

# SC23 Network Research Exhibition

## SENSE and Rucio/FTS/XRootD Interoperation

SC23-NRE-015 Abstract  
SENSE Rucio Workflow Services Team

### **Abstract**

This demonstration will show new mechanisms enabling better integration of advanced networks services into domain science workflows. These workflows typically coordinate and orchestrate compute and storage resources, and initiate associated data management/movement activities. High performance Research and Education (R&E) networks are a key infrastructure component needed for the data movement tasks. Currently the domain science workflow processes are forced to view the network as an opaque infrastructure into which they inject data and hope that it emerges at the destination with an acceptable Quality of Experience. There is little ability for applications to interact with the network to exchange information, negotiate performance parameters, discover expected performance metrics, or receive status/troubleshooting information in real time. Developing mechanisms to allow an application workflow to obtain information regarding the network services, capabilities, and options, to a degree similar to what is possible for compute resources is the primary motivation for this work.

This specific work is focused on the Open Science Grid (OSG) / Compact Muon Solenoid (CMS) Large Hadron Collider (LHC) workflows with Rucio/FTS/XRootD based data transfers and the interoperation with the ESnet SENSE (Software-Defined Network for End-to-end Networked Science at the Exascale) system.

### **System Description**

Guided by the framework and objectives described in the previous sections, a system vision and design has been developed, and a prototype

implementation has been completed which consists of the following key components:

- Rucio and SENSE Interoperation and Coordination
- Rucio and FTS Interaction
- FTS and Site DTN Cluster Interaction
- SENSE and Network Service Provisioning
- SENSE and Site Data Flow Integration with Network Services

Figure 1 shows an architecture and workflow diagram which includes each of these areas. A brief description of each of the key components is provided below.

Rucio is the entity which has data location awareness and decides which data needs to be moved between sites in support of higher level LHC workflows. Rucio formulates detailed data movement commands and instructs the File Transfer Service (FTS) to move the data. FTS acts as a data movement queue and interacts with the XRootD clusters at the sites to initiate and monitor data movement.

SENSE (Software-Defined Network for End-to-end Networked Science at the Exascale) provides the mechanisms to enable multi-domain orchestration for a wide variety of network and other cyberinfrastructure resources in a highly customized manner.

For this project we introduce an interaction between Rucio and SENSE to enable assignment and management of flow priority which will be reflected in network services provisioning. The objective is to provide Rucio with an ability to identify which flows should have higher priority in terms of network resources, and then adjust that

over the lifecycle of the data movement operations.

A key objective of this early work is to minimize the impacts and changes needed to the current Rucio implementation and operations. As a result, in this architecture a Data Movement Manager (DMM) has been introduced. The DMM translates Rucio requests into more specific network services requests that the SENSE Orchestrator can act upon. Future implementations may result in this DMM being integrated into Rucio, the SENSE Orchestrator, or remaining stand alone. For this initial work, Rucio sends a request to DMM which will include the following: data amount, source site, destination site, relative priority.

Figure 2 provides a description of the messaging workflow between the Rucio, DMM, and SENSE.

Figure 3 shows the deployment sites and typical site architecture.

Additional details regarding this system are available in the following paper:

- Data Transfer and Network Services management for Domain Science Workflows, 2022 Mar 15, <https://arxiv.org/abs/2203.08280>

### **Goals**

The SC23 goal of this experiment is to showcase the interoperation between SENSE enabled network services and CMS focused data transfers using the Rucio and FTS systems. This early work is intended to show a proof of concept for data movement systems that can interact with the network to optimize their operations. Another objective is to facilitate more detailed community discussions regarding how the independent and autonomous workflow and network systems can cooperate and adjust in real time to provide improved domain science system performance and also better network utilization.

### **Resources**

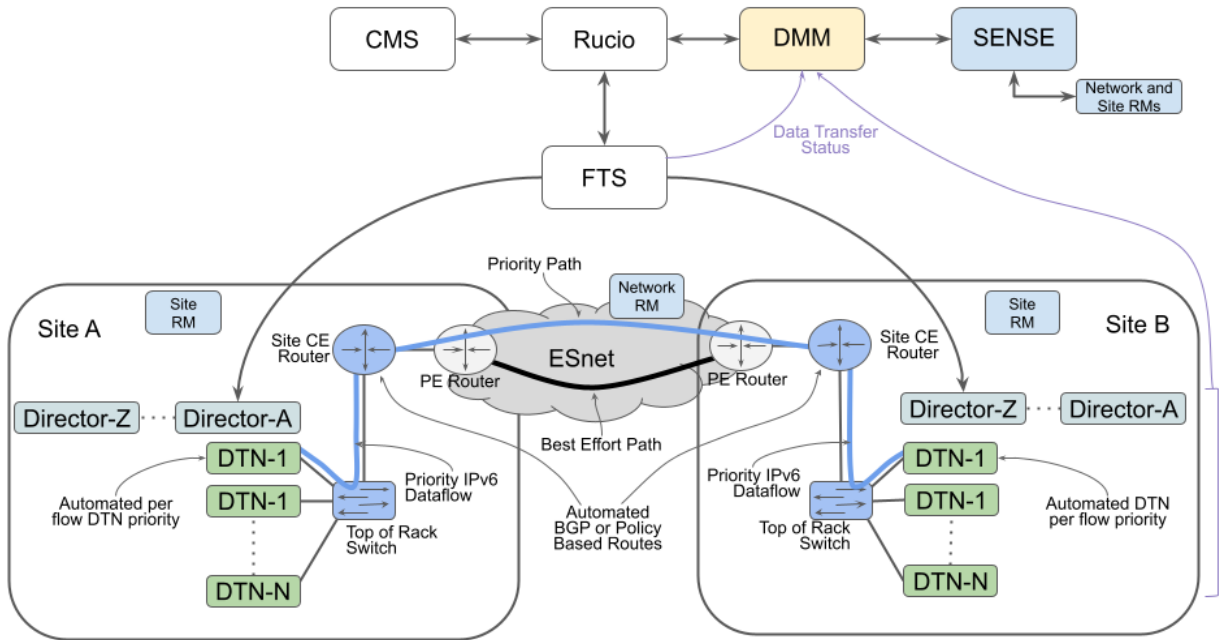
This NRE demonstration will be conducted using resources of the collaborating domains, see

Involved Parties. This will include resources at UCSD/SDSC, Caltech, ESnet, Fermilab, CERN, University of Nebraska Lincoln, and across the AutoGOLE infrastructure. Additional sites may include Vanderbilt University and SPRACE (São Paulo Research and Analysis Center). These may also be included in this demonstration depending on deployment decisions and progress.

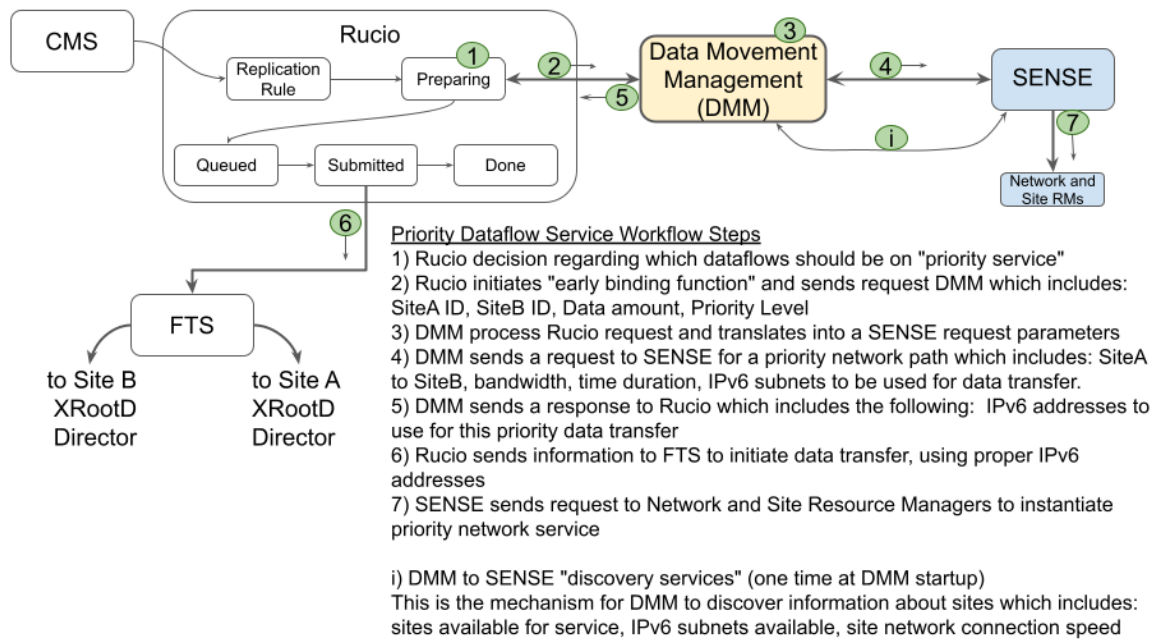
This NRE demonstration will use the AutoGOLE/SENSE infrastructure external to the SC23 in addition to links into the SC23 Exhibit Floor from StarLight in Chicago and CENIC in the Los Angeles area.

### **Involved Parties**

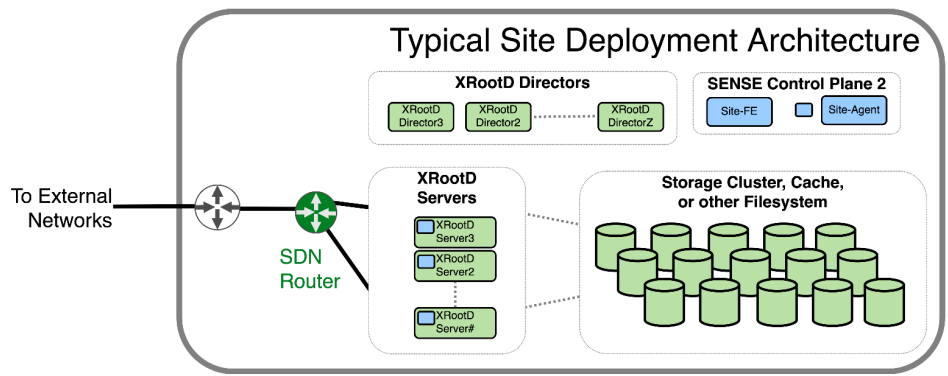
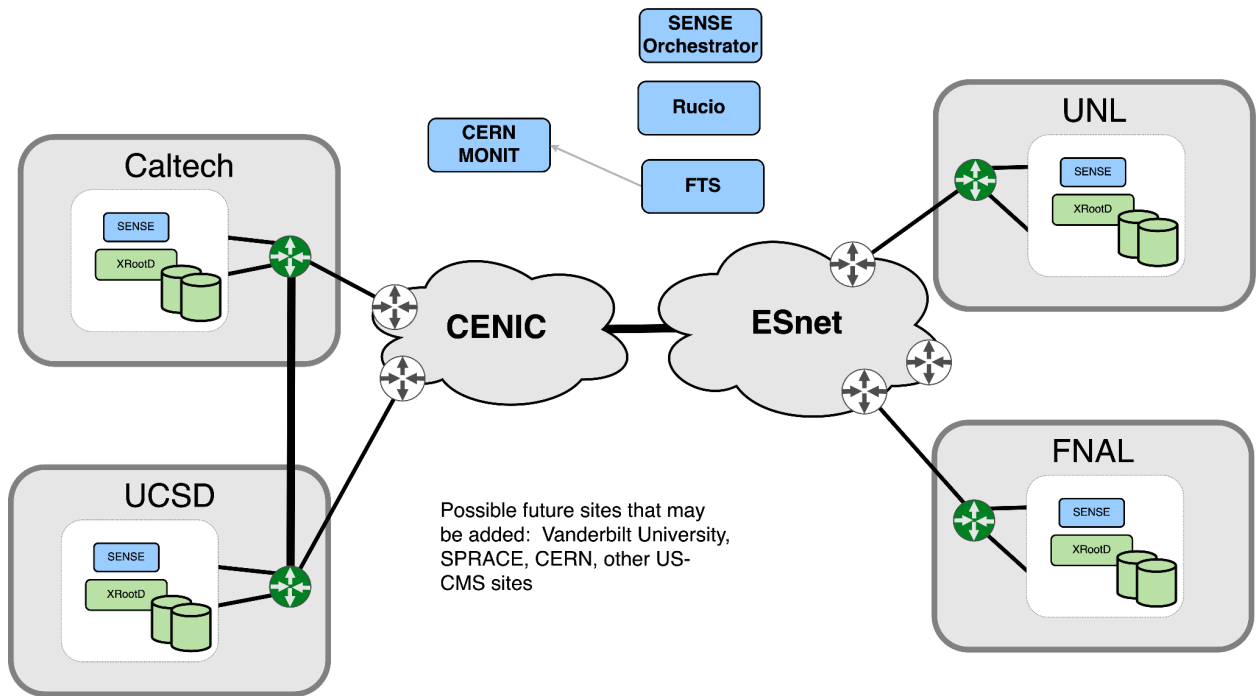
- Tom Lehman, ESnet, <tlehman@es.net>
- Xi Yang, ESnet, <xiyang@es.net>
- Chin Guok, ESnet, <chin@es.net>
- John Graham, UCSD, <jjgraham@ucsd.edu>
- Tom Hutton, UCSD, <hutton@sdsc.edu>
- Frank Wuerthwein, UCSD, <fkw@ucsd.edu>
- Igor Sfiligoi, UCSD, <isfiligoi@sdsc.edu>
- Aashay Arora, UCSD, <aaarora@ucsd.edu>
- Dima Mishin, UCSD, <dmishin@ucsd.edu>
- Diego Davila, UCSD, <didavila@ucsd.edu>
- Jonathan Guiang, UCSD, <jguiang@ucsd.edu>
- Harvey Newman, Caltech, <newman@hep.caltech.edu>
- Justas Balcas, Caltech, <jbalcas@caltech.edu>
- Preeti Bhat, Caltech <preeti@caltech.edu>
- Raimondas Sirvinskas <raimis.sirvis@gmail.com>
- Phil Demar, FNAL, <demar@fnal.gov>
- Oliver Gutsche, FNAL, <gutsche@fnal.gov>
- Garhan Attenbury, UNL, <garhan.attebury@unl.edu>
- Andrew Melo, Vanderbilt University, <andrew.m.melo@accre.vanderbilt.edu>



**Figure 1 SENSE and Rucio/FTS Interoperation Design**



**Figure 2 SENSE and Rucio/FTS Interoperation Workflow**



**Figure 3 SENSE Rucio/FTS/XRootD System Deployment**