Next Generation Internet research and activities in China

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Outline

- Brief history of Internet in China
- IPv4 based CERNET
- Why we need IPv6
- CNGI and CERNET2
- IPv6 related research activities
- International collaboration
- Future works

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- International collaboration
- Experiences we learned future works

Internet development in China

- 13 years history from 1994~2007
- Internet users in China: from 162 Millions by June 2007
- IPv4 Addresses: 118 M
- Backbone：2.5-10G DWDM+Router
- Total International links：312Gbps
- Exchange Points： over 100G （BJ，SH，GZ）
- Last Miles
  – Ethernet, WLAN, ADSL, Cable Modem, CDMA, GPRS, ISDN, Dial-up

Statistic of Internet user in China

Number of Netizen & Growth rate of China

Million

180 | 16200 | 80%

Netizen — growth rate

72.8% 75.4%

48.5%

4580 5910 6800 7950 8700 9400 10300 11100 12300 13700

34.5% 27.9% 18.2% 18.4% 18.1% 19.4% 23.4% 31.7%

2002.06 2002.12 2003.06 2003.12 2004.06 2004.12 2005.06 2005.12 2006.06 2006.12 2007.06

CNNIC

www.cnnic.cn，2007.06

Comparison with others by 2007

- World average Internet penetration rate 17.6%
- Iceland: 86.3%
- Ireland: 50.2%
- China: 12.3%

Source: http://www.internetworldstats.com/top25.htm
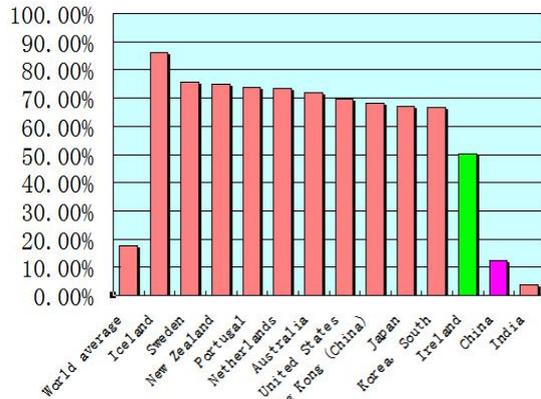
Research Networks in China

- CERNET: China Education and Research Network
  - 1994, Managed by MOE, Nation wide backbone
  - 1800+Universities and institutes, over 20 Millions users
  - 2003, CNGI-CERNET2 initiated
- CSTNET: China Science and Technology Network
  - 1994, Managed by CAS, Nation wide connections
  - 100+ institutes, Users over 1 Millions
- NSFCNET: a high speed test bed for researchers

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- **IPv4 based CERNET**
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CERNET project

- Sponsored by the Ministry of Education and other government bodies
- Started construction in 1994
- A nation-wide Academic network connecting to higher education institutes
- 3 tier structure
  - backbone/regional/campus network
- Total backbone bandwidth 360G
- 38 Gigapop in 36 cities
- NOC / NIC / CCERT
- Provide basic and advanced services
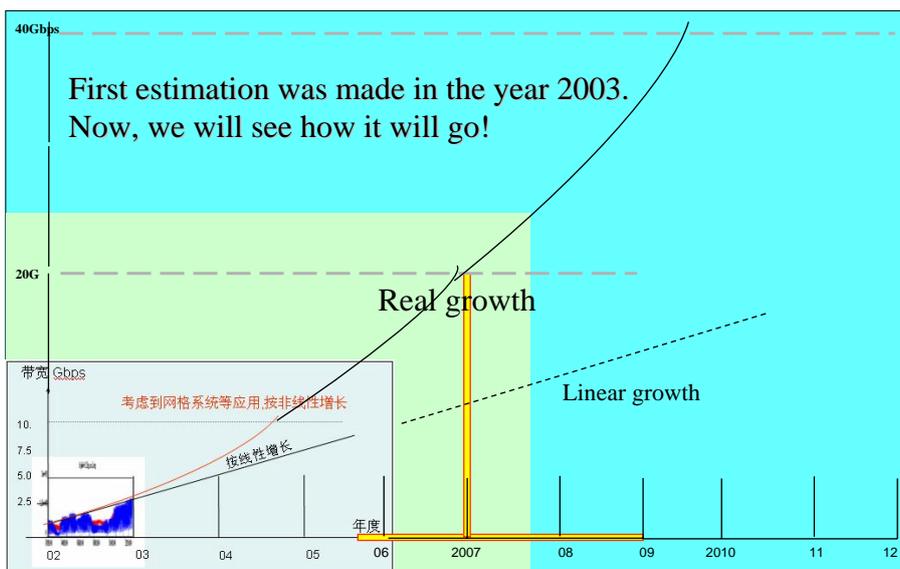- Multicast for e-Learning

CERNET IPv4 Backbone
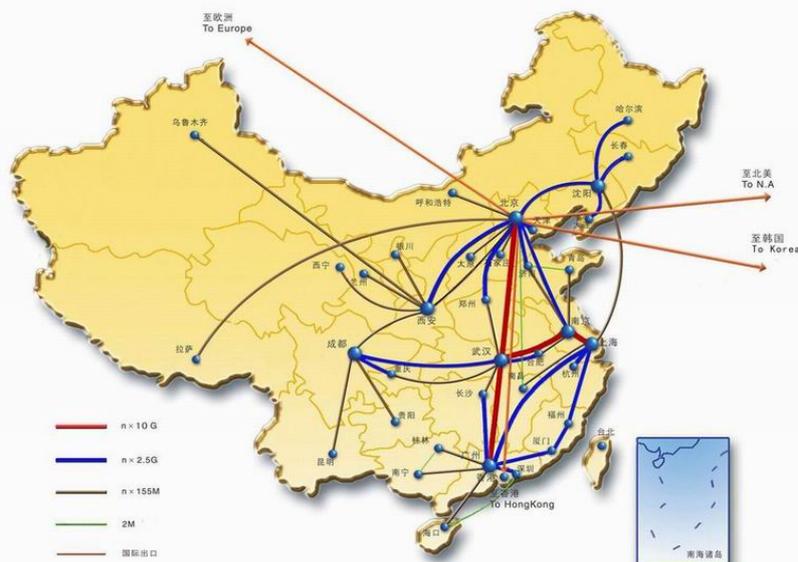
CERNET backbone upgrade

Compare with 1994, the backbone bandwidth has had a dramatic upgrade.

Year	Backbone bandwidth
1994	Router, Lease-line 64K
1997	Router, Satellite bi-directional 4M
2000	Router, SDH 155M
2002	Router, DWDM 2.5G
2004	Router, DWDM 2.5G/n*2.5G
2005	Router, DWDM 2.5G/n*2.5G/10G
2007	Router, DWDM 2.5G/n*2.5G/10G/2*10G

CERNET backbone traffic trend

Sample of Backbone monitoring

- Self-developed network management system deployed

delay

Packet loss

One day traffic graph in Dec.2006

Industry efforts for higher speed

- There are higher speed demand
- High-end router vendors support 40G POS port
- CERNET has tested 40G between 2 cities over 100KM successfully
- Internet2 announced that 100Gbps (multiple 10Gbps wavelengths) backbone has been built by Level3 in June 2007
- IEEE802.3 HSSG set agenda for 40/100Gbps Ethernet

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What is IPv6?

- Today, we use IP protocol version 4 with limited addresses
- Developed by IETF, with much larger address space, IPv6 will be used for Next Generation Internet
- 128bit long address, security enhanced and many other good features

0	4	12	16	24	31
Version	Class		Flow Label		
Payload Length			Next Header		Hop Limit
128 bit Source Address					
128 bit Destination Address					
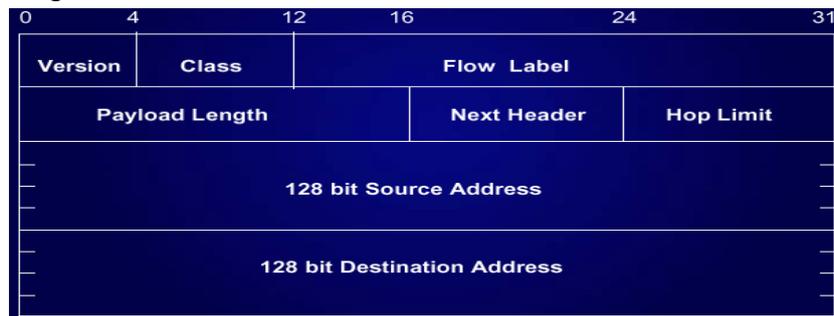
Good features of IPv6

- Large numbers of address spaces
  - IPv6 Addresses: 3.4×10^{38}
  - NGI will connect all of electronic devices not only computers
- Trust network: real IP address network architecture
- Improved routing
  - Route aggregation reduces the size of routing tables
  - Simplified header reduces router processing loads
- Enhanced security and QoS
  - Mandatory IPsec support all fully IPv6 compliant devices
- Improved support for mobile IP and mobile computing devices
- Provide a platform and opportunity for a revolution which improves today's Internet to NGI

Why we need IPv6

- Population in China is more than 1.3billion
  - Regardless on other usages, 1 IP address per person, we need
    - 77 /8 IPv4 address
    - According to ICANN in March 2007, only 48 /8 left in global pool, no sufficient IPv4 address available now
- The number of mobile phone subscribers in China is more then 501million by July, 2007
  - If connect to Internet, more than 29/8 IPv4 addresses needed
  - Sensor network / industrial deployment need more IP addresses

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IPv4 address shortage warning from ICANN

- 10 more /8 of IPv4 address had been allocated in 2006
- Run out of supply is projected within 3~4 years
- Migrate to IPv6 is inevitable
- Waiting or embracing?

Status of the remaining /8s

ICANN
iana

2%
2%
24%
48 /8s available
73%

Protocol | Status Unclear | Class E | Available
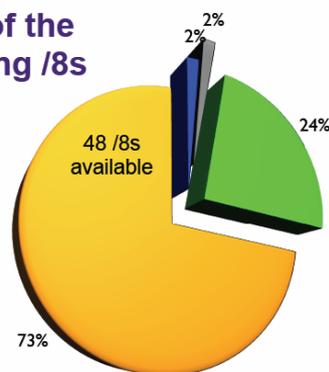
Mar 2, 2007   APNIC 23 Meeting – Bali, Indonesia   7

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Challenges of current Internet

- IPv4 Internet: 80% traffic of information Infrastructure in world
- Challenges of current Internet
  - Scale: from connected computers to other devices
  - Security: more trustiness needed
  - High performance: faster end-end performance
  - Real time: VoIP and video streaming service
  - Mobile: mobile communication over Internet
  - QoS: people expect quality ensured services
  - Economic model: how to make sustained development
  - others
- Security is one of the more important challenges to current Internet

What's Next Generation Internet?

- Scalability
  - More devices connected via IPv6
- High performance of end to end
- Security enhanced
- Mobility for both terminal and network
  - WiMax, 3G and the beyond
- Real time
- Management
- Economy side
- …

Next Generation Internet and IPv6 Activities in China

- IPv6 Test bed in 1998
- NSFCNET: 2000，First IPv6 network in China
- MOU with UCAID: CERNET on March 2000,
     NSFCNET and CSTNET on May 2000
- Peer Connection Agreement with Abilene:
     CERNET on March 2000
- 2003, CJ-IPv6，
- 2003, CNGI Project: CNGI-CERNET2
- International Connections
  - 1G Internet2
  - 622M TEIN2 link to EU
- China-EU joint research

Some IPv6 Testbeds in China
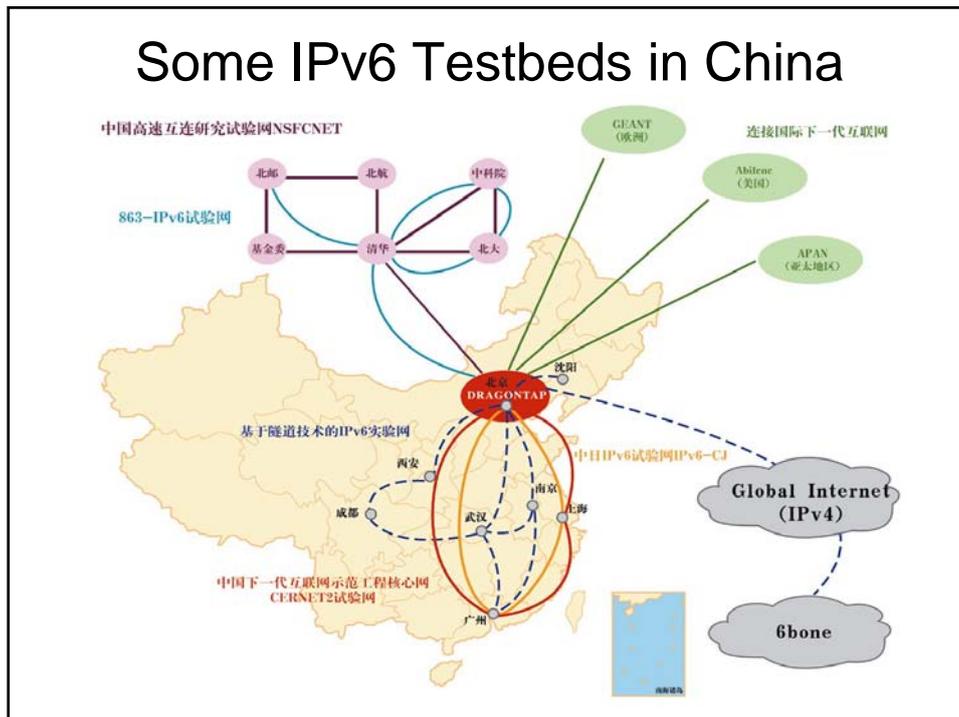
CNGI Project

- Initiated in 2002, approved by government in 2003
- Leaded by National Reform and Development Committee, 170M USD
- Joint with MST, MOE，CAS，MII，NSFC，CAE,…
- Main objective
  - CNGI Backbone: nation wide, 30-40 Giga POPs and 300 campus networks, international linkage
  - Network technology and advanced applications
  - Transfer successful results to information industry
- All NSPs have involved in this project
  - CERNET, China Telecom，Unicom，Netcom/CSTNET，China Mobile, China Railcom

CERNET and CERNET2

I2/GEANT2/APAN IPv4/IPv6

Internet IPv4

CERNET2 Backbone IPv6

CERNET backbone IPv4

AUP free only for CERNET2

CERNET DWDM Network

CNGI－CERNET2 Backbone

国内其他下一代互联网

欧洲GEANT2

CNGI 6IX

美国Internet2

哈尔滨

长春

沈阳

亚太APAN

大连

兰州

郑州

北京

天津

济南

成都

西安

合肥

南京

上海

重庆

武汉

杭州

长沙

厦门

广州

10 Gbps

2.5Gbps
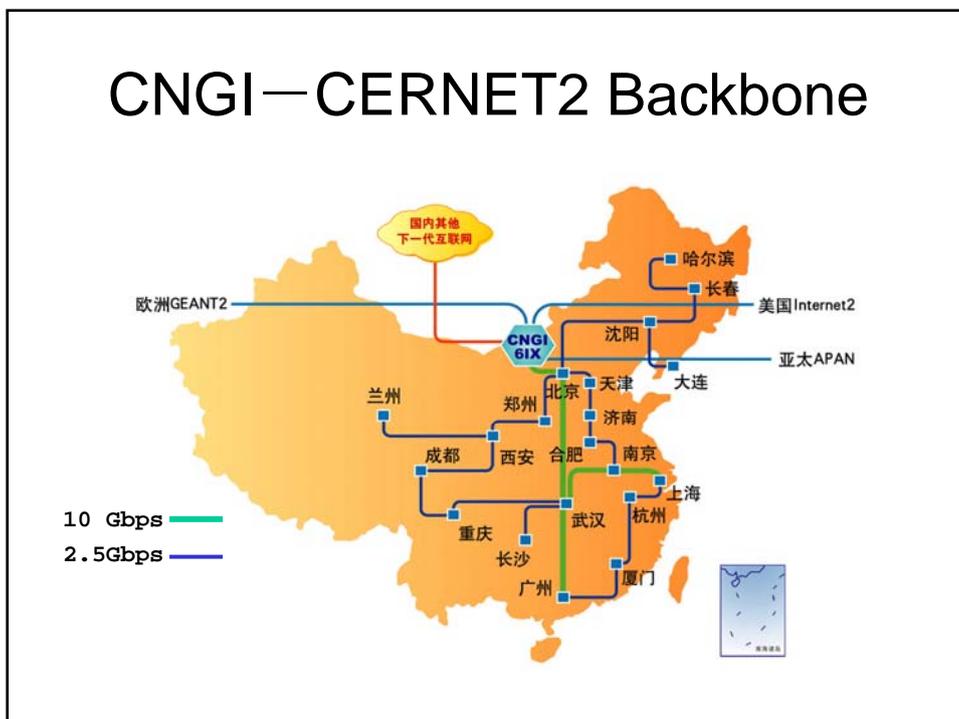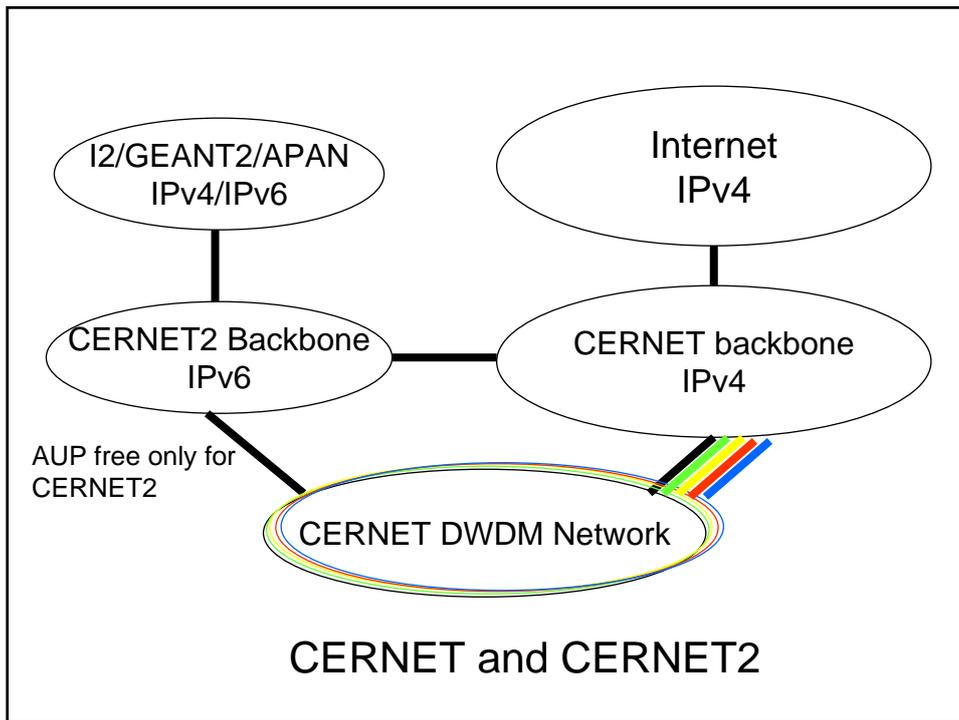
IPv6 based Network Management
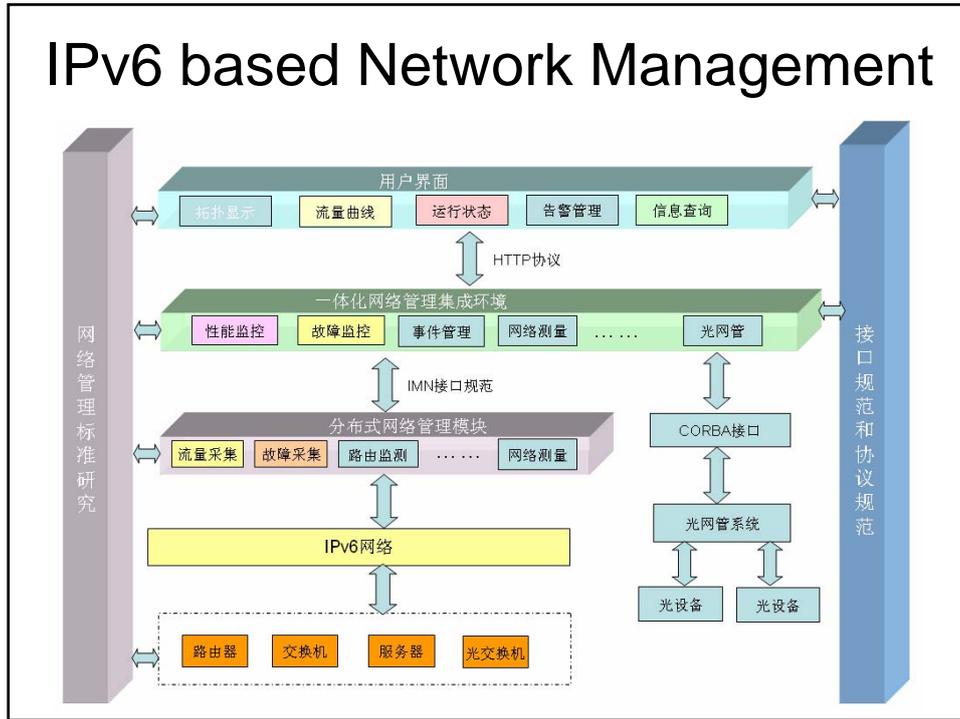
CNGI－6IX
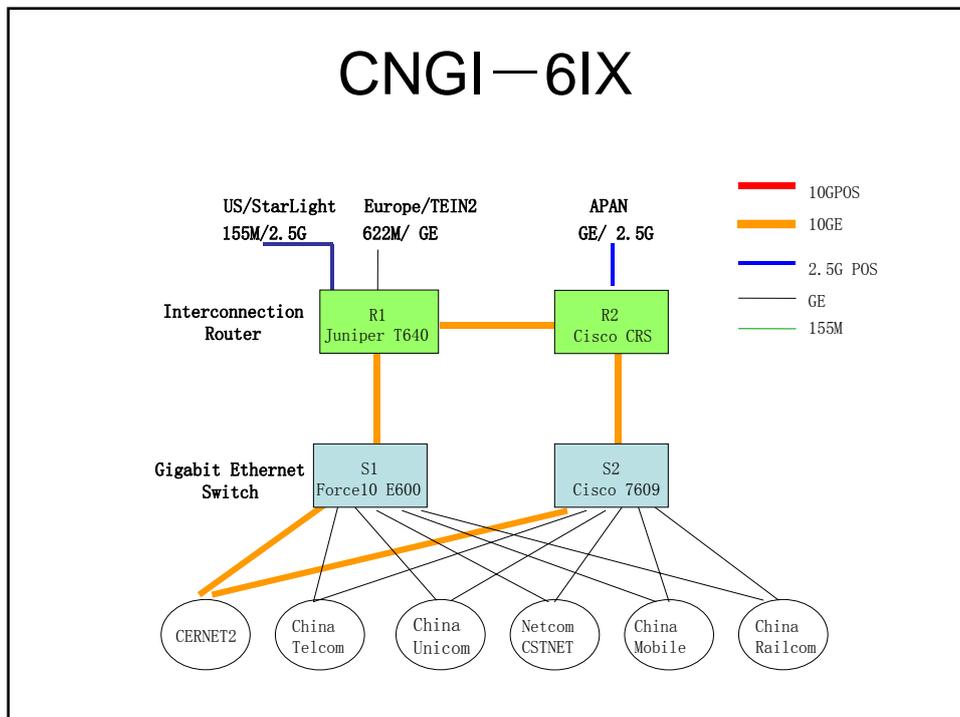
CNGI-6IX

CERNET2 Backbone router monitor
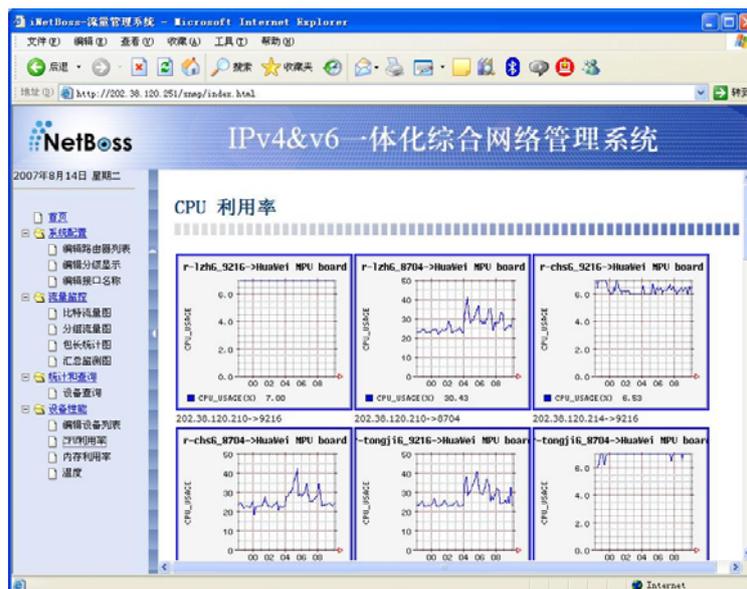
CNGI-CERNET2's Key Technology Points

- Native IPv6 Network
- Dual stack campus network
- Multi-vender Core Routers
- Authentic IPv6 Addressing Architecture
  - SAVA: Source Address Validation Architecture
  - as a BoF proposal in IETF68 Meeting
- IPv4 over IPv6
  - Softwire: an IETF working group in IETF69
- Application trials
  - 6PlantLab
  - SIP and WLAN Communications
  - IPv6 IPTV Applications
  - P2P Model Applications
  - Multicast trials

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Future Internet Research in the World

- Future Internet testbed have been connected together in the world
  - Internet2, GÉANT2, TEIN2, CERNET2, …
- Future Internet and IPv6 Standard Development
  - IETF
- Future Internet research projects
  - GENI and FIND
  - FIRE and other Euro-NGI joint research projects
  - NSFCnet, CNGI in China
  - APII in Korea and Japan
  - …

Some Thinking about NGI

- The lower transport layer will remain "simple and transparent"
- The scale will be much larger than before
- Migration is a concern for operators
- People are thinking adding more signaling
- Security and QoS issue will be addressed more intensively
- Overlay networks will still play important role
- Economic model need more study
- Current solutions still did not fit the requirement, we are still seeking promising idea of theory and experiment

THU IPv6 router

- Backplane: 128Gbps
- Line card capacity: 80Gbps
- OC-48, GE port
- Packet length: up to 32K
- Wire speed
- Power redundancy
- Control card 1+1 backup
- Main switch card support 1+1 backup
- Support self-resilience
- Firmware online upgrade

LUT IPv6 test-bed

- Setup the test-bed in 2000
- connected to CERNET IPv6 network
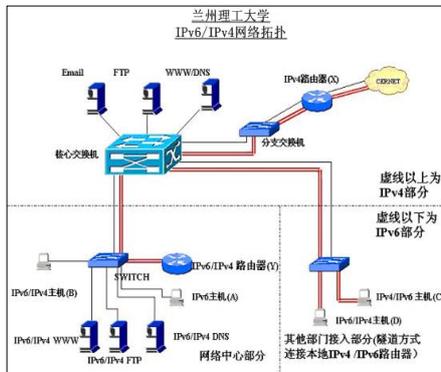
QoS-Group-Based DWFQ

- CS Dept. of PKU
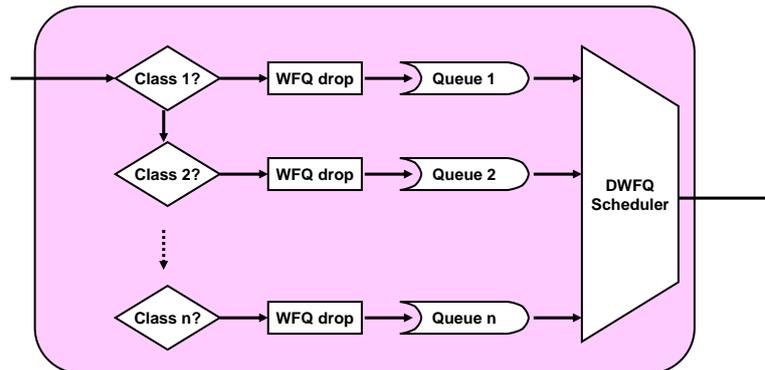
L3 dual stack switch by CAS

IPv6 enabled game on mobile phone

- OS:
  - Symbian
- IPv6
- No infrastructure support
  - P2P mode
- Interactive
  - Person to person
  - Person to server
- By CAS
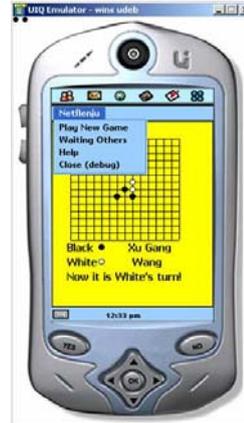
IPv6 video-phone, CAS

- SIP proxy
- AAA server
- Positioning server
- Network monitor
- Heartbeat server
- Configuration management server
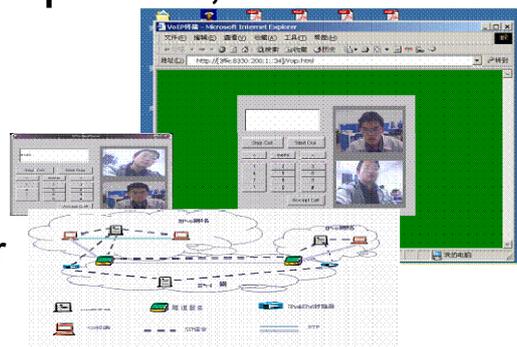
IPv6 VPN by NEU

Public Assistant Services by BIT

PKU: IPv6 home network

SJTU: E-Service

IPv6 based NTP by BUPT

SAVA trail

Softwire trial

6PlanetLab

IPv6 Cooperation Working

实时远程医疗手术观摩

跨国界的艺术表演
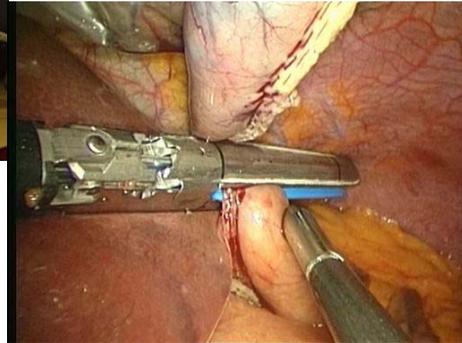
IPv6 based IPTV

Large Scale IPv6 Virtual Reality

IPv6 Remote Education System

IPv6 based Access Grid

图像处理 生物计算 海量数据 访问网格 计算力学 远程教育

高性能应用

图像平台

网格安全 Portal 网格开发环境 信息中心 统一管理层 计算节点层

Computing resource
- Aggregated: 20万亿次
- Storage: over 200TB

CNGI-CERNET2

ChinaGrid: 22 Universities in China

东北大学
清华大学
北京航空航天大学 北京大学
山东大学
西安交通大学 东南大学
华中科技大学 上海交通大学
国防科技大学
华南理工大学 中山大学
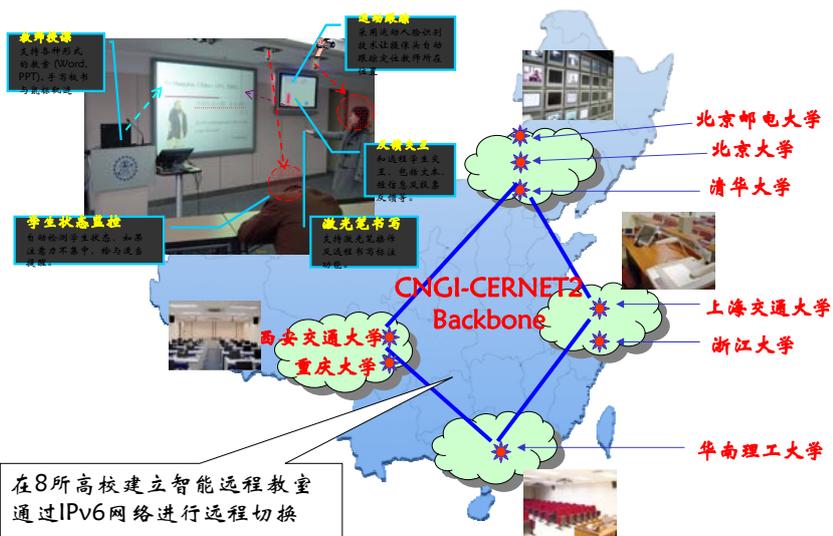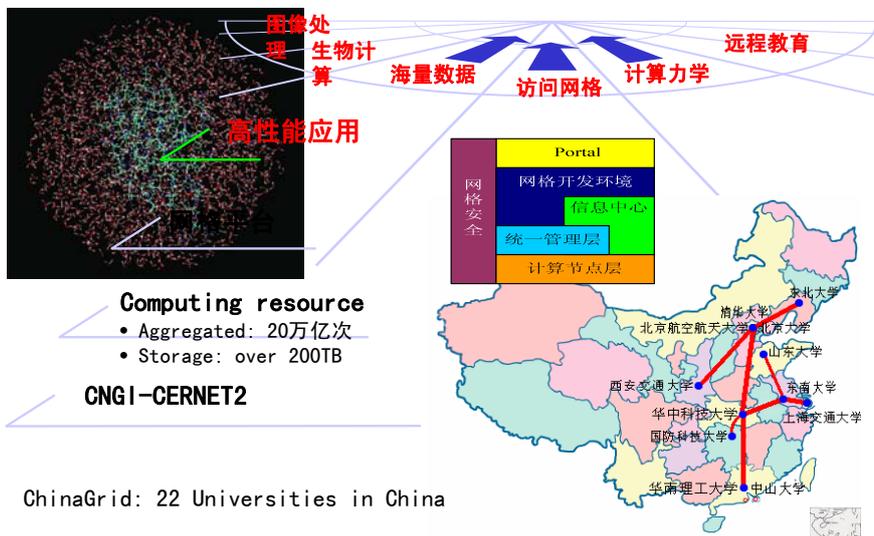
IPv6 P2P Sharing Content Deliver

P2P File Sharing
ngMaze

P2P Streaming
AnySee

2006年10月29日至2007年1月22日

图1: CNGI04-12-2A项目IPv6用户发展情况

清华大学	836
北京大学	7695
华南理工大学	3552
华中科技大学	1799
浙江大学	8790
上海交通大学	20
北京邮电大学	582
西安交通大学	26
兰州大学	176
重庆大学	18
中南大学	2
东南大学	39
中国科技大学	3419
山东大学	2372
复旦大学	13
同济大学	7
厦门大学	3
东北大学	102
吉林大学	5
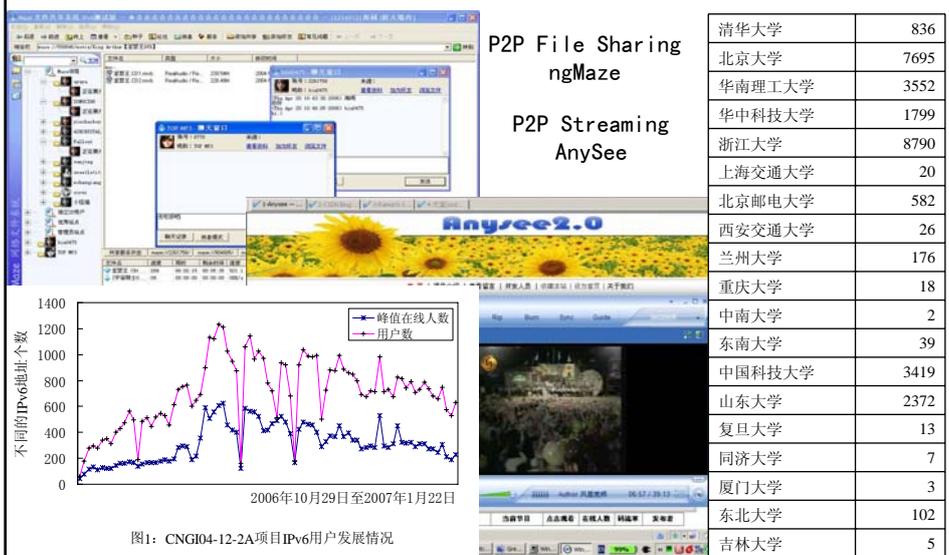
IPv6 Sensor Networks

河道水情监测

入河水质监测
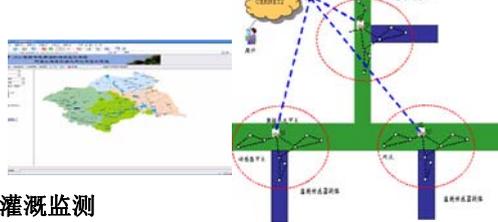
精准农业灌溉监测

传感器部署

WiFi/WiMax and SIP based IPv6 Mobile Communication

WLAN 单模手机/PDA
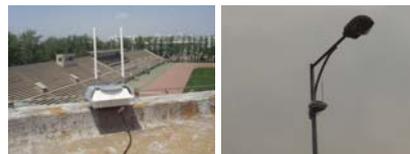
校园无线AP的部署

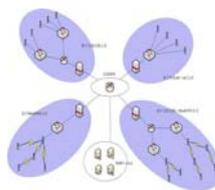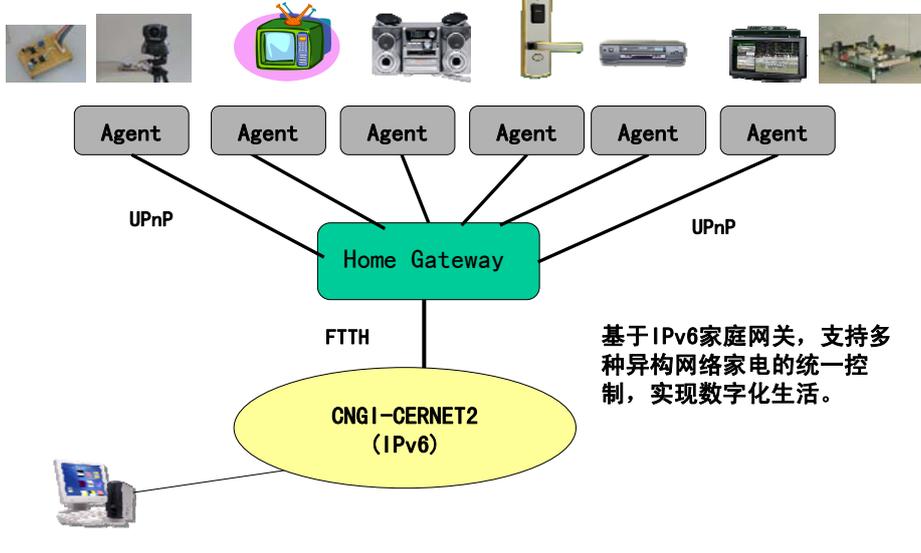WLAN手机移动通信

无线接入的IPTV/VOD

无线接入校园网方式

校园无线网络覆盖

IPv6 Digital Home Network

Agent　Agent　Agent　Agent　Agent　Agent

UPnP　　　　　　　　　　　　　　UPnP

Home Gateway

FTTH

基于IPv6家庭网关，支持多
种异构网络家电的统一控
制，实现数字化生活。

CNGI-CERNET2
（IPv6）

IPv6 Transportation Monitoring

线圈采集监控窗口　　　　　内环线高架

- 感应线圈车流量采集
- 流动车辆GPS数据采集
- 视频采集

南北高
架

传感器
采集数据

交叉口线圈位置

GPS发射装置　　　GPS位置地图显示

GPS实时监控窗口

流动车
辆采集
数据

视频采
集

International Collaborations

- Organization and projects
  - Univ.
  - EU/FP6
  - EU/TIEN2
  - NSF/APAN
  - Internet2
  - CJv6
  - KOSEF
  - IETF
  - IEEE
  - …

IPv6 related research in BUPT

CNGI projects in BUPT

- Management System for Integrated Service Platform Based on Multilevel JMX, lead by Professor Junliang CHEN
- Study on QoS mechanism for networking and its implementation, lead by Prof.Wendong WANG
- Others
  - Research and Test on large-scale Router and Multicast technology base on CNGI
  - IPv6 based Grid computing
  - General e-Learning platform on CNGI

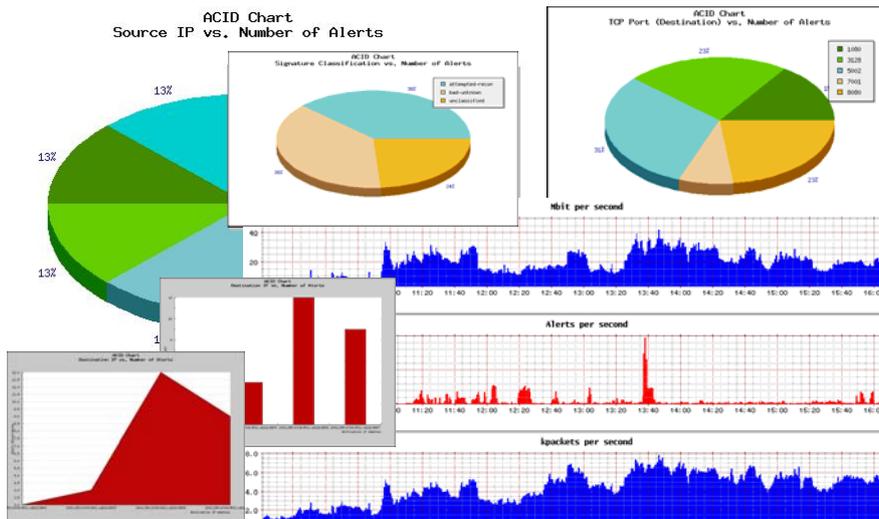# Mobile IPv6 trial between China and Japan

CJ-IPv6 project
Initiated by CJ-Government
In 2004

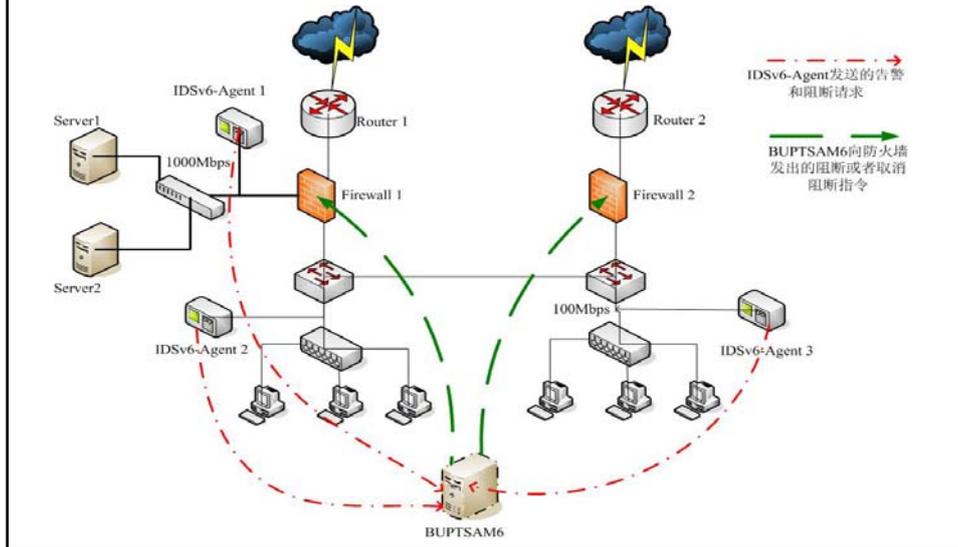# IPv6 network management system
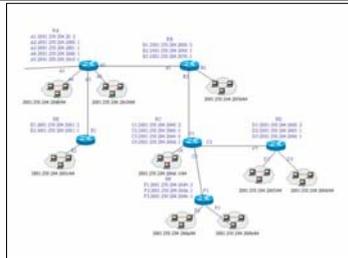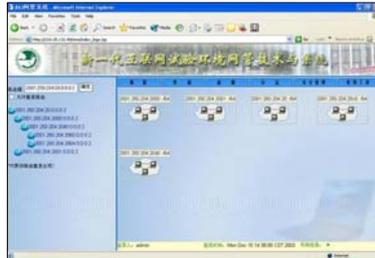
- Joint project with Nokia
- Funded by: China 863 Project (2001AA112137)
- Standards Supported
  - SNMPv1, v2c, v3
  - RMON, disman
- Support WLAN MIBs
- RFC2465-MIB-based Topology Discovery
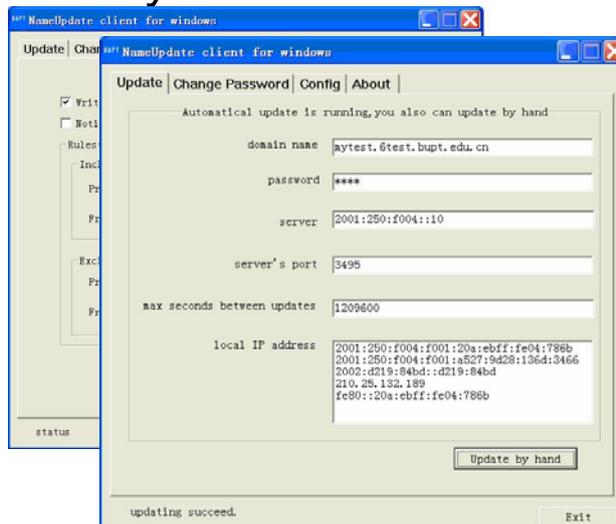- IPv4/IPv6 Dual stack

IPv4/IPv6 dual stack IDS system

# Distributed IDSv6 implementation

DARS6 – a solution to
Dynamic and Secure DNS

- DNS is important for IPv6
- DHCPv6 dose not support DNS Dynamic Update
- We developed a solution by DNS proxy server and Linux/Windows clients to provide DNS dynamic update and secured binding.

A solution by using DARSv6 Proxy Server

■ The DARSv6 - Proxy server listen on the port, if message received from the valid client, then send the DNS update to the DNS server;

■ The DARSv6 - Proxy server also provides some management function such as domain names management, authentication and other security control for the DNS server.
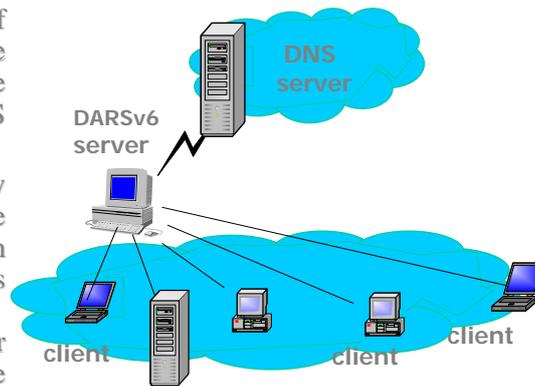
Dual stack NTP trial service

- IPv4   http://ntp.buptnet.edu.cn
- IPv6   http://[ntp.buptnet.edu.cn]

- Go4IT project is one of the European Union founded 6th Framework Programme (FP6) for IPv6 testing
- Total 13 partners in this project.
  - Inno/ETSI/INRIA/CETECOM/FOKUS/ISPRAS/Jtest/BII/CATR /BUPT/IPT
- Go4IT project intends to provide Research Infrastructure users with free **TTCN-3** based **IPv6** testing environment including **test tools**, **test suites** and the related **services**.
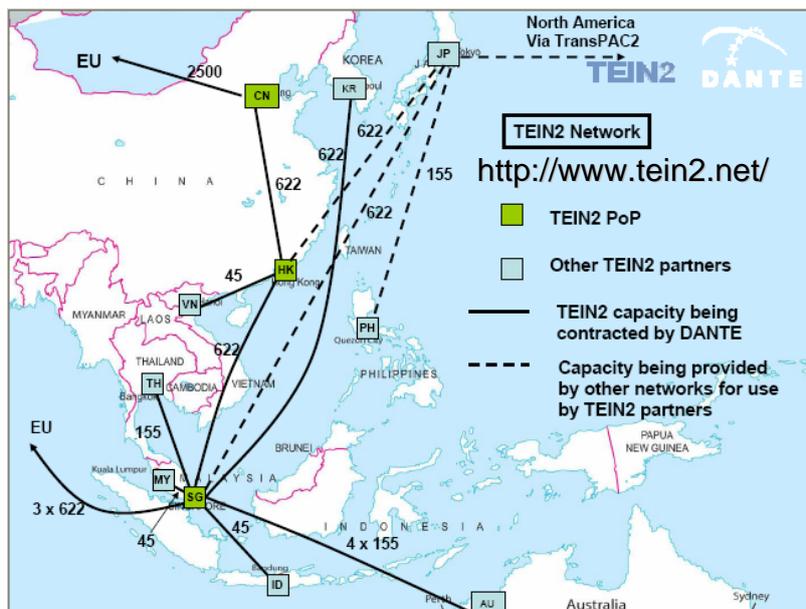
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The Global Reach of CNGI-CERNET2

TEIN2 and ORIENT

BUPT with FP6/7

- There are several FP6 projects jointly participated by researcher from EU and BUPT
  - VAS CHINA [FP6-2004-IST-3-015774]
  - MING-T / PARTAKE[FP6-2004-IST-3-015857]
  - Go4IT [FP6-2004-Infrastructures-6]
  - EC-GIN [FP6-2006-IST-045256]
  - …
- More collaborations are expected

Future works

- CERNT/CERNET2 Backbone upgrade
- Service enhancement
- Provide more applications
- Promote scientific researches
- Deliver difference level of trainings
- Cooperation with domestic and overseas partners

Let us create our future together!

Thanks!