PREDICTING NUMBER OF TRANSMITTING NODES IN WLAN

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ABSTRACT

- 802.11 protocol was standardized by the IEEE for Wireless Local Area Networks. [1]
- The Bianchi Model is an analytical model to analyze the performance of 802.11. [2]
- Distributed coordination function is the primary medium access control method for 802.11.
- Markov Chain is a stochastic model in which the statement is independent of prior statements.[4]

INTRODUCTION

- The aim is to validate Bianchi Model by predicting the number of transmitting nodes in the WLAN.
- Collision probability was calculated from the data obtained from simulations performed for different node numbers and varied times using NS2.
- The number of nodes was estimated using the Gaussian Distribution.

WLANs

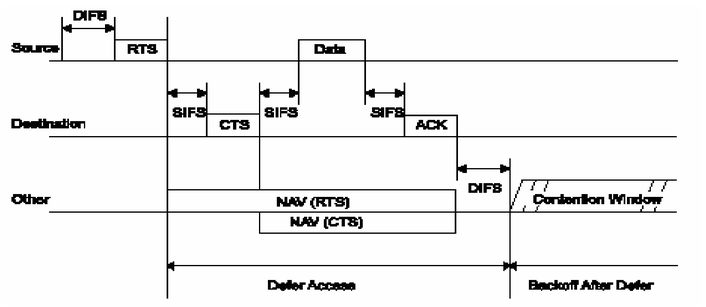
- The station transmits if the channel is idle for a period equal to a (DIFS).

802.11b Parameters[3]

Parameters	Value
SIFS	10 µs
DIFS	50 µs
Slot Time Duration	20 µs
Propagation Delay	2 µs
Physical Layer Header	192 bits / 1Mbps
Mac Header	224 bits / 11Mbps
RTS	160 bits / 1Mbps
CTS	112 bits / 1 Mbps
ACK	112 bits / 1 Mbps
CWmin / CWmax	32 / 1023

- The backoff time is uniformly chosen in the range for each packet transmission (0,W-1).
- The contention window is determined by the number of packet transfers that have failed.

Basic Access Mechanism[2]

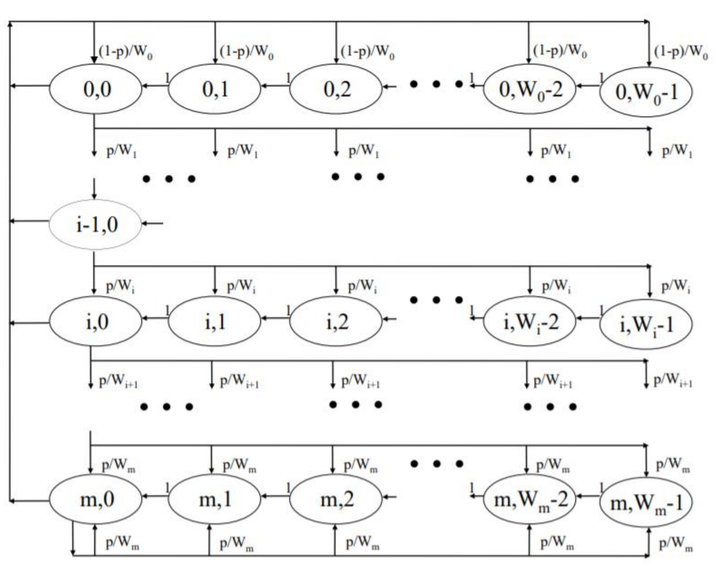


- It obeys the backoff rules and sends a special short frame (RTS).
- When the receiving station detects an RTS frame, CTS frame for it to send after a SIFS.
- No other station can detect the channel idle for a DIFS until the end of the ACK because the SIFS is shorter than a DIFS.
- The AgentTrace and MacTrace protocols were kept open in the node configuration to include only collision, received, and transmitted information.
- UDP does not retransmit lost packets.

MARKOV CHAIN

- Bianchi's model calculates the probability of a packet transmission failure due to collision.[1]
- The Markov chain is a mathematical system that goes between transitions from one state to another based on probabilistic criteria.
- Bianchi Model is based on, (n – 1) Wi-Fi devices, and the Axes Point always have data to transmit.

Markov Chain Transition Probabilities[4]



- {s(k),b(k)}
- s(k) = Number of previous attempts for transmitting
- b(k)= The backoff counter

$$1 - p = \left(1 - a(p)\right)^{n-1} \quad [4]$$

- The probability of station transmits: 1 – p
- The probability of collides: p
- The probability of a station having transmission is equal to other (n-1) stations do not transmit.

$$a(p) = \frac{2(1-2p)}{(1-2p)(W+1)+pW(1-(2p)^m} \quad [4]$$

- Attempt probability can be calculated after solving for probability 'p'.

NODE ESTIMATION

- The number of dropped divided by the number of all events gives the collision ratio.
- That ratio is calculated according to simulation results which are saved in the trace file.
- Also, the collision probability value is calculated according to the Markov Chain.
- Finally, intervals are determined due to the standard deviation and the collision probability.
- Estimation is performed with Gaussian distribution.

RESULTS

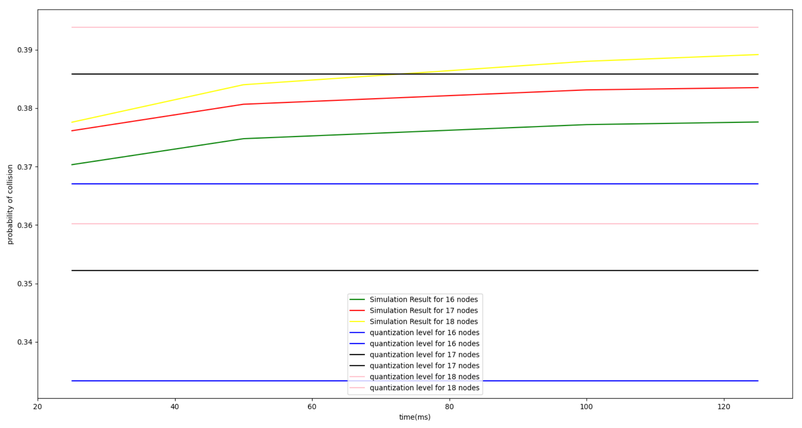
Collision Probability Comparison

	Collision Probability				
		Observed Results According to Simulation			
Node Number	Calculated using Markov Chain	25ms	50ms	100ms	125ms
3	0.105	0.072717	0.073041	0.073196	0.073222
4	0.145	0.138020	0.138321	0.138468	0.138489
5	0.18	0.182684	0.182970	0.183103	0.183123
6	0.208	0.218308	0.219171	0.219604	0.219746
7	0.2315	0.244756	0.246369	0.247074	0.247245
8	0.2528	0.279832	0.286449	0.289835	0.290447
9	0.272	0.298623	0.304325	0.307220	0.307751
10	0.28	0.312299	0.318268	0.321205	0.321735
11	0.289	0.316774	0.317998	0.318614	0.318713
12	0.3035	0.328786	0.329888	0.331084	0.331343
13	0.3165	0.342604	0.351873	0.356581	0.357469
14	0.329	0.352657	0.358931	0.362100	0.362785
15	0.34	0.353314	0.356095	0.357564	0.357850
16	0.3502	0.370320	0.374763	0.377173	0.377619
17	0.369	0.376126	0.380656	0.383113	0.383502
18	0.377	0.377583	0.383995	0.388003	0.389154
19	0.385	0.386096	0.390603	0.393109	0.393544
20	0.3917	0.391884	0.395802	0.397954	0.398344

Node Estimation Comparison

	Estimation of Node Numbers According to Simulation Results			
Node Number	25ms	50ms	100ms	125ms
3	2	2	2	2
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	9	9	10	10
9	10	11	12	12
10	11	12	12	13
11	12	12	12	12
12	12	13	13	13
13	13	15	15	15
14	14	16	16	16
15	14	15	15	16
16	16	17	17	17
17	16	17	17	17
18	17	17	18	18
19	17	18	18	18
20	18	19	19	19

Quantization Level Control



CONCLUSION

- The calculated collision probability values from the Bianchi Model and the observed collision probability values coincide with each other.
- For nodes 17 and 18, simulation results are in the specified interval and correct estimations are done.
- The wrong estimation occurred for 16 nodes as a result of exceeding the determined levels
- As a result of the positions of the nodes or the simulation time, deviations may occur.

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