Assisted living technologies for older and disabled people in 2030

Annexes to a draft final report to Ofcom

David Lewin, Stephen Adshead, Britta Glennon and Brian Williamson of Plum
Tim Moore of Sagentia
Leela Damodaran of Loughborough University
Paul Hansell of Aegis

March 2010
### Annex J  Network reliability requirements of ALTs

| J1 | Network reliability/availability |
| J2 | Availability of power            |
| J3 | Wireless requirements            |
| J4 | Security                         |

### Annex K  Network architecture requirements of ALTs

| K1  | General characteristics         |
| K2  | Network types                   |
| K3  | The overall network architecture|
## Annex A  Stakeholder interviews

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alzheimer's Society</td>
<td>Leicester City Council - Telecare Manager</td>
</tr>
<tr>
<td>AT Care</td>
<td>London Borough of Hackney</td>
</tr>
<tr>
<td>Barnet District and Borough Council - Telecare Coordinator</td>
<td>London Borough of Newham</td>
</tr>
<tr>
<td>BiancaMed</td>
<td>LSE</td>
</tr>
<tr>
<td>BIS – four interviews</td>
<td>Manchester Metropolitan University</td>
</tr>
<tr>
<td>BT Group Plc</td>
<td>Microsoft Accessibility Business Unit</td>
</tr>
<tr>
<td>BUPA</td>
<td>National Institute of Adult Continuing Education</td>
</tr>
<tr>
<td>City University</td>
<td>Nintendo</td>
</tr>
<tr>
<td>Continua Health Alliance</td>
<td>Nottingham PCT</td>
</tr>
<tr>
<td>Cornwall PCT NHS</td>
<td>O2</td>
</tr>
<tr>
<td>Department of Health</td>
<td>Philips Research Laboratories</td>
</tr>
<tr>
<td>Digital Unite</td>
<td>Scottish Centre of telehealth</td>
</tr>
<tr>
<td>DLG</td>
<td>Skype</td>
</tr>
<tr>
<td>Ex-BT futurologist</td>
<td>Technology office within the NHS</td>
</tr>
<tr>
<td>Facebook</td>
<td>University of Bradford, Digital Media &amp; Systems Research</td>
</tr>
<tr>
<td>Fitness2live Ltd</td>
<td>University of Brighton</td>
</tr>
<tr>
<td>Help the Aged</td>
<td>University of Dundee</td>
</tr>
<tr>
<td>IBM</td>
<td>University of York</td>
</tr>
<tr>
<td>Independent Age</td>
<td>World Wide Web Consortium</td>
</tr>
<tr>
<td>International Longevity Centre</td>
<td>WSDAN</td>
</tr>
<tr>
<td>Invest Northern Ireland</td>
<td>WSD trials – Cornwall – social care</td>
</tr>
<tr>
<td>King’s College</td>
<td>WSD trials – Cornwall – health care</td>
</tr>
<tr>
<td>Leeds Metropolitan University</td>
<td></td>
</tr>
</tbody>
</table>
Annex B  Current delivery of care to older and disabled people

B1  Introduction

This annex provides more detail in support of Chapter 2.

B2  Who needs care now?

Before we can consider the impact of an ageing population on the need for care of older and disabled people, we must establish who needs care today. In making this assessment we take an holistic view rather than focusing solely on older people.1

Social care

We use as our measure of need for social care the number of people with disability as measured on the Richayzen Walsh scale (the RW scale for now on). This scale measures disability from 0 (healthy) to 10 (severely disabled), based on ability to undertake activities in daily living such as washing, dressing, cooking and getting up and down stairs. We use this scale to define three groups for analysis purposes:

- Healthy (0 on the RW scale and Area B of Figure B1)
- Mildly disabled and unlikely to need long-term care (1 to 6 on the RW scale and Area A of Figure B1)
- Moderately to severely disabled (7 to 10 on the RW scale and Area C of Figure B1)

Figure B1 shows how a population of 100,000 20-year-olds will divide between these three groups as they age, while Figure B2 shows how the current adult population is divided between the three groups.

We can see that:

- There are around 1.8 million people with moderate to severe disabilities in the UK
- 72% of these are age 65 or over
- The incidence of moderate to severe disability increases rapidly with age from around 1% of those of working age to 50% of those over 85.

1 Which we define as those over 65
Health care

Defining the need for health care is more challenging. Indeed there is considerable evidence that, at the margin, health care is rationed - by the treatments which are made available, by how long a patient must wait, or by how much he or she must pay for care. So instead we look at how the current UK health care expenditure of £109 billion per annum is spent by age group and disability. We define those who are in the last year of life as a separate category. Figure B3 presents our findings. It indicates that:

\[\text{Source: Increasing longevity and the economic value of healthy ageing and working longer, Professor Les Mayhew, Cass Business School, February 2009}\]
\[\text{Source: As Figure B1}\]
1. Expenditure on health care in the last year of life is more than 20 times greater than the average
2. Disabled people consume 3 to 4 times more health care than those without any disabilities
3. Spend on health care per head of population reduces somewhat as people age once we split out expenditure on last year of life and look at healthy and disabled people separately. This reduction probably reflects the fact that the NHS is more likely to offer people management of their conditions rather than expensive curative treatment as they get older.

Figure B3: Spend on health care by age and disability

<table>
<thead>
<tr>
<th>Age category</th>
<th>Healthy</th>
<th>Disabled</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (m)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td></td>
<td></td>
<td>14.7</td>
</tr>
<tr>
<td>20 – 64</td>
<td>32.6</td>
<td>2.8</td>
<td>35.4</td>
</tr>
<tr>
<td>65+</td>
<td>5.1</td>
<td>4</td>
<td>9.1</td>
</tr>
<tr>
<td>Last year of life</td>
<td></td>
<td></td>
<td>0.6</td>
</tr>
<tr>
<td>% health care expenditure</td>
<td></td>
<td></td>
<td>59.8</td>
</tr>
<tr>
<td>&lt;20</td>
<td></td>
<td></td>
<td>15%</td>
</tr>
<tr>
<td>20 – 64</td>
<td>40%</td>
<td>13%</td>
<td>53%</td>
</tr>
<tr>
<td>65+</td>
<td>4%</td>
<td>10%</td>
<td>14%</td>
</tr>
<tr>
<td>Last year of life</td>
<td></td>
<td></td>
<td>18%</td>
</tr>
<tr>
<td>Expenditure per person £pa (assuming £100 bn pa spend)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td></td>
<td></td>
<td>1020</td>
</tr>
<tr>
<td>20 – 64</td>
<td>1227</td>
<td>4643</td>
<td>1497</td>
</tr>
<tr>
<td>65+</td>
<td>784</td>
<td>2500</td>
<td>1538</td>
</tr>
<tr>
<td>Last year of life</td>
<td></td>
<td></td>
<td>30000</td>
</tr>
</tbody>
</table>

Although it is not possible to measure need for health care overall, it is possible to measure the scale of some health care problems which:

- Have a high incidence among older people
- Might benefit from telehealth services delivered into the home.

Figure B4 lists some of these conditions. The numbers in Figure B4 are not additive. In many cases an older person may suffer from two or more of the conditions at the same time.

---

4 Source: As Figure B1
5 0 on RW scale
6 1+ on RW scale
Figure B4: Incidence of conditions affecting older people

<table>
<thead>
<tr>
<th>Condition</th>
<th>Estimated number of sufferers in the UK (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type II diabetes</td>
<td>2.1</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease (COPD)</td>
<td>1.6</td>
</tr>
<tr>
<td>Cardiovascular diseases</td>
<td>2.4</td>
</tr>
<tr>
<td>Late onset dementia</td>
<td>0.7</td>
</tr>
</tbody>
</table>

**B3 How is care provided now?**

**Health care**

The NHS, and its 1.3 million employees, delivers 87% of health care by expenditure in the UK, with privately funded health care making up the remaining 13%. The latter proportion has fallen steadily over the past 10 years.

In 2007/08 the NHS budget was £102 billion. Administration of the NHS in Scotland, Wales and Northern Ireland is the responsibility of the devolved governments there. The NHS in England, which accounts for over 90% of NHS spend, is controlled by the Secretary of State for Health.

In England Primary Care Trusts (PCTs) are responsible for the allocation of more than 80% of NHS spend. There are currently 152 PCTs which are each responsible for meeting the health care needs of its local population, typically around 400,000 people. The PCTs:

- Are allocated a budget by the Department of Health, based on population served, but weighted for demographics and by local morbidity and mortality
- Make an assessment of the care needs of the population they serve
- Contract for services to meet these needs with hospital, mental health, and specialist trusts (for secondary care) and with GPs, dentists, pharmacists and ophthalmologists (for primary care). The idea of each contract is to meet needs as cost effectively as possible
- Then monitor contracts to see if agreed service levels are met.

PCTs typically spend around 20% of their budget on primary care and 80% on secondary care.

**Social care**

The bulk of social care is provided on an informal basis by the friends and families of those who need it. Based on statistics provided by Carers UK, we estimate the value of the time spent on this informal care at £58 billion per annum. This estimate is confirmed by Mayhew. In comparison expenditure on formal social care - in institutions and at home combined - is currently £19 billion per annum.

---

7 With GPs and their drugs budgets accounting for around 75% of primary care spend.

8 Same source as Figure B1
Unlike health care, we have seen a rapid move in the last 20 years from a model of direct provision of care by local authority employees to one in which local authorities commission care from independent organisations. Some of these are profit maximising providers; others are voluntary organisations or social enterprises. Figure B5 shows the scale of this shift in the pattern of local authority spend on care.

Figure B5: Local authorities spend on social care

<table>
<thead>
<tr>
<th>% of spend on commissioning care from independent providers</th>
<th>1990</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential care services</td>
<td>20%</td>
<td>90%</td>
</tr>
<tr>
<td>Home care services</td>
<td>&lt;5%</td>
<td>75%</td>
</tr>
</tbody>
</table>

As a result the value chain for the delivery of social care now looks like Figure B6. These flows show the money spent directly on social care. In addition the Government spends around £14 billion per annum spent on Disability Living Allowance or Attendance Allowance.

Figure B6: The value chain for the delivery of social care

Figure B7 provides estimates of the number of older and disabled people in receipt of formal social care. The categories of care listed here are not additive. For example many who receive home help also receive meals-on-wheels and attend day care centres. We can see, by comparing the numbers in

---

9 Transforming the market for social care, Institute of Public care, June 2009

10 Attendance Allowance is paid those who first claim for disability benefits after the age of 65; Disability Living Allowance is paid to those who first claim when under 65
need against the numbers receiving care that those who are likely to benefit most from assisted living services in their own home are those at Points 6 and 7 on the RW scale\textsuperscript{11}

Figure B7: Number of older and disabled people in receipt of the main care services

<table>
<thead>
<tr>
<th>Measure</th>
<th>Number (m)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>People over 65</td>
<td>9.5</td>
<td>Figure B2</td>
</tr>
<tr>
<td>People with mild disability (RW scale 1 to 6)</td>
<td>3.1</td>
<td>Figure B2</td>
</tr>
<tr>
<td>People with moderate or severe disability (RW scale 7+)</td>
<td>1.3</td>
<td>Figure B2</td>
</tr>
<tr>
<td>People in residential care homes</td>
<td>0.4</td>
<td>Health Care Scenario study\textsuperscript{12}</td>
</tr>
<tr>
<td>People in sheltered housing</td>
<td>0.7</td>
<td>Health Care Scenario study</td>
</tr>
<tr>
<td>People receiving home help</td>
<td>0.3</td>
<td>Health Care Scenario study</td>
</tr>
<tr>
<td>People receiving meals on wheels</td>
<td>0.1</td>
<td>Health Care Scenario study</td>
</tr>
<tr>
<td>People attending day care centres</td>
<td>0.1</td>
<td>Health Care Scenario study</td>
</tr>
</tbody>
</table>

**Total spend on care**

Figure B8 summarises current expenditure on care in the UK. We can see that social care costs fall mainly on individuals while health care is provided mainly by the NHS.

Figure B8: Expenditure on care in the UK\textsuperscript{13}

<table>
<thead>
<tr>
<th>Social care</th>
<th>Total £bn pa</th>
<th>Private £bn pa</th>
<th>% private</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal social care</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>institutional</td>
<td>13.4</td>
<td>5.3</td>
<td>40%</td>
</tr>
<tr>
<td>Home</td>
<td>5.7</td>
<td>1.3</td>
<td>23%</td>
</tr>
<tr>
<td>Informal care by friends and relatives</td>
<td>58</td>
<td>58</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>77.1</td>
<td>64.6</td>
<td>84%</td>
</tr>
<tr>
<td>Health care</td>
<td>109</td>
<td>14</td>
<td>13%</td>
</tr>
</tbody>
</table>

\textsuperscript{11} We estimate that there are around 1.1 million older people at Point 6 on the RW scale and a further 0.6 million at Point 7 or 8 combined.

\textsuperscript{12} Health Technology Scenarios and Implications for Spectrum, Fathom Partners, March 2008

\textsuperscript{13} Source: Figure B1 plus ONS 4/08
Annex C  Digital participation services

C1  Introduction

This annex discusses potential future developments in digital participation services: social interaction, entertainment and learning. These services may be crucial in the assisted living world to offset potential isolation of older people resulting from the automation of their care. We have found that there is a strong connection between the different service areas. Older people often mix communication and entertainment activities, and similar technology drivers affect developments in both areas.

Many digital participation services will be internet-based and the same services used by older people as the population in general. In this case a key issue is the accessibility of these mainstream services to older people, and whether variants of them (e.g. applications built on top of a common platform) will be developed to serve the specific needs of older people. Similarly, there is a need for access to the internet to use these services.

There is potential for digital participation services to meet needs other than those for social interaction, entertainment and learning. Our research has found ways that these services may provide a way of monitoring older people, as an indirect substitute for or complement to telecare or telehealth monitoring services.

B2  Main short-term developments

In the short-term there will be evolutionary development of current platforms and services, and an increase in use of these services by older people. In relation to social interaction, the main short-term developments include:

- Growth in usage of internet social networking services (e.g. Facebook) by older people. These services have already seen strong growth in usage among older people: Facebook claimed a “massive increase in uptake” recently.\(^\text{14}\). It is likely that this growth will continue, though take-up of the service by older people will be limited by its perceived relevance (some interviewees thought that social networking services do not enable the deeper kind of social interaction that older people want) and internet access. Interviewees thought that intergenerational communication (e.g. keeping in touch with children and grandchildren) will be an important driver for growth.

- Increased use of internet-based instant messaging / communication services (e.g. Skype) for video calling. For similar reasons to above, interviewees expect growth in these services among older people. Skype found that the proportion of its users who are predominantly users of video calling (i.e. use video calling more than voice calls or messaging) is highest in the 55+ age group. Unlike other age groups older people are not engaging with instant message or voice calling. The former is too different for them and, in the latter case, they prefer to use the telephone, except perhaps for cost reasons. Further growth in video calling may be driven by dedicated video

\(^\text{14}\) In the US in May 2009 the site had 2.2 million US users over the age of 55 who return to the site monthly, compared to 2.8 million in March. Despite the monthly decrease, over the 6 months to March 2009 the number of users over 55 grew by a factor of over 5 times.\(^\text{14}\) It is likely that similar trends are seen with in the UK user base of Facebook.
calling devices (e.g. Asus video phone[^15] for Skype which is aimed at older, less experienced users).

- Use of social networking and instant messaging services via non-PC platforms. For example, the Nintendo Wii console (if connected to broadband) supports Facebook and a proprietary video calling application called Wii Speak. Interviewees thought that these platforms might be easier for older people to use than PC-based services. However, this development would be held back by the limited penetration of games consoles among older people.

- Continued provision of telephone-based services such as conferencing calling. An Age Concern project set up user groups for the housebound. Westminster Council in London is involved in developing a platform called Get Together, which uses telephone conferencing to get older people who live on their own to talk to one another. One interviewee thought that these types of service meet many of the social interaction needs of older people. Therefore, it is likely that similar schemes will continue.

- Continued use of web tools for arranging real-life social interaction. Some interviewees think that digital social interaction is most important as a means to initiate face-to-face social interaction. A study of ‘Geriatric1927’, an 82 year old YouTube blogger, found that he used YouTube to start real friendships that he would continue offline. One interviewee found that people like to arrange face-to-face meetings with people who they meet in chat rooms. Tools that enable people to arrange real-life meetings range from event organisation tools in Facebook to simple conversations in web chat applications. Naturally, this aspect of social interaction is most relevant to conversations in which at least one of the participants is mobile rather than housebound.

In the area of entertainment services, in the short-term there will be developments in digital television and games platforms and the emergence of new internet based services. Specifically there will be:

- Increasing digital television penetration. With help from the digital switchover Help Scheme digital television should reach all older people with television by 2012. The implication will be more choice of channels and, in some cases, the use of a PVR and a return path enabling internet access (see below) and on-demand services. These will offer viewers more choice and flexibility of viewing (e.g. catch-up and on-demand services).

- Increasing access to internet services on the television set. Initiatives to connect digital television receivers to the internet include project Canvas, a set-top box specification including a broadband return path developed by a joint venture between the BBC and ITV. If approved[^16], this will allow viewers to watch on-demand services, such as the BBC iPlayer and other internet content, via television sets. The broadcast industry has also agreed an open standard for a return path on the digital terrestrial television platform for inclusion in the specification of devices provided for the digital switchover Help Scheme. Equipment should be available in 2010. This would mean that information and other services currently available on the web may become accessible to older people on the television sets. This is potentially an easier interface for older people to use than the PC.

- Increased use of games consoles by older people. The Nintendo Wii console has been a success with older people in residential homes. It is likely that uptake among older people at home will increase. One interviewee thought of the device as “the new family board game” and

[^15]: http://www.skype.com/allfeatures/videophones/
[^16]: The BBC trust will need to approve the BBC’s role in the venture and is currently consulting on the issue.
saw it having an application in enabling intergenerational play (e.g. in families), as well as play among older people: in care homes or multi-player games connecting people at home.

- Development of games with health benefits. In Japan there is a channel on the Nintendo Wii Fit console that monitors people’s exercise over time and shares data about people’s performance with an insurance company. Nintendo has also launched a vitality sensor, a finger-worn device that measures pulse and blood pressure, for use with its consoles. This may lead to the development of more health and fitness related games.

- Further development of internet entertainment services. Most significant are internet video services that enable people to access catch-up and, in some instances, archive television programming. The BBC’s iPlayer is the best known example of these services. Though these services are not developed specifically for older people, they will enhance their viewing options as they do for the population in general. Internet-based entertainment services also offer older people music, radio, games and other entertainment content.

- Increasing use of hobby-based internet services, which may include elements of social interaction. For those who lack social confidence, a social networking site to share an interest in (say) knitting may be more attractive than one with the primary function of social interaction alone. But it might over time help the user to develop a richer social network.

There is likely to be an increased provision of online learning courses. The University of the Third Age\(^\text{17}\) offers a range of online courses that cater specifically for older people. Provision of these or similar services may increase in future. At the same time the content of the courses may become richer as learning providers make use of available web content and tools.

There is a big educational task in helping older people to be literate in the use of technology. One interviewee suggested that about half of the older people in adult education are learning IT skills. One of the main drivers is the need for social contact with families which encourages older people to learn how to use email. It is likely that, in addition to structured courses, there will be continued development of software and services that help users to learn as they go along (e.g. advanced ‘help’ features). However, interviewees also took the view that group learning is important to give older learners support and encouragement.

As a large number of these developments are internet-based services (e.g. instant messaging, social networking sites, internet video services) the accessibility of the web for older people will be a major issue. Over the short term, developments in accessibility for older people include:

- Development of web accessibility guidelines for older people. The World Wide Web Consortium (W3C) has set up the WAI-AGE project to create guidelines for older people that will be incorporated into W3C standards (e.g. HTML5). The project will also support developers and providers of authoring tools to ensure that the content created is accessible. The guidelines will relate to a range of dimensions of web content, from readability of text and understanding of links, to navigation and, potentially in future, audio features (for people with hearing loss).

- Gradual improvement in the implementation of W3C guidelines. Currently, implementation of W3C WAI guidelines is patchy due to awareness, training and commercial issues. However, the W3C believes that these issues will be overcome as awareness grows and the tools are put in place to make it easier for developers (and other authors of web content) to create accessible content.

\(^{17}\) http://www.u3a.org.uk/
In parallel accessibility is being addressed by software developers who are making their own products more accessible and findings ways to display web content so that it is more accessible. For example, accessibility is an inherent part of Microsoft software (operating systems and applications) which it is making “safe and easier to use”. The company sees accessibility and trust/security being very closely linked. In addition, an ecology of software developers are creating applications that address specific accessibility needs (e.g. screen readers).

There may also be improvements in hardware accessibility due to application of universal design principles, though there is some uncertainty due to the cost to manufacturers of meeting usability requirements.

B3 Possible long-term developments

There is a set of common technology and service enablers that cut across the development of the different digital participation services: social interaction, entertainment and learning. Many interviewees took the view that these enablers would form the building blocks for new services, and expected to see much innovation in the way that these building blocks are put together to create new services. The first section below lists the main enablers. The sections that follow give examples of the types of digital participation services that these enablers may lead to as well as other developments specific to each type of service.

Enablers for development in digital participation services

Several interviewees saw the complexity of the keyboard and PC interface as a barrier to the use of digital participation services, particularly internet-based services, by older people. There was a strong view that improvements in human-machine interfaces could lead to a step change in the usability of all digital participation services. The main long-term developments in this area include:

- Gesture-based control. The Nintendo Wii console already enables people to control the device by waving a hand-held controller. Microsoft has developed its own form of gesture based control for the Xbox 360 (project Natal) that uses video cameras to detect motion and facial expressions. Similarly in the television environment Phillip’s has developed uWand, a 3D control technology to supersede the television remote control\(^ {18} \). Taken to its extreme this trend could lead to accurate full-body motion sensing.

- Speech control. Speech control is already available though limited in its accuracy. Interviewees saw this as an area of evolutionary change that might in 20 years offer older people an alternative to other interfaces. Speech to text (STT) conversion is already used in captioned telephony services to help deaf people make telephone calls. Over the next 20 devices may routinely include STT software which is trained to recognise the caller’s voice. But there are substantial technical problems in implementing developing network / server-based STT due to the limited quality of audio eg mobile connections and varying speech patterns and accents of callers.

- Brain-computer interfaces. In the long-term it may be possible to use brain sensors (e.g. skull caps with electrodes placed on the head) to control services, removing the need for a physical

---

\(^ {18} \) http://www.rapidtvnews.com/index.php/200908244537/philips-unveils-wii-like-remote-control.html
input. For example, BrainGate\(^{19}\) has developed a neural interface system for use with disabled people.

Technology is also emerging which will record and store data about people's lives to complement their own memories. At its most simple this could be recording pictures throughout the day as Microsoft Research has done with SenseCam\(^{20}\), a digital camera worn around the neck that takes pictures throughout the day when triggered by changes in light level or at regular intervals. In future data collection may be automated and the type of data collected and stored much more sophisticated. For example, HERMES\(^{21}\) (Cognitive Care and Guidance for Active Ageing) is a European Union project which is equipping older people's homes with video and audio recording as well as giving them PDA devices which together will record their activities at all times with a view to using this record for assisted living applications. There is potential to use this data within social interaction and entertainment services. The value of this data is likely to be much better unlocked over the next 20 years as data analytics improve.

At the service level 3D spaces / virtual worlds and augmented reality services will form platforms for a range of social interaction and entertainment services. **Virtual worlds** are computer-generated 3D representations of real or artificial environments. These may appear on the internet (e.g. Second Life) or on proprietary platforms (e.g. console games). In these spaces users are often represented by 'avatars' and are able to navigate the virtual world as in the real world. Augmented reality services may also develop. **Augmented reality** is the general term used to describe the use of computer-generated images to supplement or enhance a real view of the world. For example, representations of an older person's living room could be augmented with information about the status of sensors e.g. fridge sensors could allow the augmented reality system to show which food is in the fridge in a life-like representation without an older person having to get up and look at it.

Artificial intelligence (AI) will help people to get more from devices and services. Today people's interaction with technology is very much one way: they typically give instructions and dictate what the device or service does. Some new interfaces (e.g. Microsoft's project Natal) are two-way which means that the computer can see the user. This information could be used by AI systems to guide a dialogue with the user. For example, web search may develop into a dialogue: the user would ask a simple question (e.g. “what film should I watch tonight?”) and the AI system would refine the search by asking additional questions of the user (e.g. “do you prefer Westerns or comedies?”, “do you like Clint Eastwood?”) depending on their responses. If the user looks confused the AI system might ask a question of clarification, whereas if the user appears interested it would continue respond with more suggestions of the kind that stimulated that response. For older people AI would take some of the complexity out of interactions with the web, making it more like a natural language conversation.

Finally, the information structure of the internet may change if the semantic web develops. The World Wide Web Consortium (W3C) is working on the semantic web: an extension to the web as it is today, but with the data and relationships expressed in a way that machines can easily understand.

Intelligent agents’ would solve problems for people on the semantic web (e.g. answer a question, compare prices) by automatically filtering and interpreting this information. Older people could use intelligent agents instead of engaging with the full complexity of the internet.

---

\(^{19}\) http://www.braingate.com/


\(^{21}\) http://www.fp7-hermes.eu/project-summary.html
One interviewee thought that human-mediated computer interaction will also develop. In this model real people remotely help end users to perform tasks on the internet, rather like a human equivalent of intelligent agents.

**Social interaction services**

Social interaction services may evolve to become significantly richer in terms of format, data and availability. In short, these services will become more similar to face-to-face interactions, offering a higher level of satisfaction for users. The main potential developments include:

- **Video communication.** Though video calling is already available on internet-based services such as Skype and MSN, in future the usability of these kinds of services may improve significantly due to improvements in interfaces (e.g. gesture control). This may mean that these services are more widely used by older people. Interviewees saw potential for ‘armchair’ videoconferencing becoming more widespread as the television becomes a “viable communications device” due to internet-enabled television sets. This would simply require people to attach a webcam to their television or for manufacturers to include webcams in television sets.

- **Always-on communications.** In future communications links may be always on. Rather than logging in to social networks or initiating calls there will be some level of communications running in the background. This would enable people in older people’s support networks to check in on them without interrupting them with a call. For example, an older person might have a permanent video connection with her daughter and a live feed of health monitoring data sent to five people in their support network of friends and family.

- **Pervasive communications.** In future social interaction services will be available on a greater range of devices and platforms (e.g. messaging services may be available on any device). In the case of social networking services, porting to easy-to-use platforms such as games consoles may improve the accessibility for older people. It may also mean that communications services are available throughout the home (e.g. on fridge displays) and outside it (e.g. mobile). One interviewee thought that e-paper devices and flexible video displays would appeal to older people as these kinds of displays aim to mimic real paper.

- **Mobile communications.** The availability of these social interaction services on mobile may enabled older people to get out and about or to live their lives vicariously. One interviewee thought that the latter would be the more interesting development. People in a housebound older person’s support networks (e.g. a home help) would show them things from the outside world (e.g. choices of items in a shop).

- **Richer contextual data in communications services.** In future the contextual data carried by communications services (currently e.g. status in instant messaging services) may increase to include health monitoring, wellness and other data that people choose to provide. This data could be shared with older people’s support networks so they could be monitored in the context of communication, and assistance provided as appropriate. One interviewee suggested that people may also share clips from recordings of their lives (as described in section 0) e.g. to illustrate a past event to a friend during a call. People might also be able to bring computer generated objects into real video conversations.

- **Social interaction in 3D worlds and the use of augmented reality.** Already people can interact socially in virtual worlds such as Second Life and in some multi-player games. In future,
improved interfaces may mean that this kind of interaction is more suitable for older people. In the long-term 3D worlds could be enhanced with real video to give a greater sense of realism (e.g. people appear as themselves rather than avatars). However, one interviewee thought that this kind of development is too impersonal and frivolous for older people. Another took the view that 3D offers only a “pretty overlay” on top of existing services.

Many of the social interaction platforms will be generic, aimed at the mass market rather than older people specifically. However, there is some scope for the creation of tools and applications for older people on these platforms. One interviewee thought that public service applications for older people may be developed on the Facebook platform in future.

Entertainment services

Entertainment services will develop as the underlying platforms change. The most significant developments will be in entertainment services delivered over the television, games and internet platforms. The main possible developments include:

- Move to internet-based entertainment. Increasingly over the next 20 years video services will be delivered over the internet. End users will be able to choose from a large range of programming, accessed through aggregators such as digital stores, recommendation providers or search engines. The interfaces for these services (e.g. media player) may also support innovation in the provision of additional information and services around the video content. For older people this may mean that they are able to see additional information about a programme or new forms of accessibility content (e.g. descriptions of programming).

- Access to archive content. The move to internet-delivered entertainment could also enable the supply of more archive content (e.g. old television programmes). The range of programming on offer will no longer be limited by spectrum. One interviewee thought that access to archive content would be particularly important to older people as it is “part of who we are and how we define ourselves”. Potentially, they could share this content with their families to illustrate the past (e.g. a kind of history lesson).

- Entertainment devices becoming hubs for other services. Games consoles have become increasingly sophisticated and some now include DVD players and are connected to the internet. In 20 years these consoles may further develop into, or be replaced by, all-round home entertainment devices. Due to their advanced capabilities these devices could be the optimum platform for older people to use all digital participation services and potentially a platform for telecare and telehealth applications too.

- The integration of health and healthy living features into games. Games can be a good way to provide physical (and mental) stimulation and to collect data about people’s wellbeing. Future generations of consoles may include sophisticated body sensors that measure things such as heartbeat, skin temperature and so forth. This would enable the development of games that are able to provide e.g. physical therapy for older people through play. For example, Eldergames22, a European Commission funded research project, is looking into the adaptation of ICT for play-related therapeutic intervention among elderly people.

---

22 www.eldergames.org
• Social entertainment. Developments in games and television platforms will enable them to become increasingly social forms of entertainment. For example, people could talk to one another while watching television (using internet-delivered services on a digital television platform) or play games with friends using multiplayer console games (e.g. a group of housebound older people playing a carpet bowling game together). The communications and entertainment technology would be integrated.

• Entertainment in 3D worlds. In theory 3D worlds can offer the user any kind of activity that is available in the real world, either as a representation of real world places and events or as fictional ones. There is the potential for entertainment activities to be among these representations. For example, users could visit museums, watch sporting events or travel overseas in a 3D world without having to leave home. Interviewees thought that this would be particularly valuable to housebound older people. This development could also apply to services other than entertainment (e.g. shopping).

Learning

Possible developments here include new ways of providing structured learning (e.g. courses) and ways of making the information provided on the internet easier to interpret.

• Interactive structured learning may develop. Learning providers may make use of the capabilities of new platforms to create more interactive learning materials. One interviewee suggested a model in which courses would be developed that aggregate web-based tools and information. For example, a travel learning course may integrate Google maps to enable people to visit relevant places.

• Integration of learning with communication and entertainment. The traditional view of the adult education sector is that social contact is very important: people go on courses for a mix of social and learning purposes. This behaviour might be mirrored on the web, with learning providers integrating social interaction services into learning materials or addressing difficult learning topics through game play.

• Ways to filter the web to help people find information that they can trust. Some learning involves finding and analysing information rather than taking courses. For example, people diagnosed with a health condition may want to learn more about it. These needs tend to be very specific. One interviewee thought that there is a need to overcome the inherent tension between amount of information on the web and trust. Intelligent agents on the semantic web may in future help people to navigate the web to find trusted and reliable information. Alternatively recommendation-based filtering may be used (e.g. via social interaction services).

Accessibility

Over the next 20 years there is likely to be a significant improvement in the accessibility of web content. New guidelines will be developed as new technologies emerge and existing guidelines will be better implemented as new tools are developed to help developers and other content creators to do so. These developments will address accessibility issues relating to the way that web content is displayed and interacted with.
In the longer-term more general issues of complexity in the web more may be addressed using the semantic web and intelligent agents. This could mean intelligent agents are able to go out and find relevant information for an older person without them having to directly browse the relevant web sites. In the context of entertainment services an example would be finding out what entertainment options are available in the evening.

For people with physical impairments mainstream services will become easier to use. For example, gesture, voice and multi-touch control interfaces will reduce the limitations on the use of services by people suffering from arthritis. In addition, software tools to assist people with impaired sight or hearing will also improve. One interview thought that an ecology of software providers would continue to supply these kinds of tools, which would by 2020 be available for all those who need them.
Annex D   Teleworking

D1   Summary

Teleworking has the potential to provide many older workers with the opportunity to work and/or volunteer for longer, to help prevent a shrinking workforce from having to support a growing retiree population. It is clear from data that the number of teleworkers is steadily growing in both the UK and worldwide, with older people making up a substantial proportion – as employees, self-employed entrepreneurs, and volunteers. There are a number of benefits to and drivers of growth of teleworking for the population as a whole, but particularly for retirees/older people. This group typically has increased obligations that make working full-time at an office difficult, such as doctor’s appointments, providing care for spouses or friends, and helping with grandchildren. They also may have more difficulty commuting to work due to physical impairments that limit driving ability and the ease with which they can take public transport. These make the flexibility of working or volunteering from home particularly attractive for older people. Although some barriers do exist, such as IT security and maintenance concerns and low broadband take-up rates among the elderly, the benefits which teleworking brings in attracting and maintaining employees provide an incentive to explore ways to overcome these barriers. Many of these barriers are similar to those which discourage take-up of digital participation services by older people.

D2   Teleworking in the UK

Teleworking is commonly mentioned as one method of reducing the strain a steadily ageing population puts on the economy by extending the working life of older people. Teleworking allows older workers to:

- Continue working full- or part-time without the struggle of a commute, particularly for those who have acquired physical limitations with age which make travel difficult
- Work around increased personal obligations such as more doctor’s appointments or the need to care for ageing family, or to help with grandchildren.
- Ease gradually into retirement, giving them the ability to have more control over their time without giving up paid employment entirely.

The ONS’s most recent Labour Force Survey\(^{23}\) shows that in spring 2005 there were 3.1 million people in the UK who worked mainly at home or in different places using home as a base – about 11 percent of the population. Examination of earlier surveys reveals a steady increase in the proportion of both home workers\(^{24}\) and teleworkers\(^{25}\) in the UK since 1997, as shown in Figure D1 below.

---
\(^{24}\) Defined as “people in the UK who work mainly in their own home, or in different places using home as a base”.
\(^{25}\) Defined as homeworkers who “used a telephone and computer to carry out their work”.

© Plum, 2010
However, these numbers are not very informative, indicating only that homeworkers are becoming increasingly dependent on communication technologies to do their work, since the survey’s definition of ‘teleworkers’ does not include the part-time teleworkers who make up the majority of the teleworking force. A 2006 survey done by the Industrial Relations Service (IRS)\(^\text{26}\) showed that full-time home-based teleworking is the least common form of telework; the other forms were regular, nomadic, or ad hoc teleworking. The survey also showed that most employers expect their home-based teleworkers to be in the office from time to time.

Looking from the opposite perspective – that of the number of employers who offer teleworking – provides more information. The CBI Employment Trends Survey 2007\(^\text{27}\) shows that 46 percent of employers offer teleworking to at least some employees, up from 11 percent in 2004. And a Conference Board of Canada survey produced similar results – the share of employers making use of teleworking rose from 11% in 1989 to 50% in 1999\(^\text{28}\). Although this does not tell us the numbers of employees who telework within each company, the two surveys together do indicate that teleworking is growing. In particular, the ONS report shows that teleworking is more common and is growing at a faster rate among workers aged 50 or over – from five percent (below the average of nine percent) in 1997 to 12 percent (above the average of 11 percent) in 2005.

### D3 The views of older workers

A survey done by AARP\(^\text{29}\) revealed that flexibility is one of the qualities which older workers name when describing their ideal job, and one in three older workers identified the “ability to work from home” as essential. It further indicated that employers who offer flexible schedules, such as that


offered by teleworking, are more likely to retain older workers past retirement. Other research\textsuperscript{30} has also demonstrated that long working hours are a factor pushing older workers into retirement. However, another US survey reported that almost two of three older workers feared that working at home would hinder their chances at a promotion due to the lack of contact with their employer\textsuperscript{31}.

D4 Drivers of teleworking growth

There are clear benefits for both teleworkers and their managers. Teleworkers can enjoy increased flexibility in their schedule – if they miss work for a doctor’s appointment, in order to care for a partner or grandchild, or because of sickness they can quickly make it up because of easy access to their at-home workplace. In particular, older workers often have partners or friends for whom they have caring responsibilities which can make working full time out of the home quite difficult. The flexibility in work schedules which teleworking introduces can allow them to continue to work full time and/or reduce absenteeism by allowing them to work around their obligations as carers. The reduced commute time is beneficial for teleworkers of all ages, but in particular for older workers who may have difficulty commuting because of physical impairments that affect driving or limit their ability to use public transportation\textsuperscript{32}. It also can substantially reduce costs in petrol consumption or public transport tickets.

Managers will have access to a larger labour pool, reduced office space expenses, increased tax incentives in some cases, and the benefits of assured business continuity and compliance with green initiatives.

A number of global developments are also likely to fuel further increases in the number of teleworkers everywhere\textsuperscript{33}:

- Globalization. An employer’s search for talented and skilled workers now extends worldwide – it is not limited to areas within an easy commute.
- Technology enablement. Technologies now allow integration of multiple forms of communications and networks into a single device for similar performance as that in the office.
- Online communication tools. Employers are better able to supervise their employee’s work from a distance via new corporation collaboration tools and communication applications.
- The need for business continuity. Teleworking allows work to continue through natural disasters, pandemics, etc.
- Regulation and corporate green initiatives. Congestion charges, business incentives, and regulations to cut down CO2 emissions and traffic congestion make teleworking an option for saving money and for compliance.


\textsuperscript{31} Buchholz, Garth A. The workforce trend of the 21\textsuperscript{st} century. http://digitalpractices.com/docs/Douglas-Telework-Nov08.pdf


D5  Barriers to teleworking

Although there are an increasing number of employers who allow teleworking, there are also a number of concerns which prevent many companies from providing the option of teleworking\(^{34}\):

- Dubiousness about the level of performance of employees working out of view of their supervisors. Contrary to this concern, however, Cisco released survey results\(^{35}\) indicating that telecommuting did not negatively affect their employees’ work. In fact, 69 percent of the employees surveyed cited higher productivity, and 75 percent said the timeliness of their work improved. 83 percent of employees said their ability to communicate and collaborate with co-workers was the same as, if not better than, it was when working on-site, and 67 percent of survey respondents said their overall work quality improved.
- Health/safety requirements and insurance issues in some cases.
- Tax concerns.
- Lack of adequate broadband access at home, although some employers will provide the necessary equipment for their employees. This is particularly a concern for the over 65 group, who have less than a 33 percent take up of broadband\(^{36}\). According to an Urban Institute paper\(^{37}\), perceived higher costs of older workers, such as high wages tied in with seniority, higher health care, and pension costs already makes some employers reluctant to retain older workers, without additional costs of installing broadband and other equipment in their homes. However, the Urban Institute’s paper also argues that employers should weigh these against the benefits of having a trained employee with specialised skills and knowledge relevant to the job.
- Security concerns, both regarding connection security and laptop encryption/password security.
- IT’s ability to remotely operate and manage the connections of teleworkers working outside the office and often across significant distances.

There are a number of jobs which require the employee’s physical presence, such as nursing, plumbing, construction, etc which cannot offer teleworking. However, this proportion of the job market is shrinking as service-based industries such as financial services, information technology, and communications services continue to grow.

In an effort to address some of these barriers, a non-binding framework agreement was developed at the European level in 2003 and then specifically for the UK providing guidance on teleworking for employers\(^{38}\). The UK guidance provides a checklist of issues to consider when implementing teleworking and advice on how to overcome some of the common obstacles to teleworking. It has been revisited since then and is still a useful source for looking at some of the ways to successfully implement teleworking as a tool for coping with the ageing population.

D6 The self-employed elderly

Research shows that self-employment becomes more prevalent with age due to its advantages of flexibility and independence, qualities which older workers especially value as they near or pass retirement age – although this could change with increasing numbers of employers offering flexible work options such as teleworking. Older workers typically have access to capital and business experience that younger workers do not have, giving them the advantage in successfully starting a company. Some older entrepreneurs have always been self-employed, and some become self-employed after or as a transition to retirement. Self-employment has continued to get easier with growing access to communications tools such as broadband and computers which enable work from home.

An alternative form of self-employed work from home is freelance work. Many older professionals who find it difficult to find full-time work but who do not wish to start their own company turn to freelancing. In response to growth in a population segment which is likely to find freelancing appealing, namely older people, technology could enable targeted markets to develop online to address this need. These markets could be designed explicitly for older people to take on short-term projects or tasks at their own pace and according to their own hours, adapting to their need to continuing earning money and be active while maintaining flexibility in their hours to accommodate other needs such as informal care or health concerns.

However, sustained growth in the number of older self-employed workers is dependent on having the appropriate equipment and technology at home for doing work, and older people have the lowest broadband take-up rates in the UK.

D7 Online or virtual volunteering

Teleworking is not just a tool for continuing paid employment; it can also be useful for volunteer work. Volunteering can be difficult for older people for many of the same reasons as for paid work - commuting difficulties, other obligations to family, and health concerns. However, there are increasing numbers of organisations and charities offering online/virtual volunteer programs such as the UN, Nabuur, and RNIB. These sorts of programs, which make volunteering from home possible, overcome many of the obstacles older people face in volunteering past retirement. Although previous research in the US has shown that older people have typically made up the smallest proportion of the volunteer force, new opportunities for volunteering from home may change this.


40 NIACE.


42 http://www.nabuur.com/

43 http://www.thesite.org/workandstudy/volunteering/virtualvolunteering/search?searchType=details&id=1408306

Annex E   The impacts of demographic change

E1   The impact of demographic change on care requirements

Demand for care will increase over the next 20 years as the UK’s population ages. Change is driven by two main factors:

- A more rapid growth in the number of older people than in the adult population as a whole. Figure E1 illustrates.

- The fact that, as people live longer, the period of life with disability will increase on current trends. Currently life expectancy increases by 77 days each year while healthy life expectancy increases by only 49 days. So in the next 20 years the life expectancy for a 20-year-old will, on current trends, increase by 4.2 years but healthy life will increase by only 2.6 years.

Figure E1: Changes in the age structure of the adult population

<table>
<thead>
<tr>
<th>Age group</th>
<th>Popln (m) 2007</th>
<th>Popln (m) 2025</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-64</td>
<td>35.5</td>
<td>37.9</td>
<td>+7%</td>
</tr>
<tr>
<td>65-84</td>
<td>8.3</td>
<td>11.2</td>
<td>+35%</td>
</tr>
<tr>
<td>85+</td>
<td>1.2</td>
<td>2.4</td>
<td>+100%</td>
</tr>
<tr>
<td>Total adult</td>
<td>45.0</td>
<td>51.5</td>
<td>+14%</td>
</tr>
</tbody>
</table>

Future requirements for social care

Modelling these effects, which interact in complex ways, Mayhew estimates that the population of moderately and severely disabled people in the UK will grow from 1.8 million in 2007 to 2.6 million in 2025 - an increase of 44%. Figure E2 illustrates.

Figure E2: The increase in the disabled population by 2025

<table>
<thead>
<tr>
<th>Category of disability</th>
<th>Adult popln 2007 (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20-64</td>
</tr>
<tr>
<td>Healthy</td>
<td></td>
</tr>
<tr>
<td>Mild (1 to 6 on RW scale)</td>
<td>2.4</td>
</tr>
<tr>
<td>Moderate to severe (7+ on RW scale)</td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td>35.5</td>
</tr>
<tr>
<td>% moderate to severe</td>
<td>1%</td>
</tr>
</tbody>
</table>

45 Source: As Figure B1
46 Increasing longevity and the economic value of healthy ageing and working longer, Professor Les Mayhew, Cass Business School, February 2009
Future requirements for healthcare

The ageing of the population is likely to increase requirements for health care rather less than requirements for social care. This reflects the fact that the biggest requirement for health care resources comes in the last year of life\(^\text{47}\) and that deaths are projected to remain roughly constant over the next 20 years.

Using figures supplied by Mayhew, we estimate that the ageing demographic will increase requirements for health care by 16% over the next 20 years\(^\text{48}\). But this calculation ignores the rapid growth in certain diseases. For example:

- There are around 0.7 million sufferers from late onset dementia in the UK at the moment. This group is projected to grow to 1.2 million by 2027 – a 70% increase\(^\text{49}\)
- The number of people with diabetes in the UK is growing rapidly. Between 1997 and 2003 there was a 74% increase to 2.5 million people.

It is interesting to note that both these conditions are, to a considerable degree, preventable. Recent research\(^\text{50}\) indicates that smoking and obesity both substantially increase the chance of dementia, while obesity is strongly linked to Type II diabetes - which now accounts for more than 90% of diabetes in the UK.

E2 Supply-side trends

How will major trends over the next 20 years impact the ability of carers to meet the increased need for care? We can expect:

- An increase in the proportion of older and disabled people requiring formal rather than informal care
- A reduction in the financial ability of the state to fund care
- A substantial rise in the private funding of care.

We consider each of these points below.

---

\(^{47}\) £30,000 per person versus £1400 per person on average for the rest of life

\(^{48}\) The impact of new health care technologies on demand for health care is likely to be significantly greater than this

\(^{49}\) Dementia UK, King's College and Alzheimer's Society, 2007

\(^{50}\) A study published in the Journal of Neurology, Neurosurgery and Psychiatry in August 2009 shows that smokers aged between 46 and 70 have a 70% higher risk of chronic memory loss than their non smoking peers
The increased requirement for formal care

The increase of over 40% in demand for social care will not be matched by an equivalent increase in the number of potential informal carers. The working age population for example is expected to grow by only 7% over the next 20 years. At the same time demographic trends suggest that a growing proportion of those requiring care will need some kind of formal rather than informal care. In particular:

- The proportion of single person households, where there is no partner to provide informal care,, is growing - from 25% in 1991 to over 40% by 2027\(^{51}\)

- The proportion of childless women, living in households which cannot rely on children for informal care, is also growing. Less than 10% of women born in 1945 remained childless\(^{52}\). This proportion rose to 15% for women born in 1955 and looks set to rise to 20% for women born in 1965. However this trend is likely to have its biggest impact after 2030

- There is anecdotal evidence that families are becoming steadily more separated by distance.

To quote from a recent Help the Aged report\(^{53}\):

*Increasing divorce rates, smaller families, fewer women having families or having families later in life, and family moving further afield, will combine to make the provision of unpaid care and support for older people in their own homes or with families more difficult.*

The combined effect of these trends is that more older and disabled people will require formal care. In addition we can also expect a higher proportion of healthy older people acting as informal carers.

The ability of the state to finance formal care

There are a number of factors which will affect the ability of the state to finance formal care without it having to fundamentally change the balance of its spending programmes. These are:

- The impact of an ageing population on GDP per head. Calculations by Mayhew suggest that this demographic change would, if current morbidity trends and labour participation rates continued without productivity improvements, reduce GDP per head by 24% over the next 20 years

- The size of the workforce. At current labour participation rates, we can expect the workforce to grow by 7% over the next 10 years. A reduction in youth unemployment, illustrated in Figure E3, and an increase in labour participation rates amongst older people\(^{54}\) will increase this figure. But these effects are offset by a growing requirement for informal care\(^ {55}\). A 40% increase in informal care to match need for care would represent a substantial reduction in the potential workforce.

- Productivity improvements. We might reasonably expect workforce productivity to continuing to improve at a steady 2% per annum as it has over the past two decades\(^{56}\).

---

\(^{51}\) ONS statistics plus Plum extrapolation

\(^{52}\) ONS statistics database

\(^{53}\) *Future communities 2009,* Help the Aged, 2009

\(^{54}\) This requires the UK to reverse a long-term trend towards early retirement. In 1950 90% of 60 to 64-year-olds were economically active. By 2000 this proportion had fallen to 50% according to UN statistics

\(^{55}\) According to Carers UK there are currently 5.9 million informal carers in the UK who spend 7.7 billion hours per year caring for others. This equates to 4.2 million full-time workers in the economy - assuming a 35 hour week.

\(^{56}\) See for example *Macro-scenarios to 2025,* Indepen for Ofcom, December 2007
In combination these factors suggest that the UK’s ability to grow GDP at historically observed rates of around 2% per annum in real terms will be significantly limited by its ageing population.

There are also short-term factors which impact on the UK Government’s ability to fund additional care requirements. In particular there is general agreement that, over the next decade, increases in government spending will be severely limited by the need to reduce government borrowing which rose sharply in response to the recent global banking crisis.

The NHS has enjoyed substantial increases in funding over the last 10 years - with a 7% per annum growth in funding at constant prices between 2000 and 2006. But this will not continue. Even to maintain NHS spending at current levels while cutting all other government spending by 2% would, according to the IFS, still require a tax rise of £340 per family per year to return government borrowing to sustainable levels by 201557.

Figure E3: Current levels of youth unemployment in the UK

The NHS may, to some degree, be protected from cuts by the pledges of UK politicians of all parties to preserve and improve it. The same cannot be said of local authority social services funding.

Given this analysis we might reasonably expect:

- NHS spending to remain steady in real terms over the next five years or so, followed by modest growth at 1 to 2% pa
- Cuts in funding of social care over the next five years before a return to modest growth.

Private funding of care

We can expect the proportion of formal care which is privately funded to rise over the next 20 years given:

- The difficulties which the Government is likely to face in increasing its funding of care

57 See joint IFS Kings Fund study on health spending in the UK, July 2009
• The growing wealth of older people over the next 20 years. We have yet to find studies which measure this effect. But there is general consensus that the housing equity available to older people has grown substantially over the past 20 years and that many older people will enjoy relatively generous defined benefit pensions over the next 20 years.

58 Whether older people will use this wealth to fund their own care will depend upon attitudes towards inheritance
Annex F  The Government’s responses to an ageing population

F1  Introduction
To deal with the UK’s ageing population, the Government has launched or planned over 40 initiatives in the last two years. Some are designed to help improve social care of older and disabled people; others to improve the lives of older people. We discuss the most significant of them below, focussing on:

- Those which are likely to be especially significant in shaping delivery of care to older people over the next decade and
- Those which are especially relevant to the development of assisted living.

F2  The Government’s ageing strategy
In July 2009 the Government published a report Building a Society for All Ages in which it set out its overall strategy for dealing with an ageing population. Key points include:

- The intention to publish a green paper on the care needs of its ageing population
- Initiatives to help people plan better for their old age
- The intention to publish a green paper on families and relationships. This will look at the roles older people can play within the family and, conversely, the roles families can play in supporting older people
- A review of the default retirement age
- The business opportunities generated by an ageing population
- The need to develop health prevention (sic) packages.

F3  Developing the NHS
In June 2008 the Government published the Darzi Report High Quality Care for All. This report sets out a plan to improving the quality and effectiveness of the NHS. The main measures proposed are grouped under five main headings:

- The need to increase healthy living through community-based programmes and raising awareness of health issues within the UK population
- The need to expand personal choice over health care, including the possibility of personal budgets
- The need to improve quality of service within the NHS by explicitly monitoring quality of care and by improving processes so as to get basic procedures right first time
- The need to involve clinicians and other staff more in decision-making within the NHS
The need to encourage and foster innovation within the NHS.

F4 Developing social care services

In December 2007 the Government published *Putting People First*. This report proposes to change the adult social care system to one which:

- Is locally owned and run
- Offers maximum choice and control of services to their users
- Is based on person centred planning
- Offers self-directed support with individually tailored support packages in which telecare is seen as integral
- Involves personal budgets which allow service users, in many cases, to decide for themselves how the social care budget which their needs entitled them is best spent.

F5 Digital inclusion

In October 2008 the Government published its *Delivering Digital Inclusion* report. This report looks at digital inclusion across the UK population as a whole. But it is especially important to assisted living given the current low levels of digital inclusion of older people and the importance of broadband Internet connections for digital participation services. The report’s main recommendations are:

- To develop a charter for digital inclusion which sets out principles on which stakeholders can act
- To propose the appointment of an independent Digital Inclusion Champion who can drive digital inclusion forward with the help of an Expert Task Force.

The report also draws together existing and new initiatives in a Digital Inclusion Action Plan.

F6 Digital Britain

The Digital Britain report, published in June 2009, made a wide range of proposals to enable the UK to maximise the economic and social value it gains from digital services. Of particular relevance to our study is the section in the report which identifies the barriers to digital participation and proposes measures to remove them. It builds on the *Delivering Digital Inclusion* report by confirming the appointment of Martha Lane-Fox as the Digital Inclusion Champion and announcing Ofcom’s Social Marketing Campaign. With a budget of up to £12 million this multi-stakeholder initiative is designed to raise awareness of the benefits of digital inclusion.

We discuss digital inclusion further elsewhere in this working paper.
Many in the NHS are sceptical about the cost effectiveness of telehealth. At the same time there is general agreement that there is a need for the NHS and local authorities to work together more effectively to deliver care into the home. With these two concerns in mind the Department of Health launched the Whole System Demonstrators (WSDs). The objectives of the WSDs are:

- To measure the effectiveness of telecare and telehealth
- To improve care coordination when delivering care to those with both social and health care needs at home
- To develop appropriate financial incentives for efficient care of such people
- To enable people to take more responsibility for managing their own conditions.

See Section 4.2 for more details.

This project is testing the effectiveness of targeted early interventions within the home for those requiring care. The project involves 29 local authority projects which ran from the April 2006 to March 2008. An evaluation is expected by December 2009.

---

These concerns are less prevalent in social services departments. This is reflected in the relative take-up of telehealth and telecare. According to the stakeholders we interviewed, there are well over 1 million homes equipped with telecare system but only a few thousand homes currently using telehealth applications.
Annex G  The needs of older and disabled people

G1  The basis for our findings

The aim of this Annex is to set out our understanding of what older people and their informal carers think about assisted living services – what attracts them, what concerns them, and what needs are unmet. The findings of this working paper will feed into the final report for the study. They are based on three main sources:

- A literature review to see what previous studies involving primary research with older people across the English-speaking world have to say about user reactions to telehealth and telecare services. The sources of the literature review are listed in Section G6, together with sources on the teleworking material.

- A review of relevant findings from the stakeholder interviews

- Interviews with 12 individuals within the UK who work closely with older people on the take-up of digital services and the use of other assisted living technologies. Notes on the interviews are listed at the end of this annex

- A scenario validation workshop with five experts who work closely with older people.

The findings from these three sources are generally highly consistent, although they also indicate a number of areas of tension. For example, while older people were generally enthusiastic regarding the use of telecare and telehealth services, they also expressed concerns that their use could lead to reduced social interaction. In this Working Paper we summarise the findings from these sources, indicate and discuss some of the issues that arise, and conclude with a list of key success factors for the adoption of assisted living technologies.

The Literature Review

Using a combination of search terms[^60], around 75 relevant publications were found, including studies in the US, Australia and Europe as well as in the UK. The studies were analysed to extract findings about what attracts users and carers to, and deters them from, telecare and telehealth services. There are some general points to note about the findings from the literature:

- The literature is fragmented. It covers a diverse range of services and applications that broadly fall into the category of assisted living, and the subject matter is spread across a variety of domains covered by a wide range of researchers.

- The types of studies involving users can broadly be grouped into two categories, (i) those which sought users’ evaluations of actual services or applications they had experienced, and (ii) those which sought reactions to demonstrations, descriptions or prototypes of potential services or applications, primarily through focus group discussions. The range of systems discussed include both first generation alarm based monitoring systems and second generation systems with more continuous monitoring and artificial intelligence based interpretation.

[^60]: Assisted living / telecare / telehealth / telemedicine / assistive technology WITH user/patient/person/individual satisfaction, views, opinions, feedback, perceptions, attitudes, needs experience evaluation acceptability
• Users’ responses to ALTs, while mostly positive, were influenced by the context of the studies. For example, they depended on factors such as whether users had direct experience of technologies, their awareness and knowledge of technologies and services, their own needs and their current state of health.

• A small number of studies have provided the most detailed information – examples include McCreadie & Tinker (2005), Hanson et al. (2006), Coughlin et al. (2007), and Demiris et al. (2008). Other studies have tended to complement and confirm the findings reported by these studies.

• Sample sizes are variable – only a few studies report sample sizes greater than 100 and most are considerably smaller (although the information that is freely available – in some cases only brief abstracts – is not always sufficient to identify sample sizes).

Interviews

Interviews were carried out with 12 people from eight leading UK organisations which work directly with older people in differing roles. Some of these individuals are responsible for providing care services, some work for organisations/charities providing advice and support to older people, and some have research roles that involve working with older people to investigate their needs and responses to a range of technologies. In addition, we sought the views of two people involved with the Whole System Demonstrator trials in roles where they supervised those with direct contact with users. The interviews aimed to gain an understanding of end user and carer issues which arise in their use of assisted living technologies.

G2 What do older people need?

Most of the literature discusses the reactions and responses to actual or potential specific features or services. Very few studies separately identify the specific needs of older people that are being, or could be, met by assisted living services, with a couple of exceptions. One study reveals that there are five areas of daily life which are important to older people: keeping clean and comfortable, enjoying a clean and orderly environment, being safe, accessing social contact and company, and keeping active and alert. Another study identifies some important psychological needs; older people want to maintain their dignity, be able to enjoy the smaller things, feel at home in their environment, and be able to achieve a sense of completeness in their life. Complementing these findings from the literature, our interviews revealed that older people want:

• The freedom to have a choice in their behaviour, even if this includes their wish to eat unhealthily, or their choice not to exercise.

• Face-to-face contact with other people.

• A social life, whether virtual or in person.

• Desirable, tasteful products that do not look like hospital equipment (particularly for devices that are meant to be worn).

• Products and services which are both easy to use and accessible.

61 Qureshi and Henwood (2000)
62 Andersson et al. (2008)
• To be able to exercise choice in a market and be a consumer.
• To be able to stay in their own homes for as long as possible.

To summarise, our research to date suggests that the basic needs of older and disabled people are as follows. In most cases, they want to:
• Live independent lives at home for as long as possible.
• Enjoy life outside the home, as far as any physical impairments they may have will allow.
• Enjoy rewarding and stimulating lives, with minimum loneliness and isolation.

We consider in the following section what attracts end users to telehealth, telecare, digital participation and teleworking services and to what extent these services meet the above stated needs. We then go on to consider the concerns which these services might introduce for older people and their informal carers.

**G3 What attracts end users?**

**Telehealth and telecare services**

The literature review and interviews reveal that the majority of users and informal carers generally have positive views toward telehealth and telecare services. There is widespread consensus that such technologies could help older people stay independent and/or remain in their own homes for longer, but the studies highlight that there are differences of opinion regarding whether services would be most useful in a ‘preventive’ or ‘early warning’ role or whether they should be only used for ‘crisis management’. In particular:

- There is some evidence that telecare and telehealth services are most welcomed by those who have existing concerns about their health and ability to cope independently, and who lack adequate social support.
- Some studies suggest that older people feel these services would lessen the monitoring burden on friends and family, and/or would reduce their sense of dependence upon others.
- Services such as health monitoring and alarms are seen as potentially beneficial in saving cost and time for older people themselves, as well as for society more widely, in terms of reduced hospital admissions, emergency department and medical practitioner visits and associated travel.
- Older people feel that services could give them ‘greater peace of mind’, e.g. by alleviating personal concerns about their health problems or by making them feel more safe and secure in their homes (in one study, for example, the perceived value of motion detectors was for detecting intruders rather than monitoring older people themselves).
- Services/devices that provide users with feedback and information about their own health conditions are seen as potentially encouraging active participation in their own health management, in addition to helping doctors to better manage their health conditions.
- Telecare services (providing they are discreet) may be acceptable to those very independent older people who refuse to have carers or social services involved.
Digital participation services

Digital participation services span a wide range of communication services (e.g. email, text, SMS, video, Skype etc.) and myriad other services which provide information, education and learning opportunities as well as offering entertainment, enabling leisure pursuits, social networking, and many other activities; these services are typically internet-based. There is enormous potential for digital participation services to enhance the lives of all, but in particular they could greatly improve the lives of older people. Working Paper 2 of the study provides more details on how digital participation services might help enrich the lives of older and disabled people, while this working paper aims to identify older people’s perceptions of these services.

The benefits from digital participation services that have been identified by and for older people include:

- Greater social contact with friends and family. This is particularly relevant for those people who are unable to leave their homes. For example,
  - “People who live alone, especially, have little human interaction or communication with the outside world, especially if they are housebound. Having the internet allows them to keep in touch with people and to reconnect.”
  - “They want to be able to communicate with their family – applications like Skype are very popular.”

- The potential to save money from shopping, booking holidays online etc. However, many older people are not comfortable with making online purchases without human support; e.g. they might need help to ensure they are using a secure site or may be uncomfortable giving their card information.

- The ability to take up or continue hobbies and interests, and an expansion of entertainment possibilities.

- The potential to earn some money, e.g. from sites like eBay.

- Increased independence. Older people want to be able to do things such as shopping for their own food themselves, rather than leaving it to neighbours or family.

- The means to be involved in the community through e-public services, etc.

Teleworking

There are few surveys of older people’s views towards teleworking, but it does seem clear that a number of older people want the financial independence and psychological fulfilment which comes from having even a part-time job. At the same time, older people often have caring responsibilities or health concerns which may prevent them from wanting to or being able to work full time. A survey done by AARP\(^3\) revealed that flexibility is one of the qualities which older workers name when describing their ideal job, and one in three older workers identified the “ability to work from home” as essential. In addition, 65% of respondents to the survey are looking for ways to better balance work with personal life and 52% have at least one person for whom they are responsible for providing care.

Teleworkers can enjoy increased flexibility in their schedule – if they miss work for a doctor’s appointment, in order to care for a partner or grandchild, or because of sickness they can quickly make it up because of easy access to their at-home workplace. The reduced commute time is beneficial for teleworkers of all ages, but in particular for older workers who may have difficulty commuting because of physical impairments that affect driving or limit their ability to use public transportation \(^{64}\). It also can substantially reduce costs in petrol consumption or public transport tickets.

**G4 What attracts informal carers to ALTs?**

**Telecare and telehealth services**

The majority of studies reported in the literature have focused on the reactions of end users (i.e. older/disabled people themselves), while only a small number have included reactions from informal carers such as family members or friends and/or from professionals involved in some way in assisted living. Both the literature and the interviewees indicate, however, that informal carers welcome telecare in the form of monitoring services such as movement detectors which can provide them with reassurance and information about aspects of their loved ones’ health and behaviours \(^{65}\). Such systems can give informal carers a better understanding of people’s daily patterns of behaviour, which in turn can provide reassurance and peace of mind, potentially helping to keep older people in their own homes for longer. They can also be useful in supporting discussion of care needs with the older person and/or with formal carers. In particular, we find that:

- Telehealth systems appear to offer less significant benefits to carers than telecare systems, but still provide some reassurance, as carers know that their relatives are being monitored and looked after.

- Some studies \(^{66,67}\) have also found that some informal carers are interested in monitoring which could detect subtle changes in health, giving advance warning of potential problems. (However, older adults themselves are less enthusiastic than their family members or friends about such monitoring).

- One of the motivations of informal carers in helping parents to live independent lives at home is to retain wealth within the family. Going into a care home is expensive and can quickly reduce an older person’s estate to near zero \(^{68}\). Carers would prefer services that are paid for by state-funded institutions rather than by older people themselves, but there is some evidence that relatives would be prepared to help with the costs of telecare, especially when they live far away.

While carers’ responses to telehealth services were generally positive, there were some conflicting findings. For example, one large study \(^{69}\) comparing residents’ and family members’ satisfaction with their actual experience of assisted living environments found that family members’ satisfaction with the

---


\(^{65}\) Price et al. (2008)

\(^{66}\) Wild et al (2008)

\(^{67}\) Hanson et al, (2007)


\(^{69}\) Levin & Kane (2006)
facilities was consistently lower than the residents’ satisfaction. The authors of this study propose some possible reasons, e.g. people in AL are dependent upon their carers in the AL environment and therefore are reluctant to give low ratings, or that they rate it more positively because the alternative would be a nursing home.

Digital participation services

Digital participation services are relevant to end users rather than to informal carers. So we do not consider them in this section.

Teleworking

Teleworking can be particularly beneficial for part-time informal carers. A 1997 study in Toronto provides a number of case studies showing how the flexibility provided by teleworking lets people to continue with both their job and their care, allowing those they care for to remain home for longer. For example, a carer can do their work at unusual times in order to care for the older person, working in the early morning or late evening when the older person might be in bed. For less time-flexible work, one case study points out that even being able to work in the next room provides reassurance for the carer – they are nearby if an emergency happens and they are able to easily check on the older person for ten minutes at a time.

G5 What deters end users and carers?

Evidence from the published literature and the interviews indicates that, despite a generally positive reaction to ALTs, there are also a number of specific concerns and deterrents. We look at these concerns under three headings of telecare and telehealth services, digital participation services and teleworking services below.

Telecare and telehealth services

In combination, the published studies and interviews suggest that older people have the following concerns about telecare and telehealth services:

- The concerns most often reported in published studies are about privacy and confidentiality. This includes worries about what happens to personal data collected about an individual’s behaviour (e.g. who might see it and how might it be used). Older people feel strongly that they should have ownership and control over their own data and who can access it. In addition, surveillance aspects of ALTs give rise to the response from some people that they do not like the idea of “big brother”.
- Many individuals have doubts regarding their capacity to learn, use and manage the ALTs independently.

71 When we use the term ALT in this section we are referring to telehealth and telecare
There are concerns about the potential for such technologies to lead to less social interaction.

Lack of trust in the institutions delivering ALTs is also in evidence. In one study older people were sceptical that there would be sufficient clinical resources to respond to alarms and crises. Other concerns are that devices would not be properly maintained, leading to failures, false alarms etc.

The kind of information that could be collected could create greater anxiety for themselves or their families (e.g. monitoring gradual decline, or false alarms).

There are concerns about stigmatization, e.g. being seen to need support. The intrusive or stigmatizing impact of ALTs attributed to the ‘medical’ appearance of much of the current telecare equipment is a deterrent to acceptance of ALTs. People prefer their need for help to be less obtrusive, and they express the view that they do not like being seen as ‘a patient’. One interviewee commented “most patients do not like the equipment to be obvious and intrusive - although some do like to show it off. Some find it stressful”.

Another cause for rejection appears to be its lack of consistency with the self-image of some individuals: “it (ALTs) would be very good for someone else, but I’m too old/not ill enough to need it”. The considerable number of potential service users who refused to participate in some important pilot studies either because they did not consider themselves ill enough or because they found it uncomfortable to be reminded of how ill they actually were, e.g. “patients dislike the daily reminders that they are unwell” suggests that how people see themselves can strongly influence their response to ALTs.

Lack of sufficient relevant information is cited as a significant barrier to more widespread adoption of ALTs. As one interviewee expressed it: “Often people don’t hear about it until it is too late, when the crisis happens, at which point costs skyrocket and a lot of care is required. They need the technology before this point is reached to prevent the crisis.”

Carers generally are concerned about the autonomy of older people and their right to be respected in any decisions about their health care – they do not believe that services should be implemented without their consent ‘for their own good’.

Digital Participation Services

The costs of equipment, broadband services, and especially of the learning process are a major deterrent. Interviewees reported that costs of digital participation are a major barrier for some – especially for older people who cannot afford the fees for tutoring (£25 per hour). This cost is seen as more prohibitive than purchasing the computer and broadband, because you can get cheap second-hand computers and a low-cost broadband network, but weeks of training add up. If the older person lives in a sheltered housing/care centres, the centres usually pay for them. But training costs are a particular barrier for those who are housebound or are too embarrassed to go to group classes, which are often cheaper or free. To help to alleviate this problem, attempts are made to reach poorer groups such as Silver Surfers’ day, when training is free, but this is not enough. For example one interviewee cited the “fair number of people who stop after one lesson. While this is sometimes because they

72 However, it should be noted that according to Independent Age, older people often significantly overestimate the equipment and access costs. Better awareness of these costs could help encourage take-up.
decide it is too hard, it is also sometimes because of the expense. Families will often buy the first class as a gift and the older person will decide they don’t want any more after that initial class.”

The fear of failure to learn the necessary digital literacy is also an important barrier to the take-up of digital participation services. There are two components - fear of the technology itself and concerns about the learning process:

- Interviewees who are on the ‘front line’ introducing older people to the use of computers comment that the initial reaction of their clients to technology is that it is frightening. One interviewee commented that “they find keyboards in particular scary – they see touch-typists and think that in order to use a keyboard you have to be able to type like that’. But she continues “generally, the whole system is tough – there isn’t any one aspect that is easy”.

- Another reason for the fear is that people feel stupid when they struggle to learn to use the technologies. Older people typically distrust technology because of privacy or security concerns, and if they overcome these fears and have even one bad experience this can be a permanent reversal. Human support is a necessary part of this process for dealing with these types of situations.

The learning context itself can be daunting as many have not engaged in formal learning since leaving school decades ago. To overcome some of this fear, some third sector organisations (e.g. Age Concern, Digital Unite) provide tutors who go to the older people’s homes. They report that typically people are more comfortable and at ease in their own home, and the tutor can focus one-on-one and do some “hand-holding” with the person. This offers a very different approach to holding classes, and gives reassurance and support to individuals who would be unlikely to participate in other forms of instruction. However, other respondents believe that the social environment of a class, if conducted appropriately, is the most effective, because it provides peer support.

Other concerns raised by older people include the following:

- Many older people are concerned that technology will replace the human interaction they have. However, if technologies are marketed as facilitating new social interactions rather than replacing former human interactions, this fear may be at least partially alleviated.

- Some older people associate the Internet with work and would prefer not to continue using it after they retire.

- Interfaces and applications are typically not aimed at older people and therefore have accessibility issues and limited relevance. While the market does not necessarily need to be directed at only older people, suppliers should be aware of design and control concerns for older people. In addition, many of the entertainment programs and devices are not relevant or interesting to older people.

- Older people do not want technologies, products and services over which they have no control. There should be options for personalization (i.e. larger text, better contrast, etc) and for turning them off if not wanted.

Teleworking

The main barrier to teleworking is similar to that of the other ALTs, in that older people are uncomfortable with some of the technology required. Although teleworking typically only works for
professions which use computers and the Internet already, it lacks the IT support which is readily available in most offices. Additionally, an AARP survey\textsuperscript{73} revealed that one in four older workers have trouble keeping up with new technology required to do their job and 29\% do not wish to learn new skills at this stage in their careers. Therefore, even those older people who habitually use some technology at work may have difficulty using it at home without support.

Equipment costs also pose the same financial barrier as for other ALTs as the large majority of older people's homes are not equipped with adequate broadband or computer hardware/software for teleworking.

Another concern cited is highlighted by a US survey which reported that almost two of three older workers feared that working at home would hinder their chances at a promotion due to the lack of contact with their employer\textsuperscript{74}. This in turn, leads to the tensions discussed later between employers and employees and more generally, the home life-work balance.

G6 Literature sources


Advanced Care Technologies Programme, 2009. AT assessments <http://www.actprogramme.org.uk/content/66/at-assessments>, [accessed 23.09.09].


Kings College London and the University of Reading, 2004. Introducing assistive technology into the existing homes of older people; feasibility, acceptability, costs and outcomes. Institute of Gerontology: Kings College London.


Steele, R. et al., 2009. Elderly persons’ perception and acceptance of using wireless sensor networks to assist healthcare. International Journal of Medical Informatics, IN PRESS. <http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6T7S-4X49N36-1-3&_cdi=5066&_user=6701128&_orig=search&_coverDate=08%2F31%2F2009&_sk=9999999999&view


Annex H  Application standards for ALTs

There is currently a variety of medical communication application standards, which include:

- IEEE11073
- Health Layer 7 (HL7)
- DICOM & PICS. These are image protocols for high resolution pictures which are mainly used for telemedicine and hence are not considered further in this document

IEEE11073

The IEEE 11073 family of standards is concerned with providing plug-and-play interoperability between point-of-care medical devices as well as personal care devices for use in the home.

The idea of plug and play is that the clinician or patient simply makes the connection and the two medical devices automatically negotiate and configure the connection. There is no “bedside” or home device configuration by technicians. The standards are based on the standard seven layer OSI Communications Model (physical through-application layer) and means independence from any specific “make & model”.

The standards are also designed such that transport has a small memory footprint and scales appropriately from simple devices to more complex systems such as a ventilator / vital signs monitor. The standards support both polled and event-driven interfaces.

The application protocol layers are also future proofed by providing the ability to “ignore what isn’t recognised”. If a device includes in a message something which the managing system does not support, the unrecognised part can be skipped and parsing resumed without loss of subsequent data.

The standard is separated into four basic areas:

- Device Data & Services (11073.1.x)
- General Application Profiles (11073.2.x)
- Transport & Physical Layers (11073.3.x / .4.x)
- Internetworking (11073.5.x), which covers radio frequency and infra red wireless

Health Layer 7

HL7 is an ANSI standard and is a high level text stream protocol which sits on top of other protocols. It could be sent over IEEE11073 or even over a standard TCP/IP based network. The protocol is designed to be implemented over IEEE11073 IP based communications, so as to give the medical device industry a stable, definitive and testable communications infrastructure.

HL7 is based on event-driven messaging i.e. messages are only exchanged when an event occurs. It is not suitable for use in polling. “Keep alive” and other network safety messages should be kept on lower levels of the OSI 7-layer model and HL7 should not be used for this purpose.

HL7 Version 3 is based on an object-oriented development methodology and uses an extended version of UML to enable full design and test analysis. The standard uses a Reference Information
Model (RIM) to create messages. The RIM provides a representation of the semantic and lexical connections that exist between the information carried in the fields of HL7 messages. In XML terminology this would be referred to as the *style sheet* or XSL file. The RIM is also similar to the Resource Document Framework, which is part of the semantic web.
Annex I   Medical regulation of ALTs

If an ALT has a medical use, then the product will need to comply with medical device regulation.

What is a “medical device”?

The European legal definition of a “medical device” is as follows:

Any instrument, apparatus, appliance or material, including the software necessary for its proper application intended by the manufacturer to be used for the purpose of:

- diagnosis, prevention, monitoring, treatment or alleviation of disease,
- diagnosis, monitoring, treatment, alleviation of or compensation for an injury or handicap,
- investigation, replacement or modification of the anatomy or of a physiological process,
- control of conception,

and which does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means.

Under this definition a medical device:

- May be assisted in its function by using pharmacological, immunological or metabolic means.
- A piece of software could be classified as a medical device.

In the EU, this definition is used in the two key medical device directives:

- The Medical Devices Directive 93/42/EEC (MDD). This covers general medical devices such as first aid bandages, X-ray machines, ECG machines.
- The Active Implantable Medical Devices Directive 90/385/EEC (AIMDD). This covers devices which are active and implantable in a patient e.g. a heart pacemaker, bladder stimulator etc

Compliance with both of these directives is regulated in the UK by the Medicines and Health care products Regulatory Agency (MHRA). Compliance is complicated for suppliers by the fact that there are currently inconsistencies between these two directives and the more general RTTE Directive.

Classification of a medical device in the MDD

Medical devices are classified depending upon their use. The classification then dictates the extent to which the device is regulated, both during manufacture and design and in terms of testing and clinical trials. However, regardless of classification, medical devices should be developed under ISO13485, which allows for a complete audit trial of the development process.

Classification of a medical device is a complex procedure, which is covered in Annex IX of the Medical Devices Directive. However there are four main classes of device:

- Class I: non-invasive medical devices.
- Class IIa: Surgically invasive devices intended for transient or short term use.
- Class IIb: Implantable devices and long-term surgically invasive devices.
• Class III: Devices which contain a drug delivery or action element

Class I devices are subject to the least stringent regulation and Class III devices to the most stringent regulation. We expect that the majority of ALTs used for monitoring a condition will be in Class I. Some ALTs may be categorised as belonging to more strictly regulated classes and may fall under the AIMDD classification – for example a pace maker with built-in mobile communications.

Implications of medical regulations

With IEEE11073 and HL7, the upper levels of the OSI model are well represented and in many cases are application agnostic. However, the appropriate choice of physical and transport layer will be heavily dependent upon the application carried. Hence it is likely that devices will need to be classified for medical communications and a suitable physical/transport layer set of standards, with certain minimum quality of service parameters, specified to carry this application.

For example: a blood pressure monitor is not a critical device and any convenient physical and transport layer standard, such as Bluetooth would be suitable. However, a morphine syringe pump or heart pacemaker would require more predictable and controlled communications and hence might require defined, interference-free, radio spectrum with a suitable set of transport layer standards. In both cases HL7 could be used for the higher levels of communication.

For some medical applications there is a need to specify the performance of the physical/transport layers. But for others there is a wide range of standards which might be used for the physical/transport layer. Indeed in this case it is arguable that there are too many lower layer standards that could be used and this may well be a barrier to market development as it reduces economies of scale, reduces the possibilities for interoperability (or makes it more complex) and creates confusion for the purchaser. The CHA appears to have recognised this problem and has selected a subset of network standards - Bluetooth for wireless and USB for wired. While the range of standards has at least been downsized it remains to be seen whether the “right” choice\textsuperscript{75} has been made.

\textsuperscript{75} Right meaning a successful result (i.e. widespread use) rather than the best technical result.
Annex J  Network reliability requirements of ALTs

J1  Network reliability/availability

In future we will need to address issues concerning overall network reliability and availability.

Existing circuit switched systems, whether wired (POTS) or wireless (Cellular), achieve a grade of service that provides confidence that important messages will get through. In contrast the advent of broadband has introduced a grade of service which is generally described as “best efforts”. While this functions perfectly well most of the time and delivers important messages in a timely fashion there are no guarantees that this will always be the case. As other communications networks migrate to IP based packet switched systems it is not entirely clear whether such systems will be able to satisfy the delivery of important messages at a sufficiently low level of risk.

There are other applications carried over the internet where the timely delivery of messages is of equal importance for technical reasons, rather than the safety-of-life reasons we are dealing with here. For example, real-time voice and video have stringent requirements in terms of latency and jitter (latency variation). Protocols exist to prioritise packets associated with these applications and it could be imagined that similar protocols might be applied to some applications associated with healthcare.

There are also problems of network uptime. The traditional PSTN is designed to be available for a very high proportion of the time to its users. Residential broadband services are designed to lower standards - in which the failure of an edge server can lead to down times for subscribers of many hours.

Until prioritisation of health care communications traffic is established, and broadband IP networks are designed to higher availability standards, there are other techniques that can be employed to ensure important messages get through. The main technique is to employ redundant communication paths and this can be backed up with acknowledgement / retransmission protocols to ensure the message has arrived at its destination.

In the overall architecture suggested in Figure 1, a certain amount of redundancy will almost automatically be provided. In the case of the body area network there is a need to be able to link to the home network when located there, and also a need to be able to connect to a wide area network when out of the home. These are likely to be satisfied by a WiFi and/or Bluetooth and/or ZigBee interface and a cellular network interface respectively. Since the cellular interface is also likely to work in the home, a redundant path is therefore available when in the home. When out of the home and where coverage is only provided by cellular networks (i.e. no WiFi hotspots are available), redundancy could take one of two forms:

- Either the use of more than one SIM card in the body area network gateway or
- Some form of special agreement between network operators that allows for roaming from one network to another on a single SIM card.

There are two private gateways in the overall architecture; one associated with the body area network and the other associated with the home network. In both cases we expect that at least two (and possible more) network interfaces will be provided to ensure a suitable level of communications reliability / availability.
Apart from redundancy associated with the gateways it is also necessary to consider the situation with regard to the individual communications links within the body area network and the home network. It is possible that any of these individual links could be disrupted for any number of reasons. One technique to mitigate the effect of this, along with other benefits (e.g. extension of coverage) is to deploy a mesh architecture. It is notable that a number of wireless standards with heritage in the building automation sector (e.g. ZigBee and Z-Wave) include this facility. The 802.11 family also includes mesh functionality in the 802.11s standard, but this is still in draft form.

### J2 Availability of power

Another aspect of reliability/availability concerns the fact that over the end-to-end chain there are several devices that use power and therefore could be prone to power failure.

Historically, using the 999 emergency services number as a comparator, this concern was handled by advising households to maintain a landline and use a wired telephone. This ensured that the emergency number was available in the event of a power cut because power came from the local exchange which itself had back-up sources of power (generator and/or batteries). This is still the case today and any telephony device based on wireless (generally portable for convenience) usually contains a statement recommending that a landline and wired telephone is maintained. However, this is simply advisory and today’s lifestyle of mobile and cordless phones suggests that the risk of power loss with respect to an important safety-of-life facility is not high on the list of priorities for many end users.

It is possible that the same attitude could apply to ALTs. However the risk of an emergency happening to an individual using certain types of ALT device (the ones providing critical data) will almost certainly be higher that the risk of an emergency happening to a member of the public who might need to use the 999 service. It is therefore important that the power available to ALT devices and gateways all along the end-to-end chain is ensured by suitable means at an appropriate level of availability.

### J3 Wireless requirements

Here we consider the amount of spectrum that might be required if the various types of network previously identified are to be wireless based. Apart from the amount that might be required, there is also the issue of whether spectrum should be licensed or licence-exempt and, in the case of the latter, whether it should be shared spectrum commons or whether it should be dedicated.

**Body Area Network**

As discussed earlier there are two parts to the body area network; the links between devices on or around the body and the gateway to other networks. Here we consider the links between devices on or around the body. The link from the gateway to other networks is considered part of the home and wide area networks and is discussed in the sub-sections which follow.

In general the communications links of a body area network require regular transfer of small amounts of data generated by sensors on the body. Such equipment is likely to be classified as a Class I
On this basis it is likely that low power standards such as Bluetooth, ZigBee etc can be considered. These operate in non-specific licence-exempt bands at 2.4 GHz and 868 MHz.

In the longer term, as medical care moves from the hospital to the home, we can expect that the body area network will start supporting devices that are not simply sensors on the body but include implantable / surgically invasive devices and/or drug delivery devices. Such devices have a higher (medical device) Class categorisation and require far more robust communications links in order to be certified.

There is already a CEPT allocation for medical implants at 401 to 406 MHz which the UK has implemented. This is the same as the FCC MedRadio Service allocation in the US. The allocation was recently extended by 1 MHz at either end of an existing band. It is thought that the extension was due to "apparent" congestion caused by competing technologies rather than inherent congestion due to current or foreseen demand.

In the US the FCC is in the middle of a rulemaking process\textsuperscript{76} to establish specific frequency bands and rules for the operation of Medical Body Area Network (MBAN) systems using body sensor devices. The frequency bands being considered are:

- 2300 – 2305 MHz
- 2360 – 2395 MHz
- 2400 – 2483.5 MHz
- 5150 – 5250 MHz

In the UK the higher two bands are currently available on a licence exempt basis under certain power density rules. In the case of the specific 5 GHz sub-band, although Dynamic Frequency Selection (DFS) to detect radars is not required, there is an indoor-only restriction. Insofar as the 2 GHz bands are concerned there are unresolved MoD and PMSE interests here.

As a result of medical device rules it appears likely that, if implantable / surgically invasive devices and/or drug delivery devices (Classes IIa, IIb and III) as well as non-invasive devices (Class I) are to be simultaneously supported by a body area network, such a network will have to be dual band – i.e. use a dedicated frequency band for the Class IIa, IIb and III devices, and a shared frequency band for the Class I devices.

### Home network

Here we consider the links between devices around the home (ranging from sensors to video devices and including the body area network gateway) and the home gateway to the public networks of the outside world. We consider the links between the home gateway and remote servers over the public networks in the following sub-section.

Whereas the communications links associated with a body area network will only need to support the regular transfer of small amounts of data, the demands of ALTs on the home network will be much greater. The home network will not only have to support the data from the gateway of the body area network and the relatively low amounts of data from sensors around the home, but it will also have to

\textsuperscript{76} FCC Notice of Proposed Rulemaking: Amendment of the Commission\textquotesingle s Rules to Provide Spectrum for the Operation of Medical Body Area Networks. FCC 09-57. ET Docket No. 08-59. 29 June 2009.
support video in various flavours, especially for digital participation services. The most demanding of the video applications will be real-time video interaction with friends, relatives, carers or clinicians at remote sites.

It is possible that a mix of home networking technologies will be used to satisfy the various requirements. These are likely to include:

- Low power / low data rate wireless technologies (2.4 GHz and 868 MHz - e.g. Bluetooth, ZigBee etc) to support sensors around the home and the body area gateway connection
- Wi-Fi family technologies (2.4 GHz and 5 GHz) to support the higher data rate applications around the home – this would include the real-time video applications
- Wireless repeaters or mesh architecture to increase range
- The wired option which could be standard Ethernet cabling or connections over mains wiring (HomePlug / Powerline)

We note that the wireless options all operate in licence-exempt frequency bands which can be used by other types of system. For many ALT-based applications the expected performance in terms of link reliability / availability will be acceptable. But it is also possible that implantable / surgically invasive devices and/or drug delivery devices will need to be supported in the home. Such critical applications require better network performance for home network links than that afforded by wireless links operating in shared licence-exempt bands. This implies the reservation of dedicated licence exempt spectrum for such links.

There are precedents for the special provision of spectrum for local area ALT-based applications.

- In the EU Licence-exempt spectrum (near 170 and 870 MHz) for the sole use of social alarms has been set aside for this purpose for many years. While this allocation does not related to medical devices as classified by European Directives, it does show a recognition that certain critical ALT-based applications need more reliable communications links than that offered by shared licence-exempt spectrum.
- In the US the FCC have made special provision for the Wireless Medical Telemetry Service (WMTS) which uses the bands 608 to 614 MHz, 1395 to 1400 MHz and 1427 to 1432 MHz. However, these are only available for use in clinical establishments and not for use in the home. It will be interesting to see whether the FCC address the possibility of providing such links in the home as a complement to their Medical Body Area Network NPRM following their public notice 77 seeking comments on health care delivery elements of the national broadband plan.

**Wide Area Network**

Here we address the requirements which ALTs place on the various public networks to which the home gateway and the body area gateway connect. This includes both wired (fibre, cable, copper) connections and wireless connections (the mobile networks and Wi-Fi hotspots).

These facilities are and will continue to be available to the population as a whole over the years to come. The functionality required to support ALTs in the home and on the person when out and about

---

will in general be provided by these networks as a matter of course during their continuing development. At the same time we note that most of the networking demands of Telehealth, Telecare and Digital participation services are no more onerous than the demands of other sectors. We therefore conclude that, in terms of the network sizing of public networks, ALTs will not be a major driver.

**Network reliability and availability** is an important issue however. For body area networks and home networks, our analysis suggests that additional dedicated licence exempt spectrum might be required to support critical ALT-based applications so as to provide appropriate levels of network reliability. But what is the best way to ensure similar levels of reliability in wide area networks?

Over the next 20 years the main public network platforms - both fixed and mobile - will move from circuit switched to IP networks and the reliability/availability of these networks will need to improve significantly (to or close to current standards for POTS) if they are to be acceptable for telecommunications applications generally. The precise reliability/availability of public IP networks in the long term is as yet ill-defined.

It is unlikely that the functionality of the public IP network platforms will be influenced significantly by the networking requirements of ALT based applications. It is more reasonable to assume that the functionality of ALT-based services will be constrained by the network functionality of the public IP network platforms and that ALT-based systems will be designed to minimise these constraints.

It is interesting to note that the FCC has instigated an investigation into the issue of broadband supporting health care, one objective being “to further understand the gaps between current connectivity infrastructure and the connectivity requirements for various health IT applications across the health care ecosystem.” The FCC’s Public Notice asks an extensive and comprehensive set of questions (6 closely typed pages) and if the responses are as comprehensive as the questions it should immediately become clear what network shortcomings there are (in the US) but not necessarily what can be done about it.

### J4 Security

Security is important at two levels - data security and network security.

**Data security** concerns the privacy of data at a personal/patient level. This is addressed at the higher application layers and can be ensured through one or more of password protection, encryption and physical isolation. It appears there are no hard and fast requirements in this area. It is expected that facilities or institutions might undertake a risk assessment and implement measures accordingly. We note that public concerns around personal data can become very significant from time to time.

**Network security** concerns relate to protecting network resources from unauthorised access. In this regard wireless networks are more vulnerable than networks based on other means of transmission. Wireless security can be ensured through a combination of authentication and encryption. In addition measures such as intrusion prevention can be implemented to make sure network facilities are not denied to bona fide users. There is a certain level of complexity to the best network security and while we expect that sufficient resources to implement adequate security would be available at an enterprise level, we do not expect that such resources would be widely available in the home.

---

78 Ibid (FCC Public Notice).
For both these types of security there are well tried technical means for addressing the various issues. So there are no technical issues that are specific to ALTs, apart from the sheer scale of the task and, in the case of individuals, a certain level of complexity that needs to be overcome. In general security breaches, if a security system is in place, are more likely to be due to human error than technical failure. Given the demographic we are dealing with when considering security of ALT-based applications, human failure at one end of the communications chain is likely to be higher than average.
Annex K  Network architecture requirements of ALTs

K1  General characteristics

Considering the ALT-based applications overall (i.e. without regard to the Telehealth, Telecare and participation categorisation) it can be seen that, for the purpose of networking considerations, they each fall into one or more of the following groups:

- Connections between devices on or around the body to a host device which itself may or may not be on or around the body\(^{79}\)
- Connections between devices around the home connected to a host device
- Connections from the home to specific and non-specific remote sites
- Connections from devices/host(s) on or around the body to specific (and non-specific) remote sites when the person is out of the home (or more generally, anywhere)

For the third category above (home to remote sites) we can also identify those applications which are little or no different from a networking point of view to applications likely to be in widespread use by the rest of the population. In these cases issues are more likely to be related to usability rather than networking problems.

In addition to the topological characterisation of the above groups we also need to consider characterisation of the data in each case with regard to:

- The quantity of data exchanged in a transaction and the frequency of those transactions
- The tolerance of a data transfer to delay (latency)
- The reliability of a network at a macro level.

K2  Network types

In the first instance we can see, from the characterisation of the ALT-based applications in terms of topology, that the overall network architecture could be satisfied by a number of area networks with gateways between them. Simply, these networks would be:

- A Body Area Network
- A Home Network
- A Metropolitan or Wide Area Network

Note that in all cases networks could be wired or wireless. Clearly where mobility is required wireless is the only satisfactory answer.

If it is accepted that such an overall topology of three interlinked network types could support the ALT-based applications identified in other working papers, we can now look at each network in terms of the issues that might be involved and in particular the implications for spectrum where applications

\(^{79}\) The host device may be a processor associated with a sensor or it might be a gateway serving a number of processors or other host devices.
demand mobility. Furthermore, if we assume that ALT-based applications are not sufficiently influential in themselves to act as drivers of network implementation, we can also examine whether the foreseen developments in networks will support the various applications adequately.

**Body Area Network**

In the past individual devices on or about the body would have been connected by wires. Increasingly wireless is used for convenience, usually in clinical establishments (i.e. under medical supervision) and related to implanted or in-body devices.

In the future it is foreseen that multiple devices will be used on the person and these will need to be managed in terms of the data they generate. There are several network architectures that could satisfy this requirement:

- Each on-body device connects directly into the home network (see sub-section that follows)
- Each on-body device connects directly to a gateway also situated on the person
- Each on-body device connects through other on-body devices (i.e. mesh configuration) to a gateway also situated on the person

Regardless of the architecture that prevails in the future, there are two important aspects that need to be addressed, namely, power consumption and security. These considerations also apply to sensors around the home which fall within the home network domain discussed in the sub-section that follows.

**Home Network**

Clearly, home networks can be established using wired connections, much like an office Ethernet based Local Area Network (LAN). However, except in new builds, wireless networks are more likely to be used for various reasons including aesthetics, installation disruption and cost. The wireless alternative is useful for convenience and on aesthetic grounds but coverage is not necessarily uniform and usability is not yet at a stage where ubiquitous deployment would be sustainable. We note that the HomePlug/Powerline wired alternative can also suffer from non-uniform coverage because of electrical noise which is often caused by other equipment in the same house using the mains supply.

The basic requirement is for all devices in the home (i.e. sensors, processors or host devices, on-body devices or gateways, etc) to connect with a home gateway which might also incorporate a home processor (computer) and switch / router.

As in the case of the Body Area Network above, more than one architecture is possible or even necessary because of coverage issues. Some of the options include:

- Multiple wireless access points. These generally require a wired backhaul to the home gateway
- Wireless repeaters which effectively extend the range of a wireless access point. These are likely to be employed with respect to a single wireless access point that is integrated with the home gateway/router.
- A mesh network which, like the option above, effectively provides a wireless backhaul to the home gateway.
Note that in the case of the last two options there are capacity implications on the end-to-end link as some of the available capacity is being used for backhaul. While the payload capacity is thereby reduced this is unlikely to be an issue for many applications since they only require relatively low data rates. For those applications requiring high data rates this is an issue that needs to be taken into account.

In the end it is likely that the home networking solution will be a hybrid of the options above, given that the home situation of individuals varies significantly.

**Metropolitan or Wide Area Network**

There are three aspects here in terms of connection to the rest of the world; the fixed connection from the home, the mobile connection from the person and the possibility of using connections on a nomadic basis.

The **fixed connection** from the home will rely to a large extent on whatever broadband facilities are available at the time\(^{80}\), noting that the capability of such a broadband connection will not necessarily be uniform across the country. Furthermore, and based on the current approach to broadband provision, the service provided by such a connection is only on a best efforts basis. The reliance on broadband connections by commerce and individuals is increasingly recognised along with the non-guaranteed nature of the service. This contrasts with the service reliability of today's circuit switched telephony service (POTS), albeit providing a lower bandwidth, where a significantly higher level of service is provided and this is reflected in the fact that POTS is recognised as being suitable for the 999 emergency line whereas internet based VOIP is not. The overall reliability / availability of networks and their suitability for telecare/health applications is discussed in more detail later.

The **mobile connection** from the person will in the first instance be supported by public mobile networks. As in the case of the fixed connection, the capability of such a mobile connection will not necessarily be uniform across the country. In a similar way to the fixed connection and the quality of service contrast between POTS (circuit switched) and the internet (packet switched), it is not yet clear how future cellular technologies are going to provide the quality of service demanded by more stringent applications.

The **nomadic connection** from the person will be supported by hotspots, usually based on 802.11 WiFi access points connected directly into the internet. These hotspots will tend to be favoured over and above a connection to the mobile network for applications with demanding data requirements (and/or for associated cost reasons).

It can be seen from the latter two options above (the mobile connection and the nomadic connection) that there is every likelihood that an individual going about their business will have a device with more than one wireless interface. This is already the case and there is every reason to suppose that multiple wireless interfaces on a personal device will be integrated into an overall health care ecosystem.

\(^{80}\) Depending on how government strategy results in the implementation of universal broadband access, connection to the home could be wired (fibre or cable), wireless (mobile networks or some form of fixed wireless access) or satellite.
K3  The overall network architecture

Putting these three network types together leads to the overall architecture shown in Figure K1 below. It can be seen that this is made up of three area networks (body, home and wide area networks) with gateways between them as noted earlier.

The following features of Figure K1 are worth noting:

- Wired connections are represented by solid lines81 and wireless connections are represented in a general sense by dotted arrows.
- The left hand side of the diagram represents public networks both wired and wireless, and both local area (WiFi hotspots) and wide area.
- The upper right hand side of the diagram represents a home network with a gateway supporting a number of devices both fixed and mobile.
- The lower right hand side of the diagram represents the case where the mobile device is a person who in turn is carrying a body area network.
- The body area network will need to interface to both the home network and public networks.
- The fixed devices in the home network could be hard wired but this is not shown in the diagram.
- The home network is based on a wireless gateway (i.e. router and wireless access point combination) with one or more associated wireless access points supporting wireless connections to devices around the home. These connections may be direct from device to gateway or through host devices, repeaters or associated access points, or via a mesh network.
- Access points might be needed if different wireless technologies are used within the home. These can either be separate from the home gateway (and connected by wire or wireless to the home gateway) or be integrated in the home gateway.
- The body area network is a smaller (in area) version of the home network in terms of architecture (i.e. devices connected wirelessly to a gateway which then has an interface to another network). This gateway architecture has the advantage that the body area network, for example, should be able to interface to networks in other locations (e.g. GP's surgery, hospital, ambulance).

This general architecture is not specific to any particular set of radio frequencies. It is possible, however, that some of the links for the applications we are dealing with may use specific (dedicated) frequencies. At the same time it is clear that some of the architecture is the same as that which would be appropriate for more general networking around the house. If different frequencies are used for telehealth applications and for other home applications (such as entertainment) then the home gateway will have to deal with more than one frequency band. For example a single gateway could have multiple radio transceivers for services that are differentiated by frequency. Whether this happens will be determined by the market. However, this requirement should not be regarded as a significant barrier to the deployment of wireless-supported ALTs in the home. It is straightforward to link a wireless gateway used for specific ALTs into a more general home gateway using either a wired or wireless connection.

81 This has also been used for public network backhaul even though microwave links are used but this aspect is outside the scope of this study.
Figure K1: A general network architecture to support ALT based applications
<table>
<thead>
<tr>
<th>Category of ALT</th>
<th>ALT based service</th>
<th>Location</th>
<th>Comms links required</th>
<th>Amount of data</th>
<th>Tolerable latency</th>
<th>Reliability required</th>
<th>Architecture implications</th>
<th>Network Group(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Telehealth</strong></td>
<td>Continuous home monitoring services use a combination of data feeds from sensors which provide information on weight, pulse, blood pressure/gas/glucose and lung capacity - supplemented by automated queries of service users when monitoring service data indicate the need. Avatars provide the human face and voice for such interactions.</td>
<td>Home</td>
<td>Body sensors to processor and processor to remote site. Remote site / processor to user interface.</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Body area network with gateway to connect to home network and processor which in turn is connected to the internet. Return path to user interface. More than one connection type for redundancy.</td>
<td>A + B + C</td>
</tr>
<tr>
<td><strong>Telehealth</strong></td>
<td>Body area networks link to mobile devices to enable monitoring outside the home</td>
<td>Anywhere</td>
<td>Body sensors to mobile and mobile to remote site. Remote site / mobile (processor) to user interface.</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Body area network with gateway to connect to public networks (e.g. cellular and WiFi) or home network. Return path to user interface. Mobile or gateway provides necessary processing power and user interface. More than one connection type for redundancy.</td>
<td>A + D</td>
</tr>
<tr>
<td><strong>Telehealth</strong></td>
<td>Artificial intelligence software interprets the monitoring data with a bias to false positives to minimise failure to diagnose serious problems.</td>
<td>Anywhere</td>
<td>Processor to user interface / remote site</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Mobile or gateway provides necessary processing power and user interface.</td>
<td>B + C + D</td>
</tr>
<tr>
<td><strong>Telehealth</strong></td>
<td>Home image monitoring is used, eg for early detection of skin cancers</td>
<td>Home</td>
<td>Image capture device to processor and processor to remote site</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>Image capture device connection to home processor.</td>
<td>B + C</td>
</tr>
<tr>
<td><strong>Telehealth</strong></td>
<td>Sensors which ensure adherence to medication programmes are available and reliable</td>
<td>Anywhere</td>
<td>Sensors to processor and processor to user interface</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Connections between sensors and processor whether that be the home or mobile processor. Synchronisation between the two processors likely to be required.</td>
<td>A + B + D</td>
</tr>
<tr>
<td><strong>Telehealth</strong></td>
<td>Computerized cognitive behavioural therapy is used extensively to treat depression and anxiety.</td>
<td>Home</td>
<td>Processor to user interface. Processor to remote site</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Computer interaction supported by computer connection to the web.</td>
<td>C</td>
</tr>
</tbody>
</table>

\(^2\) See key at end of appendix for definition of network group
<table>
<thead>
<tr>
<th>Category of ALT</th>
<th>ALT based service</th>
<th>Location</th>
<th>Comms links required</th>
<th>Amount of data</th>
<th>Tolerable latency</th>
<th>Reliability required</th>
<th>Architecture implications</th>
<th>Network Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telehealth</td>
<td>Gait monitors are used by older people with a mobility problem to detect when the condition worsens and allow early intervention.</td>
<td>Anywhere</td>
<td>Sensors to processor and processor to remote site</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Sensors connect with gateway (possible using a body area network) to connect to public networks (e.g. cellular and WiFi) and home network. Mobile or gateway provides necessary processing power. No user interface expected.</td>
<td>A + B + C + D</td>
</tr>
<tr>
<td>Telehealth</td>
<td>End users have access to their health care records with software to interpret the data and to show how the user is progressing relative to others with the same condition</td>
<td>Anywhere</td>
<td>User interface to processor and processor to remote site</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Internet connection - with sufficient capacity to support image transfer</td>
<td>B + C + D</td>
</tr>
<tr>
<td>Telehealth</td>
<td>There is a helpline for users to call if they have any concerns or problems</td>
<td>Anywhere</td>
<td>User interface to remote site</td>
<td>Low (or voice)</td>
<td>Low</td>
<td>Medium</td>
<td>Computer interaction or voice connection</td>
<td>Dx</td>
</tr>
<tr>
<td>Telecare</td>
<td>There is continuous monitoring of the activities of older people in the home from sensors which detect eg movement, eating and sleep patterns</td>
<td>Home</td>
<td>Sensors to processor and processor to remote site</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>Sensors connect to home network (possibly mesh) and home processor</td>
<td>A + B + C</td>
</tr>
<tr>
<td>Telecare</td>
<td>Optional video monitoring of older people in the home</td>
<td>Home</td>
<td>Cameras to processor and processor to remote site</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Cameras connect to home network (possibly mesh) and home processor</td>
<td>B + C</td>
</tr>
<tr>
<td>Telecare</td>
<td>Artificial intelligence software detects significant abnormalities in behaviour patterns and triggers alarms</td>
<td>Anywhere</td>
<td>Processor to user interface / remote site</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Mobile or gateway provides necessary processing power and user interface and connects to remote site</td>
<td>B + C + D</td>
</tr>
<tr>
<td>Telecare</td>
<td>There is also continuous monitoring of the environment in the home eg floods, gas escapes, fire, adequate heating</td>
<td>Home</td>
<td>Sensors to processor and processor to remote site</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Sensors connect to home network (possibly mesh) and home processor</td>
<td>B + C</td>
</tr>
<tr>
<td>Telecare</td>
<td>Reminder systems (using the voice of a close relative) are used by those with cognitive impairments</td>
<td>Anywhere</td>
<td>Processor to user interface</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>Mobile or gateway provides necessary processing power and user interface.</td>
<td>B</td>
</tr>
<tr>
<td>Telecare</td>
<td>Video calling is used for consultation with care workers</td>
<td>Home</td>
<td>Internet connection</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Assumed to be covered by broadband services available to the rest of the population</td>
<td>Cx</td>
</tr>
<tr>
<td>Category of ALT</td>
<td>ALT based service</td>
<td>Location</td>
<td>Comms links required</td>
<td>Amount of data</td>
<td>Tolerable latency</td>
<td>Reliability required</td>
<td>Architecture implications</td>
<td>Network Group</td>
</tr>
<tr>
<td>----------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>----------------</td>
<td>-------------------</td>
<td>------------------------</td>
<td>----------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Telecare</td>
<td>Navigation systems on mobile devices allow older people with visual or cognitive impairments to find their way around safely outside the home</td>
<td>Anywhere</td>
<td>Location device to user interface. Location device to web.</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>Customised navigation device</td>
<td>D</td>
</tr>
<tr>
<td>Telecare</td>
<td>Location services enable carers to find someone with dementia who becomes lost outside the home.</td>
<td>Anywhere</td>
<td>Location device to remote site</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>Customised navigation device</td>
<td>D</td>
</tr>
<tr>
<td>Telecare</td>
<td>Personalised virtual reality fitness programmes with feedback on relative performance are widespread use eg WiiFit</td>
<td>Home</td>
<td>User interface to fitness device (possibly via processor). Fitness device to web (possibly via processor).</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Small amount of data transfer over the web.</td>
<td>B + C</td>
</tr>
<tr>
<td>Telecare</td>
<td>Robots perform household tasks</td>
<td>Home</td>
<td>User interface to processor and processor to robot. Robot to web (via processor).</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
<td>Robots assumed to be relatively autonomous with small amount of data transfer for user instructions / set-up and connection to web.</td>
<td>B + C</td>
</tr>
<tr>
<td>Telecare</td>
<td>There is a helpline for users to call if they have any concerns or problems</td>
<td>Anywhere</td>
<td>User interface to remote site</td>
<td>Low (or voice)</td>
<td>Low</td>
<td>Medium</td>
<td>Computer interaction or voice connection</td>
<td>Dx</td>
</tr>
<tr>
<td>Digital participation services</td>
<td>Social interaction: Web-based social networking, used to maintain contact with friends and family and to organise face-to-face meetings; Internet-based ‘armchair’ video calling; Always-on communications links with close contacts, which may carry live feeds of status data (e.g. wellbeing information)</td>
<td>Anywhere</td>
<td>Internet connection (incl video)</td>
<td>Not significantly different to the rest of the population</td>
<td>Low</td>
<td>Medium</td>
<td>Assumed to be covered by broadband services available to the rest of the population</td>
<td>Dx</td>
</tr>
<tr>
<td>Category of ALT</td>
<td>ALT based service</td>
<td>Location</td>
<td>Comms links required</td>
<td>Amount of data</td>
<td>Tolerable latency</td>
<td>Reliability required</td>
<td>Architecture implications</td>
<td>Network Group</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>----------------</td>
<td>-------------------------------------------</td>
<td>---------------------------</td>
<td>-------------------</td>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Digital participation services</td>
<td>Entertainment: Internet-based video services, including access to archives (e.g. BBC dramas from the 70s and 80s); Multi-player connected motion/gesture controlled games that stimulate physical exercise and enable social interaction (e.g. bowling leagues); Virtual reality worlds that older people can use as a gateway to real-life activities (e.g. visiting concerts, going shopping)</td>
<td>Anywhere</td>
<td>Internet connection (incl video)</td>
<td>Not significantly different to the rest of the population</td>
<td>Low</td>
<td>Low</td>
<td>Assumed to be covered by broadband services available to the rest of the population</td>
<td>Dx</td>
</tr>
<tr>
<td>Digital participation services</td>
<td>Learning: Web-based learning integrated with social interaction (e.g. virtual evening classes)</td>
<td>Anywhere</td>
<td>Internet connection</td>
<td>Not significantly different to the rest of the population</td>
<td>Low</td>
<td>Low</td>
<td>Assumed to be covered by broadband services available to the rest of the population</td>
<td>Dx</td>
</tr>
<tr>
<td>Digital participation services</td>
<td>Teleworking: to enable higher workforce participation, more job flexibility and to stimulate mental activity.</td>
<td>Anywhere</td>
<td>Internet connection</td>
<td>Not significantly different to the rest of the population</td>
<td>Low</td>
<td>Low</td>
<td>Assumed to be covered by broadband services available to the rest of the population</td>
<td>Dx</td>
</tr>
<tr>
<td>Digital participation services</td>
<td>Other: Range of government and private services (e.g. shopping, information, voting, local government) accessible via simple interfaces (e.g. accessible web, virtual reality); Online skills exchanges e.g. one older person cooks a meal for another in return for jobs around the house</td>
<td>Anywhere</td>
<td>Internet connection</td>
<td>Not significantly different to the rest of the population</td>
<td>Low</td>
<td>Low</td>
<td>Assumed to be covered by broadband services available to the rest of the population</td>
<td>Dx</td>
</tr>
<tr>
<td>Digital participation services</td>
<td>Technical support services: These might be specifically designed for older people, to call when things go wrong or when users cannot remember how to do something.</td>
<td>Anywhere</td>
<td>User interface to remote site</td>
<td>Low (or voice)</td>
<td>Low</td>
<td>Medium</td>
<td>Computer interaction or voice connection</td>
<td>Dx</td>
</tr>
</tbody>
</table>
### Key

<table>
<thead>
<tr>
<th>Amount of data</th>
<th>Low</th>
<th>Machine data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Machine data</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td>Images</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>Video</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tolerable latency</th>
<th>Low</th>
<th>milliseconds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td>seconds</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>Hour</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reliability required</th>
<th>Low</th>
<th>Best efforts (current internet QoS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mobile network equivalent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Always on (equivalent to POTS QoS)</td>
</tr>
</tbody>
</table>

*Where reliability might be seen as a mixture of coverage and quality of service*

<table>
<thead>
<tr>
<th>Network type</th>
<th>Network Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Area Network</td>
<td>A</td>
<td>Body device to host</td>
</tr>
<tr>
<td>Home Network</td>
<td>B</td>
<td>Home device to host</td>
</tr>
<tr>
<td>Wide Area Network (Fixed)</td>
<td>C</td>
<td>Home to remote sites (Cx if rest of population)</td>
</tr>
<tr>
<td>Wide Area Network (Mobile)</td>
<td>D</td>
<td>Body device/host to remote sites (Dx if rest of population) Dx satisfied by Cx in the home where Cx may also include B</td>
</tr>
</tbody>
</table>