Personal Health Records, Mobile Biosensors and Smartphones for Developing Countries

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Telehealth is for
- Everybody, even those who are not ill
- People who do not have 24/7 broadband Internet access.
- People who probably do have cellphones or nowadays smartphones.

Christine Horn 2011

Basis of Telehealth
- Information about the person’s health status. (Person, not Patient)
- Contained in the health record
- more specifically the Personal (or Personally Controlled) Health Record PHR

The PHR contains (ideally)
- Data stored by User / Owner (Person)
- Data stored by healthcare providers
- Data from measurements
  - Biosensors for temperature, blood pressure, heart rate, etc
- Contextual information (see Ahsan & Seldon)
The PHR is located

- online
  - Indivo (3.1 ...X), DOSSIA, MyOSCAR
  - Microsoft Health Vault
- on the phone
  - H’andy Sana 210, OnTrack Diabetes,

Biosensor “system”

Overview Model

Biosensor standards

- Device standards
- Communication standards
  - USB Personal Healthcare Device Class
  - Bluetooth Health Device Profile
  - Zigbee Health Care Profile (802.15.4)
- ISO/IEEE 11073 Personal Health Devices (X73PHD)

Methods: Devices - Standards

IEEE 11073-20601-2008

- an openly defined, independent standard for converting the information profile [of personal health devices] into an interoperable transmission format, so the information can be exchanged between personal biosensor devices and compute engines with this overall System Model.
Methods: Device Specialization

- IEEE 10404™- Pulse Oximeter
- IEEE 10406™ –Basic Electrocardiograph (1- to 3-lead-ECG)

Methods: Device Message Exchange

A scanner can report measurements from several other objects in a single message. There are two types of scanner: episodic (which sends a notification when some event occurs) and periodic (which sends notifications at regular intervals).

Methods: Extending Device Message Exchange

Our approach is to extend the Agent – Manager data transmission to the PHR system.

Reality check

- Existing biosensor devices do not adhere to standards – e.g. digiO2 CardioCare, (Nonin 9560)
- Portable Health Devices have no good market in developing countries
- Advanced smart phones have capabilities to replace biosensors
- Standardization should allow phone manufacturers to integrate health device profile and sensors with hardware and software for ease of application development.
**Reality check**

Nonin 9560 Onyx II Specification:
- Oxygen Saturation Display Range: 0 - 100% \( \text{SpO}_2 \)
- Pulse Rate Display Range: 18 - 321 BPM

**digiO2 Cardio Care ECG recorder Specification:**
- Baud rate=9600bps, Databits=8,
- Stop bits=1, Parity bit=None, Flow control=None

**Cardio Care ECG/EKG**

<table>
<thead>
<tr>
<th>Byte Sequence</th>
<th>contents</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0x55</td>
<td>Start byte</td>
</tr>
<tr>
<td>2-3</td>
<td>0x00</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0x01</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0x81-0x89</td>
<td>Sequence code</td>
</tr>
<tr>
<td>6-21</td>
<td></td>
<td>ECG data package (gSample rate = 256 Hz) (\text{range} = 0-4096)</td>
</tr>
<tr>
<td>22</td>
<td>0xB6</td>
<td>Stop byte 1</td>
</tr>
<tr>
<td>23</td>
<td>0x0B</td>
<td>Stop byte 2</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>Checksum package</td>
</tr>
</tbody>
</table>

**Nonin Onyx 9560**

To select the data format the host must send the 9560 the following 6 byte command string:

<table>
<thead>
<tr>
<th>Byte 1</th>
<th>Byte2</th>
<th>Byte3</th>
<th>Byte4</th>
<th>Byte5</th>
<th>Byte6</th>
</tr>
</thead>
<tbody>
<tr>
<td>FF02</td>
<td>FF07</td>
<td>FF02</td>
<td>0x02</td>
<td>0x02</td>
<td>0x03</td>
</tr>
</tbody>
</table>

**Nonin Data Packet**

Three bytes of data are transmitted 1 once per second:

**Byte 1 - Status**

<table>
<thead>
<tr>
<th>BIT</th>
<th>BIT6</th>
<th>BIT5</th>
<th>BIT4</th>
<th>BIT3</th>
<th>BIT2</th>
<th>BIT1</th>
<th>BIT0</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

**Byte 2 - Heart Rate (HR-D)**

<table>
<thead>
<tr>
<th>BIT</th>
<th>BIT6</th>
<th>BIT5</th>
<th>BIT4</th>
<th>BIT3</th>
<th>BIT2</th>
<th>BIT1</th>
<th>BIT0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

**Byte 3 - SpO2-D**

<table>
<thead>
<tr>
<th>BIT</th>
<th>BIT6</th>
<th>BIT5</th>
<th>BIT4</th>
<th>BIT3</th>
<th>BIT2</th>
<th>BIT1</th>
<th>BIT0</th>
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</tbody>
</table>

**Byte 4 - Status2**

<table>
<thead>
<tr>
<th>BIT</th>
<th>BIT6</th>
<th>BIT5</th>
<th>BIT4</th>
<th>BIT3</th>
<th>BIT2</th>
<th>BIT1</th>
<th>BIT0</th>
</tr>
</thead>
<tbody>
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</tr>
</tbody>
</table>
Another option: the phone

- Smartphone sensors
  - camera
  - accelerometer
  - gravity, etc
  - touchscreen

Phone sensors

- Camera
  - pictures of person
  - heart rate
  - SpO2

Biosensor “system” phone

Our Proposed Framework

Putting health data online 1

- Most “remote data collection” systems require broadband
- SANA collects text, audio, images, video. Transmits via SMS & Wifi
- openRosa (openMRS) requires Internet connection
- X73 Specifies Agent – Manager data Transmission.
### Putting health data online 2

- Opposite approach: reduce the volume of data with on-phone processing
  - mostly plain text
  - instead of ECG or PPG, transmit HRV parameters
  - shrink images to < 20 KB

### Putting health data online 3

#### Issues of concern
- Transmission speeds/bandwidth
- Communication channel
- Security of transmitted data
- Integrity of data
- Privacy

### Thank you!

- **Collaborators since 2006**
  - Hamid Moghaddasi, Tehran, Iran
  - Seo Wei Jye (Sam), Kuching, Malaysia
  - Jofry Sutanto, Pontianak, Indonesia
  - Wee JoNah (Shane), Kuching, Malaysia
  - Ali A.A. Al-Habsi, Yemen
  - S M Kalaiarasi, Melaka, Malaysia