WHITE PAPER

TELECARE WITH SMART POWER SOCKETS

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1 TABLE OF CONTENTS

2 INTRODUCTION

The existing models for funding social care are unsustainable. UK public sector funding is constrained by budget cuts, alongside a deeply rooted cultural expectation that the State will pay for care services. The increasingly ageing population and their families are faced with funding care privately.

Telecare, also known as TECS (Technology Enabled Care Services), has been used for decades but it has not caught up with the potential of the Internet of Things (IoT). IoT being loosely defined as the connection of ordinary, everyday items to the Internet to produce actionable information [i]. The cultural gap between generations means that the potential of IoT has not been communicated and telecare service users are uncertain about consenting to be monitored, however benignly.

KemuriSense is manufacturing the first IoT power socket, with multiple sensors, designed to fit into the fabric of ordinary residential property. It is a standard, off-the-shelf double power socket fitted with IoT hardware, which is constantly communicating via the Internet. A patent is pending, and at time of writing, KemuriSense® Smart Power Sockets are a unique product.

The Founder's inspiration for the design was his mother, living 300 miles away, and slowly declining through the stages of dementia. She had a regular pattern of activity in her kitchen. She would get up at the same time each day, have a cup of tea and a slice or two of toast. The rest of the day also had a regular pattern. Machine learning and analytical software can find patterns and detect changes from normal activity. He could not buy fixed IoT power sockets to collect and transmit multiple streams of data – so he invented KemuriSense® Smart Power Sockets.

From conception in 2013, it took until January 2017 to bring Smart Power Sockets into production. They feed data into an analytics engine that learns patterns of sensor activity. Smartphone apps display the results. Furthermore, large numbers of changes over a few hours trigger alerts to families, carers or alarm response centres. This is the Kemuri® Wellbeing Monitor service. It provides passive monitoring for any vulnerable people living independently. They could be people with dementia, learning disabilities, epilepsy, stroke or impaired vision, or wheel chair users.

As true IoT devices, they can be deployed wherever there is a mains power supply, hence not restricted to telecare. Smart Power Sockets can be installed in any building to monitor for movement of people, use of power and ambient conditions of temperature and humidity. They can provide information for building facilities managers, medical researchers and security companies.

This White Paper considers the problems of ageing and how telecare can help people to live independently. Different types of telecare are compared to the needs and capabilities of vulnerable people living independently, with specific reference to older people with declining cognition.

> " ***... this is a unique product ... for both self funder and LA funding as a potential option that fills a gap that conventional telecare does not***."
>
> Commissioning Manager at a County Council.

3 PROBLEMS OF AGEING

Most importantly, care should be focussed on the needs of older people. Many are in denial of their declining capacity to undertake activities of daily living. They are proud people after a long life, and don't like being reminded of the stigma related to ageing. They resent changing their lifestyle and reject unfamiliar wearable devices such as pendant alarms and fall monitors.

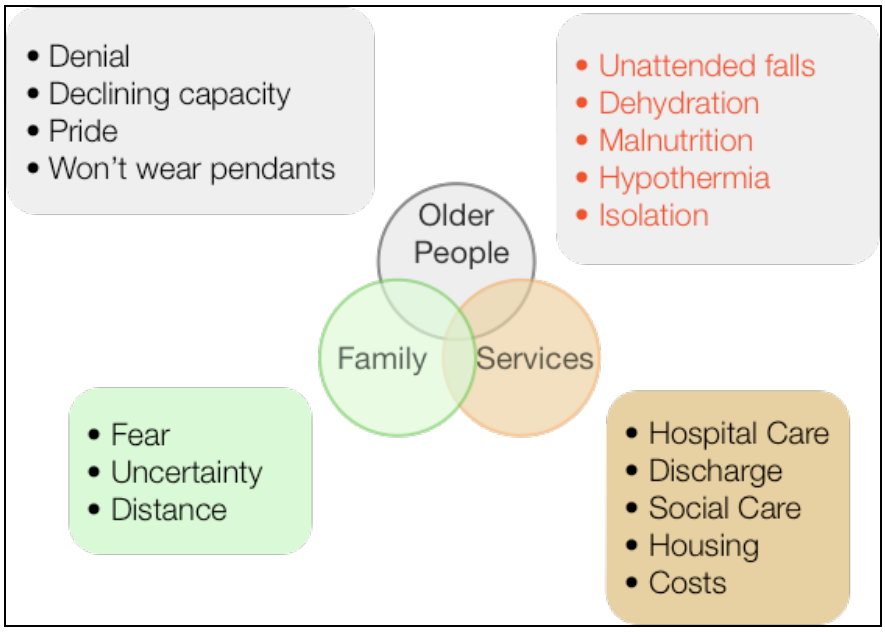

Figure 1: Caring for Ageing

Families, especially if they live many miles away, are concerned about unattended falls, incapacitating medical events and providing healthy nutrition.

Service organisations, such as hospitals, GPs, Social Services, domiciliary carers and housing managers are faced with rising demand, lower budgets and gaps in telecare provision. Delayed transfer of care and unsafe discharges from hospitals are all increasing pressure on NHS and care services.

3.1 Falls

The unpalatable facts are[ii]:

- Falls are the largest cause of emergency hospital admissions for older people, and significantly impact on long-term outcomes, a major cause of people moving from their own home to residential care;
- Falls account for up to 40% of ambulance call-outs to homes for people aged 65+, costing £115 per callout;
- One in three people aged over 65, and half of those aged over 80, fall at least once a year. Falls are the commonest cause of death from injury in the over 65s;
- Falls cost the NHS more than £2 billion per year and also have a knock-on effect on productivity costs in terms of carer time and absence from work.

If people are unable to call for help or don't have a daily care visit, then they may lie unattended for days. They become dehydrated, undernourished and possibly hypothermic. Their health outcomes from medical attention are poorer and may lead to premature death.

3.2 Dehydration

Dehydration is a common problem, especially with older people[iii]:

- Poor health outcomes eg two-fold increase in the mortality of stroke patients;
- Poor mental performance eg memory, attention, concentration and reaction time;
- Common complications eg low blood pressure, weakness, dizziness, increased risk of falls, pressure sores and skin conditions;
- Reduced fluid intake increases risk of constipation, urinary tract infections increase and may cause acute kidney injury;
- Reduced intake at night does not reduce urinary incontinence frequency or severity;
- Risk factor for falls in older people and associated with pressure ulcers, faecal impaction and cognitive impairment.

3.3 Malnutrition

Malnutrition increases with age[iv]:

- 1.3 million people over 65 suffer from malnutrition, and the vast majority (93%) live in the community;
- Nearly one third of all older people admitted to hospital are at risk of malnutrition;
- 50% of older people admitted to hospital from care homes were found to be at risk of malnutrition;
- Malnutrition costs the NHS £7 billion per year. Risk (in 2010) was 28% in patients < 60 years old, 32% aged 60-79 years and 44% if > 80 years old;
- Women have a higher prevalence of malnutrition than men in all age groups;
- Malnourished patients stay an average of 5-10 days longer in hospital.

3.4 Hypothermia

Hypothermia affects many people in the UK[v]:

- This winter, 25,000 older people could die prematurely from the cold;
- There are 15 times more excess winter deaths each year than road traffic fatalities;
- Heart and circulatory diseases are the largest causes of mortality in adults over 65 and are particularly affected by winter temperature;
- Cold homes cost the NHS in England more than £1.36 billion every year;
- Nearly 1 million people aged 65 and over have had to cut back on food shopping over recent years to cover the cost of utility bills.

3.5 Isolation

Chronic loneliness is endemic and exacerbated by smaller families with children who move away from their parents[vi].

Figure 2: Loneliness

Older people often have difficulty coping with digital technology and do not understand smartphones and tablets. Even the capacity to make phone calls declines. In such cases, older people benefit from personal contact with family or friends who understand their weekly routine activities and can discuss their immediate needs.

4 SAFE INDEPENDENT LIVING

4.1 Stakeholder Needs

People with early stage dementia frequently resist change. Many wish to live independently without intrusion from carers or even family members. Many will not co-operate with daily phone calls or wearing life-saving technology, such as fall detectors.

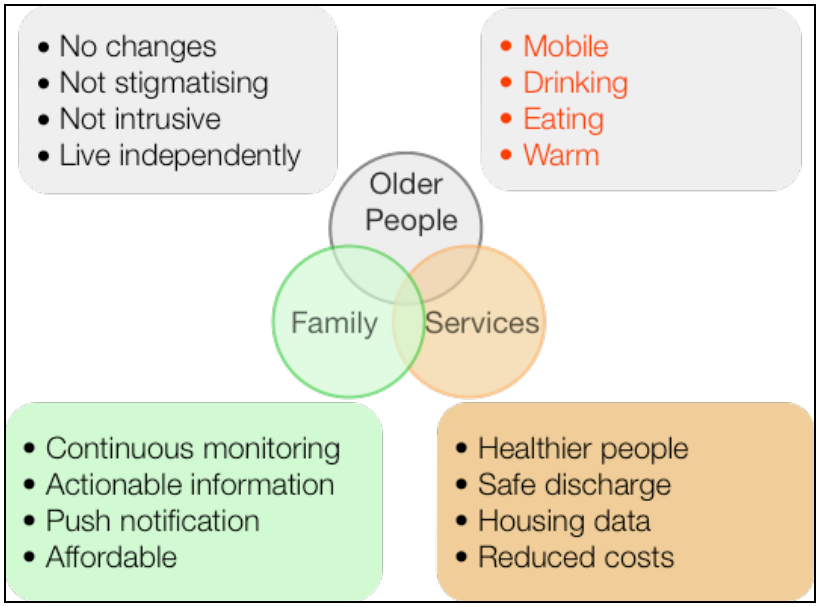

Figure 3: Telecare stakeholder objectives

In general, families and carers are reassured when they know that people are moving around normally, drinking enough, feeding themselves and keeping warm. They can take action as and when the risks are high, possibly by increasing frequency of domiciliary care. This needs continuous monitoring with alerts when increased risks are identified.

Service organisations and housing providers need reliable information to fulfil their duty of care to vulnerable people. However, public sector budgets are stretched by the increasing demand for acute services, with little remaining for investing in innovative preventive care. Continuous home monitoring provides actionable information that leads to better wellbeing and healthier people that have shorter hospital stays and safer discharge. Preventive telecare generates efficiencies in both Health and Social Services.

4.2 Telecare Trends

Telecare provides health and social care from a distance, directly to the user, with support from information and communications technology (ICT). It includes the use of a wide range of devices and sensors installed in people's homes that transfer information for diagnosis or monitoring purposes. Information can help health and social care professionals to understand changes in the individual's condition and when intervention might be needed.

A broad spectrum of applications and service elements fall under the definition of telecare. This can be classified into three generations of telecare (based on an evolution of the traditional "social alarm" model). First generation telecare solutions use a telephone unit and an attachment with a button that can be triggered by the user in case of required assistance. Second generation solutions trigger alarm automatically, enabled by the implementation of sensors. When activated, the alert is raised in a monitoring centre that initiates the necessary response. These have evolved alongside technology into more sophisticated smart systems including advanced forms of sensor-based Smart Homes and Ambient Assisted Living (AAL) technologies which support data collection and interpretation. The data is analysed on a regular basis to monitor wellbeing and assess the need for help and support. Recent telecare devices include mobile and video-based telecare[vii].

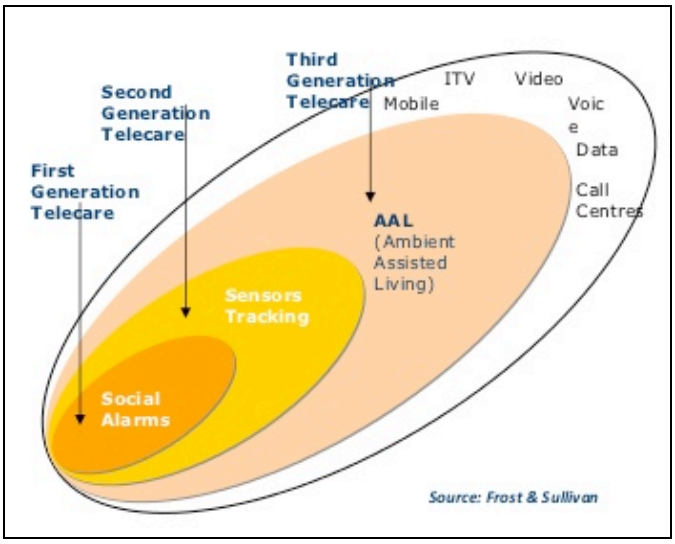

Figure 4: Trends in telecare

Mainstream telecare is currently mostly limited to the first generation systems, whilst the second and third generation systems are more widely used in pilot programmes and research activities. The Telecare market is characterised by diversity of device suppliers and service providers, but volumes remain low. According to market analysts, second and third generation systems have not attracted mainstream commissioning from health and care services.

Kemuri leapfrogs hub-based technology that relies on a complex set up of wireless-connected sensors. The latter, in practice, may not be suitable for many older people living independently. Kemuri supports Ambient Assisted Living and can be classified as third generation telecare.

4.3 Telecare Matrix

As the UK population ages, the need for care and support across the population is projected to rise. These trends pose several challenges to policymakers, both in managing the effects on public spending, and in enabling individuals with care needs to live independent lives, in their own homes, for as long as possible. Policymakers have identified telecare as an important way in which the cost to the public finances of supporting an ageing population can be reduced. There are over 6 million people providing informal care, and telecare can reduce the burden of caring on their lives.

The remote monitoring of emergencies and lifestyle changes over time helps to manage the risks associated with vulnerable people living independently in their own homes. Common risks associated with ageing include Preventive telecare enables earlier intervention and reduces medical complications. It is also used to monitor people in their re-ablement following discharge from hospital.

Kemuri has analysed telecare in a 2X2 matrix; the type of service user versus the type of device. Telecare service users are categorised as active or declining, as defined by their understanding of ageing, technology and need for co-operation. Declining service users are unwilling, unable or forget to use telecare devices that need active input. Devices are classified as Preventive or Reactive, defined by whether they report before or after a risk event.

The telecare user and devices matrix is presented in the table below:

	Active Service User • Understands ageing • Understands telecare • Co-operates with changes • Won't remove devices	**Declining Service User** • In denial • Declining cognition • Resists lifestyle change • No understanding of Telecare
Preventive devices (monitoring before a risk event)	• Wireless continuous sensors • Batteries acceptable • Wearable acceptable • Broadband acceptable	• Wired continuous sensors • Mains powered • No wearables • Tamperproof • Broadband not acceptable
Reactive devices (alerting after a risk event)	• Pendant alarms • Fall monitors • Pull cords • Battery sensors (e.g. smoke alarms) • ~1 million using pendants	• Mains sensors (e.g. smoke alarms and CO monitors) • Intrusion alarms • ~ 500,000 not wearing issued pendants

Figure 5: Telecare matrix

Preventive devices with a hub and multiple wireless sensors are adequate for active service users. They have batteries that need replacement and reliable wireless connection. The problem is that sensors are moved, or thrown away by accident, and this can create false alarms. Service users often do no have the skills to re-connect wireless devices that have lost communication to a hub.

Wearable preventive telecare devices, such as trackers, must be worn by active service users who co-operate by remember to wear them and charge batteries. Some wearables depend on having a Wi-Fi broadband connection – not present in the homes of the oldest generation. Reactive devices that need action are not effective for declining service users, possibly with early stage dementia, who have to understand the risk and replace batteries.

The commonest reactive telecare device is the pendant alarm. They are reliable, effective and low cost. But they need an active service user to push the red button in the event of an emergency.

Only 8% of people who have them issued wear them all the time and 32% never wear them[viii]. This old technology is not effective for people, who do not understand their value and leave unused pendants on bedside tables. An estimated £80 million is being wasted on pendant alarms that are not providing any value. These funds could be diverted into more effective monitoring of older people with cognitive impairment.

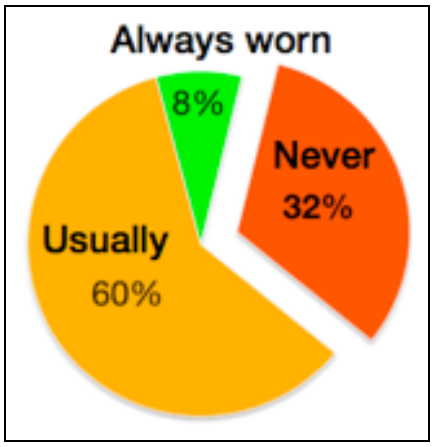

Figure 6: Use of pendant alarms

Preventive devices can delay the need for full-time residential care by identifying deterioration in activities of daily living. Telecare helps people to live independently in their own homes – rather than in residential care. It also reduces the burden on informal carers by reducing the 'personal costs' of care by family members, such as non-participation in the labour market. Telecare has potential economic and well-being benefits to service users, families and the State. Central government and local authorities have sought to boost usage of telecare over the last decade through grants and pilots. However, recent budget reductions are transferring the costs to personal or voluntary sector sources.

Active service users are able to use any form of preventive telecare. This could include products such as CanaryCare, Just Checking and Lively. They distribute several wireless, battery-powered sensors in key locations in a property and collect data for sending to Web services via the Internet. Dashboards show sensor activity and can be set to raise alerts. None of them measure power usage. 3-Rings and Wemo are mains plug-in devices in this category that do identify power use, but they only have one sensor and are easily removed by service users.

Kemuri is uniquely positioned in this matrix for declining service users needing a preventive multi-sensor device. Kemuri monitors continuously and does not impact the lifestyle of older people in any way. It is specifically designed for carers of the estimated half million older people who resist change to their lifestyle and do not use technology. It is mains-powered and tamperproof.

An additional benefit of Kemuri is installation when service users are active, but there's no need to change as they decline. This is cost effective when memory loss has only just become apparent, but not clinically diagnosed as dementia. It is ideal for retirement villages and sheltered accommodation, given the anticipated decline over a number of years.

5 KEMURI WELLBEING MONITOR

The Kemuri® Wellbeing Monitor is an innovative tool in the carers' armoury. It processes the data collected from KemuriSense® Smart Power Sockets via the Internet. Powerful servers learn patterns of sensor readings and every hour check for changes in each sensor. They should be used alongside other reactive telecare services, such as fire alarms, that have been assessed as prudent in a care plan for individual service users.

Families, carers and sheltered housing wardens log on to a simple app shows a summary of the previous week.

Figure 7: Kemuri weekly summary screen

The App colour codes hours and days according to the number of changes from normal during the time period. In the example above:

- Green days had zero, or only few changes;
- Amber days had a moderate number of changes;
- Red days, had many changes.

An option is available to send alerts for authorised people, or alarm response centres, to investigate the reason. To minimise false alarms, alerts can be tuned to depend on the number of changes each day.

Wardens managing many properties in sheltered housing can use a dashboard screen that shows the daily indicator for all their properties. They can immediately identify people at the greatest risk and give them priority for a personal call, possibly averting serious medical complications.

It shows Individual detailed sensor readings, together with a marker to show whether it has been a positive or negative change.

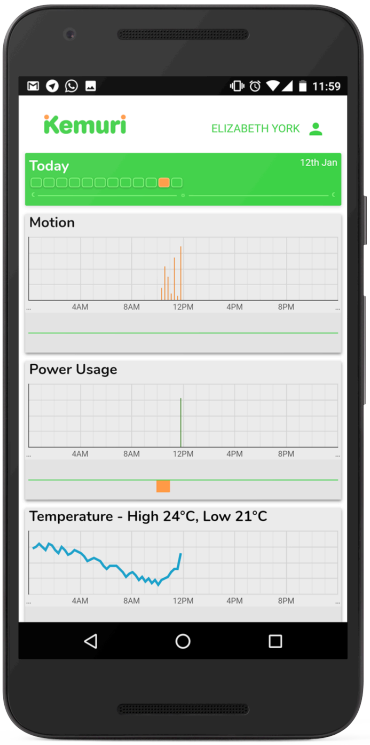

Figure 8: Kemuri daily details screen

In the example above, temperature was higher than the normal limit, motion was less than normal and a kettle boil was late. This was not a problem because it was a hot summer's day and the gentleman went out to his garden.

In addition to a daily visual check, any authorised person can receive an alert if there have been a large number of changes in a day. This is most useful for alarm response centres, who provide a 24/7 service for alerts from a wide range of telecare devices.

6 KEMURI TECHNOLOGY

6.1 Smart Power Sockets

KemuriSense Smart Power Sockets are IoT devices..

Figure 9: KemuriSense Smart Power Socket

The key features are:

- Mains input and output;
- CE certified for installation on a ring main as an replacement to a standard power socket;
- Multiple sensors: motion, power usage, temperature, humidity, power supply voltage, battery voltage and signal strength;
- Internal capacity to add extra sensors;
- Radio transmitter and receiver that uses the best available GSM signal;
- Battery back up for 18 hours, continuing to collect data during a power cut. The server sends alerts if power loss is longer than a few hours;
- Buzzer;
- Calibration by sending SMS messages;
- Remote firmware upgrade via Over The Air Programming (OTAP);
- Open API for customers who want to process raw data;
- Capacity to add additional IoT sensors, such light and sound sensors;
- Design life of five years.

A portable version is operational within seconds. It has a flexible lead and plug with a 13 Amp fuse; ideal for temporary use and assessments, such immediately after hospital discharge. No skills are required for installation.

Figure 10: Portable Smart Power Socket

6.2 Web Services

After transmission via the Internet, data processing is performed on servers located in the UK. Data is analysed every hour to build up a pattern of normal movement and power use sensor readings. Each hour is matched against previous patterns for the same hour of the day and recorded as normal, small change or large change.

Average temperature is compared against upper and lower limits, which are both adjustable. Readings outside the range are counted as low or high changes. The West Midlands Public Health Observatory, has these guidelines:

- 24°C - Top range of comfort
- 21°C - Recommended living room temperature
- 18°C - Recommended bedroom temperature
- 16°C - Resistance to respiratory diseases weakened
- 12°C - More than two hours at this temperature raises blood pressure and increases heart attack and stroke risk
- 5°C - Significant risk of hypothermia

The processed data is sent to the App and alerts are optionally sent to nominated people after a high number of changes.

The raw data is available to certified organisations that wish to perform their own data analysis.

7 REFERENCES

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