CodeBlue: An *Ad Hoc* Sensor Network Infrastructure for Emergency Medical Care

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**Mass Casualty Events**

Large accidents, fires, terrorist attacks
- Normal organized community support may be damaged or destroyed
- Large numbers of patients, severe load on emergency personnel

Manual tracking of patient status is difficult
- Current systems are paper-, phone-, radio-based

Sensor nets have potential for large impact
- Real-time, continuous vital monitoring
- “Electronic triage tag” to store patient data
- Immediate alerts of changes in patient status
- Relay data to hospital, correlate with pt. records
CodeBlue Architecture

Vital sign sensors and active tags

Location beacons

CodeBlue Information Plane

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Wireless PDAs and fixed terminals

Other hospital information systems

Ambulance MDTs
CodeBlue Architecture

Scalable, robust “information plane” for critical care
- Ad hoc, any-to-any routing with dynamic discovery of routes
- Runs across a range of devices, from motes to PDAs to PCs

Publish/subscribe data delivery model
- Sensor nodes publish vital signs, location, identity
- Rescue/medical personnel subscribe to data of interest
- In-network filtering and aggregation of data to limit bandwidth and information overload

Reliable delivery of critical data
- Content-based prioritization
  - e.g., patient stops breathing or loss of network connectivity
  - Scale transmit power to limit interference or issue “SOS” messages

Decentralized authentication and security
- Handoff of credentials across rescue personnel
- Seamless access control across patient transfers
VitalDust: Wireless vital sign monitoring

MICA2–based pulse oximeter using BCI, Inc. OEM board

- Measures heart rate, blood oxygen saturation
- Mote–based ECG currently under development
- PDA– and PC–based applications for multi–patient triage
- Integration with iRevive, PDA–based patient care record system for EMTs
Research Challenges

Scalable, flexible routing infrastructure
- Many existing ad hoc routing schemes are connection-oriented
- Much work in sensor networks focused on many-to-one data collection
- We require more flexible naming and pub/sub semantics

Rapid, robust, ad hoc deployment
- Must operate without external network or computational infrastructure
- Decision-making must be fully distributed
- Zero administrative overhead for setup and configuration

Coping with enormous ranges of density and node volatility
- Must scale to very high node densities
- Communication must adapt to widely varying network conditions

Lightweight, decentralized security mechanisms
- Sensor nodes are too primitive for expensive public-key approaches
- Still must support flexible security policies
Current Status

MICA2–based pulse oximeter using BCI, Inc. OEM board and EKG using custom–designed board
  • Happy to share designs and hardware itself

PDA–based runsheets and pulseox software

Shared–key encryption and MAC layer based on SKIPJACK

Power–aware, multihop routing protocol prototype

Collaborations with Boston–area hospitals:
  • Boston Medical Center
  • Brigham and Women's Hospital

For more information:
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