

Übersleep: An innovative mechanism to save energy in IEEE 802.11 based WLANs

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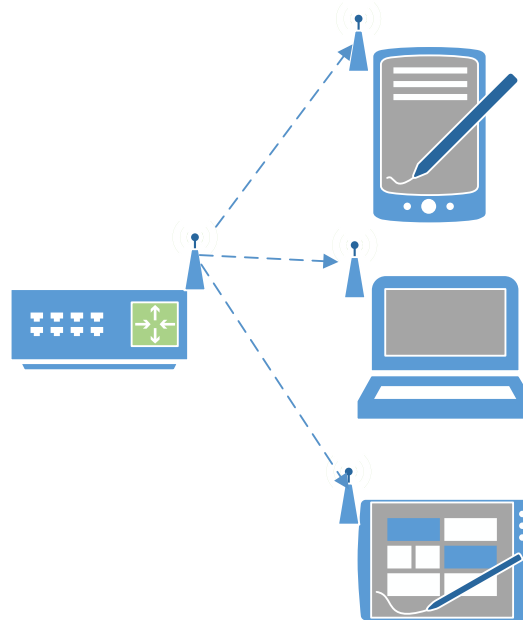
Outline



- ▶ The Problem
- ▶ Related Work
- ▶ Übersleep
- ▶ Factors affecting power savings
- ▶ Experimental Setup
- ▶ Results
- ▶ Extrapolation of results to 802.11ac
- ▶ Conclusion

The Problem

- ▶ Increasing use of Wi-Fi on battery powered mobile devices
- ▶ Wi-Fi adapters can consume significant amounts of power; hence Wi-Fi power saving implies longer battery life



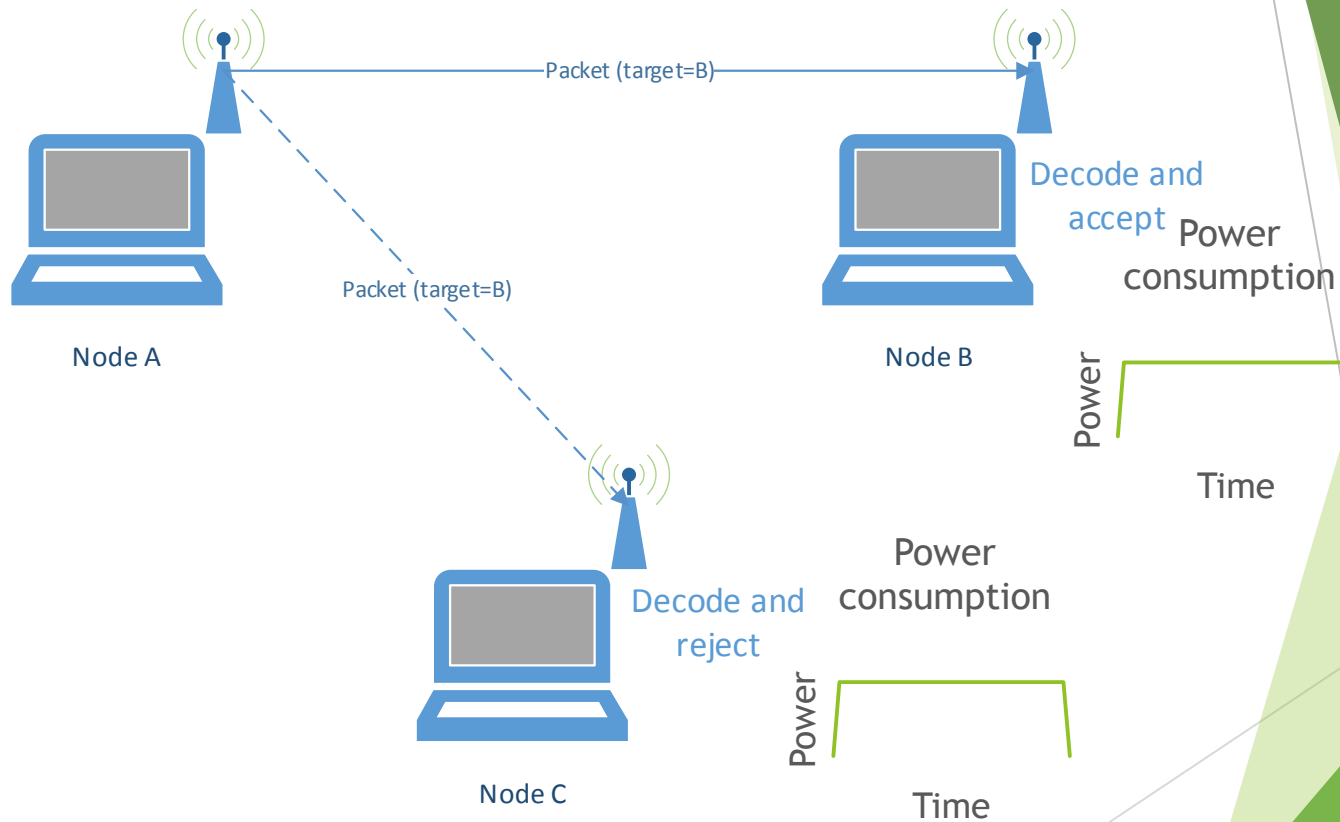
Existing Work

- ▶ Chatterjee *et. al.* proposed saving power during VoIP sessions using *adaptive and non-adaptive multi sleep* at ICDT '07
- ▶ Agrawal *et. al.* proposed saving power for short TCP file downloads and web browsing using Opportunistic Power Save Mode at IEEE ICC 2010
- ▶ C. Peng *et. al.* (Mobicom '12) and S. Nedevschi *et. al.* (NSDI'08) propose to trade off network performance in terms of achievable throughput and latency for energy saving

Existing Work

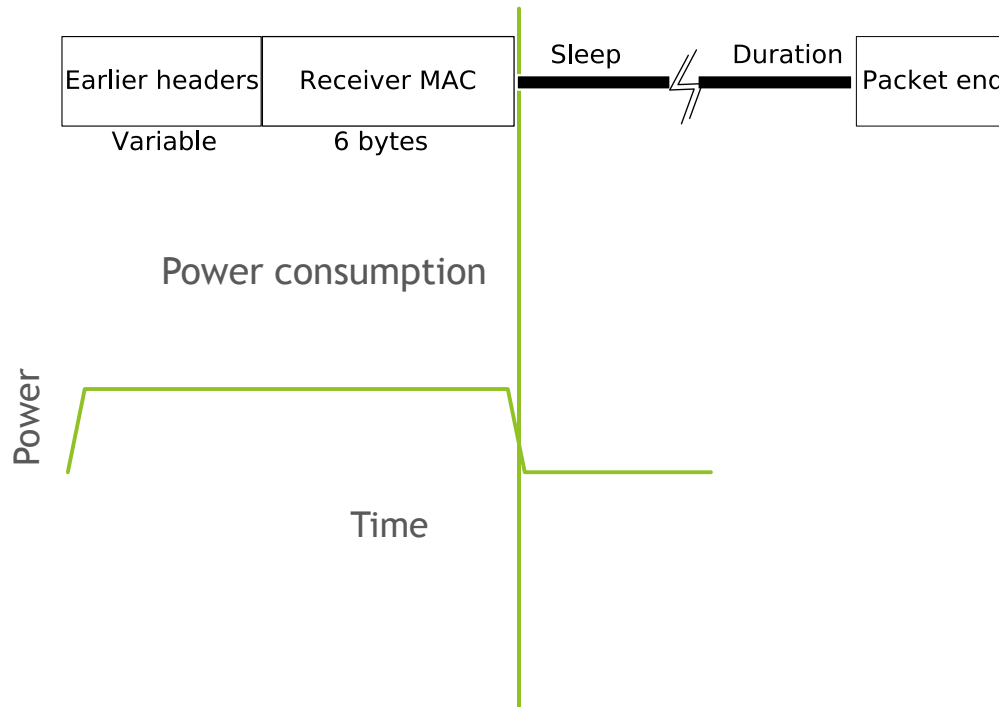
- ▶ Existing approaches either require a specific type of load (for example VoIP) or lead to degradation in throughput.
- ▶ The proposed approach, on the other hand, is generic enough to handle all types of load, and does not affect throughput

Power consumption at idle neighbors



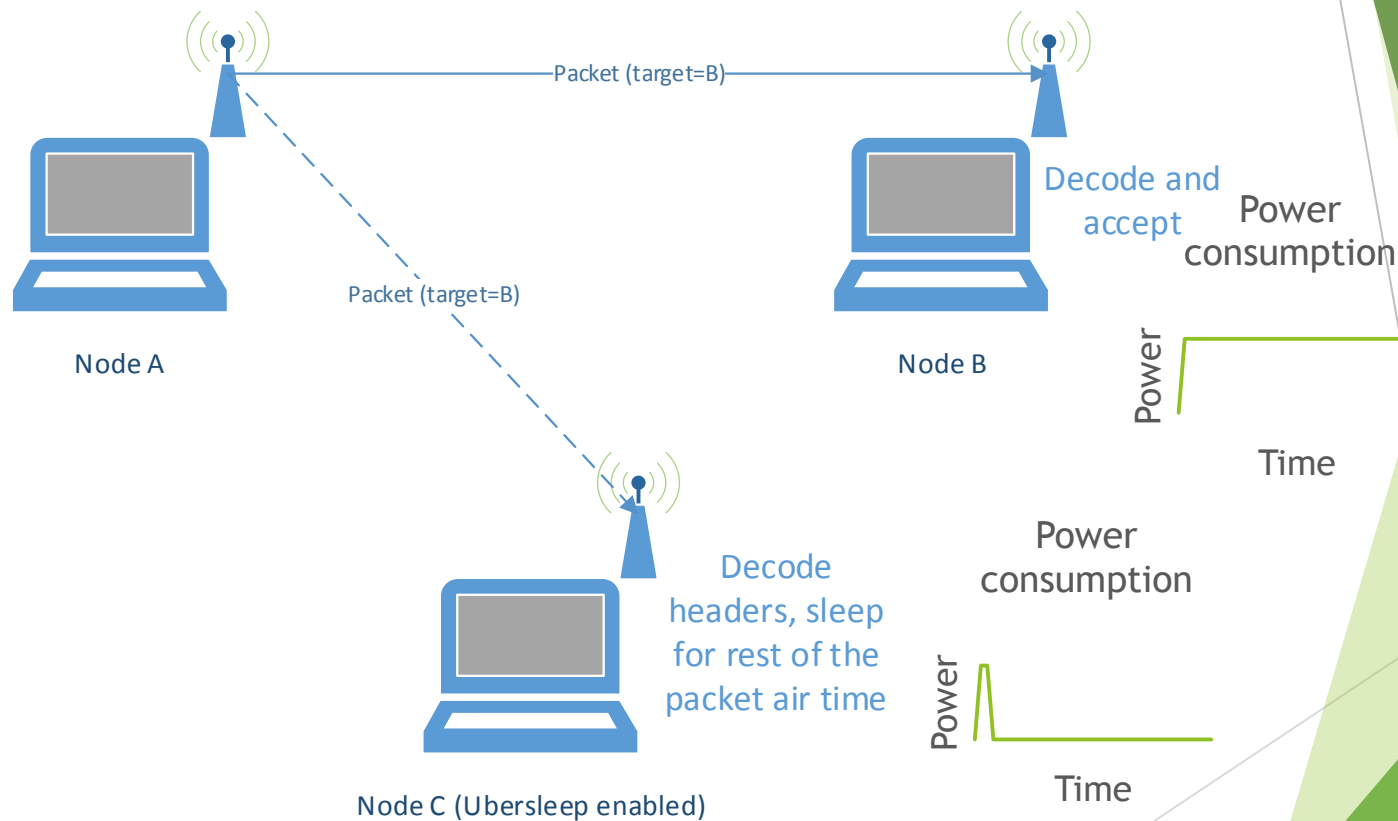
Power wasted decoding unnecessary packet

The idea behind Übersleep



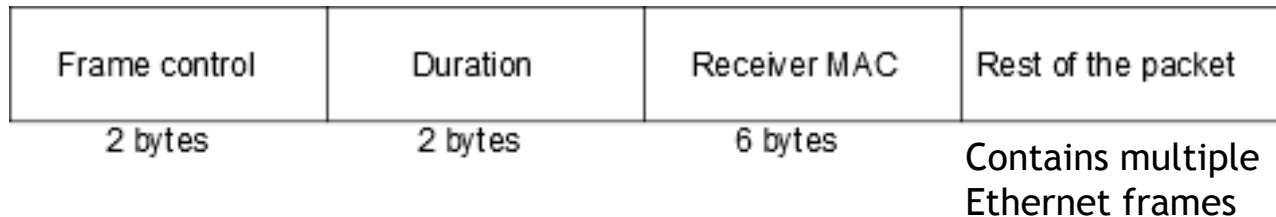
At this point, nodes can detect whether they need to process this packet or not; rest of the packet can be ignored if the recipient is a different node

Power consumption at idle neighbors with Übersleep

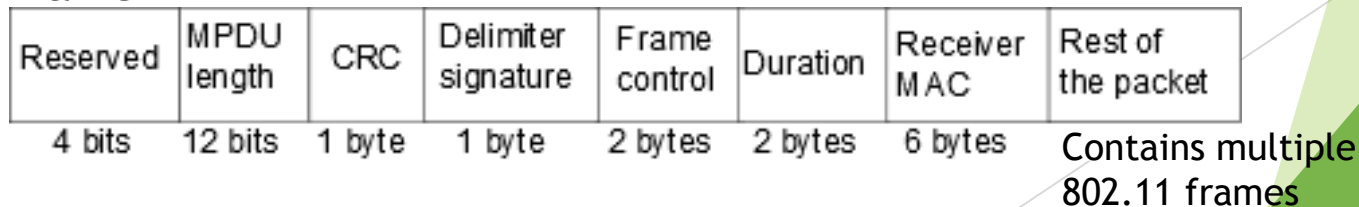


802.11n and Übersleep

- ▶ 802.11n introduced packet aggregation
- ▶ A-MSDU: Multiple Ethernet frames with common 802.11 headers



- ▶ A-MPDU: Multiple 802.11 frames sent in a single PHY frame

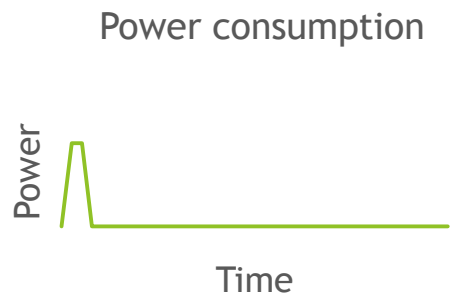


Übersleep's savings are improved by packet aggregation

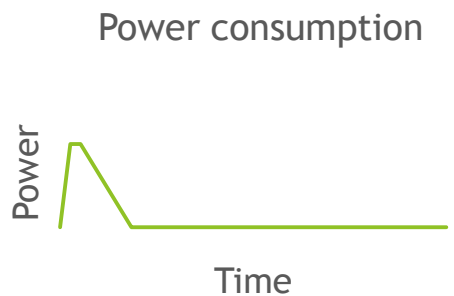
- ▶ Aggregate packets occupy the channel for longer amounts of time
- ▶ All aggregate packets have same destination
- ▶ Therefore we can sleep for the entire aggregate's duration after scanning only one packet

Factors affecting Übersleep

- ▶ Time taken by the NIC to turn off/on

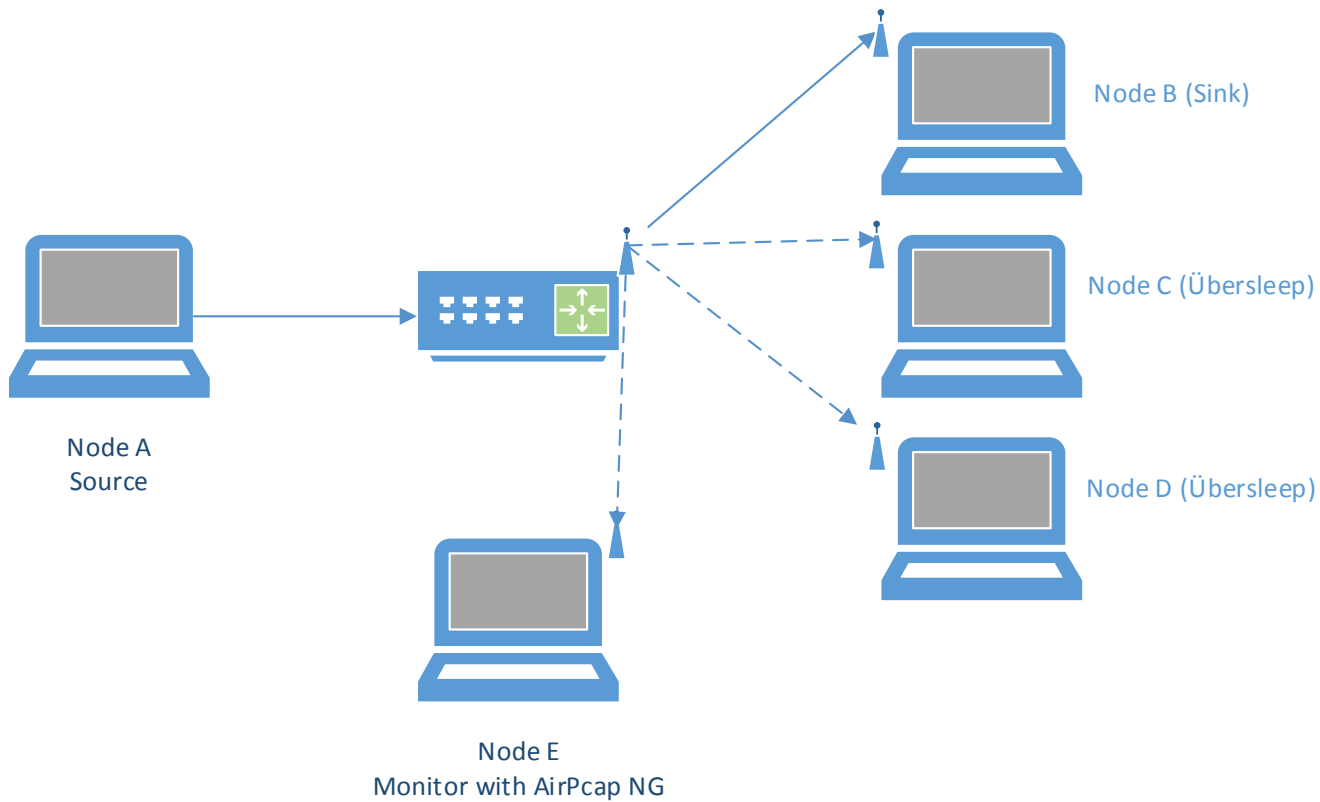


NIC with lower off/on time



NIC with higher off/on time

Experimental Setup

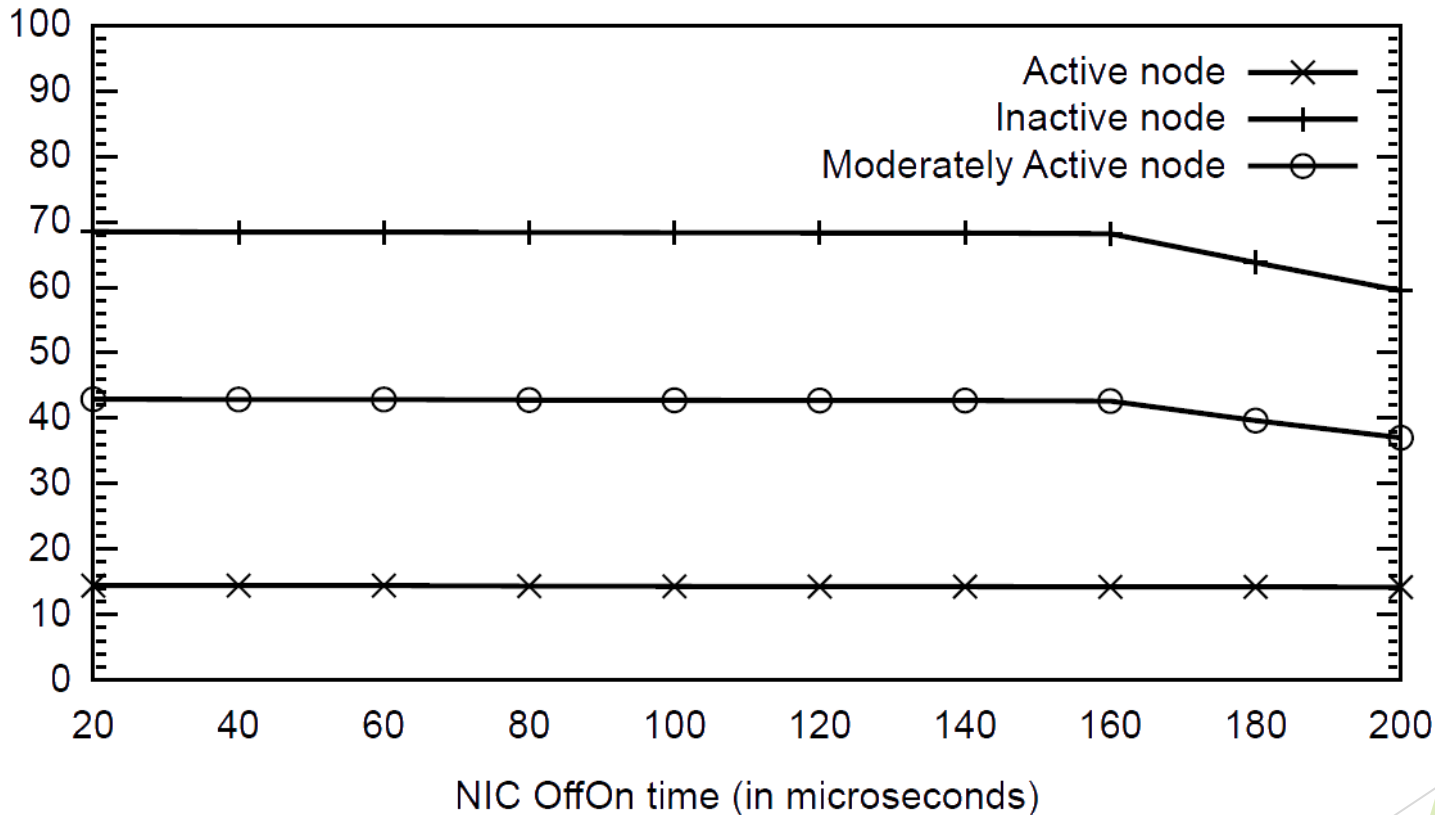


Experimental parameters

- ▶ It is assumed that the power drawn by the NIC during power on/off operations is equal to the power drawn during RX.
- ▶ The power consumption by the NIC was assumed to be as follows:
 - ▶ RX Mode:
 - ▶ 0.94W (1 stream)
 - ▶ 1.27W (2 streams)
 - ▶ 1.60W (3 streams)
 - ▶ IDLE mode: 0.1W

Time saving for 802.11n

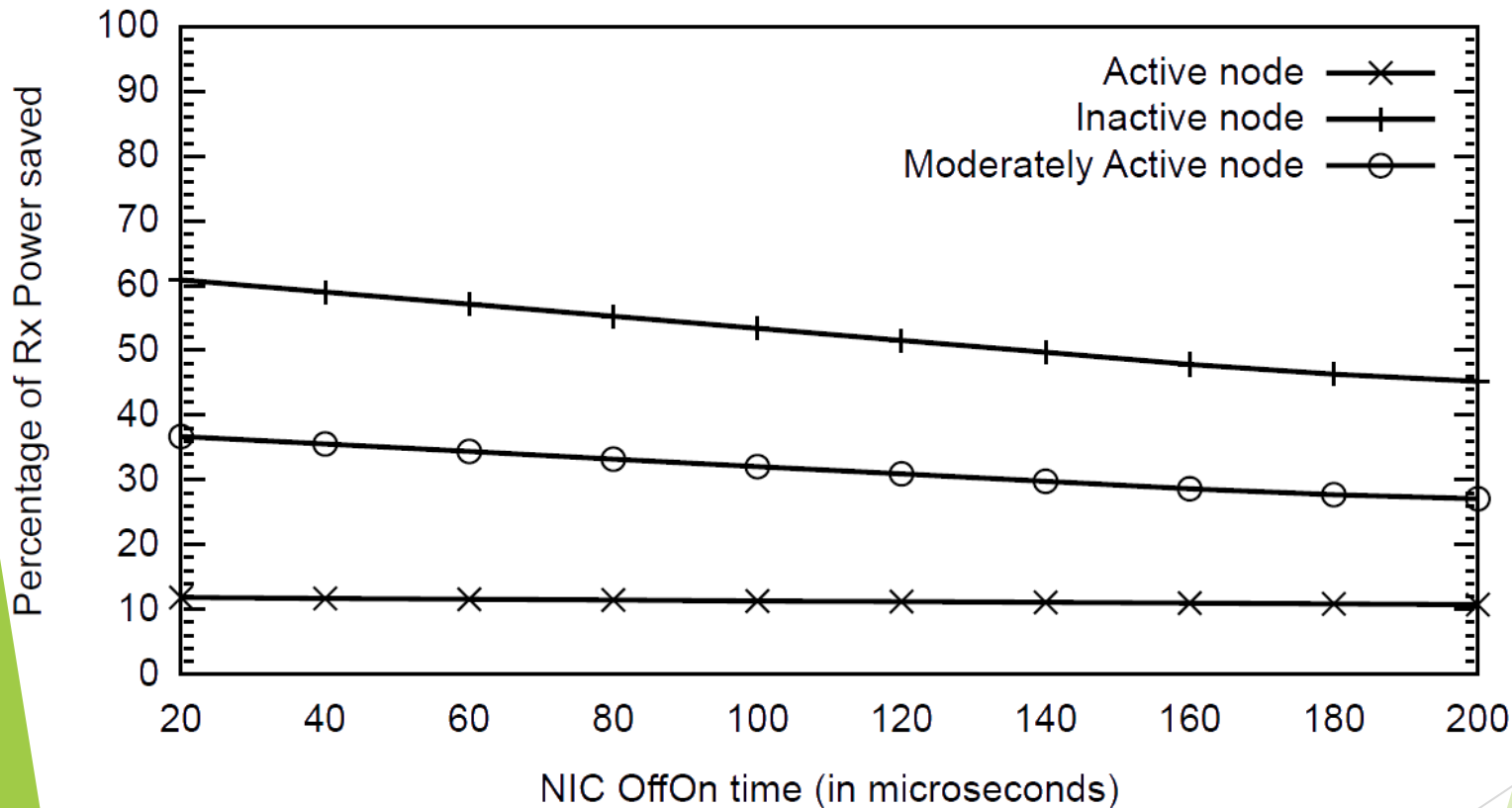
Idle time for 802.11n



The percentage of time saved by Übersleep is independent of NIC off/on time till a threshold at which it can no longer activate on some of the packets

Power saving for 802.11n

Rx Power Saving for 802.11n



As the NIC off/on time increases, the power saved by Übersleep decreases since the NIC consumes full power during the on/off operation

Extrapolating our results to 802.11ac

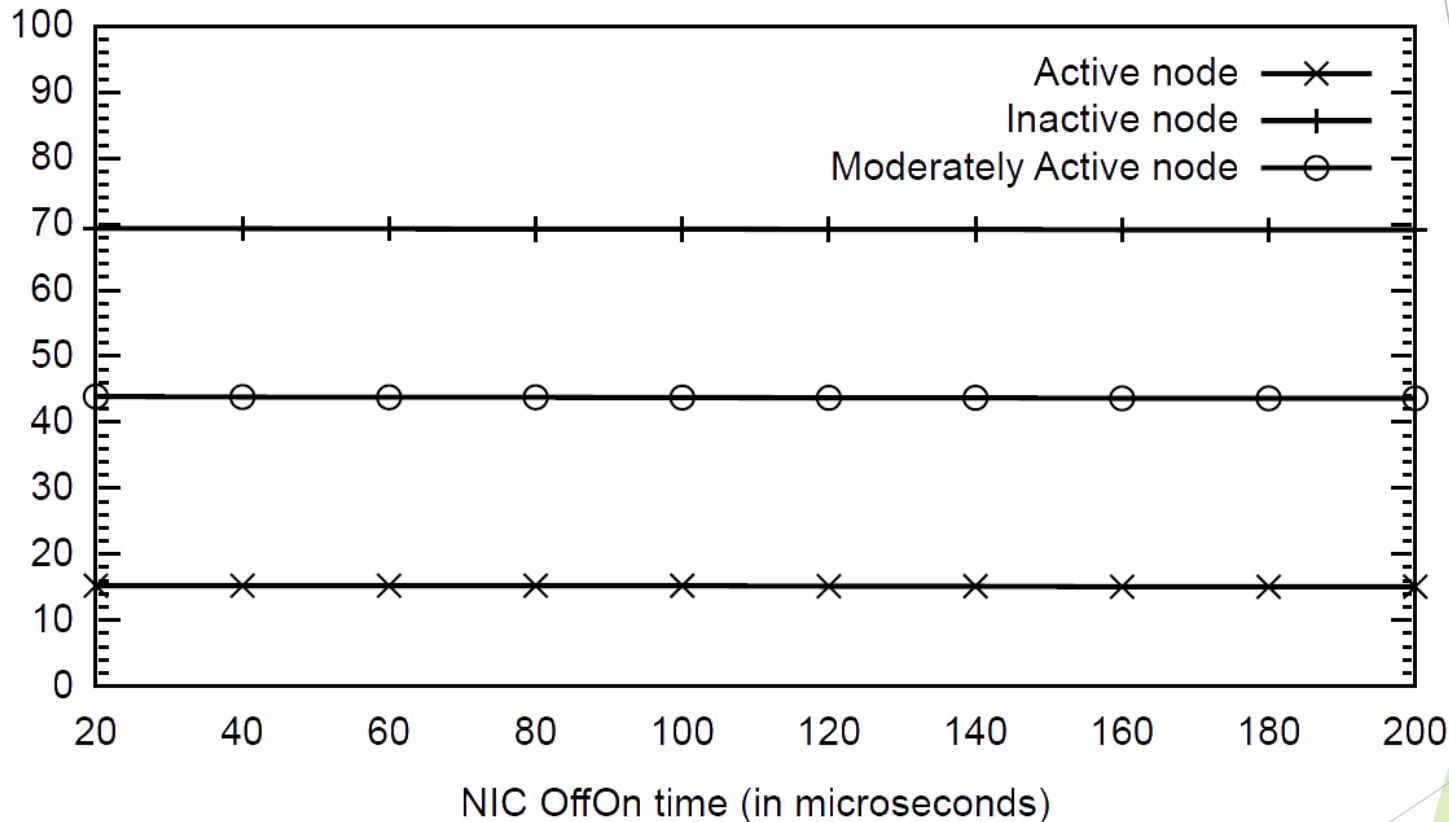
- ▶ In this paper, we have accounted for the following differences between 802.11n and 802.11ac:
 1. **Increase in packet sizes:** 802.11ac increased the maximum packet size to 1MB (as compared to 64KB in 802.11n).
 2. **Increase in rates:** 802.11ac also significantly increased the datarate when compared to 802.11n (by a factor of 6930/600)

Extrapolating our results to 802.11ac

- ▶ In this paper, we have accounted for the following differences between 802.11n and 802.11ac:
 3. **Power Consumption:** We have made the assumption that the power consumption remains same for 802.11ac NICs as compared to 802.11n (In practice, the actual power saving that Übersleep achieves for 802.11ac may be higher than our calculations because all 802.11ac packets are necessarily A-MPDUs)

Time saving for 802.11ac

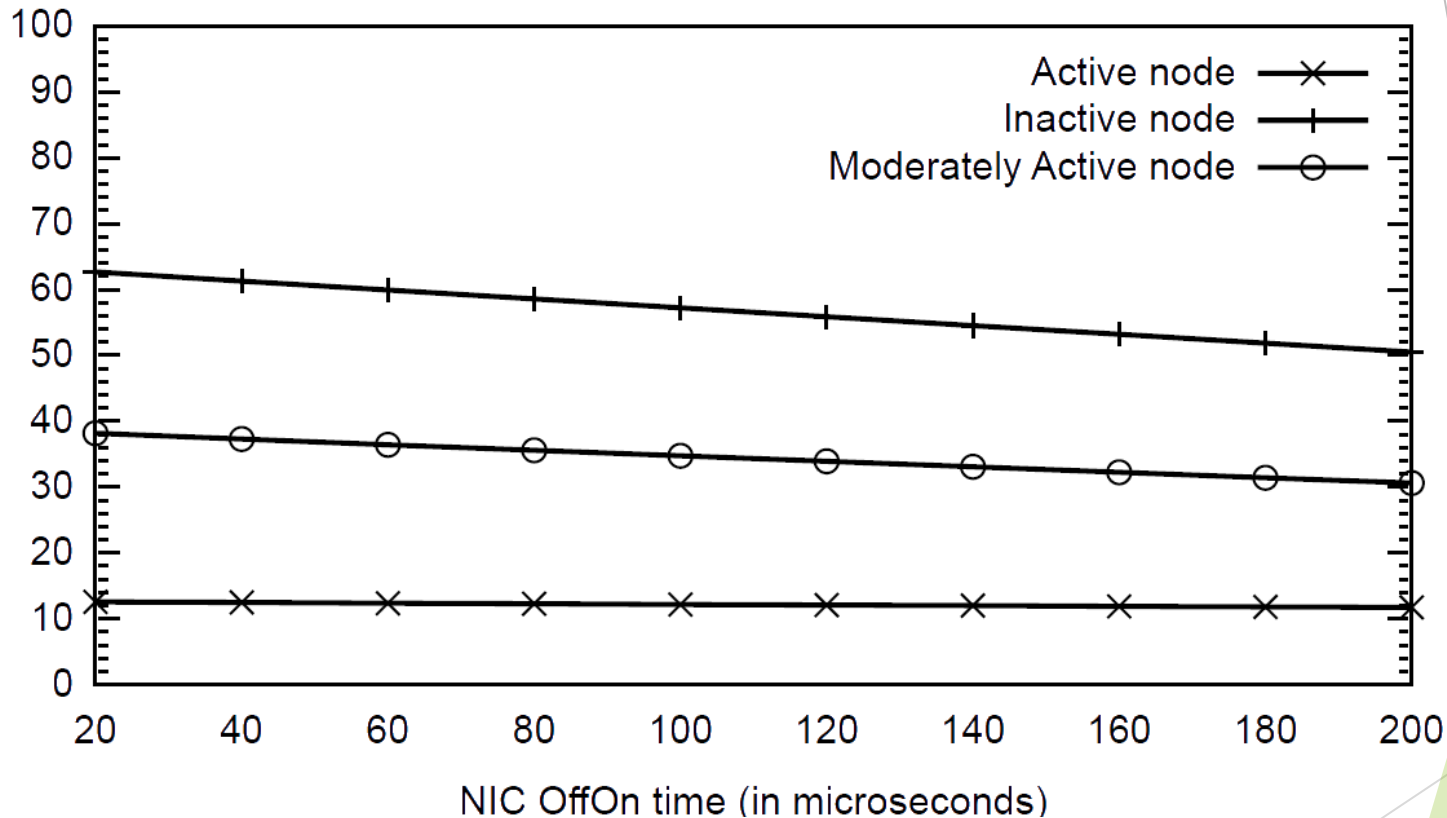
Idle time for 802.11ac



The percentage of time saved by Übersleep is independent of NIC off/on time since the packets are so long that Übersleep can activate on all the packets irrespective of the NIC off/on time

Power saving for 802.11ac

Rx Power Saving for 802.11ac



The percentage of power saved by Übersleep decreases linearly with NIC off/on time since Übersleep activates on all packets

Conclusion

- ▶ Übersleep saves power by identifying whether the received packet was destined for the receiving station or not.
- ▶ Stations can then ignore the packets in the channel not destined for them
- ▶ Although switching the STA on or off consumes power, Übersleep can effectively save power for STA's with NIC off/on time and power in an appropriate range.
- ▶ The power saving results can be extrapolated for 802.11ac cards from the 802.11n results that we achieved.

Thank You

Please send feedback to:
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