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PERFORMANCE ANALYSIS OF POLLING MAC'S FOR EXO-ATMOSPHERIC WIRELESS SENSOR NETWORK

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Presentation Outline

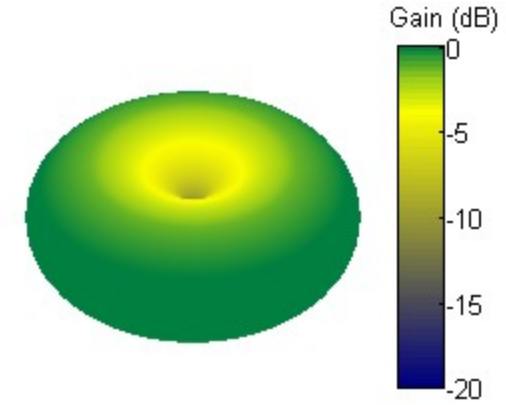
- Introduce the Exo-Atmoshperic Application
  - WLAN containing nodes that move and utilize non-isotropic antennas.
- Polling Algorithms
  - Channel Aware Round Robin (CARR)
  - Channel and Congestion Aware (CCA)
- Asymmetry
  - Variance between data and control packet sizes.
  - Fading Channel due to node movement.
- Performance Analysis
- Conclusion

Exo-Atmospheric Application

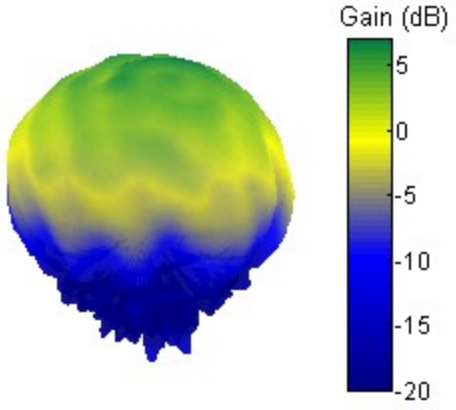
- A WLAN that contains 1 AP and *n* nodes.
- Network organized into a star topology.
- Nodes generate equal amounts of equally important data.
- Nodes move away from the AP at some constant rate.
- Nodes rotate at some constant rate.
- Nodes utilize non-isotropic antennas.
  - Patch
  - Dipole

Exo-Atmospheric Application Constraints

- Nodes are Size Weight and Power Constrained (SWAP).
- Attitude control expensive in terms of power and size.
- MAC layer solutions are much cheaper.
- MAY layer solution must address fading due to node movement.



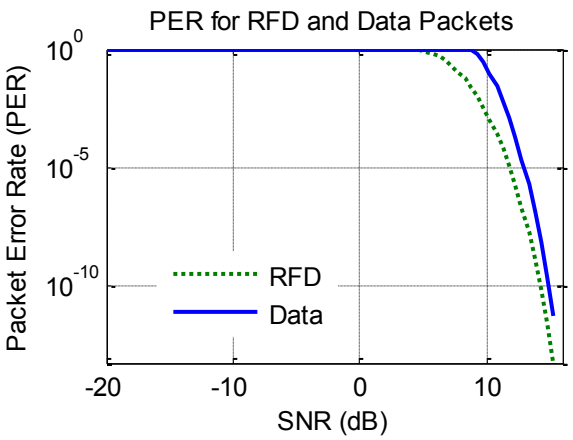
Dipole Antenna Gain

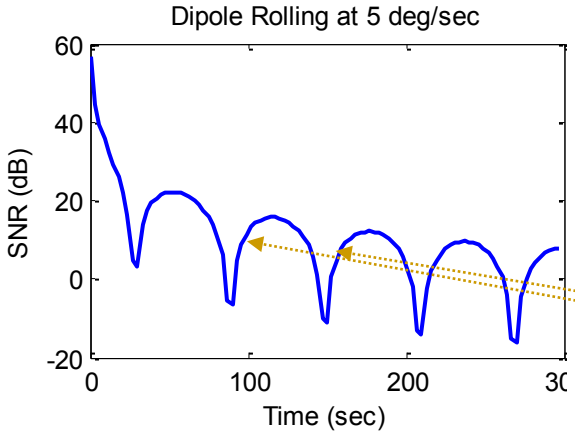


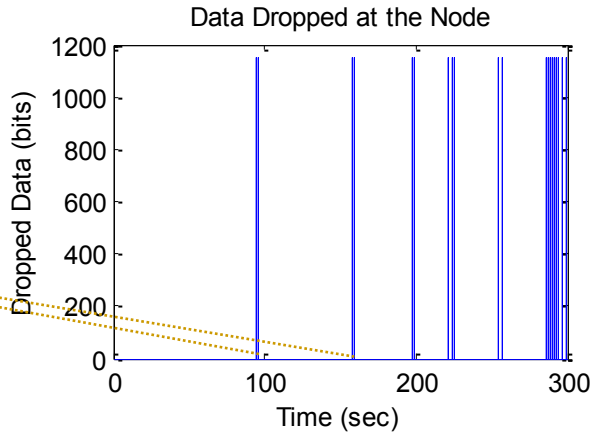
Patch Antenna Gain

Asymmetry Example

- Asymmetry between a node and an AP due to different data and control packet sizes (1152 and 14 bytes) and moving non-isotropic antenna.
- Node movement included with non-isotropic antennas magnifies the asymmetry between AP and nodes.

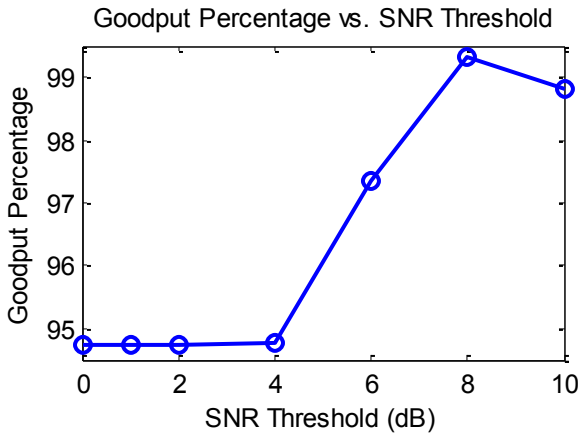






Channel Awareness

- The MAC can discriminate based on the link quality by using an SNR metric, i.e. SNR Threshold.
- An SNR Threshold parameter is realizable since RSSI is a common metric provided by radio manufactures.
- SNR Threshold mitigates asymmetry.



CARR and CCA Algorithms

Channel Aware Round Robin

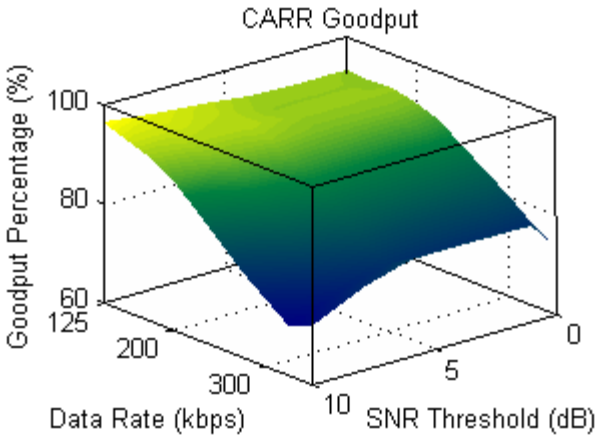
- Round robin with SNR Threshold parameter.
- AP polls nodes in round robin fashion
- Only if the SNR is above SNR Threshold node sends No Data Available (NDA) or data packet.

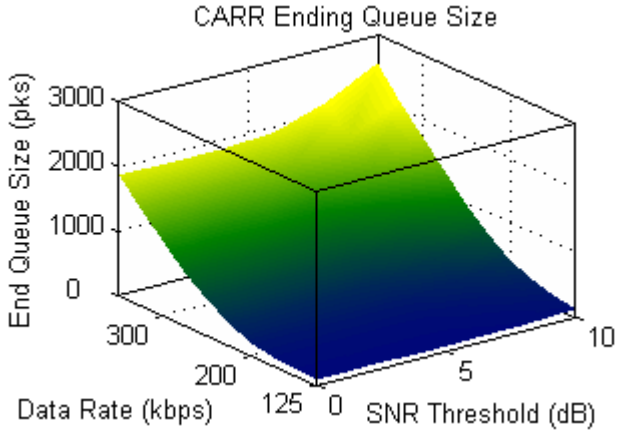
Channel and Congestion Aware

- Block round robin
- Size of “block” for each node based on priority.
- Priority assignment 1-4.
  - 1 – High Congestion/Good Link
  - 2 – Low Congestion/Good Link
  - 3 – High Congestion/Bad Link
  - 4 – Not Congested/Bad Link
- Only if the SNR is above SNR Threshold node sends No Data Available (NDA) or data packet.

Performance Analysis of CARR

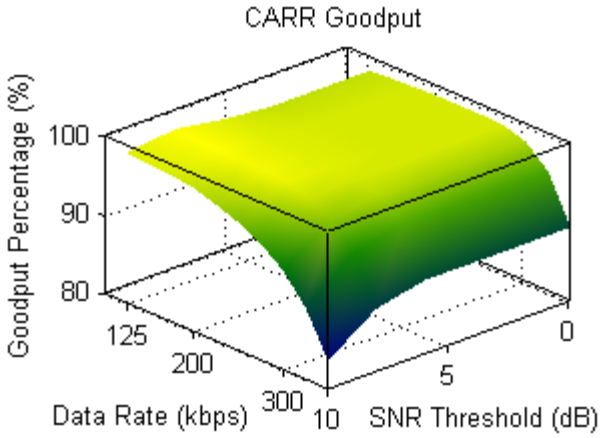
- 8 – Node network with nodes that use patch antennae.
- Goodput Percentage drops drastically with data rate.
- Ending Queue size grows with data rate.
- CARR only performs well at low data rates.

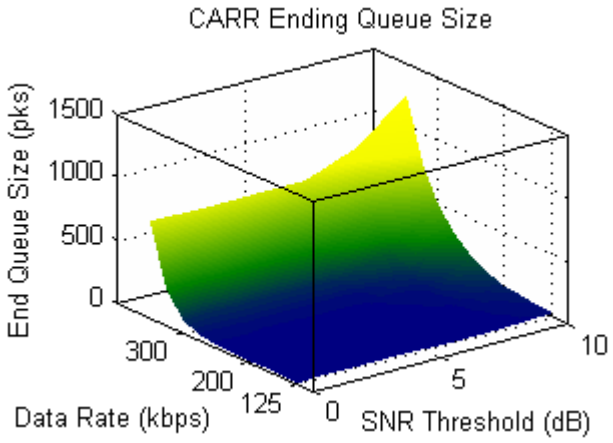




Performance Analysis of CARR cont.

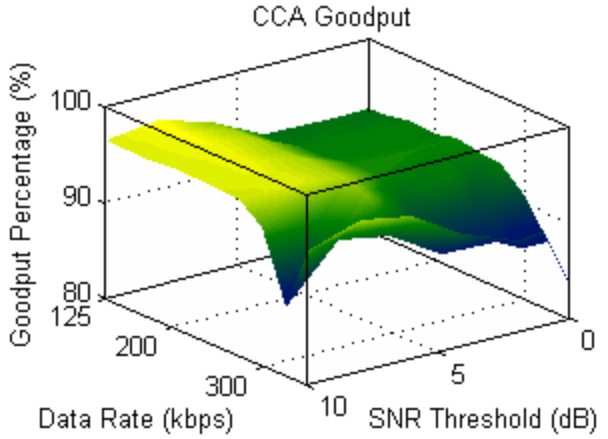
- 12 – Node network with nodes that uses dipole antennae.
- Goodput Percentage sufficient over larger region.
- Ending Queue size smaller over larger region.
- CARR with dipole antennas, as opposed to patch antennas, performs better over larger range of data rates.

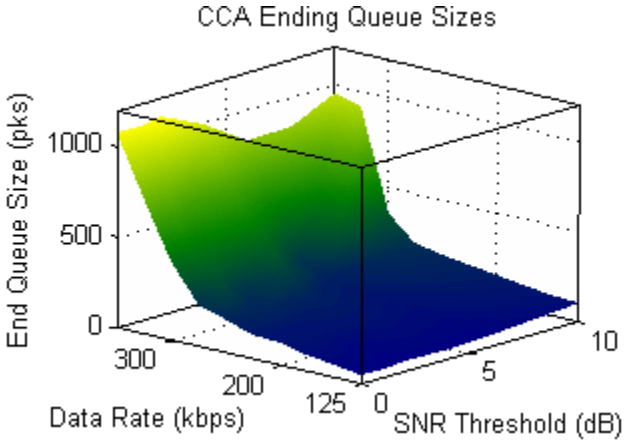




Performance Analysis of CCA

- 8 – Node network with nodes that use patch antennae.
- Goodput Percentage also drops with data rate.
- Ending Queue size also increases with data rate.
- CCA performs considerable better than CARR.





Performance Analysis of CCA cont.

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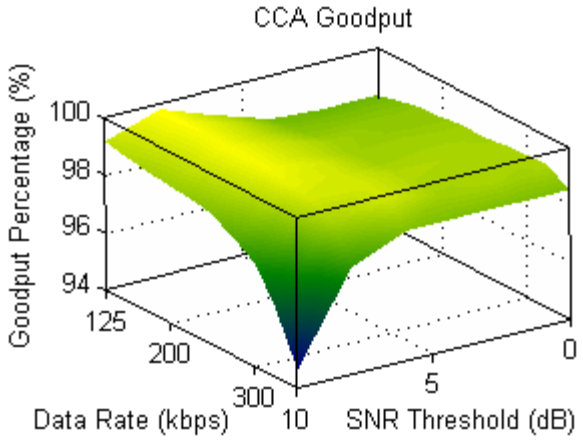
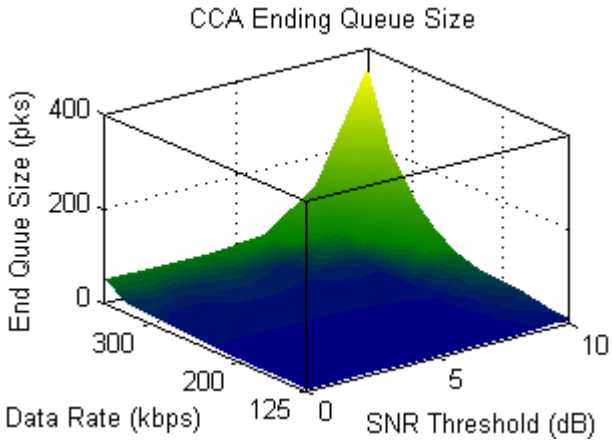
- Ending Queue size smaller over larger region.
- CCA with dipole antennas, as opposed to patch antennas, performs better over larger range of data rates.





Conclusion and Future Work

- CCA performs considerably better than CARR.
- CARR is simpler than CCA.
- Antenna type limits range of operability for both algorithms.
- Simulate more complex MAC protocol.
- Use multiple antennas on each node and study the benefit of antenna diversity.