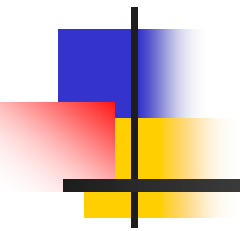
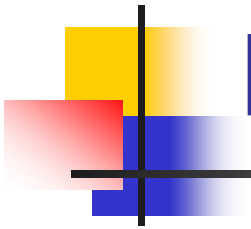
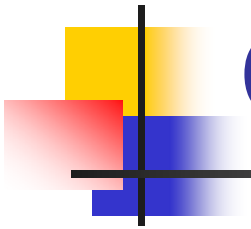


# VoIP + NAT



# References

- “SIP, NAT and Firewalls”, Fredrik Thernelius
- Baruch Sterman and David Schwartz, “NAT Traversal in SIP”, Deltathree
- “STUN – Simple Traversal of UDP Through Network Address Translators”, RFC 3489, IETF
- “An Extension to the SIP for Symmetric Response Routing”, RFC 3581, IETF

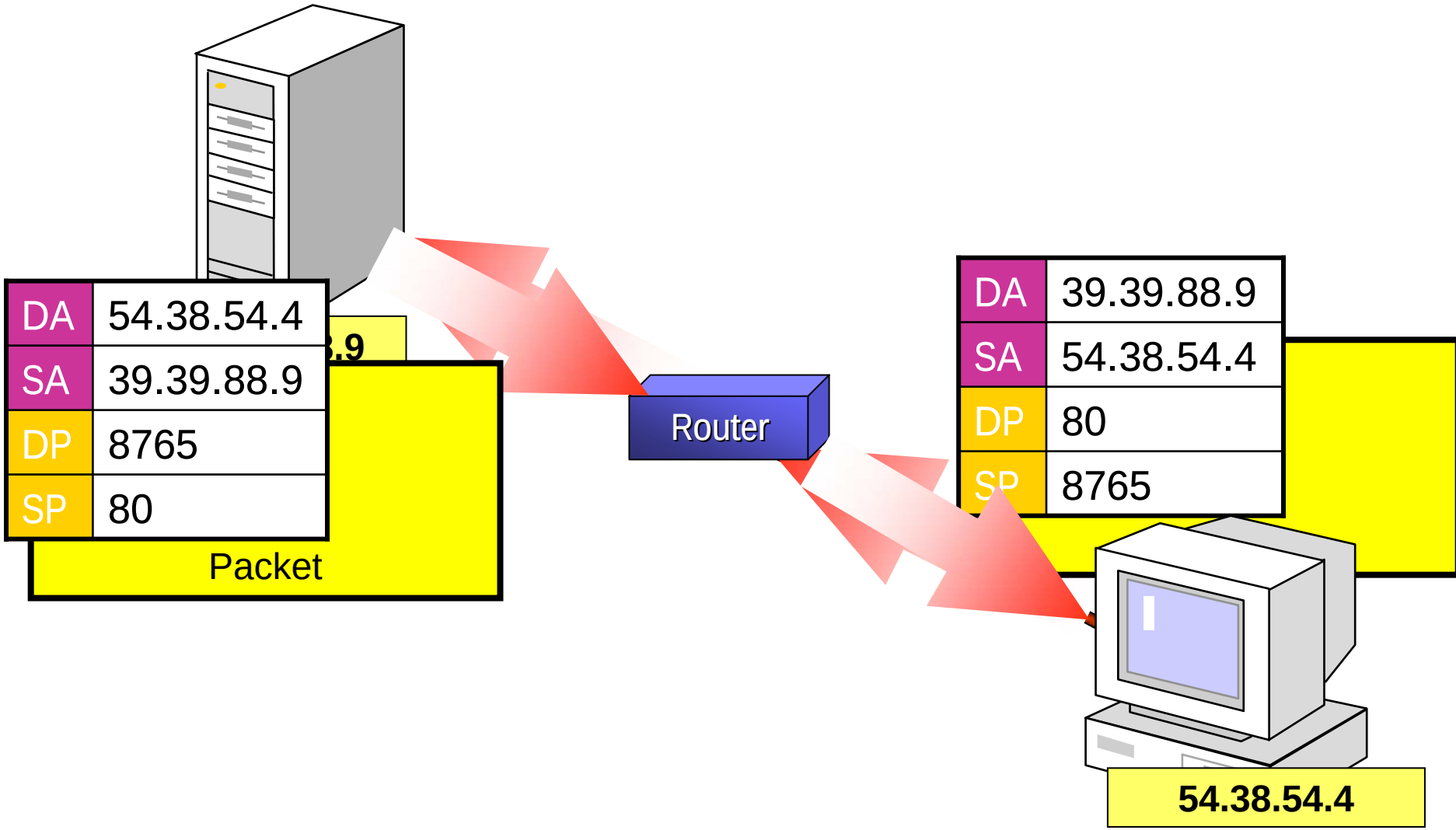


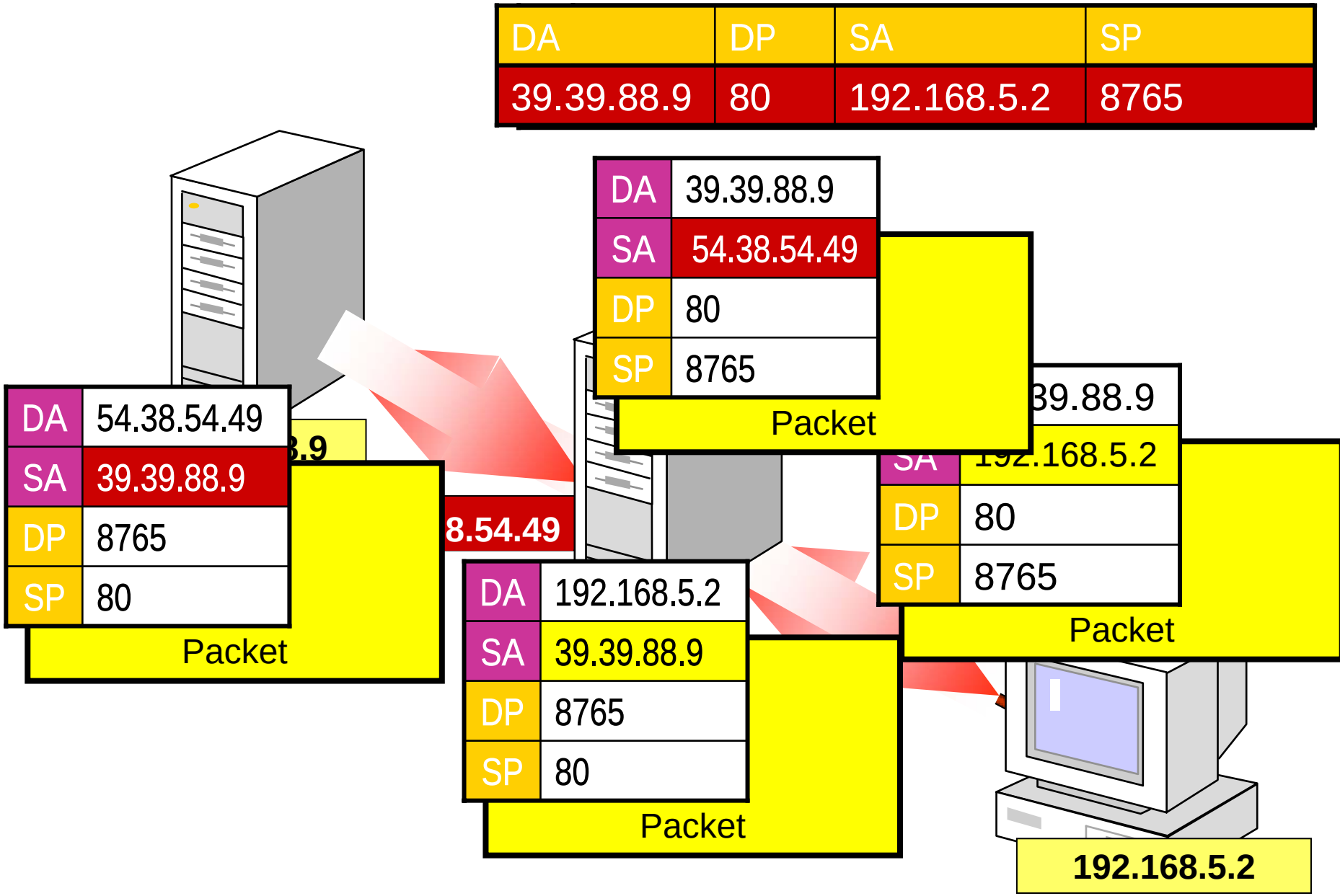
# Outline

- Introduction
- The Problem of VoIP + NAT
- Possible Solutions for VoIP + NAT

# What is NAT?

- NAT - Network Address Translation
  - RFC 3022 - Traditional IP Network Address Translator (Traditional NAT)
  - RFC 1918 - Address Allocation for Private Internets (BCP 5)
  - RFC 2993 - Architectural Implications of NAT
  - RFC 3027 - Protocol Complications with the IP Network Address Translator
  - RFC 3235 - Network Address Translator (NAT)-Friendly Application Design Guidelines
- Convert Network Address (and Port) between private and public realm
- Works on IP layer
- Transparent to Application


DA
54.38.54.4
SA
39.39.88.9
DP
8765
SP
80
Packet
Router
DA
39.39.88.9
SA
54.38.54.4
DP
80
SP
8765
54.38.54.4


DA
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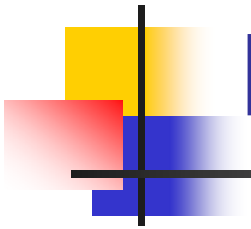
SP 8765
Packet
DA 192.168.5.2
SA 39.39.88.9
DP 8765
SP 80
Packet
DP 80
SP 8765
Packet
192.168.5.2

# Flavors of NAT [1/3]

## Static NAT

- Requiring same number of globally IP addresses as that of hosts in private environment
- Mapping between internal IP addresses and external addresses is set manually
  - This mapping intends to stay for a long period of time



# Flavors of NAT [2/3]

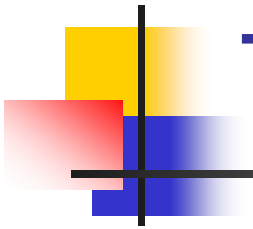
## Dynamic NAT

- Collect the public IP addresses into an IP address pool
- A host connecting to the outside network is allocated an external IP address from the address pool managed by NAT

# Flavors of NAT [3/3]

**NAPT (Network Address and Port Translation)**

- A special case of Dynamic NAT
  - Use port numbers as the basics for the address translation
- The mechanism most commonly used

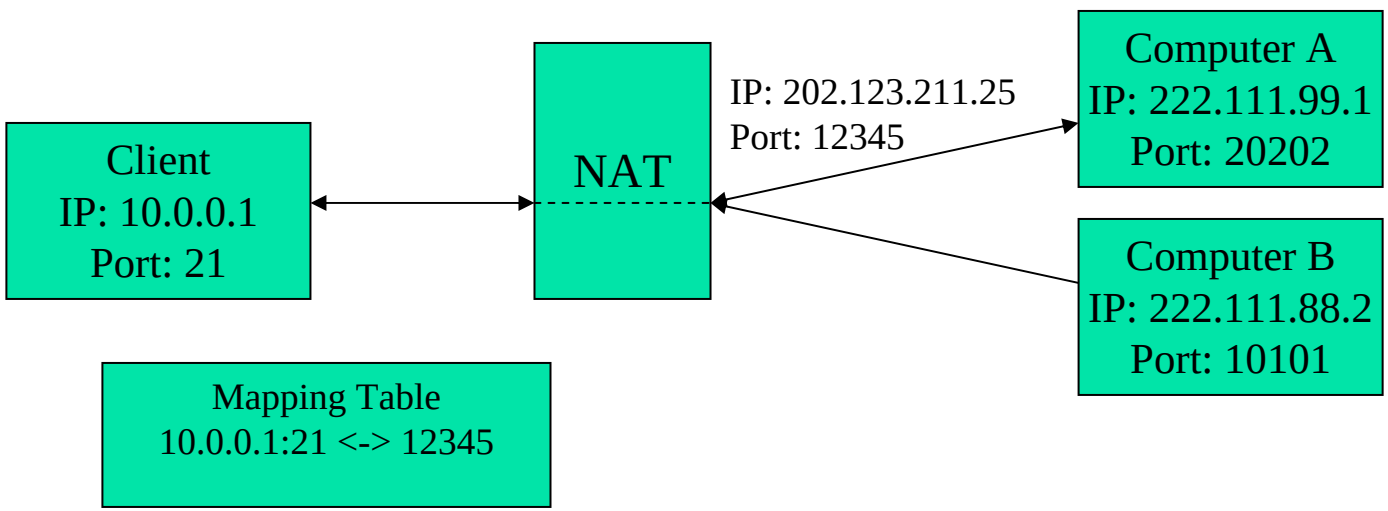


# Types of NAT

- Full Cone
- Restricted Cone
- Port Restricted Cone
- Symmetric

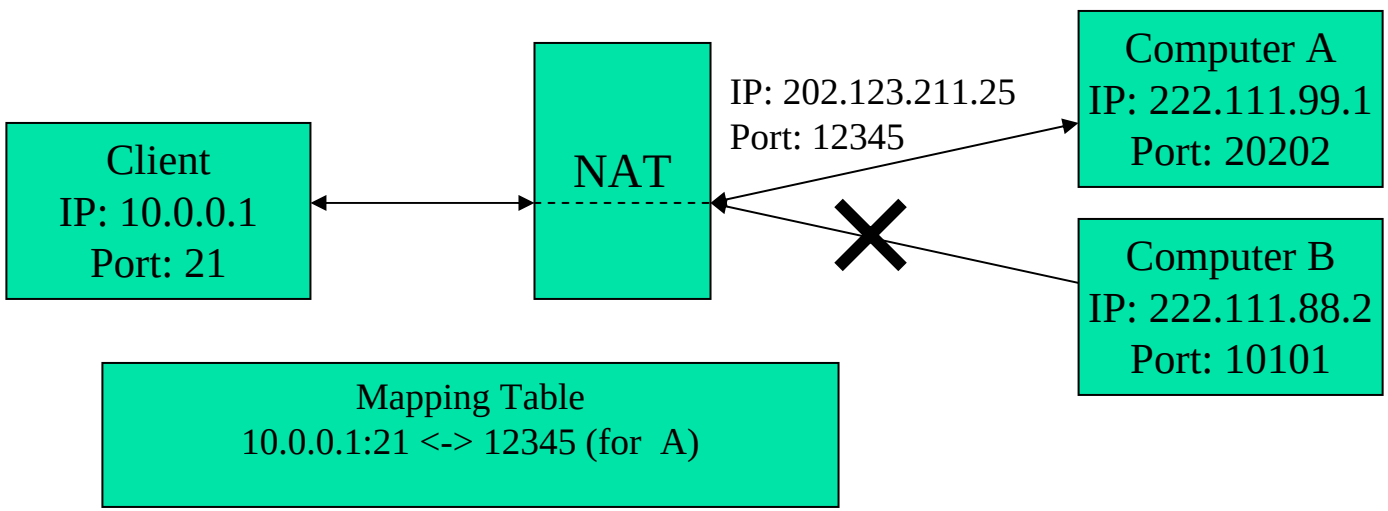
# Full Cone NAT

- Client sends a packet to public address A.
- NAT allocates a public port (12345) for private port (21) on the client.
- Any incoming packet (from A or B) to public port (12345) will dispatch to private port (21) on the client.



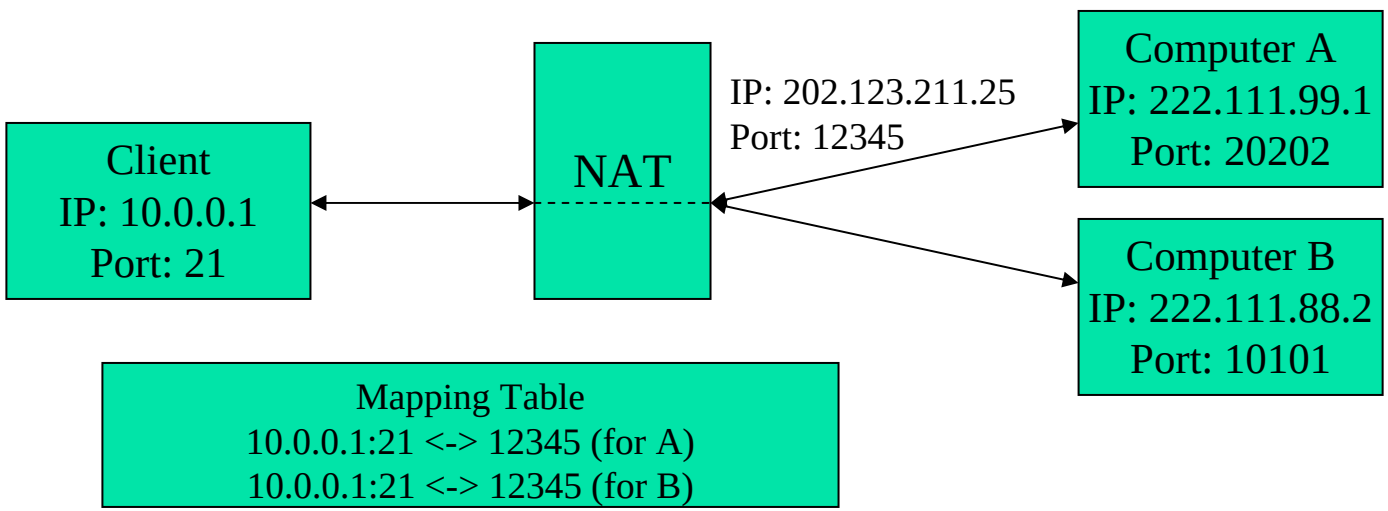
# Restricted Cone NAT [1/2]

- Client sends a packet to public address A.
- NAT allocate a public port (12345) for private port (21) on the client.
- Only incoming packet from A to public port (12345) will dispatch to private port (21) on the client.



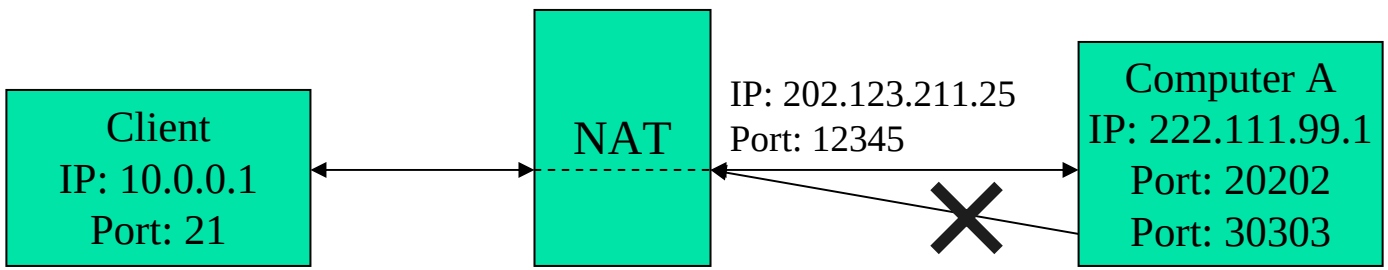
# Restricted Cone NAT [2/2]

- Client sends another packet to public address B.
- NAT will reuse allocated public port (12345) for private port (21) on the client.
- Incoming packet from B to public port (12345) will now dispatch to private port (21) on the client.



# Port Restricted Cone NAT

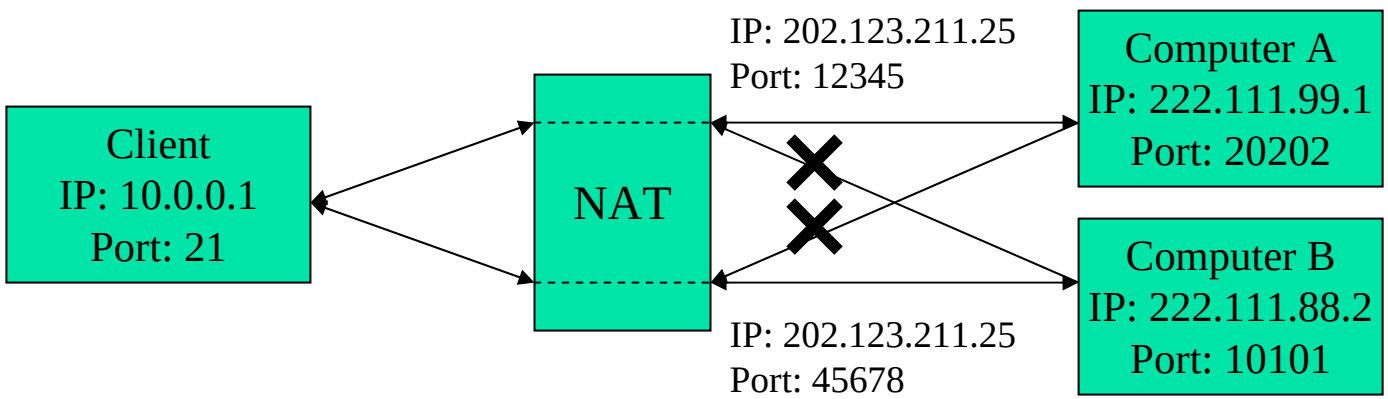
- Client sends a packet to public address A at port 20202.
- NAT will allocate a public port (12345) for private port (21) on the client.
- Only incoming packet from address A and port 20202 to public port (12345) will dispatch to private port (21) on the client.



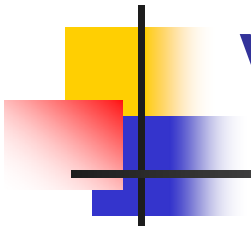

Mapping Table
10.0.0.1:21 <-> 12345 (for A : 20202)
*10.0.0.1:21 <-> 12345 (for A : 30303)*

# Symmetric NAT

- NAT allocates a public port each time the client sends a packet to different public address and port
- Only incoming packet from the original mapped public address and port will dispatch to private port on client

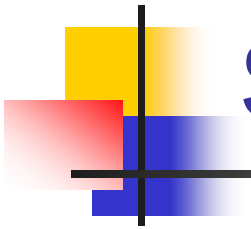



Mapping Table
10.0.0.1:21 <-> 12345 (for A : 20202)
10.0.0.1:21 <-> 45678 ( for B : 10101)



# VoIP Protocol and NAT

- NAT converts IP addresses on IP layer
- Problem 1:
  - SIP, H.323, Megaco and MGCP are application layer protocol but contain IP address/port info in messages, which is not translated by NAT
- Problem 2:
  - Private client must send a outgoing packet first (to create a mapping on NAT) to receive incoming packet



# Solving NAT Traversal Problems

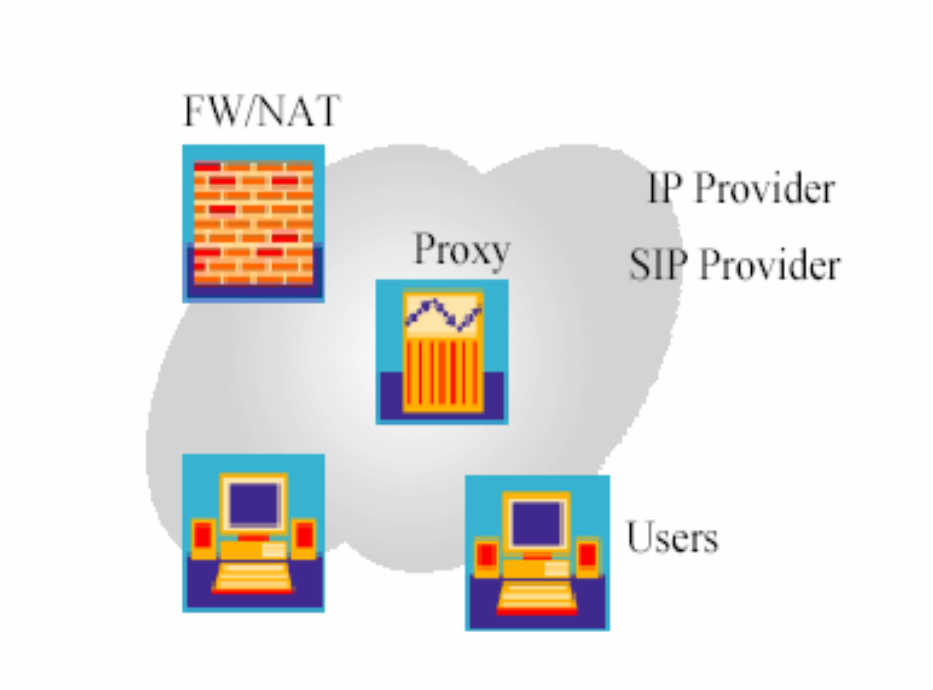
- Objectives
  - Discover mapped public IP & port for private IP & port
  - Use mapped public IP & port in application layer message
  - Keep this mapping valid
- Issues
  - NAT will automatically allocate a public port for a private address & port if needed.
  - NAT will release the mapping if the public port is “idle”
    - No TCP connection on the port
    - No UDP traffic on the port for a period (1 min~5 min)
  - Keep a TCP connection to destination
  - Send UDP packets to destination every specified interval

# NAT Solutions

- IPv6 (Internet Protocol Version 6)
- UPnP (Universal Plug-and-Play)
  - UPnP Forum - http://www.upnp.org/
- Proprietary protocol by NAT/Firewall
  - SIP ALG (Application Level Gateway)
  - No standard now
- SIP extensions for NAT traversal
  - RFC 3581
  - Works for SIP only, can not help RTP to pass through NAT
- STUN (Simple Traversal of UDP Through Network Address Translators)
  - RFC 3489
  - Works except symmetric NAT
- TURN (Traversal Using Relay NAT)
  - draft-rosenberg-midcom-turn-04
  - for symmetric NAT

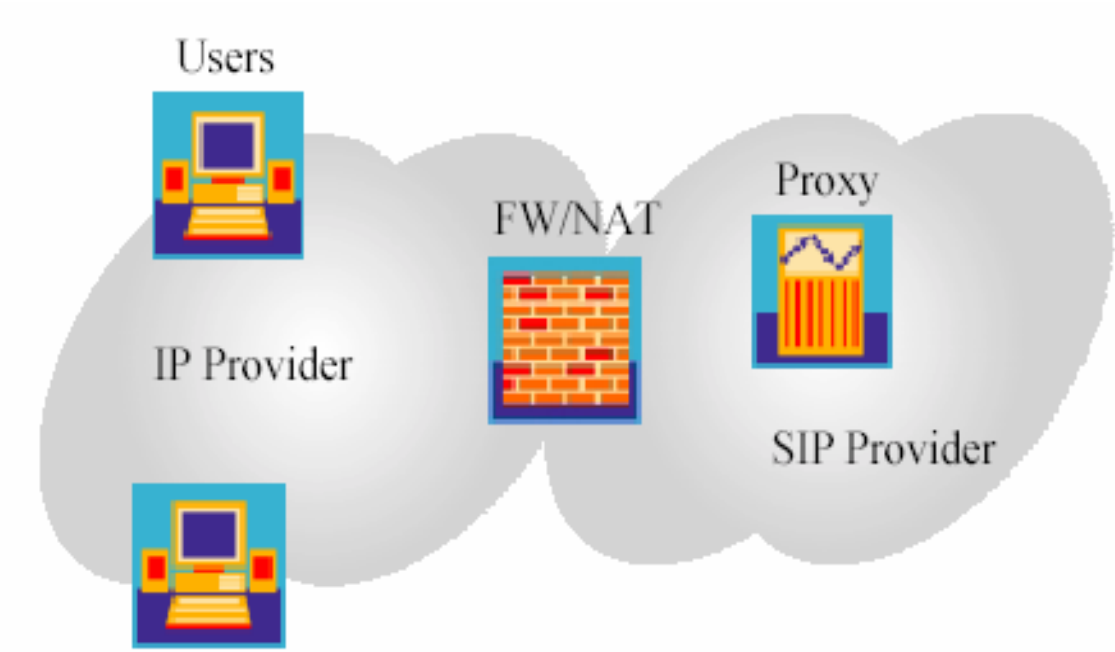
# Two Distinct Cases – NAT Deployment [1/2]

Case I : SIP Provider is the IP Network Provider



# Two Distinct Cases – NAT Deployment [2/2]

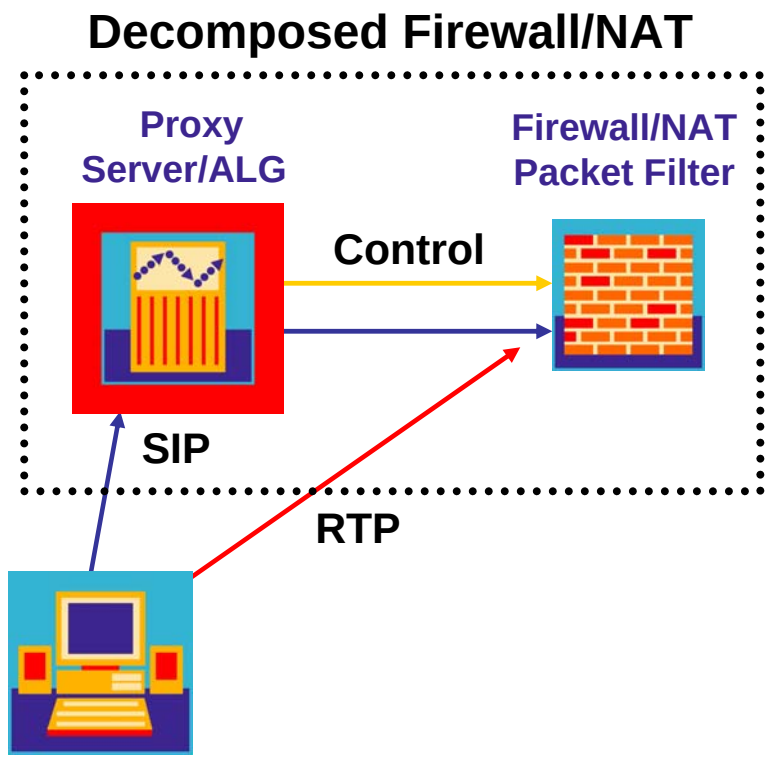
Case II : SIP Provider is **NOT** IP Network Provider



# Solution for Case I – ALG [1/2]

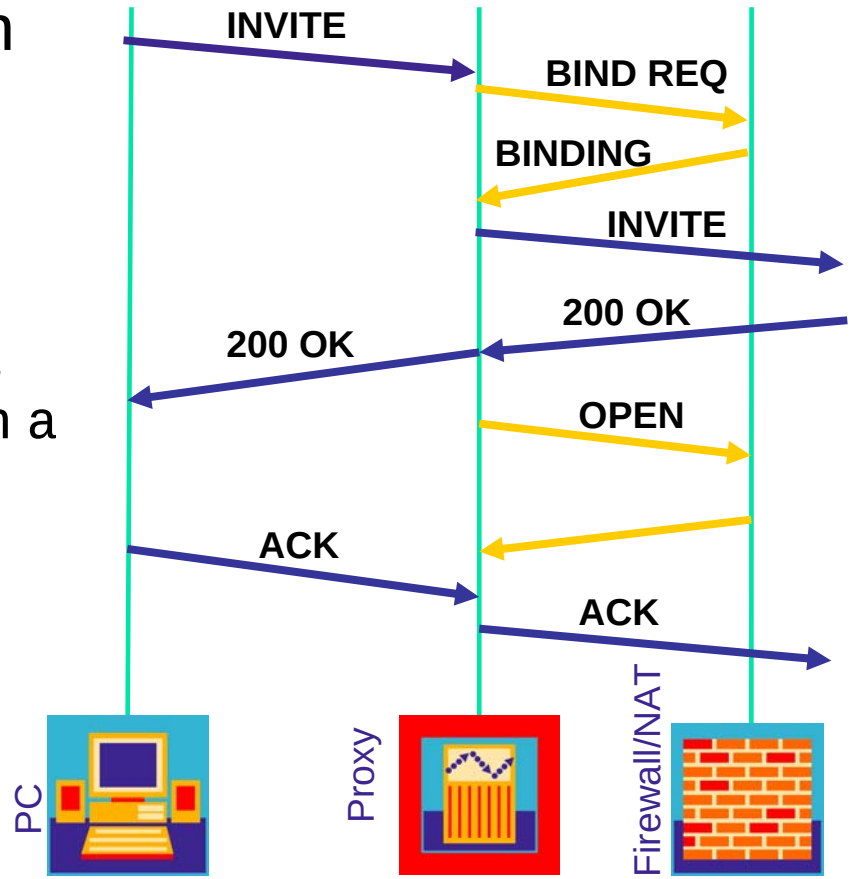
## Separate Application Layer NAT from IP Layer NAT

- Like MEGACO Decomposition
  - **MG = Packet Filter**
  - **MGC = Firewall Control Proxy**
- Advantage
  - **Better scaling**
  - **Load balancing**
  - **Low cost**
  - **Expertise problem solved**



# Solution for Case I – ALG [2/2]

- Control Protocol Between Application Layer NATs and IP Layer NATs
- Main Requirements
  - **Binding Request**: give a private address and obtain a public address
  - **Binding Release**
  - **Open Hole** (firewall)
  - **Close Hole** (firewall)



# Proposed Solution for Case II

**Much harder problem**

- No way to control firewall or NAT
- Cascading NATs
- Variable firewall NAT behaviors

**Proposed Solution**

- Make SIP "NAT-Friendly"
  - Minor extensions
  - Address the issues for SIP only, not RTP
  - Accepted by IETF (RFC 3581)
- Develop a protocol for traversal of UDP through NAT
  - Work for RTP
  - Also support other applications

# SIP Extension to NAT Friendly

## Client Behavior

- Include an “**rport**” parameter in the Via header
  - This parameter MUST have no value
  - It serves as a flag
- The client SHOULD retransmit its INVITE every 20 seconds
  - Due to UDP NAT binding period and to keep the binding fresh

# SIP Extension to NAT Friendly [2/2]

## Server Behavior

- Examine the Via header field value of the request.
  - If it contains an "**rport**" parameter,
    - A "**received**" parameter
    - An "**rport**" parameter
- The response MUST be sent to the IP address listed in the "received" parameter, and the port in the "rport" parameter.

# Example [1/2]

Client A: 10.1.1.1
Proxy B: 68.44.10.3
NAT C: 68.44.20.1

- A issues request
  INVITE sip:user@domain SIP/2.0
  Via: SIP/2.0/UDP 10.1.1.1:4540;**rport**;branch=z9hG4bKkjshdyff

- A→C (mapping port 9988)→B
  INVITE sip:user@domain SIP/2.0
  Via: SIP/2.0/UDP proxy.domain.com;branch=z9hG4bKkjsh77
  Via: SIP/2.0/UDP 10.1.1.1:4540;
  **received=68.44.20.1;rport=9988**;
  branch=z9hG4bKkjshdyff

# Example [2/2]

3) Server B receives the response
SIP/2.0 200 OK
Via: SIP/2.0/UDP proxy.domain.com;branch=z9hG4bKkjsh77
Via: SIP/2.0/UDP
10.1.1.1:4540;**received=68.44.20.1**;**rport=9988**;
branch=z9hG4bKkjshdyff

3) B (68.44.10.3:5060) → C (68.44.20.1:9988) → A
SIP/2.0 200 OK
Via: SIP/2.0/UDP
10.1.1.1:4540;**received=68.44.20.1**;**rport=9988**;
branch=z9hG4bKkjshdyff