Real Time Video Surveillance System with Wireless Sensor Network

Presented by wslee

Outline

- Introduction
- System Design
- Performance Evaluation
- Conclusions
- References

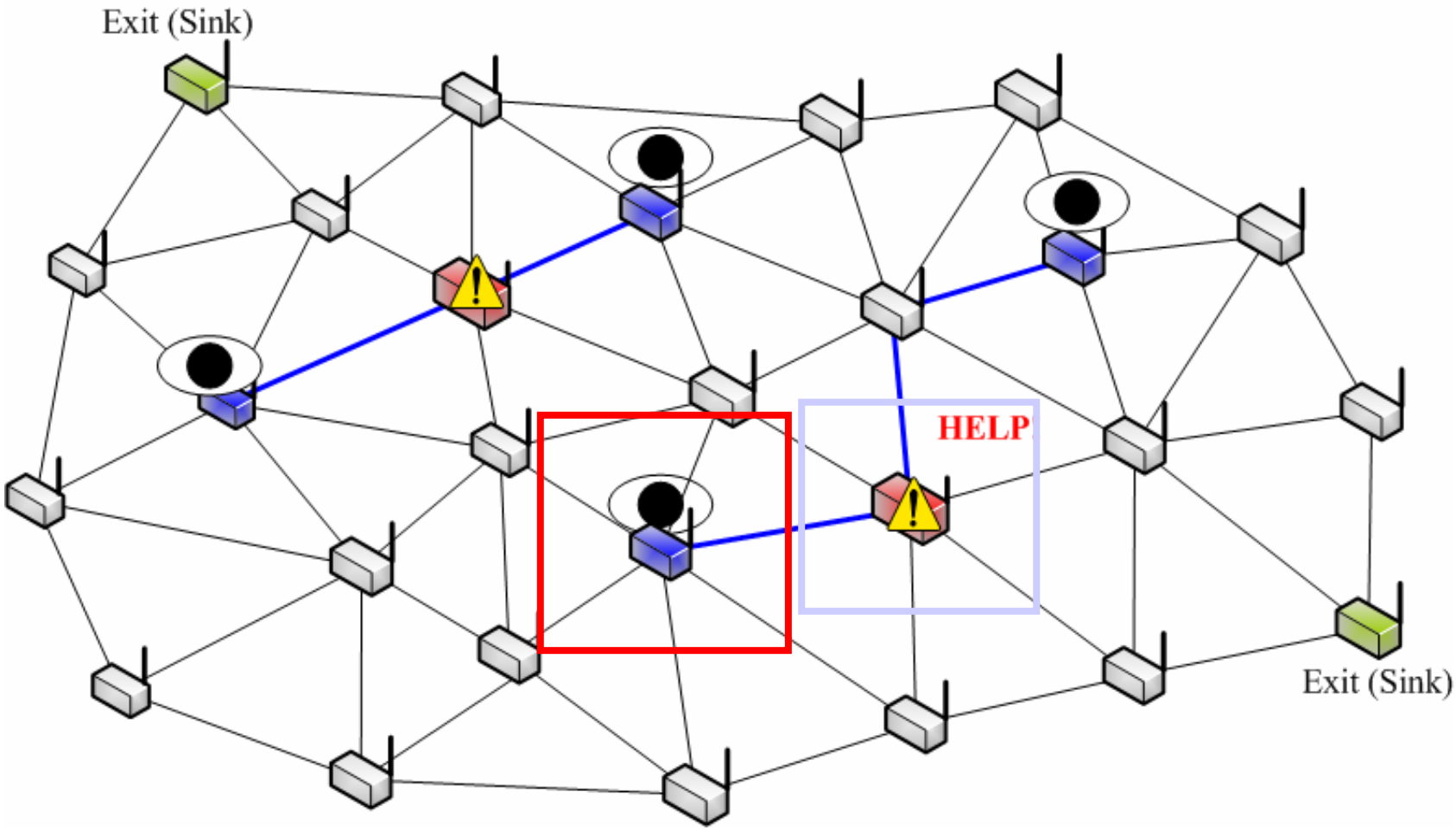
Introduction

- One goal of surveillance system is to collect information about the behavior and position of interested targets in the sensing environment.
- In traditional video surveillance systems, the number of video camera governs system performance and cost. Another shortcoming is unaware of environmental variations.

Introduction

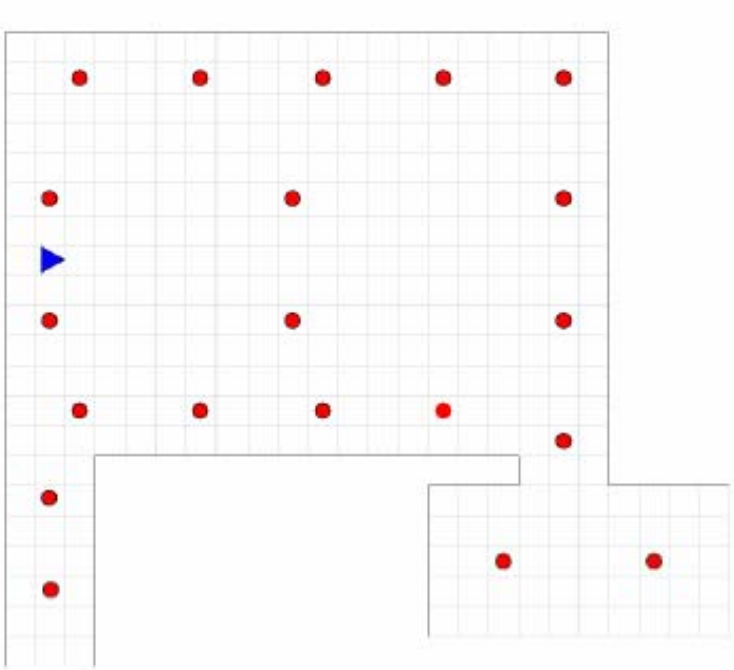
- The WSN is very versatile but the reported information is typically very brief and lack of more in-depth information. A video surveillance system provides detailed image information but produces much more useless data and analysis overhead.
- To integrate WSN with video surveillance system provides an opportunity to significantly improve surveillance systems,

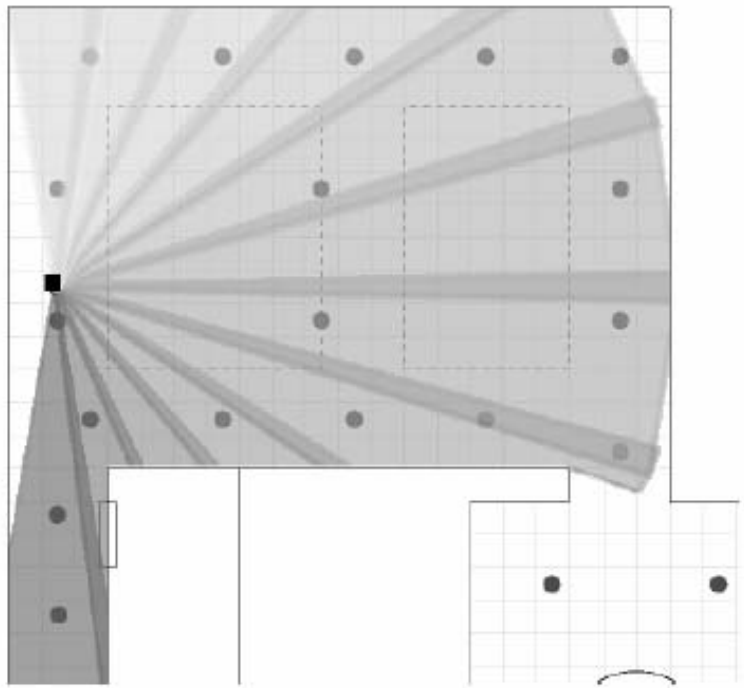
Scenario Overview



Scenario and assumptions

- Given an office, a corridor or a building, we want to monitor it by some cameras and a wireless sensor network.



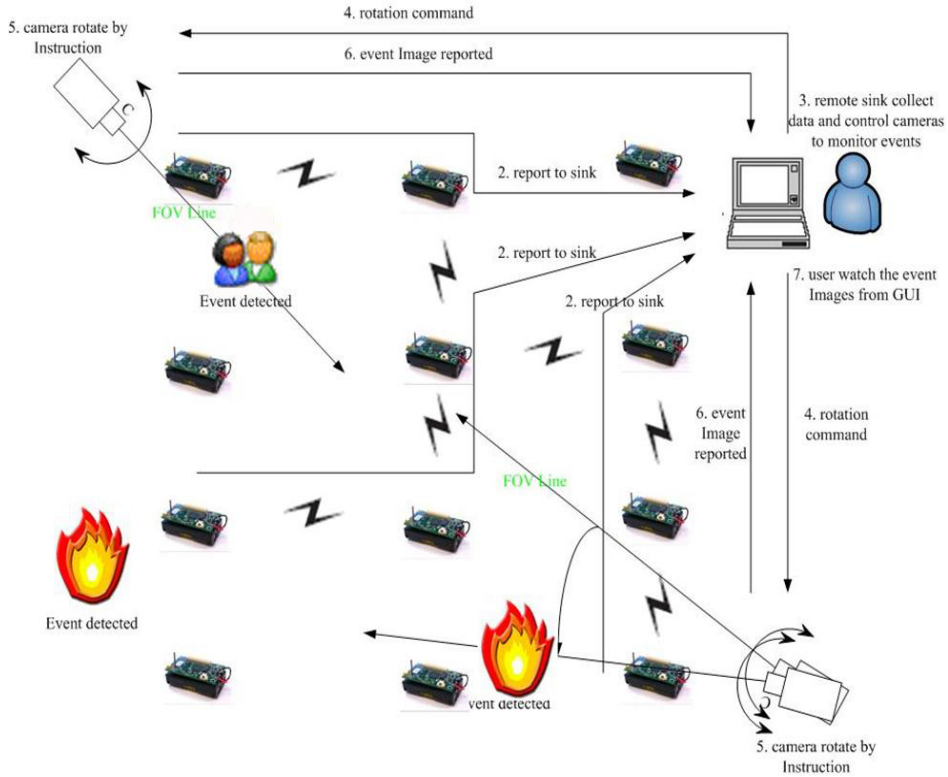


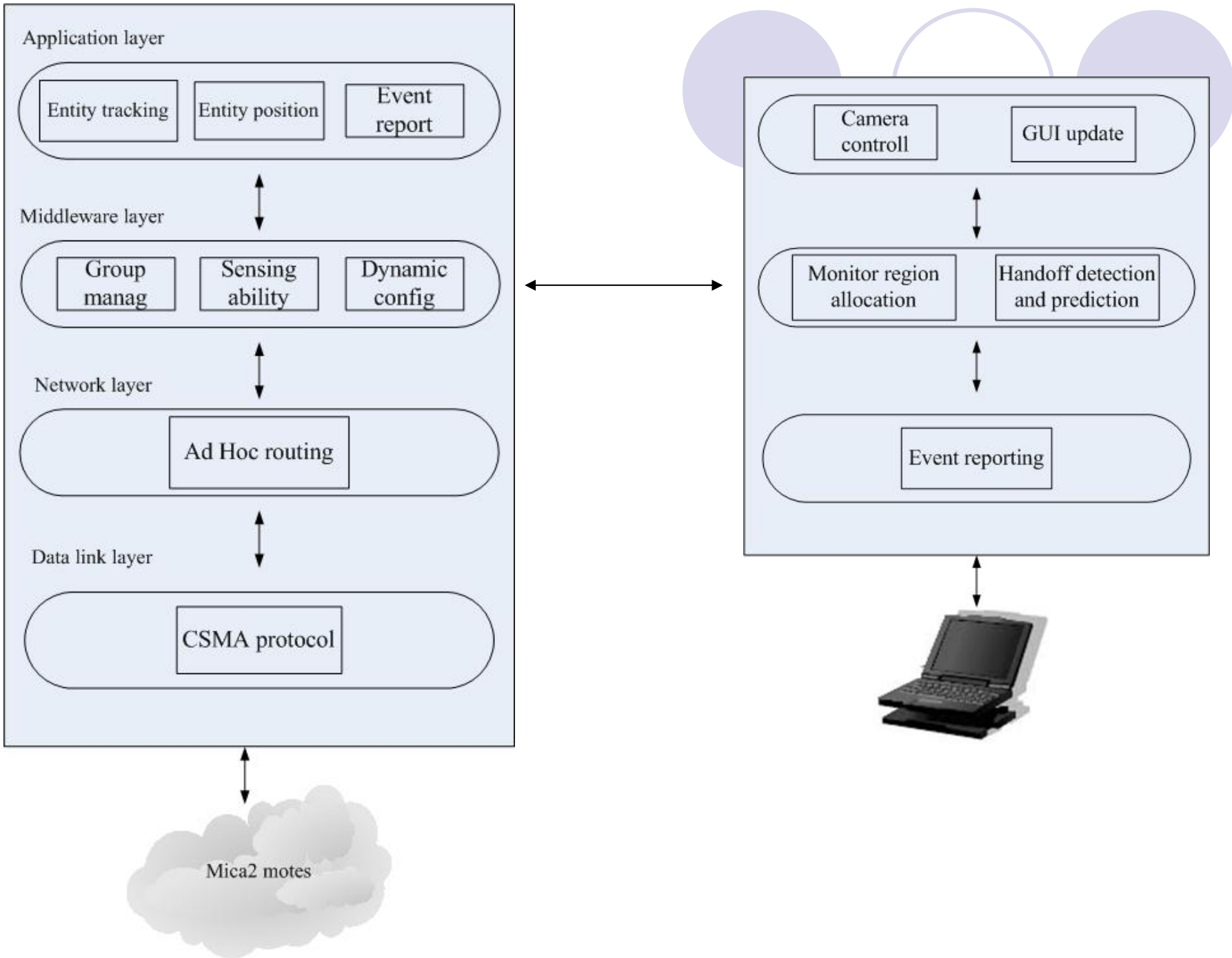
Scenario and assumptions

- We assume
  - The sensors allocated in the monitor region are uniformly distributed.
  - Every sensor is aware of it position. They can all directly or indirectly communicate with each other.
  - The detected objects can emit some signal (such as voice or light) that can be detected by sensors or objects themselves are phenomenal.
  - A sink node would collect the detected event information and control the cameras to monitor events for achieving fully observation.
  - The information, including absolute positions and IDs of sensors, and the range of PTZ, rotation angle, rotation speed and range of field of view, of cameras are known.

System description

- The system is composed by 16 motes and 2 video cameras. To describe the sensor abilities and can fit the physical world application.
- Each sensor equipped a sensor broad can detect 4KHz sound
- The event is triggered by a 4KHz sounder.



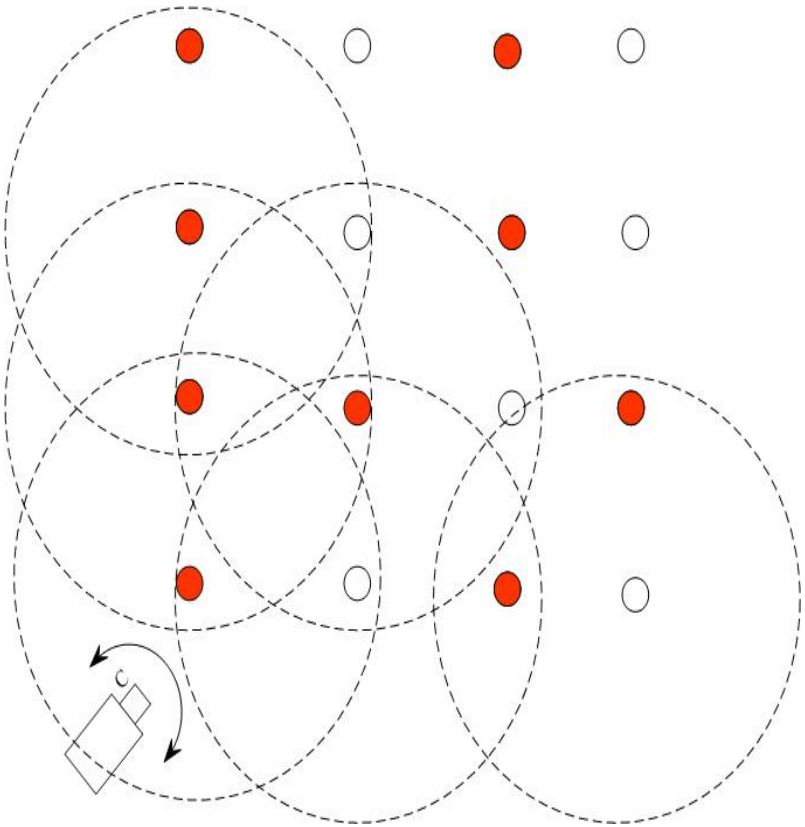

Application layer
Entity tracking
Entity position
Event report
Middleware layer
Group manag
Sensing ability
Dynamic config
Network layer
Ad Hoc routing
Data link layer
CSMA protocol
Mica2 motes
Camera controll
GUI update
Monitor region allocation
Handoff detection and prediction
Event reporting

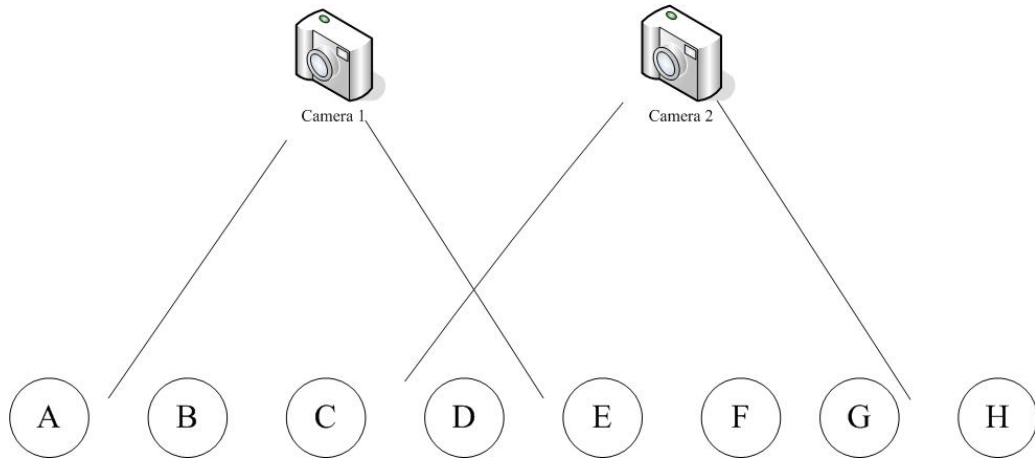
System design

- Network Initialization
  - Routing tree creation
  - Neighboring tables
  - Dynamic Reconfiguration
- Event Position
  - Event position scheme

System Design

- Monitoring Region Allocation
  - Circular monitoring region
  - Monitoring region allocation scheme





Cameras Monitor Region Allocation Scheme

input: N 個 event list => camera[N];
output:分配每個Camera照一個set,其看到的事件總合是最大的 a event set S

sort all event sets by their event numbers
S=0;

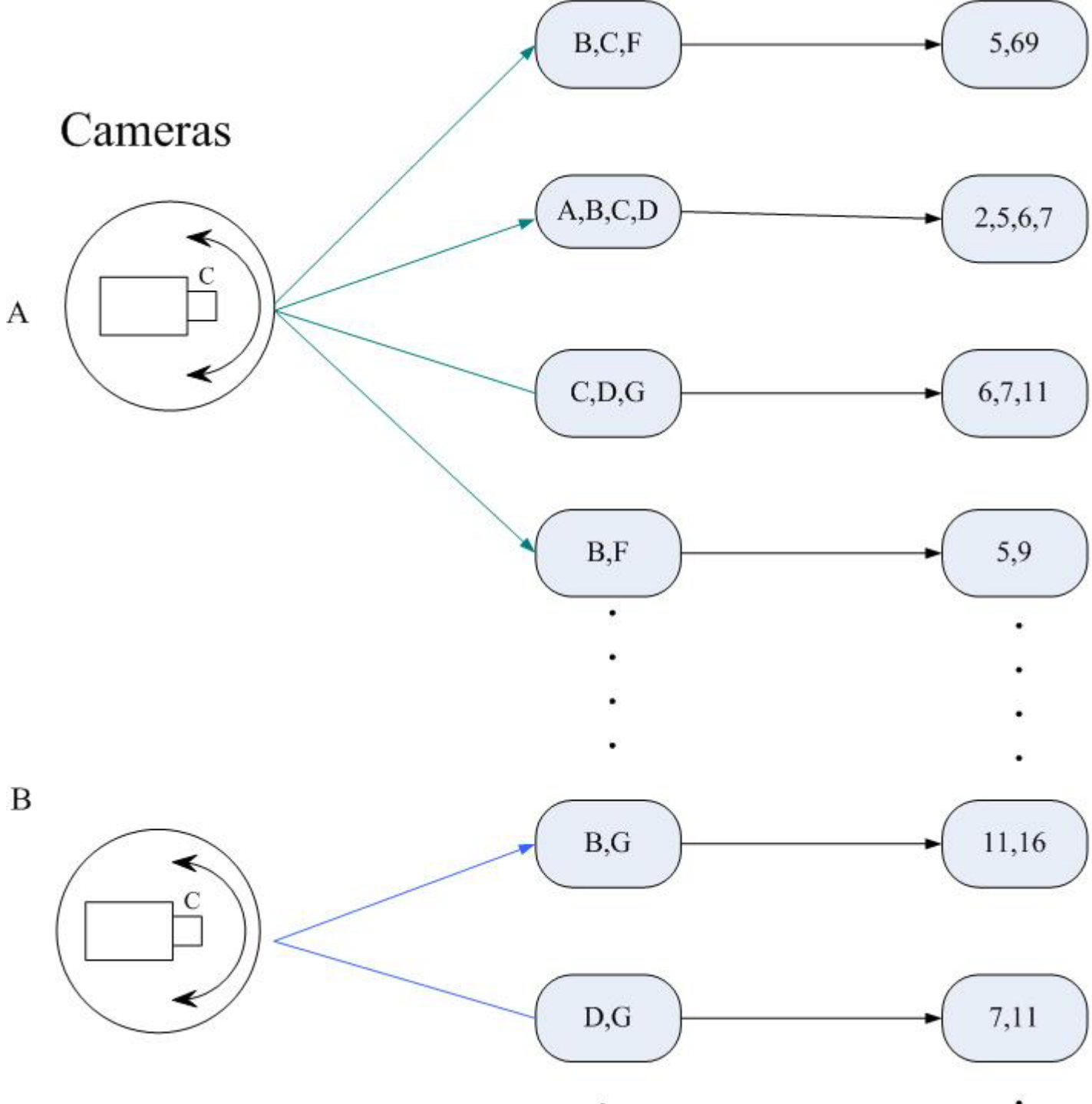
choose the event set Eci of the largest event number
(if more than one set with largest number, choose one
make corresponding camera min rotation)
add Eci to S and remove other sets belonging to the
same camera

while (camera!=0)

choose one set Ej from all sets that

(Ej U S) is max(or more than one set fit this
,choose one make min rotation to its corresponding
camera)

add Ej to S and remove other sets belonging to the
same camera

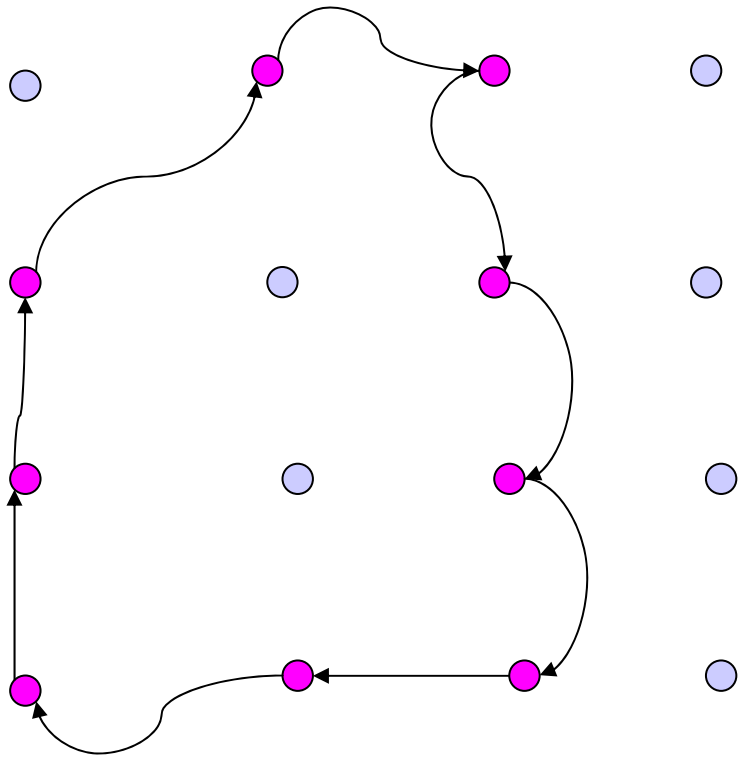

Cameras
A
C
B
C
B,C,F
5,69
A,B,C,D
2,5,6,7
C,D,G
6,7,11
B,F
5,9
B,G
11,16
D,G
7,11

System Design

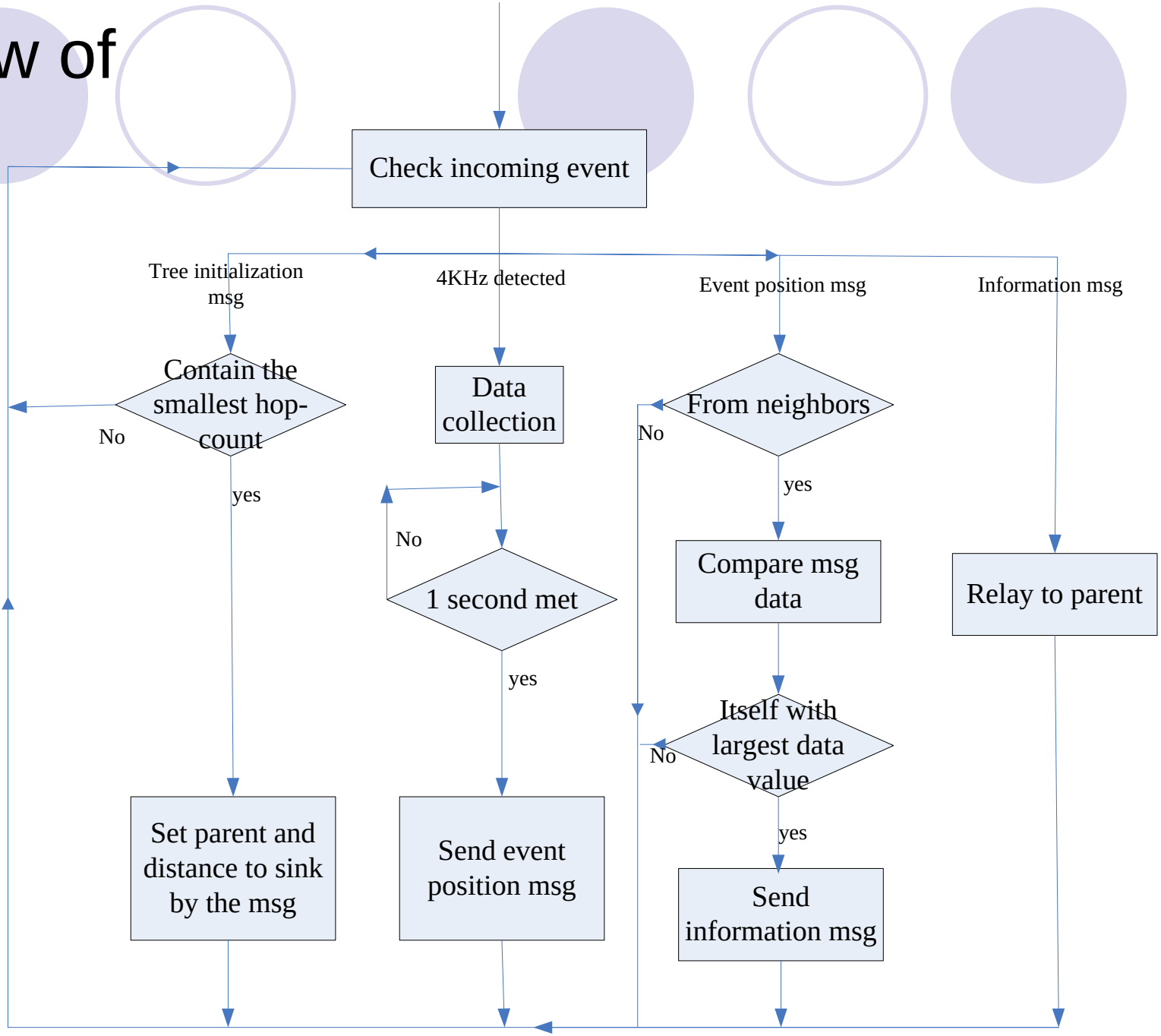
- Handoff operation
  - Inter cameras information exchange while a mobile object moving around.
  - The current position and the passed routes of the mobile object is recorded and use to predict the next destination if it enters the covered region of several cameras.
  - A virtual event is added into the cameras' event lists which related to that position.

Handoff operation

- Handoff operation
  - Inter cameras information exchange while a mobile object moving around.
  - The current position and the passed routes of the mobile object is recorded and use to predict the next destination if it enters the covered region of several cameras.
  - A virtual event is added into the cameras' event lists which related to that position
  - If the prediction failed, the WSN will soon re-catch its position and sink can correct the system and command the right camera to monitor it.



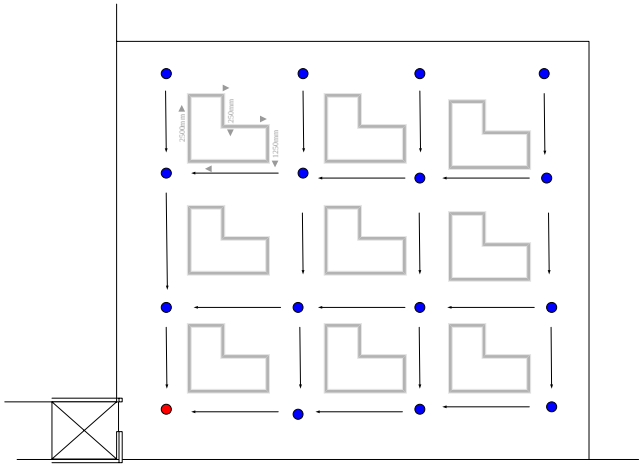
Workflow of sensors

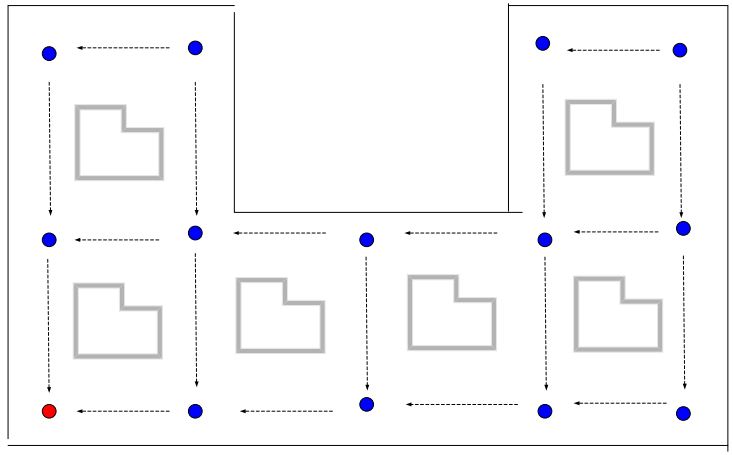


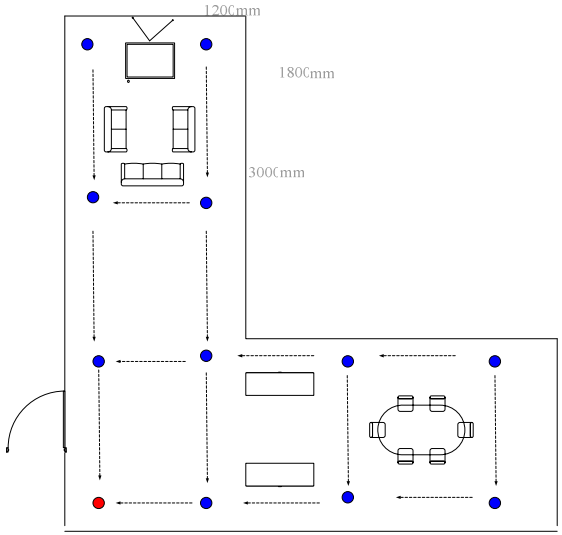
Performance Evaluation

- We conduct the following experiments for an operational field of size 4m x 4m grid through an actual deployment of MICAZ using setup described in Section 3.
- We demonstrate the performance in terms of analysis of Quality of Surveillance, handoff operation and system delay in three difference scenarios.

Performance Evaluation

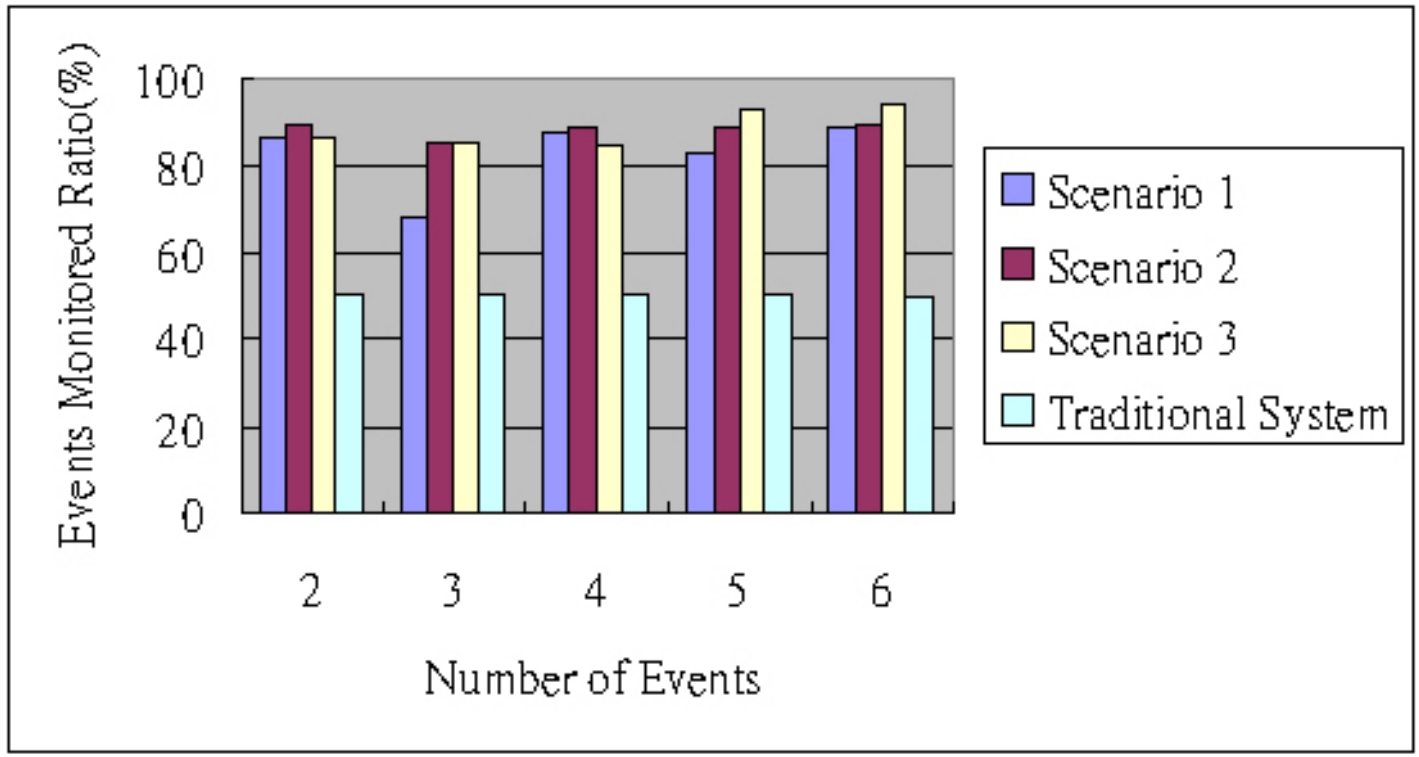






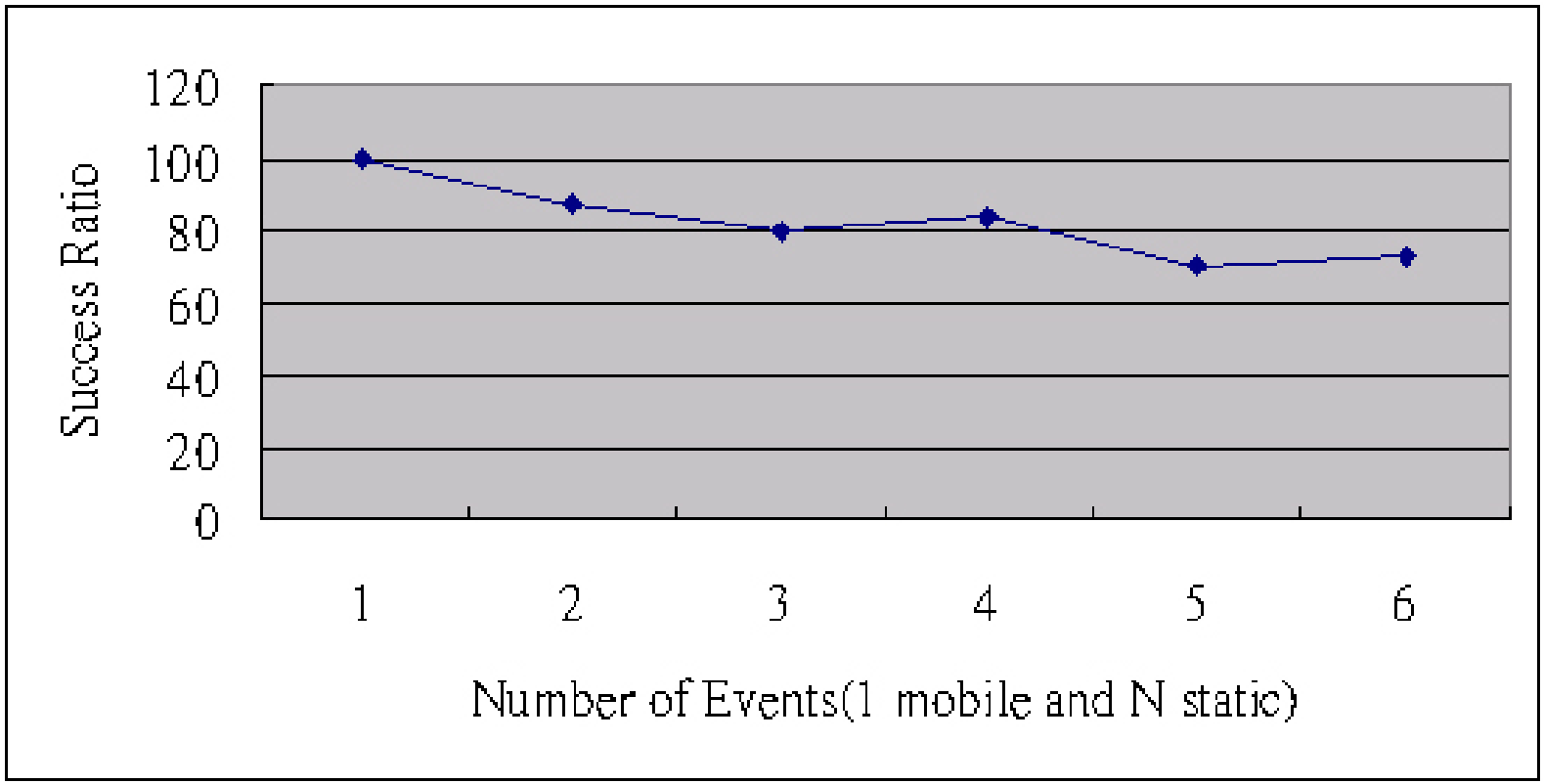
Performance Evaluation

- Quality of Surveillance



Performance Evaluation

- Handoff Successful Rate



Performance Evaluation

- System Delay
  - System delay includes several parts:
    - Data collection of sensors
    - Event position
    - information report and process of monitor region allocation
    - Rotation of cameras
  - To sum up, the system can track people at the speed about 2.4km/hr and the speed of a grown-up is 4 kilometers per hour.

Conclusions

- The main contribution of the paper is the idea to integrate WSN with video camera technology to provide better surveillance service and the implementation of this system.
- The context awareness of WSN and in-depth information of video camera provide a complete view of observed region and help to decrease the demand of manpower.
- The system can monitor the environments with fewer cameras and greatly improve the weakness and enlarge the application scope of traditional dumb surveillance systems.

References

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