Overview of [mobile-ip] & [seamoby]

Nokia Research Center

Mountain View, CA USA

Charles E. Perkins

http://people.nokia.net/charliep

charliep@iprg.nokia.com

NOKIA

Outline of Presentation

- Mobile IP in General
- What's great for mobility about IPv6?
- How Mobile IPv6 works
- Recent results from Mobile IPv6
- Context Transfer and Seamless Handover
- Challenges for the future

NOKIA

Earth with 2 Billion Mobile devices

- One billion is a large number; we're there as of June, 2002?
- It's never been done before!
- In the beginning, most of them will not be Internet enabled, but they will come online rapidly
- If IPv4 can do it at all, it will be at a tremendous (unimaginable, even) cost in complexity
- Only IPv6 offers enough addresses; the Internet is still young!
- IPv6 also offers the features needed for mobile networking
- Only Mobile IPv6 takes advantage of the IPv6 features to offer seamless roaming.
- Network-layer roaming also enables significant cost reductions and improved deployability

NOKIA

Protocol Stacks vs. Mobility

- Mobility affects every layer of the protocol stack
  - Physical layer: variable S/N ratio, directionality, etc.
  - Link-layer: error correction, hidden terminal effects, …
  - Network layer: what this talk is about!
  - Transport layer: congestion vs. errors, ?QoS?
  - Application configurability, service discovery
- Eventually, the Internet will be dominated by mobile nodes
  - but as of now the IETF effort doesn't reflect this!
- Low level protocols attempt to provide transparency
- But application protocols sometimes need triggers
  - ➔ need for new APIs to support mobility
- Levels 8, 9, and 10 are also affected by mobility
- Profile management and adaptive network environment

NOKIA

Why Mobile IP?

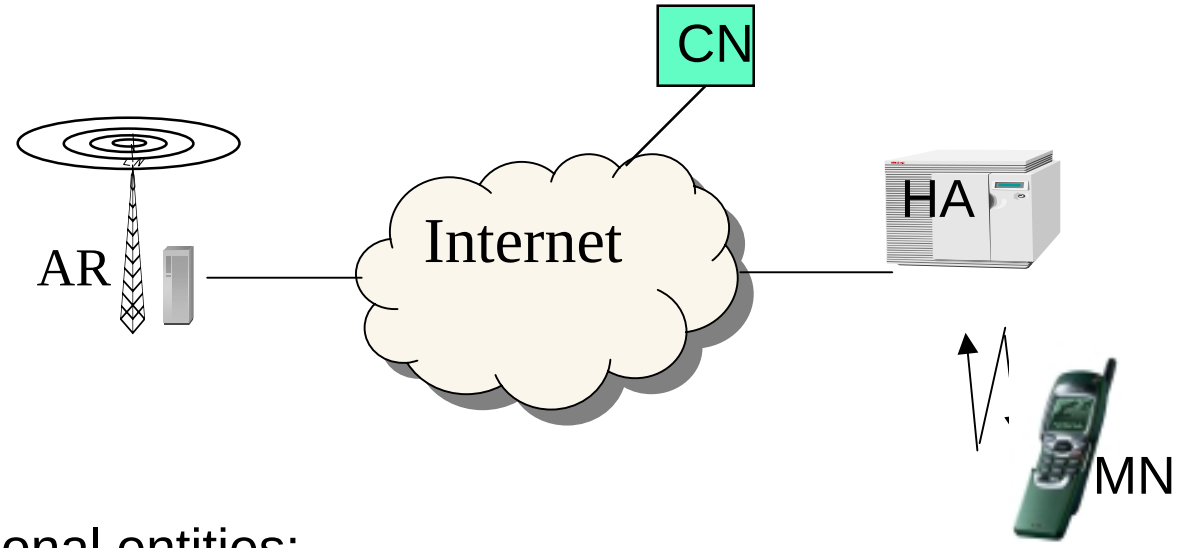
- Both ends of a TCP session (connection) need to keep the same IP address for the life of the session.
  - This is the *home address*, used for end-to-end communication
- IP needs to change the IP address when a network node moves to a new place in the network.
  - This is the *care-of address*, used for routing

Mobile IP considers the mobility problem as a *routing* problem

- managing a *binding* – that is, a dynamic tunnel between a care-of address and a home address
- *Of course*, there is a lot more to it than that!

NOKIA

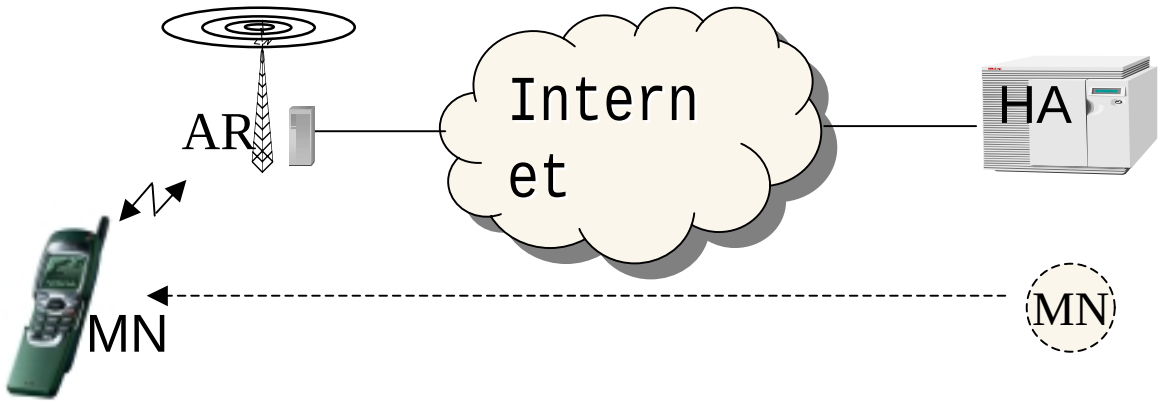
Overview of Mobile IP



- Functional entities:
  - Mobile Node (MN) (shown on Home Network)
  - Home Agent (HA)
- Other entities
  - Access Router (AR)
  - Correspondent Node (CN)

NOKIA

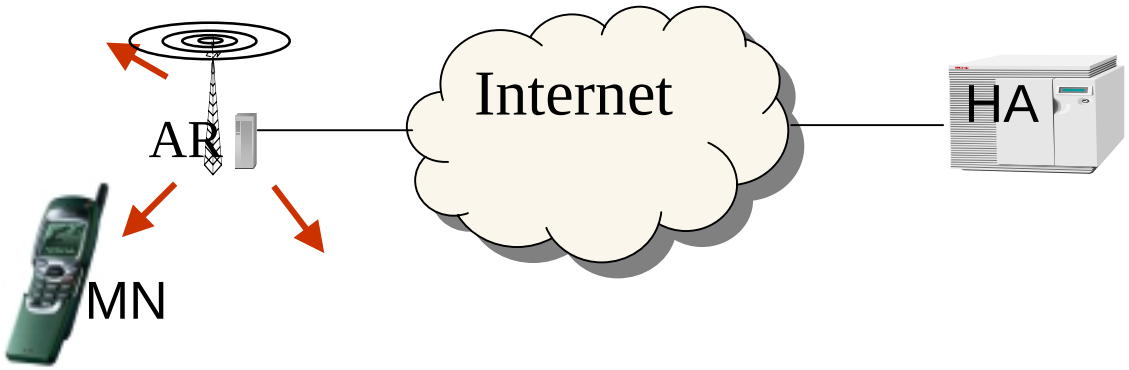
Addresses used with Mobile IP



- Home address
  - Embodies the *identity* of the mobile node
  - Exists on the *Home Network*
- Care-of address
  - Embodies the *location* of the mobile node
  - Exists on the network served by the *Access Router*

NOKIA

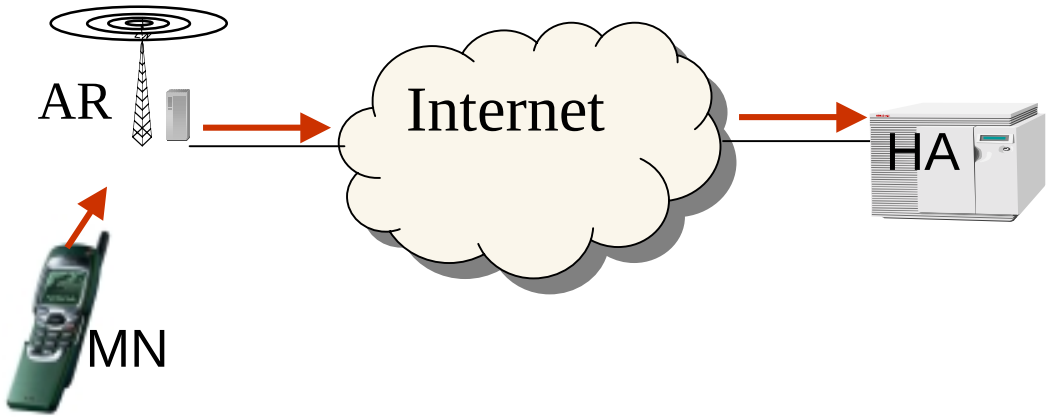
Router Advertisement



- AR discovery / Care-of Address Acquisition
  - Router Advertisement (contains routing prefix)

NOKIA

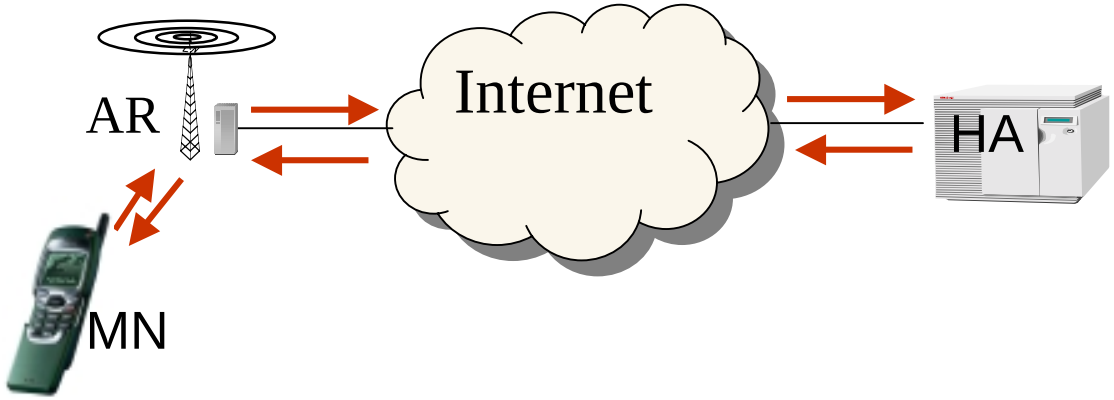
Sending Care-of Address to the Home Agent



- Mobile node formulates care-of address from AR advertisement
- Mobile node Unicasts Binding Update to Home Agent

NOKIA

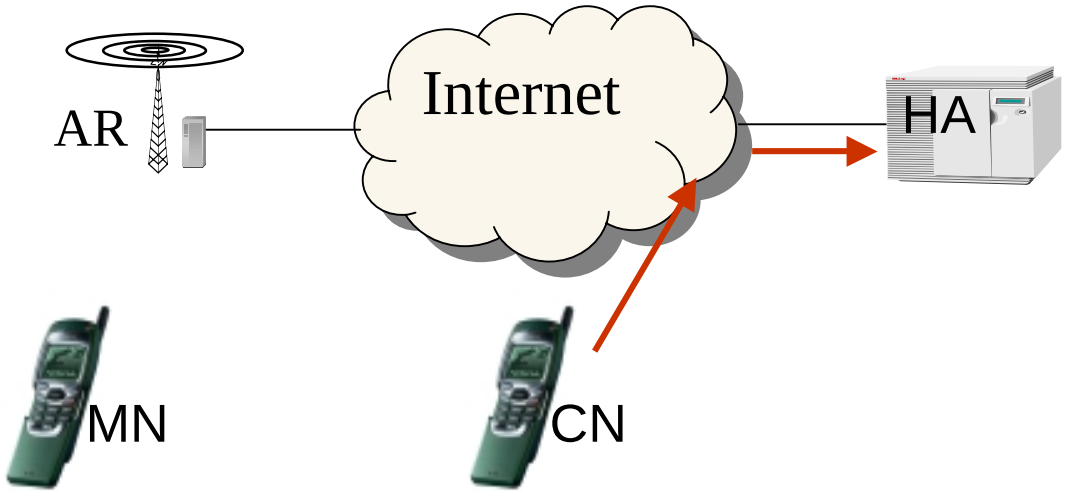
Home Agent Accepts Binding



- Home Agent Accepts Binding Information
  - Mobile obtains care-of address from AR advertisement
  - Mobile Unicasts Binding Update to HA
  - HA returns Binding Acknowledgement

NOKIA

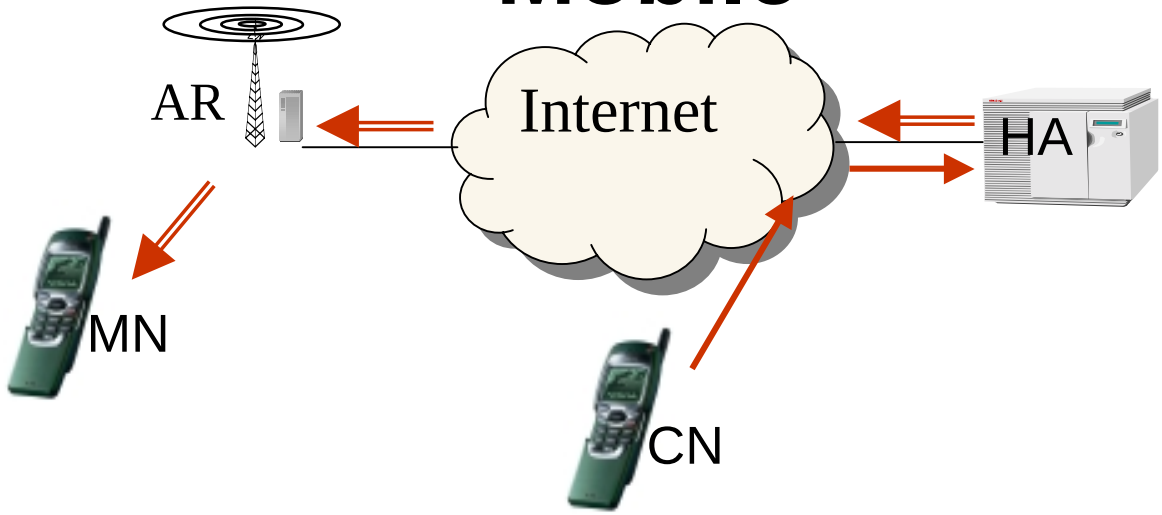
Overview of Mobile IP: Routing to Mobile



- Correspondent node sends packets to mobile's home network

NOKIA

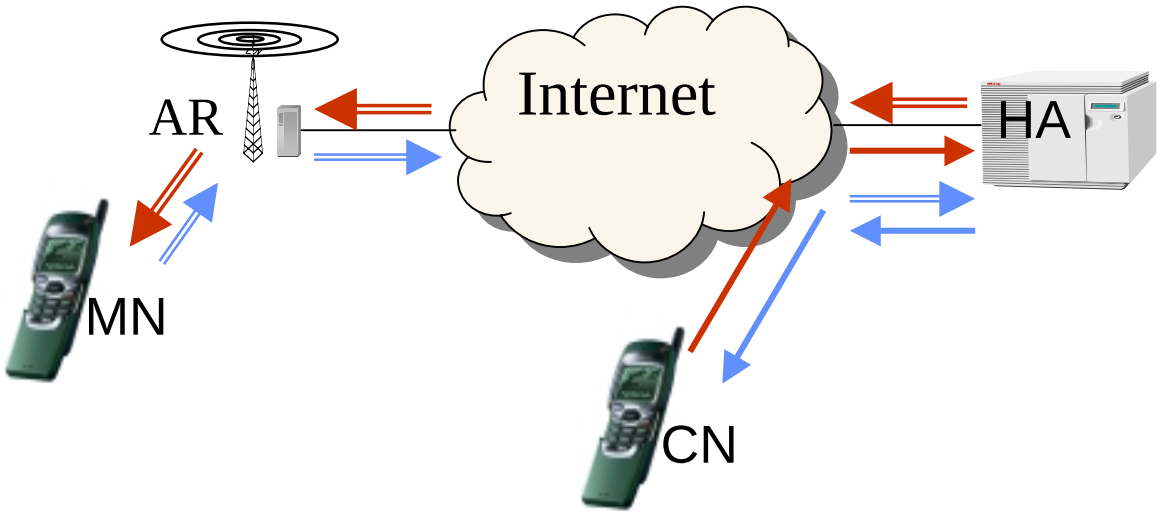
Overview of Mobile IP: Routing to Mobile



- Correspondent node sends packets to mobile's home network
- Home Agent intercepts packets and tunnels them to care-of address

NOKIA

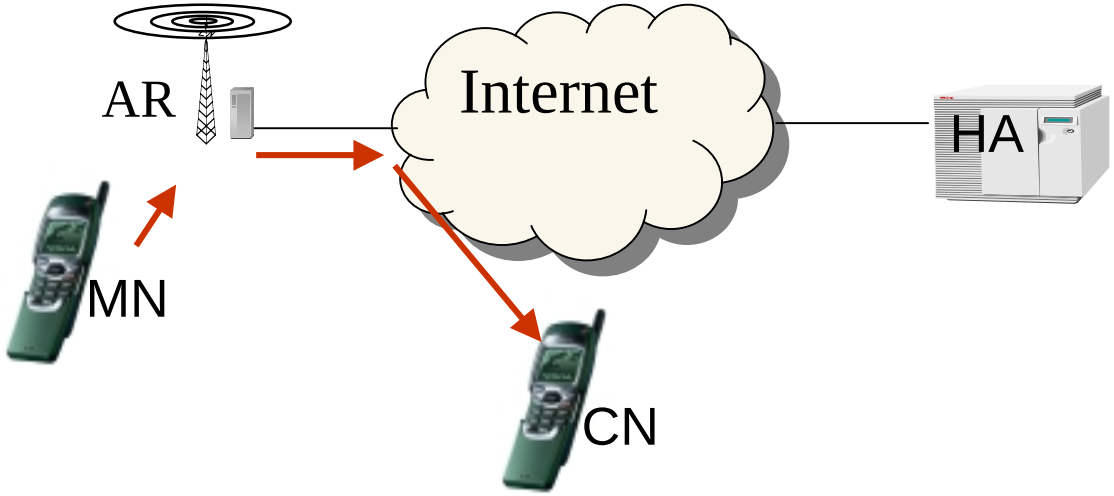
Routing without Binding Update at Correspondent Node



- Mobile reverse tunnels packets to home network
- Source (CN) nodes send packets to mobile's home network
- HA intercepts packets and tunnels them to care-of address

NOKIA

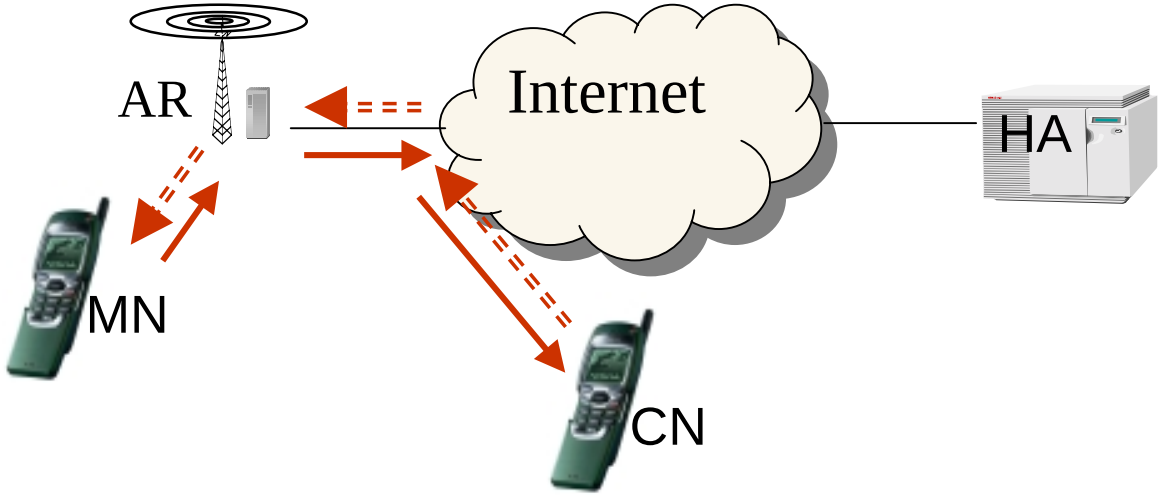
Overview of Mobile IP



- Mobile sends a Binding Update to the Correspondent Node
  - Correspondent node needs to have a security association with mobile node

NOKIA

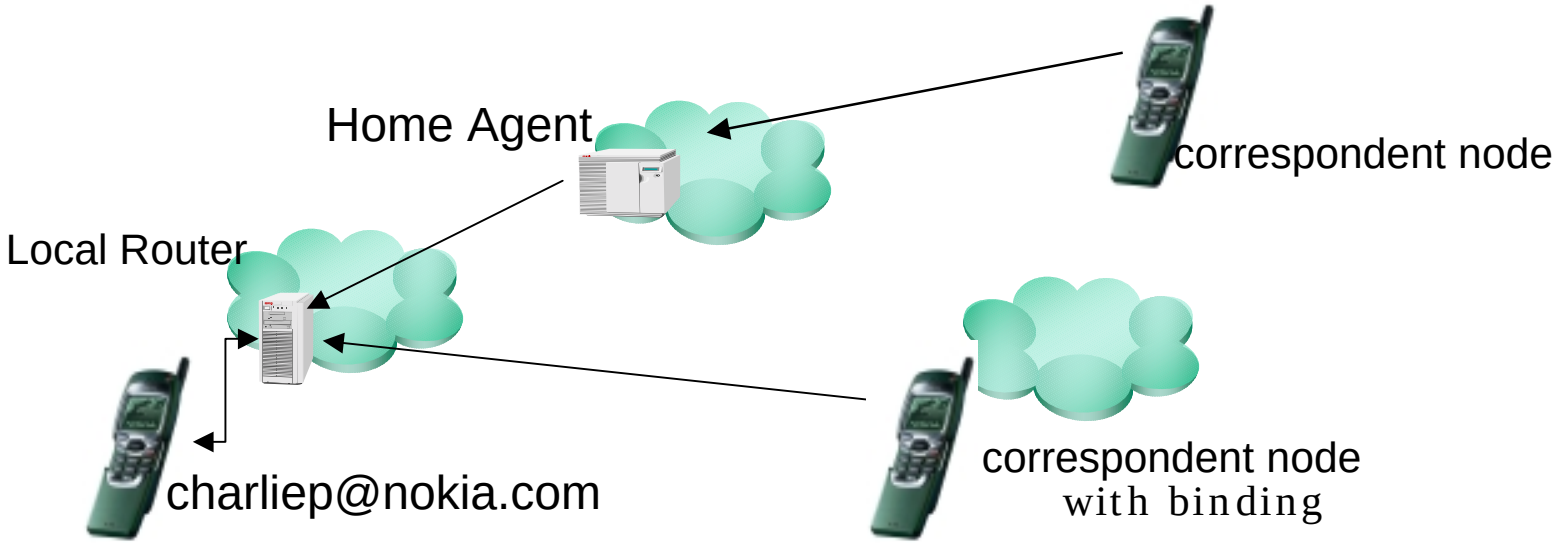
Overview of Mobile IP



- Mobile sends a Binding Update to the Correspondent Node
  - Mobile node routes packets directly to source
  - Correspondent node send packets directly to mobile node's care-of address
    - *uses routing header*

NOKIA

Mobile IP protocol overview



- Routing Prefix from local Router Advertisement
- *Seamless Roaming*: Mobile Node appears "*always on*" home network
- Address autoconfiguration → care-of address
- Binding Updates → home agent & correspondent nodes
  - (home address, care-of address, binding lifetime)

NOKIA

Features added to IPv6

- Binding Cache management in new Mobility Header
  - (a lot like the existing Destination Options header)
- Route optimization using new Route Header
  - (Almost exactly like the existing Route Header was used)
- New ICMP messages
  - For Home Agent discovery
- New Router Advertisement extension
  - For renumbering
  - Binding Request message type

NOKIA

Route Optimization

- Most Internet devices will be mobile, so we should design for that case for the health of the future Internet
- Binding Update *SHOULD* be part of every IPv6 node implementation, according to IETF specification
- Reduces network load by ~50%
  - (depending on your favorite traffic model)
- Route Optimization could *double* Internet performance
  - reduced latency
  - better bandwidth utilization
  - reduced vulnerability to network partition
  - eliminate any potential Home Agent bottleneck

NOKIA

Security issues: (IPsec *NOT sufficient*)

- Authentication Header *mandatory to implement*
- Encapsulating Security Payload *mandatory to implement*
- Needed for Binding Update
  - Remote Redirect problem
- Key distribution still poorly understood
  - PKI?
  - AAAv6 w/ symmetric key?
- Can your m-commerce server manage 10 million security associations?
- Can your light bulb manage 10 security associations?
- *"First, do no harm"*

NOKIA

Message Types

- Binding Cache Maintenance
  - Binding Update
  - Binding Acknowledgement
  - Binding Request
- Home Address Option
- Return Routability Tests
  - Home Address Test Initiate
  - Care-of Address Test Initiate
  - Home Address Test
  - Care-of Address Test
- Renumbering Messages
  - Mobile Prefix Solicitation
  - Mobile Prefix Advertisement
- Home Agent Discovery

NOKIA

Header Types

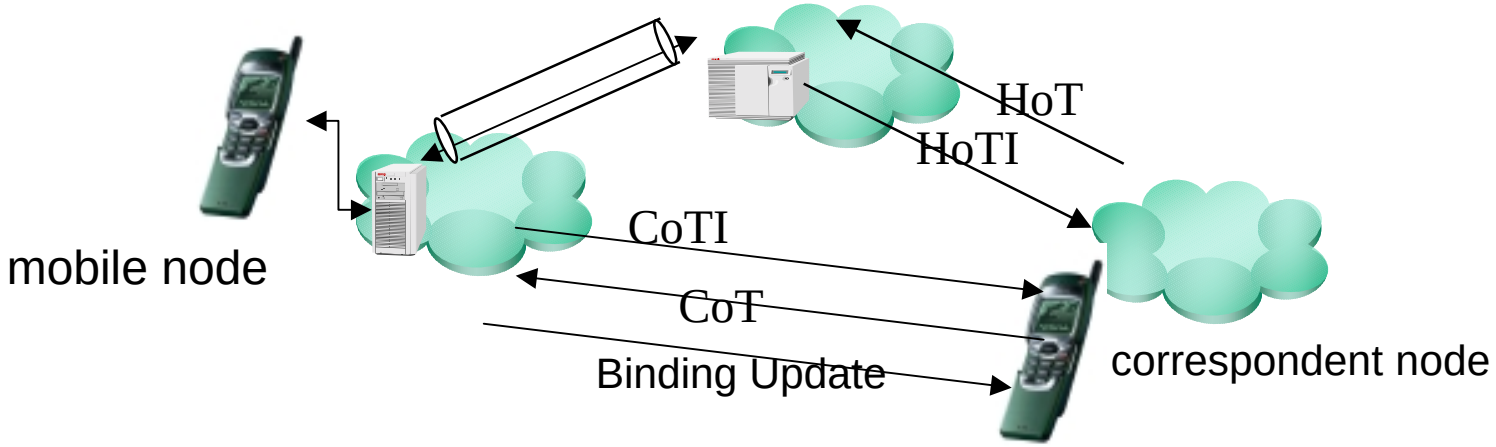
- Mobility Header
  - All Binding Cache messages
  - Return Routability messages (HoTI, CoTI, HoT, CoT)
- New Routing Header for comfortable firewall administration
  - Used by correspondent nodes
  - Has intermediate node == mobile node's care-of address (cannot be forwarded)
  - Presumably makes firewall administrators happier
- Destination Option Header contains Home Address Option
- IPv6 in IPv6 encapsulation
- *Non-Final* Mobility Header
  - Same messages, but can carry payload also
  - Should be a working-group document by the this time
- ICMP for Home Agent Discovery

NOKIA

Establishing a Binding Security Association

- BSA is needed specifically for authenticating Binding Updates
- Return Routability (RR) tests rely on routing infrastructure
- Mobile IPv6 RR enables mobile *authentication* not *identification*
  - Latter could require validation via *certificate authority*
  - The correspondent node only has assurance that the Binding Update comes from the same node as before
- Mobile IPv6 solution resists Denial of Service (DoS) attacks
- "First, do no harm"
  - That is, we must be as safe as communications between statically located IPv4 network nodes
  - Only nodes between correspondent node and home network can disrupt traffic

RR Protocol Overview



- Test return routability for home address (HoTI, HoT)
- Test return routability for care-of address (CoTI, CoT)
- HoT and CoT carry nonces to be combined to make K*bu*
- Very few nodes see nonces in both HoT and CoT
- BSA in current specification is short-lived
- Correspondent node keeps no *per-mobile* state during HoT/CoT
- Diffie-Hellman could be another option
  - but it's either expensive or patented

NOKIA

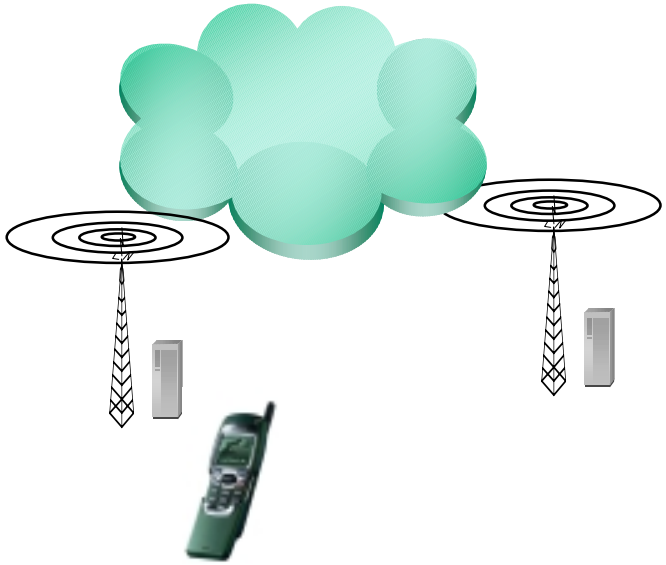
Mobile IPv6 status

- Mobile IPv6 testing event Sept 15-17, 1999
  - Bull, Ericsson, NEC, INRIA
- ETSI bake-offs, 2000 & 2001 – success!
- Connectathon March 2000, 2001, 2002 – success!
- Return Routability for Key Establishment
- Distinguishing between renumbering and movement
  - tunneled router solicitations and advertisements
- Authentication data in option, as well as in AH or ESP(?)
- Fast handover design team has issued Internet Draft
- Chairs and ADs are pushing for re-completion
  - Draft …-19.txt has gone to the IESG

NOKIA

Smooth/Fast/Seamless Handover

- Smooth handover == low loss
- Fast handover == low delay
  - 30 ms?
  - Can router pre-empt Duplicate Address Detection??
- Seamless handover == *smooth* and *fast*



NOKIA

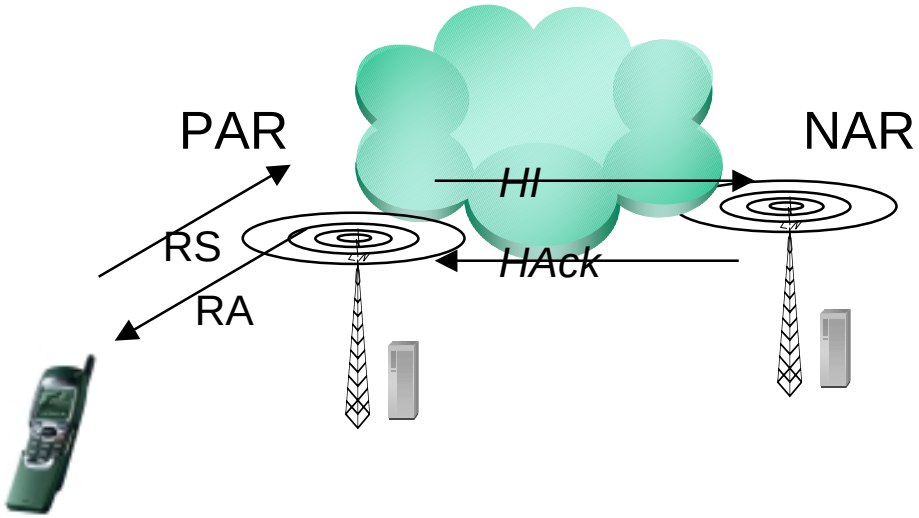
Context Features for Transfer

- Feature state established to minimize connection overhead
  - Mainly, to conserve bandwidth
- Header Compression
- Buffered Data
- Quality of Service requirements, and perhaps accounting data
- Security Association with access router, authorization tokens
- Application context transfer also needed, but not appropriate for resolution within mobile-ip, aaa, rohc, or seamoby working groups
- Care-of Address, MAC address, etc. handled via *fast handover*

Context Transfer Framework

- Control messages
  - HI and Hack (ICMP messages) from Mobile IPv6 fast handover design team are good candidates
  - What about scenarios besides smooth handovers?
  - Context features requested/provided as options
  - Could be another ICMP message, or SCTP, or Dest Opt, or ??
- Generic Profile types
  - Could be used with any control messages
  - Most kinds of context features will have a number of variants, each with different profile types (e.g., QoS, or [rohc])
  - Profile types would be registered with IANA, and each specification would lay out fields of suboptions
  - Presence vectors/default values for each field

Mobile-controlled handover

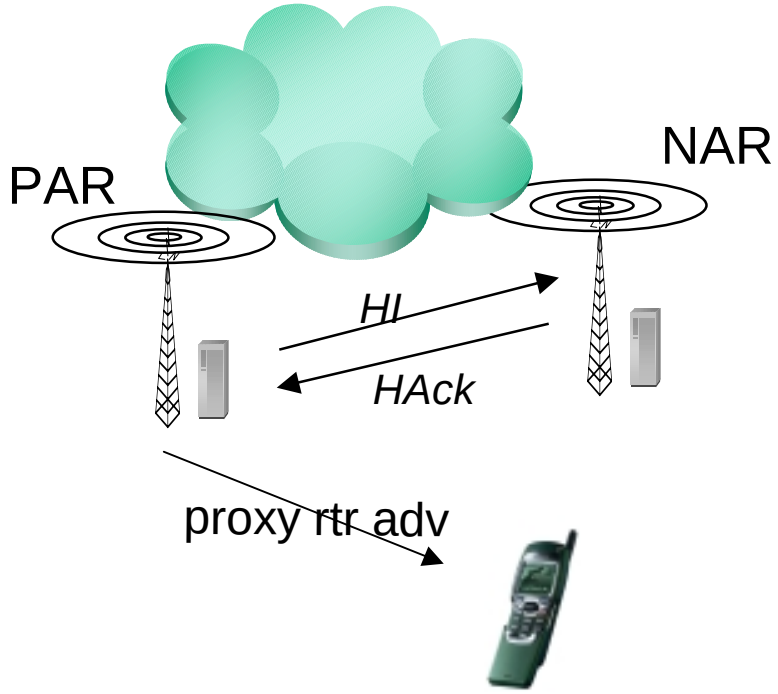


One scenario: mobile sends special Router Solicitation (RS)

- Previous Access Router → *Proxy* Router Advert. (RA)
- Previous Access Router sends Handover Initiate (HI)
- New Access Router → Handover Acknowledge (HACK)

NOKIA

Network Controlled Handover



- Previous access router (PAR) sends Proxy Router Advertisement on behalf of the new access router (NAR)
  - contains prefix and lifetime information, etc.
- PAR sends *Handover Initiate* message to NAR
- Mobile node *SHOULD* finalize context transfer at NAR

NOKIA

Features Needed from Layer 2

- For Mobile IPv6
  - Indication that handover has occurred
- For smooth handover
  - Indication that handover is occurring
  - Indication that handover is about to occur
  - Indication about next access point/access router
- Next week in Atlanta: Trigtran
  - To discuss what “layer-2” triggers are needed

Summary and Conclusions

- Mobile IPv6 offers *scalable*, *secure*, and *high-performance* mobility management
- Mobile IPv6 is working, and new issues are resolved
  - There's lots of interoperability experience, but new draft is different
  - Implementation is natural under IPv6 and IPsec
- Binding Update now has a lightweight key establishment protocol
  - *"First, do no harm"*
- Fast Handover has been developed for improved handover performance (goal: smooth voice handovers – and, *video*!)
- Context Transfer to preserve link contexts to avoid re-establishment (gaining further performance improvements)