Wireless challenges in the Ageing in Place environment

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TU/e

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Context
Ageing population

2000 World

- Female: 2%
- Male: 62%

65 yr

15 yr

Population per 5 year age group (M)

2050 World

- Female: 16%
- Male: 63%

65 yr

15 yr

Population per 5 year age group (M)


Young societies
Less than 10 per cent of population aged 60 and over

Ageing societies
10-19 per cent of population aged 60 and over

High-ageing societies
20-29 per cent of population aged 60 and over

Hyper-ageing societies
30 per cent or more of population aged 60 and over

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Countries with faster ageing population
Proportion of population aged 60 or over in 2015 and 2050

US Emergency Department visits by elderly

More than one third results in hospitalization

19 million emergency department visits by US older adults

• 38% arrive by ambulance
• 36% result in hospital admission

Injuries and falls are the number one cause of ED visits (Unintentional falls make up 13.5%), but also heart disease, chest pain, abdominal pain, adverse drug reactions, COPD, pneumonia and urinary tract infections are common causes of ED visits in older adults.

Ref: NCHS data brief 130 - Emergency Department Visits by Persons Aged 65 and Over: United States, 2009–2010
Cost of healthcare

US example

Lower Healthcare Costs by Utilizing Technology to Help Manage and Prevent Chronic Diseases

• In 2013, the US government spent $591 billion on Medicare. However, Medicare is projected to have insufficient funds to pay all hospital bills beginning in 2030

• Chronic disease accounts for 86% of US healthcare costs, which can be reduced by enabling the healthcare ecosystem with innovative technology

Cardiovascular
$193 Bn spent on direct medical expenditures

Diabetes
$176 Bn spent on direct medical expenditures

Obesity
$147 Bn linked to medical expenditures

Cancer
$157 Bn spent on direct medical expenditures

Source: Beth Seidenberg, KPCB General Partner and Lynne Chou, KPCB Partner. Sources: Kaiser Family Foundation website and CDC website http://www.cdc.gov/chronicdisease/overview/

Ref: Mary Meeker, KPCB, May 2015, Internet trends

Many elderly cannot afford nursing home or assisted living cost
Care is changing
From professional to consumer
Internet of Everything

Fastest growth in IoE/IoT devices

It Will Soon Be Larger Than The PC, Tablet, And Smartphone Markets Combined

Source: BI Intelligence Estimates

Ref: BI Intelligence, 2015
Internet of Everything

Healthcare will benefit

Nearly All Industries Will Benefit, But Early Adopters Are In Logistics ...

Top Industries With Investments In IoT Solutions

- Manufacturing
- Transportation And Warehousing
- Information
- Wholesale Trade
- Health Care And Social Assistance
- Retail Trade
- Finance and Insurance
- Utilities
- Mining
- Real Estate And Rental And Leasing
- Construction
- Professional, Scientific, And Technical Services

Source: BI Intelligence Estimates

Ref: BI Intelligence, 2015
Trend: internet traffic growth
Amount of data is staggering – we are just starting

More than 1 Zetabyte per year in 2016
All movies ever made in 3 sec in 2018

Source: Cisco VNI, 2014
The percentages in parentheses next to the legend denote the device traffic shares for the years 2013 and 2018, respectively.

Trends landscape

- **Mesh**
  - BT Mesh
  - Zigbee 3.0
  - BT Mesh
  - Zigbee 3.0
- **SubGHz**
  - 802.11ah
  - 2016 new Wi-Fi standard
- **Z-wave Plus**
  - 2016 new standard
- **IP Protocols**
  - CoAP
  - REST
- **Longrange**
  - LoRa
    - NL, Belgium, France, Singapore
    - 300 bit/sec
    - 5-10 km
    - 900 MHz / ISM
  - Sigfox
    - France
  - Weightless
    - UK
  - Global M2M Alliance
  - M2M World Alliance
- **Cellular M2M**
  - LTE MTC
    - Machine Type Communication
  - LTE-D2D
    - Device to Device
  - OneM2M
  - LTE-U
    - 3GPP
    - 5 GHz unlicensed
  - IPSO
  - SmartM2M
- **Service APIs**
  - AllJoyn
  - Weave
  - HomeKit
- **IP for Smart Objects**
- **IP Protocols**
  - LTE
  - Device to Device
  - OneM2M
  - LTE-U
  - IP for Smart Objects
  - ETSI
Industry consortia
Wireless, IoT

Note: example snapshot of industry relations, oct2015 based upon web research, excl industrial internet
Changing Digital Health Landscape
Philips HSDP
Elderly Care Journey (video)
Care continuum
Consumer and professional health converging

We see two major opportunities:
• “Industrialization of care”: enable providers to deliver lower-cost care with better outcomes
• Drive convergence of professional health care and consumer spaces
The challenge is to create a healthcare experience that is as intuitive and effective as on-line banking or shopping

For administrators
• How do we support and excel in an outcomes-driven business model?
• How can we leverage skilled resources across entire populations?

For providers
• How can I access meaningful information at the point of decision?
• How do I effectively and efficiently manage someone’s care remotely?

For consumers
• How can I manage my care without becoming consumed by it?
• How do I know I’m receiving value? What do I look for?
Philips **HealthSuite** Digital Platform
designed to support the Health Continuum

Cloud-based HealthSuite Digital Platform

**Multiple devices / applications contribute to a rich data set**

- **Hundreds of thousands of consumers on ActiveLink®**
- **Smart Air Purifier** launched in China (2014)
- **15PB+ imaging studies** in our imaging informatics solutions across 1200+ hospitals
- **2+ million ICU stays** in our eICU solutions
- **190+ million patients** a year monitored through our patient monitors
- **6+ million patients** supported at home and on the go
Propositions based upon HSDP

Proposition A
- Applications
- Business Logic
- Services

Proposition B
- Applications
- Business Logic
- Services

Proposition C
- Applications
- Business Logic
- Services

Foundation

Identity & Permission Services
(Security, Identity, Access, Consent)

Orchestration Layer
(API Access, Metering, Billing, Workflow)

Big Data Cloud

Device Cloud

HealthSuite Digital Platform
Ageing in place
Healthcare customer and consumer needs

Care continuum for elderly / ageing consumers

Healthy living
Help people to live a healthy life in a healthy home environment

Prevention
Enable people to manage their own health

Diagnosis
Ensure first time right diagnosis with personalized and adaptive care pathways

Treatment
Enable more effective therapies, faster recovery and better outcomes

Home care
Support recovery and chronic care at home

Monitoring, informatics and connected care
Improve population health outcomes and efficiency through integrated care, real-time analytics and value-added services
Example

1. Holistic view of the patient supports rapid diagnosis of aortic valve insufficiency
2. Aortic valve replaced in minimally invasive surgery
3. Recovery is monitored in the eICU
4. Rapidly discharged and goes home – monitoring continues
5. GP monitors entire cycle
6. Diet and fitness regime; Tracking her own health online
HealthSuite Digital Platform connects Philips and third party solutions across the continuum of care.
Ageing in place

How to support ageing in your own home?

<table>
<thead>
<tr>
<th>Personal Emergency response systems</th>
<th>Activity of Daily Living Monitoring systems</th>
<th>Social care systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication management systems</td>
<td>eHealth systems</td>
<td>Other Wellbeing systems</td>
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</table>

Seven out of ten U.S. adults track health indicators for themselves or a loved one.*

Philips strives to help patients to take a more active role in managing their health and enhance care provider's clinical decision making.

The HealthSuite digital platform is designed to connect devices and data from hospital to home.

* All references can be found in the speaker notes
Ageing in place

All support systems require some type of wireless connectivity

Personal Emergency response systems
- 3G
- Sub GHz
- Wi-Fi

Activity of Daily Living Monitoring systems
- 3G
- Sub GHz
- Wi-Fi
- 15.4

Social care systems
- 3G
- 4G
- Wi-Fi

Medication management systems
- 2G
- 3G
- BTLE

eHealth/Vital Signs systems
- 3G
- BTLE

Other Wellbeing systems
- 3G
- 4G
- Wi-Fi
- BTLE
- LoRa
Case 1 – Lifeline GoSafe
Personal help and automatic fall detection of frail elderly

Web services
two-way phone call
with emergency call centre

Outdoor location

Indoor location

Web services
two-way phone call
with emergency call centre

Handover to Home gateway

Outdoor

Indoor

3G

Wi-Fi

GPS

Sub GHz

3G

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Case 2 – Activity of Daily Living Monitoring

Monitoring home situation of frail elderly

- Home Gateway
- 3G
- Wi-Fi
- Home sensors
- Proprietary
- Z-wave
- Zigbee
- 11ah
- Sub GHz
- 2.4 GHz
- Other

Web services
Reporting sensor measurements to remote care
Case 3 – Vital Signs Monitoring/eHealth

Elderly Chronic Diseases Management/ Ambulatory care

- Home Gateway/Tablet
- 3G
- Wi-Fi
- 2.4 GHz
- BT/BTLE
- Vital Signs
- HSDP cloud services
- Video Cloud service
- eCare Coordinator Clinical/professional service

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Wireless challenges (1)

Homes of elderly

- Battery powered sensors
  - Tradeoff between transmit power, number of sensor activations, richness of data transmitted
  - Frequency of changing batteries → more than 1 year
  - Transition from sleep mode

- Distance in the home
  - Single hop
  - Multi hop/mesh (need for powered nodes)

- Penetration in the home
  - Multiple walls
  - Blockage by human bodies

- No wired internet available
  - In many cases elderly do not have internet at home

- 3G coverage
  - Often no coverage with a single provider
  - Fallback to GPRS if at end of cellular range (no video capability anymore)
  - Placement at home of 3G router
Wireless challenges (2)

Characteristics of elderly / other

• Unobtrusiveness
  – Do elderly in the home notice the sensors
  – On body versus off body sensors
• Cost of sensors
  – Tradeoff with multiple sensors or single wireless sensors
• Availability
  – Off the shelf from various vendors
  – Proven in the field
• Differentiation between multiple persons
  – In the neighborhood of wireless sensors
• Geographical
  – Spectrum availability
  – Duty cycle
  – Afraid of electro magnetic radiation
End to end challenges

Many wireless connections involved

- Sensors
- Home Gateway
- Cloud services
- Users

Security
Privacy
Reliability
Cost effectiveness
Semantic context
End to end challenges

Many wireless connections involved

Security

Privacy

Reliability

Cost effectiveness

Semantic context

Final thoughts
Final thoughts

• Society needs to deal with the ageing population
• Unobtrusive monitoring with IoE/IoT and wireless sensor networks is a key technical opportunity
• Competing platforms – multiple will exist with cloud integration
• Enabling new services for ageing in place
• Security and privacy will be key

• Some questions/challenges for the research community
  – Low power battery powered wireless sensors with multi year lifetime
  – Streaming low data rate data while preserving lifetime (e.g. heart rate, ECG)
  – Distance in a home of an elderly
  – Semantics of billions of wireless sensors