Logic Link Control
IEEE 802.2
ISO 8802

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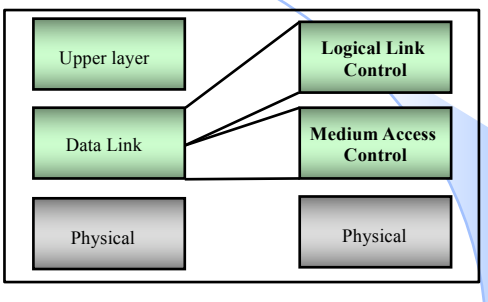
IEEE 802 Model



Introduction

- Data Link Layer
  - ISO 7498
  - To ensure reliable transmission between two adjacent stations
  - Provide reliable exchange services with:
    - acknowledgement
    - connection
    - flow control
  - HDLC (High Level Data Link Control)
    - issued from SDLC (IBM), BSC (CII)

Introduction - 2

- Data Link Layer
  - 1980's
  - Local Area Networks
  - Higher reliability of data transmission
  - Lower error ratio
  - Other applications
  - Other services and protocols

Contents

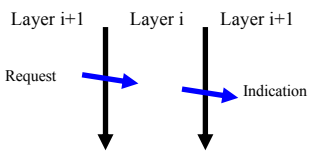
- Types of services and general concepts
- LLC 1
- LLC 2
- LLC 3
- Protocol

Logical Link Control

- Three service types
  - Type 1: LLC 1
    - **Without connection**
    - **Without acknowledgement**
  - Type 2: LLC 2
    - **With connection**
    - **With acknowledgement**
  - Type 3: LLC 3
    - **Without connection**
    - **With acknowledgement**

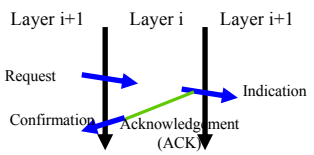
Without Acknowledgement

- Services and Protocols



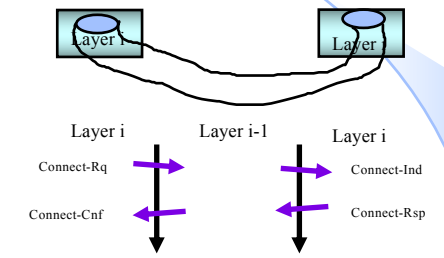
Acknowledgement

- Services and Protocols



Connection

- (Logical) Connection mode



Connection - 2

- Connection mode
- 3 phases
  - Connection establishment
  - Data transfer
  - Connection release or closing or disconnection
- Presence of remote entity
- Quality of Service negotiation

Connection - 3

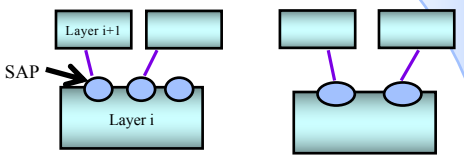
- Connection mode
- Quality of Service negotiation (QoS)
  - Protocol parameters to be set before data transfer
  - Parameters depending on the protocol
  - PDU length
  - Time-out
  - Numbering
  - Full duplex / half duplex transmission
  - Segmentation / concatenation

Flow Control

- Flow Control
- Flow regulation between
  - neighboring stations, or
  - end to end stations
- To avoid overwhelming
  - at the receiver, or
  - in intermediate stations
- Static or dynamic

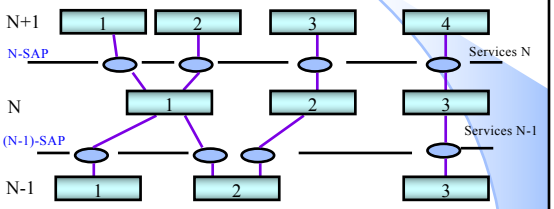
Addressing

- Addressing - 1
  - SAP: Service Access Point used to address an upper layer entity



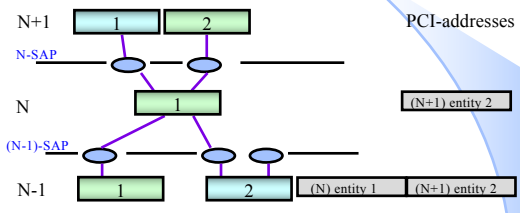
Addressing

- Addressing - 2



Addressing

- Addressing - 3



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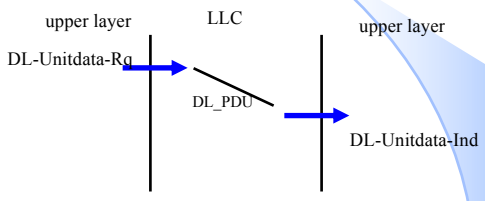
LLC Type 1

- Datagram exchange
  - without connection
  - without acknowledgement
  - without flow control
- Error detection
- No error recovery
  - untrusted to an upper layer protocol
  - useful if very low error ratio
  - very simple service and protocol

LLC 1

- DL-UnitData-Rq (AS, AD, Data, priority)
- DL-UnitData-Ind (AS, AD, Data, priority)



LLC 1

- Advantages
  - Simple
- Disadvantages
  - No detection of reception node is powered off
  - No detection of lost frames
  - The reception node detects error in the frame, but no error recovery
  - Without flow control

Contents

LLC 2

- Connection Management
  - DL-Connect-Rq (AS, AD)
  - DL-Connect-Ind (AS, AD)
  - DL-Connect-Cnf (AS, AD)
  - DL-Disconnect-Rq (AS, AD)
  - DL-Disconnect-Ind (AS, AD)
  - DL-Disconnect-Cnf (AS, AD)

LLC 2

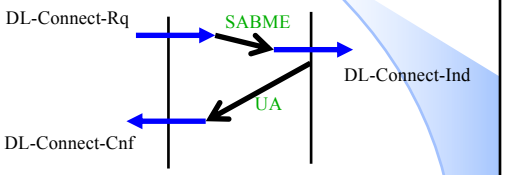
- Data Exchange
  - DL-DataConnect-Rq (AS, AD, L-Sdu)
  - DL-DataConnect-Ind (AS, AD, L-Sdu)
  - DL-DataConnect-Cnf (AS, AD, Status)

LLC 2

- Connection Control
  - DL-Reset-Rq (AS, AD)
  - DL-Reset-Ind (AS, AD)
  - DL-Reset-Cnf (AS, AD)
  - DL-ConnectionFlowControl-Rq (AS, AD, Qty)
  - DL-ConnectionFlowControl-Cnf (AS, AD, Qty)

LLC Type 2

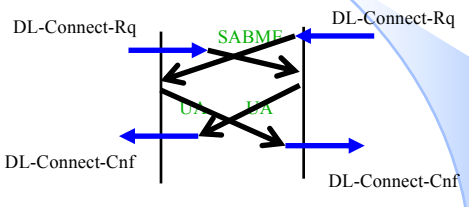
- Connection request (half duplex)



SABME: Set Asynchronous Balanced Mode Extended
UA: Unnumbered Acknowledgement

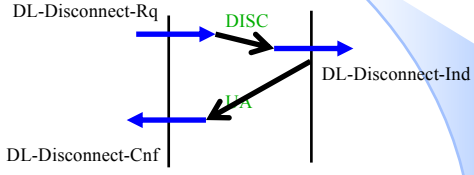
LLC 2

- Connection request (full duplex)



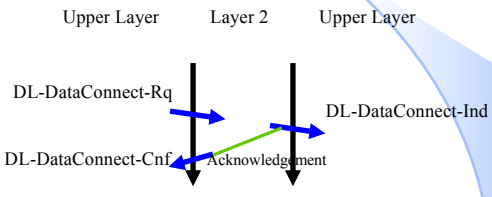
LLC 2

- Disconnection request



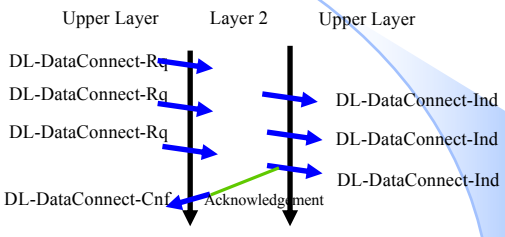
LLC 2

- Data Exchanges (simple)



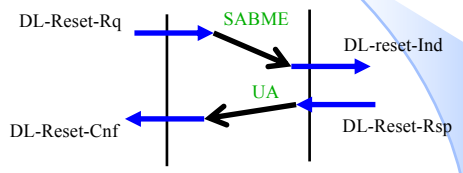
LLC 2

- Data Exchanges (sliding window)



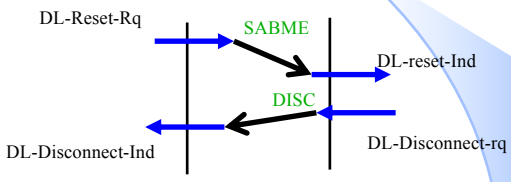
LLC 2

- DL-Reset



LLC 2

- DL-Reset



LLC 2

- Advantages
  - it detects that reception node is powered off
  - it detects lost frames
  - it detects the errors in the frame at the reception node and request retransmissions
  - with flow control
- Disadvantages
  - connection phase
  - disconnection phase

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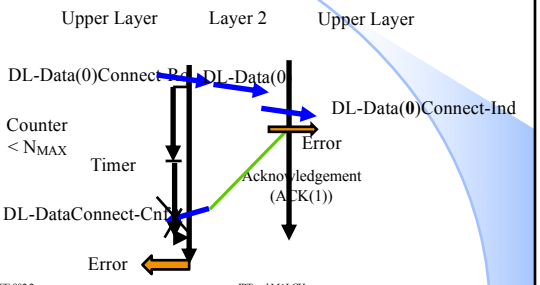
LLC 3

- DL-DataAck-Rq (AS, AD, data, Prio, Serv-class)
- DL-DataAck-Ind (AS, AD, data, Prio, Serv-class)
- DL-DataAck-Status-Rq (AS, AD, data, Prio, Serv-class, status)

LLC 3

- Data Exchanges

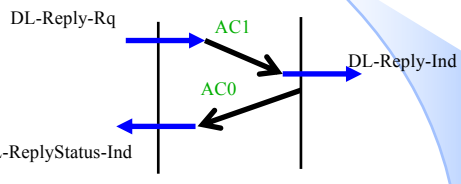


LLC 3

- DL-Reply-Rq (AS, AD, data, Prio,Serv-class)
- DL-Reply-Ind (AS, AD, data, Prio,Serv-class)
- DL-ReplyStatus-Ind (AS, AD, data, Prio, Serv-class, status)
- DL-ReplyUpdate-Rq (AS, data)
- DL-ReplyUpdate-Status-Ind (AS, Status)

LLC 3

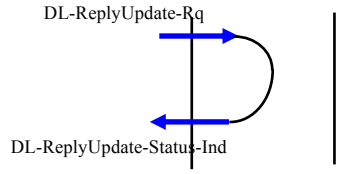
- DL-Reply



AC: Acknowledged Connectionless sequence, numbered 0 or 1

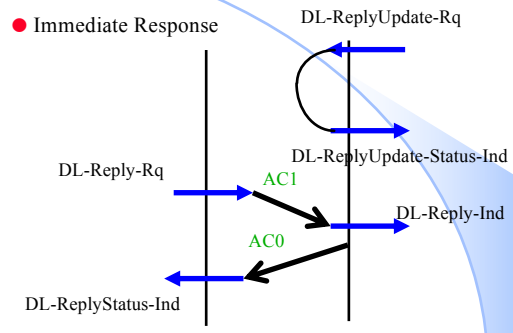
LLC 3

- DL-Reply Local Update



LLC 3

- Immediate Response



LLC 3

- Immediate Response
- Local update of a buffer
- DL-Reply used to read a remote buffer
- Retentive Buffer
- No acknowledgement in strict sense
- A response containing a value

LLC 3

- Advantages
  - it detects lost frames
  - it detects that reception node is powered off
  - it detects the errors in the frame at the reception node and requests retransmissions
  - it detects duplicated frames
- Disadvantages
  - Double of frames in the network (frame and ACK)
  - without flow control

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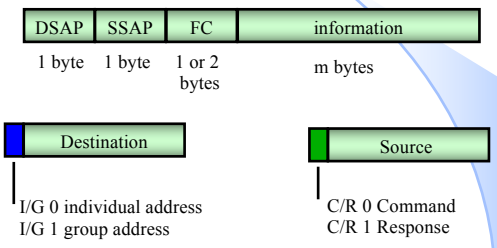
Protocol

- A protocol:
  - is a set of rules to:
    - build the PDUs
    - schedule or sequence the different PDUs
  - may be considered as generated by a grammar
- The LLC protocol is common for the 3 services types
- The FCS is considered as computed and verified by the MAC layer

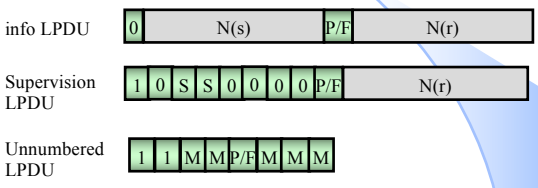
Protocol - 2

- Protocol Data Unit (PDU) format



Protocol - 3

- Control Field (FC)



Protocol - 4

Service type	LPDU type	FC	Command name	Response name
Type 1	unnumbered	1100*000 1111*101 1100*111	UI XID Test	XID Test
Type 3	unnumbered	1110*110 1110*111	AC0 AC1	AC0 AC1

Protocol - 5

Service type	LPDU type	Field control	Command name	Response Name
Type 2	Info PDU	0N(s)*N(r)	I	I
	Supervision PDU	10000000*N(r) 10100000*N(r) 10010000*N(r)	RR RNR REJ	RR RNR REJ
	Unnumbered PDU	1111P110 1100P010 1100F010 1111F000 1110F001	SABME DISC	 UA DM FRMR

Protocol - 6

- I Information
- UI Unnumbered Information
- XID Exchange Identifier
- TEST Test
- RR Receive ready
- RNR Receive Not Ready
- REJ Reject
- P/F Poll or Final

Protocol - 7

- SABME Set Asynchronous Balanced Mode Extended
- DISC Disconnect
- UA Unnumbered Acknowledgement
- DM Disconnect Mode
- FRMR Frame Reject

LLC 1 - Protocol

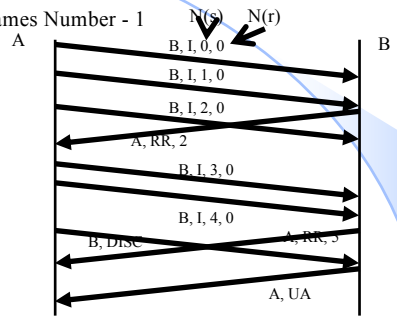
- DL-Unitdata-Rq
  - generation of an UI - PDU
- Reception of an UI - PDU
  - generation of a DL-Unitdata-Ind
- PDU XID and Test are used for station management

LLC 2 - Protocol

- Data Exchange
- N(r) Sequence number in reception
  - Number of the waited frame
- N(s) Sequence number in transmission
  - Number of the sent frame
- Several frames may be sent without waiting for an acknowledgement
- Numbers managed through sending and receiving windows

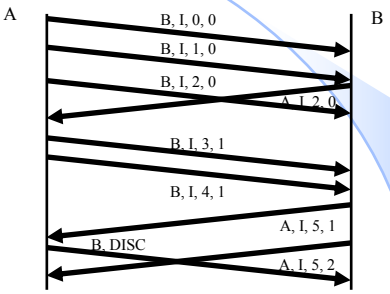
LLC 2 – Sliding Window Protocol

- Frames Number - 1



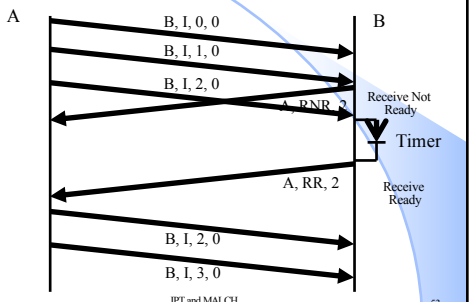
LLC 2 – Sliding Window Protocol

- Frames Number - 2



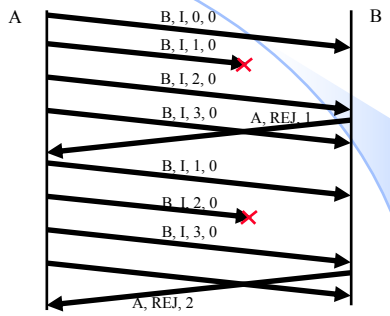
LLC 2 – Sliding Window Protocol

- Frames Number - 3



LLC 2 – Sliding Window Protocol

- Frames Number - 4



LLC 2 - Protocol

- Error detection
  - use of time-out (timer)
  - enabled when a PDU info is sent
  - when time-out is expired, transmission of a PDU RR to request a response (the acknowledgement may be loss)
  - the remote entity must answer with a PDU RR indicating the next waited PDU
  - loss of Ack N(r) = i and reception of Ack N(r) = i+p, the last replaces the loss Ack

LLC 3 - Protocol

- DL-DataAck
- 2 Unnumbered PDU
  - AC0 and AC1
  - AC: Acknowledged Connectionless sequence, numbered 0 or 1
  - *n* alternatively equal to 0 and 1
  - Alternate bit protocol
  - P/F always equal to 0

LLC 3 - Protocol

- DL-Reply
- Analog to DL-DataAck
  - with request: P=1
  - with response: F=1
  - time - out enable at the request to wait for the response
  - Stop and Wait technique

Conclusion

- LLC 2 is never used with all the capabilities
  - Connection is sometimes used
  - Sliding windows very rarely
- Exchange of messages is done according to LLC 3 DL-DataAck, with Stop and Wait
- Exchange of data is done according to LLC 3 DL-Reply
- In real time local area networks
  - Only services are similar never the protocols

References

- IEEE/ISO 802.2-1989. ISO/IEEE International Standard - Information processing systems — Local area networks - Part 2: Logic Link Control
- ISO/IEC 8802-2:1998. Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 2: Logical link control