

LAMBDA STATION: A NETWORK PATH FORWARDING SERVICE TO INTERFACE PRODUCTION NETWORK FACILITIES TO ADVANCED RESEARCH NETWORK PATHS

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Project Description:

Lambda Station is a network service which mediates secure alternate path access on demand between major storage & analysis installations and high performance, advanced wide-area networks (WANs). The WANs may be intermittently available, dedicated to certain purposes, subject to reservation, and/or requiring special path setup. Access is carefully managed to robustly switch selected flows to the high-performance path, either before connection setup or while the flows are already in progress, and switch them back to the production path when the high-performance path is no longer available, or when the traffic volume no longer warrants its continued use. Lambda Station removes the need for multiple network connections on major scientific storage and analysis facilities, which would add unwanted cost and complexity. It also eliminates any need for network-intensive applications to be taught path setup and access methods in order to utilize high bandwidth advanced WANs.

Specific objectives of the Lambda Station project:

- Dynamic alternate path selection
- Graceful cutover and fallback
- Per flow granularity on alternate path forwarding

Project Design:

Lambda Station is a software project. From a design perspective, the Lambda Station service has four logical components:

- Lambda Station Controller
- Network Reconfiguration Module
- Local Configuration Schema
- Application Awareness

The first three components reside on the Lambda Station server, a system dedicated to providing the service. The fourth component resides within applications on host systems seeking to use the service.

Lambda Station Controller: The central logic for Lambda Station. Includes interface definitions and protocol specifications for external communications with applications & other Lambda Stations. It includes a scheduler that maintains state information on Lambda Station service requests.

Network Reconfiguration Module: The component that establishes & tears down alternate network paths. It modifies local network infrastructure dynamically with policy-based routing (PBR) entries for selective forwarding of data flows. Perimeter ACLs are appropriately toggled. It also coordinates scheduling, setup, & teardown of advanced WAN paths.

Local Configuration Schema: A database that defines network configurations specific to the local Lambda Station environment and necessary for the service. This includes alternate WAN path definitions, PBR clients (paths), local clients (hosts), and requestors identity information. Information on at least one remote Lambda Station is needed, with dynamic exchange of known Lambda Station information.

Application Awareness: The capability in an application to request Lambda Station service. In addition to interfacing to the Lambda Station server, this means marking Differentiated Service Code Points (DSCP) within packets appropriately for service. It also means exchange of Lambda Station

awareness between local and remote applications.

Project Accomplishments To Date:

Approaching completion of its first year in development, the Lambda Station project now demonstrates full cycle functionality. Specifically:

- Lambda Station Controller:
 - Supports a fully functional service ticket request process, including coordination with the remote end Lambda Station server.
 - Provides a defined interface with 20 primitives, utilized for client host and peer Lambda Station coordination.
 - Based on SOAP server, utilizing basic authentication via SSL (today).
 - Peer Lambda Station dynamic information exchange
- Network Reconfiguration Module:
 - Provides dynamic PBR forwarding setup & teardown in both directions, and across multiple local routers. PBR forwarding based on IP source/dest. pair & assigned DSCP code point.
 - Concurrent ACL entry modification on alternate path perimeter to enable, then shut down access for designated flows.
 - Functional WAN path setup, manual at present, but capable of automated setup, when suitable WAN interfaces exist.
- Application Awareness:
 - Lambda Station aware versions of Iperf (LSIperf) & Traceroute (LSTraceroute) developed.
 - Progress on developing Lambda Station awareness in Storage Resource Manager (SRM), & GridFTP client - server Lambda Station setup/teardown coordination.
- Lambda Station Testing:

- Successful end-to-end, full duplex tests across UltraLight & UltraScience Net
- Tests on impact of alternate path cutover & fallback successfully completed.
- Graceful cutover & fallback demonstrated, including dynamic adjustment for larger available path MTU.

Project Impact:

The testing and deployment next steps for this project are to integrate the Lambda Station client capability into the standard Grid storage system, SRM. Once this functionality is in place, high impact data transfers between DOE-funded LHC physics Tier-1 and Tier-2 centers in the US will be conducted. Future development of Lambda Station will focus on preparing for diverse deployment environments, varying in how sharply the clients are able to identify their high-impact traffic, how tightly the calls to Lambda Station are coupled to the applications, and how much control Lambda Station is permitted over site routers. The Grid-secured service-oriented architecture of Lambda Station makes it readily usable by Grid applications with proper authorization.

Summary:

Lambda Station is a research project intended to enable production-use systems and storage facilities to make use of advanced research networks or other alternate network paths. It is based on the concept of dynamic reconfiguration of production local area networks for select forwarding of specific data flows. If the research project proves to be successful, it could enable DOE-supported data-intensive science research programs, such as high-energy physics, to make effective use of emerging optical network technologies and the high bandwidth capacity they offer.

Additional information available at:

<http://www.lambdastation.org>