

Application

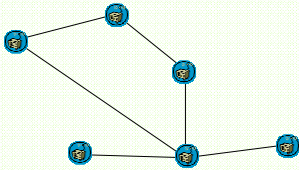
The background of this work is a shipping container tracking system for a small/medium size port. The system enables efficient tracking and management of containers within a storage area by exploiting the advantages of wireless sensor network nodes used as container tags. It doesn't require any additional infrastructure and blends seamlessly with the current management/tracking methods used in the port, effectively extending their capabilities with remote querying, localization and security.

Challenge

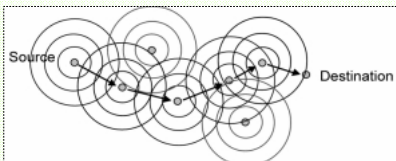
Main challenge in realization of the project is the environment, the fact that containers provide physical, visual and radio shielding. Radio frequency communication is limited by multipath propagation in its extreme - phenomena such as reflection and diffraction would be omnipresent. In order to facilitate accessibility to each container tag, an approach different than direct communication needs to be taken.

Solution

By using multihop routing protocols container tags can form a self-configuring, self-healing multihop network with no fixed infrastructure (ad-hoc).

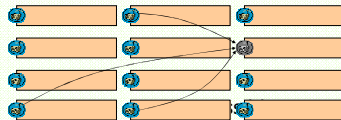


The information can then be forwarded from one tag to another from/to any point in the network, enabling communication with each container tag.

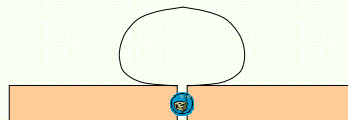


Verification

The tests performed in Cork Port container yard proved that in a real life container layout scenario communication between tags that are up to 2 containers apart is possible.



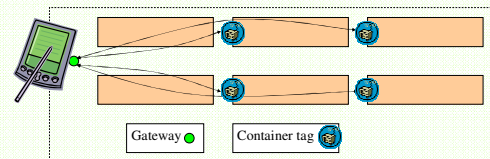
Further tests showed that tag antenna radiates from the 10cm wide gap between the containers in a wide angle.



Realization

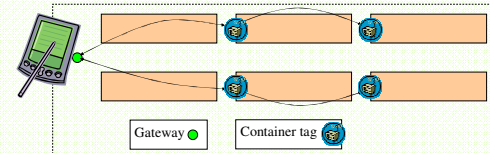
Phase 1 deployment:

Small scale (4 nodes) system deployment with direct RF communication providing full functionality with all tags in communication range.



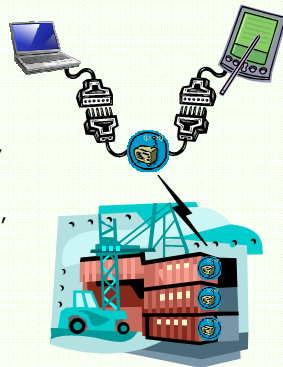
Phase 2 deployment:

Medium scale (~20 nodes) system deployment with multihop ad-hoc networking expanding system capabilities with scalability.



User Interaction

In order to facilitate user interaction with the system, a Graphical User Interface has been developed. It acts as a bridge between a PDA or Laptop, and the WSN network - communicates through a serial connection with a Gateway mote, which in turn interacts with the deployed container tags wirelessly using ZigBee standard RF communication in unlicensed ISM band.



Software

Wireless Sensor Networks operating system: TinyOS

WSN motes run TinyOS, dedicated operating system providing support for several hardware WSN platforms: micaZ, DSYS25Z or tmote Sky.



Graphical User Interface

- Laptop/Desktop - .NET Framework (Windows XP)
- PDA - .NET Compact Framework (Windows Mobile)

References

- TinyOS Community Forum: www.tinyos.net
- David Gay, Philip Levis, David Culler, Eric Brewer: "nesC 1.1 Language Reference Manual", May 2003;
- Dr. Thomas Haenselmann: "An FDL'ed Textbook on Sensor Networks"
- David J C MacKay: "Information theory, inference, and learning algorithms"

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