CS 224 Assignment - II

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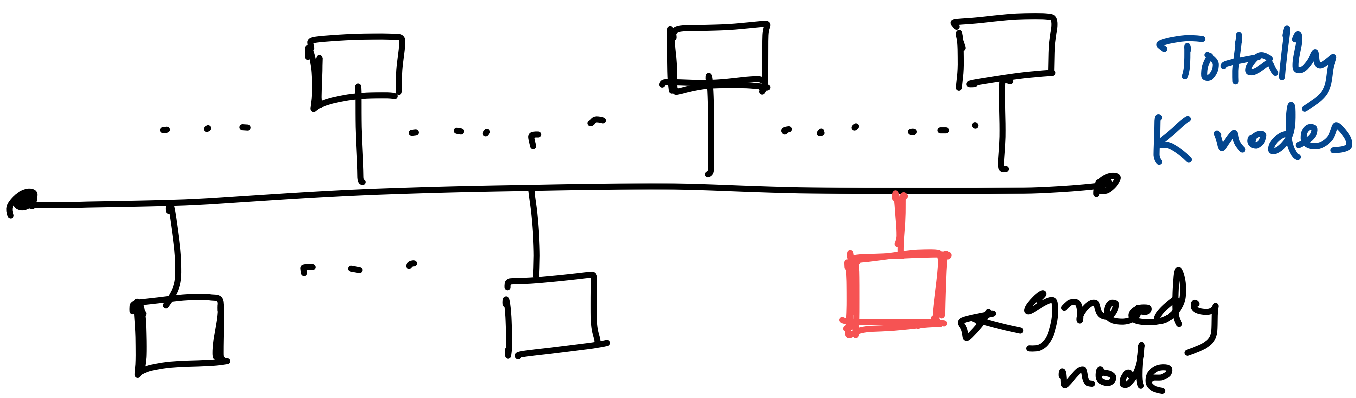
Q1) The node wishes to transmit atleast N% of successfully transmitted frames.

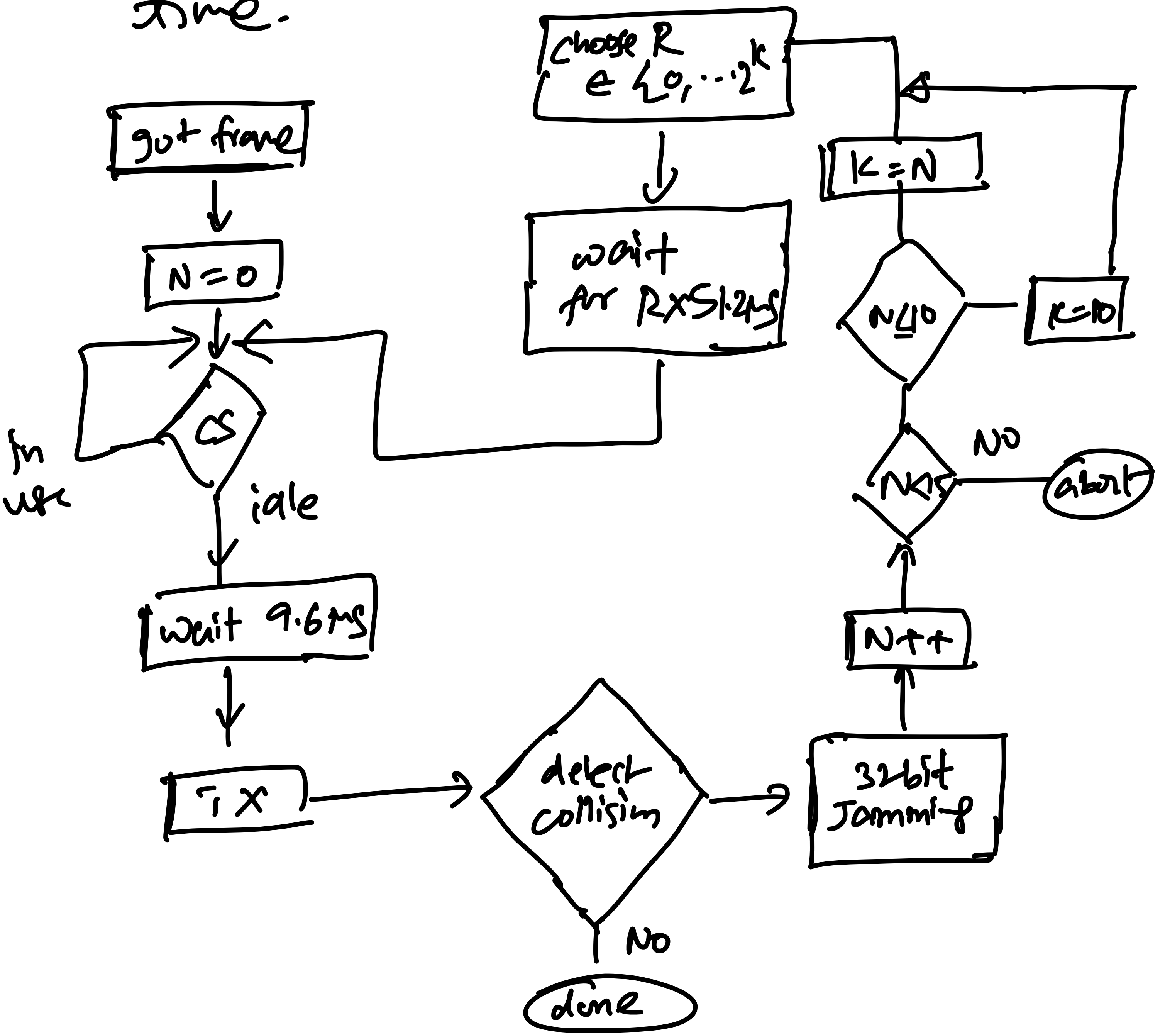
Given that all other nodes STRICTLY follow IEEE 802.3 Standard.

The greedy node can go about in the following way.

Suppose the bus is as follows



for all of the nodes at any given time.



Flow Chart for IEEE 802.3

Suppose all the frames used are of the same size.
Suppose each normal node transmits H frames over time T on average after taking into account collisions etc.

thus total frames transmitted by the normal nodes on average is

$(K-1)H$ in time T.

the greedy node must transmit at least N% of the total frames where $0 \leq N < 100$

suppose greedy transmits G frames in T time

$$\frac{G \cdot T}{(G+(K-1)H) \cdot T} \geq \frac{N}{100}$$

$$100G \geq NG + (K-1)NH$$

$$(100-N)G \geq (K-1)NH$$

$$G \geq \frac{(K-1)NH}{100-N}$$

taking the limiting case

G must be $\left(\frac{(K-1)N}{100-N}\right) H$

define $\hat{G} := \min\{G\} = \frac{(K-1)NH}{(100-N)}$

To do the same, the greedy node must transmit atleast G frames in time T (large enough to average out random backoff)

The greedy node can follow a "modified" version of the above Ethernet protocol

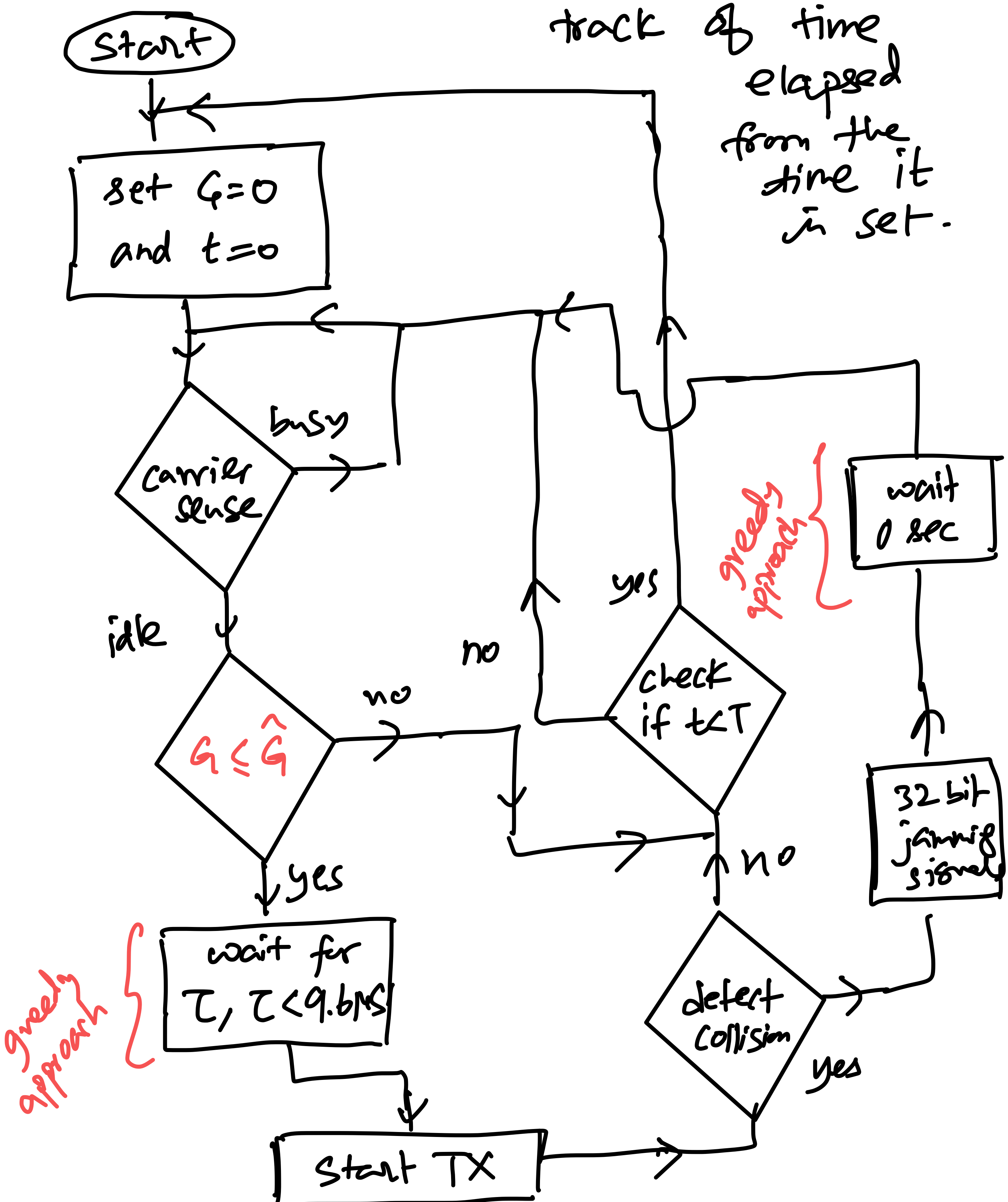
pick G timestamps in the time T say $t_0, t_1 \ldots t_{G-1}$ where the carrier is idle and then make sure it greedly transmits before any other node.

This can be done by not waiting for the 9.6 μs whenever the carrier is idle and directly transmitting or waiting for a shorter time than 9.6 μs, to transmit greedily before any other node.

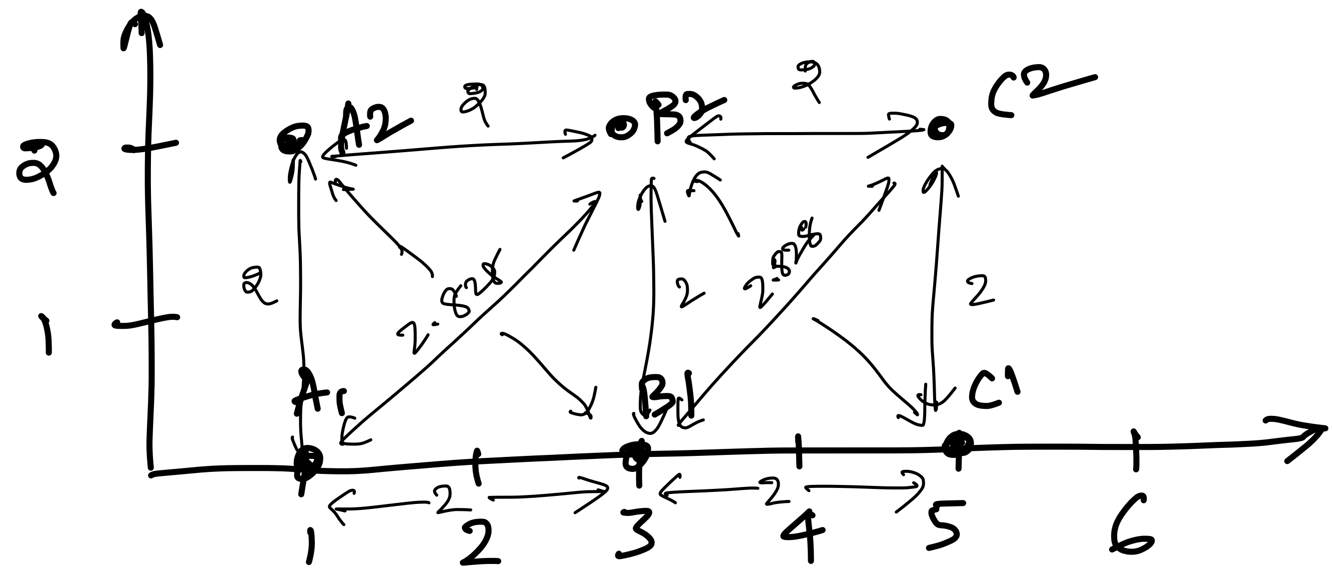
In case of collision, perform the retransmission greedily wait time is 0.

The algorithm is described in the following flowchart

the variable t keeps track of time elapsed from the time it is set.



(Q2) wiFi space topology for the given question



Given:

- Any node can carrier sense, recieve packets RTS, CTS, DATA, ACK $\Longleftrightarrow$ the distance between it and other node is < 3.
- Data packets are of same size
- A_1 sends to A_2 only, B_1 sends to B_2 only, C_1 sends to C_2 only.
- T_A is throughput of $A_1 \to A_2$.
- T_B is throughput of $B_1 \to B_2$.
- T_C is throughput of $C_1 \to C_2$.

- Throughputs are averaged over time to smoothen out effects of random selection of contention window - etc

we need to discuss the nature of relationship between T_A, T_B, T_C.

Approach:

(1) claim: $T_A = T_C = \hat{T}$

This is because of symmetry reasons if we interchanged the positions of A_1 with C_1 and A_2 with C_2 the relative distance between the various nodes in range would be same, hence $T_A = T_C$.

(2) Now to compare the magnitude of T_B and $\hat{T}$.

let us denote the set of nodes in range of a node X as S_X

thus $S_{A_1} = \{A2, B1, B2\}$

$S_{A2} = \{A1, B1, B2\}$

similarly we have

$$S_{B_1} = \{A2, B2, C2, A1, C1\}$$

$$S_{B2} = \{A2, C2, B1, A1, C1\}$$

let C_X denotes the set of nodes from which a node X can recieve CTS.

let R_X denote the set of nodes from which node X can recieve RTS.

$A1 \rightarrow C_{A_1} = \{A_2, B_2\}$ $\quad R_{A_1} = \{B_1\}$

$A2 \rightarrow C_{A_2} = \{B_2\}$ $\quad R_{A2} = \{A_1, B_1\}$

meanwhile,

$B1 \rightarrow C_{B_1} = \{A_2, B_2, C_2\}, \quad R_{B_1} = \{A_1, C_1\}$

$B2 \rightarrow C_{B_2} = \{A_2, C_2\}, \quad R_{B_2} = \{A_1, B_1, C_1\}$

also we know that throughput decreases if a node faces interruptions due to MAC protocols to avoid collisions.

Also the probability of interruptions of a node X by nodes around it increases with $N(C_X)$ and $N(R_X)$ as the likelihood of X to recieve an RTS and CTS increase and hence it must wait for the other nodes to complete wireless communication.

Note: $N(\,)$ denotes the cardinality of a finite set.

Thus $B_1 \to B_2$ is more likely to face more interruptions as compared to $A_1 \to A_2$ or $C_1 \to C_2$ due to above reasons, hence we can conclude that

$$T_A = T_C > T_B$$

or

$$T_A > T_B, \quad T_C > T_B, \quad T_C = T_A.$$