NAT and IPv6: We meet at last!

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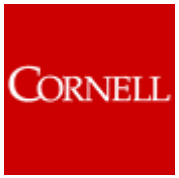
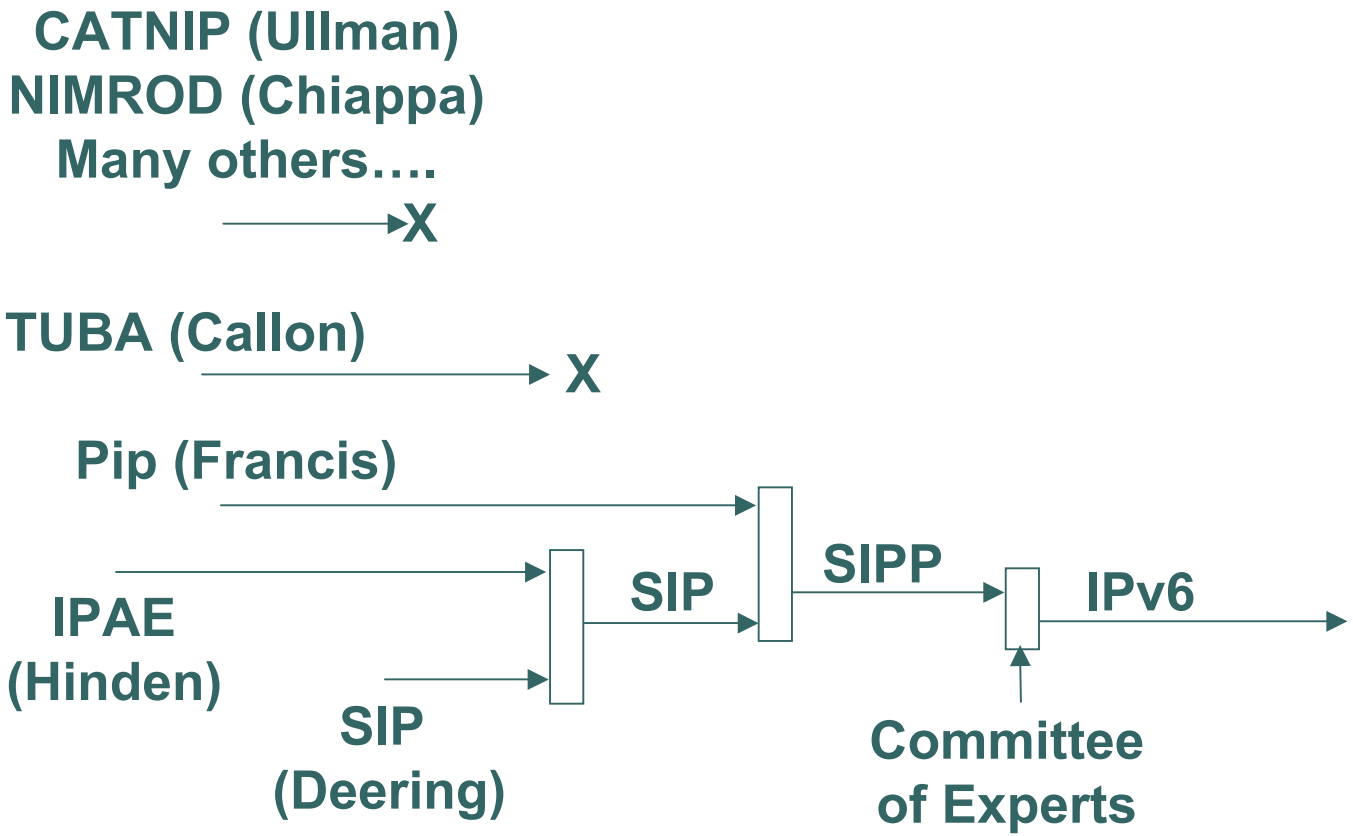


NAT and IPv6: We meet at last!

- History and evolution of IPv6 and NAT
- Teredo: NAT and IPv6 collide and form a new particle
- Possible futures of IPv6 and NAT???

IPv6 evolutionary tree (1992-1993 time frame)



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IPng proposals in a nutshell

- TUBA: OSI's CNLP
- Pip: New header structure
  - 64-bit unique ID, plus a stack of routing labels
- SIP: A simplified IPv4 with 64 bit addresses
- IPAE: Originally IPv4-over-IPv4, later thought of as a transition mechanism

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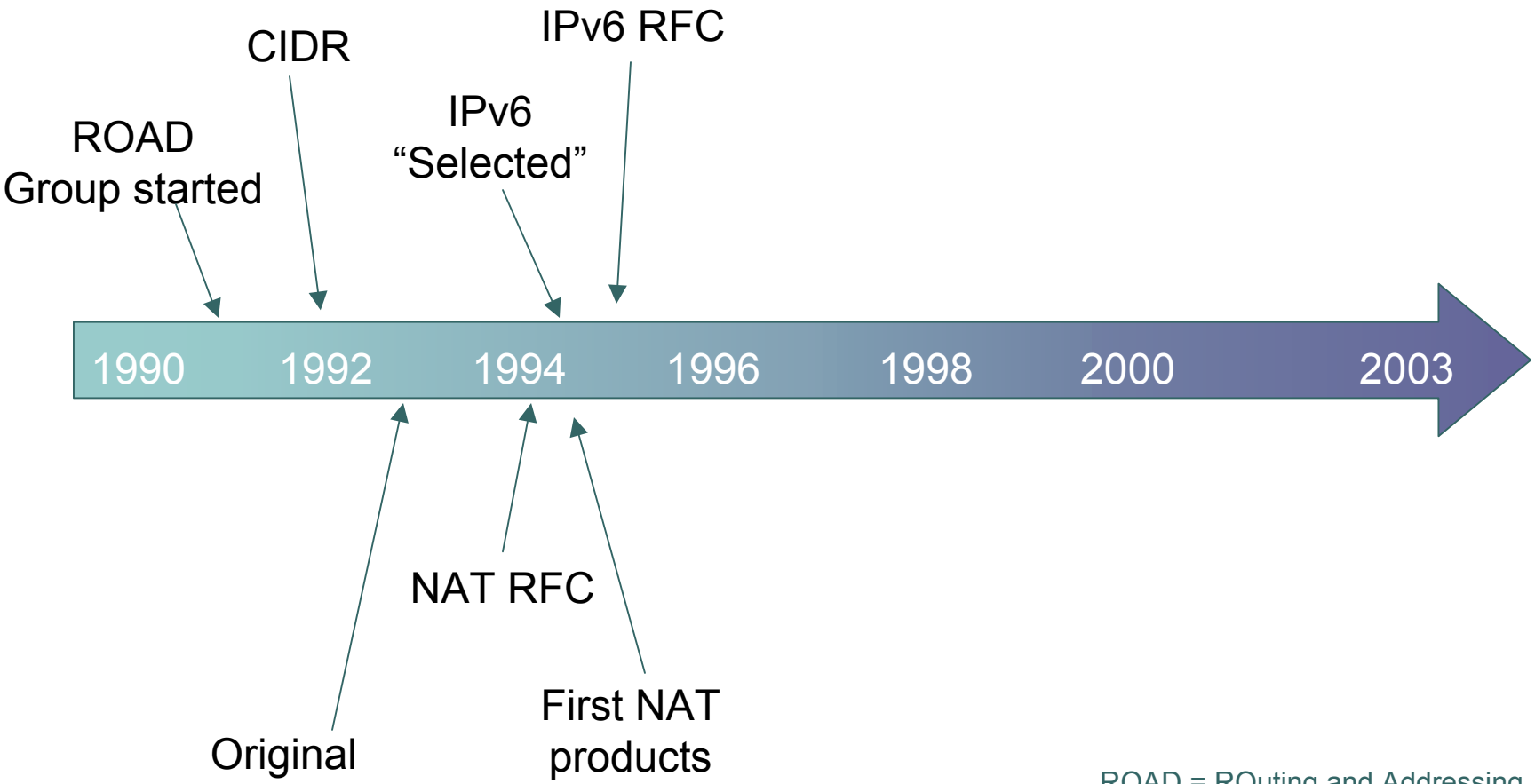
View of the world, circa 1990

- Just starting to worry about address depletion
  - Mainly because of poor utilization, not number of hosts (class A, B, C)
- IP was still "*the identifier*"
  - Long term stable, globally unique
  - DNS not universally deployed
- Note: This is before the web!

IPv6 and NAT history



ROAD = ROuting and Addressing
CIDR = Classless Interdomain Routing
NAT = Network Address Translation

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Original goals of IPv6: IPv4 with bigger addresses

- Different proposals had different goals
  - There was never a real requirements process
  - IPv6 reflects Deering's goals
- Bigger addresses
- Simplify the header, fix a few minor problems
- Otherwise change as little as possible!

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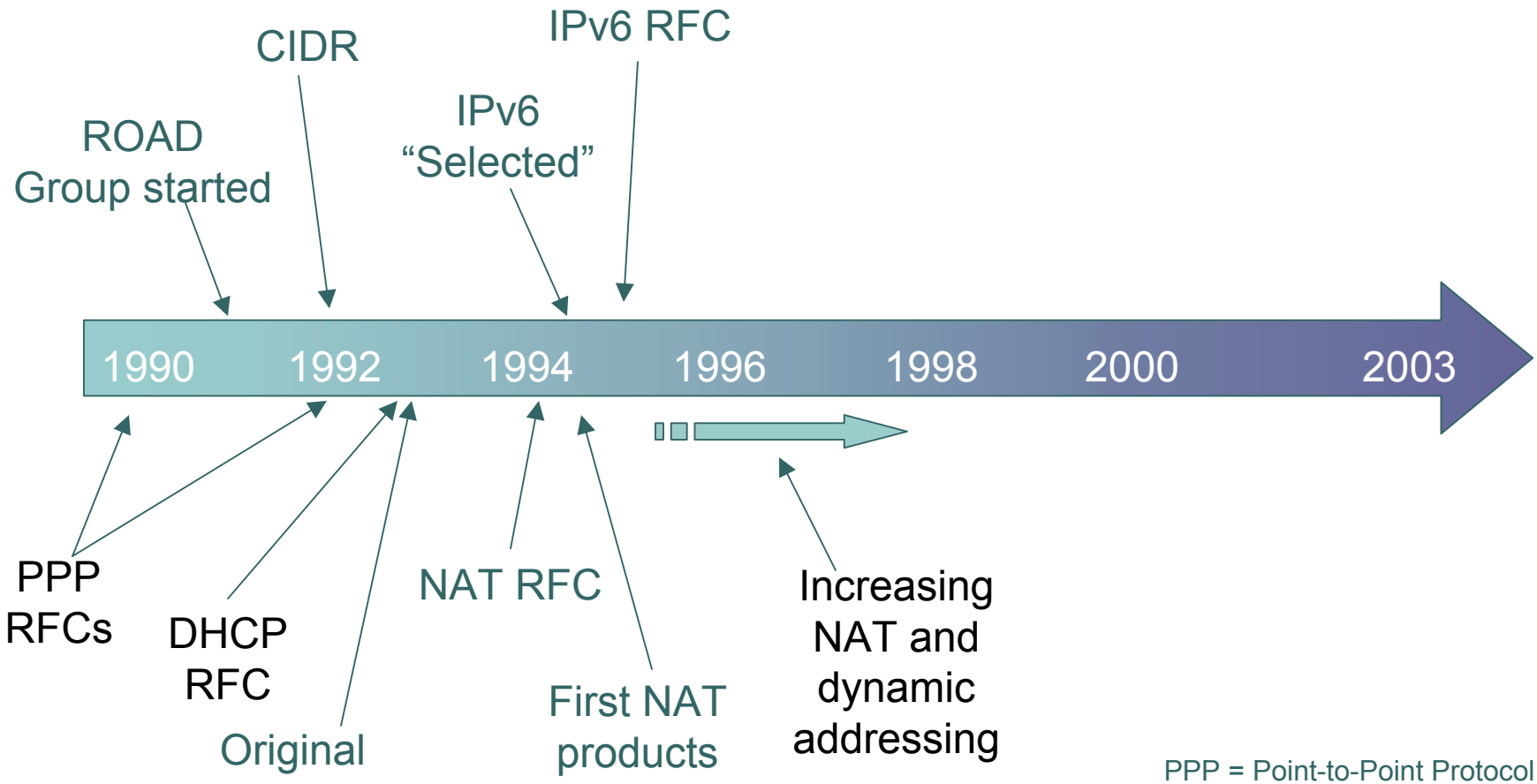
In particular…

- No new routing architecture
- No new security architecture
- No new QoS architecture

- Improved auto-configuration, mobility (maybe), multicast

Increased use of NAT and dynamic IP addresses



PPP = Point-to-Point Protocol
DHCP = Dynamic Host Configuration Protocol

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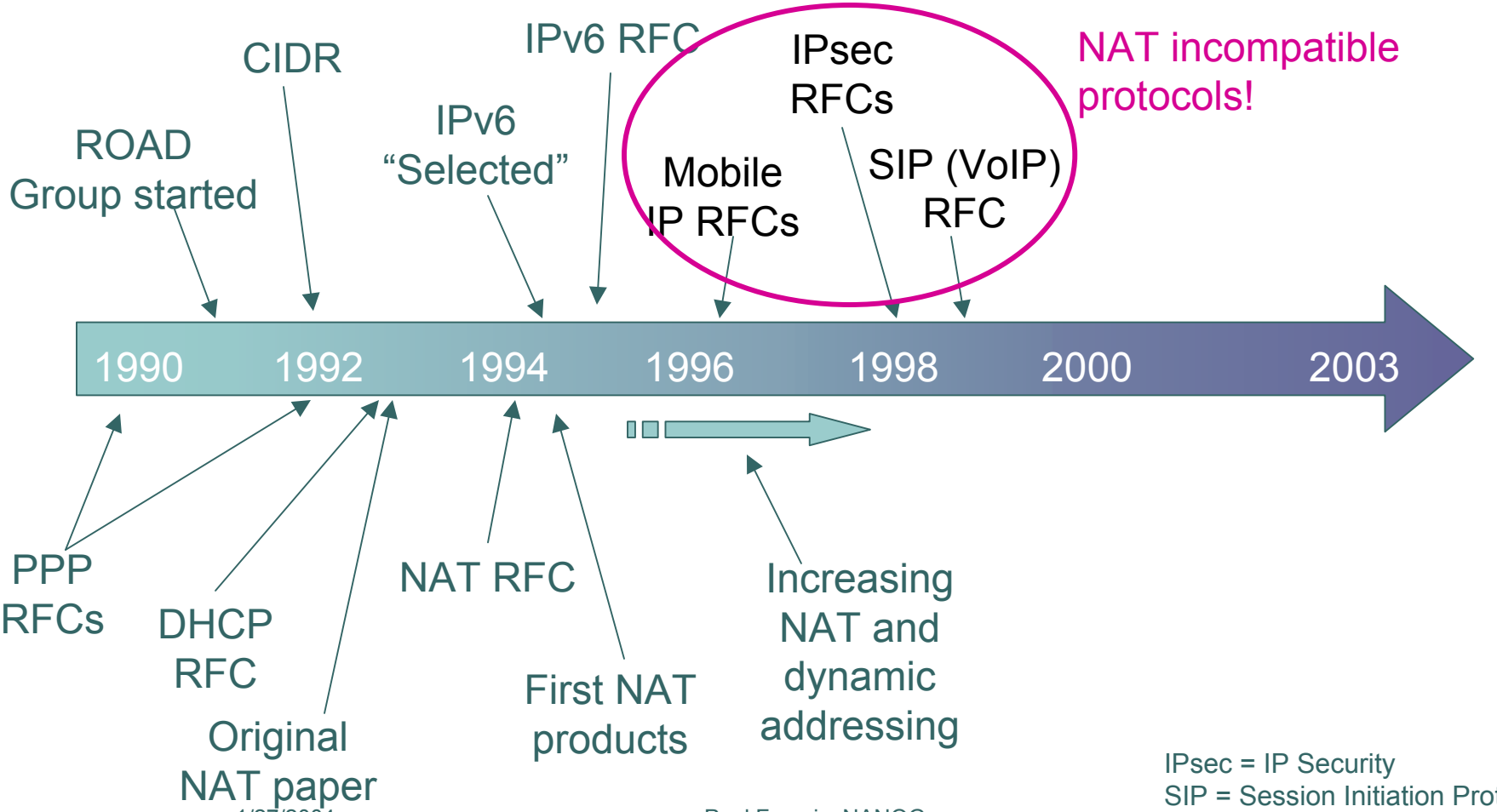
Disadvantages of NAT

- State in network
  - (though firewalls have state anyway)
- Slow/expensive processing
  - (though not in the core where it really matters)
- Breaks apps that carry IP addresses
  - (though people know not to do this now)
- Breaks with IP segmentation
  - (but you don't want to segment anyway)
- *Doesn't allow incoming connections!!*
  - (but some firewalls prevent this anyway!)

IETF continues to willfully ignore NAT



IPsec = IP Security
SIP = Session Initiation Protocol
VoIP = Voice over IP

How did NAT harm the internet?

- For client/server protocols, very little harm
  - Web, email, FTP, Net news, IRC (chat)
- Clients can contact servers, many more clients than servers
- Various ways to identify clients
  - Email address, PPP NAI, HTTP cookies, SIP URIs, MIP NAI, . . .

FTP = File Transfer Protocol
IRC = Internet Relay Chat
NAI = Network Access Identifier
URI = Uniform Resource Identifier

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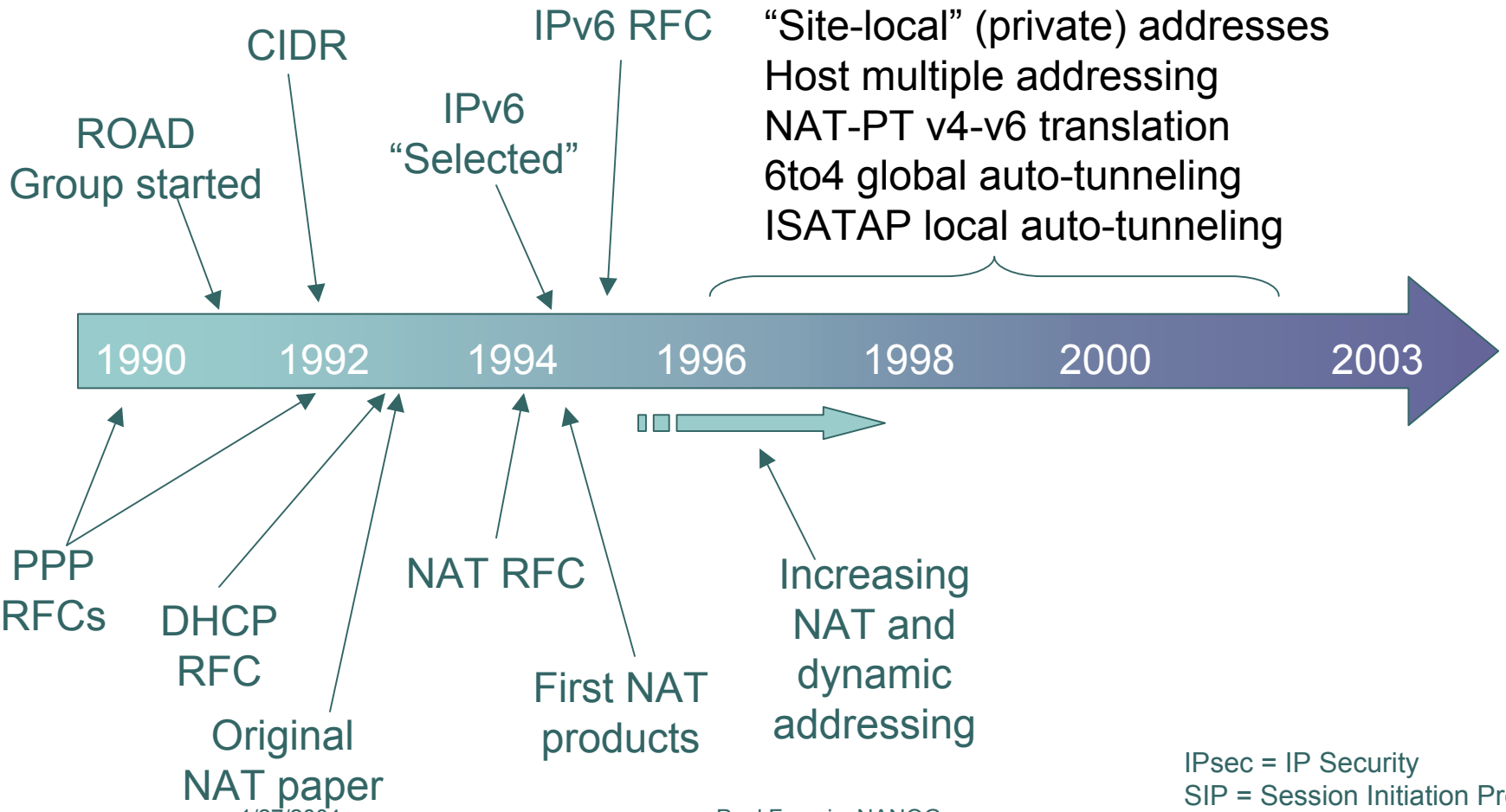
How did NAT harm the internet?

- For peer-to-peer applications, who knows?
- If not for NAT, we might now be regularly using internet phone, have all kinds of interesting group applications, etc.
  - But then again, we might not…
- But this wasn't enough motivation to migrate to IPv6

IPv6 addressing goes through various mutations



IPsec = IP Security
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IPv6 address mutations

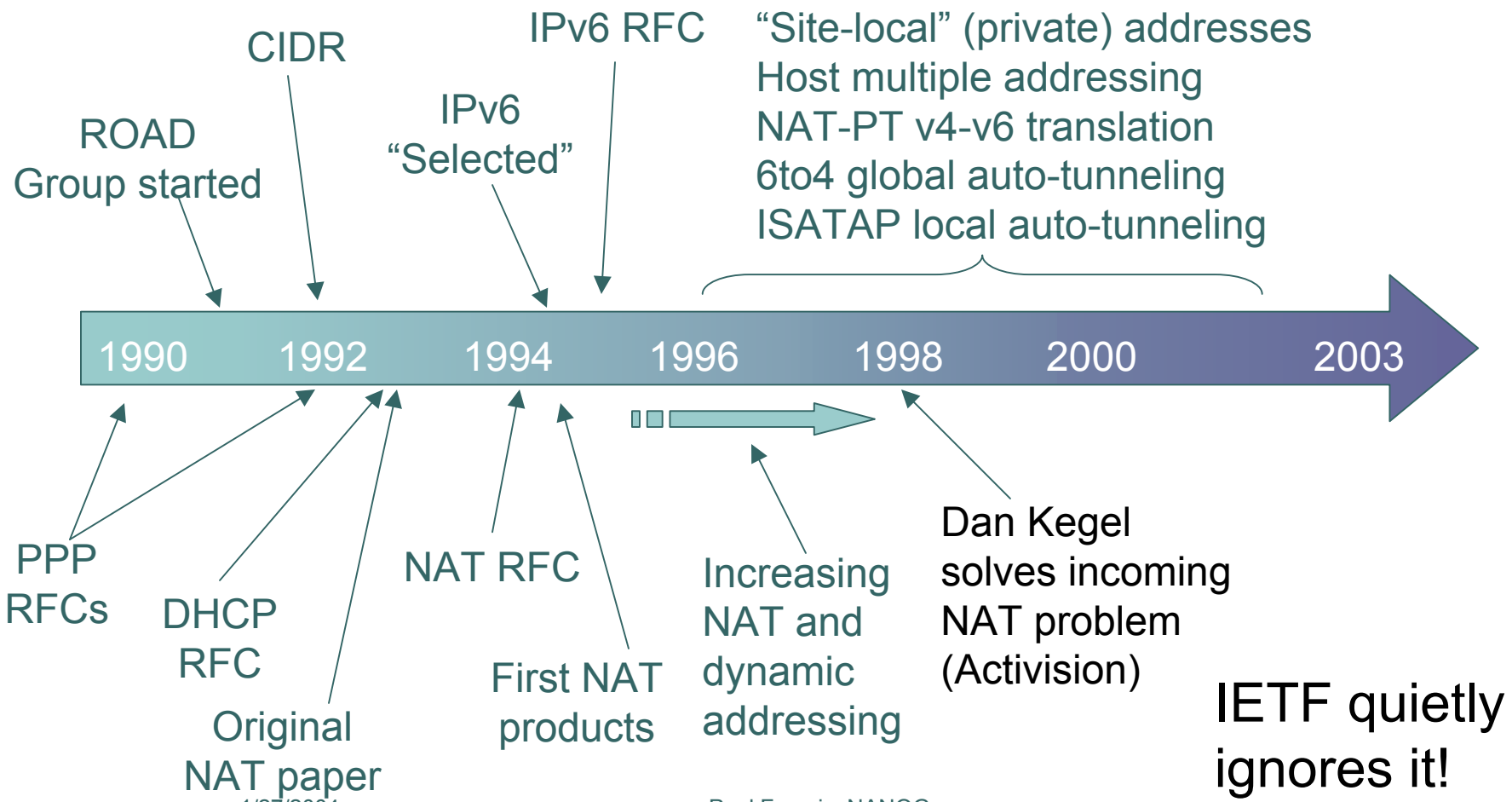
Site-local address

In-site NAT-TP

6to4

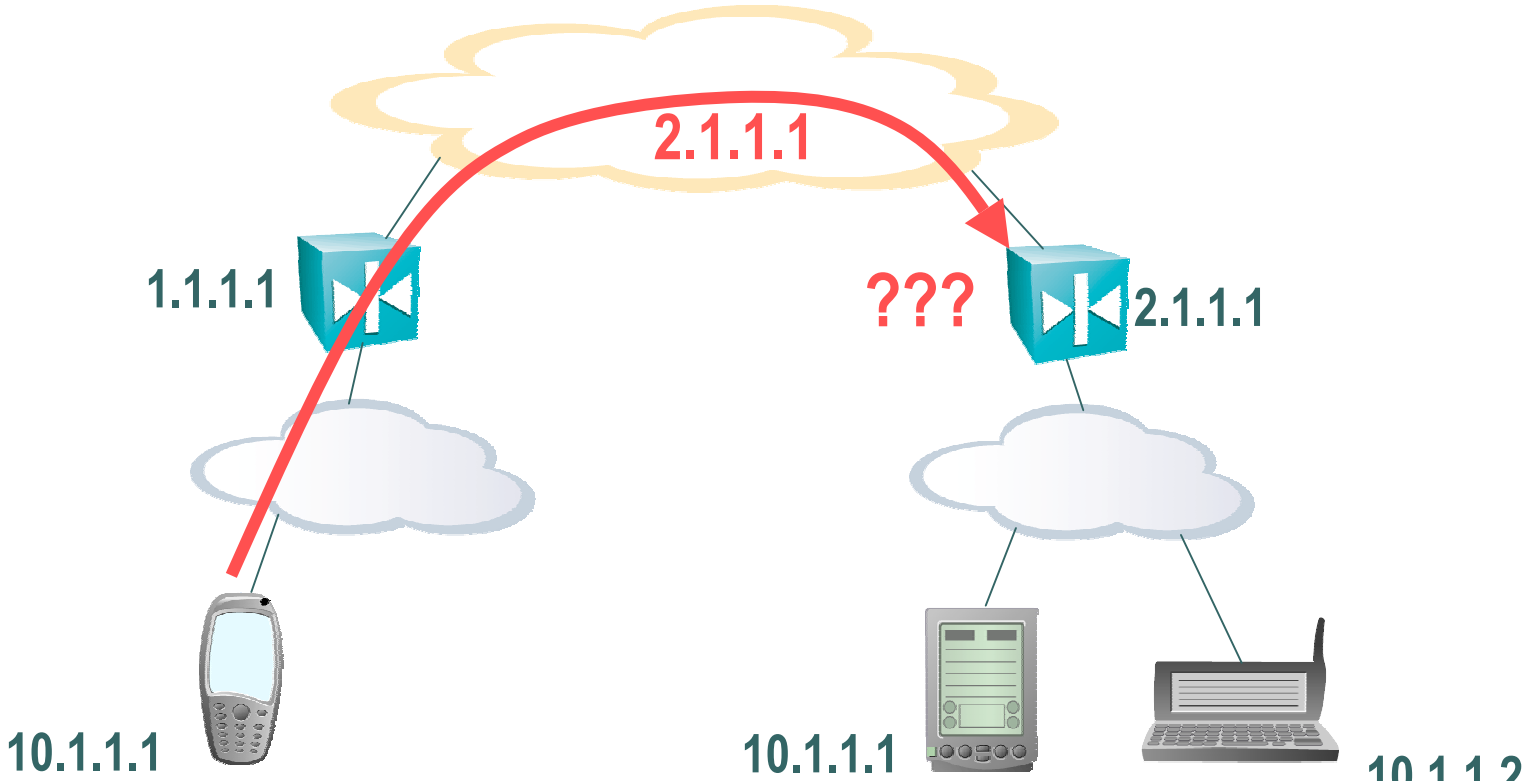
ISATAP

Dan kegel's NAT breakthrough

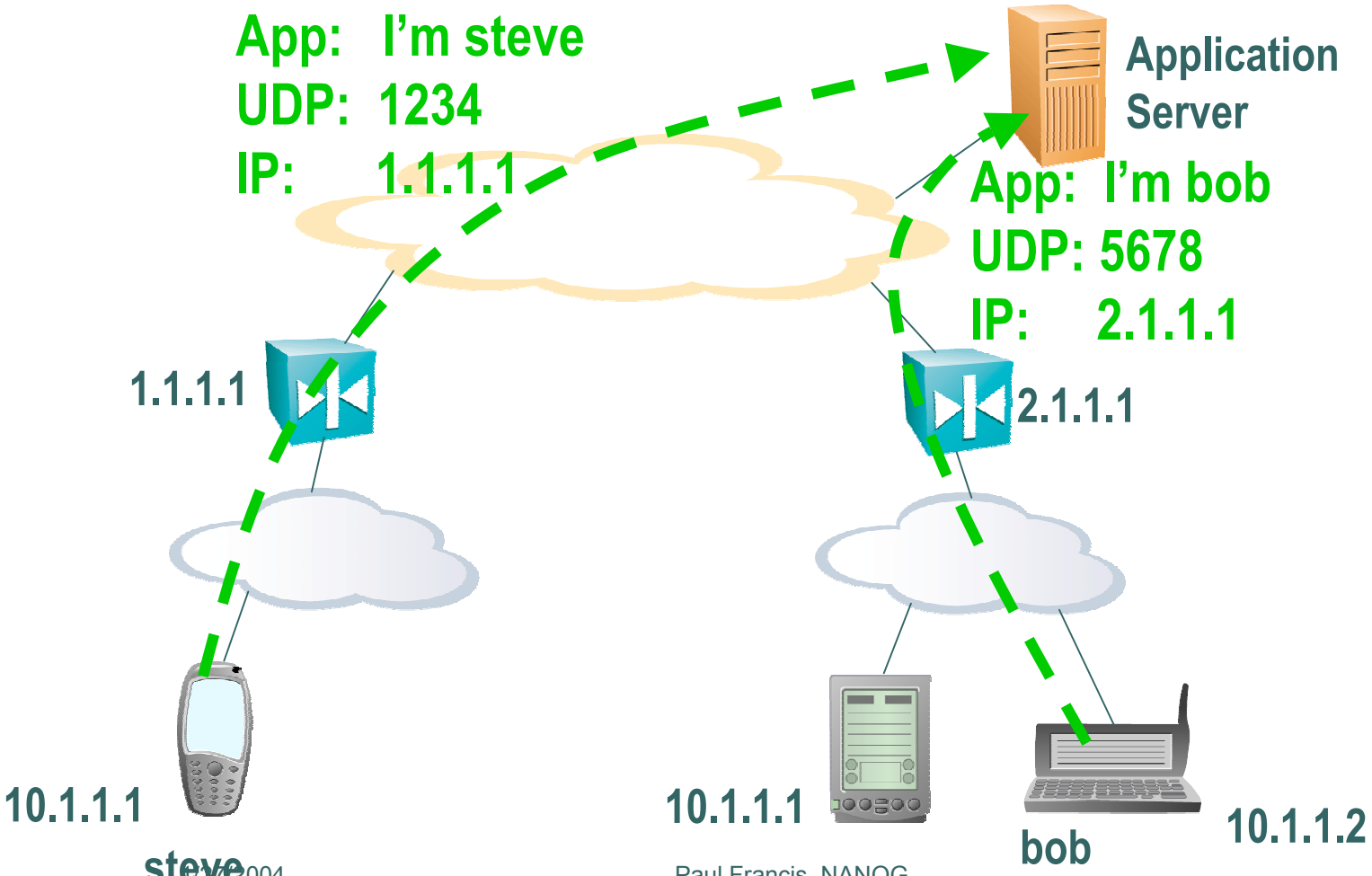


IETF quietly ignores it!

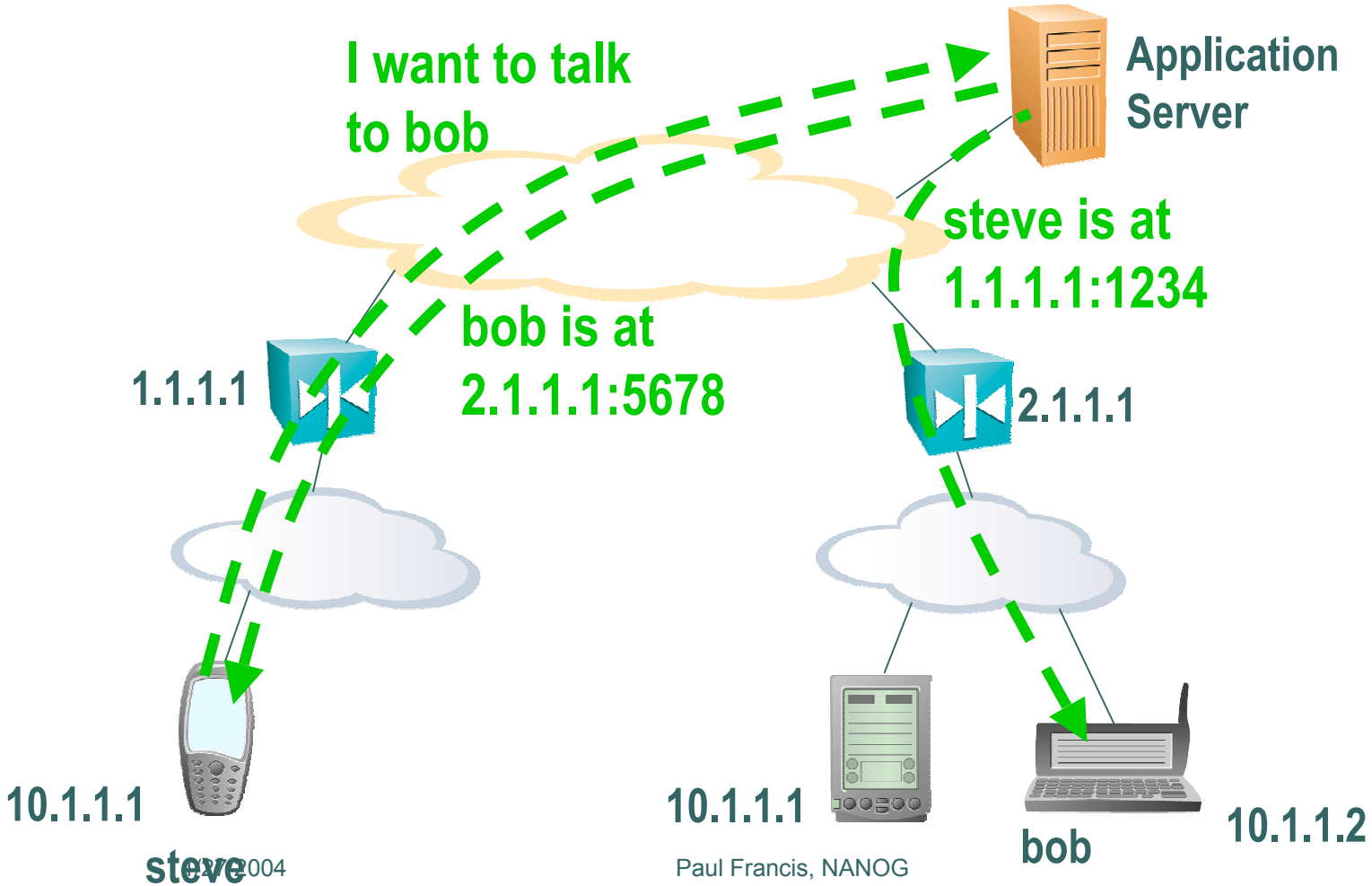
Packet can't come in until NAT box has mapping



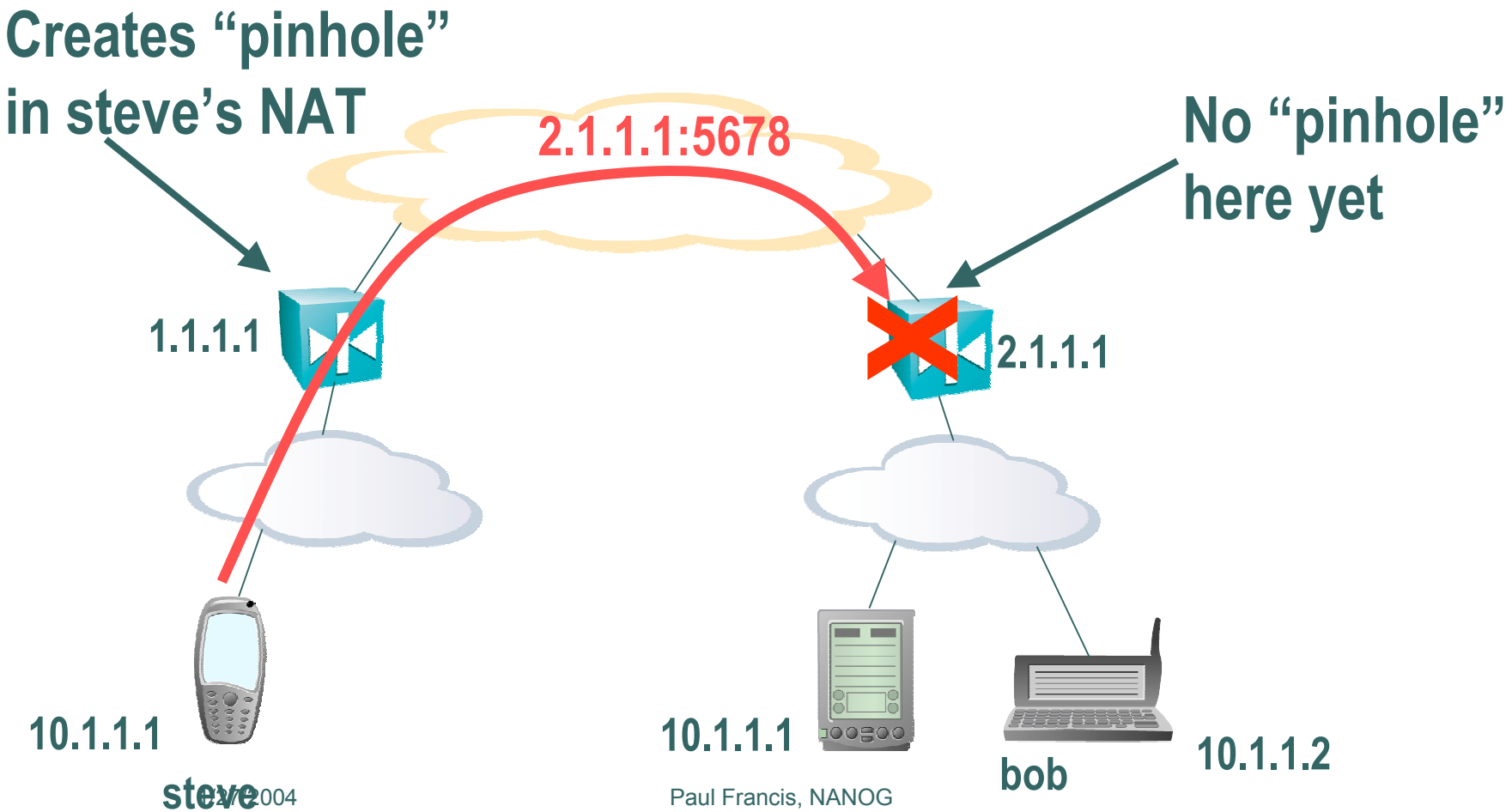
Steve and Bob register with globally addressed server



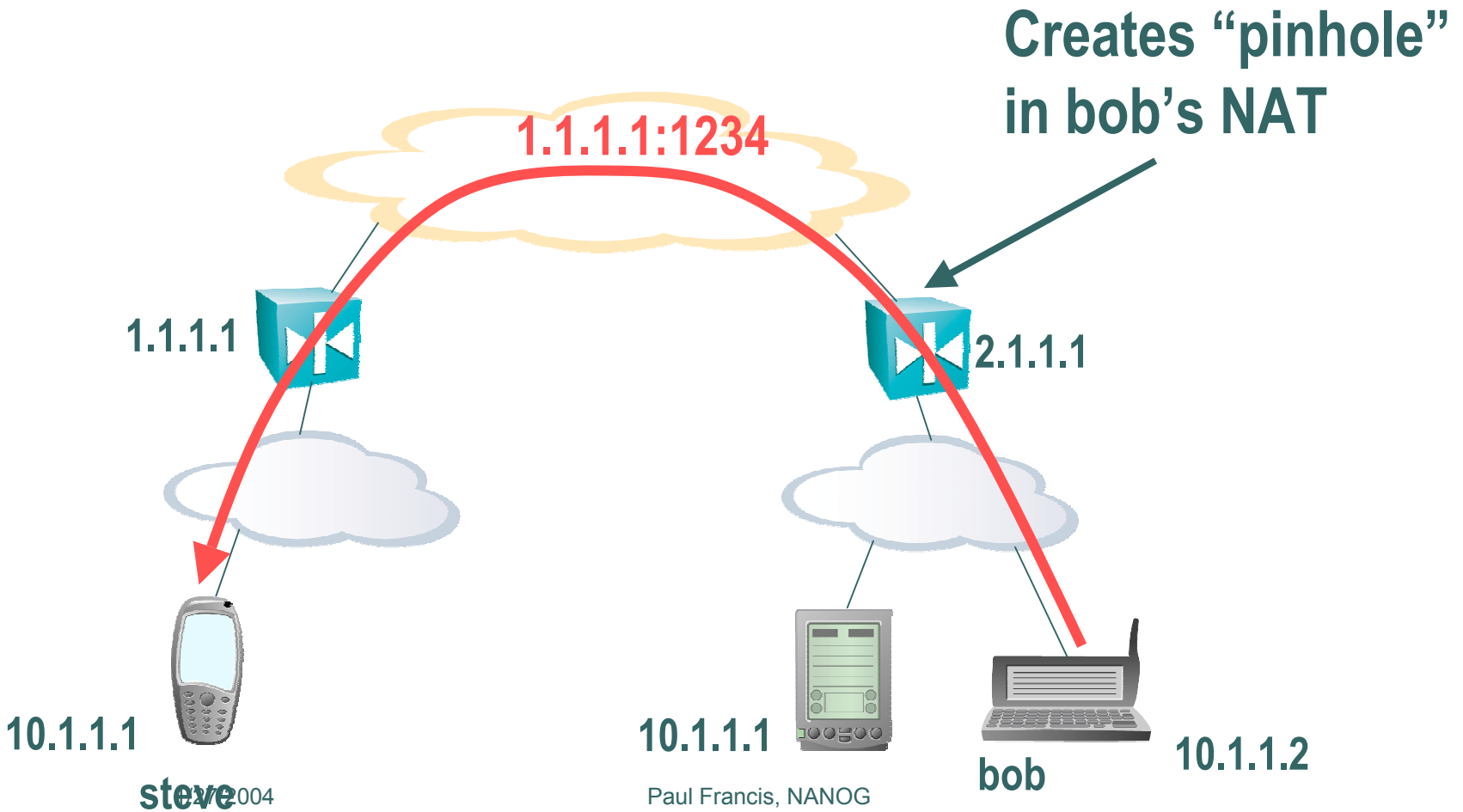
Server tells Steve and Bob each other's NAT mapping



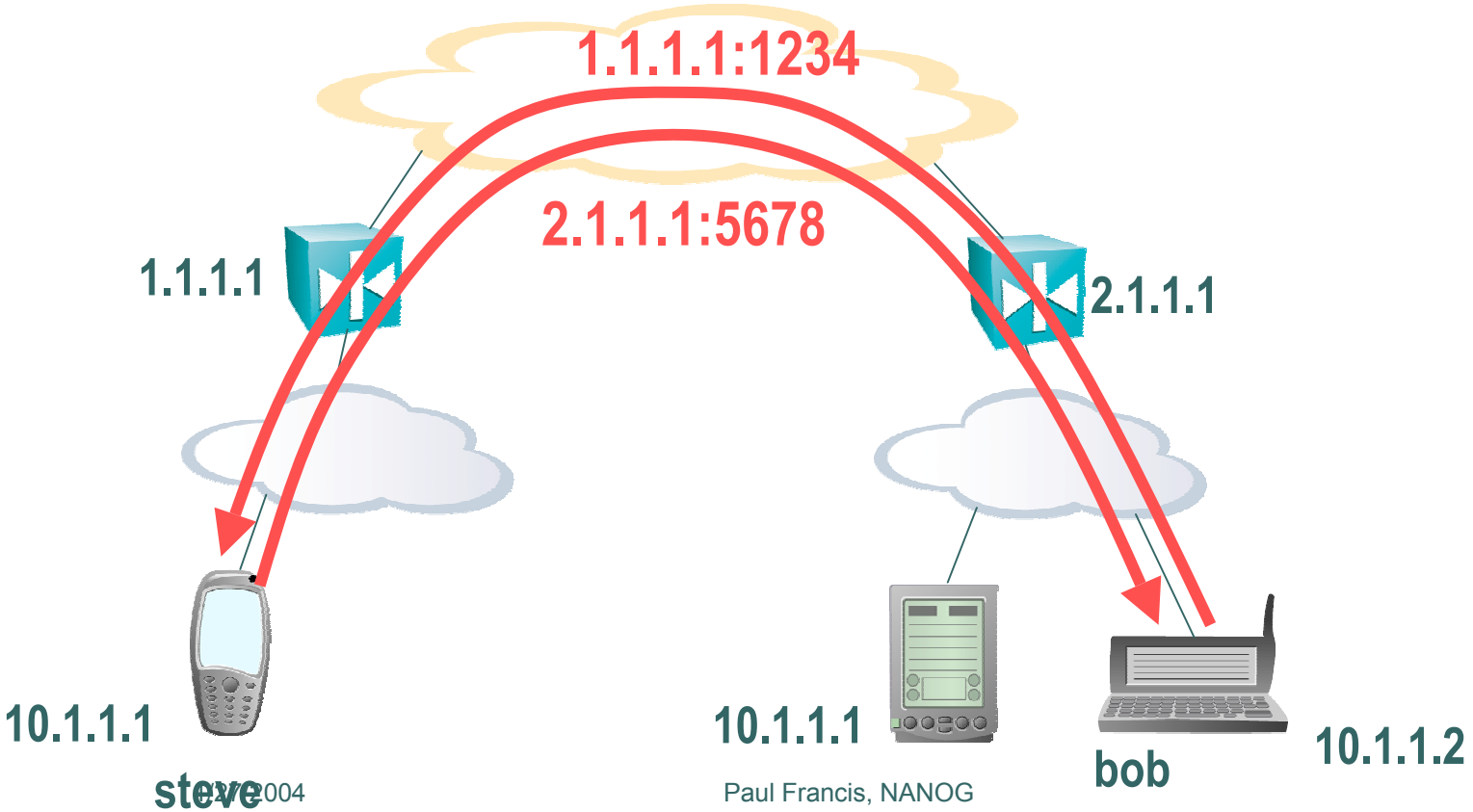
Steve sends “bubble packet” to create his mapping



Bob does the same, but this packet gets through



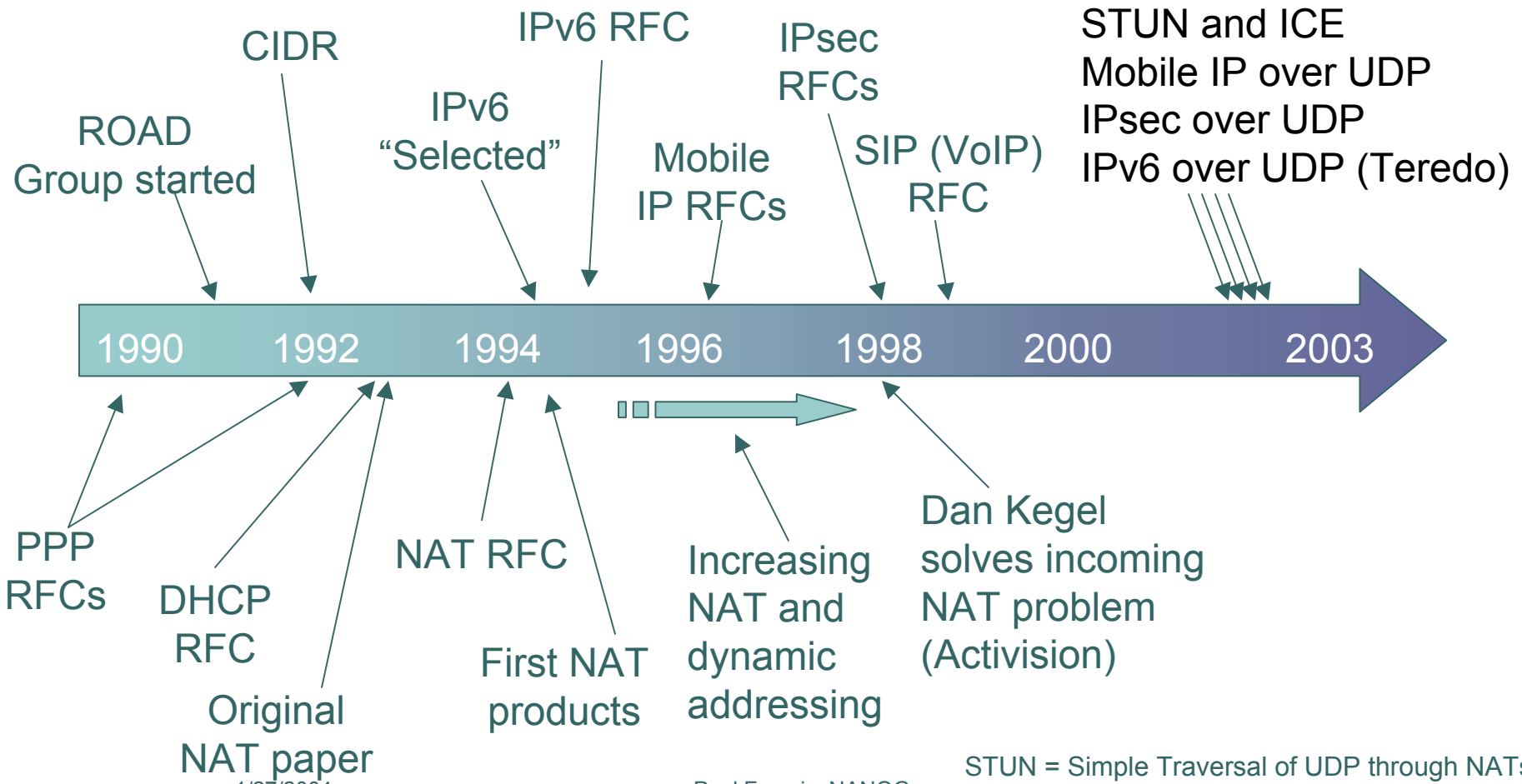
Steve and Bob can talk!



Limitations of this approach

- Doesn't work with some kinds of NATs
  - NAT must always assign same external port to a given internal port
- Doesn't work for TCP
  - Because TCP is *usually* asymmetric… expects a listener and a connecter
    - Windows OSs and some firewalls enforce this
  - We have a project to fix this problem
- Many corner cases (for instance, two hosts behind same NAT)

Sea change in IETF attitude towards NAT



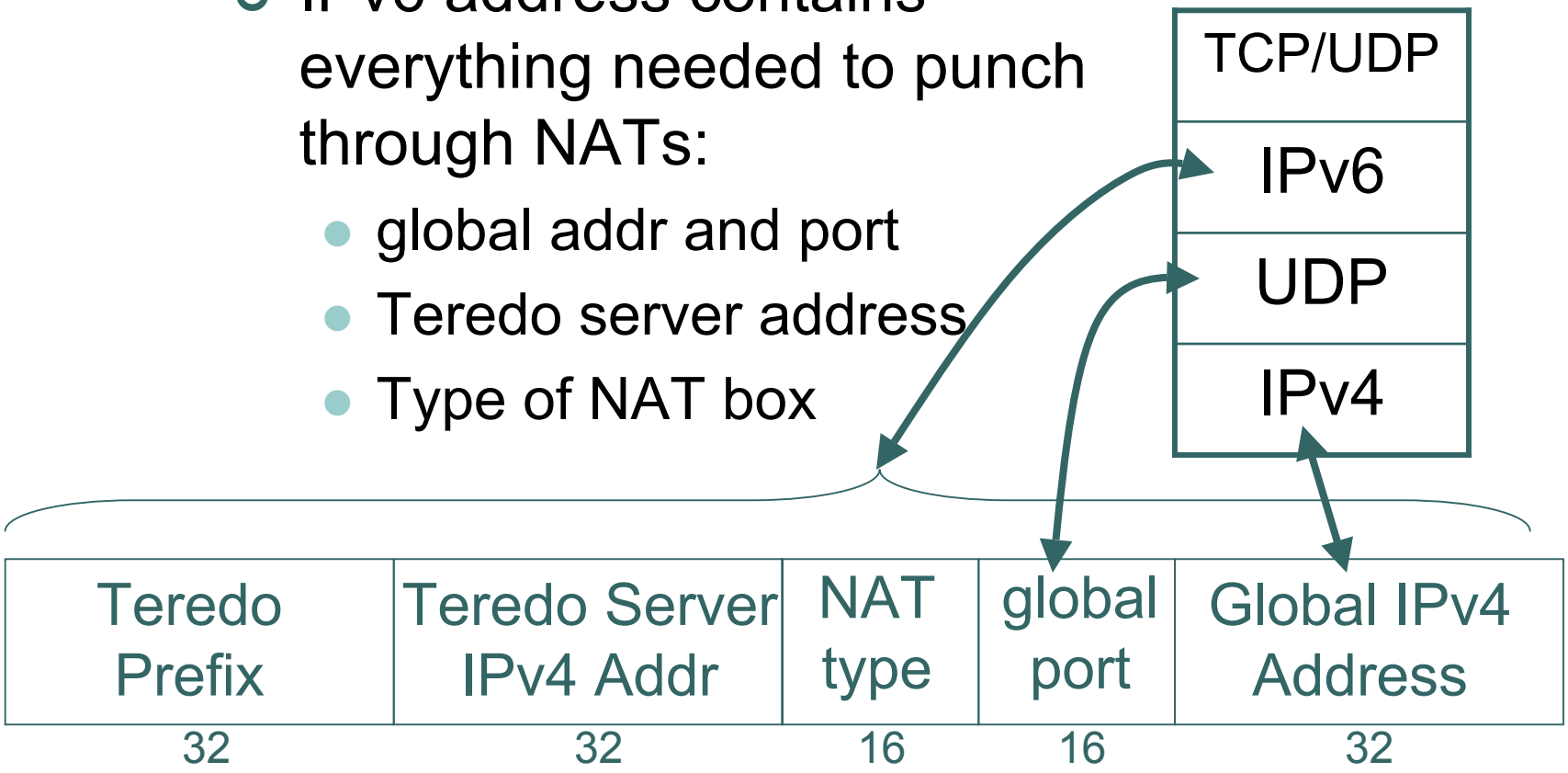
STUN = Simple Traversal of UDP through NATs
ICE = Interactive Connectivity Establishment

NAT Friendliness

- STUN/ICE/TURN
  - Protocols that utilize SIP (Session Initiation Protocol) to punch through NATs
  - Doesn't allow direct P2P TCP connections
- IPsec or MIP over UDP
  - NAT-friendly encapsulations
- Teredo (IPv6-over-UDP)
  - Utilizes IPv6 to punch through NATs
  - Requires stack change in OS

Teredo (where NAT meets IPv6)

- IPv6 address contains everything needed to punch through NATs:
  - global addr and port
  - Teredo server address
  - Type of NAT box



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Teredo, STUN/ICE, and IPv6 status

- Microsoft is pushing Teredo
  - As the basis of its P2P toolkit API
  - In its 3degrees P2P application
- SIP community is moving ahead with STUN/ICE
  - Not sure how productized it is
- IPv6 --- hard to read
  - Still not “critical” in Asia as of one year ago

Possible futures

- P2P community converges on STUN/ICE or Teredo
  - Demand for IPv6 routers never materializes
    - Or this spurs demand for IPv6 routers? I doubt it.
  - Firewalls, management tools, etc. evolve to support STUN/ICE or Teredo
  - This is the best outcome
  - I like STUN/ICE better than Teredo
    - Nicer naming, and I think we know how to solve TCP issue
- Or, no convergence, P2P world remains ad hoc and fragmented
  - But I still don't think we'll see IPv6 in routers
  - Likely future if IETF doesn't accept NAT…