Teredo: IPv6 through NAT, over UDP

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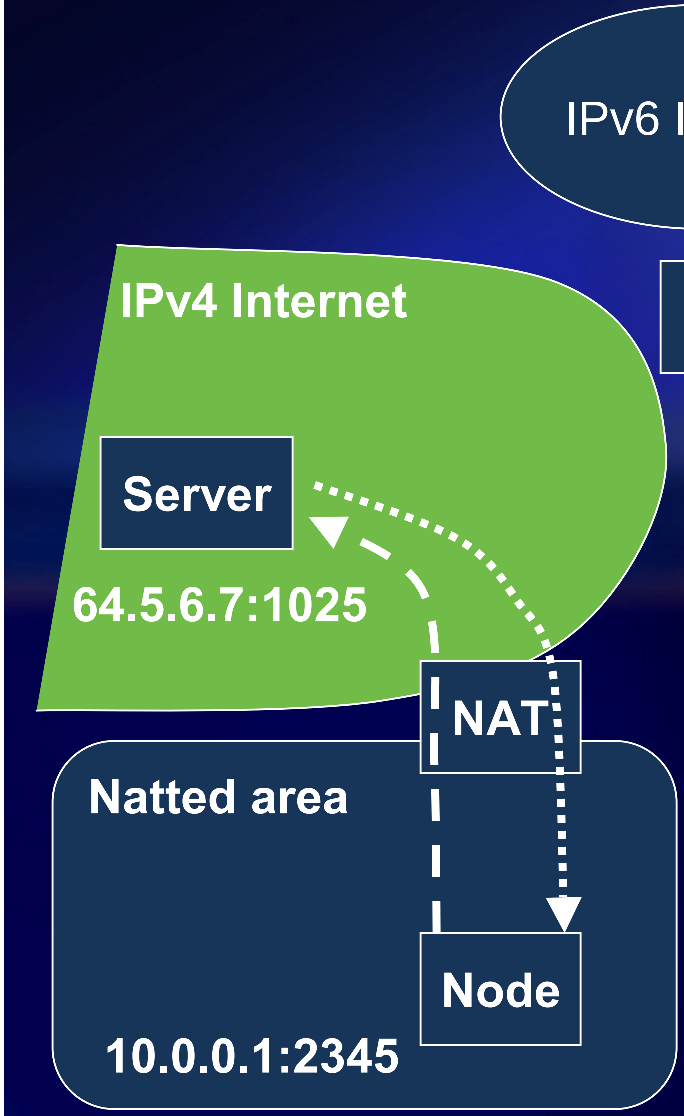
Presenting Teredo

- Model of operation
- Adapting to various NAT forms
- Operational considerations
- Security considerations
- What is in a name

Teredo: IPv6 behind a NAT

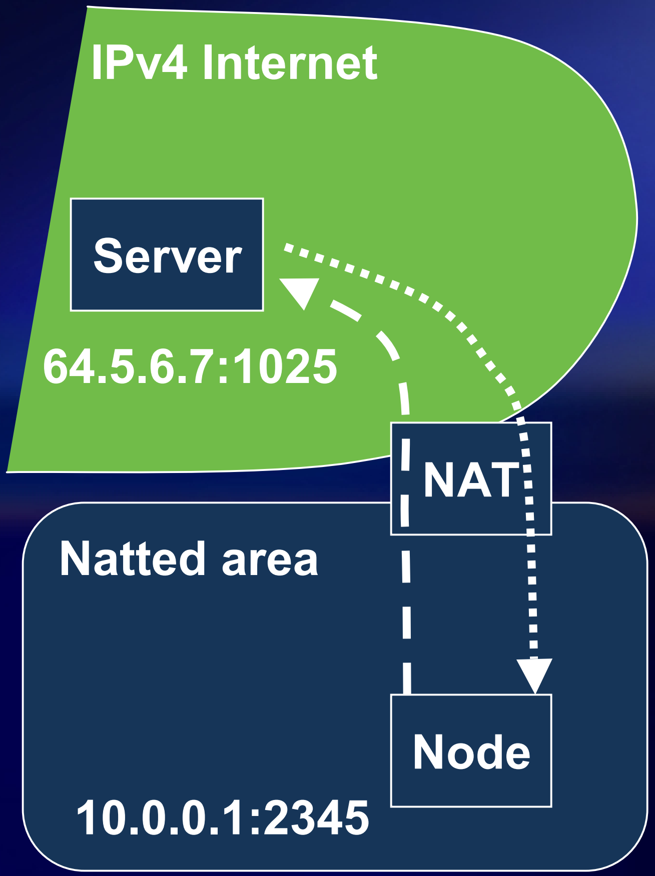


- **Teredo server:**
  - Helps host discover its "mapped" address
  - Provides prefix: xxxx:IPv4:port::/64
  - Example: xxxx:4050:607:401::/64
- **Teredo relay:**
  - Advertises xxxx://16
  - Tunnel over UDP to "IPv4:port"
  - NAT will relay to host
- **Between host:**
  - First packet through server,
  - Use "bubbles" to pierce the NAT, enable transmission

Teredo objects & entities

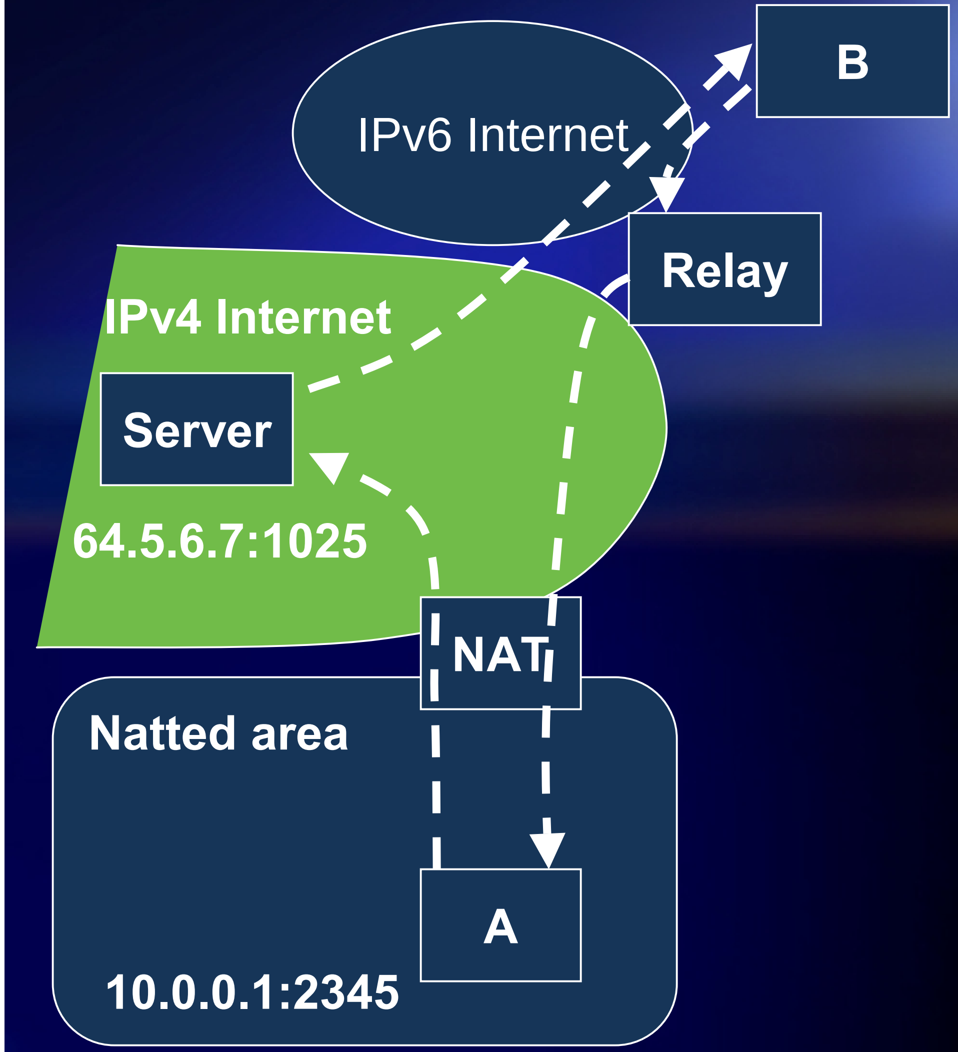
- Client: the node behind a NAT
- Server: helps the client connect
- Relay: forwards IPv6 packets to clients
- Teredo IPv6 prefix: xx:://n (TBD IANA)
  - Used to construct all Teredo addresses
- Teredo address prefix: xx:IPv4:port::/m
  - Embeds the "mapped address & port" of the client
- Teredo IPv4 anycast address: x.y.z.t
  - Used by relays and servers
- Teredo UDP port: pppp
  - Used by relays and servers

Qualification Procedure



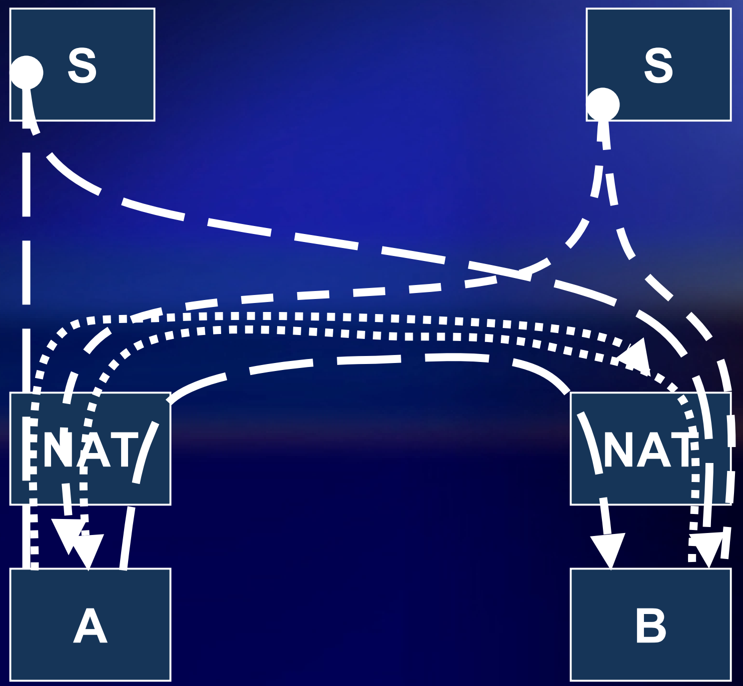
- Client sends “Router Solicit” :
  - Over UDP
  - Fixed “anycast” address of server
- Server replies with “Router advertisement”
  - Prefix includes “mapped IP address” and “mapped port.”
  - Example: xx:4005:607:401::
- Client is qualified!
  - Address: prefix + Identifier

Transmission between Teredo & regular IPv6 node



- Teredo to IPv6 (A-B)
  - A sends to server,
  - Server relays to IPv6.
- IPv6 to relay (B-A)
  - B sends to A (IPv6)
  - Packet routed to relay
  - Relay sends to A (UDP), same source address, port as server

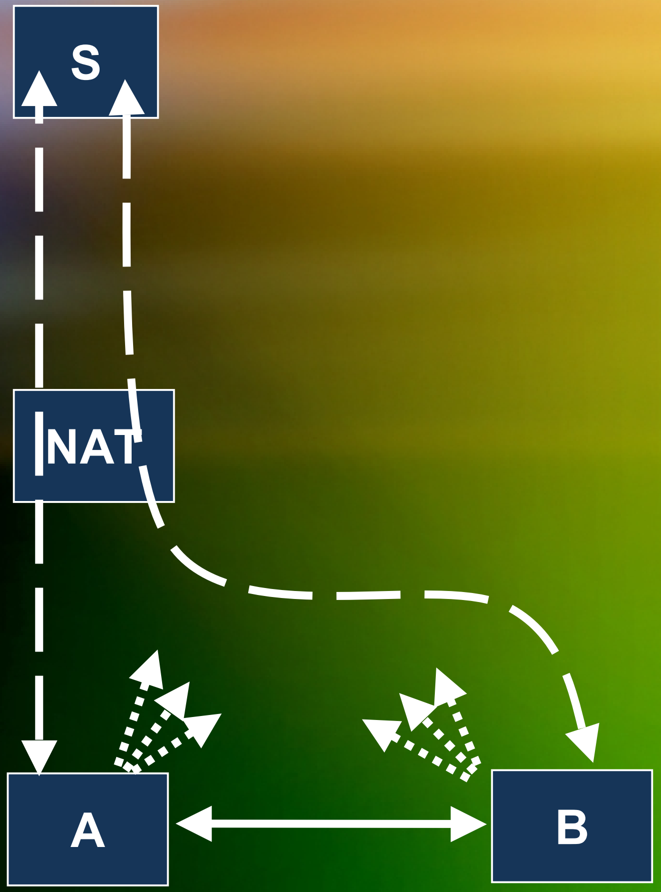
Transmission between Teredo nodes



- First packet, A→ B
  - A sends bubble to B
  - Packet through server,
  - Server relays with "anycast" address, use existing hole
- Reply, B → A
  - If bubble received, send direct to A
  - Else, send through S, send bubble to A
- Follow on packets
  - If bubble or direct packet received, direct path.
  - Else, through server.

Transmission between Local Teredo nodes

- Qualification:
  - A & B get address from server S
- Advertisement
  - A & B send multicast bubble, advertise their local address
  - Multicast bubbles are cached
- Direct transmission
  - Packets are sent directly, over the local network, using UDP encapsulation
- Limitation
  - Single link!

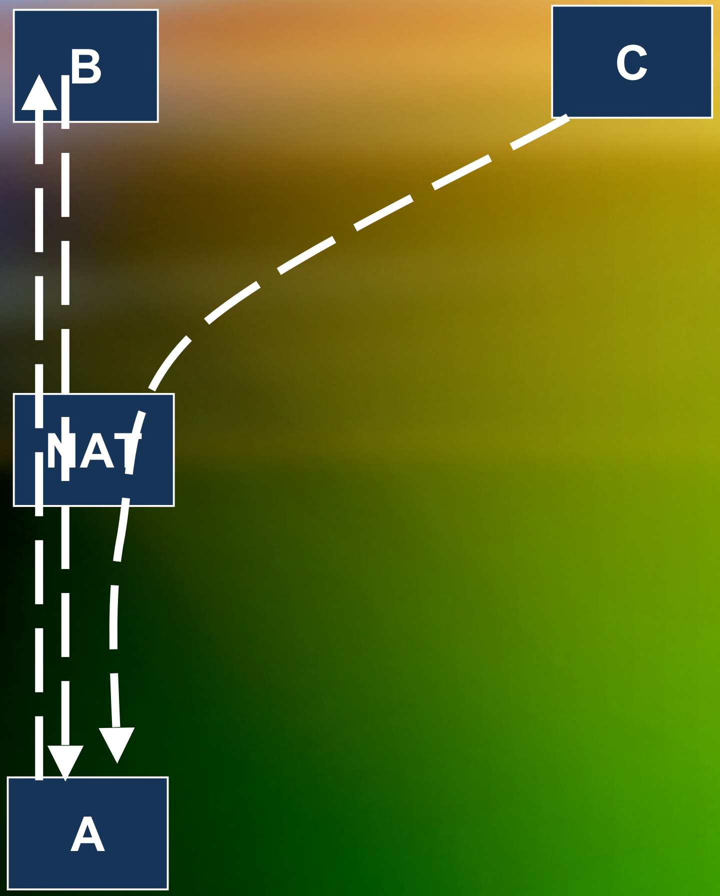


Adapting to all NAT forms

- Four forms of NAT
  - Cone NAT
  - Restricted Cone
  - Port Restricted Cone
  - Symmetric
- Additional parameter: delay

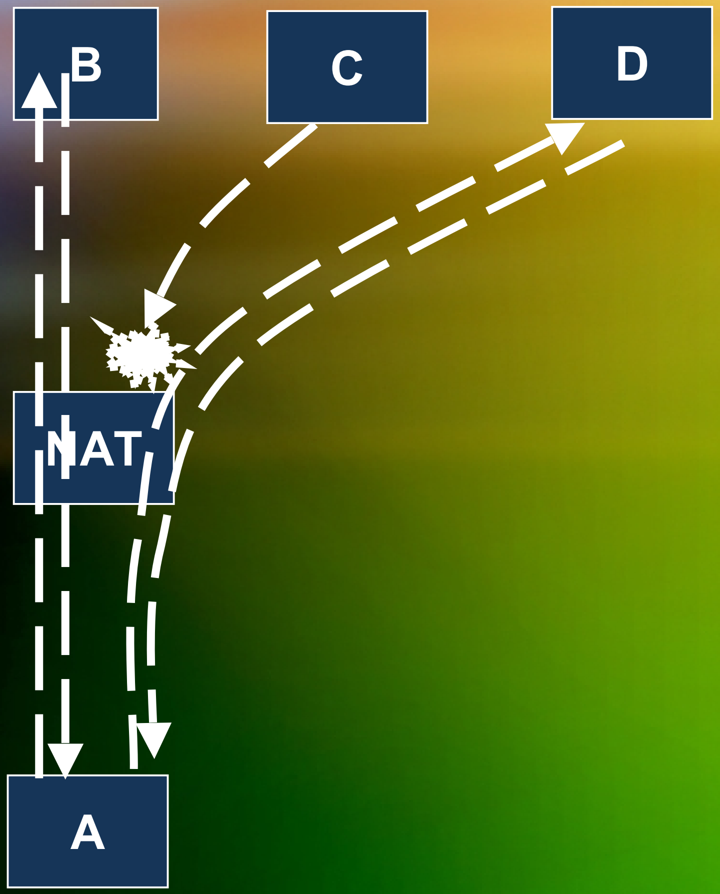
Cone NAT

- UDP packet creates a mapping in NAT
  - Inside: 10.0.0.2:3456
  - Outside: 64.5.6.7:1025
- Target (B) can reply
- Third party (C) can also reply



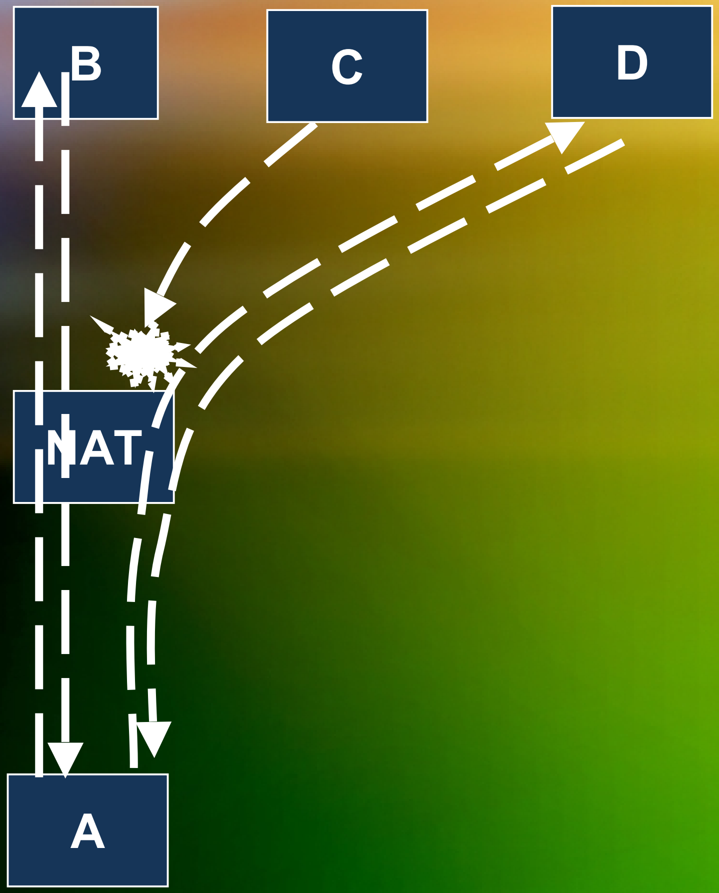
Restricted Cone NAT

- UDP packet creates a mapping in NAT
- Target (B) can reply
- Random third party (C) cannot reply…
- Traffic to other party use the same mapping
- If spoken to, can respond



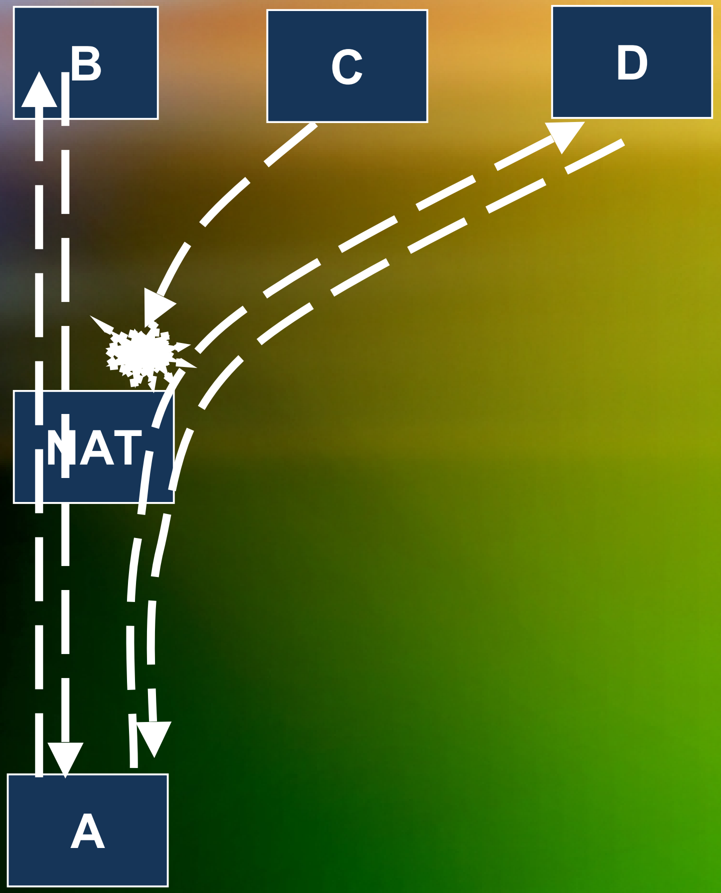
Port Restricted Cone NAT

- Same behavior as restricted cone, with one difference, more restrictive:
  - If traffic send to “port-x”, return is only authorized from same port.



Symmetric NAT

- Mapping of internal port varies as a function of target
- Generally coupled with "port restricted" behavior.



Design goal: passing all types of NAT

- Use a single address & port for servers and relays:
  - Only one hole to maintain in the NAT
  - See maintenance procedure, next slide
- Wait for receiving a “bubble” or a “direct packet” before sending on direct path
  - 1st packet goes through server for all NAT
  - 2nd packet goes direct in 40% of NAT (open)
  - 3rd packet goes direct in 95% of NAT (protected)
  - Keep using a server as relay in 5% of cases (weird)

Maintenance procedure

- NAT mapping will time out after “some period”
  - Maintain a timer: last packet from “server”
  - Refresh the mapping if timer elapses
  - Detect possible change of mapping during refresh
- Period is variable
  - Assume 30 seconds initially
- Use secondary port to test the timer:
  - Get mapping for secondary port
  - Test packet from primary port to secondary through server after “candidate timer”
  - If packet received: try larger value (2 minute max)
  - Else: try smaller, or stop.

Operation issues: routing

- Teredo network determined by
  - Teredo IPv6 address prefix,
  - Teredo IPv4 anycast address,
  - Teredo UDP port
- Restriction on IPv4 anycast
  - Must be “topologically correct”
  - → must advertise “reachability” to all
- Restriction on IPv6 source
- Option: run separate networks

Security issues

- Big concern: address spoofing
  - Relays can be abused to source "funny" traffic, hide the source
  - Teredo address only as "proven" as IPv4 source address (i.e. not much)
- Mitigating factors
  - Teredo enables IPSEC end-to-end
  - Teredo traffic to third parties can easily be filtered-out, preventing DDOS attack

What is in a name?

- Teredo Navalis:
  - Wood boring salt water mollusk
  - 10-15 cm in length, 10 mm in diameter
- Looks nasty, but
  - “the animal only survives in relatively clean and unpolluted water; its recent comeback in several Northern American harbors is a testimony to their newly retrieved cleanliness”

Teredo: what is the timeline?

- Spec passed WG last call, received IESG comments
  - Expect RFC in 2002
- Development of code in Windows XP
  - Starting now; relatively simple.
  - Availability as some form of Windows XP update
- Other developments
  - Expect 6 months after RFC for routers (Cisco),
  - Maybe some NAT
- Deployment of servers
  - Deploy Windows based test server by December 2001 in Redmond (done)
  - Test by ISP in early 2002 – hopefully!

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