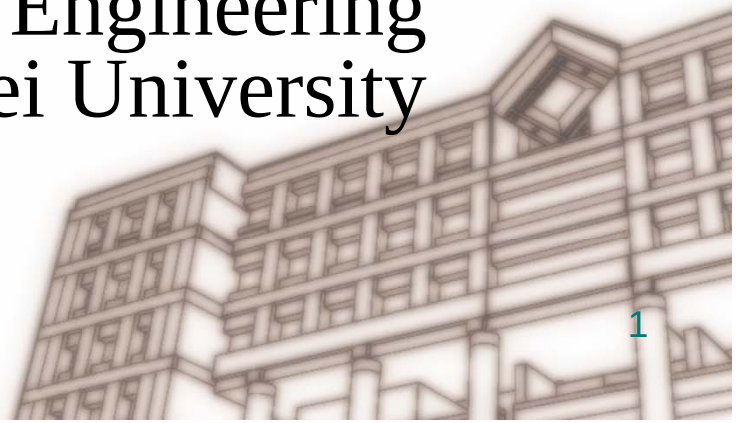
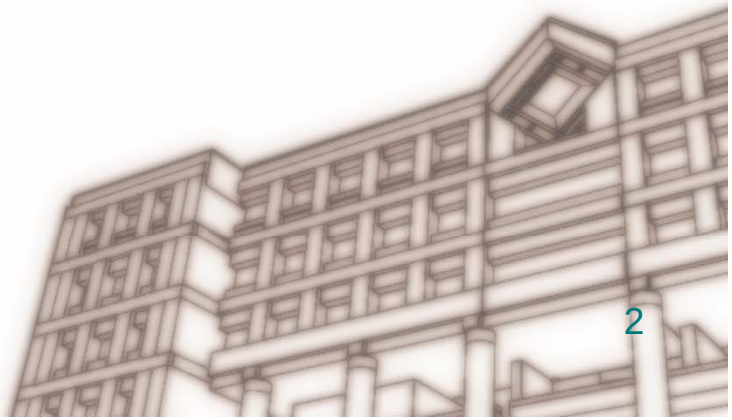
Chapter 12: HVE-Mobicast: A Hierarchical-Variant-Egg-Based Mobicast Routing Protocol for Wireless Sensornets

Prof. Yuh-Shyan Chen
Department of Computer Science
and Information Engineering
National Taipei University



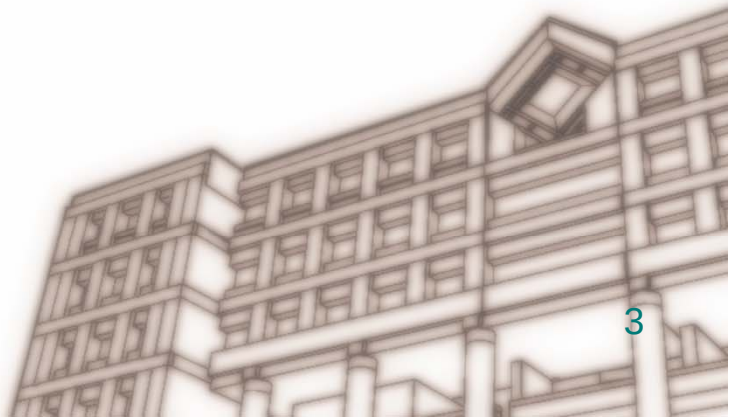
Publication

- ***IEEE Wireless Communications and Networking Conference*** (**WCNC 2006**), Las Vegas, NV, USA, 3-6 April 2006.
- ***Telecommunication Systems***, Vol. 41, No. 2, pp. 121-140, June 2009. (2008 SCI=0.423)



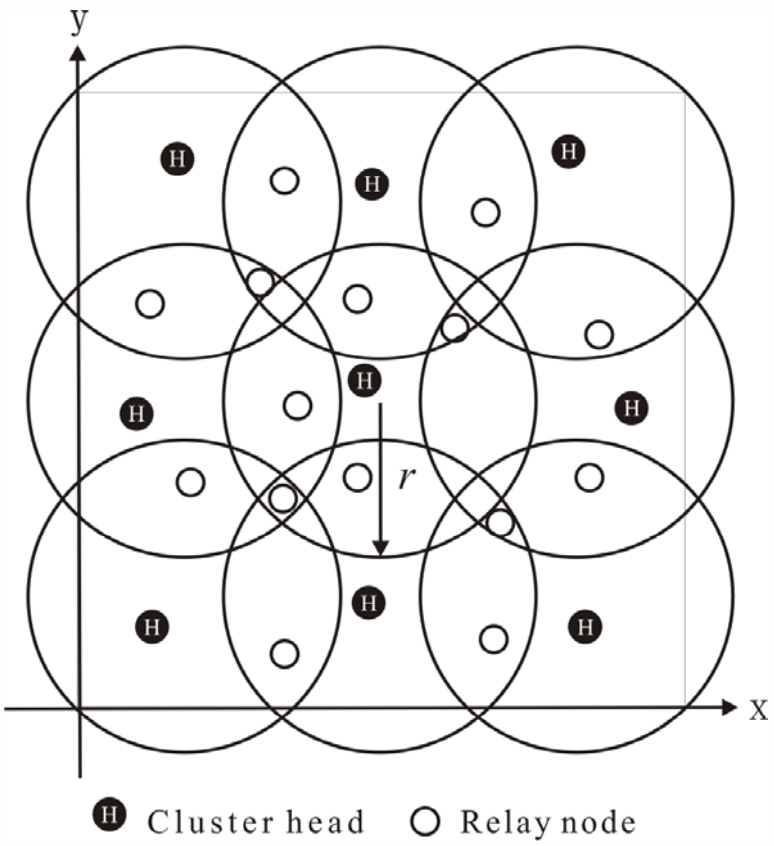
Outline

1. Key contributions of the HVE-mobicast routing protocol
2. Related works
3. A Hierarchical-Variant-Egg-Based Mobicast Routing Protocol for Wireless Sensornets
4. Performance analysis
5. Conclusion

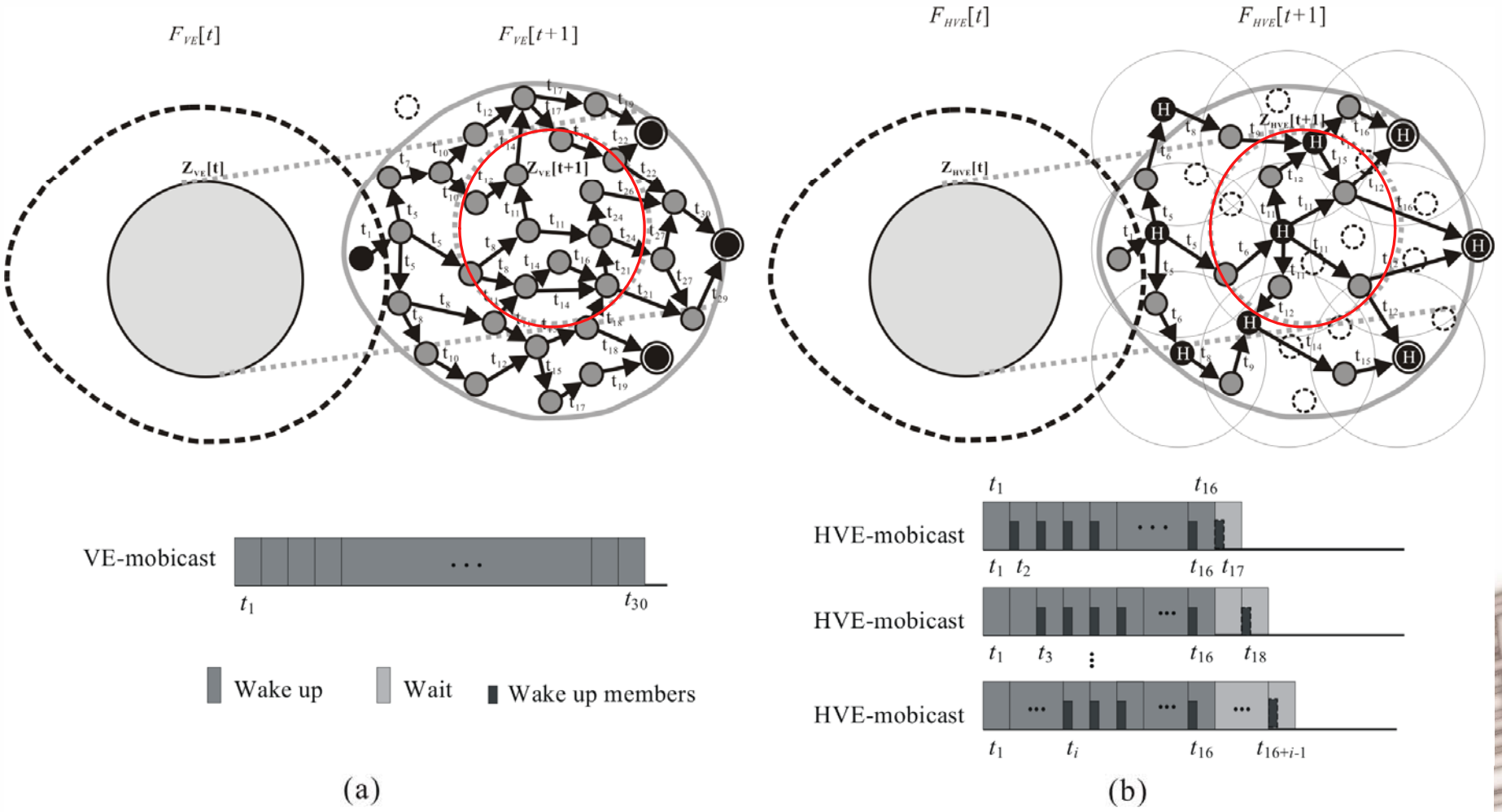


Our basic idea

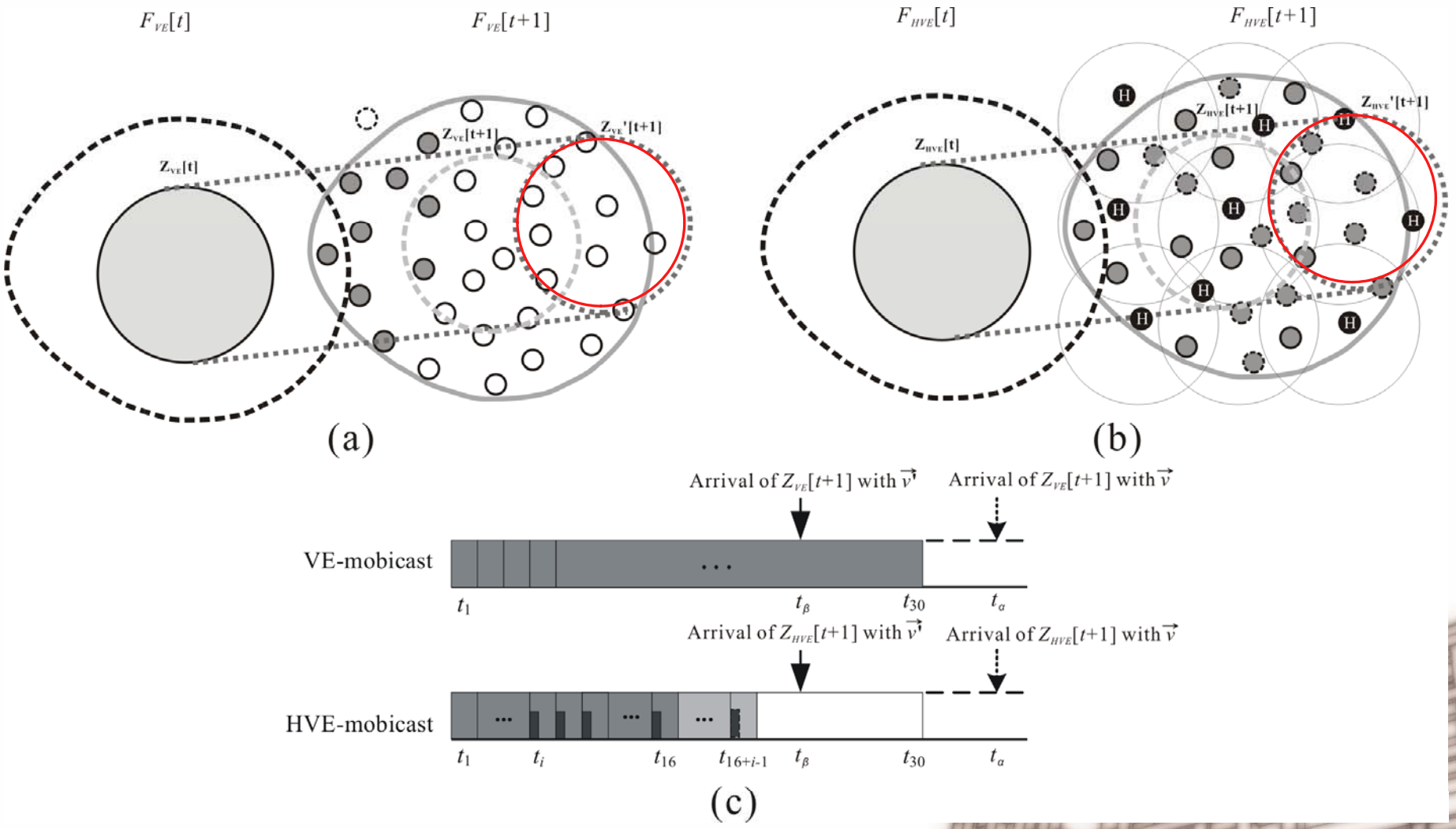
- Proactive construct environment
  - Hierarchical structure –cluster



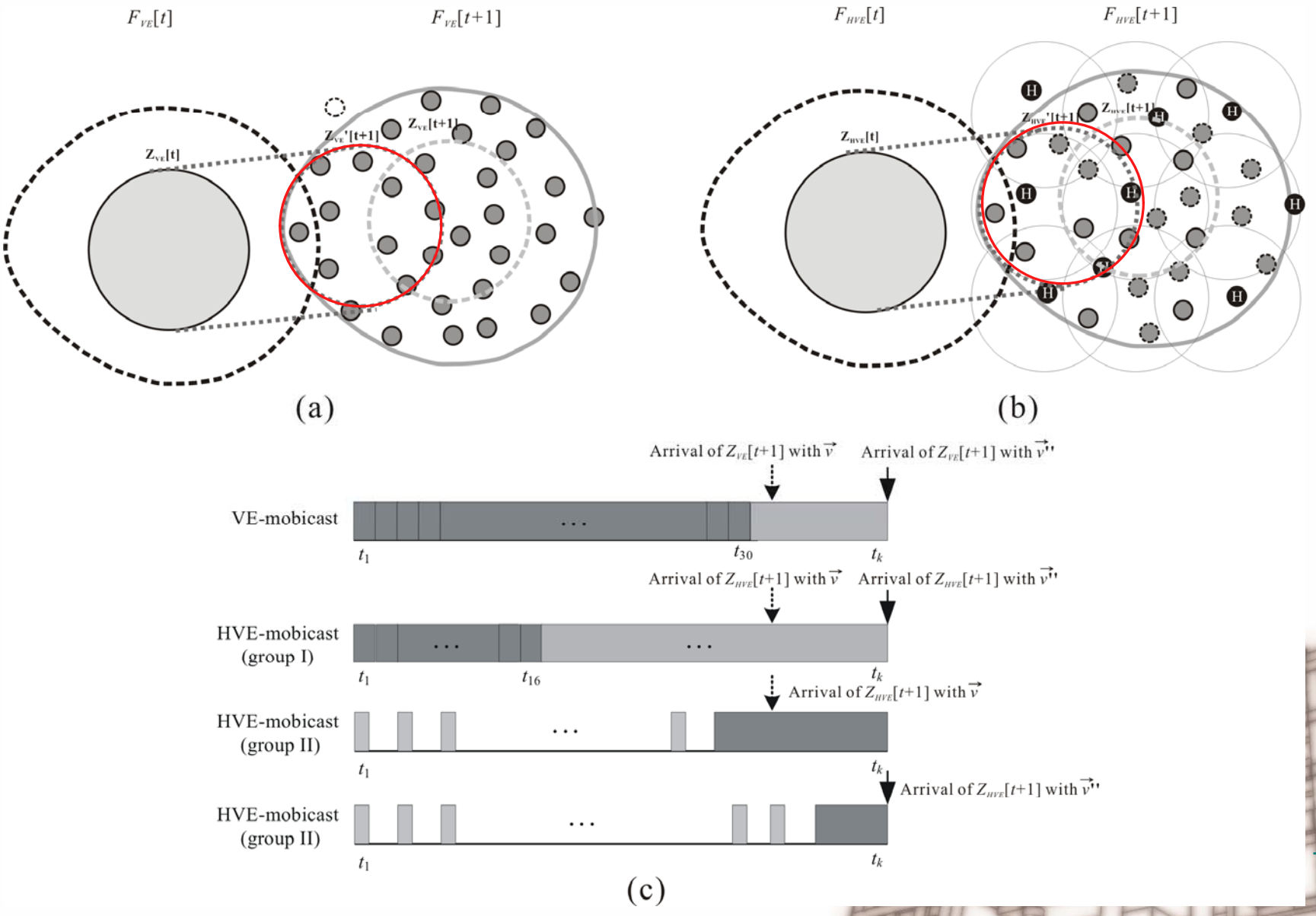
Normal situation



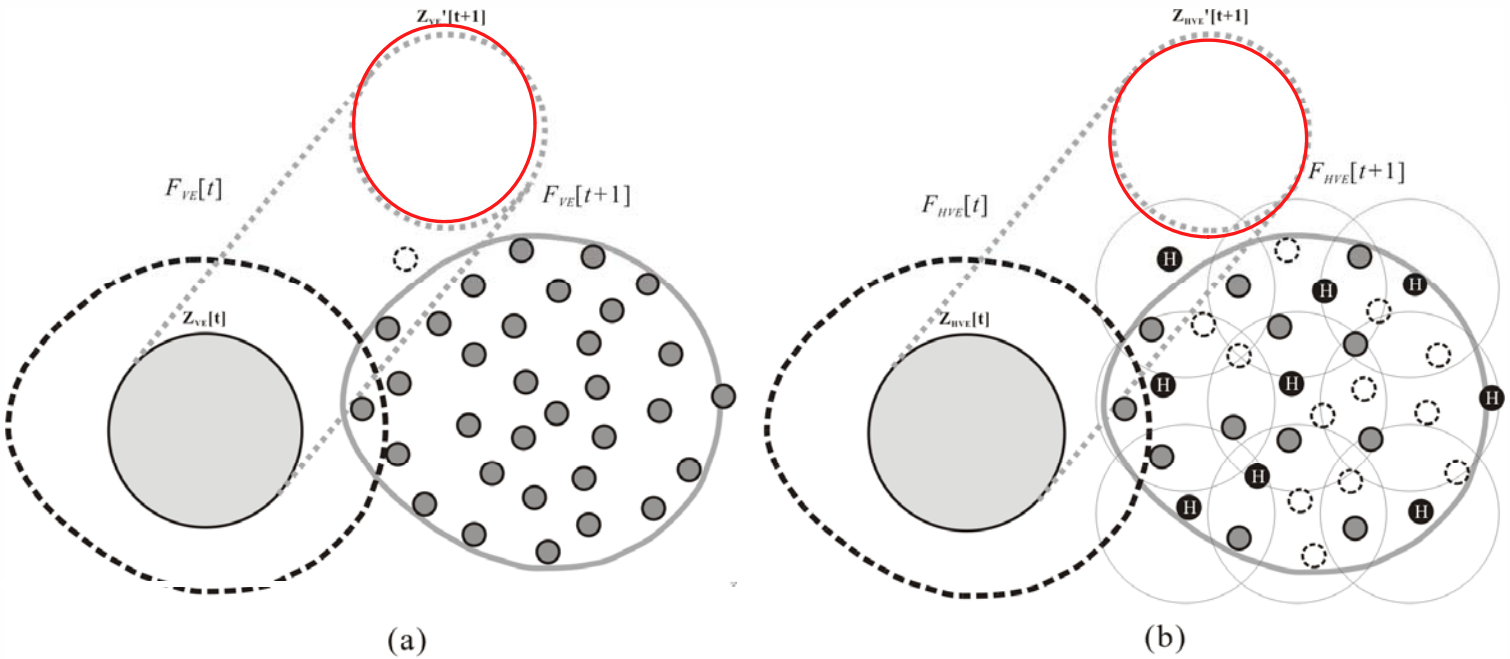
Increase speed

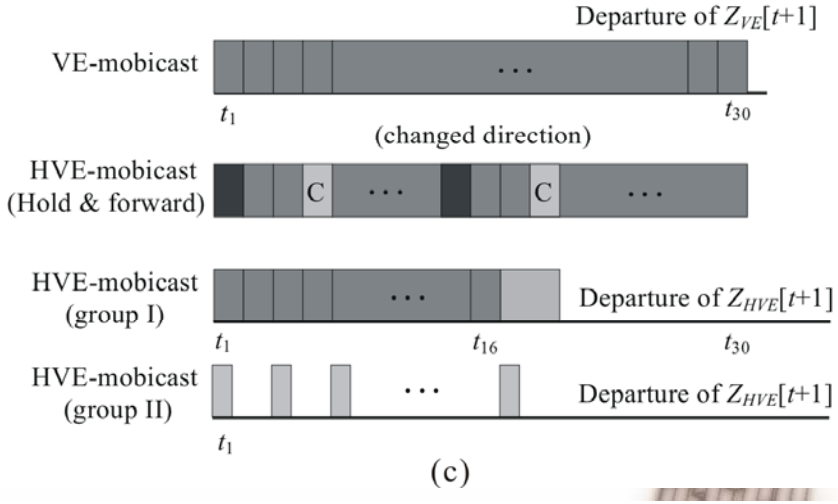


Decrease speed



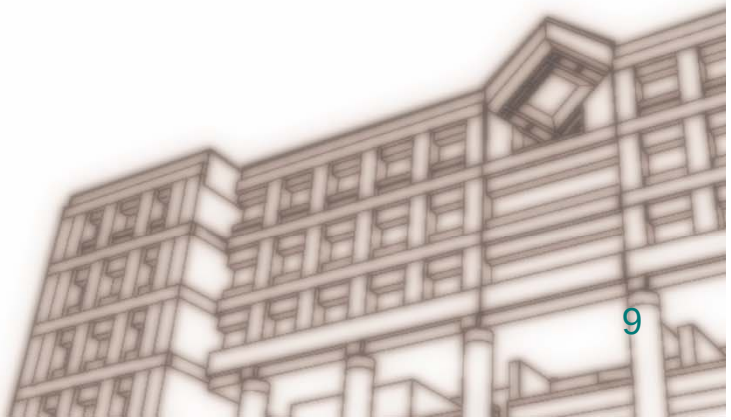
Changed direction



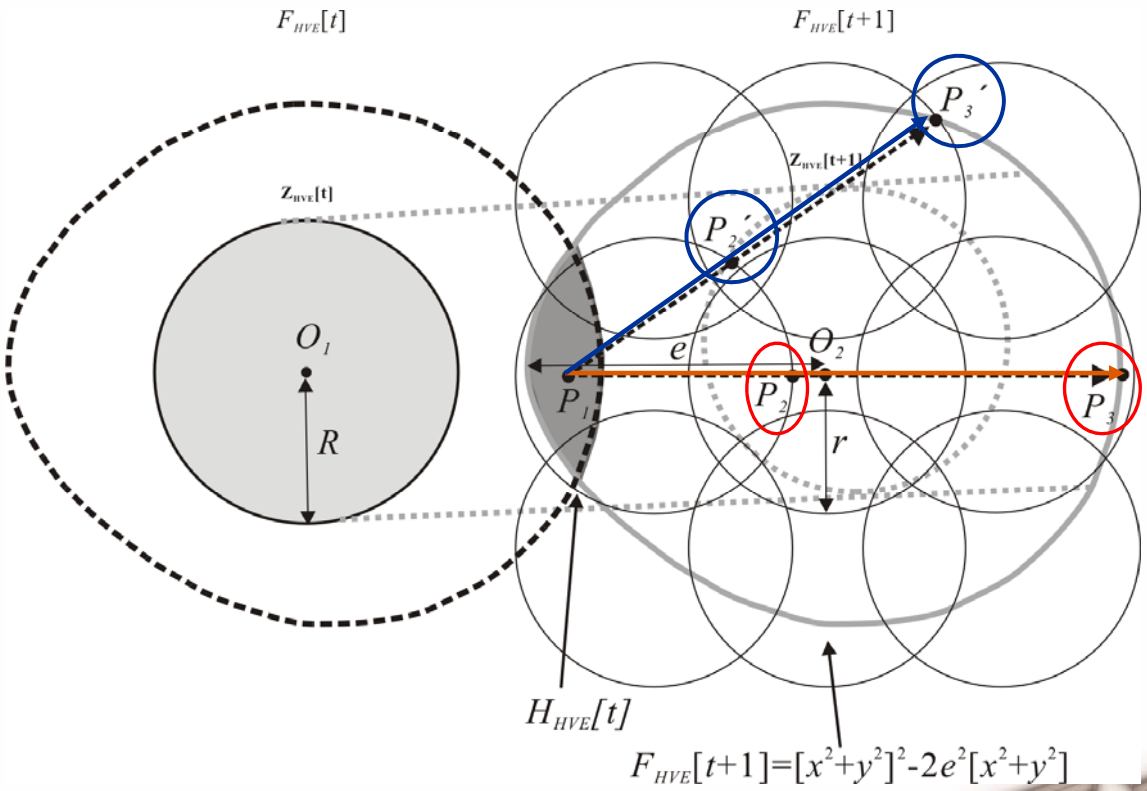


A Hierarchical-Variant-Egg-Based Mobicast Routing Protocol in Sensornets

- Variant-egg forwarding zone can adapt to dynamic speed of delivery zone
- Two phases
  - Phase I: Egg estimation phase
  - Phase II: Distributed Hierarchical-variant-egg-based mobicast phase



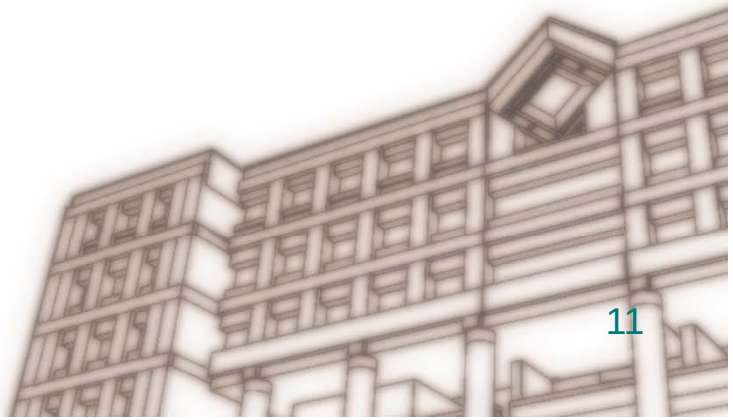
Phase I: Egg estimation phase



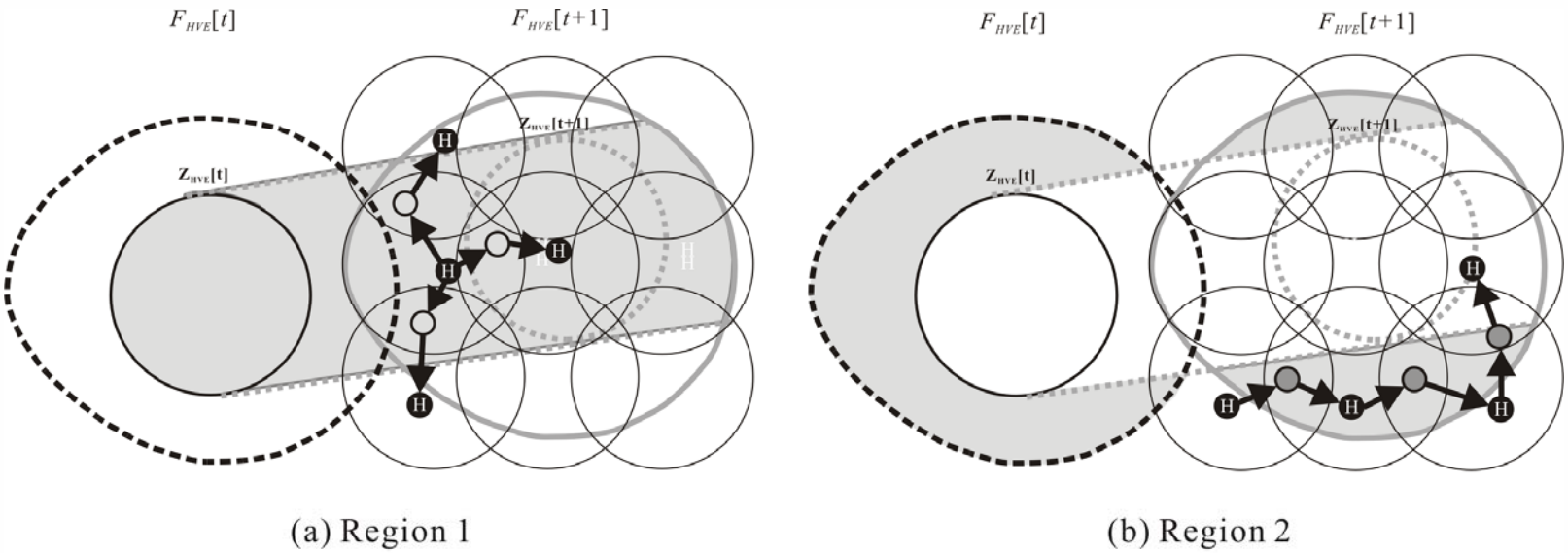
- P_1 forward message through P_2 within $\frac{\overline{P_2P_3}}{r}+1$

Phase II: Distributed Hierarchical-variant-egg-based mobicast phase

- Control packet $P_{HVE}(\frac{h}{H}, N_{11}, N_{12}, ..., N_{1j})_{t_j}$
  - $\frac{h}{H}$ is used to limit the number of packet forwarding
  - N_{11}, N_{12}, …, N_{1j} keeps the path history
  - P_{HVE} packet is forwarded at time t_i
  - New P_{HVE} packet is forwarded at $t_x = t_y + d + backoff\_time$
  - *d:* number of relay nodes



Forwarding rule for relay nodes

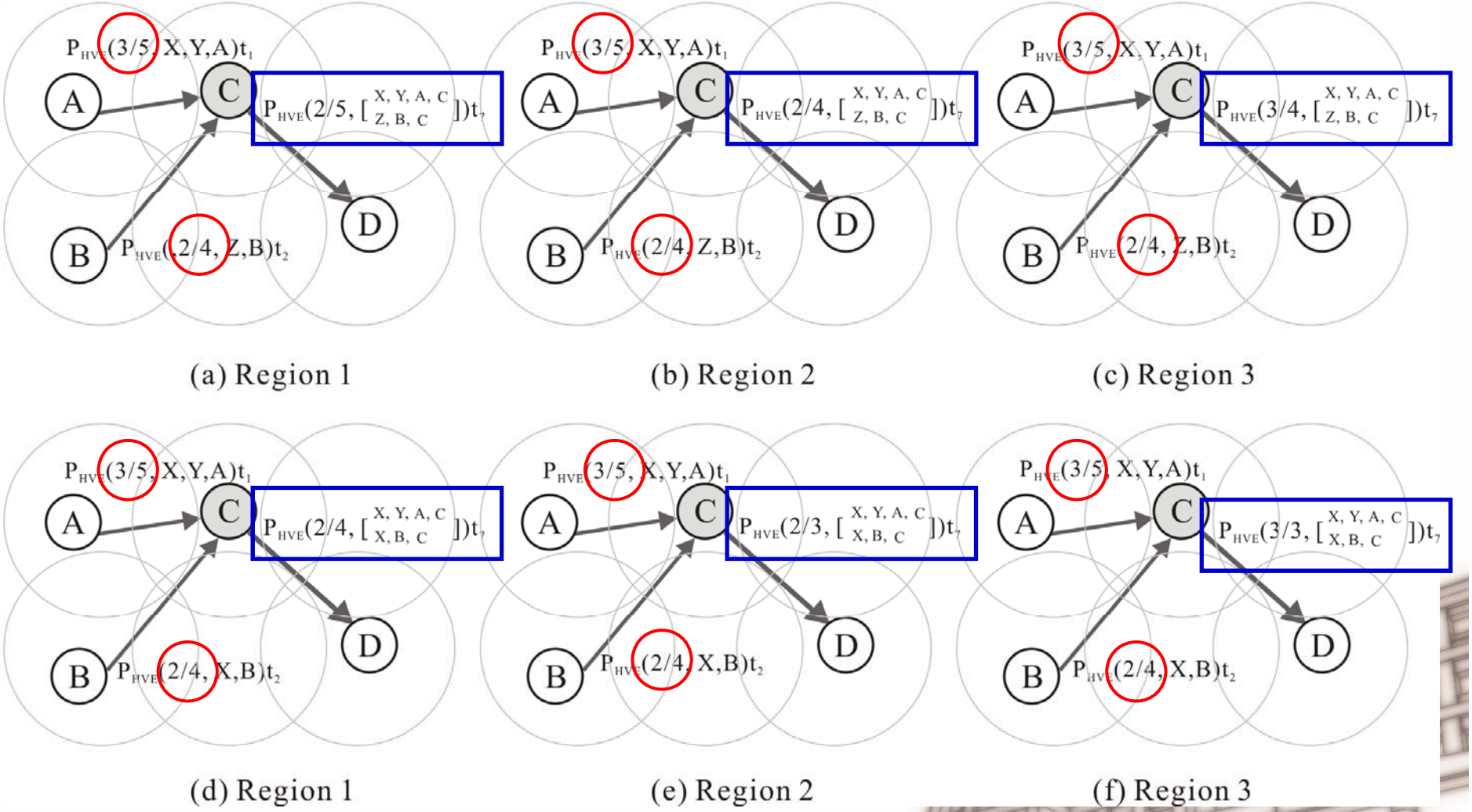


(a) Region 1

(b) Region 2

(c) Region 3

Merging rule for cluster head

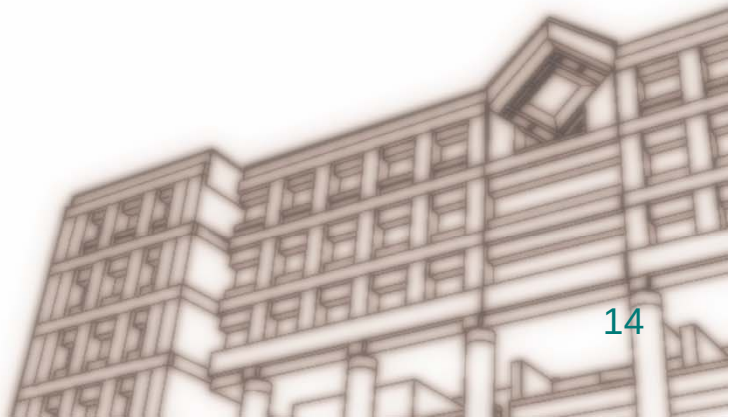


(a) Region 1 (b) Region 2 (c) Region 3

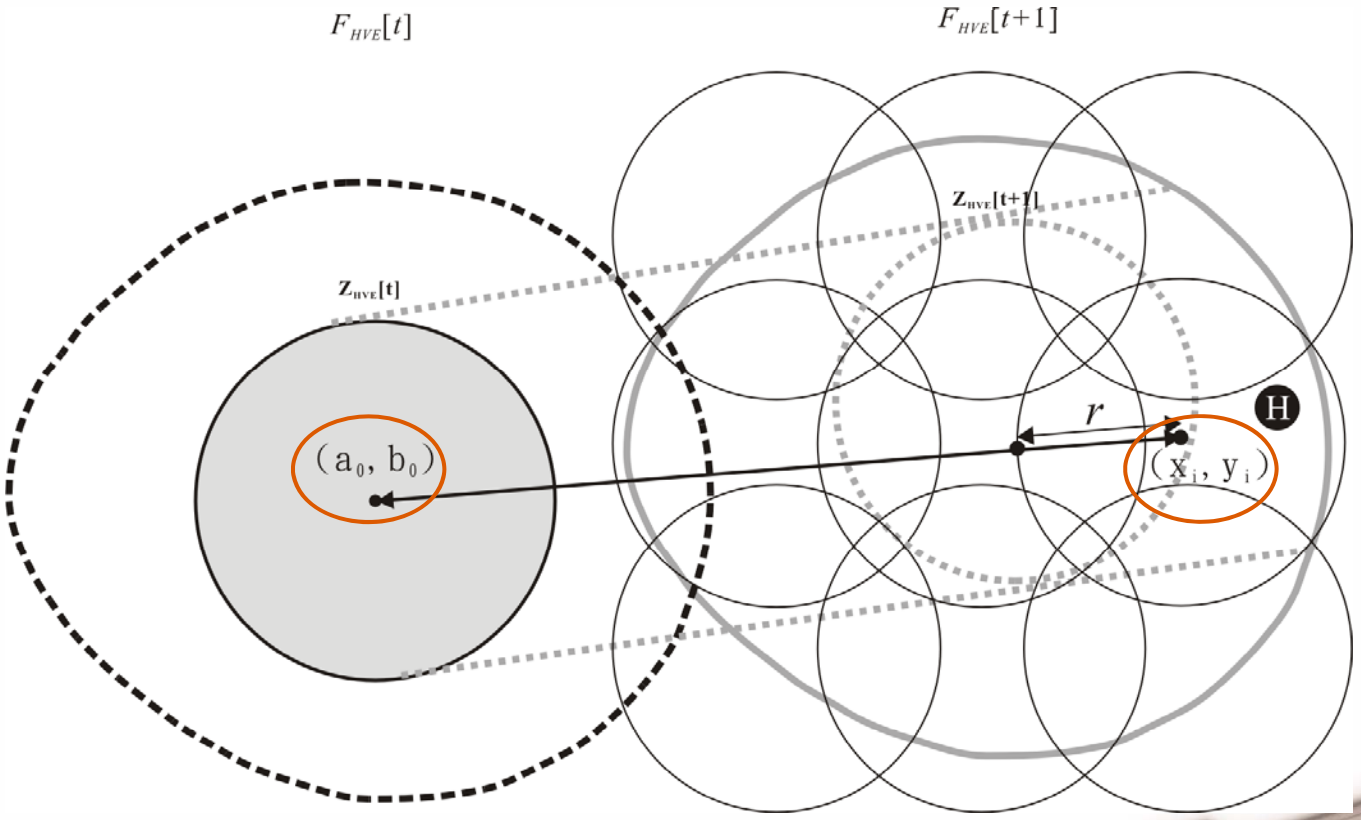
(d) Region 1 (e) Region 2 (f) Region 3

The rule of merging operations

- Let $\frac{h_{merge}}{H_{merge}} = \frac{\underset{1 \le i \le m}{Min} \; h_i}{\underset{1 \le i \le m}{Max} \; H_i}$, if H is in region 1
- Let $\frac{h_{merge}}{H_{merge}} = \frac{\underset{1 \le i \le m}{Min} \; h_i}{\underset{1 \le i \le m}{Min} \; H_i}$, if H is in region 2
- Let $\frac{h_{merge}}{H_{merge}} = \frac{\underset{1 \le i \le m}{Max} \; h_i}{\underset{1 \le i \le m}{Min} \; H_i}$, if H is in region 3



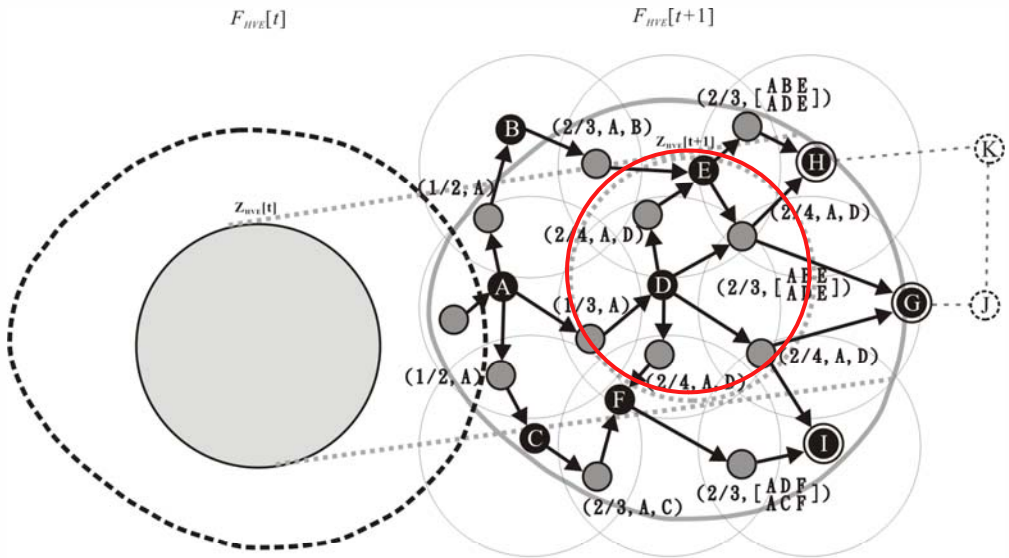
The setting of *waiting timer*



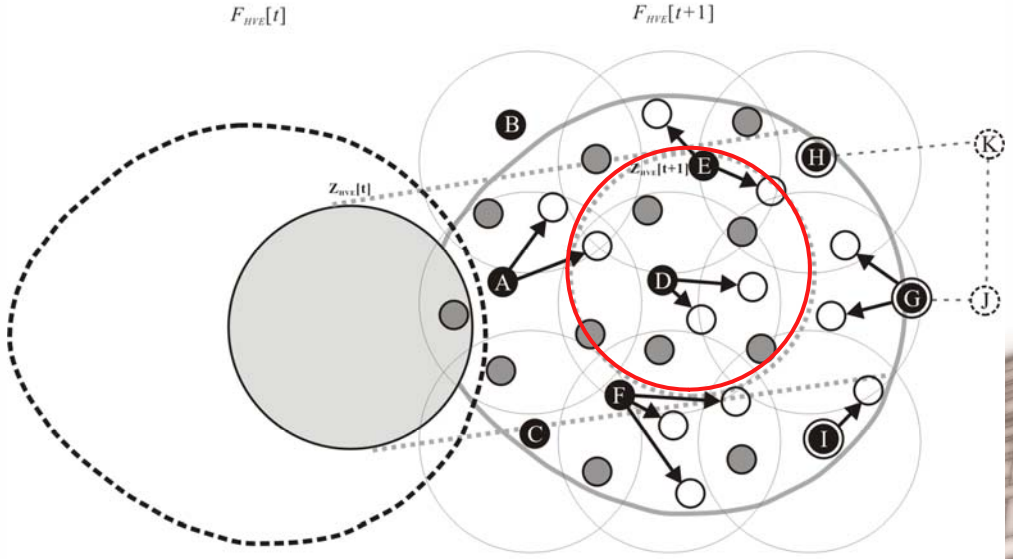
The setting of *waiting timer*

- *Waiting timer:* $T_w = T' - T''$
- $T' = \frac{D((x_i, y_i) - (a_0, b_0)) - r}{|V|}$
  - (x_i, y_i) is the center point of cluster *i*
  - (a_0, b_0) is the center point of the $Z_{HVE}[t]$
  - $D((x_i, y_i) - (a_0, b_0))$ is the distance between (x_i, y_i) and (a_0, b_0)
- $T'' = \underset{1<x<N}{Min} t_x$, N is the number of relay nodes
  - If *waiting timer > 0*, cluster head will wake up members while the *waiting timer* is expired
  - Otherwise, if *waiting timer* <= 0, cluster head will wake up members instantly.

Normal situation

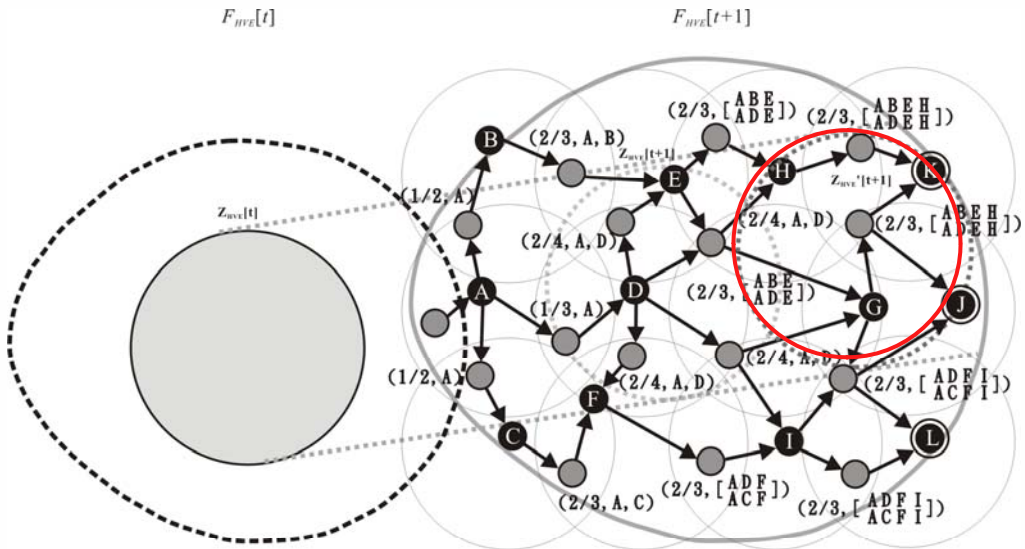


(a)

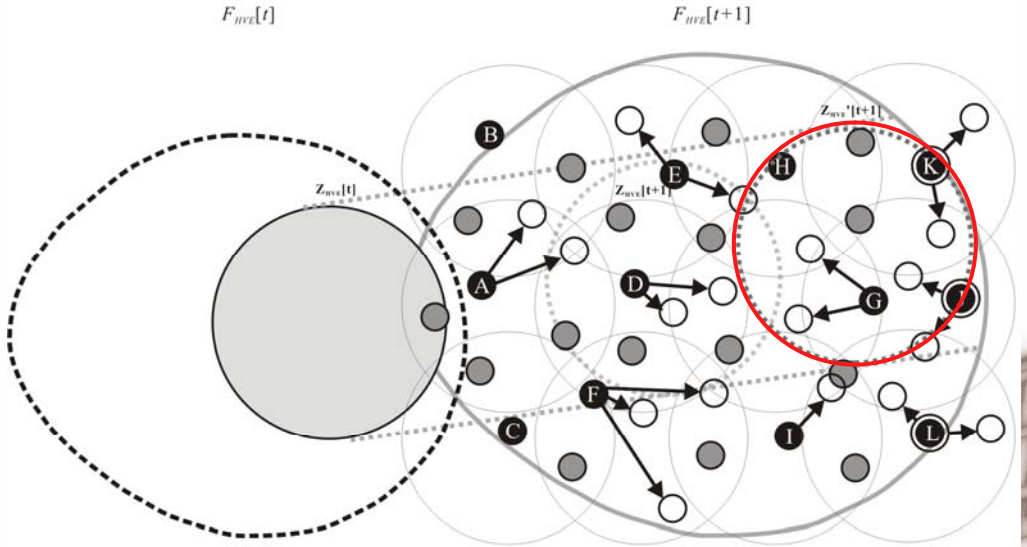


(b)

Increase speed

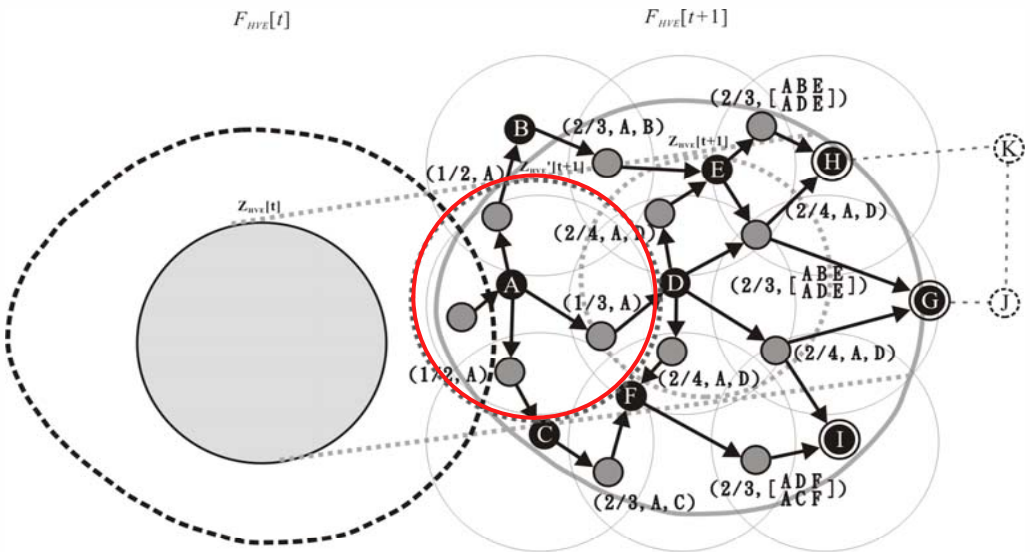


(a)

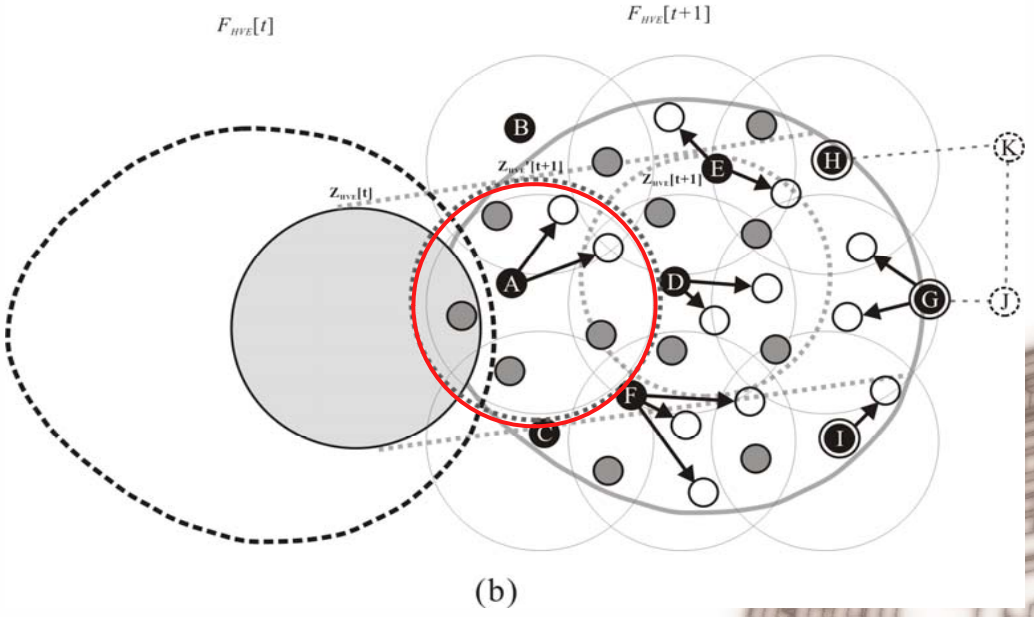


(b)

Decrease speed

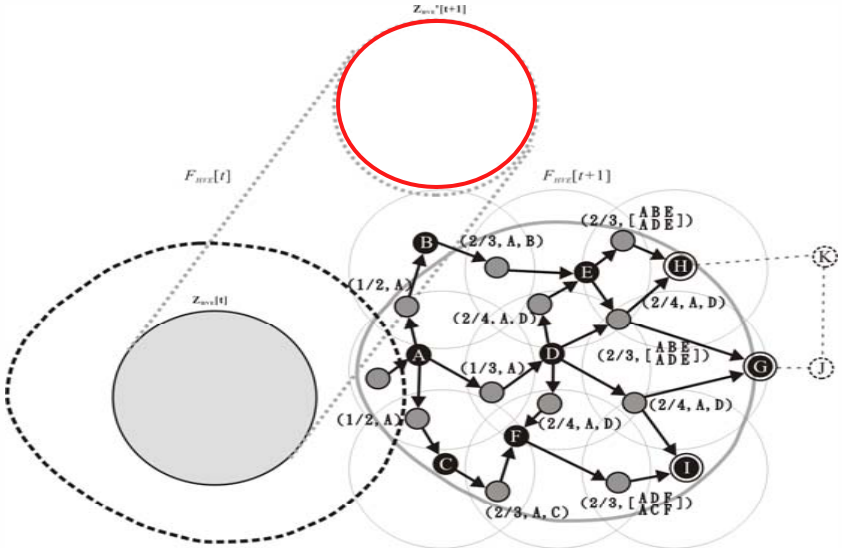


(a)

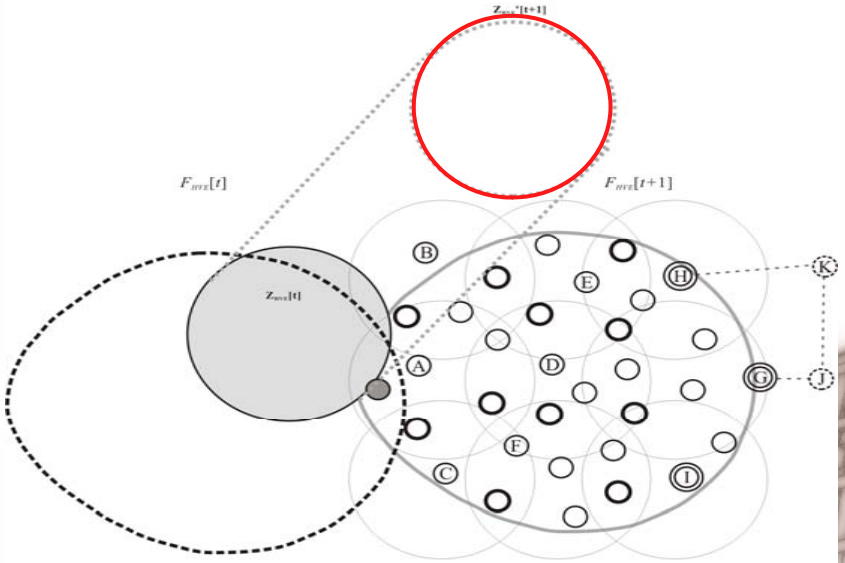


(b)

Change direction

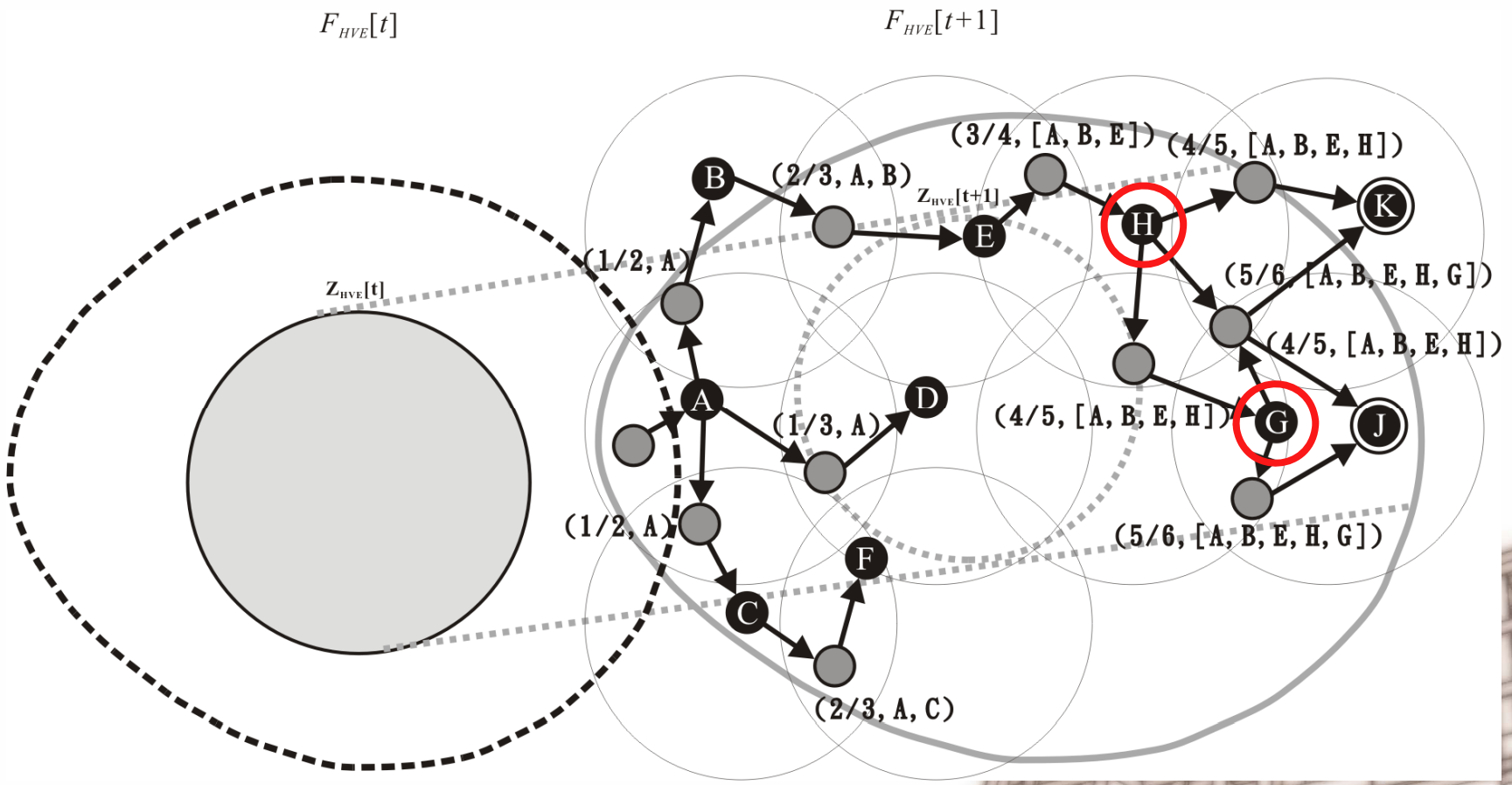


(a)



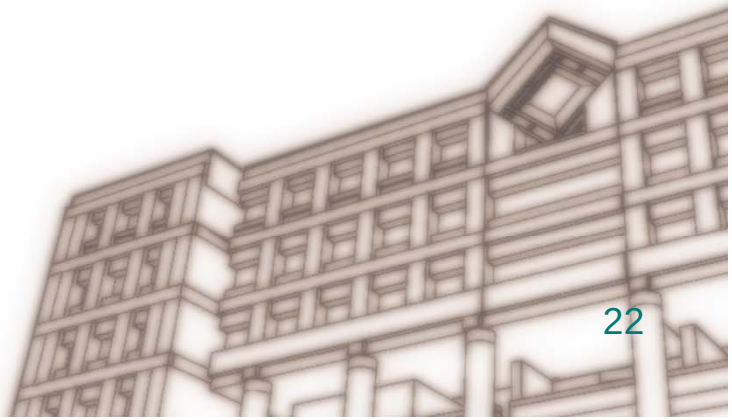
(b)

Example of hole problem in HVE-mobicast



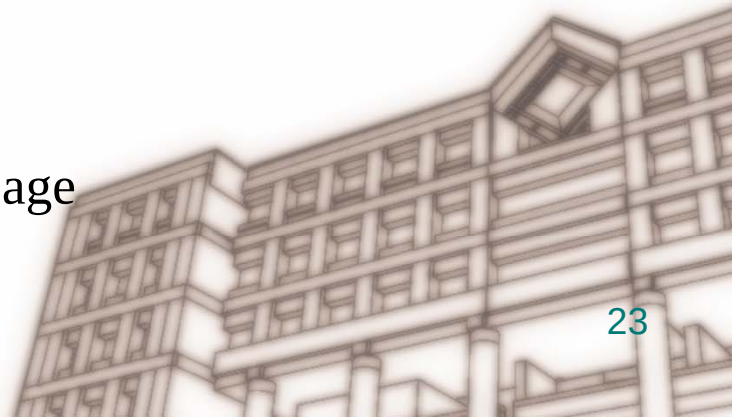
Outline

1. Key contributions of the HVE-mobicast routing protocol
2. Related works
3. A Hierarchical-Variant-Egg-Based Mobicast Routing Protocol for Wireless Sensornets
4. Performance analysis
5. Conclusion



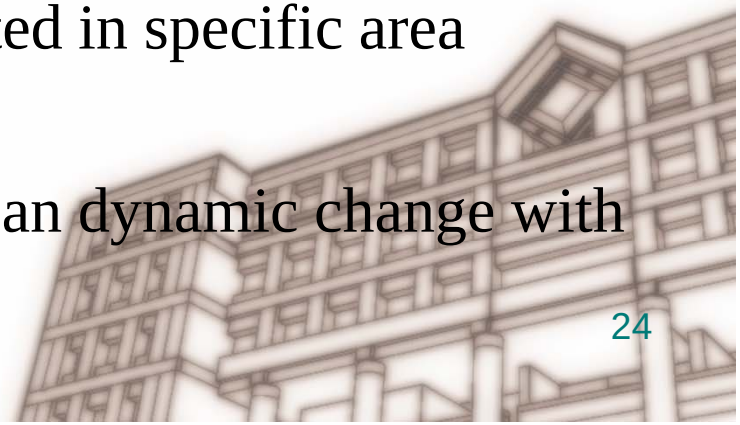
Performance analysis

- The simulation environment
  - 1000 x 800 m^2 area with 800 sensor nodes which are setting by random
  - The communication radius of sensor node is 35 meters
  - The delivery zone is a circular delivery zone
    - velocity is 45 m/sec and radius is 45 meters
  - Consumption of power is denoted as n = W (walt)
    - n = 1, sensor node in sleeping mode
    - n = 5, sensor node in active mode
    - n = 10, sensor node transmits the message



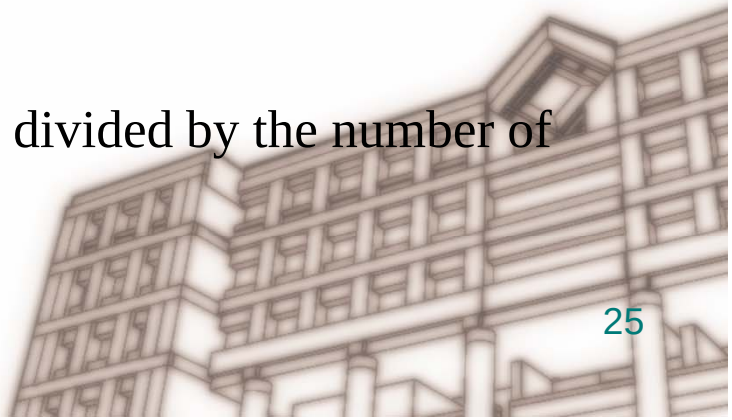
Parameters

- Rotation frequency (RF)
  - The total numbers that spatiotemporal application changes the direction using
- Rotation angle (RA)
  - The angle that spatiotemporal application change
    - Simulation has nine different angles from 5 to 45
- Network Density (ND)
  - The density of sensor nodes are located in specific area
- Moving Speed (MV)
  - The moving speed of delivery zone can dynamic change with time

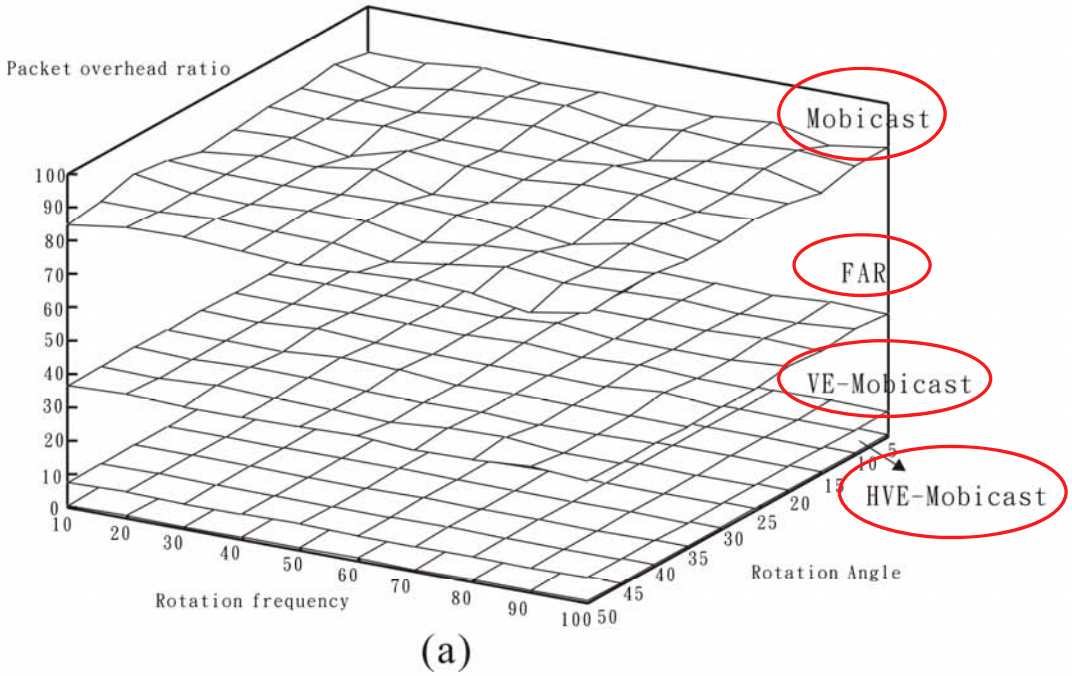


Performance metrics

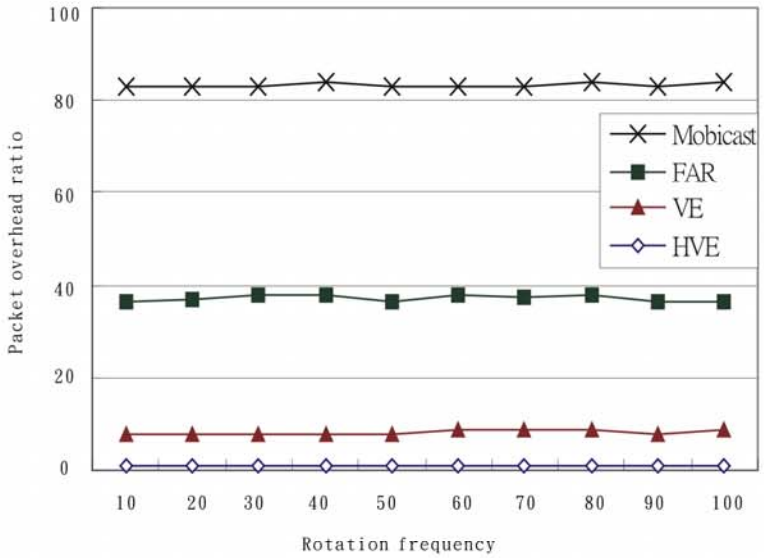
- Packet Overhead (PO)
  - The total numbers packets that every sensor node transmits including the control and mobicast message
- Power Consumption (PC)
  - The total power of every sensor nodes that consume in simulation time
- Needless Wake-up Nodes (NWN)
  - The number of wake-up nodes in the forwarding zone that delivery zone does not go through them
- Successful Wake-up Ratio (SWR)
  - The number of wake-up nodes in $F_{HVE}[t+1]$ is divided by the number of nodes should be wake up in $F_{HVE}[t+1]$



Performance of *packet overhead* vs. *rotation frequency*

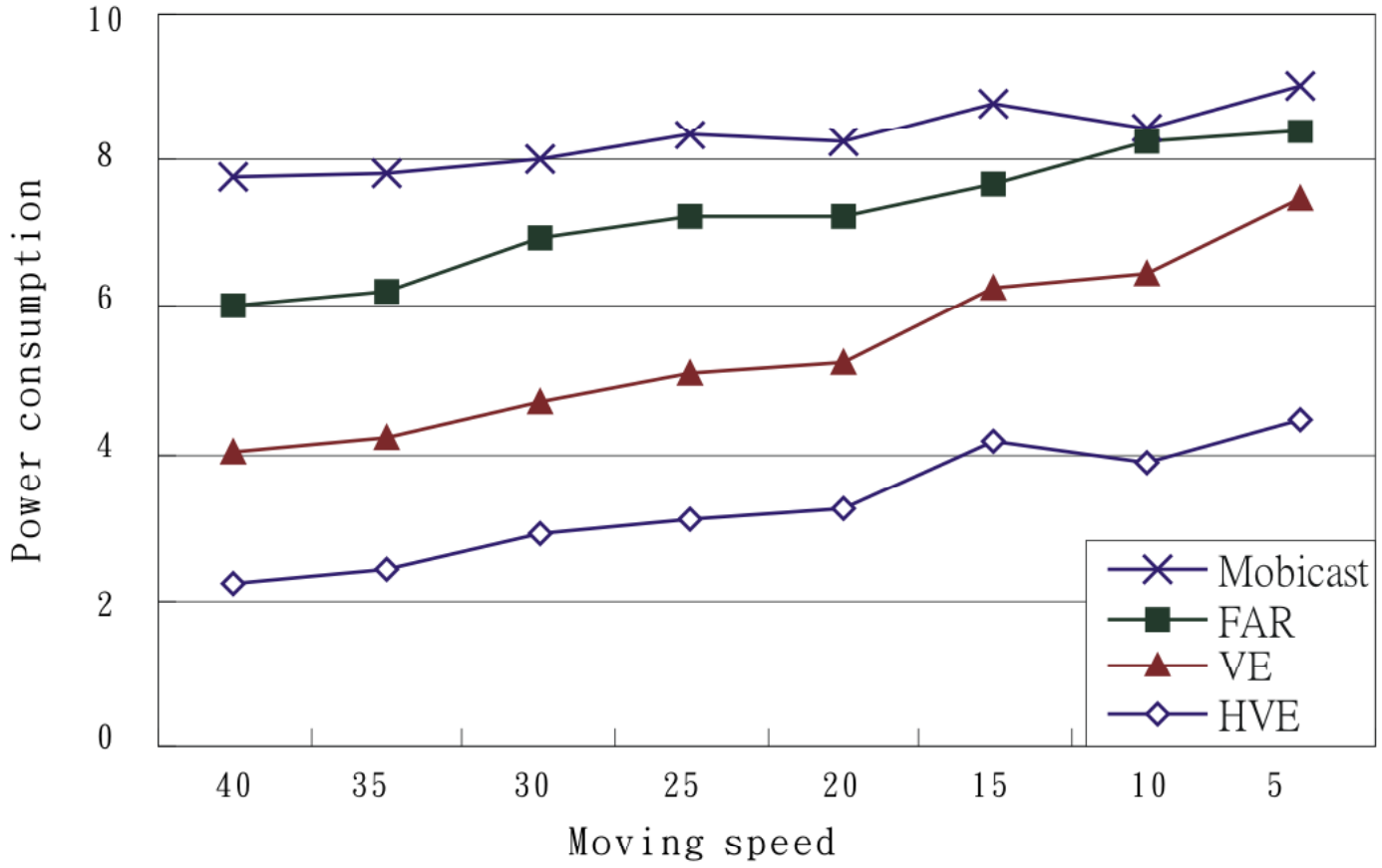


(a)

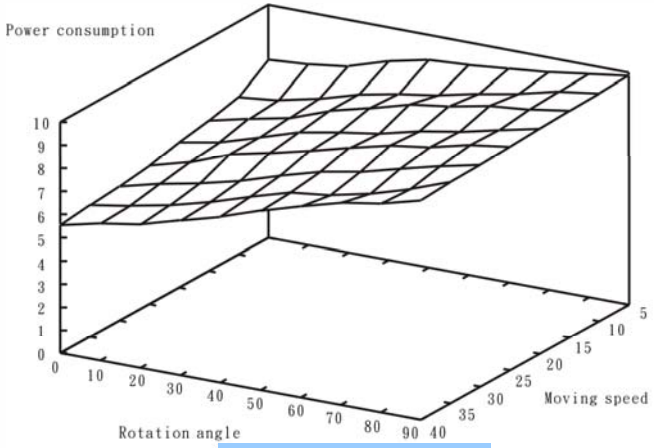


(b)

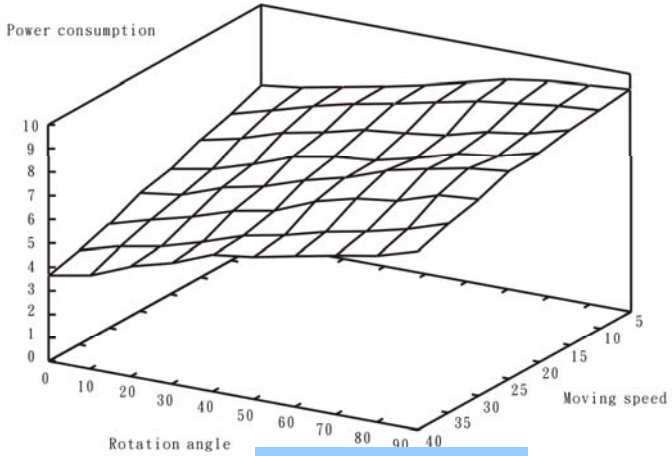
Performance *power consumption* vs. *moving speed*



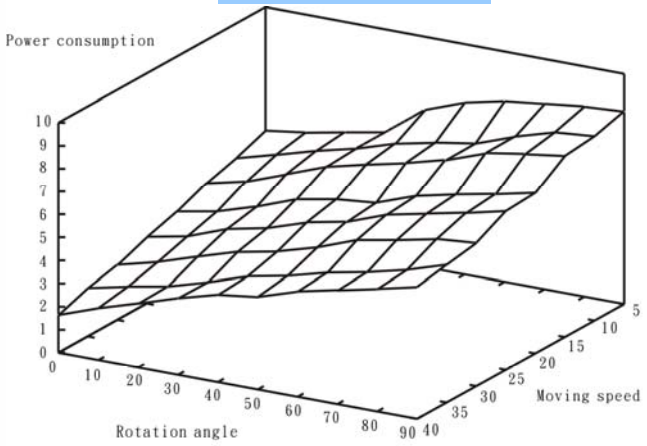
Performance of *power consumption* vs. *moving speed*



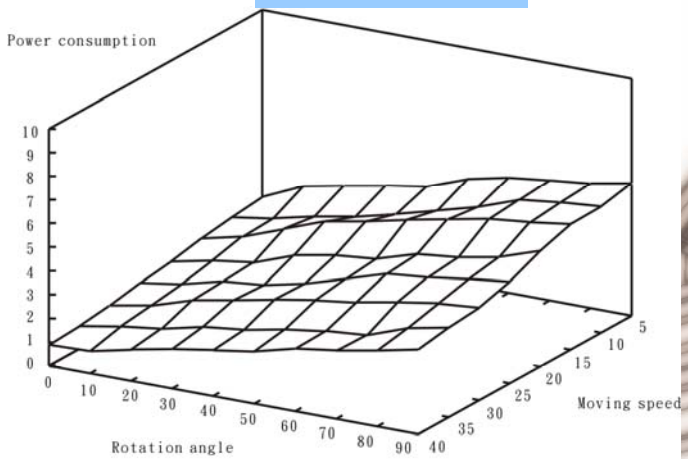
a) Mobicast



b) FAR

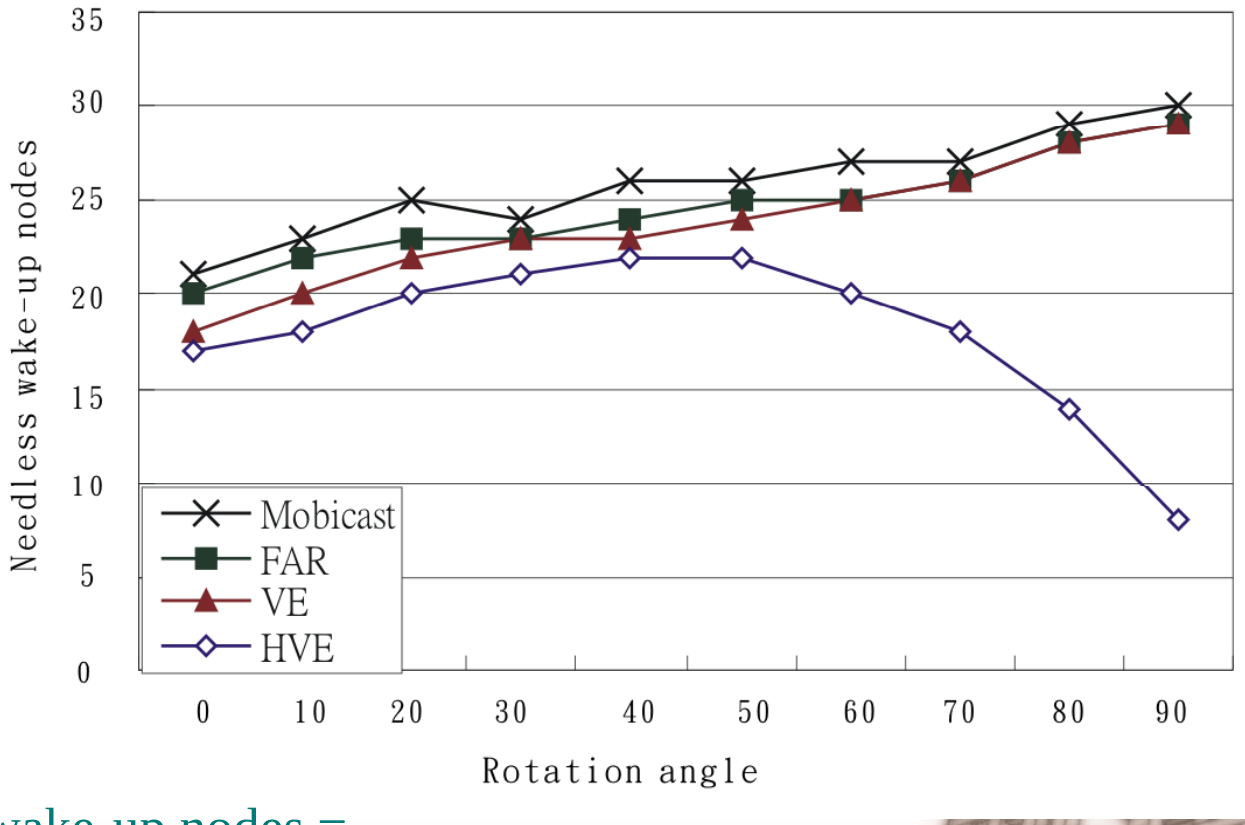


c) VE-Mobicast



d) HVE-Mobicast

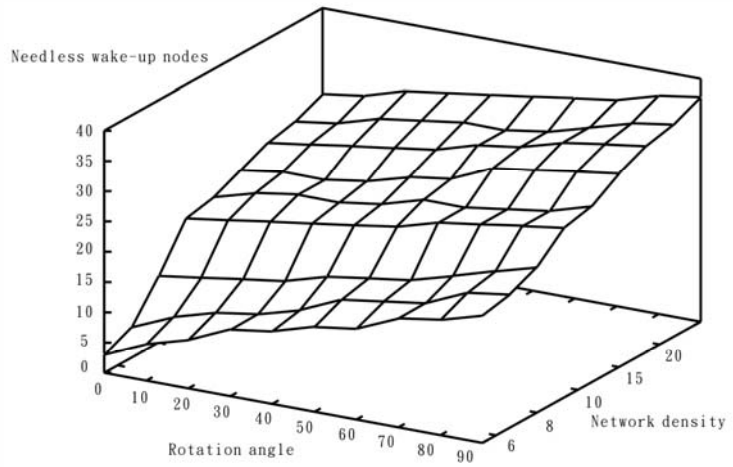
Performance *needless wake-up nodes* vs. *rotation angle*



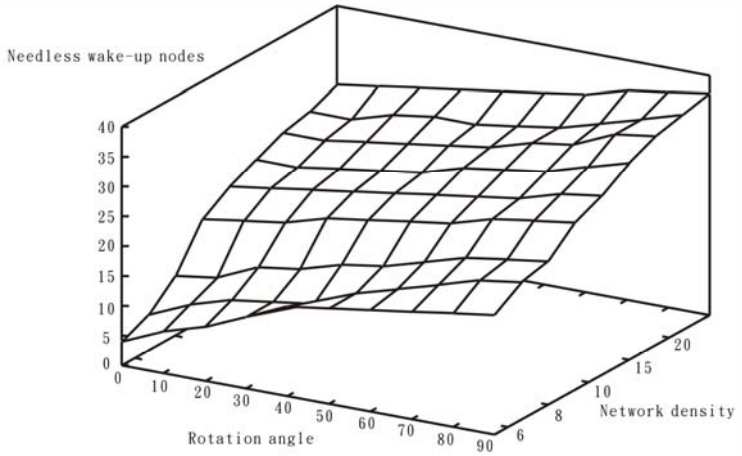
Needless wake-up nodes =

Forwarding zone 已經叫醒的 nodes數 – delivery zone在forwarding zone 實際所經過的nodes數

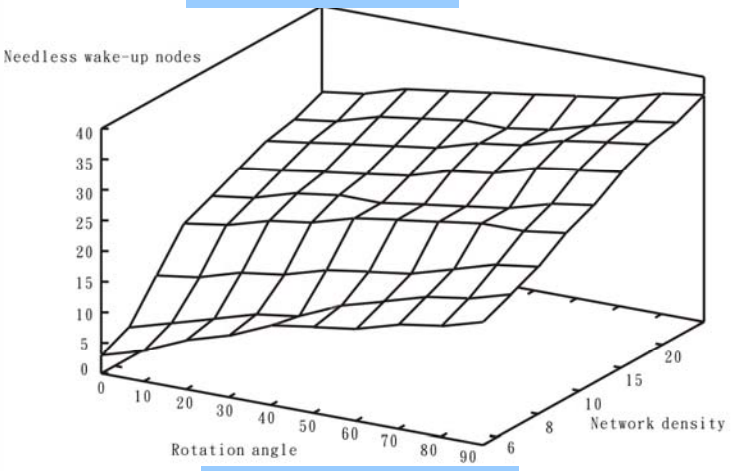
Performance *needless wake-up nodes* vs. *rotation angle*



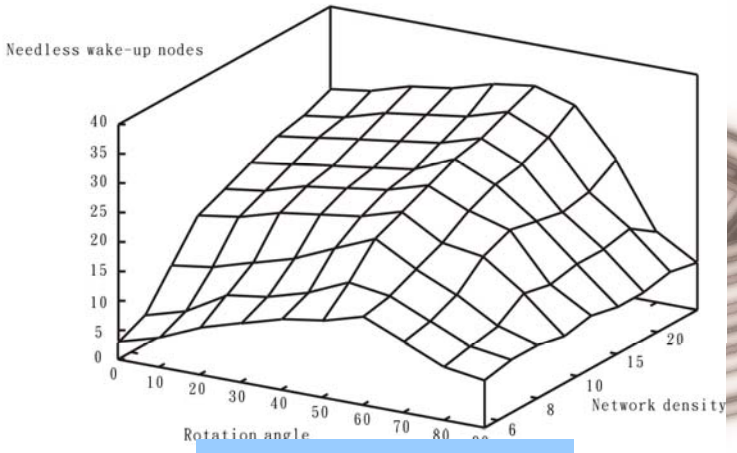
a) Mobicast



b) FAR

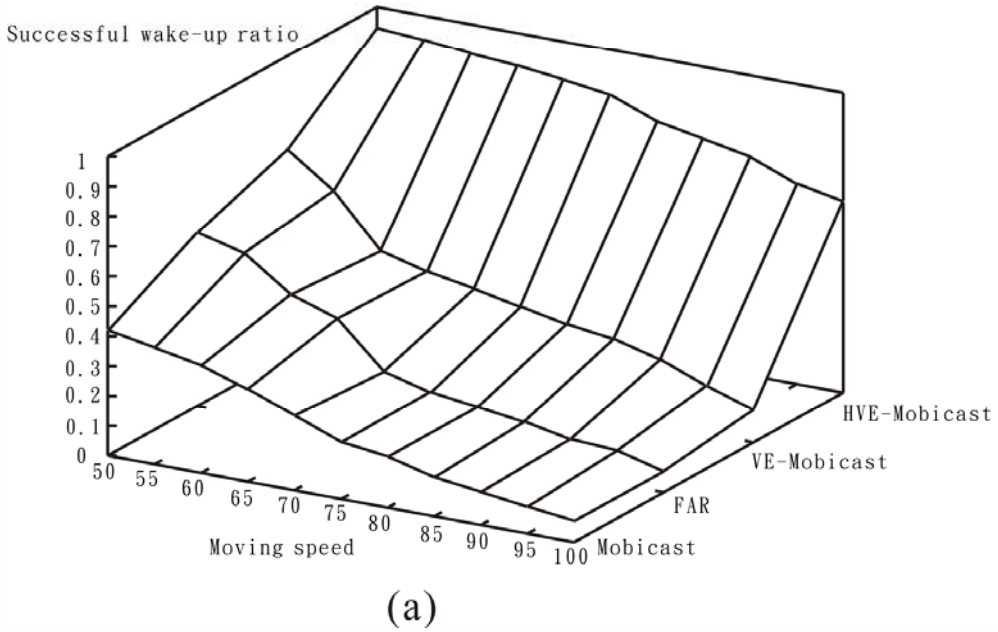


c) VE-Mobicast

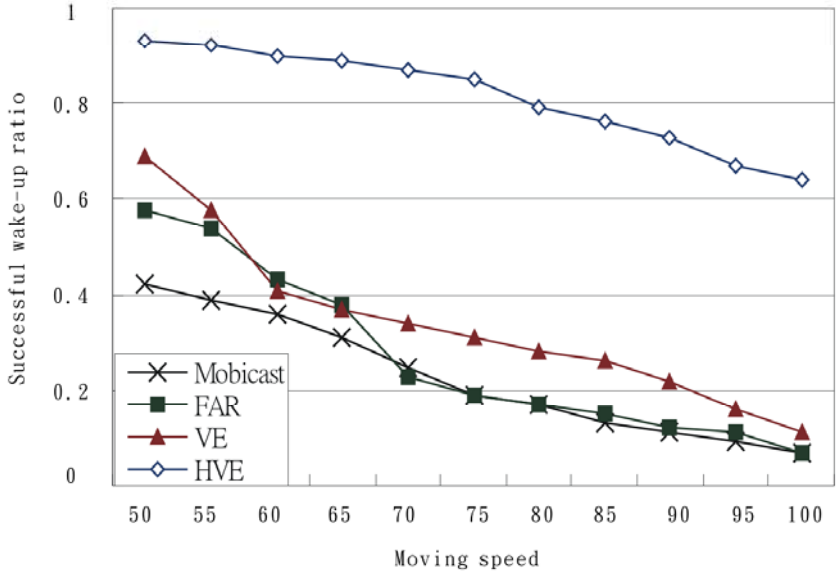


d) HVE-Mobicast

Performance of successful wake-up ratio vs. moving speed



(a)



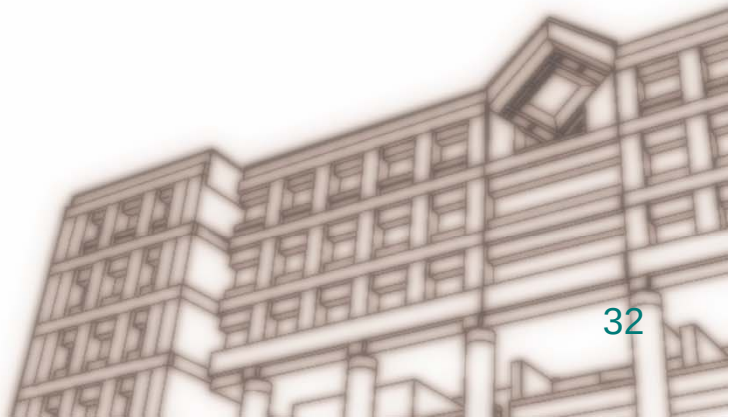
(b)

Successful wake-up ratio =

delivery zone到達時已經叫醒的 nodes數 / forwarding zone 中的nodes總數

Outline

1. Key contributions of the HVE-mobicast routing protocol
2. Related works
3. A Hierarchical-Variant-Egg-Based Mobicast Routing Protocol for Wireless Sensornets
4. Performance analysis
5. Conclusion



Conclusions

- HVE-mobicast routing protocol is more power-efficient to extend the network lifetime
- Hierarchical structure - cluster
  - Routing-efficient
  - power-efficient
  - Reduce packet overhead
- HVE-mobicast routing protocol can adapt to dynamic speed of delivery zone