



Broadband Network Design - CERNET Experience

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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



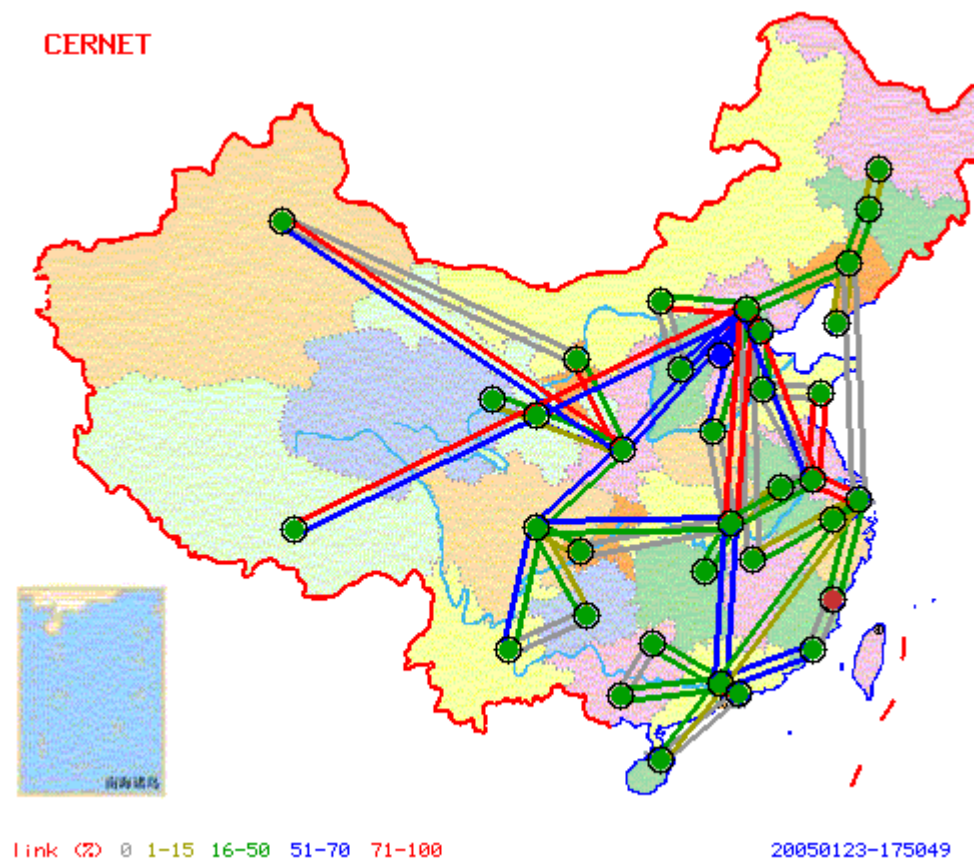
Introduction

- 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 Backbone (1)





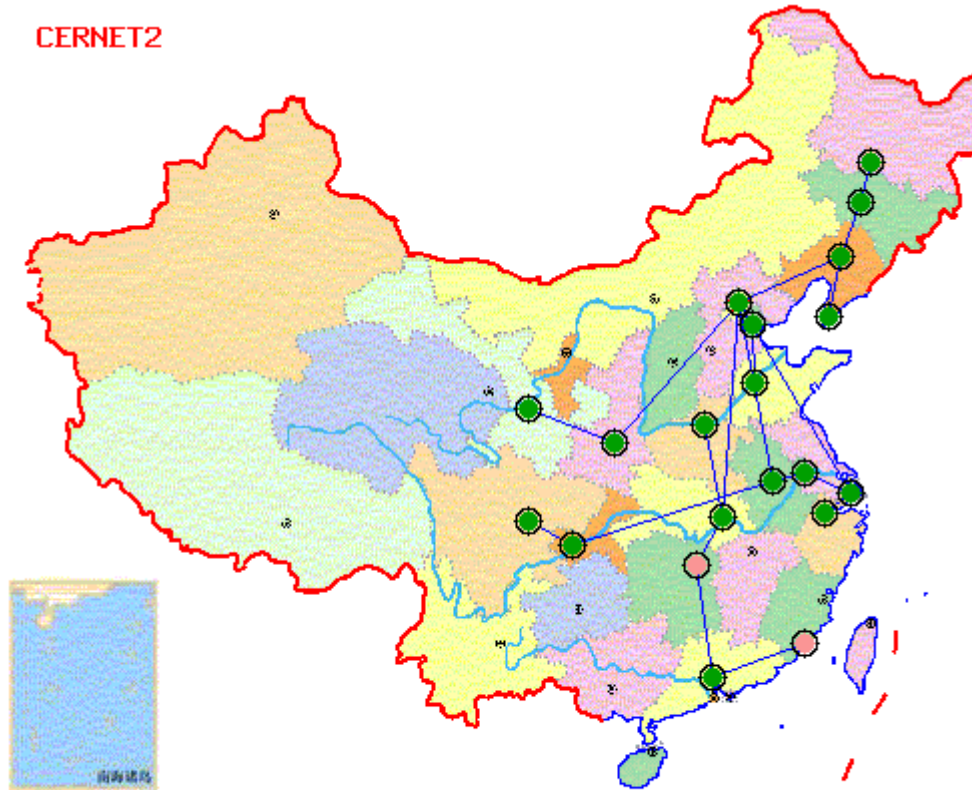
CERNET Backbone (2)

- 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 (1)

CERNET2



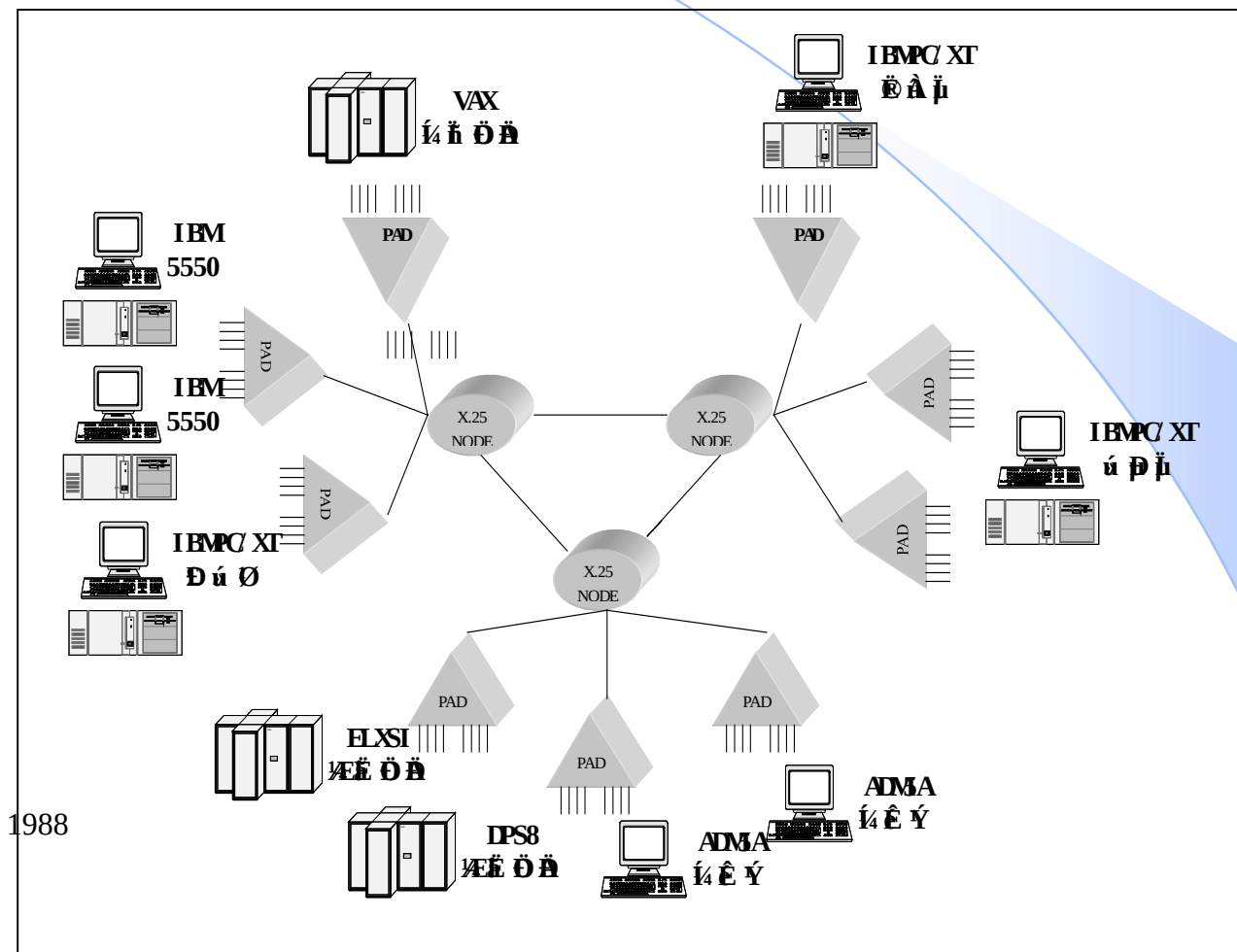
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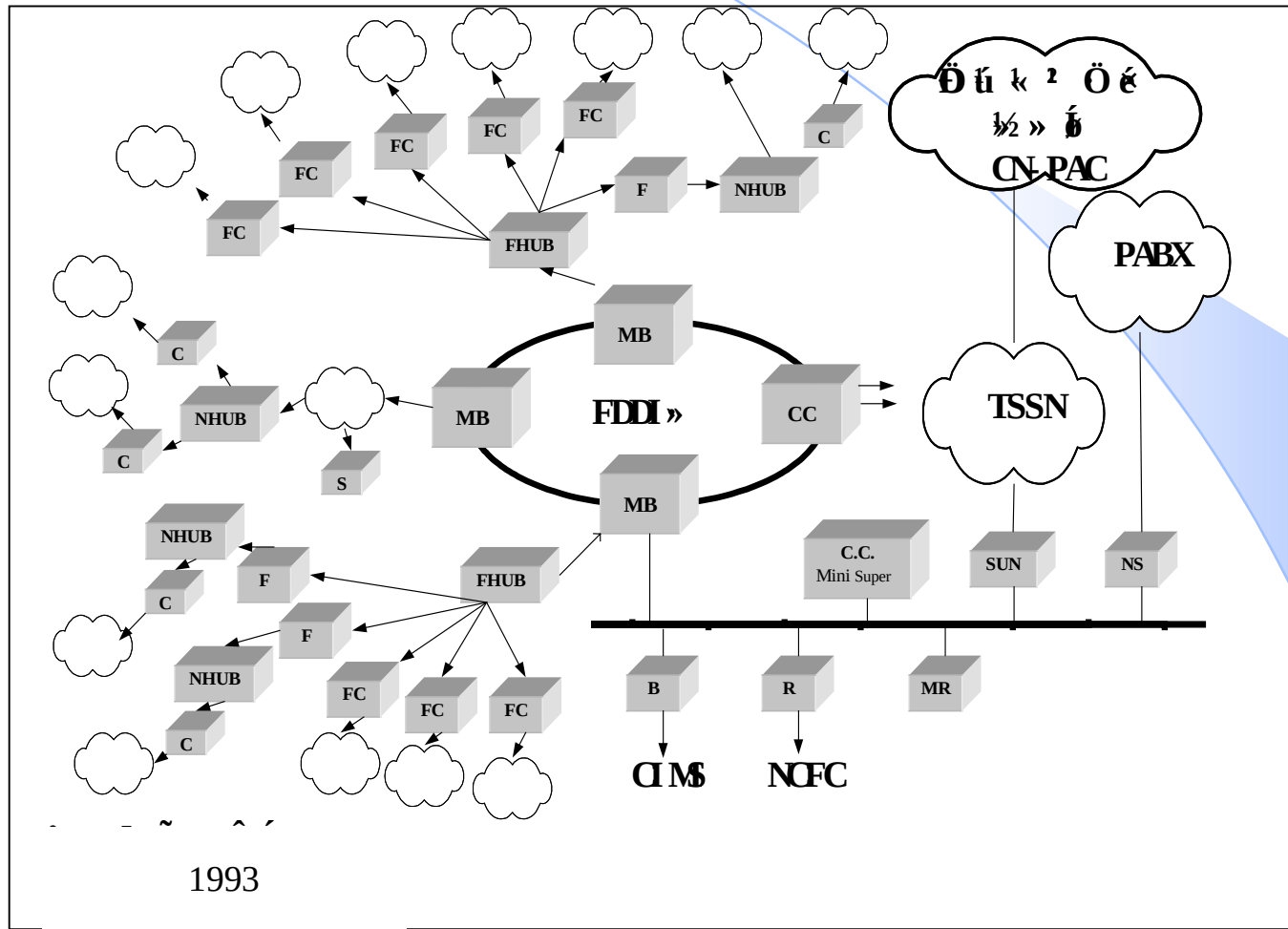
CERNET2 Backbone (2)

- 5 10 GPops 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

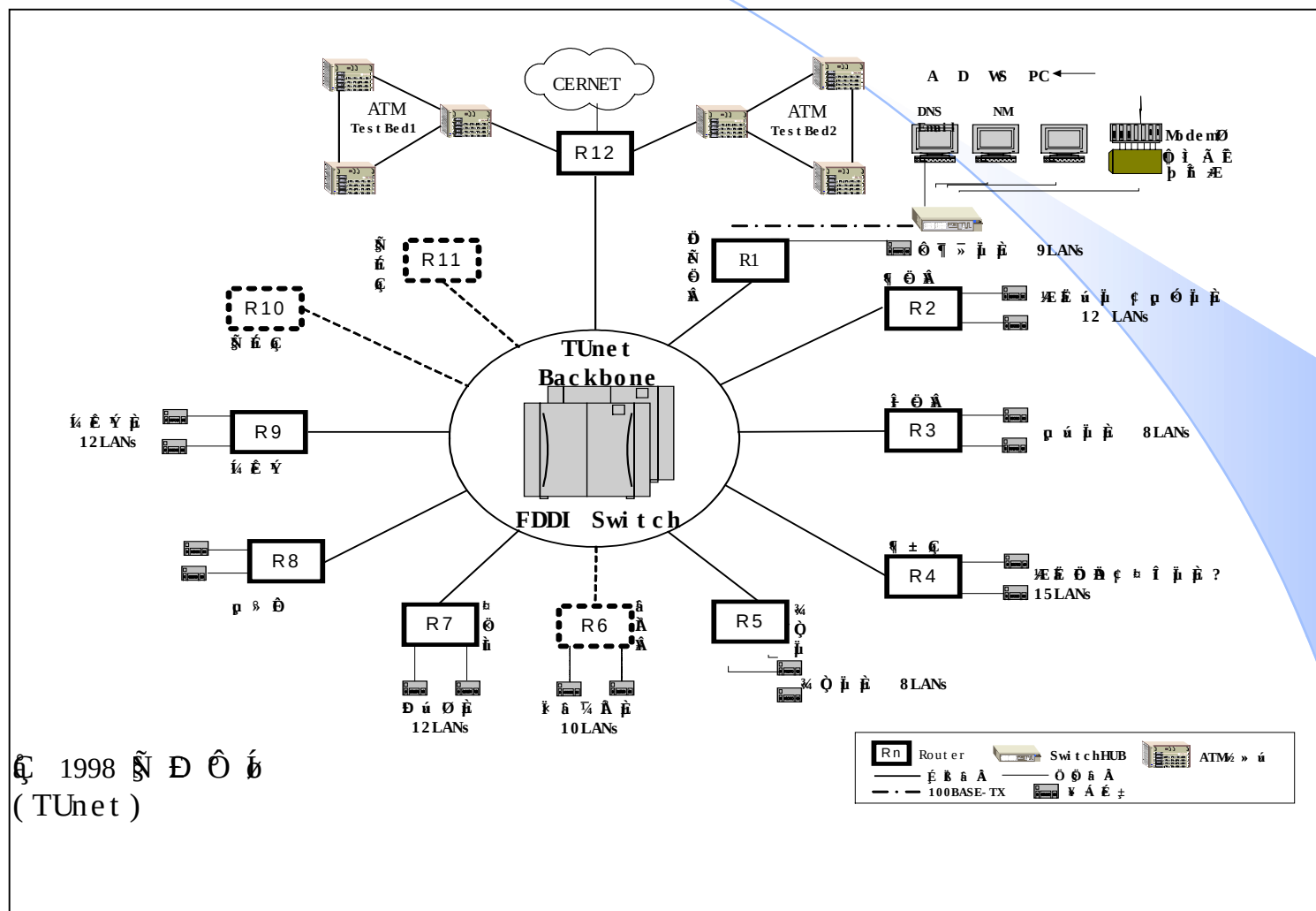


TUNET 1993





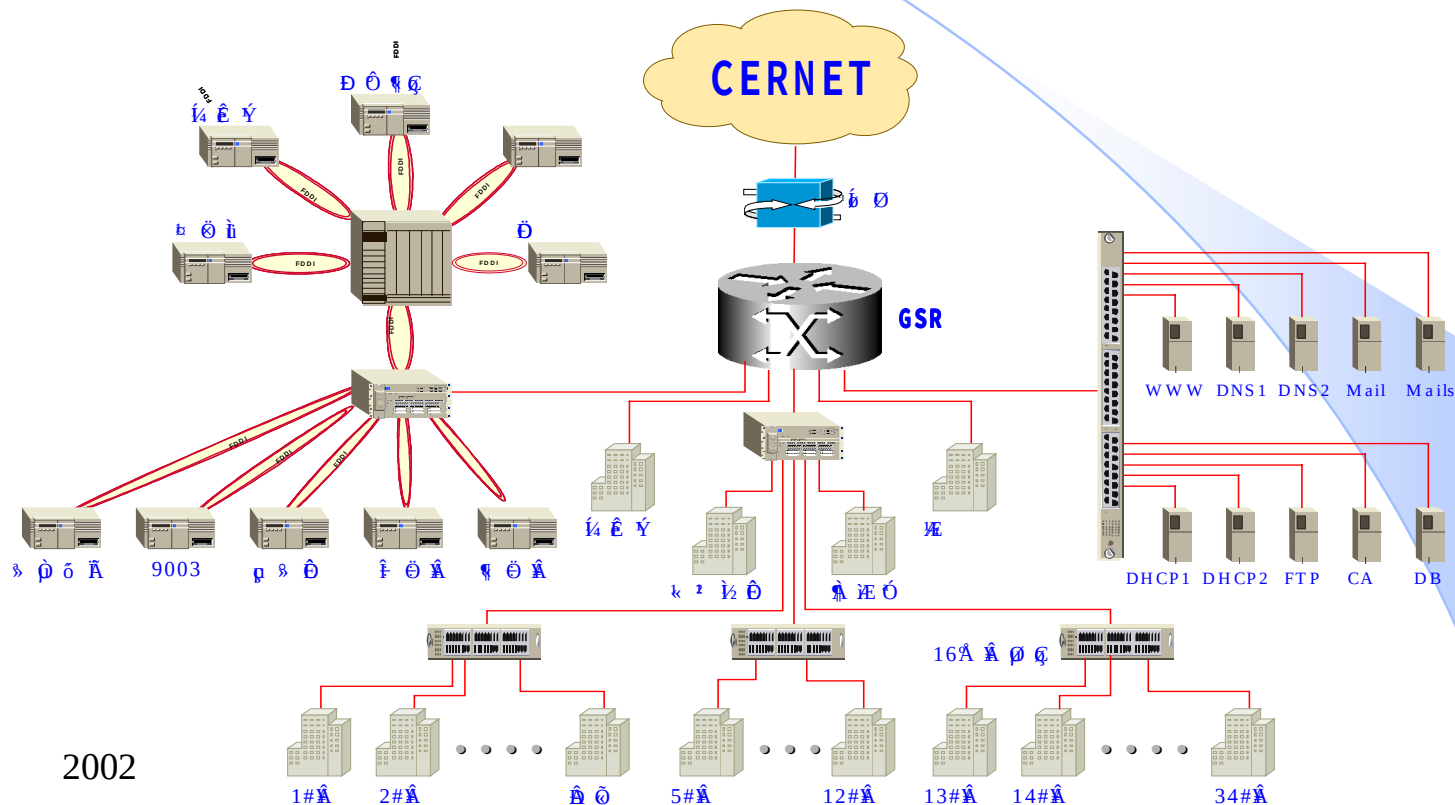
TUNET 1998



1998 年 10 月
(TUNET)



TUNET 2002

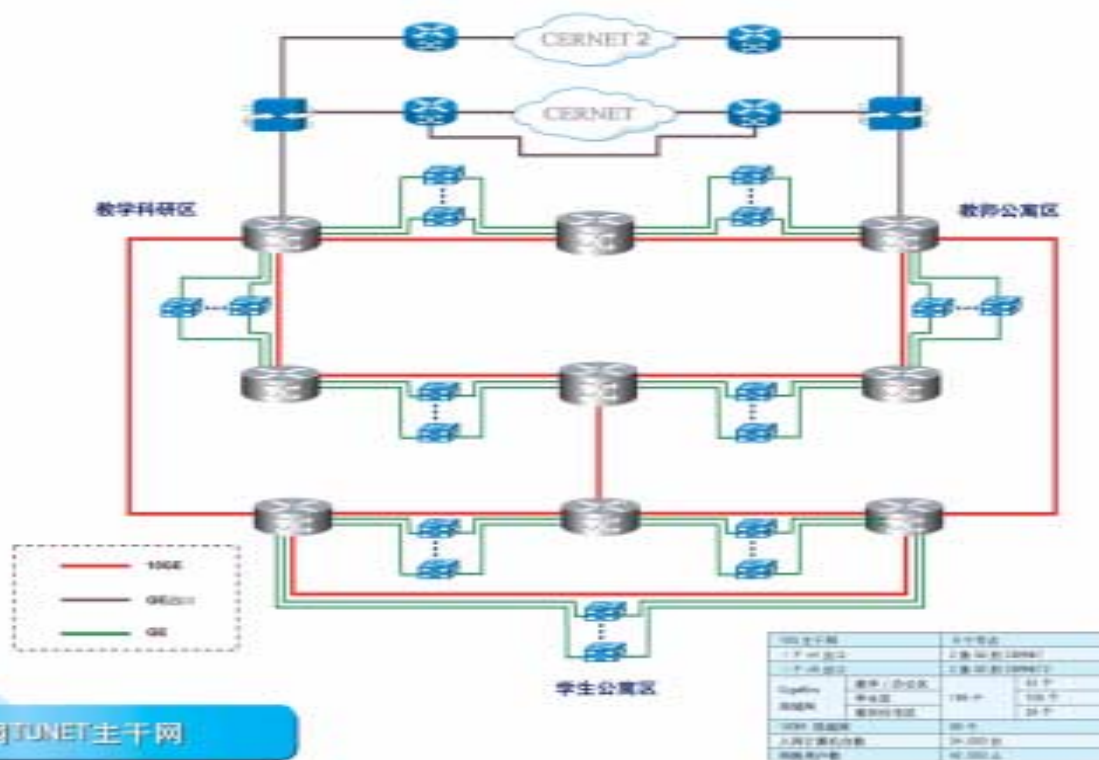


2002 TUNET



TUNET 2004

2004



清华大学校园网TUNET主干网



THUNET Facts

THU	
total student num	30000
border bandwidth (M)	2000
local bandwidth (M)	70000
IP address	65536
border bandwidth per head (M)	0. 07
local bandwidth per head (M)	2. 33
address per head	2. 18



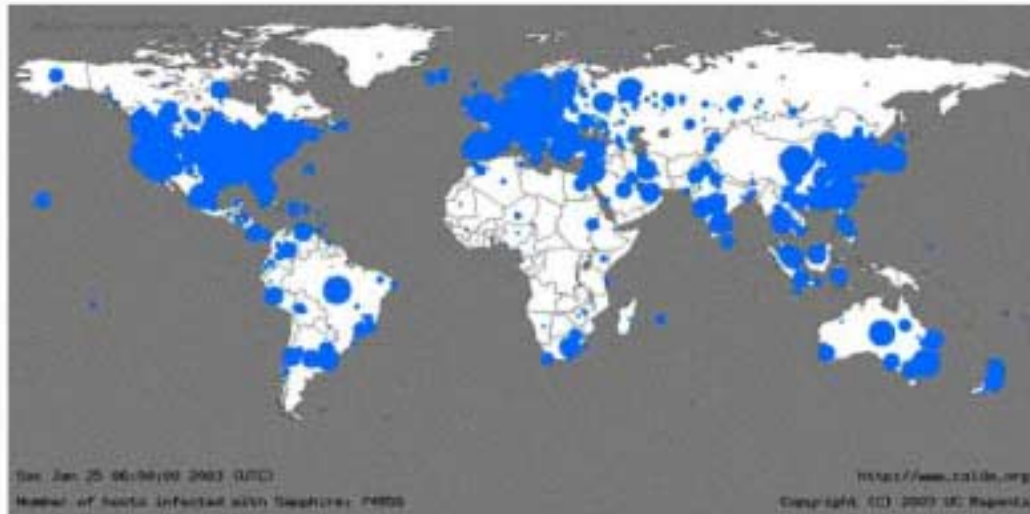
Design Considerations

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

Emergence Response

The SQL Slammer Worm: 30 Minutes After “Release”

Cisco.com



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



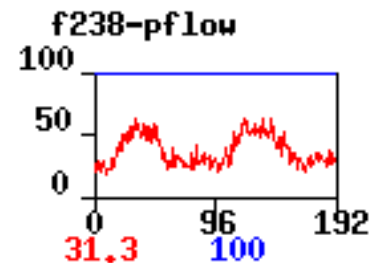
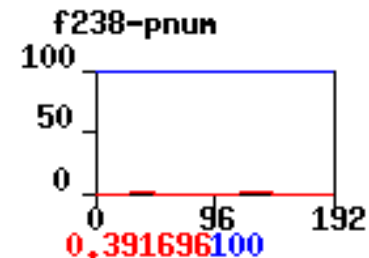
Technical Design

- Packet forwarding
 - Routing
 - switching
- Network management
 - throughput/performance
- User management
 - Gateway
 - PPPoE
 - 802.1x
 - VLAN



Top 20 Usage Distribution

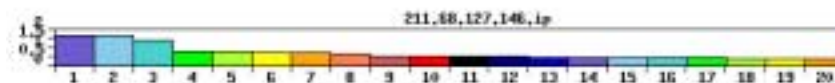
- 0.3% of the users
- 30% of the bandwidth





Top 20 Case Study

● Normal case



1	202.196.255.005 =>	129.013.073.109	TCP	1.65	[0.58%]	144	[0.12%]	1500	58	rank
2	202.197.144.235 =>	047.038.076.143	TCP	1.64	[0.58%]	144	[0.12%]	1490	59	rank
3	210.025.241.021 =>	159.226.231.044	TCP	1.35	[0.40%]	125	[0.10%]	1420	63	rank
4	143.089.112.067 =>	162.105.246.200	TCP	0.79	[0.26%]	69	[0.06%]	1494	57	rank
5	129.079.228.200 =>	202.038.124.008	TCP	0.76	[0.24%]	70	[0.06%]	1401	84	rank
6	140.113.141.044 =>	211.071.015.144	TCP	0.69	[0.24%]	60	[0.05%]	1500	116	rank
7	140.113.128.190 =>	219.225.238.165	TCP	0.68	[0.24%]	60	[0.05%]	1481	116	rank
8	210.025.241.006 =>	202.112.179.007	TCP	0.66	[0.23%]	60	[0.05%]	1440	63	rank
9	202.196.100.011 =>	220.140.039.038	TCP	0.50	[0.18%]	51	[0.04%]	1288	121	rank

● Abnormal case



1	202.038.101.131 =>	133.069.133.062	UDP	26.37	[2.24%]	3718	[1.23%]	1030	126	rank
2	122.069.123.042 =>	202.038.101.122	UDP	27.25	[2.14%]	2582	[0.85%]	1388	53	rank
3	210.025.241.016 =>	202.202.013.211	TCP	6.76	[0.53%]	615	[0.20%]	1442	63	rank
4	210.025.241.021 =>	220.200.148.115	TCP	5.07	[0.40%]	444	[0.15%]	1497	63	rank
5	210.025.241.021 =>	202.113.034.001	TCP	4.44	[0.35%]	388	[0.13%]	1500	63	rank
6	210.025.241.006 =>	202.194.222.180	TCP	4.18	[0.33%]	365	[0.12%]	1500	63	rank
7	140.113.017.209 =>	211.063.090.099	TCP	2.95	[0.23%]	258	[0.09%]	1500	51	rank
8	140.098.193.112 =>	202.119.122.027	TCP	2.94	[0.23%]	279	[0.09%]	1410	51	rank
9	202.118.179.107 =>	140.121.216.157	UDP	2.13	[0.17%]	265	[0.09%]	1055	120	rank
10	218.193.021.116 =>	140.128.048.280	UDP	2.10	[0.17%]	244	[0.08%]	1042	120	rank

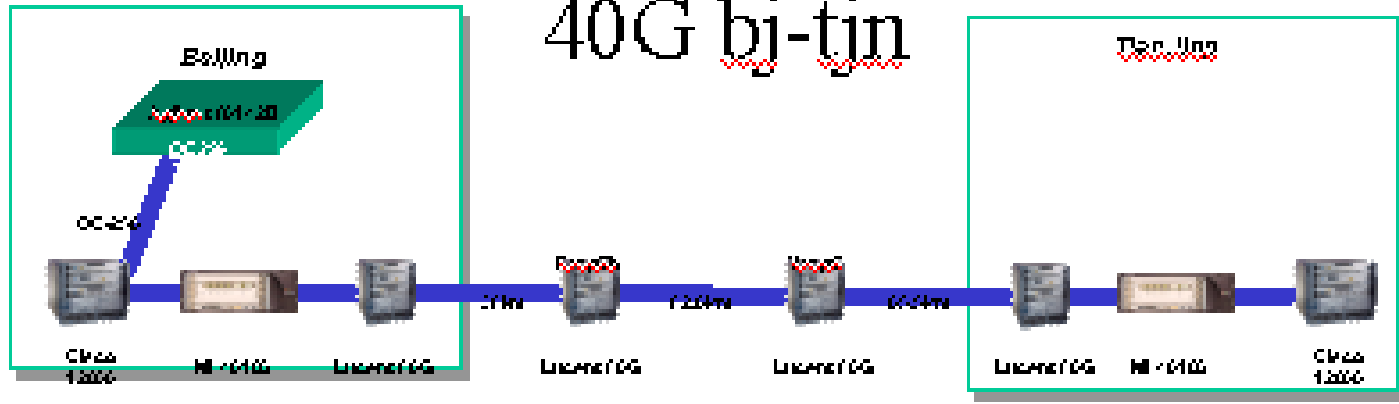


Chinese University Connectivity Demand

- 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





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