

# Third-Generation (3G) mobile IP systems

## **Evolution of Mobile Cellular Communication Systems**

### **The first and second generation systems**

- Designed primarily to offer a single service, (e.g. speech).
- Data service based on circuit switched technology, providing low-data-rate service over voice channel using conventional modem.

### **General Packet Radio Services(GPRS)**

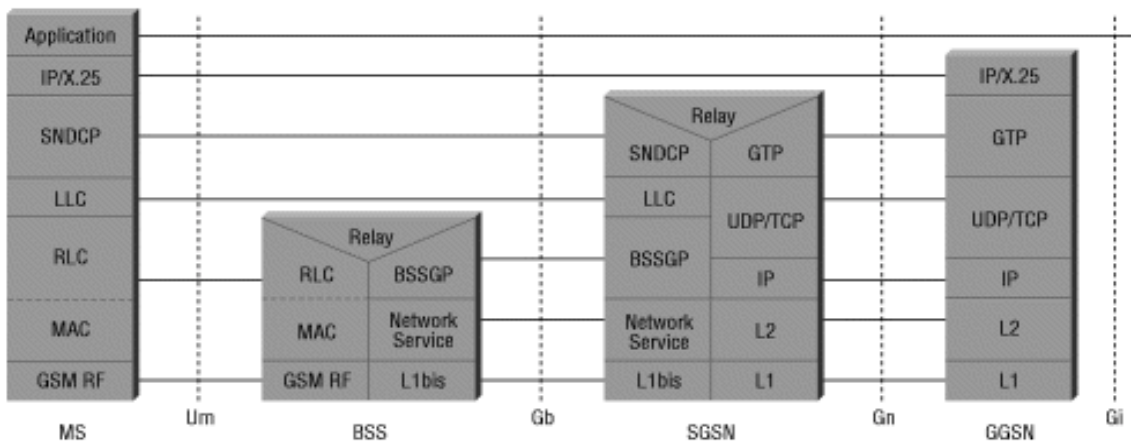
- Tunneling network layer packet between a mobile terminal and a standard IP or X.25 packet network.
- Data rate for IP based packet speeds up to a maximum theoretical rate of 160 kbps.
- GPRS tunnel protocol GTP operates on top of TCP/IP protocol and tunnel packet between SGSN and GGSN.
- ETSI has started investigating the integration of Mobile IP in GPRS.
- Two mainly components in the core network:
  - Serving GPRS Support Node (**SGSN**)
  - Gateway GPRS Support Node (**GGSN**)

## Third generation Mobile telecommunication Systems (UMTS/IMT2000)

- Data service domination
- Provide internet and multimedia services
- W-CDMA will be the dominant air interface
- Data rate (UMTS): 144Kbps for fast moving, 384k bps for low speed and 2 Mbps for static and indoor use.
- Core Network Architecture
  - Evolved GSM & evolved ANSI-41
  - Innovative architecture All IP transport network is developing.

### -Core Network Protocol

Global mobility (macromobility) will be based on Mobile IP or evolved Mobile IP.



**GPRS Network Protocol Stack**

## **Mobile IP Protocol**

- Standard builds on the Internet protocol by making mobility transparent to applications and higher level protocol

### **Basic terminology**

**Mobile Node** – mobile host or router that can continue to communicate with other nodes over the Internet at any location with constant IP address.

**Home address** – An IP address assigned for the mobile node. It remain unchanged regardless of where the node is attached to the Internet.

**Care of address** – The termination point of a tunnel toward a mobile node.

Two type : Foreign agent care of address and collocated care of address.

**Home agent** – a router on a mobile node's home network which delivers datagrams to departed mobile nodes and maintains current location information for each node.

**Foreign agent** – a router on a mobile node's foreign network which cooperate with the home agent to complete the delivery of diagrams to the mobile node.

**Tunnel** – The path a datagram follows while it is encapsulated.

## Standard Mobile IP Protocol

- **Mobile agent discovery**
  - **Agent Advertisement**
  - **Agent Solicitation**
- **Registration Process**
  - **Registration Requisition**
  - **Registration Reply**
- **Routing and Tunneling**

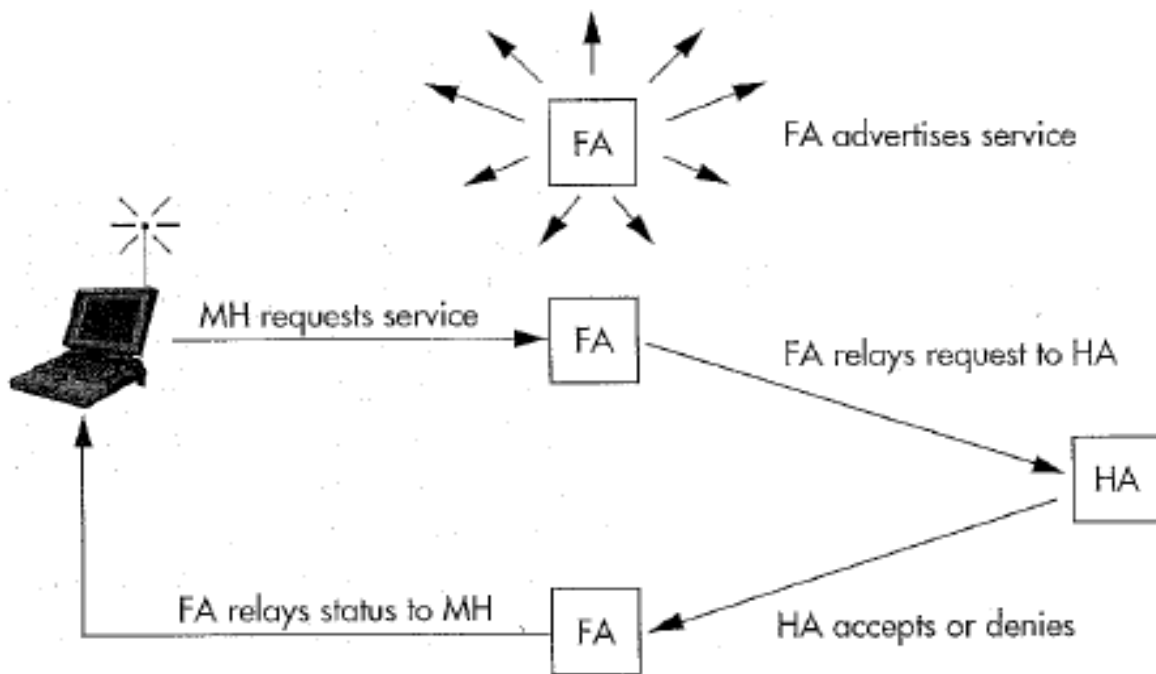


figure2 Registration in Mobile IP

## Encapsulation ( Tunneling )algorithms

- IP within IP Encapsulation
- Minimal Encapsulation

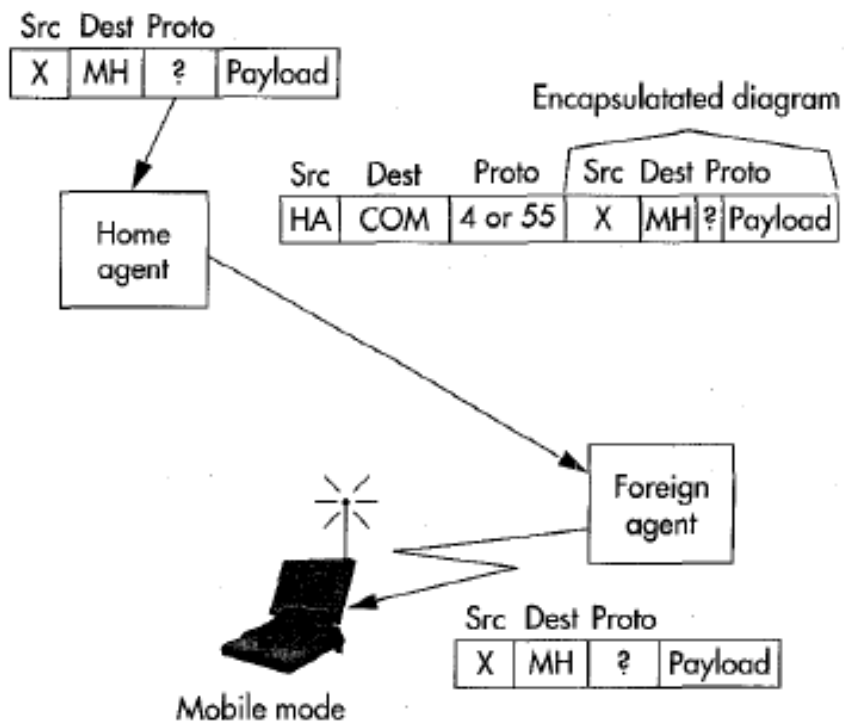


Figure 3 Tunneling in Mobile IP

## **Route Optimization in Mobile IP**

- Triangle Routing Problem
- To solve this problem, Let the correspondent node has an up- to- date mobility binding for the mobile node in its routing table.
- Home agent is responsible for providing binding updates to the corresponding nodes. Local bindings enable most packets in traffic session to be delivered by direct routing
- Handover management: During hand off, A moving node always informs its previous foreign agent about its new care-of address. Previous foreign agent can forward packets to its current location.

### **Disadvantage:**

- Increase the complexities and further more authentication.
- Exchange of control message and processing overhead.
- Changes are required at the corresponding nodes.
- Cashed binding are possibly inconsistent.

## **Distributed Registration Extension to Mobile IP**

- Separate the registration and forwarding services. Registration service can be provided by registration server while the forwarding service can be provided by a network entity called care-of agents.

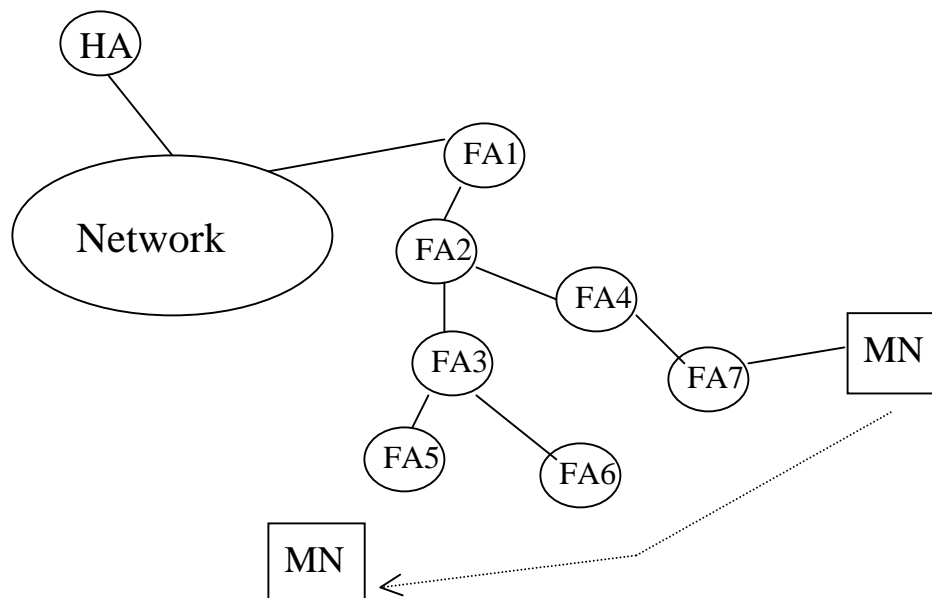
- Different types of registrations, Local, home and transit registrations supported. Mobile node moves with one routing domain only needs to perform local registration.

- Do load-balancing according to the dynamically changing traffic needs.

- Reduce the number of trusted entities in the network and ease the key management problem.

## Local Registration with Hierarchical Foreign Agents

- FA are arranged hierarchically in a regional topology
- FA advertisements contain the complete regional hierarchy of FAS supporting that local register.
- Binding entry associated with the MN at each FA will point to the care-of-address at the next lower level of the hierarchy.
- A datagram arriving at the top of the hierarchy will be decapsulated and reencapsulated over a new tunnel ending at the next lower level.
- Local register is replied from FA currently serving MN to the next higher level towards the common common ancestor FA to the care of address at the new and previous service area.
- FA fault tolerance



## **Security service to Mobile IP**

### **- Authentication of location updates**

by altering the location bindings in registration messages and the location binding update messages, creating bogus messages, or replaying prerecorded messages, an adversary could redirect IP traffic.

Data integrity protect, origin authentication and anti-replay services must be provided.

### **- Access control of mobile nodes**

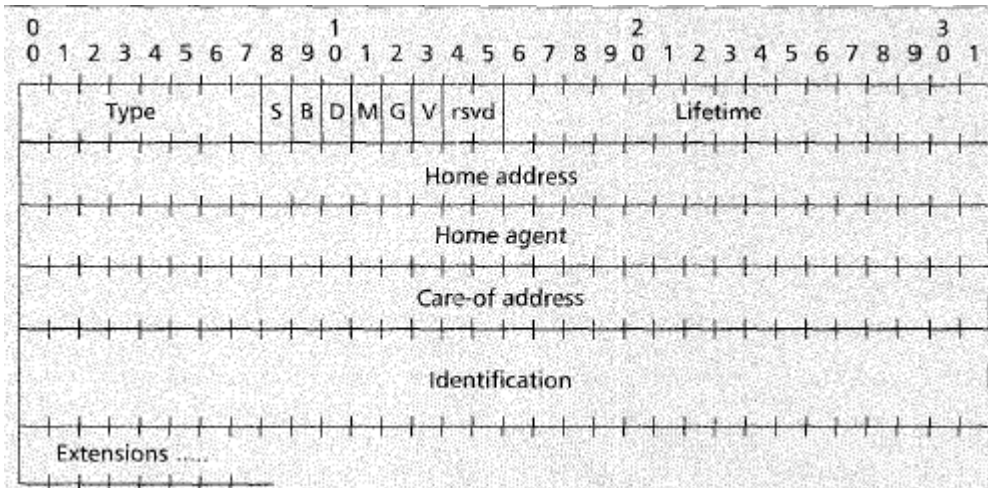
Verifying the identity of the mobile node, checking the current status of the mobile with a relevant authority such as the corresponding home agent.

### **-Secure tunneling of redirected IP packets**

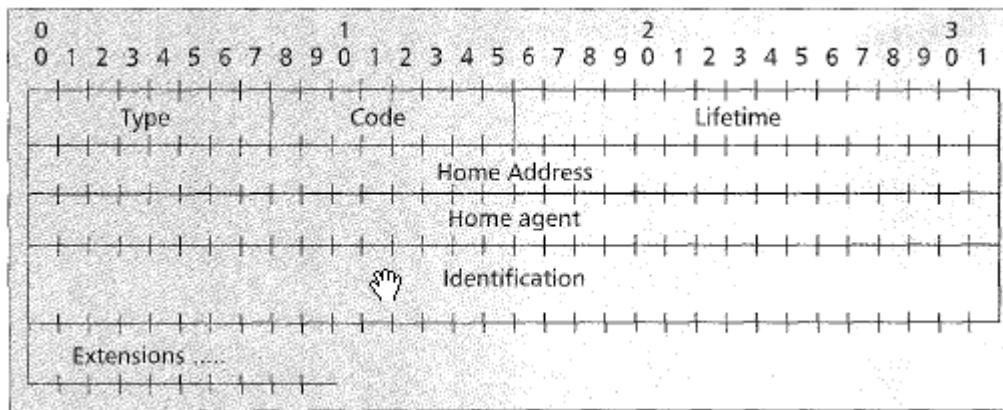
Using Encapsulating Security Payload, tunneling mode of IP security protocols.

## **Securing the registration procedure in mobile IP**

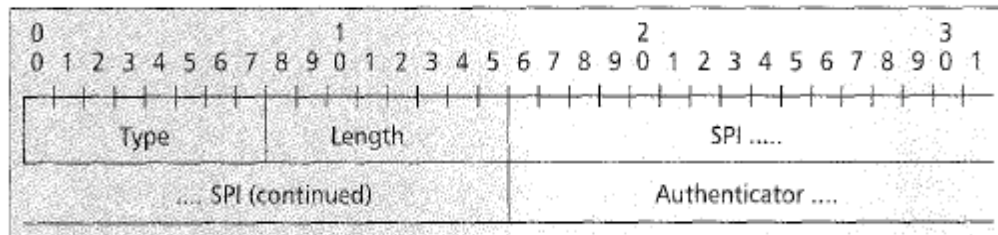
- Mobile-home authentication extension is required in all registration requests and replies.
- SPI field selects the authentication algorithm and authentication algorithm, mode.
- Default algorithm: Each mobile node and home agent must share a security association and be able to use MD5 with 128-bit keys to create unforgettable digital signatures for registration requests.
- Identification field is used to make each request must contain unique data. Time stamp or newly generated random number is inserted into the field.



Register Request Format



Register Reply Format



Mobile IP authentication extensions

## References:

- 1."Evolution of Mobile Cellular Communication Systems", Dr.Monira A.Abu El-Ata , 17th National Radio Science Conference, NRSC'2000
2. "A Vision of UMTS/IMT-2000 Evolution", *Aghvami, H.; Jafarian, B.* Electronics & Communication Engineering Journal , Volume: 12 Issue: 3 , June 2000
- 3."Mobile and the Internet", Richard R.Parry, IEEE Potentials, 1998
- 4."Mobile IP", Charles E.Perkins, IEEE Communications Magazine, May 1997
- 5."Mobile host protocols for the Internet ",Hac, A.; Lei Guo Vehicular Technology Conference, 1999. VTC 1999 - Fall.
- 6."Mobile Networking Through Mobile IP", *Perkins, C.E.* IEEE Internet Computing , Volume: 2 Issue: 1 , Jan.-Feb. 1998
7. " Dynamic Registration Extension of Mobile-IP " , [www.globecom.net/ietf/draft/draft-chuahli-mobileip-dremip-00.html](http://www.globecom.net/ietf/draft/draft-chuahli-mobileip-dremip-00.html)
8. "Mobile-IP Local Registration with Hierarchical Foreign Agents Approach", IETF Draft, February 1996.
9. "Supporting Reduced Location Management Overhead and Fault Tolerance in Mobile-IP Systems", *Omar, H.; Saadawi, T.; Lee, M.* Computers and Communications, 1999. Proceedings. IEEE International Symposium on 1999
- 10." Cellular IP", <http://www.ctr.columbia.edu/~andras/cellularip/>
- 11."A public-Key based Secure Mobile IP", J.Zao et al., Proc. ACM Mobicom 97, ACM, New York, Oct.1997
- 12."The MD5 Message-Digest Algorithm", IETF RFC 1321, Apr,1992.