VitalDust: Wireless Sensor Networks for Emergency Medical Care

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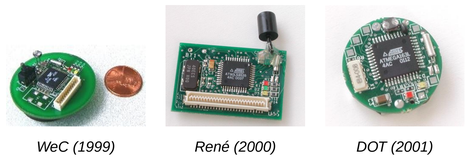
Wireless Sensor Networks

Family of UC Berkeley "mote" designs



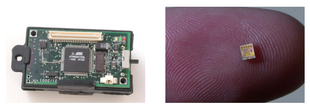
WeC (1999) *René (2000)* *DOT (2001)*

Exciting emerging domain of deeply networked systems

- Typical 4 MHz microcontroller, 4 KB RAM, 128 KB ROM
- FSK radio up to 19.2 Kbps, range > 100m
- 15-20mA active (5-6 days), 15μA sleeping (21 years, but limited by battery)

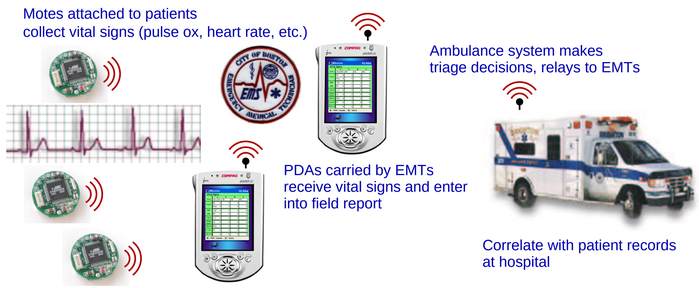
Drive towards miniaturization and low power

- Eventual goal - complete systems in 1 mm^3, MEMS sensors



MICA (2002) *Speck (2003)*

VitalDust: Emergency Medical Triage



- Patient motes form ad-hoc wireless network with EMT PDAs
- Enables rapid, continuous survey of patients in field
- Requires secure, reliable communications

Research Challenges

Flexible Network Communications Infrastructure

- Nodes adapt to changes in location, connectivity, and link quality
- High-risk patients receive higher network service level

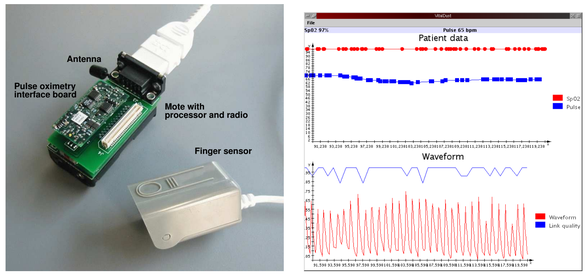
Distributed Data Collection and Integration

- In-network data aggregation and analysis
- Patient data integrated into hospital information systems

Fault-tolerance and Data Integrity

- Resilience to node failures and assurance of accurate data

VitalDust Prototype

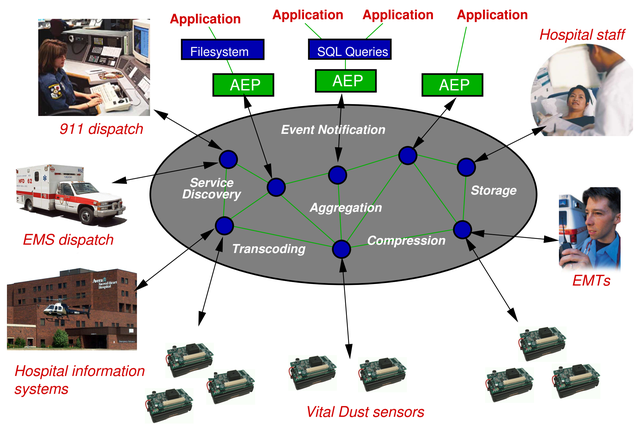


- Mica2 motes transmit blood oxygen and pulse statistics
- PDA visualization tools allow mobile patient monitoring

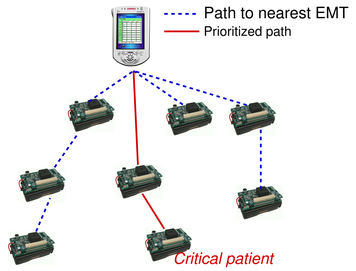
iRevive: Mobile Patient Care Record

- PDA-based Patient Care Record software
- Collect incident information, observations, procedures
- Automatic transfer of PCR to hospital on arrival

The Hourglass Data Collection Network



Wireless Ad-Hoc Routing for Critical Care



- Dynamic route discovery
- Prioritize path for critical patients
- Security
- Adaptive energy conservation

Mass Casualty Events and Disasters

Biochemical Attack Scenario

- EMTs easily identify and treat high-risk patients

Coordinated Response

- Sensors assess situation and invoke emergency response services

Improved Organization

- Automatic, optimized allocation of hospital and triage resources

Other Applications

Ventilator study in Pediatric Intensive Care Unit

- Capture continuous pulse-ox data on PICU patients
- Correlate with ventilator failures
- Study duration and severity of desaturation events

Sudden Infant Death Syndrome (SIDS) Research

- Embed vital sign sensors in diapers to research cause of SIDS
- Home computer serves as intermediary to remote database

Emergency Department Waiting Room

- Continuously monitor patients in waiting room
- Rapid response to sudden change in patient status

Future Work

Multi-Hop Routing Protocol

- Design prioritization and power conservation strategies

Hourglass Data Collection Network

- Peer-to-peer publish/subscribe overlay network
- Push aggregation and filtering services into overlay nodes
- Forthcoming project to link metropolitan 911/EMS dispatch services (Telecom City)

Demonstrations and Deployment

- Demo VitalDust prototypes for Boston area hospitals and EMT teams
- Interested parties conduct case studies using VitalDust technology