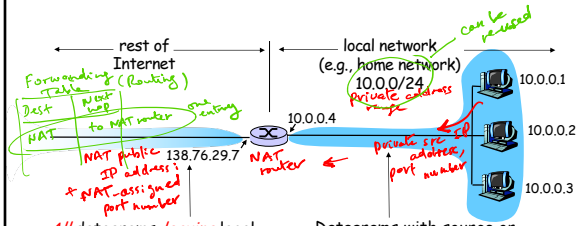
NAT: Network Address Translation



All datagrams *leaving* local network have same single source NAT IP address: 138.76.29.7, different source port numbers

Datagrams with source or destination in this network have 10.0.0/24 address for source, destination (as usual)

13

NAT: Network Address Translation

- Motivation: local network uses just one IP address as far as outside word is concerned:
  - no need to be allocated range of addresses from ISP: - just one IP address is used for all devices
  - can change addresses of devices in local network without notifying outside world
  - can change ISP without changing addresses of devices in local network
  - devices inside local net not explicitly addressable, visible by outside world (a security plus)

14

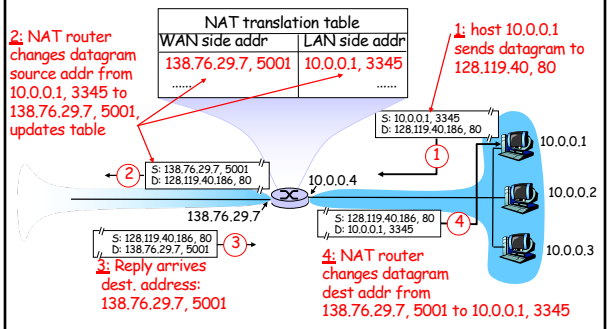
NAT: Network Address Translation

Implementation: NAT router must:

- *outgoing datagrams: replace* (source IP address, port #) of every outgoing datagram to (NAT IP address, new port #)
  - . . . remote clients/servers will respond using (NAT IP address, new port #) as destination addr.
- *remember (in NAT translation table)* every (source IP address, port #) to (NAT IP address, new port #) translation pair
- *incoming datagrams: replace* (NAT IP address, new port #) in dest fields of every incoming datagram with corresponding (source IP address, port #) stored in NAT table

15

NAT: Network Address Translation



16

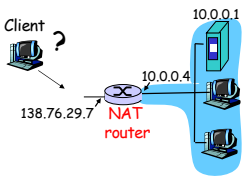
NAT: Network Address Translation

- 16-bit port-number field:
  - Up to 64K simultaneous connections with a single LAN-side address!
- NAT is controversial:
  - routers should only process up to layer 3
  - violates end-to-end argument
    - NAT possibility must be taken into account by app designers, eg, P2P applications
  - address shortage should instead be solved by IPv6 ?

17

NAT traversal problem

- client wants to connect to server with address 10.0.0.1
  - server address 10.0.0.1 local to LAN (client can't use it as destination addr)
  - only one externally visible NATted address: 138.76.29.7
- solution 1: statically configure NAT to forward incoming connection requests at given port to server
  - e.g., (138.76.29.7, port 2500) always forwarded to 10.0.0.1 port 25000

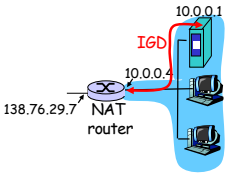


18

NAT traversal problem

- solution 2: Universal Plug and Play (UPnP) Internet Gateway Device (IGD) Protocol. Allows NATted host to:
  - learn public IP address (138.76.29.7)
  - add/remove port mappings (with lease times)

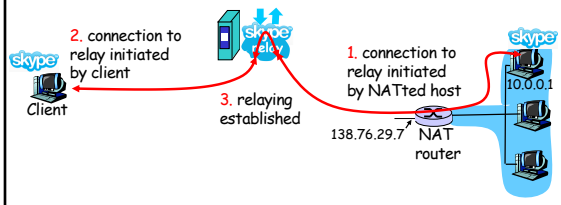
  i.e., automate static NAT port map configuration



19

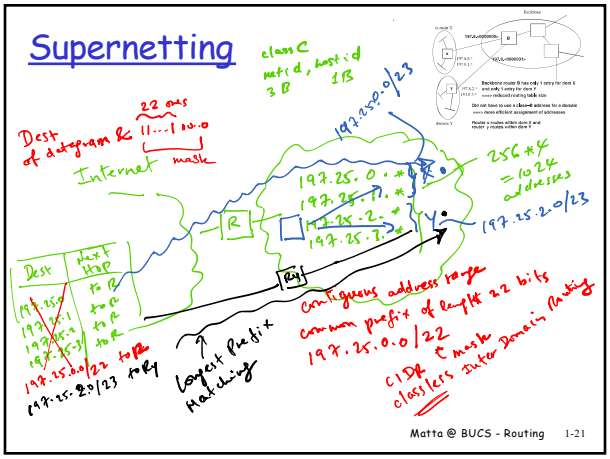
NAT traversal problem

- solution 3: relaying (used in Skype)
  - NATed client establishes connection to relay
  - External client connects to relay
  - relay bridges packets between two connections



20

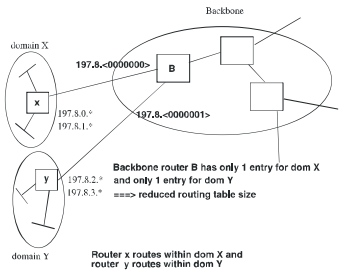
Supernetting



21

Supernetting

- Assign block of contiguous network numbers to near-by networks
- Called CIDR: Classless Inter-Domain Routing
- Represent blocks with a single pair <first_network_address, common prefix>
- Use a bit mask (CIDR mask) to identify block
- All routers must understand CIDR addressing
- Hierarchical addressing and routing
- Longest Prefix Matching when looking up routing table



22

IP addresses: how to get one?

Q: How does *network* get net id part of IP address?

A: gets allocated portion of its provider ISP's address space

ISP's block	11001000 00010111 00010000	00000000	200.23.16.0/20
Organization 0	11001000 00010111 00010000	00000000	200.23.16.0/23
Organization 1	11001000 00010111 00010010	00000000	200.23.18.0/23
Organization 2	11001000 00010111 00010100	00000000	200.23.20.0/23
...	….	….	….
Organization 7	11001000 00010111 00011110	00000000	200.23.30.0/23

23

IP addresses: how to get one?

Q: How does a *host* get IP address?

- hard-coded by system admin in a file
  - E.g. in Windows: control-panel -> network-> configuration -> tcp/ip -> properties
- DHCP: Dynamic Host Configuration Protocol: dynamically get address from a server
  - "plug-and-play"

24

DHCP: Dynamic Host Configuration Protocol

Goal: allow host to *dynamically* obtain its IP address from network server when it joins network

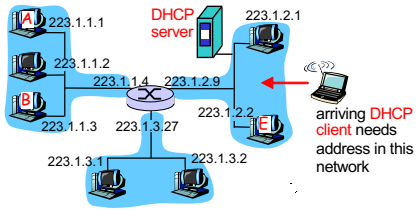
- Can renew its lease on address in use
- Allows reuse of addresses (only hold address while connected and "on")
- Support for mobile users who want to join network

DHCP overview: over UDP

- host broadcasts "DHCP discover" msg
- DHCP server responds with "DHCP offer" msg
- host requests IP address: "DHCP request" msg
- DHCP server sends address: "DHCP ack" msg

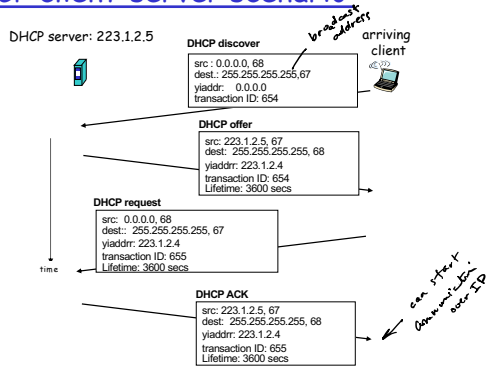
25

DHCP client-server scenario

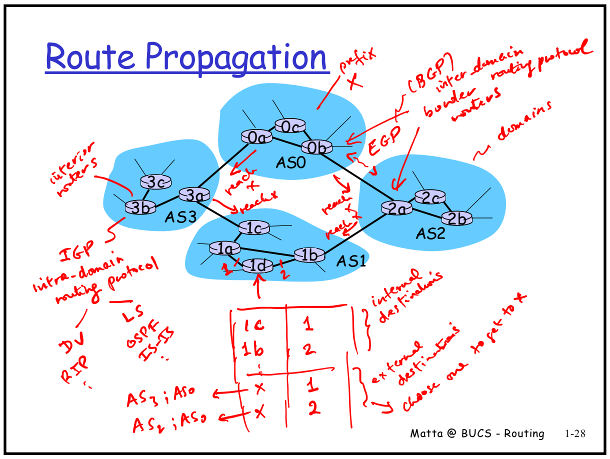


26

DHCP client-server scenario



27


Route Propagation
AS0
AS1
AS2
AS3
0a
0b
0c
1a
1b
1c
1d
2a
2b
2c
3a
3b
3c
prefix x
(BGP) inter-domain routing protocol
border routers
domains
EGP
interior routers
IGP intra-domain routing protocol
LS
OSPF
IS-IS
DV
RIP
internal destinations
external destinations
choose one to get to x
Matta @ BUCS - Routing 1-28

28