Risk Management in Intrusion Detection Applications with Wireless Video Sensor Networks

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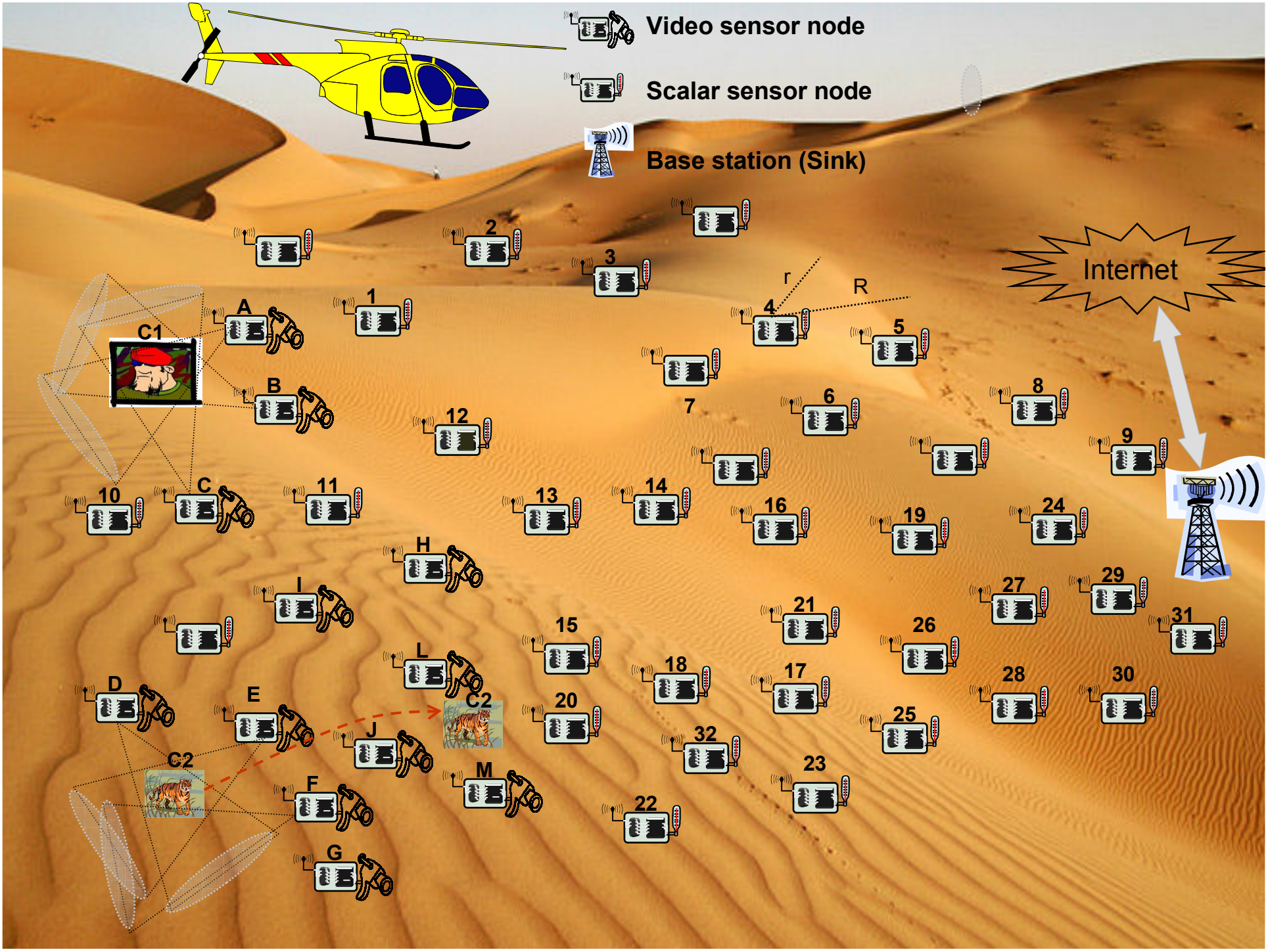
Overview

- Introduction of wireless video sensor networks
- Surveillance applications
- Coverage and scheduling
- Application Criticality
- Experimental Results


Video sensor node
Scalar sensor node
Base station (Sink)
Internet
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R
A
B
C
D
E
F
G
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I
J
L
M
C1
C2
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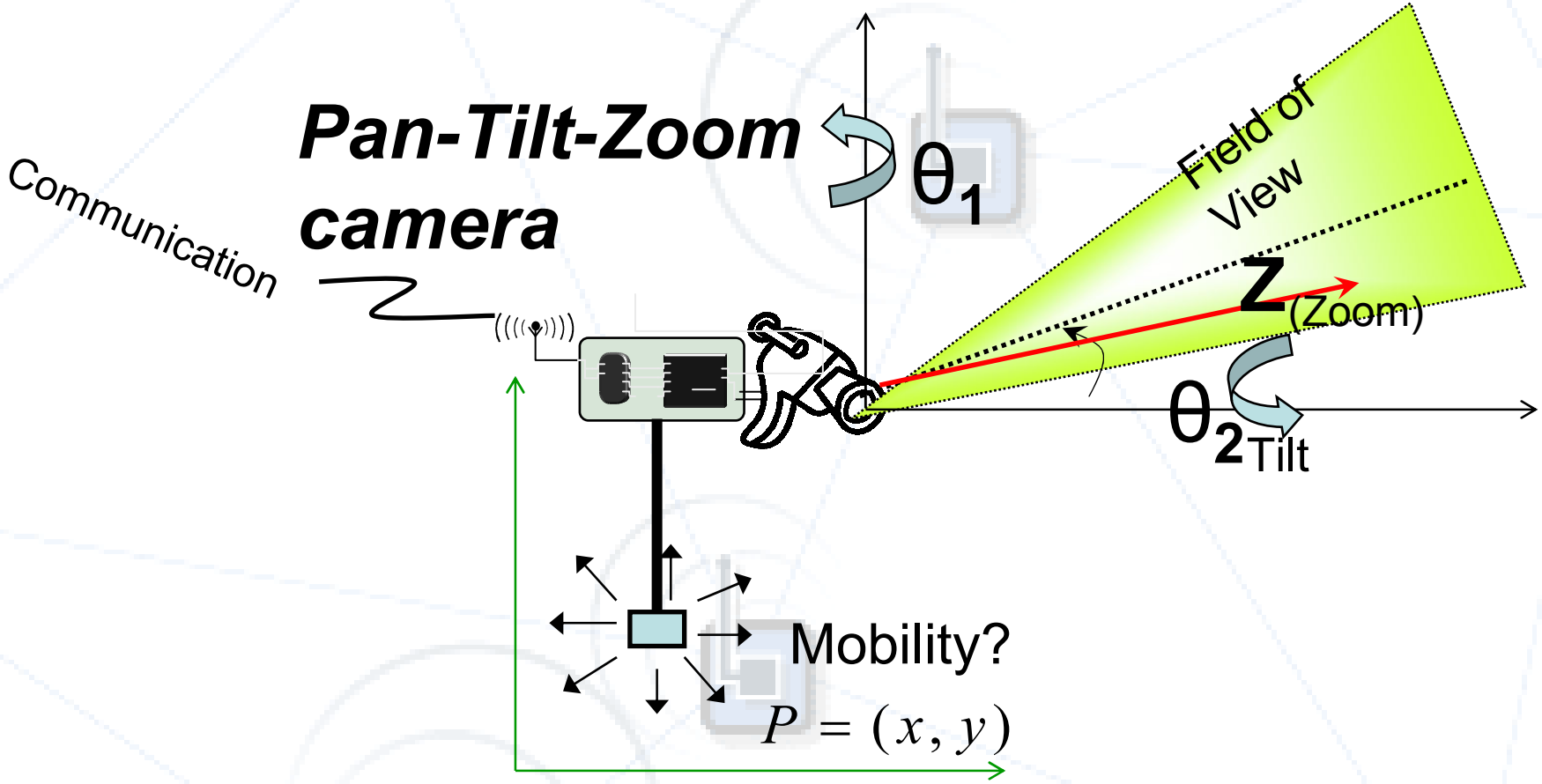
Video Sensor Node



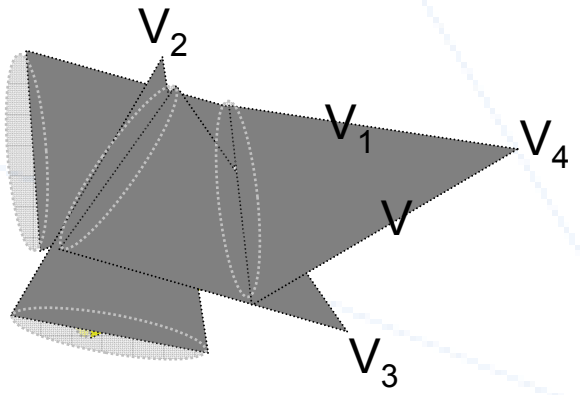
$N(P, \Theta_1, \Theta_2, Z)$

Surveillance Applications

- Surveillance video applications :
  - Quality of the captured image
    - Unnecessary to send image with high bandwidth
  - Energy consideration
    - Redundancy and coverage

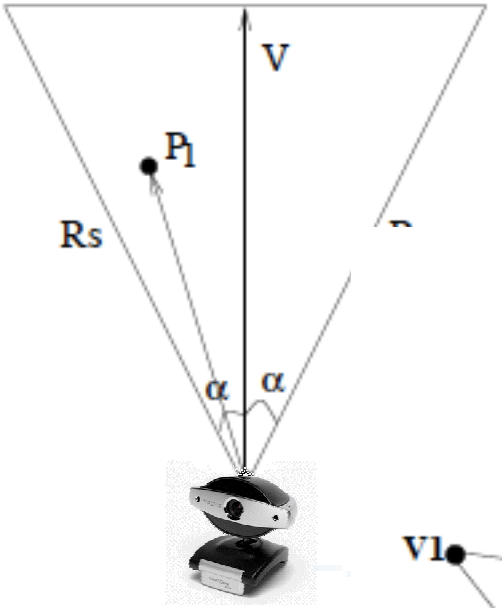
Node's cover set

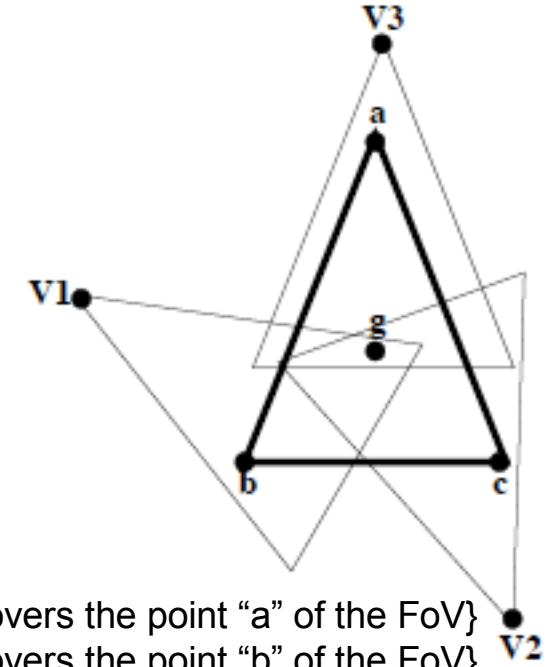
- Each node v has a Field of View, FoV_v
- $Co_i(v)$ = set of nodes v' such as $\cup_{v' \in Coi(v)} FoV_{v'}$ covers FoV_v
- Co(v)= set of $Co_i(v)$



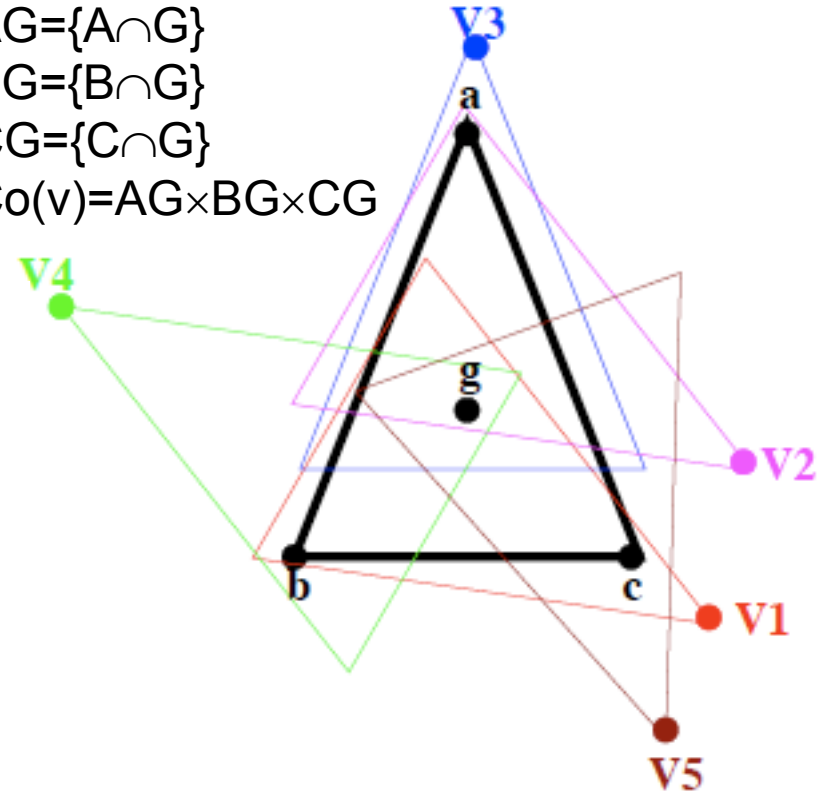
$Co(v)=\{V_1, V_2, V_3, V_4\}$

Finding v's cover set





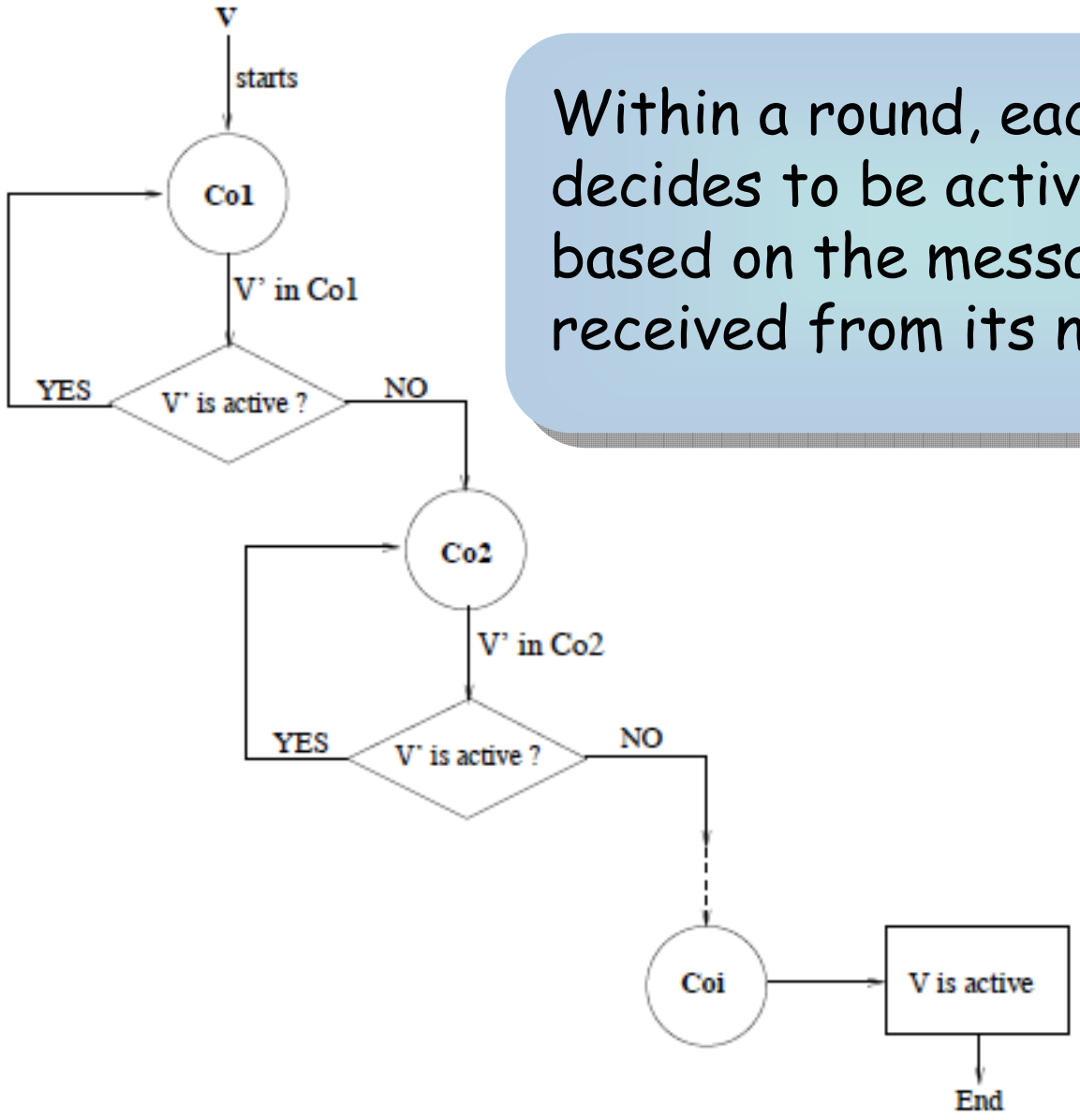
AG={A∩G}
BG={B∩G}
CG={C∩G}
Co(v)=AG×BG×CG



A = {v ∈ N(V) : v covers the point "a" of the FoV}
B = {v ∈ N(V) : v covers the point "b" of the FoV}
C = {v ∈ N(V) : v covers the point "c" of the FoV}
G = {v ∈ N(V) : v covers the point "g" of the FoV}

Co(V)= {
{V },
{V 2, V 1},
{V 3, V 1},
{V 2, V 4, V 5},
{V 3, V 4, V 5}}

Active node selection



Within a round, each node decides to be active or not based on the messages received from its neighbors

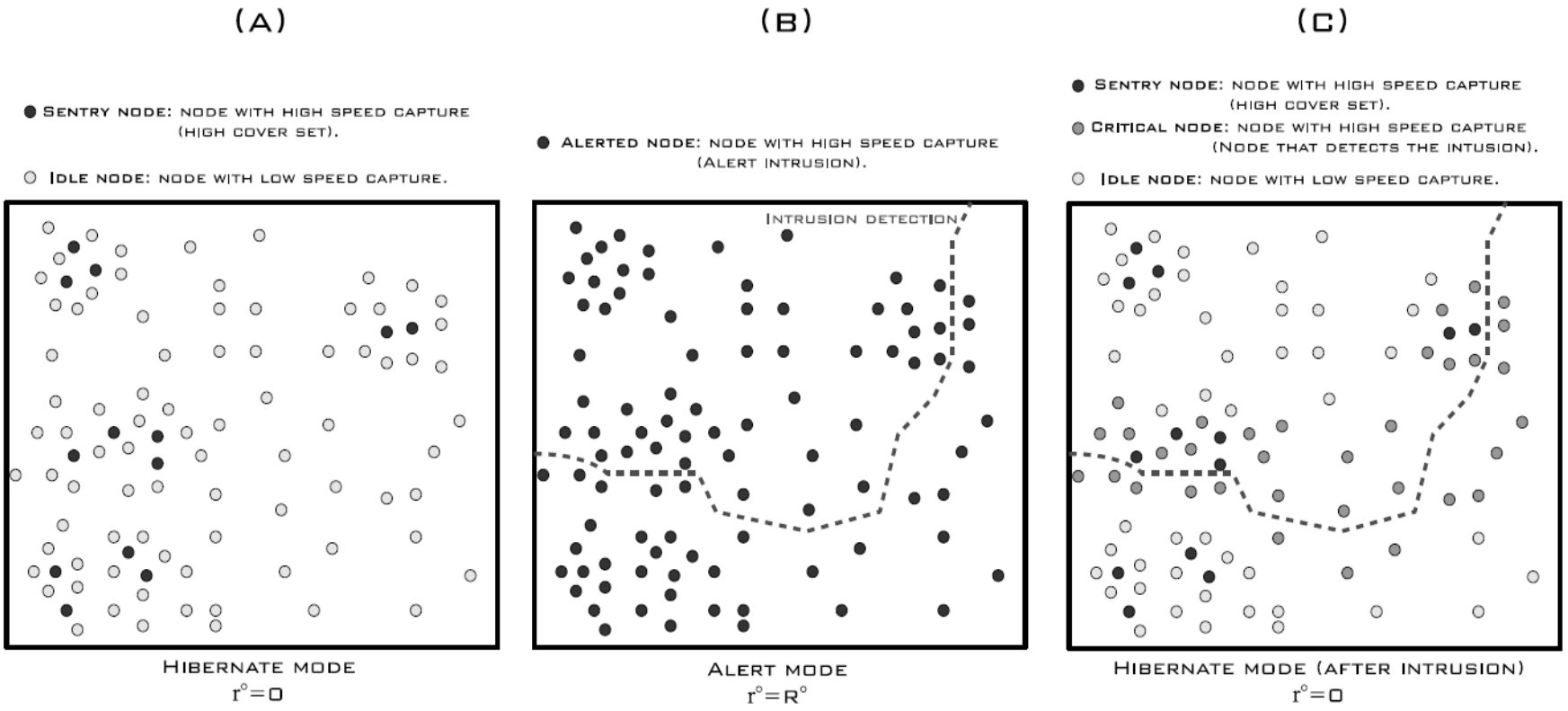
Application's criticality

- All surveillance applications may not have the same criticality level, $r^0 \in [0,1]$
  - Environmental, security, healthcare,…
- Capture speed should decrease when r^0 decreases
- Sensor nodes could be initialized with a given r^0 prior to deployment

How to meet app's criticality

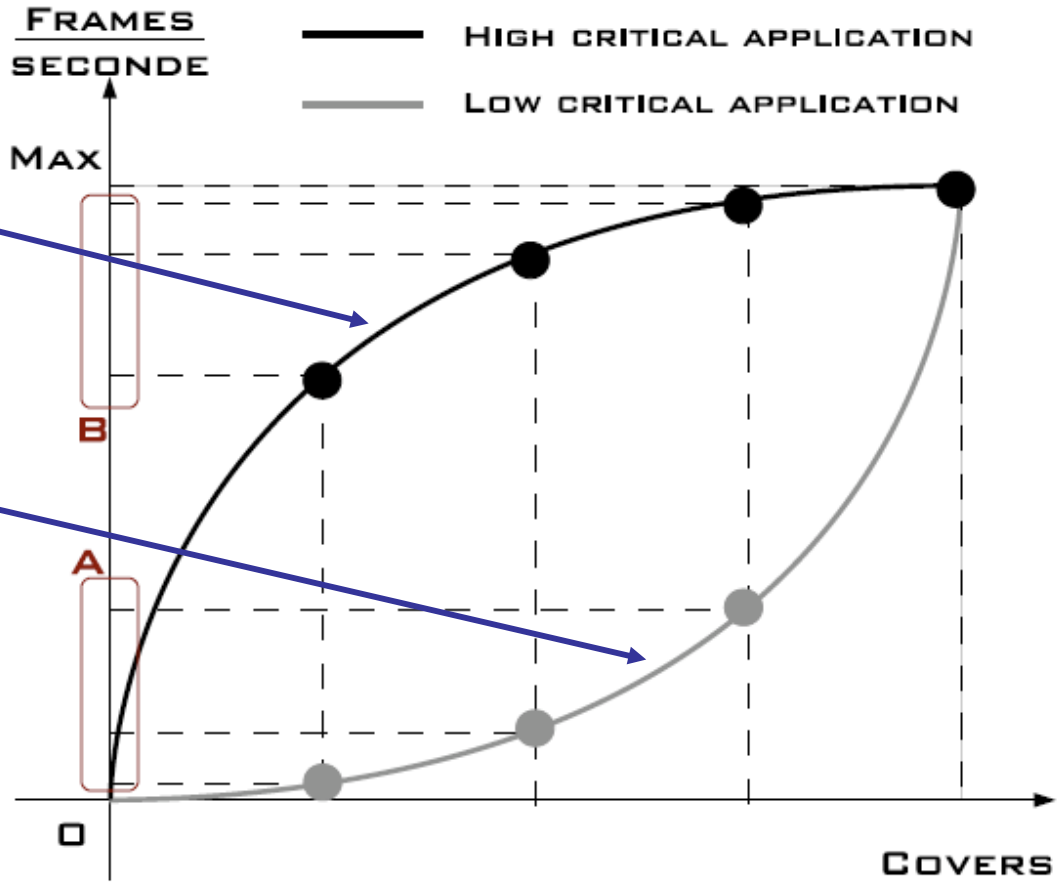
- Capture speed can be a « quality » parameter
- Capture speed for node v should depend on the app's criticality and on the level of redundancy for node v
- V's capture speed can increase when as V has more nodes covering its own FoV - cover set

Evolution of the video network nodes



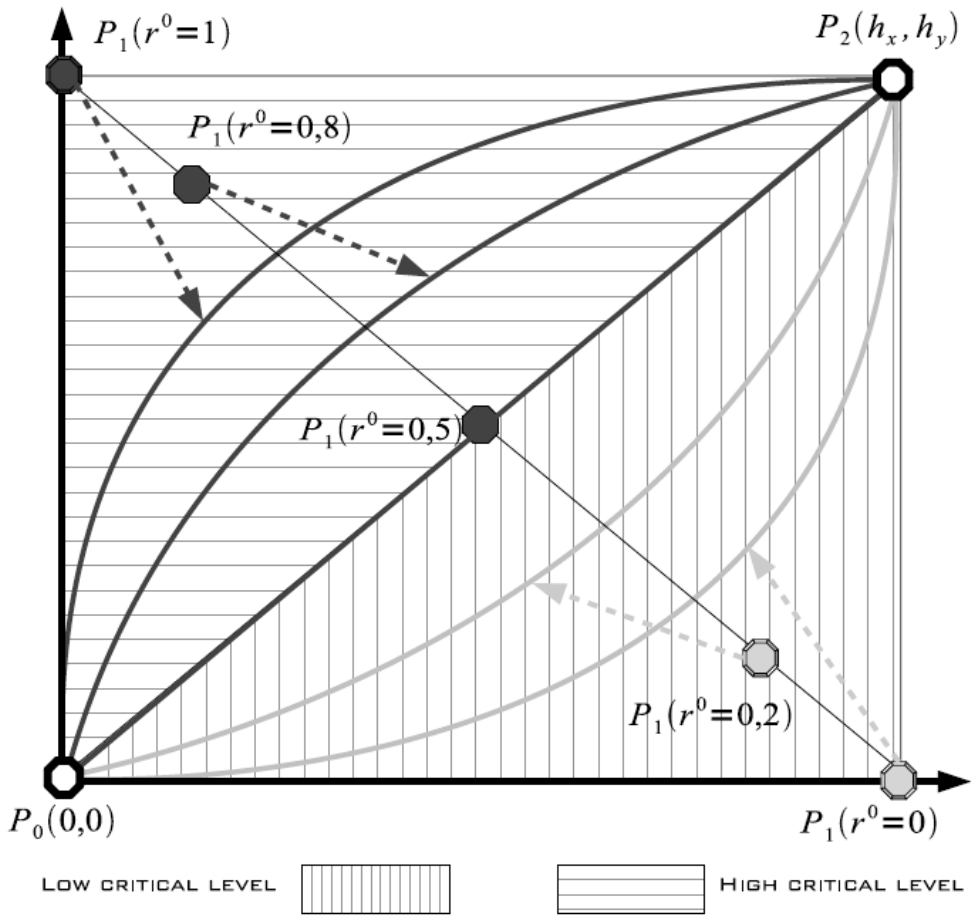
Criticality model (1)

- Link the capture rate to the size of the cover set
- High criticality
  - Convex shape
  - Most projections of x are close to the max capture speed
- Low criticality
  - Concave shape
  - Most projections of x are close to the min capture speed
- Concave and convex shapes automatically define sentry nodes in the network



Criticality model (2)

- r^0 can vary in [0,1]
- BehaVior functions (BV) defines the capture speed according to r^0
- $r^0 < 0.5$
  - Concave shape BV
- $r^0 > 0.5$
  - Convex shape BV
- We propose to use Bézier curves to model BV functions



Some typical capture speed

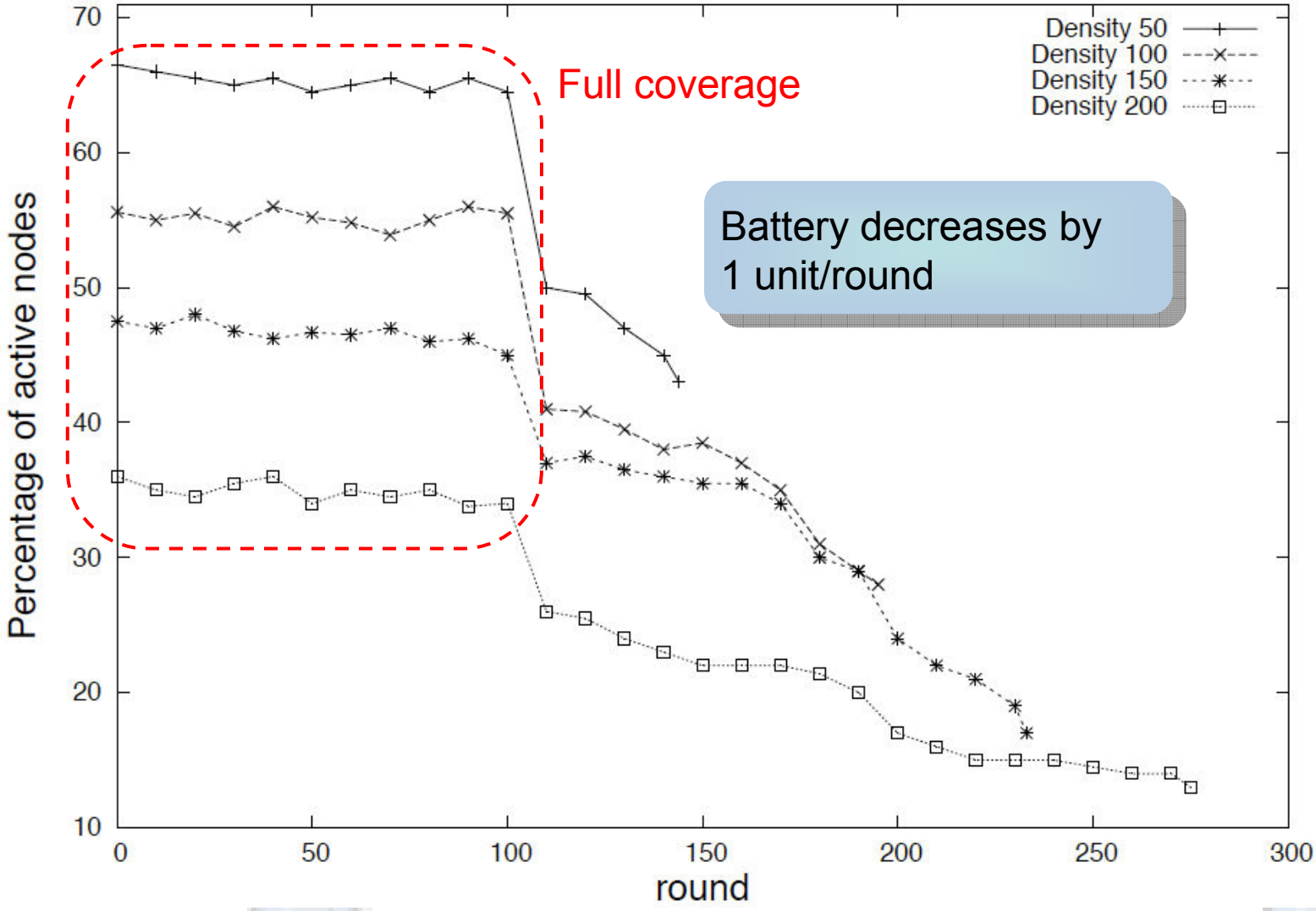
- Maximum capture speed is 6fps
- Nodes with size of cover set greater than 6 capture at the maximum speed

r^0 \ $\lvert Co(v)\rvert$	1	2	3	4	5	6
0.0	0.05	0.20	0.51	1.07	2.10	6.00
0.2	0.30	0.73	1.34	2.20	3.52	6.00
0.5	1.00	2.00	3.00	4.00	5.00	6.00
0.8	2.48	3.80	4.66	5.27	5.70	6.00
1.0	3.90	4.93	5.49	5.80	5.95	6.00

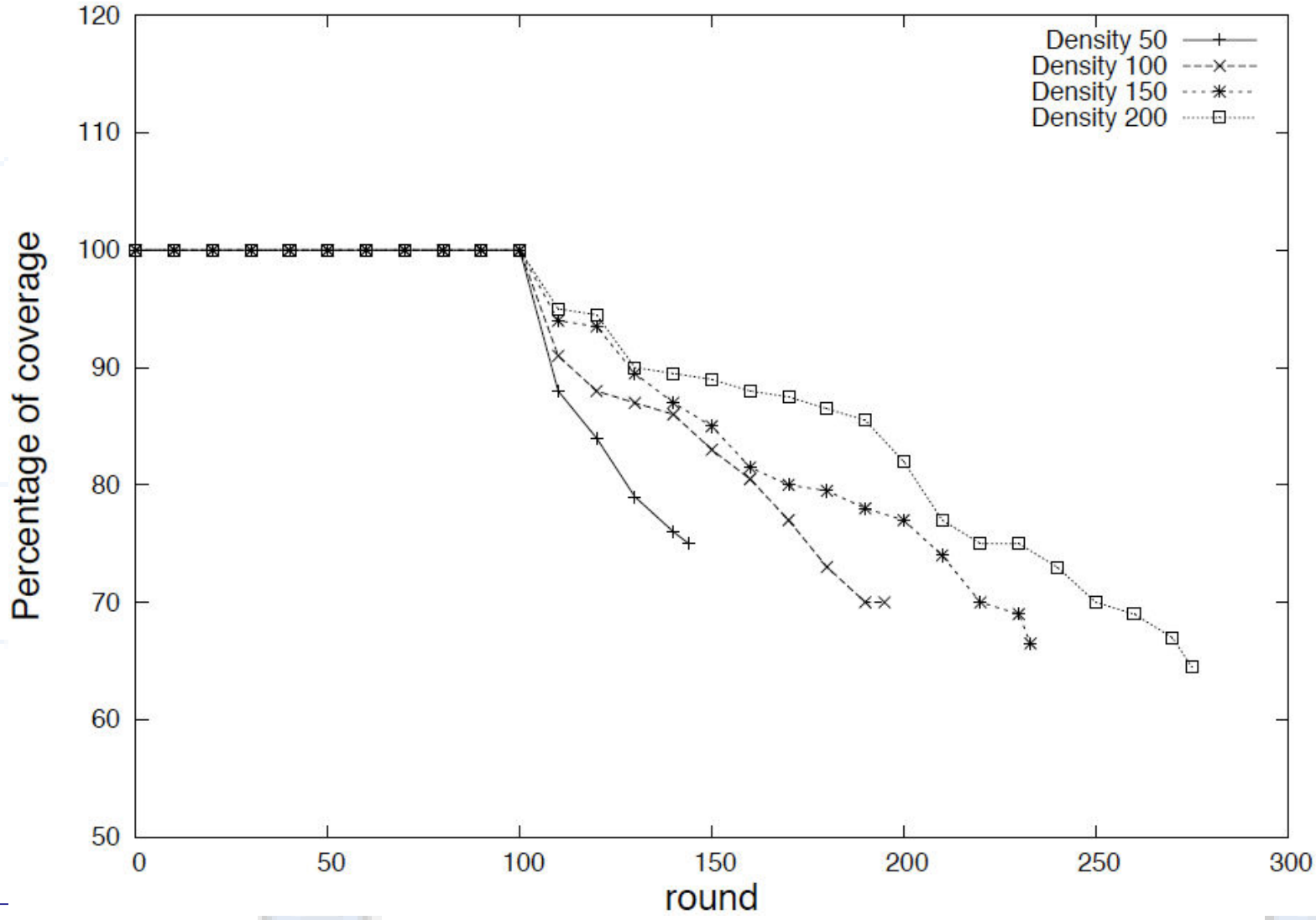
Simulation settings

- OMNET++ simulation model
- Video nodes have communication range of 30m and video sensing range of 25m, FoV is a sector of 60°
- Battery has 100 units
- Full coverage is defined as the region initially covered when all nodes are active

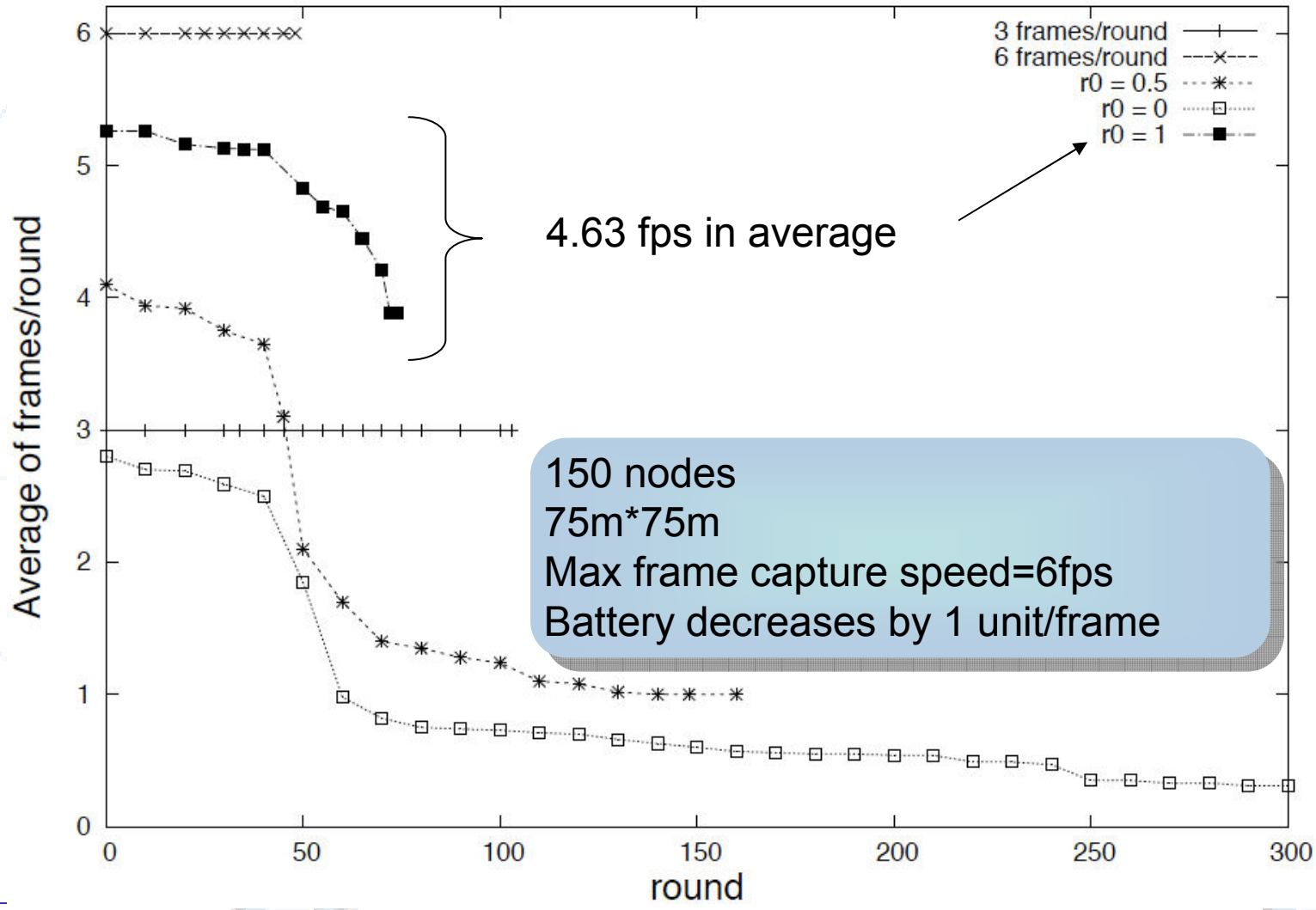
Percentage of active nodes



Percentage of coverage



Average capture speed



150 nodes
75m*75m
Max frame capture speed=6fps
Battery decreases by 1 unit/frame

Conclusions & future works

- Criticality model with adaptive scheduling of nodes
- Optimize the resource usage by dynamically adjusting the provided service level

- Extension for risk-based scheduling in intrusion detection systems
- Congestion control