

Enabling Seamless Internet Mobility

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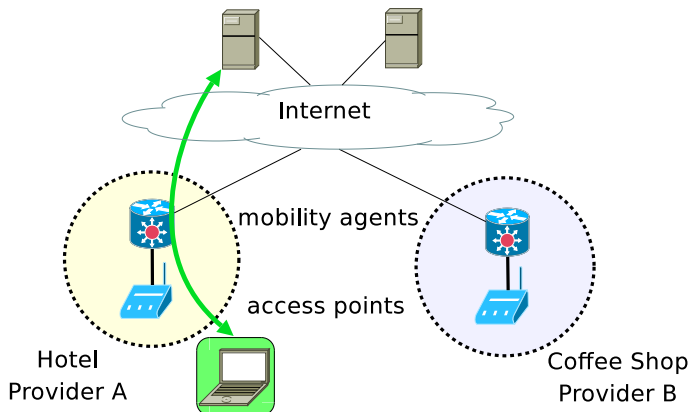
Mobility

- Cellular-based networks
 - ▶ Mature hand-over techniques
- IP-based networks
 - ▶ Mobility not an issue when Internet was designed
 - ▶ Problem: Mangling of identifier and locator within IP address

Our goal: Seamless Internet mobility for any user

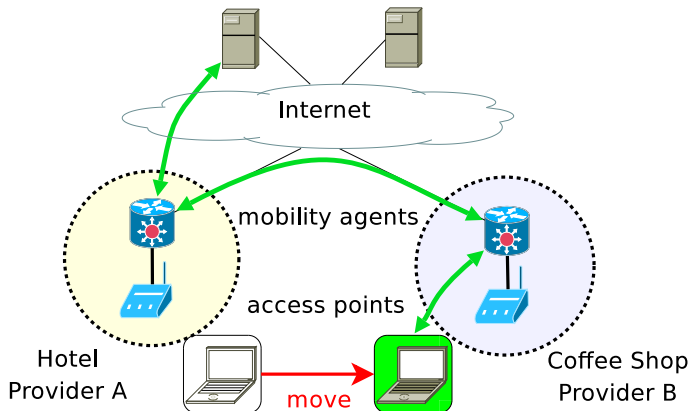
- Maintain workspace (existing network connections)
- No manual configuration by user
- Minimal network overhead

Seamless Mobility - Example



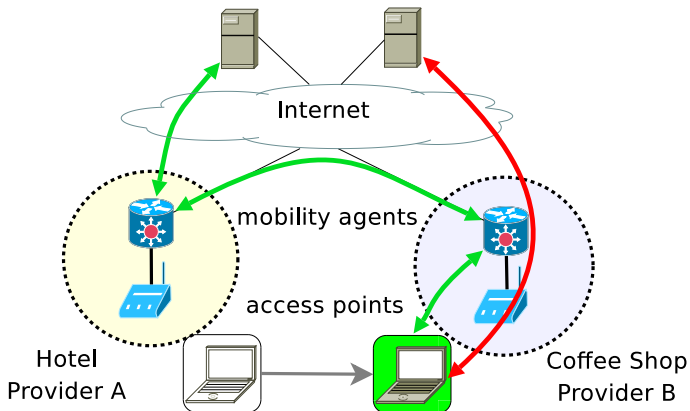
- User in hotel initiates a session

Seamless Mobility - Example



- User moves to coffee shop, session relayed via previous network

Seamless Mobility - Example



- New session routed directly

Seamless Internet Mobility System (SIMS)

- **Non-goal:** Ubiquitous reachability of mobile nodes
- **Design goals**
 - ▶ Maintain workspace (existing connections)
 - ▶ Robust, scalable and easy to deploy (IPv4 + IPv6)
 - ▶ Allow for roaming between different providers
- **Key ideas**
 - ▶ Existing sessions are relayed
 - ▶ New sessions use current IP address
 - ▶ Majority of sessions short-lived (heavy-tailed)
 - ⇒ Few sessions to be preserved

Outline

- 1 Related Work
- 2 Seamless Internet Mobility System (SIMS)
- 3 Discussion
- 4 Conclusion

Outline

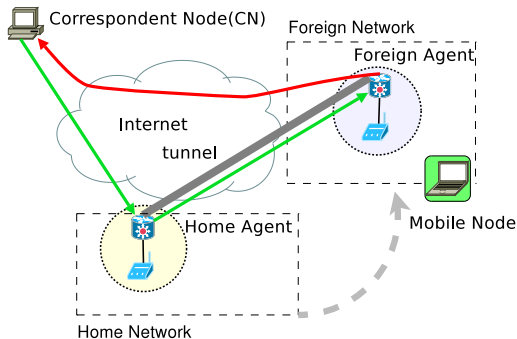
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Mobile IPv4 and IPv6



- Triangular routing for *all* sessions
 - ▶ *Problems*: Ingress filtering, overhead
- Mobile IPv6: Route optimization, binding updates
 - ▶ *Problems*: Binding requires time, support at CN needed

Other Mobility Solutions

- **Network layer**

- ▶ Augment Mobile IP: e.g., Hierarchical Mobile IPv6
- ▶ Change layer: e.g., Routing on flat labels (ROFL)

- **Shim layer** between network and transport layer

- ▶ Example: Host Identity Protocol (HIP)

- **Application layer**

- ▶ Example: Session Initiation Protocol (SIP)

Problems of existing approaches:

- Fundamental changes required (e.g., ROFL)
- Limited integration into today's Internet (e.g., Mobile IP)

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Design Requirements

- 1 **Mobility without permanent IP address**
 - ▶ Works without home agents
- 2 **No overhead for new sessions**
 - ▶ “Triangular” routing only for old sessions
- 3 **Preservation of sessions**
 - ▶ Hand-overs transparent to applications (keep IP address)
- 4 **Robust, scalable, easy to deploy**
 - ▶ No changes to Internet architecture
- 5 **Roaming**
 - ▶ Change between networks of different authorities

Architectural Components

- **Mobile node (MN)**

- ▶ Moves between networks: E.g., laptop, cell phones
- ▶ Maintains list of visited network with ongoing sessions
- ▶ Triggers hand-overs

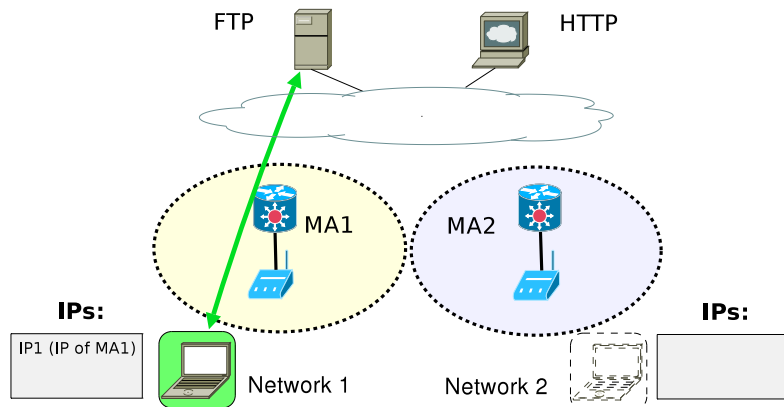
- **Correspondent Node (CN)**

- ▶ Peer communicating with MN (Web, SSH, VPN server etc.)

- **Mobility Agent (MA)**

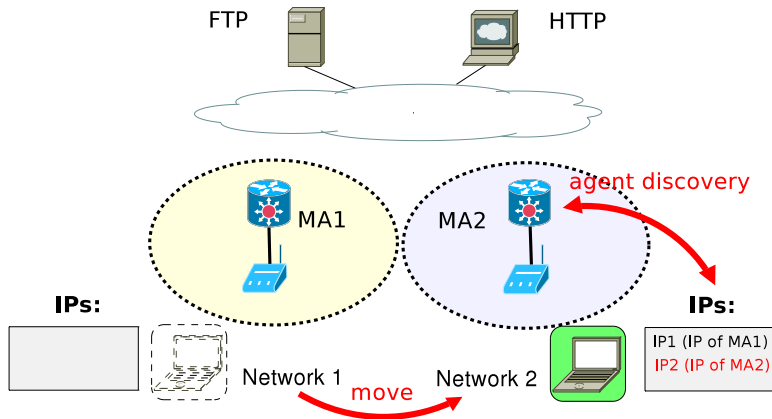
- ▶ Announces mobility service inside a network
- ▶ Acts as default gateway for packets sent by MNs
- ▶ Maintains tunnels to relay “ongoing” sessions

Moving between networks



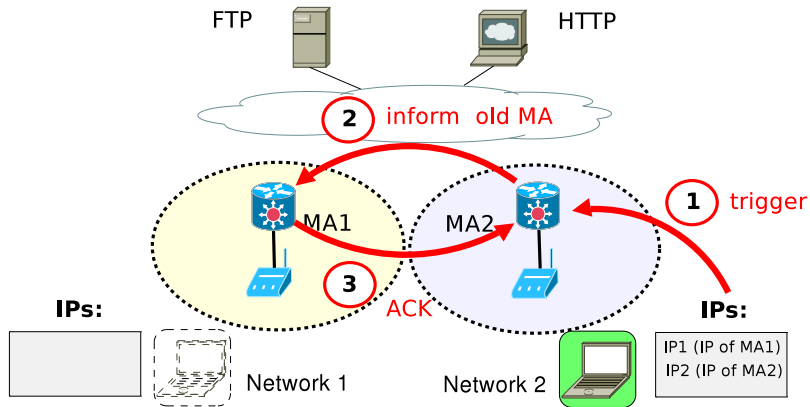
- MN starts FTP session from network 1
- Session directly routed to FTP server

Moving between networks



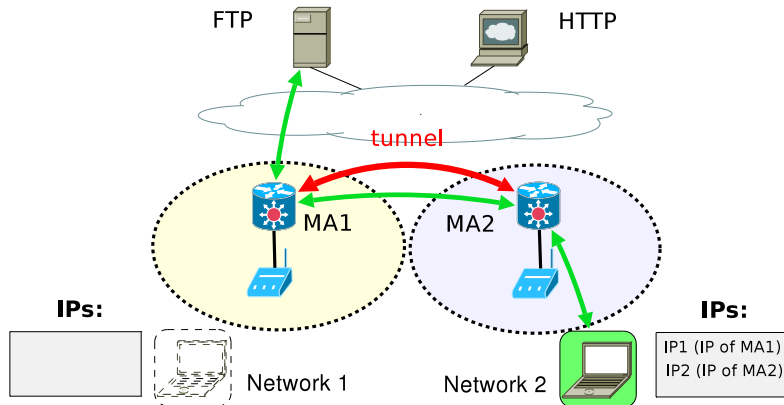
- MN moves to network 2, ongoing session to FTP!!
- Agent discovery: MN needs to find a MA
- MN obtains additional IP address of new network

Moving between networks



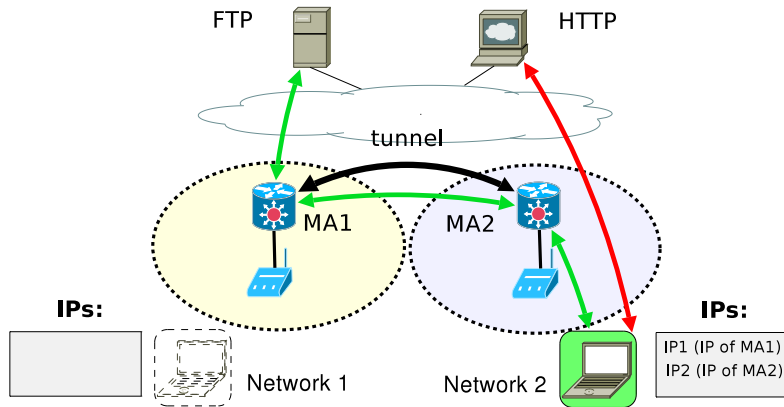
- 1 MN triggers setup of tunnel
- 2 MA 2 configures its tunnel side and requests tunnel setup from MA 1
- 3 MA 1 sends ACK

Moving between networks



- Tunnel between MA 1 and MA 2 is established
- Packets to FTP use IP 1 and are relayed over tunnel (in both directions)

Moving between networks



- MN sends HTTP request to web server
- Packets are routed directly and use IP2

Some Implementation Details

- **Agent discovery**
 - ▶ Prerequisite: Layer-2 connectivity
 - ▶ Regular broadcasts by MA or explicit search by MN
- **State**
 - ▶ Most state kept by MNs
 - ▶ IP addresses of previous MAs
- **Forwarding at MA:** Based on *source IP* of incoming packets
 - ▶ IP from other MA: Decapsulate, send to MN
 - ▶ IP from MN inside network: Forward as normal
 - ▶ IP from outside network: Encapsulate and send over tunnel

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Discussion (1)

	MIP	SIMS
No permanent IP needed	-	✓
New sessions: no overhead	-	✓
Short layer-3 hand-over	?	✓
Easy to deploy	-	✓
Support for "roaming"	-	✓

- Design requirements satisfied
- Promising experiences with prototype implementation

Discussion (2)

- **Security**

- ▶ Protect wireless access networks: WPA
- ▶ Protect signaling between MAs: Secure tunnels
- ▶ Prevent hijacking of sessions: MA provides credentials to MN

- **Accounting**

- ▶ Requires identification of users (e.g., X.509 certificates)
- ▶ Intra-provider traffic: Measure traffic at MA
- ▶ Inter-provider traffic: Measure traffic at tunnel endpoints

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Conclusion

- **Key ideas:**

- ▶ Most connections are short-lived
- ▶ New sessions: Use current IP address, route directly
- ▶ Ongoing sessions: Relay via previous network, keep IP address

- **Seamless Internet Mobility System (SIMS)**

- ▶ Maintain workspace (existing network connections)
- ▶ No manual configuration by user
- ▶ Minimal network overhead

- **Future work:**

- ▶ Extend with security and accounting mechanisms
- ▶ Test in real environment