Data Link Protocols

- Data Link Services
- HDLC
  - Connection-less services
- Ethernet (covered elsewhere)

Functions of a Data Link Protocol

Framing PDUs

Addressing Destination

Error Detection / Error Recovery

Link Management

Components of a DL

Hardware
Frame Format
Protocol
Buffer Memory
Event Timers

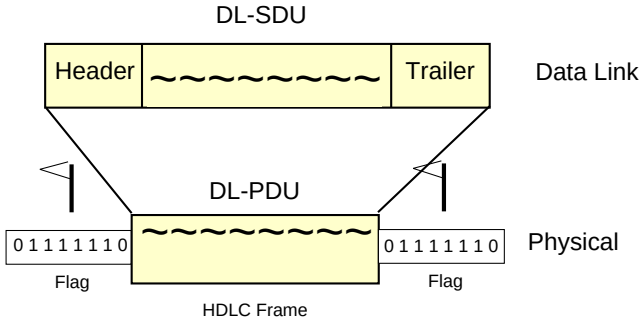
High Level Data Link Control Protocol

- Definitions and Modes
- HDLC framing
- Connection-less services
- Throughput

HDLC Framing

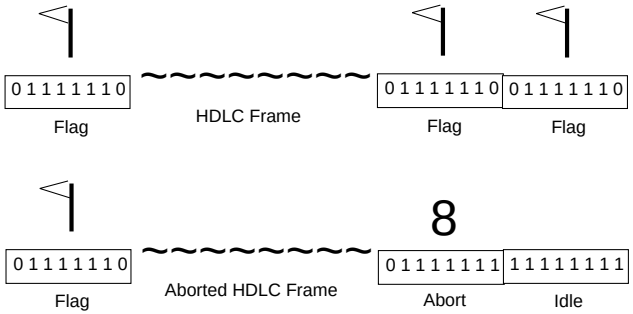
- Flags
- 0-bit insertion
- Cyclic Redundancy Check

HDLC DATA LINK

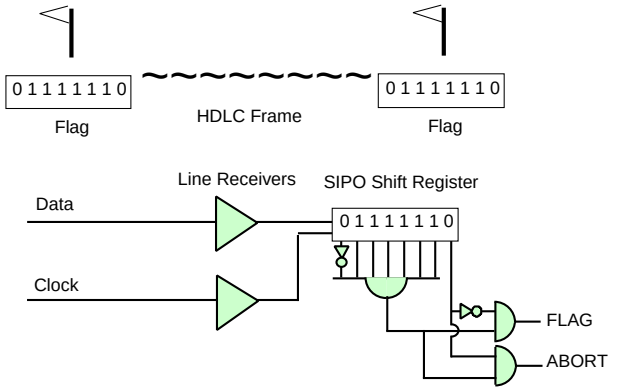


Need to provide:
- Frame Delineation
- Data Transparency
- Error Control

HDLC Frame Delineation

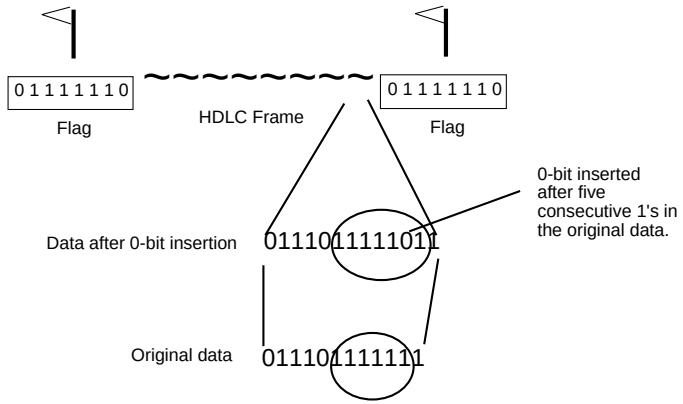


HDLC Flag Detection

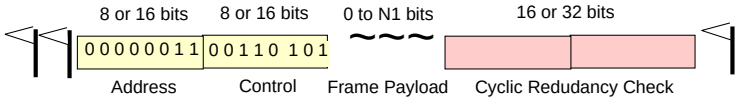


N.B. Real implementation uses a Finite State Machine (FSM)

HDLC 0-Bit Insertion



HDLC Frame Structure



N1 = maximum number of bytes in the frame payload

Typical values: 128 B, 576 B, 1500B, etc

HDLC CRC

Why is a CRC needed?

To verify correctness of data
What happens if we don't check?

How can data become corrupted?

Noise
Interference
Errors in network components
Faulty cabling
Cosmic rays ???

CRC Generator Polynomials

CRC-16 = $x^{16} + x^{12} + x^5 + x$

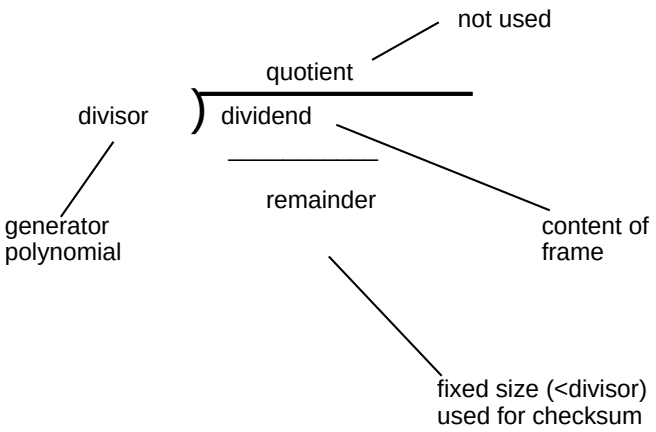
CRC-CCITT = $x^{16} + x^{12} + x^5 + 1$

CRC-32 = $x^{32} + x^{26} + x^{16} + x^{12} + x^{11} + x^{10} + x^5 + x^4 + x^2 + x + 1$

Cyclical Redundancy Check

Properties of a CRC-16	Synchronous Block/Frame Protocols Implemented in Hardware
1-bit error	100% Detected
2-bit errors	100% Detected
Odd errors	100% Detected
Burst errors < 16 bits	100% Detected
Burst errors exactly 17 bits	99.9969% Detected
All other error bursts	99.9984 % Detected

Cyclical Redundancy Check



CRC - Why Modulo 2 Division?

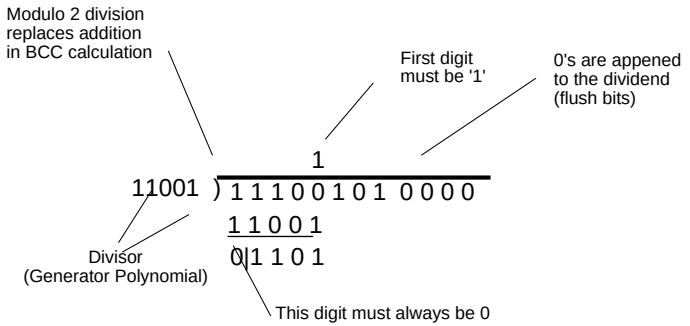
Because the hardware solution is simple!!!!!

Truth Table for Modulo-2 Division (XOR)

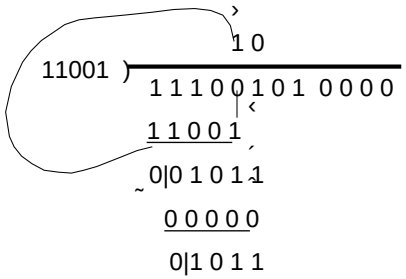
0 0 = 0
0 1 = 1
1 0 = 1
1 1 = 0

CRC calculations ignore the carry

CRC Example (1)

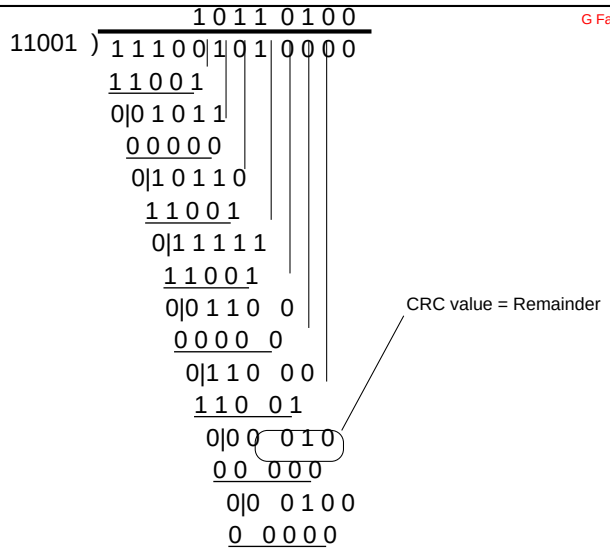


CRC Example (2)

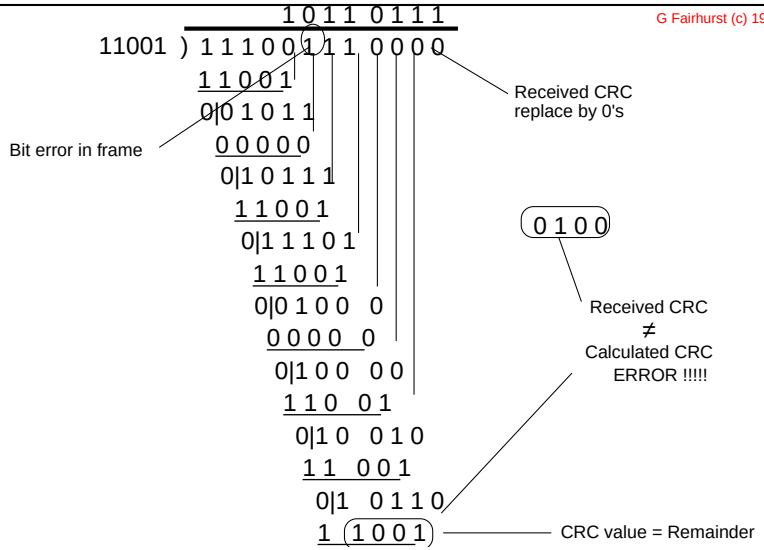


‹ Bring next digit of dividend down
› Copy msb of value to quotient
´ Insert 0 (if quotient 0) or divisor (if quotient 1)
^ Calculate XOR sum
~ Discard msb of value (always 0)

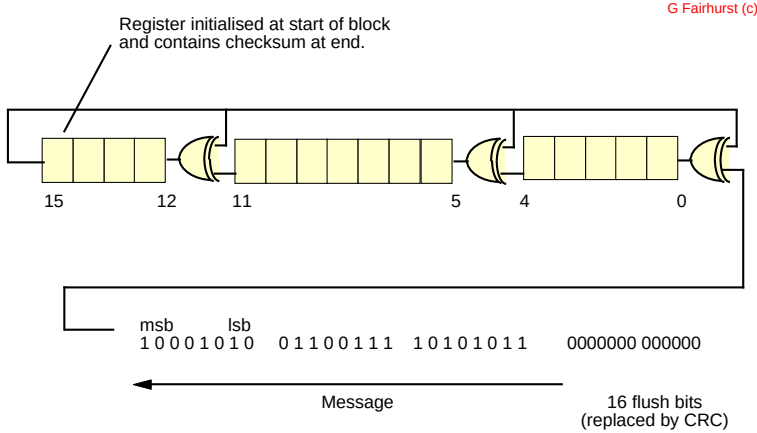
CRC Example (3)



CRC Example (4)



CRC Hardware



HDLC Frame Layer Summary

Synchronous Transmission

Clock and Data required at the receiver

Bit-Oriented Protocol (Transparent)

Frames delimited by flags
Hardware support required
Any data may be sent in payload
Transmitted frame size depends upon payload

Integrity checked by a CRC

Frames with good CRC forwarded
Frames with error CRC discarded
Frames terminated by abort sequence also discarded

3 Architectures

Multi-drop bus
Point to Point link \
Token passing ring **<--- This is covered by the course**

What you should know!

You should know....

HDLC is a standard for synchronous communications

HDLC is bit-oriented

HDLC uses a cyclic redundancy checksum

HDLC supports 3 architectures

HDLC Connection-Less Service

- Frame Format
- Transfer of Data

Best Effort Service

A best effort service ....

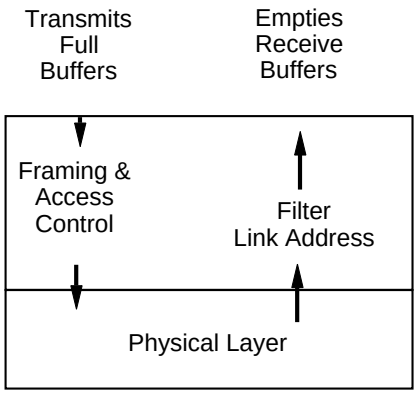
provides no guarentee of delivery

provides no notification of loss

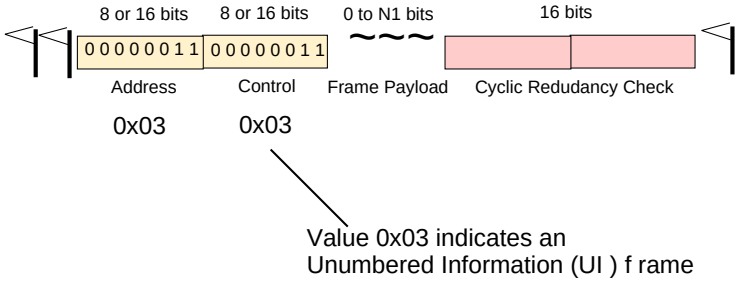
provides no protection from duplication

provides no guarentee of original order

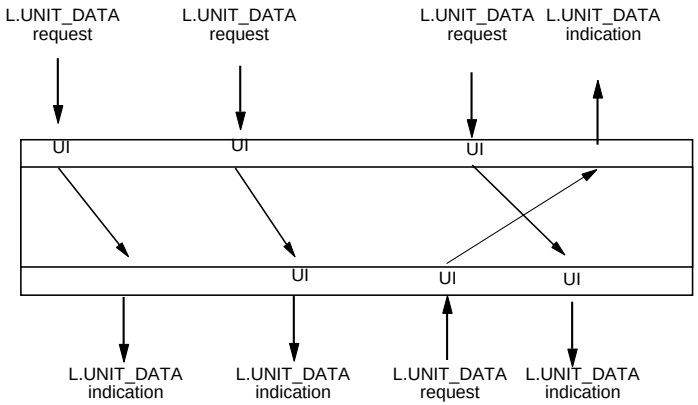
Basic Connection-Less Service



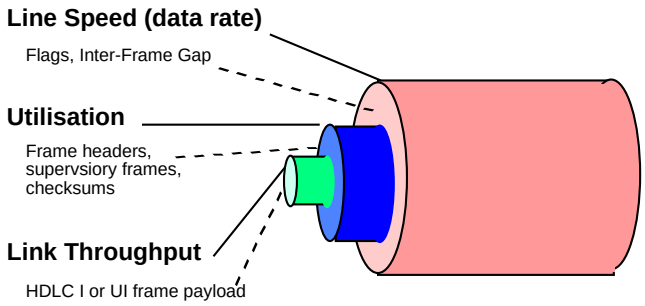
UI Frame Format



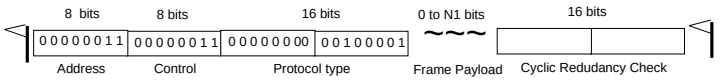
HDLC Connectionless Service



HDLC Performance



Point-to-Point Protocol (PPP)



0xFF (all nodes)

0x03 UI

e.g. IP = 0x0021
IP-CP = 0x8021
LCP = 0xC021

(e.g. IP packet)

2 byte value identifies type of payload

N1 typically 1500 B.

RFC 1134, 1989

Self - Help THINGS TO THINK ABOUT (1)

Do you know:

How the data link receiver finds the start of:
- (a) An Ethernet Frame
- (b) An HDLC Frame

How the receiver finds the end of:
- (a) An Ethernet Frame
- (b) An HDLC Frame

??

What is a Best Effort Service?

Reliability

Implies....

All information is received	(no loss, no residual errors)
No information is duplicated	(no extra copies)
Sequencing	(original order is preserved)

Reliability

Connection-Less	**Connection-Oriented**
Best Effort	Reliable
CRC Required	CRC Required
Simple Parameter Negociation	Link Management
No Confirmed Delivery	Acknowledgments
No Flow Control (?)	Flow Control
No Error Control	ARQ