# WiFi-Nano: Reclaiming WiFi Efficiency through 800 ns Slots

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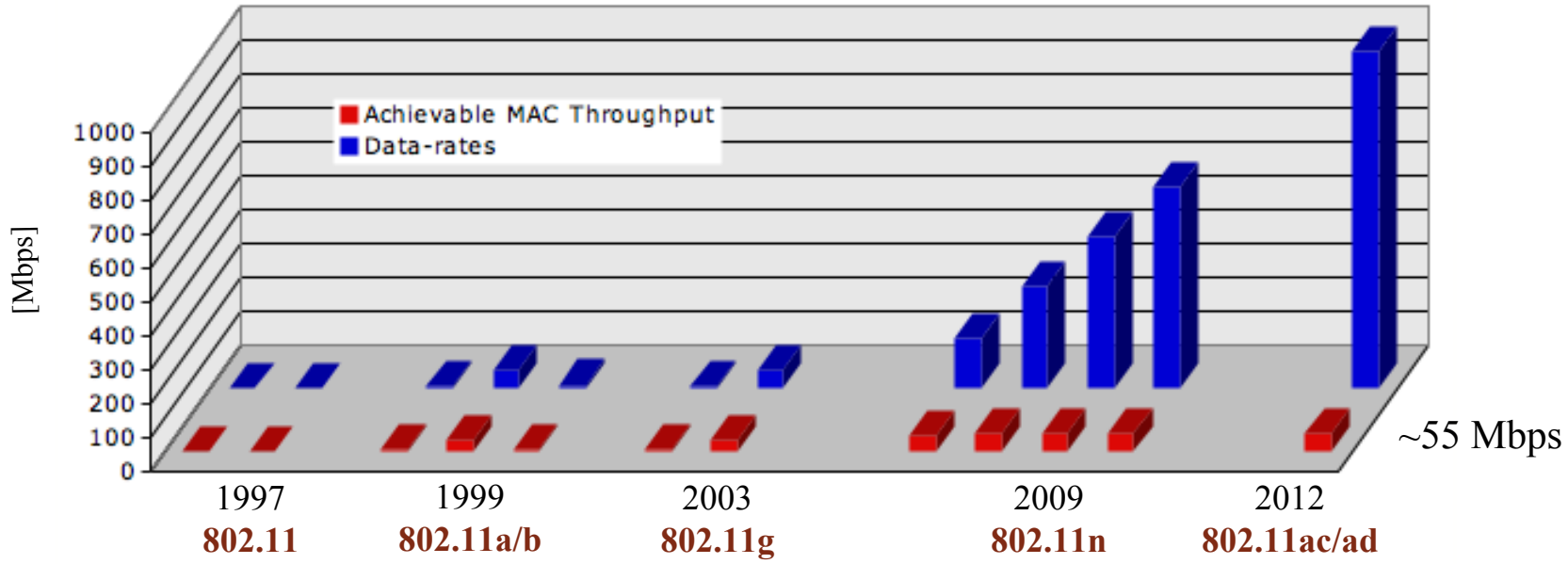
# Problem Overview

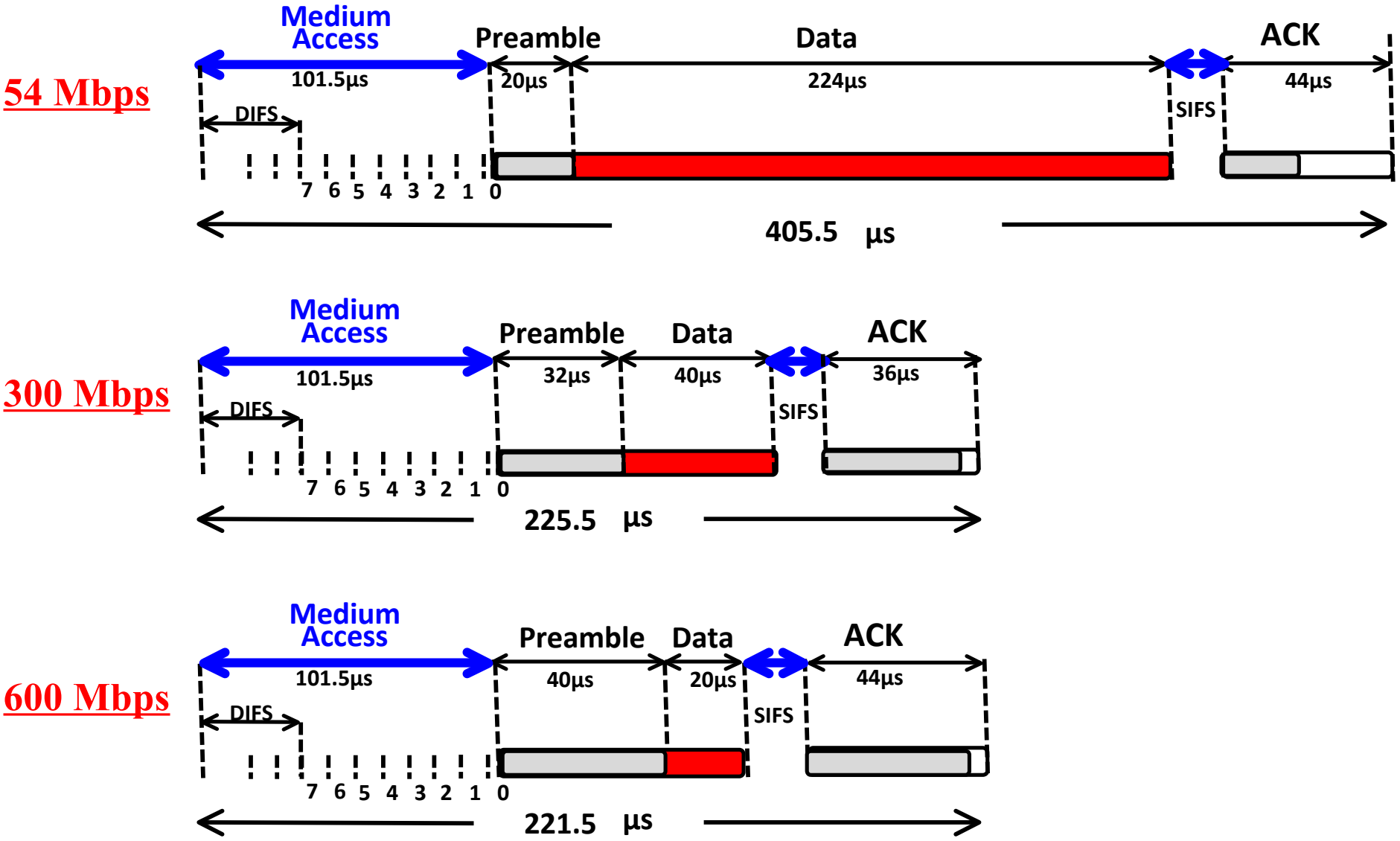



- 802.11 **data-rates** have increased from 1 Mbps to 1 Gbps
- *Throughput* ***performance*** *has not seen a commensurate increase*

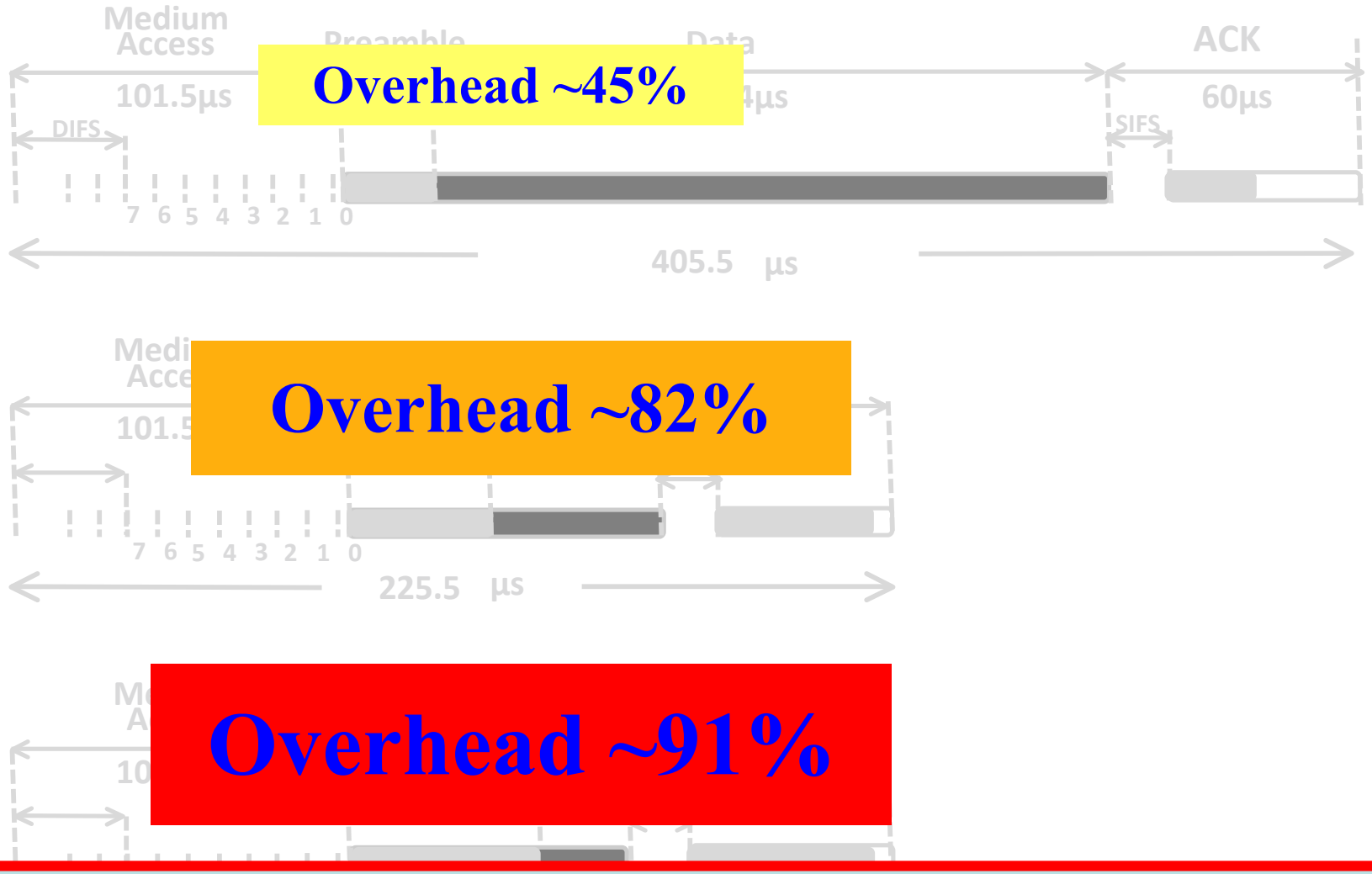
# Contribution

WiFi-Nano increases 802.11 throughput up to 100%

# Why Throughput << Data-rate?



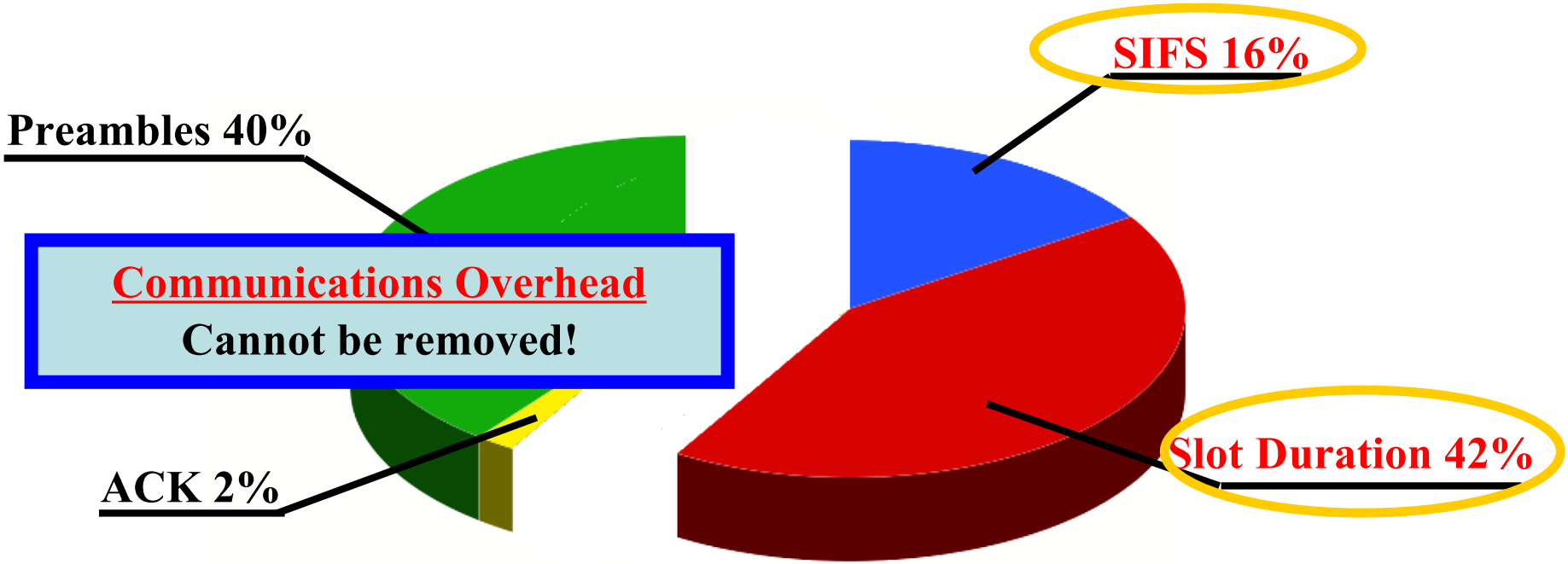
# Why Throughput << Data-rate?



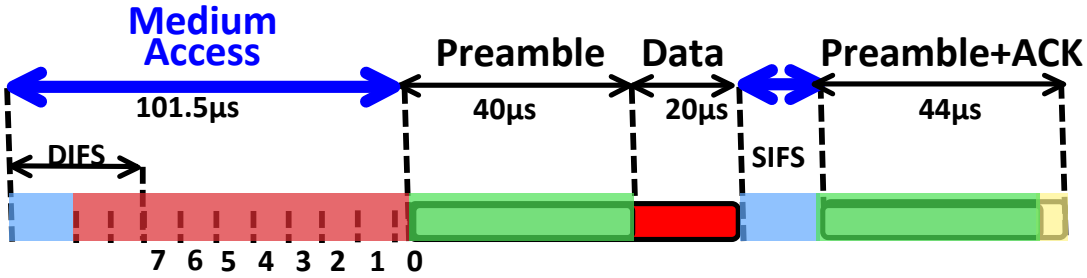

802.11 overhead does not scale with data-rate

# Motivation

## Overhead Components

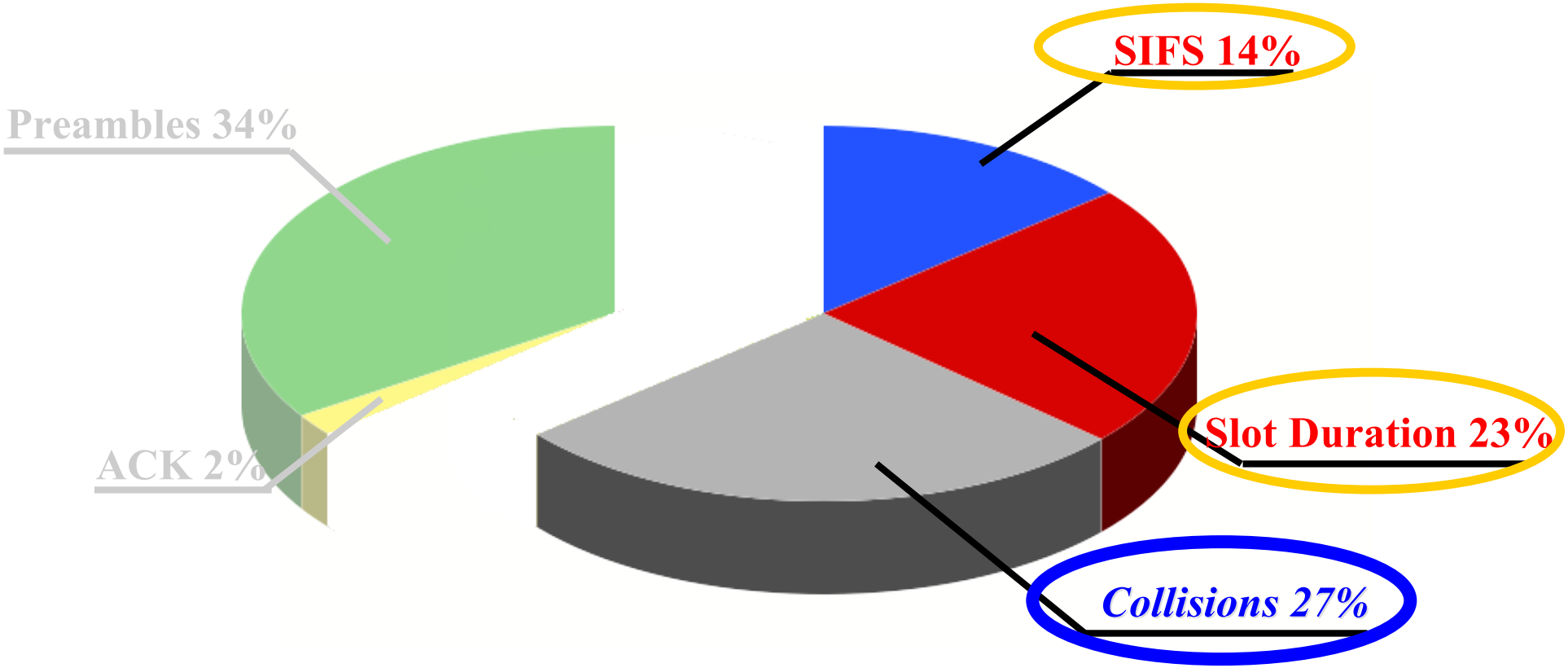



## Single Link Case



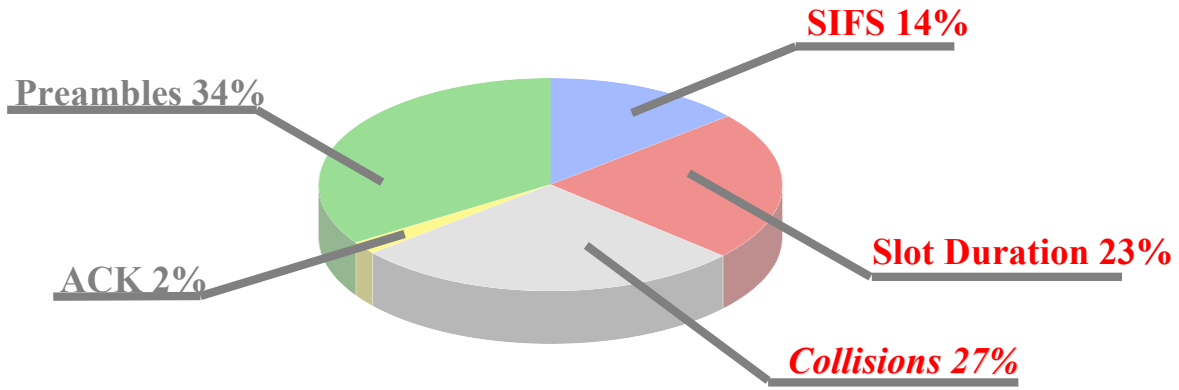
# Motivation

## Overhead Components




Multiple Links Case (30)

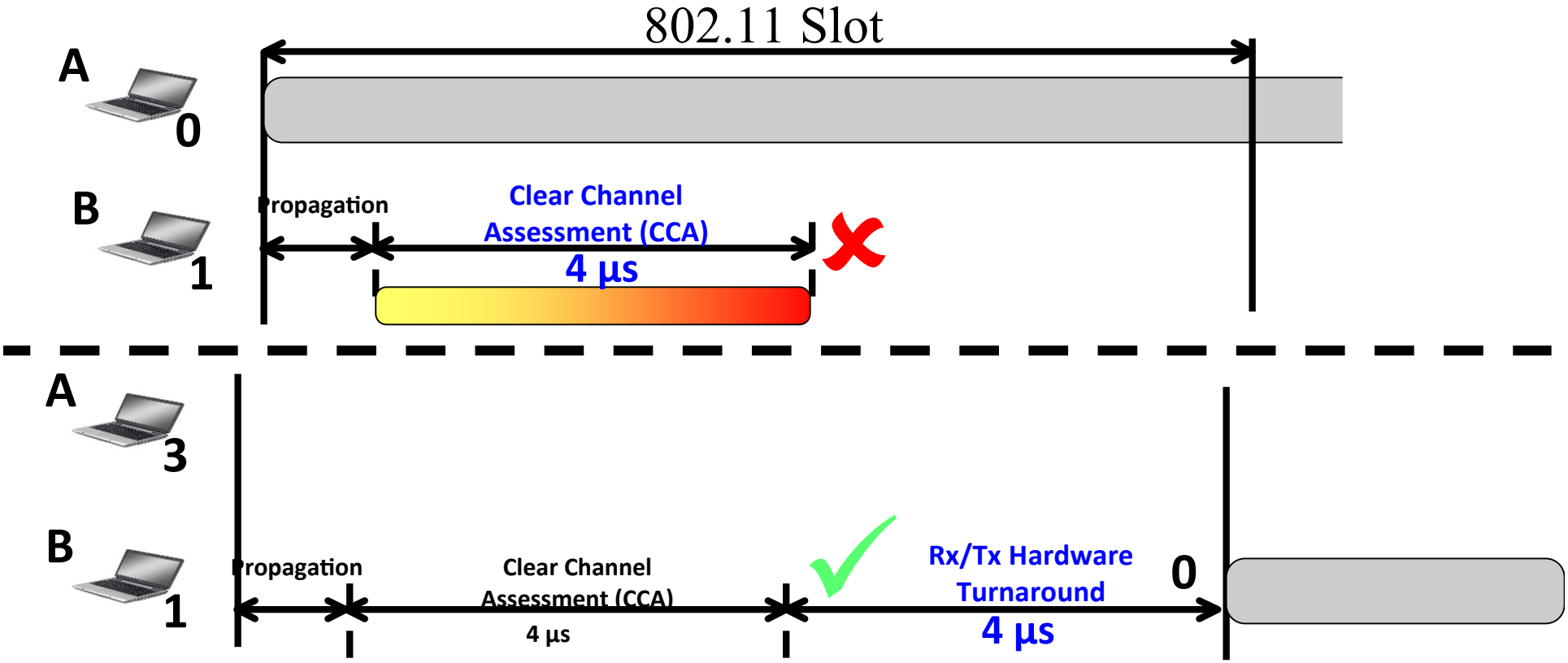
# Objective




- Reduce **slot duration**
  - and reduce the occurrence of **collisions**
  - … while preserving fairness
- Remove **SIFS**

# Challenge: Slot Duration

- 802.11a/n slot duration of **9 µs** is *close to the* ***minimum feasible***




Key assumption:

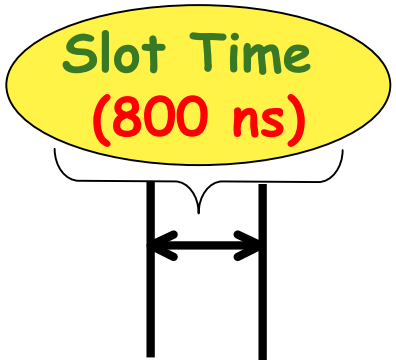
**Preamble detection and transmission are serial**

# Speculative Preambles

**Preamble detection and transmission occur in parallel**

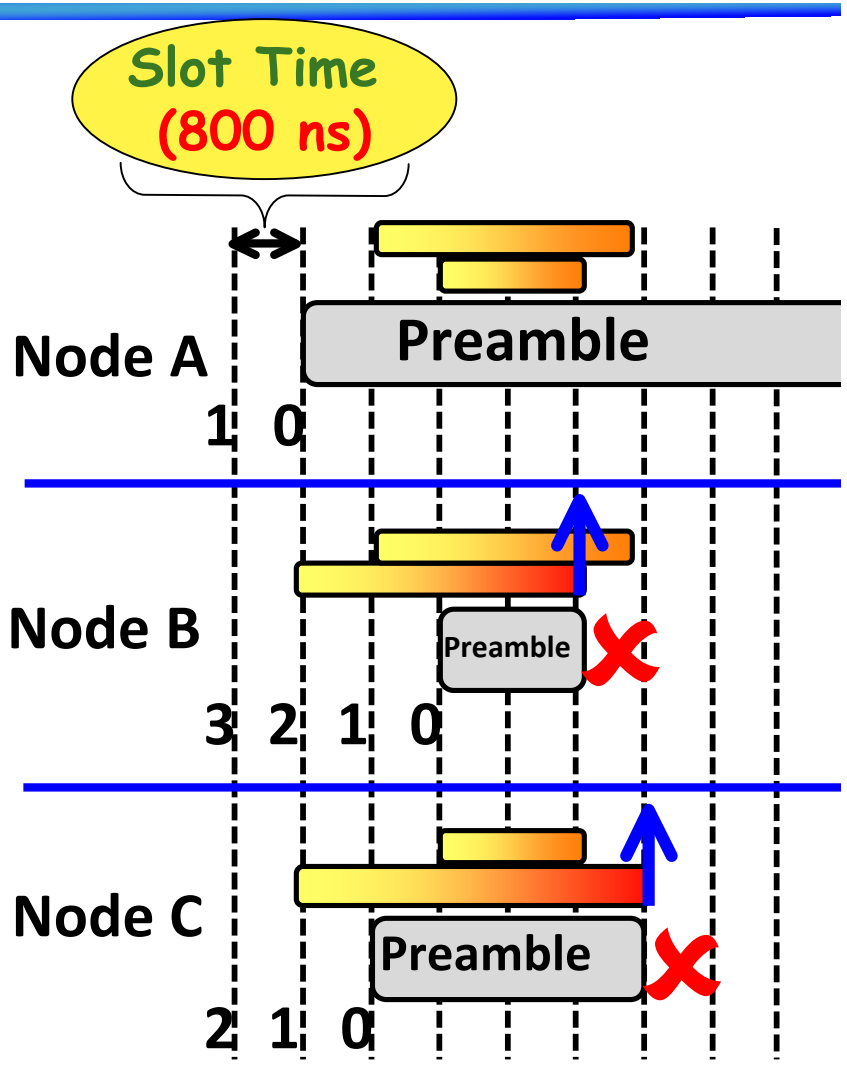
*Clear Channel Assessment may take multiple slots*

**The slot time can be reduced to a round-trip propagation delay**



# Speculative Preambles

1. As soon as the backoff expires, a node transmits its preamble
2. CCA: A node transmitting a preamble continues to attempt to detect incoming preambles
3. A node aborts its transmission if it detects a preceding preamble




Medium Access time decreases from 101.5 µs to 7.6 µs

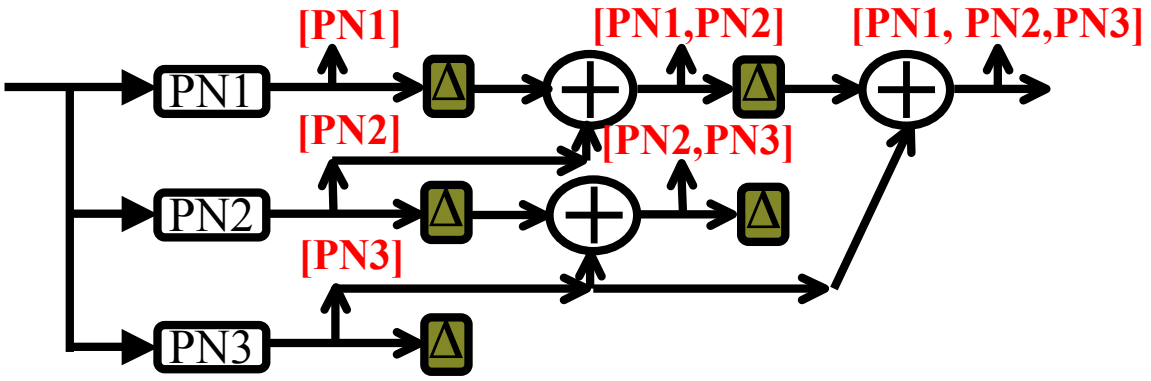
# WiFi-Nano Design

| Objectives | Techniques |
| --- | --- |
| ✓ Slot Time Duration | Speculative Preambles |
| Collisions | Probabilistic Collision Resolution |
| Fairness | Counter Roll-back |
| | Minimum Slot Size |
| SIFS | Speculative ACKs |

# Implementation

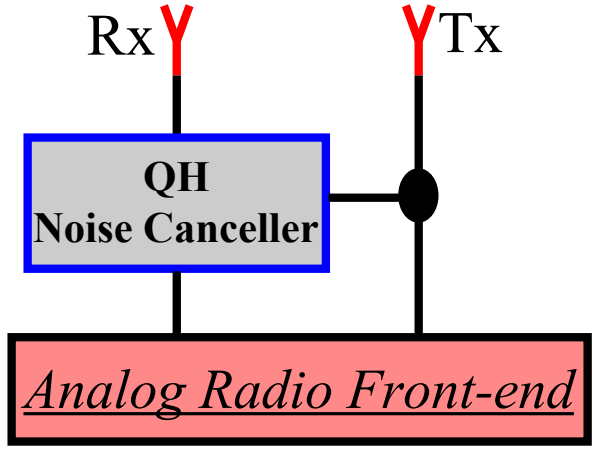
- Detect preambles and their starting time **under interference**

**Lattice Correlator**




- **Simultaneously transmit and detect preambles**

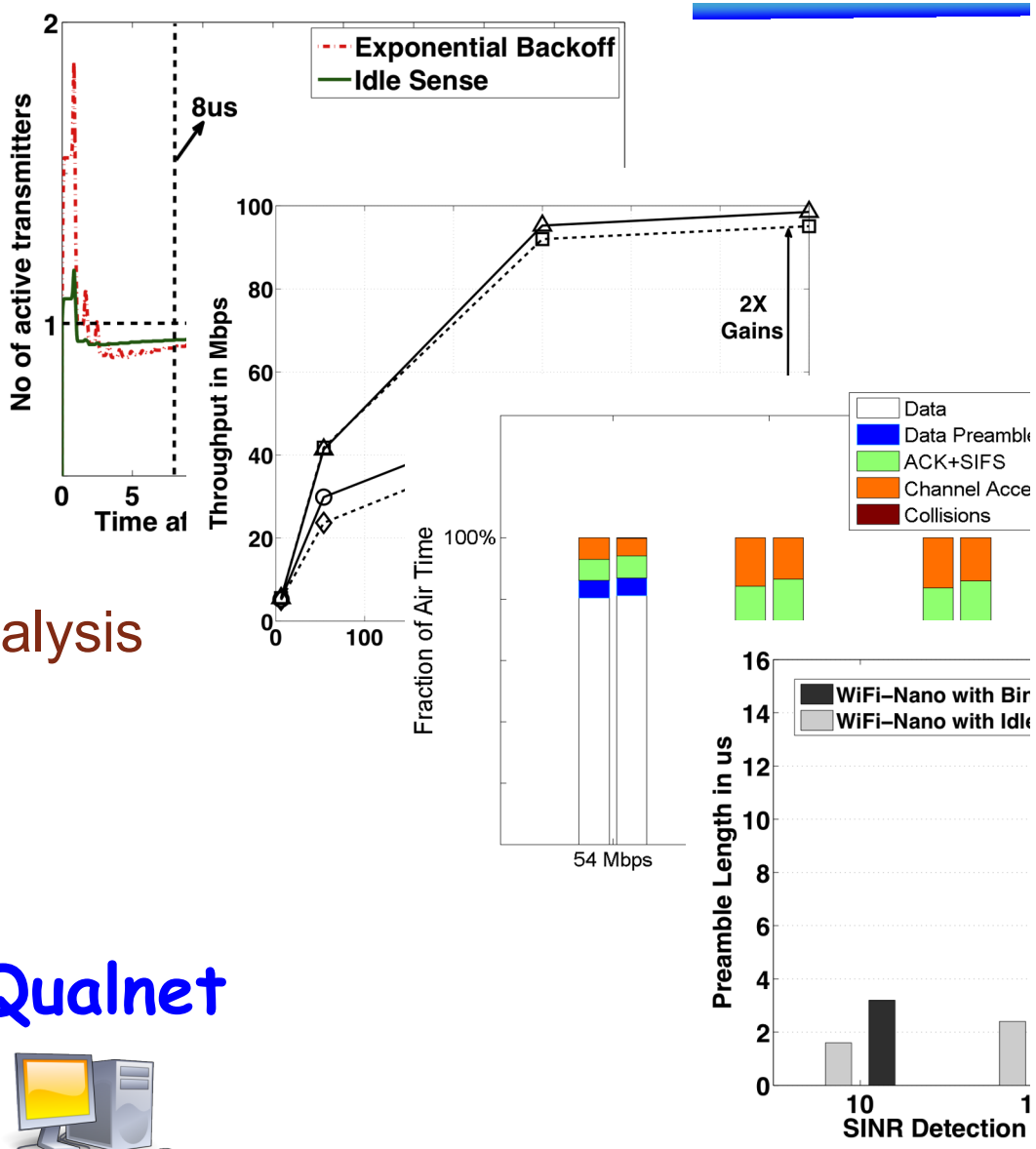
**Analog Self-Interference Canceller**




- **Interference may require longer preambles**

# Results

- **Experiments**
  - Reliability of Preamble Detection
  - Efficiency Gain and Analysis
  - Fairness

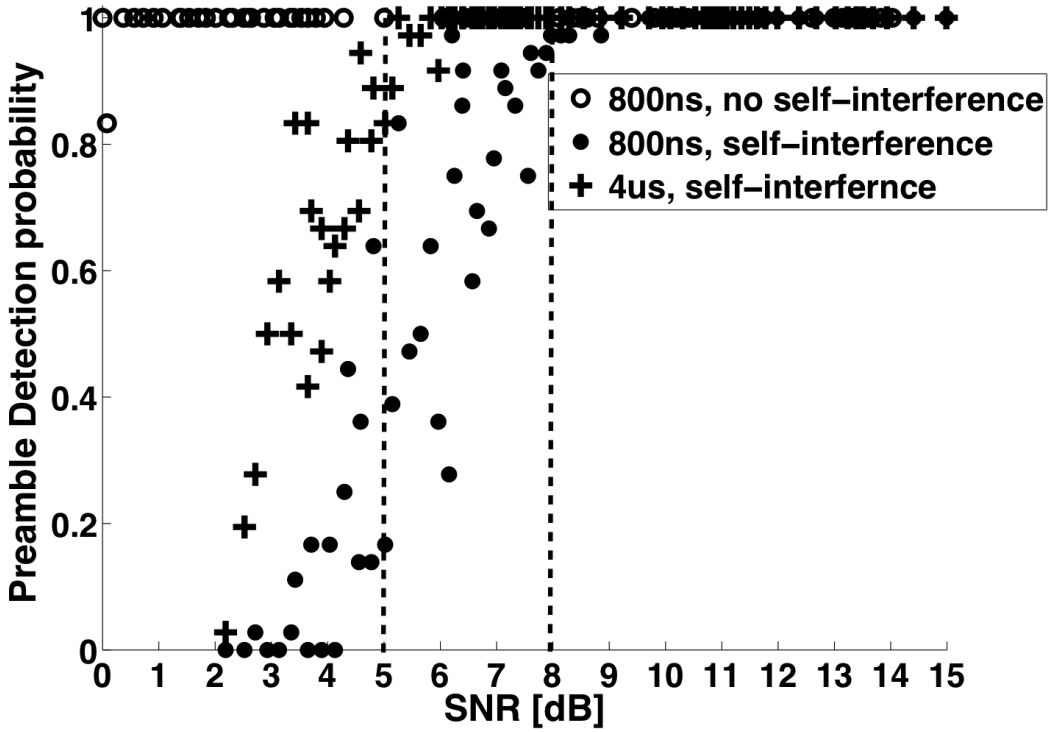



Lyrtech

Qualnet

# Preamble Detection

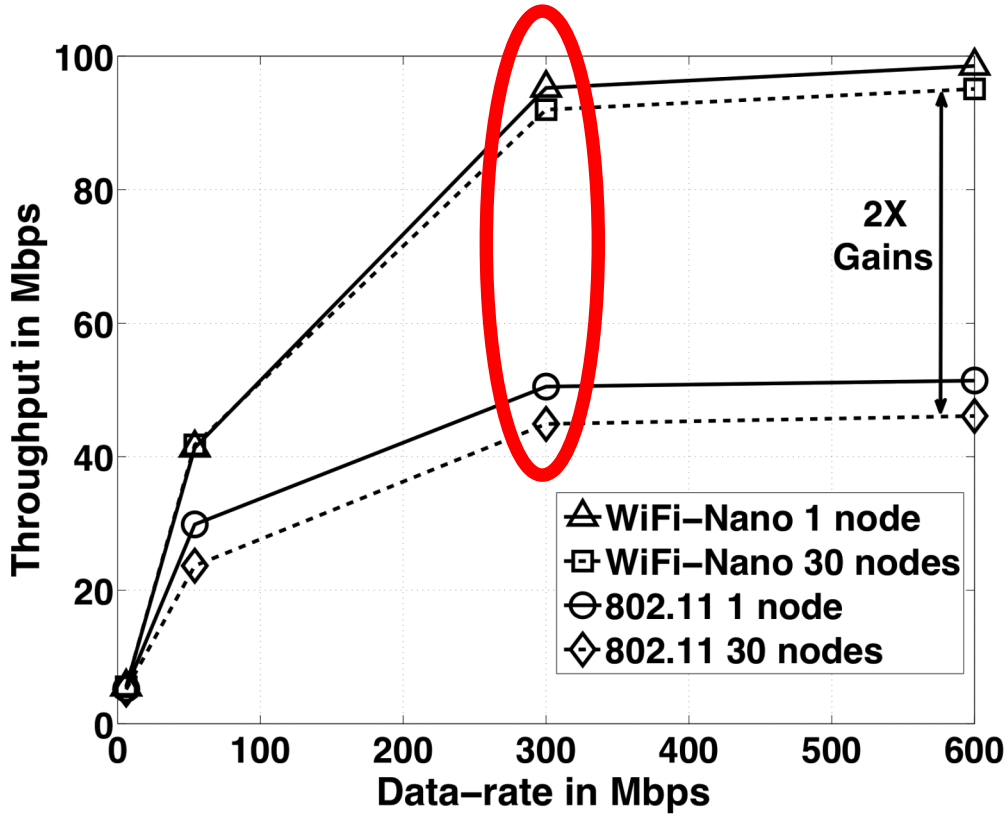
*Can nodes reliably detect preambles despite self-interference?*




***Slightly longer preambles permit to maintain reliability***

# Efficiency

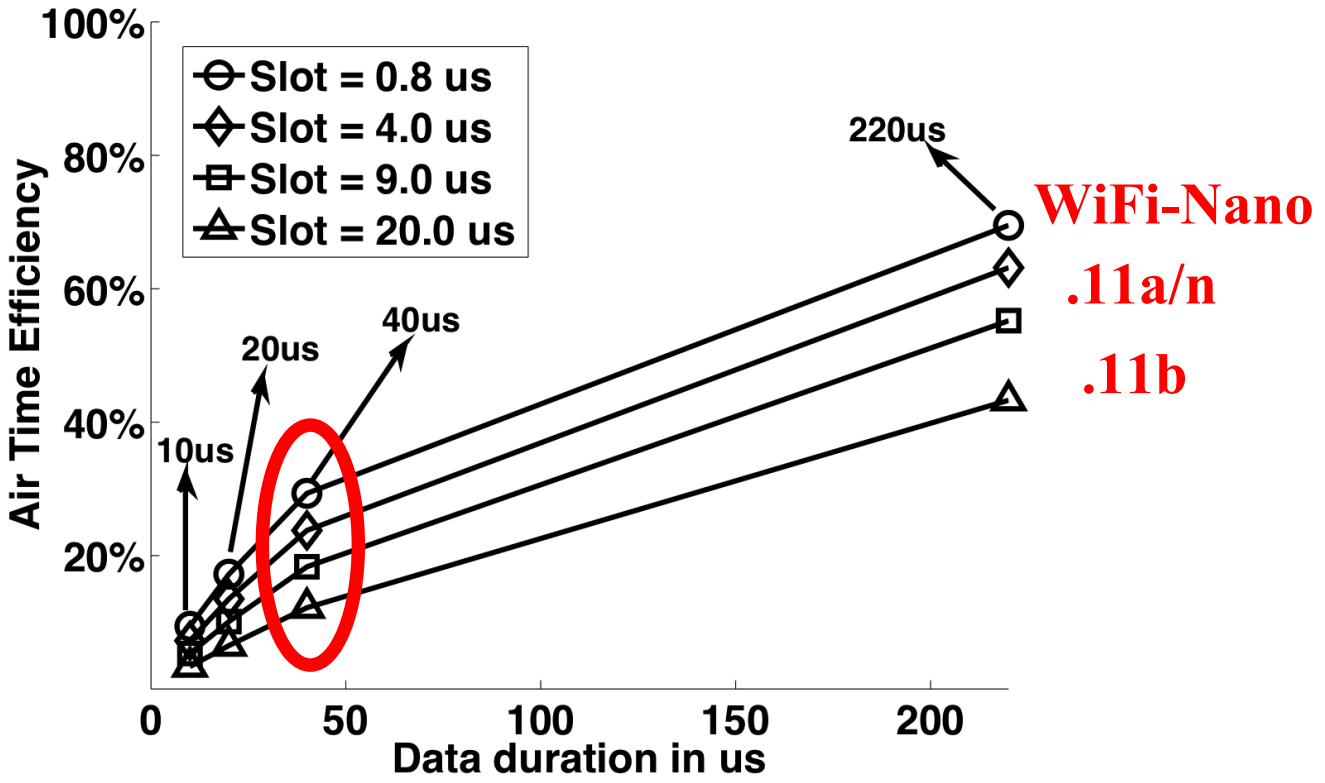
Efficiency f(data rate, #nodes)




*WiFi-Nano increases the throughput up to 100%*

# Efficiency

Efficiency f(data rate, slot time)




*WiFi-Nano increases the throughput up to 100%*

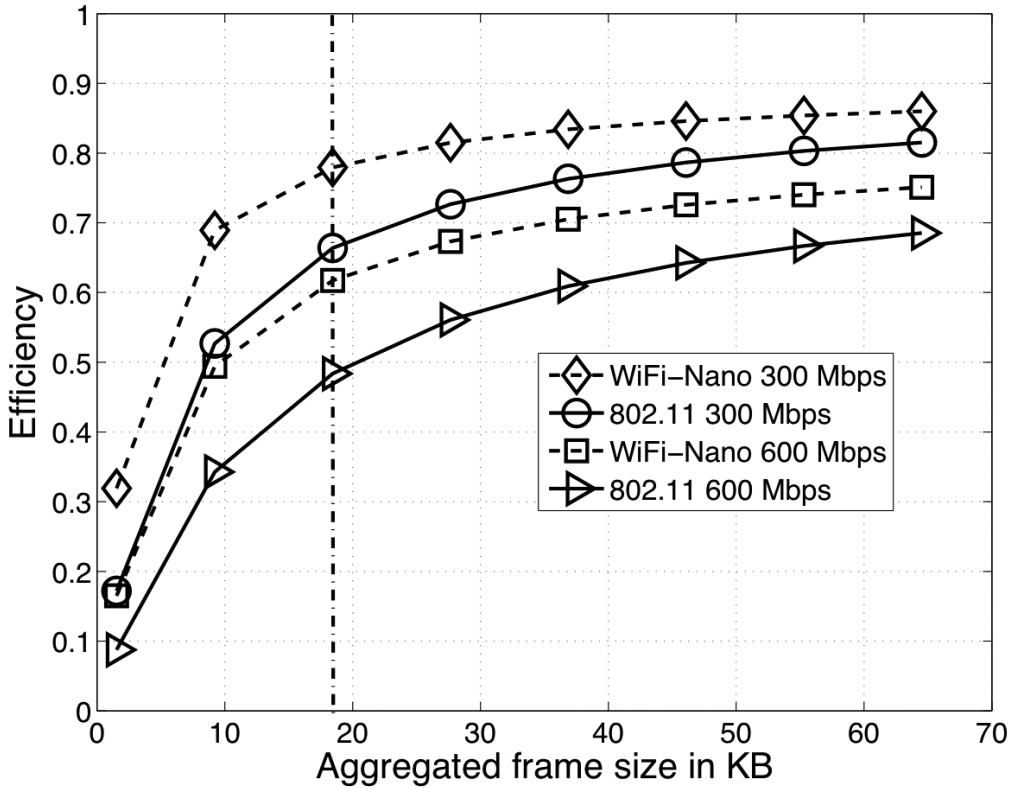
# How to Achieve More?

## Frame Aggregation

- Works only for single-link bulk downloads
- **Practically difficult to achieve**
  - Small packets (TPC ACKs)
  - Short flows (HTTP)
  - Delay sensitive applications (TPC, VoIP)

# Frame Aggregation

- **Practically difficult to achieve**
- Related work reports **18 kB** as average aggregation




*At 18 kB, WiFi-Nano gains 25% over 802.11 at 600 Mbps*

# Summary

802.11 overhead can be > 90%

- WiFi-Nano permits to
  - Reduce the **slot time to 800 ns**
  - Reduce the occurrence of **collisions to nearly 0**
  - **Remove SIFS**

WiFi-Nano increases 802.11 throughput up to 100%

# *WiFi-Nano: Reclaiming WiFi Efficiency through 800 ns Slots*

# Q&A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