A MOBILITY-AWARE ADAPTIVE POWER CONTROL ALGORITHM FOR WIRELESS LANS

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- Wireless LAN communication standards like Wi Fi 802.11b have gained widespread adoption and provide untethered access to remote data.

- Mobile communication systems, including cell phones and wireless laptops, face challenges due to limited battery lifetime. Low power communication is crucial to extend device battery life.

- Two techniques for achieving low power communication are reducing the time of communication and compressing transmitted data, as well as reducing transmit power.

- Transmit power control is a technique that actively adjusts transmit power to limit power consumption while still achieving correct packet reception. It can be generalized to other wireless networks.

- Existing approaches to transmit power control in wireless ad hoc networks have limitations, such as assuming separate data and control channels or lacking adaptability to mobility.

- Adjusting transmit power in wireless ad hoc networks can impact network connectivity, especially in terms of fluctuating between sparse and dense interconnection modes.

- Minimum-energy routing algorithms consider node power costs and link power costs to optimize energy consumption in wireless ad hoc networks.

- The introduction of transmit power control adds complexity to such algorithms.

- The presented algorithm focuses on applying power control in the presence of multipath noise and mobility. The decision of whether to employ power control is left to entities like ad hoc routing algorithms.

- The algorithm is unique in its adaptation to mobility, noise fluctuations in received signal strength, and flexibility to handle asymmetric channels.

- The policy question of whether to employ power control in wireless ad hoc networks is not addressed by the algorithm, which focuses on the application of power control techniques.

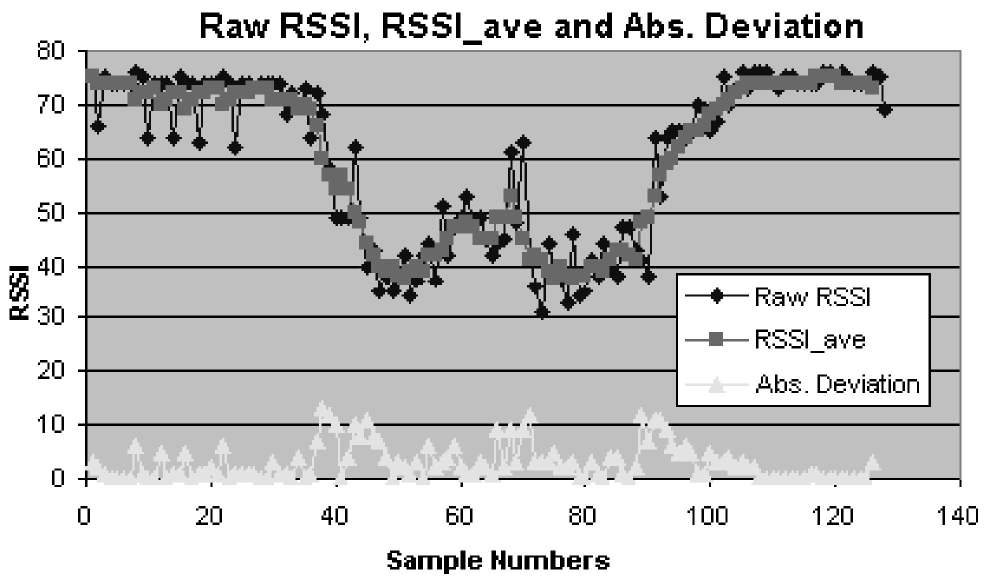
ALGORITHM

The primary objective of our work is to design, implement and test a distributed adaptive transmit power control algorithm for wireless LANs that is able to simultaneously:

• Minimize power consumption in node-to-node communication

• Adapt to mobility of one or both endpoints

• Maintain the connection while minimizing packet loss caused by multipath noise



In our algorithm, for each packet, the receiver computes the unidirectional path loss, equal to the difference between the transmitted power and the received signal strength (RSS). The optimal transmit power between a sender-receiver pair can be represented as PT x Op t = Path Loss(t) + RSS min

- 1. Path loss encompasses various effects such as multipath fading, shadowing, and overall signal attenuation.

- 2. RSS min is the minimum threshold below which reliable packet reception cannot be guaranteed.

- 3. The transmit power for Cisco Aironet 350 cards has a lower limit of 0 dBm.

- 4. PT x Op t is the optimized transmit power, which is determined by Equation 1 and keeps the sender and receiver minimally connected.

- 5. RSS (Received Signal Strength) varies over time due to short-term multipath-induced noise.

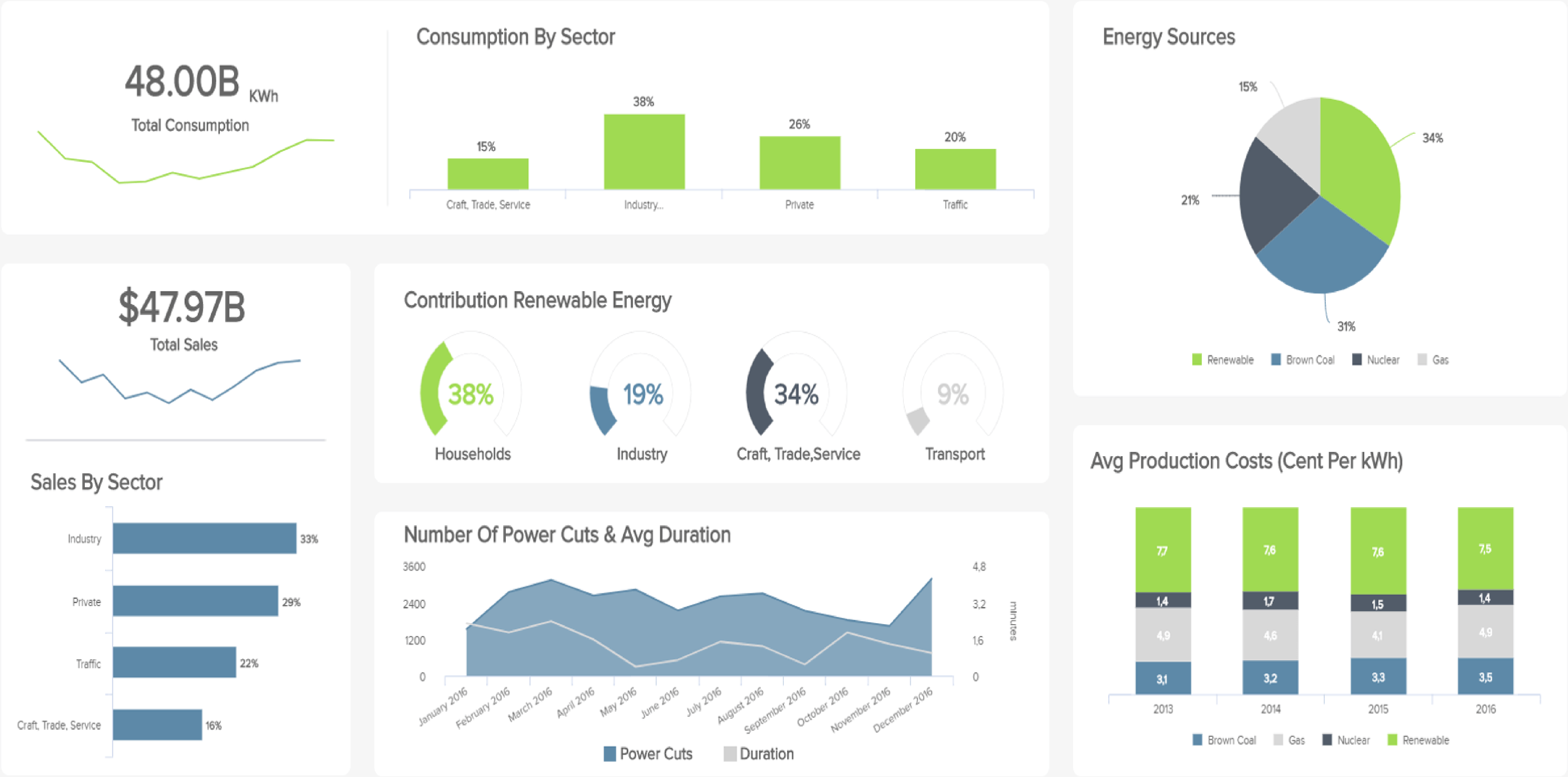
- 6. A cushion called Mth resh is added to PT xOpt to prevent unnecessary packet loss when RSS momentarily falls below RSS min.

- 7. The fixed cushion of 3 dBm above RSSmin is found to be effective in preventing most below-threshold packet losses.

- 8. Mobility introduces additional RSS variation, and significant changes in the RSS average can indicate mobility.

- 9. The algorithm calculates the smoothed RSS average and variance to detect long-term changes in RSS.

- 10. When mobility is detected, PTx Opt is recalculated to adapt to RSS variations and minimize below-threshold packet losses. Please note that the summary has been condensed and may not include all the details present in the original text.


48.00B KWh
Total Consumption
Consumption By Sector
15%
38%
26%
20%
Craft, Trade, Service
Industry...
Private
Traffic
Energy Sources
15%
34%
21%
31%
Renewable
Brown Coal
Nuclear
Gas
$47.97B
Total Sales
Sales By Sector
Industry
33%
Private
29%
Traffic
22%
Craft, Trade, Service
16%
Contribution Renewable Energy
38%
Households
19%
Industry
34%
Craft, Trade,Service
9%
Transport
Number Of Power Cuts & Avg Duration
3600
2400
1200
0
4,8
3,2
1,6
0
minutes
January 2016
February 2016
March 2016
April 2016
May 2016
June 2016
July 2016
August 2016
September 2016
October 2016
November 2016
December 2016
Power Cuts
Duration
Avg Production Costs (Cent Per kWh)
7,7
1,4
4,9
3,1
7,6
1,7
4,6
3,2
7,6
1,5
4,1
3,3
7,5
1,4
4,9
3,5
2013
2014
2015
2016
Brown Coal
Gas
Nuclear
Renewable

Performance analysis

1. The experimental setup for transmit power control involved using a callback mechanism to extract the RSS for each packet.

2. The transmit power was reset between two user-level peer processes on separate 802.11 laptops.

3. The setup allowed for the calculation of energy savings, and a maximum of 25% energy savings were achieved, including idle energy consumption.

4. To determine the optimal values of α and β, an experiment was designed using a set of RSS samples at fixed distances (3m, 5m, 7m, and 9m) between source and destination nodes.

5. The experiment aimed to minimize false positives and detect mobility accurately.

6. For the optimal value of α (smoothing factor), the number of false positives should be minimized.

7. The algorithm was tested with different α values ranging from 0.1 to 0.9, and it was found that values of α between 0.7 and 0.9 resulted in the fewest false positives.

8. Higher values of α (e.g., 0.9) reduced the responsiveness to true mobility, as the heavily smoothed RSS responded slowly to rapid changes associated with mobility.

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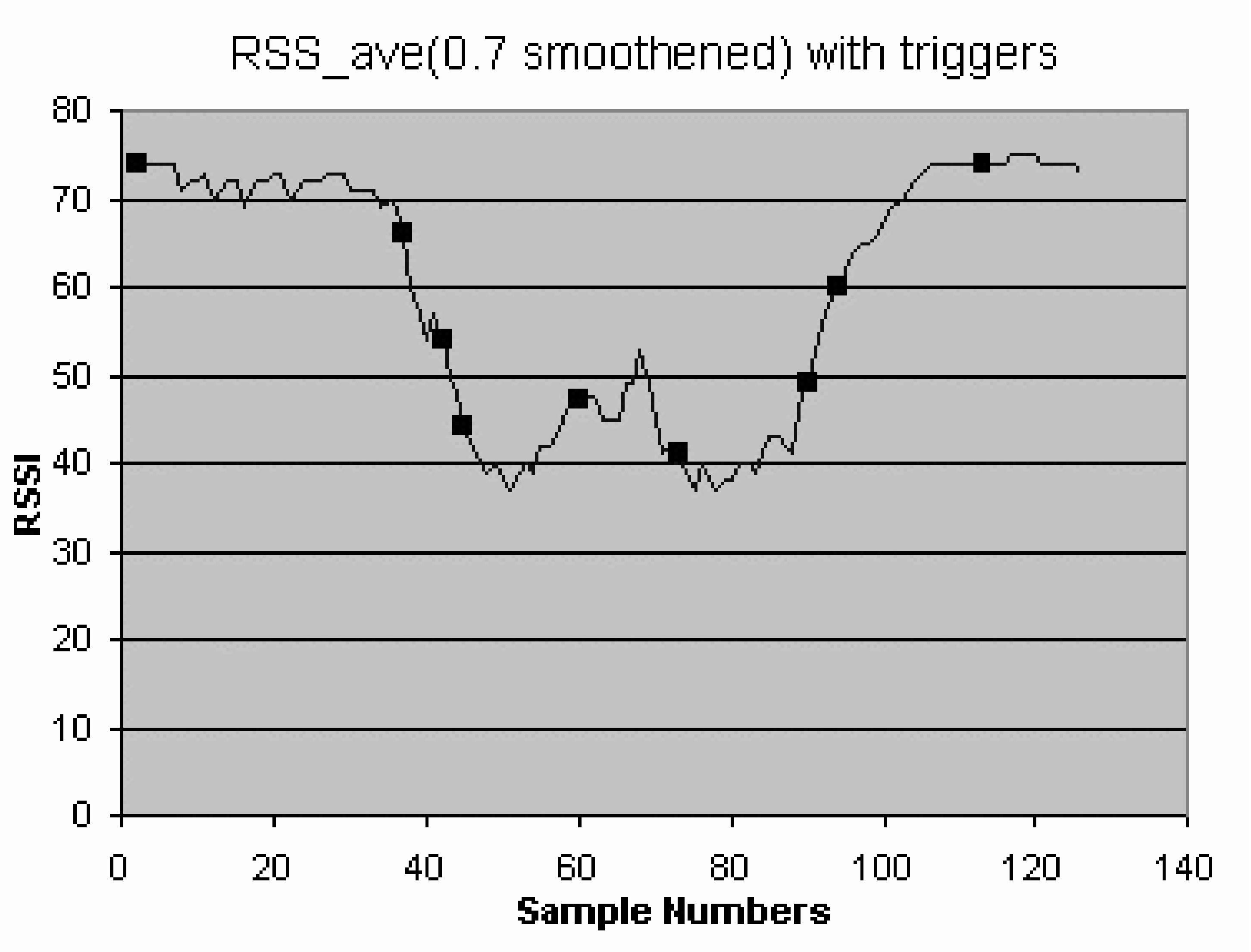
• 9. An optimal value of α of 0.7 was determined for different transmit powers (20dBm/100mW, 17dBm/50mW, and 13dBm/20mW), which remained consistent.

• 10. The analysis focused on the static network scenario, and the chosen α value of 0.7 provided a good balance between minimizing false positives and detecting true mobility. Please note that the summary has been condensed and may not include all the details present in the original text.



CONCLUSION

1. The paper presents a distributed adaptive transmit power control algorithm for wireless networks that can adapt to mobility and handle multipath-induced noise.

2. The algorithm calculates exponentially weighted moving averages of the received signal strength's mean and deviation to detect significant long-term changes in the mean and distinguish them from short-term multipath variations.

3. At each motion event, the algorithm adjusts the transmit power to account for the smoothed deviation, preventing excessive packet loss when the received signal strength (RSS) becomes highly variable and falls below the minimum reception threshold.

4. The algorithm is designed for energy-limited ad-hoc networks and focuses on power management and MAC protocols.

5. The research references several related studies and publications on power control, MAC protocols, and power-aware routing in wireless ad-hoc networks. Please note that the summary has been condensed and may not include all the details present in the original text.