Data Link Layer:
Protokol High level Data Link Control (HDLC)

Data Link Services

- Connection-oriented services: memberikan pengiriman paket terurut bebas error
  - setting-up koneksi: setting up variables dan alokasi buffer
  - transfer paket: paket 'dikemas' dlm frame data link
  - penutupan koneksi
- Connectionless service
  - acknowledged service
  - unacknowledged service

Sejarah DLL Protocols

- SDLC - Synchronous Data Link Control (IBM)
- HDLC - High-level Data Link Control (ISO & CCITT)
- ADCCP - Advanced Data Communications Control Protocol (ANSI)
- LLC - Logical Link Control (IEEE 802.2)
- ISO 33009, ISO 4335 Data Link Control

Tipe Station HDLC

- Primary station
  - mengontrol operasi link
  - frame yg dibangkitkan disebut command
  - menjaga link logik terpisah ke masing-masing station secondary
- Secondary station
  - dibawah kontrol primary station
  - frame yg dibangkitkan disebut respons
- Combined station
  - dapat membangkitkan command dan respons

Mode Transfer HDLC

- Normal Response Mode (NRM)
  - Konfigurasi unbalanced
  - Primary menginitialisasi transfer ke secondary
  - Secondary hanya boleh transmit data sebagai respond thd command dari primary
  - Digunakan pada multi drop lines
  - Host computer sebagai primary
  - Terminal sebagai secondary

Mode Transfer HDLC

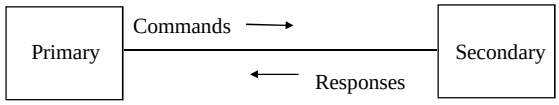
- Asynchronous Balanced Mode (ABM)
  - Konfigurasi balanced
  - Kedua macam station dapat menginisiasi transmisi tanpa menerima persetujuan
  - Paling luas digunakan
  - Tidak ada overhead polling

Mode Transfer HDLC

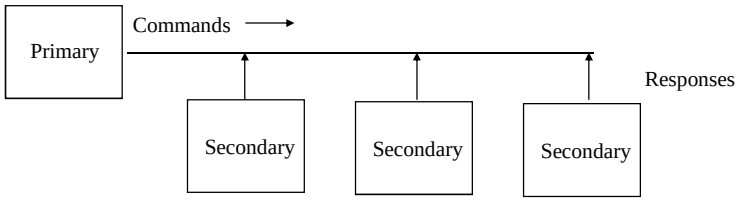
- Asynchronous Response Mode (ARM)
  - Konfigurasi unbalanced
  - Secondary dapat menginisiasi transmisi tanpa izin dari primary
  - Primary bertanggung jawab thd saluran
  - Jarang digunakan

Konfigurasi HDLC

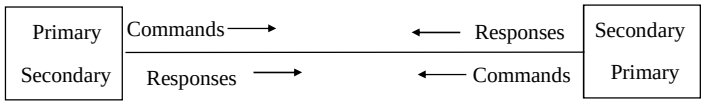
Unbalanced Point-to-point link



Unbalanced Multipoint link



Balanced Point-to-point link between Combined Stations



Format Frame HDLC

- Flag (8 bit) : 01111110
- Address (8 bit extendable 16 bit):
  - Konfigurasi unbalanced → address secondary
  - Konfigurasi balanced
    - Frame command → address receiving station
    - Frame response → address dari station pengirim
- Control field (8 extendable 16 bit)
- Information field (variabel): berisi informasi user
- FCS: CRC 16 bit atau 32 bit dikalkulasi pd field control, address dan informasi

Bit Stuffing

- Bit stuffing digunakan untuk mencegah kemunculan pola flag didalam frame HDLC
- Pengirim akan menyisipkan ekstra "0" setiap ditemui lima deretan "1" yg berturutan
- Penerima mencari lima deretan biner "1" berturutan, jika diiukuti "0" berarti bit stuffing → bit dihilangkan
- Contoh:
  - Deretan data informasi: 0110111111111100
  - Setelah bit stuffing: 011011111011111000

Control Field HDLC

Information Frame

1	2-4	5	6-8
0	N(S)	P/F	N(R)

Supervisory Frame

1	0	S	S	P/F	N(R)

Unnumbered Frame

1	1	M	M	P/F	M	M	M

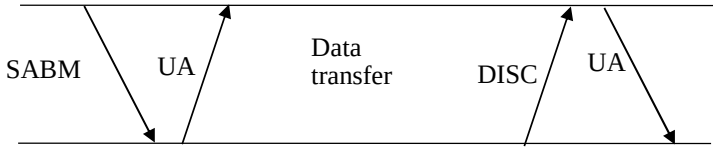
Frame-Frame HDLC

HDLC Commands and Responses

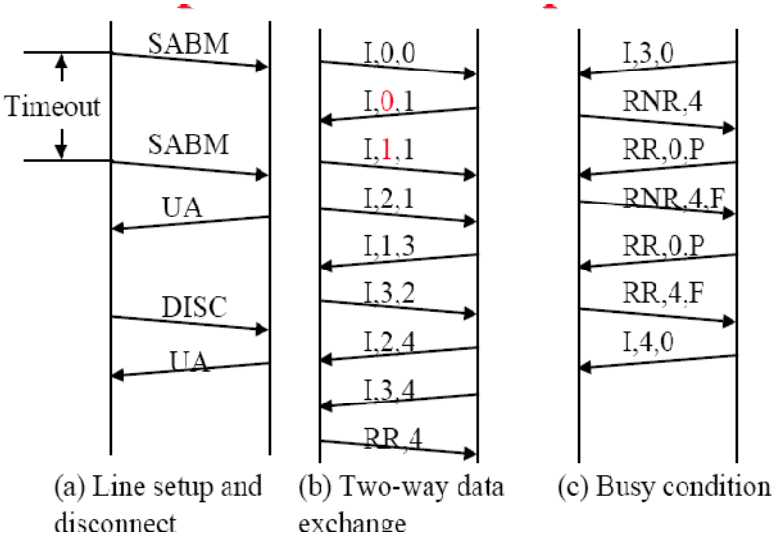
Name	Function	Description
Information (I)	C/R	Exchange user data
Supervisory (S)		
Receive Ready (RR)	C/R	Positive acknowledgment; ready to receive I-frame
Receive Not Ready (RNR)	C/R	Positive acknowledgment; not ready to receive
Reject (REJ)	C/R	Negative acknowledgment; go back N
Selective Reject (SREJ)	C/R	Negative acknowledgment; selective reject
Unnumbered (U)		
Set Normal Response/ Extended Mode (SNRM/SNRME)	C	Set mode; extended = two-octet control field
Set Asynchronous Response/ Extended Mode (SARM/SARME)	C	Set mode; extended = two-octet control field
Set Asynchronous Balanced/ Extended Mode (SABM/SABME)	C	Set mode; extended = two-octet control field
Set Initialization Mode (SIM)	C	Initialize link control functions in addressed station
Disconnect (DISC)	C	Terminate logical link connection
Unnumbered Acknowledgment (UA)	R	Acknowledges acceptance of one of the above set-mode commands
Disconnected Mode (DM)	R	Secondary is logically disconnected
Request Disconnect (RD)	R	Request for DISC command
Request Initialization Mode (RIM)	R	Initialization needed; request for SIM command
Unnumbered Information (UI)	C/R	Used to exchange control information
Unnumbered Poll (UP)	C	Used to solicit control information
Reset (RSET)	C	Used for recovery; resets N(R), N(S)
Exchange Identification (XID)	C/R	Used to request/report identity and status
Test (TEST)	C/R	Exchange identical information fields for testing
Frame Reject (FRMR)	R	Reports receipt of unacceptable frame

Operasi HDLC

- Pertukaran frame-frame: informasi, supervisory dan unnumbered
- Tiga phase:
  - Inisialisasi
  - Transfer data
  - Penutupan



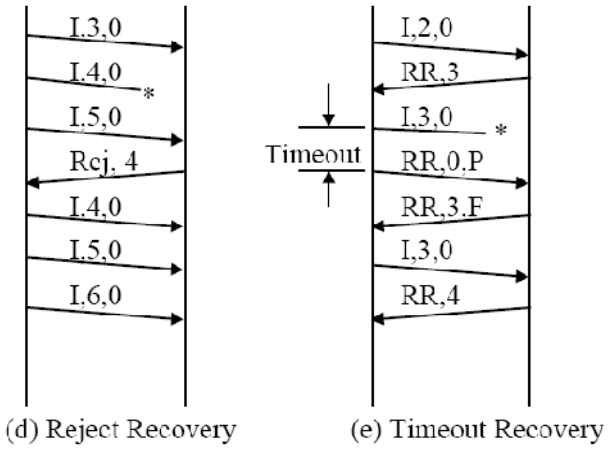
Proses Komunikasi HDLC



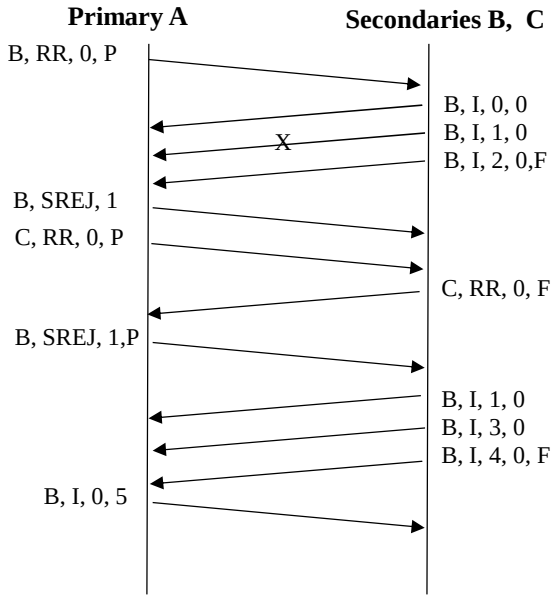
(a) Line setup and disconnect

(b) Two-way data exchange

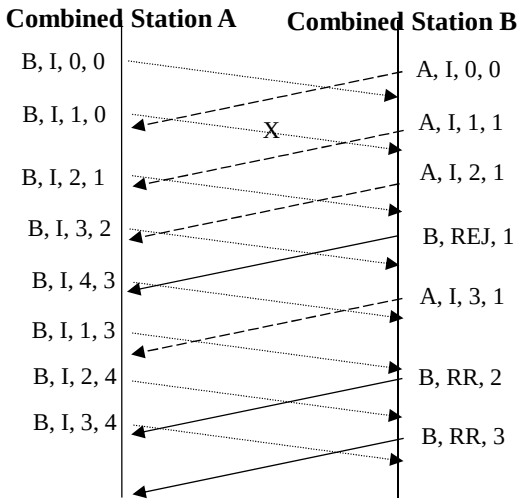
(c) Busy condition



Operasi pada Normal Response Mode



Operasi pada Asynchronous Balanced Mode



Protocol DLC Lainnya

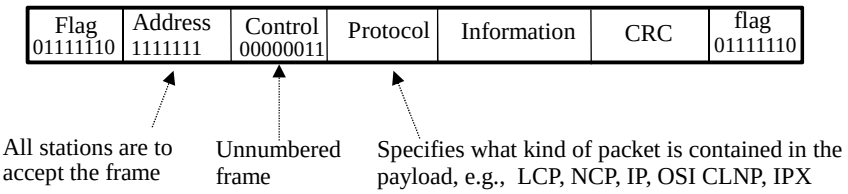
- Link Access Procedure, Balanced (LAPB)
  - Bagian dari X.25 (ITU-T)
  - Subset dari HDLC (ABM)
  - Link point-to-point antara sistem dan node packet switching
- Link Access Procedure, D-Channel (LAPD)
  - ISDN (ITU-T)
  - ABM
  - Sequence number selalu 7 bit (tidak 3 bit)
  - Field address 16 bit terdiri dari dua sub-addresses
  - satu utk device dan satu lagi utk user (layer diatas)

Protocol DLC Lainnya

- Logical Link Control (LLC): umumnya utk "shared medium networks" (broadcast media)
  - IEEE 802
  - Frame format berbeda
  - Link control dibagi dua antara medium access layer (MAC) dan LLC (di atas MAC)
  - Tidak ada primary dan secondary (semua station adalah peer)
  - Dua addresses diperlukan:
    - pengirim dan penerima

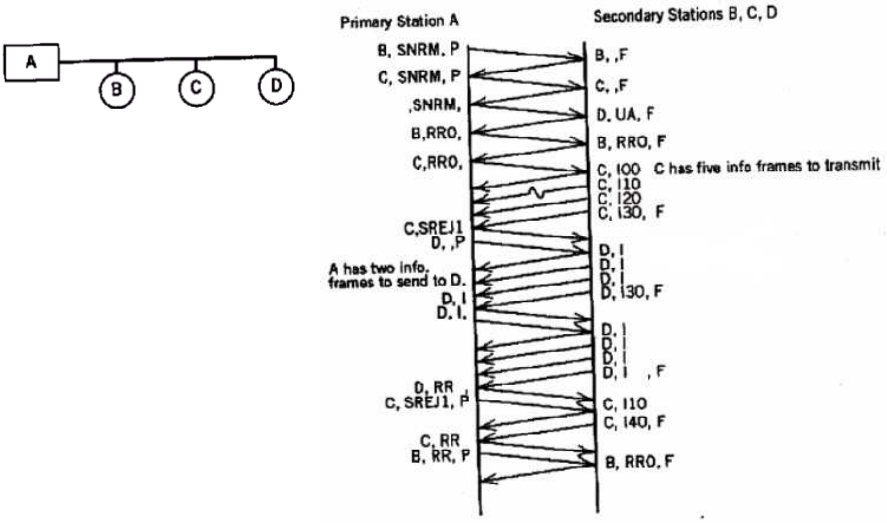
Protocol DLC Lainnya

- PPP (Point-to-Point Link Protocol)
- Layout frame utk PPP:



In-Class Excersise

Pd gb di bawah, primary station A berkomunikasi dengan secondary station B, C dan D menggunakan protokol data link standar (misalnya HDLC) pada saluran dua-arah half-duplex. Gambar (b) memperlihatkan urutan transmisi data antara A dan B, C serta D dengan menggunakan notasi singkat A Y N(S) N(R) P/F (A:Address, Y:Command/Response, N(S): Sequence number pengirim, N(R):Sequence number penerima, P/F:Poll/Final). Pada gambar isi harga A,YN(S)N(R),P/F



In-Class Excersise

2. Kejadian (event) berikut terjadi antara primary station A dan dua secondary station B dan C pada saluran multidrop half-duplex bebas error menggunakan protokol HDLC. Event e_1, e_2, e_3, e_4 adalah:
   - e_1 = A mengaktifkan link dg B dan C menggunakan normal response mode
   - e_2 = A mem-pool B utk trafik, B merespons dg mengirimkan 4 frame I, kemudian A meng-aknowledge B tanpa memberikan tambahan hak utk transmit
   - e_3 = A mem-poll C untuk trafik dan C hanya meng-acknowledge A
   - e_4 = A mengirimkan 3 frame ke B dan memberikan hak B untuk transmit. B merespons dg mengirimkan 5 tambahan frame dan A meng-acknowledge

   a. Perlihatkan pertukaran frame antara primary station A dan dua secondary station B dan C.
   b. Sekarang asumsikan terjadi transmsisi error pada frame pertama dari 5 frame yang dikirimkan oleh B ke A pada event e_4. Perlihatkan dua kemungkinan prosedur untuk error recovery. Juga asumsikan bahwa ukuran window adalah 7. (Cat. Gunakan notasi A,YN(S)N(R),P/F)