Signaling & Network Control (NETW 704)

Lecture 4: Message Transfer Part 3

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C3.220
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- Point Code
- MTP3 Message Format
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MTP3

- Corresponds to OSI Layer 3
- Function: Provides routing between SS7 Signaling Points
- Responsible for:
  1. Signaling Message Handling (SMH)
     Routing messages to their destination
  2. Signaling Network Management (SNM)
     Set of messages and procedures whose purpose is to handle network failures
MTP3

- Each SS7 node (signaling point) is uniquely identified by a **Point Code (PC)**
  - National Signaling PC (NSPC)
  - International Signaling PC (ISPC)

- An International Switching Center (ISC) is identified by both a NSPCs & ISPCs

- All nodes that are part of the international signaling network use the ITU-T ISPC globally.

- NSPCs are based on either the ITU national format or the ANSI format (North America).

- Each routing label contains both an
  - Originating Point Code (OPC)
  - Destination Point Code (DPC).
MTP3 – ITU-T Point Codes

- Single identifier (14 bits) that designates a specific node
- Based on a hierarchical structure that contains the three fields:
  1. Zone (1-6)
  2. Area/Network (UK 144, France 016 to 023)
  3. Signaling Point (defined in the country Range 1 to 254)

Example PC in UK: 2-144-001
MTP3 – Message Format

- Consists of two fields
  1. Service Information Octet (SIO)
  2. Signaling Information Field (SIF)
MTP3 – Message Format

SIO (Service Information Octet)

<table>
<thead>
<tr>
<th>Binary Value</th>
<th>Message Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>International</td>
</tr>
<tr>
<td>0001</td>
<td>International Spare</td>
</tr>
<tr>
<td>0010</td>
<td>National</td>
</tr>
<tr>
<td>0011</td>
<td>National Spare</td>
</tr>
</tbody>
</table>
MTP3 – Message Format

SIO (Service Information Octet)

- **Service Indicator** field specifies the MTP user, thereby allowing the decoding of the information contained in the SIF

<table>
<thead>
<tr>
<th>Binary Value</th>
<th>Type of Payload</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>Signaling Network Management Messages</td>
</tr>
<tr>
<td>0001</td>
<td>Signaling Network Testing and Maintenance Messages</td>
</tr>
<tr>
<td>0010</td>
<td>Signaling Network Testing and Maintenance Special Messages (ANSI) or Spare (ITU-T)</td>
</tr>
<tr>
<td>0011</td>
<td>SCCP</td>
</tr>
<tr>
<td>0100</td>
<td>Telephone User Part</td>
</tr>
<tr>
<td>0101</td>
<td>ISDN User Part</td>
</tr>
<tr>
<td>0110</td>
<td>Data User Part (call and circuit-related messages)</td>
</tr>
<tr>
<td>0111</td>
<td>Data User Part (facility registration and cancellation messages)</td>
</tr>
<tr>
<td>1000</td>
<td>Reserved for MTP Testing User Part</td>
</tr>
<tr>
<td>1001</td>
<td>Broadband ISDN User Part</td>
</tr>
<tr>
<td>1010</td>
<td>Satellite ISDN User Part</td>
</tr>
<tr>
<td>1011 - 1111</td>
<td>Spare</td>
</tr>
</tbody>
</table>
MTP3 – Message Format

SIF (Signaling Information Field)

- Contains the Routing Label and Signaling Information (actual user data - e.g., SCCP, TCAP and ISUP message data).

- Routing Label comprised of 3 fields:
  - Destination Point Code (DPC)
  - Originating Point Code (OPC)
  - Signaling Link Selection (SLS)
MTP3 – Message Format

Signaling Link Selection (SLS)

- The selection of outgoing link is based on information in the DPC and Signaling Link Selection field.

- The SLS is used to:
  1. Ensure message sequencing
     Any 2 messages sent with the same SLS will arrive at the destination in the same order of sending
  2. Allow equal load sharing of traffic among all available links.

If a user part sends messages at regular intervals and assigns the SLS values in a round-robin fashion, the traffic level should be equal among all links (within the combined linkset) to that destination.
MTP3 – Message Format

Signaling Link Selection (SLS) - Message Load Sharing

- User traffic is typically load-shared across different paths to maintain a balanced load on network equipment.
- There are two types of SS7 load sharing:
  - Load-sharing across linksets in a combined linkset
  - Load-sharing across links within a linkset
- The actual algorithm for generating the SLS code is not specified by the SS7 standards
- SLS field determines the distribution of messages across linksets and links as they traverse the network.
- The originating node generates an SLS code and places it into the Routing Label. At each node in the message path the SLS is used to map the message to a specific link.
MTP3 – Message Format

Signaling Link Selection (SLS) - Message Load Sharing

But: messages taking different paths could arrive out of order

- The SLS codes for messages related to a particular communications exchange, such as an ISUP call, are generated with the same value to insure in-sequence delivery because they could take different network routes.

- Example:
  - SSP A generates the same SLS code 0100 for all messages associated with this particular call.
  - Messages from SSP B that are related to the same call use SLS code 0101 for all messages.
MTP3 – Message Format

Signaling Link Selection (SLS) ITU-T
ITU-T networks use a four-bit SLS value

➢ If a combined linkset is being used:
  • one bit of the SLS code is used to select the linkset at each node
  • remaining bits are used to select the link within the linkset

➢ If a combined linkset is not being used:
  • all bits can be used to select a link within the linkset.

The ITU-T standards are not explicit about which bits are used for link and linkset selection.
MTP3 – Message Format

Signaling Link Selection (SLS) ANSI

ANSI networks use an eight-bit SLS code

- If a combined linkset is being used:
  The least significant bit of the SLS is used for linkset selection the remaining bits are used for link selection

- If a combined linkset is not being used:
  All bits are used to select the link when routing over a single linkset.
MTP3 – Message Format

Routing Label

ITU-T Routing Label
- Point code is 14 bits length
- 4 bits for SLS

ANSI Routing Label
- Point code is 24 bits length, divided in 3 fields
- One octet for each
MTP3 Functions

MTP3 is responsible for:

1. **Signaling Message Handling (SMH)**
   - Routing messages to their destination

2. **Signaling Network Management (SNM)**
   - Set of messages and procedures whose purpose is to handle network failures
MTP3 Functions - SMH

Signaling Message Handling (SMH)

Is performed in 3 steps:

- **Discrimination**
  - determining whether an incoming message is destined for the node that is currently processing the message.

- **Distribution**
  - When the discrimination function has determined that a message is destined for the current node.

- **Routing**
  - Routing takes place when it has been determined that a message is to be sent to another node.
  - There are two circumstances in which this occurs:
    - node originates a message to be sent to the network.
    - an STP has received a message that is destined for another node.
MTP3 Functions - SMH

Signaling Message Handling (SMH)
MTP3 Functions - SMH

Signaling Message Handling (SMH)

**Alias Point Code Routing**

- An alias Point Code is a secondary PC used, in addition to the unique primary Point Code, for identifying a node.
- Another common name for an alias is a **Capability Point Code**.
- Multiple nodes (usually two) share the alias PC; this allows messages to be routed to either node using a common PC.
MTP3 Functions - SMH

Signaling Message Handling (SMH)

Alias Point Code Routing

Example:
- The PC for STP 1 is 200-1-1, and the PC for STP 2 is 200-1-2.
- The alias PC 200-1-10 is used to identify both STP 1 and STP 2.
- As a result, SSP A can route messages to 200-1-10 while load sharing across STP 1 and STP 2.
MTP3 Functions - SNM

Signaling Network Management (SNM)

➢ **Traffic Management:**
  - Responsible for dealing with signaling traffic, which are the messages generated by MTP3 users
  - Keep traffic moving toward its destination, even in the event of network failures and congestion, with as little message loss or mis-sequencing as possible
  - This movement often involves rerouting or retransmission

➢ **Route Management:**
  - Exchanges information about routing status between nodes
  - Sends messages to notify other nodes about any changes
  - Supplies information to traffic management

➢ **Link Management:**
  - Activates, deactivates, and restores signaling links.
  - Notifying MTP users of the availability of signaling links
  - Invoking procedures to restore service
MTP3 Functions - SNM

Signaling Network Management (SNM)

Route Management

- Signaling route management communicates the availability of routes between SS7 nodes.

- Failures such as the loss of a linkset affect the ability to route messages to their intended destination.

- Route management uses the following messages to convey routing status to other network nodes:
  - Transfer Prohibited (TFP)
  - Transfer Restricted (TFR)
  - Transfer Allowed (TFA)
  - Transfer Controlled (TFC)
MTP3 Functions - SNM

Signaling Network Management (SNM)

Route Management

- Each node maintains a state for every destination route. As route management messages are received, the state is updated based on the status conveyed by the message. This allows nodes to make appropriate routing choices when sending messages.

- Routes can have one of three different states:
  - Allowed
  - Prohibited
  - Restricted
MTP3 Functions - SNM

Route Management – Transfer Restricted

- Indicates a limited ability to route messages
- Signifies that the primary route is unavailable and that another route should be chosen, if it exists
- If the restricted route is the last available route in a routeset, it is still used for routing
MTP3 Functions - SNM

Route Management – Transfer Prohibited

- Indicates a complete inability to route messages to the affected destination.
- If one exists, another route must be chosen for routing.
- If no route exists, traffic management is notified that it cannot route messages to the destination.
MTP3 Functions - SNM

Route Management – Transfer Allowed

- Indicates that a route is available for carrying traffic
- Normal state for in-service routes
- When a route has been in the restricted or prohibited state and full routing capability is restored, the route’s status is returned to transfer allowed.
MTP3 Functions - SNM

Route Management – Transfer Controlled

- Indicates congestion for a route to a particular destination
- TFC message implies "transmit" congestion, in contrast to the "receive" buffer congestion handled by MTP2
MTP3 Functions - SNM

Route Management – Routeset Test

- Is part of the Transfer Prohibited and Transfer Restricted procedures

- While Transfer Prohibited and Transfer Restricted convey the status of the routeset, Routeset Test checks to ensure that the status is correct
MTP3 Functions - SNM

**Signaling Network Management (SNM)**

**Traffic Management**

Depends on the information provided by link management and route management to direct user traffic by using the following procedures:

- Change over
- Emergency changeover
- Time-controlled changeover
- Change back
- Time-controlled diversion

- Forced rerouting
- Controlled rerouting
- MTP restart
- Management inhibiting
MTP3 /User Part Communication

MTP3 uses primitives to communicate with MTP users about its routing status.

- **MTP-Transfer**:  
  - Indicates the ability to transfer messages to a destination  
  - This is the normal state for a destination when the network is healthy

- **MTP-Pause**:  
  - Indicates the complete inability to transfer messages to a particular destination  
  - This primitive informs the MTP user that no messages should be sent to the destination
MTP3 /User Part Communication

MTP3 uses primitives to communicate with MTP users about its routing status.

- **MTP-Resume:**
  - Indicates the ability to transfer messages to a previously unavailable destination

- **MTP-Status:**
  - Indicates a partial routing ability
  - This is used to indicate the congestion level to the user part in the case of multiple-level congestion.
MTP3 /User Part Communication