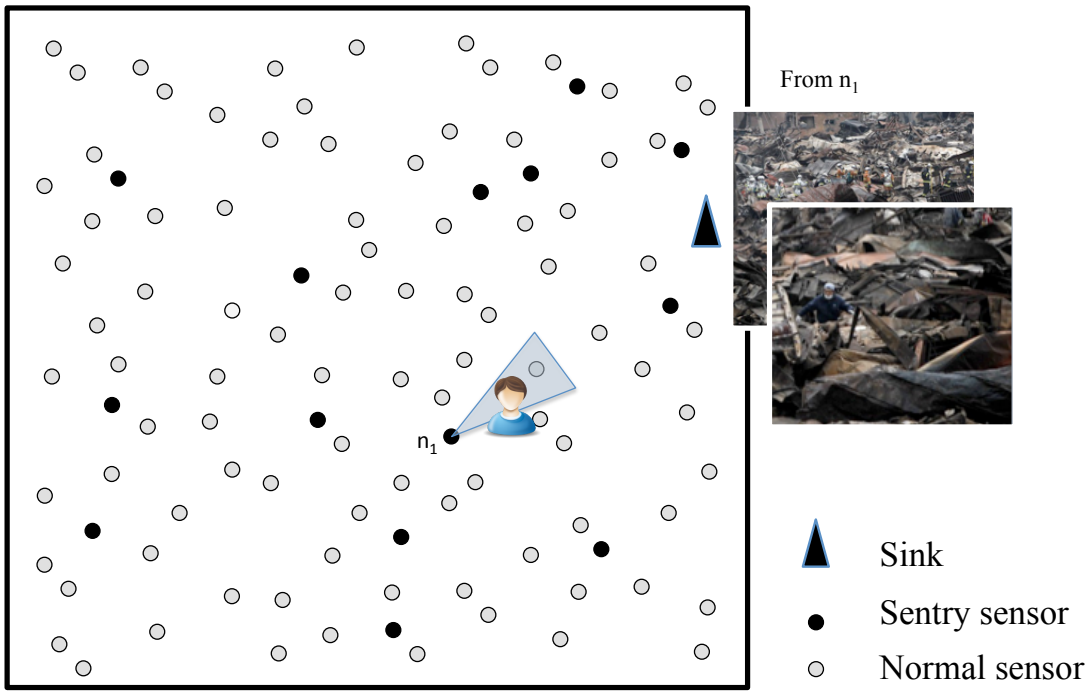
2-Hop Neighborhood Information for Cover Set Selection in Mission-Critical Surveillance in Wireless Image Sensor Networks

M. DIOP , C. PHAM, O. THIARE

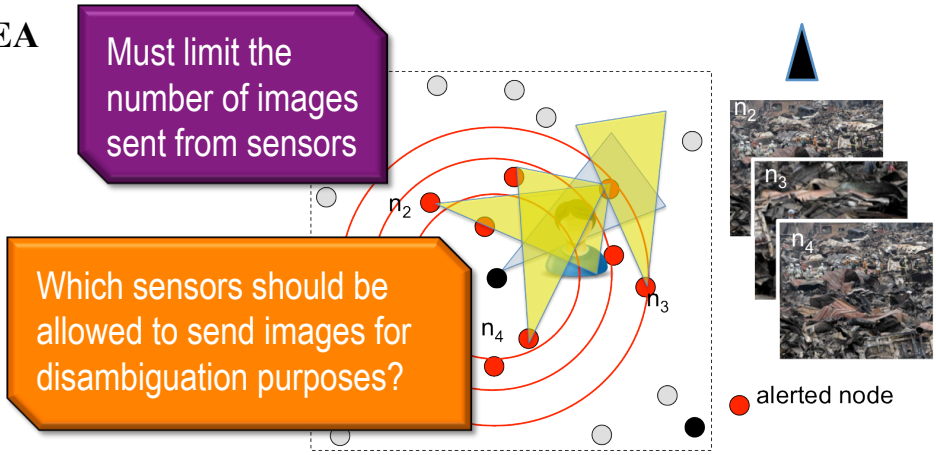
IFIP Wireless Days 2013
13-15 Nov. 2013, Valencia, Spain

Context



On Event Detection

- Criticality-based scheduling of image sensor's activity
- A cover set for *V* is a subset of nodes which covers its FoV area



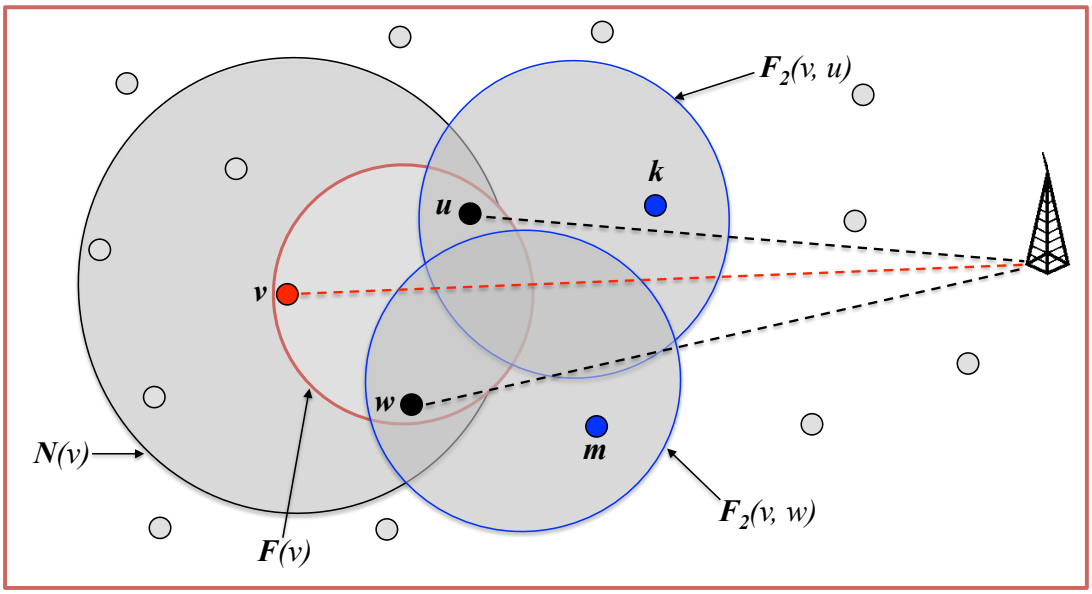
- Simultaneous transmission of large volume of visual data
- Detecting events is important, but receiving images with high quality is very important

Contributions

- A cover set selection approach which
  - Determines the most relevant cover sets to be activated
  - Uses on 2-hop neighborhood knowledge
  - Defines metrics to probabilistically determine the likelihood of multipath transmissions required
- T-GPSR wherein routing decisions are also based on 2-hop information

2-HOP INFORMATION

$$\mathbf{F_2}(v,u) = \left\{k | d(k, Sink) < d(u, Sink), u \in F(v), k \in N(u)\right\}$$



$$\mathbf{F}(v) = \left\{u | d(u, Sink) < d(v, Sink), u \in N(v)\right\}$$

MULTIPATH & NUMBER OF IMAGES

- MULTIPATH IS A COMMON FEATURE IN WIRELESS AD-HOC NETWORKS
- MULTIPATH CAN BE USED FOR RELIABIITY, LOAD-BALANCING, MITIGATING CONGESTION THUS PACKET LOSSES
- AS MORE IMAGES NEED TO BE SENT, A HIGH NUMBER OF PATHS TOWARDS THE SINK IS DESIRABLE

#IMAGE & #PATH LIKELIHOOD

$$R_{2-hop}(Co_i(v)) = \frac{1}{|Co_i(v)|} \sum_{w=1}^{|Co_i(v)|} \frac{|F_2(w)|}{NbOptimalPaths(w)}$$

- $R_{2\text{-}hop}$ MEASURES THE LIKELIHOOD OF A GIVEN COVER SET TO FIND AS MANY NEEDED 2-HOP PATHS AS REQUIRED BY THE CAPTURE RATE OR # IMAGES

UNSHARED RELAY NODES LIKELIHOOD

- 2-HOP POTENTIAL FORWARDERS MAY HAVE FEW RELAY NODES THEMSELVES
- A COVER SET WITH MANY UNSHARED RELAY NODES PER 2-HOP FORWARDER HAS BETTER EFFICIENCY

$$R_{relay}(Co_i(v)) = \frac{1}{|Co_i(v)|} \sum_{w=1}^{|Co_i(v)|} \frac{|F(w)|}{|F_2(w)|}$$

- THE $\frac{|F(w)|}{|F_2(w)|}$ RATIO EXPRESSES THE LIKELIHOOD THAT A 2-HOP FORWARDER HAS SEVERAL UNSHARED RELAY NODES

Cover-set's Transmission Quality Factor

- Each cover set is then associated to a Transmission Quality (TQ)
- TQ is used to score and classify cover sets at a sentry node

$$TQ(Co_i(v)) = \alpha \times R_{2-hop}(Co_i(v)) + \beta \times R_{relay}(Co_i(v))$$

- $\alpha+\beta = 1$

T-GPSR

- GPSR is a geographic routing protocol
- We extended GPSR with 2-hop neighborhood information
- Whenever a source node *V* needs to forward a data packet, it chooses the closest potential 2-hop forwarder to the sink in $F_2(V)$

Evaluation & Simulation

- 400 sensors in an 400m * 400m area
- Sensor nodes have an 60° angle of view, a depth of view of 25m and a communication range of 30m
- Scenario 1: first active cover set is chosen
- Scenario 2: 2-hop selection and GPSR are used
- Scenario 3: 2-hop selection and T-GPSR are used

Image Quality

- 320*320 pixels
- 205 pkts
- Image encoding method (CRAN)

- Original image
  &
- Received images with various packet loss ratios

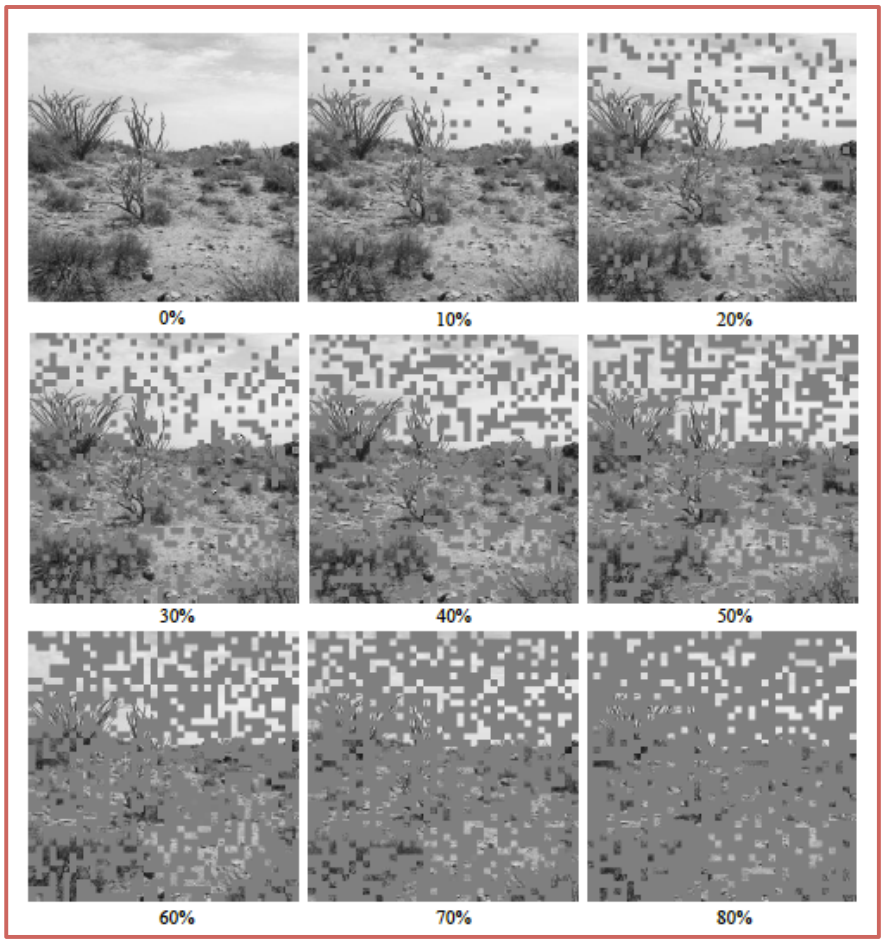
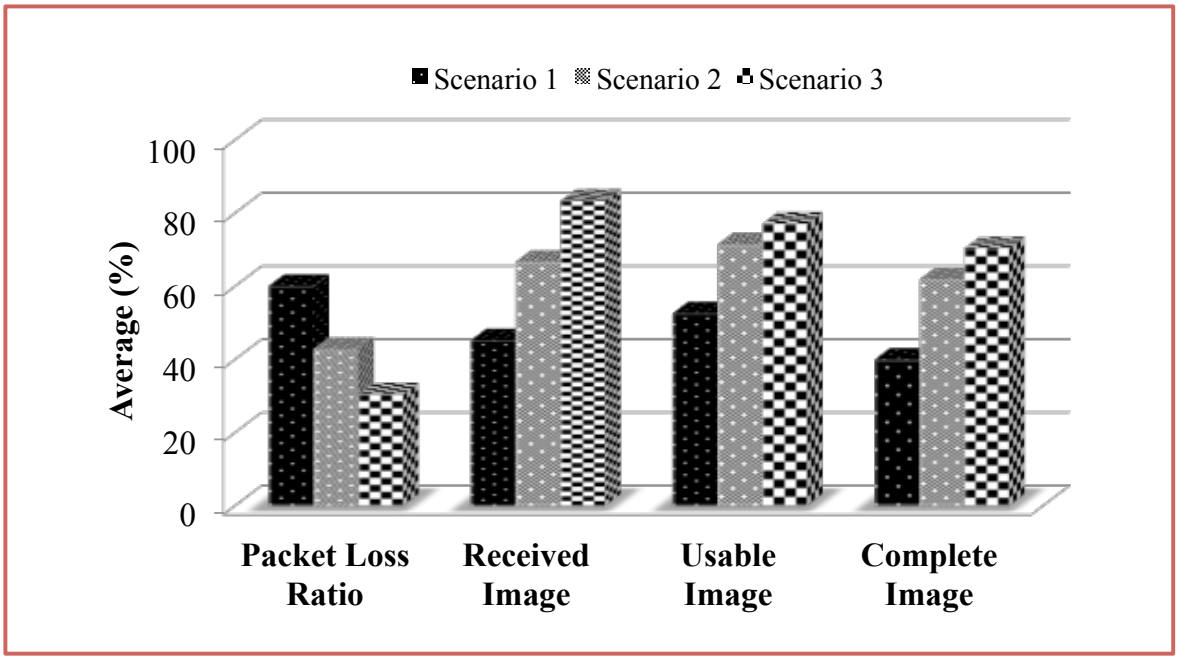
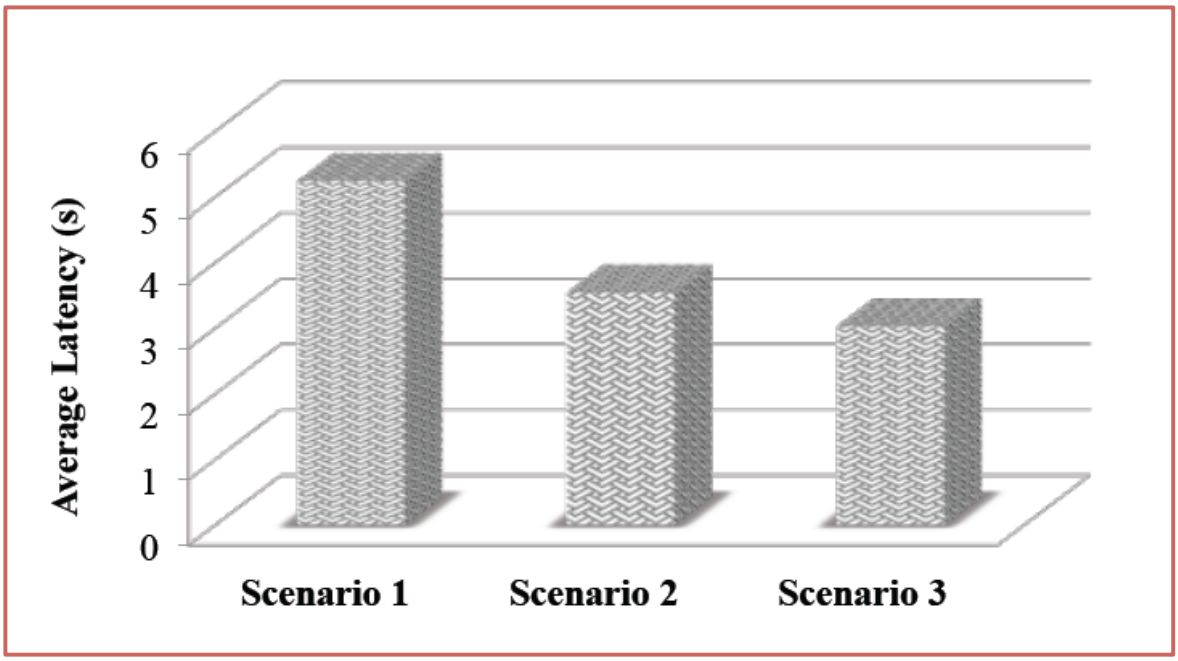


IMAGE STATISTIC AT THE SINK



- AN IMAGE WITH MORE THAN 60% PKT LOSSES IS SAID UNUSABLE

IMAGE DELIVERY LATENCY



- THE IMAGE TRANSMISSION TIME AT THE SOURCE NODE TAKES 0.94S

Conclusion

- We proposed an optimized cover set selection approach based on 2-hop neighborhood information to determine the most relevant cover sets to be activated
- We extended GPSR for image transmission wherein routing decisions are also based on 2-hop knowledge
- Simulations have shown that our proposal reduces the packet loss ratio to provide better received image quality at the sink
- Future work: cover set mutual exclusion to better control simultaneous image transmission

Thank You For Your Attention