
# IPv6: Engine for Next-Generation Internet

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# Outline

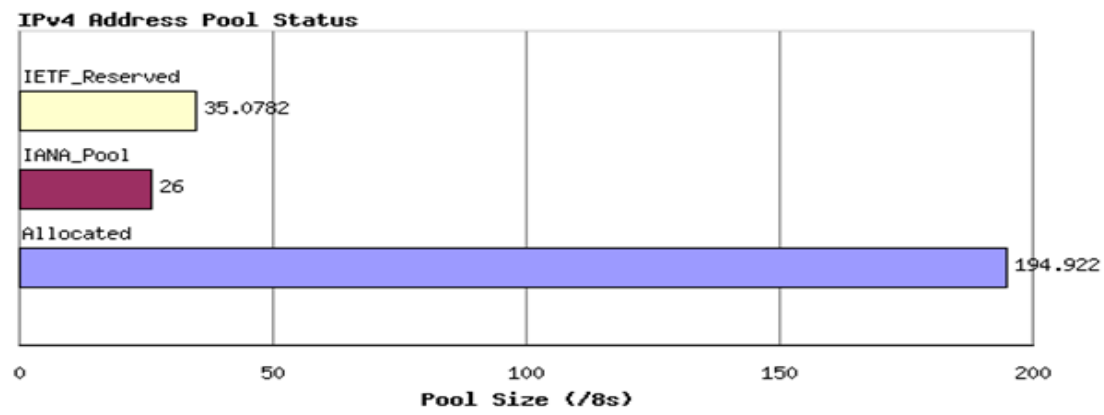
- Background of IPv6 transition
- Basic technologies for IPv6 transition
- Active work in IETF
  - IPv6 transition in backbone
  - IPv6 transition in access networks
- IPv6 Transition in CNGI-CERNET2
- Conclusion

# Background

## Problems of IPv4

- **The address exhaustion**
- **Routing scalability: de-aggregated address allocation, address trading & CIDR**
- **Widely use of NAT & private addresses: break end-to-end principle**
- **……**

**Transition from IPv4 to IPv6**




| Projected Unallocated Address Pool Exhaustion | |
|---|---|
| IANA | **03-Feb-2011** |
| APNIC | **19-Apr-2011** |

**http://www.potaroo.net/**

# Background

- Advantage of IPv6
  - Automatic host configuration
  - Simplified/fixed IP header
  - More secure
    - Authentication, data integrity, privacy
  - Support for more options and extension
  - Flow Label for QoS
  - Mobility support is better
  - Larger address space (2^128)

Killer Application?

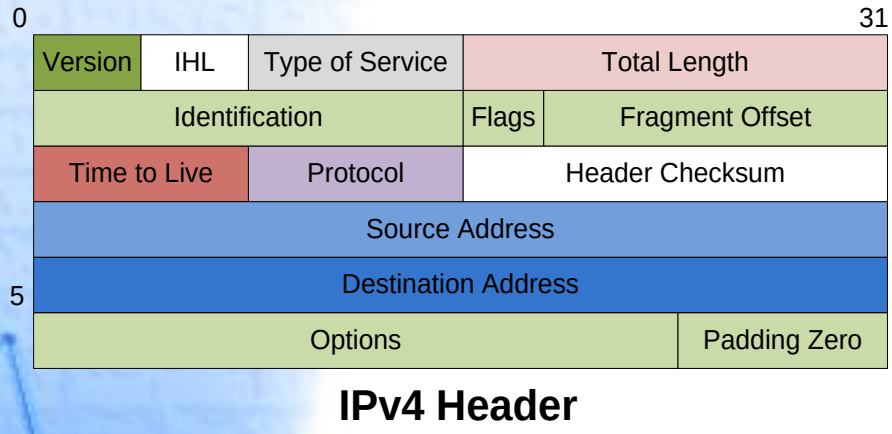
**Fundamental Reason for IPv6 transition**

# Current IPv4/IPv6 situation

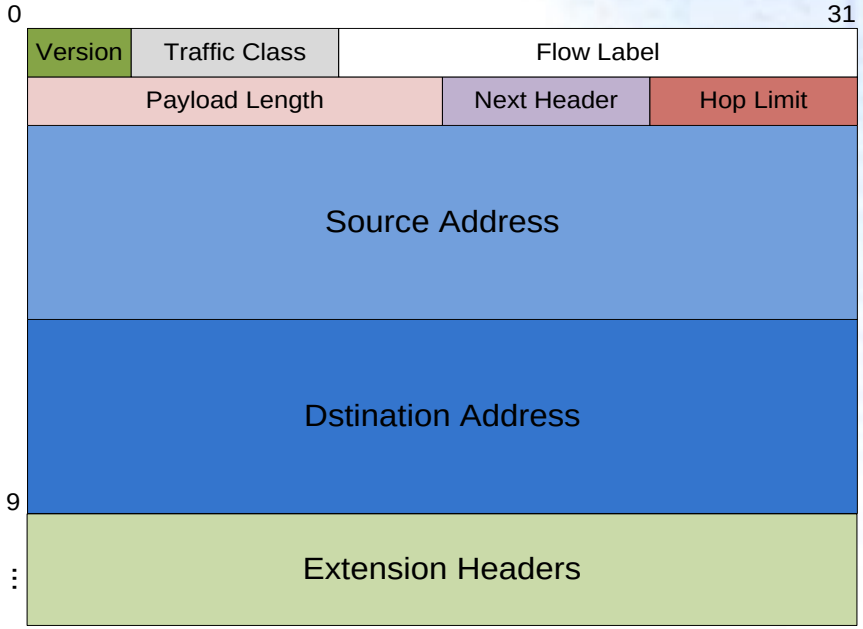
- 15-year history of IPv6
  - RFC 1883 (1995), RFC 2460 (1998)
  - 6Bone, Euro6IX, CNGI-CERNET2
- From transition to IPv4/IPv6 coexistence
  - large number of IPv4 users and networks in large scale
  - It is impossible to upgrade overnight
  - IPv4/IPv6 coexistence will be a long period
- Policy on IPv6 transition
  - IPv6 incremental deployment is difficult
    - Due to the limitation of existing transition technologies
  - Huge cost to upgrade to IPv6 network
    - Without short-term revenue for both ISPs & ICPs
  - Some substitute technologies are still active
    - NAT-liked technologies

# IPv4-IPv6 Transition Tech.

- Interaction between IPv4 & IPv6 protocols?
  - Protocol fields conversion?
  - Address mapping?
    - IPv4=>IPv6: $2^{32}$ => $2^{128}$ √
    - IPv6=>IPv4: $2^{128}$ => $2^{32}$ ×
  - **IPv6 is not backward compatible with IPv4**

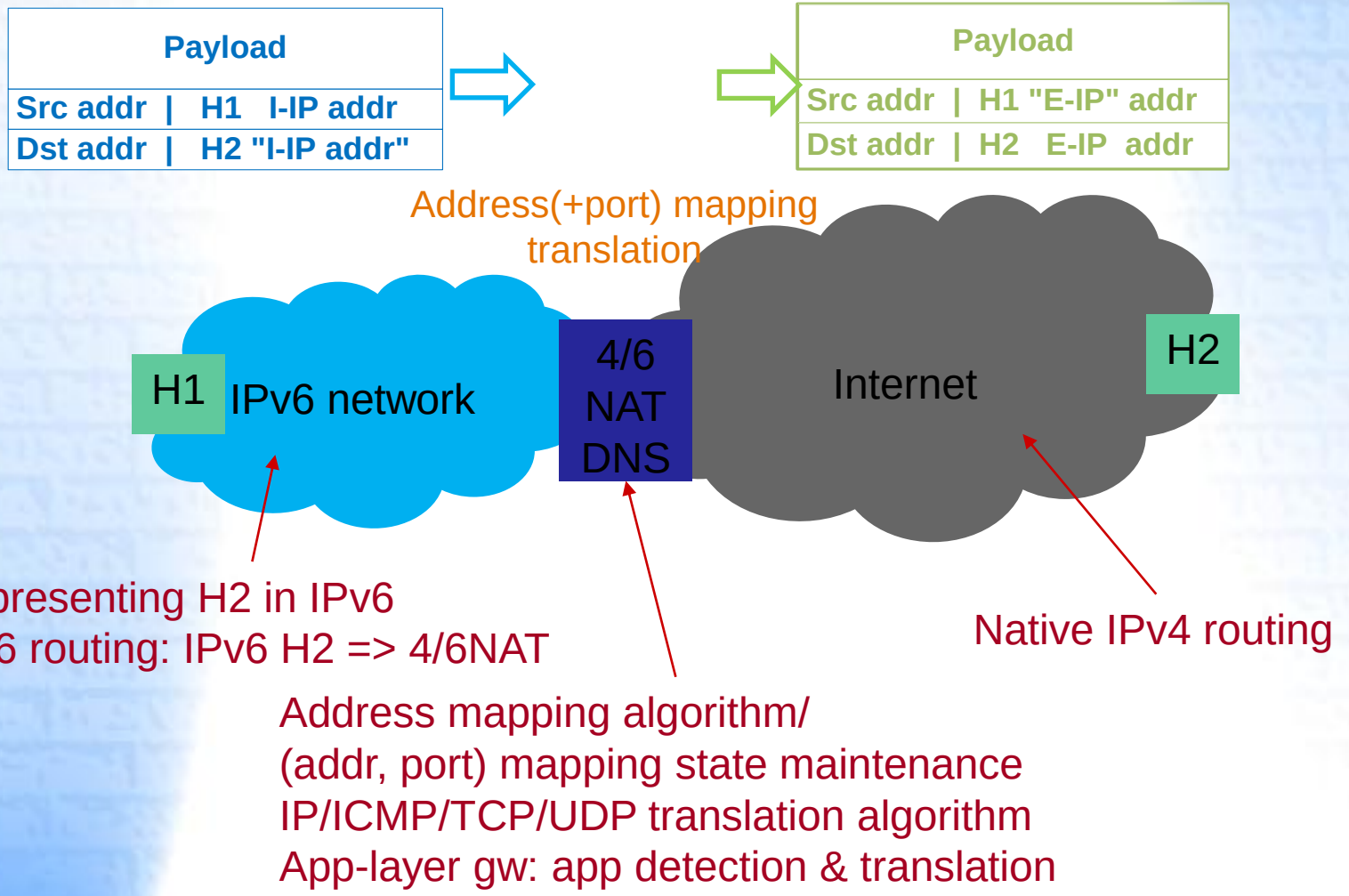



**IPv4 Header**



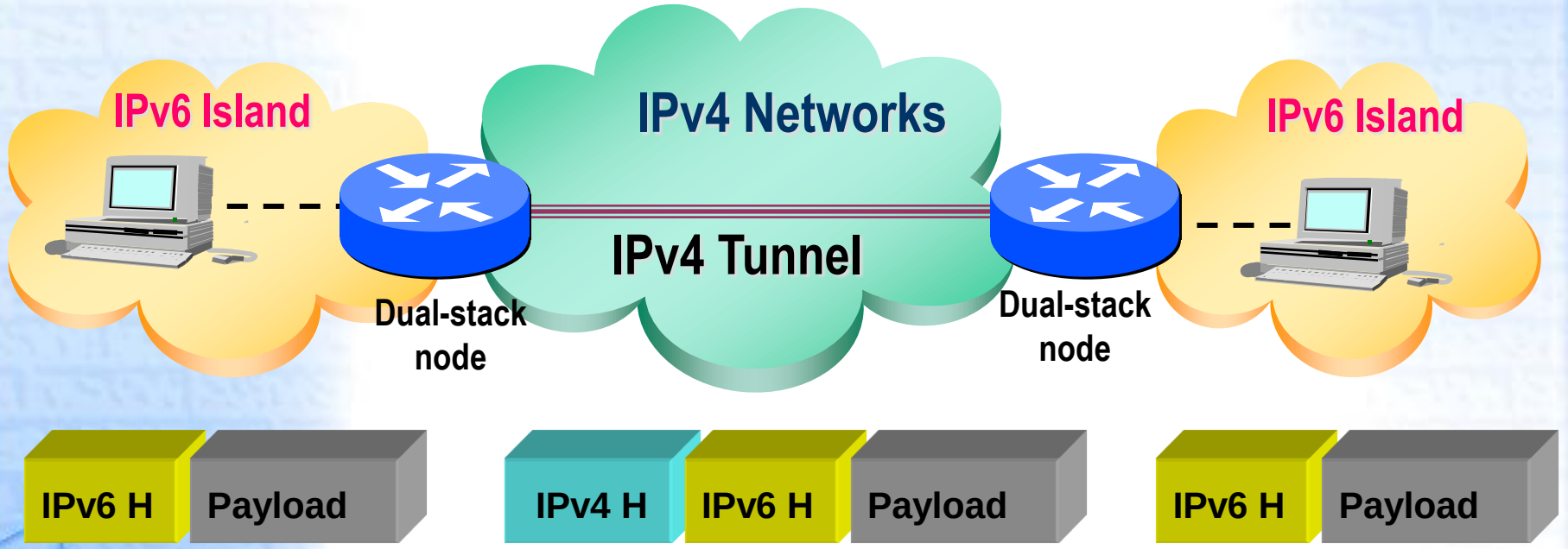

**IPv6 Header**

# Basic Principle for Translation

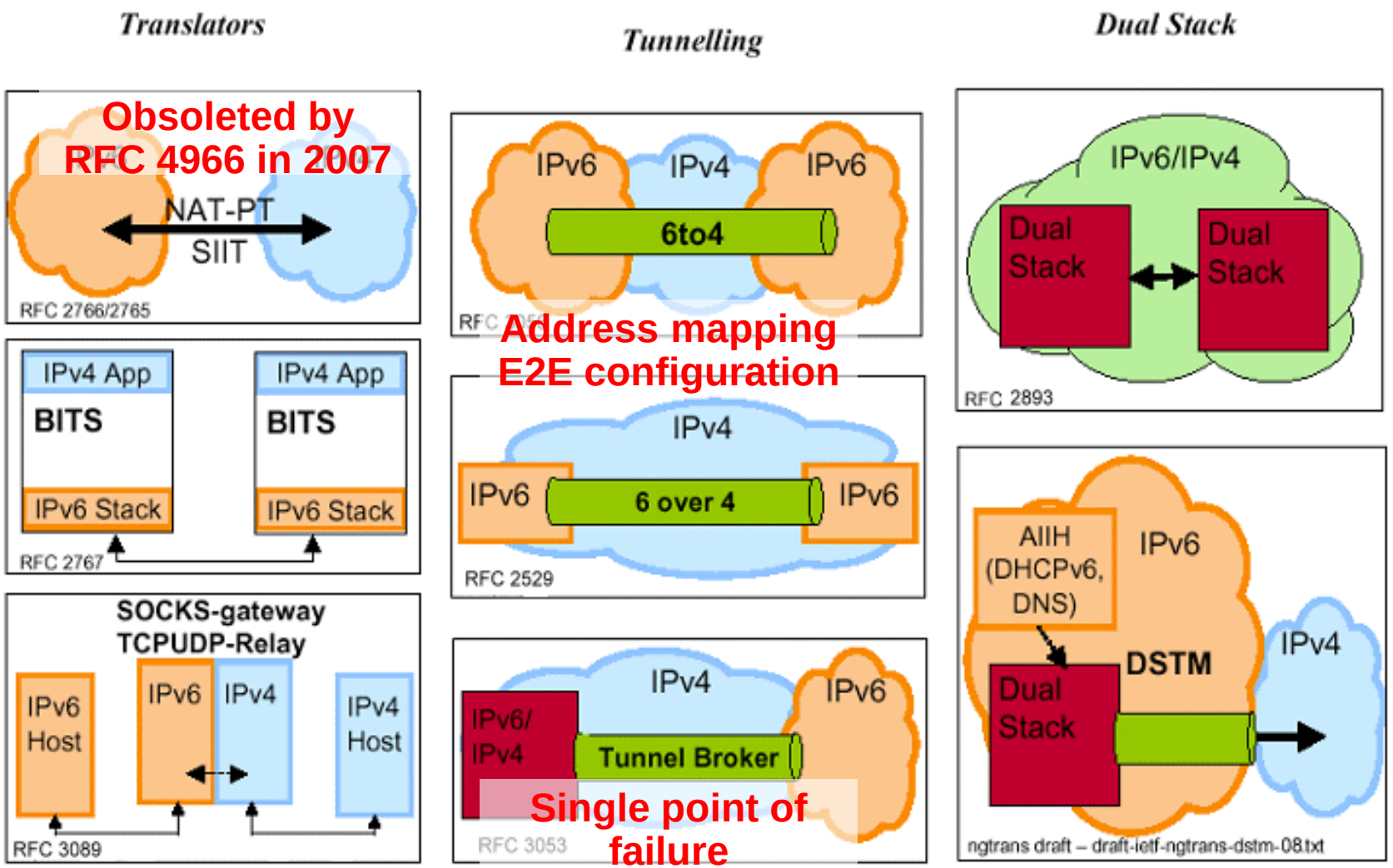


# Configured Tunnels

- End-to-end configuration
- Tunnel encap & decap



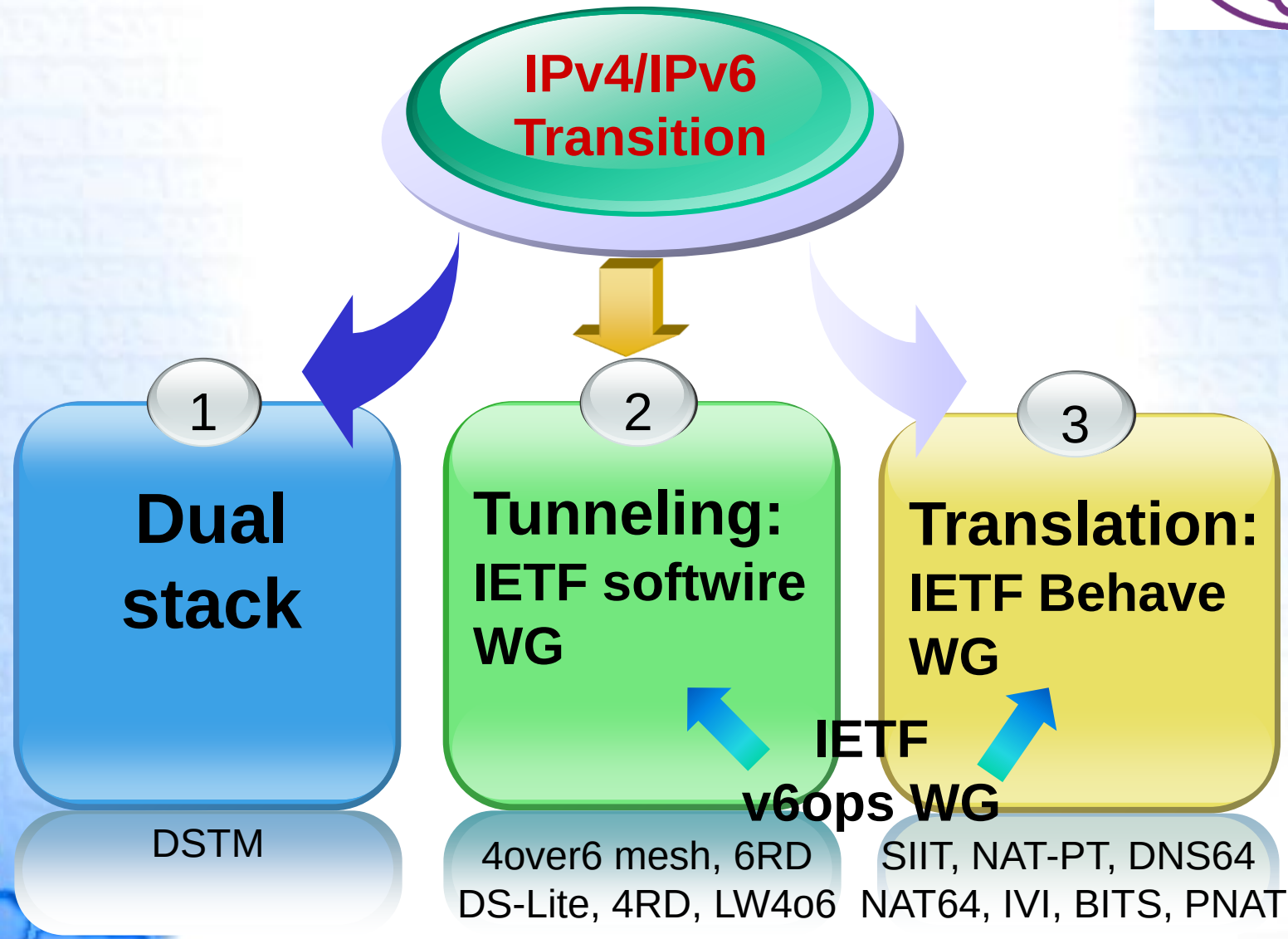
# Basic IPv4/IPv6 Transition Tech.



# Difficulties in IPv6 transition

- Addressing & routing
  - IPv4/IPv6 routing not compatible
  - Heterogeneous address resources allocating in access network
  - IPv4/IPv6 address mapping
- End-to-end transparency
  - Cross-layer design in nature for applications
  - Transparent to upper layer and end users
- Mapping state maintenance
  - Per-flow stateful, stateless
  - Scalability issues
- Protocols in Different layers
- Device on different part in networks

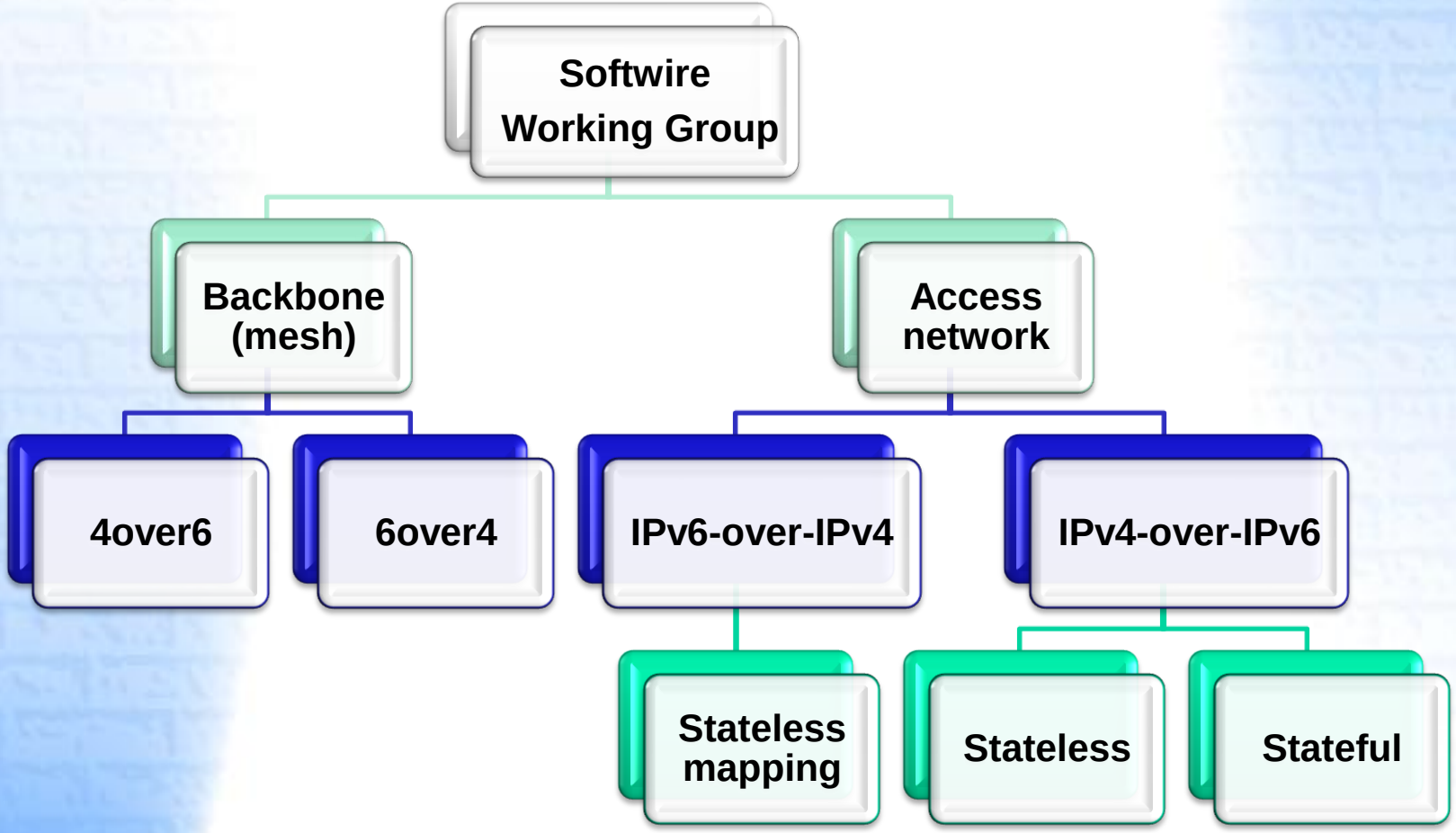
# IPv6 Transition Tech. in IETF



# IPv4/IPv6 Transition Tech: comparison


- Difficult to deploy Dual-Stack in large scale
  - High cost on equipment and maintenance
  - Can't solve the problem of IPv4 address shortage
  - No IPv4/IPv6 interoperation
- Limitations of IPv4/IPv6 translation
  - Break end-to-end transparency
  - Application Layer Gateway (ALG)
  - Introduce IPv4 routing into IPv6 network
  - Scalability on both network size and speed
  - Most apps don't support IPv6 -> nothing to translate

# IETF Softwire work on IPv6 transition

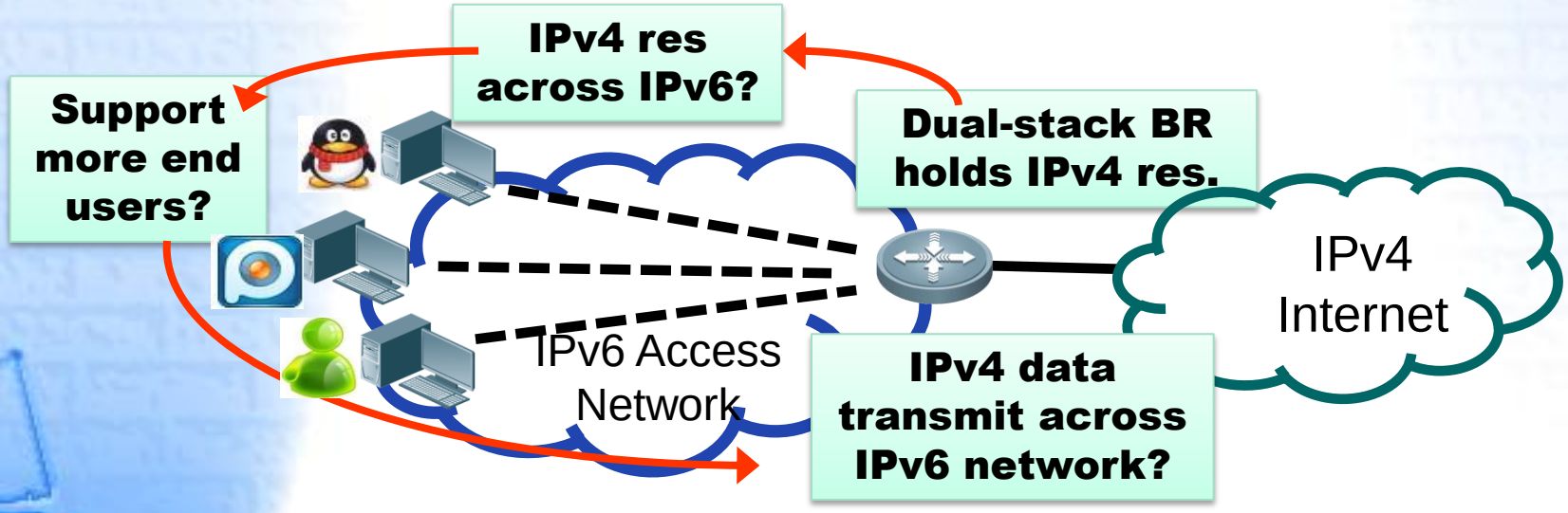


# P.K. in IETF 84

- CISCO
- THU
- SOFTBANK
- IP INFUSION
- ISC
- RD-IPTECH
- COMCAST
- CHINAMOBILE
- HUAWEI
- FREEBITS

# 4over6 requirement in Access Network

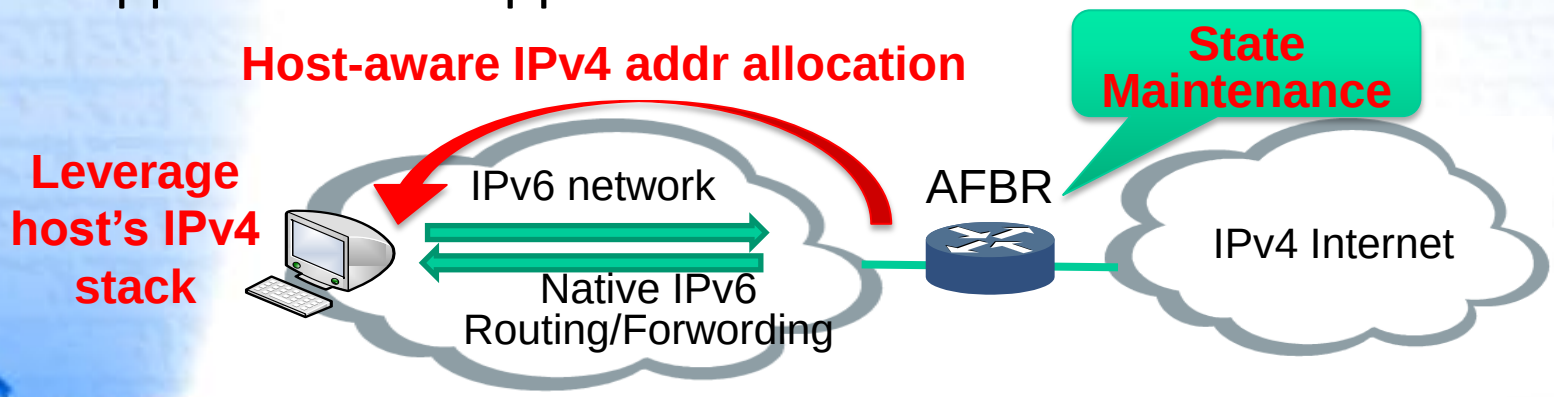
- Scenario analysis
  - Operators have to build IPv6 only access network due to shortage of IPv4 addresses
  - Most current ICP services & apps. are IPv4 only
  - Users in IPv6 only network demand IPv4 services
  - End-to-end transparency



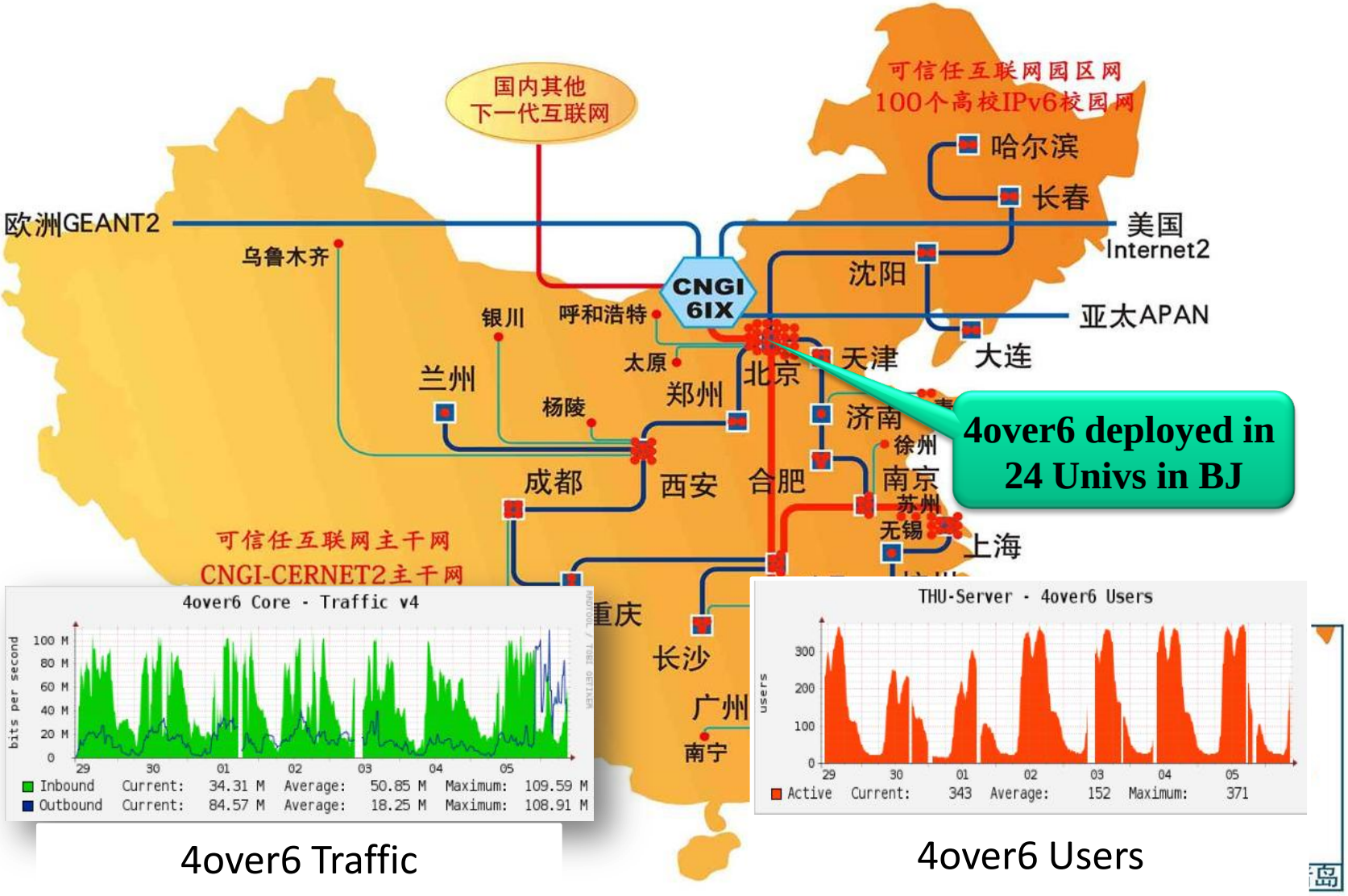
# 4over6 for 4/6 interconnection

- **Key points in xlate tech.**
  - On-demand IPv4 addr allocation on AFBR, unaware to host
  - IPv4/IPv6 translation on AFBR, with state maintenance
  - Only use IPv6 stack on host (IPv6-based apps)
- **4over6 for 4/6 interconnection**
  - Leverage existing IPv4 stack on host
  - Make host aware of IPv4 addr allocation
  - Support all IPv4 apps

SKYPE/MSN?
PPLive?



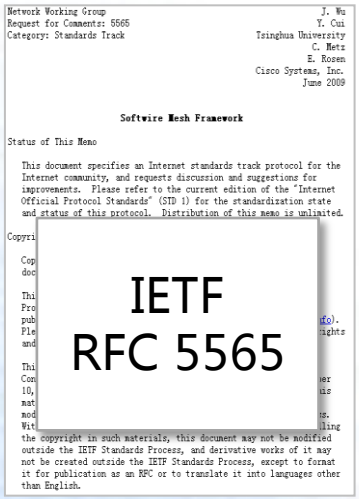
# 4over6 on CNGI-CERNET2

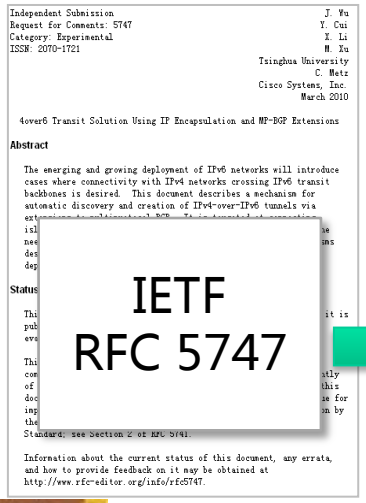



4over6 Traffic

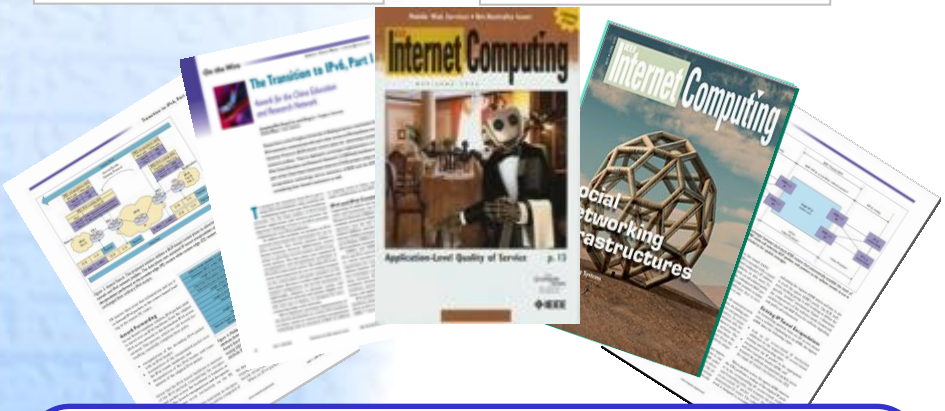
4over6 Users

# 4over6: Achievements of THU

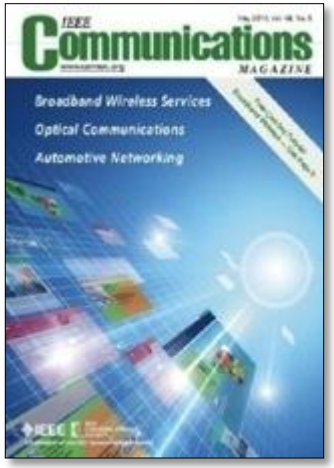



- 3 IETF RFCs
- Over 10 IETF drafts, including 4 WG drafts
- Focus on IPv6 transition for over 8 years, with deployment experiments




3 papers published on IEEE Internet Computing (SCI IF 3.108)




IEEE Communications SCI IF 2.446


IEEE Network SCI IF 1.934

# World wide Influence of THU’s works


文 化 新 闻　人民日报　2007年3月2

短短数年跃入世界前列——

“互联网之父”盛赞我下一代互联网研究

本报北京3月1日讯　记者杨健报道：“中国在下一代互联网研究方面的进步给我留下了非常深刻的印象。短短数年中，你们取得了别的国家需要很长时间才能取得的成就。”“互联网之父”温顿·瑟夫天这样评价我国下一代互联网研究的进展。

温顿·瑟夫是在受聘担任清华大学名誉教授的仪式上说这番话的。他因为设计了互联网TCP/IP协议和互联网基础体系结构，被誉为“互联网之父”。

温顿·瑟夫在详细参观了解中国下一代互联网示范工程主干网CERNET2之后，对CERNET2的工作给予高度评价。他认为，即使与日本等先进国家的同行相比，CERNET2的研究也是领超前的。中国下一代互联网研究已经走在了世界前列。CERNET2项目成员积极参与下一代互联网标准的制定，有两项成果已经或即将成为国际标准。

谈到真实源地址认证，温顿·瑟夫建议在网络通信协议中加入身份认证的编号。这种“实名制”的运用，将大大提高下一代互联网支持无线服务的能力。

Vinton G. Cerf
Inventor of TCP/IP

“IPv4 over IPv6 techno-logy have made great contributions to the Internet … NGI research of China is advanced over the world.”

## 4over6 Industrial Influence

清華大學

HUAWEI　france telecom　中国电信 CHINA TELECOM　T - -　Juniper NETWORKS

Bii 天地互连　Comcast.　cisco　YAMAHA

# Summary

- Transitions in IPv6 transition
  - From killer app to address space
  - From transition to coexistence
  - From translation to tunneling
  - From 6over4 to 4over6
  - From network to users
- Who should be the pioneer?
  - User, ISP, CP, government?
  - Accept/push IPv6 as early as possible
- Opportunity & challenge
  - Explore the advantage/disadvantage on IPv6
  - Try our best to make our Internet better


# Thank you!

**Yong Cui**

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