Location Management in Mobile Networks

Outline

- Introduction
- Location Management in PCS systems
- Important issues in Location Management
- Performance of Location Management
- What will happen in future ...
- Reference

Introduction

- What is Location Management in mobile networks?
- Why is Location Management important in mobile networks?
- The requirement of Location Management in mobile networks.

What is it?

- Location Management is the process to determine the current location of a mobile terminal
- In a PCS (Personal Communications Service) system, the location of a called portable must be determined before the connection can be established.

Why important ?

- In a mobile networks, the location of the terminal can not be deduced from its endpoint address, like in a wired networks.
- Additional addressing schemes and protocols are needed to locate and track mobile terminals.
- Handoff of connections happens in mobile networks: losses & QoS guaranteed

Requirements (ATM forum)

- User Transparency
- Location and user information confidentiality
- Cell / Network Identification
- Minimize Signaling load
- Roaming should be possible
- Scalable

Two services

- Location management can be divided into two different services:
  - Mobile tracking: to keep track of the current location of the mobile terminal.
  - Mobile locating: to find the current location of the mobile node for the delivery of an incoming call.

Location management in PCS

- Overview
- Components in Location Management
- Interactivities in mobile tracking and locating
- Approaches and standards

Overview

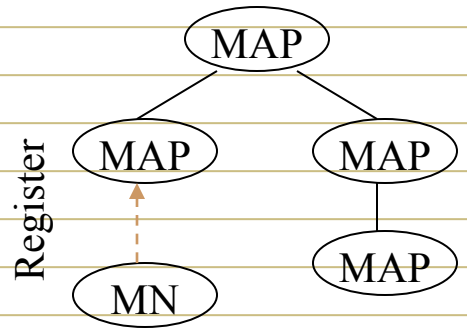
- In a wireless communications system, mobile users are located in system-defined zones that correspond to bounded geographical areas.
- Location Management: managing the information required to locate wireless users who move from zone to zone.
- End-device identifier:
  - endpoint identifier
  - location identifier

Components in the Location Management

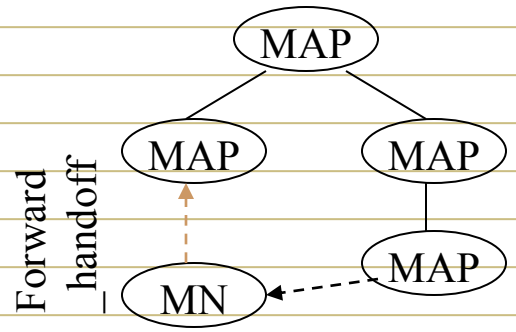
- Location server:
  - maintain the location of all the nodes in the group.
- Mobile Access Point:
  - provide a point of attachment to the network for the mobile nodes and routing capability.
- Mobile Node:
  - can be connected into network via MAP, no routing capability.
- System Manager:
  - manage the network

Mobile tracking

- Two possible scenarios in mobile tracking:
  - When start-up, the remote node has to register itself.
  - When handoff, the remote node has to update its current attachment point.

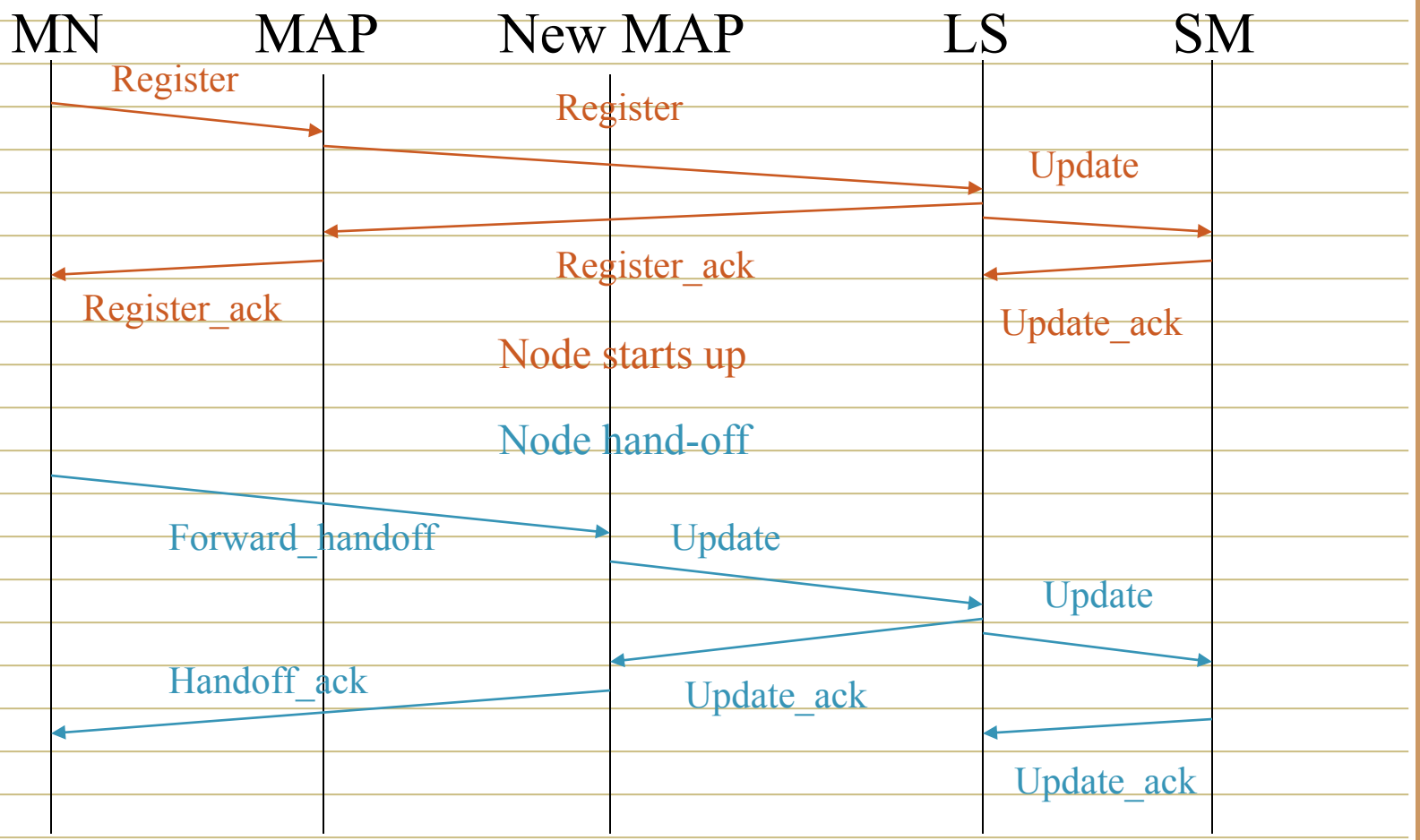


Mobile node starting up



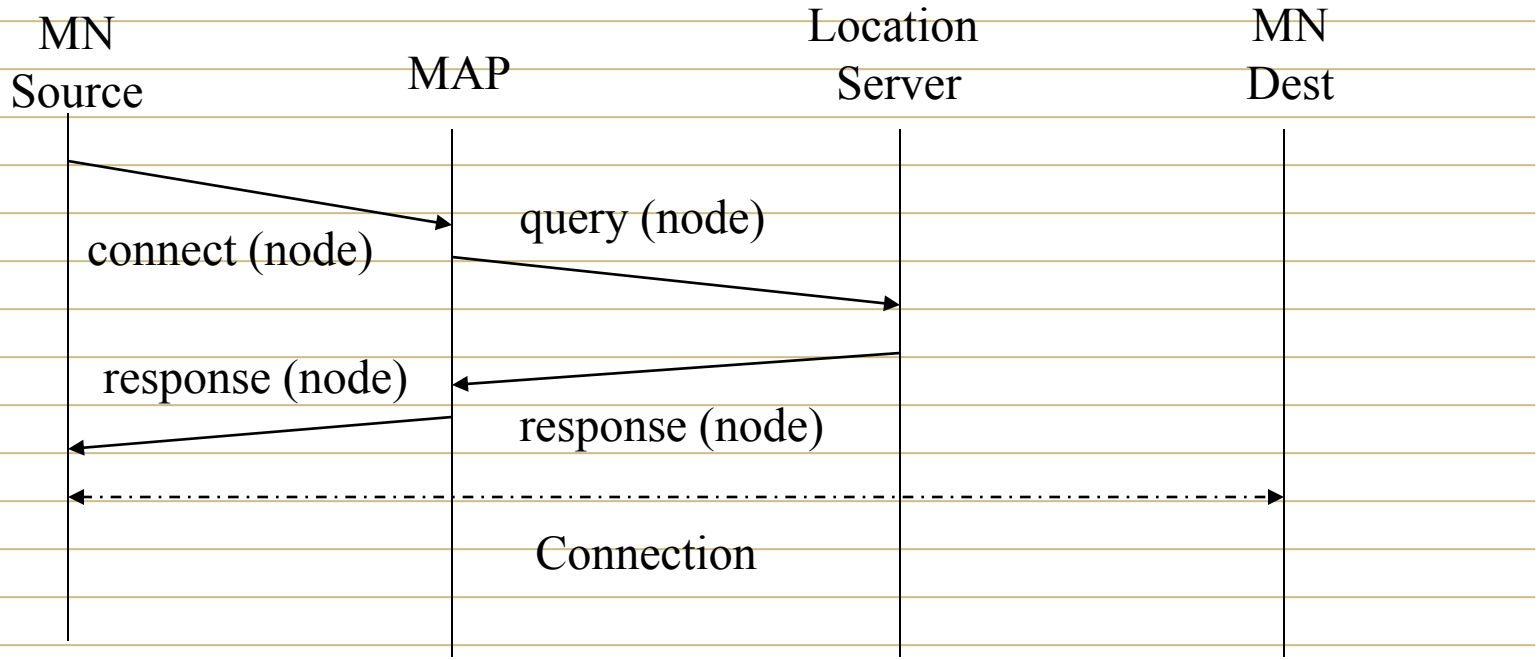
Mobile node handoff

Mobile Tracking (cont.)



Mobile locating

- To find out the current attachment point of a mobile node to begin a session to it.



Standards in Location Management

- PCS networks
  - IS - 41, GSM
- ATM forum approach:
  - Mobile PNNI scheme
  - Location registers scheme
- Two way to implement:
  - Location management as an external service
  - Integrated connection setup and location management.

PCS networks standard

- GSM and IS-41:
  - Home Location register (HLR): home database of the user's profile.
  - Visitor Location Register (VLR): copies of profiles of users not at home but currently located.
  - Query HLR to find VLR.

ATM Forum approach

- Mobile (Private Network - Network Interface) PNNI scheme
  - Signaling to the home switch of the destination mobile node.
  - Propagate location updates during connection.
- Location registers scheme
  - each group maintains a set of location registers
  - each register contains information about the current attachment point of the various mobile nodes.

Important issues in Location Management

- Trade-off in Location Management:
  - lookup (locating) vs. update (tracking)
- Efficient Location Management
  - profile replication or caching
- Data Management
- Different approaches

Trade-off in location management

- Node information update effort
  - when a node moves … …
  - keep track of the mobile node
- Node finding effort
  - locate the node when setup connection
  - route to the destination

Efficient Location Management

- Message traffic due to the find and registration operations is significant.
- User profile lookup occurs in any call
  - To access the caller's profile for authentication
  - To access the callee's profile for location information and connection status.
- User profile update occurs:
  - to signal user equipment activation or deactivation
  - to signal user call connection or register user movement.

Efficient Data Management

- Granularity based location management
- Profile Replication or caching:
  - caching: the accuracy of the data.
  - replication: keeps all copies up-to-date, no invalidation problem.
- Load balancing in Location-Information Databases (LIDs)

Granularity based location management

- Hierarchical location management
- Fine grained approach:
  - the network is divided into clusters
  - each cluster consists of a number of base stations and a location server
- Coarse grained approach:
  - a global view of the location of the mobile node is maintained.
  - The location server maintains the information about the cluster in which the mobile node is residing.

Hierarchical profile Replication

- To reduce the latency of profile lookup at the expense of increased update and storage cost.
- Selectively replicating user profile, based the locality exploited from user calling and mobility patterns.
- Propagate the updates to each profile replica.

Adaptive location management strategy for mobile IP

- Call-to-Mobility ratio: the relative frequency of searches as compared to updates
- How the overall costs of location management can be reduced?
  - Basic triangle routing: high call-to-mobility ratio
  - Static update scheme: low call-tomobility

Adaptive Location Management Strategy for Mobile IP cont.

- Working Set of Hosts for Mobile Host (MH)
  - the set of hosts that a given MH communicates most frequently with is very small (locality)
- Limitation:
  - For mobile IP
  - how about in PCS system?...

Dynamic approach to location management

- Reduce the location updates: reduce the communication overhead.
- Distribute location information among location servers
- Share the responsibility of location tracking among location servers equally.
  - The distribution of Mobile Host (MH) varies with time.
  - Location of some MHs are queries more often than others
- Replicate location information

Dynamic approach to location management cont.

- The location servers storing the location information of an MH is a function of the identities of the MH and the cell in which that MH is present.
  - Location server changes while MH moving
  - MHs in the same cell need not have the same set of location servers.
- A greater number of location servers should maintain location information about hot MHs, fewer for cold MHs.

Performance of Location Management

- Performance Metrics:
  - Signaling load: exchange of a number of messages.
  - Time to locate the current attachment point of a mobile node.
  - Scalability: when the number of nodes and traffic generated in the system increase.
- Performance is a function of:
  - The underlying database architecture
  - location management algorithm

Future

- Location Management in 3rd generation mobile networks.
- Distributed computing and object oriented
  - Intelligent Networks (IN): capability sets.
  - Common Object Request Broker Architecture (CORBA): location, replication, and migration transparency

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