Network stratum

➢ Sub-IP layer: Multi-layer network (MLN)
  – MPLS, SDH, OTN, WDM
  – Lower layer provides Virtual Network Topology (VNT) to upper layer.

➢ Optimization
  – Route optimization / Topology optimization
  – Global optimization / Local optimization
Application stratum

- Inter-DC communications
- Bulk data transfer
  - Data backup, disaster recovery, etc.
- Emerging high bandwidth image applications
  - Sporting events, live converts, 3D video applications, remote medical surgery, etc.
- Research & education network applications
  - E-VLBI, e-Learning, scientific computing, etc.
Cross stratum interface

Application stratum

Inquiry

Status

Network stratum

Optimization if needed…
Cross stratum optimization

- Resource optimization (application and network)
- Responsiveness to quickly changing demands
- Enhanced service resilience (via cooperative recovery techniques between application and network)
- Quality of application experience (QoE) enhancement
Expected research items

- Baseline network/application model
- Trust relationships model
- Data center/cloud based applications
- Key interfaces and their functionality
- Role of TE based network infrastructure, (G)MPLS
- Resiliency mechanisms
- Responsiveness to application/network interaction.
Cross-stratum interface between application and network

- Interface commands
  - Setup
  - Modification
  - Teardown
  - Inquiry

- By adding parameters, applications can use the functions such as 1.-5.
  - flowKey, applicationType, maxBandwidth, minBandwidth, maxDelay, maxDelayVariation, protection, setupTime, setupTimeRange, teardownTime, teardownTimeRange, fileSize, deadline, deadlineRange

1. Circuit setup (immediate)
2. Circuit setup (future reservation)
3. Modification
4. Bandwidth reservation for file transfer
5. Network availability inquiry
Prototype implementation

- Implementation of basic commands (Setup and Teardown)
- XML format

`Setup(
flowKey,
applicationType,
maxBandwidth, minBandwidth,
maxDelay, maxDelayVariation Range, protection,
setupTime, setupTimeRange,
teardownTime, teardownTimeRange, fileSize,
deadline, deadlineRange)`

```xml
<?xml version="1.0" encoding="UTF-8"?>
<pce>
  <command>setup</command>
  <request>
    <layer>multilayer</layer>
    <src>
      <id>2</id>
      <ip>1.0.0.201</ip>
    </src>
    <dst>
      <id>2</id>
      <ip>1.0.0.202</ip>
    </dst>
    <fixed>1</fixed>
  </request>
  <restriction>
    <band>1.000000E+08</band>
    <setupTime, setupTimeRange, teardownTime, teardownTimeRange, fileSize, deadline, deadlineRange)
  </restriction>
  <request-id></request-id>
  <path-deletetime>
    <date>2009/02/02</date>
    <time>12:59</time>
  </path-deletetime>
</pce>
```
Demonstration of dynamic topology reconfiguration
(at Super Computing 2009)

- We have implemented and successfully verified our on-demand video transmission and dynamic topology reconfiguration with a GMPLS-controlled experimental network constructed upon R&D testbeds: JGN2plus (NiCT) and GEMnet2 (NTT)
- Demo shown at SC09 booth #2164, through international connections supported by JGN2plus, GEMnet2, and Pacific Wave
Thank you!