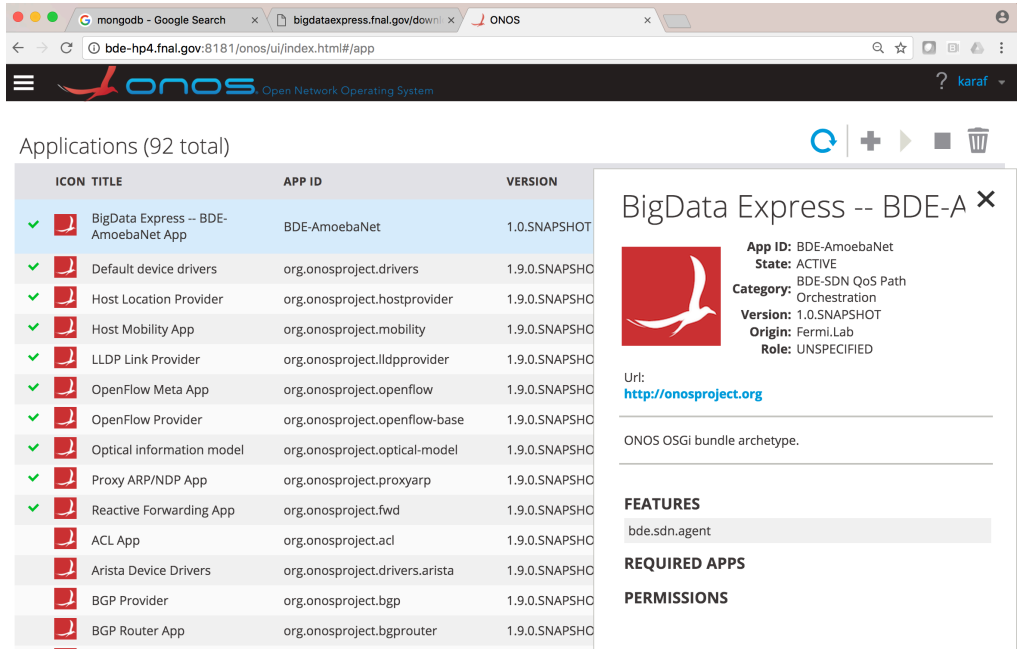
- Providing AMQP interface to allow application to program network at run-time for optimum performance
  - JSON-RPC style communication
  - Dynamic and flexible interaction with network
- Qos-based routing and path calculation
  - Bandwidth
  - Delay (coming soon)
- Fast provisioning end-to-end network path with guaranteed Qos
  - VLAN-based layer-2 path
  - TCP/IP-based layer-3 path
- REST-based network initialization and configuration



AmoebaNet

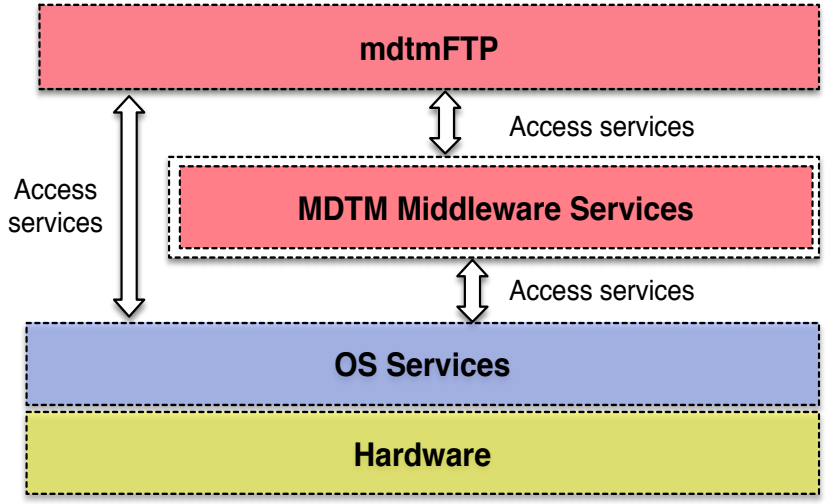
- AmoebaNet is implemented using Java upon ONOS
- 3K+ lines of code
- http://bigdataexpress.fnal.gov/Releases.html
- Docker release





mdtmFTP
A high-performance data transfer tool

- Pipelined I/O-centric design to streamline data transfer
- Multicore-aware data transfer middleware (MDTM) optimizes use of underlying multicore system
- Extremely efficient in transferring of Lots Of Small Files
- Various optimization mechanisms
  - Zero copy
  - Asynchronous I/O
  - Batch processing



A DOE/SC/ASCR-sponsored research project
Software is available at: http://mdtm.fnal.gov

BigData Express SC'17 DEMO

- BigData Express: a schedulable, predictable, and high-performance data transfer service
  - QoS-guaranteed data transfer
  - DTN as a service
  - Network as a service
  - Distributed resource brokering/matching

A DOE/SC/ASCR-sponsored research project

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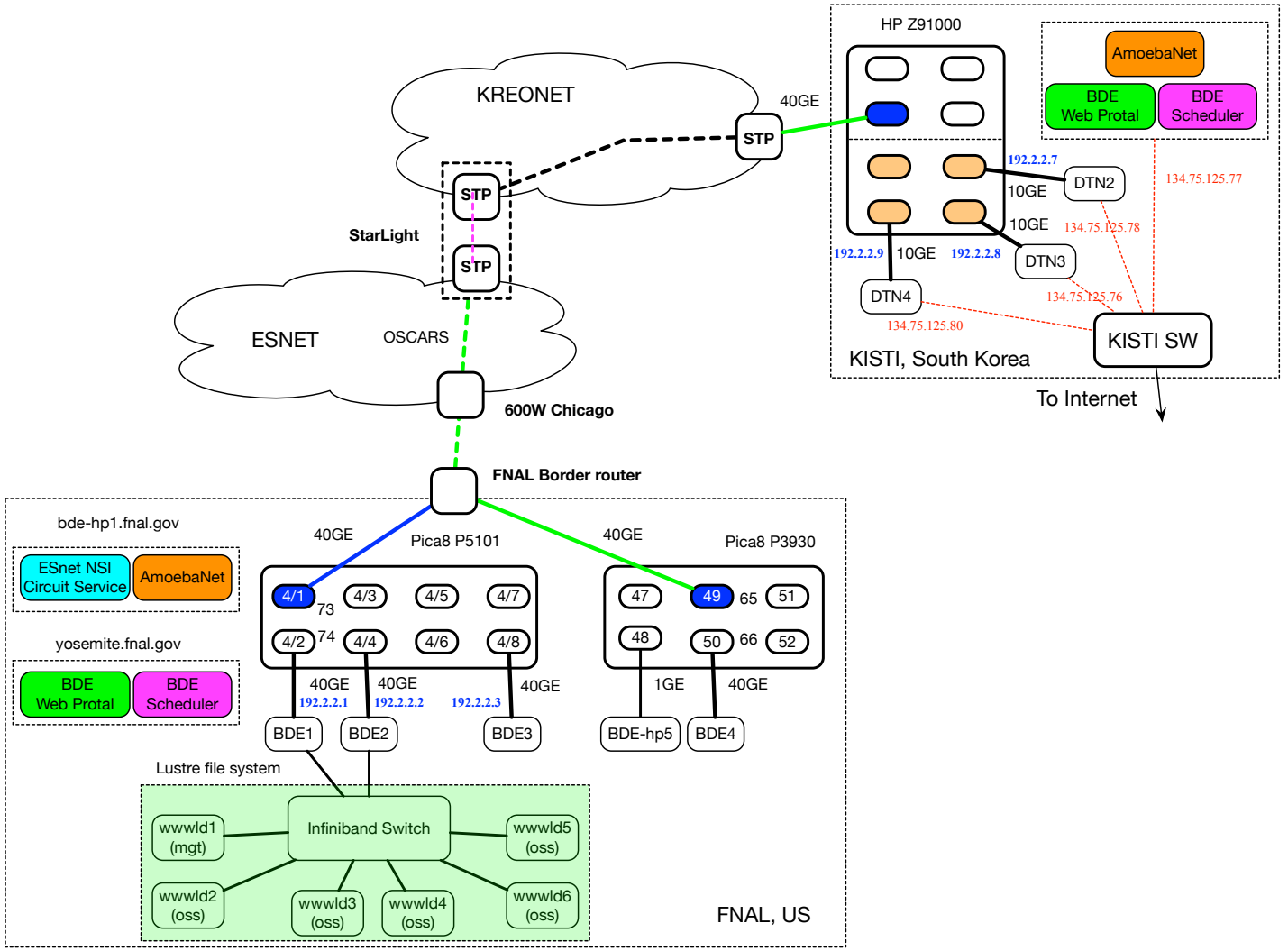
A Cross-Pacific SDN Testbed