Wireless and Mobile Network Architecture

Chapter 5: IS-41 Network Signaling

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Outline
- Introduction
- Signaling System No.7
- Interconnection and Message Routing
- Mobility Management Using TCAP
- PCN/PSTN Call Control Using ISUP
- Summary

Introduction
- Support PCS network (PCN) network management
  - IS-41 (Interim Standard 41)
  - GSM MAP (Global System for Mobile Communications Mobile Application Part)
- Interactions between PCN and PSTN (IS-41)
  - Interconnection Interfaces
  - Message Routing
  - Mobility Management
    - Tracks the locations of the mobile users
  - Call Control
    - Sets up the call path

5.1 Signalling System No.7
- Common channel signaling (CCS)
  - POTS
  - SS7
- Three functions:
  - Monitor
  - Addressing
  - Communicating information
Fig. 5.1

The SS7 protocol layers

- **Message Transfer Part (MTP)**
  - MTP Level 1: physical, electrical and functional characteristics of the signaling links connecting SS7 components
  - MTP Level 2: reliable transfer of signaling messages between two directly connected signaling points.
  - MTP Level 3: messages routing, network management.

- **Signaling Connection Control Part (SCCP)**
  - MS has MIN (Mobile identification number)
  - GTT (global title translation)

Fig. 5.1 SS7 interconnection between a PCN and the PSTN.

Cont

- Three Component:
  - Service Switching Point (SSP)
  - Signal Transfer Point (STP)
  - Service Control Point (SCP)

- Two types signaling links:
  - **Access link (A-link)**
    - Between SSP and STP
    - upper bound : 128 pairs (16 for most switch suppliers)
  - **Diagonal link (D-link)**
    - Connects STPs
    - upper bound : 64 pairs

Fig. 5.2

The SS7 signaling protocol.

- OMAP
- TCAP
- ISDN-UP
- SCCP
- MTP Level 3
- MTP Level 2
- MTP Level 1
- Message Transfer Part
- Transaction Capabilities Application Part
- Signaling Connection Control Part
- Application
- Presentation
- Session
- Transport
Continued

- **Transaction Capabilities Application Part (TCAP)**
  - Provides the capability to exchange information between applications using noncircuit-related signaling

- **Integrated Service Digital Network User Part (ISUP)**
  - Circuit-switched network connections (call setup/release)

### Fig. 5.2

The Mobile Application Part
Transaction Capabilities Application Part
Signaling Connection Control Part
Message Transfer Part

### 5.2 Interconnection and Message Routing

- **Two trunks:**
  - Type 2A: connection between a PCN and a PSTN tandem switch
  - Type 2B: connection between a PCN and a PSTN end-office switch

- **Two types signaling links:**
  - **Access link (A-link)**
    - upper bound: 128
  - **Diagonal link (D-link)**
    - upper bound: 64 pairs

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**Fig. 5.2** The SS7 signaling protocol.
5.3 Mobility Management Using TCAP

- Three purposes:
  - Inter-MSC handoff
  - Automatic roaming
  - Operations, administration, and maintenance

- TCAP message consists of two portions:
  - Transaction
  - Component

Transaction

- Transaction: specifies the package type
  - QueryWithPermission
  - Response
  - ConversationWithPermission
  - Unidirectional

Table 5.1 | G.41 TCAP Message Formats

<table>
<thead>
<tr>
<th>Transaction/Component Type</th>
<th>TCAP Message Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Query</td>
<td>RETURN RESULT(Left)</td>
</tr>
<tr>
<td>Query</td>
<td>RETURN ERROR(Left)</td>
</tr>
<tr>
<td>Conversation</td>
<td>RETURN RESULT(Left)</td>
</tr>
<tr>
<td>Conversation</td>
<td>RETURN ERROR(Left)</td>
</tr>
<tr>
<td>Response</td>
<td>RETURN RESULT(Left)</td>
</tr>
<tr>
<td>Response</td>
<td>RETURN ERROR(Left)</td>
</tr>
<tr>
<td>Unidirectional</td>
<td>RETURN RESULT(Left)</td>
</tr>
<tr>
<td>Unidirectional</td>
<td>RETURN ERROR(Left)</td>
</tr>
<tr>
<td>Transaction</td>
<td>RETURN RESULT(Left)</td>
</tr>
<tr>
<td>Transaction</td>
<td>RETURN ERROR(Left)</td>
</tr>
<tr>
<td>ConversationWithPermission</td>
<td>RETURN RESULT(Left)</td>
</tr>
<tr>
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</tr>
</tbody>
</table>
Component

- Component: specifies the number and the types of components to be performed
  - INVOKE
    - Is used to invoke an operation (such as location register)
  - RETURN RESULT
    - Is used to return the results of an invoked operation
  - RETURN ERROR
    - Is used to report the unsuccessful completion of an invoked operation.
  - REJECT
    - Is used to report the receipt and rejection of an incorrect package or component.

Registration Process (six TCAP transaction)

- **Transaction 1**: MSC2 detects MS in its service area, send a RegistrationNotification(INVOKE) to its VLR2.
- **Transaction 2**: both MSC1 and MSC2 are served by VLR2 => only record identity of MSC1.
  Otherwise: Create T2, send RegistrationNotification(INVOKE) to the MS’s HLR.
- **Transaction 3**: HLR sends a RegistrationCancellation(INVOKE) to VLR1, cancel the registration record.

Cont.

- **Transaction 4**: The cancellation propagates to MSC1.
- **Transaction 5**: VLR2 sends a QualificationRequest(INVOKE) to the HLR to check the MS’s qualification for receiving services
- **Transaction 6**: VLR2 sends a ServiceProfileRequest(INVOKE) to the HLR to obtain the service profile for the roaming MS
PCN/PSTN Call Control Using ISUP

- MIN is dialed, the end office (EO) notices that the number is for wireless service.
- EO sends a query message to obtain MS's temporary local directory number (TLDN).

Land-to-mobile call setup

- **Step 1:** EO sends Initial Address Message (IAM) to the MSC for trunk setup.
- **Step 2:** EO sends Continuity Message (COT) to ensure satisfactory transmission quality.
- **Step 3:** When the IAM arrives at the MSC, the MSC pages the MS.
  - Busy: call collision => call forwarding/waiting, returns a REL message.
  - Idle: MSC send Address Complete Message (ACM).
  - No response: redirect call or return a REL message.
- **Step 4:** MS answers the call, an Answer Message (ANM) is sent to EO, the call is established through the trunk path.
- **Step 5:** EO sends Release Message (REL) to indicate trunk is being released.
- **Step 6:** MSC responses Release Complete Message (RLC) to confirm trunk has been placed in an idle state.
Mobile-to-land call setup

- **EXM (Exit Message)** indicates SS7 call setup information has successfully progressed to the IXC.
- **SUS (Suspend Message)**
  - When the called party hangs up the phone
  - Indicate the called party has disconnected
- EO expects one of the following two events to occur:
  - Receives REL message. EO disconnects the trunk.
  - The called party goes back Off-hook. EO sends *Resume Message (RES)* to MSC.

**Cont.**

- Before SUS timer expires:
  - The calling party hangs up. The MSC sends a REL to the EO and disconnects the trunk.
  - A REL arrives at the MSC. The MSC disconnects the trunk.
  - A RES arrives at the MSC. The SUS timer is stopped and connection continues
  - The MSC SUS timer expires; the MSC disconnects the trunk.

**Summary**

- SS7-supported interactions between PSTN and PCN
  - Two types trunk connections (Type 2A, Type 2B)
  - Two types signaling links (A-link, D-link)
- TCAP: mobility management
- ISUP: Call setup/release
- MTP: message routing
- SCCP: GTT