Early Binding Updates for Mobile IPv6

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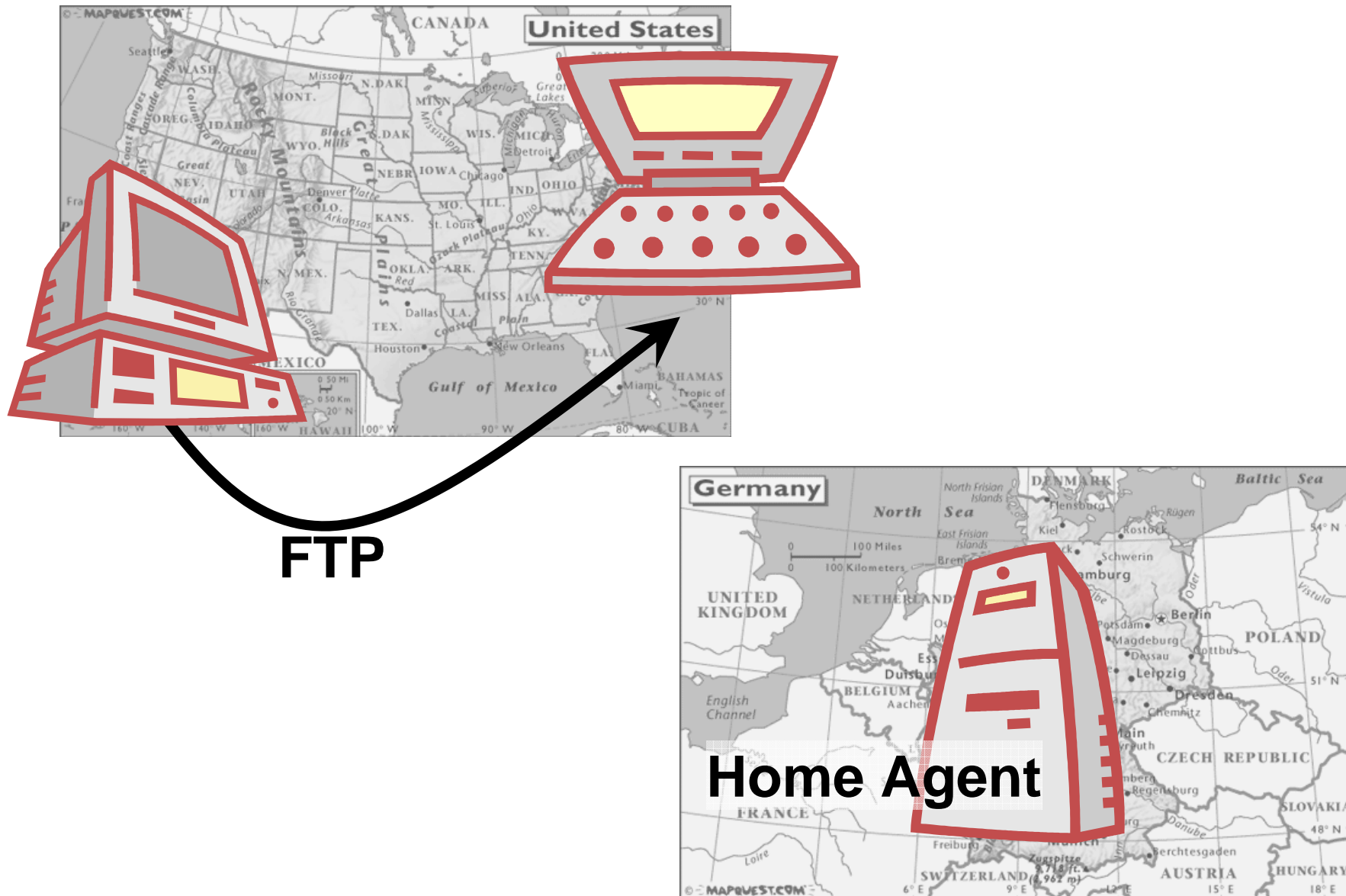
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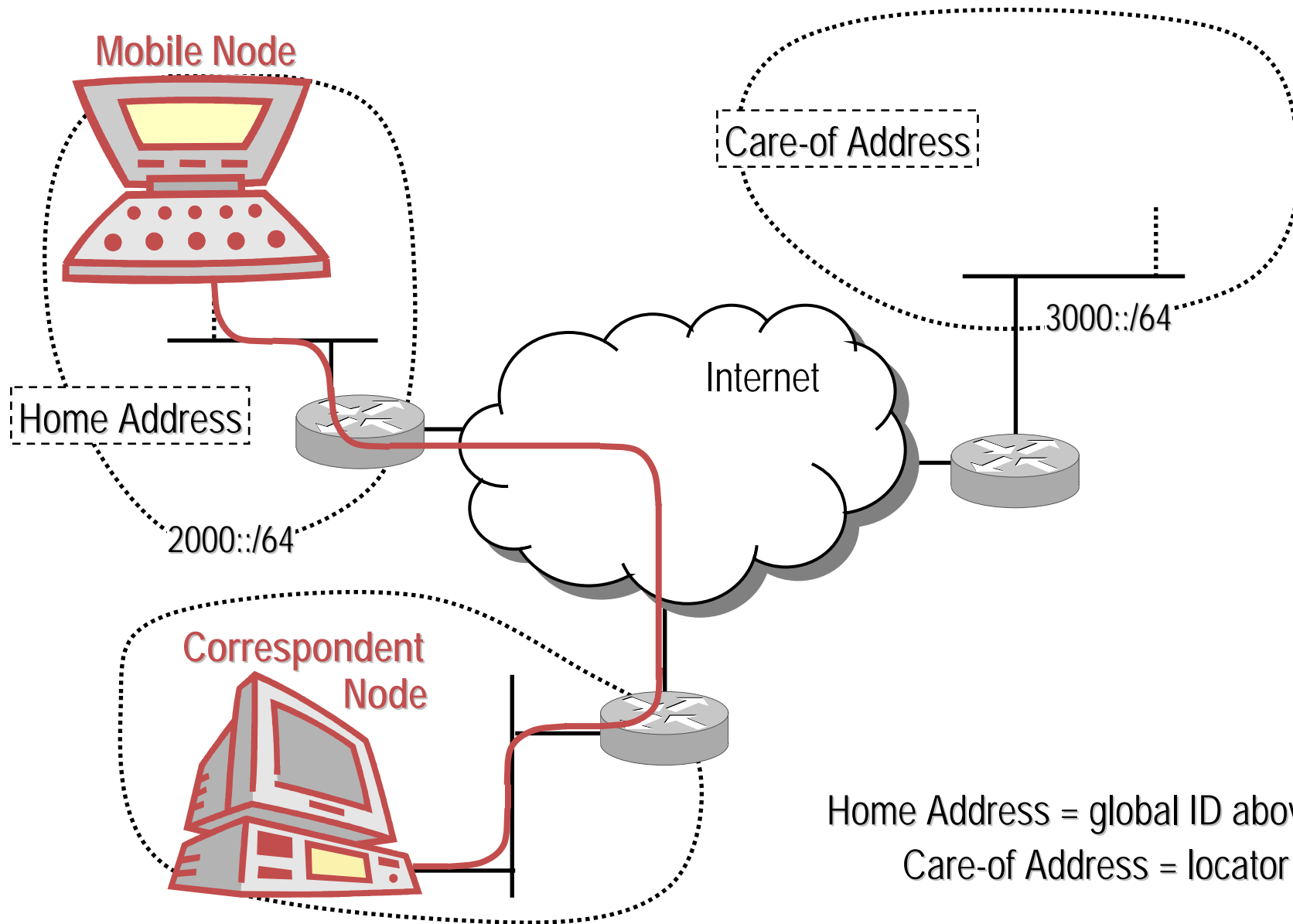
IEEE Wireless and Communications and Networking Conference

New Orleans, March 15, 2005

Mobile IPv6 Scenario
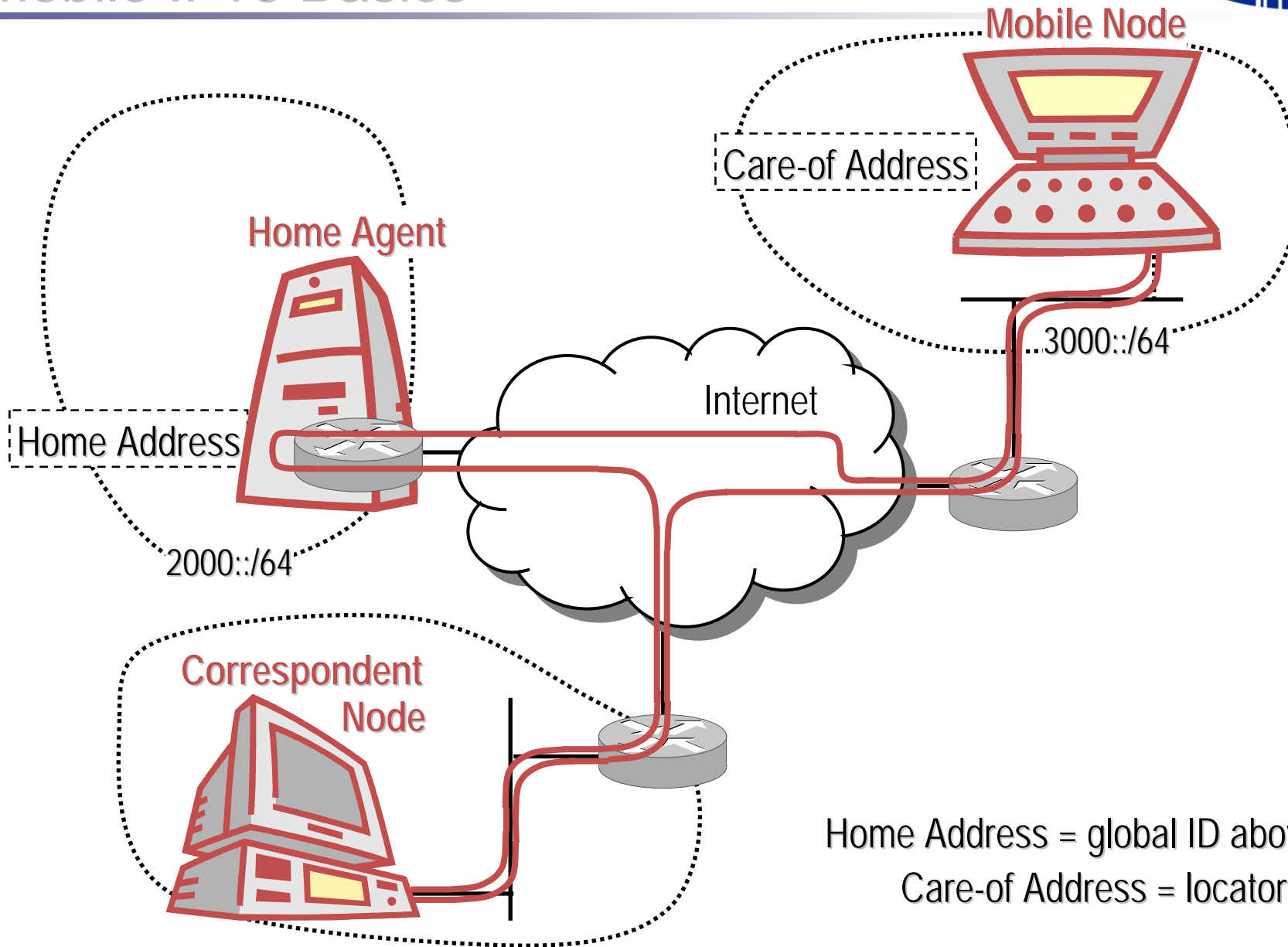

FTP

Home Agent

Outline

- Mobile IPv6 basics

- Security and efficiency

- Proposed optimization

  - Early Binding Updates

  - Credit-Based Authorization

- Analysis

- Conclusion

Mobile IPv6 Basics

Mobile Node

Care-of Address

3000::/64

Internet

Home Address

2000::/64

Correspondent Node

Home Address = global ID above IP

Care-of Address = locator

Mobile IPv6 Basics

Mobile Node

Care-of Address

Home Agent

3000::/64

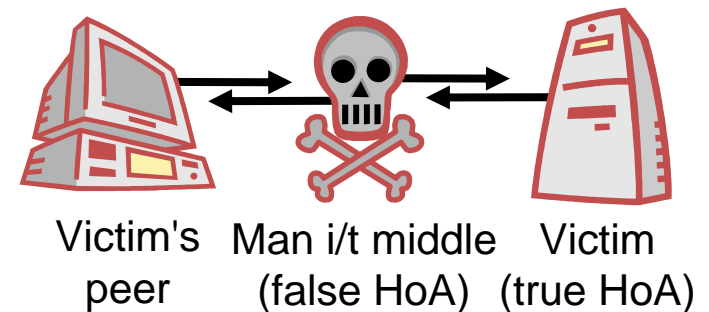Internet

Home Address

2000::/64

Correspondent Node

Home Address = global ID above IP
Care-of Address = locator

Be Aware!

Issue 1: Impersonation

- Attacker **binds a false HoA** to some CoA

- Unauthorized use of a HoA $\Rightarrow$ connection
hi-jacking, eavesdropping, man-in-the-middle attacks, DoS

Victim's peer — Man i/t middle (false HoA) — Victim (true HoA)

Issue 2: Packet Misdirection

- Attacker **redirects packets to a false CoA**

- Unauthorized use of a CoA $\Rightarrow$ flooding

Amplification

Attacker (true CoA) — Attacker's peer — Victim (false CoA)
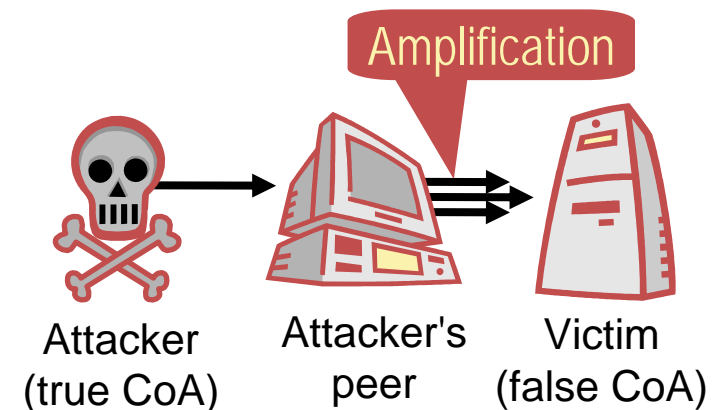
Solution: **HoA/CoA-ownership proofs** (HoA/CoA tests)
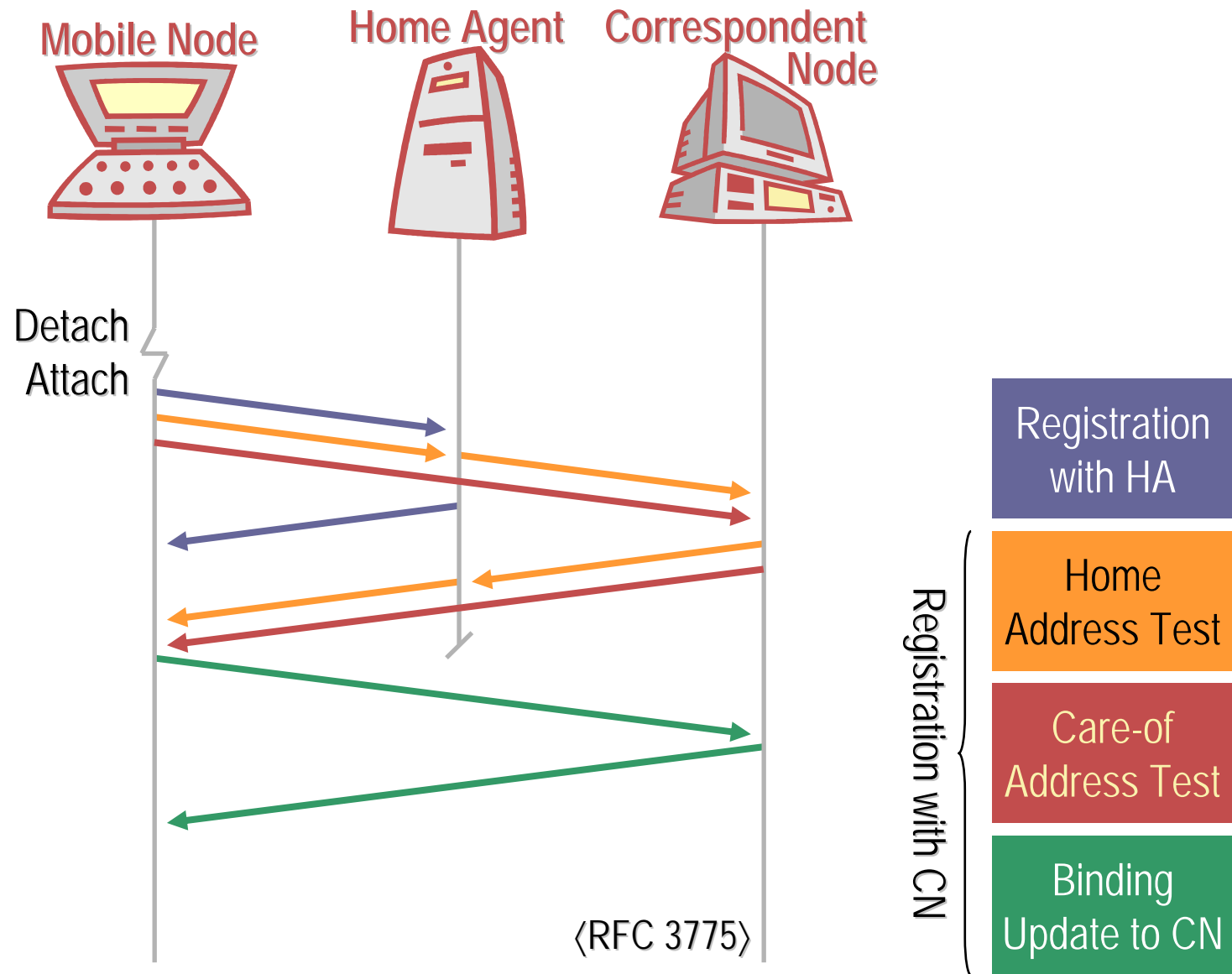
What Mobile IPv6 Does About It…

Relationship btw. MN and HA

- **Long-lasting**

- Pre-configuration: Credentials, authorization records
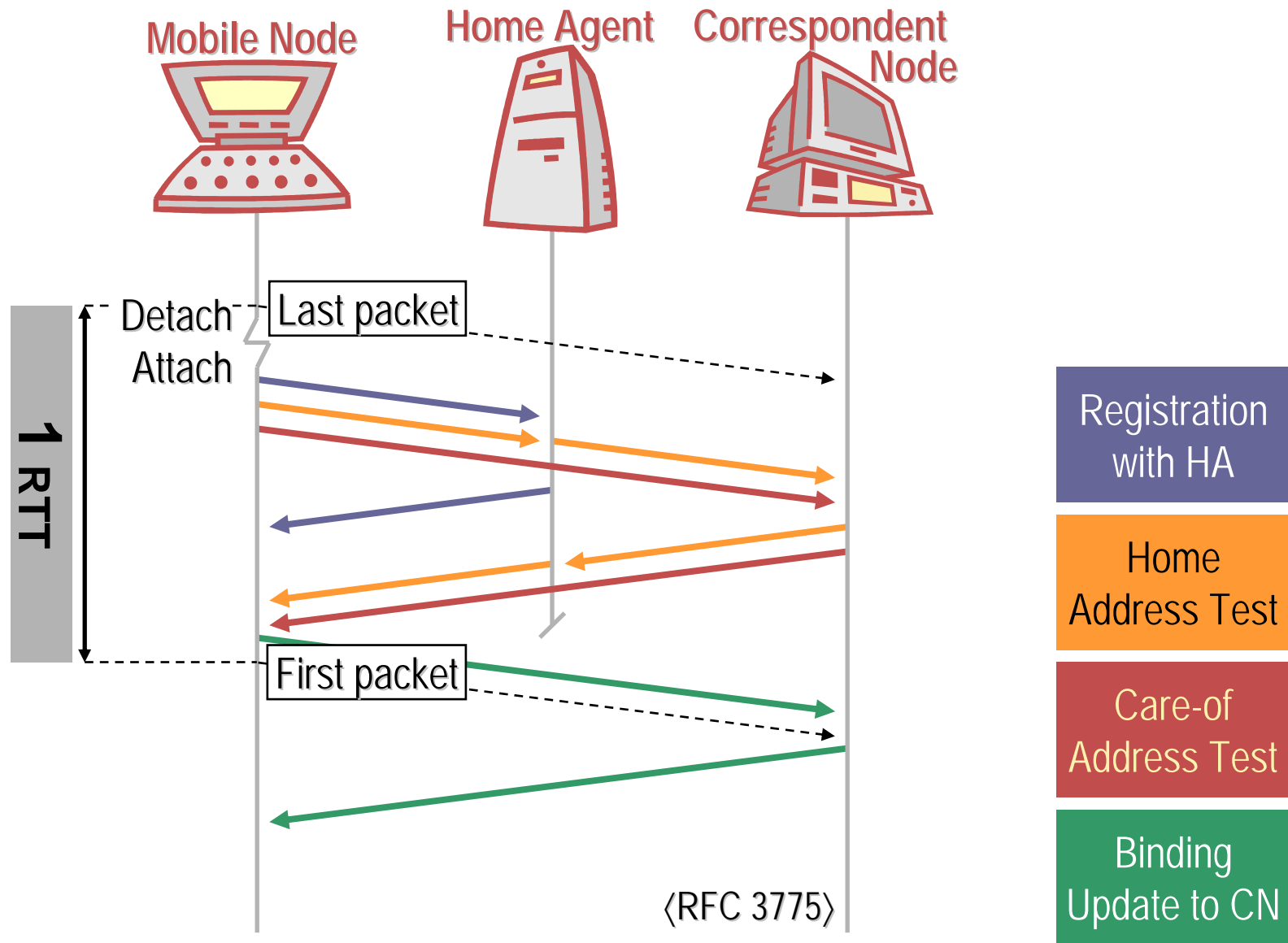
- Mobile IPv6: **IPsec authentication**

Relationship btw. MN and CN

- Usually **without history**

- No pre-configuration

- Key exchange insufficient; HoA/CoA-ownership proof required

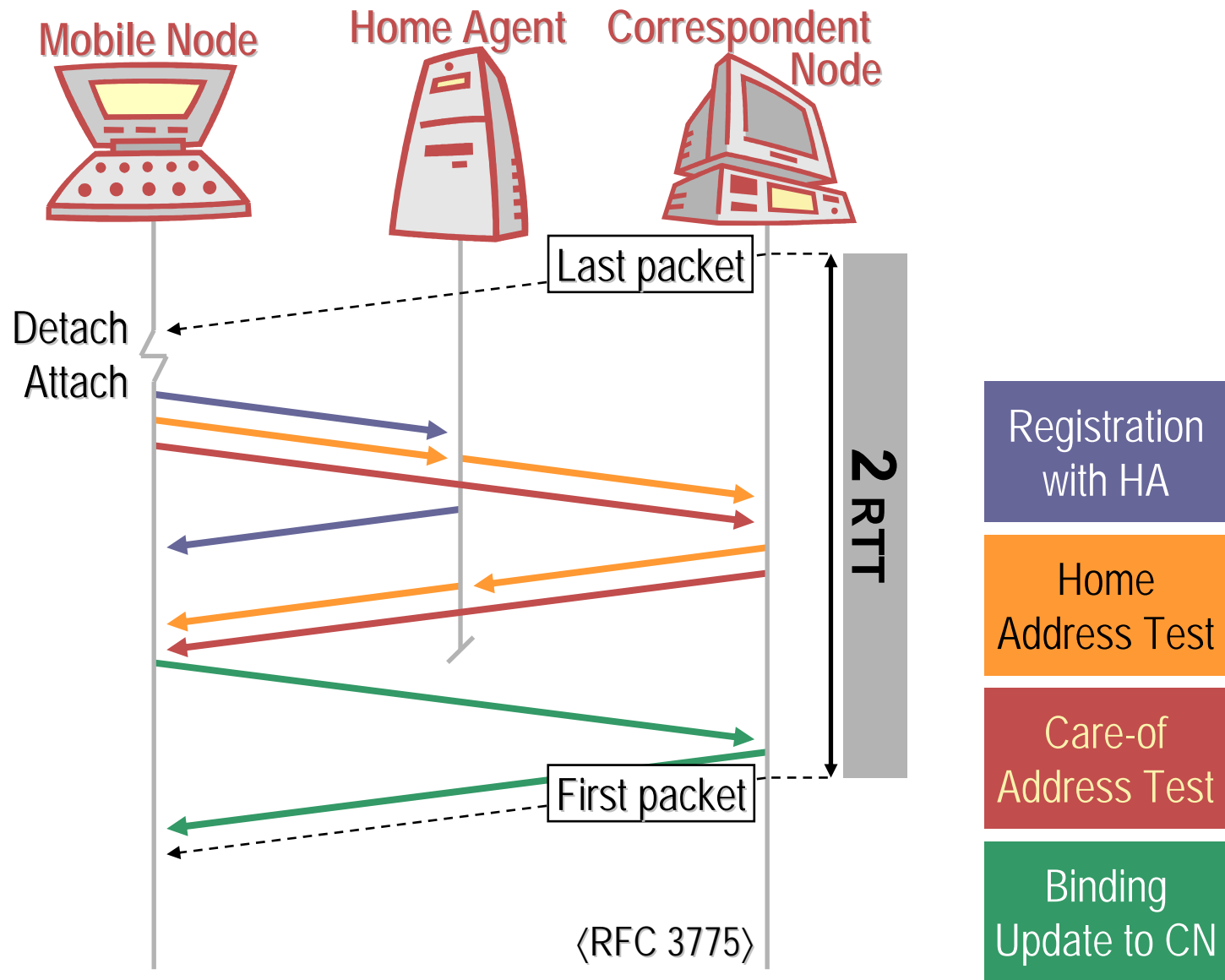- Mobile IPv6: non-cryptographic **HoA/CoA tests**

What Mobile IPv6 Does About It…

...And How This Performs

Mobile Node • Home Agent • Correspondent Node

Detach
Attach
Last packet
First packet

1 RTT

⟨RFC 3775⟩

Registration with HA

Home Address Test

Care-of Address Test

Binding Update to CN

...And How This Performs

Mobile Node   Home Agent   Correspondent Node

Last packet

Detach
Attach

2 RTT

First packet

⟨RFC 3775⟩

Registration with HA

Home Address Test

Care-of Address Test

Binding Update to CN
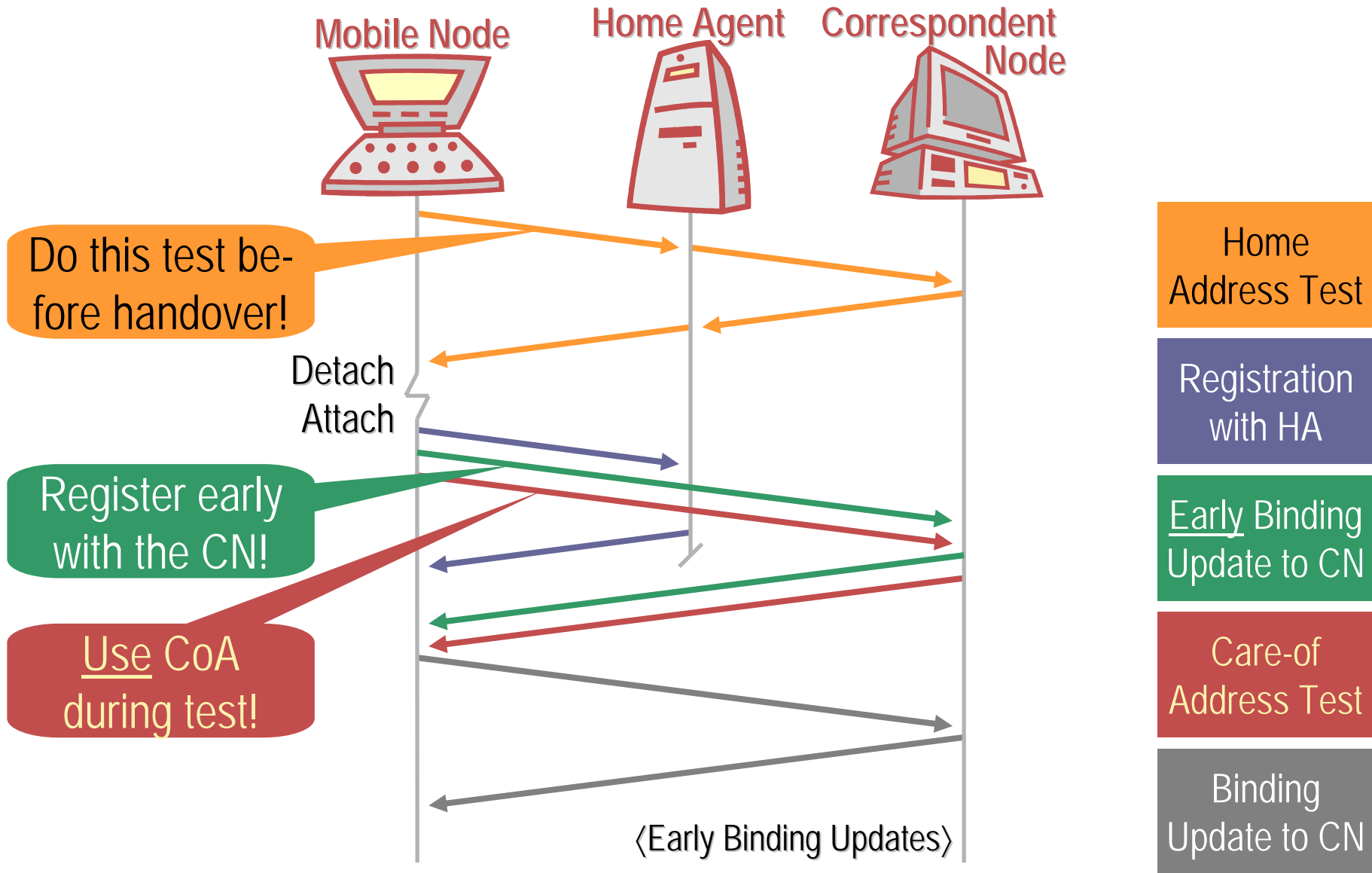
Our Objectives

Need Optimization Which…

- **significantly reduces handover latency**
  across domains and without special network support

Related Work

- Local: **Hierarchical Mobile IPv6, Fast Handovers**

  - pro: low latency, zero packet loss

  - con: network support required, no inter-domain optimization

- End-to-end: **Cryptographically Generated Addresses**

  - pro: cryptographic HoA-ownership proof, eliminates HoA test

  - con: CoA test still required

Our Approach: Early Binding Updates

TeleMatics

Mobile Node   Home Agent   Correspondent Node

Do this test be-fore handover!

Detach
Attach

Register early with the CN!

Use CoA during test!

⟨Early Binding Updates⟩

Home Address Test

Registration with HA

Early Binding Update to CN

Care-of Address Test

Binding Update to CN

Unverified Care-of Addresses

Issue: CoA unverified for a while

- Period of vulnerability btw. Early and standard Binding Update

- Negligible in some scenarios, usually requires additional protection

Solution: Prevent amplification

- Observation: amplification (not misdirection per se) makes redirection-based flooding attractive

- Rationale: no amplification $\Rightarrow$ redirection-based flooding unattractive

- Credit-based technique

Our Solution: Credit-Based Authorization

Mobile Node

Home Agent

Correspondent Node
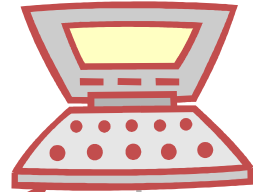
Acquires credit by <u>sending</u> pkts.

Consumes credit for <u>being sent</u> pkts. to unverified CoA
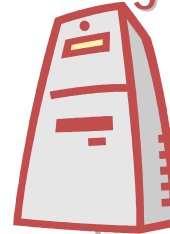
Maintains credit account

Our Solution: Credit-Based Authorization
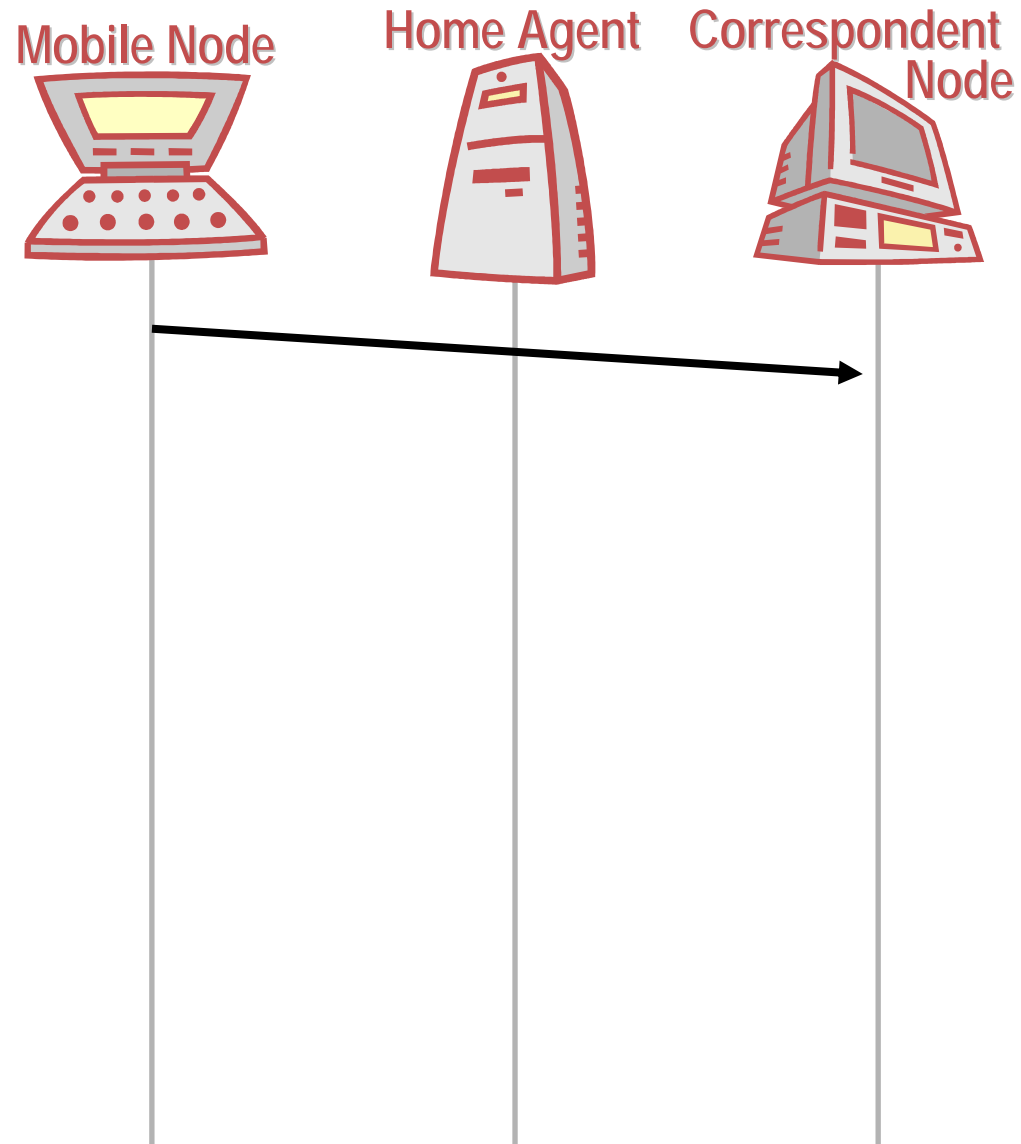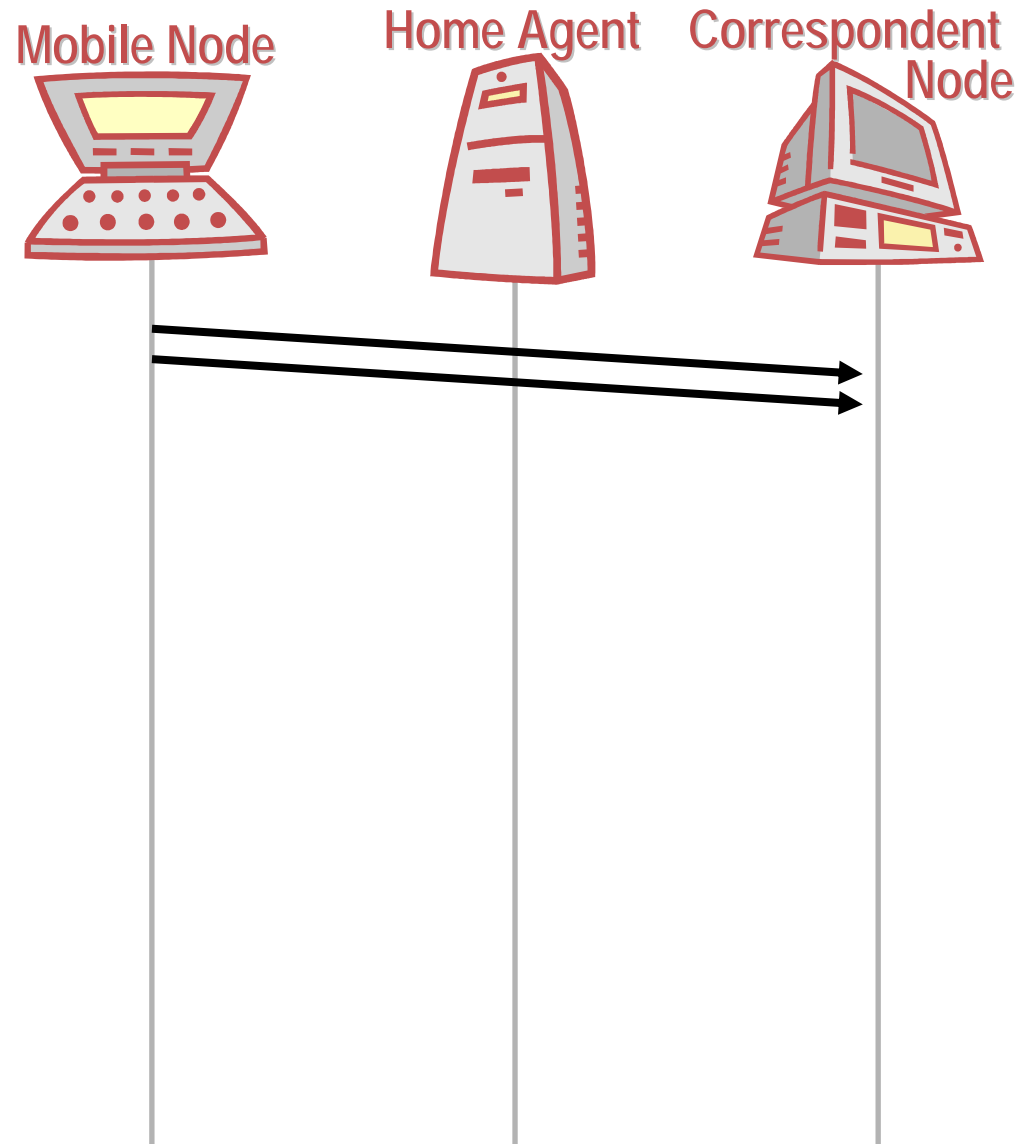
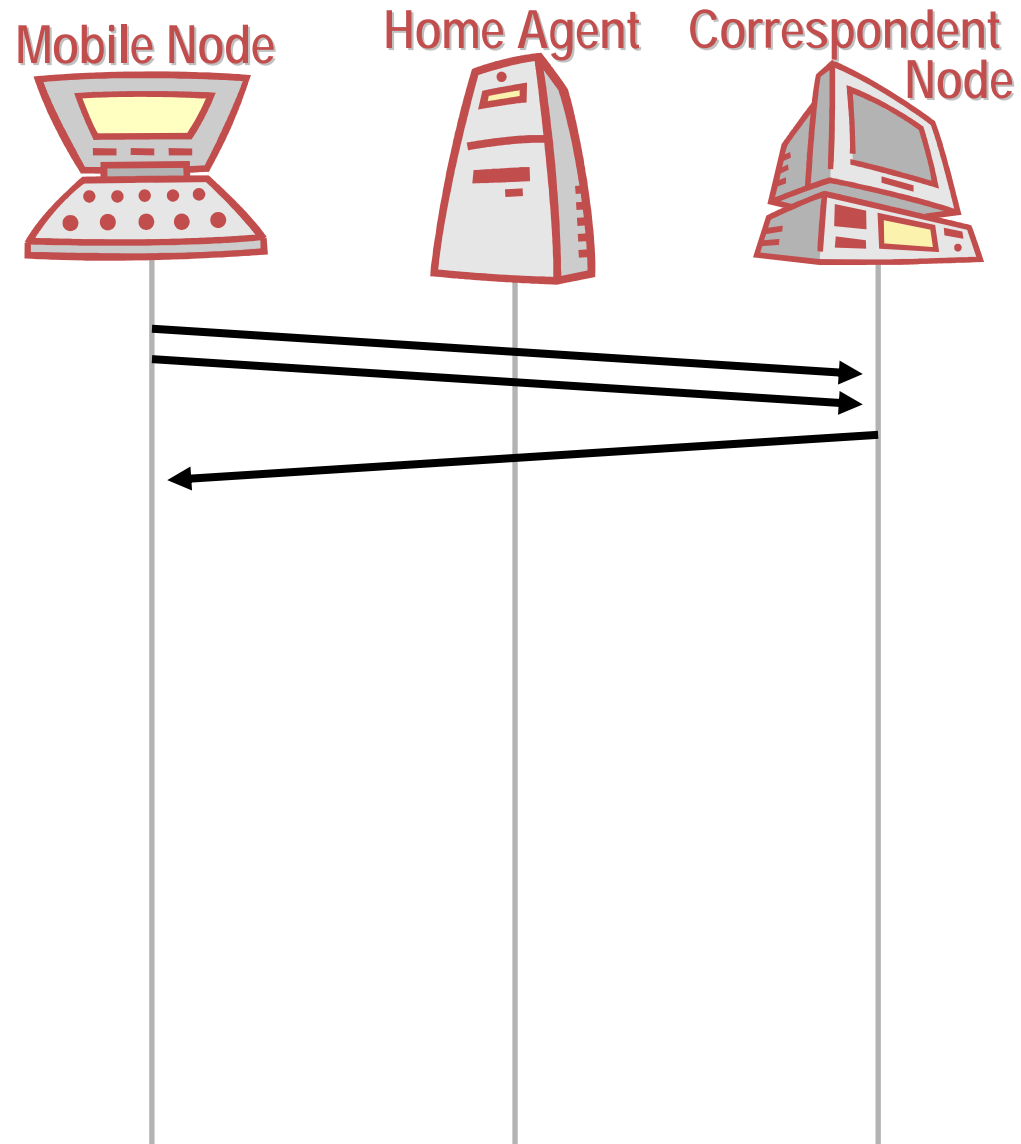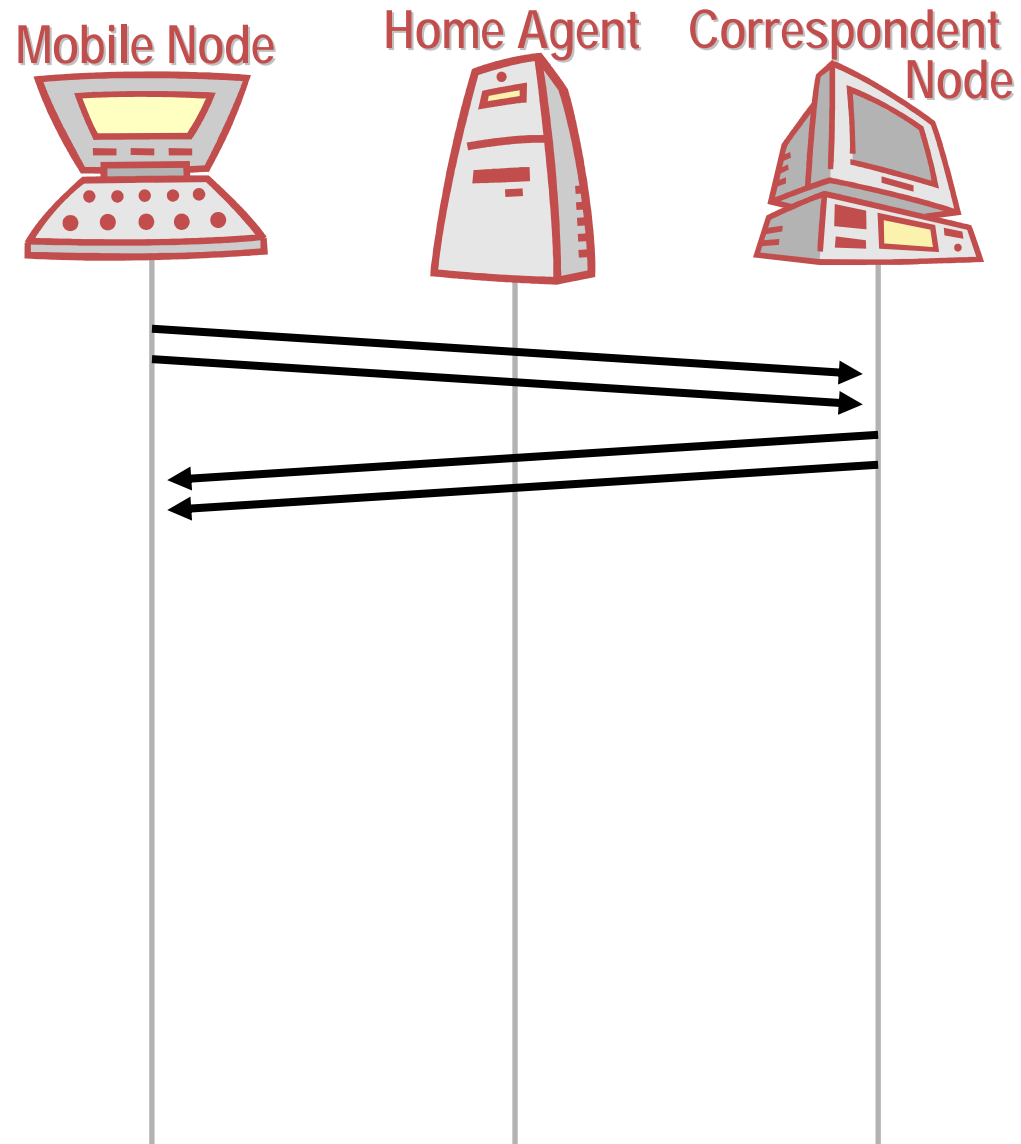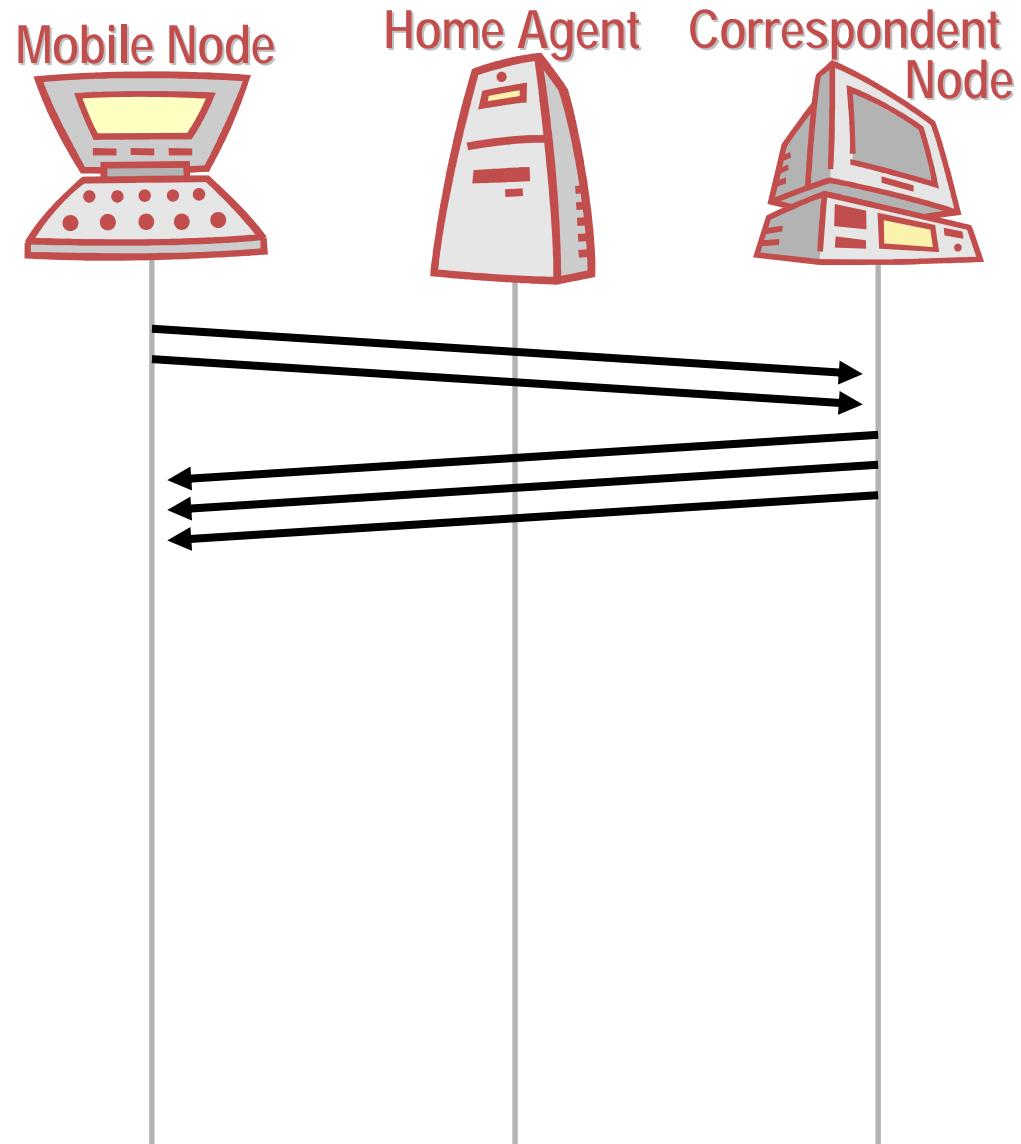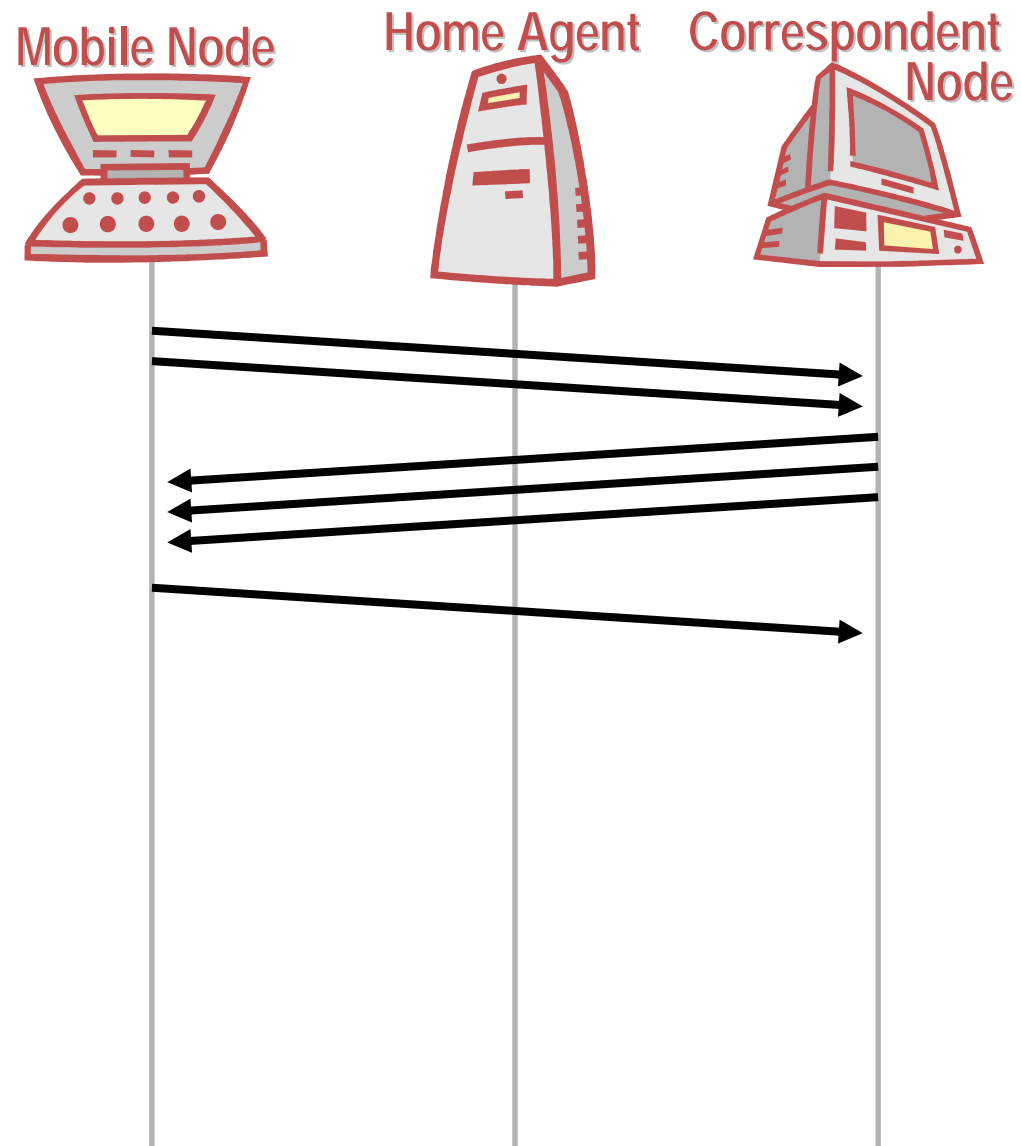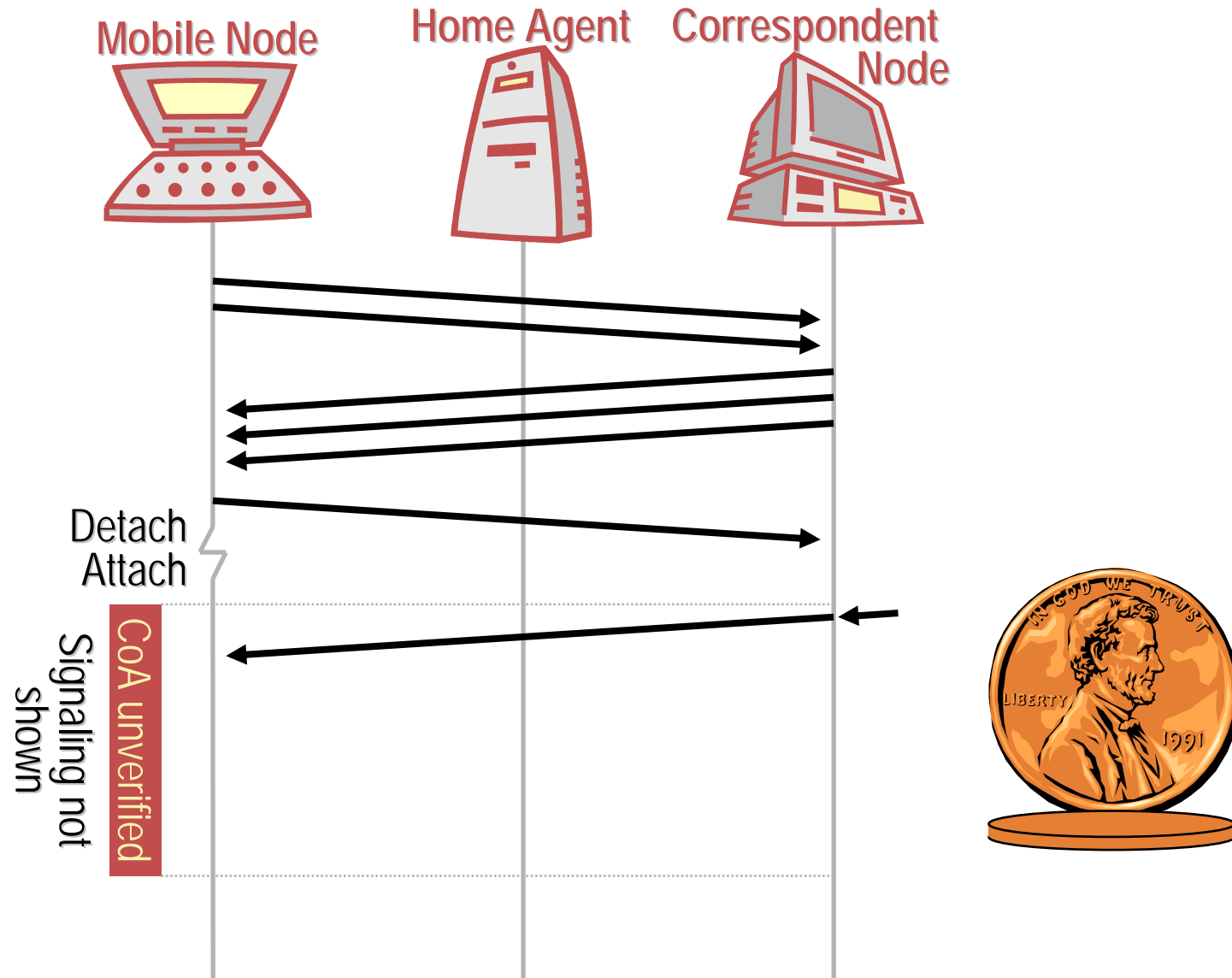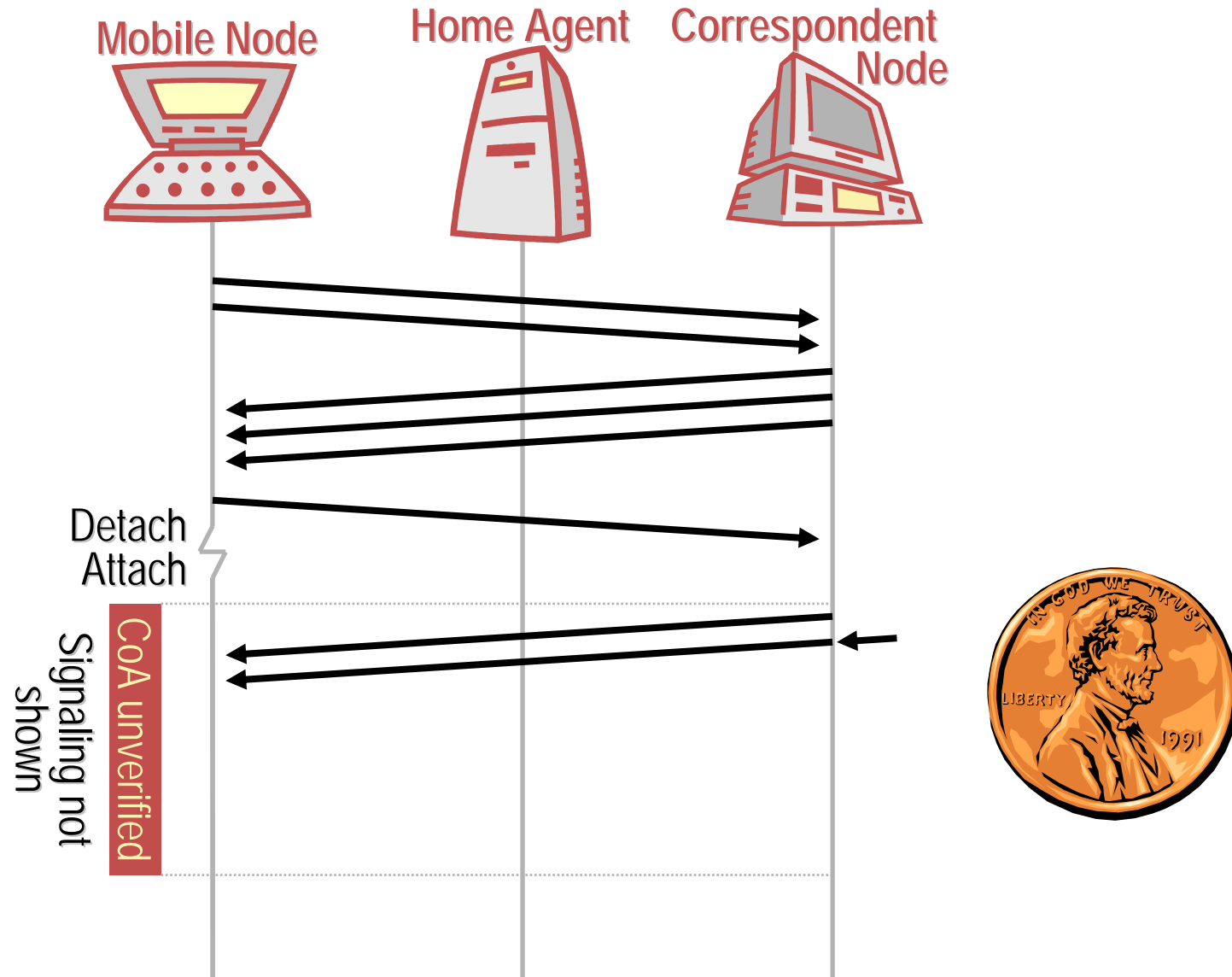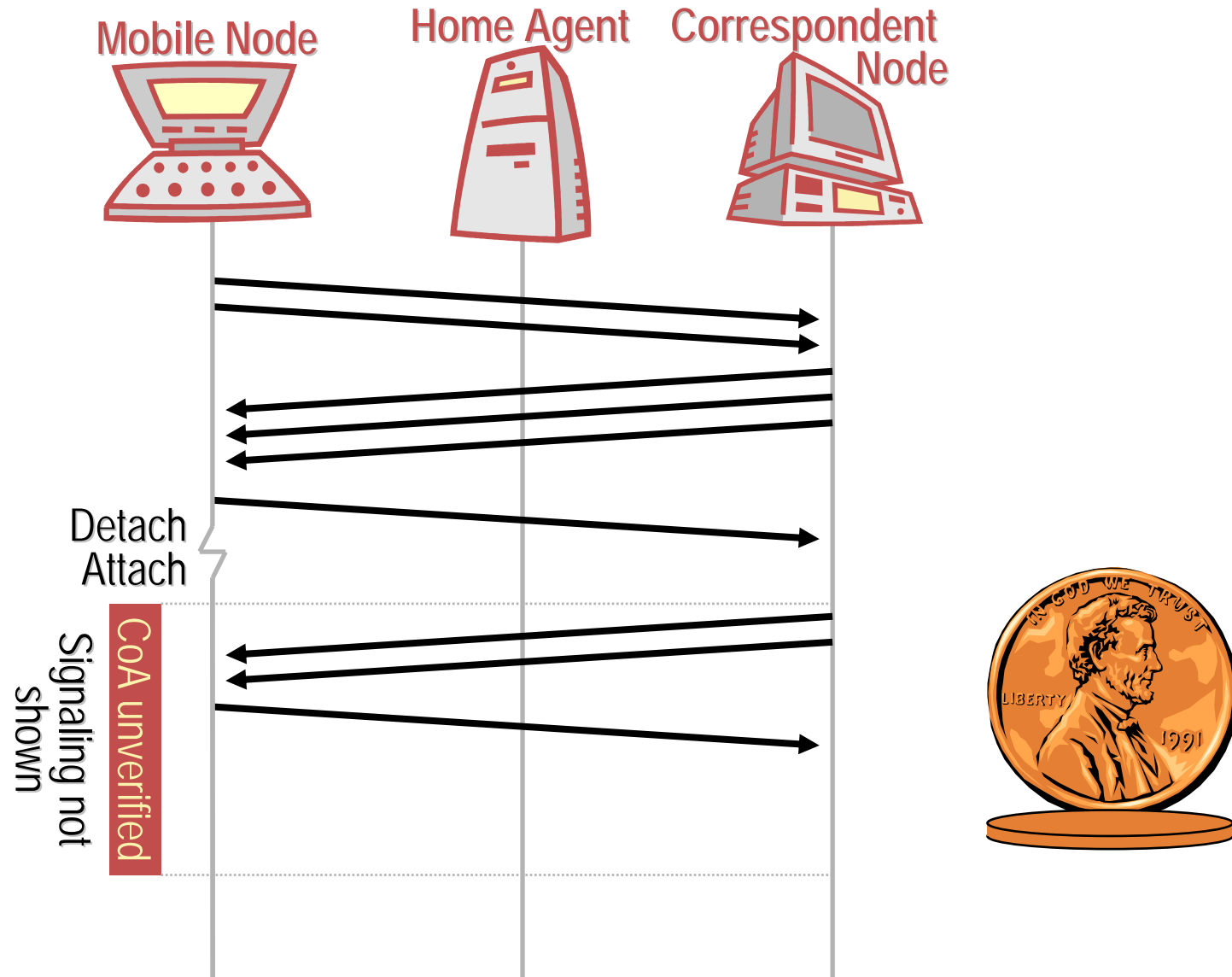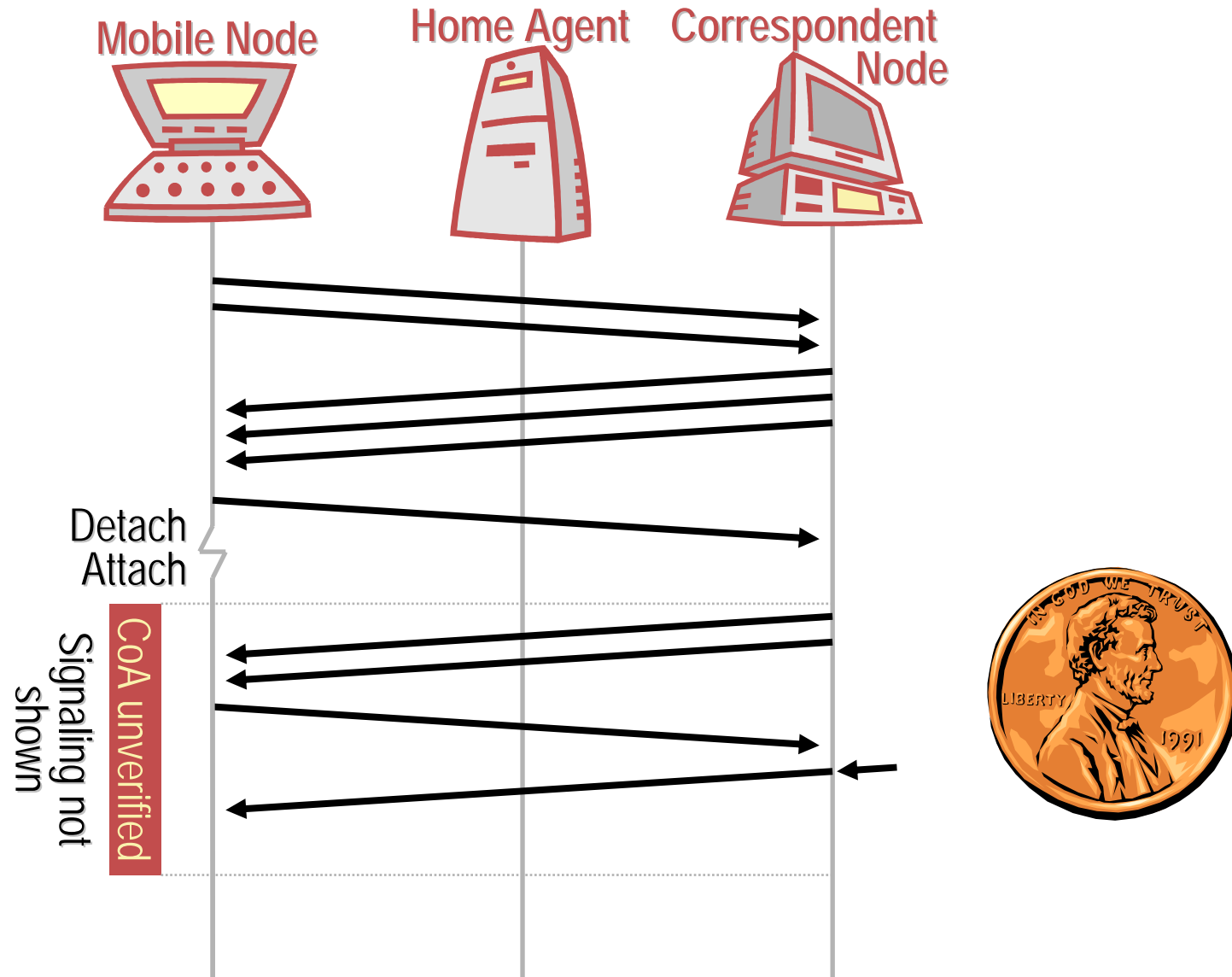**Mobile Node**   **Home Agent**   **Correspondent Node**

Our Solution: Credit-Based Authorization

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Mobile Node

Home Agent

Correspondent Node

Our Solution: Credit-Based Authorization

Mobile Node   Home Agent   Correspondent Node

Detach
Attach

CoA unverified

Signaling not shown

Our Solution: Credit-Based Authorization

Our Solution: Credit-Based Authorization

TeleMatics

Mobile Node **Home Agent** **Correspondent Node**

Detach
Attach

CoA unverified

Signaling not shown

Our Solution: Credit-Based Authorization

Mobile Node   Home Agent   Correspondent Node

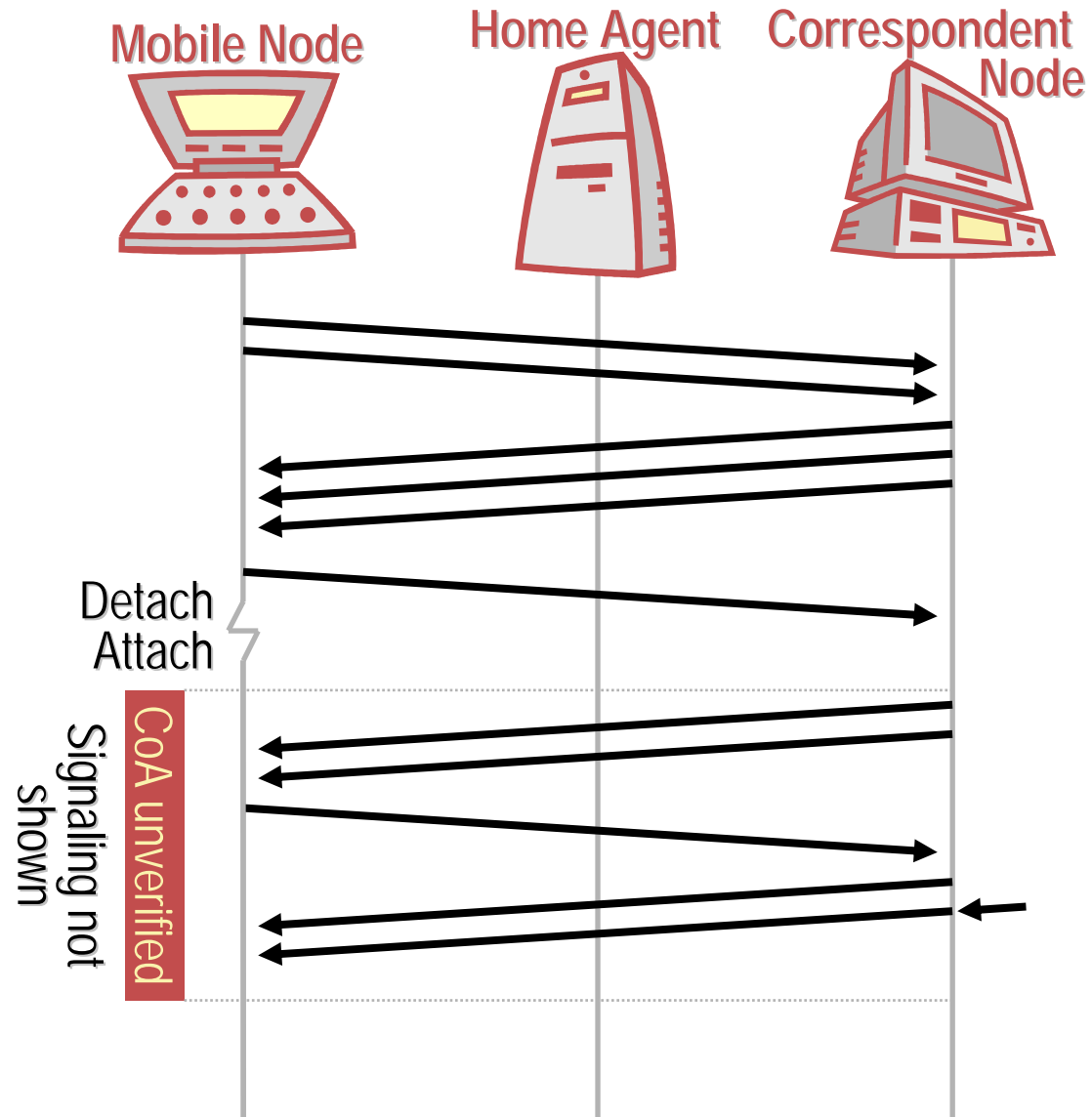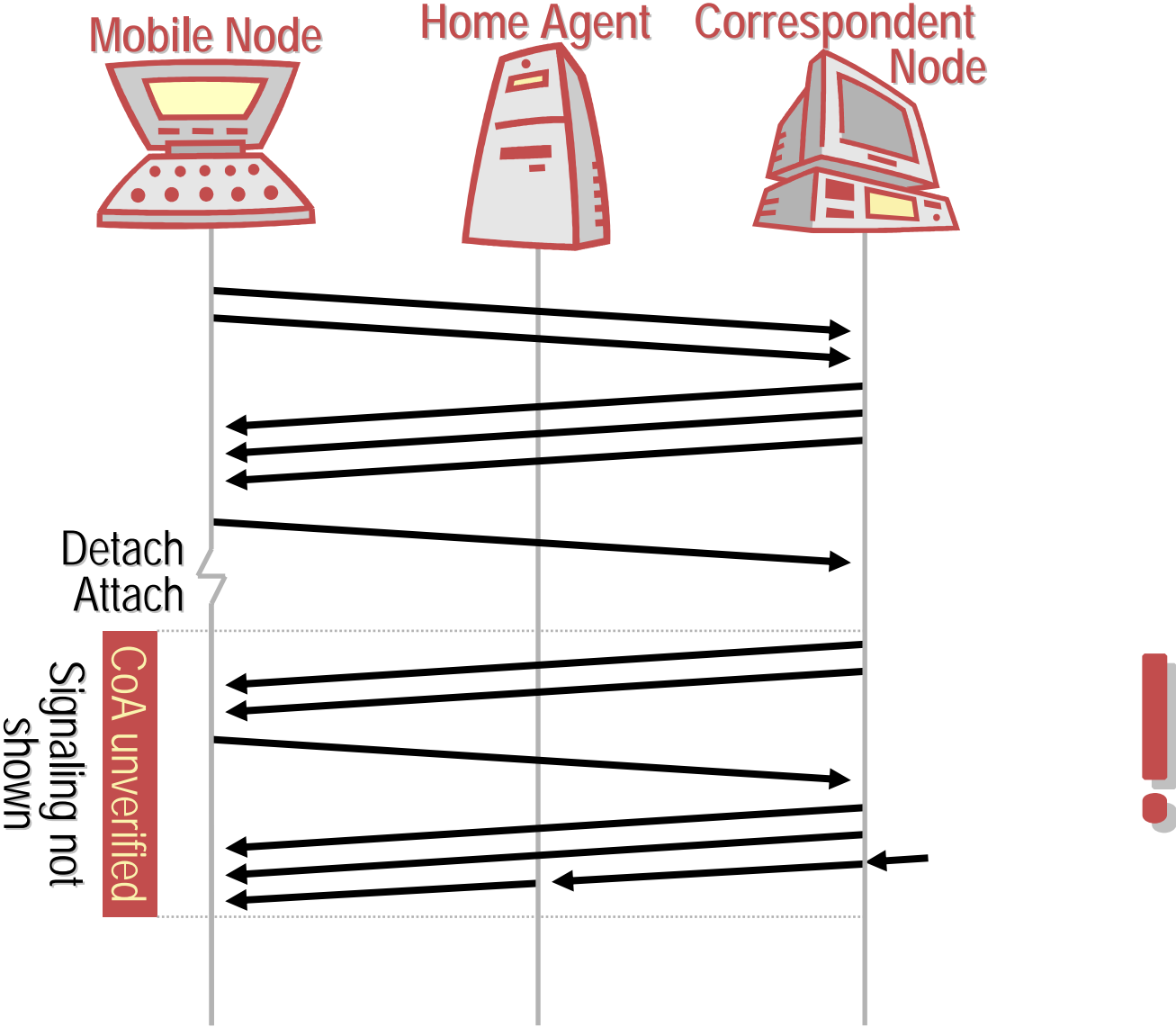Detach
Attach

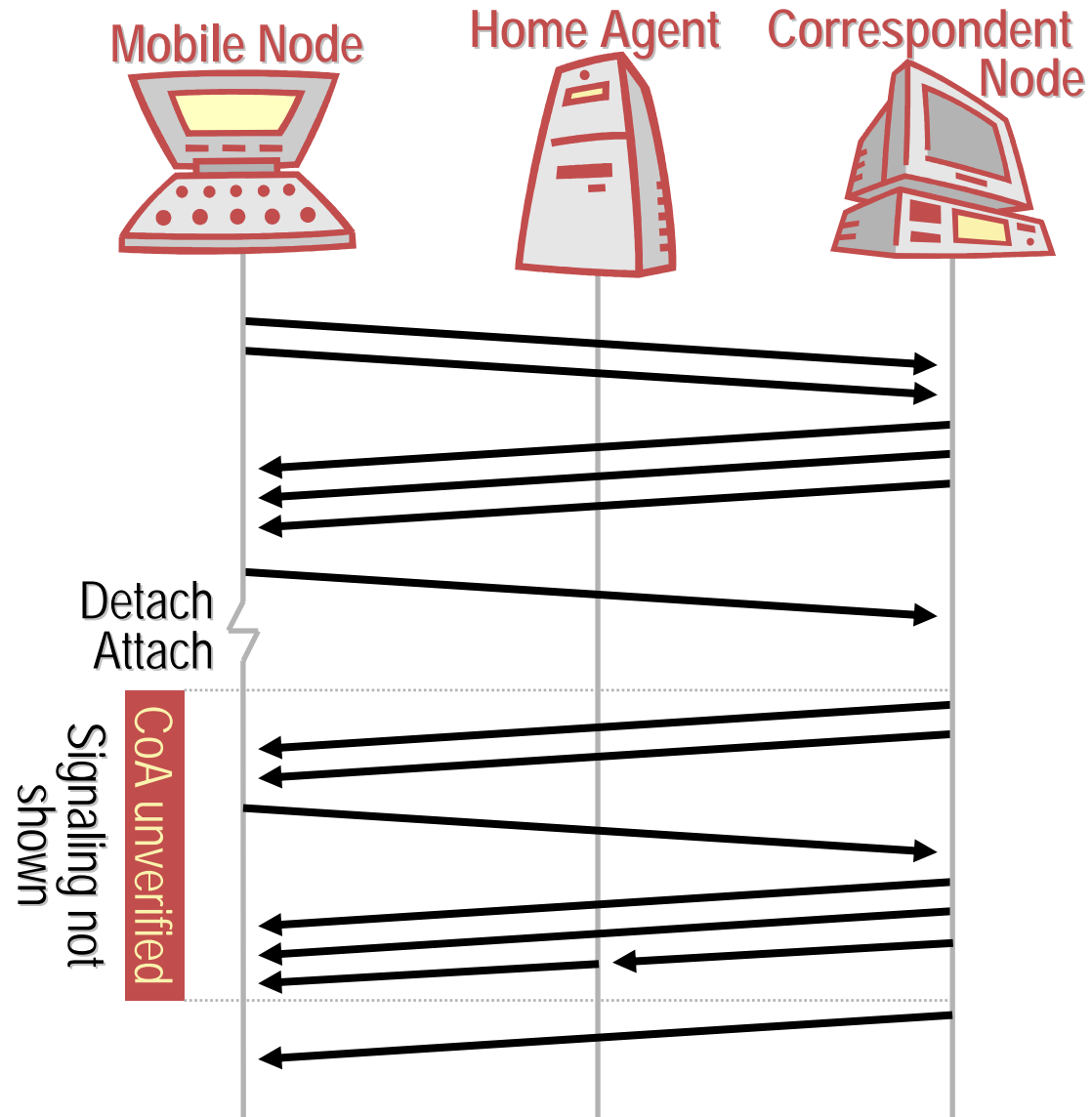CoA unverified

Signaling not shown
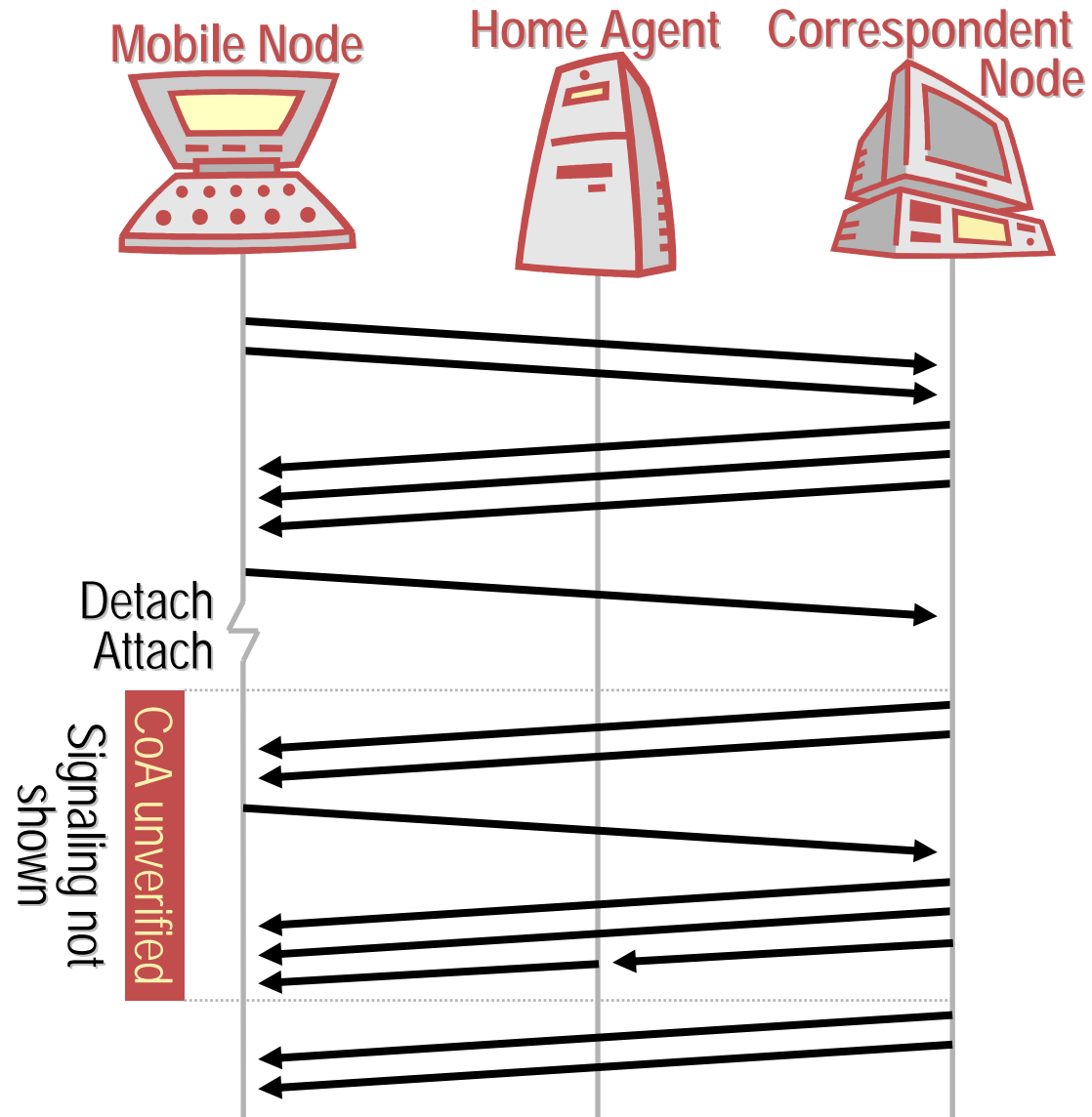
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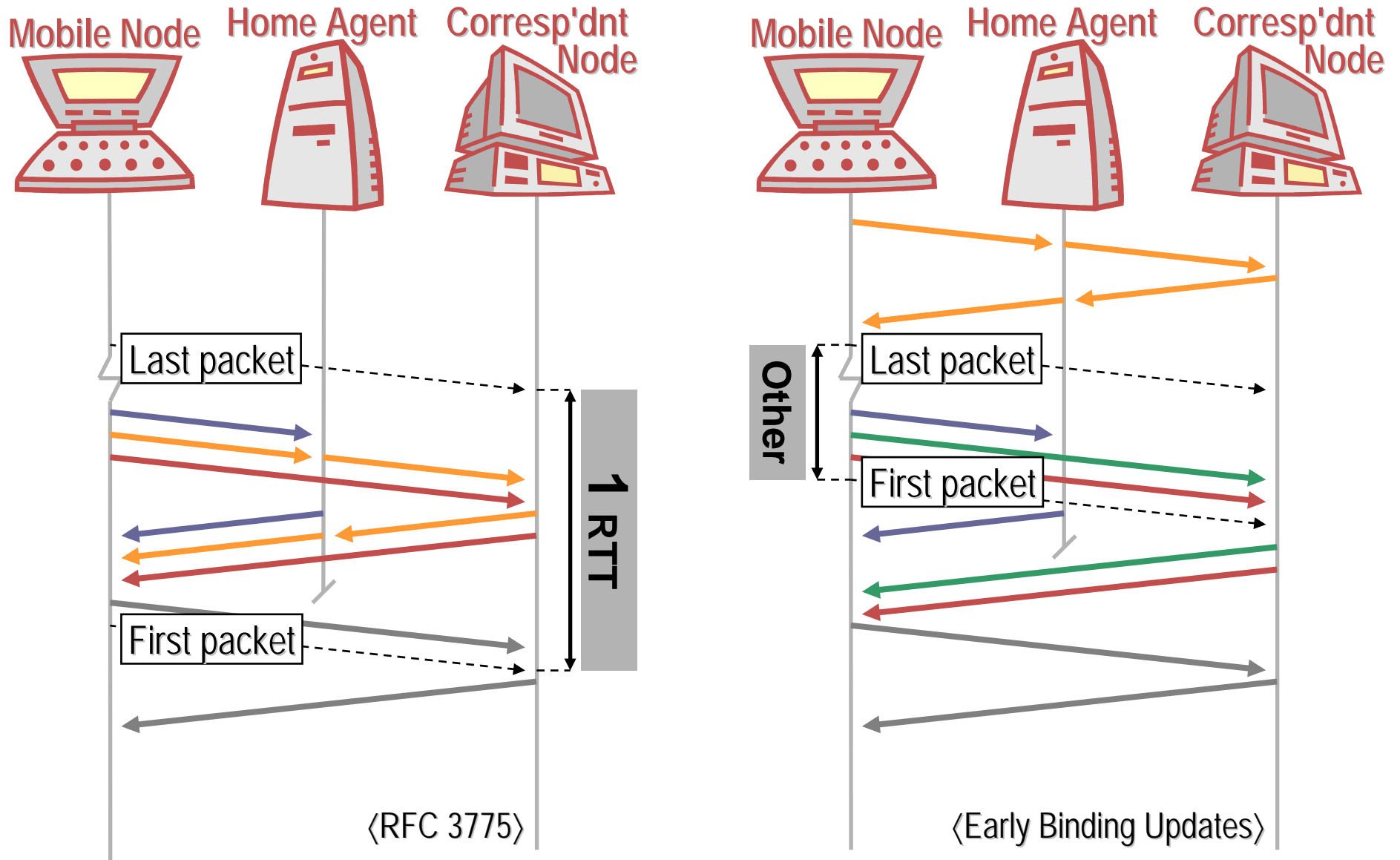
Asymmetric Traffic Patterns

Issue: Asymmetric Traffic Patterns

- Some applications feature asymmetric traffic patterns
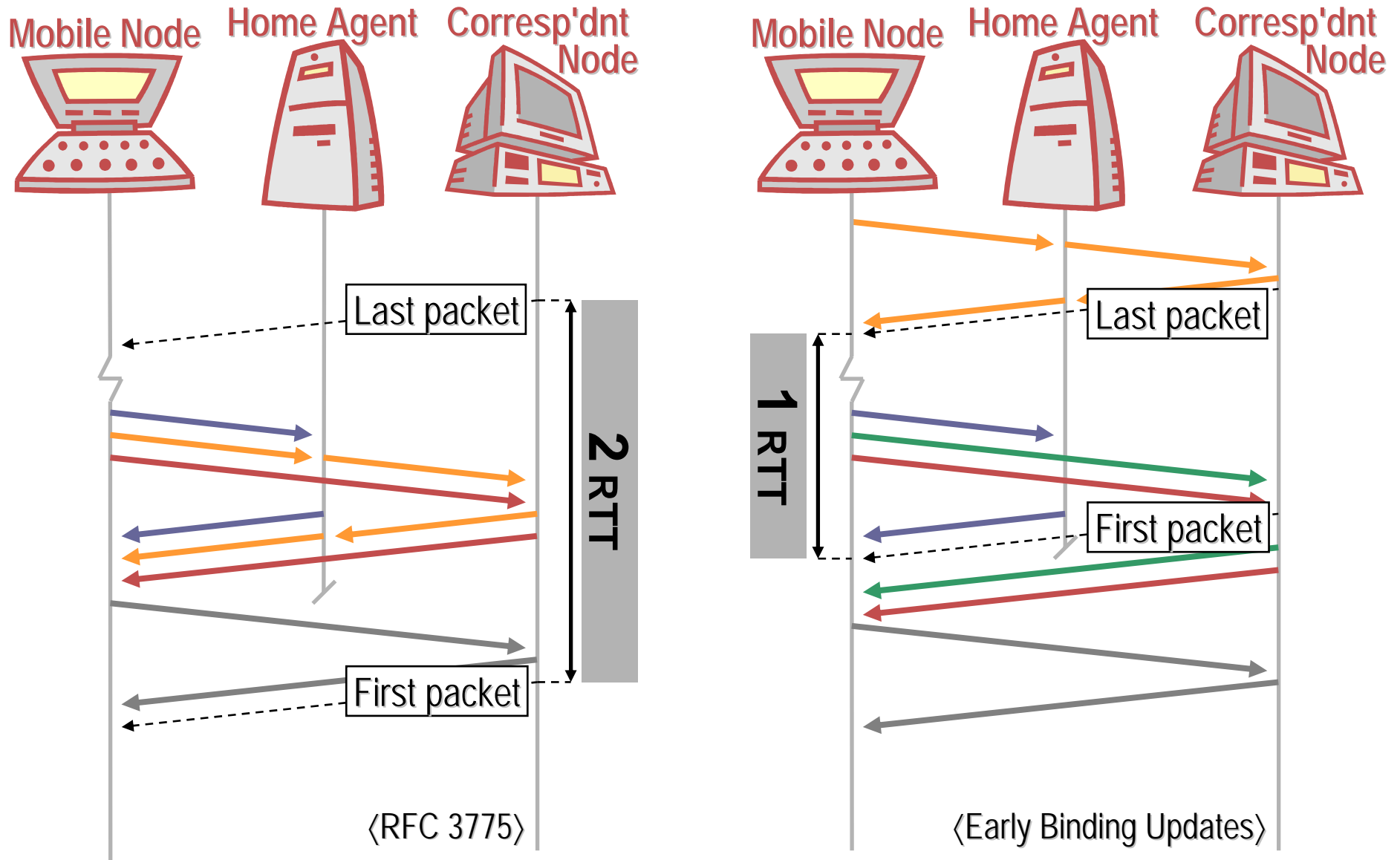
- No sufficient credit upon handover

Solution: Credit for Packet Reception and Processing

- Feedback mechanism for CN

- Care-of Address Spot Checks (in-band extension of CoA tests)

- Not covered here

How Much Do We Benefit?

Mobile Node   Home Agent   Coresp'dnt Node

Last packet

1 RTT

First packet

⟨RFC 3775⟩

Mobile Node   Home Agent   Coresp'dnt Node

Other

Last packet

First packet

⟨Early Binding Updates⟩

How Much Do We Benefit?
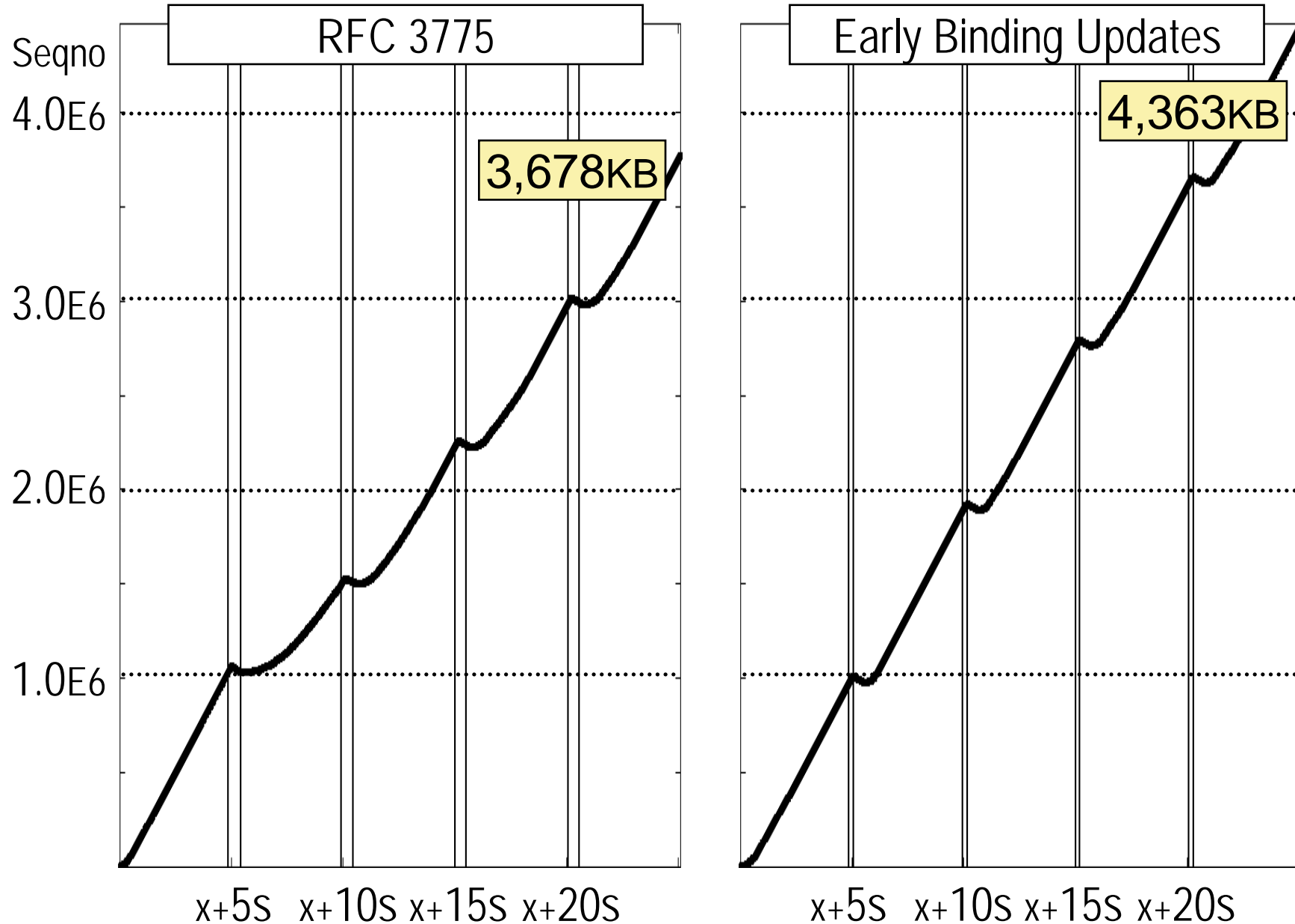
Analysis of Early Binding Updates

Advantages of Early Binding Updates

- Half of standard latency, or less

- No special network support
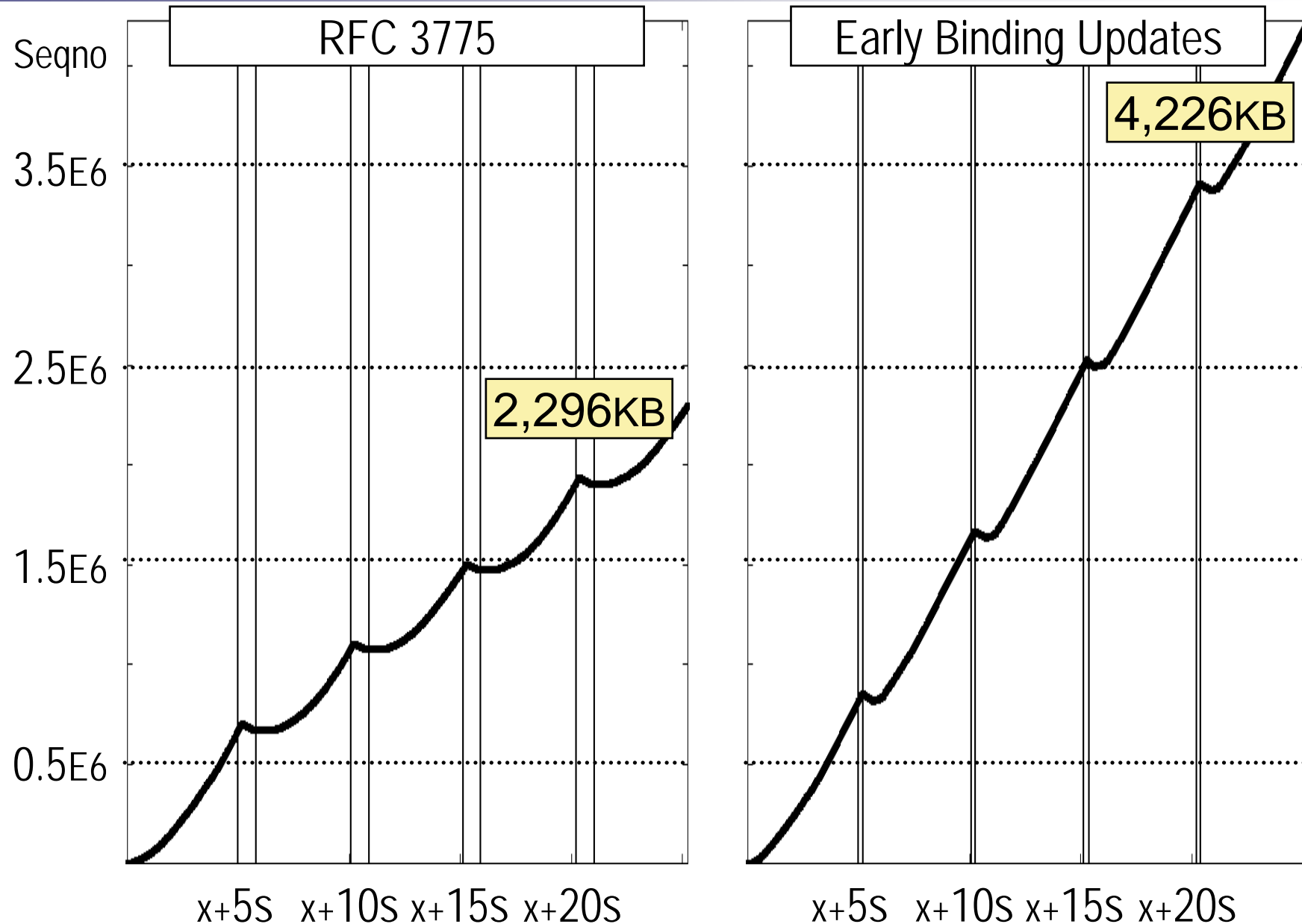
- Applicable to inter-domain handovers

Drawbacks of Early Binding Updates

- Additional signaling for proactive HoA tests (if done periodically)

- Still 1 RTT latency

Scenario 1: TCP Throughput

Preliminary Results of TCP Experimentations

Conclusion

Current Status

- Implementation in FreeBSD 5.3, Kame-Shisa Mobile IPv6

- Ongoing work in IETF, IRTF; CBA now to be integrated into HIP

Open Issues

- Impacts on applications? Effects on TCP retransmission timers?

Future Perspectives

- Proactive registration <u>before</u> handover $\Rightarrow$ eliminate remaining delays