G 364: Mobile and Wireless Networking

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M-W, 11:40am-1:20pm, 109 Rob

Mobility Management

- Crucial problem in PCS
  - Affect the performance of the system
  - Determine customer happyness
- PCS architecture:
  - BSs, MSs, MSCs
  - Two types of databases
    - Home location register (HLR)
    - Visitor location register (VLR)

Mobility in PCS Networks

- Handoff: The MS moves from a BS to another BS while engaged in conversation (also handover or automatic link transfer)
- Roaming: The MS moves from one PCS system (e.g., Boston) to another (e.g., New York City)
- Mobility management is described in (sub)standards: EIA/TIA IS-41 (for AMPS, IS-136, IS-95) and GSM MAP

Handoff, Strategies

- Three strategies for detecting the need of handoff
  1. Mobile-controlled handoff: MSs monitor the signal with surrounding BSs
  2. Network-controlled handoff: BSs measure the signal strengths with MSs (AMPS)
  3. Mobile-assisted handoff: The network asks the MS to measure the signals from BSs (GSM, IS-95)

Handoff, Types

- Inter-BS handoff
  - The new and the old BS are connected to the same MSC
- Intersystem handoff
  - The new and the old BS are connected to different MSCs

Inter-BS handoff, 1

- Example with mobile-controlled handoff

1. MS suspends conversation and signals on an idle channel of the new BS
2. MSC transfers the encryption information to the selected idle channel of the new BS and sets up the new conversation path to the MS. The paths are bridged by the MSC and the MS is informed to switch to the new channel

Inter-BS handoff, 2

3. After the MS has been transferred to the new BS it signals the network and resume conversation on the new channel
4. Upon receiving the handoff completion signal the network releases the resources associated with the old channel

Inter-BS handoff, 3

- For network-controlled handoff all signaling messages are exchanged between the MS and the old BS on the failing link (→ must be fast)
- If the new BS does not have an handoff channel, the call can be dropped: Forced termination (least desirable event)

Forced termin. reduction, 1

- Nonprioritized scheme: A handoff is treated as a new call
- Reserved channel: Some channels in the BSs are reserved for handoff calls
- Queuing priority: Based on overlapping cell coverage (handoff area). If a channel is not available the new BS puts the request in a waiting queue

Forced termin. reduction, 2

- Subrating scheme: A new channel for an handoff call is created by sharing resources with an ongoing call. A full-rate channel is temporarily divided into two channels each half the original rate. When occupied channels are released they revert to full-rate

Instersystem Handoff, 1

- Example with network-controlled handoff (IS-41) with MS from MSC A to MSC B

1. MSC A asks MSC B to perform handoff measurements. MSC B chooses one of its BSs for performing the measurements and returns them to MSC A

Instersystem Handoff, 2

2. MSC A asks MSC B to set up a voice channel. If a voice channel is available in the BS of MSC B the MS is going to, MSC B instructs MSC A to start the link transfer
3. MSC A sends MS a handoff order. MS synchronizes to the new BS. MSC B informs MSC A that the handoff is successful. MSC A then connects the trunk (call path) to MSC B and completes the handoff procedure

Roaming Management

- The MS moves from one PCS system (e.g., Boston) to another (e.g., LA)
- Two basic operations
  - Registration (or location update): The MS informs the system about its current location
  - Location tracking: The system locates the MS (needed to deliver a call)

Roaming strategies

- Both in IS-41 and GSM MAP
- Two-level strategies: Two-tier system of home and visited databases
  - Home Location Register (HLR): System where the used subscribed to the PCS
  - Visitor Location Register (VLR): System visited by the MS

Home Location Register

- Network database in the MS home system
- Stores and manages all mobile subscription of an operator
- An MS identity is assigned for record purposes (directory number, profile info, current location, validation period)

Visitor Location Register

- Network database in the visited system
- Temporarily stores subscription information of the visiting subscribers
- Needed to the visited MSC to provide the service
- Information are sent by the home MSC

Registration, 1

1. MS moves from a visited system (NY) to visited system (CA): Need registration in the VLR of the CA system
2. CA VLR informs the MS's HLR (NJ) of the new location. The HLR acks, sending the MS profile

Registration, 2

3. The CA VLR informs the MS of the successful registration (the "network has been found")
4. After step 2. the HLR sends a deregistration message to the NY VLR. The NY VLR acknowledges the deregistration

Originating a Call from MS

- MS contacts the MSC of the visited system
- The call request is forwarded to the VLR for approval
- If approved, the MSC sets up the call to the called party (PSTN setup procedures)

Location Tracking, 1

- Needed for call delivery

1. From a wireline phone: Call is forward to the originating switch in the PSTN:
   - Queries the HLR to find the current MS's VLR
   - The HLR queries the current MS's VLR to obtain a routable address

Location Tracking, 2

2. The VLR returns the routable address to the originating switch through the HLR
3. Based on the routable address, a trunk (voice circuit) is set up from the originating switch to the MS via the visited MSC

Roaming Under SS7

- Interaction between the PCS network and the PSTN: Mobile roaming management and the PSTN signaling
- Common Channel Signaling (CCS): Signaling method for control and management function in the PSTN
  - Supervisory functions
  - Addressing
  - Call information provisioning

CCS

- A CCS channel
  - Conveys messages to initiate and terminate calls
  - Determines the status of some part of the network
  - Controls the amount of traffic allowed
- Out-of-band signaling network for carry signaling messages

Signaling System No. 7 (SS7)

- Is a CCS system that improves earlier signaling systems for supporting more than "plain old telephone services" (POTS)
- Takes care of the signaling between the PSTN and the PCS network

SS7 network

- Three components
  1. Service Switching Points
  2. Signal Transfer Points
  3. Service Control Points

(Figure 2.7, pg. 24 of the textbook)

Service Switching Point (SSP)

- Telephone switch interconnected by SS7 links
- Performs call processing for calls that originate or terminate at that switch
- In the PSTN is it called central office or end office
- In the PCS network it is called MSC

Signal Transfer Point (STP)

- A switch that relays SS7 messages between network switches and databases
- Routes the messages to the correct outgoing signaling links (based on the address field on the SS7 message)
- They come in pairs (for robustness/reliability)

Service Control Point (SCP)

- Contains databases for providing enhanced services
- Accepts queries from an SSP and returns the requested information
- In case of mobile application, it may contain the HLR and or the VLR

SS7 Network, links

- Trunks (voice circuits) connect SSPs to carry user data/voice information
- The signaling links connect SCPs to STPs and STPs to SSPs
- SSPs and SCPs are connected indirectly through STPs

Registration in SS7, 1

- MS moves from VLR1 to VLR2 (figure 2.8, page 25 of the textbook)
- Step 1. MS enters the area controlled by MSC2. MSC2 launches a registration query to its VLR2 through STP2 (not co-located)
- Step 2. VLR2 sends a registration message to the MS's HLR: For this it sends a Mobile Identification Number (MIN) to STP that translate MIN to its HLR address

Registration in SS7, 2

- Step 3. The MIN-to-HLR translation is done by STP by a table look-up technique called Global Title Translation (GTT). STP forwards the registration message to HLR
- Step 4. After registration, HLR sends an ack back to VLR2 (no need to pass through STP)

Registration in SS7, 3

- Step 5. After Step 3 HLR sends a deregistration message to VLR1 (obsolete records are cancelled). VLR1 acknowledges
- The process as described is message intensive and techniques have been proposed for reducing the cost, especially of deregistration

Call Delivery in SS7

- Several STPs and a GTT maybe required to access HLR for call delivery in SS7
- Several STPs may be visited to obtained a routable address from the VLR
- Several caching-based techniques have been proposed for reducing call delivery traffic

Assignments

- Read Chapter 2 of the textbook
- Updated information on the class web page:

  www.ece.neu.edu/courses/eceg364/2004sp