

COMP3203 Final Exam Notes

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1 Test 1 Stuff (Brief and Important Only)

1.1 Units

prefix	base 10 conversion	base 2 conversion
pico	10^{-12}	2^{-40}
nano	10^{-9}	2^{-30}
micro	10^{-6}	2^{-20}
milli	10^{-3}	2^{-10}
—	10^0	2^0
kilo	10^3	2^{10}
mega	10^6	2^{20}
giga	10^9	2^{30}
tera	10^{12}	2^{40}
peta	10^{15}	2^{50}

- $Hz \implies$ cycles per second
 - $GHz \implies 10^9$ cycles per second
 - etc.

1.2 Equations

1.2.1 Frequency and Period

- $T = \frac{1}{f}$
- $f = \frac{1}{T}$

1.2.2 Wavelength

- $\lambda = vT$
- $f = \frac{v}{\lambda}$, since $f = \frac{1}{T} \implies \lambda = \frac{v}{f}$
 - for electromagnetic waves in a vacuum, $v = c$

1.2.3 Bandwidth

- B = lowest frequency – highest frequency
 - Hz
 - bps
 - or any scalar of the above two

1.2.4 Delay

- propagation delay = $\frac{\text{distance}}{\text{speed of light in medium}}$
- transmit delay = $\frac{\text{packet size}}{\text{bandwidth}}$
- queue delay = buffering and switching delays at nodes
- **total delay** = propagation + transmit + queue
- **RTT** or round-trip-time = $2 \times \text{delay}$

1.2.5 Delay Bandwidth Product

- # of bits = $B \times D$
 - e.g., # of bits = $10bps \times 10s = 100b$
- this is the number of bits of data that can be sent before the first bit arrives
- we can send $2(B \times D)$ bits before we receive the first reply bit

1.2.6 Shannon Capacity

- maximum theoretical capacity
- $C = B \log_2 \left(1 + \frac{S}{N}\right)$, where $\frac{S}{N}$ is the signal/noise ratio
 - high $\frac{S}{N} \implies$ good capacity
 - low $\frac{S}{N} \implies$ poor capacity $\because \log_2(1 + 0) = 0$
- $\frac{S}{N}$ should be in Db

1.2.7 Redundancy

- redundancy = $\frac{n+r}{n}$
- r redundancy bits must cover $n + r$ bits for errors
 - in other words, 2^r must be able to express $n + r$ bits
 - this means $2^r > n + r$
 - or, $n < 2^r - r$

1.3 Error Checking

- VRC
- LRC
- CRC
 - *this is usually used before ARQ*
- checksum

2 ARQs

- (A)utomatic (R)epeat Re(Q)uests
- strategy to handle errors detected by the CRC
 - or whatever other detection method
- main types
 - **stop and wait**
 - sliding window
 - **go back N**
 - **selective reject**

2.1 Sliding Window

2.1.1 Go Back N

- most commonly used sliding window
- sequential frames numbered $n \bmod N$
- send up to $N - 1$ frames **before an ACK is received**
- **unbounded sequence numbers** is a hurdle for sliding window in **non-FIFO** channels

ACKs and NAKs

- if no error
 - send RR (ACK) for frame[n]
- if error
 - send REJ (NAK) for frame[n]
- if frame lost, send a NAK
- if no ACK or NAK received before *timeout*, **assume lost**

When Sender Receives a NAK[n]

- resend frame[n] and all frames sent since

When a Sender Receives No ACK or NAK

- go back to the previous ACK and resend all frames sent since

2.1.2 Selective Reject

- similar to go back N
- **BUT** we only resend the **lost frame**
 - out of order!
 - receiver needs *sorting logic* to store frames after a NAK
- in general, smaller window size

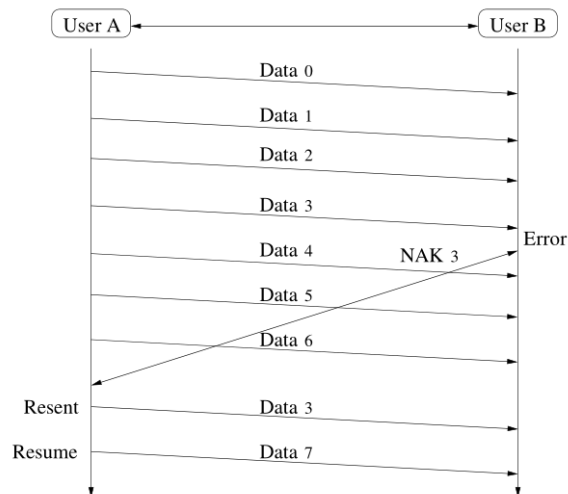


Figure 1: An example of the Selective Reject protocol.

2.2 Stop and Wait

- also called an **ABP**
 - *alternating bit protocol*
 - because the label bits alternate between 0 and 1
- you can think of it as sliding “window” with a **window size of 1**
- works only in **FIFO queues**
 - suitable for **data link layer**

2.2.1 Errors in Stop and Wait

- two main types
- **frame errors**
 - damaged frame
- **ACK errors**
 - damaged acknowledgement

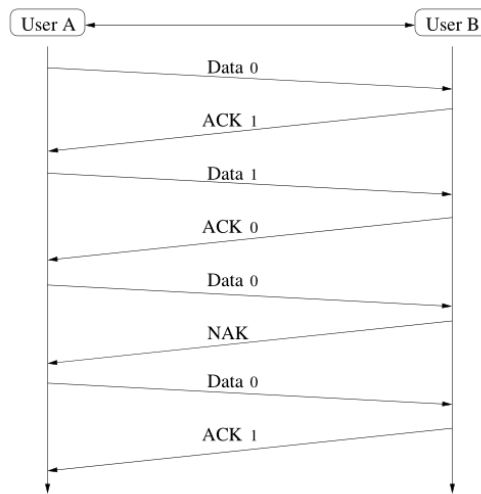


Figure 2: A diagram of the Stop and Wait ARQ protocol.

Frame Errors

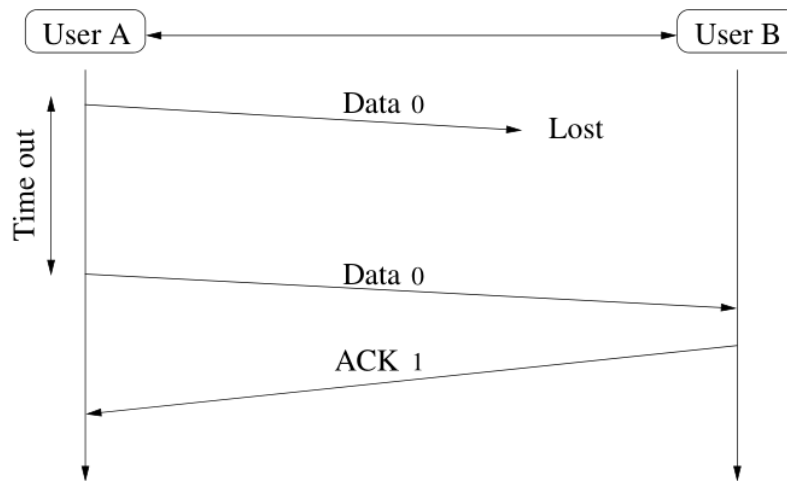


Figure 3: A lost frame error in the Stop and Wait ARQ protocol.

- frame is damaged
 - one or more bits have been altered
- discard the frame
- source waits for ACK
 - if it doesn't receive one, it will resend

ACK Errors

- frame is received but ACK is damaged
- sender will resend message
- receiver will accept the same message twice
 - so we need to label frames
 - and label ACKs

- use a bit for this
 - $\text{ACK}[b]$ acknowledges frame $[b + 1 \bmod 2]$
 - says receiver is ready for frame $[b]$

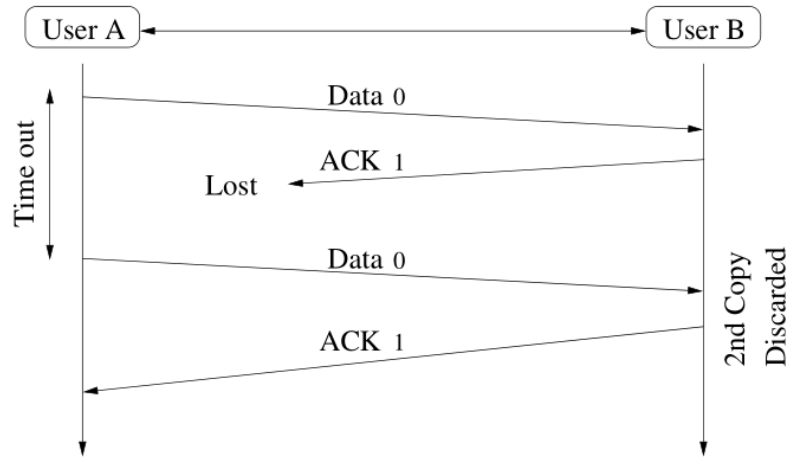


Figure 4: An ACK error in the Stop and Wait ARQ protocol.

2.2.2 Correctness

- satisfies:
 - safety
 - algorithm never gives an incorrect result
 - always results in a “corrected” error
 - liveness
 - never enters a deadlock condition

3 Multiaccess

3.1 LANs

- two types
 - **switched**
 - lines, multiplexes, switches
 - hierarchical addressing scheme
 - routing tables
 - **broadcast**
 - no routing
 - flat addressing scheme
 - (M)edium (A)ccess (C)ontrol to coordinate transmissions
 - **preferred over switched** due to **simplicity**

3.2 The Problem with Shared Channels

- in *point-to-point* networks we have signal as a function of one transmitted signal
- in *shared* networks, we may have **more than one** transmission contributing to a signal

3.3 MAC Protocol

3.4 Uncoordinated Access Control

3.5 Ethernet

3.6 Coordinated Access

3.6.1 Tree Algorithm

3.6.2 Binary Countdown

3.6.3 Bitmap

4 Wireless

4.1 Cellular

4.2 Ad Hoc

4.2.1 UDG

4.2.2 Compass Routing

4.2.3 Face Routing

4.3 Bluetooth

5 GPS

5.1 Three Techniques

5.2 Satellites

6 Routing

6.1 Distance Vector (RIP)

6.2 Link State Protocol (LSP)

6.3 MSTs

6.4 Dijkstra

7 IP

7.1 IPv4

7.1.1 Classes of Address

7.1.2 Subnets

7.1.3 Subnet Masks

7.2 IPv6

7.3 DHCP

7.4 ARP

7.4.1 RARP

8 TCP

8.1 How it Works (Sliding Window)