SAPHE – Smart and Aware Pervasive Healthcare Environment: Experiences from the Trial

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Healthcare trends and drivers

- **Aging population** - by 2025, 20% of all Europeans will be older than 65

- **500,000** people in UK currently live in *care homes*, 40% of these could be supported at *home*

- 90% of older people want to stay in their *own homes*

- 5% of hospital patients, many with a long term condition, account for 49% of all acute bed days

Source: Office for National Statistics

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**Ageing Population**

- Under 16's
- Over 65's

**Gross Expenditure Per Head of Population 2003-04**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Expenditure (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>births</td>
<td>3,000</td>
</tr>
<tr>
<td>0-4</td>
<td>1,500</td>
</tr>
<tr>
<td>5-15</td>
<td>500</td>
</tr>
<tr>
<td>16-44</td>
<td>75</td>
</tr>
<tr>
<td>44-64</td>
<td>100</td>
</tr>
<tr>
<td>65-75</td>
<td>150</td>
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<tr>
<td>75-84</td>
<td>200</td>
</tr>
<tr>
<td>85+</td>
<td>4,500</td>
</tr>
</tbody>
</table>

Source: UK Department of Health: Departmental Report 2006
Provide a **pervasive health and social care solution** that is optimised for the **aging population** and patients with **long-term conditions**.

- **Unobtrusive low-power wireless sensor** networks for **long term** vital sign and **home monitoring**
- Early detection of deterioration through **context-aware** sensing and data fusion for **trend analysis**
- Addresses the needs of all **stakeholders**
User Insights for Stakeholders

• Patients
  – Elderly people living at home
  – One or more chronic conditions

• Formal Carers
  – Community Matron (CM)
    • Skilled nurse
    • Case management skills

• Informal Carers
  – Friend
  – Relative
  – Neighbour

• Clinician

• Call Centre, Installation Engineers
SAPHE End-to-End System
What do we Sense?

- In and around the home
  - PIR: room occupancy
  - Door sensors
  - Fridge usage
  - Ambient temperature
  - Weight
  - Blood pressure
  - Sleep quality & bed exits

- Body worn
  - Activity levels
  - SPO2
  - Pulse rate
  - ECG
SAPHE Wireless Technologies

- No “one-size fits all” wireless technology
- Standardized solutions
  - Wi-Fi: high bandwidth, mains, 100m
  - Bluetooth: large battery, 10m, 8 nodes
  - ZigBee: low bandwidth, small battery, 65k nodes
- Proprietary solutions
  - Low power radio: coin-cell
  - Ultra low power radio: printed battery
Liverpool Trial

• SAPHE systems installed in 8 homes
  – 2 installations scheduled
  – Trial started in February 2009 for 6 months
  – Recruiting has been time-consuming
• Large quantity of data collected
  – 7 million sensor events!
  – Failsafe design proven
    • “Store and Forward” on sensors and hubs
• Valuable experiences from all stakeholders
Experiences – Installation Engineer

• Dedicated local contact needed
  – Ad-hoc technical support and intervention

• System installation is complex
  – Installation involves patient engagement and education
  – 4-5 hours from scratch; 2-3 hours when pre-configured

• Wireless Networks
  – Multiple wireless technologies need different setup
  – Bluetooth sensors out of range
  – Wireless allows devices to be moved at a later date

• Proactive monitoring of system integrity needed
  – Offline sensors or systems not always picked up
  – Faults reported by CMs may reduce overall acceptance
Experiences – Community Matron

- Community matrons keen to be involved
  - Difficulty in identifying patients from their caseload
- Mobile device (3G netbook) received most negative feedback
  - Network connectivity and speed
  - Weight and size
- Mobile access is of great value
  - Response to ad-hoc patient contact
  - Controlled sharing of data with patients
- Activity shown to be of value to CM
  - Behavioral changes picked up that were symptomatic of health problems
- Website co-designed with CMs
  - Need to rely on data integrity
  - Interpreted data needs evidence
Interpreted Data needs Evidence

Location confirmed by sensor events and not artefacts
Correlation of Information between Sensors
Experiences – Service User

• Overall patients have accepted the technology
  – Innovative approaches to overcome issues
• Main issues have been with e-AR sensor:
  – Size and comfort
  – Competing with hearing aids, oxygen, glasses
  – e-AR is being re-designed to be belt worn
• Charging sensors
  – Dexterity for mini-USB cables
• Scales
  – Audibility of prompts
• Blood pressure accuracy
  – Calibration of device
Service User Interface

- Engage users in their care
  - Access their readings and other relevant information
  - Encourage compliance
  - Feedback that system is working
- Users interact using television
  - Universally known
  - Well defined design guidelines
- Community matron can send messages
  - Appointment reminders
Conclusions

• SAPHE extends what is normally monitored
  – Activity has proven to be useful
  – Other new sensors still need to be understood
• Wireless sensors alone do not improve healthcare delivery
  – Need for complete system
  – Presentation of sensor data important to all stakeholders
• Accuracy of sensors vital
  – Patients understand their conditions and symptoms
  – Discrepancies between sensors causes concern
• More analysis needs to be done on the data
  – Correlate sensors readings
  – Interpret readings with CM to understand health status
Vision for the Future – A Wish List

• “Invisible” sensors
  – House is completely covered without being seen
• One wireless network
  – All sensors use the same (compatible) wireless technology
• Easy installation
  – Out of the box installation by users
  – No need for professional intervention
  – Upgrade new features as required
• Data visualisation
  – User can open access to other stakeholders
  – Access information anywhere
  – Correlated information from many sensors for accurate status