Transition to IPv6: IVI in the University Campus

C. Bao, X. Li
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Abstract

• Due to the IPv4 address deletion problem, the IPv4 and IPv6 will be coexistent at least for the next decade. In the past three years, we have been developing stateless and prefix-specific translation (IVI).

• In this session we will share our IPv6 transition experience and introduce the IVI deployment program for 100 Campus networks in China.

• In addition, we will discuss the IPv6 transition scheme for the developing countries and the possible collaboration with the Internet2 member universities.
IPv4 count down
The networks we are running
CERNET IPv6 transition experience

- **IPv4** CERNET
  - 1500 universities
  - 20M subscribers

- **IPv6 only** CERNET2
  - 100 universities
  - 1M subscribers

- **Tunnel IPv6 over IPv4** CERNET-6Bone

- **Tunnel IPv4 over IPv6** IETF softwire WG

- **Dual-Stack** NFSCNET

- **Translation IVI** Bi-direction Stateless Translation IETF Behave WG

- **Timeline**
  - 1994
  - 1998
  - 2001
  - 2004
  - 2005
  - 2006
  - 2007
  - 2008
CERNET (IPv4)

- CERNET is the first (1994) nation wide Internet backbone in China.
- CERNET ranks 30 in global CIDR report.
- Over 2,000 universities on CERNET with about 20M subscribers.
<table>
<thead>
<tr>
<th>#</th>
<th>AS</th>
<th>ORG</th>
<th>Origin Name</th>
<th>IP Address</th>
<th>prefix</th>
<th>Transit</th>
<th>Description</th>
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<tbody>
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<td>17674204 /7.92</td>
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<td>Transit: 0 /0.00</td>
<td>DAIMLER-AS Daimler Autonomous System</td>
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</tbody>
</table>
University ranking

2006 中国大学研究生院前 100 名综合实力一览表

2007 中国大学排行榜十强名单 评价
CERNET-6Bone

- CERNET-6bone is the first (1998) IPv6 network in China.
- Ping traffic
Dual stack NSFCNET


- It provides IPv4/IPv6 unicast and multicast services to the education and research community, but very, very few IPv6 traffic.
CERNET2 (IPv6)

- Built in 2004, with national coverage
- CERNET2 is the largest IPv6 backbone in China.
- About 200 universities connected to CERNET2 with about 1M subscribers.
Be unique, be different

- Protocol selection
  - Pure IPv6
- Equipment
  - Multiple vendors
- Complexity
  - Multiple ASs
- Transition
  - IPv4 over IPv6 (IETF softwire)
  - IVI stateless translation (IETF behave)
- Architecture
  - Source address authentication (IETF SAVI)
Softwire IPv4 over IPv6

- Provide IPv4/IPv6 dual-stack service in PE, but run IPv6-only in P routers
  - IETF softwire WG
- Save operation cost.

IPv4 over IPv6
To encourage transition

- **CERNET (IPv4)**
  - Congested and charged.
- **CERNET2 (IPv6)**
  - Light loaded and free of charge.

- So, for using high quality and free network, port your application to IPv6.
IPv6 applications

- Video
- Sensor networks
- Beijing 2008 Olympic website
IPv4 and IPv6 traffic

IPv4 traffic is about 10% of IPv4 traffic.
Remarks

• Upgrading network to dual stack does not mean transition. The IPv6 traffic is still very small.
  – NSFCNET

• Promotion IPv6 can help, but does not help to fully solve the transition problem.
  – CERNET2
The killer application

- Video?
- P2P?
- Internet of Things?
- The intercommunication with the IPv4 Internet is the killer application of IPv6.
We invented IVI

Stateless and prefix specific.
- 1:1 IVI without IPv4 address sharing
- 1:N IVI with IPv4 address sharing
Transition technologies

• Dual stack
  – IPv4 address depletion problem
  – $N^2$ problem

• Tunnel
  – Still need dual stack
  – IPv4 address depletion problem
  – Upgrade tunnel points

• Translation
  – Add a translator
Translation scenarios

**Scenario 1** “an IPv6 network to the IPv4 Internet”  < NAT64
**Scenario 2** “the IPv4 Internet to an IPv6 network”

**Scenario 3** “an IPv4 network to the IPv6 Internet”  < NAT64
**Scenario 4** “the IPv6 Internet to an IPv4 network”

**Scenario 5** “an IPv6 network to an IPv4 network”  < NAT64
**Scenario 6** “an IPv4 network to an IPv6 network”

**Scenario 7** “the IPv6 Internet to the IPv4 Internet”
**Scenario 8** “the IPv4 Internet to the IPv6 Internet”
IETF behave WG document layout

- Framework (info)
- Scenarios
- Operation modes
- Building blocks

- Address format (std)
  - Address format
  - Prefix recommendation

- Translation (std)
  - Header translation
  - ICMP handling

- DNS (std)
  - A\rightarrowAAAA mapping
  - DNSSec handling

- Session database (std)
  - Mapping table handling

- Others (APL-ALGs, multicast, …)
### IPv6 Addressing of IPv4/IPv6 Translators

**Draft:** draft-ietf-behave-address-format-01.txt

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### IP/ICMP Translation Algorithms

**Title:** IP/ICMP Translation Algorithms

**Draft:** draft-ietf-behave-v6v4-xlate-20

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### Stateful NAT64: Network Address and Protocol Translation from IPv6 Clients to IPv4 Servers

**Title:** Stateful NAT64: Network Address and Protocol Translation from IPv6 Clients to IPv4 Servers

**Draft:** draft-ietf-behave-v6v4-xlate-stateful-12

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### DNS64: DNS extensions for Network Address Translation from IPv6 Clients to IPv4 Servers

**Title:** DNS64: DNS extensions for Network Address Translation from IPv6 Clients to IPv4 Servers

**Draft:** draft-ietf-behave-dns64-11

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### The CERNET IVI Translation Design and Deployment for the IPv4/IPv6 Coexistence and Transition

**Draft:** draft-xli-behave-ivi-07

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### BEHAVE WG

**Title:** BEHAVE WG

**Draft:** draft-ietf-behave-v6v4-framework-09

---

### BEHAVE WG

**Title:** BEHAVE WG

**Draft:** draft-ietf-behave-v6v4-xlate-stateful-12

---

### BEHAVE WG

**Title:** BEHAVE WG

**Draft:** draft-ietf-behave-v6v4-xlate-stateful-12
Stateless translation (IVI)

A subset of IPv6 addresses
Mapping Rule: IPv4 addresses are embedded from bit 40 to bit 72 of the IPv6 addresses of a specific /32.

Example: ISP’s IPv6 /32 2001:250::/32
borrowed IPv4 address (IVI4): 202.38.108.0/24
mapped IVI IPv6 address (IVI6): 2001:250:ffca:266c::/64
It is the (end) users who are communicating with users/contents located in IPv4 (IPG4 & all other IVI4(j)) via IVIG46(i).
IVI address mapping (2)
IVI routing

Routing and mapping configuration example

```
IPv4  R1  192.168.2  192.168.1.1
IPv6  R2  2001:DB8::2

ip route IVI4/k 192.168.1.1
ipv6 route 2001:DB8::1/40 2001:DB8::1

ip route 0.0.0.0 0.0.0.0 192.168.1.2
ipv6 route IVI6/(40+k) 2001:DB8::2

mroute IVI4-network IVI4-mask pseudo-address interface source-PF destination-PF
mroute6 destination-PF destination-PF-pref-len
```
## IVI reachability matrix

<table>
<thead>
<tr>
<th></th>
<th>v4</th>
<th>IVI</th>
<th>Non-IVI</th>
</tr>
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<tr>
<td>IPG4</td>
<td>OK</td>
<td>OK</td>
<td>NO</td>
</tr>
<tr>
<td>IVI</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Non-IVI</td>
<td>NO</td>
<td>OK</td>
<td>OK</td>
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IVI incremental deployment (1)
IVI incremental deployment (2)
IVI incremental deployment (3)
Header translation (IPv4 → IPv6)

<table>
<thead>
<tr>
<th>IPv4 Field</th>
<th>Translated to IPv6</th>
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</thead>
<tbody>
<tr>
<td>Version (0x4)</td>
<td>Version (0x6)</td>
</tr>
<tr>
<td>IHL</td>
<td>(discarded)</td>
</tr>
<tr>
<td>Type of Service</td>
<td>(discarded)</td>
</tr>
<tr>
<td>Total Length</td>
<td>Payload Length = Total Length - IHL * 4</td>
</tr>
<tr>
<td>Identification</td>
<td>(discarded, cf. Subsection V-C)</td>
</tr>
<tr>
<td>Flags</td>
<td>(same as above)</td>
</tr>
<tr>
<td>Offset</td>
<td>(same as above)</td>
</tr>
<tr>
<td>Time to Live</td>
<td>Hop Limit</td>
</tr>
<tr>
<td>Protocol</td>
<td>Next Header</td>
</tr>
<tr>
<td>Header Checksum</td>
<td>(discarded)</td>
</tr>
<tr>
<td>Source Address</td>
<td>Apply IVI stateless address mapping</td>
</tr>
<tr>
<td>Destination Addr.</td>
<td>(same as above)</td>
</tr>
<tr>
<td>Options</td>
<td>(discarded)</td>
</tr>
</tbody>
</table>
# Header translation (IPv6 → IPv4)

<table>
<thead>
<tr>
<th>IPv6 Field</th>
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<tbody>
<tr>
<td>Version (6)</td>
<td>Version (4)</td>
</tr>
<tr>
<td>Traffic Class</td>
<td>(discarded)</td>
</tr>
<tr>
<td>Flow Label</td>
<td>(discarded)</td>
</tr>
<tr>
<td>Payload Length</td>
<td>Total Length = Payload Length + 20</td>
</tr>
<tr>
<td>Next Header</td>
<td>Protocol</td>
</tr>
<tr>
<td>Hop Limit</td>
<td>TTL</td>
</tr>
<tr>
<td>Source Address</td>
<td>Apply IVI inverse address mapping</td>
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<tr>
<td>Destination Addr.</td>
<td>(same as above)</td>
</tr>
<tr>
<td>—</td>
<td>IHL = 5</td>
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<tr>
<td>—</td>
<td>Header Checksum recalculated</td>
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</table>
IVI DNS (DNS46 and DNS64)

- **DNS46**
  - Authoritative DNS server
    - Example
    - `www.ivi2.org` A 202.38.108.2

- **DNS64**
  - Caching DNS server
    - Example
    - `www.mit.edu` A 18.7.22.83
DNS64

IPv4 Domain

A/MX Request

A/MX Response

DNS ALG as IPv4/6 translator

IPv6 Domain

AAAA Request

AAAA Response
ALG issue

- **IVI supports**
  - *web*: ssh, telnet, DVTS, vlc, email

- **ALG requirements**
  - *ftp*
  - URL contains IPv4 literals
www.ivi2.org

Prefix-specific and Stateless IPv4/IPv6 Translation

**IVI source code download**

The IVI IPv4/IPv6 packet translation implementation as a Linux kernel patch is available below.
- IVI v0.1.5 kernel patch for Linux kernel 2.6.15
- IVI v0.1.6 kernel patch for Linux kernel 2.6.16

The IVI A/A66 DNS proxy implementation is available below.
- IPv6 0.1.0 code
- IPv6 0.2.3 code

For installing and configuring, please follow the instructions in the source code packages.
- To have a quick look at IVI packet and Linux IPv6.
Equipments
Deployment issues

- Network topology
- Address plan
- IVI address calculator
- Host configuration
- Trouble shooting
Network topology

IVI DNS=2001:250:aaa0:100:1::2

CNGI-CERNET backbone

IPv6 Campus

2001:da8:ff3a:c8e4:fe00::/64

Campus IPv6 /48
IVI IPv6 /64

2001:da8:ff3a:c8e4:100::/64

Default route

2001:da8:ff3a:c8e4:200::/64

2001:da8:ff3a:c8e4:300::/64

2001:da8:ff3a:c8e4:fd00::/64

H1

H2

H3

H253
Address plan

- **IVI subnet**
  - IVI4=58.200.228.0/24
  - IVI6=2001:da8:ff3a:c8e4::/64

- **R interface address**
  - 2001:da8:ff3a:c8e4:fe00:: (58.200.228.254)

- **IVI6 hosts**
  - 2001:da8:ff3a:c8e4:100:: (58.200.228.1)
  - 2001:da8:ff3a:c8e4:200:: (58.200.228.2)
  - ......
  - 2001:da8:ff3a:c8e4:fd00:: (58.200.228.253)
Address translation calculator

- **From IPv4 to IPv6**
  - [http://www.ivi2.org/cgi-bin/ivimap.pl?ipv4=0.0.0.0/0&lir=2001:da8](http://www.ivi2.org/cgi-bin/ivimap.pl?ipv4=0.0.0.0/0&lir=2001:da8)

- **From IPv6 to IPv4**

Address translation calculator: [http://www.ivi2.org](http://www.ivi2.org)
Host configuration

- **Static configuration**
  - IPv6 address/prefix length: 2001:da8:ffca:266e:100::/64
  - default gateway: 2001:da8:ffca:266e:fe00::
  - Nameserver: 2001:da8:aaae::201
  - Disable auto-configuration

- **Auto-configuration**
  - Cannot use SLAAC
  - Cannot use stateless DHCPv6

- **Stateful DHCPv6**
  - IPv6 address/prefix length: DHCPv6
  - default gateway: RA
  - nameserver: DHCPv6
Trouble shooting (1)

IPv4 address

IPv6 address

IPv4

IVI

IPv6

Non-IVI

PREFIX=2001:da8:ff00::/40
Trouble shooting (2)

From this host
- IPv6 server environment
  - ping 2001:da8:ff72:1580:1f00:: # 18.181.0.31
  - ping 6 your host
  - traceroute 2001:da8:ff72:1580:1f00:: # 18.181.0.31
  - traceroute6 your host
  - wget -O http://www.edu.cn
  - dig4 www.mit.edu

From your IPv4 host
- ping 58.200.255.1 # 2001:da8:ff7a:c0ff:100::
- traceroute 58.200.255.1 # 2001:da8:ff7a:c0ff:100::

From your IPv6 host
- ping 6 2001:da8:ff7a:c0ff:100:: # 58.200.192.1
- traceroute6 2001:da8:ff7a:c0ff:100:: # 58.200.192.1

xshitemguiw
CNGI-CERNET2 100 campus

1: Project Architecture

2: Campus network IPv6 upgrades (100)

3: Key technologies (6)

4: Applications (20)

5: International/Domestic peering
Key technologies

• Source address validation and services
• IPv4/IPv6 transition
• Large-scale IPv6 multicast
• Backbone management
• Service platform
• Campus management
Campus network connectivity

- Global IPv4
- Global IPv6
- CERNET (IPv4)
- CERNET2 (IPv6)
- IPv4-only
- IPv4/IPv6 Dual-stack
- IPv6-only
- NAT64
Backbone IVI setup

IPv6 Internet

IPv4 Internet

CERNET

CNGI - CERNET2
IPv6/32
IPv6/48
IPv4 Internet
IPv6 Internet

IVI core
DNS64
DNS46

Campus

IVI IPv6
IPv6/48
Non - IVI IPv6
Non - IVI IPv6

100 universities
## IVI address assignment

<table>
<thead>
<tr>
<th>单位名称</th>
<th>城市</th>
<th>IPv4 地址</th>
<th>IPv6 地址</th>
</tr>
</thead>
<tbody>
<tr>
<td>北京大学</td>
<td>北京</td>
<td>58.200.128.0/24</td>
<td>2001:da8:ff3a:c880::/64</td>
</tr>
<tr>
<td>清华大学</td>
<td>北京</td>
<td>58.200.129.0/24</td>
<td>2001:da8:ff3a:c881::/64</td>
</tr>
<tr>
<td>北京航空航天大学</td>
<td>北京</td>
<td>58.200.130.0/24</td>
<td>2001:da8:ff3a:c882::/64</td>
</tr>
<tr>
<td>北京邮电大学</td>
<td>北京</td>
<td>58.200.131.0/24</td>
<td>2001:da8:ff3a:c883::/64</td>
</tr>
<tr>
<td>中国人民大学</td>
<td>北京</td>
<td>58.200.132.0/24</td>
<td>2001:da8:ff3a:c884::/64</td>
</tr>
<tr>
<td>北京理工大学</td>
<td>北京</td>
<td>58.200.133.0/24</td>
<td>2001:da8:ff3a:c885::/64</td>
</tr>
<tr>
<td>北京师范大学</td>
<td>北京</td>
<td>58.200.134.0/24</td>
<td>2001:da8:ff3a:c886::/64</td>
</tr>
<tr>
<td>中央民族大学</td>
<td>北京</td>
<td>58.200.135.0/24</td>
<td>2001:da8:ff3a:c887::/64</td>
</tr>
<tr>
<td>中国地质大学</td>
<td>北京</td>
<td>58.200.136.0/24</td>
<td>2001:da8:ff3a:c888::/64</td>
</tr>
<tr>
<td>北京交通大学</td>
<td>北京</td>
<td>58.200.137.0/24</td>
<td>2001:da8:ff3a:c889::/64</td>
</tr>
<tr>
<td>对外经济贸易大学</td>
<td>北京</td>
<td>58.200.138.0/24</td>
<td>2001:da8:ff3a:c88a::/64</td>
</tr>
<tr>
<td>北京科技大学</td>
<td>北京</td>
<td>58.200.139.0/24</td>
<td>2001:da8:ff3a:c88b::/64</td>
</tr>
<tr>
<td>北京工业大学</td>
<td>北京</td>
<td>58.200.140.0/24</td>
<td>2001:da8:ff3a:c88c::/64</td>
</tr>
<tr>
<td>中国农业大学</td>
<td>北京</td>
<td>58.200.141.0/24</td>
<td>2001:da8:ff3a:c88d::/64</td>
</tr>
<tr>
<td>北京化工大学</td>
<td>北京</td>
<td>58.200.142.0/24</td>
<td>2001:da8:ff3a:c88e::/64</td>
</tr>
<tr>
<td>北京语言大学</td>
<td>北京</td>
<td>58.200.143.0/24</td>
<td>2001:da8:ff3a:c88f::/64</td>
</tr>
</tbody>
</table>
Tsinghua campus WLAN example

IVI路由器
L3 switch configuration

• Cisco7609
  interface Vlan30
    no ip address
    ipv6 address 2001:DA8:FF3A:C881:100::/64
    ipv6 enable
    ipv6 nd prefix default 2592000 604800 no-autoconfig
    ipv6 nd managed-config-flag
    ipv6 nd other-config-flag
    ipv6 nd ra suppress
    ipv6 dhcp relay destination 2402:F000:1:901::9:8

<table>
<thead>
<tr>
<th>Flags</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>no-autoconfig</td>
<td>A=0</td>
</tr>
<tr>
<td>managed-config-flag</td>
<td>M=1</td>
</tr>
<tr>
<td>other-config-flag</td>
<td>O=1</td>
</tr>
</tbody>
</table>
DHCPv6 server configuration

• ISC DHCP4.1.1-P1:

    subnet6 2001:da8:ff3a:c881::/64 {
      … …
      range6 2001:da8:ff3a:c881:fe00:: 2001:da8:ff3a:c881:fe00::;
      option dhcp6.name-servers 2001:250:aaa0:100:1::2;
      option dhcp6.domain-search "v6.tsinghua.edu.cn";
    }
Windows 7 client

<table>
<thead>
<tr>
<th>无线局域网适配器 无线网络连接:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>连接特定的 DNS 后缀 . . . . . . .</td>
<td>v6.tsinghua.edu.cn</td>
</tr>
<tr>
<td>描述: . . . . . . . . . . . . . . . . . . . . . . .</td>
<td>Intel® WiFi Link 5100 AGN</td>
</tr>
<tr>
<td>物理地址: . . . . . . . . . . . . . . . . . . . . . .</td>
<td>00-21-5D-18-7C-52</td>
</tr>
<tr>
<td>DHCP 已启用 . . . . . . . . . . . . . . . . . . .</td>
<td>是</td>
</tr>
<tr>
<td>自动配置已启用 . . . . . . . . . . . . . . . . .</td>
<td>是</td>
</tr>
<tr>
<td>IPv6 地址 . . . . . . . . . . . . . . . . . . . . . .</td>
<td>2001:da8:ff3a:c881:600::&lt;首选&gt;</td>
</tr>
<tr>
<td>获得租约的时间 . . . . . . . . . . . . . . . . . .</td>
<td>2010年7月14日 15:20:59</td>
</tr>
<tr>
<td>租约过期的时间 . . . . . . . . . . . . . . . . . .</td>
<td>2010年7月14日 16:40:18</td>
</tr>
<tr>
<td>本地链接 IPv6 地址 . . . . . . . . . . . . . . .</td>
<td>fe80::59ba:eb07:15fe:393a%12(首选)</td>
</tr>
<tr>
<td>默认网关 . . . . . . . . . . . . . . . . . . . . .</td>
<td>fe80::219:7ff:feab:c600%12</td>
</tr>
<tr>
<td>DHCPv6 IAID . . . . . . . . . . . . . . . . . . . .</td>
<td>218112349</td>
</tr>
<tr>
<td>DHCPv6 客户端 DUID . . . . . . . . . . . . . . .</td>
<td>00-01-00-01-12-7B-1C-DF-00-21-5A-F7-96-08</td>
</tr>
<tr>
<td>DNS 服务器 . . . . . . . . . . . . . . . . . . .</td>
<td>2001:250:aaa0:100:1::2</td>
</tr>
<tr>
<td>TCPIP 上的 NetBIOS . . . . . . . . . . . . . .</td>
<td>已禁用</td>
</tr>
<tr>
<td>连接特定的 DNS 后缀搜索列表:</td>
<td>v6.tsinghua.edu.cn</td>
</tr>
</tbody>
</table>
C:\Users\james>ping news.sina.com.cn

正在 Ping cernetnews.sina.com.cn [2001:da8:ff79:c200:ce00::] 具有 32 字节的数据:
来自 2001:da8:ff79:c200:ce00:: 的回复: 时间 = 7ms
来自 2001:da8:ff79:c200:ce00:: 的回复: 时间 = 9ms
来自 2001:da8:ff79:c200:ce00:: 的回复: 时间 = 4ms
来自 2001:da8:ff79:c200:ce00:: 的回复: 时间 = 5ms

2001:da8:ff79:c200:ce00:: 的 Ping 统计信息:
数据包: 已发送 = 4, 已接收 = 4, 丢失 = 0 (0% 丢失),
往返行程的估计时间<以毫秒为单位>:
最短 = 4ms, 最长 = 9ms, 平均 = 6ms
Remarks

• Windows 7
  – Plug and play
  – Dibbler server does not work properly for Windows 7
  – The default gateway is from RA

• Windows XP
  – Does not have build in DHCPv6 client
  – Cannot resolve DNS via IPv6
Windows XP auto-configuration (1)

- Windows XP does not have DHCPv6
  - Download dibbler client
- Windows XP cannot resolve DNS via IPv6 transport
  - DHCP assign a RFC1918 addresses, via IPv4 resolver to get AAAA
  - Use DNSMASQ to proxy the IPv4 and IPv6 DNS queries
Windows XP auto-configuration (2)
Dibbler DHCPv6 configuration

```bash
bc35205:xing $ cat server.conf
define "eth0" {
    // also ranges can be defined, instead of exact values
    t1 1800-2000
    t2 2700-3000
    preferred-lifetime 3600
    valid-lifetime 7200
}

# assign addresses from this pool (put as many as /128s, as required)
class {
}
class {
}
class {
}
class {
}
```
The Windows XP configuration

- Install IPv6 stack by run cmd and type ipv6 install
- Set network configuration to DHCP
- Download
  - Install dibbler-client only.
- Start → All Program → dibbler client Edit Config File
  - modify iface to match the local system.. for example

```
iface "本地连接 4" {
  ia
}
```

- Start → All Program → Dibbler Client Run in the console, every time in the IVI mode
  - Setup Client Install as service 不工作。
Useful links

• DHCP

• DHCPv6 (Dibbler)

• DNS proxy
  – http://www.thekelleys.org.uk/dnsmasq/

• Dibbler Windows client
New progress

- **1:N IVI**
  - Share IPv4 address among IPv6-only hosts
- **1:N dIVI**
  - Share IPv4 address among IPv6-only hosts
  - Do not require ALG
  - Do not require DNS64
- **IVI66**
  - Map SLAAC address to IVI addresses
• If $R=256$
• A /24 is equivalent to a /16
The IPv4 Internet

1:N IPv6

An IPv6 network

The IPv6 Internet

Hgw0

Hgw1

Hgw2

HgwK

H0 DS

H1 DS

H2 DS

HK DS
IPv6 Internet

IPv4 Internet

IVI

nat66

IVI addresses

Any IPv6 addresses
IVI and Internet2
Move forward

- Constrains
  - IPv4 addresses are running out (2011-2012)
  - Incremental deployment

- Major goals
  - Move contents to IPv6
  - Increase subscriber base
Possible solutions

• If the SP has enough IPv4 addresses
  – Deploy dual stack access network, wait for some part of the Internet is IPv6-only

• If the SP does not have enough IPv4 addresses
  – Deploy dual stack access network, install CGN (NAT44), wait for some part of the Internet is IPv6-only
  – Or construct a IPv6-only access network, install stateless IPv4/IPv6 translator (IVI)
The IVI solution

- **Move contents to IPv6**
  - Build IPv6-only access network
  - Use 1:1 IVI to make IPv6-only servers accessible to the IPv4 Internet

- **Increase subscriber base**
  - Build IPv6-only access network
  - Use 1:N IVI or 1:N dIVI to provide IPv4/IPv6 services to customers
The IPv4 Internet

The IPv6 Internet

IPv4/IPv6 Core Network

Dual-stack core

IPv4/IPv6 Access network

XLATED IPv6 access

1:N IVI

1:1 IVI

servers

clients

IPv6 servers

IPv6/Shared IPv4 clients
Recommendations

• For developed countries
  – Move servers to IPv6-only and deploy IVI translator
  – Build new IPv6-only segments of the campus network and deploy IVI translator

• For developing countries
  – Build IPv6-only campus network and deploy IVI translator
IVI IPv4/IPv6 transition