Chapter 5: Signalling in ATM Networks

TOPICS

– Introduction
– The signaling AAL (SAAL)
  • The SSCOP
  • Primitives
– ATM addressing
– The Q. 2931 signaling Protocol
  • Information elements
  • Q.2931 messages
• Point-to-point SVC connections are established over the private UNI using the signaling protocol Q.2931.

• Point-to-multipoint SVC connections are established over the private UNI using the signaling protocol Q.2971 in conjunction with Q.2931.
The establishment of an ATM connection across a private ATM network is done using the *private network node (or network network) interface (PNNI)*
The PNNI protocol consists of the following two components:

– *PNNI signaling protocol*
  • It is used to dynamically establish, maintain and clear ATM connections

– *PNNI routing protocol*
  • It is used to distribute network topology and reachability information between switches and clusters of switches.
  • This information is used to compute paths
The signalling protocol stack

- Signalling
- SAAL
- ATM
- Physical
Q.2931 runs above SAAL
The Signalling AAL (SAAL)

Service specific convergence sublayer

Service Specific Coordination Function (SSCF)

Service Specific Connection Oriented Protocol (SSCOP)

Common Part Convergence Sublayer

AAL 5

ATM SAP

AAL SAP
The SSCOP

The SSCOP’s functions are:

– Establishes/releases a connection to a peer SSCOP

– Maintains an assured transfer of frames over the connection. This is achieved using error detection and recovery by retransmission, and flow control.
### The SSCOP messages

<table>
<thead>
<tr>
<th>Functional Category</th>
<th>SSCOP PDU Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishment</td>
<td>BEGIN (BGN)</td>
<td>Used to request the establishment of an SSCOP connection.</td>
</tr>
<tr>
<td></td>
<td>BEGIN ACKNOWLEDGEMENT (BGAK)</td>
<td>Used to acknowledge acceptance of an SSCOP connection request by the peer SSCOP</td>
</tr>
<tr>
<td></td>
<td>BEGIN REJECT (BGREJ)</td>
<td>Used to reject the establishment of a connection requested by the peer SSCOP</td>
</tr>
<tr>
<td>Release</td>
<td>END</td>
<td>Used to release an SSCOP connection between two peer SSCOP entities.</td>
</tr>
<tr>
<td></td>
<td>END ACKNOWLEDGEMENT (ENDAK)</td>
<td>Used to confirm the release of an SSCOP connection requested by the peer SSCOP</td>
</tr>
<tr>
<td>Resynchronize</td>
<td>RESYNCHRONIZATION (RS)</td>
<td>Used to resynchronize buffers and the data transfer state variables.</td>
</tr>
<tr>
<td></td>
<td>RESYNCHRONIZATION ACKNOWLEDGEMENT</td>
<td>Used to acknowledge the acceptance of a resynchronization request.</td>
</tr>
<tr>
<td>Recovery</td>
<td>ERROR RECOVERY (ER)</td>
<td>Recovery command</td>
</tr>
<tr>
<td></td>
<td>ERROR RECOVERY ACK (ERAK)</td>
<td>Recovery acknowledgment</td>
</tr>
<tr>
<td>Assured transfer</td>
<td>SEQUENCED DATA (SD)</td>
<td>Used to transfer user data.</td>
</tr>
<tr>
<td></td>
<td>STAT REQUEST (POLL)</td>
<td>Used by transmitting SSCOP to request status information from the receiving SSCOP</td>
</tr>
<tr>
<td></td>
<td>SOLICITED STATUS RESPONSE (STAT)</td>
<td>Used to respond to a POLL. It contains the sequence numbers of outstanding SD PDUs and credit information for the sliding window.</td>
</tr>
<tr>
<td></td>
<td>UNSOLICITED STATUS RESPONSE (USTAT)</td>
<td>Similar to STAT message, but issued by the transmitter when a missing or erroneous SD PDU is identified.</td>
</tr>
<tr>
<td>Unacknowledged data</td>
<td>UNNUMBERED USER DATA (UD)</td>
<td>Used to transfer data in an non-assured manner</td>
</tr>
<tr>
<td>Management data</td>
<td>UNNUMBERED MANAGEMENT DATA (MD)</td>
<td>Used to transfer management data in a non-assured manner</td>
</tr>
</tbody>
</table>
The assured transfer scheme

• The transmitter periodically sends a POLL PDU to request the status of the receiver. The POLL contains:
  – The sequence number of the next SD PDU to be sent by the transmitter
  – Poll sequence number. Poll sequence numbers are between 0 and n-1, where n = 2^{24}-1, and they are independent of the SD PDU sequence numbers.
• The receiver, upon receipt of a POLL, responds with a **STAT PDU** which contains the following information:
  – An SD sequence number up to which the transmitter may transmit (i.e. the window),
  – The number of the next SD PDU expected,
  – The echoed poll sequence number, and
  – A list of all SD PDUs that are currently missing or have been received erroneously.

• **USTAT PDU**
  – It can also be sent by the receiver whenever it receives an erroneous SD PDU.
How does Q.2931 communicate with SAAL?

- SAAL functions are accessed by a signalling protocol, such as Q.2931 or Q.2971, through the AAL-SAP, using the following primitives:
  - **AAL-ESTABLISH**,  
  - **AAL-RELEASE**,  
  - **AAL-DATA**, and  
  - **AAL-UNIT-DATA**
The four primitive types

- Signaling protocol
- SAAL
- request
- confirm
- indication
- response
- ATM end-station
- ATM switch
• **AAL-ESTABLISH**
  – It is issued by a signalling protocol to SAAL in order to request the establishment of a connection over the UNI to its peer protocol.

• **AAL-RELEASE**
  – It is issued by a signalling protocol to SAAL to terminate a connection established earlier on using the AAL-ESTABLISH primitive.

• **AAL-DATA**
  – Used by the signalling protocol to request the transfer of messages to its peer signalling protocol over the UNI.

• **AAL-UNIT-DATA**
  – Used to request a data transfer over an unreliable connection.
Establishment of a connection between two peer signaling protocols
Termination of a connection between two peer signalling protocols

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Transfer of a signalling message
The signalling channel

- **Non-associated signalling**
  - In this mode, all the VC connections are created, controlled, and released via the signalling channel VPI/VCI=0/5.

- **Associated signalling**
  - In this mode, only the VC connections within the virtual path x are created, controlled, and released via the signalling channel VPI/VCI=x/5.
Public ATM addresses:
The E.164 addressing scheme

digits  1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16

| U, M | Country code | Area, city, exchange, end-system |
Private addresses:
The NSAP ATM formats

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An example of an NCSU address:

- The ICD format is used
  - AFI=47, indicates that an ICD ATM format is used
  - ICD=0005, indicates that a NIST coded HO-DSP is used
  - DFI=80, indicates that the next three bytes represent the administrative authority, in this case MCNC, which is responsible for handling the regional traffic.
  - AA-FFE4A00, assigned to MCNC by NIST
  - RDN=xxx, assigned by MCNC. For NCSU, RND=0101
  - AREA=yyyyy, to be assigned by RDN owner, such as NCSU
An NCSU address

- 47.0005.80.FFEA00.0000.0101.1114.400000000223.00

Prefix - 13 bytes or 104 bits
Addresses represent geographical regions in a hierarchical manner.
The format of the signalling message

<table>
<thead>
<tr>
<th>Byte</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Protocol discriminator</td>
</tr>
<tr>
<td>2</td>
<td>0 0 0 0</td>
</tr>
<tr>
<td>3</td>
<td>Flag</td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
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<tr>
<td>6</td>
<td></td>
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<td>7</td>
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<td>8</td>
<td></td>
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<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>≥10</td>
<td></td>
</tr>
</tbody>
</table>
Information Elements

• Signalling messages may contain a large number of data. This data is grouped together into *Information Elements*.

• New Information Elements can be added to provide signalling support for new schemes.
The structure of an information element

```
<table>
<thead>
<tr>
<th>byte</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>IE identifier</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IE instruction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of IE</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of IE</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IE specific information</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
```
Information Elements

- **AAL parameter IE**: It is used to indicate the AAL parameter values used between the end-devices.
- **ATM traffic descriptor IE**: It is used to specify the traffic parameters in the forward and backward direction of the connection.
- **Broadband bearer capability IE**: It is used to define the ATM service requested for a new connection.
- **Broadband high-layer IE, broadband low-layer IE**: They are used for compatibility checking by the called user.
- **Broadband repeat indicator IE**: It is used to indicate how repeated IEs are to be interpreted.
- **Call state**: It is used to describe the current status of the call.
Information Elements

- **Called party number IE, called party sub-address IE, calling party number IE, and calling party sub-address IE**: These IEs are used to identify the called user and calling user.

- **Cause IE**: It is used to describe the reason for generating certain messages and indicates the location of the cause originator.

- **Connection identifier IE**: It is used to identify the VPI/VCI allocated to the connection at the UNI.

- **End-to-end transit delay IE**: It is used to indicate the maximum acceptable transit delay and the cumulative transit delay to be expected for the connection.

- **Extended QoS parameters IE**: It is used to specify the acceptable values and the cumulative values of some of the QoS parameters.

- **Transit network selection IE**: It is used to identify a transit network that the call may cross.
Q.2931 messages

• Call establishment messages
  – SETUP
  – CALL PROCEEDING
  – ALERTING
  – CONNECT
  – CONNECT ACKNOWLEDGEMENT

• Call clearing messages
  – RELEASE
  – RELEASE COMPLETE

• Miscellaneous messages
  – NOTIFY
  – STATUS
  – STATUS ENQUIRY
Call establishment