G 364: Mobile and Wireless Networking

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

Mobility Databases

- LU and call delivery/termination rely heavily on the VLR and HLR and related operation
- If the mobility databases fail, service is not possible
- Failure recovery is very important for mobile cellular communication

The HLR

- HLR contains all permanent subscriber data other than security information (secret keys)
- An HLR record consists of
  - MS information: IMSI, MSISDN (the phone number of a MS)
  - Location information: ISDN number of the current VLR and MSC
  - Service information: Service subscription, restrictions and supplementary services

The VLR

- The VLR is the database of the service area visited by the MS
- It contains all subscriber data of a MS needed for call handling
- A VLR record consists of
  - MS information: IMSI, MSISDN (the phone number of a MS) and TMSI
  - Location information: ISDN number of the current MSC and the LAI (ID of the current LA)
  - Service information: Subset of what stored in HLR

HLR Failure Restoration

- For GSM HLR it is mandatory to save updates into nonvolatile storage
- Change of service info are saved *immediately* after any update
- Location information is *periodically* backed up
- Uncovered period = time between the last back up and before HLR restart

HLR Restoration Procedure

- Step 1: HLR sends an SS7 TCAP message to VLRs of all its MSs
- Step 2: VLRs derive all MSs of the HLR. For each such MS they send an SS7 TCAP message to the HLR
- After this location update the HLR record is recovered
- Not robust, since MS can move to VLRs with no MS from the failed HLR during the uncovered period, so …

VLR Identification Algorithm

- Identify the exact VLRs to be contacted by the HLR after the HLR failure
- The implementation of the VIA requires extra data structures in the HLR
- Extra lists are also required in the HLR back up
- All the VLRs in the list are messages by the HLR during recovery

VLR Failure Restoration

- Service information of a VLR record is recovered by the first contact between the VLR and the HLR of the corresponding MS
- Location information is recovered by the first radio contact between the VLR and the MS
- MS information is recovered either by contact with the MS or with the HLR
- Record restoration is initiated by: MS registration, MS call origination, MS call termination

MS Registration for Recovery

- Since VLR record was cancelled by the failure, VLR consider the registration as a case of inter-VLR movement
- The corresponding procedures (re)create the lost record
- Problem: The TMSI is not recognized and MS is asked to send IMSI over the air

Call Origination for Recovery

- When MSC sends to VLR a call origination message, the MS record is not found
- A system error is generated: “unidentified subscriber”
- Request is rejected, and MS must register again (basic location update procedures)
- After the registration procedure the VLR record is recovered

Call Termination for Recovery

- This is a thirteen steps procedure (Figure 11.7)
- Includes expensive operations such the search for mobile users that involves ALL BTSs connected to a MSC (they must do the paging)
- To avoid "wide area paging" GSM might ask the MSs to re-register periodically

VLR Overflow Control, 1

- Number of records in a VLR changes dynamically
  - New records = new visiting users
  - Old records = deleted when users move out
- VLR may overflow because of too many new users
- An overflow control scheme is needed

VLR Overflow Control, 2

- In case of overflow a user cannot register = no cellular services are available to the user
- A suite of algorithms is presented for offering services in case of overflow
- These require just an extra flag in the HLR entry for a MS. No modifications are made to the MS

Algorithm O-I: Registration

- MS moves into a LA of VLR V2
- If VLR is not full → regular registration
- If VLR is full, registration happens in two steps:
  1. Registration request
  2. Registration response
- (Figure 11.10)

Step 1, Registration Request

- Step 1.1: Same as for registration when VLR is not full
- Step 1.2: VLR is full. V2 has a replacement policy, and select a record for deletion (the overflow user)
  - Random selection, based on recent activity
  - The new user can be selected (i.e., no record is created for the new user)
- Step 1.3: HLR is notified about the new and the deleted user

Step 2, Registration Response

- Step 2.1: HLR updates the location of the new user and sets the flag of the deleted user
- Step 2.2: HLR acks registration and sends new user's info to V2 (profile is not sent if the new user is also the deleted one)
- V2 sends an acknowledgement to MS

Algorithm O-II: Cancellation

- User u1 moves from VLR V1 to VLR V2
- If u1 is not an overflow user, cancellation is like Inter-VLR registration steps 7 and 8
- If u1 is an overflow user, there is no record with V1: Cancellation resets the flags in the HLR *if* u1 is not an overflow user in V2 (Figure 11.11)

Algorithm O-III: Call Origination

- Six steps procedure (Figure 11.12)
- Step 1: The MS sends the call origination request to V2
- Step 2: V2 cannot find its record and denies the call
- Steps 3 and 4: Algorithm O-I is executed
- Steps 5 and 6: MS reissues call origination request, and normal call registration is executed

Algorithm O-IV: Call Termination

- Three steps procedure (Figure 11.13)
- Step 1, Location query
  - 1.1 Calling party dials telephone number of u1. The request is sent to the originating switch
  - 1.2 The originating switch sends a location query to the HLR
  - 1.3 HLR determines that u1 is an overflow user and query about routing information. u1 profile is sent along

Step 2, Location Response

- 2.1 If V2 is not full a record for u1 is created. If V2 is full a record is deleted and used for u1. A routable address is created for u1 and sent to the HLR
- 2.2 HLR sends the routable address to the originating switch. If a record is deleted the overflow flags are updates at the HLR

O-IV: Steps 2.3 and 2.4

- 2.3 The originating switch sets up the trunk to the MSC based on the routable address
- 2.4 The MSC pages the mobile phone and the call path is established

GSM Short Message Service, 1

- GSM SMS provides connectionless transfer of small messages
- Low capacity, low time performance
- First trial in December 1992: From a PC to a MS, Vodafone GSM network, UK
- SMS operates like a paging service
  - It is two way!

SMS, 2

- Every SMS can contain up to 160 characters of the GSM alphabet (GSM 03.38)
- Longer messages via:
  - SMS concatenation: Long message = standard short messages one after another
  - SMS compression: Compression techniques are used

SMS, 3

- SMSs are transported via a GSM SDCCH (Standalone Dedicated Control CHannel) signaling channel
  - SMSs can be received while the user is talking
- Two types of SMSs:
  - Cell broadcast: All subscribers in a given area are reached
  - Point-to-Point: Message is delivered to a specific user (two way paging) (we will see this type)

SMS Architecture, 1

- The SMS network architecture is described in Figure 12.1
- SMS is delivered from the originating device to a Short Message Service Center (SM-SC)
- SM-SC is connected to the GSM network via a special MSC, called SMS Gateway MSC (SMS GMSC)

SMS Architecture, 2

- SMS GMSC follows the GSM MAP for roaming to deliver the message to the current MSC of the destination
- The MS must run special software and have enough memory to manage and store received SMSs
  - SMSs can be stores either in the SIM or in the memory of the ME

SMS Architecture, 3

- MS can send and reply to SMSs
- Message is delivered to a short message service internetworking MSC (SMS IWMSC) and then to the SM-SC
- Recipient can be another MS, a fax machine, or an Internet PC
- Messaging is facilitated by several technologies
  - E.g., predictive text input algorithm

SMS: Types of Messages

- User specific: Displayed to the user
- ME specific: Processed by the ME. Used (by the vendor) to trigger functions in the ME (e.g., a Nokia smart message is a ME specific message)
- SIM specific: Similar to ME specific, it is processed at the SIM. Used by the operator for triggering SIM functions

SM Service Center, SM-SC

- Supports high quality SMS service
- Should be scalable, highly available and reliable
- Typically implemented on high speed servers
  - E.g., Compaq alpha server, Sun SPARK station, HP 9000
- Support for TCP/IP and for WAP

Assignments

- Read chapters 11 and 12 of the textbook
- Updated information on the class web page:

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