Ad-Hoc Networks for …

… Independent Living

(value added sensing)

Pawel Gburzynski

Olsonet Communications, Ottawa, Canada
University of Alberta, Computing Science, Edmonton, AB, Canada (emeritus)
Vistula University, Warsaw, Poland

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Militza (Brugges)
collaboration with Alphatronics, Belgium
Annonciaden (Antwerp)
collaboration with Alphatronics, Belgium
What to sense?

- the abominable panic button
- local remote control
- location independence
- monitoring
- tracking
- simplicity

acceleration
position
movement
LF-loops
...
RSS

May 2017
Alphanet highlights

true Ad-Hoc (as opposed to sensor-to-access-point)
- mobility, e.g., trips, field events (system on the road)

flexible, proprietary semi-infrastructure
- ISM band, ≠ BT, ≠ ZigBee, ≠ WiFi

integrated, virtual development platform
- complete, authoritative, virtual development and testing
Alphanet highlights

- Form ad hoc groups with flexible self-monitoring capabilities
- Trigger alarms from sensor readings or violations of configured groups
- Natural extensions, e.g. mobile groups
TARP

the ubiquitous, network-wide communication scheme: selective, cache-driven flooding (re-casting)
The forwarder’s dilemma

❖ where should I forward the packet?
❖ how can I learn the identity of the next node on the path?
❖ how do I make sure to know that identity at all times?

❖ should I transmit (broadcast) the packet?
❖ will I help when I do that?
❖ won’t my assistance be redundant?

P-P TARP
Tags and Pegs

Pegs

the same low end hardware base for all device types, e.g., CC430 by TI:

- 4K RAM
- simple ISM RF module
- typical rate: 38.4 kbps
- low energy

Tags
The praxis: Tags & Pegs

- Tags implement some end functionality, e.g., sensing; a Tag can be mobile.
- Pegs act as semi-infrastructure (e.g., static, devoid of sensors/actuators, used solely for communication).
- Pegs can be used as reference, e.g., for location tracking (those that do not move).
- Pegs can be powered from external sources, while Tags are battery powered.
- Everybody can forward, if needed (flexible roles).
Praxis development: PicOS

Versatile Network Interface

API  plugins

program  TARP  NULL  BOSS

PHY (drivers)

OS kernel  CC1100  UART
Praxis development: VUE²

Virtual Underlay Execution Engine

(an authoritative emulator for complete praxes)
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Virtual Underlay Execution Engine
(an authoritative emulator for complete praxes)

RF channel model
Node configuration
Node distribution
Mobility models
Agents
Indoor location tracking

based solely on crude RSS, yet surprisingly accurate (for the task at hand)
Pegs as anchors

- direct transformation of RSS into distance doesn’t work (subtler correlation is needed)
- we can afford many Pegs (redundant coverage doesn’t pollute the RF channel)
- profiling: manual, automated, hinted (by other location indicators, e.g., LF loop sensors, chargers)
Location bursts

A series of 32 short packets transmitted at increasing power levels (in groups of 4):

- PL 0
- PL 1
- PL 7

Pegs receive what they can and forward the corresponding RSS vectors to the OSS.
# loc 1'0'2, att 5 "23-Apr-2017 19:59:03"

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Peg

power level
Like RFID/ranging combo

- low power levels have priority; this way closeness to a Peg tends to result in a good estimate

- allows for sparse coverage in areas where tolerance can be afforded: no need to be close to a Peg for a “reasonably good” estimate

- history option, i.e., tracking versus (infrequent, on-demand locating)
A few numbers

for what they are worth

RF range: 100 m ballpark in open air (minimal antennas), 10-50 m in a building, depending on wall type …

practical accuracy (on-demand [alarm] mode): 90%+

recommended coverage: 1.5 Pegs per “location”

energy budget (Tag): ca. 4 mAs per burst: 1 b/h \( \rightarrow \) 1.2 uA extra current drain, idle current: ca. 3 uA, 1 event/h \( \rightarrow \) 20 years on a 1 Ah (3 V) battery
That’s it

THANK YOU