802.11 WLAN MAC Layer Modeling

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TEAM 2: 802.11 WLAN MAC layer modeling

Outline

- Objective
- Overview
- ns-2
- Results (.nam)
- Results (.tr)
- Conclusions
- Future Objectives
Project Objective: Analyze the relationships of the parameters for a modified EO Markov model and validate the model under certain assumptions with (ns2) network simulations.
System Layout

Overview

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Overview

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Previous Analysis of Markov Model

\[
\text{Prob (packet dropped due to collision)} = p^{L+1}
\]

<table>
<thead>
<tr>
<th>Exact # retries</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>...</th>
<th>b</th>
<th>...</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>1-p</td>
<td>p(1-p)</td>
<td>(p^2(1-p))</td>
<td>...</td>
<td>(p^b(1-p))</td>
<td>...</td>
<td>(p^L(1-p) + p^Lp)</td>
</tr>
</tbody>
</table>

\[
\text{Avg # of retries} = \frac{p}{1-p} \left(1 - p^L\right)
\]
Outline

- Analyzed Markov model
- Compared analytical results with computed results to verify the analysis.
- Use analytical results compared with network simulations to determine whether the system can indeed be modeled with a Markov chain.
Ns-2 simulator

- Input: .tcl file
- Output Trace File: .tr file
- Output: .nam file
Ns-2 simulator

• Closely relates to real world.
• A packet-based event-driven simulation.
• Can incorporate the wireless mechanism
• Allows for mobile stations
• Provides animations
Example of a ns2 simulation
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Nam Trace

Nam Trace Format

\(<\text{type}>\) -t <time> -s <source id> -d <destination id> -p <pkt-type> -e <extent> -c <conv> -a <packet attribute> -i <id> -k <trace level>

<table>
<thead>
<tr>
<th>type</th>
<th>t</th>
<th>s</th>
<th>p</th>
<th>i</th>
<th>k</th>
</tr>
</thead>
<tbody>
<tr>
<td>h, r, d, +, -</td>
<td>0~ simTime</td>
<td>0~ NSTA</td>
<td>cbr, ACK</td>
<td>0~ #pkts</td>
<td>AGT, MAC</td>
</tr>
</tbody>
</table>
The packet is on the air from $t$, if at $t$

$$\text{type}='h' \ \text{AND} \ \text{k}='\text{MAC}' \ (\text{Hop})$$

The medium is busy in

$$[t, t+\text{pktTransTime}]$$

The medium is busy in collision case.
Nam Trace: Medium Busy Time

Medium Busy Time \( \geq \) critical number

Medium Busy Time \( < \) critical number

\[ \text{NSTA} \]
Numerical:

$$\text{AvgRetries (node)} = \frac{\sum \# \text{Retries of this packet}}{\# \text{pktsSendToThisNode}}$$

with

$$\# \text{Retries (packet)} = \# \text{Hop} - 1$$

Theoretical:

$$\text{AvgRetries (node)} = \frac{p}{1 - p} \times (1 - p^{L})$$

where \(p\) is the collision probability and \(L\) is the max \# retries.

But how to find \(p\)?
\[ p = \frac{\text{pktDropDueCol}}{\sqrt{\text{pktDropDueCol} + \text{pktTransSuc}}} \]

\[ \text{pktSend} = \]

\[ \text{Type}='h' \text{ AND } k='\text{AGT}' \text{ AND } p='cbr' \]

\[ \text{pktDropDueCol}+ \]

\[ \text{Type}='d' \text{ AND } k='\text{IFQ}' \text{ AND } p='cbr' \]

\[ \text{pktDropDueQueue}+ \]

\[ \text{LastHopTime}+\text{pktTransTime}>\text{sucTime} \]

\[ \text{pktDropDueEnd}+ \]

\[ \text{Type}='r' \text{ AND } k='\text{AGT}' \text{ AND } p='\text{ACK}' \]

\[ \text{pktTransSuc} \]
Average number of retries

![Graph showing the average number of retries over nodes with numerical and theoretical data.](image-url)
Average number of retries

![Graph showing the average number of retries with numerical, theoretical, and relative error data points.](image-url)
Example of a .tr output

<table>
<thead>
<tr>
<th>Time</th>
<th>Source and Destination Id</th>
<th>Event Type</th>
<th>Node Id</th>
<th>Layer</th>
<th>Drop Reason</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>t</td>
<td>-t 2.963933562</td>
<td>s</td>
<td>-Hs 13</td>
<td>-Dd -2</td>
<td>Ni 13</td>
<td>-Na 50.18</td>
</tr>
<tr>
<td>t</td>
<td>-t 2.964151051</td>
<td>d</td>
<td>-Hs 8</td>
<td>-Dd -2</td>
<td>Ni 8</td>
<td>-Na 76.52</td>
</tr>
<tr>
<td>t</td>
<td>-t 2.965693895</td>
<td>s</td>
<td>-Hs 0</td>
<td>-Dd -2</td>
<td>Ni 0</td>
<td>-Na 0.00</td>
</tr>
<tr>
<td>t</td>
<td>-t 2.965703895</td>
<td>s</td>
<td>-Hs 0</td>
<td>-Dd -2</td>
<td>Ni 0</td>
<td>-Na 0.00</td>
</tr>
</tbody>
</table>

Size of packet

Unique Packet Id
Average number of retries

- From simulation
- From calculation

- Avg number of retries for AP
- Avg number of retries for station
Average number of retries for AP with varying packet period and offset
Average number of retries with varying packet period and offset

5 Stations
Comparison between of the average number of retries from calculation and simulation.
Conclusions

• Estimated parameter ‘p’
• Determined the saturation value
• Established validity of the Markov model
• Established importance of assumption of synchronicity
(Someone Else’s) Future Objectives

- Use the .nam and .tr files to extract information about
  - Average service time
  - Average wait time
- Use the above times to find relationships between parameters
- Compare computed results and simulated results for different packet arrival configurations
- Compute the throughput/delay
- Create a deterministic model
Questions?