Grid optimized Network Control Plane

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Agenda

- Grid Application requirements on Carrier Networks
- Current practices:
  - The overlay case
  - Grids - Network Management interconnections
- Practical experiences:
  - ARGON and Meta-scheduler
- Levels of Grid Application - Network Control integration
- Standard Organization Synergy outlooks
Grid Applications are Shared

- Grids are geographically distributed and connected by a wide-area network
- Grids are heterogeneous in many Resource aspects: computing, storage, sensor/instruments
- A collection of Grid services can “dynamically” be established and then leave the Grid
- Grid Application Servers are shared and accessed “on-demand” by a set of Grid session through Grid Middleware services
Convergent Carrier Networks are Shared

- Network Infrastructure is a collection of switching technologies (regions): e.g. Ethernet Wavelength, SONET/SDH, IP/MPLS and others
- Network infrastructures is enabled to provide different Connectivity Services to its users
- Network infrastructure is shared between different class of application users
- Operational Network is able to reconfigure its connections with its control plane
Network Connectivity services for Grids should rely on:

- **Multipoint Connectivity Services**
  - A Grid session interconnect multiple resource end points

- **Inter-Domain Traffic Engineering extensions**
  - A Grid session can span several Administrative domains

- **Multi-Switching Capability Connections**
  - A Grid session can be transported by several network layers and/or cross several network regions

- **Different Signaling options for Network Resources**
  - In advance: scheduled bandwidth requests
  - Real-time: immediate bandwidth provisioning
Grid Application Requirements on the Network (con’t)

In most of the cases Grid applications are overlaid on the Network infrastructure and do not communicate their QoS requirements:

- Dedicated resources or over-provisioning are required to sustain the highest value of QoS needed
- Shared resources and no QoS (best-effort)

Enhancements of Grid Application → Network control interactions are required to

- Allow network control plane to deliver dynamically connectivity with the correct QoS values
- Configure Network according to Grid application needs, (re)configuration should be fast, accurate and automatic
- Orchestrate end-2-end Grid and Network resources
Application Users request Grid Services to the Servers through the Middleware Application triggering e.g. XML/HTTP/TCP/IP session(s).
Specifications for Grid applications to interact with its transport network

Specifications for more Grid → Network interactions:

- Control for resource discovery, resource selection and signaling is more uniform
- Virtualization for Grid and Network Resources:
  - To control the resources allocated during a Grid session
- Grid applications can provide directly their QoS requirements to shared controlled network
- End-to-end resource cross optimization is enabled:
  - end Grid resources: CPU, storage, instruments; and
  - network resources: bandwidth with QoS guarantees
Integrated Model: exploits the control functions

- Integrated (Grid+Network) Control relies on resource virtualization with combined resource discovery, selection and reservation.
- Coupling Grid Sessions and Connections set-up/release enable efficient use of the resources at multiple sites.
- Grid sessions express its bandwidth needs, and Network establishes very quickly an exclusive VPN.

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Compendium of architectures and functionality alternatives

- **Level 0**: Application - Network Resources are disjointedly controlled: no hook
  - End-Hosts solely drive the Grid applications operations on a full provisioned network

- **Level 1**: Management plane based system: Grid - NMS
  Middleware interactions: “Gateway” hook
  - Grid / Connection requests are centralized

- **Level 2**: Application Control functions - Network Control functions interactions:
  - Grid / Connection Controls are integrated and can be distributed
  - Cross-optimization between Grid and Network Resources enabled at each location and globally
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«Application – Network hook» where ?

Level 0 ?

Level 1 ?

Level 2 ?

Network Management

RSVP

(S)RTCP

RTP

SIP

HTTP

Application (Web-Service)*

Media Encoding

SDP

SOAP

SigComp

TCP/SCTP

IPv4 / IPv6

Network Resources

DHCP

DNS

UDP

reserve/allocate

* e.g. GRAAP

possible configuration

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Level 1 example: ARGON - Network Architecture Allocation and Reservation in Grid-enabled Optic Networks

Overlay Model case:
- Optical domain is not visible to IP domain
- MPLS domain can not perform efficient TE (two Routing AS)
- GMPLS UNI signaling

Multi-Region Network

Proxy-UniClient
- Alcatel
- Database
- SNMP Server
- CLI
- ARGON
- Administration
- Service provisioning

GMPLS Switch
- Controller
- Auto Discovery
- Listener
- RSVP
- SNMP Client
- UNI

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1) User specifies Job
2) MetaScheduling Request (WS-Agreement)
3) Negotiation and Reservation
4) MetaScheduler Reply (WS-Agreement)
5) Job transfer to UNICORE System
6) All Job Components including Network QoS are provisioned automatically

Level 1: Meta-Scheduling Service – Architecture

1) User specifies Job
2) MetaScheduling Request (WS-Agreement)
3) Negotiation and Reservation
4) MetaScheduler Reply (WS-Agreement)
5) Job transfer to UNICORE System
6) All Job Components including Network QoS are provisioned automatically
Grid sessions span several Administrative Domains

- A set of automated procedures for non-technology specific inter-domain: AAA, Negotiation, Pricing can be required
- Connection signaling may not be uniform end-to-end precluding end-to-end controls

* From Geant2 / Afrodite Sevasti
Level 1 → 2: Grid Application / Network Resources Provisioning sequence

- Grid Application requests intercepted by the network controllers for delivering the connection with the exact QoS
Level 2: Grid Application Server Discovery

- Joint Resource Advertisements for Grid + Network
- Combination of Grid Application and Network protocol discovery
Level 2: Grid aware Network Resource Signaling

- Joint Signaling for Grid + Network Resource Reservation
- Combination of Grid Application and Network protocol signaling to accommodate Grid information Resource Request/Reserve message exchanges

Grid Session X resource signaled:
- Computer:
  - # of CPUs: 32
  - CPU processing: 1 Ghz
  - CPU Memory: 500 MBytes
- Storage:
  - Local HD: 50GBytes
  - Back-up: 50GBytes
  - Encryption: high

Grid Session Y resource signaled:
- Storage:
  - Local HD: 250T Bytes
  - Back-up: 500GBytes
  - Encryption: high

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Standards Organizations and Fora Working on Control Network Standards or Specifications

ITU-T Rec.s
• Architecture
• Protocols
• Management

RFCs
• Protocols

Impl. Agreement.
• Protocols

OIF
OPTICAL-INTERNETWORKING-FORUM

MTNM
• Info Model

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OGF: Open Grid Services Architecture and its Control functions

- **Execution Management**
  - Job description & submission
  - Scheduling
  - Resource provisioning

- **Data Services**
  - Common access facilities
  - Efficient & reliable transport
  - Replication services

- **Resource Management**
  - Discovery
  - Monitoring
  - Control

- **Information Services**
  - Registry
  - Notification
  - Logging/auditing

- **Self-Management**
  - Self-configuration
  - Self-optimization
  - Self-healing

- **Security**
  - Cross-organizational users
  - Trust nobody
  - Authorized access only

OGSA "profiles"

Web services foundation

From: «OGF Standards Activity» - Steven Newhouse

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Any Level of Integration requires Synergies

- Control Integration raises Scalability issues
  - Performance associated messaging / processing have to be carefully analyzed for design
  - Grid Session Dynamic constraints are not uniform
- Integrated approach enables distributed Control capabilities for Grid Applications and Networks
  - Rapid, Flexible and Uniform
- Uniform Control enables richer interactions between the Network and the Grid applications
- Liaisons / Synergies between the Standard organizations are needed and will have to be established