G 364: Mobile and Wireless Networking

CLASS 24, Wed. Apr. 7 2004

Stefano Basagni

Spring 2004

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

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 SM 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

- SMs are transported via a GSM SDCCH (Standalone Dedicated Control CHannel) signaling channel
  - SMs can be received while the user is talking
- Two types of SMs:
  - 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
- SM 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

SMS Protocol Hierarchy

- The protocol hierarchy for mobile generated SM is illustrated in Figure 12.2 (for mobile terminated SMS we would have GMSC instead of IWMSC)
- Four layers: SM Application Layer (AL), SM Transfer Layer (TL), SM Relay Layer (RL), and SM Connection Management Sub-layer (CM-sub)

Short Message Transfer Layer

- SM-TL provides service to transfer SM-AL short messages
- SM-TL primitives generate a reference number, Short Message Identifier (SMI) for every short message
- SM-TL Transfer Protocol (SM-TP) consists of four types of Transfer Protocol Data Units (TPDUs)

SM-TP TPDUs, 1

- SMS-SUBMIT: Conveys a SM (TP user data, TP-UD) from MS to SM-SC. It can carry the TP-UD validity period
- SMS-DELIVER: Conveys a SM from SM-SC to MS. Contains a time stamp of when the SM arrived at the SM-TL of the SM-SC. A More-To-Send Boolean parameter tells the MS if there are further messages

SM-TP TPDUs, 2

- SMS-STATUS-REPORT: Conveys a report from SM-SC to the MS about the status of a SM originated at the MS. Initiated optionally by SMS-SUBMIT
- SMS-COMMAND: Conveys a command from the MS to the SM-SC. E.g., a query about a submitted SMS, cancellation of status report, deletion of an SMS

SMS-SUBMIT, Parameters, 1

- The TPDU SMS-SUBMIT contains:
  - Message Type Indicator (MTI): Type of the TPDU. 01 for SMS-SUBMIT
  - Reject Duplicate (RD): Indicates if the SM-SC should reject the duplicated SMS-SUBMIT TPDU
  - Validity Period Format (VPF): Specifies the format of the validity period

SMS-SUBMIT, Parameters, 2

- Status-Report-Request (SRR): Indicates whether a status report should be sent back to the sender
- User Data Header Indicator (UDHI)
- Reply Path (RP): Indicates whether the reply path is used

Other TPDUs

- Similar to SMS-SUBMIT
- SMS-DELIVER has a More-To-Send field and a Status Report Indicator (SRI) field
- Every TPDU except SMS-STATUS-REPORT has a protocol field
- All TPDUs are either priority or non-priority

Short Message Relay Layer

- SM-RL provides services to transfer TPDUs and the corresponding delivery report for the SM-TL
- An SMI is generated for every SM
- Communications between peer SM-RL entities at the MS and at the MSC follow the rule of the Short Message Relay Protocol (SM-RP)
  - Provides networking functions between MS and the SM-SC which talks via TCAP/MAP to the MSC

SM-RP RPDUs

- RP-DATA: Passes the TPDU+ to and from the MS and the network
- RP-SM-MEMORY-AVAILABLE: Indicates that the MS has memory available to receive more SMs
- RP-ACK: Acknowledges either RP-DATA or RP-SM-MEMORY-AVAILABLE
- RP-ERROR: Reports any error of a corresponding RP-DATA

Connection Manager Sub-Layer

- SMS CM-sub provides services to support SM-RL
- Peer Short Message Control (SMC) entities communicate via the Short Message Control Protocol (SM-CP)
- MS has two SMC entities, for handling outgoing and incoming messages

SM-CP Protocol Elements

- CP-DATA: Delivers RPDUs between MS and MSC
- CP-ACK: Acknowledges the corresponding CP-DATA
- CP-ERROR: Provides the causes of the messaging procedure error

Mobile-Originates Messaging

- In MO messaging the MS sends a SM to the SM-SC
- SM-SC sends to destination (another MS or paging device)
- Logical message path:

  MS → origin. MSC → IWMSC → SM-SC
- (IWMSC can be the originating MSC)

MO Message Flow, Part 1

- MO message flow is organized into three parts
- Part 1 is comprised of 6 steps (Figure 12.3)
- Step 1: SM-TL issues a SMS-SUBMIT TPDU to the SM-RL by the SM-RL-DATA (Request) primitive

Part 1, Step 2

- The SMR entity creates an RP-DATA(MO) RPDU and invokes the MNSMS-ESTablish(Request) primitive to transfer it. SMR sets the timer TR1M and expects RP-ACK before it expires. If TR1M expires the CM connection and the MM connection are aborted (SM-TL receives a report)

Part 1, Step 3, 1

- SMC entity establishes the MM-connection (Figure 12.4)
- 3a: MS sends a CM_SERV_REQUEST message to the MSC (service type different from a voice call transmission)
- 3b: Co_SMS_MSC (SMS coordinating process) is invoked in the MSC. A MAP_PROCESS_ACCESS REQUEST is sent to VRL (GSM MAP, sent via SS7 using TCAP)

Part 1, Step 3, 2

- 3c: VLR checks whether the MS is legal to receive the message. If so, it acknowledges the MSC request
- 3d: The MSC forwards the acceptance to the MS by sending the message CM_SERVICE_ACCEPT

Part 1, Step 4

- Once the connection with MSC has been established, SMC creates the CP-DATA containing the RPDU and sends it to the MSC
- A timer TC1* is set, and a corresponding result is expected
- If TC1* expires the RPDU (CP-DATA) is resent (up to 3 times)
- If unsuccessful, an error is reported to the MS-RL layer and the CM-connection released

Part 1, Step 5

- MSC acks the CP-DATA message with a CP-ACK
- Upon receiving, SM-SC resets TC1*
- SMS-SUBMIT request is forwarded from the SMC entity to the SMR entity of the MSC via the MNSMS-ESTablish(Indication) primitive

Part 1, Step 6

- The SMS-SUBMIT request is forwarded from the SMR entity to the SM-TL of the MSC (SM-RL-DATA(Indication) primitive)
- A timer TR2N is set and SMS-STATUS-REPORT is expected
- If TR2N expires SMR requests SMC to abort the CM connection and send a report indication to the SM-TL
- Note: SM-TP involves only MS and SM-SC

MO Message Flow, Part 2

- Comprised of 6 steps (Figure 12.5)
- Step 7: the MOSM_MSC process is invoked in the MSC
- VRL is queried (e.g., MSISDN): Request for checking on violation or change in supplementary services
- Step 8: VLR either acks OK, or provide error causes: teleservice not provisioned, call barred, data missing, unexpected data value

Part 2, Step 9

- If VLR is OK, the MSC sends a message to the IWMSC (gateway to the MS-SC)
- Message includes:
  - SM-SC address (provided by the MSC)
  - The sender MSISDN
  - The short message (i.e., TPDU)

Part 2, Steps 10, 11 and 12

- Step 10: SM-SC receives the short message
- Step 11: SM-SC sends a report to the IWMSC using GSM MAP
- Step 12: The message is acked by the IWMSC to the MSC

MO Message Flow, Part 3

- Comprised of 6 steps (Figure 12.6)
- Step 13 and 14: The SM-TL entity sends the SMS-STATUS-REPORT to the SMR entity at SM-RL. TR2N timer is stopped. SMR generates RP-ACK and sends it to SMC at CM-sub
- Step 15: The SMC entity generates CP-DATA and sends it to the MS. TC1* timer is set

Part 3, Steps 16 and 17

- Step 16: SMC entity of the MS receives the CP-DATA. Forwards the RP-ACK to the SMR entity, and sends a CP-ACK to the MSC
- Step 17: SMR stops the TM1R timer, forwards the SMS-STATUS-REPORT to the SM-TL, and invokes the MNSMS-RELease primitive to release the CM connection

Part 3, Step 18

- CM and MM connections are released
- If SM delivery is not successful, an error is reported to the MS:
  - Unknown service center address
  - Service center congestion
  - Invalid SM entity address
  - Protocol error
  - …

Mobile-Termination Messaging

- In MT messaging the MS receives a short message from the SM-SC
- The sender can be another MS or a traditional paging device as defined in GSM
- Logical message path:

  SM-SC → GMSC → Terminating MSC → MS
- (GMSC can be the terminating MSC)
- It is a 22 steps message flow (figures 12.7-9)

MT Message Flow, Part 1

- Step 1 and 2: SMS GMSC receives a SM (RP user data) from SM-SC. GMSC requests routing information to the MS by querying the HLR. The message includes the MSISDN
- Step 3: Using MSISDN, HLR determines routing to MS and sends back to the GMSC the MS IMSI and address of the current MSC. If failure occurs a corresponding error is reported to the GMSC

Part 1, Steps 4 and 5

- Step 4: SMS GMSC sends the message to the MSC. Similar to MO messaging, BUT with a More-To-Send parameter and the destination address here is the IMSI
- Step 5: The MSC sends a request to the VLR to obtain subscriber related information

Part 1, Steps 6-10

- Step 6: VLR executes a micro-procedure, Check_Indication, and, if check is passed, initiates the paging procedure. The LA of the MS can be known, or not (search is needed in the latter case)
- Steps 7-9: MSC performs the paging operations. If successful, the VLR is notified
- Step 10: VLR acks the MSC which can start the forwarding to the MS

MT Message Flow, Part 2

- Step 11-20: The SMR entity of the MSC generates the RP-DATA from the TPDU SMS-DELIVER and relays it to the MS
- Steps are similar to the corresponding ones in the MO messaging (Figure 12.8)

MT Message Flow, Part 3

- Step 21: After the SMS-STATUS-REPORT (Step 19) the GMSC is acked for the message it sent in Step 4
- Step 22: If MSC reports the MS absent, the GMSC informs the HLR of the current status and further actions. The result is sent to SM-SC anyway

Assignments

- Read Chapter 12 of the textbook
- Updated information on the class web page:

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