Albert-Ludwigs-Universität Freiburg

Real-Time deployment of Multihop Relays for Range Extension

-Michael R. Souryal, Johannes Geissbuehler, Leonard E. Miller, Nader Moayeri (Wireless Communications Tech Group NIST, USA)

Of
Computer networks and Telematics (Ad Hoc Networks – Block Seminar)

Under
Prof. Dr. Christian Schindelhauer, Chia Ching Ooi

By
Kiran Kumar Telukunta (Last Name)
(Master Student)

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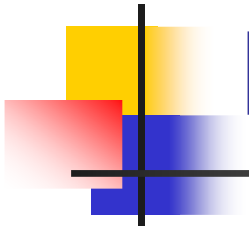
Outline

- Keywords
- Introduction
- Related work
- Relay Deployment Strategy
- Link Assessment
- Algorithm
- Prototype
- Experiments
- Conclusion

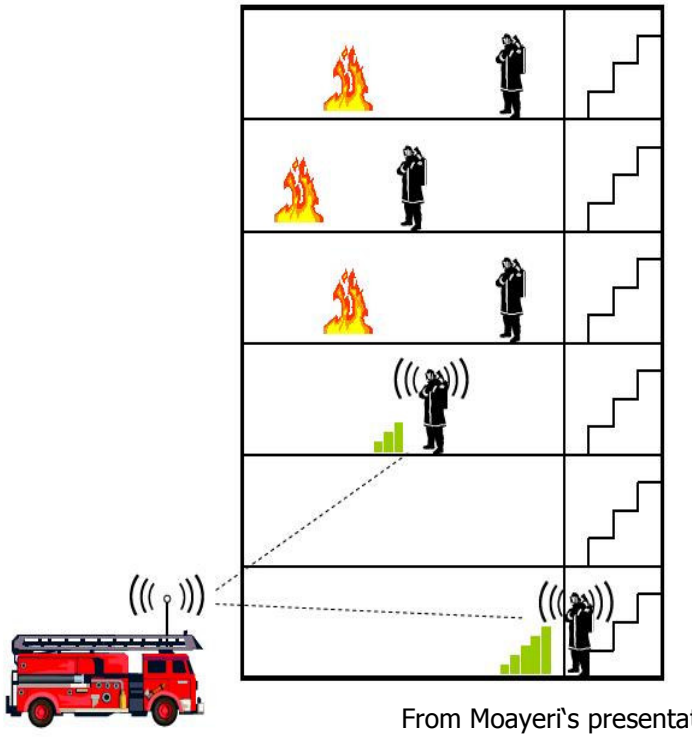


Keywords

- Deployment
- Multihop wireless networks
- First responders
- Breadcrumbs
- Sensors

Introduction

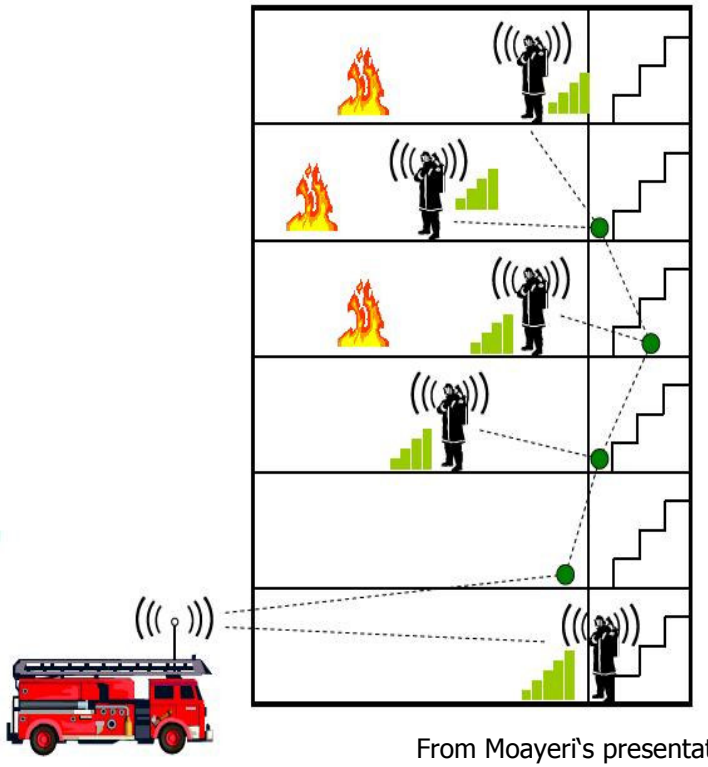
- Authors example scenario



From Moayeri's presentation

Introduction

- Authors example scenario



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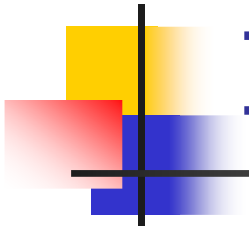


Introduction

- Reliable communication
- Lose of radio communications
- Multihop wireless communication
- Key Challenge

Related work

- UC Berkeley & Chicago Fire Department
- Virginia Tech & SAIC
- Fire WxNet – Wildland's fire environment

Related work & Relations

- UC Berkeley & Chicago Fire Department
  - Wireless sensor network (Smoke Net)
  - MICA2 mote

Picture from Crossbow

- Contrast – No nodes

Related work & Relations

- Virginia Tech & SAIC (LMDS)
  - Wider incident area
  - LMDS (Local Multi point Distribution Service)
  - GIS (Geographic information service)
- Similar
  - Broadband channel
  - Temporal Characteristics and symmetry

Related work & Relations

- Fire WxNet – Wildland's fire environment
  - Wireless sensor system (Channel probe and response protocol)
  - Verification
- Relation
  - Link charachterization studies
  - Local placement assistance

From the authors

- Relay Deployment Strategy
- Link Assessment
- Algorithm
- Prototype
- Experiments

Relay Deployment Strategy

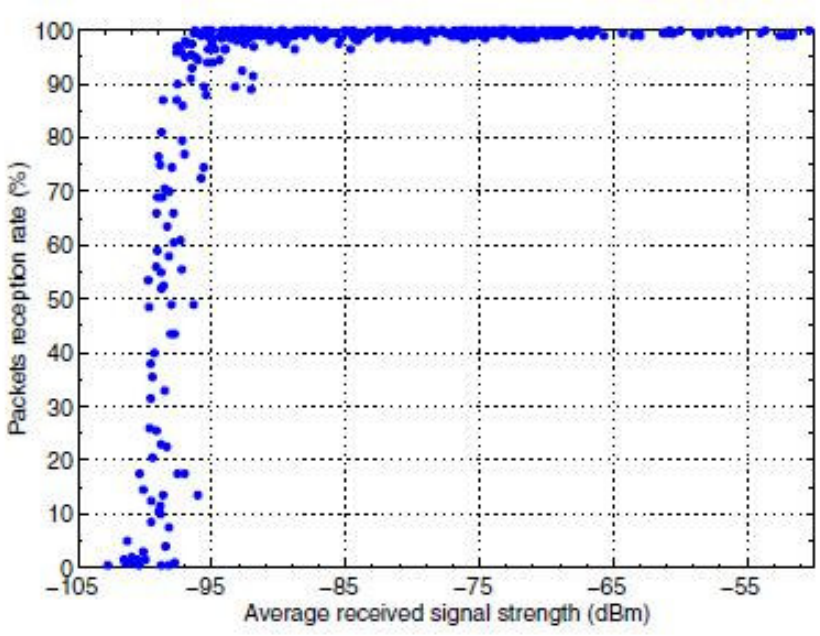
- Expression
  - $p^*_s(D/m^*) = e^{-1/n}$
  - p^*_s – packet success probability.
  - D – Total distance.
  - m – equal spaced hops.
- Observations
  - Optimum number of hops
  - Optimum probability

Link Assessment

- RSS-Based Link Assessment
- Receiver height
- Link symmetry

RSS-Based Link Assessment

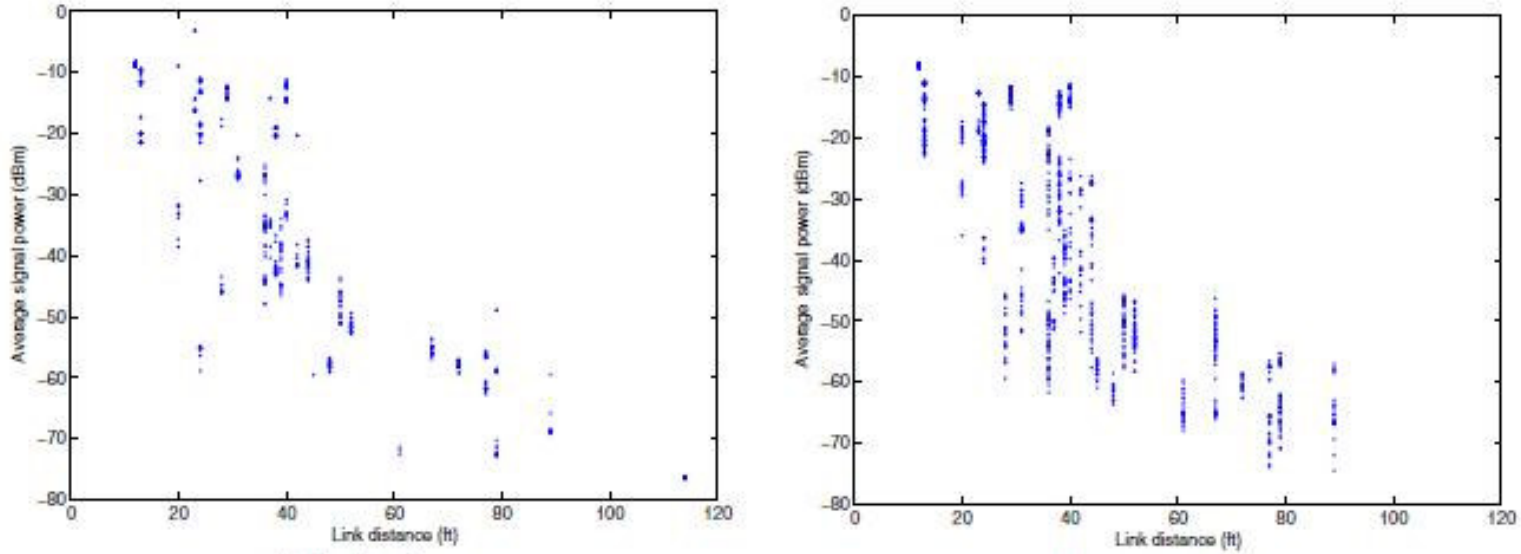
- Test Experiment – in a floor



From authors paper

RSS-Based Link Assessment

- Drawback

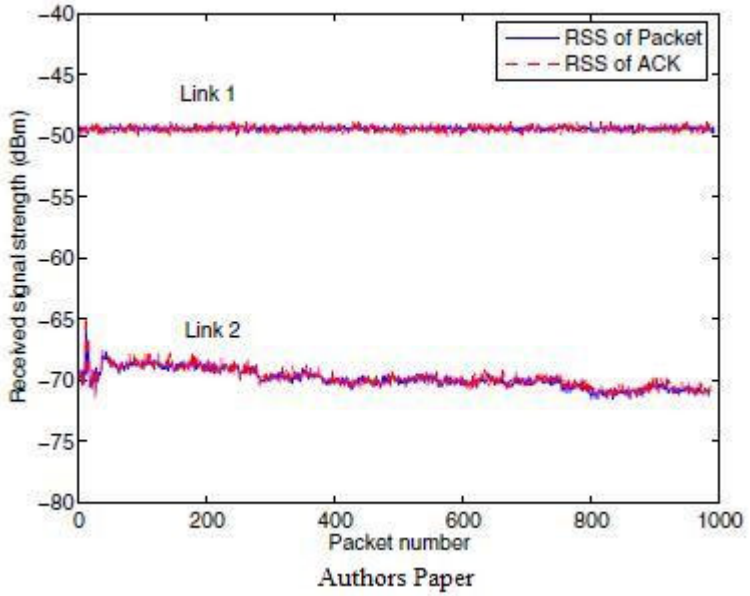


Received signal strength vs. link distance

Moayeri's Paper

Link symmetry

- RSS vs Packet Number in static environment



Authors Paper

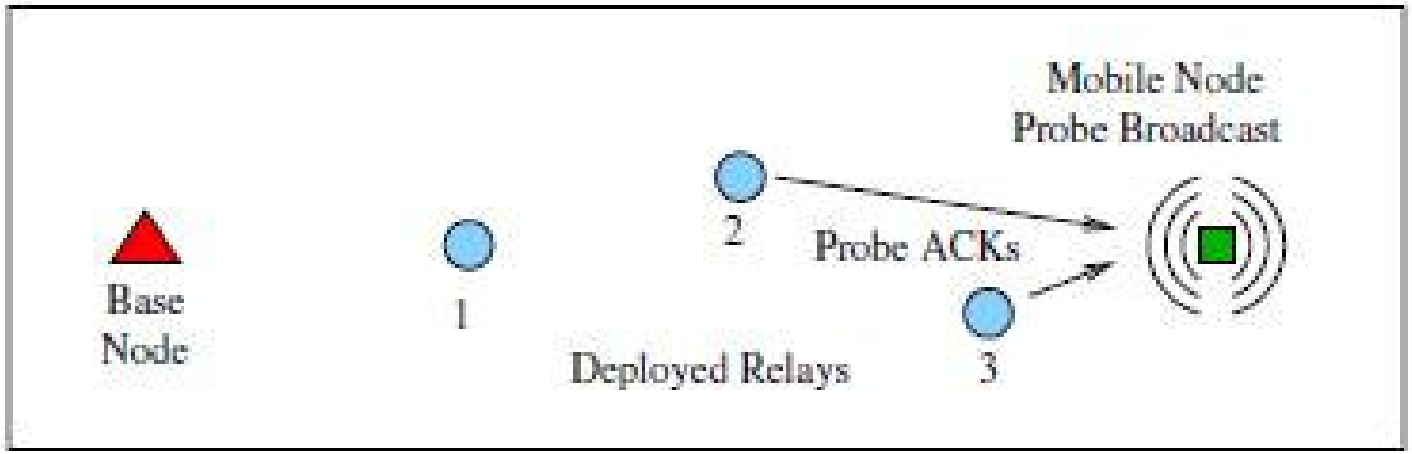
Algorithm

- Parameter Selection
- Adaptive probing
  - Threshold
- Local Placement Assistance
  - Human or robot
  - Backtracking

Parameter Selection

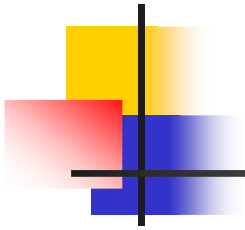
- Mobile Probe period – 100ms
- RSS averaging filter length - 20
- Threshold Signal strength -80 dBm
- RSS value for missed ACK‘s -100 dBm
- Link diversity order - 1

Probing



Channel probing

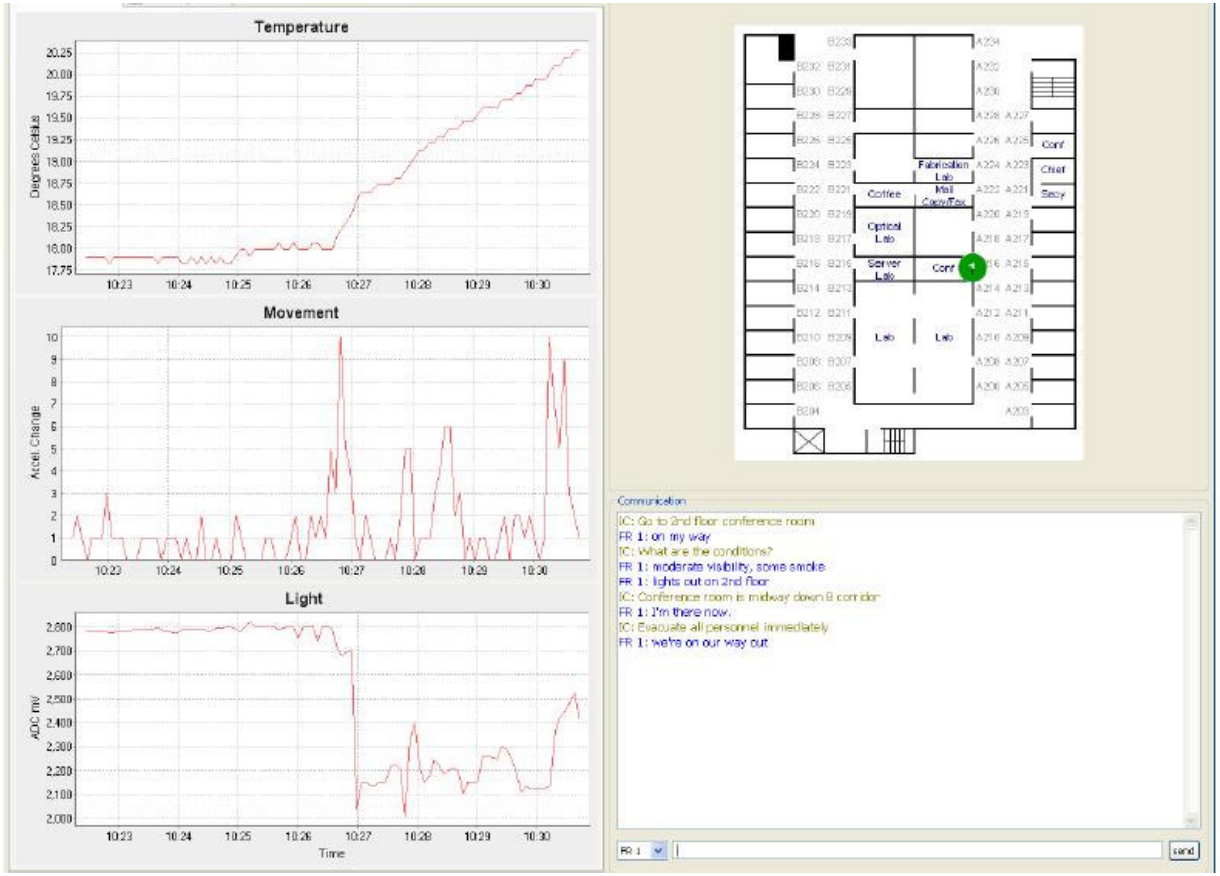
Authors Paper



Prototype

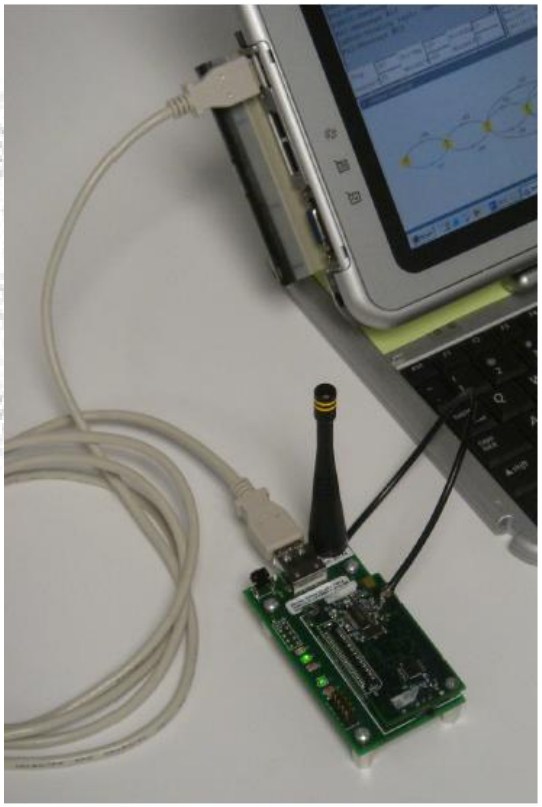
- Application Overview
- Prototype Hardware
- Routing Protocol

Application Overview



Prototype Hardware

- Base Node



Base Node from Authors paper

Prototype Hardware

- Mobile Node

From Authors Paper

Prototype Hardware

- Relays

Relays from Authors Paper

Suggestable Relay

From CrossBow Company

	MICA 2	IRIS
Frequency Band	868-916 MHz	2405-2480 MHz
Receive Sensitivity	-98 dBm	-101 dBm
Outdoor Range	150 m	> 300m
Indoor Range	-	> 50 m
Programmable	Less	More
Antenna	Not Present	Present

Routing Protocol

- Destination Sequenced Distance Vector
  - Isolates
  - Routing table
    - Number of Hops
    - Latest Update
    - Number of week links
  - Route advertisement T_{adv}

Experiment Results

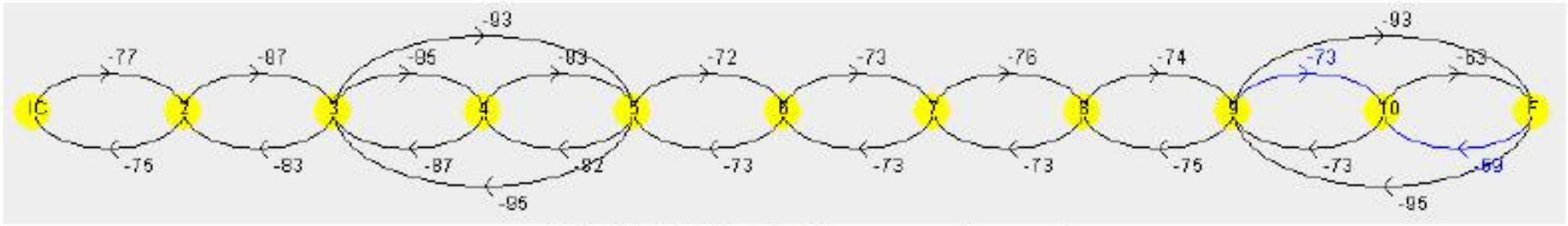
- Experimental Trials

Message Delivery Rates for Hi-Rise Trials

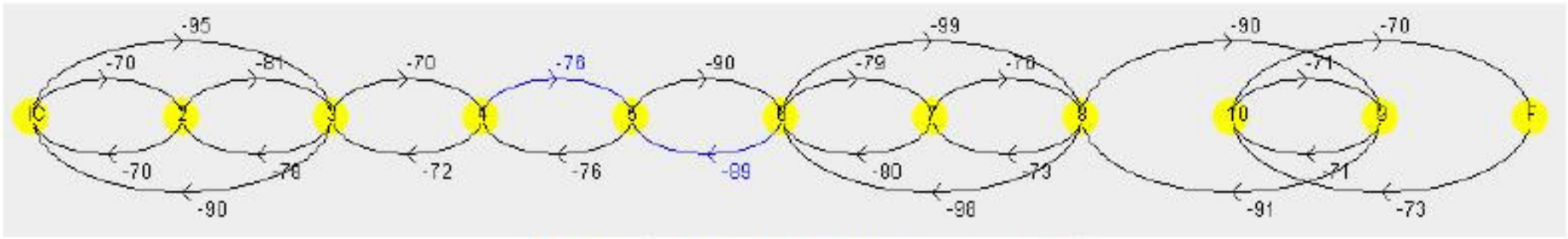
Trial No.	Deploy	Stop			Return
	Ping	Ping	Text △	Text ▽	Ping
With Local Placement Assistance					
1	99 %	100 %	100 %	80 %	95 %
2	98 %	100 %	100 %	99 %	100 %
3	96 %	99 %	100 %	100 %	98 %
Without Local Placement Assistance					
4	90 %	99 %	100 %	99 %	100 %
5	98 %	98 %	99 %	90 %	100 %
6	55 %	35 %	28 %	36 %	71 %

From Authors Paper

Experiment Results



Trial 1 (with local placement assistance)



Trial 4 (without local placement assistance)

From Authors Paper

Wireless standards

Standards	802.11b(used)	802.11a	802.11g(Zigbee – Juri Lichter)	802.11n
Cost	Low	Low	Costlier	Costliest
Speed (Ranking)	3	4	2	1
Penetration through interference (Ranking)	4	3	2	1
Signal Range (Ranking)	3	4	2	1
Best	3	3	2	1

* In all Rankings Highest is 1

Source: About.com

Example to estimate usability

- 9-11 Twin tower disaster
  - Each floor at an average 10ft+1.5ft
  - 16 floors got damaged

Conclusion

- Came up with deployment strategy
- Feasibility – Automated deployment
- Mathematical calculations lacking
- Come up with – Algorithm
  - Tests can be bettered
- Experimental Analysis
  - Better wireless standards
  - Better equipment
- Reach hard areas
  - Not sure of in some disaster situations – break between nodes

Questions Session

Thanks

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Questions ??

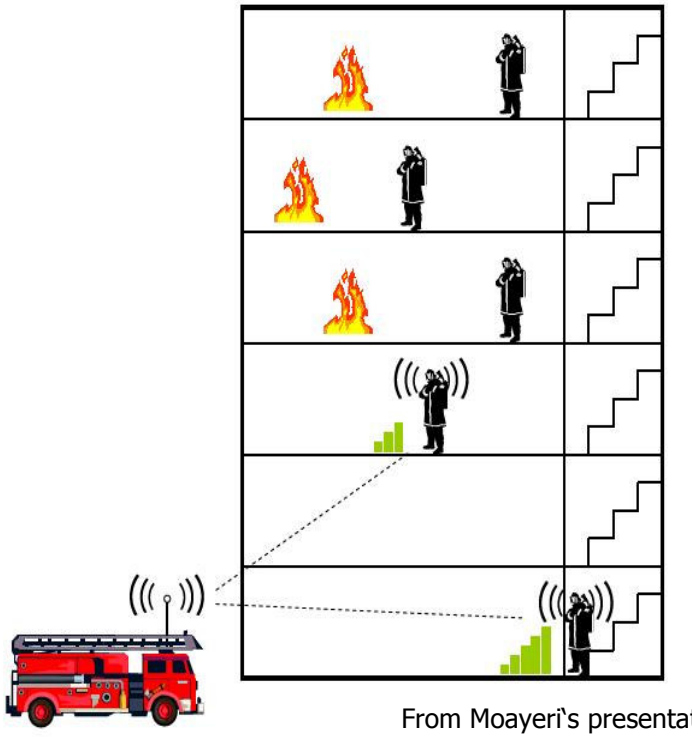
Extra Slides

- Chat communication

Application view in PDA

Extra Slides

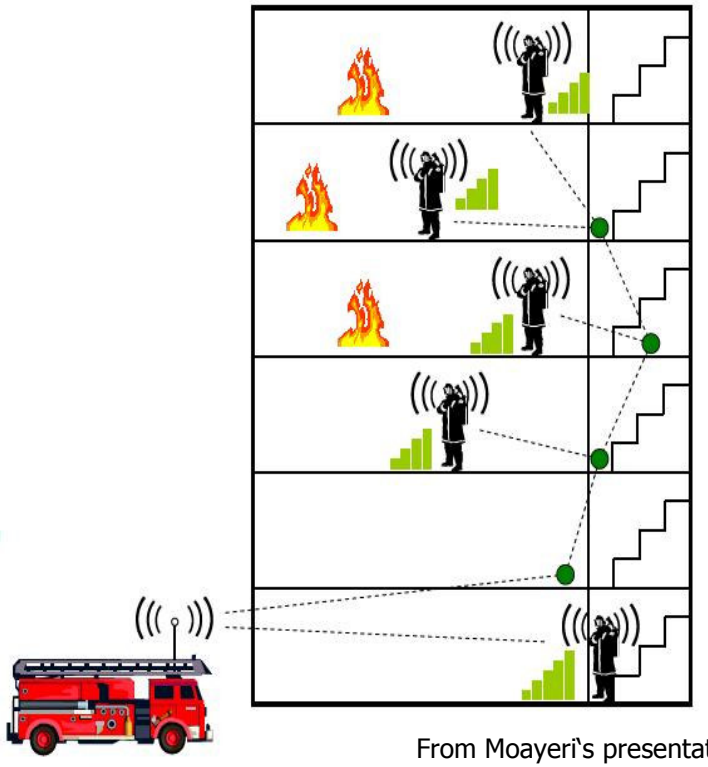
- Authors example scenario



From Moayeri's presentation

Extra Slides

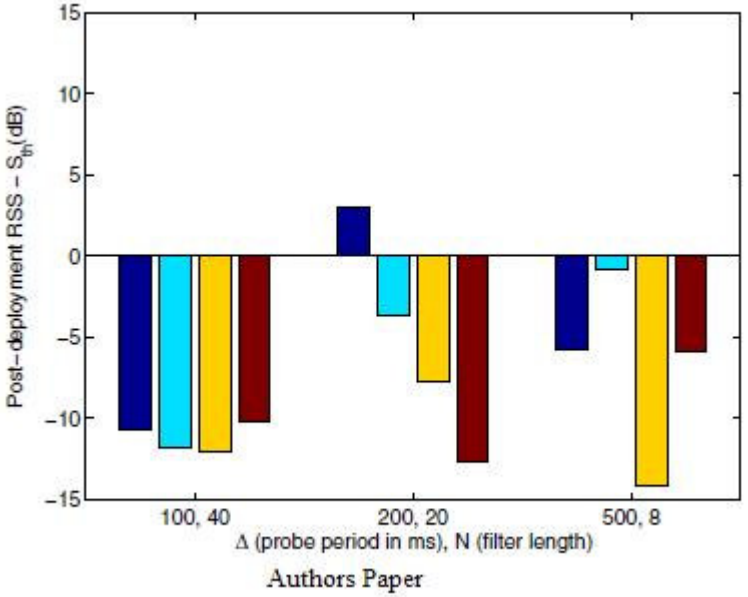
- Authors example scenario

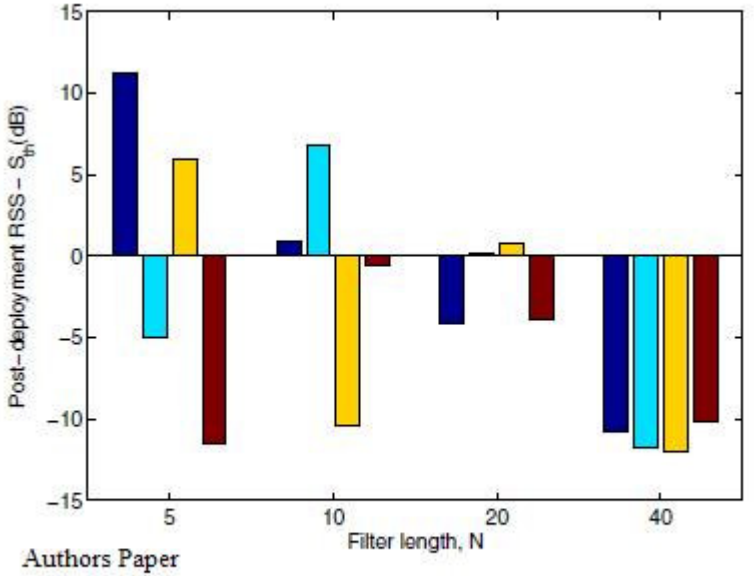


From Moayeri's presentation

Extra Slides

- Probing graphs





Deviation from deployment threshold vs. RSS filter length N; probe period $\Delta = 100$ ms