22: Communication protocols



Specific protocols

What a message looks like:

Start bit(s)	Header	Data	Error detection	End bit(s)
--------------	--------	------	-----------------	------------

Serial protocols: message sent as a sequence of bits on one wire



Start bit: 0 Data (7-9 bits)

9 bits)

Parity bit End bit: 1

Universal Asynchronous Receiver-Transmitter

Two components communicating

Each has transmit (TX) and receive (RX) line

Do not need synchronized clock (just both components at same frequency)



lmade source

idle	Start bit	Data	Parity	idle							



Problems with UART?

SPI

Serial peripheral interface Controller sends clock to peripheral and transmits with clock

Transmits clock for longer so peripheral can respond

Multiple peripherals: chip select line



SPI: one controller, multiple peripherals



Image source



Problems with SPI?

2 C	Start bit	Address (7 or 10 bits)	R/W bit	Data (8 bits)	ACK bit	Data (8 bits)	ACK bit	 End bit

Inter-integrated circuit Controller uses address to select which peripheral it is communicating with

Timing of SDA/SCL means this protocol supports multiple controllers





Problems with I2c?

Modern Vehicle Electronics Architecture

Visteon



- Four different computing domains
 - · Vastly different software in each domain
- Large number of Electronic Control Units (ECU)
 30-150 ECUs in cars today ... and growing
- Large software code base
 - 100+ million lines of code in premium cars



Modern car is an increasingly complex network of electronic systems

Image source



Controller Area Network

Used for safety-critical applications (cars)

Binary countdown for arbitration

NRZ encoding with bit stuffing



ѸҴѼѼѼѼѼѼѼѼ СГК<mark>ЛЛЛЛЛЛЛ, СГК</mark>

We have discussed serial buses. Why are parallel buses challenging?



Keeping track of data - buffers

Way for main process and transmitter/receiver to produce/consume data at different rates



Wireless communication





What are some concerns/considerations that specifically concern wireless communication?

Bluetooth

Scatternets made up of piconets

1 controller, up to 7 peripherals

Components can drop out of piconet at any time

Elect new controller if controller leaves

Signals use frequency modulation

Frequency hop across set of frequencies in case of collision



WiFi

Internet connectivity

Packets (message) transmitted on a frequency band

Use CSMA for collisions

Communicate with web servers using HTTP protocols

Summary

Study of embedded **systems** means studying how all layers affect each other

Distributed systems - multiple embedded systems talking to each other

Considerations - coordination, synchronization, reliability....