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Challenges to Security in the Mobile Internet

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Outline

- The beginning
- Current challenges
- Future challenges
- Case studies
  - Case SRTP - Importance of efficiency
  - Case Mobile IPv6 - Importance of scalability
  - Case HIP - Insignificance of IP addresses
- Conclusions

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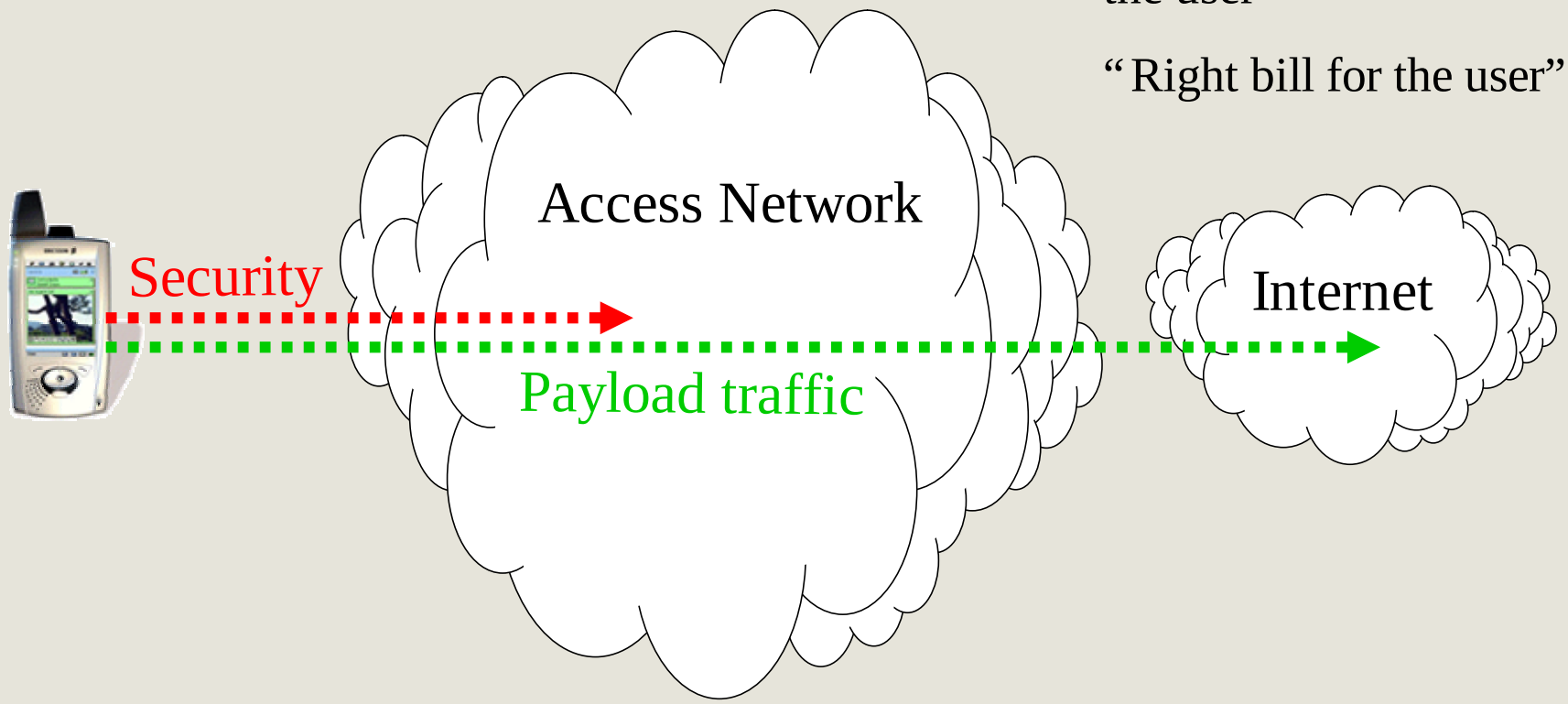
The Beginning

The First Attempts, Security Architecture

Provide access, and only it

Protect the operator from the user

"Right bill for the user"



2G, 2.5G, first WLANs

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Problems in this Architecture

- Movements were impractical
  - Mobility only within one access network
  - Multiple access networks, multiple passwords
  - Tailored for a single device
- The provided security was not for services
  - Business implications
  - Practical implications for users
- Bad performance
  - Many of the Internet protocols not tailored for wireless
  - High RTT, small bandwidth, lossy & error-prone

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Current Challenges

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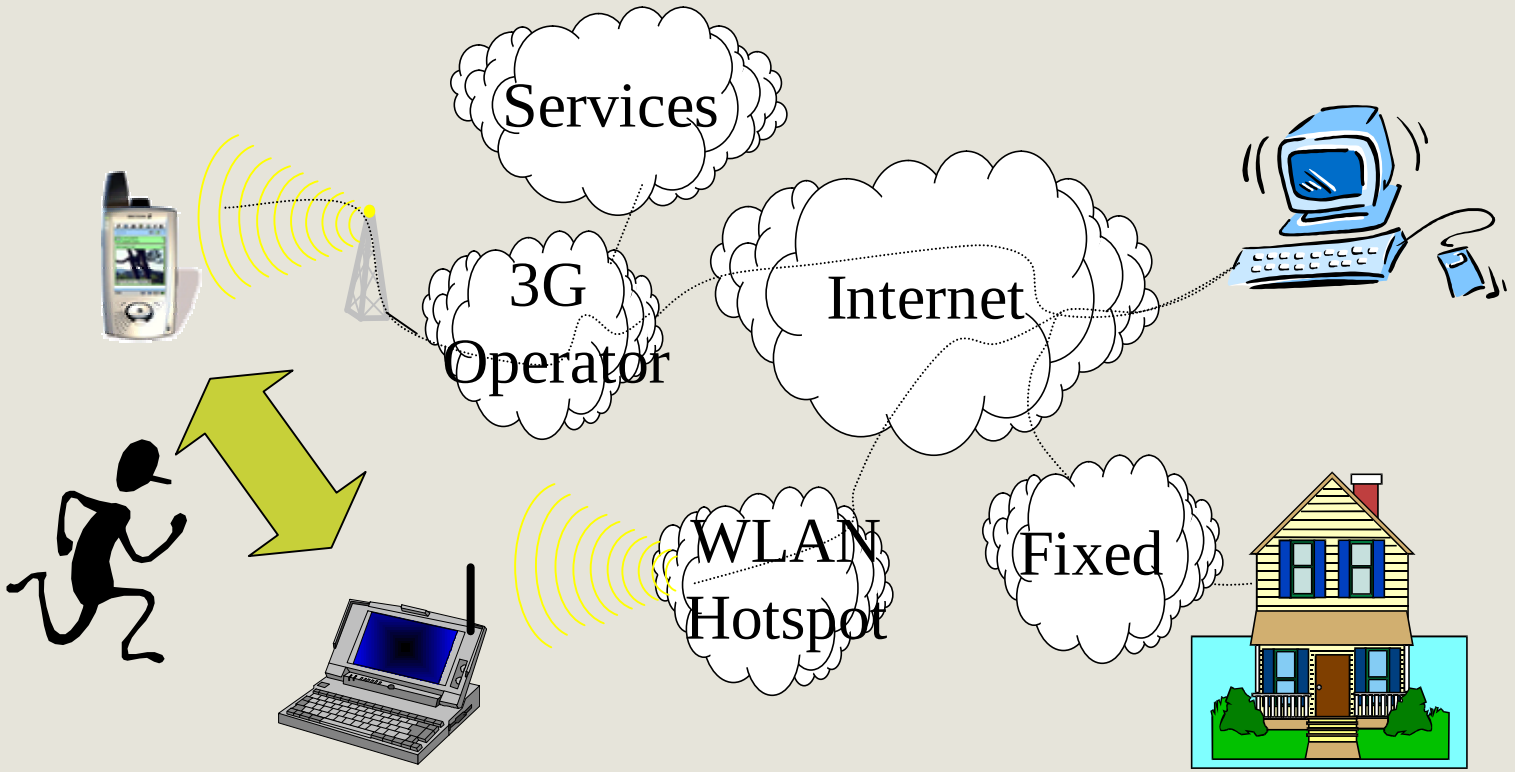
Current Architecture



Mobility, multi-access, services, improved security mechanisms

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What's New

- Include (some) services
- Basic mobility
- First solutions for multi-access
- Enhanced security mechanisms

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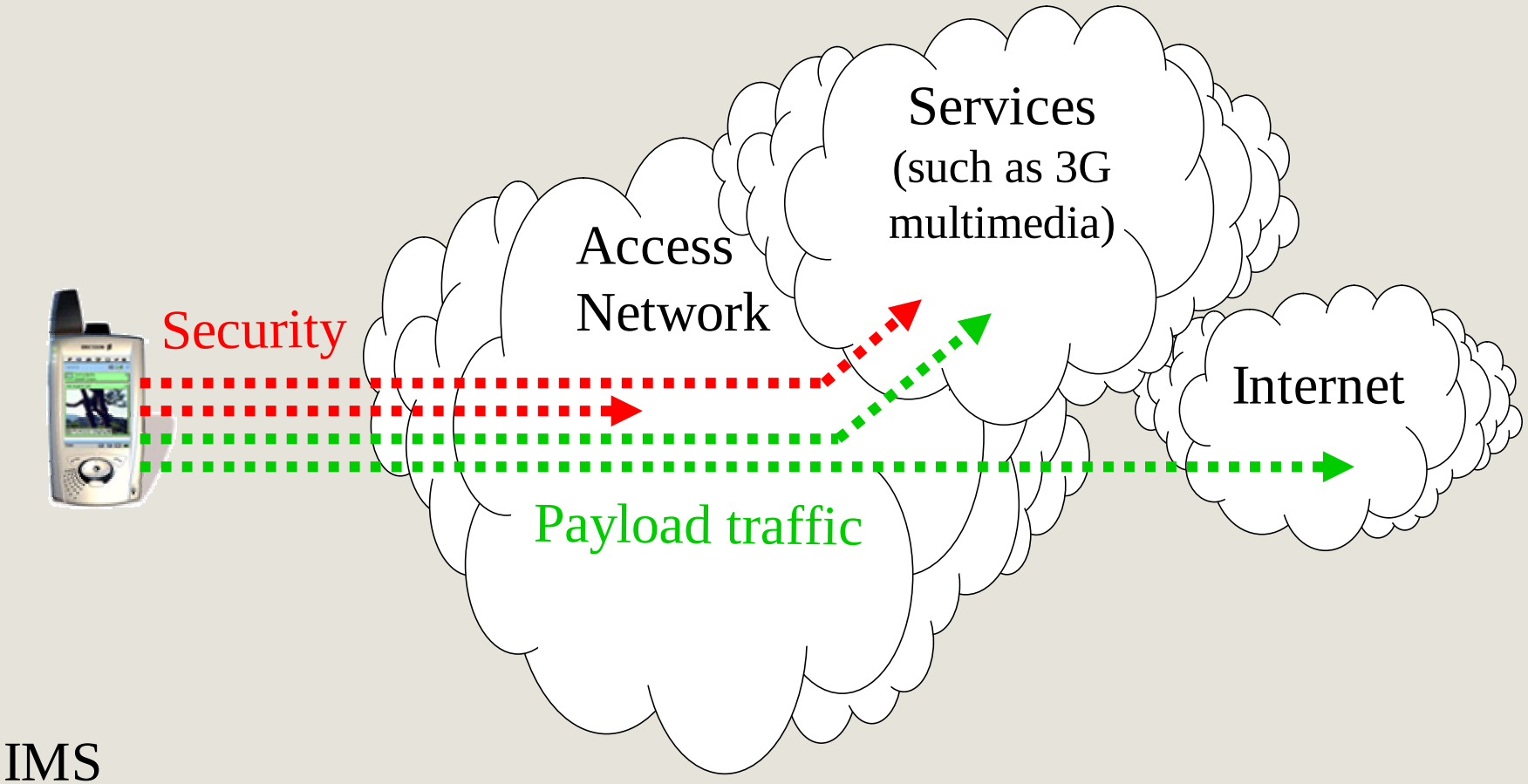
Security and Services



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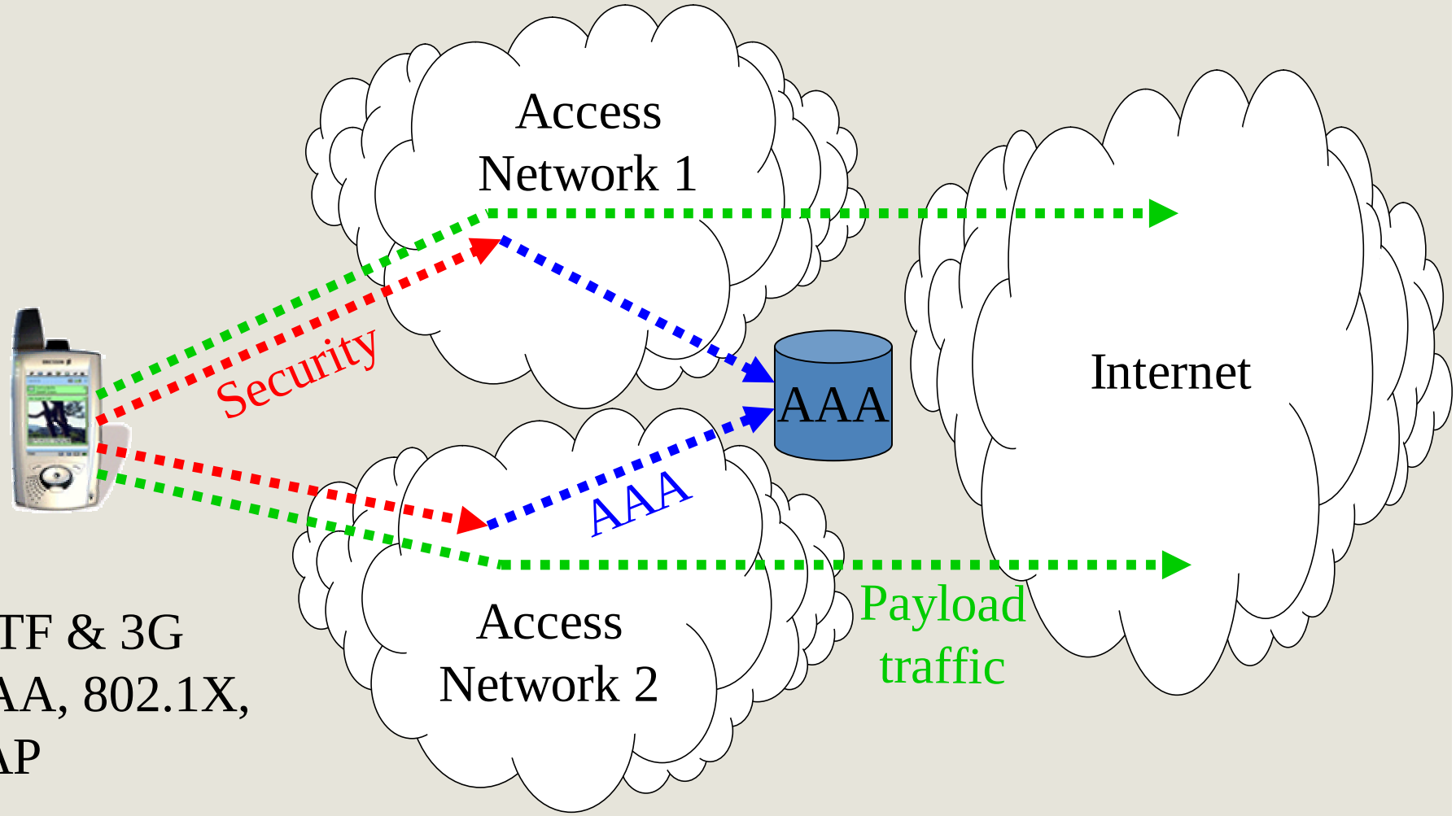
Security and Multi-Access



IETF & 3G
AAA, 802.1X,
EAP

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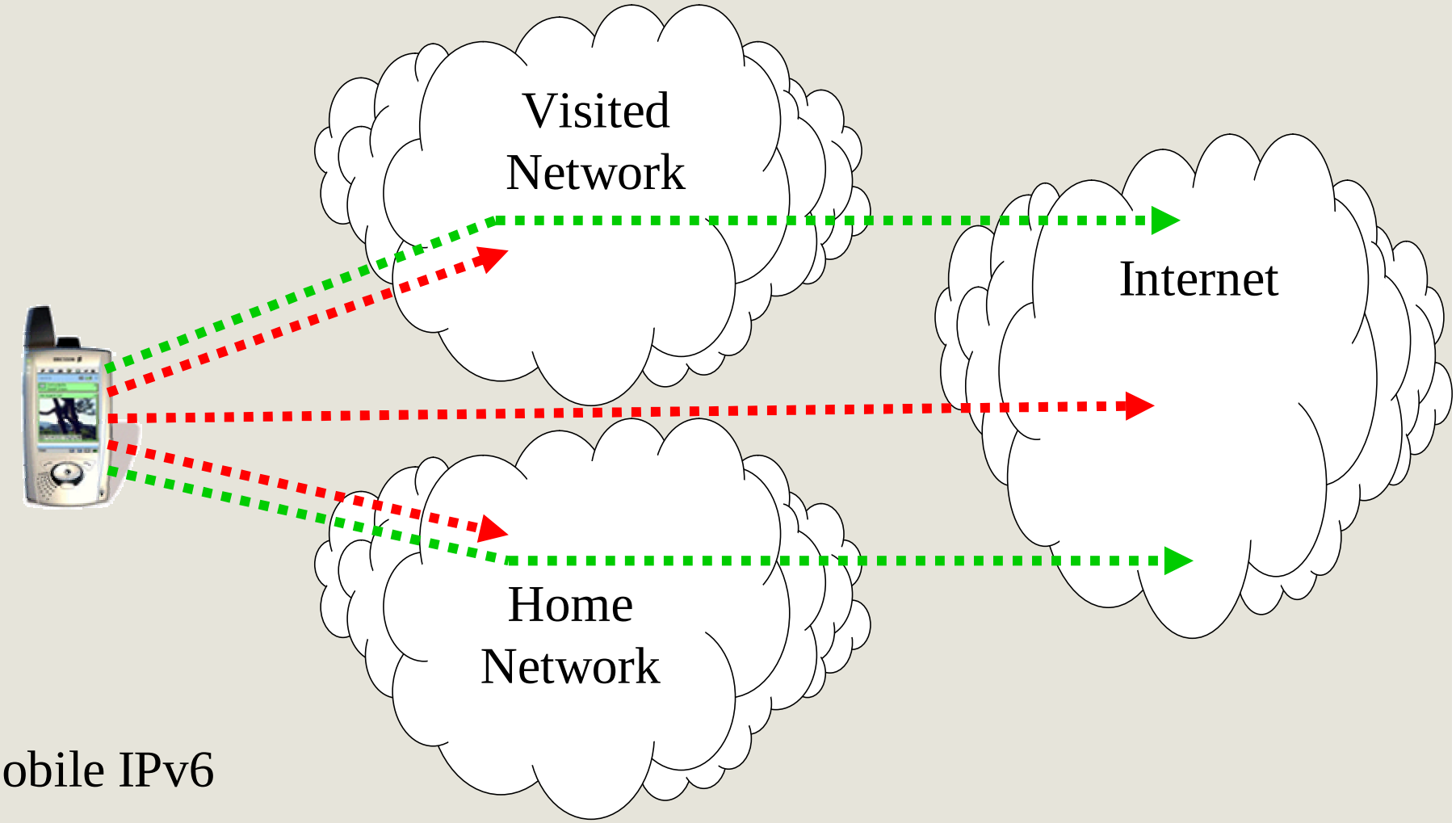
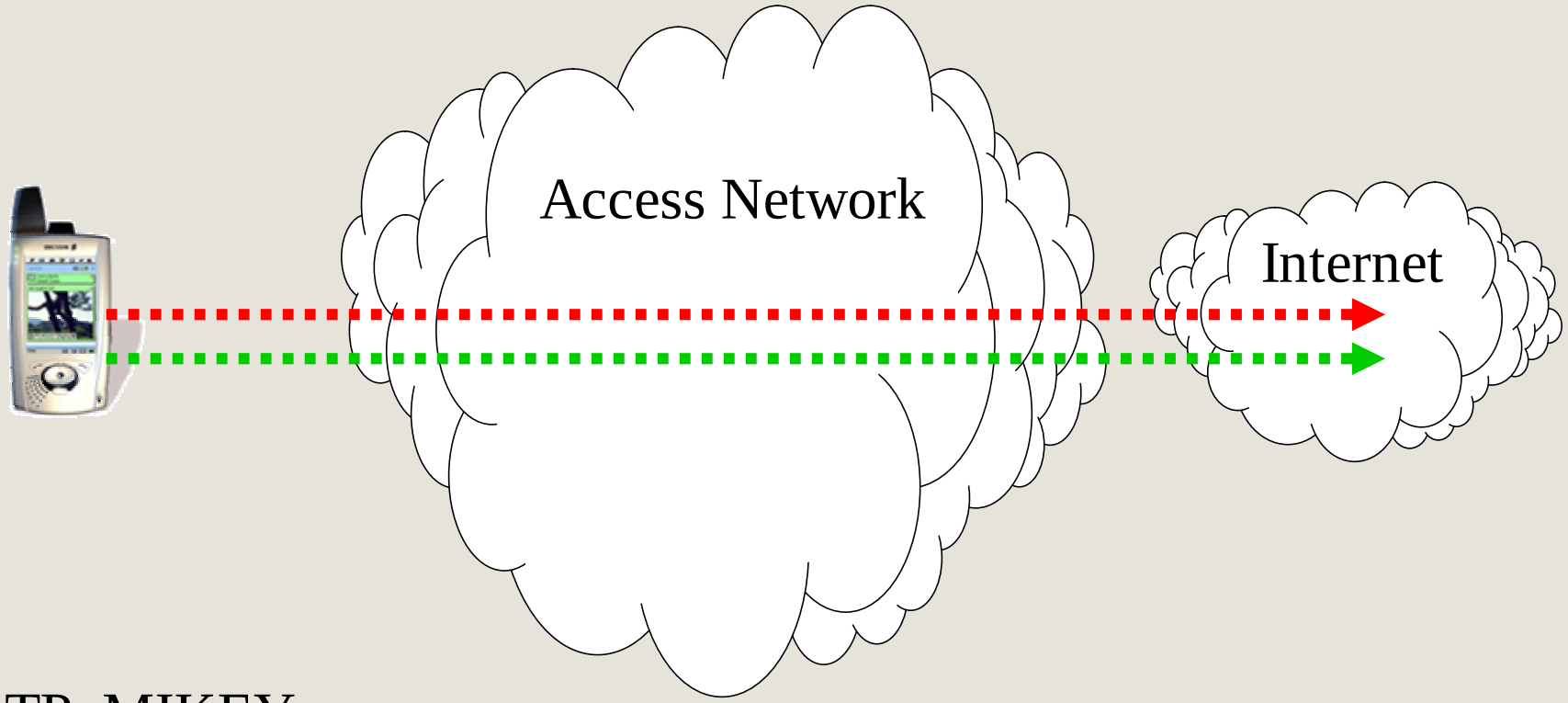
Security and Mobility



Mobile IPv6

Improved Internet Security Solutions



SRTP, MIKEY

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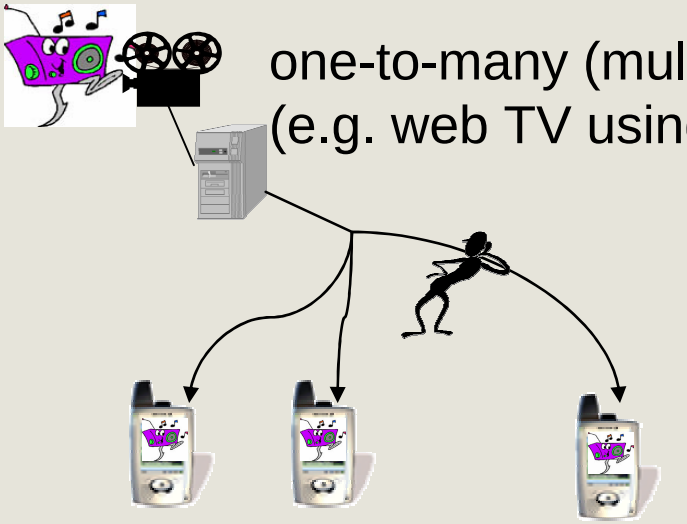
Case Study 1:
Importance of Efficiency
Importance of Wireless Considerations

Application: Multimedia Stream Protection

peer-to-peer communication (e.g. SIP call)



one-to-many (multicast)
(e.g. web TV using RTSP)

Requirements to Consider

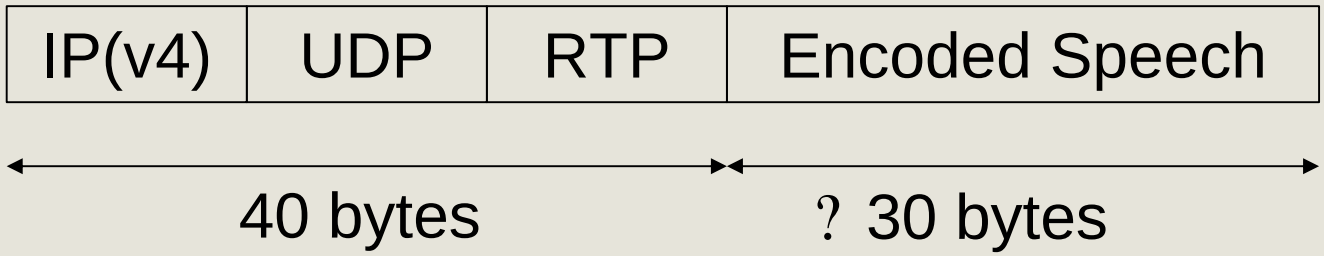
Wireless links can have

- Low bandwidth, high RTT
- Bit-errors
- Unequal Error Protection (UEP)

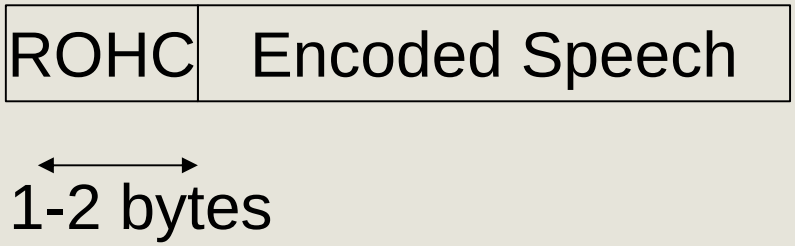
Most CODECS built to tolerate a few bit errors, but packet loss degrades speech quality

- Security processing should not increase size, bit-error rates, or packet loss rates
- Minimize # roundtrips for key-exchange

Typical VoIP Application



Header Compression (RFC 3095) needed for economy:



? Security processing must allow header compression

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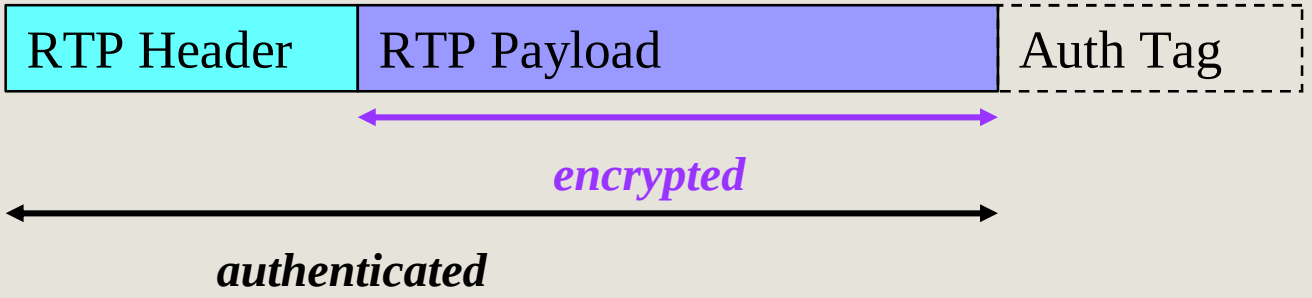
Solution: SRTP

Secure RTP protocol (SRTP)

- AES -based stream cipher encryption
- Benefits:
  - Bit-error friendly
  - No expansion & allows header compression
  - Minimal key management roundtrips with MIKEY
- Bandwidth usage halved, no delays, good voice quality!



Secure Conversational Multimedia Example

v=0
o=bob 2891092897 2891092897 IN IP4 found
s=Cool stuff
e=bob@null.org
t=0 0
c=IN IP4 found.somewhere.com
a=key-mgmt:MIKEY skaoqDeMkdwRW278
m=audio 49030 RTP/SAVP 98
a=rtpmap:98 AMR/8000
m=video 52230 RTP/SAVP 31
a=rtpmap:31 H261/90000

v=0
o=alice 2891092738 2891092738 IN IP4 lost.somewhere.com
s=Cool stuff
e=alice@w-land.org
t=0 0
c=IN IP4 lost.somewhere.com
a=key-mgmt:MIKEY uiSDF9sdhs727ghsd/dhsoKkdOokdo7eWsnDSJD...
m=audio 49000 RTP/SAVP 98
a=rtpmap:98 AMR/8000
m=video 52230 RTP/SAVP 31
a=rtpmap:31 H261/90000

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Case 2: Mobile IPv6 and the Importance of Scalable Security

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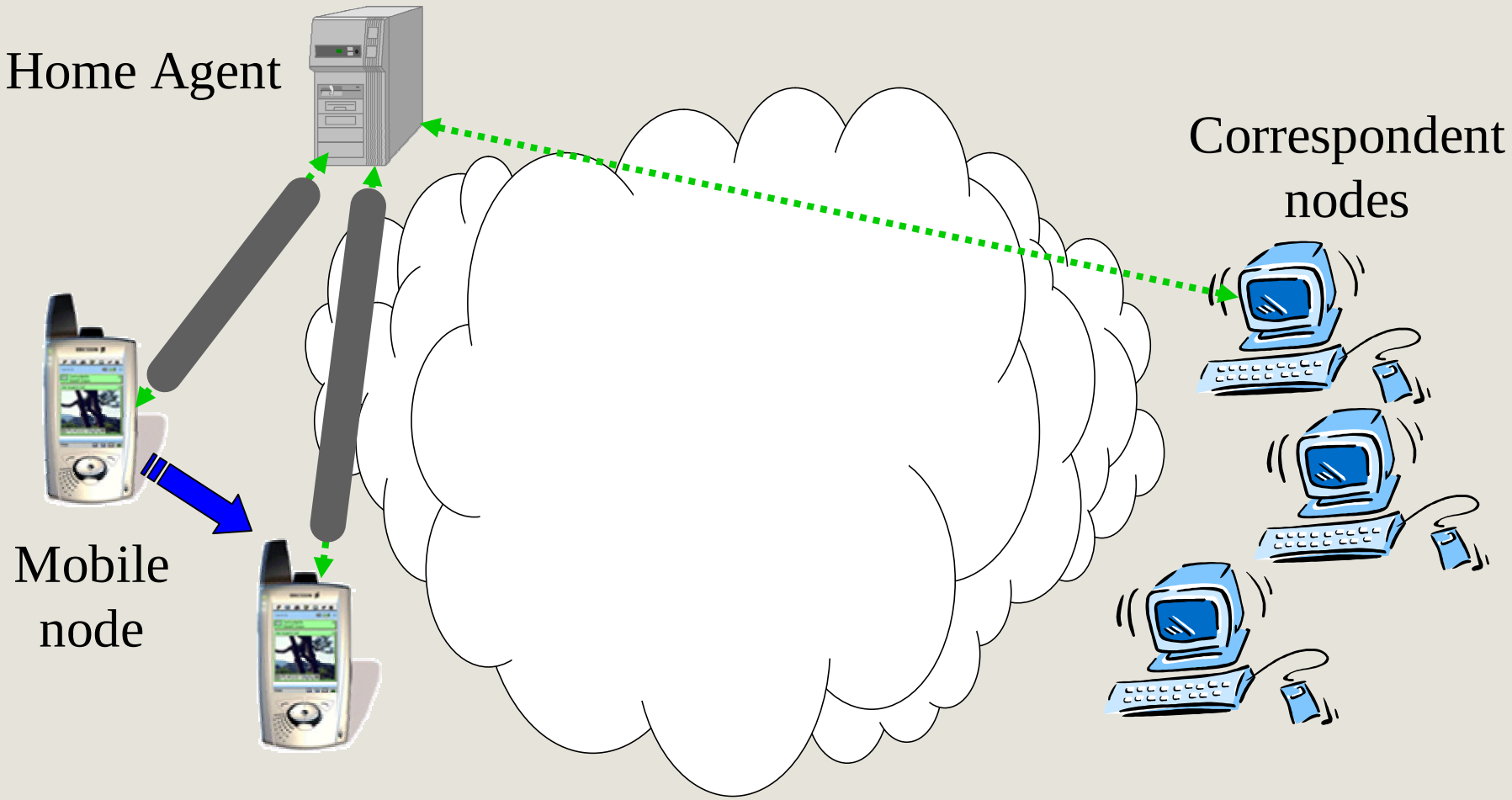
Mobile IPv6



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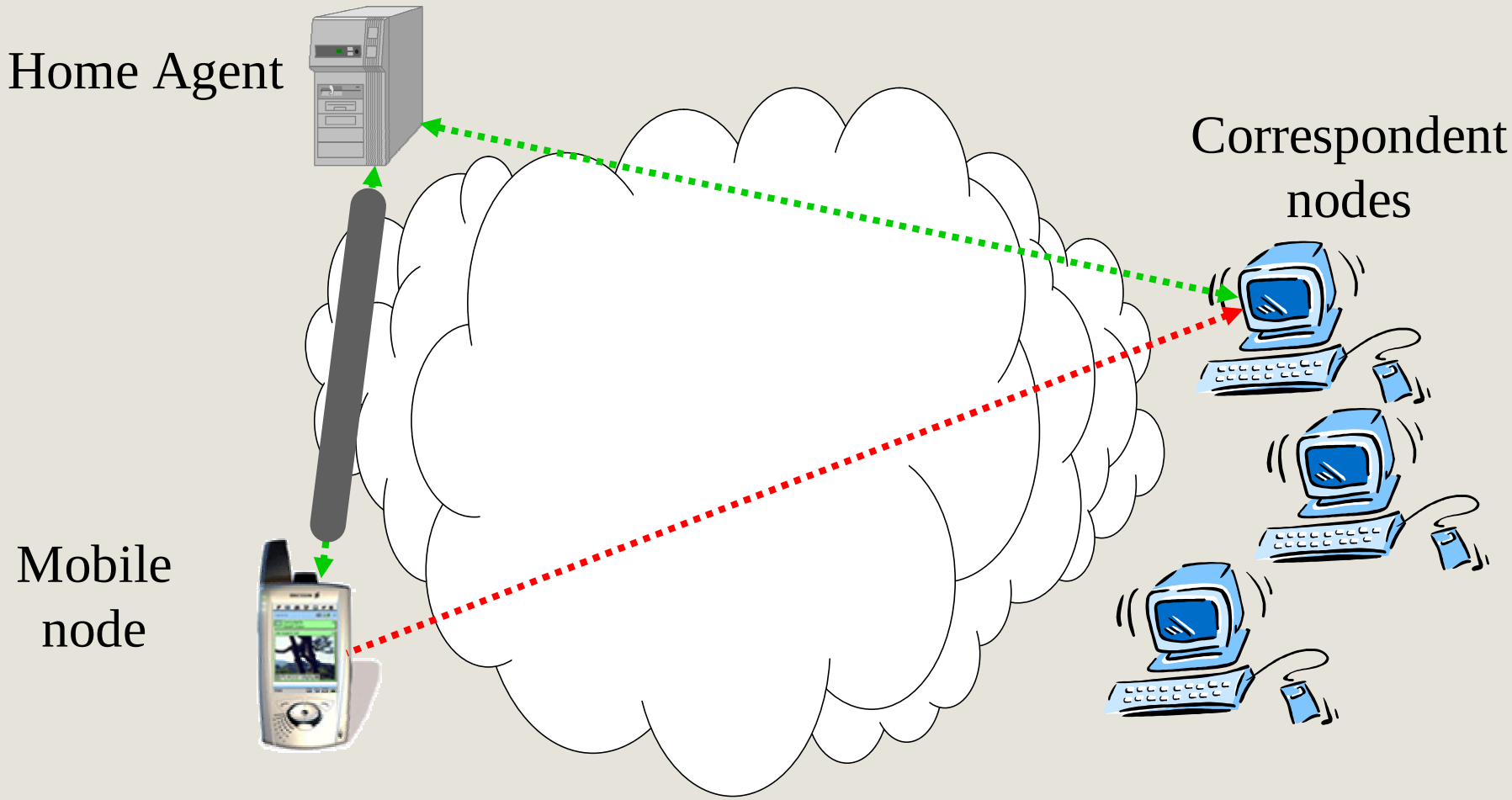
Route Optimization



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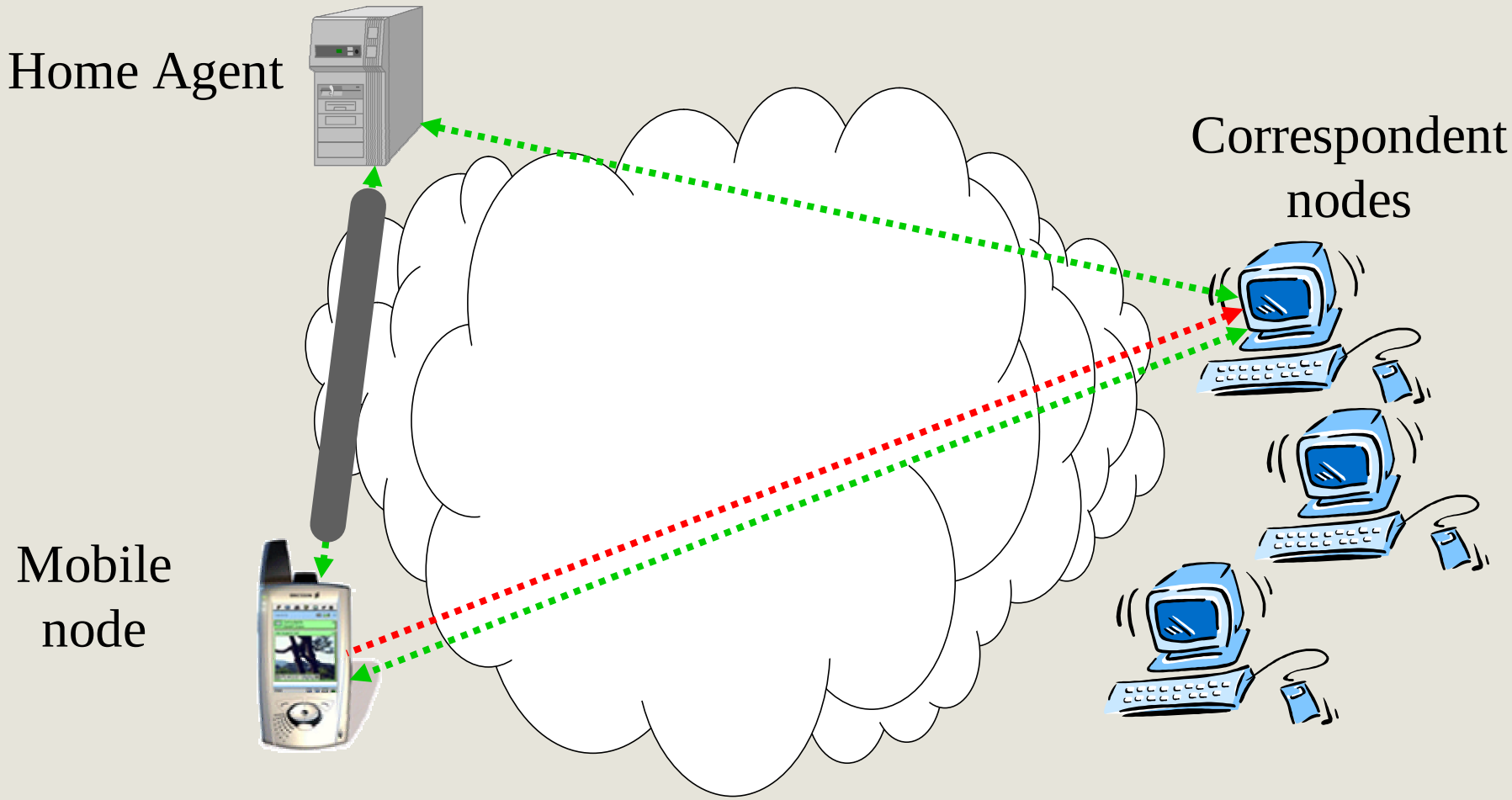
Route Optimization



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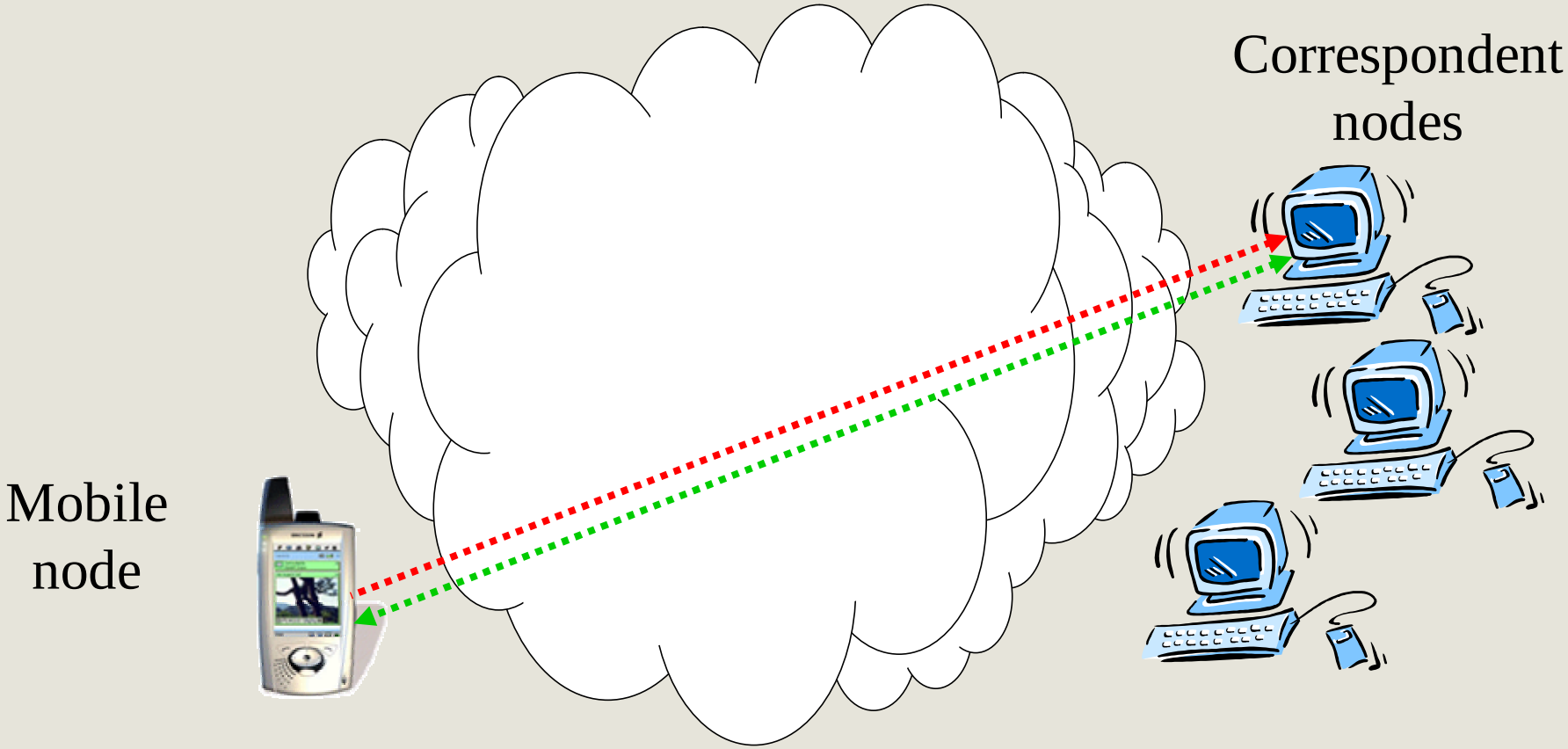
Route Optimization



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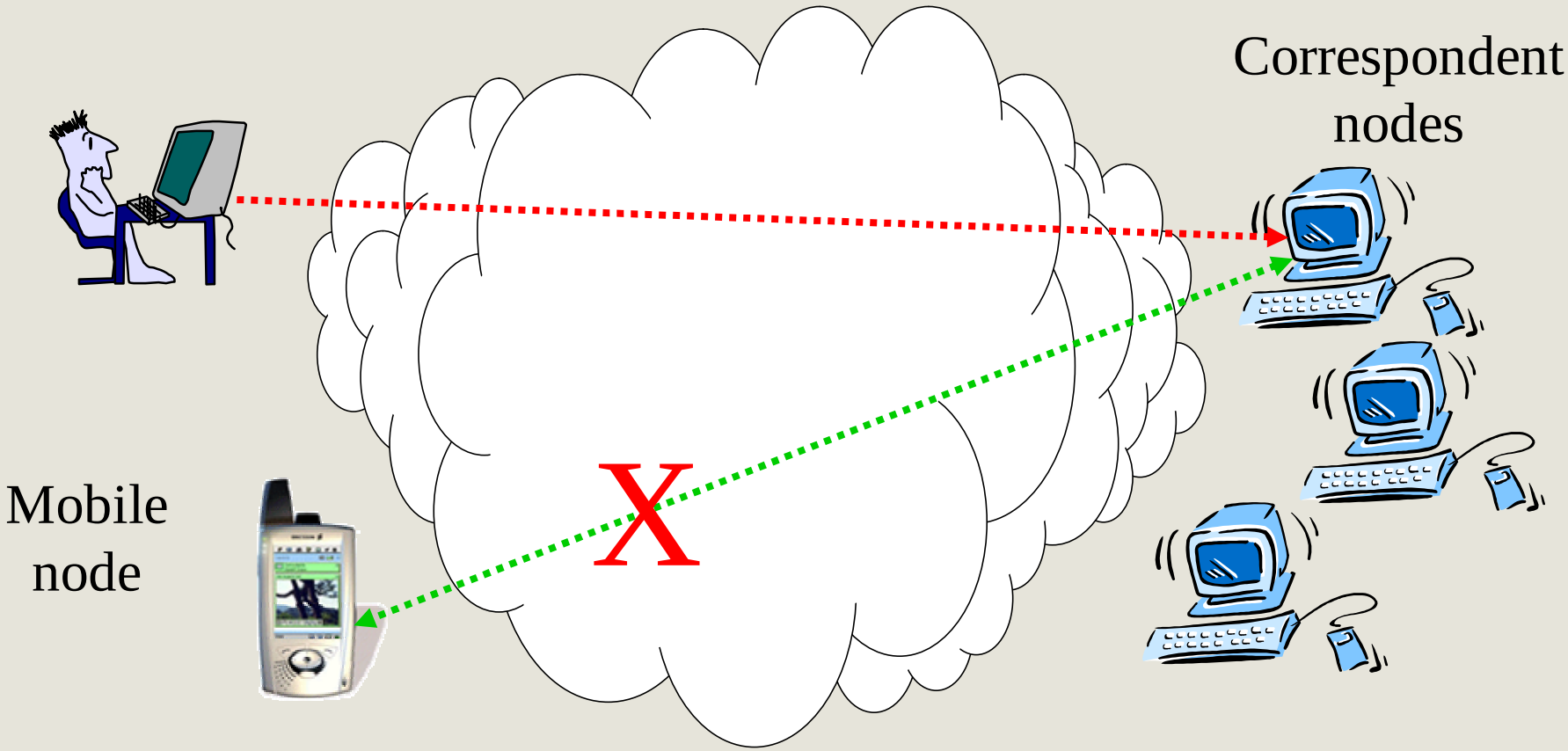
Threats Involved in Route Optimization (1)



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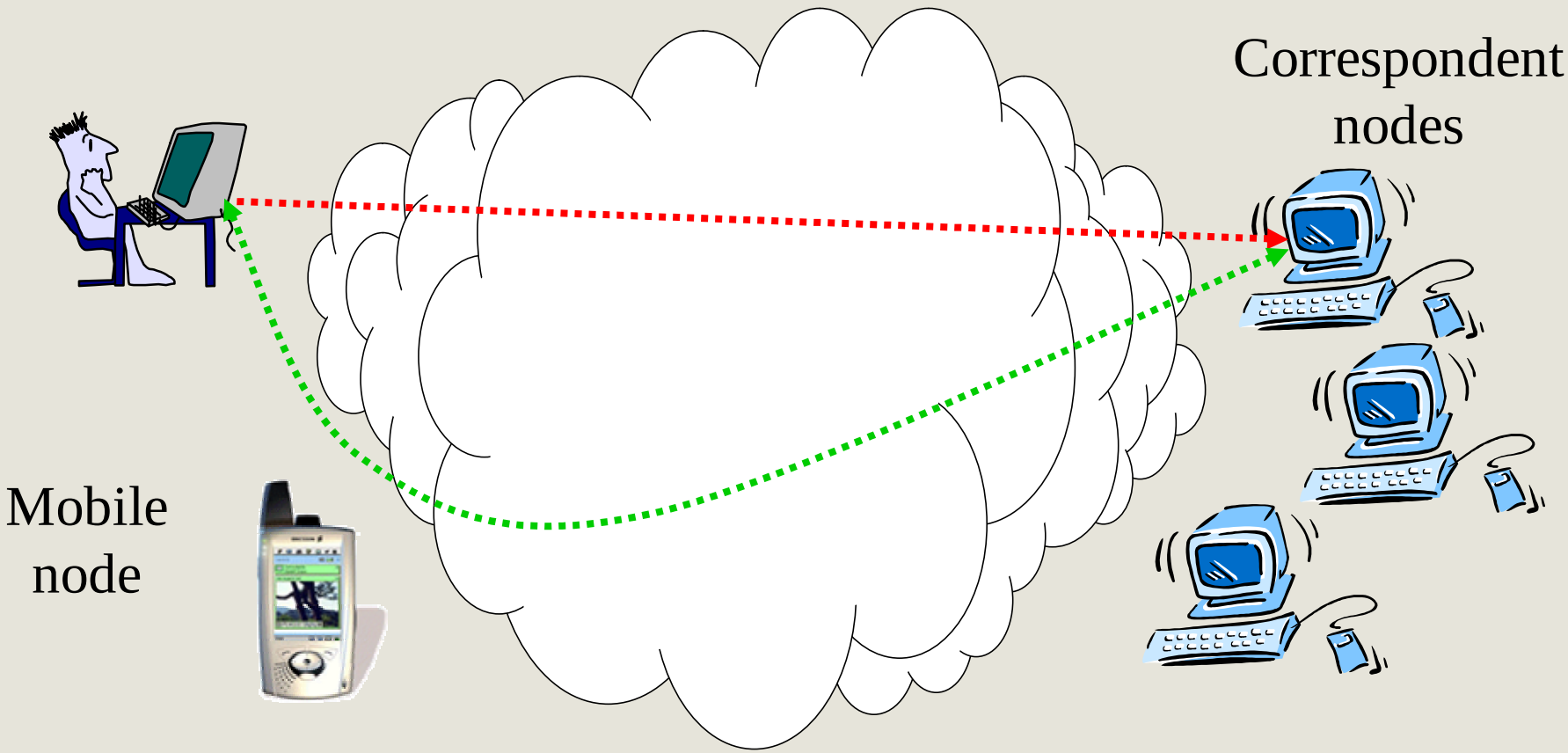
Threats Involved in Route Optimization (2)



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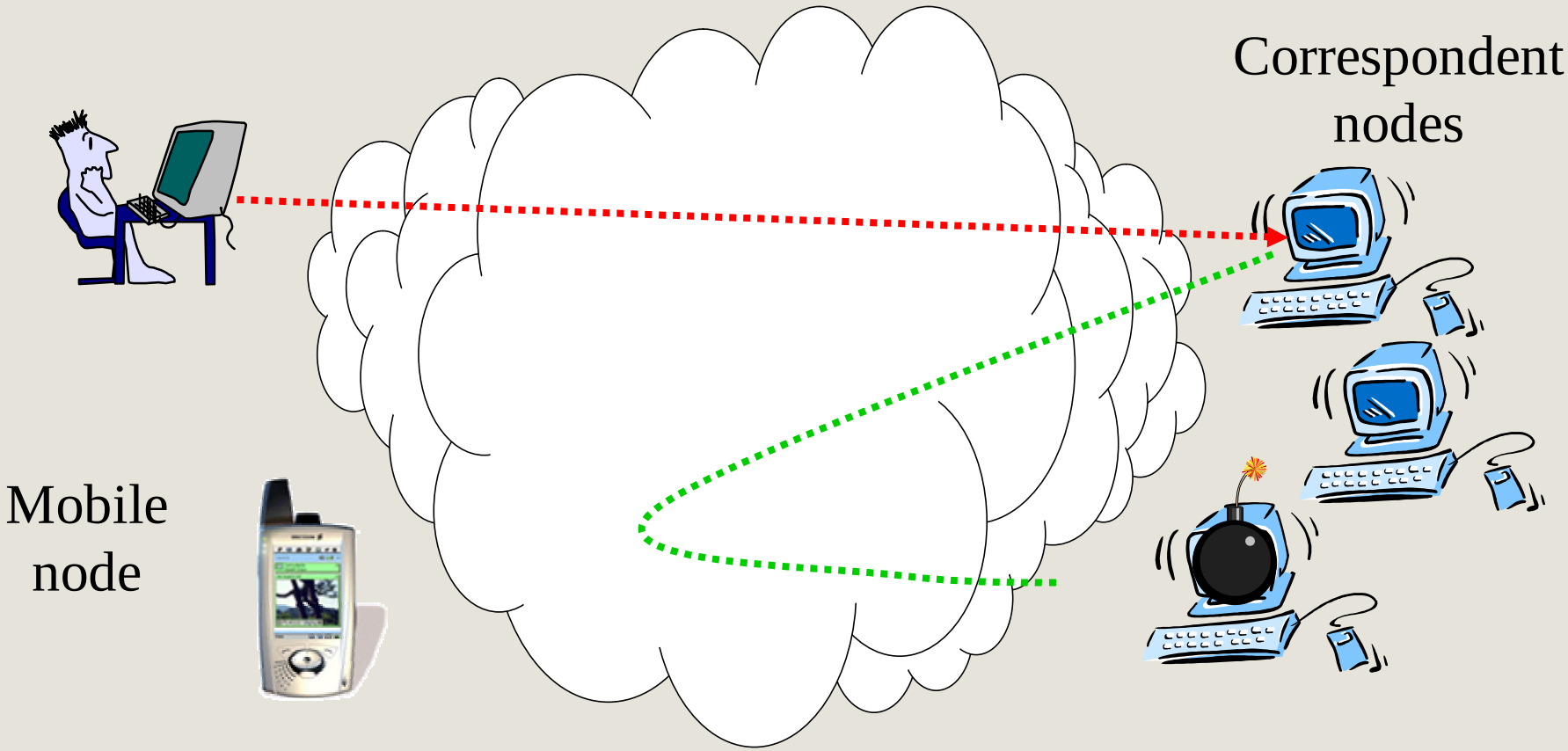
Threats Involved in Route Optimization (3)



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Securing Route Optimization

- Clearly, security is needed.
- Approach #1: All signaling must be protected by a security association.
- Are we done?

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Problems with Approach #1

- Originally, our communications to peers did not require security associations

  (Sometimes SAs were not used, but not always)
- Then we added signaling for an *optimization*
- The end result is that we need SAs for all peers
- Very, very hard to establish global security between everyone
- Worse, it wouldn't show address ownership

? RO in very limited use or no security

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Approach #2: Zero-Configuration Security

- It turns out that one can test address ownership by sending messages to the addresses
- Needs a cryptographic exchange
- But no configuration, SAs, or infrastructure
- There are some remaining threats, but these exist in IPv6 even without mobility

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Lessons Learned - Scalability

- Deployment must be feasible
- Importance of function vs. cost
- Understand the threats

  Combat the threats, not more
- Understand what the mechanisms provide
  - For instance, authentication does not help authorization

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Lessons Learned - Other

- Design security along the rest of the design
  Risk major rework if not followed!

- Take in account threats to innocent third parties

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The Future of the Mobile Internet

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What's Next?

- Seamless operation and multi-everything
- Open business and technology model
- Many co-operating devices
- Communications without a controlling operator
- Protecting the user and availability of services

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Implications of the Future Scenario

- Mobility in different forms
- Peer-to-peer trust vs. user-to-operator trust
- End-to-end vs. hop-by-hop
- Co-operative vs. centralized solutions
- Deployment and scalability of security
- Hard outside, soft inside no longer sufficient
- Privacy

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Case 3: Host Identity Protocol (HIP) and the Insignificance of IP Addresses

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Some Interesting Network Functions

- End-host mobility
  - IP address changes to the location
- End-host multihoming
  - IP address changes when another interface used
- NAT traversal
  - IP address changes all by itself...
- IPv4 - IPv6 transition
  - IP address changes; this is like NAT but useful

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Network Functions, Continued

- Mobile networks
  - IP address changes to the router's address or prefix
- Location privacy
  - IP address changes from real to the public one
- Local mobility management
  - IP address changes (locally)
- Smooth handovers
  - IP address changes or there are simultaneously many

? See the pattern?

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IP Address = locator + endpoint identifier

- Addresses act also as endpoint IDs for TCP etc
- Does this make sense?
- Enter the Host Identity Protocol (HIP):
  - New layer
  - Hosts identified by public keys (or rather their hashes)
  - Sockets bound to host identifiers, not addresses
  - Dynamic binding to current IP address
- Mobility and multi-homing are duals of each other
- Most functions in our list become easier to solve
- Something to consider? Ongoing research…
  - Mailing list “hipsec” at lists.freeswan.org

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Conclusions

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Conclusions

- Security makes a big difference in quality of our protocol designs
- Key points to consider with new designs:
  - Design security at the same time as the function itself
  - Design security for the task at hand
  - Solutions need to be scalable and deployable
  - Consider the characteristics of solutions over wireless
  - Consider threats to third parties
  - Consider architectural changes when going gets tough

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More Information

- IETF WGs: Mobile IP, Nemo, AVT, MSEC, EAP, AAA, PANA
- 3GPP WGs: SA2 (architecture) and SA3 (security)
- IEEE WGs: 802.1x and its newer versions
- Other: “hipsec” list at lists.freeswan.org