

Gemini Communication Ltd.

Innovation & Leadership

Mobile IP

The benefit of Mobile IP

“

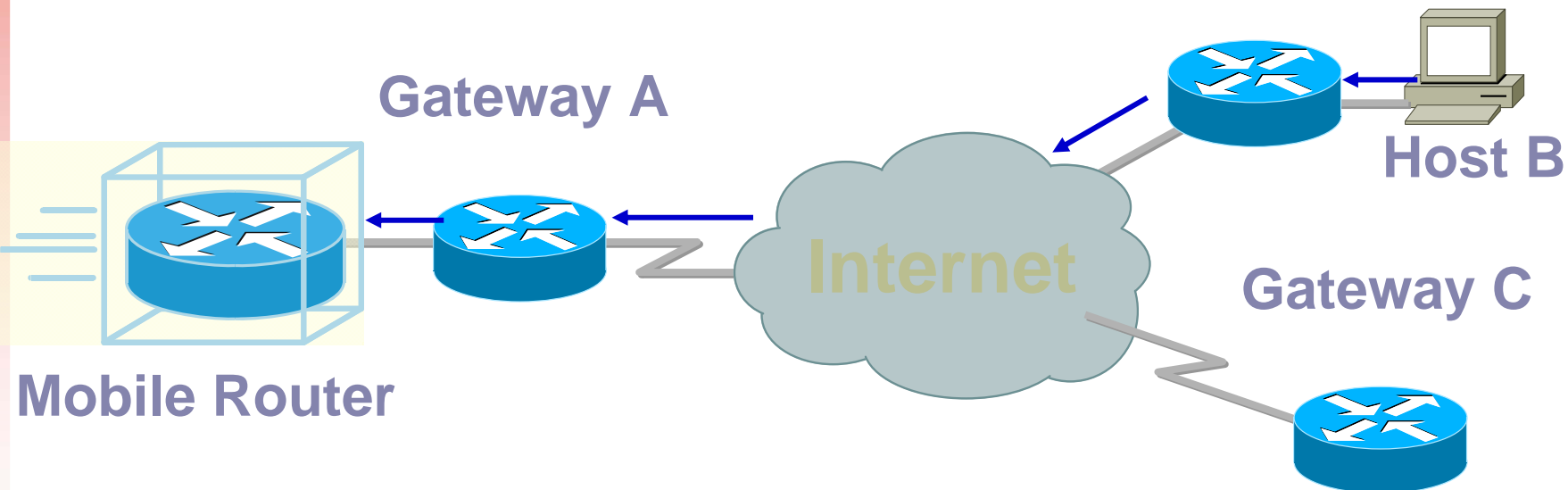
“Mobile IP provides an IP node the ability to retain the same IP address and maintain uninterrupted network and application connectivity while traveling across networks

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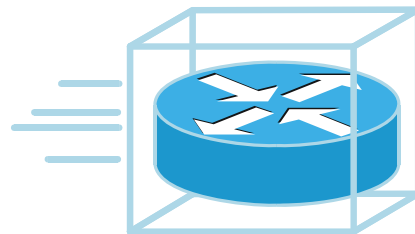
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The objective

Maintaining continuous IP connectivity while crossing network boundaries, e.g. subnets or between networks



Mobile IP



Operator Benefits

- **All applications work without modifications (unlike application/transport layer mobility)**
- **Operator can control handover policies**
- **Access link independent (unlike link layer mobility)**

Mobile Networking Technology

Solution in a Nutshell

- A mobile node has a “home address” for the end-to-end communications, but also uses a temporary “care-of address” on access networks for routing purpose.
- A home agent maintains a mobility binding of home address and care-of address.

Mobile IP Network Elements

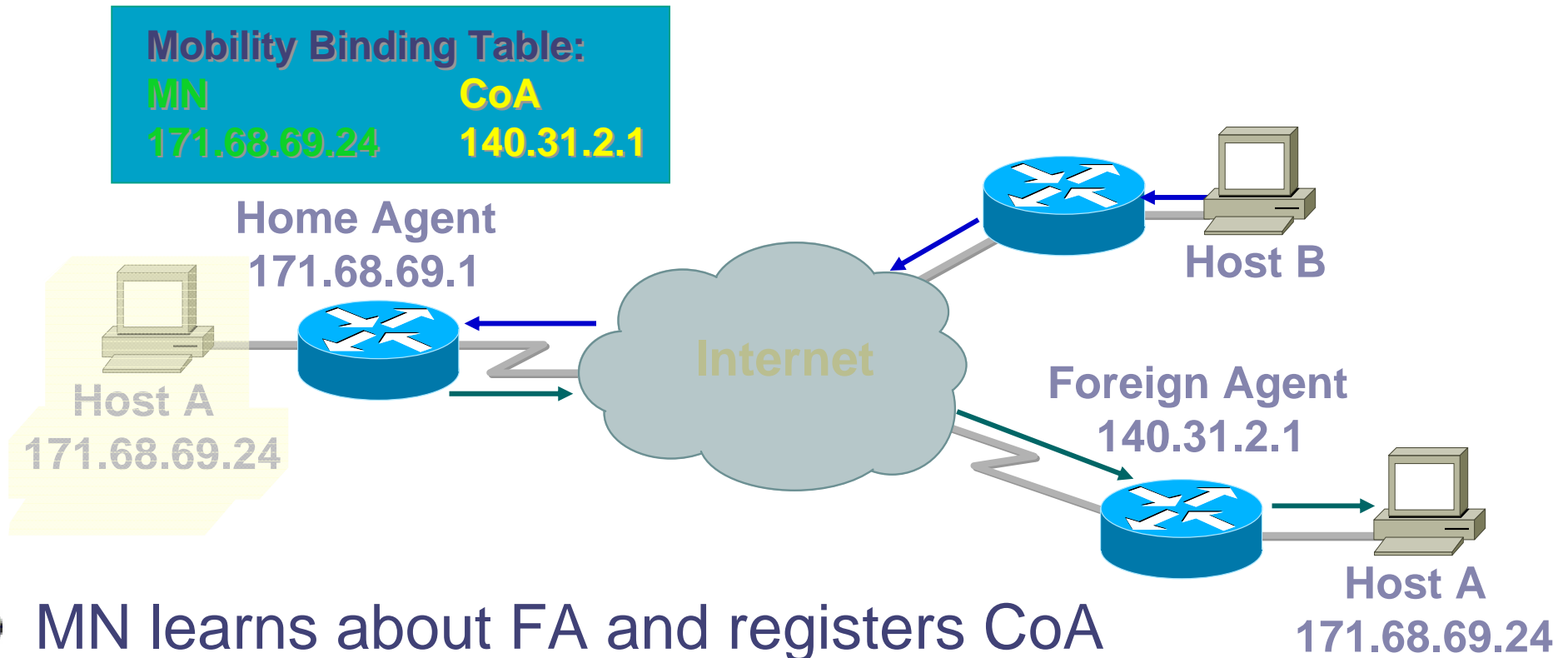
1. **Mobile Node (MN):** Mobile IP enabled clients identified by home address or NAI (notebooks, cell phones, PDAs) updates CoA via registrations
2. **Home Agent (HA):** Mobile IP enabled gateway acts as location database for MNs
3. **Foreign Agent (FA):** Mobile IP enabled gateway [Optional] off-loads CPU processing of encapsulation/decapsulation, enforces local network administration policy, allows for billing of MNs, conserves IP address space, reduce access link usage



Mobile IP Key Concepts

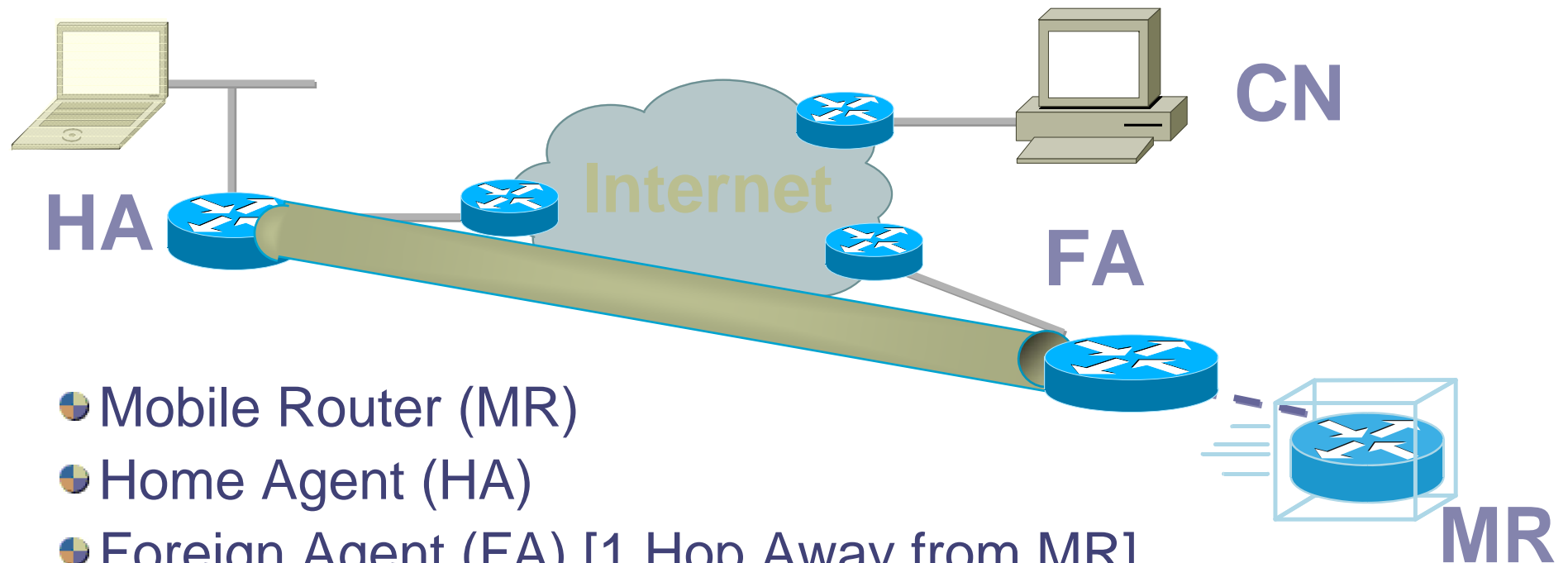
- How does the Mobile Node find out where it is?
 - **Mobility Agent Advertisements**—facilitates discovery of Mobility Agents (MN may solicit on demand)
- How does the Mobile Node inform the Home Agent of its current location?
 - **Via Registration**—updates mobility binding after successful authentication using security association between MN and HA
- How does the Mobile Node receive packets from the Home Agent?
 - **Tunneling**—Home agent adds IP header to direct packets to CoA, where decapsulation occurs

Mobile IP Activities Example



- MN learns about FA and registers CoA
- HA maintains MN location database and tunnels traffic to FA

Mobile IP Terminology

















- Mobile Router (MR)
- Home Agent (HA)
- Foreign Agent (FA) [1 Hop Away from MR]
- Care of Address (CoA) [Tunnel Endpoint]
- Correspondent Node (CN)
- Security Association (SA) [SPI/Key]
- ICMP Router Discovery Protocol (IRDP) [Advertisement]
- Registration Request (RRQ)

Options in FA advertisements

- **R** Registration required. Registration with this foreign agent (or another foreign agent on this link) is required even when using a co-located care-of address.
- **B** Busy. The foreign agent will not accept registrations from additional mobile nodes.
- **H** Home agent. This agent offers service as a home agent on the link on which this Agent Advertisement message is sent.
- **F** Foreign agent. This agent offers service as a foreign agent on the link on which this Agent Advertisement message is sent.
- **M** Minimal encapsulation. This agent implements receiving tunneled datagrams that use minimal encapsulation [34].
- **G** GRE encapsulation. This agent implements receiving tunneled datagrams that use GRE encapsulation [16].
- **r** Sent as zero; ignored on reception. SHOULD NOT be allocated for any other uses.
- **T** Foreign agent supports reverse tunneling [27].

Options in RRQ

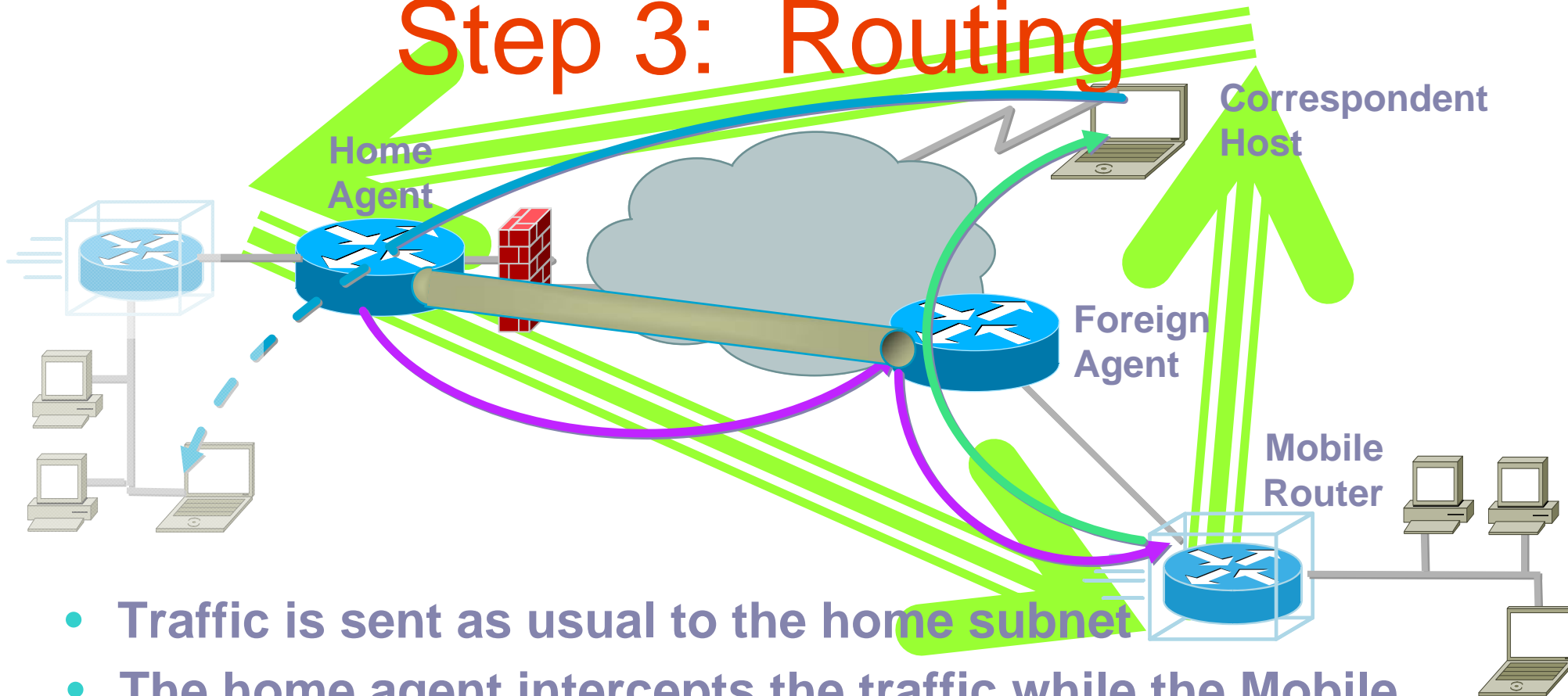
-  S Simultaneous bindings. If the 'S' bit is set, the mobile node is requesting that the home agent retain its prior mobility bindings, as described in Section 3.6.1.2.
-   B Broadcast datagrams. If the 'B' bit is set, the mobile node requests that the home agent tunnel to it any broadcast datagrams that it receives on the home network, as described in Section 4.3.
-    D Decapsulation by mobile node. If the 'D' bit is set, the mobile node will itself decapsulate datagrams which are sent to the care-of address. That is, the mobile node is using a co-located care-of address.
-    M Minimal encapsulation. If the 'M' bit is set, the mobile node requests that its home agent use minimal encapsulation [34] for datagrams tunneled to the mobile node.
-   G GRE encapsulation. If the 'G' bit is set, the mobile node requests that its home agent use GRE encapsulation [16] for datagrams tunneled to the mobile node.
-   r Sent as zero; ignored on reception. SHOULD NOT be allocated for any other uses.
-  T Reverse Tunneling requested; see [27].

MR States

MR has five states that it can be in:

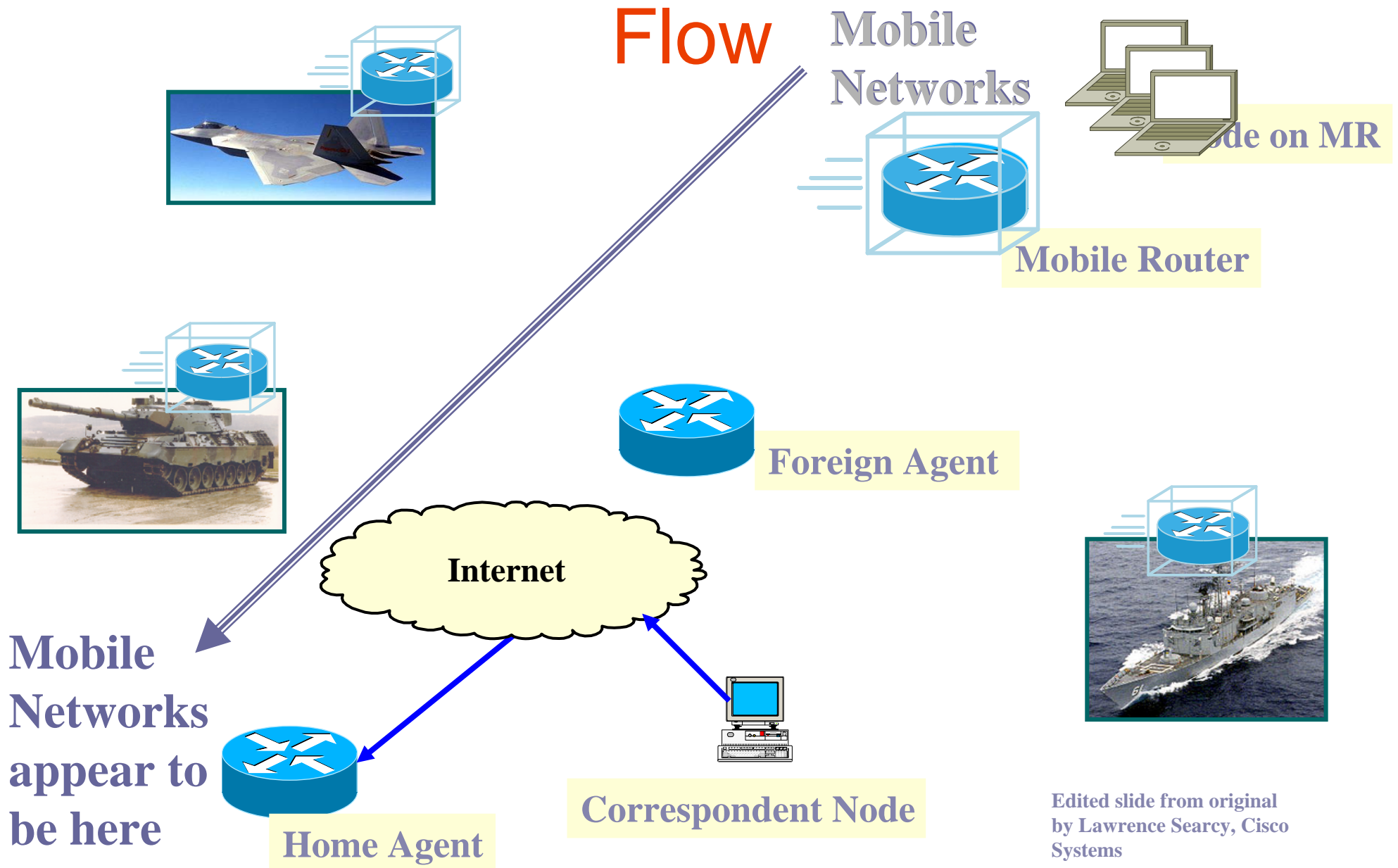
- Unknown – MR has not heard any agent advertisements and does not know where to send registration requests (RRQs)
- Isolated – MR has heard an agent advertisement
- Pending – MR has sent an RRQ and is waiting for a registration reply (RRP) from HA
- Registered – MR has been accepted and received the RRP from HA, which has set up a binding table entry, tunnels, and routes for the MR
- Home—MR is on its home network

Step 3: Routing



- Traffic is sent as usual to the home subnet
- The home agent intercepts the traffic while the Mobile Router is registered as away
- Traffic is tunneled to the CoA of the MR and forwarded to MR
- Traffic from the Mobile Networks can go directly to the correspondent host = “Triangle Routing”

Mobile Network Routing – Packet

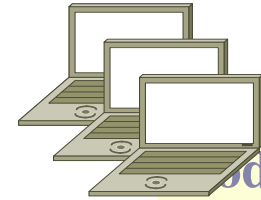


Mobile Network Routing – Packet Flow

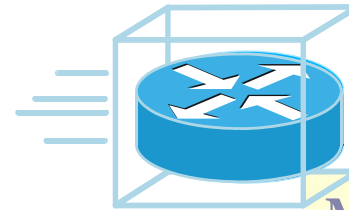


Flow

Mobile Networks



code on MR



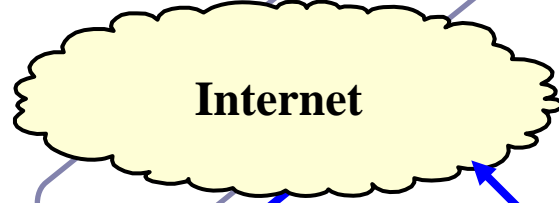
Mobile Router



HA-FA Tunnel



Foreign Agent



Internet



Mobile Network appears to be here



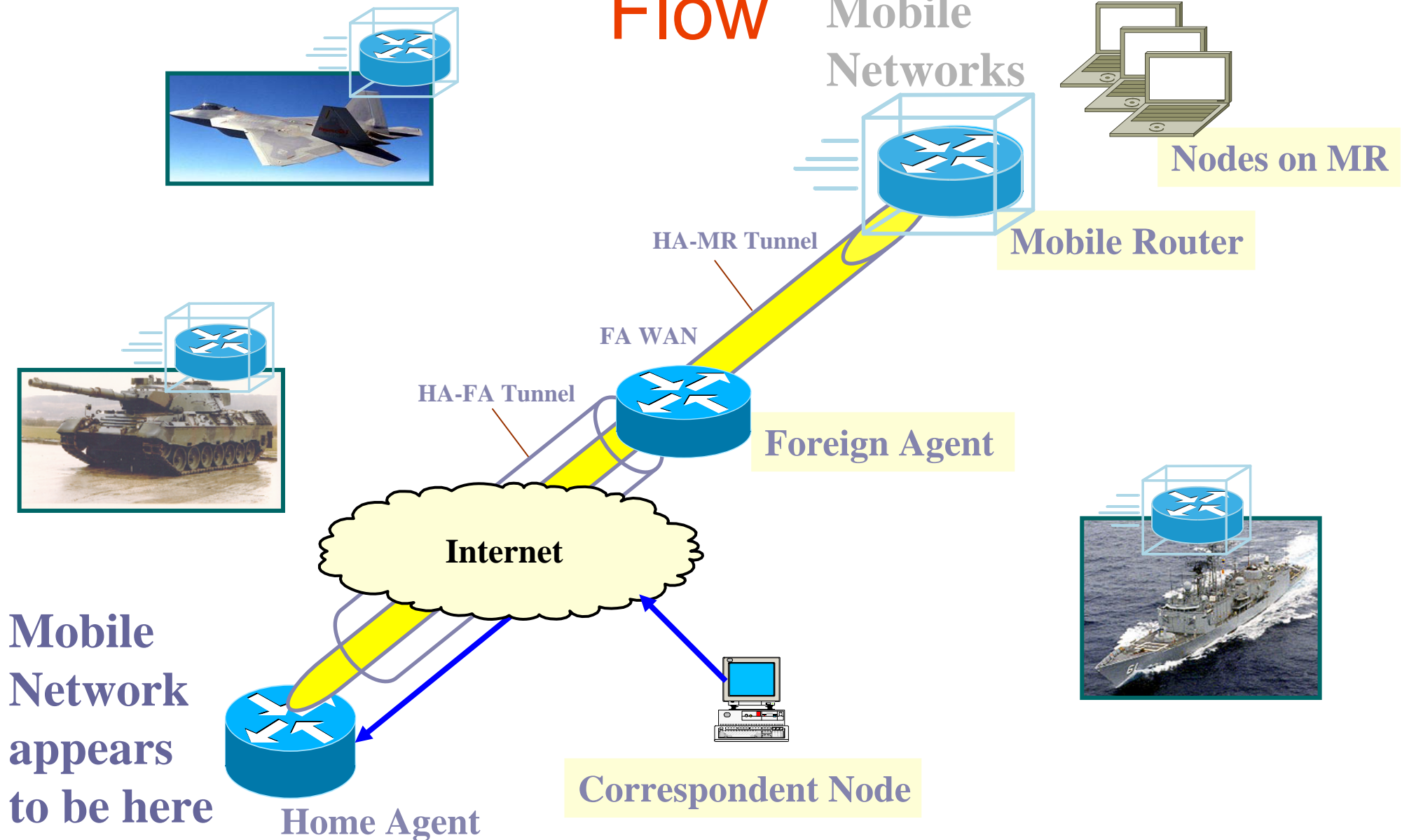
Home Agent



Correspondent Node

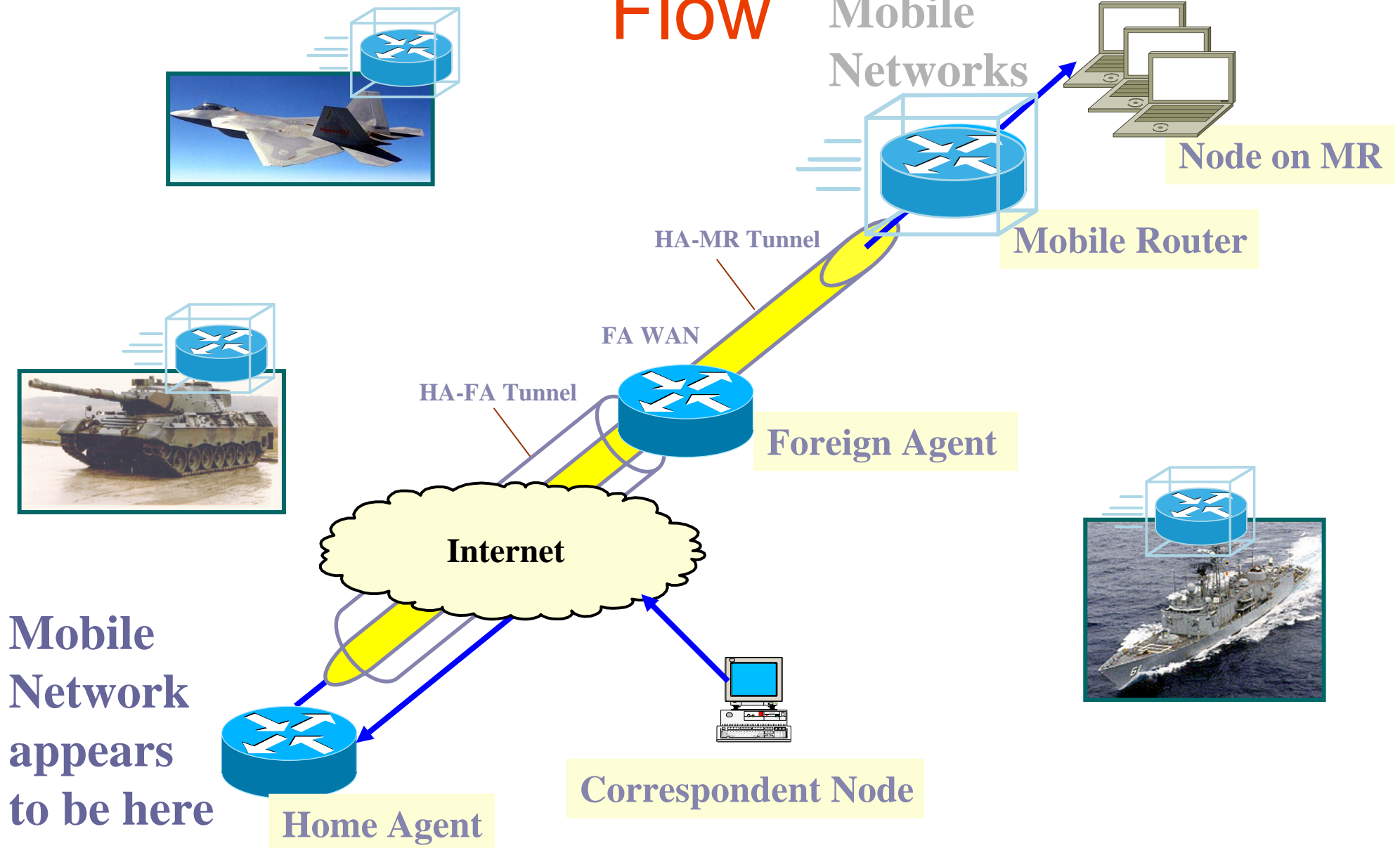
Mobile Network Routing – Packet

Flow



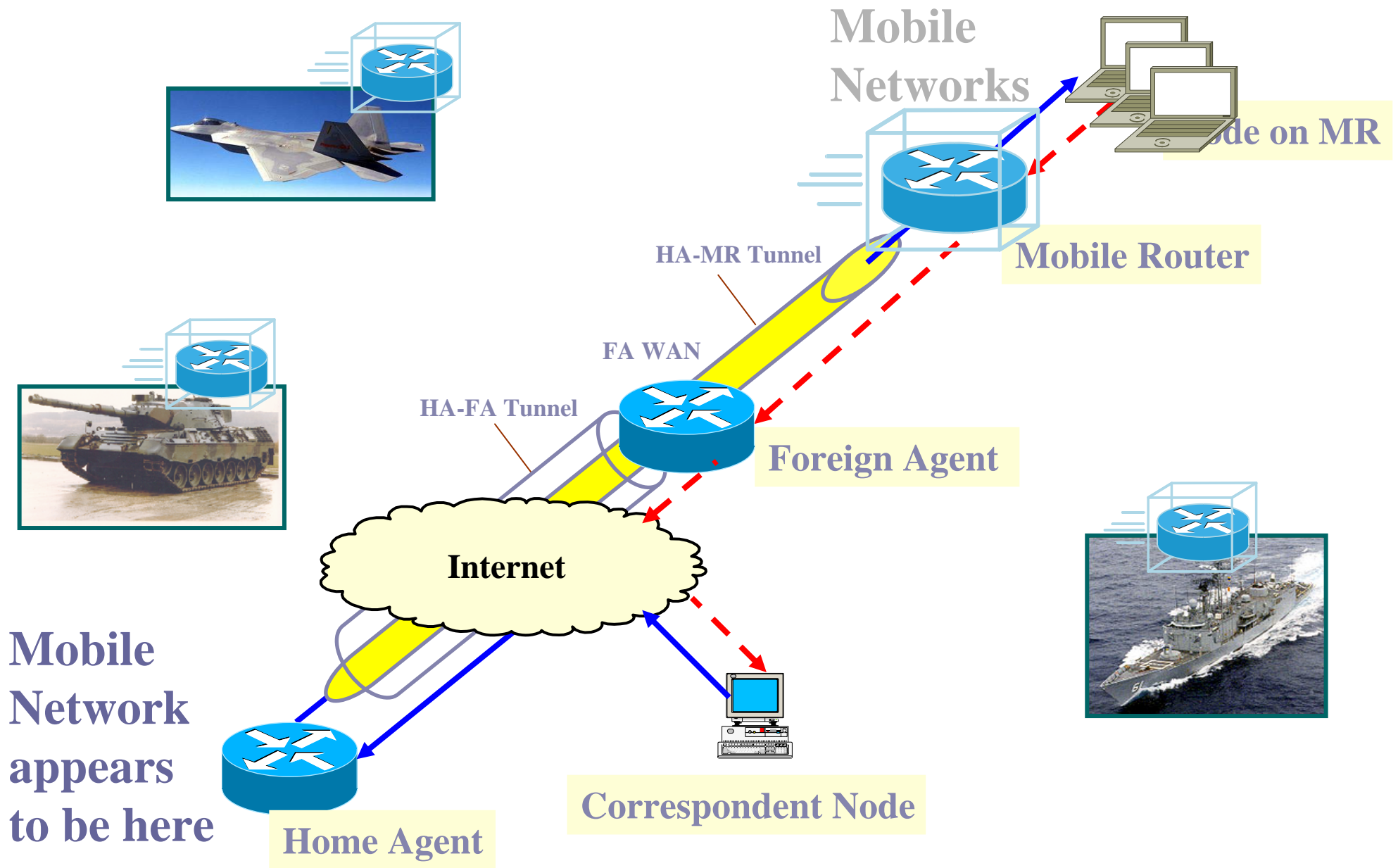
Mobile Network appears to be here

Mobile Network Routing – Packet Flow



Mobile Network appears to be here

Mobile Network Routing – Return Packet Flow



Mobile Network appears to be here

Home Agent

Correspondent Node

Foreign Agent

Mobile Router

code on MR

Mobile Networks

Tunneling

- HA double encapsulates the packets, creating two tunnels:
 - HA to FA
 - HA to MR
- FA strips outer header and forwards to MR
- MR strips inner header and forwards to node on mobile network

Outer Header		Inner Header		Original Packet
HA	FA	HA	MR	
100.100.100.1	30.30.30.1	100.100.100.1	65.1.1.1	<src> <dest> Data

Tunneling cont.

- HA dynamically creates tunnel(s) as MRs and Mobile Hosts register
- Tunnels are handled as interfaces
- HA Routing Table shows Tunnels as interfaces
- So “Tunneling” involves
 - ENCAPSULATION
 - INTERFACES IN ROUTING TABLE

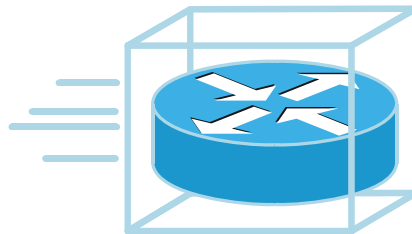
MR Routing

- Once MR is registered, routing is disabled on the MR's roaming interfaces.
- When MR is home, routing is resumed on the interfaces (bindings and tunnels are no longer needed).

Mobile Router Timers

- Agent Solicitation-By default it is off, but if configured, keeps track of when to send next solicitation
- Agent Advertisement-Based on IRDP lifetime. As advertisements are received, timer is restarted. When timer expires, agent removed from agent table.
- Registration-Keeps track of when to send registrations before the registration lifetime expires. MR re-registers until a reply is received.
- Registration lifetime-Based on granted lifetime. As replies are received, timer is restarted. When timer expires, there is no more registration.
- Hold down-By default it is off, but if configured, MR waits for timer to expire before using an agent heard on that interface.

Mobile IP Features



Mobile Router Features

- **Co-located Care-of Address**
- **Reverse tunneling**
- **Preferred interfaces**
- **Hold down timer**
- **Agent solicitation**

Mobile Router Features

- **MR redundancy**
- **MR Asymmetric Links**
- **MR Dynamic Networks**
- **Identification mismatch adjustment**
- **Sequence number detection**

Co-located Care-of Address Support



- Care-of Address resides on Mobile Router itself
 - Rather than on the Foreign Agent
- Does away with the need for Foreign Agents
- Two IP-in-IP tunnels are created: HA-Co-located address, HA-MR
 - HA-Co-located address tunnel is only used for routing
 - Tunnel “Interfaces” added in Routing table

Co-located Care-of Address cont.



- Static Co-located Care-of Address support uses the address statically configured on the roaming interface as care-of address
 - Used for fixed-IP address connections
 - e.g. Cellular Data Modem

Co-located Care-of Address cont.



- CCoA can be Static or Dynamic
- Dynamic Co-located Care-of Address support uses DHCP or IPCP to obtain a care-of address for the roaming interface

Reverse Tunneling

- Normally, routers route packets by looking at the destination address only.
- A security measure against attacks (such as spoofing), ingress filtering on a router checks the source and destination addresses on a packet to make sure that they are topologically correct.
- This poses a problem for Mobile IP because the source address of a packet from a mobile node does not belong to the network from which it emanated.

Mobile Network Routing – Packet Flow



Reverse Tunneling

- Reverse tunneling satisfies ingress filtering
- Packets from the mobile network are sent back to the HA through the tunnel
- HA de-capsulates the packets and forwards them to their destination through normal routing
- Thus, the received packets' path is topologically correct

Mobile Network Routing – Reverse Tunneling



Mobile Network appears to be here

Edited slide from original by Lawrence Searcy, Cisco Systems

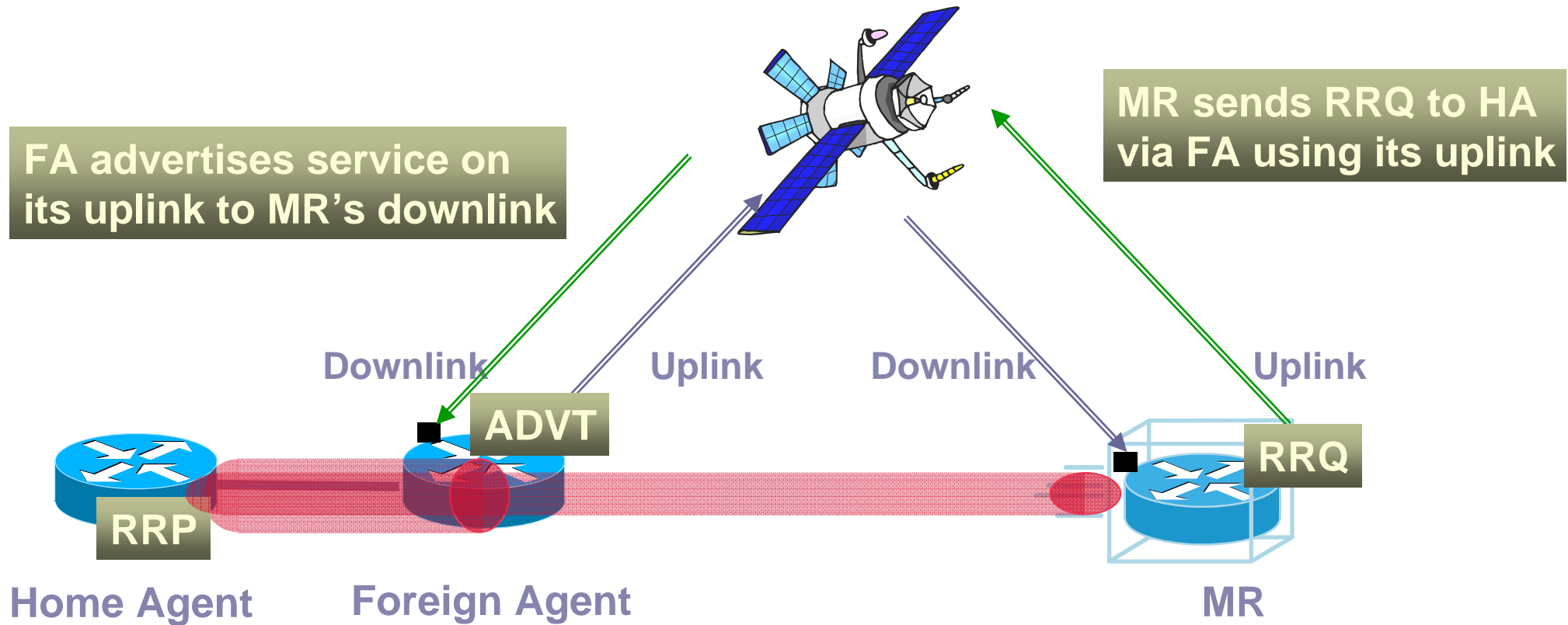
Preferred Interfaces

- By default, the Mobile Router sends data out the active interface with the highest bandwidth.
- If the bandwidth on multiple interfaces is equal, then the interface with the higher IP address is preferred.
- Priority can be configured on mobile router interfaces (default 100).
- MR prefers to register with higher priority interface.
- Uses – least-cost routing, preferential routing

Asymmetric Links

- Mobile Router can route traffic unidirectionally over half-duplex links
 - Especially for a satellite environment
- MR configured to send traffic to a downlink router even though it hears advertisements on another interface
- FA configured to advertise foreign-agent service out only one interface, the uplink interface connected to MR

Asymmetric Links



RRP is sent to FA, which forwards it to MR on its uplink.

Then tunnels are set up between HA-FA, HA-MR's downlink interface

Dynamic Mobile Networks

- **Mobile Networks can register with Home Agent dynamically (as opposed to static network configuration on HA)**
- **Critical Vendor/Organization Specific Extension (CVSE) is appended to the RRQ by MR, which contains the mobile network information**
- **Re-registrations do not append CVSE**

Dynamic Mobile Networks cont.

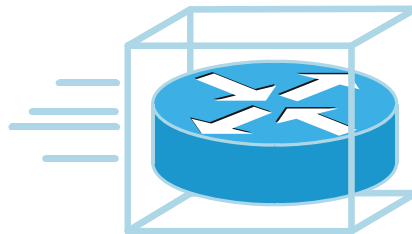
- When mobile network is added/deleted, MR immediately sends another re-registration with CVSE
- HA processes RRQ with CVSE by adding/deleting mobile network(s) and creating/deleting routes to the mobile network via MR
- If mobile network already exists HA ignores the request

Dynamic Mobile Networks cont. 2

- FA needs to be able to process RRQs with CVSE in order to forward them on to HA.
- Dynamic and Static Networks can be configured at the same time for an MR.

NOTE: CVSE is being replaced by AVSE (standards-based) in near future

Mobile IP in real deployments



Concrete applications in Mobile SP

Mobile IP key deployment points

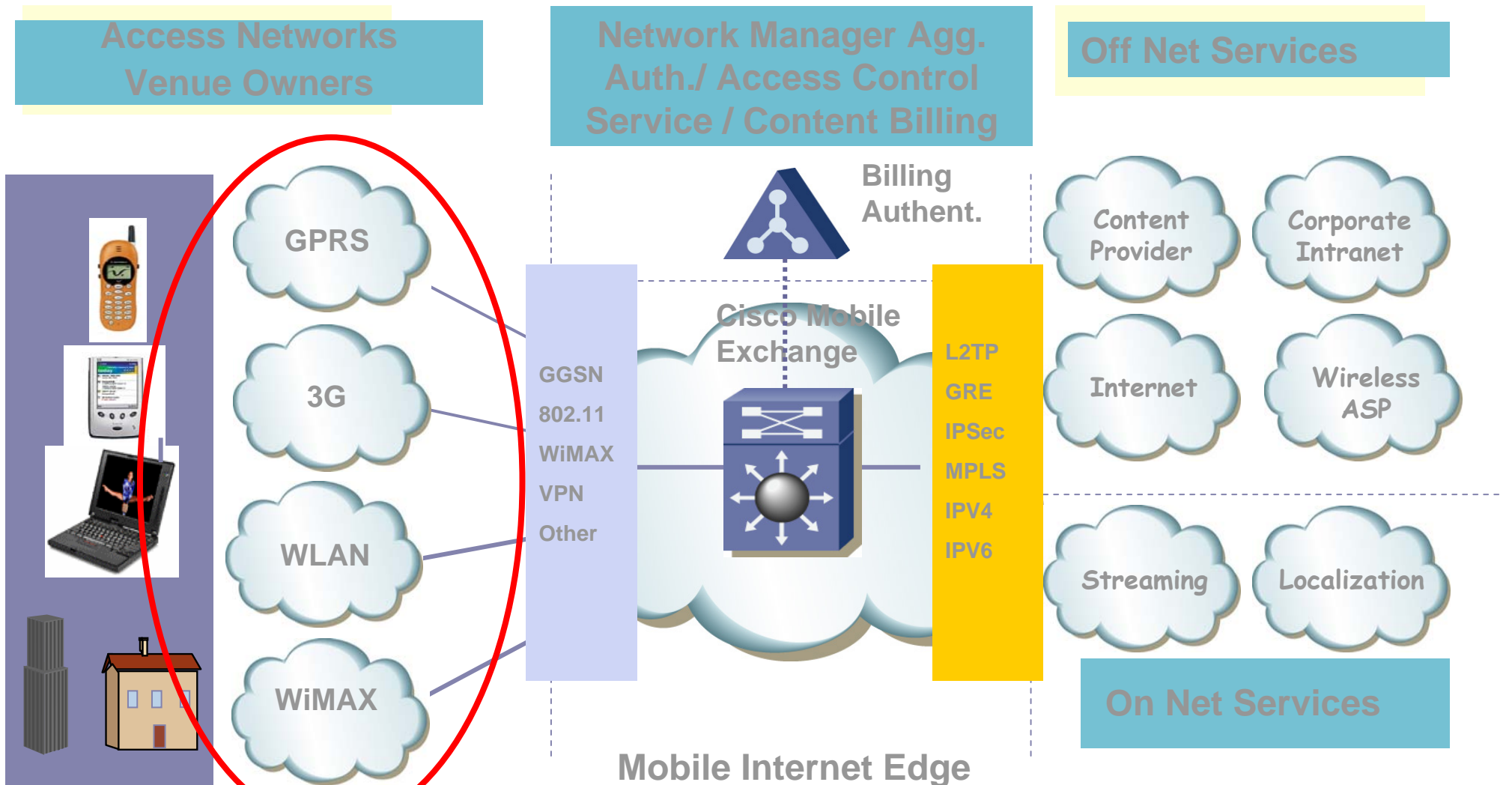
- Home Agent is the anchor point for MNs
- Bandwidth overhead and FA relationship
- Authentication process
 - It is a second authentication, for mobility service
 - There is still a initial link layer authentication
- Preferred interfaces
- Make before break and minimal / no IP interruption
 - interfacing layer 2 signal strengths

Wireless Convergence

1 Access

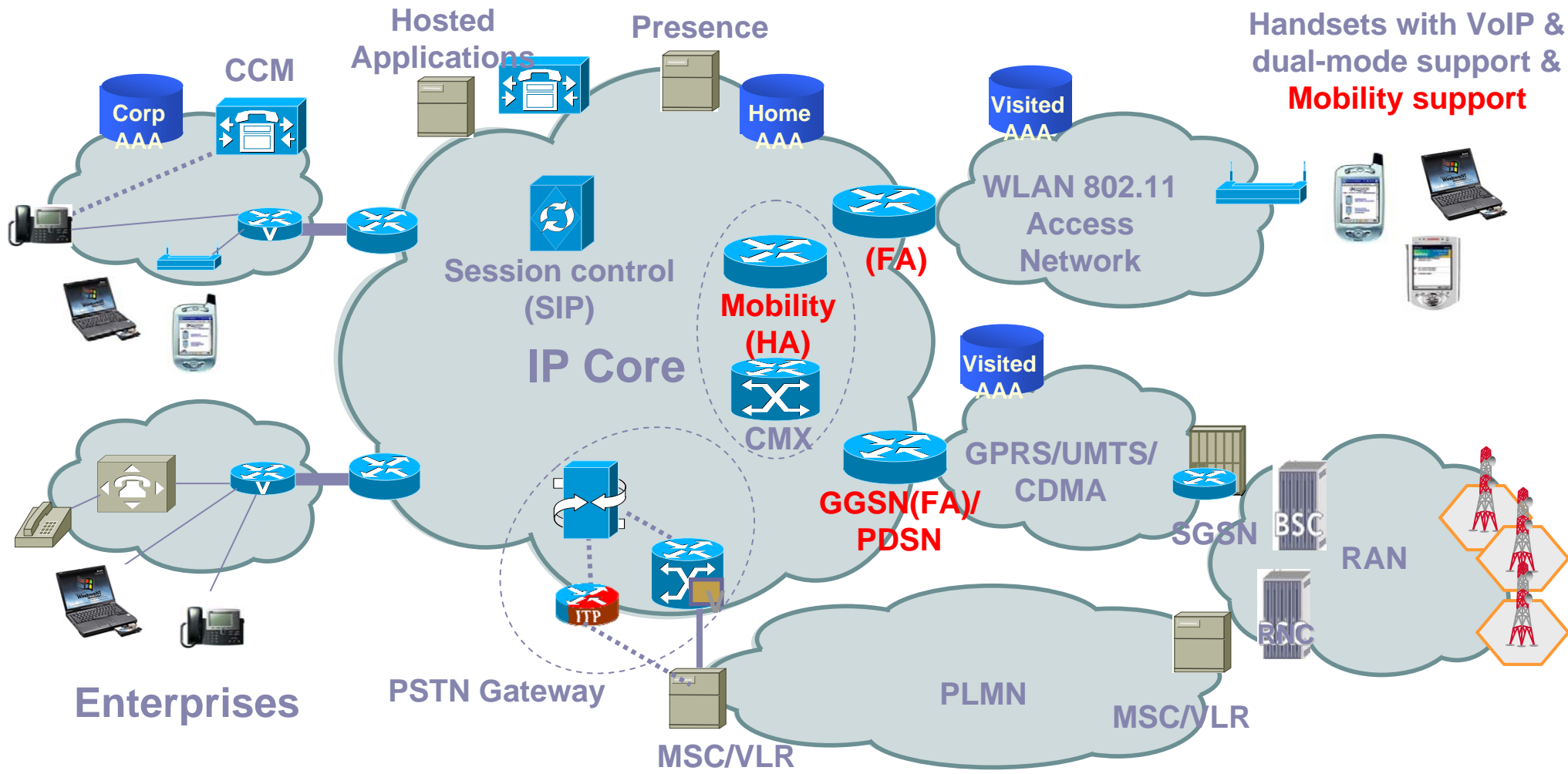
2 Control

3 Services



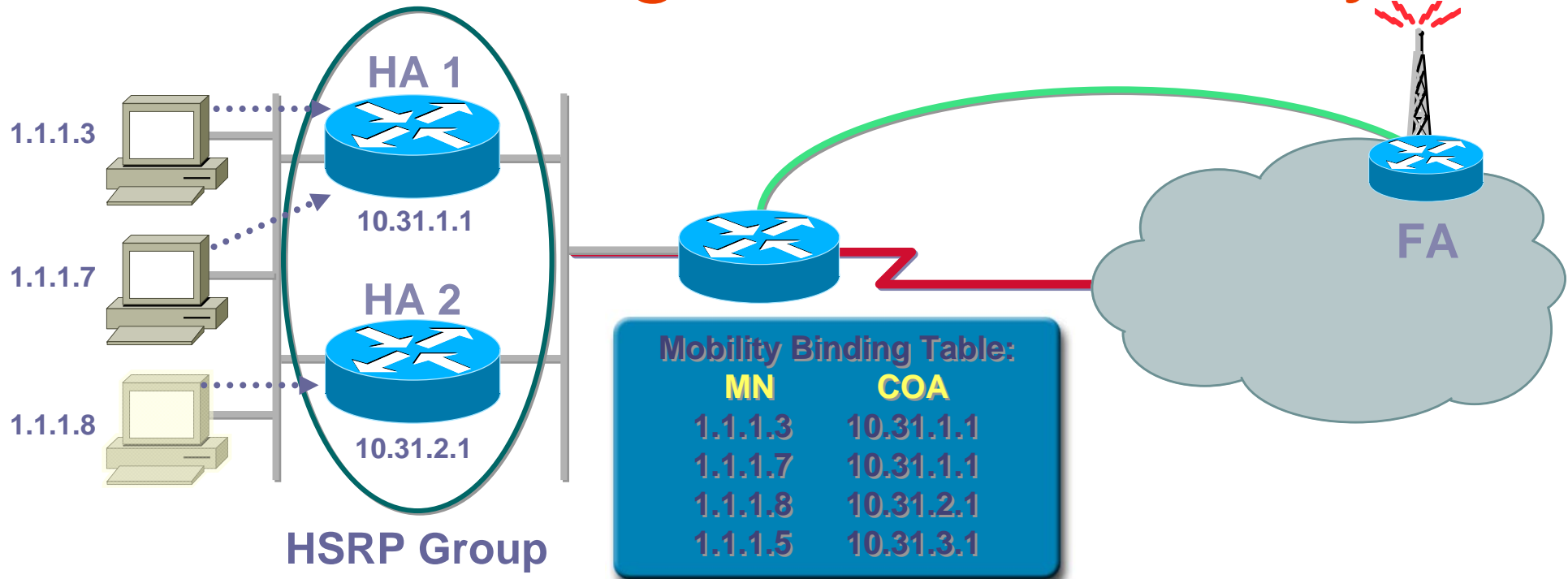
Next-Generation IP Infrastructure

All-IP Multimedia Mobile Network



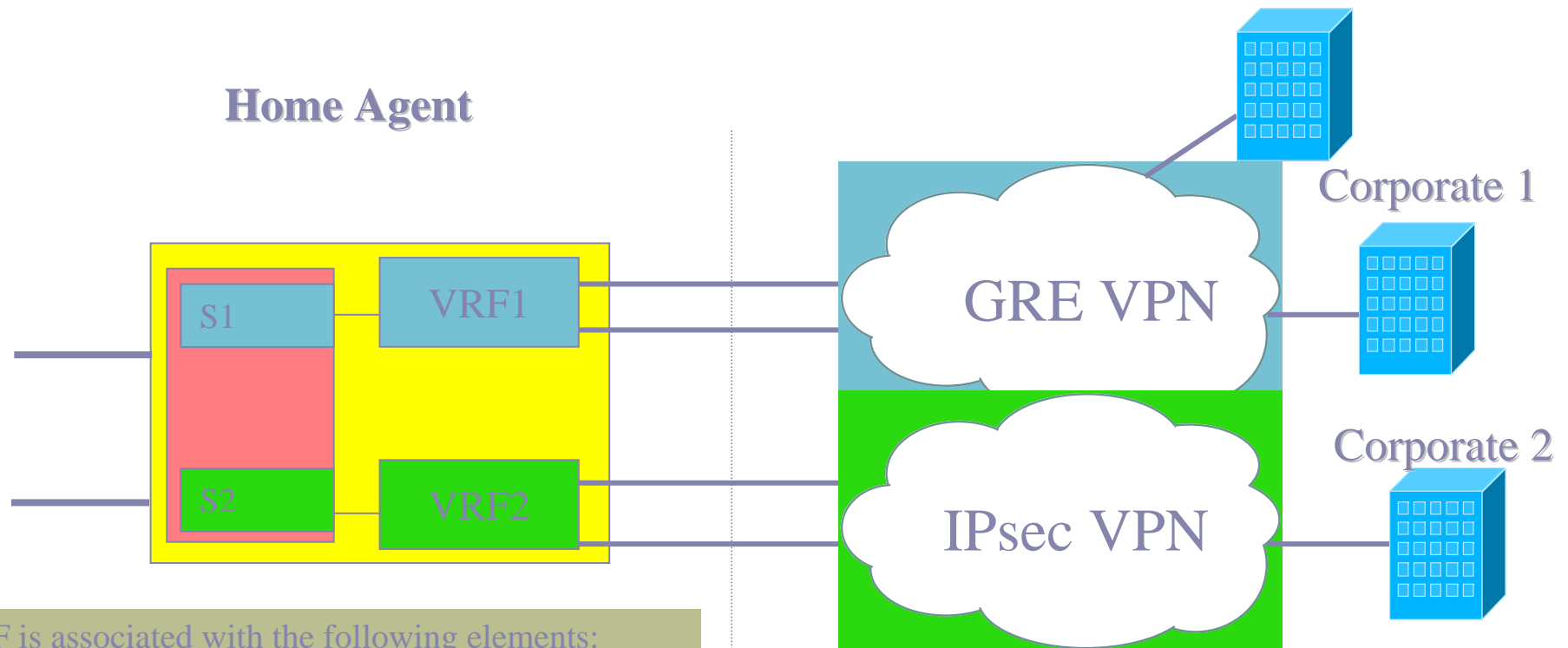
Unified IP-based infrastructure allows for uniform delivery of services across consumer, enterprise and carrier domain

Home Agent Redundancy



- Two HAs are configured in hot-standby mode, based on Cisco Hot Standby Routing Protocol (HSRP)
- Configured to provide 1:1 redundancy
- No service disruption!

Virtual HA & Security



A VRF is associated with the following elements:

- IP routing table
- Derived forwarding table, based on the Cisco Express Forwarding (CEF) technology
- A set of interfaces that use the derived forwarding table
- A set of routing protocols and routing peers that inject information into the VRF

Identification of “subscriber community”

Can be downloaded from AAA

- Criteria such as user-name, user-domain etc. may be used to identify “subscriber community”

Home Agent Summary

- Feature Rich
 - Highly Compliant to Specifications and Customer Requirements
 - Value added service support such as VRF, Hot Lining, QoS
 - Service enablement via Cisco Mobile Exchange Framework components
- Fault Tolerance
 - HA Redundancy, HA-SLB
 - Geographic Resiliency
- Product Maturity
 - Real life deployment; deployed since 2001
- Capacity and Performance Scalability
 - Small to very large deployment options
- Management
 - Provisioning, Fault Mediation, Performance Mediation, Troubleshooting & Security

Thank You

Leave IT to us

Contact : info@gcl.in