[MS-TERE]: Teredo Extensions

• Two IETFs ago, URL for Microsoft doc posted to the list
• This documented what Windows XP/Vista/Windows 7 already does
• It contains several things:
  – Security updates:
    • Now in draft-krishnan-v6ops-teredo-update
  – Support for more NAT types:
    • Now in draft-thaler-v6ops-teredo-extensions
  – Efficiency (server load) improvement:
    • Now in draft-thaler-v6ops-teredo-extensions
### NAT Types

<table>
<thead>
<tr>
<th>Dest NAT</th>
<th>Source</th>
<th>Cone</th>
<th>Address Restrict</th>
<th>Port Restricted</th>
<th>Port Rest. +UPnP</th>
<th>Port Sym. +UPnP</th>
<th>Port Pres Port Sym.</th>
<th>Seq. port sym.</th>
<th>Port Sym.</th>
<th>Address Sym.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cone</td>
<td>Cone</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Addr. Rest.</td>
<td>Cone</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Port Rest.</td>
<td>Cone</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>1+3</td>
<td>1+4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Port rest + UPnP</td>
<td>Cone</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>1+2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Port sym. + UPnP</td>
<td>Cone</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1+2</td>
<td>1+2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Port pres. Port sym.</td>
<td>Cone</td>
<td>1</td>
<td>1+3</td>
<td>-</td>
<td>-</td>
<td>1+3</td>
<td>1+4</td>
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<td>Cone</td>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Some statistics on NAT types

• Based on a study in August 2007 on NAT types:
  – ~15% chance a direct connection between two peers would work
  – ~64% chance an RFC4380 Teredo connection would work
  – ~84% chance a Teredo+extensions01 connection would work
  – Still better with latest extension for sequential NATs
• For multiparty apps, inverse network effect means even worse percentage
• Doesn’t require data to flow through some server
• Can get 100% if you use a data relay protocol but more expensive to host such relays
  – Goal is to optimize for peer-to-peer to minimize cost
1) Symmetric NAT Example

Client A  Sym. NAT  A’s Server  B’s Server  Rest. NAT  Client B

Direct Bubble to B

Indirect Bubble to B

Wrong port!

Direct Bubble (+Nonce1) to B

Indirect Bubble (+Nonce2) to B

Direct Bubble (+Nonce2) to A

Store source port

OK

OK

Direc Bubble (+Nonce1) to A
2) UPnP-Enabled Symmetric NATs

Client A
Sym. NAT
A’s Server

Get port
Get address
Direct Bubble to B
Indirect Bubble (+Nonce) to B
OK

Get port
Get address
Direct Bubble (+Nonce) to A
OK

B’s Server
Sym. NAT
Client B
3) Port-Preserving Symmetric NATs

<table>
<thead>
<tr>
<th>Client A</th>
<th>PPS NAT</th>
<th>A’s Server</th>
<th>B’s Server</th>
<th>PPS NAT</th>
<th>Client B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learn NAT type</strong></td>
<td><strong>Bind to random port</strong></td>
<td><strong>Trust B:random OK</strong></td>
<td><strong>Get address</strong></td>
<td><strong>Direct Bubble to B</strong></td>
<td><strong>Indirect Bubble (+Nonce1 +RandomPortA) to B</strong></td>
</tr>
<tr>
<td>**Direct Bubble (+Nonce1 +RandomPortB) to A:**random from B:<strong>random</strong></td>
<td><strong>Indirect Bubble (+Nonce2 +RandomPortB) to A</strong></td>
<td>**Direct Bubble (+Nonce2 +RandomPortA) to B:**random from A:<strong>random</strong></td>
<td></td>
<td><strong>Indirect Bubble (+Nonce3 +RandomPortA) to B</strong></td>
<td>**Direct Bubble (+Nonce3 +RandomPortB) to A:**random from B:<strong>random</strong></td>
</tr>
</tbody>
</table>

IETF 73
4) Sequential NAT

Client A -> Sym. NAT -> A’s Pr. Server -> A’s S. Server -> B’s Server -> Rest. NAT -> Client B

- Learn NAT type
- Bind to random port
- Guess mapped port #2
- Get address
- Direct Bubble to B
- Get mapped port #1
- Direct Bubble to B
- Get mapped port #3
- Indirect Bubble (+Nonce1 +mapped port#2) to B
- Direct Bubble to A:portInAddr
- Indirect Bubble to A
- Direct Bubble to A:mapped port#2
5) Hairpinning Example

Internet

Outer NAT

No hairpinning support

A’s NAT

Client A

UPnP

B’s NAT

Client B

UPnP

UPnP

UPnP

UPnP

IETF 73
5) Hairpinning Example (cont.)

- Client A
  - A’s NAT
    - Get mapping
  - Client B
    - B’s NAT
      - Get mapping
  - Outer NAT
  - A’s Server
  - B’s Server

Direct Bubble to B

Indirect Bubble (+LocalA +MappingA) to B

Direct Bubble to A

Indirect Bubble (+LocalB +MappingB) to A

OK

Direct Bubble to LocalA

Direct Bubble to MappingA

No hairpin!
## 6) Server Load Reduction

<table>
<thead>
<tr>
<th>Client A</th>
<th>NAT</th>
<th>A’s Server</th>
<th>B’s Server</th>
<th>NAT</th>
<th>Client B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Idle</td>
</tr>
<tr>
<td>Have pkt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

- **Optimistic Direct Bubble (+Solicitation) to B**
- **Direct Bubble (+Advertisement) to A**
- **Indirect Bubble to B**
- **LOAD!**
Next Steps

• Get feedback
• AD-sponsored individual submission through INTAREA
• “Last call” in V6OPS due to history