Data Link Layer, Part 4

Exemplary Protocols

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High-Level Data Link Control (HDLC)

- a standard of DLL adopted by ISO
- originally created by IBM for mainframe-terminal communications
- also supports point-to-point, peer-to-peer links
- formed the basis of many other data link layer protocols, for example the LABP of X.25
- bit oriented framing (FLAG = 01111110)
- go-back-n sliding window protocol using 3-bit sequence number, piggybacking, and negative acknowledgments.
  ※ 7-bit sequence number is supported as an extension
**HDLC Frame Format**

- **Address**: destination DLL address
  - to identify a terminal in configurations where a link connects a mainframe and multiple terminals
  - not used in point-to-point configurations
- **Control**: determines the purpose of the frame; see next slide
- **Data**: frame data
- **Checksum**: 16-bit CRC Checksum using CRC-CCITT

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**Frame Types**

The Control field is used to distinguish three types of frames:

1. **Information Frame** (that is, data frame)

   - Seq: the sequence number of this frame
   - Next: piggybacked ACK, indicating the next expected frame (rather than the last received one)
   - P/F: used in mainframe-terminal communications; not to be discussed further
2. Supervisory Frame

<table>
<thead>
<tr>
<th>1</th>
<th>0</th>
<th>Type</th>
<th>P/F</th>
<th>Next</th>
</tr>
</thead>
</table>

- type 0: Receive Ready
  an ACK frame indicating the successful receipt of data frame Next-1
- type 1: Reject
  a NACK frame requesting the retransmission of the data frame indicated by Next; the sender must retransmit all frames starting at Next
- type 2: Receiver Not Ready
  explicitly acknowledging the “Next-1” frame and informing the sender to stop

3. Unnumbered Frame (control frame)

<table>
<thead>
<tr>
<th>1</th>
<th>1</th>
<th>Type</th>
<th>P/F</th>
<th>Modifier</th>
</tr>
</thead>
</table>

- the Type and Modifier together are interpreted as a control command
- some commands are used to negotiate the configuration of the link (mainframe-to-terminal or peer-to-peer)
- some commands are used to negotiate the length of sequence numbers
- reliability of control frames are provided by stop-and-wait
  if the command “Unnumbered Ack” is used as the ACK for other commands
PPP: Point-to-Point Protocol

The PPP protocols comprises three components:

1. A method to encapsulate datagrams (packets) over serial lines
   • the chosen format confirms with the HDLC format
2. A link control protocol (LCP) to establish, configure, and test
   the link
3. A family of network control protocols (NCPs) specific to
   protocols (IP, OSI, AppleTalk, etc.)
   • this enables network-layer specific optimizations

PPP Frame Format

<table>
<thead>
<tr>
<th>1 byte</th>
<th>1</th>
<th>1</th>
<th>2</th>
<th>up to 1500</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>flag 7E</td>
<td>addr FF</td>
<td>control 03</td>
<td>Protocol</td>
<td>Data</td>
<td>CRC</td>
<td>flag 7E</td>
</tr>
</tbody>
</table>

- Addr 0xFF is an “All-Station” address in HDLC
- Control 0x03 is the “Unnumbered Information” command (with P/F set to 0) in HDLC
**Link Control Protocol**

In order to establish communications over a point-to-point link, each end must first use the LCP to configure and test the link.

To improve link performance, the LCP further supports:

- negotiation of maximum frame size
- negotiation of address and control field compression
- negotiation of protocol field compression

Subsequently, each network layer protocol must be configured by its respective network control protocol.

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**IP Network Control Protocol**

- Dynamic negotiation of the IP address for each end
- TCP/IP header compression

This compression of transport layer information (TCP header) by a data link layer protocol (PPP) violates the OSI reference model.