



Research Consortium in Speckled Computing

Tracking People in Built Environments

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Overview

- Application built on the ENS platform.
- Must be energy neutral.
- SpeckSim simulator used for testing and algorithm development.
- Deployment in Informatics Forum using physical devices.
- Integrated with the ENS Network software platform.

Tracking Scenarios

- Tracking assets around a built environment
 - Behaviour analysis
 - Asset location
- Tracking vulnerable people
 - Emergency evacuation
- Route Guidance
 - Directions to a specific area
- Environment Interaction
 - Location aware services
- “Intruder Detection”
 - Alert when asset in a specific area

Deployment

Three flavours of ENS:



Basestation
(one of these)



Fixed
(lots of these)

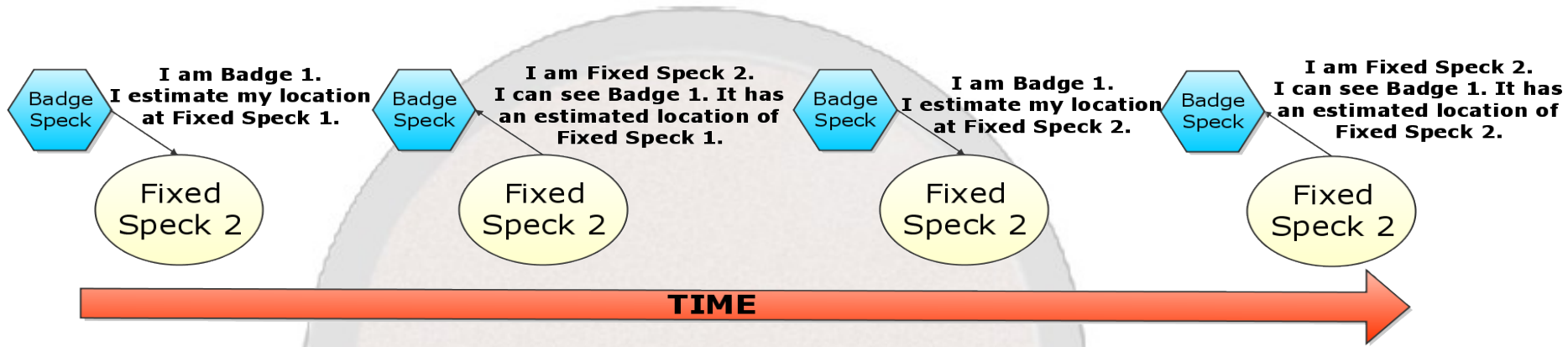


Badge
(a few of these)

How Does It Work?

- **Badge Speck**
 - Transmit radio ping every MAC frame.
 - Promiscuous radio listening to estimate location.
 - Uses RSSI to compare location estimations.
- **Fixed Speck**
 - Listen for mobile pings.
 - Transmit asset table every MAC frame.
 - Route Fixed Speck transmissions to Basestation Speck.
- **Basestation Speck / Sink**
 - Collect data.

The Location Estimation Process



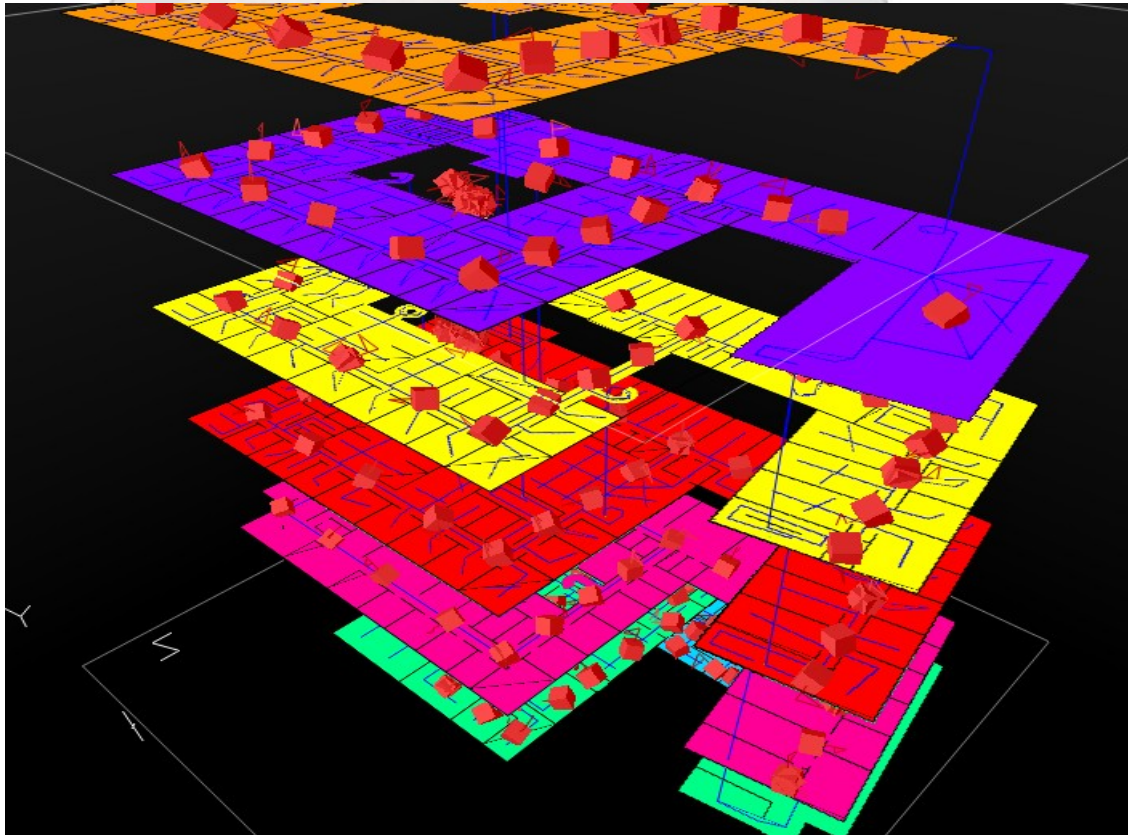
- Four stages:
 1. Badge Speck 1 transmits ID and estimation location (not Fixed Speck 2).
 2. Fixed Speck 2 confirms receive from Badge Speck 1, but with other Fixed Speck ID.
 3. Badge Speck 1 transmits ID and estimated location (correct).
 4. Fixed Speck 2 confirms receive from Badge Speck 1, with correct estimated location.

Staying “Energy Neutral”

- Application must be energy neutral
- Biggest cost is radio
- Must improve location algorithm
 - Reduce the frequency of transmissions
 - Reduce the number of packets to be routed

Simulation

- Simulation of person tracking in Informatics Forum using SpeckSim
 - Realistic multi-floor building model
 - Realistic movement of people inside building



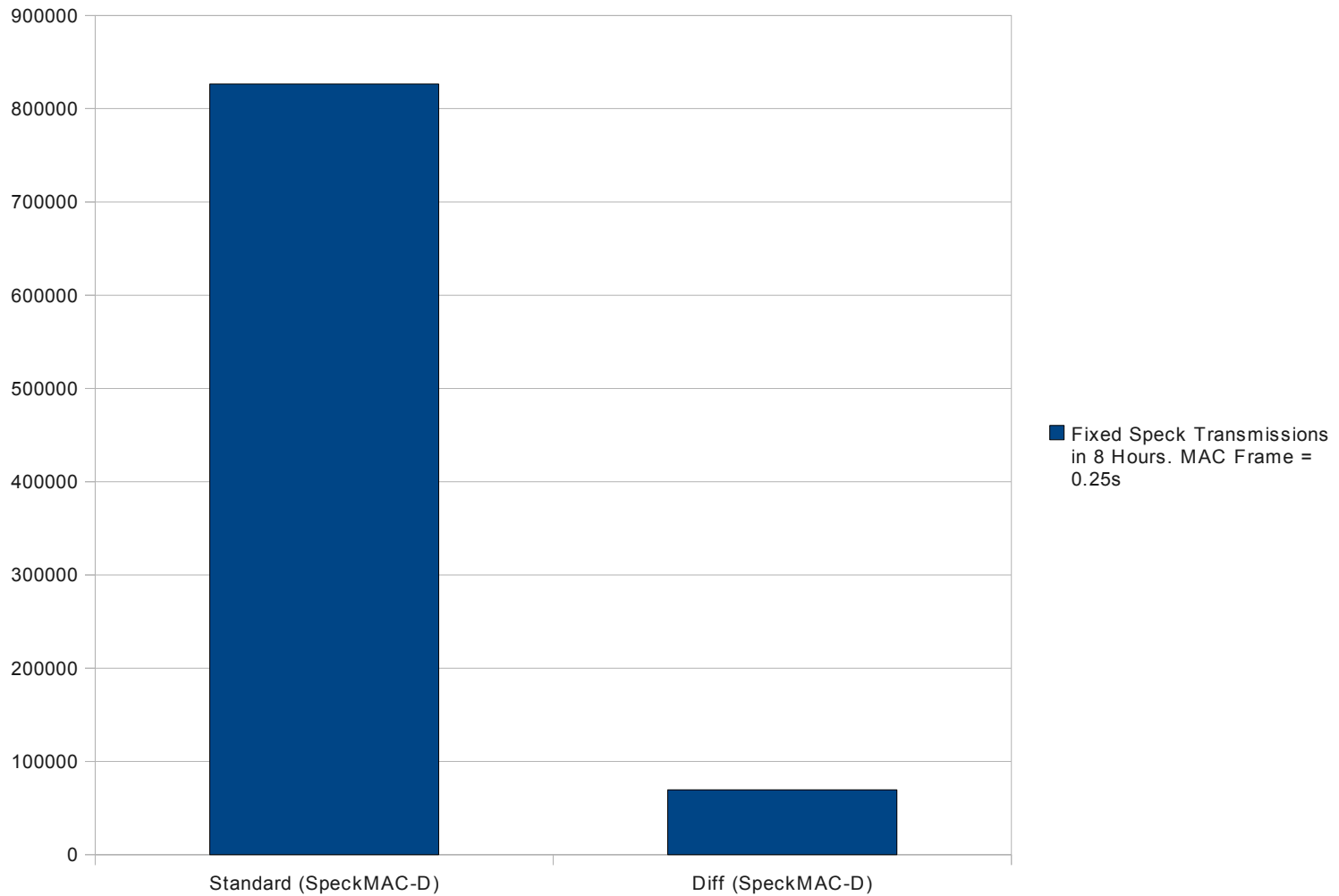
Simulation

- Statistics collected:
 - Number of messages sent.
 - Latency between fixed message transmit and basestation receive.
 - Accuracy of location estimation
 - Comparison of actual location and estimate

Staying “Energy Neutral”

- Reducing Fixed-Node Traffic:
 - Do not transmit entire asset table every frame.
 - Instead, transmit patches with differences between frames.
 - No difference = no transmission.
 - Combine differences at every tree-level on route to basestation.
 - Verify asset owners:
 - Only route data to next tree level if Fixed Speck's ID matches Badge Speck's estimated location.

Staying “Energy Neutral”

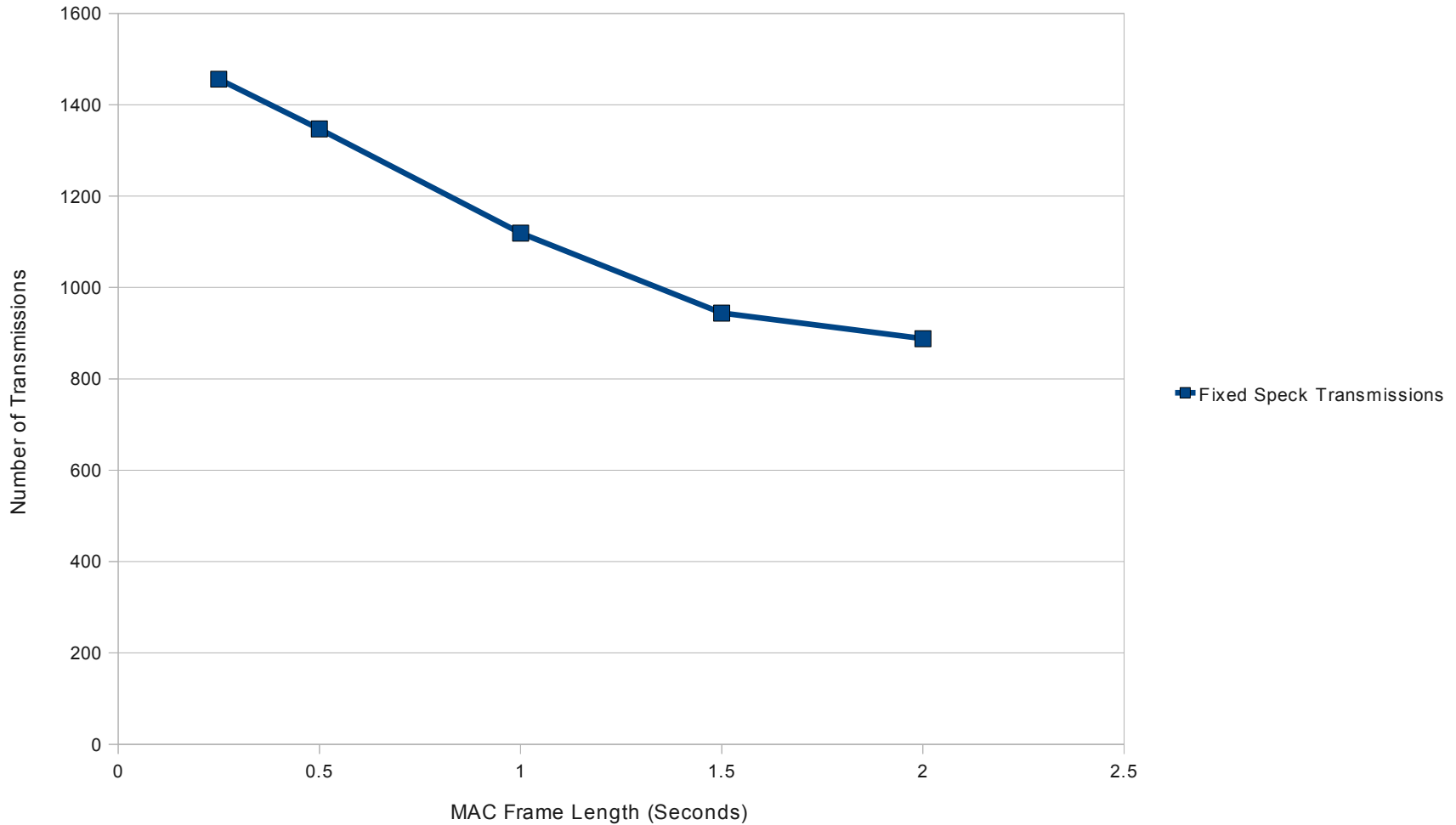


Staying “Energy Neutral”

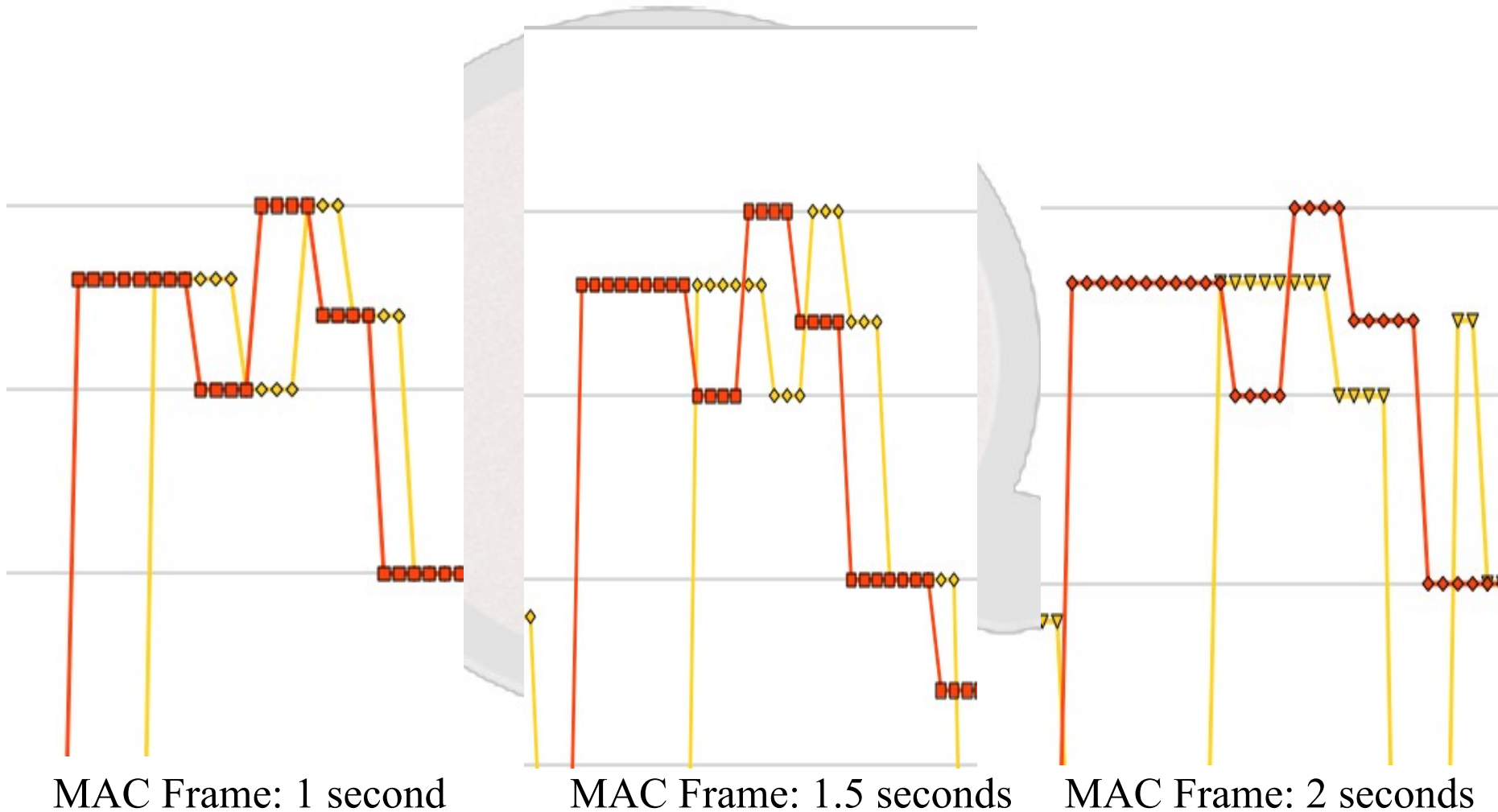
- Reduced duty-cycle
 - Increase the time between MAC Frames
 - Devices spend more time sleeping.
 - Location estimation takes longer.
 - Need to find a value where the accuracy is sufficient for the application.

Staying “Energy Neutral”

Fixed Speck Transmissions vs MAC Frame Length



Accuracy and Latency Comparison



Staying “Energy Neutral”

- Reduced Mobile-Node Traffic
 - Movement detection
 - Use accelerometer on device to detect when a Badge Speck is stationary.
 - Only transmit when moving.

Reducing Routing Latency using FSOs

- Sometimes it's important to route data very quickly
 - “Intruder Detection”.
 - Emergency Evacuation.
- Free Space Optics can be used to wake up devices or route data quickly
 - No waiting for duty cycling.
- In intruder detection, we can alert the Basestation Speck of an intrusion faster with FSOs than radio.

Further Challenges

- Handling multiple basestations / data sinks.
- Scalability of much larger networks.
- Improving location estimation.

Live Tracking Demo

- Viewer: showing Mat walking around the building this morning.
- Fixed Specks placed around this room and the Atrium.
- Viewable outside in the Atrium.

Summary

- Tracking application built on the ENS platform.
- Energy neutral using optimisations on original algorithm.
- SpeckSim simulator used for testing and algorithm development.
- Physical deployment in Informatics Forum using physical devices.
- Integrated with the ENS Network software platform.

Questions?



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