A Collaborative Network Middleware Project by Lambda Station, TeraPaths, and Phoebus

Current Deployment

BOSTON UNIVERSITY
Phoebus
NYSERNet
Phoebus
HEAnet
GEANT2
Phoebus
PIONIER
OSCARS
INTERNET2
AutoBAHN
grnet
Phoebus
cenic
merit
MiLR
ESnet
OSCARS
UltraLight
Fermilab
BROOKHAVEN NATIONAL LABORATORY
GPN
UNIVERSITY OF MICHIGAN

WAN Circuit Services
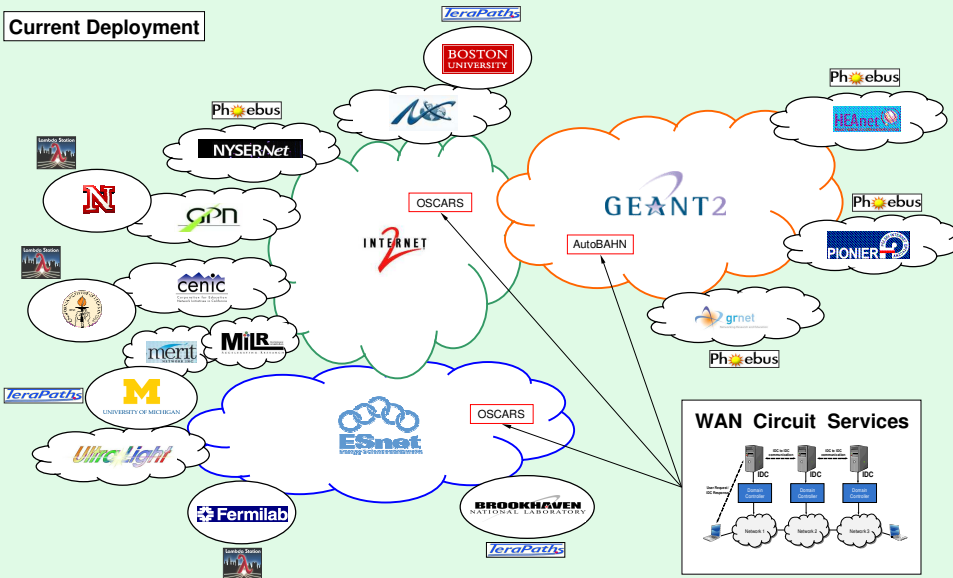
The TeraPaths, Lambda Station, and Phoebus projects were funded by the Department Of Energy's (DOE) network research program to support efficient, predictable, prioritized petascale data replication in modern high-speed networks, directly address the "last-mile" problem between local computing resources and WAN paths, and provide interfaces to modern, high performance hybrid networks with a low entry barrier for users. Within the framework of the three projects, we successfully developed services that establish on-demand and manage true end-to-end, Quality-of-Service (QoS) aware, virtual network paths across multiple administrative network domains, select network paths and gracefully reroute traffic over these dynamic paths, and streamline traffic between packet and circuit networks using transparent gateways. These services function as "network middleware" and improve network QoS and performance for applications, playing a critical role in the effective use of emerging dynamic circuit network services. They provide interfaces to applications, such as dCache SRM, translate network service requests into network device configurations, and coordinate with each other to setup up end-to-end network paths.

Building upon the success of the three projects, which target the same user community, utilize compatible technologies, and have similar goals, we work together to research and develop the next generation of network middleware. We address challenges such as cross-domain control plane signaling and interoperability, authentication and authorization, topology discovery, and dynamic status tracking. Our roadmap is to co-design network models that ensure effective inter-domain topology discovery and network utilization, utilize the perfSONAR infrastructure to monitor dynamic circuit status and measure performance, enhance Grid authentication and authorization to support inter-domain trust, and integrate our joint work with the Inter-Domain Control plane efforts (IDC). The new network middleware will be deployed and fully vetted in the Large Hadron Collider data movement environment.

Lambda Station
www.lambdastation.org

- LSController – synchronizes work of all services, has control functions
- LSI - unified interface for intercommunication between LS and applications, and LS-to-LS
- LSDiscovery service – detects new lambdastations, and flow-based entities at remote and local sites
- LSRESource Scheduler – estimates bandwidth allocation, monitor real-time usage of resources
- NETWORK CONFIGURATOR – dynamic reconfiguring of LAN and WAN

- An alternate network path selection service
- Initiates setup & tear down of dynamic circuits
- Reroutes flow-based application traffic over circuit path
- Graceful cutover and fallback on path changes
- On-demand from applications (authentication & authorization)
- Deployed between Fermilab & LHC CMS Tier-2 sites at Univ. of Nebraska and Caltech

FNAL – Nebraska 7.9 Gbps with Production Data, LambdaStation Software (FNAL + Caltech)

Note there are 16 Tier2s and 66 Tier3s in US CMS and US ATLAS

Lambda Station Live Demo during Rick Summerhill's presentation at Internet2 FMM07

TeraPaths
www.terapaths.org

TeraPaths live demo at SC08: simultaneous regulation of two flows within the same WAN circuit
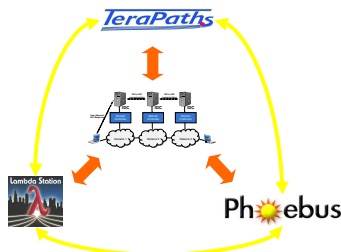
- Transparently provides end-to-end (end-host-to-end-host) paths with **QoS guarantees** at the individual data flow level
- Regulates, classifies (prioritizes) traffic
- Directs traffic into dynamically or statically configured WAN paths
- Directly configures end site LAN devices: utilizes DiffServ to condition traffic and PBR to direct traffic into L2 paths
- Automatically reserves L2 paths (circuits) within ESnet SDN and I2 DCN and L3 paths (MPLS tunnels) within ESnet SDN by invoking the OSCARS API
- Bandwidth of L2/L3 paths can be shared by multiple flows with QoS guarantees for each individual data flow

---

Phoebus
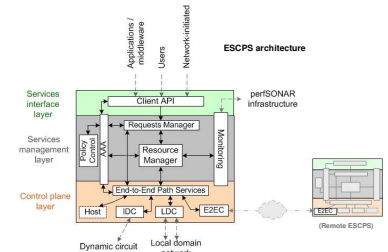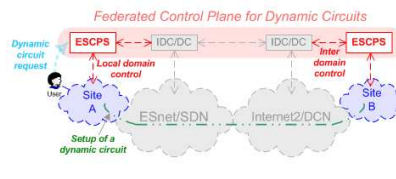http://e2epi.internet2.edu/phoebus.html

- Phoebus Gateways are placed at network access points and can be thought of as network "on-ramps"
- At a high level, the goal is to get network data to these gateways which can then intelligently move the data as efficiently as possible to the other edge of the network
- Phoebus will automatically utilize DCN resources as needed and as available
- At the other edge, it again appears as legacy traffic does today, thus neither client or server need to be modified

Phoebus Gateway
TCP/IP Connection
Dynamic Circuit

Host — Regional Network — Packet Network — Dynamic Circuit Network — Regional Network — Host

---

1st goal: interoperability

TeraPaths
Lambda Station
Phoebus

2nd goal: create the next generation: ESCPS (End Site Control Plane System)

Federated Control Plane for Dynamic Circuits

Dynamic circuit request
ESCPS ↔ IDC/DC ↔ IDC/DC ↔ ESCPS
Local domain control
Inter domain control
Site A — ESnet/SDN — Internet2/DCN — Site B
Setup of a dynamic circuit

ESCPS architecture
Applications / middleware — Users — Network-initiated
Services interface layer — Client API — perfSONAR infrastructure
Services management layer — Requests Manager — Resource Manager
Control plane layer — End-to-End Path Services
Host — IDC — LDC — E2EC — E2EC (Remote ESCPS)
Dynamic circuit control plane(s) — Local domain network infrastructure

---

BROOKHAVEN NATIONAL LABORATORY   Fermilab   UD