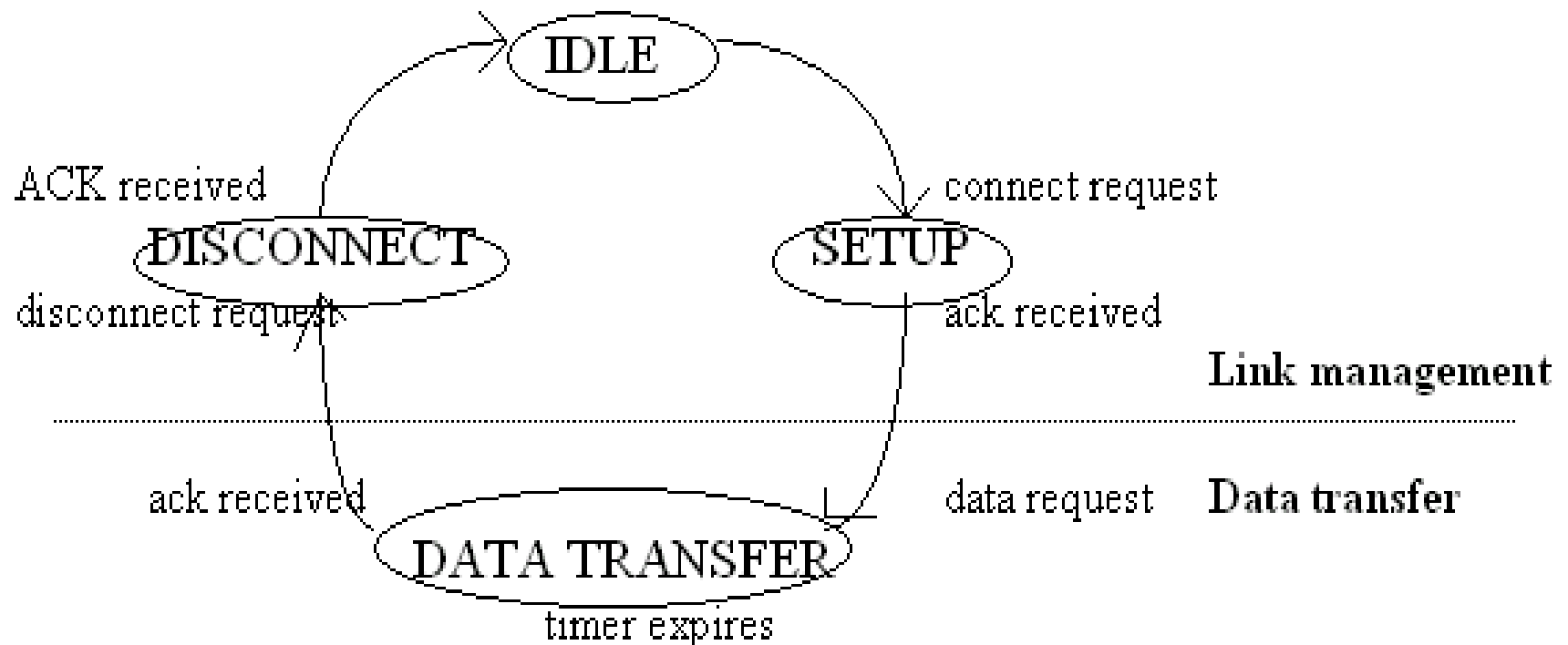# Data Link Layer Protocol

CS455

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Link management

Link set-up phase and disconnection phase are collectively referred to as link management

Data Link Layer Protocols

HDLC, ADCCP, LAP-B, LAP-D, SDLC, Kermit, XMODEM, BSC

HDLC: High-Level Data Link Control

ADCCP: Advanced Data Communications Control Protocol
            used by ANSI

SDLC: Synchronous Data Link Control
         developed by IBM in 1970 as a replacement for its
   binary synchronous (BSC) protocol.

LAP-B: Link Access Protocol – Balanced

LAP-D: Link Access Procedure D channel

Data Link Control Protocol

- For transferring data through serial data link
- Synchronous vs. Asynchronous
- **Character-oriented**: in case of slower data rate links: use Idle RQ (for example, modems using Kermit and X-modem) vs. **bit-oriented mode**: in case of higher rate link involving long physical separations (for example, radio-based satellite links, circuits through private multiplexer networks use HDLC, alternative continuous RQ protocol)

- **Best-try (connectionless) mode**: unacknowledged service: frame retransmission is managed by higher layer's function: e.g. switched network with very low BER (LANs or ISDNs) vs. **Reliable service (connection-oriented)**.

- Data link protocols are located in the two communicating DTEs (including network equipment working as a DTE).

Supervisory (master) DTE

DLP

Slave DTEs
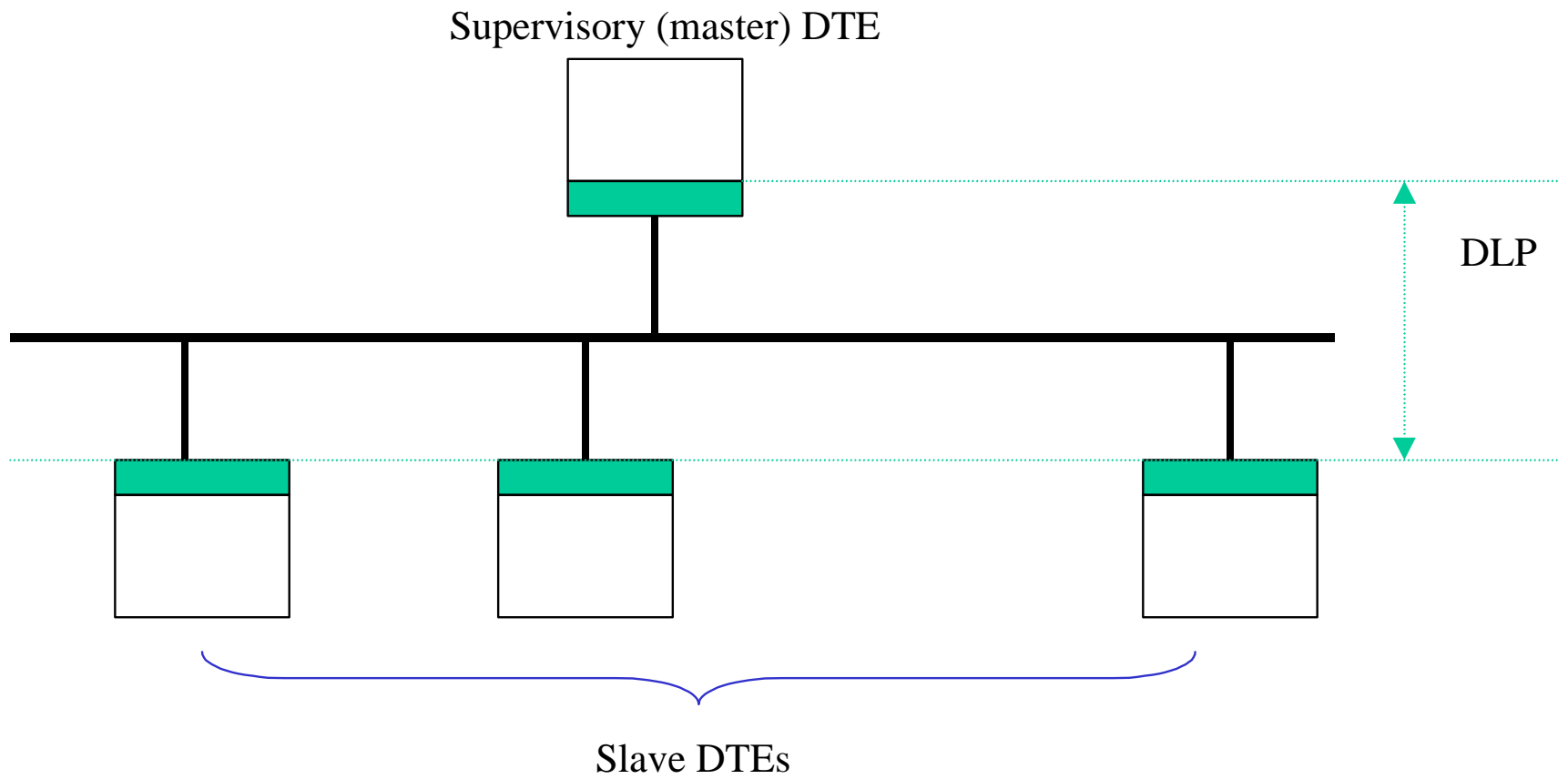
Multidrop or Multipoint topoloty

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- In multipoint topology case, there are no two transmission occur simultaneously.
- BSC (binary synchronous control) or bisync: based on character-oriented and idle RQ
- NRM (normal response mode): based on bit-oriented and HDLC
- Both BSC and NRM use **poll-select mode**.
- Poll: when master wishes to get a data from a slave, master sends poll message to the slave node.

- Select: when master wants to send data to the slave, it sends a select message.
- X.25 packet switching networks use LAPB (link access procedure, balanced) as data link protocol based on HDLC.
- ISDN (integrated service digital network) uses LAPD (link access procedure D channel) based on HDLC. (circuit-switched data network using virtual circuit)
- In LANs, LLC (logical link control, subclass of HDLC) is used (e.g: ethernet, ring, bus..).

HDLC (High-level Data Link Control)

1. Type of stations

Primary station (P): controls the operation of the link (command)

Secondary station (S): operates under the control of the P (response)

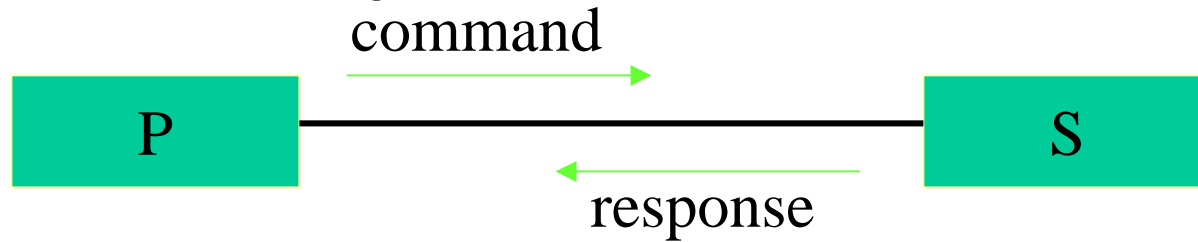Combined station (C): combines the features of P and S (response, command)

Link configurations

Unbalanced configuration
- P-to-P, Multipoint
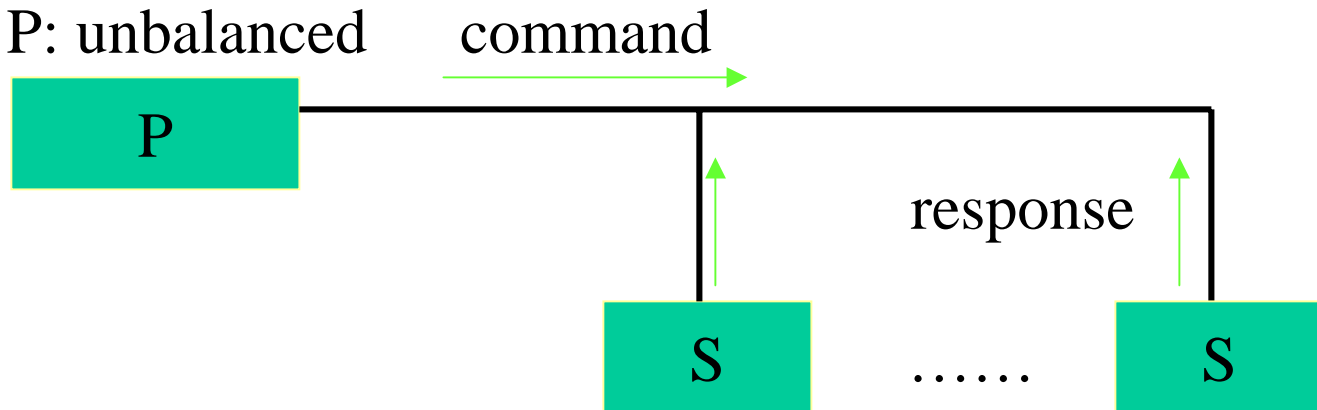- one P and one or more S
- full-duplex, half-duplex

  Balanced configuration
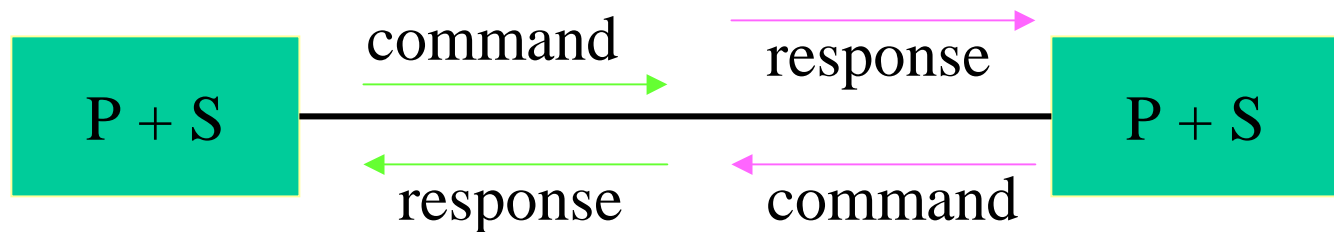- P-to-P
- two C (combined station)
- full-duplex, half-duplex

P to P: unbalanced configuration

command

P ———————→ S

←—————
response

P to multi P: unbalanced

command

P ——————→

↑ ↑

response

S …… S

P to P: balanced configuration

command ——————→ response ——————→

P + S ———————— P + S

←——— response ←——— command

Data transfer modes

Normal Responsed Mode (NRM)
-        unbalanced configuration
-        P may initiate data transfer to a S
-        S may only transmit data in response to a poll from the
P
-        multidrop line, point-to-point

Asynchronous Balanced Mode (ABM)
-        balanced configuration
-        either C may initiate transmission without permission
              from the other
-        full-duplex P-to-P

Asynchronous Response Mode (ARM)

- unbalanced configuration
- S may initiate transmission without explicit
   permission of the P
- P retains responsibility for the line, initialization,
     error recovery, and logical disconnection
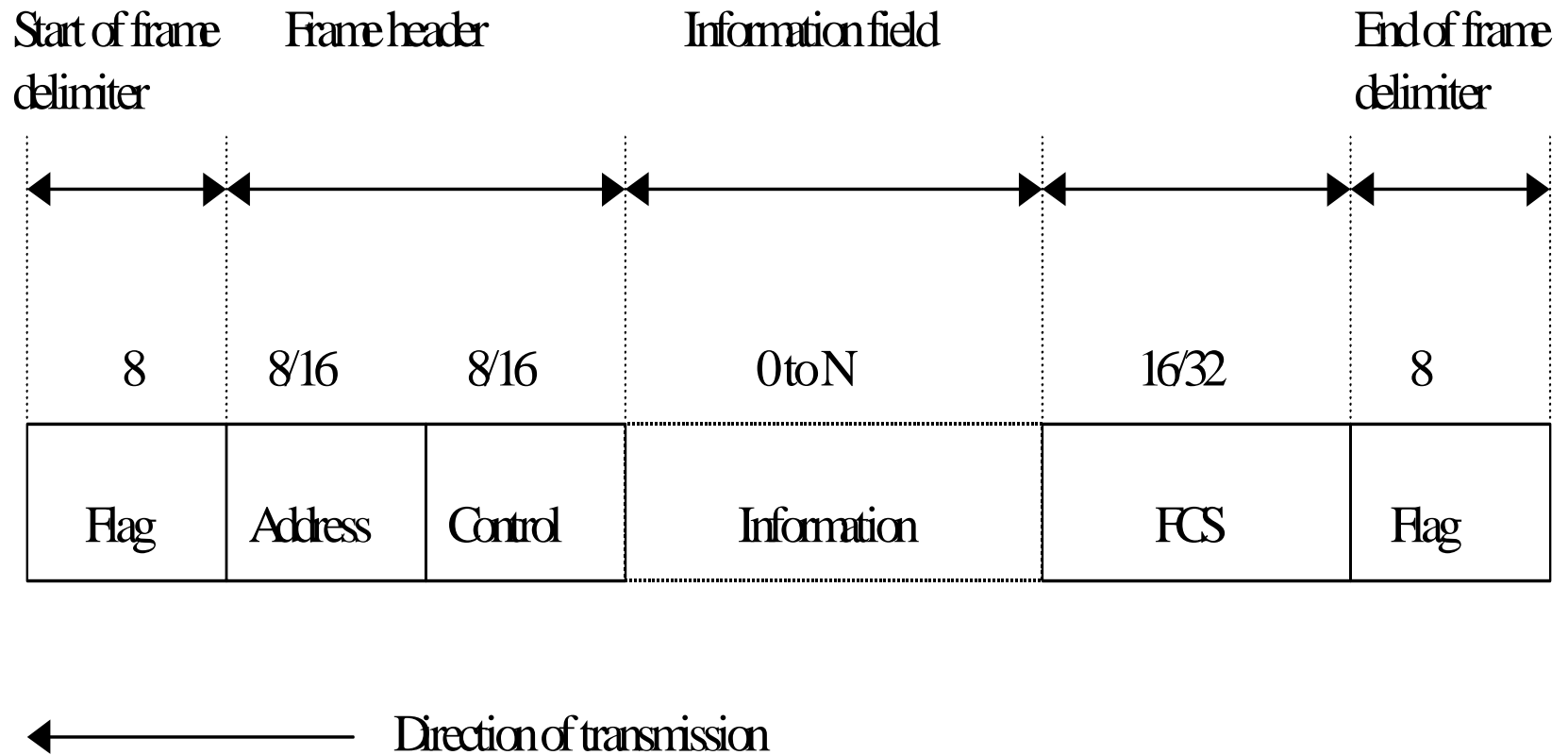- hub polling

Frame structure

        Flag: 8 bits

        Address: one or more octets

        Control: 8 or 16 bits

        Information: variable

        FCS: 16 or 32 bits

        Flag: 8 bits

	Start of frame delimiter	Frame header			Information field		End of frame delimiter
	8	8/16	8/16		0 to N	16/32	8
	Flag	Address	Control		Information	FCS	Flag

← Direction of transmission

Operation

 I-frame

    N(S) : send frame number

    N(R) : ACK frame number (next frame no. expected),
                piggyback

   P/F : Primary - poll bit (command)

        Secondary - final bit(response)

        NRM - primary issues a poll giving permission to
            send secondary sets on the last I-frame

        ARM, ABM - used to coordinate the exchange of S-
           and U-frame

S-frame: flow and error control

  RR: NRM, ABM

    P ==> RR, P (P poll S, when no I frame is available)

    S<== I -frame (when S has data, set F at the frame)

    RR, F (when no data to send)

    P ==> RR, -P (positive ACK by P)

  RNR: NRM, ABM

    p ==> RNR, P (solicit receive status)

     <== S RR, F (can receive I-frame)

        RNR, F (busy S)

    P ==> RNR, -P (busy P)

     <== S RR, F (O.K!)

    REJ: ABM(?), go back N

    SREJ: ABM, selective repeat

Classes of frames

1. Unnumbered frames
   - Link setup and disconnection
   - Unnumbered: no ACK info (no sequence #s)

2. Information frames (I-frame)
   - Carry information / data
   - May carry ACK info piggybacked (ABM, ARM)

3. Supervisory frames
   - Error and flow control
   - Contain send / receive sequence numbers

Supervisory frames

RR (Receiver Ready) and RNR (Receiver Not Ready)
- Used in NRM and ABM
- Secondary willing/unwilling to accept I-frame
- Secondary ACK

REJ (Reject) and SREJ (Selective Reject)
-Used in ABM
- Indicate out of sequence I-frame received
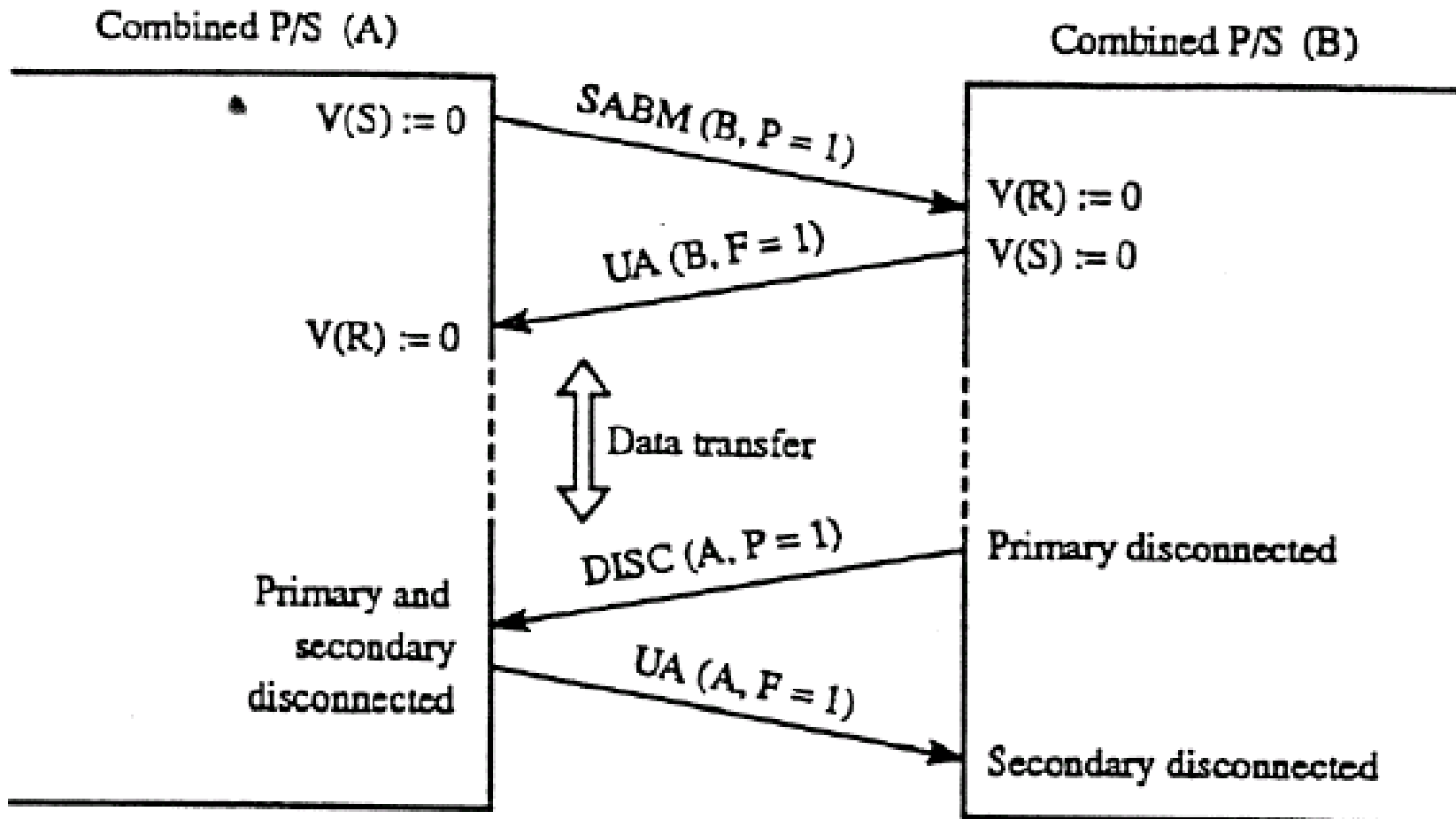- Rej: Go Back N, SREJ: Selective Repeat

Unnumbered frame

-Set SNRM/SARM/SABM: set logical link between primary
 and secondary and inform secondary of the mode of operation
-UA: ACK to other frames in this class
- DISC: Primary clears logical link

Link Management

-Exchange of unnumbered frames to setup/take down logical
  connection and Ack
- NRM: Multidrop link

ABM: Point – to - Point