HOUSING
TECHNOLOGY

internet of things

**THE INTERNET OF THINGS
IN HOUSING**

MARKET INTELLIGENCE
2017/18

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INTRODUCTION & EXECUTIVE SUMMARY

WELCOME TO HOUSING TECHNOLOGY'S 'INTERNET OF THINGS IN HOUSING 2017/18' REPORT.

Published with the kind support of Aareon, BT, Capita, Civica and RHP, as well as the EU's Cocoon project, this report looks at how UK social housing providers are planning to incorporate the internet of things into their daily operations, with the broad aims of improving the management and maintenance of their property portfolios at the same time as improving their tenants' lives.

GEORGE GRANT
Publisher and Founder,
Housing Technology

Unlike the general public's adoption of IoT-based devices, such as smartphone-operated central heating controls, where devices are installed, used and maintained in isolation by separate consumers, the social housing sector is one of the few markets where there is scope for IoT devices to be simultaneously deployed in considerable numbers to influence large-scale behavioural changes and generate a wealth of aggregated data for analysis, predictive forecasting and business planning.

The first part of the report looks at the results of a comprehensive online survey (during Autumn 2017) of hundreds of UK social housing providers into both how they are using IoT devices now as well as how they plan to use them in future; from the results of the survey, it's clear that many housing providers are in the vanguard of the IoT revolution.

The second part of the report features case studies, contributed articles and corporate profiles from a number of leading housing providers and technology suppliers, including the aforementioned Aareon, BT, Capita, Civica and RHP.

We hope you find this report useful and informative. Please get in touch (news@housing-technology.com) if you have questions about any aspect of the report as well as if you have any IoT projects that you would like to share with the Housing Technology community.

THIS REPORT IS BASED ON A COMPREHENSIVE ONLINE SURVEY BY HOUSING TECHNOLOGY'S RESEARCH TEAM OF OVER 160 HOUSING PROVIDERS. TOGETHER, THE HOUSING PROVIDERS CONTRIBUTING TO THE SURVEY DATA HAVE AROUND 1.5 MILLION PROPERTIES UNDER THEIR OWNERSHIP AND/OR MANAGEMENT AND SUPPORT OVER THREE MILLION TENANTS.

IMPORTANCE OF IOT TO HAS' OVERALL STRATEGY

KEY
- ■ Very important
- ■ Important
- ■ Unimportant
- ■ Very unimportant
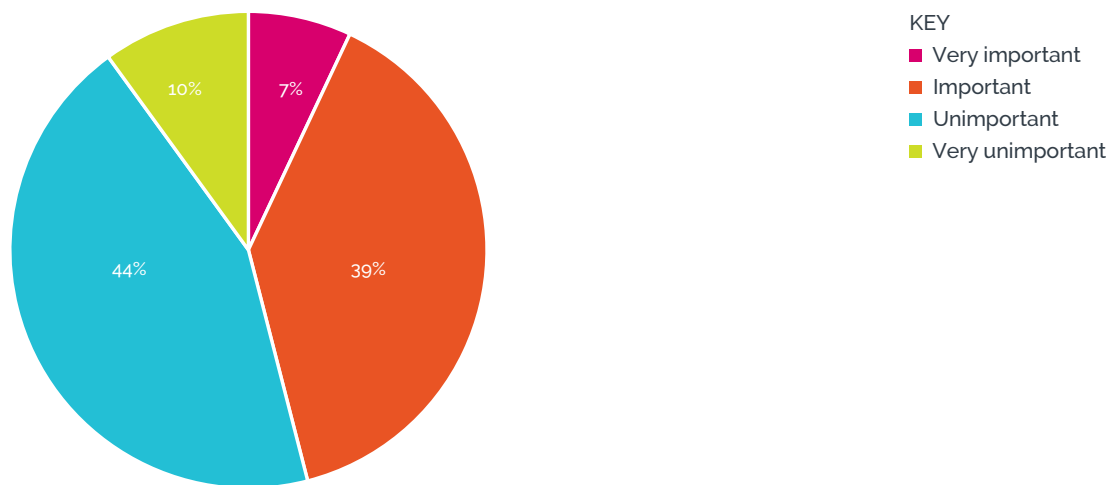
Despite the relative new-ness of IoT-based technologies, almost half of housing providers (46 per cent) rated IoT as being important to their overall strategies.

Over the next 12-24 months, we would expect more and more housing providers to place greater emphasis on IoT as the technology and devices become more established.

EXISTING IOT STRATEGIES

KEY
- ■ Yes
- ■ Under consideration
- ■ No
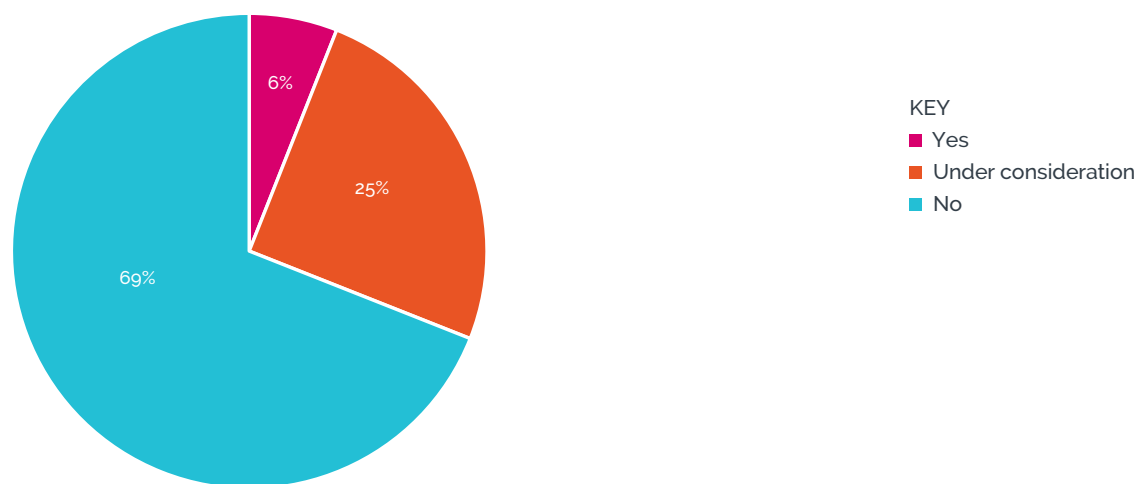
Very few housing providers (six per cent) have yet established an IoT strategy, although a quarter of them are already considering their options regarding how they might deploy IoT projects, demonstrating the potential growth of IoT over the next few years.

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BARRIERS TO IOT DEPLOYMENT

KEY
- Too new/unproven
- Integration/interoproperability
- Cost
- Low priority
- Security
- Standards
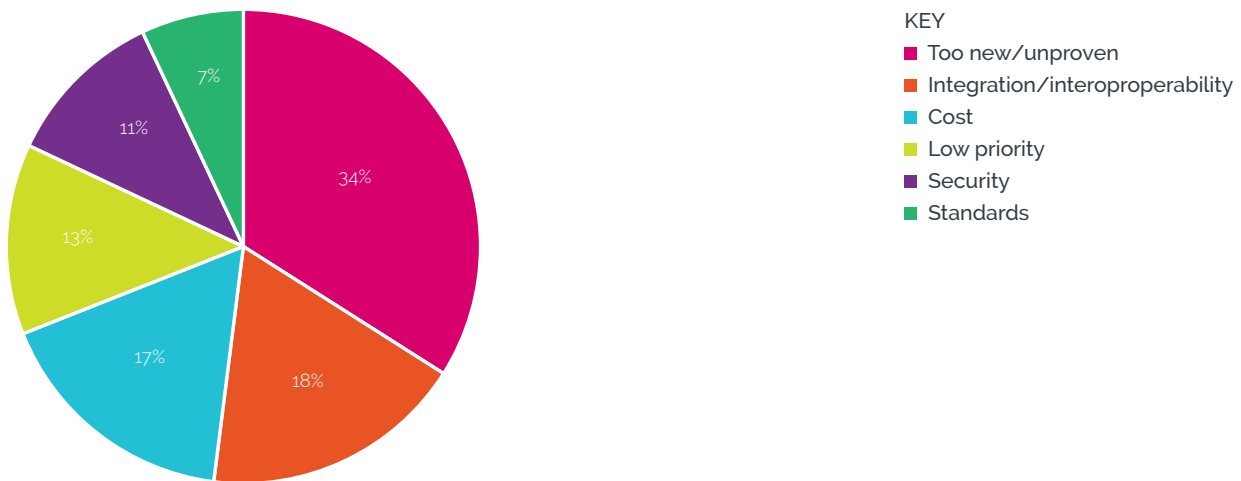
The most commonly-cited barriers to adopting IoT are fears that the technology is too new and is as yet unproven (34 per cent), but in time this figure is likely to fall as IoT technologies and projects become better established.

Integration and interoperability concerns are the second most common barriers (18 per cent); this is a reflection of

both housing providers' typical existing 'spaghetti' of isolated applications and the varying data protocols of different IoT devices from a plethora of manufacturers, despite IoT standards (seven per cent) being simultaneously considered the least important barrier to IoT projects.

NUMBER OF IOT DEVICES

KEY
- Too new/unproven
- Current deployment of IoT devices
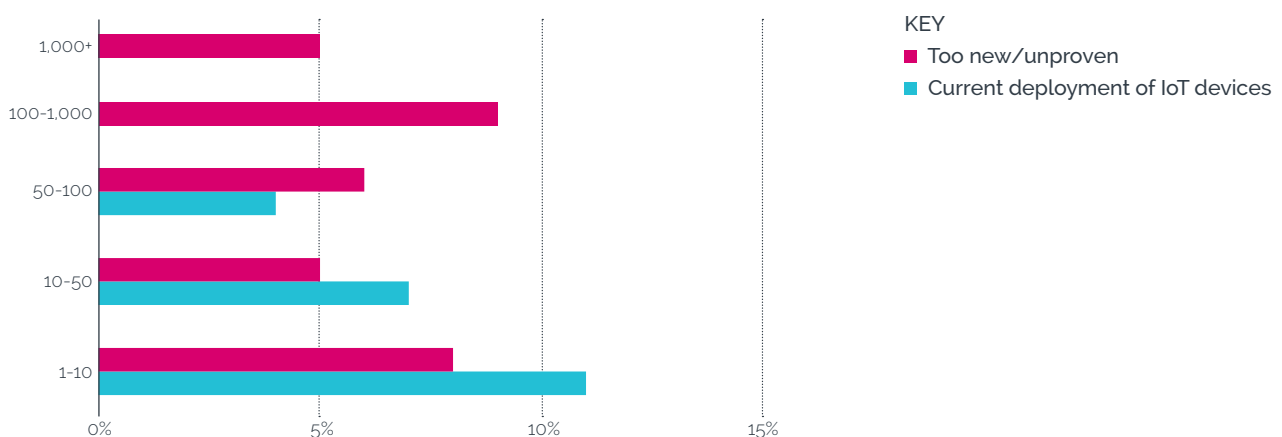
At the moment, most existing IoT deployments are very much in their pilot phases, with the majority based around the use of fewer than 50 devices, and only a few projects of up to 100 devices.

However looking ahead, the scale of the planned IoT projects shifts to larger projects of 100-1,000 devices or more.

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TIMESCALE FOR DEPLOYING IOT DEVICES

KEY
- As soon as possible
- Within 6 months
- Within 12 months
- Within 12-24 months
- Beyond 24 months
- No plans
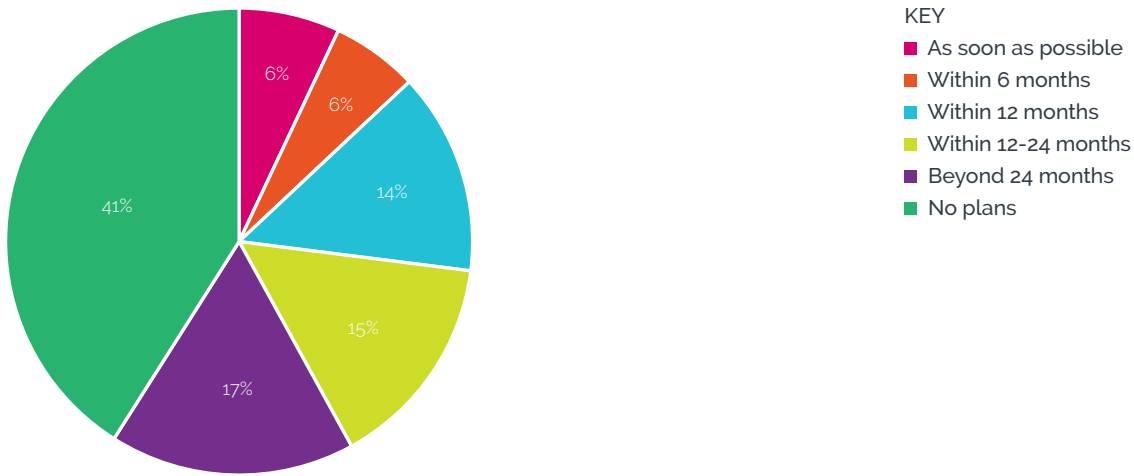
Of the housing providers with IoT plans, over half of them are scheduled for deployment within the next 12 months, and around three-quarters within the next two years. And despite 41 per cent of housing providers having no current IoT plans, the figures and associated timescales suggest an explosive growth of IoT deployments by the majority (59 per cent) of housing providers.

IOT DEVICE TYPES

KEY
- Existing IoT devices
- Planned IoT devices
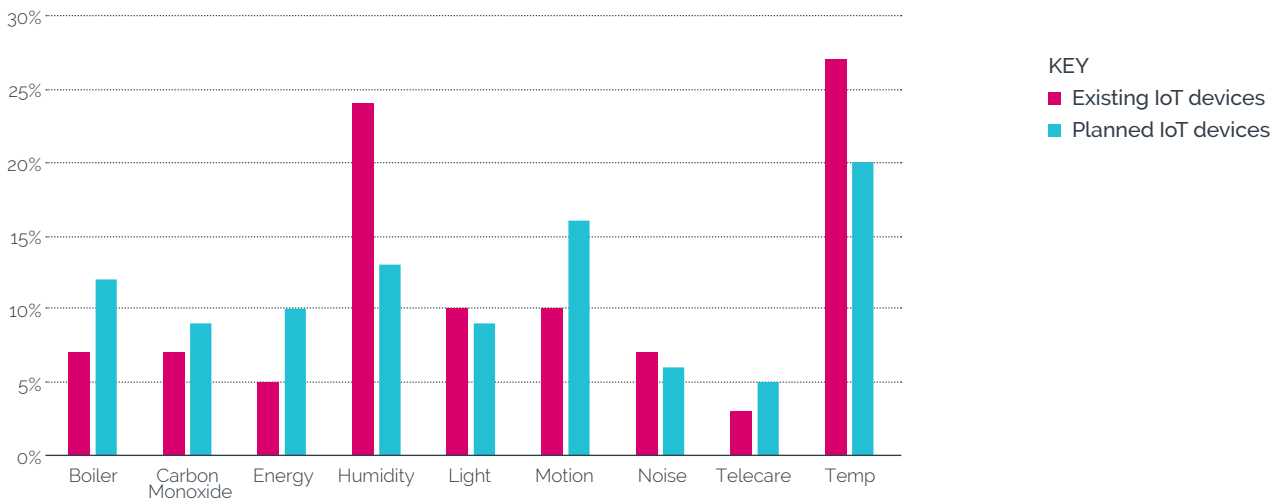
Humidity and temperature (thermostat) sensors are by far the most widely-installed IoT devices at present, almost eclipsing the total of all the other devices combined.

Of the IoT devices planned for future deployments, boiler sensors and motion detectors are expected to become much more popular, with most IoT projects likely to involve a combined package of boiler, humidity, motion and temperature sensors.

CAPITA

one

We believe technology can empower housing providers to make a difference to tenants' lives

Capita is leading the way in the research and development of how smart homes in social housing can improve tenants' lives whilst making it easier, and more cost-effective, to manage these homes.

From energy and damp sensors to advanced analytics and warning systems to help protect vulnerable people, our focus is on holistic, connected systems which offer a realistic, affordable solution across a large number of properties.

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e: cssenquiries@capita.co.uk

w: capita-software.co.uk/housing

BUDGETS FOR IOT PROJECTS

KEY
- Capital budget for IoT solutions
- Operational budget for IoT solutions
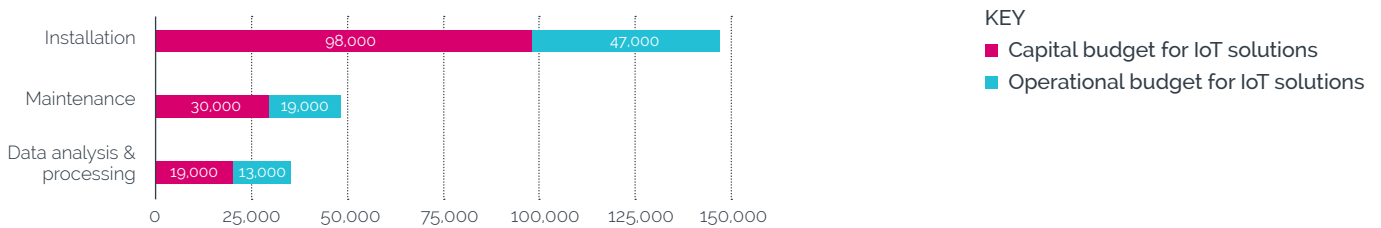
The budgets for IoT projects are split in two ways; firstly between capital and operational costs, and secondly and in parallel, between installation, maintenance and data analysis costs.

In most instances, the capital costs comprise around two-thirds of the overall costs, leaving one-third being spent on day-to-day operational expenses. This two-third/one-third split is fairly consistent across installation, maintenance and data analysis costs.

The overall cost of buying and installing IoT devices is the single largest cost, at an average of around £150,000, followed by maintenance (£50,000) and data analysis (£30,000).

IOT INTEGRATION WITH BUSINESS APPLICATIONS

KEY
- Very important
- Important
- Unimportant
- Very unimportant
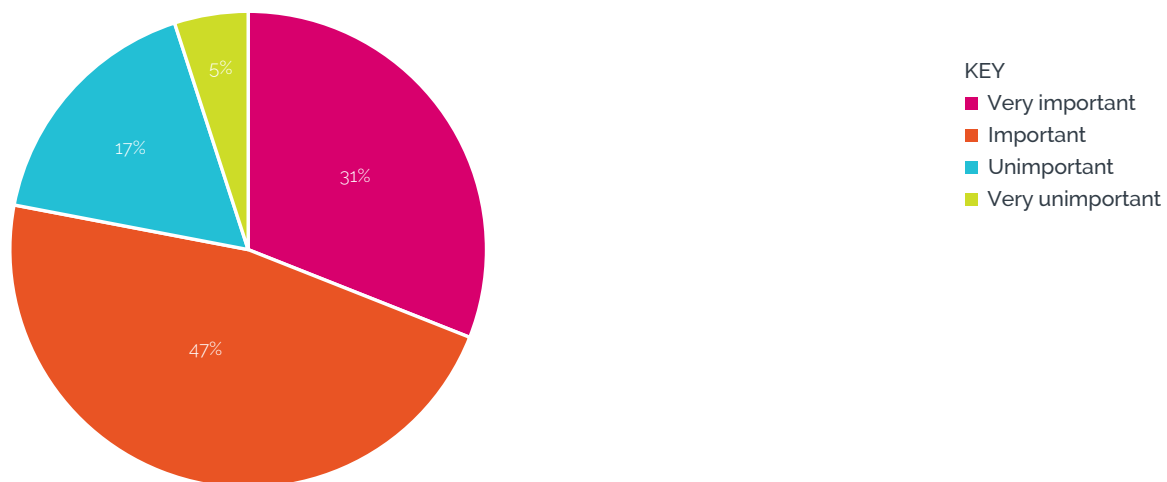
In common with the earlier chart covering the barriers to the adoption of IoT, the integration of IoT devices and their associated data with housing providers' other business applications is uniformly seen as being an important consideration (78 per cent). Conversely, it is surprising that around 20 per cent consider integration to be unimportant.

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BUSINESS AREAS INTERESTED IN IOT
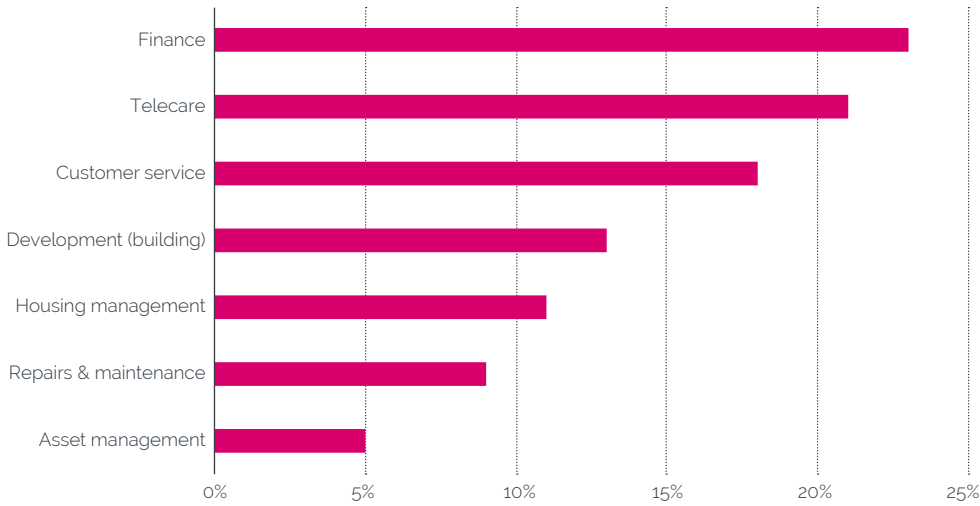
Unsurprisingly, the most frequently-cited business areas for the deployment of IoT devices are asset management, repairs and maintenance, and housing management, with customer service, telecare and finance management being the least popular.

IOT BENEFITS TO HAS & TENANTS

KEY
- IoT benefits to HAs
- IoT benefits to tenants
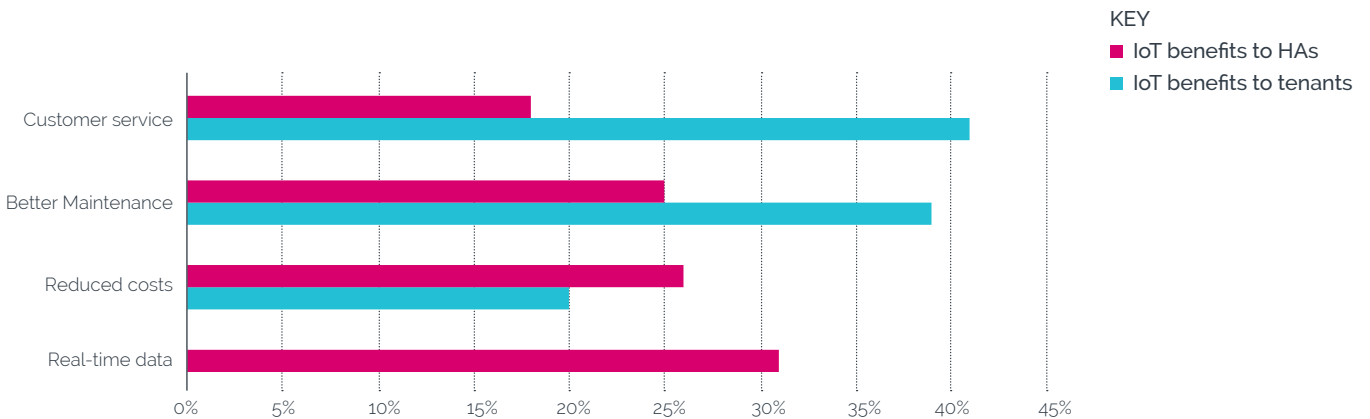
The respective benefits of IoT deployments to housing providers and to tenants are almost exact mirror images of each other.

For housing providers, the main benefits of IoT are access to real-time data about the performance of their housing portfolios and (to a lesser extent) the behaviour of their

tenants, reduced costs and better and easier maintenance, while for tenants, the benefits are mainly around better customer service, such as pre-emptive repairs and more accurate maintenance schedules, followed by lower costs, typically based on cheaper energy bills.

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Cocoon is an international research
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Swiss Federal Institute of Technology Zurich

GHENT
UNIVERSITY

TU/e Technische Universiteit
Eindhoven
University of Technology

IOT DATA INTEGRATION WITH EXTERNAL AGENCIES

Police & fire service
NHS & healthcare
Local authorities
Utility providers
Contractors (inc. DLOs)

0% 5% 10% 15% 20% 25% 30%
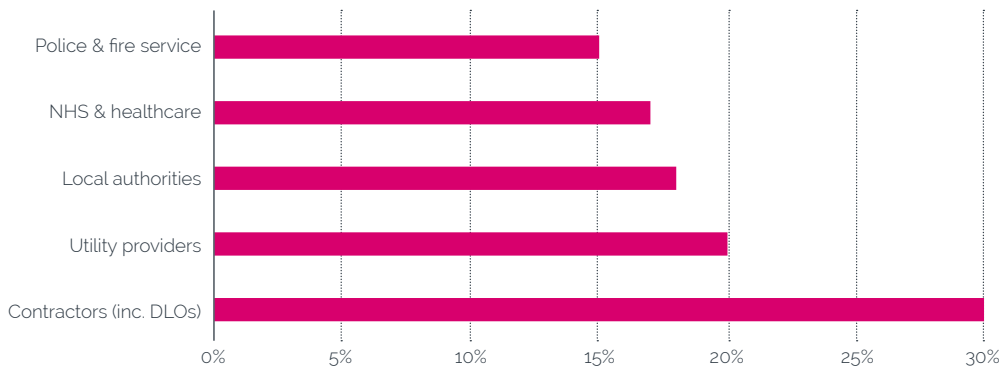
IoT deployments have the potential to integrate housing providers' data-gathering activities with those of related external agencies.

The integration of IoT-derived data with housing providers' contractors and DLOs stands out as the main area for information sharing, followed by utilities and local authorities.

TENANT INVOLVEMENT IN IOT PROJECTS

17%
28%
15%
40%

KEY
- Close involvement
- Some involvement
- Little involvement
- No involvement
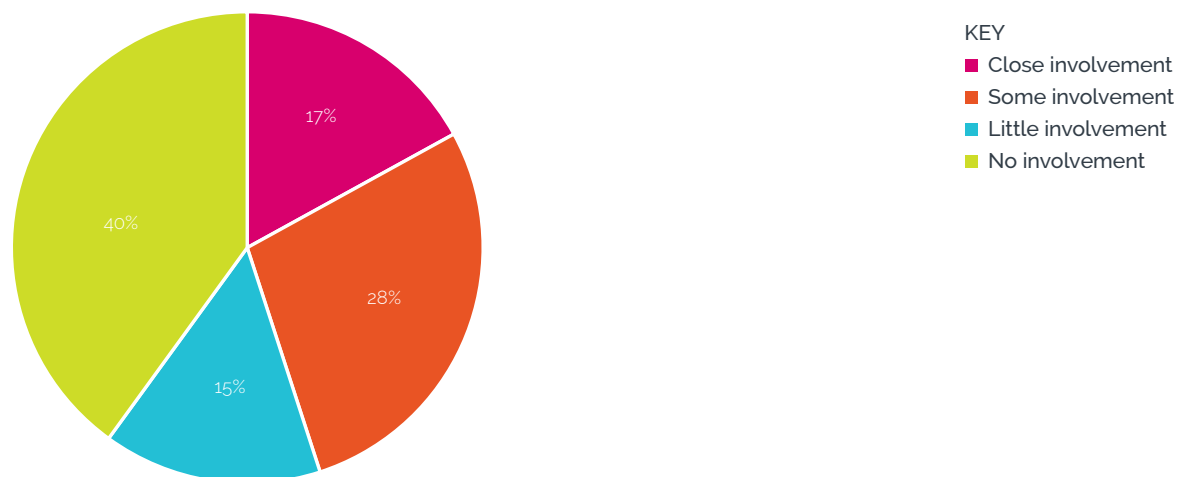
For the most part (55 per cent), housing providers are not currently involving tenants in their IoT plans, despite the fact that tenants will be the primary users of IoT devices. This low figure is perhaps an indication that many housing providers' IoT projects are still in a pilot phase as they test the rollout of the technology.

IOT USAGE
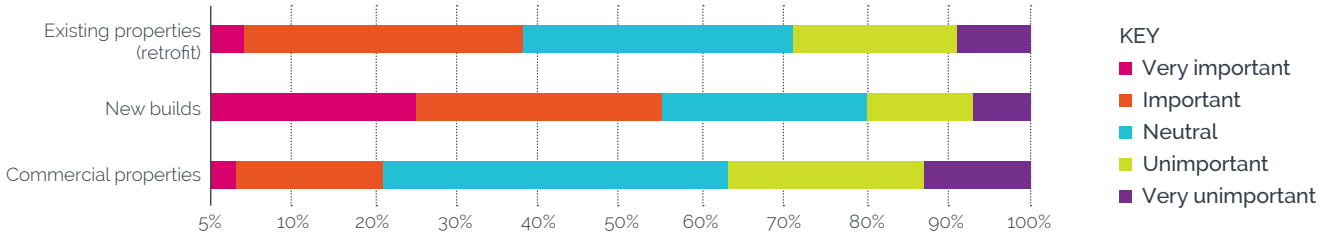
The use of IoT devices is expected to be most prevalent in new-build properties (around 55 per cent rating for importance), followed by retrofitting existing properties (around 40 per cent) and least important to housing providers' commercial properties (20 per cent).

CONCERNS ABOUT IOT DATA PRIVACY, SECURITY AND LIABILITY

Given the frequent coverage elsewhere in the media about the susceptibility of some IoT devices to hacking and malware, housing providers have significant concerns about data privacy (incl. GDPR issues), security and corporate liability when considering their IoT plans.

Over one-third of housing providers have 'considerable concerns' and overall over 80 per cent are worried about the security of IoT devices and how IoT data is transmitted, handled and stored. A mere 17 per cent are not worried about security.

IOT DATA STORAGE & PROCESSING

KEY
- IoT benefits to HAs
- IoT benefits to tenants
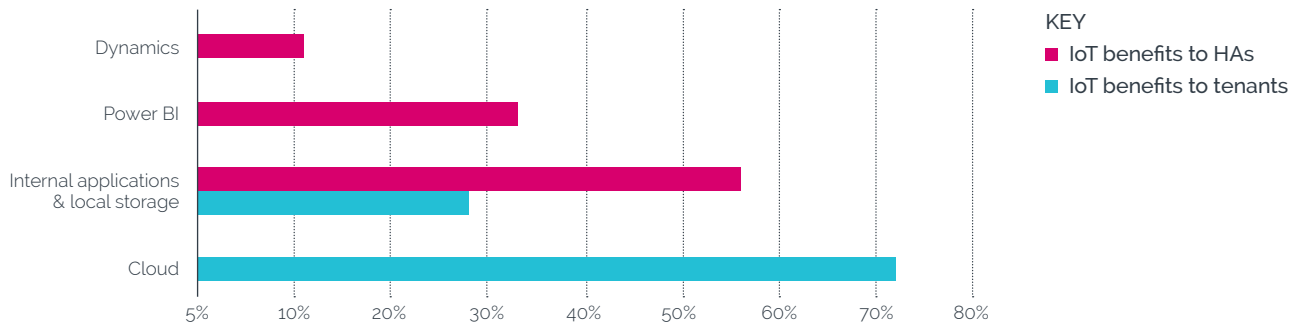
The majority of housing providers plan to use cloud services (72 per cent) to store their data derived from IoT devices, and only 28 per cent are planning to use their existing applications and local storage services for that purpose.

The situation is reversed when it comes to the processing and analysis of IoT data, with most housing providers planning to use internal services (56 per cent) ahead of cloud-based services (most commonly Power BI and Dynamics, 33 per cent and 11 per cent, respectively).

IOT IMPETUS: BUSINESS VS. IT

KEY
- Entirely business teams
- Mostly business teams
- Equal balance
- Mostly IT department
- Entirely IT department
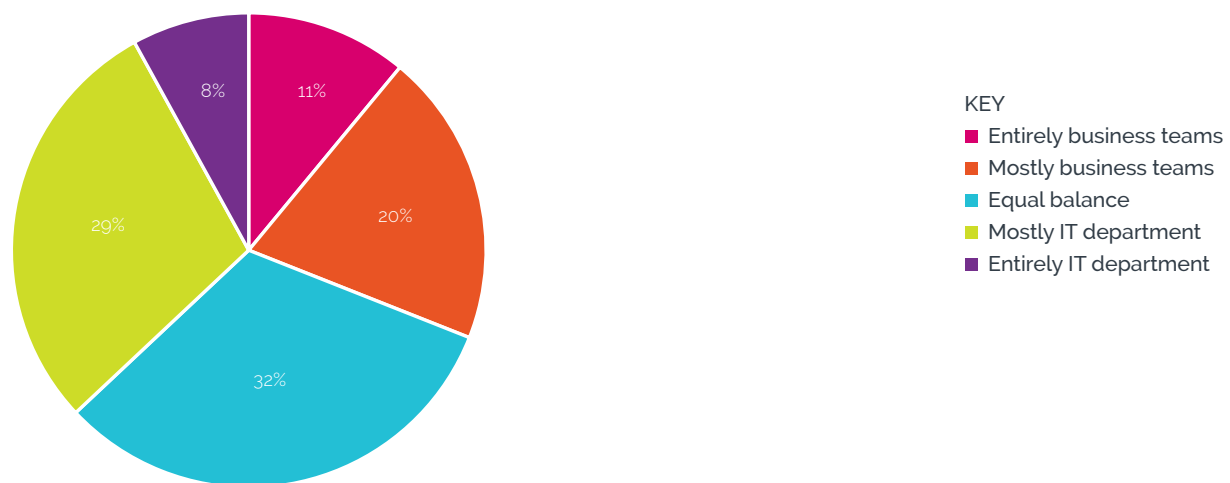
The impetus for implementing IoT projects is broadly split between housing providers' business operations and their IT teams, with a slight emphasis towards business operations driving the adoption of IoT projects.

SENIOR EXECUTIVE/BOARD UNDERSTANDING OF IOT

KEY
- Good understanding
- Some understanding
- Little understanding
- No understanding
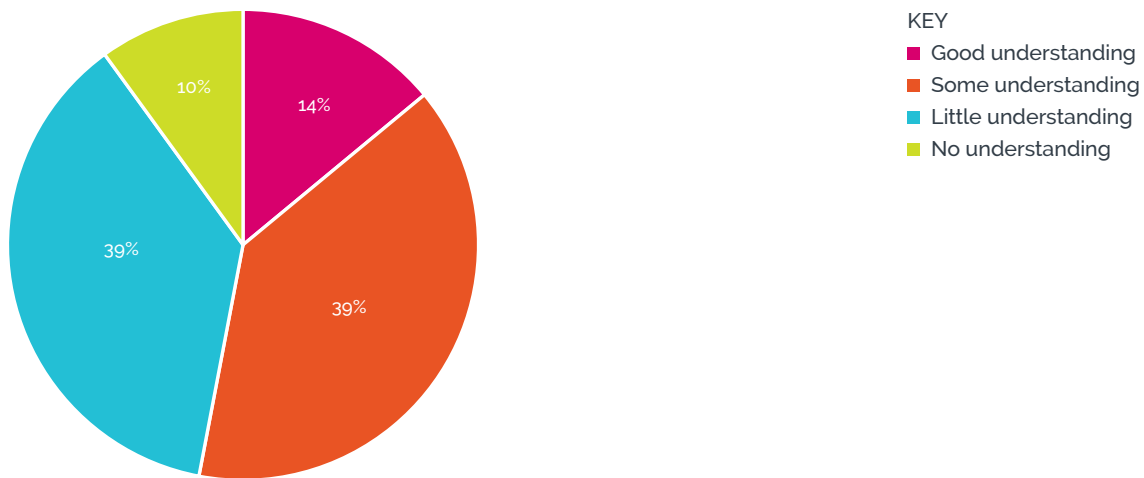
For a relatively new area of technology, it is perhaps surprising that housing providers' senior executives and board members are generally considered to have at least some understanding of IoT (53 per cent), perhaps in part because they are familiar with consumer-grade IoT devices such as Nest and Hive. However, that figure does leave 47 per cent of housing providers' senior teams with little or no understanding of IoT.

DIGITAL CUSTOMER RELATIONSHIPS – ADDED VALUE FOR ALL

Stephen Makin, Managing Director, Aareon

People are living their lives quite differently in the digital age; it has become the norm to carry electronic devices wherever we go, whether on our way to work, exercising or on holiday. The option of using our smartphones for online banking, ticket reservations and a myriad other tasks while on the move has led to a shift in expectations and demands in the field of customer relationships too. In addition to overcoming the major challenges facing the housing sector, including demographic change and energy-related renovation, the (digitally structured) relationship to the tenant as a customer is increasingly taking centre stage in the strategic and practical deliberations of housing providers.

The latter are focusing their attentions on the following key goals: optimising customer and service orientation, increasing efficiency and cutting costs, achieving process and cost transparency and, in the final analysis, positioning themselves clearly in the market and setting themselves apart from the competition. In the digital age, a customer relationship management strategy capable of taking shifts in consumer behaviour into account has become a key factor in maintaining a competitive edge.

Digital customer data: having all information constantly to hand
Given access to digitally-archived documents and transactions means that the employee tasked with dealing with incoming customer queries is always in a position to gain an overview of business relations between the potential customer or tenant and landlord or housing company to date, and to dispense the specific information requested. The outcome of every conversation is recorded transparently in digital form.

This approach is followed throughout, from the initial contact, to the subsequent handover to the future tenant, all the way to his or her moving in. Customers can be given the option of selecting their preferred communication channel from the outset. This means that housing providers are contactable by various means: via the website and by e-mail, as well as in social networks and tenant portals.

The chain of digital contact options starts with the management of prospective customers. Potential tenants require digital services when searching for a suitable home.

The electronic tenant file can easily have other relevant digital documents, such as PDF files, photos and task lists, added to it. This ensures that staff not only have the general basic data to hand, but are also quickly furnished with further information on the case in question. Tenant service and customer dialogue can be combined smoothly here without having to switch systems or media. Moreover, landlords also benefit from the direct exchange with their customers thanks to the digitalisation – and hence streamlining – of their work and communication processes. This cuts costs, and ideally also creates more scope for less standardised tasks over the entire customer relationship cycle.

Digital customer relationships: added value for all those involved
For tenants, the extensive integration of IT systems used for customer relationship management means a better all-round service experience. They can use a tenant portal to read their rental contract or latest service charge statement at any time and can raise questions whenever it suits them. A constantly engaged service phone line or limited branch opening hours – restrictive factors when it comes to customer dialogue – are

DIGITAL CUSTOMER RELATIONSHIPS – ADDED VALUE FOR ALL
Continued from previous page

now a thing of the past. Thanks to Aareon's digital solutions, damage reports considered urgent by tenants – for instance regarding defective light switches in the stairwell or broken doorbells – are automatically routed to the staff member in charge, whose system displays the notifications as they are received, enabling them to be dealt with efficiently. Some organisations take this idea one step further, authorising tenants to place orders with tradespeople for an agreed number of hours.

If the tenant cannot be contacted directly, the response takes a digital form, for instance as an email. The electronic mailbox in the tenant portal ensures that the tenant can retrieve the information at his or her own convenience.

Flexible use anywhere and at any time: the tenant app
Digital mobility is an increasingly important aspect, so the development of a customer app that provides all the main services on a smartphone as an extension of the conventional CRM portal is an entirely logical step. The app is a convenient way for tenants to check the processing status of their query or access contracts at any time, even on the go, without having to run up a PC especially for the purpose.

What's more, people's need for online dialogue has grown as digitalisation has taken hold in general, and this applies to tenants in a housing complex too. Tenant apps also provide community functions that allow local residents to set up an exchange site or debate issues affecting the neighbourhood within a tight-knit community in which people know one another and to which access is clearly regulated.

Housing organisation staff also benefit from the app because important messages can be passed on quickly to numerous tenants without having to be sent many times over. Once a particular group of recipients has been selected, the notifications are forwarded directly to customers' smartphones. As with the portal, the app offers selective control over which queries should ideally be delivered to which housing organisation employees, thereby ensuring that the mobile dialogue is also conducted by those familiar with the background of the respective case. In particular, the option of location or camera sharing on mobile devices potentially paves the way for further housing location-based services. These would enable tenants to look up the location of the nearest launderette in their neighbourhood, or to find a decent Italian restaurant in an unfamiliar city quickly and easily.

Future-oriented customer relationship management for all target groups
Is there a risk of individual tenant groups being marginalised by this digitalisation of customer dialogue? Not according to demographic trends. Surfing the net is no longer a question of age, although there are age-related discrepancies in online habits. Younger people tend to seek digital dialogue with others, while older folk prefer to search for specific information and self-explanatory service offerings. But all age groups now expect to be able to use digital services, and interest in being able to keep an eye on consumption figures for heating, water and electricity at all times is correspondingly high. The digital capture of such data and their rapid availability is now also governed by law. What could be more reasonable than to pass on this data – which is available anyhow – to tenants in the interests of good customer service?

All those involved benefit from digitalisation of the entire customer relationship life cycle, which enables landlords to maintain and track all dialogues, from tenant acquisition and support all the way to service and customer development, in a single system. There is no longer any need to search for information at length. Tenants, too, are aware of the fact that they will receive a response to queries or be informed of processing statuses faster than ever before. Thus, the timely digitalisation of CRM processes ensures customer satisfaction – as well as the future viability of the respective housing provider.

Stephen Makin is managing director at Aareon.

SMART PARKING IN MILTON KEYNES

If you're one of the nation's fastest-growing cities, spending money on vanity projects is no longer in fashion. In an explosion of common sense, today's planners have set their sights on more sensible stewardship of public funds. So it was that Milton Keynes Council together with the Open University and BT, and other partners, had the bright idea of forming MK:Smart to accelerate the development of Milton Keynes as a smart city.

Among a wide range of smart city projects, a successful pilot has deployed sensors from Deteq at the city's railway station to prove the feasibility of city-wide parking space optimisation. Innovative wireless technologies are used to beam the sensors' data to receivers on lampposts, and that information is then analysed in the central MK Data Hub, which is currently hosted by BT. The prize from full deployment will be a capital saving of at least £105 million, with reduced fuel use and vehicle emissions.

Geoff Snelson, director of strategy, Milton Keynes Council, said, "MK:Smart is part of our wider Future City programme and aims to resolve growth constraints for the city and improve quality of life for our citizens. BT is a key member of the collaborative team and, for example, has played a vital part in the parking space optimisation pilot project."

Rising to the challenges of urban growth

One of the fastest growing cities in the UK, Milton Keynes has to support that expansion within local infrastructure constraints, while meeting stretching expenditure and carbon reduction targets. Joining forces with the Open University, BT and other partners, Milton Keynes Council formed a Smart City collaboration to rise to those challenges.

The creation of a state-of-the-art hub for the acquisition and analysis of vast amounts of city data is central to the project. Information on energy and water consumption, transportation, and social and economic datasets – as well as satellite imagery and crowd-sourced data from social media – will reside and be processed there.

Snelson said, "The MK Data Hub will help us innovate in transport, energy and water management, to sustainably tackle key demand issues and pave the way to a truly smart city."

Proof-of-concept optimises station parking

There are around 25,000 parking spaces in Milton Keynes and forecasts suggest that perhaps as many as 12,000 more may be needed by 2020. Brian Matthews, head of transport, Milton Keynes Council, said, "If we don't act soon, parking in Milton Keynes will become a big problem. But we know that around 7,000 existing spaces are empty at any one time and, in some cases, this is because people don't know where to find them."

Identifying those free spaces and sending information to roadside displays and smartphone apps to guide vehicles towards available parking will help maximise the use of existing infrastructure. It will also reduce fuel use and emissions from vehicles driving around in search of spaces.

A pilot was launched to manage the use of short-term parking spaces at Milton Keynes railway station. Designed by specialist technology provider Deteq working with BT, it involved installing sensors in each of the parking bays. Bonded to the tarmac, they're powered by lithium-ion batteries with an over four-year lifespan.

Detecting the arrival and departure of a vehicle, the sensors send information wirelessly to lamppost mounted solar-powered repeaters. These aggregate the data and transmit it over the internet to the MK Data Hub. There it's processed and the resulting analysis made available on the Milton Keynes Council public information dashboard, as well as via a browser that displays bay status as red (occupied) or green (free) via an overlay to Google maps.

Matthews said, "As well as giving real-time data on parking availability, the sensors are providing us with valuable information about average parking duration. We can use that to adjust parking restrictions to meet majority customer needs."

For example, the sensors revealed that an average stay in the station drop-off zone is 16 minutes, enabling the council to adjust the wait limit upwards to 20 minutes. In future the system could also be used to aid parking enforcement.

Rollout will save vast capital sums

With the pilot a success, the council is planning to extend the parking sensor network with the deployment of 250 sensors covering a sector of the city.

Matthews said, "It wouldn't be cost effective to deploy sensors in all 25,000 parking bays, so we're using this next phase to refine the deployment plan by assessing sample-based approaches. For example, validating whether

SMART PARKING IN MILTON KEYNES
Continued from previous page

sensors installed in one in five parking bays will provide statistically-valid data on parking availability."

Better utilisation of existing parking spaces will save the council a substantial sum. Matthews said, "It costs around £15,000 to create a new parking bay. If we built new ones when there are 7,000 unused we could be wasting truly significant amounts of money."

Using MK Data Hub analysis to understand how factors such as weather and proximity to offices and shops influence parking habits will help the council better predict parking availability and needs across the city. Equally, this data will be used to inform the optimum durations and charge bands for parking in different areas.

Currently using BT wi-fi for data transfer, the project team aims to use other radio systems specifically designed to support machine-to-machine requirements, such as the recently announced low-power Weightless or Ultra Narrow Band technologies. The data generated will also help inform the planned MK:Smart Motion Map and Low Carbon Urban Transport Zone projects.

Optimising infrastructure and resource use

The smart parking project is just one MK:Smart example, but BT is involved in other strands of the programme such as smart lighting, where sensors will relay visibility data to a luminaire segment controller. This will enable street lighting to be remotely dimmed or brightened to optimise illumination. Energy savings of between 20 and 60 per cent and maintenance cost reductions of 20 to 40 per cent are within reach.

Snelson concluded, "Overall the MK:Smart initiative is forecast to make savings of 20 per cent in water use and almost three per cent in energy use, with 50 per cent less traffic congestion and reduced fuel use and vehicle emissions. Smart parking will contribute significantly to that latter area."

CAPITA

HOW TO MAKE THE MOST OF THE INTERNET OF THINGS

Helen Rogers, Head of Housing Products, Capita

When we think of smart homes it's all too easy to conjure up visions of futuristic interior-designed open plan areas with a touch of exclusivity – many still believe smart homes are a bespoke aspirational aim for the very well-heeled or for those early adopters who have the (financial and technological) means to be the first in their peer group to try it out.

And yet the reality is that the technology offers even wider benefits for the social housing sector than for privately-owned homes, both in terms of reducing the cost of property management and improving the quality of life for tenants. This is particularly true when social housing landlords look at adapting a good number of their properties at the same time.

I thought it would be useful to look at the three main considerations for social landlords when considering smart technology, to help support you in incorporating the internet of things (IoT) within your properties successfully and in the most cost-effective way possible.

Step 1: Think big: maximise the potential of economies of scale

Any plans to incorporate smart technology into homes need to be realistic and affordable. The good news is that housing providers can benefit significantly from economies of scale – what might cost a single home over £10,000 to install can be scaled down to under £300 per home when you look at applying the same technology to 1,000 properties. A scalable production environment, where the technology can be set up quickly and easily for rollout into several thousand properties across multiple sites, offers many more possibilities to reduce the costs and resources needed in property management than a much smaller initiative; it's worth adapting a significant proportion (if not all) of your property portfolio to make it a sound investment.

Step 2: Consider the potential of a holistic programme

Don't limit yourself to thinking about individual niche elements of smart homes, such as heat sensors and security alarms – these are all useful, but much more can be achieved when you look at the technology holistically. Sensor hardware can be connected to pass and receive information for business intelligence and analysis purposes, to trigger activity needed following that finding. For example, if the sensors pick up on a maintenance issue, perhaps the extractor fan in a bathroom has stopped working when the light is turned on, a telephone call can be made automatically to the maintenance team and a visit arranged using scheduling and mobile technology. In this instance, you would be considerably reducing the risk of damp issues caused by condensation, before any damage to the plaster has a chance to take hold.

Step 3: Make a wish list of what you'd like the technology to achieve

Every social landlord has particular pain points – areas of property management which consume huge resources and funding. For most, these pain points include expensive repairs where a maintenance issue in a property hasn't been picked up early enough, the frustration of no-access visits, and the difficulties of costly litigation. Imagine if each of these areas could be significantly improved with the use of technology which is already in place now? Think about what currently drains your resources, and why, so that any system you put in place supports the resolution of these.

Let's take the first area of repairs, which represents around 80 per cent of housing providers' overhead costs. Where the data allows you to monitor stock condition accurately, you have a better understanding of your properties and can intervene early to keep repair costs to a minimum.

The same applies to the cost of no-access visits, where the tenant isn't available to let the engineer into their home, currently a drain on the social housing sector to the tune of some £70 million per year. Where maintenance and repairs can be carried out remotely, not only do you save the time of your administrative, contact centre and engineer teams, but you also reduce the considerable legal costs of having to bring numerous injunctive proceedings against tenants to grant access for necessary work to be undertaken.

Last but not least, the issues of housing litigation are often linked to a tenant's claim that the home they live in is in disrepair. As demonstrated above, not only can you avoid many of these claims by the home being well-maintained in the first place, but where a tenant has fallen into arrears and makes a retrospective claim for disrepair, the data provides you with the evidence to show the exact condition of the home at that time.

Bringing technology into the real world of social housing

The potential benefits of connected sensor technology for social housing

HOW TO MAKE THE MOST OF THE INTERNET OF THINGS
Continued from previous page

landlords are huge – in addition to the cost advantages, understanding more about the performance of homes can deliver new insights into how efficiently a home is being heated, and even the links between heating and the health of residents.

At Capita, we've been researching the potential of the IoT in relation to social housing providers, in particular the development of technology when applied across a number of properties simultaneously. We've been looking at how sensors in properties can capture data on air quality, temperature, carbon monoxide, humidity and energy efficiency so that you can pre-empt maintenance problems before they become an expensive liability. We've also been exploring how the intelligence you gather can not only put you in more control of how your current housing stock is managed, with fewer visits needed by your team to each property, but how it can help inform future building and purchasing decisions, ensuring sound investment of capital for the future.

In addition, we've been examining how connected systems can provide other valuable data for analysis, providing an early warning system to highlight tenants who may be struggling, perhaps with vermin, damp or fuel poverty, before these become major health issues.

We've been trialling our research and development by putting the technology into practice with Castles & Coasts Housing Association (until recently known as Two Castles Housing). We've also explored the return on investment of smart technology with Solihull Community Housing.

What those projects have taught us is that not only can this technology be applied feasibly and affordably in the real world, but that the possibilities for collating and interpreting data to improve the short-, medium- and long-term management of homes are limitless. That's where we're focusing our research and development, and on a considerable scale. We know that once social landlords have the technology installed in homes, with a dashboard to start analysing readings, not only are you able to have an immediate impact on the condition of a property, but you sustain it for the future, protecting your investment and ultimately potentially safeguarding the health of your tenants.

Helen Rogers is head of housing products at Capita.

FLAGSHIP'S DEBEN ROAD WI-FI PROJECT

At the end of 2016, Flagship Group, in partnership with a number of local companies, launched a new pilot project which we hope can transform the way housing providers operate in the future. The exciting venture involves free wi-fi and technology upgrades installed in a block of Flagship-owned flats in Ipswich.

The project in its entirety is a first for the region and the housing sector, and is aimed at improving communication with customers, while reducing costs for them and Flagship.

Led by the customer services and asset management teams, and supported by IT, the innovative and pioneering trial aims to understand how smart technology and the internet of things (the connection of everyday objects to the internet, allowing them to send and receive data) can help improve:

- The management of Flagship's homes;
- Everyday life for customers;
- Staff access to a reliable, secure internet connection while working remotely.

The following technology upgrades were fitted to the 12 flats:

- Wi-fi access for all flats that customers and staff can use, encouraging more digital usage from our tenants;
- Smart-locks on communal and hallway doors: customers and Flagship staff can use their mobile phones to access the building;
- Switchee smart thermostats: this

is the first thermostat designed specifically for social housing. It collects environmental information to understand occupancy and automatically regulate customers' heating settings with the aim of reducing their energy bills and combatting fuel poverty;
- CCTV cameras in communal areas: customers will be able to see who is coming and going and will also increase security.

Ian Napier, commercial director, Switchee, said, "Our smart thermostat is designed specifically to target fuel poverty in social housing while providing actionable, data-driven insights for landlords. We are delighted to support Flagship in their efforts to reduce fuel poverty while leveraging IoT data insights to provide enhanced repair and maintenance outcomes for less money."

How has it been used?
- Internet access to all online facilities for our customers, both Flagship and external;
- Using Instant Messenger to send rent payment reminders;
- Emailing customer satisfaction questionnaires;

- Added security for customers with CCTV and a more secure front door.

Marie-Claire Delbrouque, director of housing and customer insight, Flagship Group, said, "The tenants involved in the trial have been very receptive and we are encouraged already at how the new technology is making their lives easier. We are hoping it will continue to be a success with the prospect of rolling it out across the company."

How successful has it been so far?
It's still early days, but an example of a customer being able to submit evidence for their housing benefit claim online, resulted in the claim being processed two weeks faster than usual and Flagship receiving payment four weeks sooner than manually submitting the evidence.

What do our customers think?
Customer feedback has been positive, with the customers stating they find it easier and more convenient to contact Flagship and feel a lot safer in their own homes.

What do we know so far?
Methods of contact have moved from predominantly being letters and phone calls to emails and texts. We believe this is down to having the technology available to them, and Flagship predominantly leading with these forms of communication.

Matt Brazier, head of IT, Flagship Group, said, "This is an exciting pilot because the changes would make a huge difference to us as a business, our customers, as well as the housing sector as a whole."

THE REAL IMPACT OF REAL-TIME DATA

Tom Way, Innovation Manager, RHP

The home of innovation

A key part of RHP's vision is to be one of the best service providers in the UK. We know that in order to achieve this vision, we need to be as easy to do business with as possible. In a sector where tenants traditionally have limited choice, we wanted to give them the choice, convenience and control to access our services, anytime, anywhere and from any device.

We started in 2012, where we used the Ocado model to become the first housing provider in the UK to offer two-hour appointment slots for repairs. Building on this, in April 2014 we developed our omni-channel strategy where we set out to improve our online services for our tenants – particularly those that involved transactions.

We billed 2016/17 as our 'year of innovation' and it doesn't get much bolder than launching the UK's first all-digital housing service, RHPi. As our answer to combatting the housing crisis, it was designed to lower costs while also improving service.

The idea behind it is simple; new customers get a good quality home on a five-year fixed term tenancy, are entitled to essential and emergency repairs and have 24/7 access to online services. These include a two-hour slot to book a repairs appointment, web chat 8am – 8pm, quick & simple ways to make payments and an e-communities discussion forum. And the best bit? If someone is in a position to move on after five years and has been a responsible tenant, they'll be given £1,000 cash back as a helping hand for their next step.

So a year on, how's it gone? Well, first, the thing we're proudest of is the overall satisfaction rate of RHPi

customers which is currently 94 per cent. In February, Housemark published an 'enhanced' version of the Homes and Communities Agency's global accounts cost analysis and we were thrilled that the data showed RHP to have the second lowest total operating cost per unit of £3,424 (out of any organisation in the list that has over 50 per cent of its operations in London, excluding solely shared-ownership providers). Proof you can reduce costs and improve service at the same time.

We talk a lot about innovating to provide better services for our customers and to create business efficiencies that'll allow us to build more homes. However it's important to remember that innovation is just as important for your employees. Just as we aim to give our customers 'choice, convenience and control' with the digital services we offer, we do just the same for our employees offering a range of self-service options they can use on the go. Employees keep in touch and drive forward cross-team working with our internal social media channel, Yammer, and use Microsoft Dynamics for CRM.

We've also worked hard to create a culture where innovation is driven from employee level with things such as the introduction of our own version of Dragons Den called '4 in 4' where people can come and pitch an idea for business improvement.

The transformative potential of IoT

The internet of things has transformed organisational structures in multiple industries; in the housing sector, this will require a migration in the way we think about customer service. At RHP, we've already adopted the 'customer success' model of service provision through which our employees support

our customers to succeed in accessing our product – our online services.

The next step to deliver service using the internet of things for us is to monitor assets and component performance to optimise customer success by pre-emptive monitoring of potential friction points. Essentially, this means fixing problems before the customer knows what they are.

To get beyond monitoring of assets to a place where our homes and components are optimised, the sector will need to embrace data insights that accurately inform the way we invest in our homes and estates. This will also enable us to understand the behaviour of our customers and the way they interact with our physical assets and online products, meaning the service can be tailored to their requirements.

Launching our strategy

Earlier this year, RHP's LaunchPod landed in South-West London. We're really excited about our most recent innovation and how we can use it to transform the housing market in our local area.

THE REAL IMPACT OF REAL-TIME DATA
Continued from previous page

Our LaunchPod has played an important part in our exploration of IoT technologies. It's powered by Extreme Low Energy (ELE) sustainable technology which captures and distributes renewable energy throughout the pod, providing a safe and reliable power supply. Intelligent monitoring allows the resident to control their energy consumption with access to real-time data in the palm of their hand. This type of off-grid installation offers complete energy security to the occupier while boasting outstanding low-carbon credentials. We've been so impressed that we'd love to deploy the infrastructure operationally.

We have installed two Cloudview camera units in LaunchPod. Cloudview encrypts CCTV output for use through its unique, secure cloud service. Cloudview controls access to footage through secure logins, ensuring data privacy while at the same time providing immediate availability to support resident and staff needs.

IoT is prevalent in the consumer market with many solutions designed for homeowners and residents. The pod has been a great opportunity to engage with suppliers and manufacturers of this type of technology and introduce them to the UK's giant not-for-profit housing sector. One example of this was a Swedish business called Minut, whose 'Point' home management system discreetly monitors noise, temperature and humidity levels, and recognises incidents such as fires and glass breakages to optimise the security of the home.

We're capitalising on our education in IoT by moving to deploy solutions operationally to solve traditional challenges including compliance testing and reporting. We're now working to pilot PhotonStar technology which enables remote monitoring of critical assets to build confidence that we're doing everything to keep our customers safe. This and other projects carry projected benefits such as enhancing safety, accurate data collection, asset preservation and customer satisfaction while also helping us save money that can be reinvested in new homes for the community.

Tom Way is an innovation manager at RHP.

BRIGHTON & HOVE'S IOT TRIAL

Brighton & Hove City Council (BHCC) is always looking for innovative ways to monitor and manage the performance of its housing stock. We have a large capital works investment programme and a boiler replacement programme alongside an ongoing repairs and maintenance service.

Until now, asset information, stock conditions surveys, Energy Performance Certificates, feasibility studies along with feedback from residents have been used to identify where larger scale capital investment projects are required.

The objectives for the study were:
· Test the use of sensor technology in building management;
· Collection of data measuring the effectiveness of capital investments;
· Collect feedback from tenants on mobile phone app and sensor use;
· Feedback from housing officers on the quality and usefulness of data;
· Increased asset data for properties.

Leach Court is a popular seniors' housing scheme in Brighton, built in 1975. The scheme is in line for a programme of repairs and improvement works. There are 108 flats in the scheme and these are split into three blocks of seven-storey flats. The proposed initial investment works into the buildings will involve:

· Improved insulation
· Window replacements
· Repairs to the existing concrete
· New roofing
· Improvements to the corridor and communal areas
· PV panels

It is expected that these works will result in improvements to the thermal performance of the buildings. At the moment, the main way of testing the outcomes of these improvement works would be reported through EPCs, fuel costs and residents' feedback. However, smart asset management sensors could test this directly by recording data about the performance of the building before, during and after the investments have taken place.

The project team researched an innovative way of collecting additional data on how buildings perform. This information is collected by a small sensor from within a home or communal area.

The sensors collect humidity and temperature readings, which provide quantitative data to measure the effectiveness of investment works to buildings. This information can also be used by tenants to maintain or improve property management.

This has developed into a pilot project whereby sensors will be placed in Leach Court to measure temperature and humidity before, during and after refurbishment. In total, the pilot is a 3-4 year study. Initially one full year of data will be collected before any works takes place, during the project period, and then for one year after the works have been completed.

The sensors are small boxes that attach to the wall without the need for wires. Information is sent to a receiver on the roof of the building which also records the outdoor temperature and humidity.

To engage residents, the project manager wrote to them explaining the nature of the pilot which was followed up with a presentation. Following the presentation, the initial sign-up was 35 residents.

BRIGHTON & HOVE'S IOT TRIAL
Continued from previous page

As part of the pilot project, the council's 'digital first' team is developing an app that residents can use to see up to date information relating to their property, the communal areas and the temperature outside.

The project team opted to use sensor technology that sends readings using low-power frequencies (similar to a smart meter or two-way radio). Other benefits of this style of sensor are that they use very little power and will run off a set of AA batteries for several years (they don't use wi-fi or a broadband connection). The transmitted data is encrypted, so that it remains completely secure and private at all times.

The pilot will provide evidence on the effectiveness of investment into our properties. This type of data could help in future decision making when planning major projects and consulting with leaseholders.

The average consumption of gas per flat in Leach Court is 15,600 kWh per year. This means that compared with the national average, the annual energy consumption is between medium to high.

On average the EPC rating for the flats is better than the average in England and Wales at 69 (average England and Wales score 60) with a potential of 73. Most EPCs advise that to improve energy efficiency within the flats, cavity wall insulation internal or external should be considered.

It is also of note that top floor flats in Leach Court are lower in their energy efficiency rating than mid-floor flats. On average top floor flats have a rating of 59 as opposed to mid-floor flats with an average of 71.

Following the pilot, results will be drawn by analysing:

- KWh of gas used per year;
- Temperature readings;
- EPC ratings;
- Tenant feedback / behaviour change;
- Housing officer feedback;
- External conditions (seasonal data).

If the additional data enhances our knowledge of building performance and provides residents with opportunities to better regulate the temperature and humidity in their homes then we can make future considerations about the use of sensor technology.

There are some considerations for use of the sensors beyond the performance of buildings; for example, social issues including fuel poverty and health issues related to damp and ventilation.

However, it's essential to consider data protection issues, use of wifi for data transfer, residents' privacy, safety online and management of data. These issues have so far been effectively managed through a low-risk option of sensor technology and data transfer.

Throughout the study and by working with residents, we will be able to address any concerns around these factors for the pilot. As a council, it was essential that we consider any data protection risks and consider the longer term implications of collecting/owning and storing data of any kind and the safety of our residents.

THE INTERNET OF THINGS IN HOUSING

Housing Technology interviewed senior business executives from Aareon, BT, Capita One Housing, Civica and RHP on how they expect to see housing providers adopting internet of things-based strategies over the next few years, the likely benefits of IoT projects, how they expect to manage the possible plethora of different IoT devices from various suppliers, and how to make sense of the volume of data generated by IoT devices.

Why is IoT important?

Aareon's product marketing manager, Mark Moynihan, said, "By having sensors in properties and connected devices, it allows a social housing provider infinitely more understanding about how their properties are used and what changes can be made that will improve their efficiency, provide a better service to their tenants and offer greater value for money."

> "The most obvious recommendation is don't treat IoT in isolation as a technology-led programme, but join it up as a business-focused initiative with business outcomes."
>
> Philip Brunkard, CIO for regional government, BT Business

Philip Brunkard, CIO for regional government at BT Business, said, "The potential of IoT touches three important areas for the future of social housing. Firstly, it can increase housing providers' capacity to build more homes by reducing the cost per asset through lower maintenance and repair costs. Secondly, data from IoT devices can give housing providers much better and more detailed information about their tenants and property usage to better align resources and operations with their strategic objectives. And thirdly, IoT can enhance the lives of tenants themselves, such as reduced utility bills, easier monitoring and reporting of ASB and nuisances, and the unobtrusive monitoring of vulnerable and elderly people."

Capita One Housing's head of business development, Stewart Davison, added, "IoT offers limitless possibilities for collating and interpreting data to improve the short-, medium- and long-term management of homes, helping to reduce the cost of property management and the potential to help providers improve the quality of life for tenants. In addition to the advantages of return on investment, understanding more about the performance of homes can deliver new insights into how efficiently a home is being heated, and has the potential to evidence links between heating and the health of residents."

Benefits to housing providers

Jeff Hewitt, executive director for housing and asset management at Civica, said, "IoT will enable housing providers to protect assets and people as they've never been protected before, along with understanding energy consumption better and having a real-time view of how assets are performing. Across their portfolio, housing providers will be able to predict repairs before they are required, rectifying issues such as damp and mould before they become a bigger issue, and reducing emergency call outs."

RHP's innovation project manager, Tom Way, said, "By using IoT-based devices to carry out compliance checks remotely and automatically means we have more confidence in our reports and spend less time travelling to properties to collect information. That means our estates and residents are safer too."

Davison from Capita One Housing added, "IoT has the potential to unlock the world of big data for housing providers, with huge benefits to be realised by using smart home-connected sensor technology. By using connected devices to capture data on temperature, carbon monoxide, humidity and energy efficiency, housing providers could move from reactive maintenance to a planned maintenance model, pre-empting issues before they become expensive liabilities."

> "Make sure you have a project team that is properly prepared; the IoT sensors will produce a lot more data and raise a lot more questions than you expect, so don't be surprised if the data starts to provide insights into areas that you hadn't expected."
>
> Mark Moynihan, product marketing manager, Aareon

Benefits to tenants

The benefits to tenants of IoT deployments can be broadly summarised as cost savings from lower utility bills and from much more responsive services from their landlords.

Aareon's Moynihan said, "IoT can help tenants manage the energy consumption in their homes more efficiently and ultimately save themselves money. For vulnerable tenants, IoT can alert the appropriate person if risks have been identified. And a tenant's property can be kept much more efficiently maintained; IoT devices can identify if an issue exists, triggering a repair to be carried out before it ever becomes a problem for the tenant."

THE INTERNET OF THINGS IN HOUSING
Continued from previous page

Civica's Hewitt said, "IoT and connected technologies will allow housing providers to safeguard tenants in a way that has never been possible before via smart alerting for relatives, neighbours, carers and emergency response teams; for example, if someone has passed out and cannot reach a physical emergency pull-cord. Tenants will also have better peace of mind that their homes will be attended to before problems grow out of control, such as damp and flooding."

> "Real time monitoring is about understanding the 'here and now' and how to rapidly identify areas of weakness and need, or where communication is needed."
>
> Jeff Hewitt, executive director, housing and asset management, Civica

Implementing an IoT programme
The general advice about implementing an IoT programme is to start small and pay particular attention to predicting and managing the 'downstream' processes, such as integration with existing business applications, and planning how the volume of IoT-based data will actually be used.

BT's Brunkard said, "The most obvious recommendation is don't treat IoT in isolation as a technology-led programme, but join it up as a business-focused initiative with business outcomes, such as improving the tenant experience, reducing per asset management costs and combine it with other potential technology enablers as an integrated initiative. For example, if you want to reduce costs by using IoT for preventative maintenance then you'll also need to engage tenants in the process to educate them on how this will work and to make them part of the change initiative."

Moynihan from Aareon said, "Start with a pilot and identify a gap in your understanding that IoT devices could provide insight on (at the moment, property sensors seem to be a good starting point). Make sure you have a project team that is properly prepared; the IoT sensors will produce a lot more data and raise a lot more questions than you expect, so don't be surprised if the data starts to provide insights into areas that you hadn't initially planned on.

"It's therefore really important that you have something, whether it's a person or a solution, which can make sense of the data you are getting; capturing telemetry is great, but unless it feeds into a broader process or is being properly analysed then it's just more data for you to store."

Davison from Capita One Housing said, "The good news is that smart homes no longer belong in the realms of sci-fi, so it's the ideal time for housing providers to start talking to suppliers like us to see how connected smart technology works in practice and the return on investment. There are two particular considerations for social landlords entering the IoT domain; firstly that they have the unique advantage of being able to benefit from the economies of scale for realistic and affordable smart homes and should therefore consider adapting a significant proportion of their properties to ensure a sound investment.

"Secondly, it's worth thinking about your own particular pain points – the areas of property management which consume huge resources and funding. When applied holistically, IoT has the potential to support the resolution of these, from enabling proactive and remote maintenance to avoid expensive late repairs and the frustration of no-access visits, to helping avoid expensive disrepair litigation."

Large-scale data-mining vs. monitoring specific properties
Unlike the adoption of IoT devices within the consumer market (typically one or two devices per household, for example) where each property is effectively a standalone IoT deployment, housing providers have the ability to aggregate IoT data from hundreds or even thousands of properties to gain an holistic view of the performance of their assets, as mentioned earlier.

Civica's Hewitt said, "Real time monitoring is about understanding the 'here and now' and how to rapidly identify areas of weakness and need, or where communication is needed. Taking the collective data from IoT devices and mining it allows for retrospective, deep-trend analysis and could identify a whole host of efficiencies and service amendments that could massively improve asset management and the tenant experience, while reducing costs."

> "IoT has the potential to unlock the world of big data for housing providers, with huge benefits to be realised by using smart home-connected sensor technology."
>
> Stewart Davison, head of business development, Capita One Housing

Brunkard from BT said, "There is a simple distinction between specific and aggregated IoT data. We can monitor assets and resources more effectively with IoT solutions. What this means is that we can use a combination of business applications and device data to create a better decision-making framework, such as when to send out a person to proactively fix a smoke detector or boiler. In that example, there's no need to mine or study large volumes of data – the data just drives the existing application and the service requirement.

"The challenge comes when you don't have the application or knowledge to create a decision or rule. By looking at past information from a number of devices, it may be possible to mine the data to create the knowledge that will enable you to develop the applications you need – to increase safety, become more efficient or improve your tenants' experience."

Capita One Housing's Davison added, "By using IoT devices to monitor their properties, housing providers can anticipate maintenance issues before they become more expensive to fix and cut down on the number of no-access visits. However, the real benefits are likely to emerge when IoT data is used on a larger scale, applied across a number of properties simultaneously; the intelligence gathered on how people are living and using their properties can help inform future building and purchasing decisions, ensuring the sound investment of capital for the future."

IoT standards and suppliers

One of the criticisms of the IoT market is that there are few data/technology standards and many separate suppliers, each with their own proprietary formats across their different IoT devices, making integration more problematic for housing providers.

RHP's Way said, "Infrastructure providers competing to create isolated networks of IoT devices is a potential barrier to success. The housing sector should be looking to stop this from happening, particularly given the sector's 'clout' based on the total number of properties under housing providers' management."

Moynihan from Aareon said, "The market for IoT devices in the home is still in its infancy. Like any emerging market, different suppliers and

"Infrastructure providers competing to create isolated networks of IoT devices is a potential barrier to success. The housing sector should be looking to stop this from happening, particularly given the sector's 'clout' based on the total number of properties under housing providers' management."

Tom Way, innovation project manager, RHP

standards will end up jostling for position, but this is largely the case for consumer devices such as Amazon Echo, Nest, Phillips Hue, Ring and a whole range of other household names. However, the types of devices that are most likely to appeal to the social housing sector will typically be those that monitor environmental, energy efficiency and asset conditions; just make sure that the data that these devices capture can be accessed in a simple and open way."

The future of IoT?

Davison from Capita One Housing said, "The IoT-based homes of today could look very much like the sensor-enabled property we've already been trialling with Castles & Coasts Housing. Smart sensor monitoring equipment will capture and analyse household data such as air quality, temperature and humidity, reporting back when a property is becoming damp so this can be remedied before the fabric of the building is damaged, and identifying where fuel poverty or overheating is an issue. Housing providers will then also be able to use the data to monitor households that appear to be struggling and work proactively with them before someone becomes ill or the property damaged, ensuring vulnerable residents have the support they need."

Aareon's Moynihan said, "The best technology makes things easier and is almost invisible. In future,

tenants will have a lot more control of their environment, the cost and the security of their property and the housing provider will have a better understanding of the needs of that tenant and how best to keep them in a safe, warm, comfortable home. The tenant may have a hub such as Amazon Echo or a smart TV to access this control, or maybe it will just be part of the self-service applications that they use to check their rent balance and report repairs. While the property won't look any different, you'll understand a lot more about it and be managing it much more efficiently."

BT's Brunkard said, "If the interoperability, integration and standards challenges can be resolved then future homes will potentially be built to be connected and 'intelligent' from the ground up. This will require a mindset change for many housing developers and providers. The IoT-connected smart home will need to evolve so that it just becomes the norm for how we live in our homes – it will need to be unobtrusive, affordable, convenient and easy to use. It shouldn't be about the technology taking over, but about how it will free us up from domestic tasks so we live in comfort and have more time to focus on the more important things."

CYBER-SECURITY THREATS IN THE SMARTHOME

Etienne Roesch, Associate Professor of Cognitive Science from the University of Reading

Dr. George Loukas, Senior Lecturer, Department of Computing and Information Systems, University of Greenwich

Dr. Ryan Heartfield, Department of Computing and Information Systems, University of Greenwich

Over the last few years, homes have been adopting artificial intelligence, computer communication, sensing and actuation technologies, in order to evolve into smarthomes with clear benefits in terms of comfort, energy efficiency, safety and security. Rather paradoxically though, it is precisely these benefits that are the most vulnerable in a smarthome, because by adopting the principles of computer communications, the smarthome has also inherited the cyber threats that come with them.

Smarthome availability attacks

In the past, home automation was based on direct connections inside the home, often wired and largely isolated from the rest of the world. If you needed your lights to be controlled automatically based on a set of sensors, you would have an electrical connection between them or some form of network linking them directly. Now, for a large number of popular smarthome devices, this is not the case.

To manually control your smart thermostat, you tap a button on your smartphone, which sends a command through your home's wifi router through the internet to a cloud service of the thermostat's manufacturer (often in a different country), which sends the command back to your wifi router, which then sends it to the thermostat. Technically, the internet connection shouldn't be needed, but manufacturers prefer it for a number of technological reasons (access to

artificial intelligence in the cloud) and business reasons (access to the data).

What this means is that if a computer virus caught on the internet disables your internet connectivity or a malicious neighbour cracks your wifi and changes the password, then you lose access to the thermostat too, and perhaps the lights, smart plugs and even locks.

A similar effect can be achieved by a criminal using a radio frequency jammer device from just outside the home, as the vast majority of smarthome devices need some form of wireless communication (most commonly wifi, Zigbee or ZWave).

Smarthome privacy attacks

The home is meant to be a place to enjoy privacy. However, connecting it to the smart grid, the cloud providers of each smart device's manufacturer and to wireless networks dramatically increases privacy risks.

For example, by monitoring the ZigBee network traffic generated in the home, one can tell whether there is anyone there. Breaching the cyber security of the networks of occupancy, motion and other sensors from outside the home is not trivial, but is facilitated by the vast number of security vulnerabilities discovered for them on a daily basis and published on the internet.

The same is true for smart meters, because a household's electricity consumption profile can provide clues about whether anyone is at home and even what they are doing.

In 2016, if GCHQ hadn't interfered at the last minute (see reference one, below), millions of smart meters would have been shipped using the same encryption key (which meant that if hackers compromised one, they would be able to compromise all). Also,

internet-connected baby cameras have long been shown to be attractive to attackers, and there have been several cases where someone would not only look through the camera, but even shout abuse to a baby in the nursery room through the camera's speaker (see reference two, below).

Voice-injection attacks

Voice-controlled intelligent services on smart speakers, such as Amazon Echo and Google Home, have been designed to improve comfort. Beyond playing audiobooks and providing weather information, they are increasingly used to control smart devices within the home. As there is no authentication regarding who speaks to the smart speaker, any voice can control it.
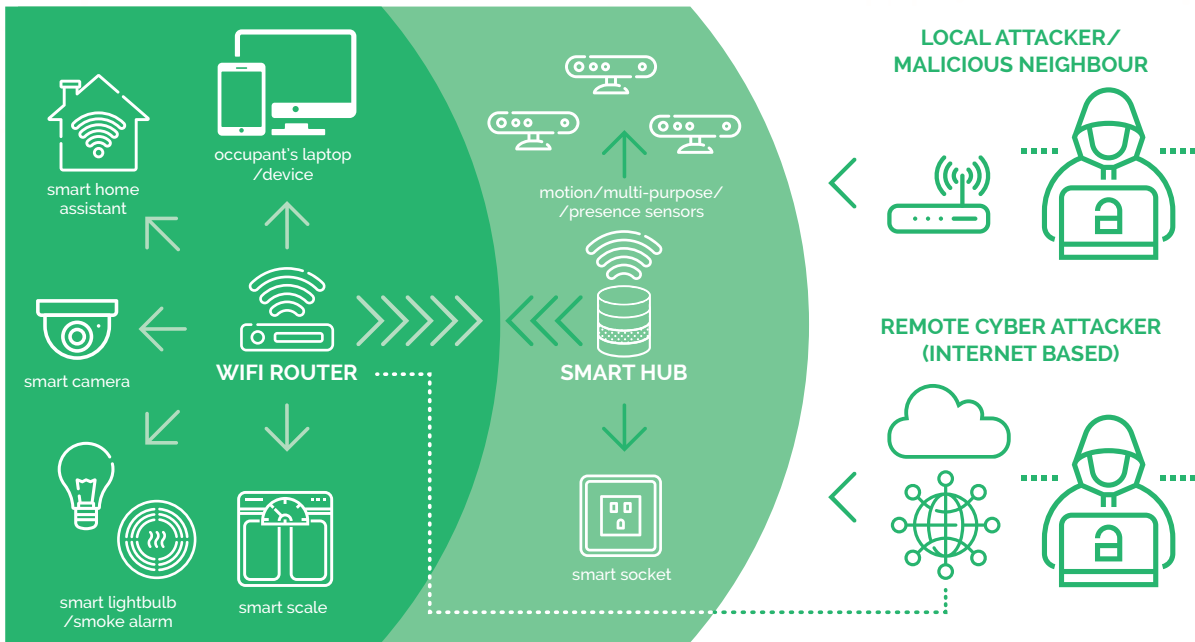
So, if a phishing email deceives one of the occupants into clicking on a YouTube video that at some point mentions "Alexa, unlock back door", Amazon Echo will act on this command. This is not that far-fetched if one remembers the six-year old girl who asked Alexa "Can you play dollshouses with me and get me a dollshouse?" and Alexa did actually order a $160 dollhouse. Then, when a news presenter repeated this on TV while covering the story, several Echos in people's homes attempted to order further dollshouses.

As the implications of using unauthenticated voice commands in one's home have started to become apparent, universities are now carrying out research on more high-tech attacks.

For example, researchers from the Berkeley and Georgetown universities have even managed to produce hidden voice commands, which are unintelligible to human beings, but are understood by these voice-controlled intelligent services. You have heard

LOCAL ATTACKER/ MALICIOUS NEIGHBOUR

REMOTE CYBER ATTACKER (INTERNET BASED)

smart home assistant

occupant's laptop /device

motion/multi-purpose/ /presence sensors

smart camera

WIFI ROUTER

SMART HUB

smart lightbulb /smoke alarm

smart scale

smart socket

The Smart Home

of malware; this is 'mal-audio' (see reference three).

Protecting the smarthome against hackers isn't trivial and there are several large-scale research projects running at the moment aiming to address the range of different security challenges introduced. However, until these produce new smarthome-specific methods, following good old cyber-hygiene principles is an excellent start.

For the majority of webcam attacks, the issue was very simple; the owners had not changed the default passwords. Also, with wifi becoming increasingly used by smarthome devices, changing the password for the wifi router once in a while is never a bad idea. It doesn't need to be every month, but having the same password for five years is unwise. Similarly, paying extra attention when clicking on attachments and visiting unfamiliar websites can reduce susceptibility to malware.

Finally, while smarthome devices have notoriously poor cyber security, most reputable manufacturers issue security updates when important vulnerabilities are discovered. You wouldn't skip

your car's service for years. So, don't leave your cameras, locks and other smarthome devices unpatched for years either. In the near future, it may well be just as important.

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UNDERSTAND YOUR IOT USERS!

They are the first in line when things go wrong, and they will hate you when it does.

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Cocoon (cocoon-project.eu) is an EU-funded international research project, gathering researchers from the University of Reading, the University of Greenwich, Ghent Univ. (Belgium), ETH Zürich (Switzerland) and Eindhoven Technical Univ. (Netherlands). In this project, we have interwoven innovations from two different disciplines to understand and improve security of home IoT technology; emotional psychology and cyber security. We aim to produce a practical understanding of the psychology of IoT users, assess risks in current and future IoT systems, and formulate provisions for the design and integration of user-centric IoT in tomorrow's homes.

The objectives of the Cocoon project are twofold:

1. To examine the emotional investment of IoT users who are in the comfort of their own home, which will not only condition their usage of the technology but also drive their reactions when security is breached, and will determine their ability to recover.

2. To put mainstream IoT technology to the test, and explore the opportunity to create a network-wide intrusion detection system (IDS), based on real-time analytics of data from such a heterogeneous set of technologies, and which users can actually use.

IoT technology is expected to merge physical and virtual worlds, creating smarthome environments that enhance wellbeing. As the physical and the virtual worlds grow closer, concerns for security, privacy and trust grow in similar measures. Addressing these concerns requires technological dispositions and interventions aligned with individuals. How do we know what users want, though? How do we know how they feel? How do they feel now, and how they will feel when things go wrong? Can we predict how they will behave then? Can this understanding help us be proactive? Can we identify types of users, who will need different levels of support? These are some of the questions that Cocoon will address.

Of course, there is no textbook or theoretical framework about how IoT users behave that one can use to formulate provisions for a real-world project deploying IoT devices in real homes. A first step for Cocoon has therefore been to approach actual users, potential users and layperson communities. We aimed to go beyond the frameworks typical to market penetration studies, and therefore turned to empirical psychology to investigate the emotional engagement of users with IoT technology, and tried to measure components of their emotional response and their perception of risks of an attack. In what follows, we present selected results from two of our earlier studies.

Who are today's IoT users, and what is their experience of IoT cyber-attacks?
The aim of the study was to draw a picture of who a typical IoT user actually is, and examine their experience of IoT threats. 214 people completed an online questionnaire (bitly.com/cocoon-experience). This sample of respondents included both students and professionals, from varied backgrounds and technological

proficiency. Most users had attended high school, were employed and/or currently following a course of study at a higher education institution.

Out of the 214 respondents who took part, 72 per cent reported not knowing what IoT is. Out of the remaining 28 per cent, 53 per cent reported that they were currently using a least one IoT device, and on average for more than three years.

Only 25 per cent of respondents rated themselves as 'expert' users (i.e. they could use all of the IoT devices' functions by themselves, without any assistance). The majority of respondents reported that they needed some degree of help for the setup, maintenance and use of the technology.

Respondents reported using a wide variety of devices, from automated lighting to smart thermostats, location tracking, personal voice assistants and even smart coffee-makers. 65 per cent of these devices were controlled by a smart phone, eight per cent by a PC and 28 per cent by some other means.

**Have you experienced IoT-based cyber-attacks?**

12%

88%

■ Yes   ■ No
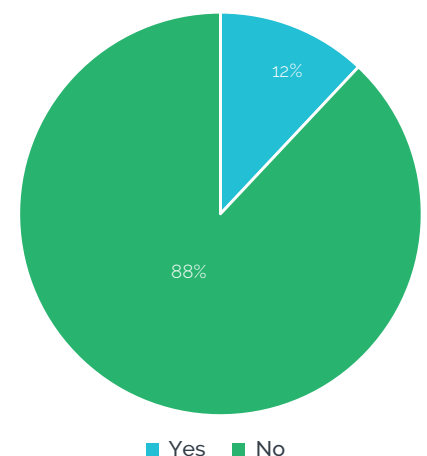
Only 12 per cent of respondents reported having experienced some

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kind of a cyber-attack related to their IoT devices. This rather low figure is perhaps unsurprising, but it is to be contrasted with the number and kinds of instances reported: 141 different experiences were reported, covering IoT devices, computers, smart phones and social network or email accounts. Most attacks were related to social media and email accounts (43 per cent), then IoT devices (22 per cent), computers (21 per cent) and smartphones (14 per cent). They reported that they had become aware of the attack(s) only because someone had told them of strange behaviour or because the device would malfunction; it was very rare for them to notice the attacks by themselves. When the respondents eventually became aware that they had been victims of an attack, they reported feeling a very wide and intense range of emotions, including stress, anger, fear, irritation, anxiety and despair.
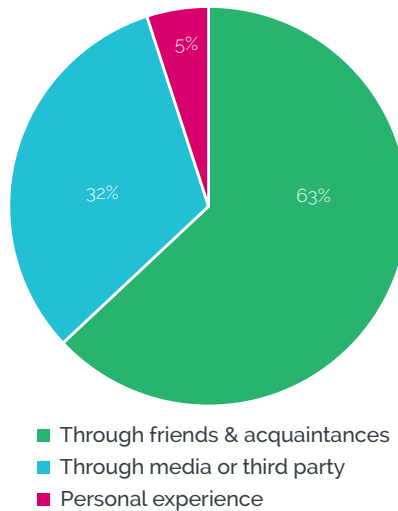
What was hacked?

- **Smartphone** — 14%
- **IoT device** — 21%
- **PC** — 21%
- **Social media or email account** — 44%
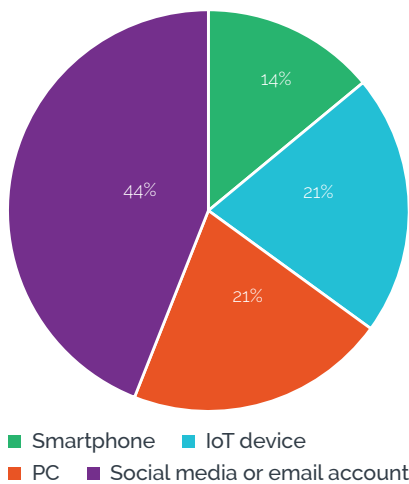
In Cocoon, further to this work, we are probing deeper into this emotional experience, with the intention of understanding the details of this relationship with the technology. Our goal is not only to understand the cognitive steps that mitigate an emotional response about an event; it is also to permit the classification of users in groups. Ultimately, we aim to produce tools that will permit the categorisation of users, to serve in the prediction of their behaviour when things go wrong

(because they inevitably will) and build tailored support strategies.

How did you learn about a IoT cyber-attack?

- **Through friends & acquaintances** — 63%
- **Through media or third party** — 32%
- **Personal experience** — 5%

How do IoT users perceive the risks associated with smarthome environments?

When users install IoT devices in their homes, they are also subjecting themselves to a new range of risks. Of course, these risks depend very much on their technological proficiency and skills, which will not only allow them to predict and prevent adverse consequences, but also enable a swift and effective response when things go wrong. In this second study, we therefore aimed to study participants' perception of risks about 10 IoT smarthome technologies, including smart televisions, network cameras and Bluetooth beacons, alongside three benchmark technologies, such as online banking.

106 students responded to an online questionnaire (bitly.com/cocoon-risks). For each technology, they were asked to rate risk characteristics that included:
- The likelihood that one might expect to experience negative consequences;
- The extent to which the risks are typically known to end-users;
- The extent to which they think they understand the technology;
- Whether the adverse consequences

of an attack might be immediately noticed by end-users;
- How much control they would have to avoid the consequent risks;
- The extent to which the risks associated with the technology were new;
- And the severity of the consequences of a potential cyber-attack.

Table one shows the aggregated, mean responses for each technology we tested. Further analysis indicated that, generally, the perceived benefits don't correlate with the perceived risks. However, the perceived risks did correlate with the level of acceptable risk. The more benefits people tended to attribute to a technology, the more acceptable the risks they associated with that technology.

Interestingly, although the level of risks for IoT technologies were generally perceived as being unacceptably high, they were still perceived as less risky than services that are more common, such as online banking. This makes sense, given the self-reported low levels of knowledge about IoT technologies, yet it is alarming.

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TECHNOLOGY	PERCEIVED BENEFIT	PERCEIVED RISK	RISK ADJUSTMENT FACTOR (1)	ACCEPTABLE LEVEL OF RISK (2)
Online banking *	66	79	2.29	34
Email over public network *	46	74	2.44	30
Network camera	42	60	1.71	35
Door/window sensor	32	44	2.01	21
Smart speaker	24	43	1.72	25
Smart smoke detector	53	36	0.95	37
Smart plug	24	35	1.41	24
Smartphone navigation app *	60	35	1.07	32
Smart thermostats	43	34	1.29	26
Bluetooth beacon	23	33	1.37	24
Smart TV	34	33	0.97	34
Smart wearable devices	33	32	1.66	19
Smart lighting	39	25	0.96	26
Average	40	43	1.53	28
Standard deviation	13.6	16.9	0.5	33
ICC	0.83	0.75	0.84	0

(1) Values higher than 1 mean that the risks should be safer; values less than 1 mean that the risks could be riskier.
(2) Acceptable levels of risks were calculated by dividing the third column by the fourth column.
* Benchmark technologies

Conclusion

Broadly, IoT technology empowers both housing providers and their tenants, and there's no doubt it will very soon play a central role in the housing sector. Housing providers will be able to monitor the status of their properties in real time, forecast demand and repair needs, as well as forecast their financial commitment and that of their tenants. Ultimately, IoT technology increases flexibility and supports agile practices in social housing.

Core to the sustainability of this multi-faceted and dynamic system are the tenants, who provide the drive and support the entire system. They are guardians of the entire system's integrity because their own knowledge and troubleshooting skills will determine their resilience in the event of cyber-attacks. They will be the first in line to suffer the consequences of

attacks, and the first able to respond appropriately. To secure the integrity of such a complex network of technology, it is therefore very important to understand how users behave and how best to empower them to take ownership of their smarthomes. New tools need to be developed, new procedures put in place, and users need to be more in tune with the technology.

Taken together, the results of our first studies demonstrate that IoT usage is still in its infancy, and therefore extremely sensitive to lack of knowledge about the technology. Today's IoT users are very different from what an IoT user will be tomorrow. Should a housing provider decide to deploy an IoT technology, it therefore falls on them to educate and support users, to foster confident and efficient practices.

Cocoon is an open research project, and we are more than happy to engage with anyone in the housing sector to help in their interactions with users, gather information about users and IoT practices, and participate in the design and deployment of user-centred IoT projects.

Please feel free to get in touch with us through our website: cocoon-project.eu.

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RHP Group is a housing association with a strong social purpose that was formed in 2000 following a transfer of stock from Richmond Council. We're a not-for-profit organisation that operates with the purpose of providing decent quality affordable homes and housing related services to people unable to rent or buy in the local private housing market.

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