Broadband Network Design - CERNET Experience

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Feb. 22, 2005
Outline

- Introduction
- The user demand analysis
- The management and security response
- The QoS experience and the tools
- The 40G IP backbone trial
- IPv6 challenges
- Conclusion
Introduction

- The university campus networks have been practicing broadband services for a very long time. This presentation will introduce the CERNET’s campus broadband services and discuss the lessons learnt.
CERNET Transport Network
CERNET Backbone (1)
CERNET Backbone (2)

- 18 national Pops are connected via multiple 2.5Gbps DWDM links
- 8 provincial Pops are connected via multiple 155Mbps SDH links
- 38 GigaPops distributed in 36 cities, covering all the provinces in Mainland China.
- 300 campus networks connect to their nearest Pops via 100Mbps-1Gbps links.
- 1,500 education and research institutions connected
- 15 million users
- 320 million students/school kids in mainland China
CERNET2 Backbone (2)

- 5 10 GPop\$s are connected via 10G DWDM links
- 15 GigaPops are connected via 2.5G links
- 25 GigaPops distributed in 20 cities.
- 100+ campus networks connect to their nearest Pops via 1Gbps links.
- Pure IPv6 service
TUNET 1988
TUNET 1998
TUNET 2002
TUNET 2004
# THUNET Facts

<table>
<thead>
<tr>
<th>THU</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>total student num</td>
<td>30000</td>
</tr>
<tr>
<td>border bandwidth (M)</td>
<td>2000</td>
</tr>
<tr>
<td>local bandwidth (M)</td>
<td>70000</td>
</tr>
<tr>
<td>IP address</td>
<td>65536</td>
</tr>
<tr>
<td>border bandwidth per head (M)</td>
<td>0.07</td>
</tr>
<tr>
<td>local bandwidth per head (M)</td>
<td>2.33</td>
</tr>
<tr>
<td>address per head</td>
<td>2.18</td>
</tr>
</tbody>
</table>
Design Considerations

- High performance
- Low operation cost
- Effective management
- Quick emergence response
Emergence Response

The SQL Slammer Worm: 30 Minutes After “Release”

- Infections doubled every 8.5 seconds
- Spread 100X faster than Code Red
- At peak, scanned 55 million hosts per second.
Technical Design

- Packet forwarding
  - Routing
  - switching

- Network management
  - throughput/performance

- User management
  - Gateway
  - PPPoE
  - 802.1x
  - VALAN
Top 20 Usage Distribution

- 0.3% of the users
- 30% of the bandwidth
Top 20 Case Study

- Normal case

- Abnormal case
Chinese University Connectivity Demand

- 16 Million students enrolled in 2003 universities and institutes located in more than 260 cities in Mainland China in year 2002.
- The average number of enrollment per university/institute is about 8,000 students.
- If 1 Mbps connectivity is required per student, an average sized campus network will need about 8 Gbps of aggregated bandwidth.
- When 80 vs. 20 rule applied, the CERNET backbone should provide 4 Tbps aggregated bandwidth reaching more than 260 cities.
- For one IP address per student assignment, 1 /8 space is needed.
40G IP Backbone Trial

40G bj-tjn

Diagram showing network setup and images of equipment.
IPv6 Transition

- Hosts
  - FreeBSD/Linux/UNIX
  - WindowsXP
- Layer 2 Switch
- Layer 3 Switch/Router
  - !!!
- Access Server
  - !!!
- DNS
  - !!!
- Applications
  - !!!
Conclusion

- High performance
- Source address authentication
- User behavior control
- 10G-40G backbone ports
- IPv6 transition