Ad hoc routing for multilevel power save protocols

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Outline

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- Related Works
- Proposed Schemes
- Simulations
- Power Balance Extension
- Conclusion

Introduction

- Designing energy-efficient protocols for ad hoc networks is important since there has been little improvement in the amount of energy stored on these devices.

- The previous power save protocols leaving a subset of nodes in a state with high energy consumption and low latency while the rest of the network remains in a power save state.

- In this paper, they propose a link layer protocol to provide k levels(k>2) of power save and a routing protocol to use this link layer effectively.

Related Works

- Common characteristic of all such ad hoc network power save protocols:

Table 1
Energy consumption and latency of bimodal power save states

State	Energy consumption	Latency
Power save	Low	High
No power save (always on)	High	Low

Related Works

- IEEE 802.11 Power Save Mode (PSM)

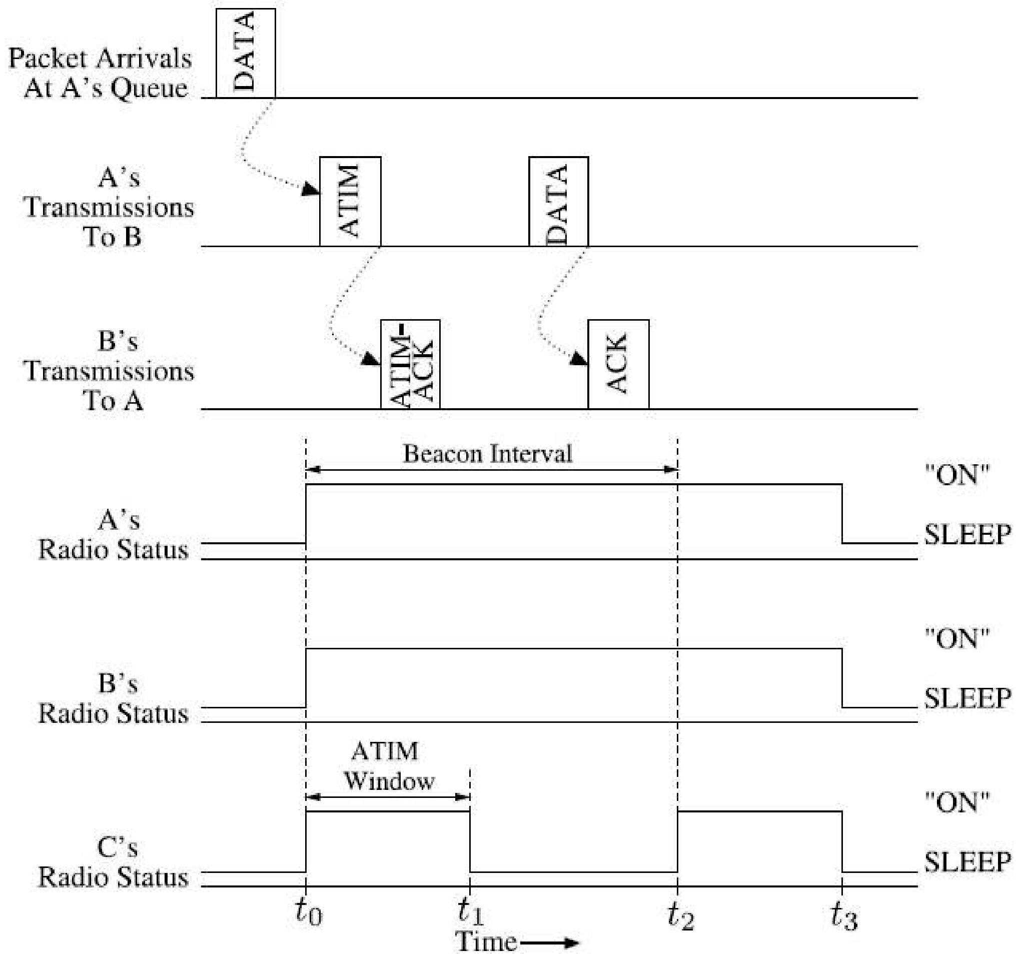
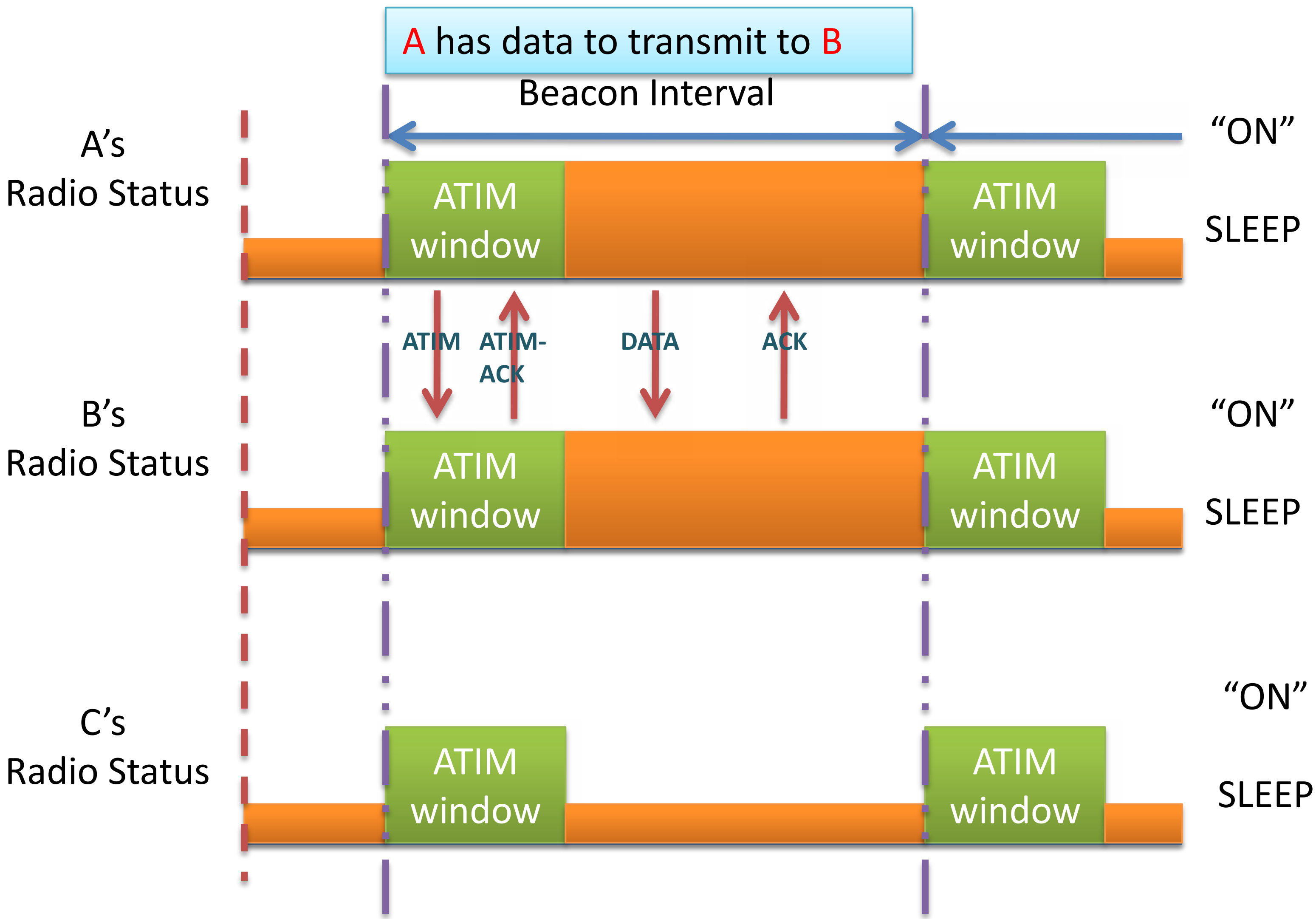


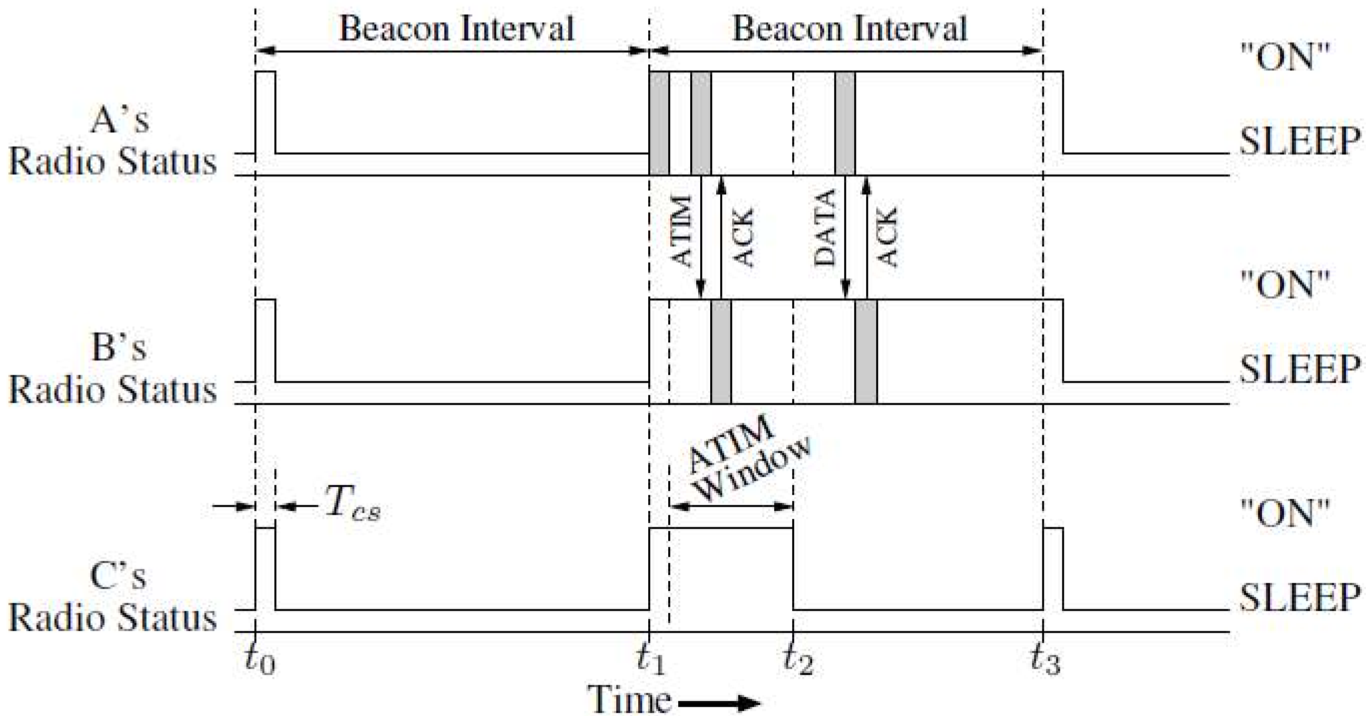
Fig. 1. IEEE 802.11 Power Save Mode (PSM) [9].

Related Works

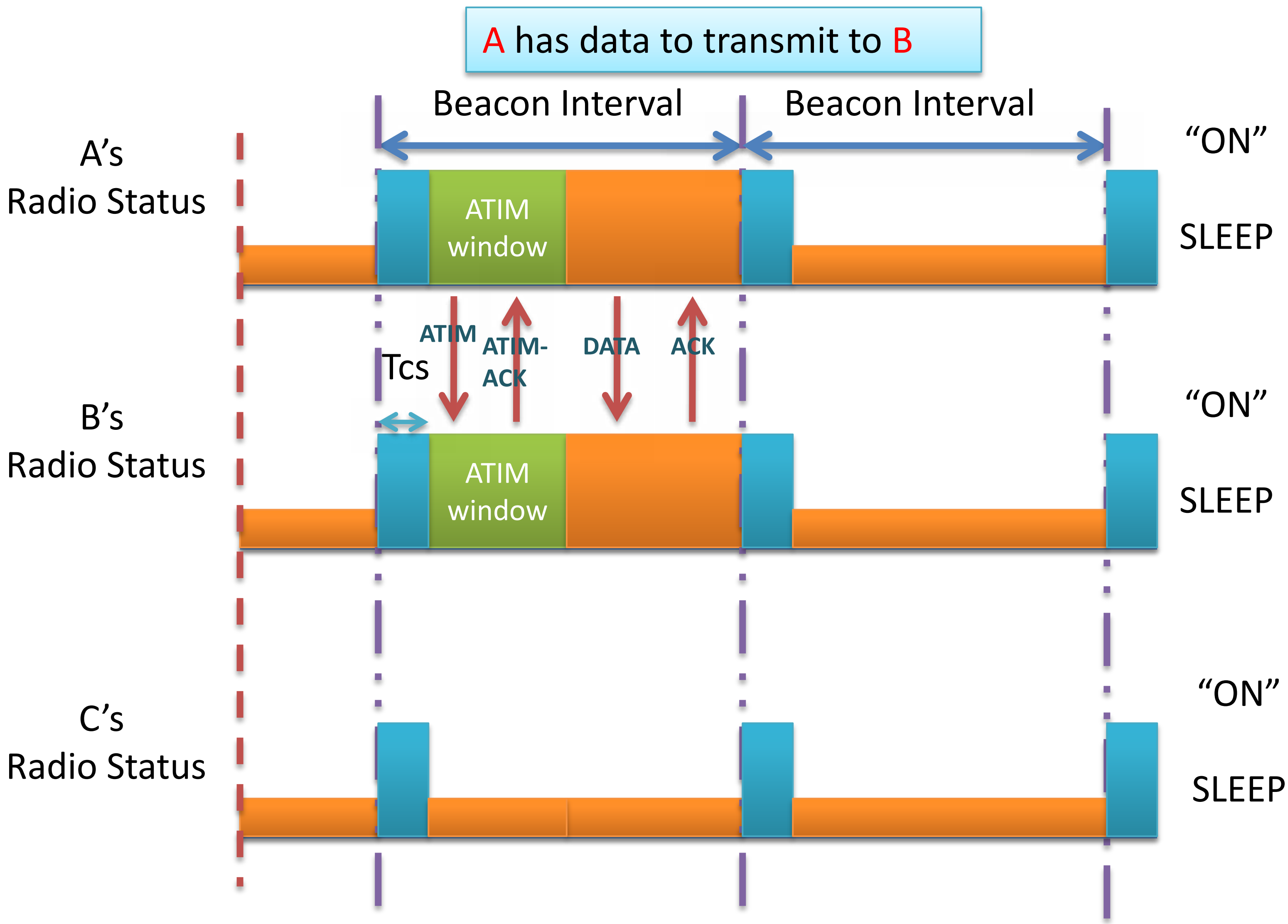


Related Works

- *Carrier Sensing Preceding the ATIM Window* protocol(CS-ATIM)



Related Works



Proposed Schemes

- Multilevel power save concept

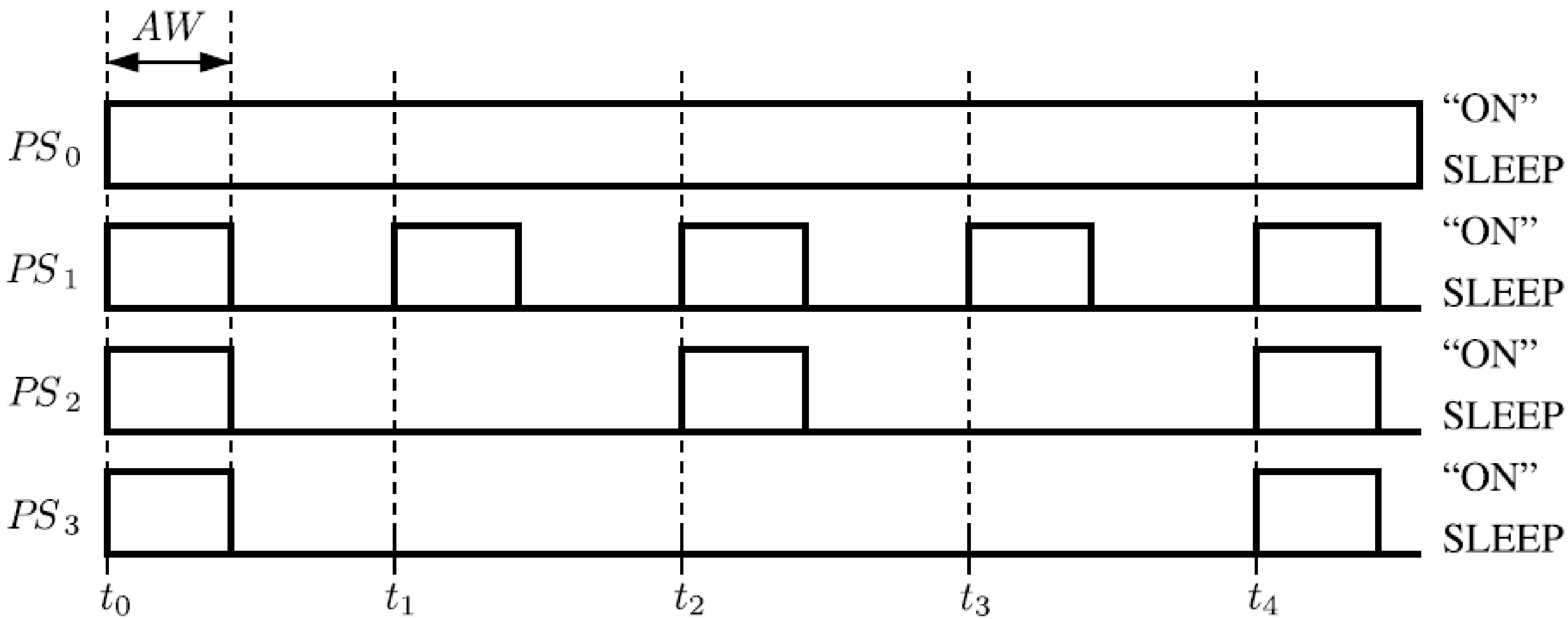
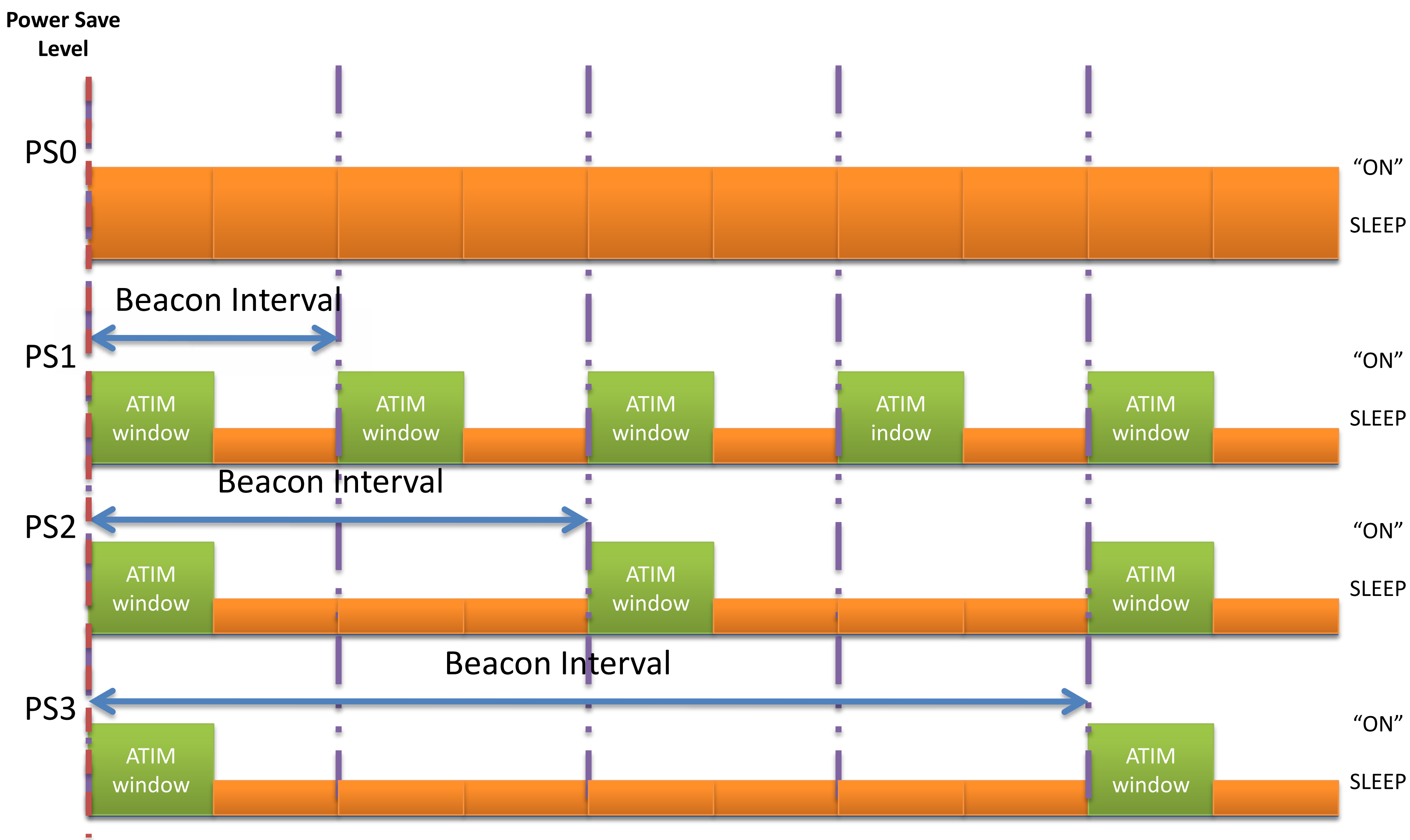


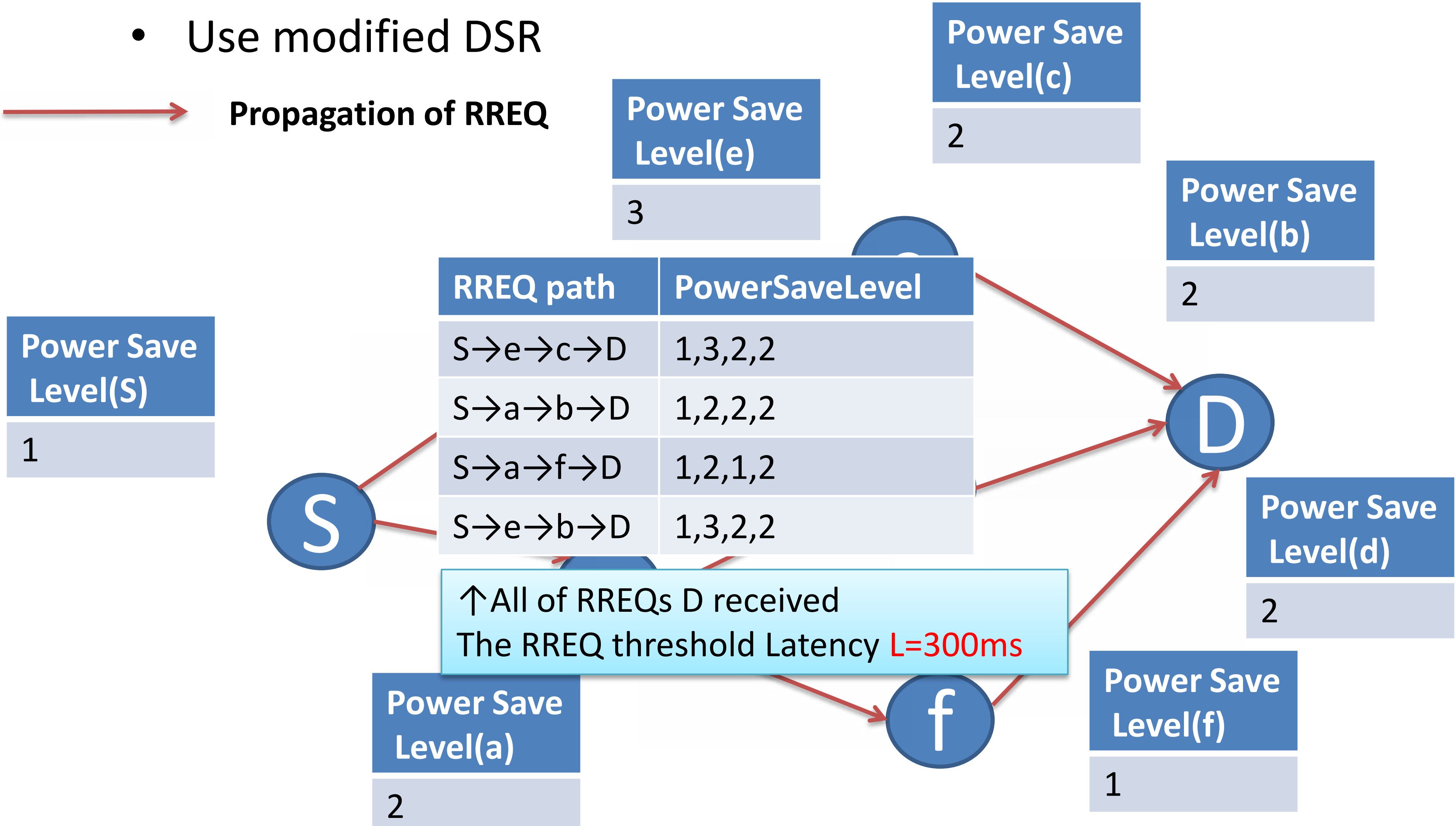
Fig. 2. Multilevel power save with 802.11 PSM [9].

Proposed Schemes



Proposed Schemes

- Multilevel power save
  - Use modified DSR

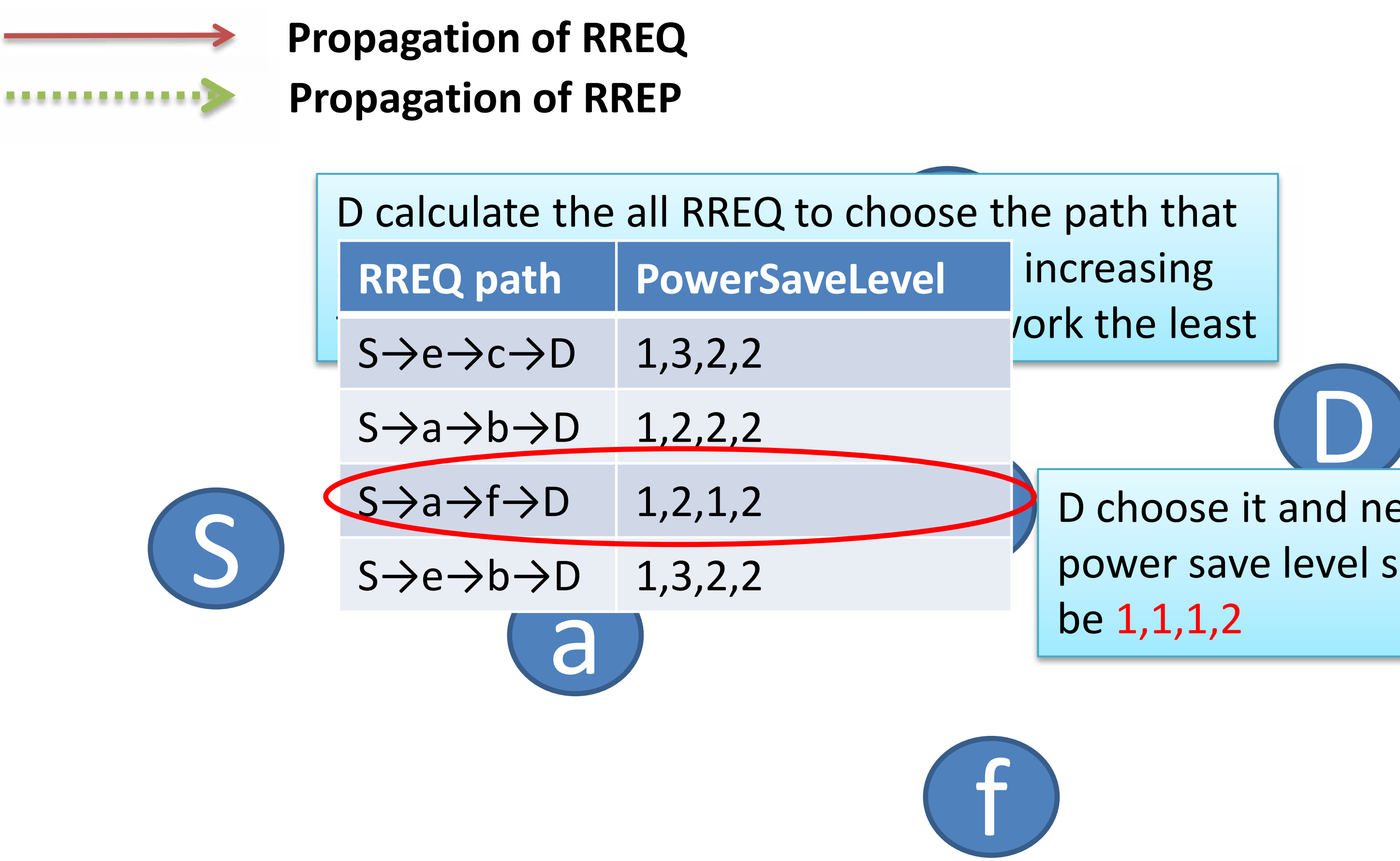


RREQ path	PowerSaveLevel
S→e→c→D	1,3,2,2
S→a→b→D	1,2,2,2
S→a→f→D	1,2,1,2
S→e→b→D	1,3,2,2

↑All of RREQs D received
The RREQ threshold Latency L=300ms

Proposed Schemes

- Multilevel power save



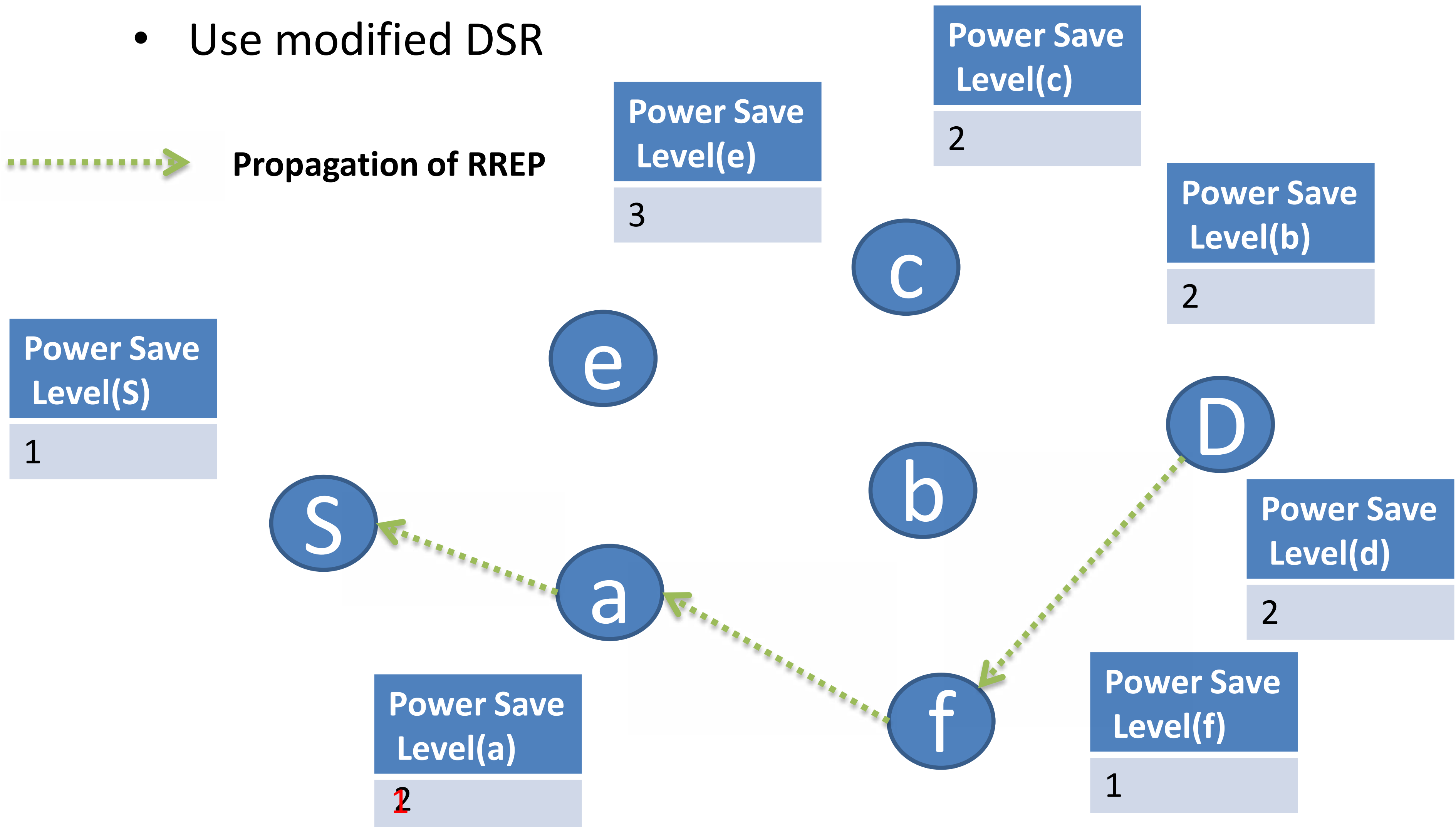
D calculate the all RREQ to choose the path that … increasing … /ork the least

RREQ path	PowerSaveLevel
S→e→c→D	1,3,2,2
S→a→b→D	1,2,2,2
S→a→f→D	1,2,1,2
S→e→b→D	1,3,2,2

D choose it and new power save level should be 1,1,1,2

Proposed Schemes

- Multilevel power save
  - Use modified DSR



Simulations

- NS2 simulator
  - Area:1000m*1000m
  - Node:50 nodes
  - Node moving speed: <40m/s with 75s pause time
  - Five flows randomly chosen source and destination
  - Transmission rate:one 512-byte packet per second using CBR traffic
  - ATIM window :20 ms
  - beacon interval(Bi_{base}): 100 ms
  - Tdelay:500ms

Simulations

Table 2
Standard deviation as percentage of mean for latency figures (Average|Maximum)

	Fig. 7		Fig. 9		Fig. 12	
Always on	29.06	29.06	25.99	25.99	29.00	29.00
802.11 PSM	33.77	52.54	29.39	29.39	56.94	56.94
Multilevel PSM	20.03	22.75	26.33	29.04	23.46	53.28
Multilevel CS-ATIM	17.61	19.43	24.86	35.56	22.04	61.39
CS-ATIM	36.06	52.01	26.94	26.94	43.72	43.72

Simulations

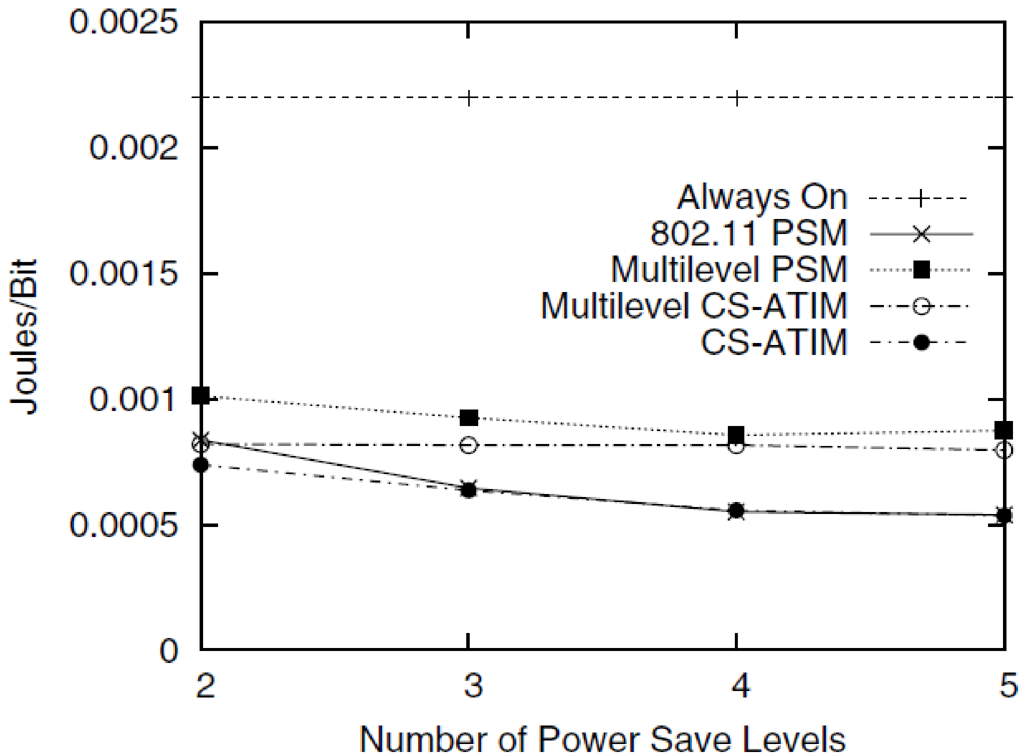


Fig. 6. Effects of the number of power save levels on energy.

Simulations

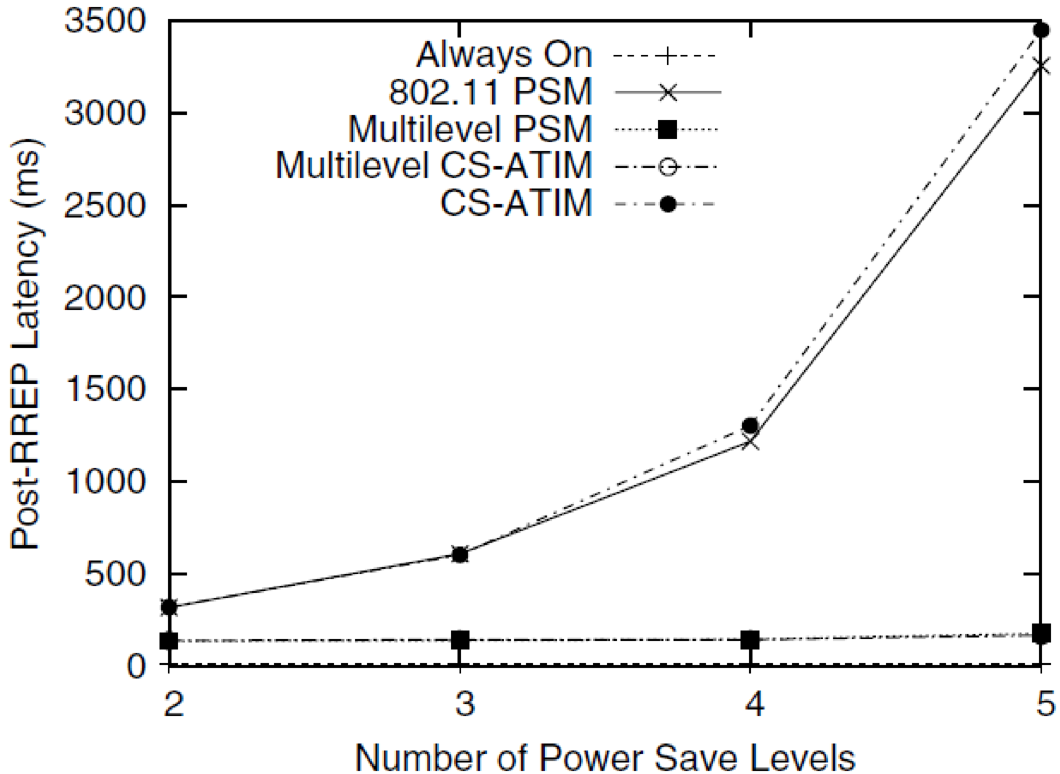


Fig. 7. Effects of the number of power save levels on latency.

Simulations

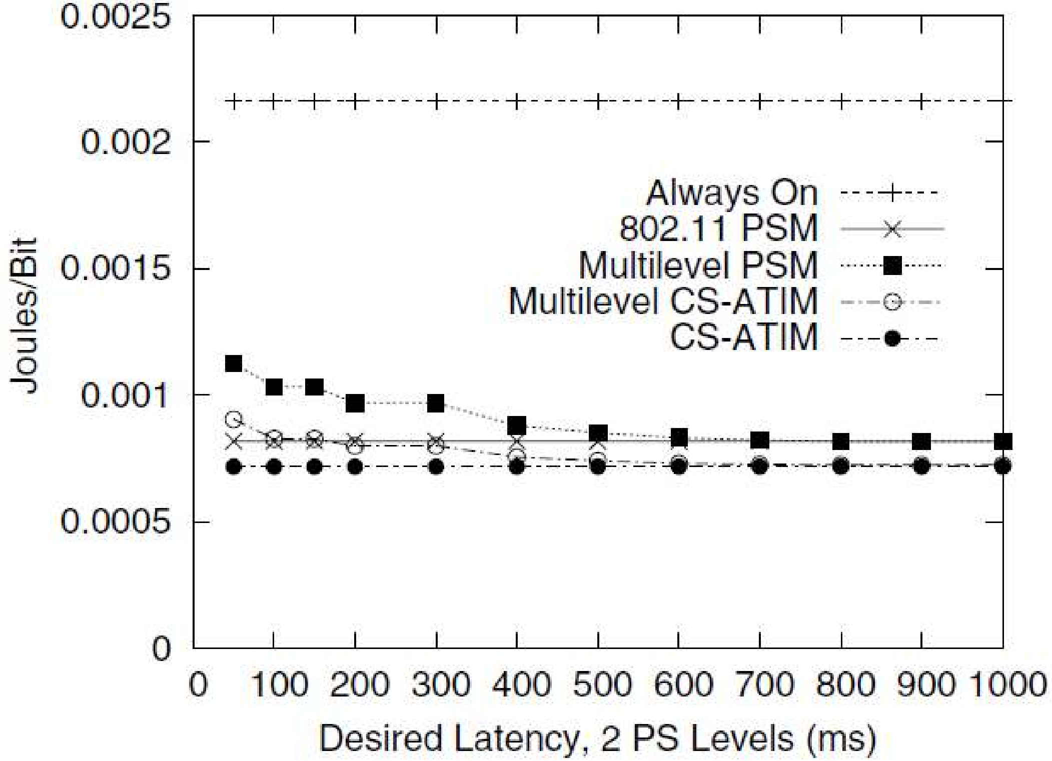


Fig. 8. Latency threshold versus energy consumption using two power save levels.

Simulations

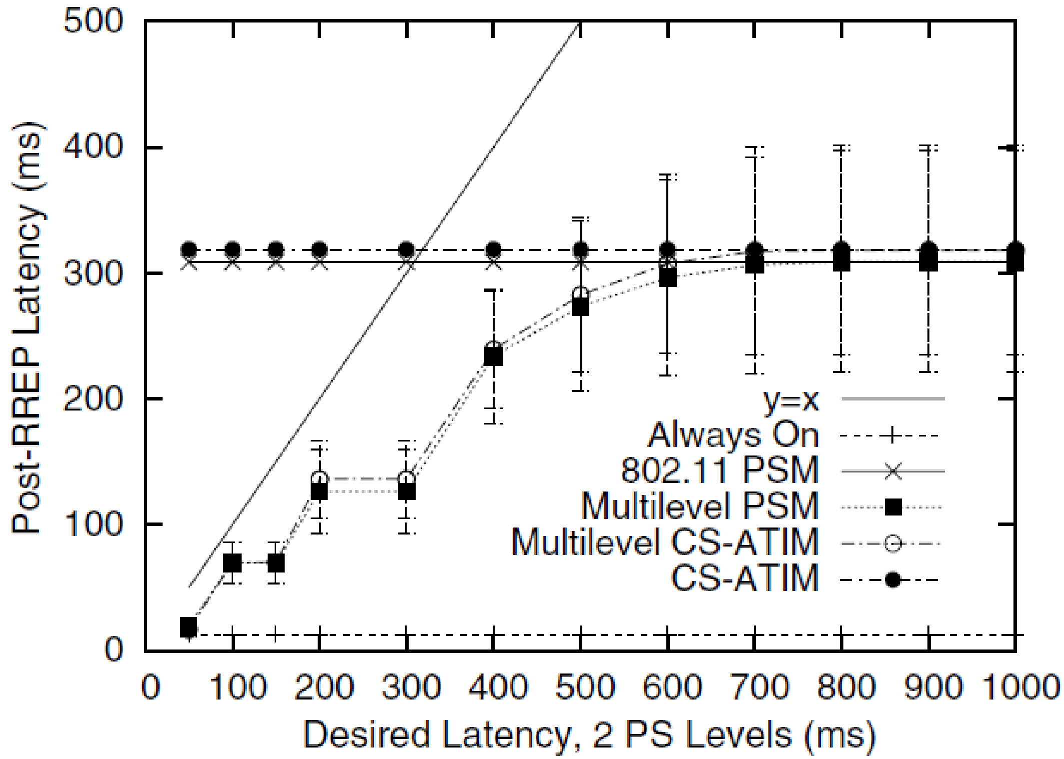


Fig. 9. Latency threshold versus observed latency using two power save levels.

Simulations

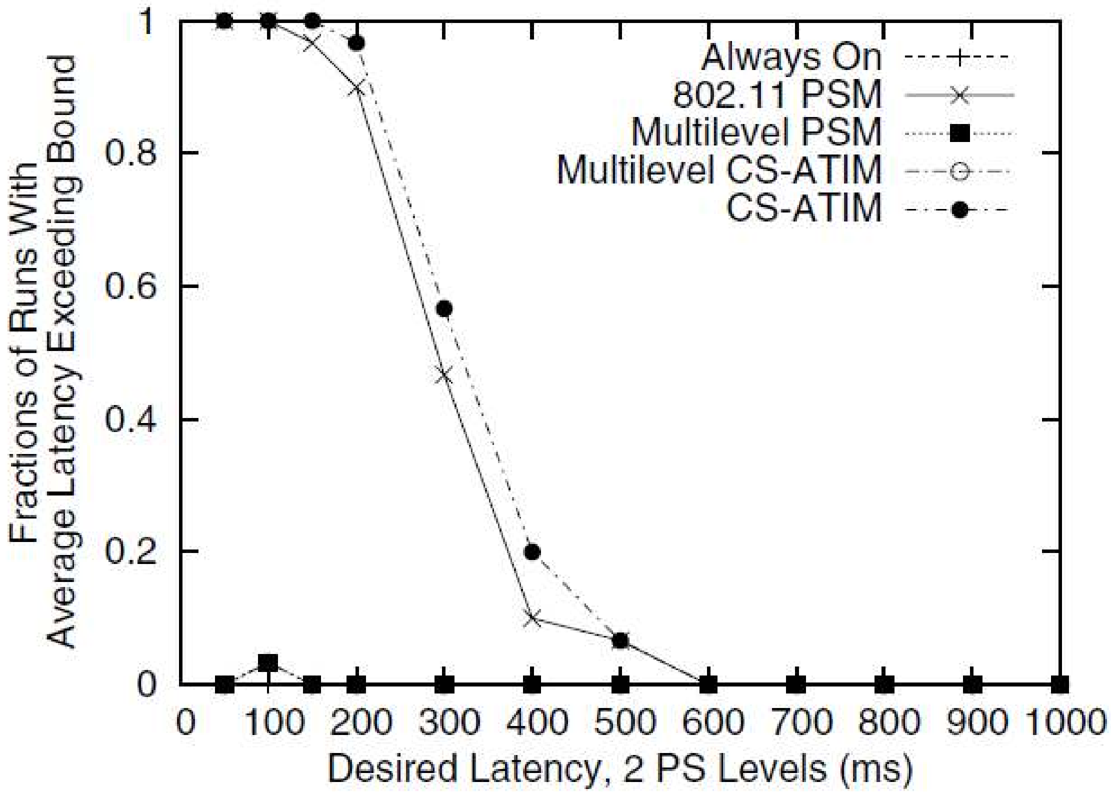


Fig. 10. Latency threshold versus observed latency using two power save levels.

Simulations

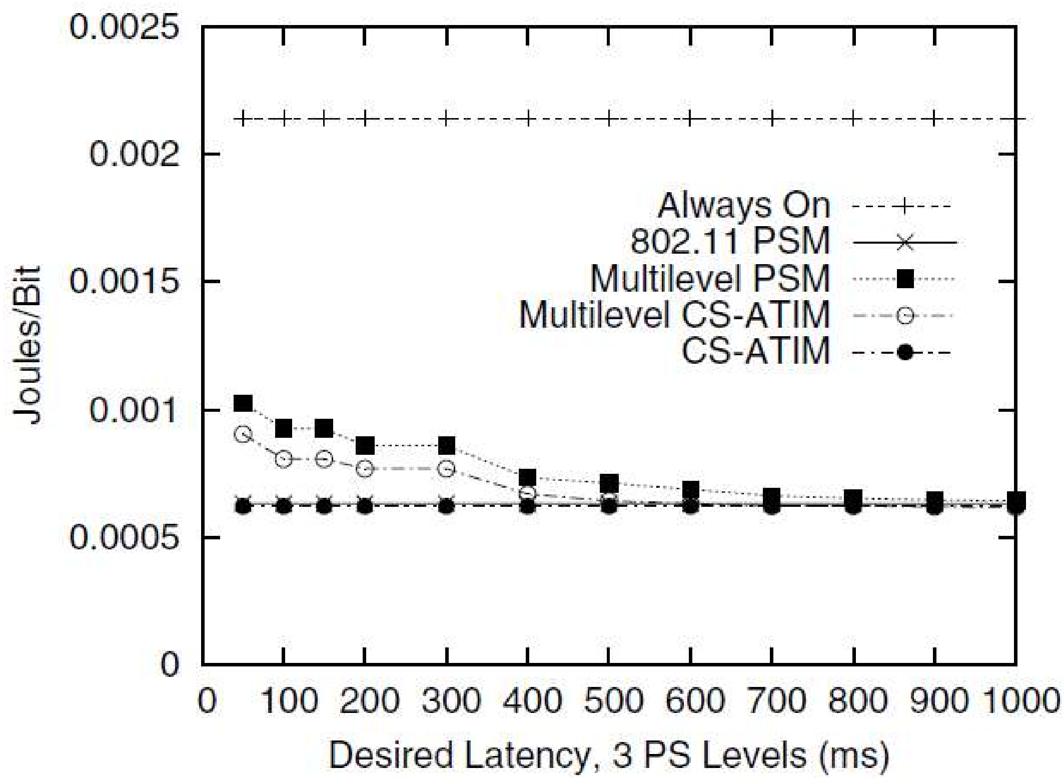


Fig. 11. Latency threshold versus energy consumption using three power save levels.

Simulations

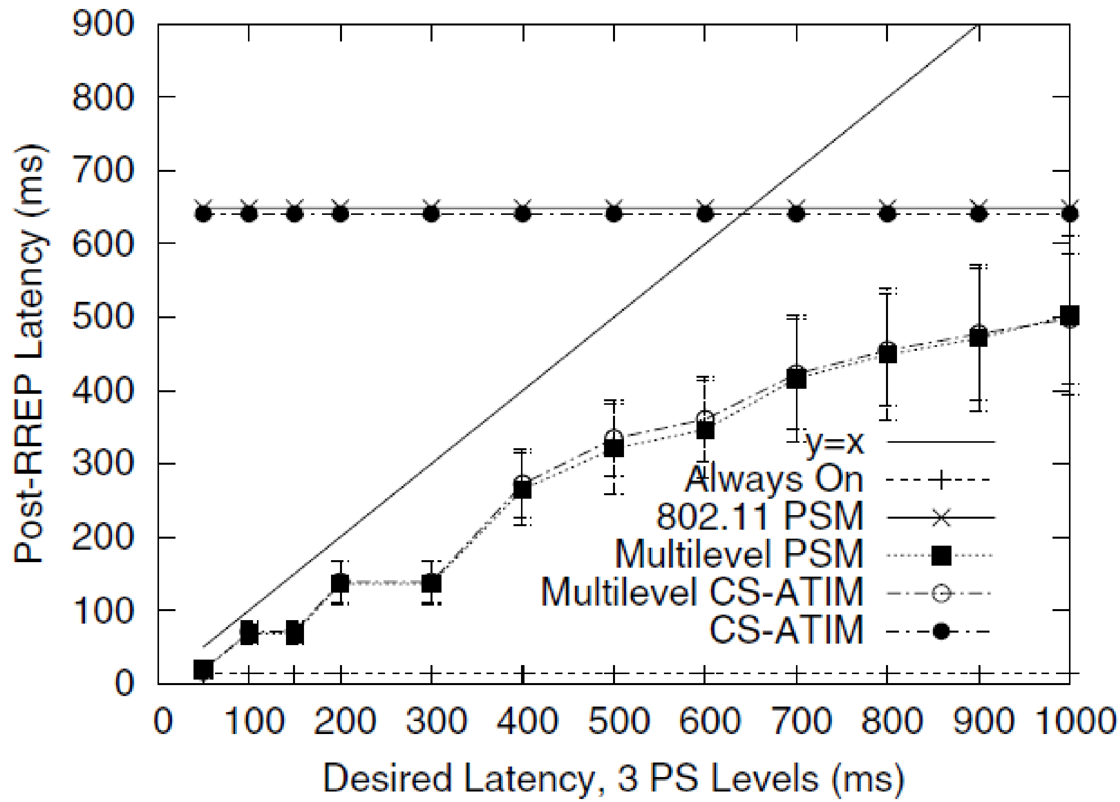


Fig. 12. Latency threshold versus observed latency using three power save levels.

Simulations

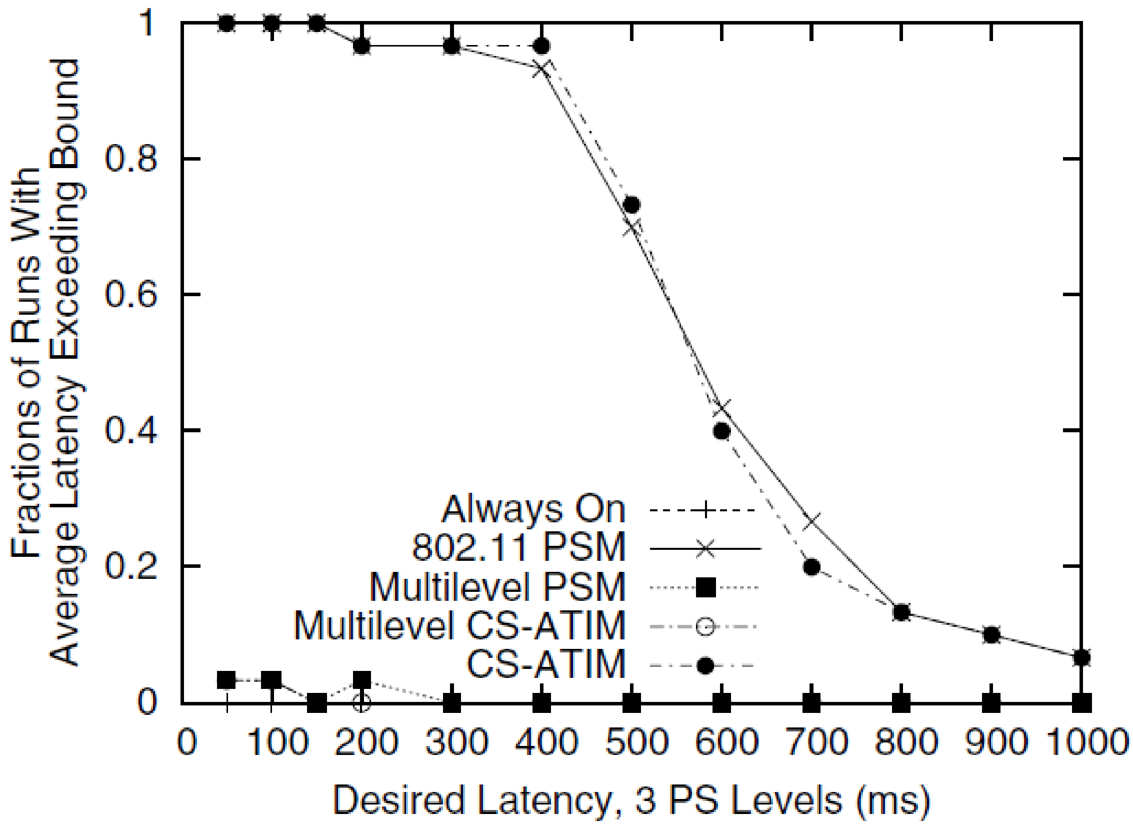
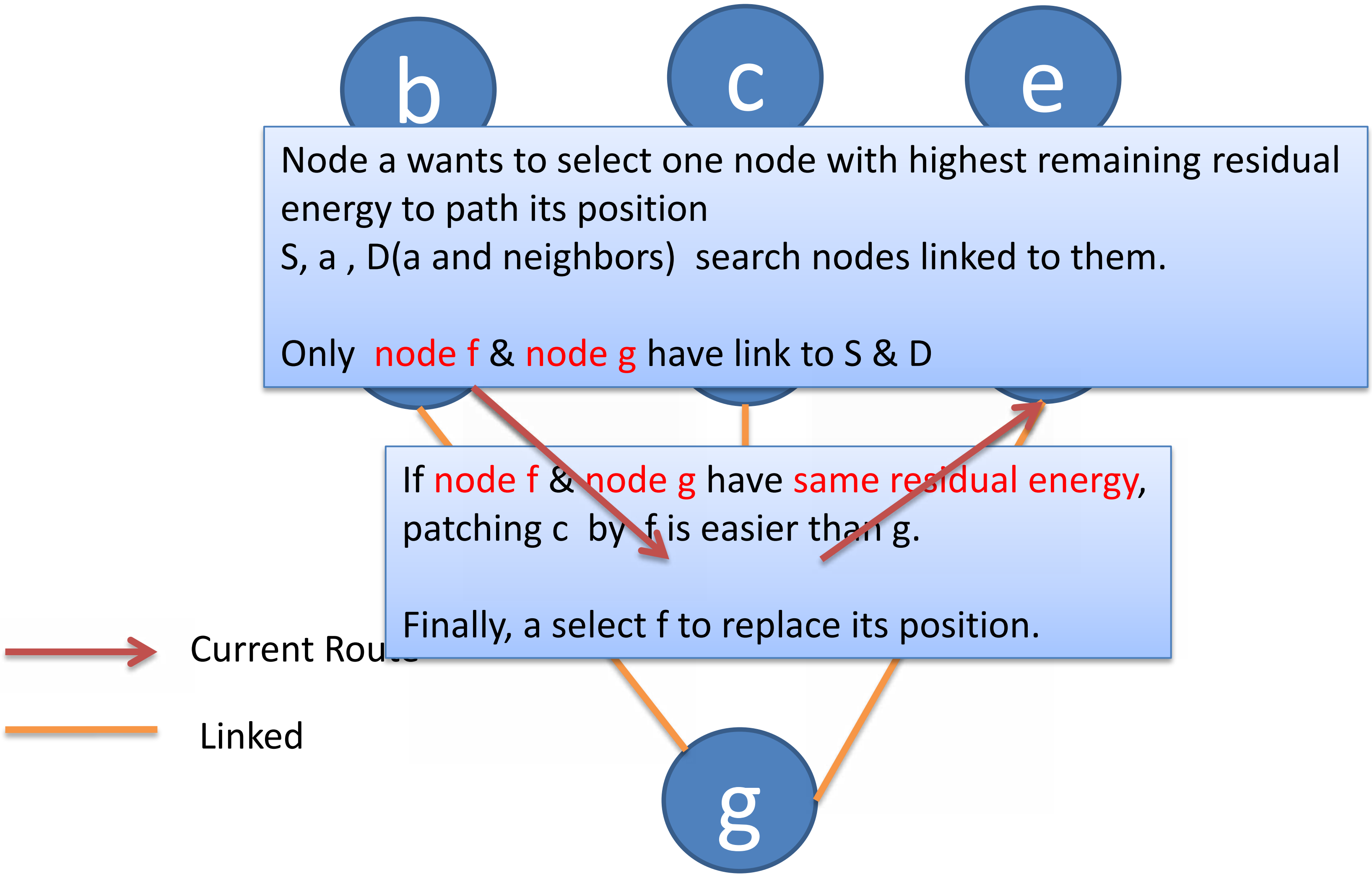


Fig. 13. Latency threshold versus observed latency using three power save levels.

Power Balance Extension



Node a wants to select one node with highest remaining residual energy to path its position
S, a , D(a and neighbors) search nodes linked to them.

Only node f & node g have link to S & D

If node f & node g have same residual energy, patching c by f is easier than g.

Finally, a select f to replace its position.

Conclusion

- Like other works, this paper proposed placing nodes in different power save states that tradeoff energy consumption and latency.
- They design protocols to handle k level(multi level) of power save states whereas previous work only focused on the k = 1(ON) and k = 2(SLEEP) cases.
- The multi level power save protocols are able to achieve the latency bound in more cases then old ones.