SC22 Network Research Exhibition: Demonstration Abstract

LHC Networking And NOTED

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Abstract

This NRE abstract describes an experimental technique, NOTED (Network Optimized for Transfer of Experimental Data), being developed by CERN for potential use by the Large Hadron Collider (LHC) networking community. This SC22 NRE will demonstrate the capabilities of NOTED using an international networking testbed.

Overview

The goal of the NOTED project is to optimize transfers of LHC data among sites by addressing problems such as saturation, contention, congestion, and other impairments.

The Worldwide LHC Computing Grid (WLCG - a global collaboration of approximately 200 interconnected computing centers) provides global computing, storage, distribution, and analytic resources supporting physics experiments using data generated by the (LHC) experiments at CERN. The WLCG's three tier structure (Tier 0 at CERN, Tier 1, and Tier 2 sites are interconnected by global high performance multi-domain networks, the LHC Optical Private Network (LHCOPN) and the LHC Open Network Environment (LHCONE). Currently, the LHC networking community is preparing for a significant increase in required network capacity, for example to manage the flows expected from the High Luminosity LHC.

The NOTED optimization method employs a combination of a) a deep understanding of the network traffic acquired by an analysis of the data flows with b) an appropriate response (e.g., dynamic allocation of additional capacity) to specific patterns detected among those flows.

For the WLCG, these data flows are generated by the File Transfer Service (FTS). NOTED has information about (and an interface to) job queues using FTS and Rucio. NOTED obtains FTS information about these flows from the Computing Resource Information Catalog (CRIC) database (http://cms-cric.cern.ch), specifically to identify the site network prefixes (IPv4/IPv6) of the storage elements generating and/or receiving the flows. No specific information on network topologies or configurations is required.

Aggregation is a key next step, the grouping of transfer information. This aggregation stage is a critical element for the decision making process. This step enables combining multiple totally independent FTS decisions to provide a comprehensive overview that allows an assessment of potential impacts by all flows on one or more network path segments, i.e., allowing anticipation of future contention/congestion.

This process also allows for the classification of transfers and the detection of those that will generate or are generating large volumes of network traffic and group endpoints by specific sites (prefixes), aggregating sites. Because this process has its own custom designed controller, this information can be used for decision making (match action/response), e.g., via dynamic controller configurations allowing potentially for full automation of decision-making regarding network allocations and reconfigurations. Decision making can involve an almost unlimited number of variables, singly or in combination, such as sites, specific flows, priorities, capacity required, capacity available, impairment issues, e.g., congestions, timing/scheduling/duration considerations, and others.

To optimize such decision making, this project is using the AI Conv-LSTM model to forecast traffic, using behavior patterns, within a time window, e.g., 5 min. As an initial experiment, the model was trained to predict traffic based on information about transfers from FTS (from TRIUMF/SFU Tier 1 to Tier0/Tier1). 2. from TRIUMF/SFU to Tier0/Tier1 and from Tier0/Tier1 to TRIUMF/SFU. This forecasting has been based on aggregated information about transfers from the previous 20 minutes.

NOTED makes use of the SENSE/AutoGOLE provisioning system to provide additional bandwidth between CERN and TRIUMF when a large and long lasting data transfer is detected.

AutoGOLE is a worldwide collaboration of Open eXchange Points and Research & Education networks that delivers end-to-end automated network services, relying on connection requests using the Network Service Interface Connection Service (NSI-CS, a technology agnostic interface). Increasingly, R&E networks across the globe use NSI to provision and release international L2 network services to facilitate multi-domain network service requests, provisioning circuits within minutes.

Goals

The SC22 goal of this NRE experiment/demonstration is to showcase the capabilities of NOTED for optimizing WAN transport of data intensive science.

Resources

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

Global high-bandwidth paths among Open Exchange Points and the SC22 venue.

Open Exchange Points, including CERNLight, NetherLight, the Montreal Open Exchange (MOXY), and the StarLight International/National Communications Exchange Facility.

This demonstration will also utilize SC22 SCinet WAN paths among multiple sites.

Data Transfer Nodes (DTNs), which are important resources for data intensive science such as the high energy physics (HEP) community. (DTNs across the world allow for fast and efficient transport of data over long distances, in part via caching mechanisms.)

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