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Computer Networks II
Mobile IP

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Mobile hosts

- Wireless or wired mobile devices
- Connection the network:
  - Wireless LAN
  - Cellular networks
  - Satellite networks
  - LAN
  - ….
- A home network offers IP connectivity
- IP mobility considers mobility over different networks

Naive options

1. Modify host IP address:
   - Implies reboot of network services and loss of transport connections

2. Propagation of host-based routing information
   - Requires routing tables of size equal to number of hosts

Requirements

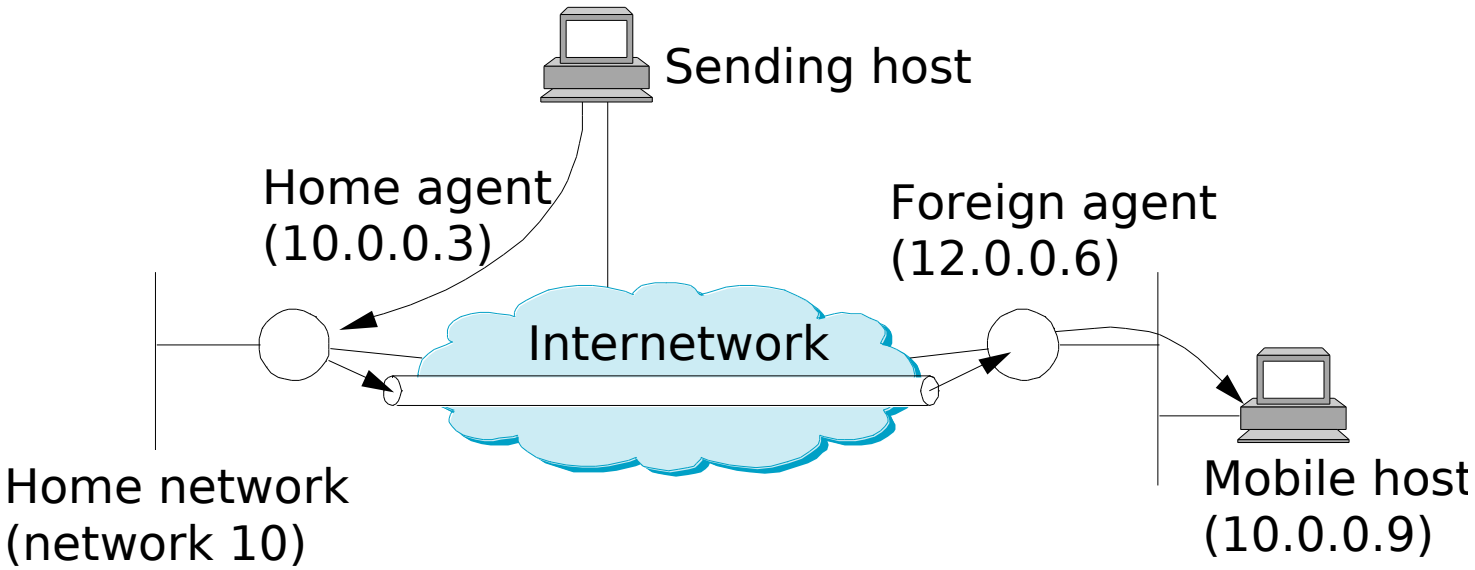
- “Connectivity anytime anywhere…”
- No modification of SW on *fixed* devices
- Mobile host movement transparent for remote application
  - E.g., TCP connections persist
  - *Consequence*: fixed IP address or equivalent solution

Mobile IP

- Transparent to applications and transport protocols
  - *Assumption*: mobile host has a permanent address
  - Host keeps address when moving
- Interoperability with IPv4 standard
- Scalability
- Security, authentication of mobile hosts when outside home network
- Macro mobility (possibility of working outside of home metwork)

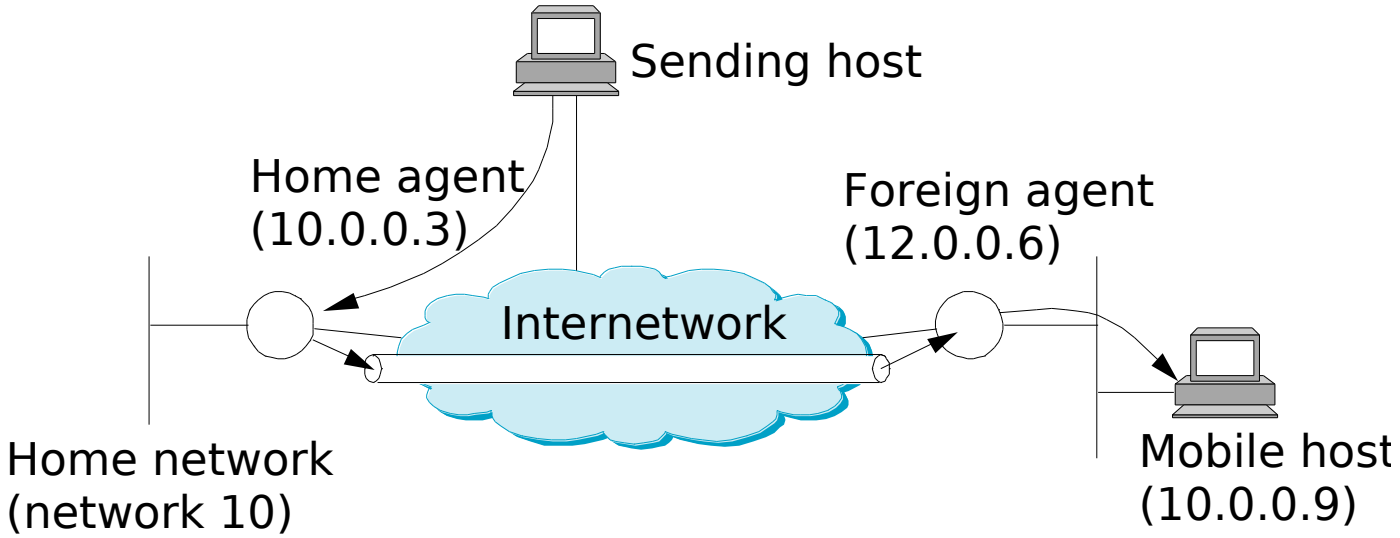
Overview of approach

- Mobile host has a *home address*
  - Home network
  - Home agent -> must implement new functionalities
- Other hosts send packets to *home address*
  - Mobile host appears as always having home address



Overview/cont.

- A *foreign agent* often present
  - Special router in network where mobile host has temporarily moved (**foreign network**)
- Home and foreign agent periodically send message to announce their presence to mobile hosts
  - These message can be sent upon request of mobile host



Rest of lecture

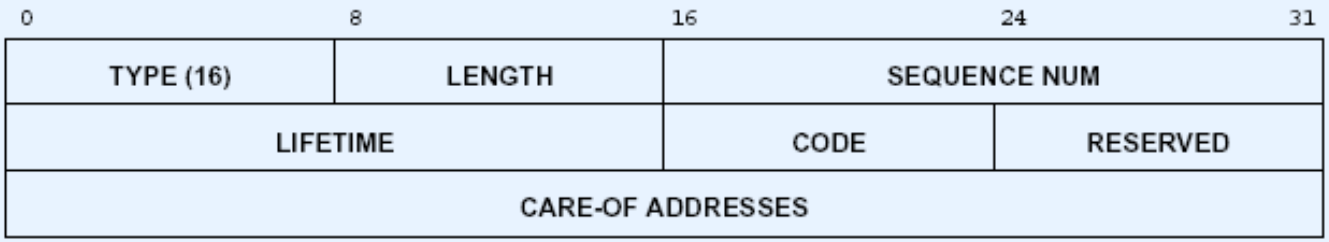
- Move detection
- Mobility agent advertisements
- Mobile host address
- Registration
  - Foreign agent
  - Home agent
- Packet transmission/receipt
  - Tunneling

Move detection

- Discovery of a new network or of home network (when returning)
- Techniques similar to those used in cellular telephony
- Dedicated nodes of the network (often foreign agents themselves) periodically announce their presence to transit mobile nodes
- Every mobile node receiving announcement from foreign agent starts a timer
- Assume loss of connectivity if timer expires before a new announcement
- If announcements received from another agent before time expiry --> try to register by this agent

Mobility agent advertisement

- Uses ICMP *router discovery*
  - Periodically sent by home/ foreign agent
  - Can be solicited with ICMP *router solicitation*
- Mobility extension of ICMP router discovery
- Recognized by different (larger) length of ICMP message



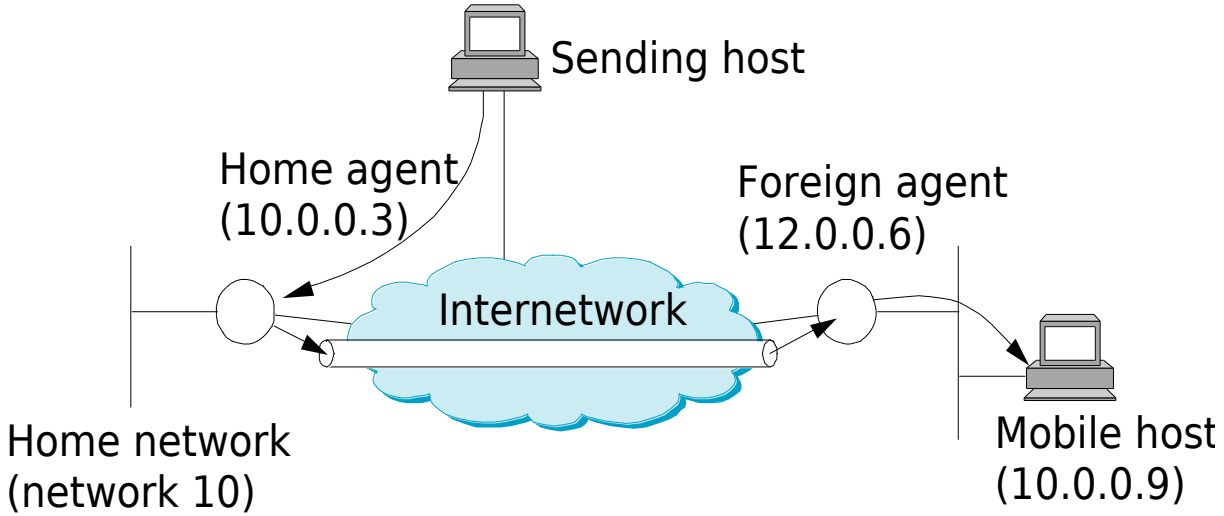
Mobility agent advertisement

- Lifetime: max. time to accept registration requests
- Sequence number: allows to match requests with replies
- Code:

Bit	Meaning
0	Registration with an agent is required; co-located care-of addressing is not permitted
1	The agent is busy and is not accepting registrations
2	Agent functions as a home agent
3	Agent functions as a foreign agent
4	Agent uses minimal encapsulation
5	Agent uses GRE-style encapsulation†
6	Agent supports header compression when communicating with mobile
7	Unused (must be zero)

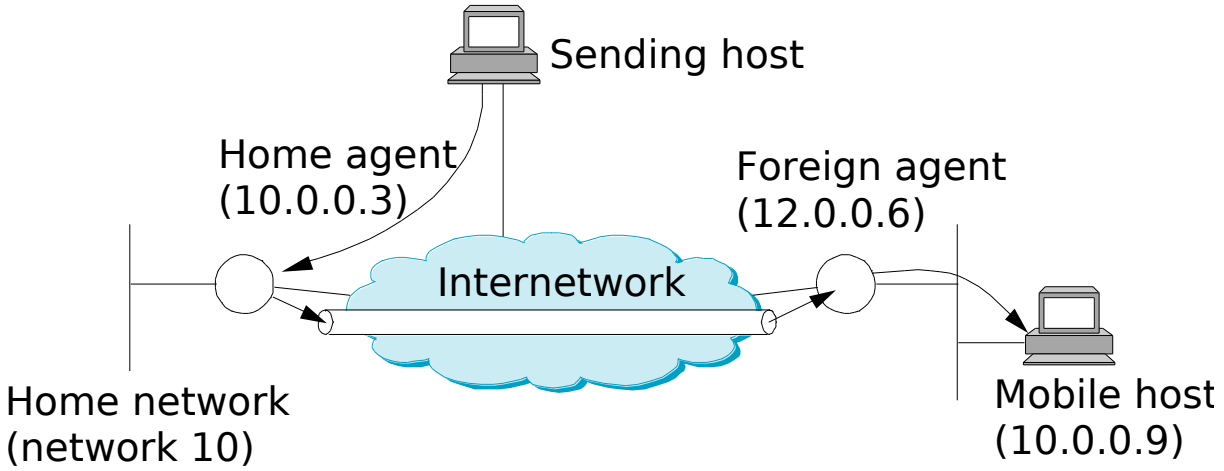
Address/Care-of-Address

- A *foreign agent* must be present in this case
- Mobile host registers by foreign agent
- Mobile host obtains a care-of-address
  - This address belongs to the foreign agent and can be shared with other mobile hosts



Address/Co-located Address

- Foreign network has no *foreign agent*
- Host uses DHCP to obtain temporary co-located address
  - Pool of addresses reserved to mobile hosts
- Host registers directly by home agent
  - Host manages mobility directly

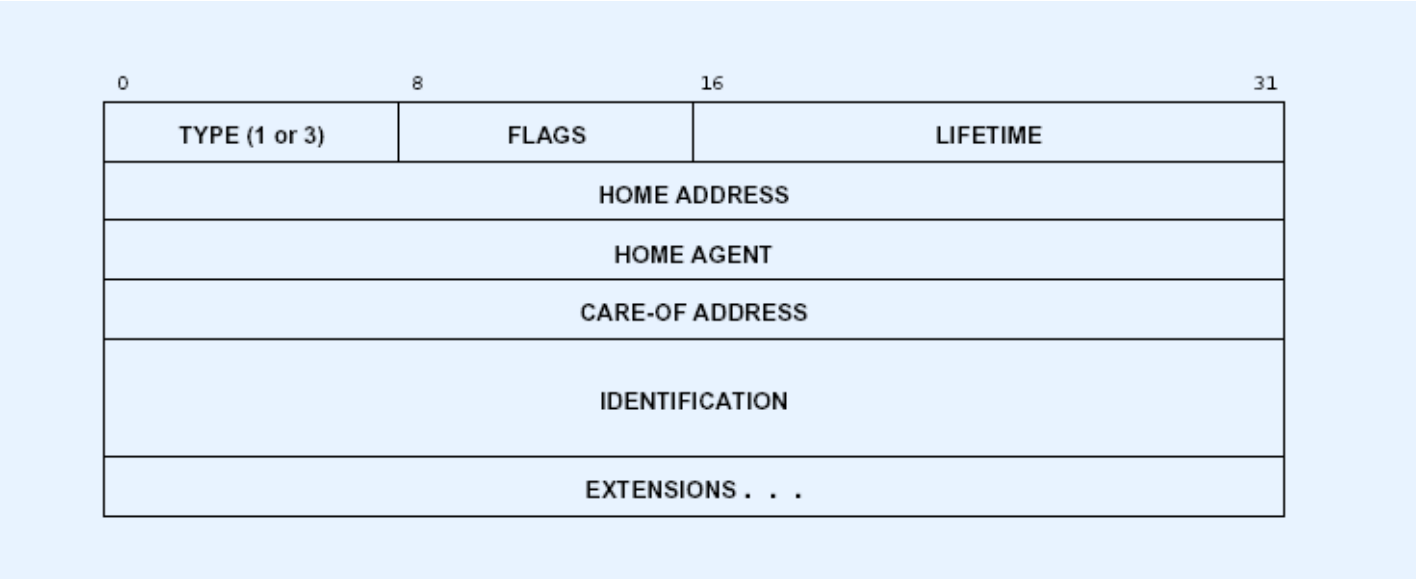


Registration

- Host uses a care-of-address:
  - Registration by foreign agent
  - Foreign agent forwards registration to home agent
  - Host knows address of own home agent
  - Communication between host and foreign agent at link level
- Host uses co-located address
  - Direct registration by home agent unless
    - Foreign agent present R bit is 1 (registration required) in mobility agent advertisement
    - This option used for security and accounting purposes
    - In this case foreign agent is not used to assign a care-of-address

Registration

- Communication over UDP (port 434)
- Type: request or reply
- LIFETIME: care-of address maintained in binding-cache until LIFETIME expires



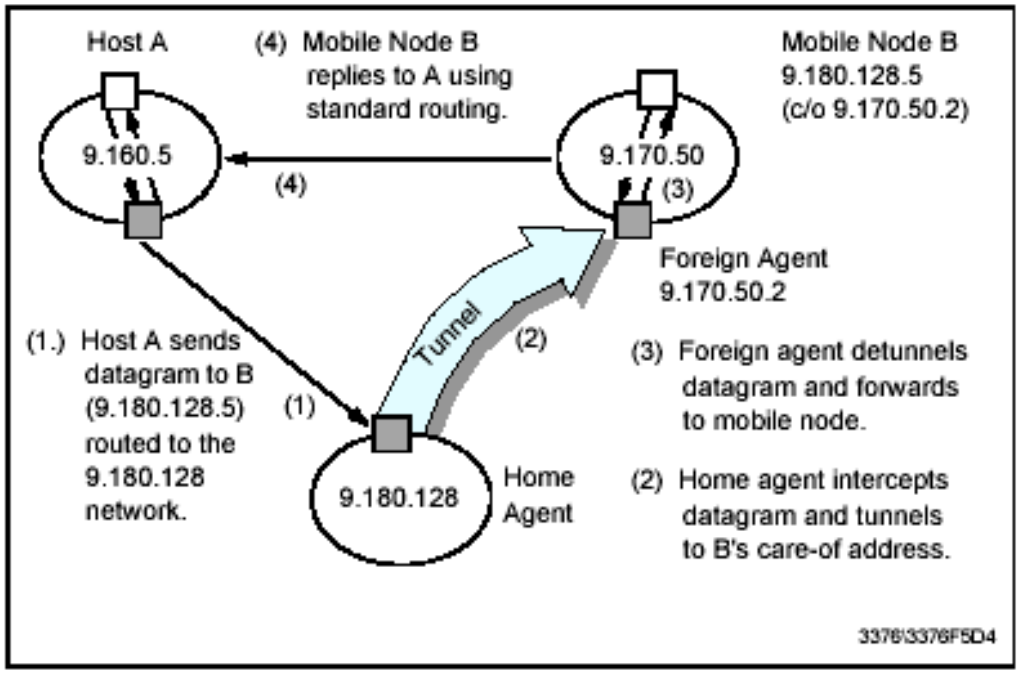
Registration

- HOME ADDRESS, HOME AGENT, CARE-OF-ADDRESS: Mobile host's home address, address of mobile host's home agent, address at foreign network used for tunneling
- IDENTIFICATION: used to match requests to replies
- FLAGS: options in communication with HOME AGENT

Bit	Meaning
0	This is a simultaneous (additional) address rather than a replacement.
1	Mobile requests home agent to tunnel a copy of each broadcast datagram
2	Mobile is using a co-located care-of address and will decapsulate datagrams itself
3	Mobile requests agent to use minimal encapsulation
4	Mobile requests agent to use GRE encapsulation
5	Mobile requests header compression
6-7	Reserved (must be zero)

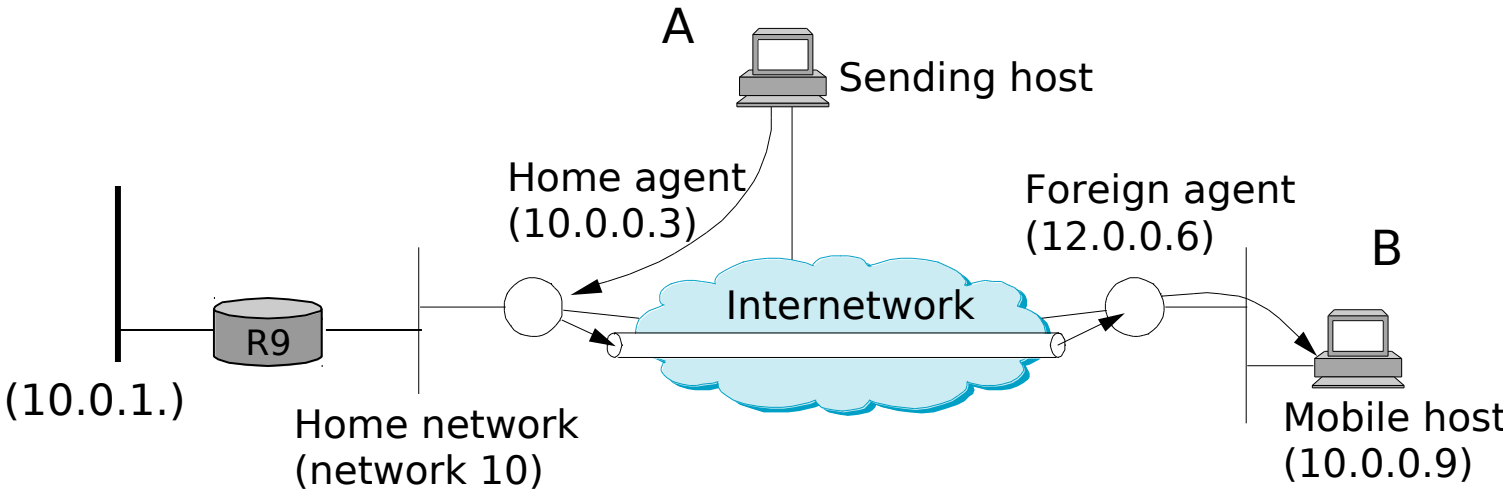
Packet receipt

- Host A sends packet to mobile host B in foreign network
  - A sends packet to B's home agent
  - Tunnel between home agent and foreign agent (or host, if co-located address)



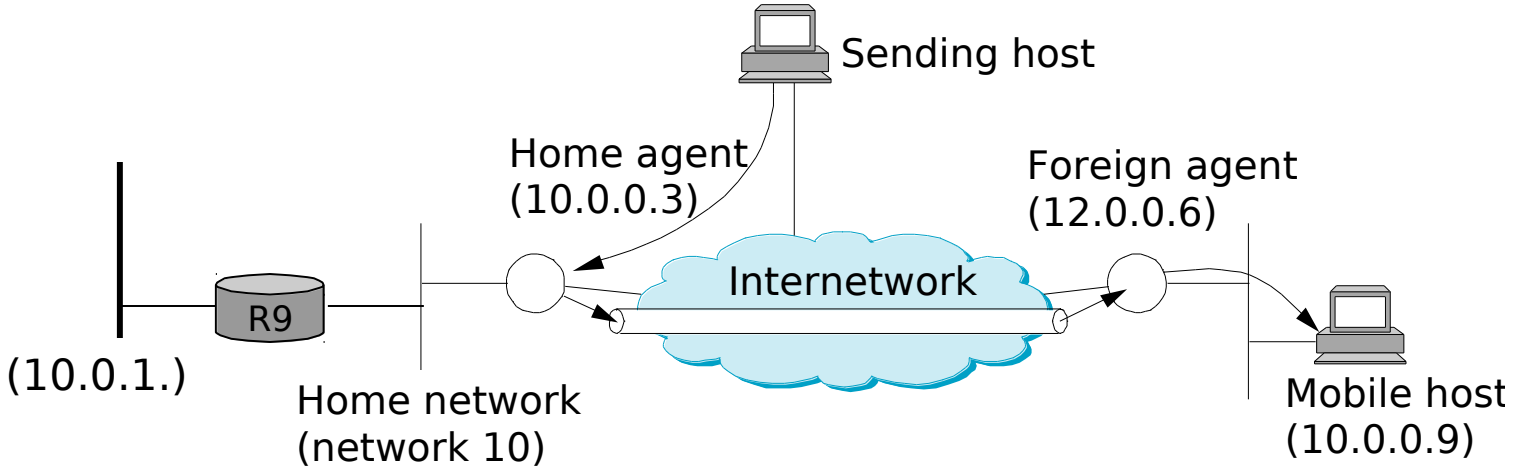
Packet receipt/cont.

- Problems:
  - Host A belongs to same home network as B
    - In this case, packet normally directly delivered at link layer and not read by routers (and therefore home agent)
  - B' home network contains other routers besides home agent
    - B belongs to subnet 10.0.1/ while home agent for network 10.0/ belongs to subnet 10.0.0/
    - R9 route packets directed at B



Packet receipt/cont.

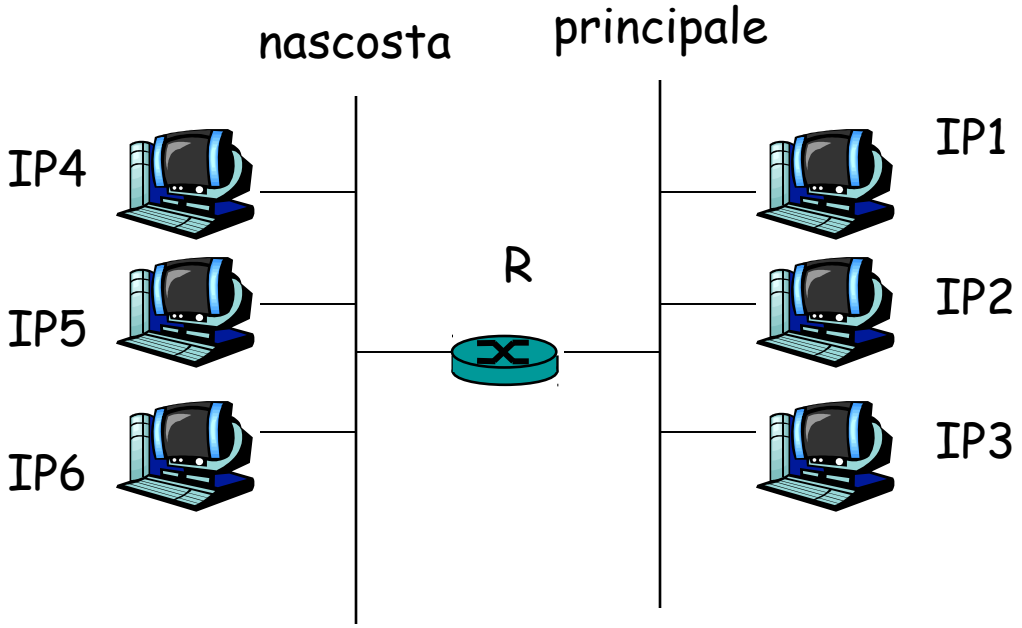
- Solution: ARP proxy
  - Home agent associates B's IP address to own physical interface towards internal network
  - Home agent sends ARP message (gratuitous ARP) with this association when B registers by foreign agent
    - In this way, ARP caches possibly containing associations for B's IP address are updated



ARP proxy (promiscuo, hack)

- Permette di definire più reti locali
  - Rete principale nota all'esterno
  - Reti locali aggiunte successivamente nascoste
- Router speciale che:
  - Funziona da switch tra le diverse reti locali
  - Funziona da router da/verso l'esterno
- I router ignorano la presenza di subnet fisicamente distinte

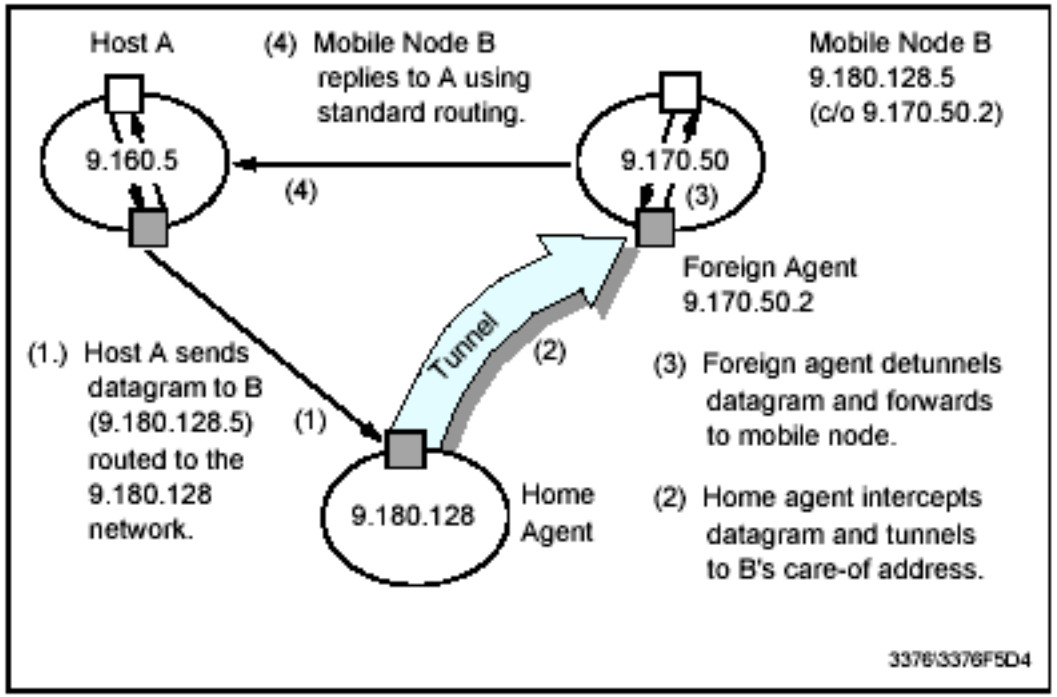
ARP proxy - cont.



- Dgram IP1⇒IP4
  - R cattura richiesta ARP bcast di H1 e restituisce proprio MAC address
  - Datagrammi da IP1 a IP4 sono spediti a R che li inoltra a IP4

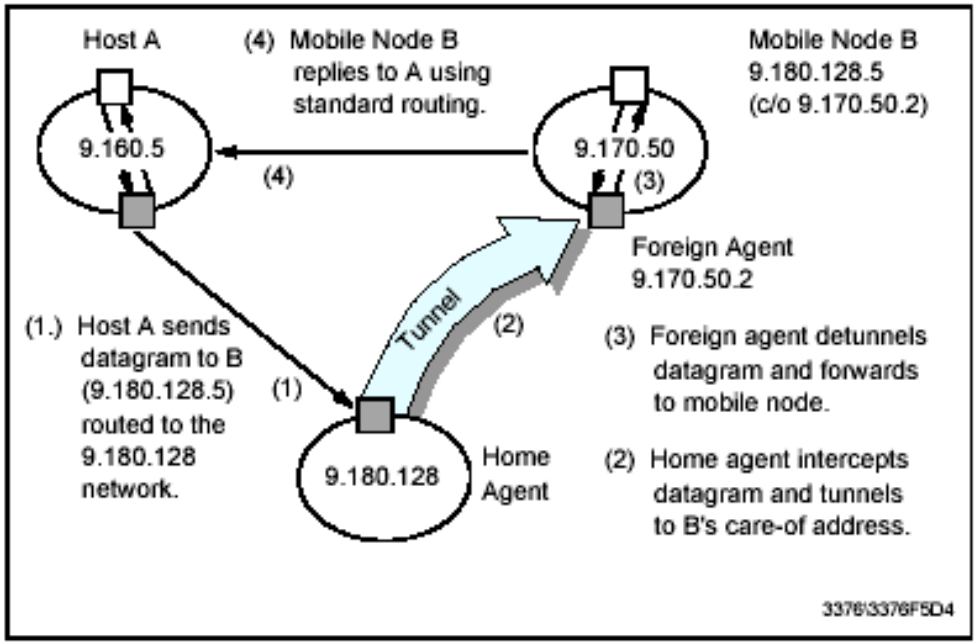
Sending packets

- Host B replies to A using standard routing



Routing

- Routing to mobile host traverses home agent
- Very inefficient if sending host close to mobile host *(triangle routing problem)*



security in mobile IP

- Session key with local router
  - Key distribution center
  - Diffie-Hellman for key exchange
- Authentication required between home agent and mobile host
  - Default algorithm is MD5
  - 128 bit keys
  - Foreign agent must support this authentication method
- Other algorithms can be applied

Other security issues

- Traffic tunneling from home agent to mobile host at corresponding care-of-address
- ARP not autheticated
- Communication between foreign and home agent must be secure

Other issues

- Firewalls: problems since they filter packets according to specific rules
  - Registration messages use UDP
- Transparency: different opinions about survival of TCP connections during mobility of hosts

References

- Ref. 1, cap. 4
- Ref. 4, cap. 19
- CISCO white paper:
  - http://www.cisco.com/en/US/tech/tk827/tk369/technologies_white_paper09186a00800c9906.shtml