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 **M**obile **A**pplication **P**art)
- 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

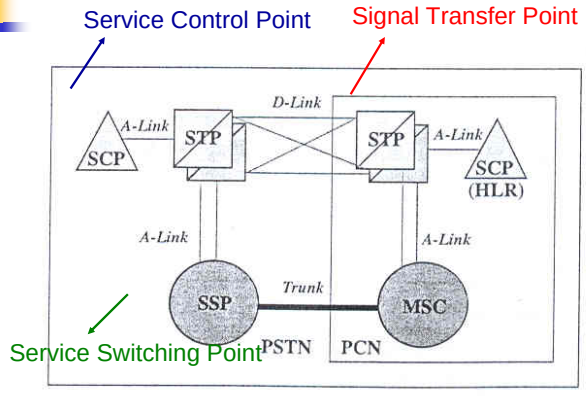

Figure 5.1 SS7 interconnection between a PCN and the PSTN.

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

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. 5.2

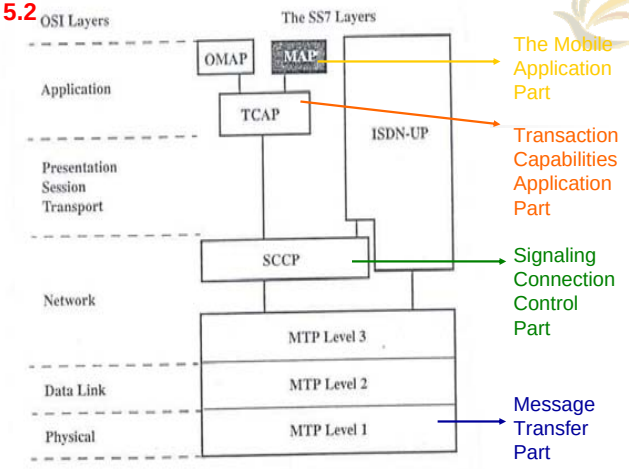

Figure 5.2 The SS7 signaling protocol.

Cont

- **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

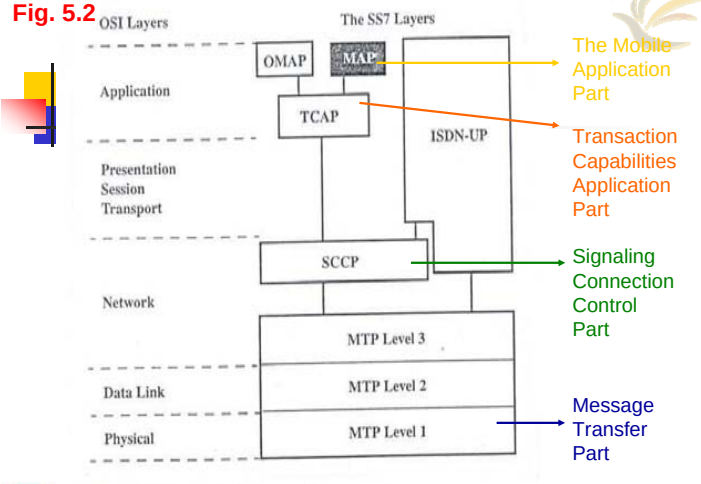

Figure 5.2 The SS7 signaling protocol.

Cont.

- **The Operations, Maintenance, and Administrations Part** (**OMAP**)
- **The Mobile Application Part** (**MAP**)
  - Both IS-41 and GSM MAP are implemented at this layer

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

Fig. 5.3

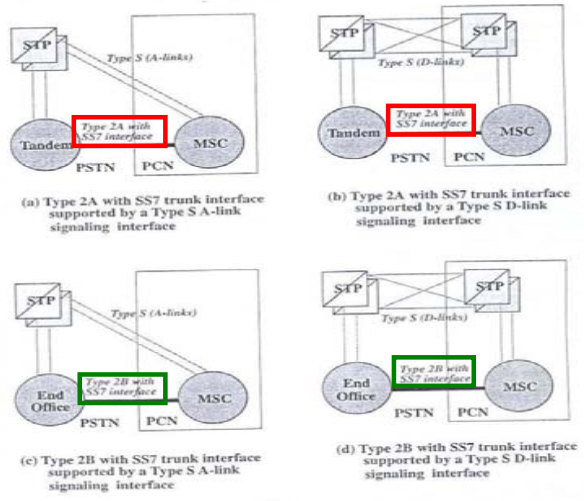

Figure 5.3 Types of interconnection between a PCN and the PSTN.

5.3 Mobility Management Using **TCAP**

- Three purposes:
  - **Inter-MSC handoff**
  - **Automatic roaming**
  - **Operations, administration, and maintenance**
- TCAP message consists of two portions:
  - **Transaction** and
  - **Component**

Transaction

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

Table 5.1

Table 5.1 IS-41 TCAP Message Formats

OPERATION	COMPONENT TYPE	PACKAGE TYPE
FacilitiesDirective	INVOKE (Last)	Query WithPermission
FacilitiesDirective	RETURN RESULT (Last)	Conversation WithPermission
FacilitiesDirective	RETURN ERROR	Response
FacilitiesDirective	REJECT	Response
HandoffMeasurementRequest	INVOKE (Last)	Query WithPermission
HandoffMeasurementRequest	RETURN RESULT (Last)	Response
HandoffMeasurementRequest	RETURN ERROR	Response
HandoffMeasurementRequest	REJECT	Response
MobileOnChannel	INVOKE	Response
QualificationRequest	INVOKE (Last)	Query WithPermission
QualificationRequest	RETURN RESULT (Last)	Response
QualificationRequest	RETURN ERROR	Response
QualificationRequest	REJECT	Response
RegistrationCancellation	INVOKE (Last)	Query WithPermission
RegistrationCancellation	RETURN RESULT (Last)	Response
RegistrationCancellation	RETURN ERROR	Response
RegistrationCancellation	REJECT	Response
RegistrationNotification	INVOKE (Last)	Query WithPermission
RegistrationNotification	RETURN RESULT (Last)	Response
RegistrationNotification	RETURN ERROR	Response
RegistrationNotification	REJECT	Response
ServiceProfileRequest	INVOKE (Last)	Query WithPermission
ServiceProfileRequest	RETURN RESULT (Last)	Response
ServiceProfileRequest	RETURN ERROR	Response
ServiceProfileRequest	REJECT	Response

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.

Fig. 5.4

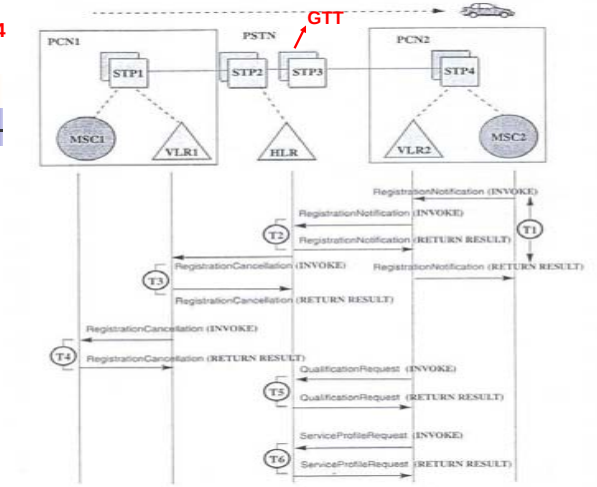

Figure 5.4 IS-41 TCAP message flow for MS registration.

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.

Fig. 5.5

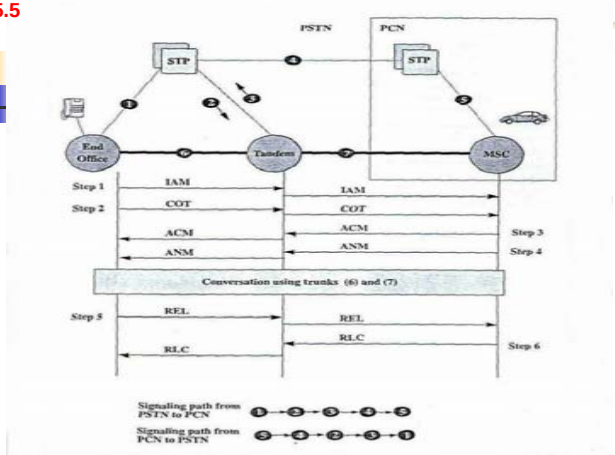

Figure 5.5 Typical message flow for type 2A with SS7 land-to-mobile call setup and release involving a tandem switch.

Cont

- **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 disconected
- 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.

Fig. 5.6

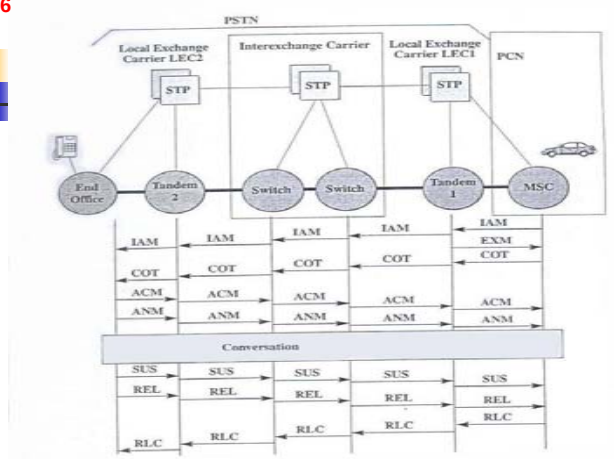

Figure 5.6 Typical message flow for type 2A with SS7 mobile-to-land call setup and release involving local exchange and interexchange carriers.

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,Type2B)
  - Two types signaling links (A-link, D-link)
- TCAP: mobility management
- ISUP: Call setup/release
- MTP: message routing
- SCCP: GTT