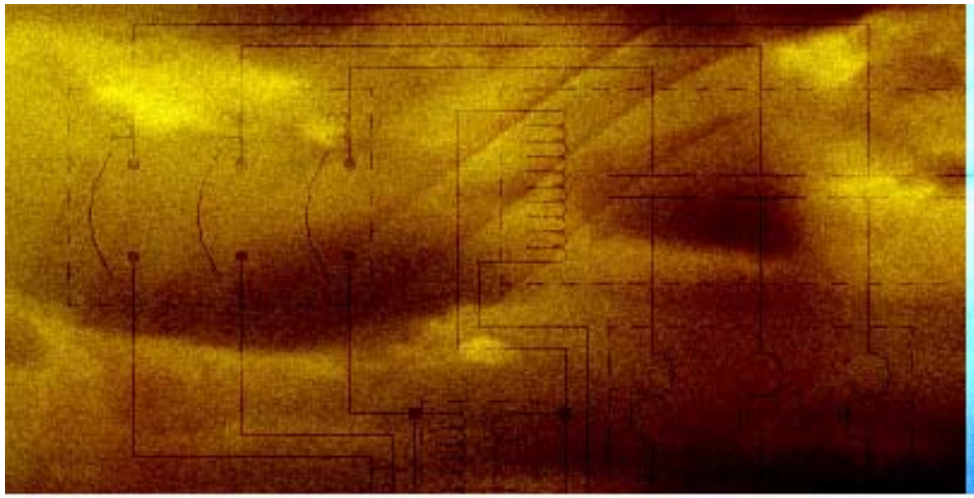


PMAC: An adaptive energy-efficient MAC protocol for wireless sensor network

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Outline

- Introduction
- PMAC
  - Pattern generation
  - Pattern exchange
  - Schedule generation
- Qualitative discussion
- Experimental results
- Conclusion

Introduction

- PMAC
  - Use bit strings ex.001
  - Adaptively determines the sleep-wake up schedules for a node based on its own traffic and that of its neighbors
  - To achieve a more power savings under light loads, and higher throughput under heavy traffic loads

PMAC

- Comparison

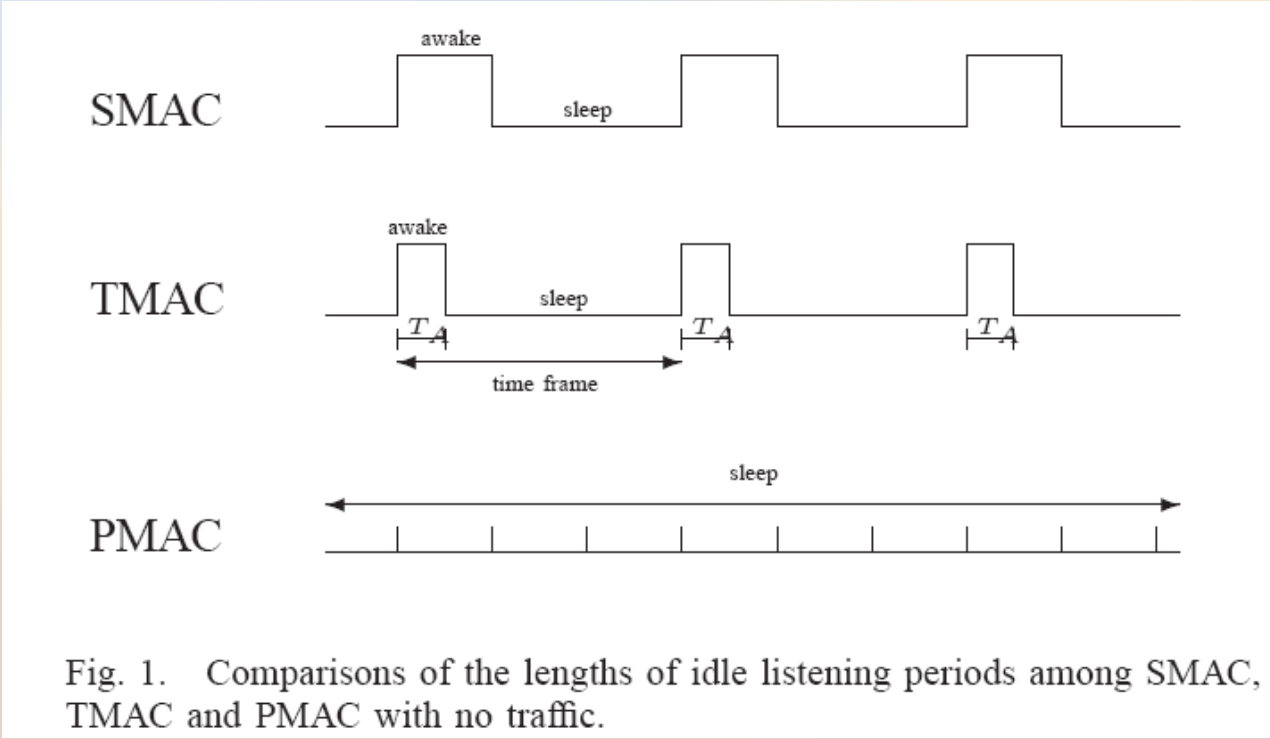


Fig. 1. Comparisons of the lengths of idle listening periods among SMAC, TMAC and PMAC with no traffic.

PMAC

- Pattern vs. Schedule
  - Sleep-wakeup pattern
    - A string of bits indicating the tentative plan
  - Sleep-wakeup schedule
    - A string of bits indicating the actual plan
    - Derived from its own pattern and, the patterns of its neighboring nodes

PMAC

- Pattern generation

  $P_{i,n}^{j}$

  – *j: node j*

  – *i: i_{th} period*

  – *n: n_{th} new pattern*

PMAC

- example

$$1\,1\,1\,1\,1\,1$$

$$P^j_{1,0} = P^j_1 = 1 \quad P^j_{1,1} = 01 \quad P^j_{1,2} = 001 \quad \cdots\cdots$$

threshold

$$1, \quad 01, \quad 0^2\,1, \quad 0^4\,1, \quad \cdots \quad 0^{\delta}\,1, \quad 0^{\delta}\,01,$$
$$0^{\delta}\,0^2\,1, \quad 0^{\delta}\,0^3\,1, \quad \cdots \quad 0^{N-1}\,1.$$

PMAC

- Pattern exchange
  - STF (super time frames)
    - PRTF (Pattern Repeat Time Frame)
    - PETF (Pattern Exchange time Frame)

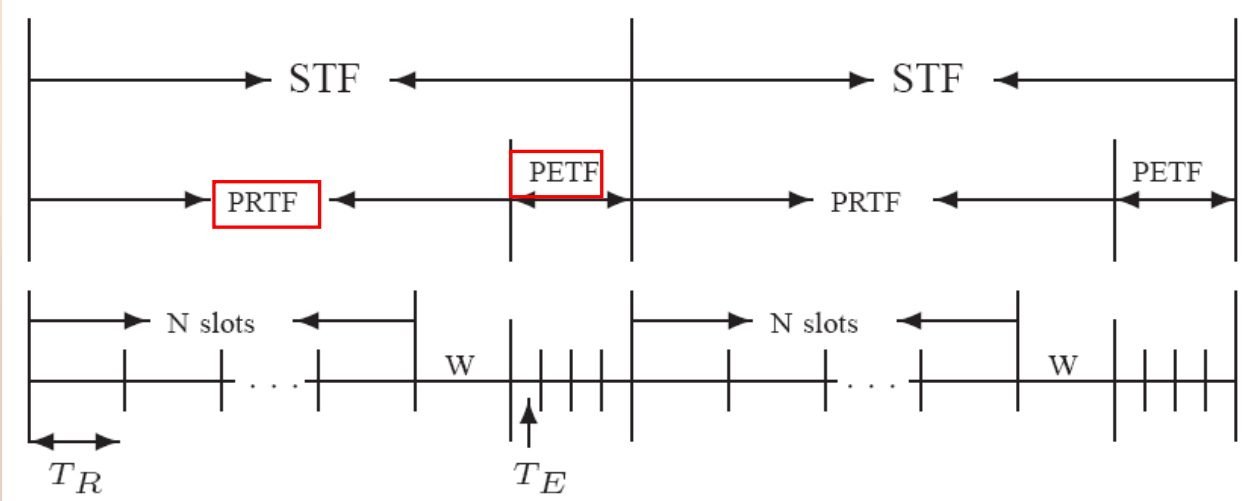


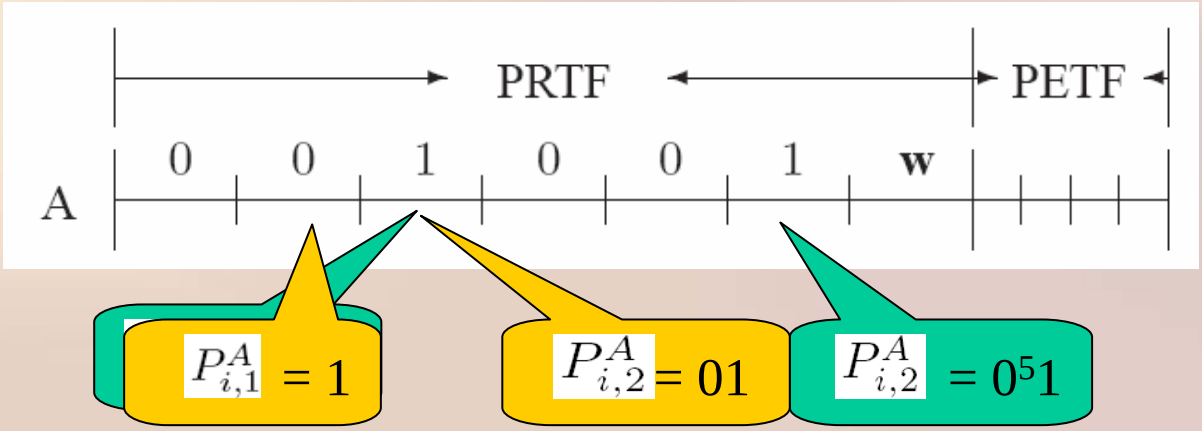
Fig. 2. Division of Time Frames

PMAC

- T_R = CW + RTS + CTS + DATA + ACK
- N ↑ ⇒ energy ↓ latency ↑
- Number of time slots in PETF = maximum number of neighbors a node could have
- T_E = long enough to broadcast a pattern

PMAC

- Example
  - δ = 4
  - N = 6
  - $P_{i,0}^{A}$ = 001



PMAC

- Schedule generation
  - 1- : wake up for a period of time

RULES TO SET THE SCHEDULE BIT FOR A SLOT IN PRTF FOR NODE j

Pattern bit at node j	Packet to send	Pattern bit at the receiving node	Schedule at node j
1	1	1	1
1	1	0	1–
1	0	*	1–
0	1	1	1
0	1	0	0
0	0	*	0

Qualitative discussion

- Adaptability to traffic conditions
- Power savings through localization
- Power savings through reduced idle listening
- Time synchronization
  - SYNC

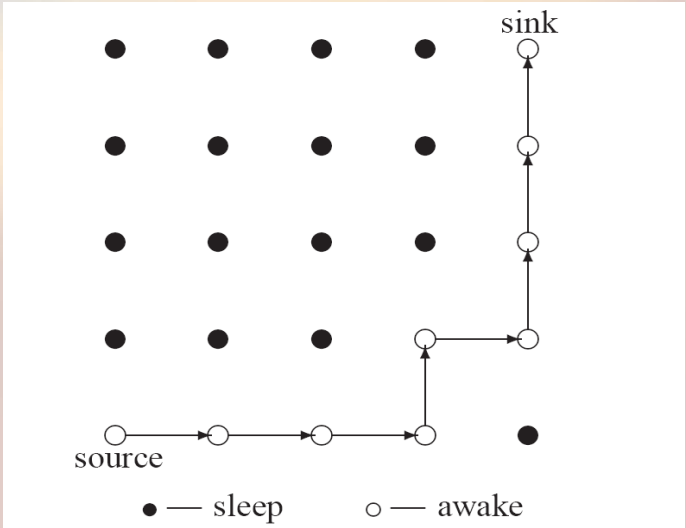


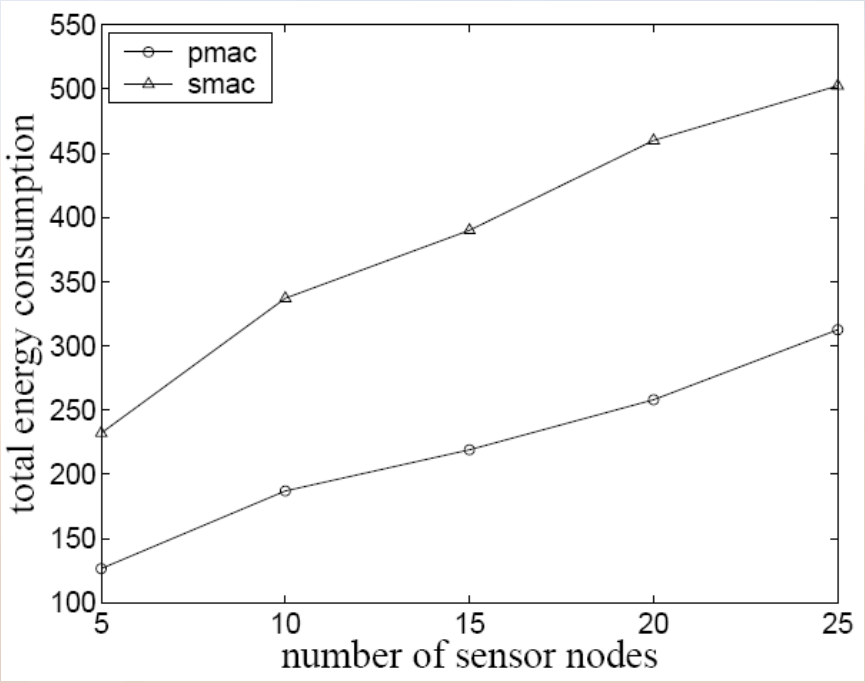
Fig. 4. Illustration of Power Saving Through Localization

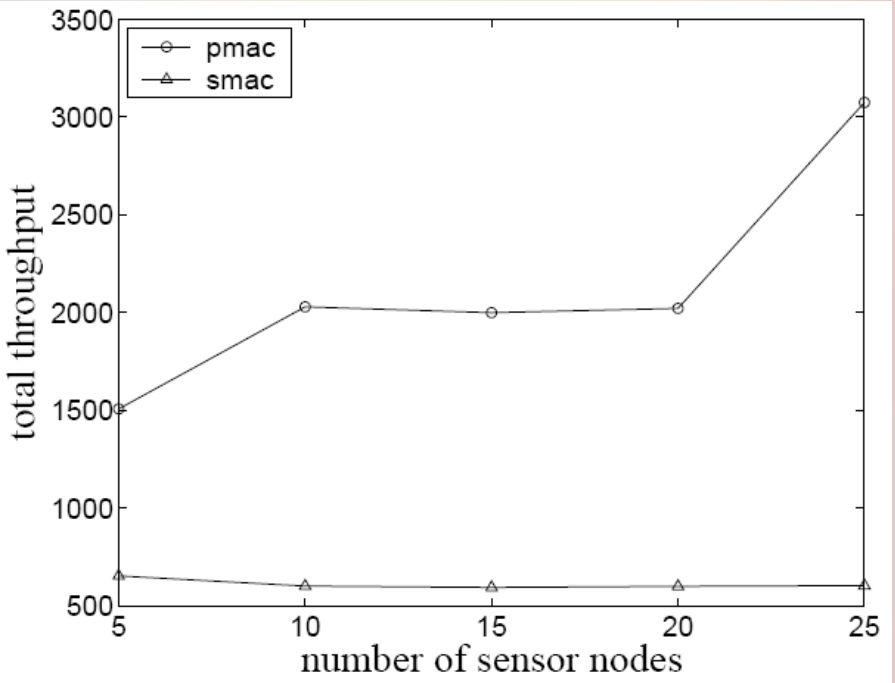
Experimental results

- Simulator: NS2
- Simulation time = 1500 seconds
- T_R = 258 ms
- T_E = 104 ms
- #Time slots in PRTF = 64
- #Time slots in PETF = 4
- $$\text{power efficiency} = \frac{\text{total throughput}}{\text{total energy consumption}}$$

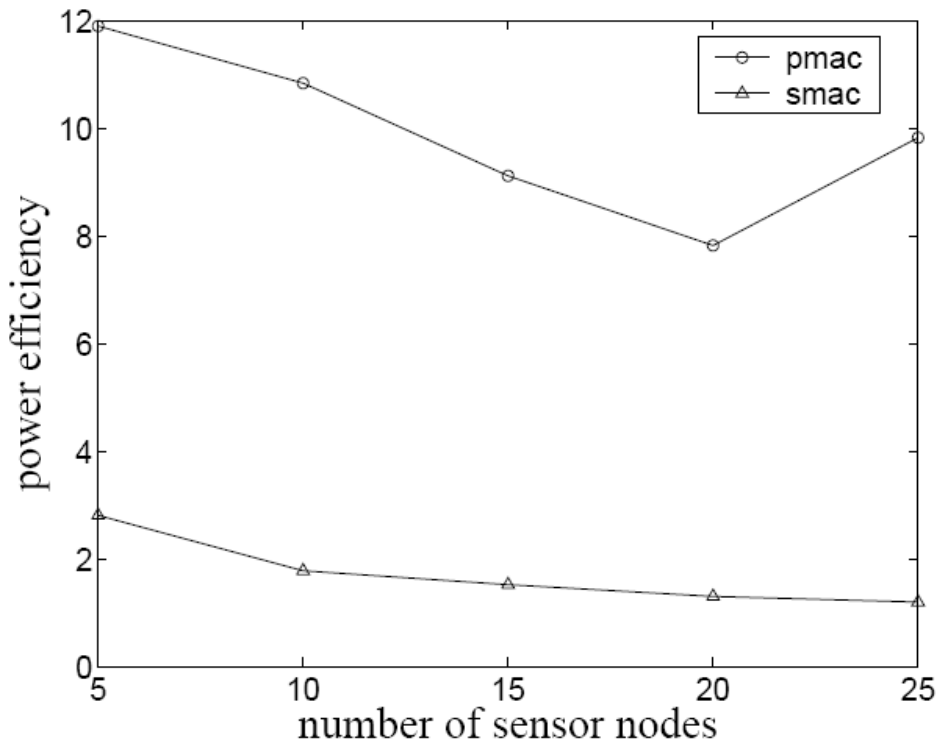
Experimental results

- Under heavy traffic load



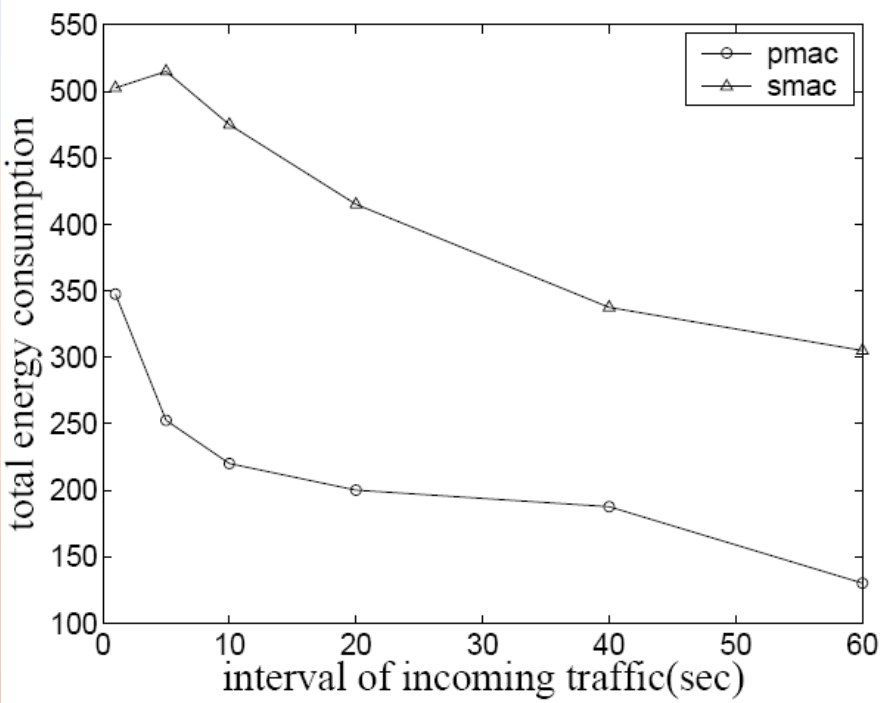


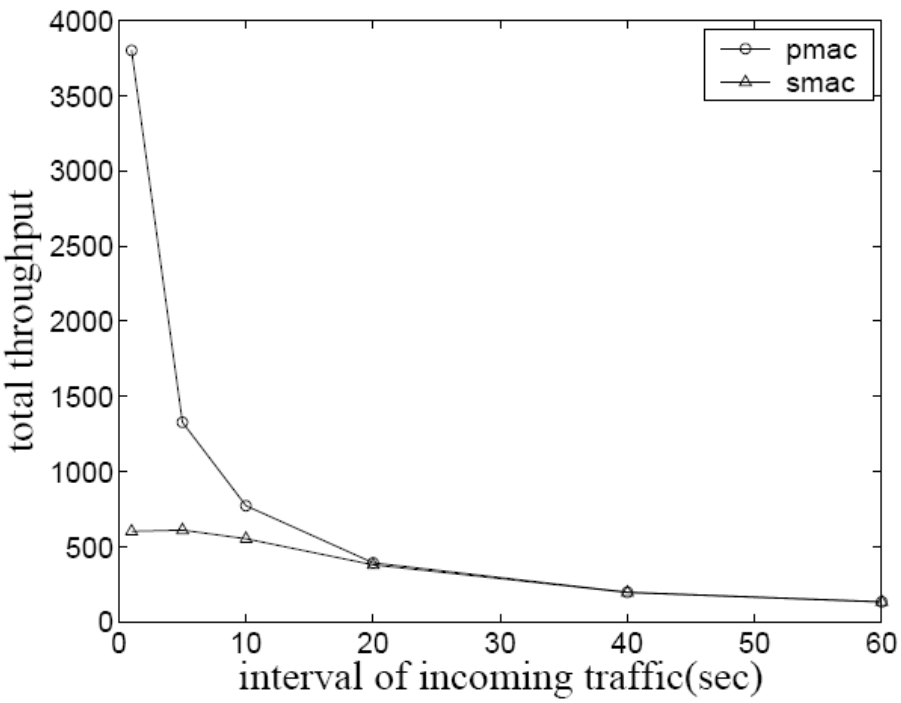
Experimental results



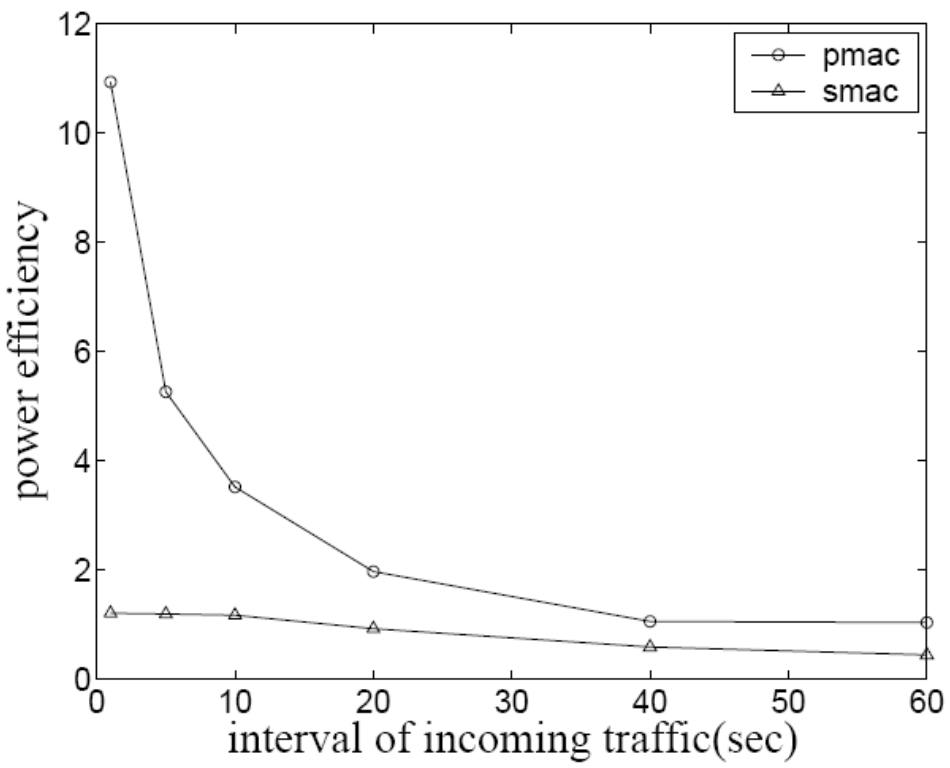
Experimental results

- Under different traffic loads





Experimental results



Conclusion

- PMAC
  - Adapt to traffic conditions
  - To achieve a more power savings under light loads, and higher throughput under heavy traffic loads