Adaptive Duty-Cycled MAC for low-latency mission-critical surveillance applications in WISN

AdHoc Now
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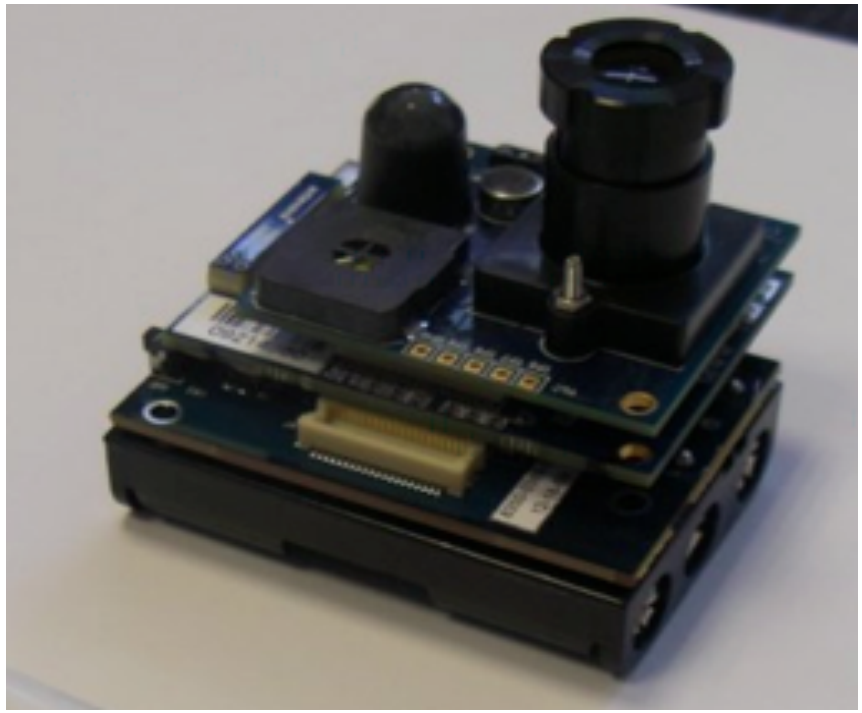
Presentation Plan

- Introduction to WISN
- Adaptive MAC protocol
- Simulation Results
- Conclusions

Wireless Image Sensor

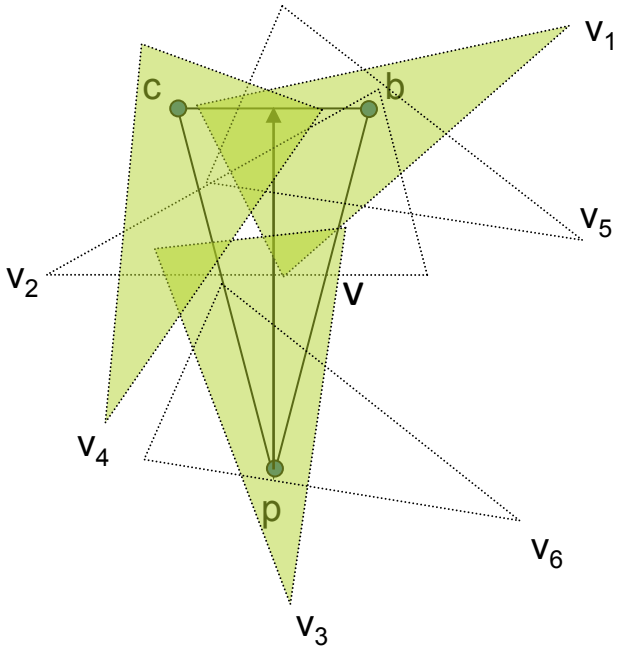
- Sensor node:
  - Camera
  - Processor
  - Radio
  - Battery



Cover Sets

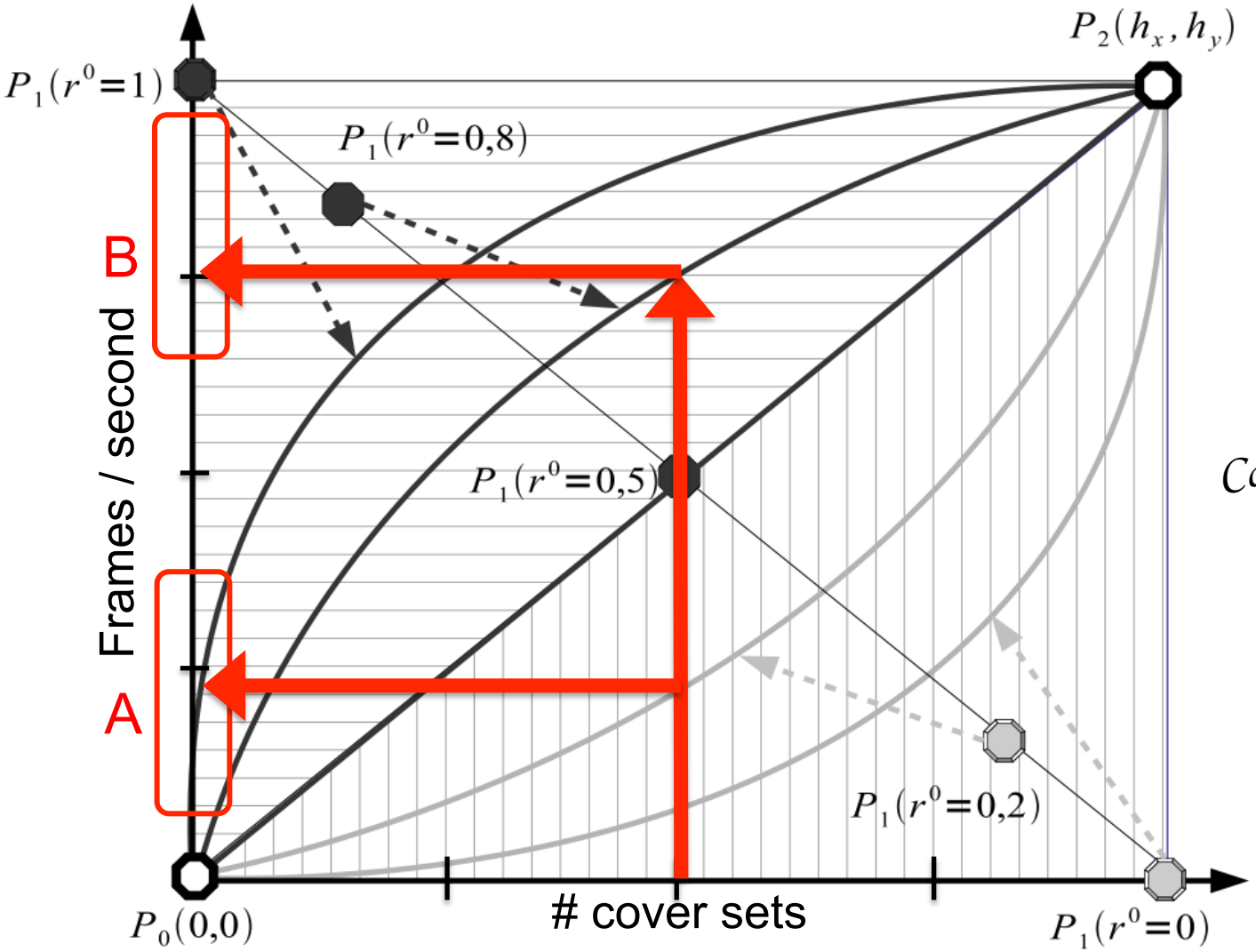
Co(V)= {
{V },
{V_1, V_3, V_4},
{V_2, V_3, V_4},
{V_3, V_4, V_5},
{V_1, V_4, V_6},
{V_2, V_4, V_6},
{V_4, V_5, V_6}
}

|Co(V)| = 7



- *Cover sets are the combination of nodes which cover the same area .*

Criticality Model



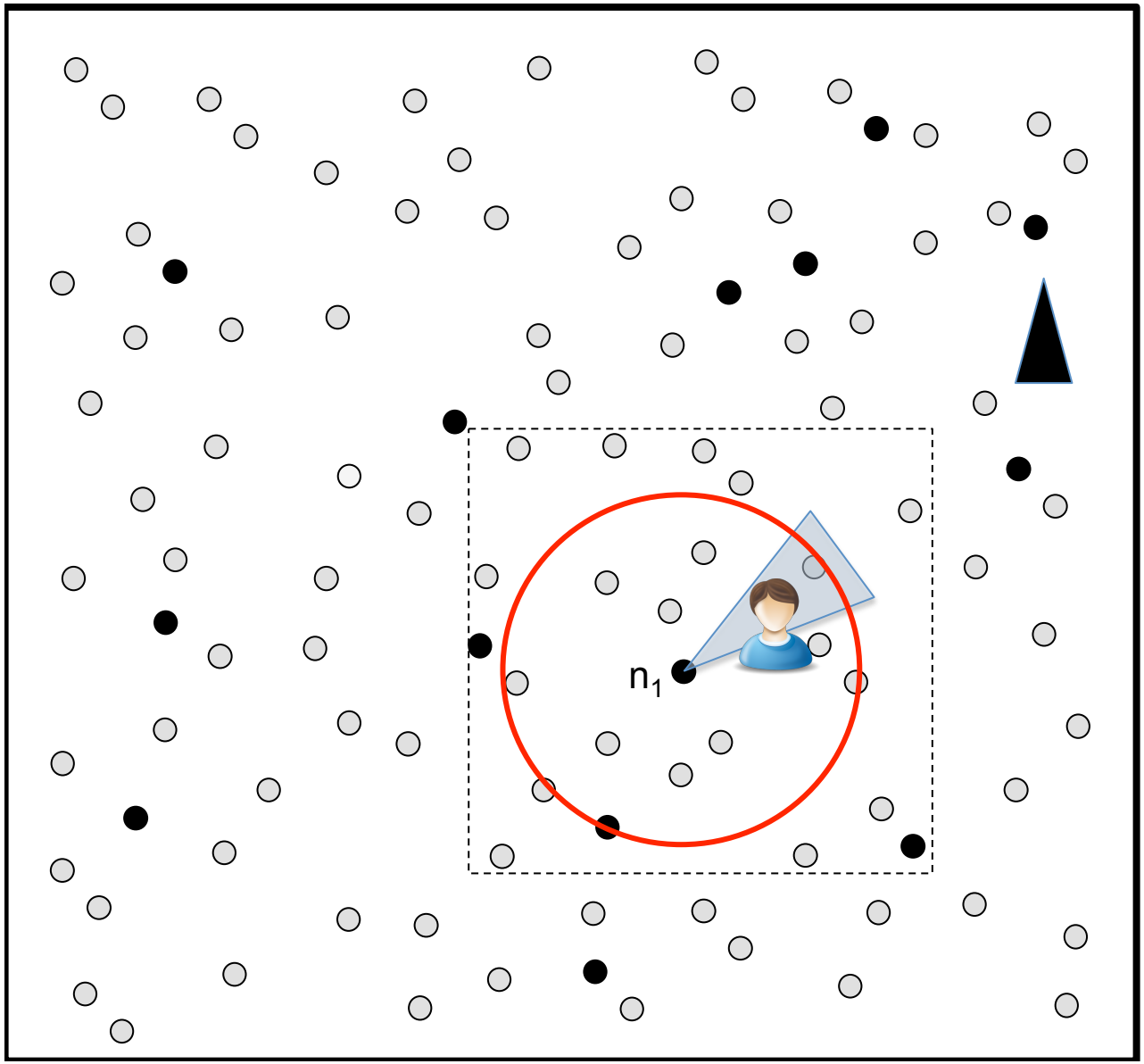
Example

Node A

Cover Sets = 6

Criticality level is represented by r^o

Alert Propagation

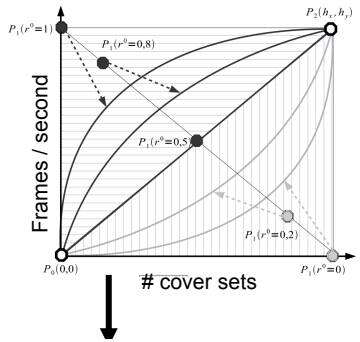


Sink

Sentry Node

Normal Node

Active and Sleep Periods of MAC layer



fps = f(criticality level, # cover sets)

Application layer

alert

SENTRY NODE

MAC layer

active | sleep | active | sleep | ...

sleep | active/listen | sleep | active/listen

MAC layer

Application layer

RELAY NODE

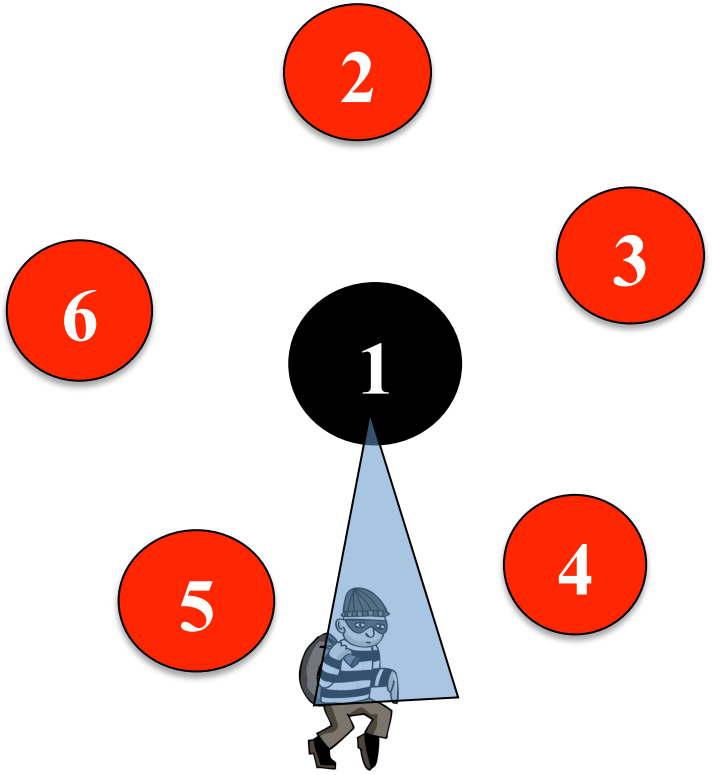
duty_cycle = f(sentry_fps, # cover sets)

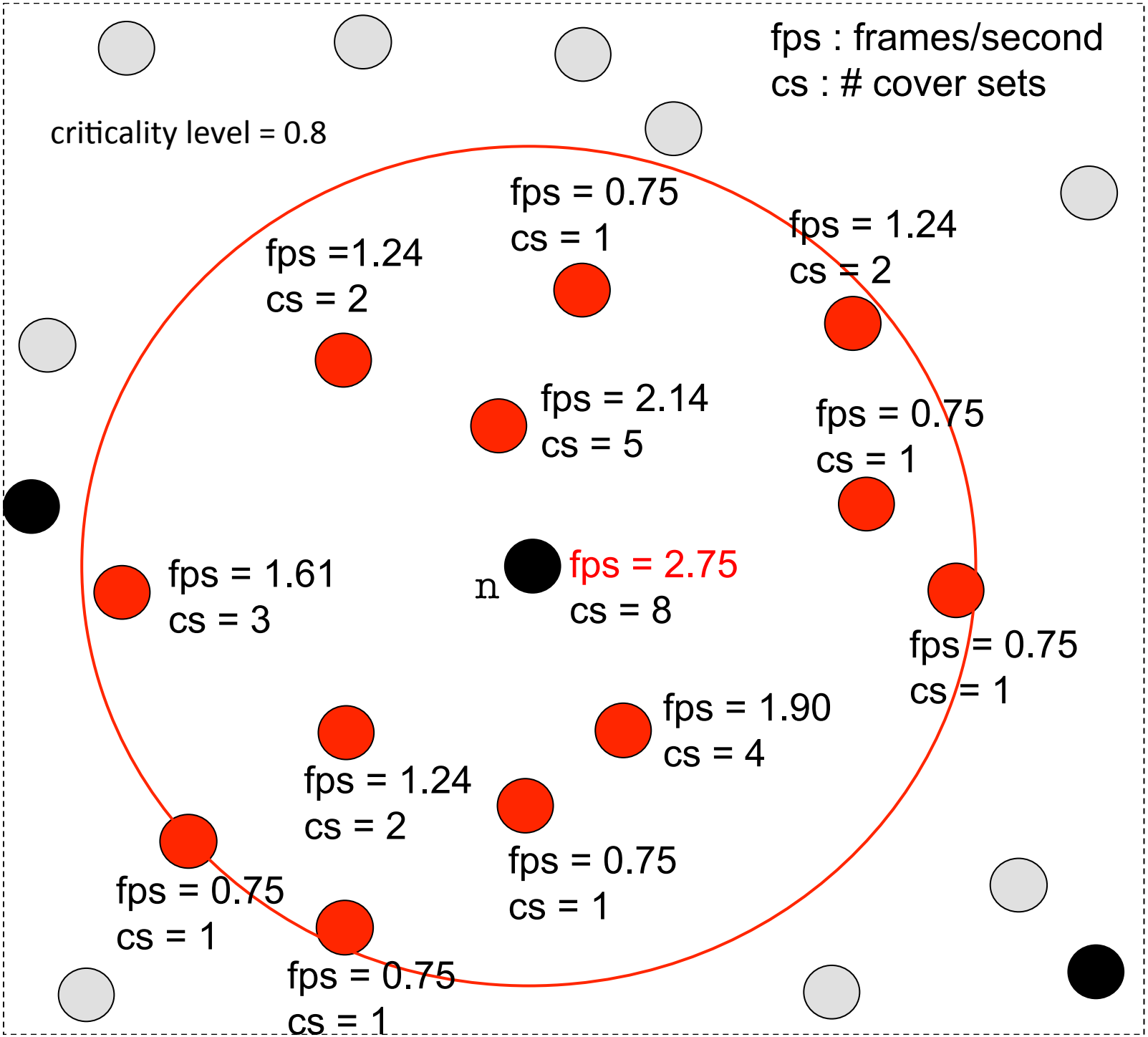
Alert Propagation

Energy

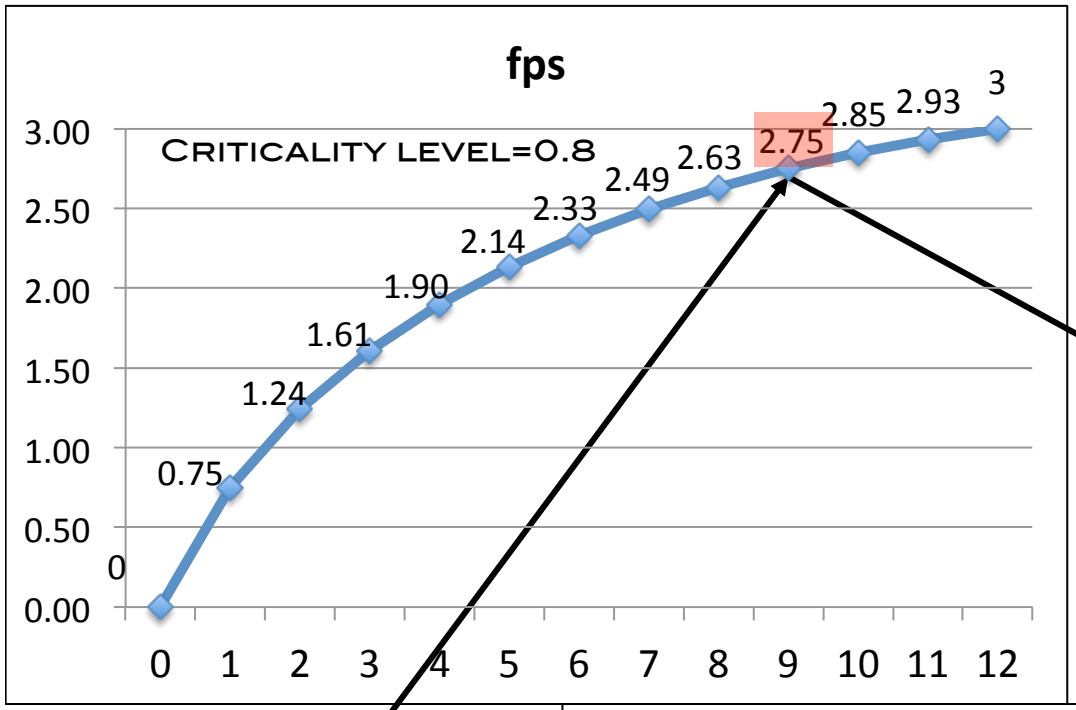
Adaptive MAC Protocol

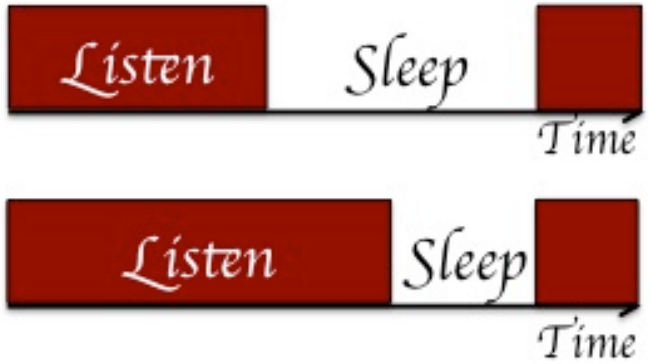
- Sentry node selection
  - Maximum capture rate ⇒ sentry node.
- Follower's duty cycle calculation
  - Duty Cycle ∝ Sentry's Capture Rate.
  - Duty Cycle ∝ Cover Sets.




fps : frames/second
cs : # cover sets
criticality level = 0.8
fps = 0.75
cs = 1
fps =1.24
cs = 2
fps = 1.24
cs = 2
fps = 2.14
cs = 5
fps = 0.75
cs = 1
fps = 1.61
cs = 3
n
fps = 2.75
cs = 8
fps = 0.75
cs = 1
fps = 1.90
cs = 4
fps = 1.24
cs = 2
fps = 0.75
cs = 1
fps = 0.75
cs = 1
fps = 0.75
cs = 1

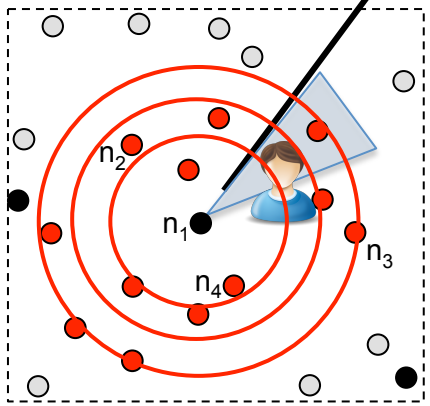
Duty Cycle Calculation

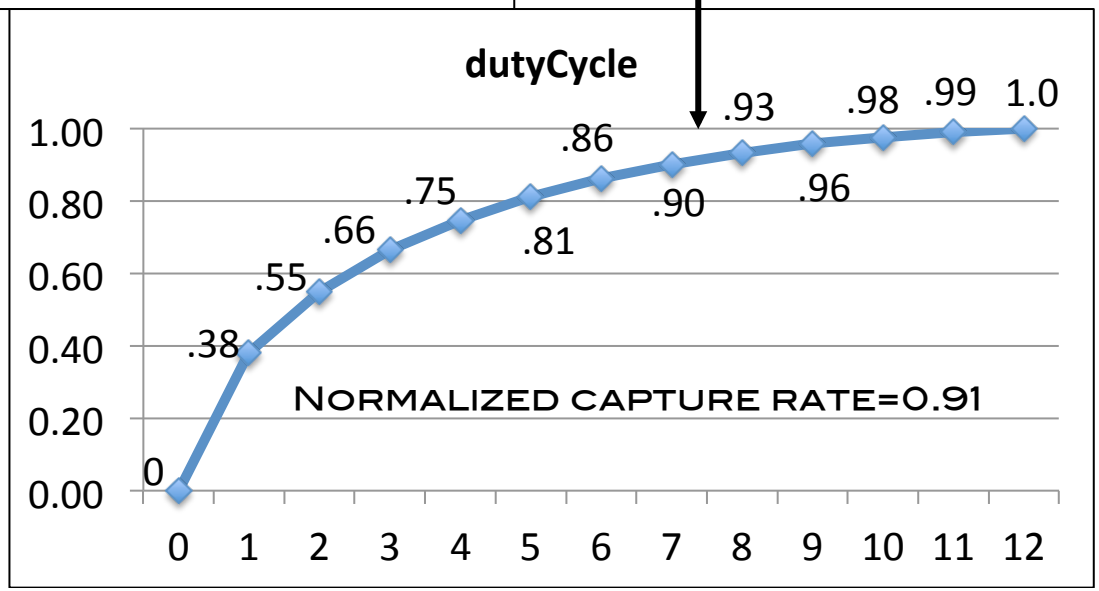




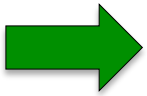
2.75/3.00=0.91

can be viewed as a new criticality level for follower nodes

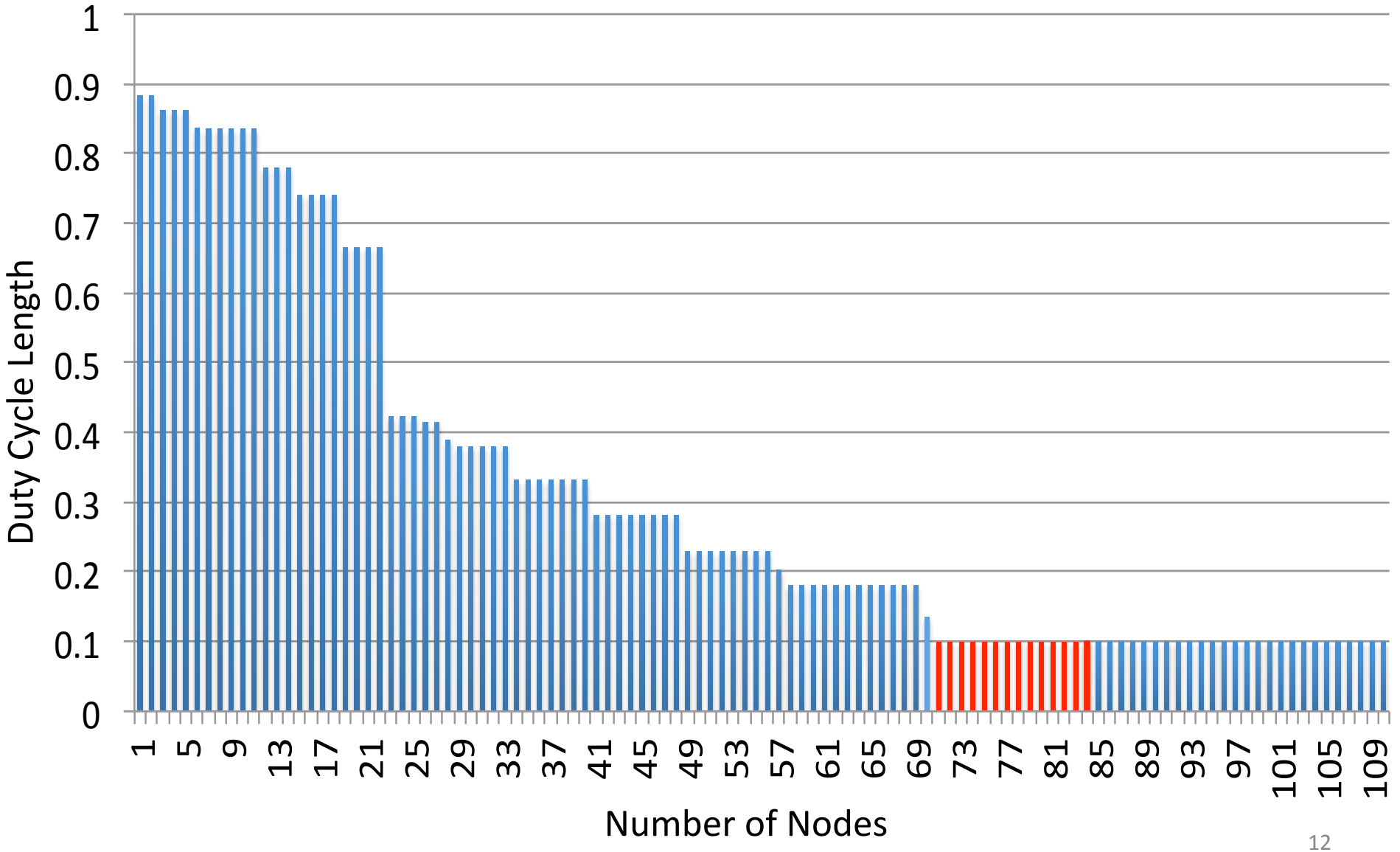




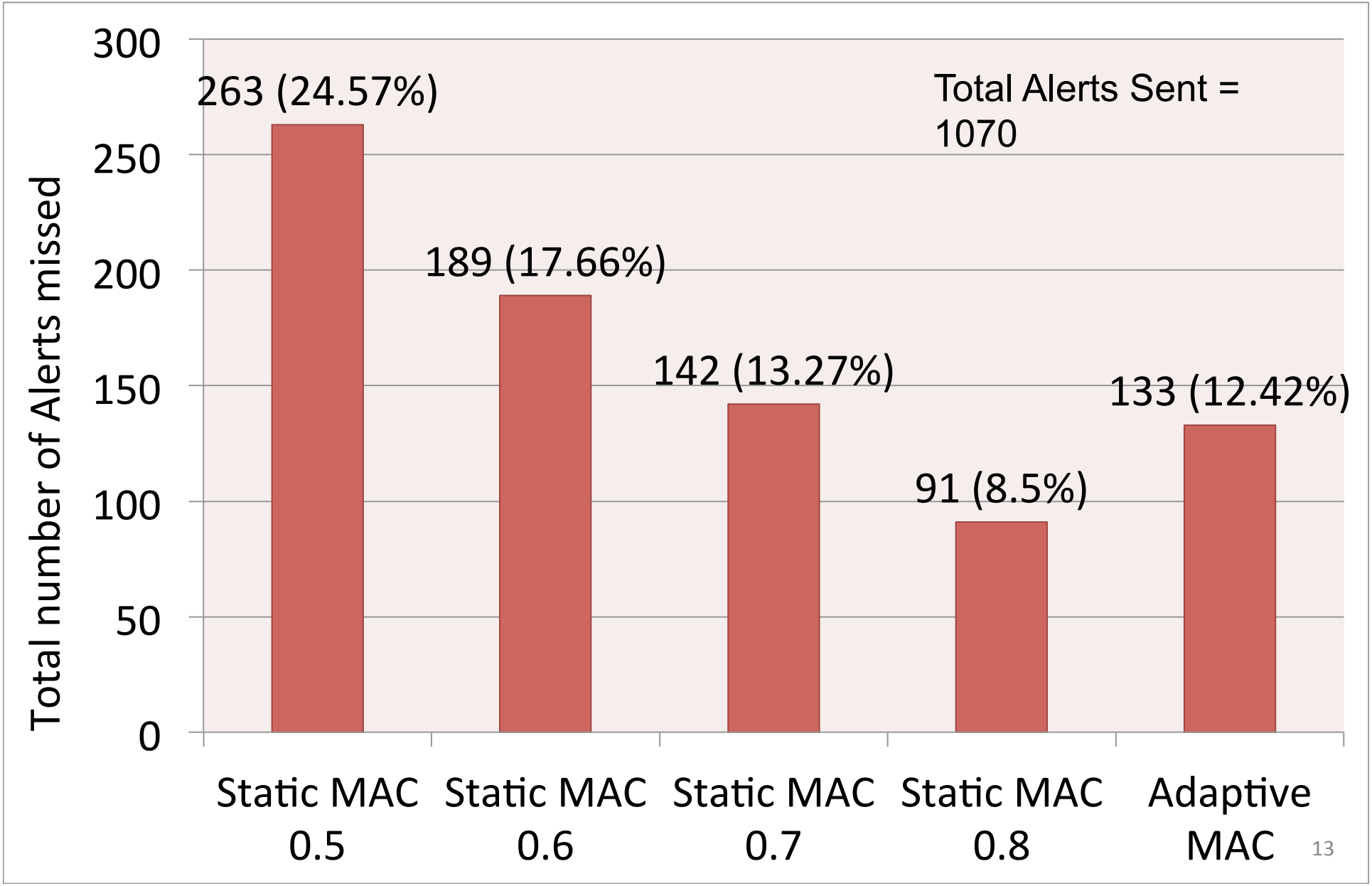
Simulation Environment

- OMNET++ / Castalia Simulator.
- Number of Nodes: 110
- Criticality Level: 0.8
- Capture rate: 0  3 fps
- Min Duty Cycle: 0.1

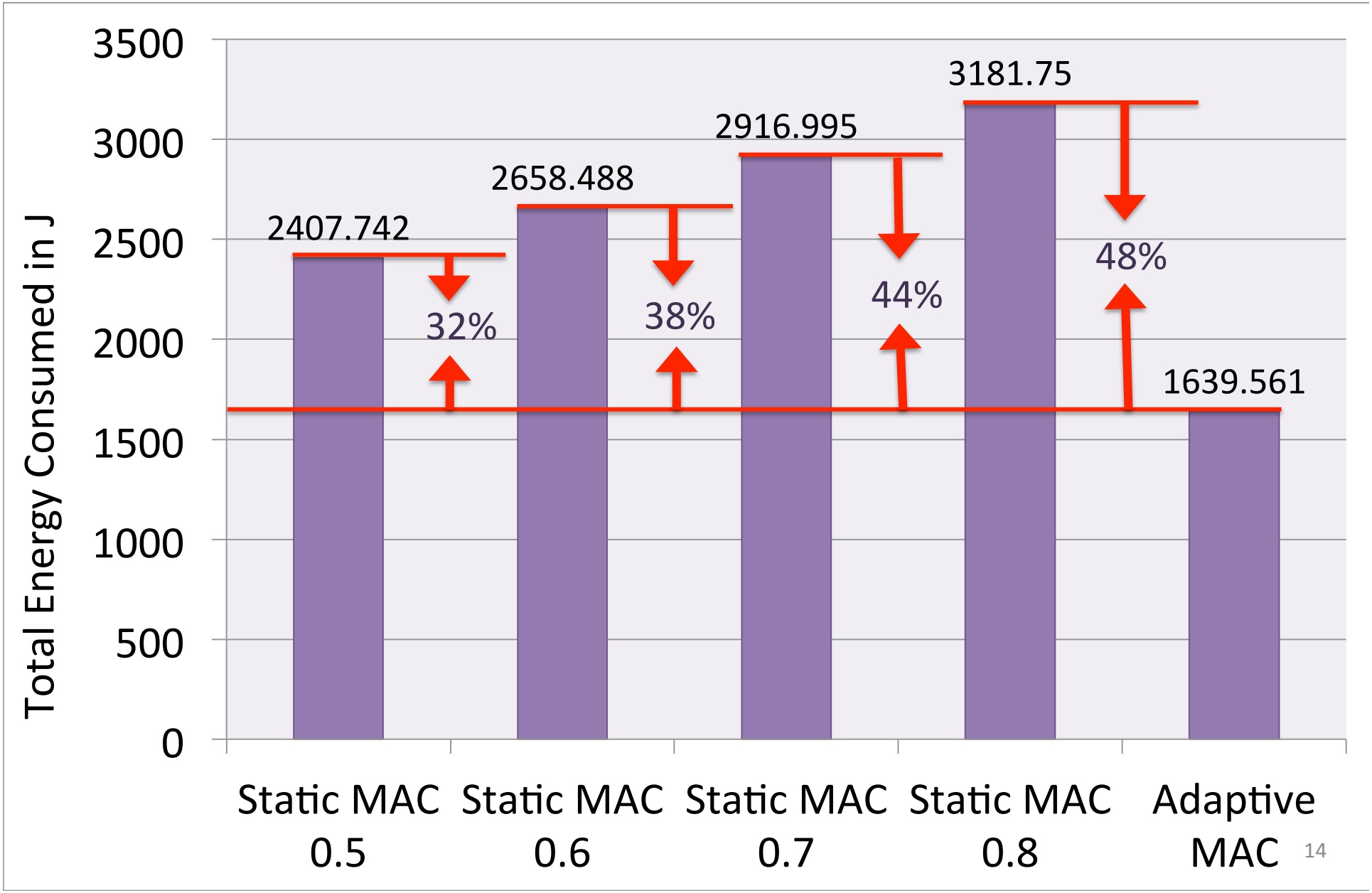
Duty Cycle length



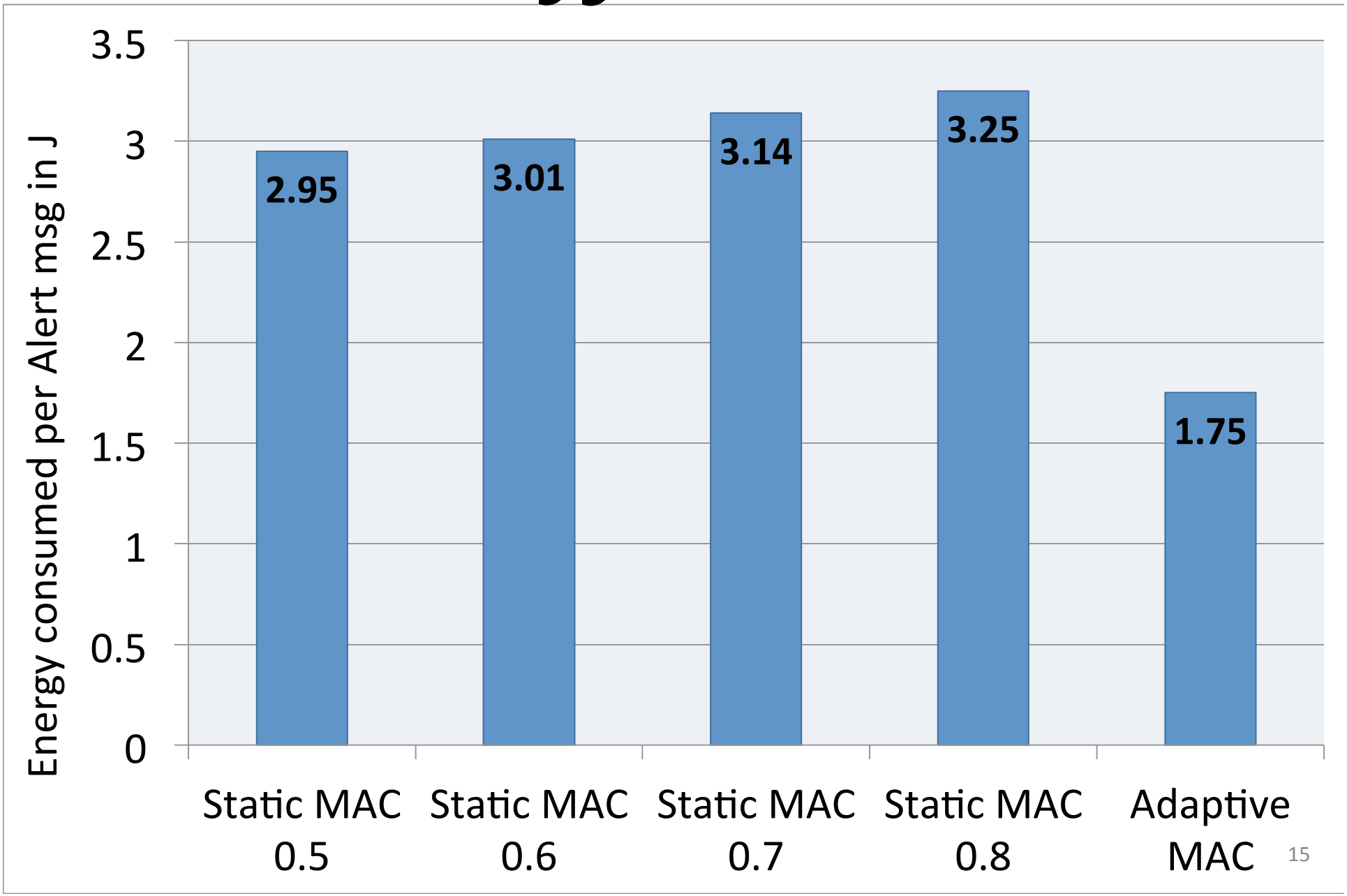
Missed Alerts



Energy Consumption

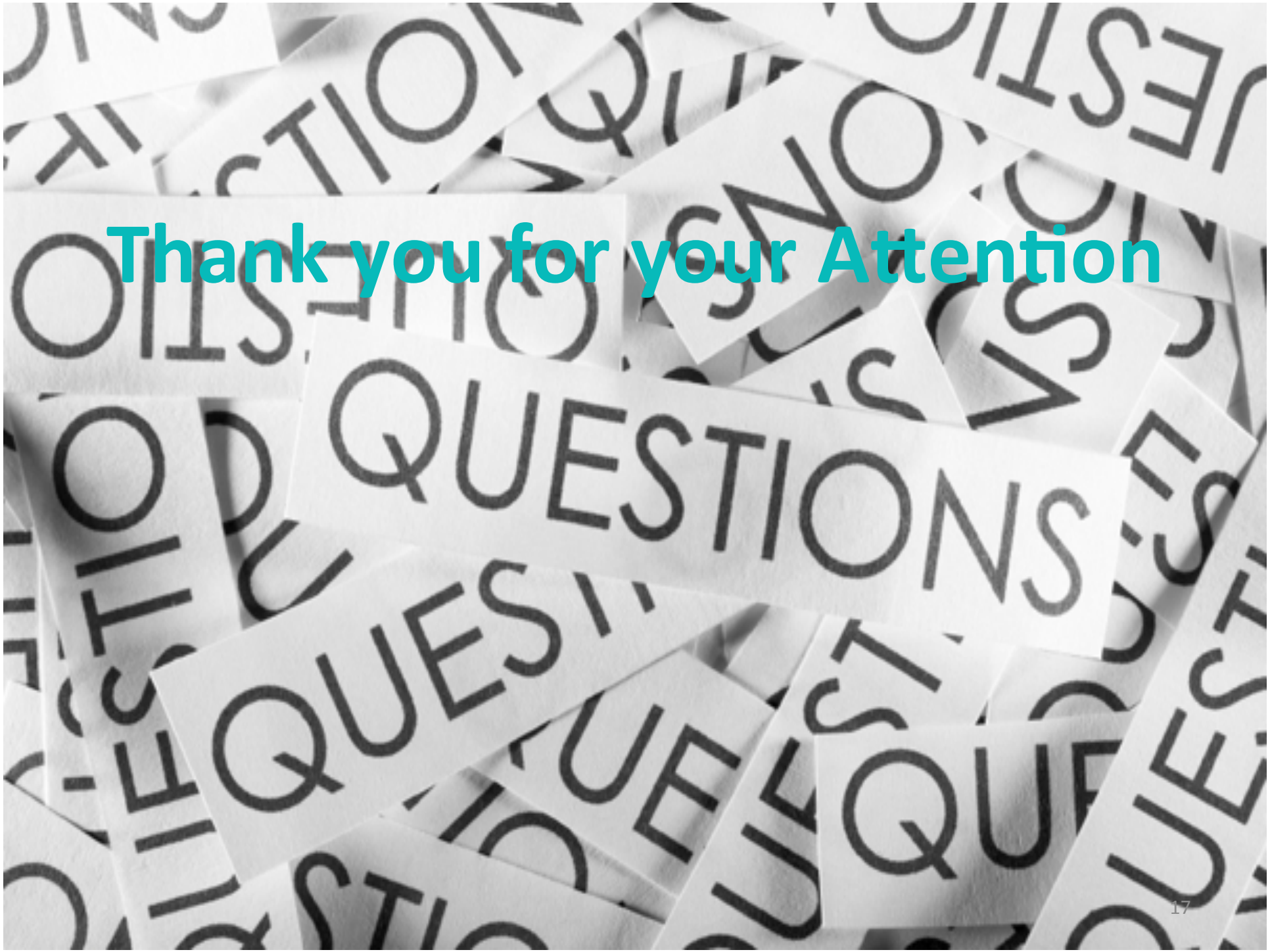


Energy Per Alert

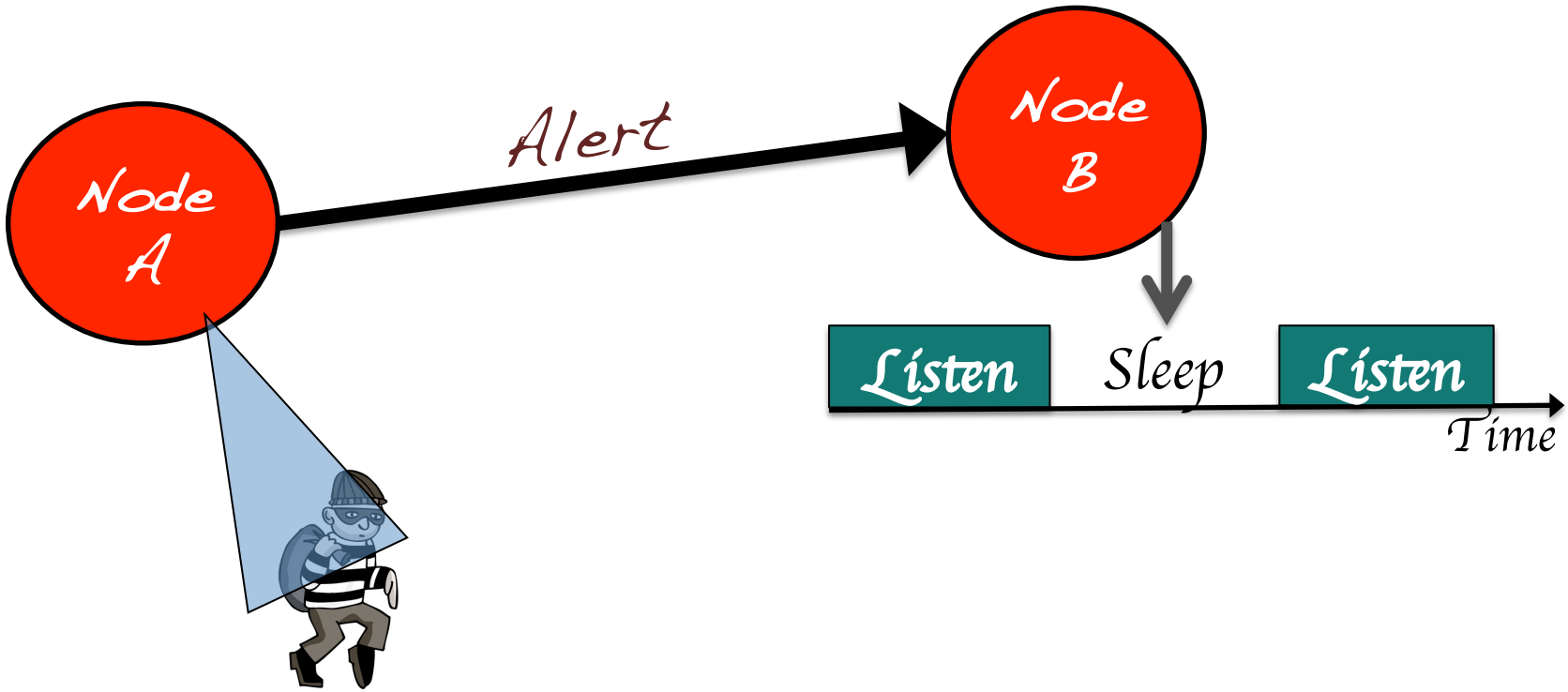


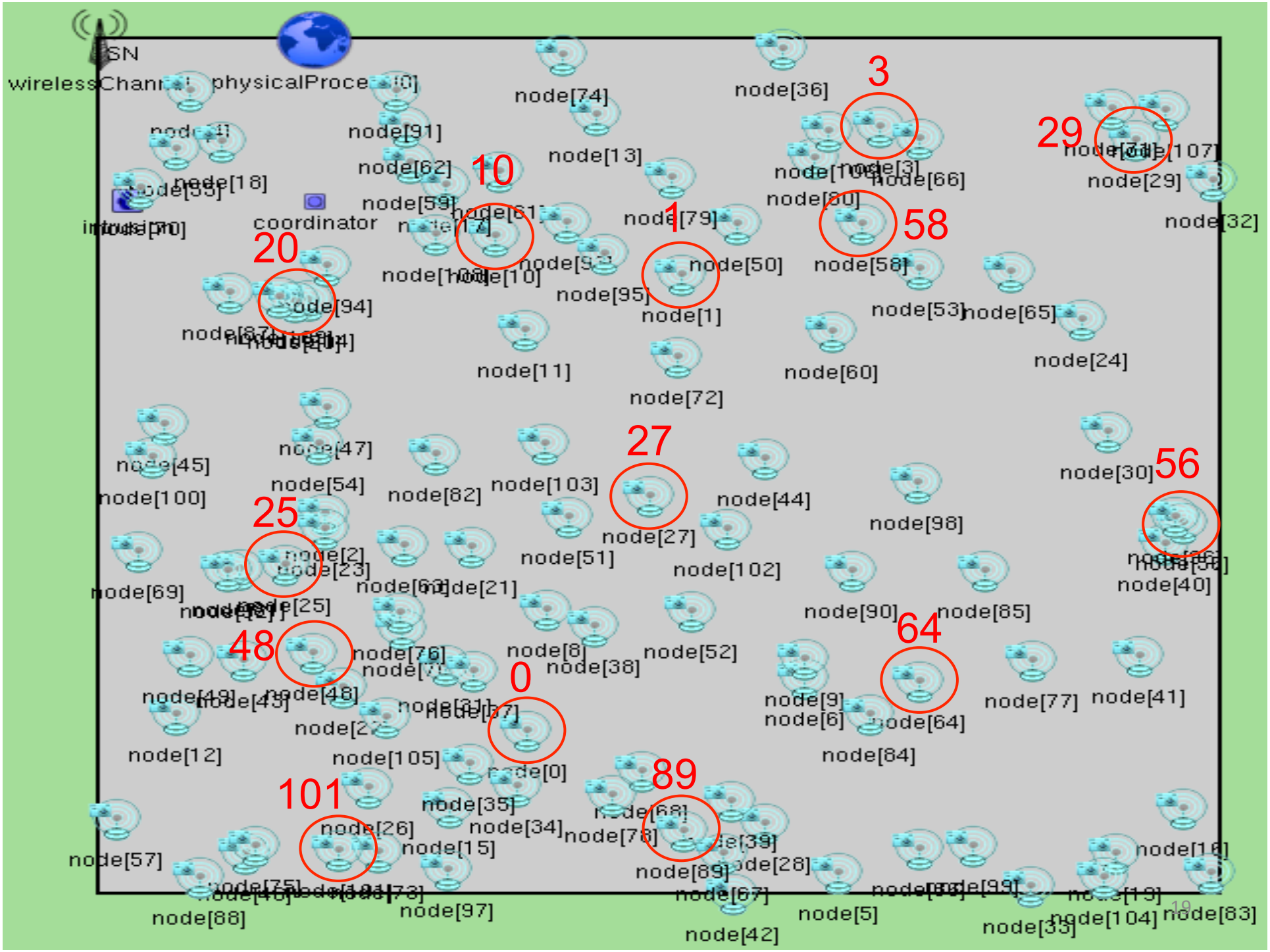
Conclusions

- We linked duty cycle with Capture Rate and No. of Cover Sets.
- 133 alerts missed in comparison to 142 of static MAC with 0.7 duty cycle.
- 48% and 44% less energy consumed in comparison to 80% and 70% duty cycled MAC, respectively.


Thank you for your Attention
QUESTIONS

Problematic




SN
wireless
physicalProce
coordinator
node[74]
node[36]
node[91]
node[13]
node[62]
node[18]
node[59]
node[61]
node[79]
node[66]
node[29]
node[32]
node[50]
node[58]
node[95]
node[1]
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node[94]
node[10]
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node[54]
node[82]
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node[100]
node[98]
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node[51]
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node[23]
node[21]
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node[69]
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node[90]
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node[6]
node[12]
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node[0]
node[84]
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node[34]
node[26]
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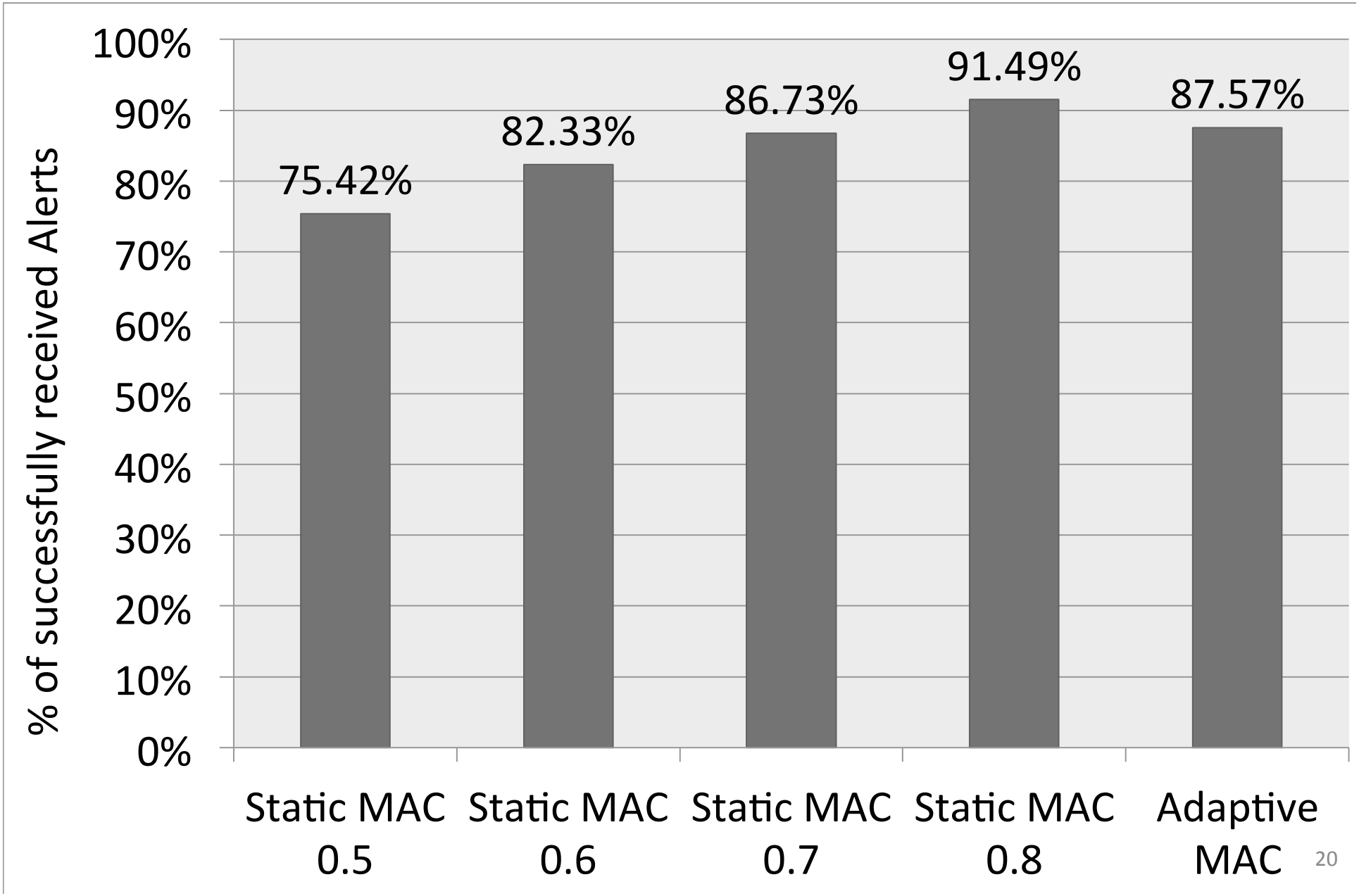
node[28]
node[89]
node[16]
node[5]
node[104]
node[83]
node[88]
node[97]
node[67]
node[42]
node[33]
3
29
10
1
58
20
27
56
25
48
0
64
89
101

Alerts Reception



Adaptive MAC Protocol