

IPv4 over IPv6 Problem Statement and Network Deployment Issues

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Outline

- Why a Pure IPv6 Backbone?**
- Why IPv4 Applications?**
- Why IPv4 over IPv6?**
- IPv4 over IPv6 Function Requirements**
- IPv4 over IPv6 Protocol Components**
- Why Should We Act Now?**

Why a Pure IPv6 Backbone?

❑ Resource argument

- IPv4 address is limited

❑ Financial argument

- Less processing power and memory required for single stack routers
- Less operation cost to maintain a single stack backbone

❑ Political argument

- The funding body just wants to build an IPv6 backbone
- We want to encourage the transition

Why IPv4 Applications?

□ In theory

- It is not difficult to port IPv4 applications to IPv6

□ In practice

- There are many technical details for the porting process and the related quality control issues

□ In addition

- We should help users to use the existing IPv4 applications for their current work, and
- The software developers should write the corresponding next version, IPv6 compatible applications, and
- Hopefully, someone is developing the IPv6 “killer Applications”

Why IPv4 over IPv6?

□ Therefore, IPv4 over IPv6 may help

- Built and/or upgrade a backbone without worrying the limited IPv4 address, have a better performance-to-cost ratio and in a “politically correct” manner
- Support existing IPv4 access networks
- Support existing IPv4 applications

□ And it may help for the transition from IPv4 to IPv6 in a cost effective, incremental and seamless fashion

In Addition

□ The methods developed may also help to find general solutions for

- IPv6 over IPv4**
- IPv6 over UDP over IPv4**
- future encapsulation methods**

IPv4 over IPv6 Function Requirements

Transparent

- **same behavior as if the IPv4 packets travel in a IPv4 or dual-stack backbone**

Lightweight

- **support high throughput and low latency**

Support both unicast and multicast

Support inner AS and inter AS routing

Support dynamic allocation of the IPv4 address for connection setup

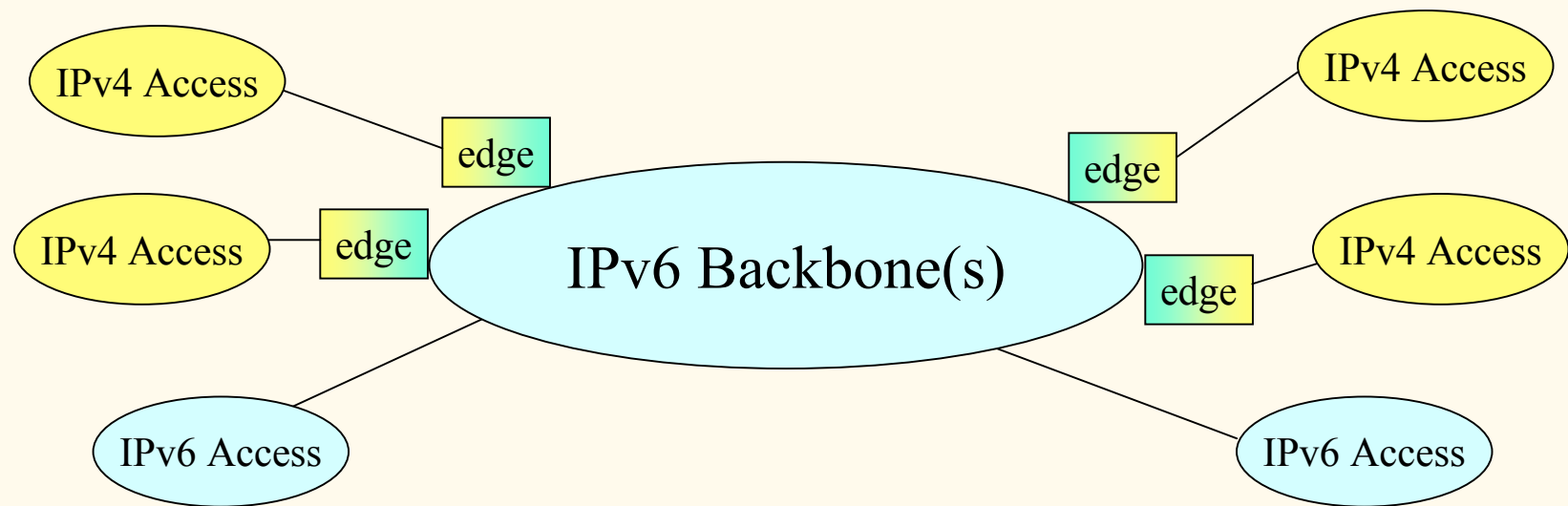
Support (simple) authentication

Support for management functions

Support for the mobile access providers

Support for network migration

IPv4 over IPv6 Topology



IPv4 over IPv6 Protocol Components

□ Control and Discovery

- Low-latency configuration/establishment
- Subscriber management
- Authentication
- Automatic endpoint discovery

□ Encapsulation

- Simple encoding
- MTU handling
- Encryption mode

Why Should We Act Now?

- ❑ **Chinese Internet users need more IP addresses and the bandwidth**
 - 83 (/8)s are required for an address per head
- ❑ **The China Next Generation Internet Project has been started**
 - It is funded by Chinese government
 - It has multiple high speed IPv6 backbones
- ❑ **The transition from IPv4 to IPv6 is very slow**
 - Information resources and applications porting is not an easy job
 - Most access networks are still IPv4

The 16th China Internet Development Report



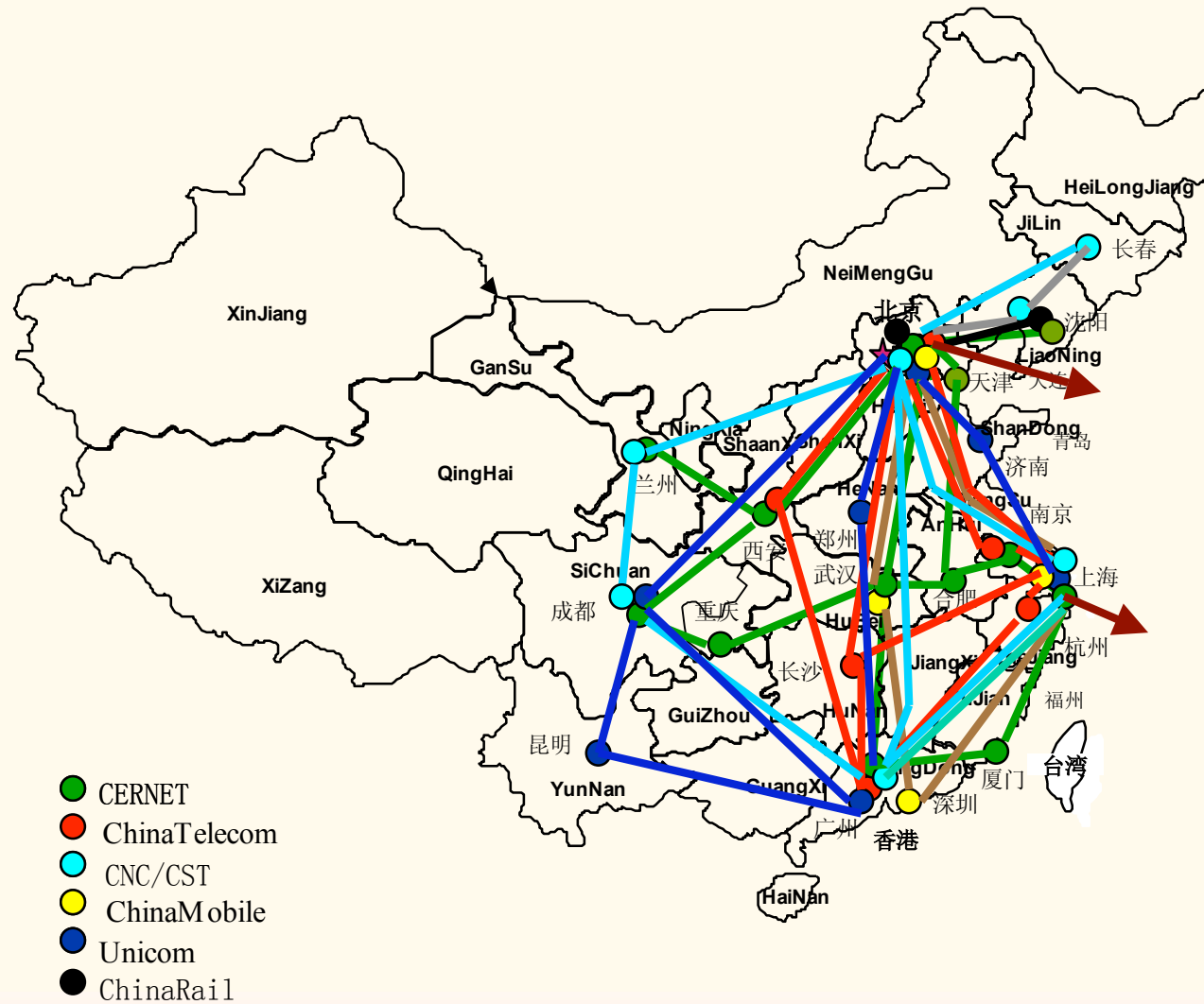
China Internet Statistics (July, 2005)

- Internet population: 103M
- ranked 2nd, (8%)
- IPv4 address: 4+ (/8)s
- ranked 4th, (1.6%)

CIDR Report

AS	AS Name	Origin	Origin IP	Origin AS	Origin Weight	Transit	Transit IP	Transit AS	Transit Weight	AS Name
1	AS721	ORG+TRN	Originate:	90504192	/5.57	Transit:	26760448	/7.33	DLA-ASNBLOCK-AS - DoD Network Information Center	
2	AS3356	ORG+TRN	Originate:	44229888	/6.60	Transit:	196805376	/4.45	LEVEL3 Level 3 Communications	
3	AS714	ORIGIN	Originate:	35720960	/6.91	Transit:	0	/0.00	APPLE-ENGINEERING - Apple Computer, Inc.	
4	AS4134	ORG+TRN	Originate:	33894400	/6.99	Transit:	15091456	/8.15	CHINANET-BACKBONE No.31,Jin-rong Street	
5	AS701	ORG+TRN	Originate:	33492224	/7.00	Transit:	48624128	/6.46	ALTERNET-AS - UUNET Technologies, Inc.	
6	AS17676	ORG+TRN	Originate:	27511296	/7.29	Transit:	495872	/13.08	JPNIC-JP-ASN-BLOCK Japan Network Information Center	
7	AS7018	ORG+TRN	Originate:	26432768	/7.34	Transit:	59303680	/6.18	ATT-INTERNET4 - AT&T WorldNet Services	
8	AS174	ORG+TRN	Originate:	23864576	/7.49	Transit:	45301248	/6.57	COGENT Cogent/PSI	
9	AS71	ORG+TRN	Originate:	20339712	/7.72	Transit:	4352	/19.91	HP-INTERNET-AS Hewlett-Packard Company	
10	AS7132	ORG+TRN	Originate:	19294976	/7.80	Transit:	7315712	/9.20	SBIS-AS - SBC Internet Services	
11	AS237	ORG+TRN	Originate:	18491904	/7.86	Transit:	90368	/15.54	MERIT-AS-14 - Merit Network Inc.	
12	AS2686	ORG+TRN	Originate:	17820160	/7.91	Transit:	1557248	/11.43	AT&T Global Network Services - EMEA	
13	AS7377	ORIGIN	Originate:	17056256	/7.98	Transit:	0	/0.00	UCSD - University of California at San Diego	
14	AS6878	ORG+TRN	Originate:	17006592	/7.98	Transit:	64256	/16.03	AS6878-T-SYSTEMS T-Systems International GmbH	
15	AS3	ORIGIN	Originate:	16974848	/7.98	Transit:	0	/0.00	MIT-GATEWAYS - Massachusetts Institute of Technology	
16	AS2647	ORG+TRN	Originate:	16895488	/7.99	Transit:	167680	/14.64	SITA SITA	
17	AS33	ORIGIN	Originate:	16842752	/7.99	Transit:	0	/0.00	HP-DIGITAL-33 - Hewlett-Packard Company	
18	AS80	ORG+TRN	Originate:	16777984	/8.00	Transit:	99584	/15.40	GE-CRD - General Electric Company	
19	AS209	ORG+TRN	Originate:	14253568	/8.24	Transit:	174776832	/4.62	ASN-QWEST - Qwest	
20	AS4766	ORG+TRN	Originate:	14240512	/8.24	Transit:	5606144	/9.58	KIXS-AS-KR Korea Telecom	
21	AS3320	ORG+TRN	Originate:	13310720	/8.33	Transit:	29234432	/7.20	DTAG Deutsche Telekom AG	
22	AS1668	ORG+TRN	Originate:	12137472	/8.47	Transit:	6709248	/9.32	AOL-ATDN - AOL Transit Data Network	
23	AS1239	ORG+TRN	Originate:	12085504	/8.47	Transit:	191942400	/4.48	SPRINTLINK - Sprint	
24	AS5089	ORG+TRN	Originate:	11266304	/8.57	Transit:	44288	/16.57	NTL NTL Group Limited	
25	AS306	ORIGIN	Originate:	11086848	/8.60	Transit:	0	/0.00	NGNET-AS - DoD Network Information Center	
26	AS4538	ORG+TRN	Originate:	10576640	/8.67	Transit:	5888	/19.48	ERX-CERNET-BKB China Education and Research Network	
27	AS2856	ORG+TRN	Originate:	10541312	/8.67	Transit:	345856	/13.60	BT-UK-AS BTnet UK Regional network	
28	AS4837	ORG+TRN	Originate:	10104064	/8.73	Transit:	4696064	/9.84	CHINA169-BACKBONE CNCGROUP China169 Backbone	
29	AS3561	ORG+TRN	Originate:	9823232	/8.77	Transit:	2608128	/10.69	SAVVIS - Savvis	
30	AS1103	ORG+TRN	Originate:	8462080	/8.99	Transit:	336128	/13.64	SURFNET-NL SURFnet, The Netherlands	
31	AS702	ORG+TRN	Originate:	8391424	/9.00	Transit:	2997760	/10.48	AS702 MCI EMEA - Commercial IP service provider	
32	AS680	ORG+TRN	Originate:	8359424	/9.01	Transit:	721408	/12.54	DFN-IP service G-WiN	
33	AS22773	ORG+TRN	Originate:	8185856	/9.04	Transit:	2017792	/11.06	CCINET-2 - Cox Communications Inc.	
34	AS4713	ORG+TRN	Originate:	7622912	/9.14	Transit:	456960	/13.20	OCN NTT Communications Corporation	
35	AS6167	ORIGIN	Originate:	7435520	/9.17	Transit:	0	/0.00	CELLCO-PART - Cellico Partnership	
36	AS786	ORG+TRN	Originate:	7348992	/9.19	Transit:	332288	/13.66	JANET The JANET IP Service	
37	AS2907	ORG+TRN	Originate:	7331840	/9.19	Transit:	3463168	/10.28	ERX-SINET-AS National Center for Science Information	
38	AS400	ORG+TRN	Originate:	7235072	/9.21	Transit:	138496	/14.92	AFCONC-BLOCK1-AS - Headquarters Standard System	
39	AS2828	ORG+TRN	Originate:	7216384	/9.22	Transit:	3566592	/10.23	XO-AS15 - XO Communications	
40	AS2914	ORG+TRN	Originate:	7097088	/9.24	Transit:	3110400	/10.43	VERIO - Verio, Inc.	
41	AS9394	ORIGIN	Originate:	6829056	/9.30	Transit:	0	/0.00	CRNET CHINA RAILWAY Internet (CRNET)	
42	AS3269	ORG+TRN	Originate:	6656000	/9.33	Transit:	513792	/13.03	ASN-IBSNZ TELECOM ITALIA	
43	AS1267	ORG+TRN	Originate:	6286080	/9.42	Transit:	568320	/12.88	ASN-INFOSTRADA Infostrada S.p.A.	
44	AS3462	ORG+TRN	Originate:	5900032	/9.51	Transit:	321792	/13.70	HINET Data Communication Business Group	

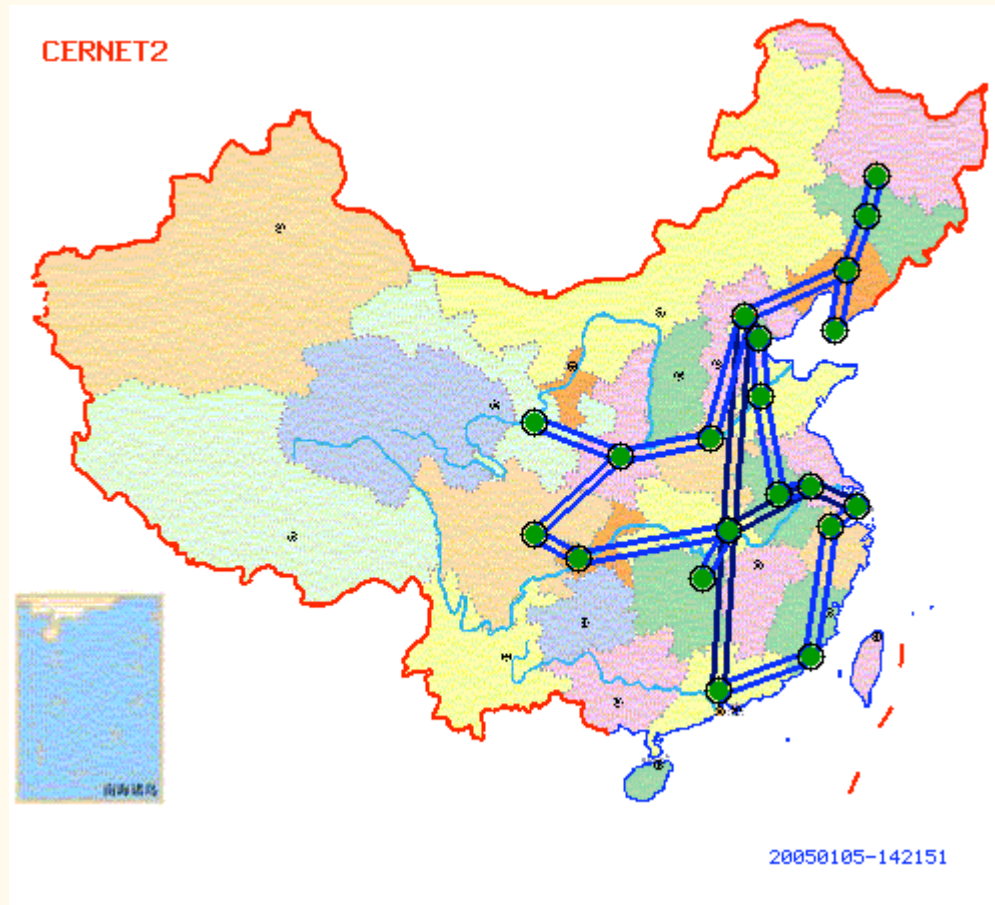
CNGI Backbones



CNGI-CERNET2

- ❑ **25 Pops in 20 cities linked via 2.5Gbps to 10 Gbps trunks**
- ❑ **IPv6 only Backbone**
 - **AS23910**
 - **2001:DA8::/32**
 - **IGP - OSPFv3**
 - **EGP - BGP4+ peering with**
 - 25 regional Pops
 - 5 CNGI backbones
 - CERNET IPv6, CJ-IPv6, NSFCNET, 863-testbed, 3Tnet, etc
- ❑ **100+ access networks**
- ❑ **IPv4 over IPv6 is required for CERNET2**

CNGI-CERNET2 Topology



Some Concluding Thoughts

- CERNET2 and CNGI requires the IPv4 over IPv6 technology and other countries may have similar requirements**
- We would not limit ourselves to only one solution in an effort to avoid delaying a solution to the Internet but, over time to find general solutions to the problem space**