

SC22 Network Research Exhibition

SENSE and Rucio/FTS/XRootD Interoperation

NRE-015

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.

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 SC22 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, and across the

AutoGOLE infrastructure. This project has plans to include future sites, possibly at FNAL, University of Nebraska Lincoln, and Vanderbilt University. 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 SC22 in addition to links into the SC22 Exhibit Floor from StarLight in Chicago and CENIC in the Los Angeles area.

Involved Parties

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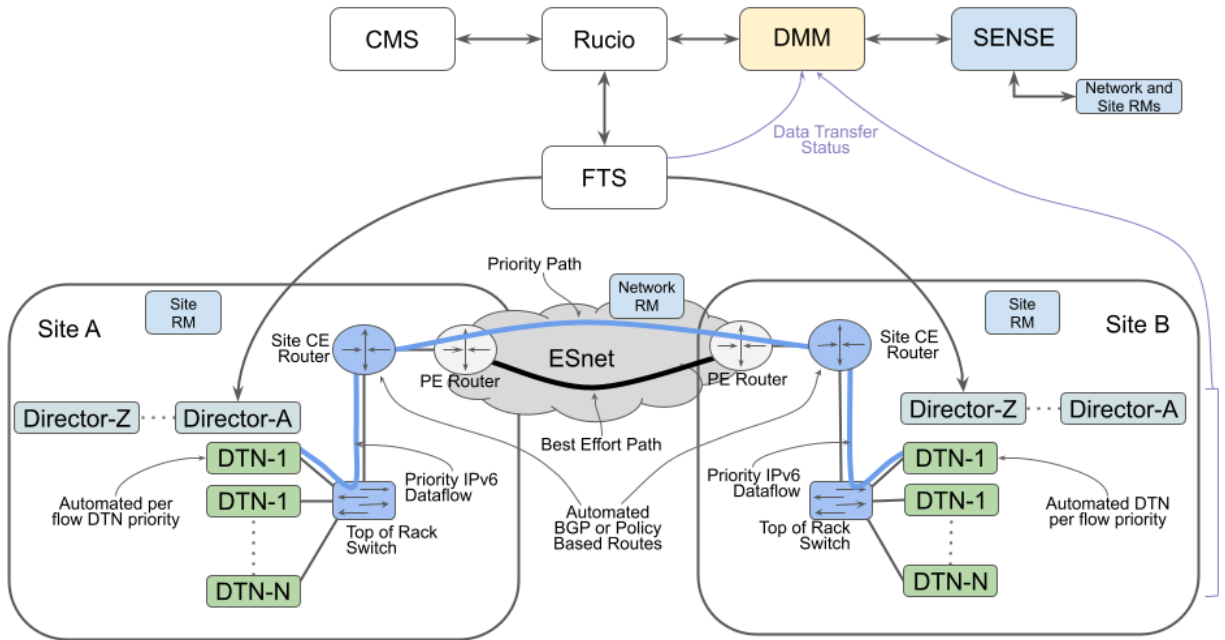


Figure 1 SENSE and Rucio/FTS Interoperation Design

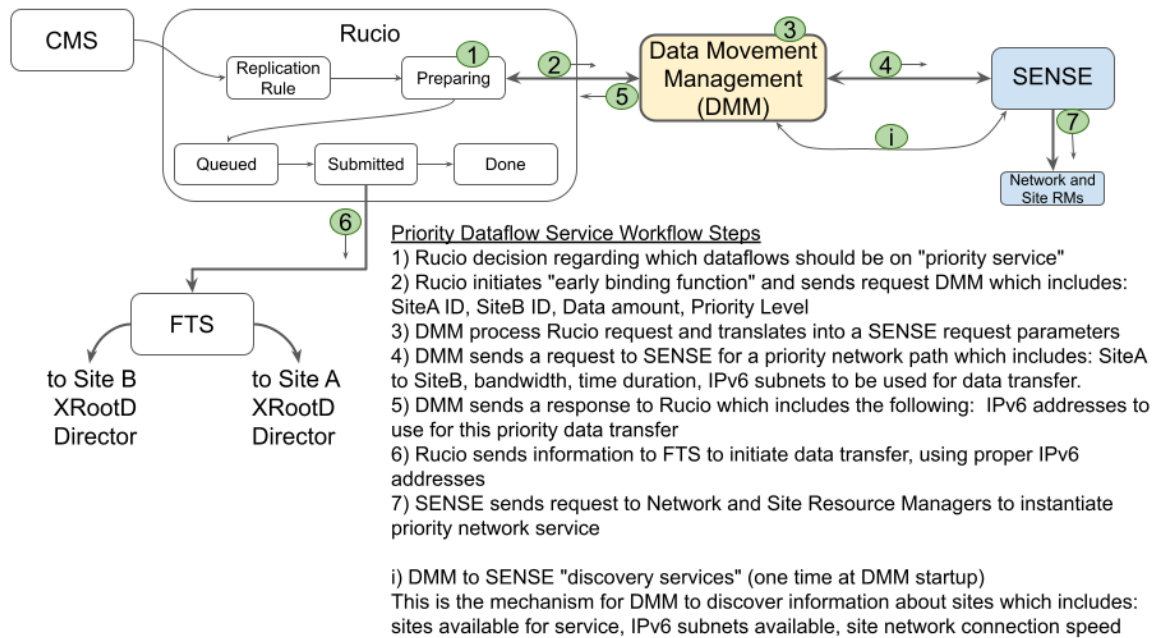


Figure 2 SENSE and Rucio/FTS Interoperation Workflow