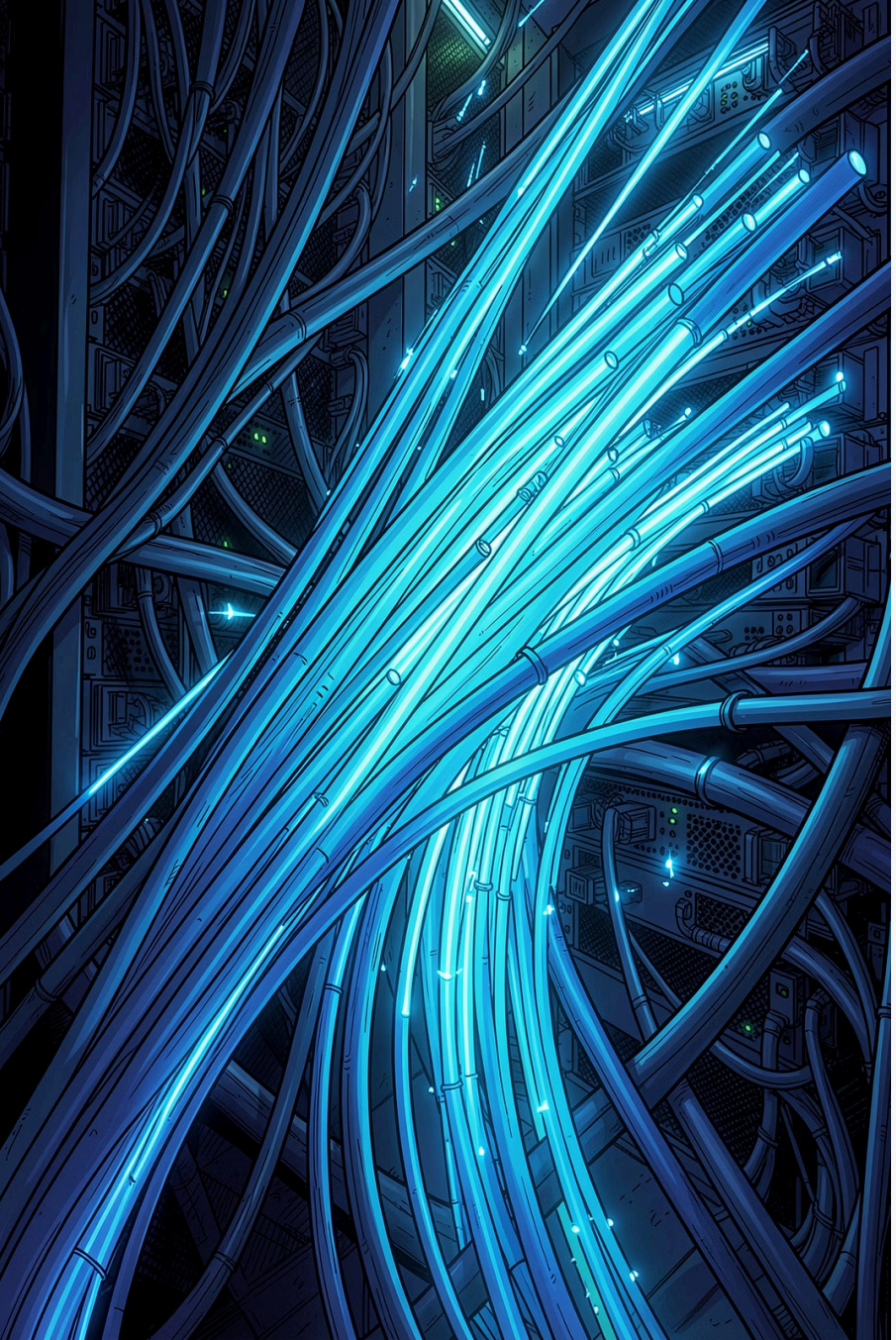


HDLC: The Backbone of Data Link Control

A deep dive into High-Level Data Link Control — the protocol that underpins reliable, structured communication across modern networks.

Origins and Evolution

HDLC (High-Level Data Link Control) was developed by the **ISO** as a bit-oriented synchronous data link protocol. It draws its roots from IBM's proprietary **Synchronous Data Link Control (SDLC)** — one of the first disciplined, structured link-layer protocols.

Over time, HDLC became the foundation for modern point-to-point and multipoint communication links, influencing protocols still in active use today.

ISO Standard

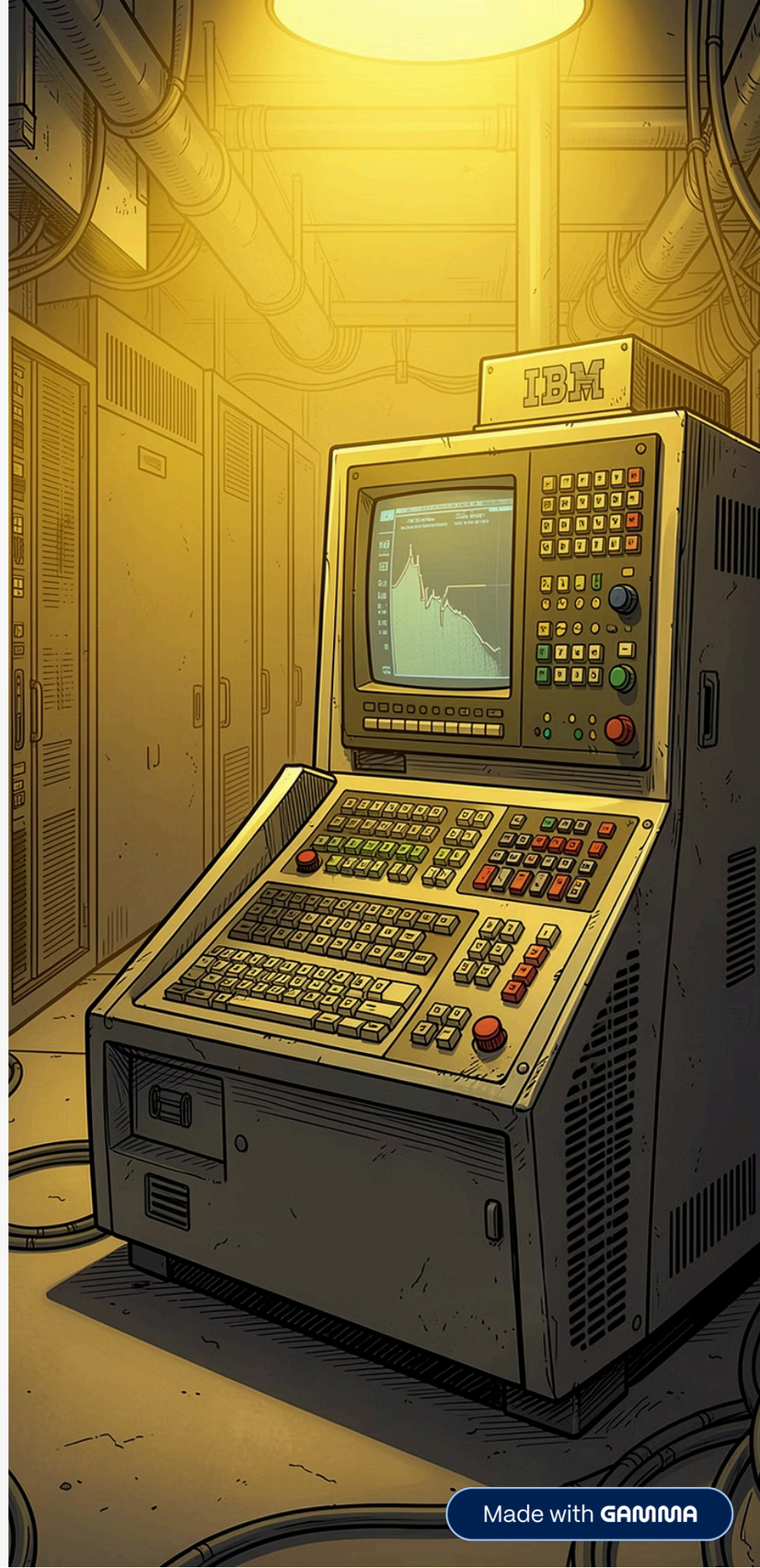
Defined as a universal, vendor-neutral synchronous protocol

SDLC Heritage

Built upon IBM's pioneering data link architecture

Broad Application

Supports both point-to-point and multipoint topologies



Station Types

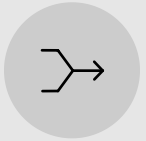
HDLC defines three distinct station roles that govern how devices participate in a link exchange.

Primary

Controls the data link entirely. Responsible for issuing **commands** and managing all secondary stations on the link.

Secondary

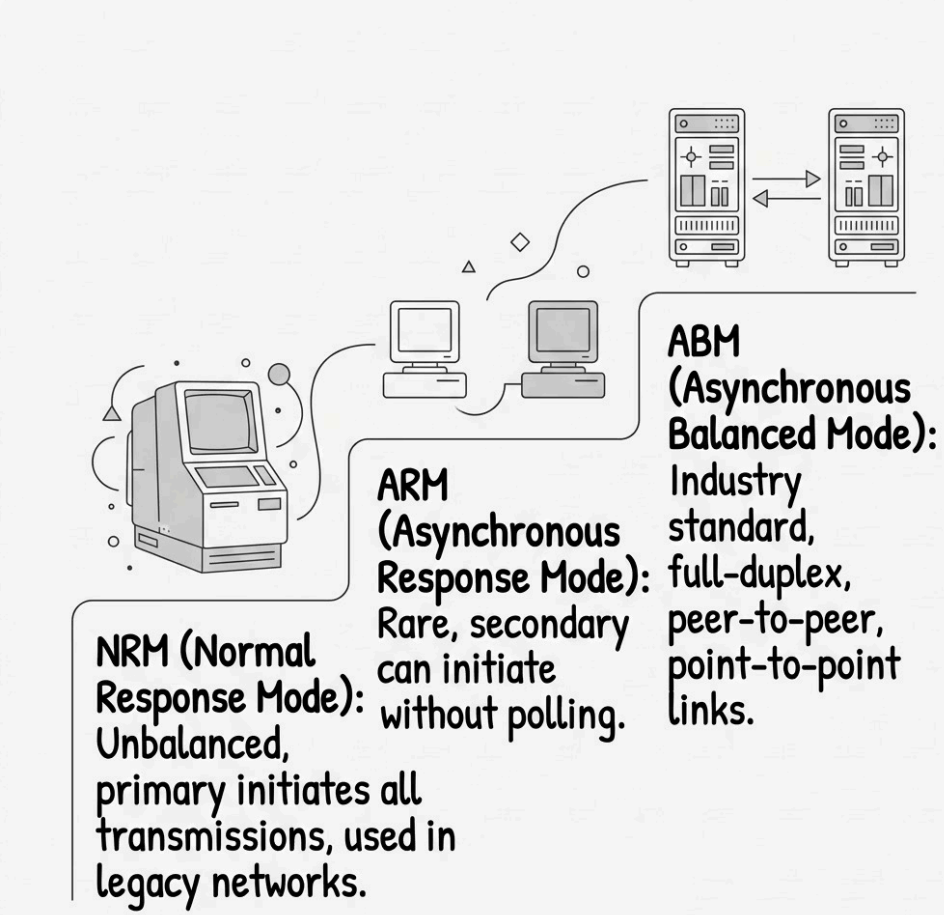
Operates strictly under the authority of the primary station. Issues **responses** only when addressed or polled.



Combined

A hybrid capable of issuing both **commands and responses** — enabling peer-to-peer, balanced communication.

Operational Modes

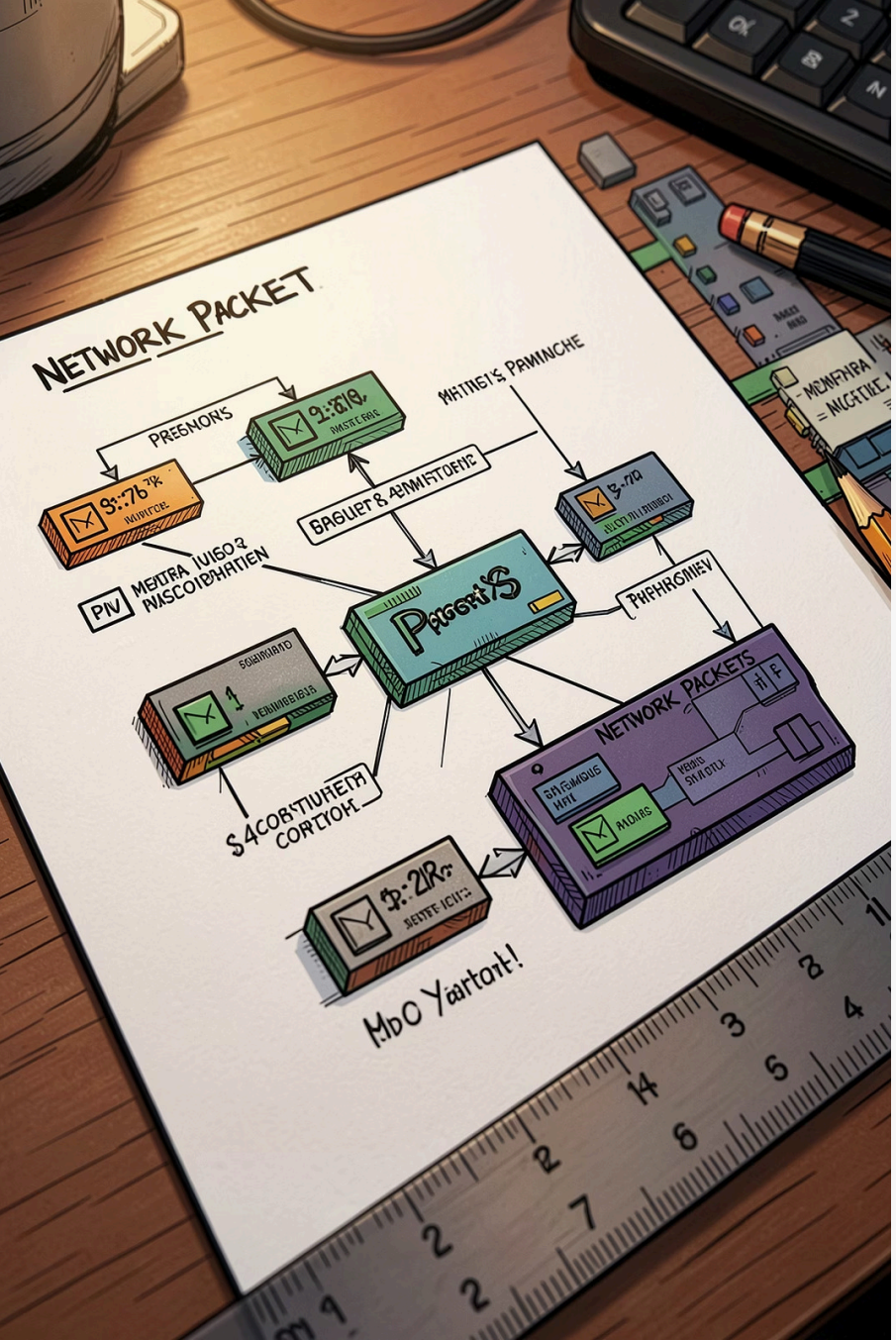


Choosing the Right Mode

NRM suits centralised, unbalanced configurations where a primary station orchestrates all activity — typical in legacy hierarchical networks.

ARM is rarely deployed but permits a secondary station to transmit without being explicitly polled.

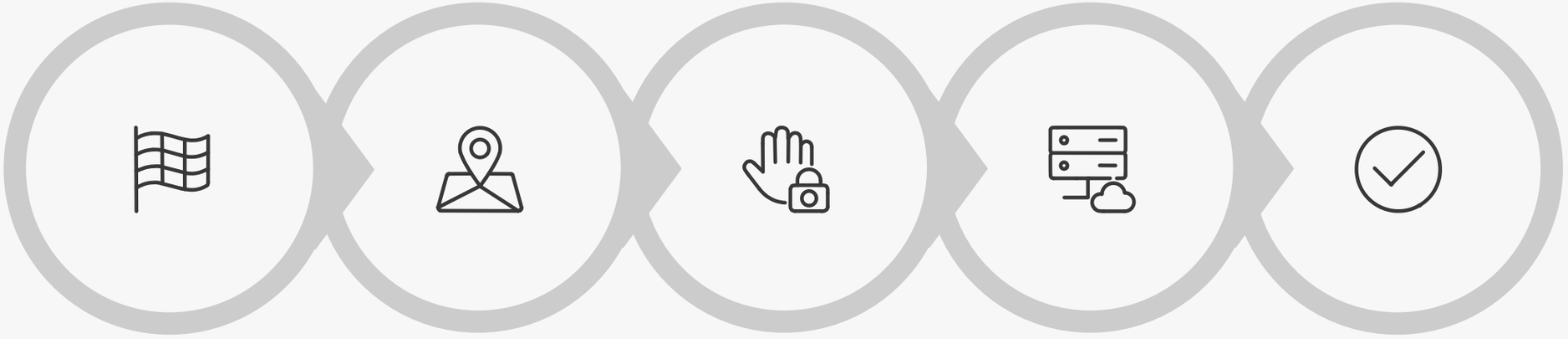
ABM is the dominant standard today — enabling full-duplex, balanced communication between two combined stations with no master/slave dependency.



HDLC Frame Structure

Every HDLC frame follows a precise, ordered structure — ensuring consistent framing, addressing, control, payload delivery, and error detection across all link types.

Frame Anatomy



Flag | Address | Control | Information | FCS

Framing & Addressing

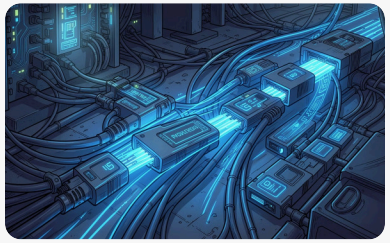
The **Flag** field (`01111110`) marks the start and end of every frame. The **Address** field identifies the relevant secondary station in multipoint environments.

Control & Integrity

The **Control** field encodes the frame type and sequence numbers. The **FCS** uses a **CRC algorithm** to detect transmission errors before data is accepted.

The Three Frame Classes

HDLC organises all communication into three frame types, each serving a distinct function within the link layer.

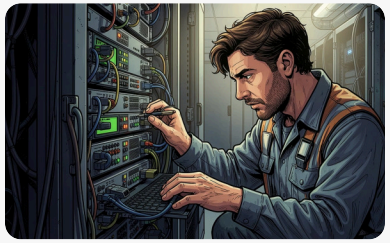


Information (I) Frames

Carry **user data** across the link. Also support **piggybacked acknowledgments**, combining data transfer and flow control in a single frame.

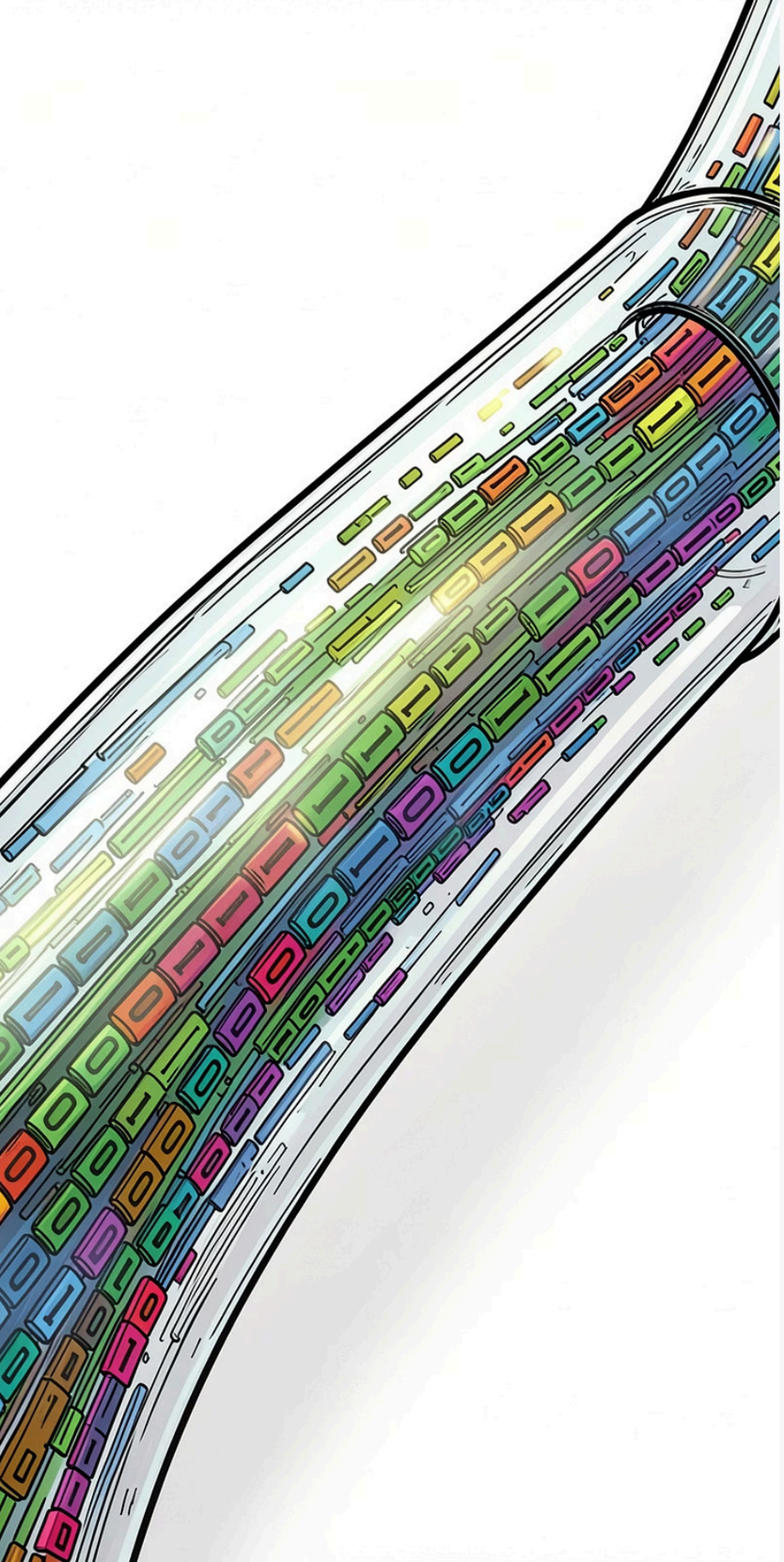
Supervisory (S) Frames

Dedicated to **flow control and error management**. Used to send acknowledgments, request retransmission, or indicate receiver readiness — without carrying user data.



Unnumbered (U) Frames

Handle **link setup, disconnection, and management** functions. Essential during link initialisation and for out-of-band control signalling.



Error and Flow Control

Sequence Numbering

Frames are numbered to preserve **data order** and track outstanding acknowledgments, enabling reliable delivery even over noisy links.

Bit Stuffing

After five consecutive 1-bits in the data stream, a 0-bit is automatically inserted — ensuring the **flag pattern never appears within payload data**.

CRC Error Detection

The **Frame Check Sequence (FCS)** applies Cyclic Redundancy Check (CRC) across every frame. Any corrupted frame is detected and discarded, prompting retransmission — guaranteeing link-layer integrity.

> Together, these mechanisms make HDLC one of the most robust data link protocols ever standardised.

Key Industry Implementations

HDLC's architecture has directly inspired several widely adopted standards across different industries and standards bodies.

LAP-B

Link Access Procedure-Balanced — the data link protocol used within **X.25 packet-switched networks**. A direct derivative of HDLC's ABM mode.

ADCCP

Advanced Data Communication Control Procedures — HDLC adapted and adopted by **ANSI** as an American national standard for data link control.

SDLC

Synchronous Data Link Control — IBM's original proprietary protocol. The direct predecessor that **set the architectural template** for the ISO HDLC standard.

Ensuring Reliable Connectivity

> HDLC remains a cornerstone of data link layer efficiency — from simple serial links to the most complex network architectures.

Proven Durability

Decades of deployment across diverse environments confirm HDLC's structural reliability and adaptability.

Universal Influence

Its design principles live on in LAP-B, ADCCP, and the broader family of modern link-layer protocols.

Essential Knowledge

Understanding HDLC is fundamental to mastering data link control and core network communication.