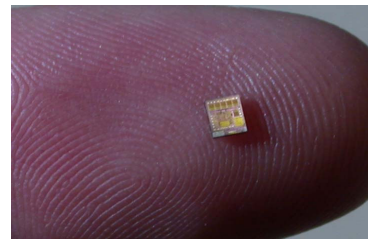


Introduction: Advances in embedded systems have led to the development of small, low-power sensor nodes (often called “motes” or “smart dust”) that consist of a simple microcontroller, a small amount of memory, a low-power radio, and various sensors that are capable of collecting, processing, and transmitting sensor data over distances of 100m or more.

Materials and Methods: The MICA mote platform (Figure 1) was developed at UC Berkeley in collaboration with Intel Research. It includes an 8-bit Atmel ATMEGA 128L microcontroller, 132K of memory, a 512K nonvolatile flash memory, and a 40 Kbps radio operating at 433 MHz or 916 MHz. The node is powered by 2 standard AA batteries. The SPEC platform (Figure 2) is a next-generation mote that incorporates the functionality of the MICA on a single 5 mm<sup>2</sup> chip.



**Fig. 1** MICA sensor node

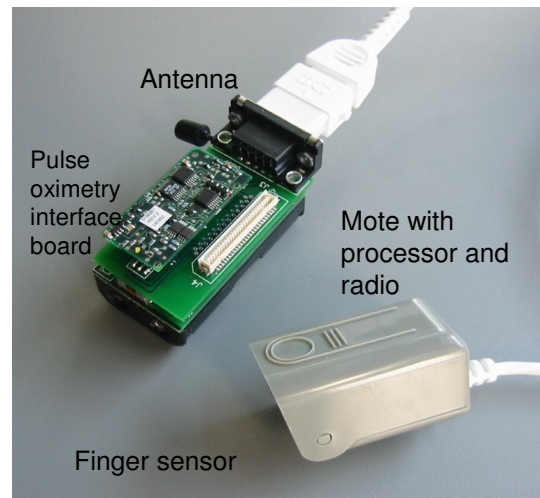


**Fig. 2** SPEC node prototype

Results: We have developed a wireless, pulse oximetry sensor based on a commercial pulse oximetry module from BCI, Inc (Figure 3). The device consists of a standard finger or ear sensor, a pulse oximetry module (BCI Micro Power Oximeter board) and a mote. The pulse oximetry module has a serial interface that relays SpO<sub>2</sub>, pulse, and plethysmogram waveform data to the MICA node using a simple protocol. It consumes only 6.6mA, which is less than half of the normal operating current of the MICA node itself.

# Resuscitation Monitoring with a Wireless Sensor Network

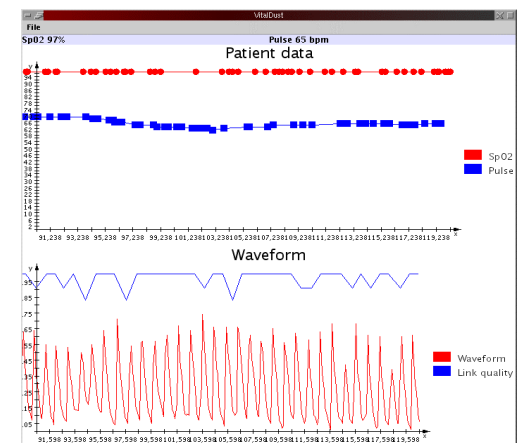
Matt Welsh PhD, Dan Myung AB, Mark Gaynor PhD, Steve Moulton MD  
Division of Engineering and Applied Science, Harvard University  
10Blade, Inc.



**Fig. 3** VitalDust

The MICA mote wirelessly transmits encrypted vital sign data along with a timestamp and unique node identifier to a receiving mote, which is connected to a PDA or PC for display. The encryption process is based on TinySec,<sup>1</sup> which uses the Skipjack<sup>2</sup> symmetric encryption algorithm. The radio communication protocol used by the MICA is capable of transmitting up to 64 packets/sec.

The receiving mote can be connected directly to a handheld device and displayed alongside other motes in the network or connected to a PC (Figure 4). When connected to a central PC, the sensor data can be transmitted via 802.11/WiFi over a longer distance and to devices not equipped with a receiving mote.



**Fig. 4** VitalDust data

1. Karlof C, Sastry N, Wagner. TinySec: Link Layer Security for Tiny Devices.

<http://www.cs.berkeley.edu/~nks/tinysec/index.html>

2. National Institute of Standards Technology, SKIPJACK and KEA Algorithm Specifications.

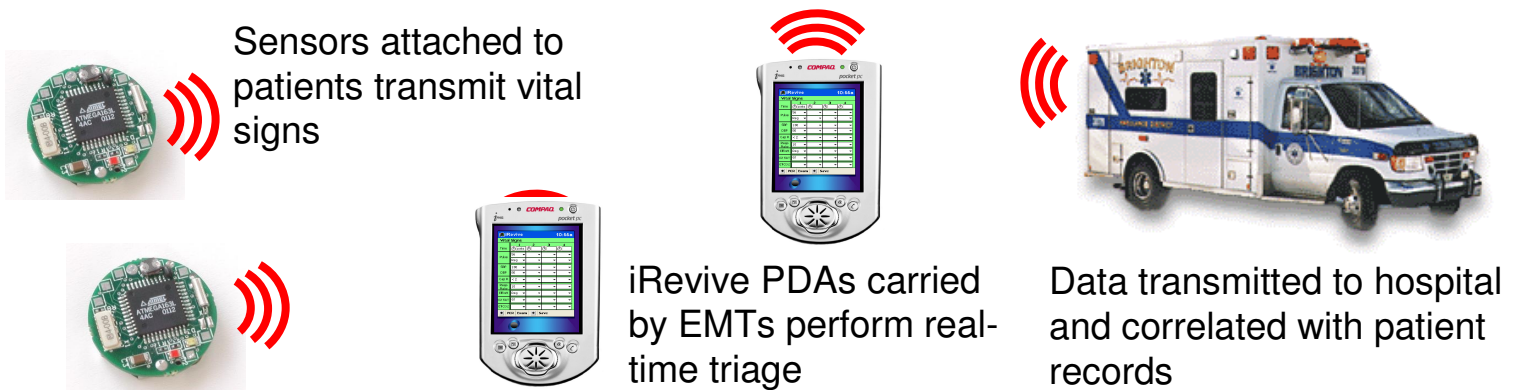
<http://csrc.nist.gov/CryptoToolkit/skipjack/skipjack-kea.htm>

iRevive: 10Blade has developed a software package called iRevive that allows complete documentation of pre-hospital emergency medical services (EMS) on a mobile device (Figure 5).



**Fig. 5** iRevive

## VitalDust/iRevive Application



## Research Challenges:

- Development of highly robust, ad hoc multi-hop routing schemes
- Prioritization of critical data, e.g. serious change in patient status
- Dynamic re-keying support for increased security

Conclusion: Sensor node and sensor network development have the potential to revolutionize patient care by allowing continuous, real-time, non-invasive, wireless monitoring of multiple patients. Relaying this information to one or more systems that are supported by the developing medical grid could yield acute, real-time triage and decision support

For More Information:

<http://www.eecs.harvard.edu/~mdw/proj/vitaldust>

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