Future Internet：Evolution vs. Revolution

Jianping WU

Tsinghua University/CERENT

December 1，2011

Contents

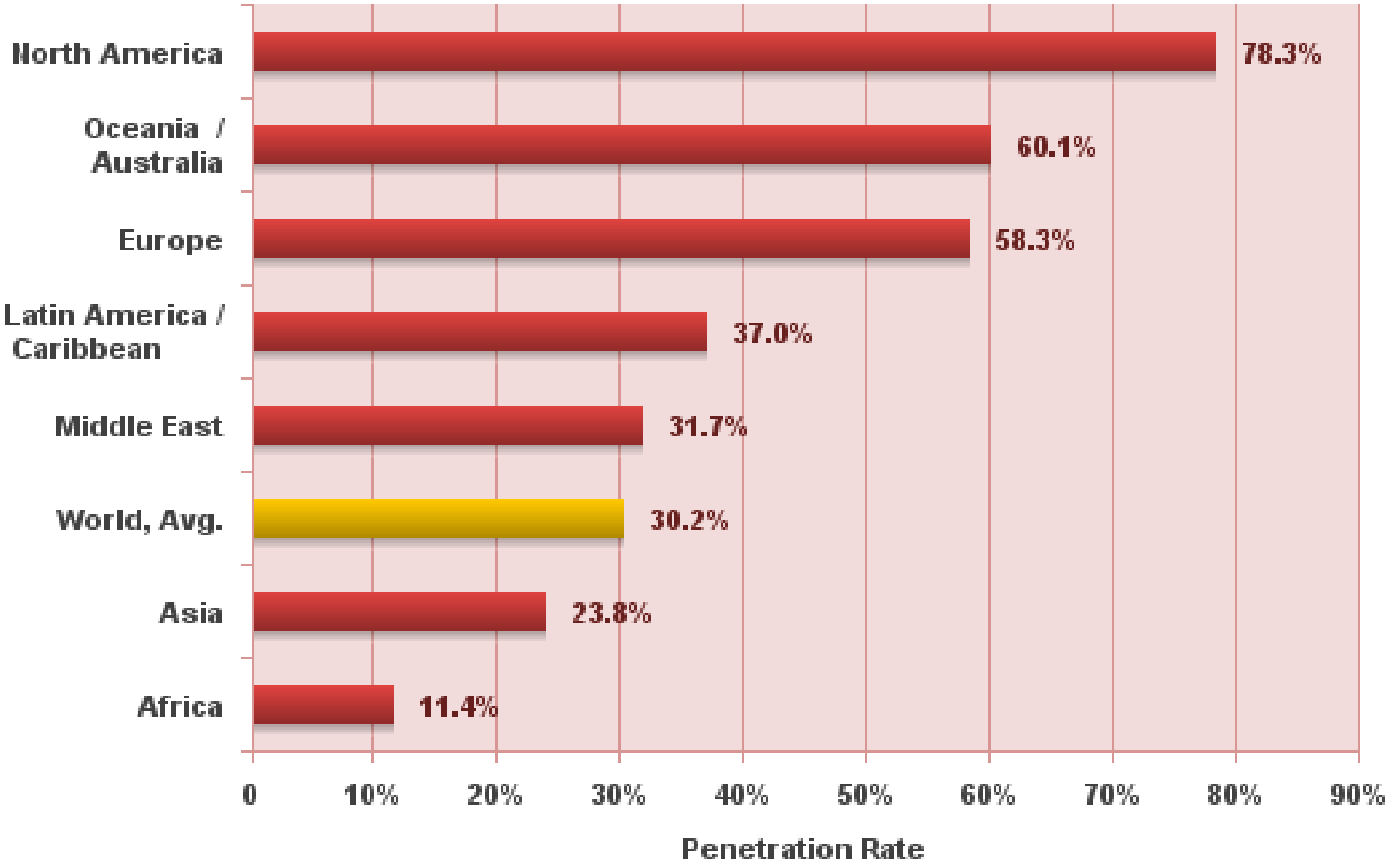
- Internet statists and growth in China
- Internet DNA and its innovation history
- Challenges from current Internet
- Innovation and evolution in Internet
- NGI and Future Internet
- Some experiences of NGI/IPv6 and its development in China
- Conclusions

INTERNET USAGE STATISTICS
The Internet Big Picture
World Internet Users and Population Stats

WORLD INTERNET USAGE AND POPULATION STATISTICS March 31, 2011						
World Regions	Population (2011 Est.)	Internet Users Dec. 31, 2000	Internet Users Latest Data	Penetration (% Population)	Growth 2000-2011	Users % of Table
Africa	1,037,524,058	4,514,400	**118,609,620**	11.4 %	2,527.4 %	5.7 %
Asia	3,879,740,877	114,304,000	**922,329,554**	23.8 %	706.9 %	44.0 %
Europe	816,426,346	105,096,093	**476,213,935**	58.3 %	353.1 %	22.7 %
Middle East	216,258,843	3,284,800	**68,553,666**	31.7 %	1,987.0 %	3.3 %
North America	347,394,870	108,096,800	**272,066,000**	78.3 %	151.7 %	13.0 %
Latin America / Carib.	597,283,165	18,068,919	**215,939,400**	36.2 %	1,037.4 %	10.3 %
Oceania / Australia	35,426,995	7,620,480	**21,293,830**	60.1 %	179.4 %	1.0 %
WORLD TOTAL	**6,930,055,154**	**360,985,492**	**2,095,006,005**	**30.2 %**	**480.4 %**	**100.0 %**

NOTES: (1) Internet Usage and World Population Statistics are for March 31, 2011. (2) CLICK on each world region name for detailed regional usage information. (3) Demographic (Population) numbers are based on data from the US Census Bureau . (4) Internet usage information comes from data published by Nielsen Online, by the International Telecommunications Union, by GfK, local Regulators and other reliable sources. (5) For definitions, disclaimer, and navigation help, please refer to the Site Surfing Guide. (6) Information in this site may be cited, giving the due credit to www.internetworldstats.com.

World Internet Penetration Rates by Geographic Regions - 2011



Source: Internet World Stats - www.internetworldststs.com/stats.htm
Penetration Rates are based on a world population of 6,930,055,154 and 2,095,006,005 estimated Internet users on March 31, 2011.


万人
50000
40000
30000
20000
10000
0
40%
35%
30%
25%
20%
15%
10%
5%
0%
21000
25300
29800
33800
38400
42000
45730
48500
16.0%
19.1%
22.6%
25.5%
28.9%
31.8%
34.3%
36.2%
29.6%
20.5%
17.8%
13.4%
13.6%
9.4%
8.9%
6.1%
2007.12
2008.6
2008.12
2009.6
2009.12
2010.6
2010.12
2011.6
网民数
互联网普及率
半年增长率

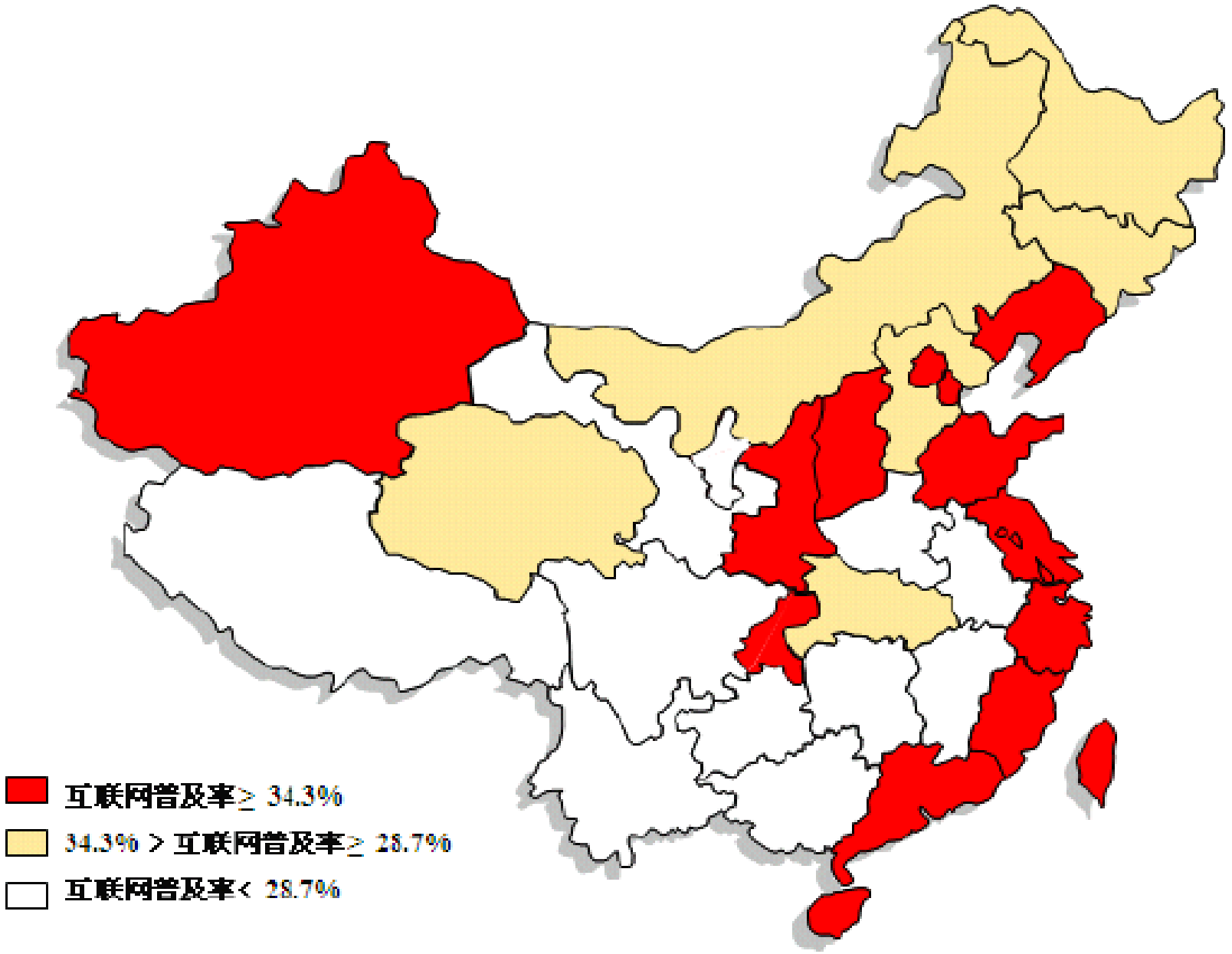


图 4 2010 年中国各省互联网发展状况

Internet DNA

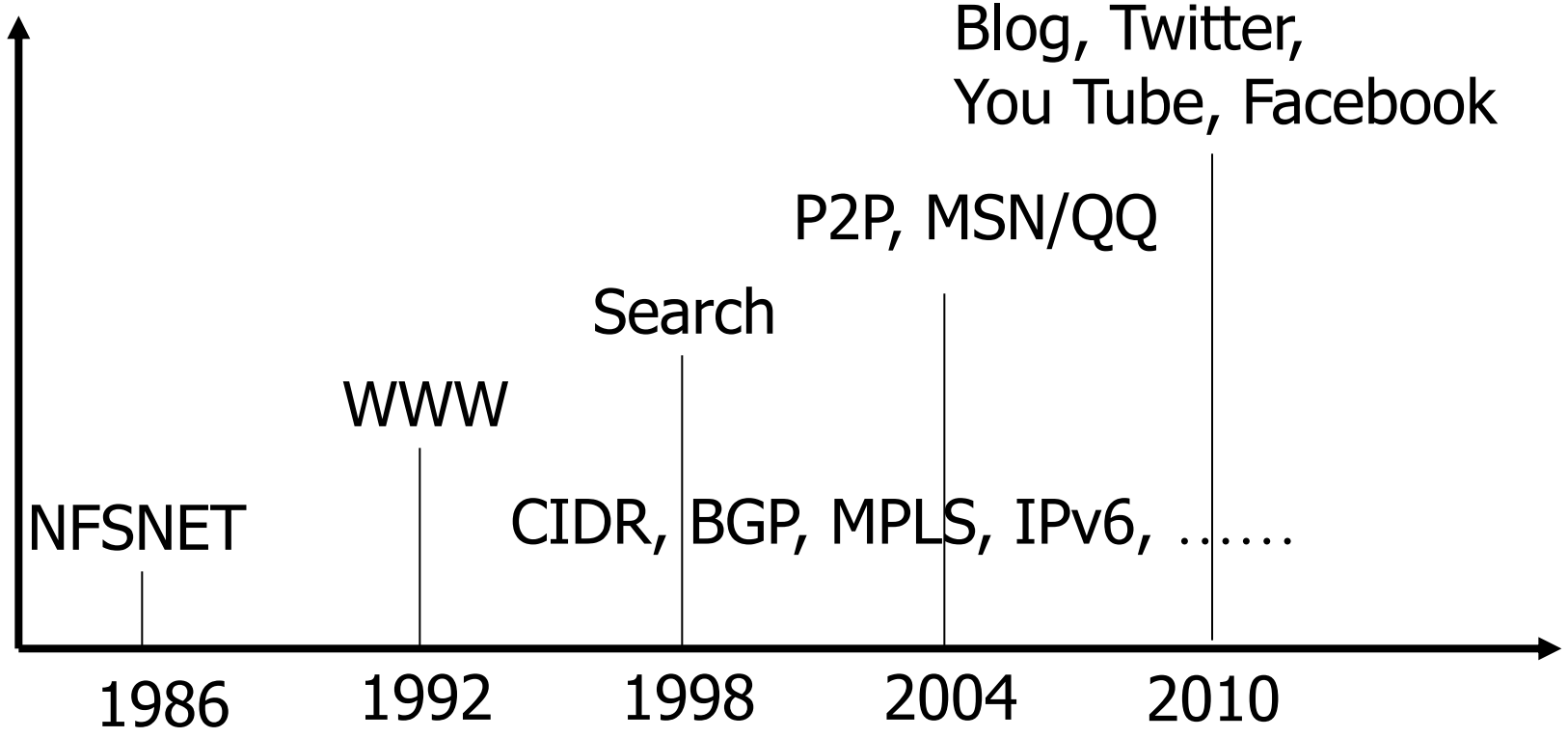
Web

Merging all of network and communication technology

All applications developed by users

Internet: Innovation History

- Innovation is the spirit of Internet
- TCP/IP is not changed



Challenges from current Internet

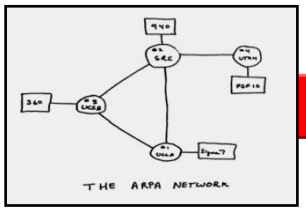
- Scalability：from connecting computers to connecting all of electronic devices
  - 3G，Internet of things，……
- Security：more trustiness
- High performance：end-end performance
- Real time：more timely
- Mobility：mobile communications over Internet
  - Not 3G only
  - WiFi/WiMax based mobile communication
- Management

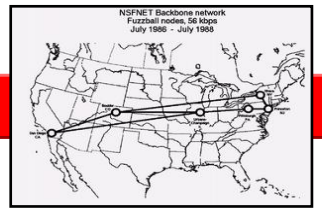
Evolution and Revolution

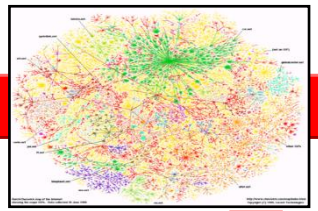
Revolution

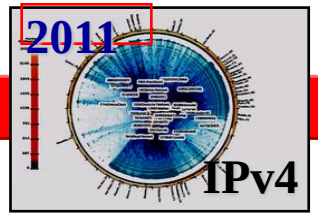
Future Internet

1969 1986 1994

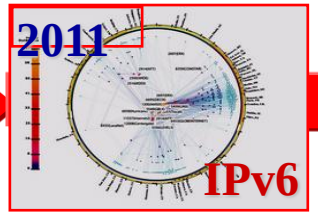








2011



Computer Network to Internet

Evolution

Internet DNA：
- IP：Use all of network and communication technology
- TCP：All applications developed by users

Challenging
- Scalability
- Security
- High Performance
- Mobility
- Real Time
- Management

Next Generation Internet
- Keep Internet DNA
- Overcome the challenges from basic components, operational principle and implement mechanism based on IPv6 platform

NGI and Future Internet

- Revolution：Future Internet
  - GENI and FIND: Clean Slate
  - May or may not be Internet DNA
- Evolution：NGI or Future Internet
  - IPv4
    - NAT
  - IPv4/IPv6: Internet2, Geant2, TEIN3
    - Less use IPv6
  - IPv6
    - Native IPv6: a new platform for Internet evolution

Some Words related Future Internet

- Next Generation Internet （NGI）：1996
  - 1996，Internet2
- Next Generation Network（NGN）：2000
  - ITU
- Future Internet：2005
  - Future Internet
  - Internet for the Future
  - Future of the Internet
- Future Network

Special Challenges from China

- Same with all challenges from current Internet
- Penetration Rates: from 30% to 70% in the future 10 years (900+ Millions users)
  - IP addresses: only IPv6
  - New challenges from design, management and operation of the largest infrastructure in the world
  - Innovation capability in Internet development
  - Governance, administration and management
  - Money?

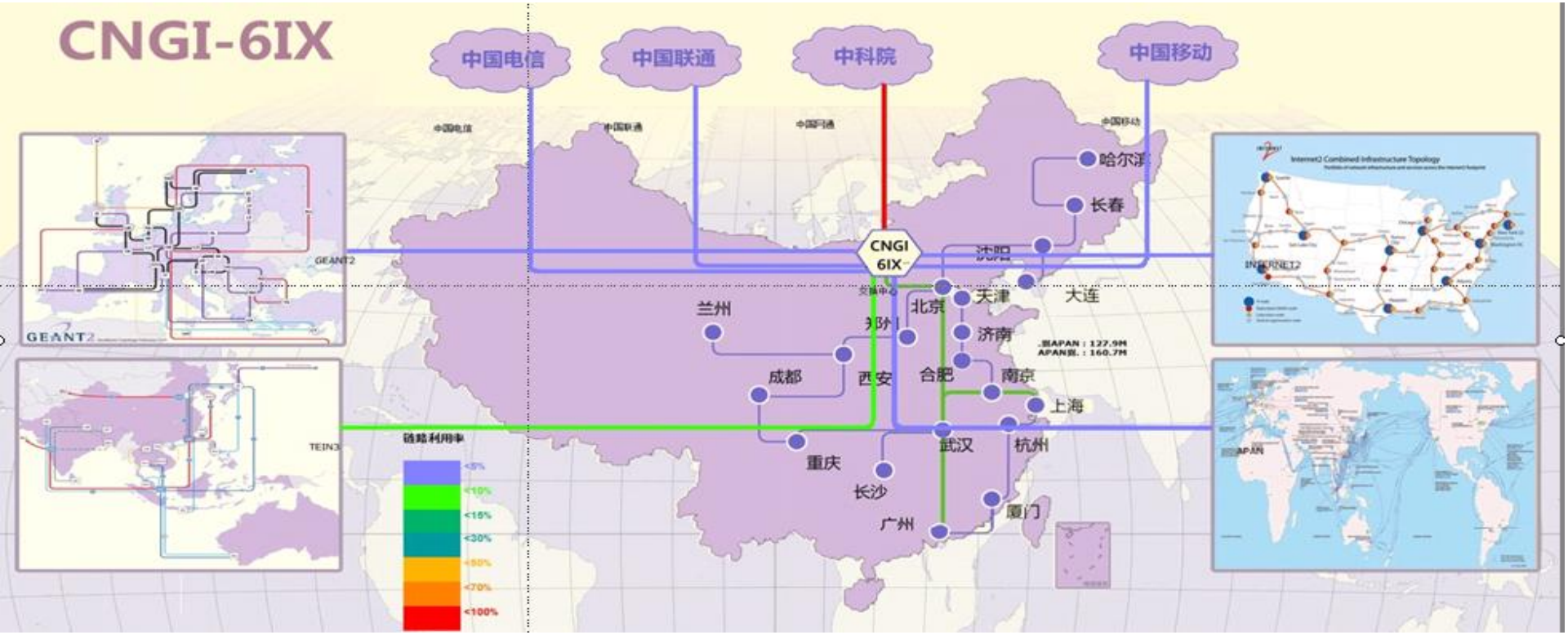
NGI and FI Development in China

- NSFC
  - Basic Research Plan on Future Internet
- MOST-973
  - Research Plan on Future Internet Architecture
- MOST-863: Next Generation Internet
  - 3Tnet，Broadband Network
  - NGI，NGN and NGB
- CNGI Project:
  - First phase：5B+ RMB

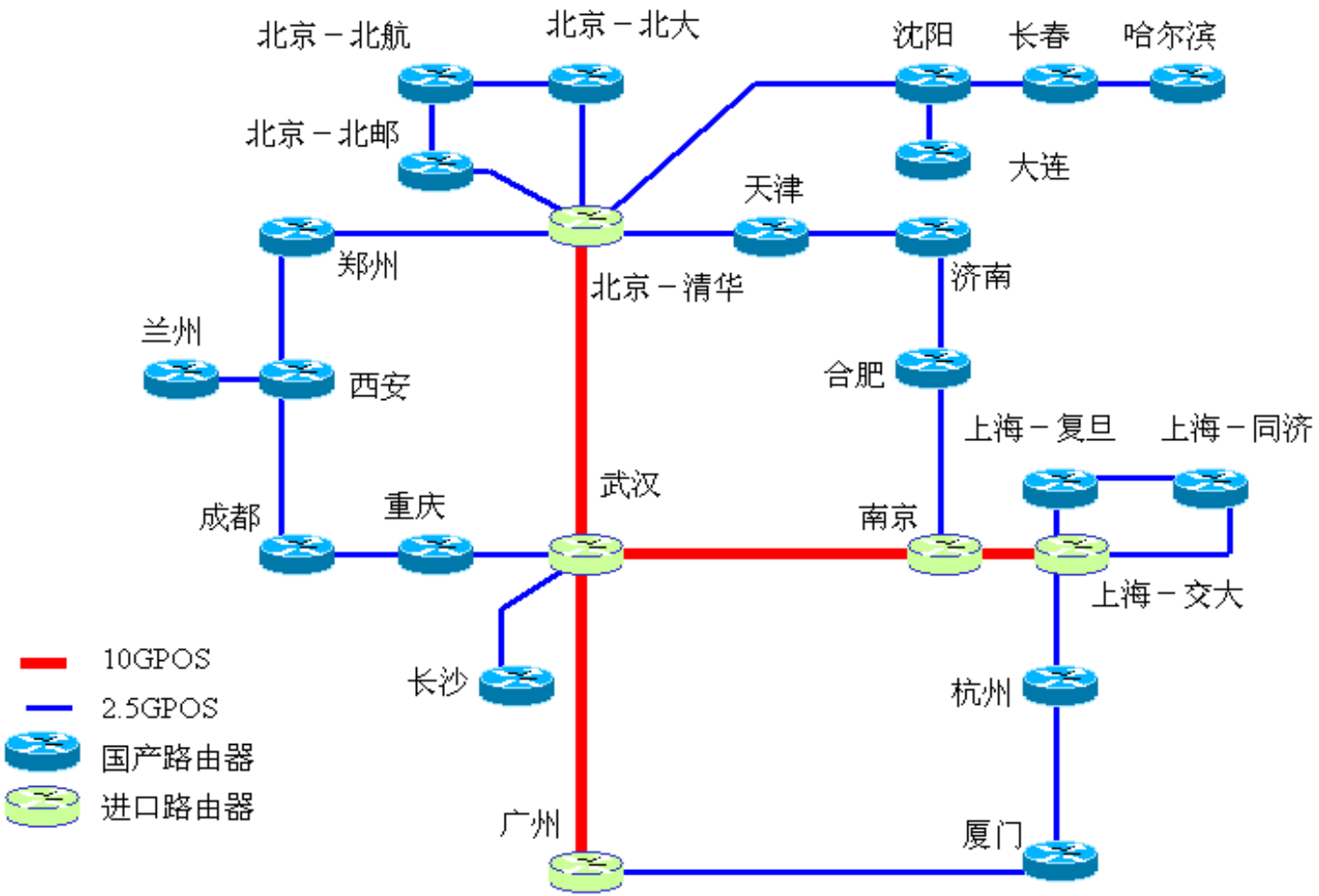
CNGI Project

- Leaded by National Reform and Development Committee
- Joint with MST, MOE, CAS, MII, NSFC, CAE, …
- First phase：2003-2008
- Main contents
  - CNGI Backbone: nation wide, 30-40 Giga POPs and 300 campus networks, international links
  - Network technology and applications
  - Delivery to information industry
- All NSPs have jointed this project
  - CERNET, China Telcom，UniCom and China Mobile

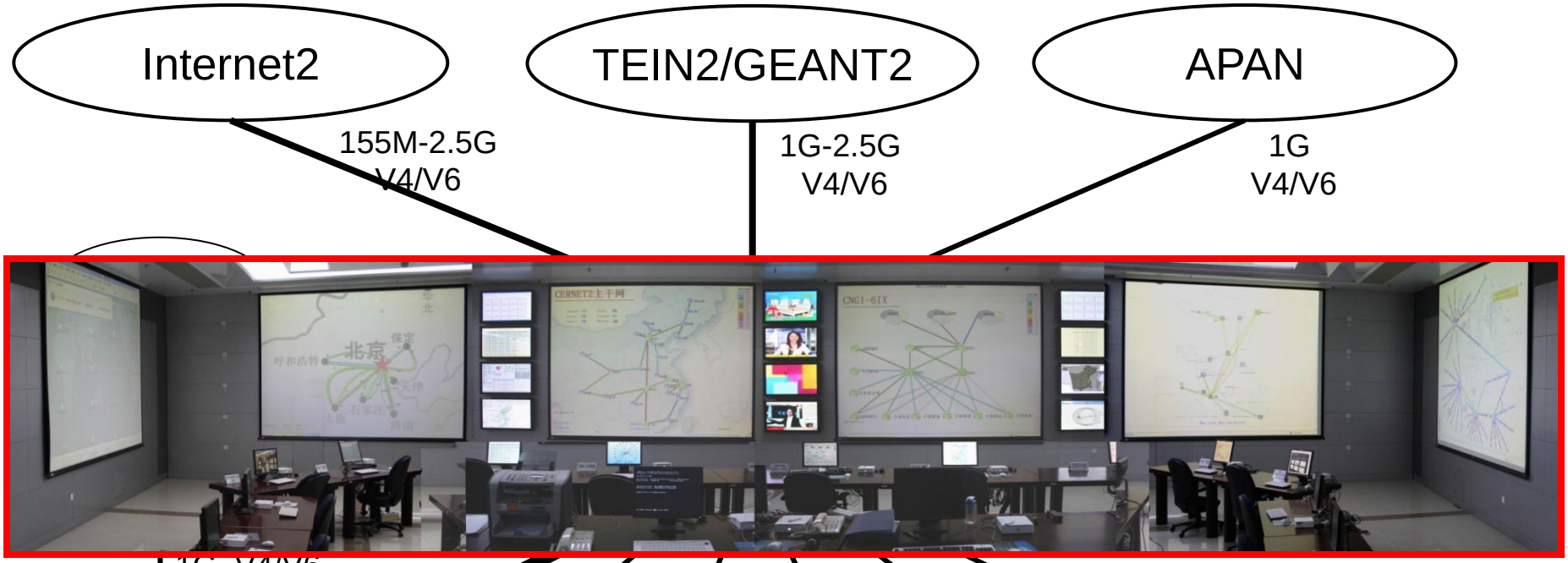
CNGI Network and Connectivity



CNGI – CERNET2 Backbone



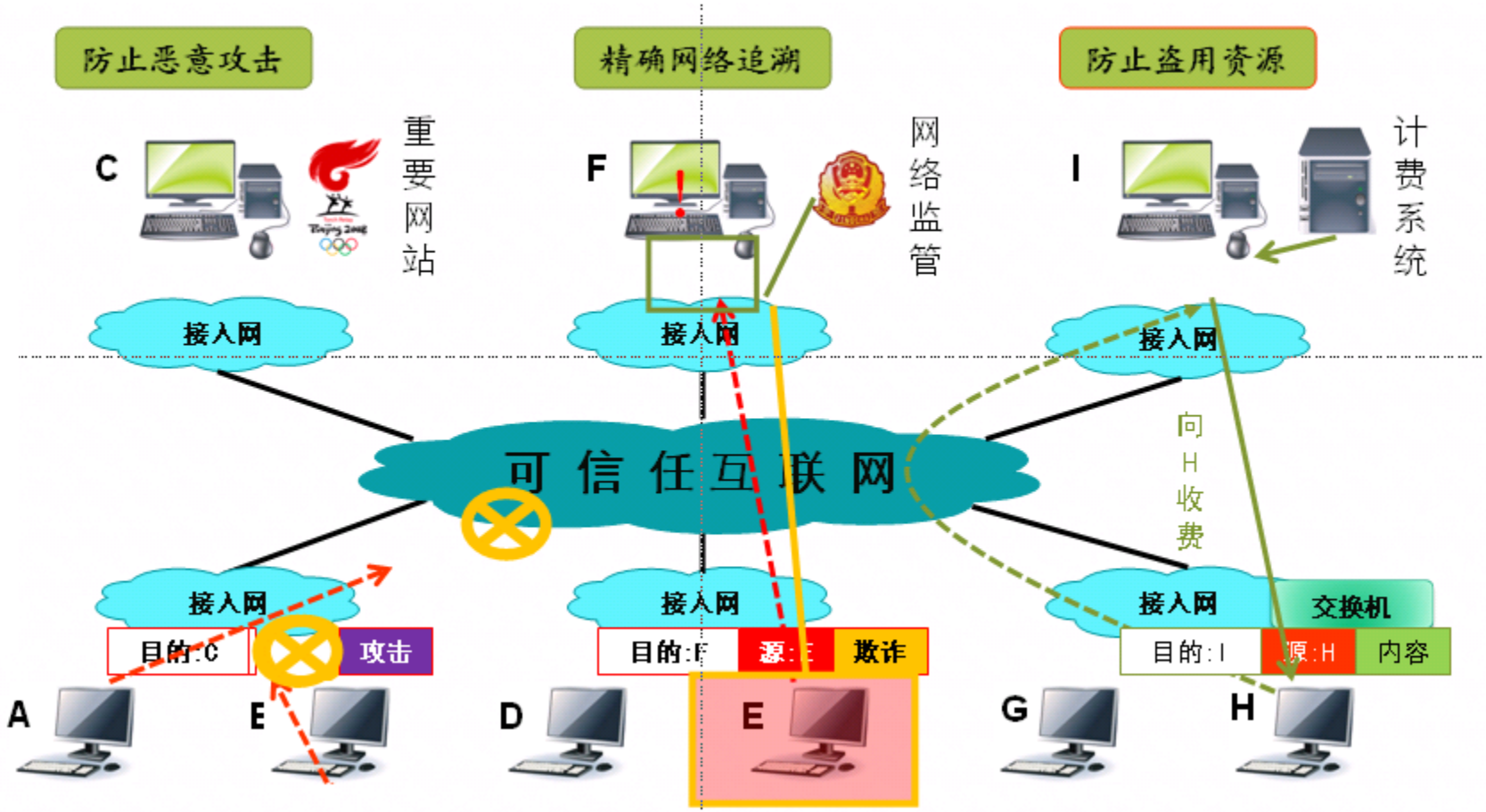
CNGI – 6IX in Tsinghua University



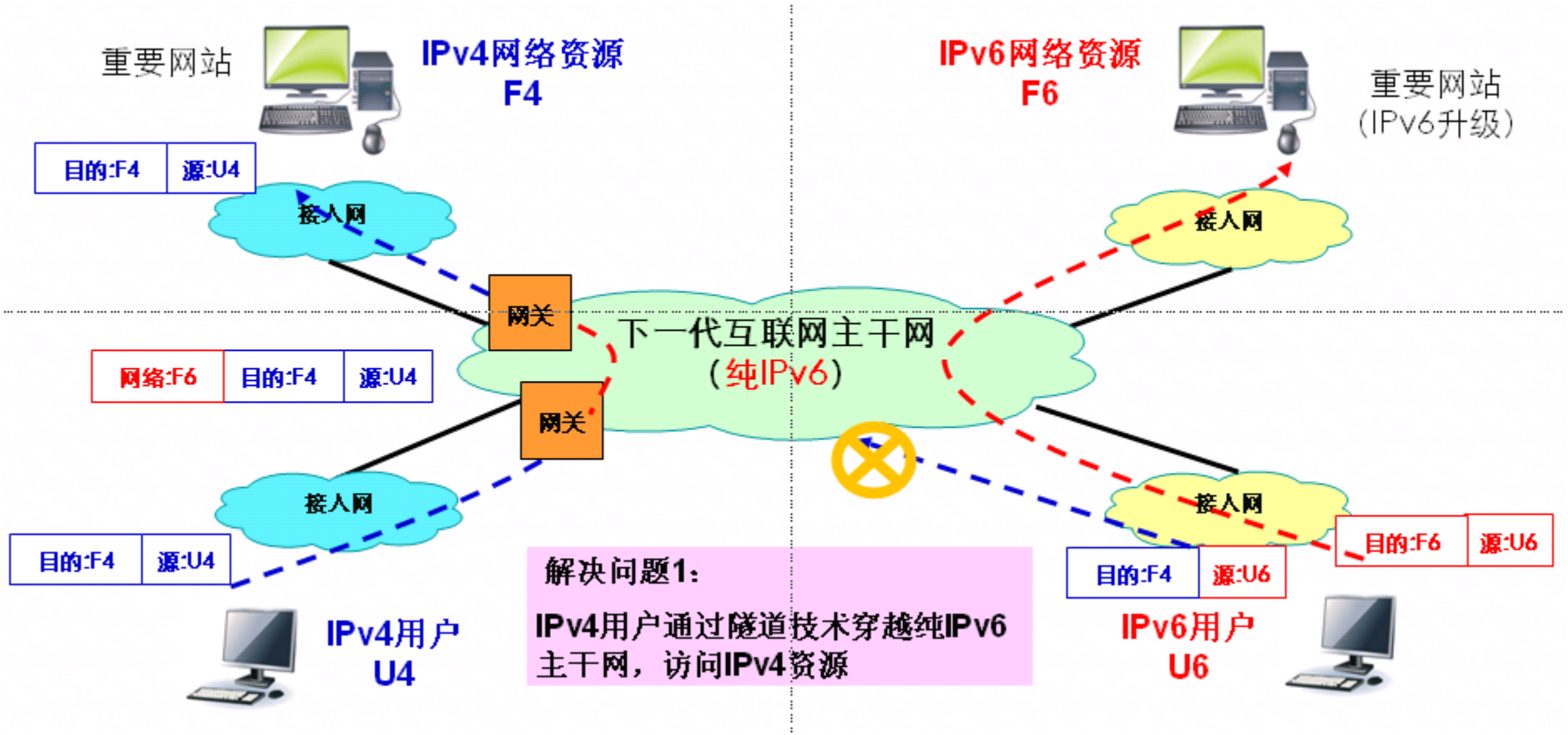
Some Experiences

- Native IPv6 Network: the largest one in the world
  - Large scale IPv6 addressing and routing
- Authentic IPv6 Addressing Architecture
  - SAVA: Source Address Validation Architecture
  - SAVI: a new IETF working group in 2008
  - RFC 5210
- Transition from IPv4 to IPv6：4over6，IVI
  - IPv4 over IPv6: Softwire-a new IETF working group in 2006，RFC 4925，RFC 5565，RFC 5747
  - IVI：RFC6052，RFC6144， RFC6145，RFC6219
- Many Technology Examinations and Applications

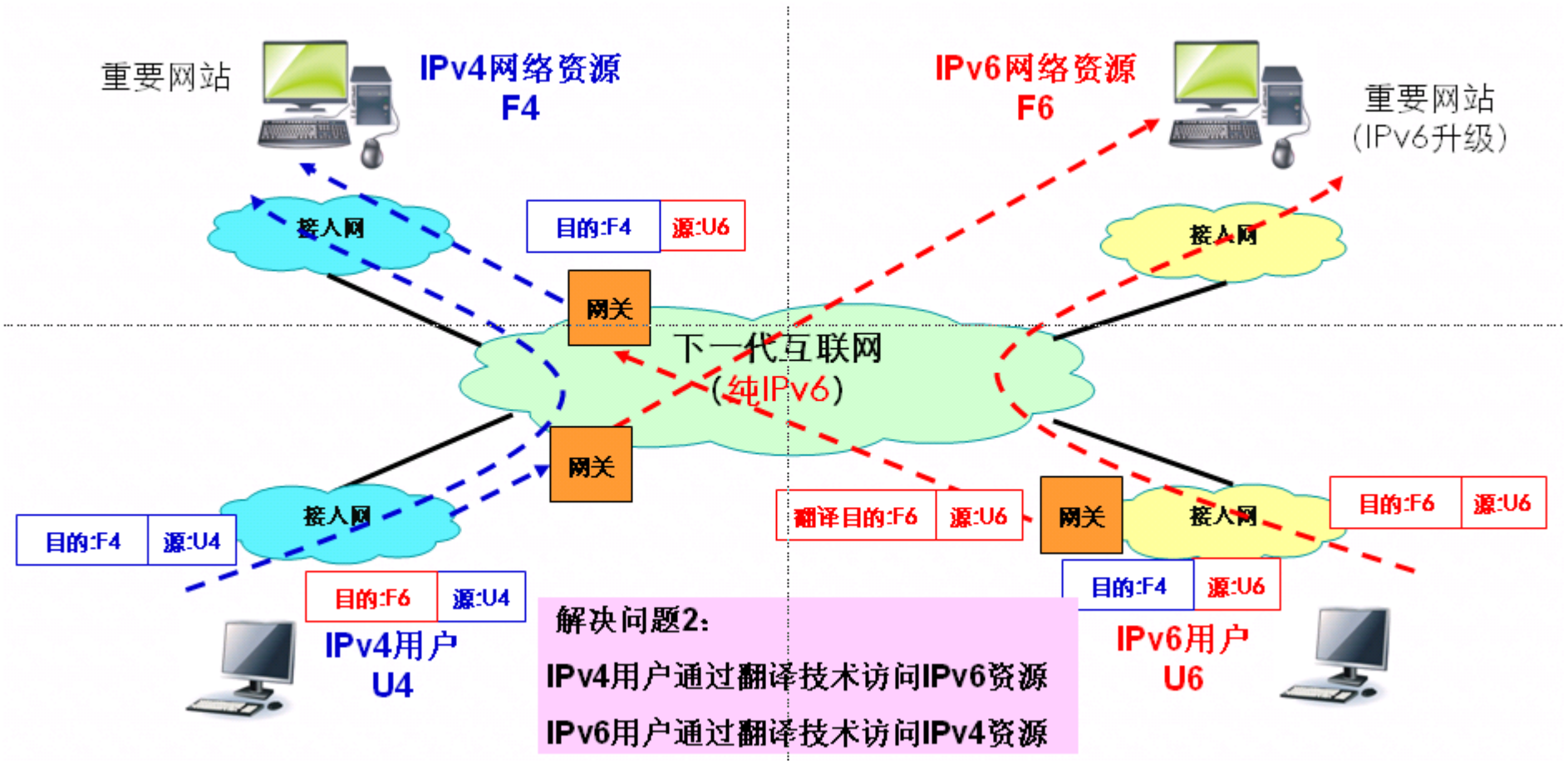
SAVA: Source Address Validation Architecture



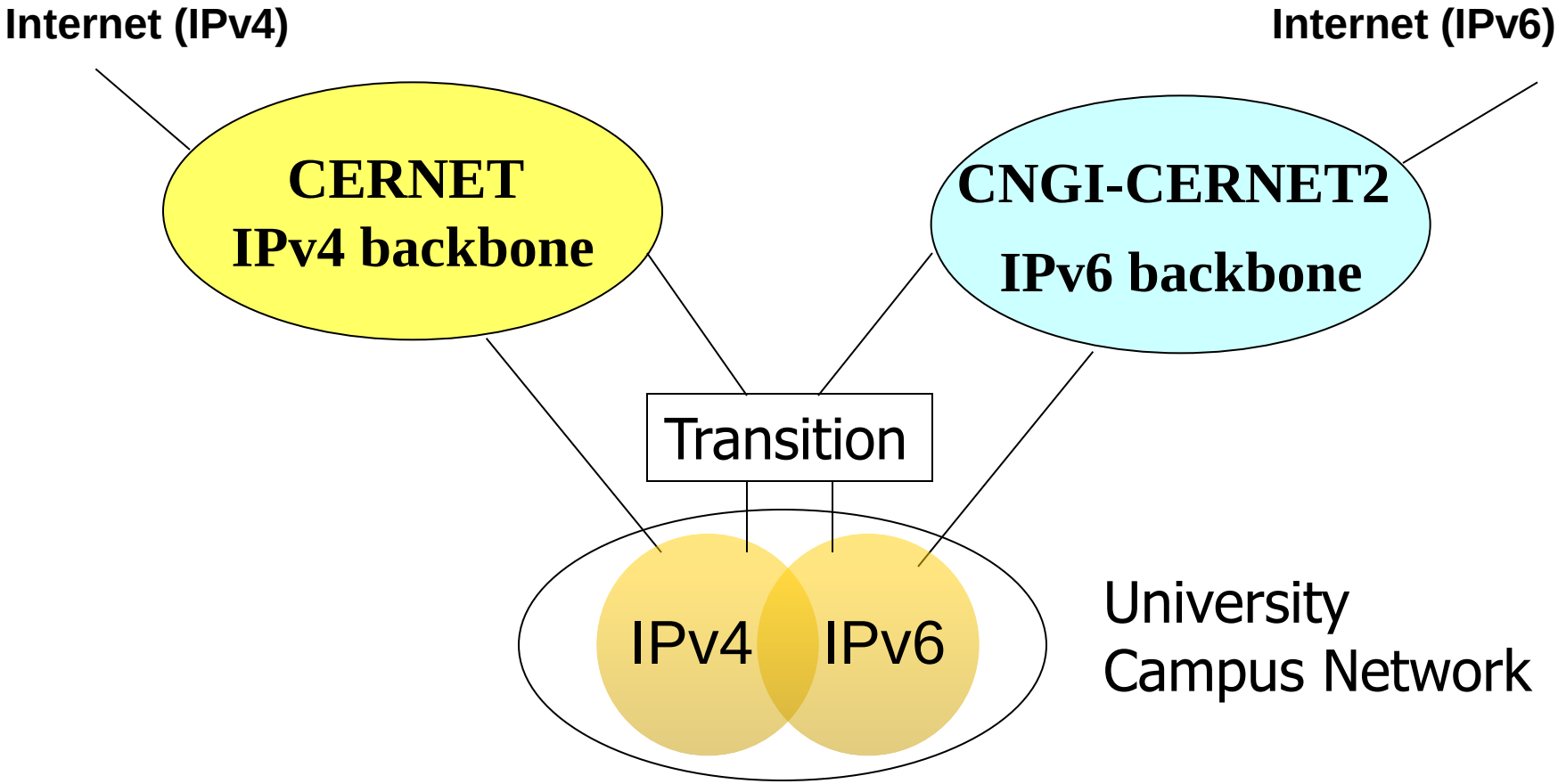
Transition: IPv4 Over IPv6



Transition：IVI



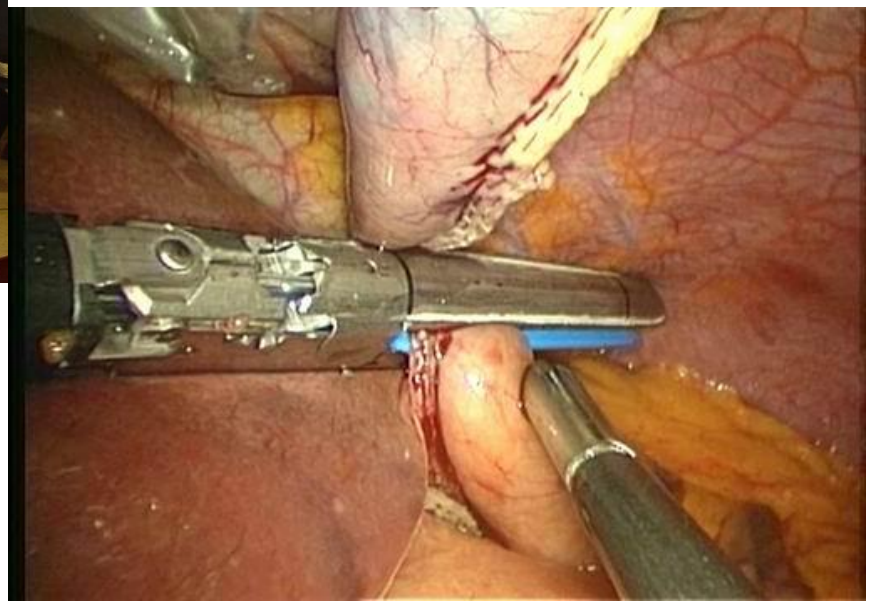
Coexistence and Transition



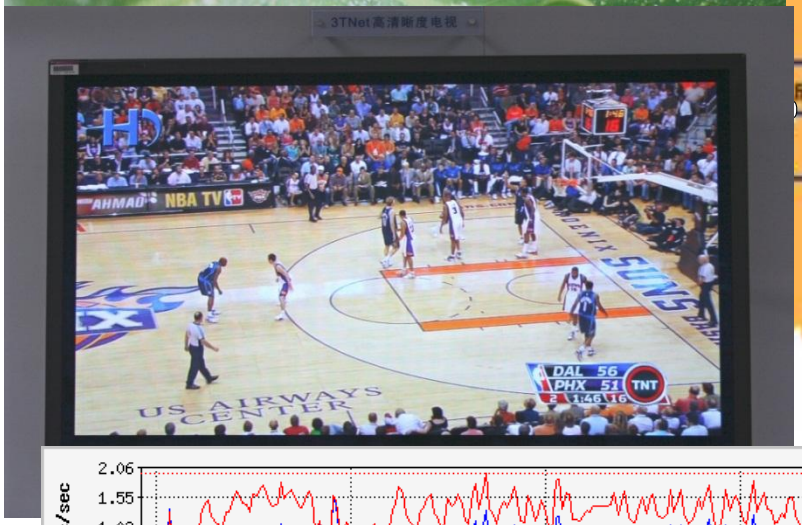
IPv6 Cooperation Working

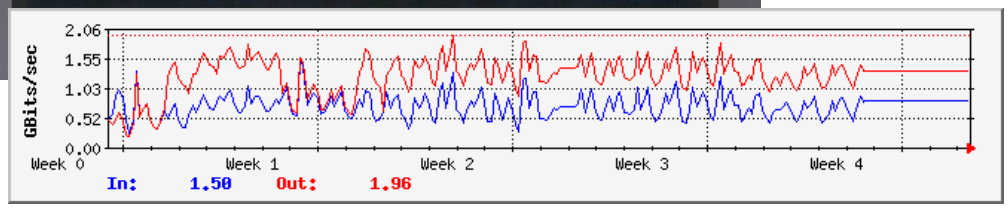
跨国界的艺术表演

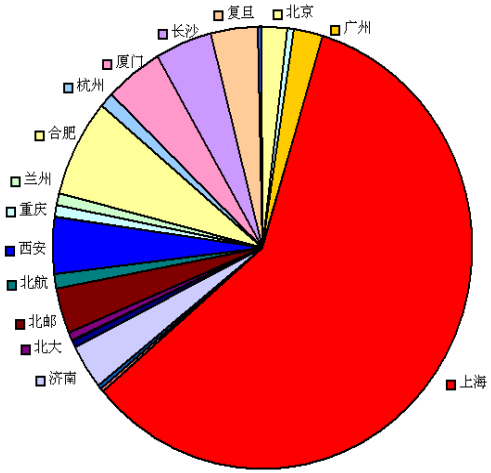
实时远程医疗手术观摩



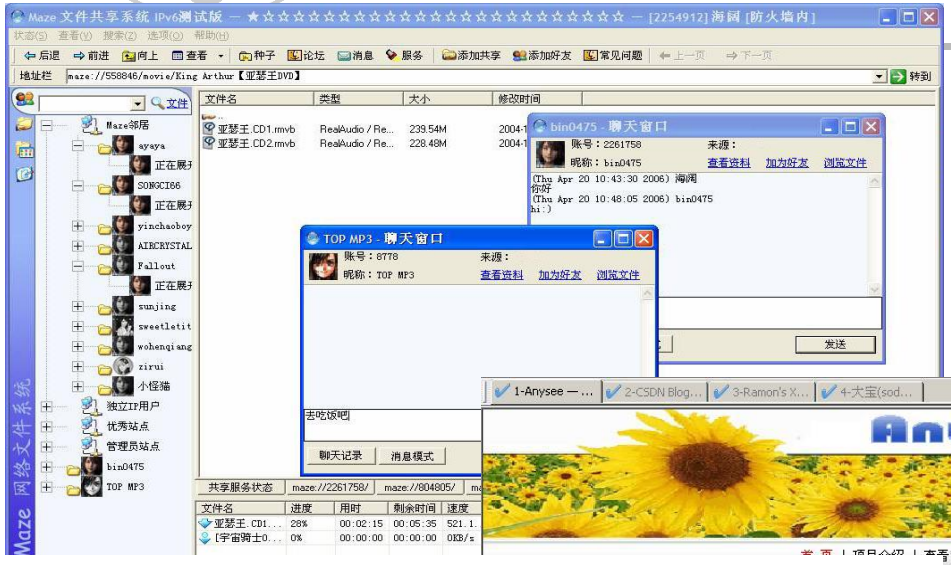
IPv6 based IPTV







IPv6 P2P Sharing Content Deliver



P2P文件共享系统

ngMaze

P2P直播流媒体系统

AnySee

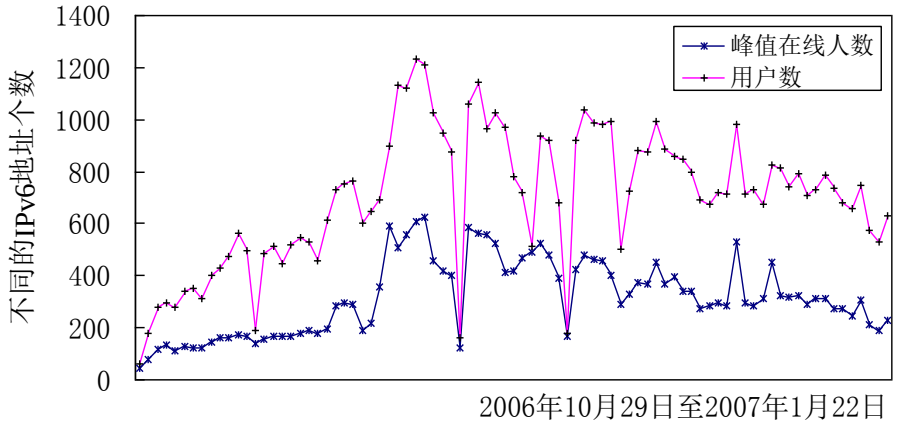
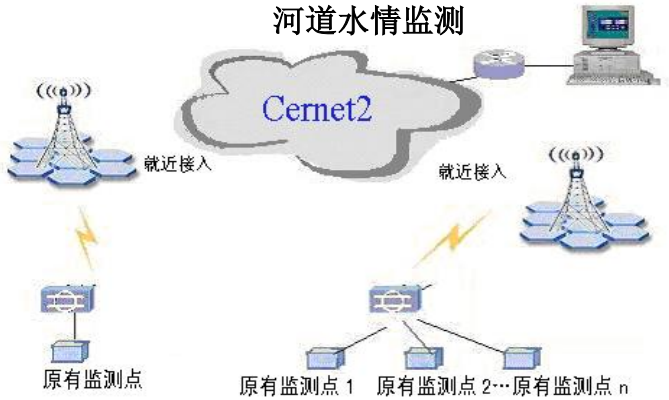


图1：CNGI04-12-2A项目IPv6用户发展情况

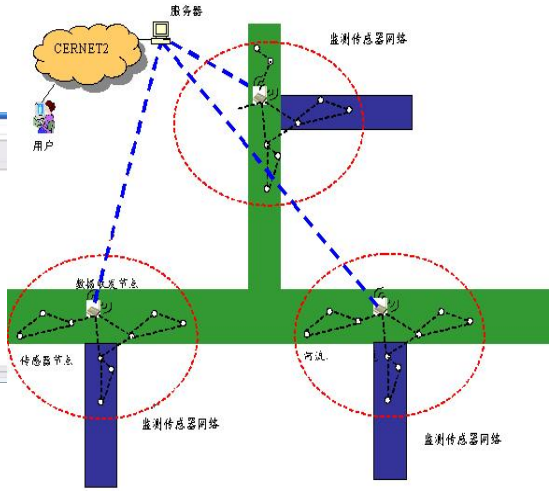
清华大学	836
北京大学	7695
华南理工大学	3552
华中科技大学	1799
浙江大学	8790
上海交通大学	20
北京邮电大学	582
西安交通大学	26
兰州大学	176
重庆大学	18
中南大学	2
东南大学	39
中国科技大学	3419
山东大学	2372
复旦大学	13
同济大学	7
厦门大学	3
东北大学	102
吉林大学	5

IPv6 Sensor Networks

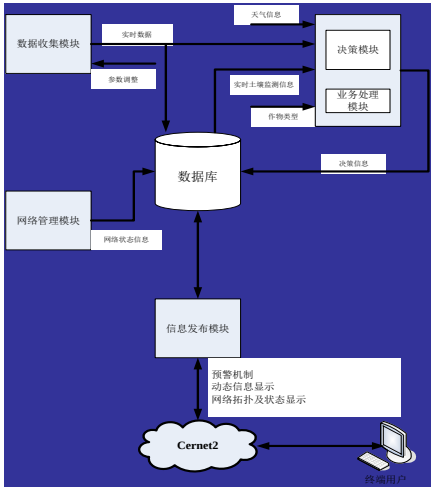
河道水情监测



入河水质监测



精准农业灌溉监测



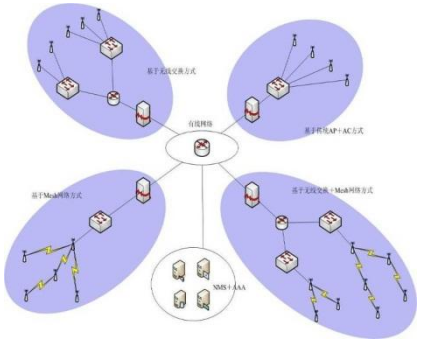
传感器部署

WiFi/WiMax and SIP based IPv6 Mobile Communication System

WLAN 单模手机/PDA

WLAN手机移动通信

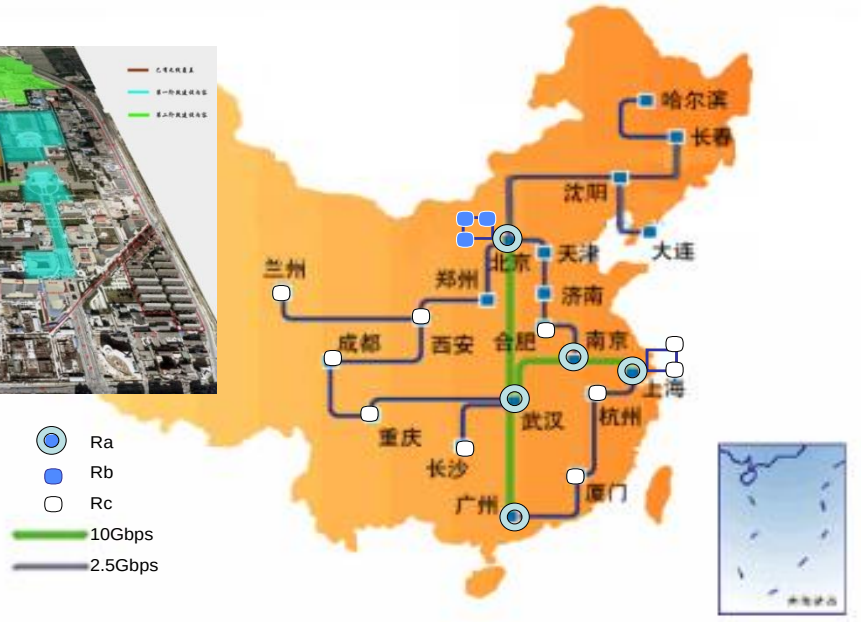
无线接入的IPTV/VOD



无线接入校园网方式

校园无线AP的部署

校园无线网络覆盖



IPv6 Digital Home Network

Agent | Agent | Agent | Agent | Agent | Agent

UPnP

UPnP

Home Gateway

FTTH

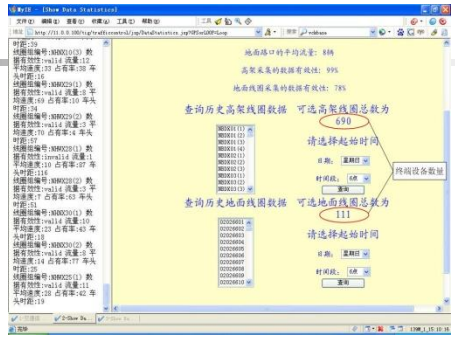
CNGI-CERNET2
(IPv6)

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。

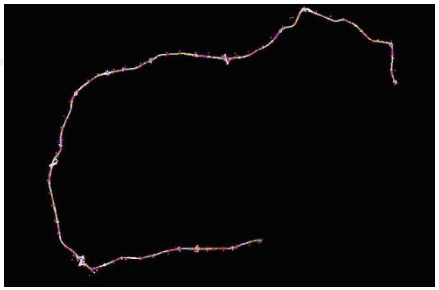
IPv6 Transportation Monitoring

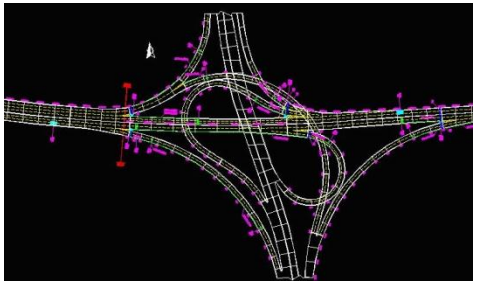
- 感应线圈车流量采集
- 流动车辆GPS数据采集
- 视频采集

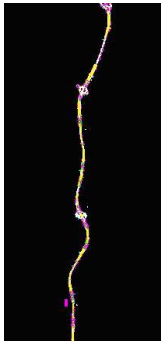
线圈采集监控窗口



内环线高架





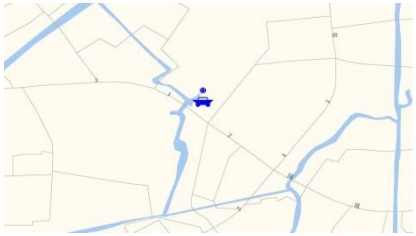


南北高架

传感器采集数据

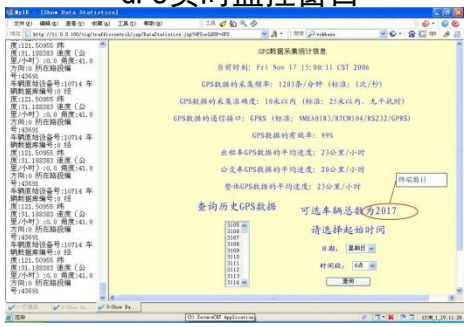
GPS发射装置

GPS位置地图显示



交叉口线圈位置

GPS实时监控窗口



流动车辆采集数据

视频采集

Beijing 2008 Olympic Games

- Many kinds of IPv6 based applications
  - Lighting, Transportation monitoring, IPTV
- First IPv6 Olympic Games Website

Some Killer Applications of the Future Internet

- Internet of Things
- Cloud Computing
  - From Grid computing to Cloud computing
- Smart Planets
- Three Networks Integration
  - Telecom，Broadcast，Internet
- Mobile Internet

Conclusions

- Internet still growth very quickly and will be the largest infrastructure in world
- Internet history is a innovation and evolution history. Innovation is the spirit of Internet
- NGI and FI will be solving the challenges from current Internet
- NGI and FI will provide a new platform for new generation Internet application
- Both evolution and revolution of Internet are needed in the future

Thanks!