

# Developing a Smart Home to Support Assisted Independent Living

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# About me

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- Developmental Robotics
  - Modelling infant development on a humanoid robotic platform
  - Better understand learning processes of infants
  - Develop new approaches for open-ended learning on a robotic platform
- Robotics for assisted living
  - Assisted navigation for wheelchair users
  - Companion robots with playful interactions but also monitoring behaviour
  - Setting up new smart home lab with sensors and robotic equipment to monitor and assist with day-to-day activities

# What is a smart home

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- "A home equipped with lighting, heating, and electronic devices that can be controlled remotely by smartphone or computer."
  - Oxford Languages





# Types of smart homes

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- Building management / optimisation
  - Energy efficiency
  - Air quality
  - Heating
  - Lighting
- Comfort
  - Automation
- Remote control
- Safety and Security
  - User / Device authentication
  - Hazards, e.g. Fire, Carbon Monoxide, leaks
- Healthcare
  - Local / Remote monitoring

# Smart Homes for Healthcare

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- Physiological
- Functional / emergency response
- Safety monitoring and assistance
- Security monitoring and assistance
- Social interaction monitoring and assistance
- Cognitive and sensory assistance

G. Demiris and B. K. Hensel, 'Technologies for an Aging Society: A Systematic Review of "Smart Home" Applications', *IMIA Yearbook of Medical Informatics*, vol. 17, no. 01, pp. 33–40, Aug. 2008, doi: [10.1055/s-0038-1638580](https://doi.org/10.1055/s-0038-1638580).



# Ambient vs. Wearable sensors

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- Wearable sensors increase ability to monitor physiological conditions, e.g. heart rate, body temperature and other vitals
- Pendent alarms for the elderly
- Rely on person remembering and being willing to wear
- High risk of false positives and false negatives from wearable fall sensors and personal alarms



# Aberystwyth Smart Home Lab





# Smart Home Lab

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- What is it?
  - Research space for co-creating, developing and evaluating new technologies for use in and around the home
  - 3-bedroom bungalow
  - Fully functional with potential for participants staying overnight
  - Initial equipment includes wide range of sensors for monitoring environment and activities internally
  - Various initial robots (mobile, manipulator, companions)



# Smart Home Lab Research

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- Research applications and interests
  - Technology to support independent living for older adults, those living with a disability, and associated stakeholders
  - Close collaboration with Psychologists, health and social care practitioners across Wales for projects relating to supporting independent living for older adults
  - Developing and evaluating technologies for rural health care including remote access to medical practitioners and technologies for monitoring health and wellbeing
  - Developing technologies for supporting return home from hospitals
  - Developing robotics applications to assist with day-to-day activities
- Scope for broader research applications

# The house itself

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- Blank slate for retro-fitting smart technology



# Sensors in the smart home

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- Commerical WiFi sensors

- Eufy Camera doorbell
- Radar based movement sensors
- Smoke alarms
- Locator tags

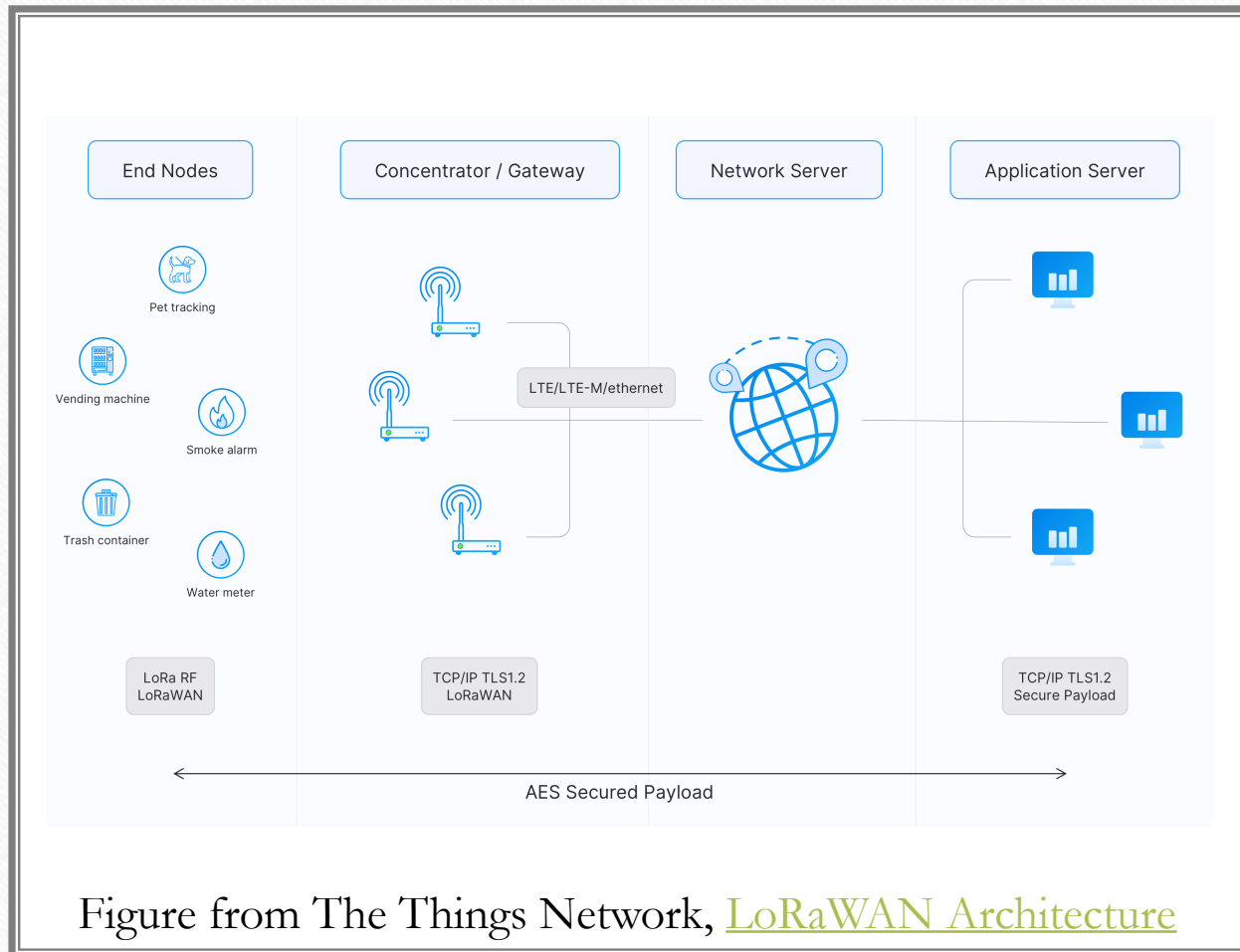
And more...

- Commerical LoRaWAN sensors

- Environmental Sensors
- Seat occupancy
- Motion sensors
- Door sensors
- Sound sensors
- Smart plugs
- RFID card reader
- Various buttons

# What is LoRaWAN?

- LoRa – protocol for long range radio communication
- Small data packets
- LoRaWAN adds system architecture for the network and communication protocol
- Up to 15km range





# Automation in the Smart Home Lab

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- Google and Alexa home assistants
- Blind and curtain motor controllers
- Switchbots
- Smart light bulbs
- Smart plugs
- Stair lights
- Memo minder
- Door openers
- LoRaWAN
  - IR remote control
  - E-ink information displays

# Robotic Assistants

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- Companion Robots
- Telepresence Robot
- Robotic assistant
- Robot vacuum cleaner



# Challenges faced so far

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- Networking
  - WiFi connectivity of various devices
- Many apps for WiFi based devices
- Interconnectivity between different brands
- Configuration of some LoRaWAN devices
- Currently working on a dashboard to display all sensor data in one place



# Supporting Care Circles

**Powys County Council:** Chris Evans, Sally Heaton

**Psychology:** Rachel Rahman, Charles Musselwhite, Katherine Parsons

**Computer Science:** Patricia Shaw, Fred Labrosse





This is Mary  
and Joe

# Supporting Care Circles

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- Working with stakeholders to explore challenges for independent living where technology could be used to assist
- Workshops with
  - Service users
  - Informal carers (e.g. family, friends)
  - Formal carers, (e.g. social care, occupational therapists)



# Technology for home care support

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- Workshops 1 and 2 to identify problem areas in the home
- Questions:
  - Within the home, what are your biggest challenges/fears? Areas, activities,...
  - What might help you feel more confident living independently / supporting someone living independently?

# Workshop 3 - scenarios

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Mrs Jones lives alone. Her daughter and son-in-law live close by. In recent years Mrs Jones has been getting more forgetful. Her family are concerned that she is forgetting to take her medication and she has lost a little weight recently.

Mrs Jones' family are going on holiday for two weeks and have asked the Home Support service if they can keep an eye on her during this time.



# Scenario questions

Think  
about the  
following  
questions

If information was being collected within the house, what information would be useful to monitor about Mrs Jones, her activity in the house or the house environment?

Are there any alerts or reminders that would be useful for Mrs Jones to receive? If so, what type of alerts and when?

In this situation, who do you believe would be best to receive the alerts?

Would you have any concerns about you receiving this (or other) information? What? Why?

Would you have any concerns about somebody else receiving this (or other) information? (e.g., family, GP?) Who? Why?

# Next stage

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- Co-design of a home monitoring system with dashboards for monitoring activity
  - What would you want to see on the dashboard?
  - Who should be involved with the design?
  - What notifications would you want it to send and to whom?
  - Who should have access to it and should they see different displays?





Remember Mary?  
Mary became a  
member of the Builth  
Wells Home Support  
service following the  
loss of her husband  
Joe, over 2 years ago.

# Co-designing a new dashboard





# Potential benefactors and benefits

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- Service users
  - Support to feel more confident living on their own, whilst still connected to community
- Unpaid carers
  - Confidence that the person is safe and well, or will be notified quickly if need help
- Paid carers
  - Insights into what activities have been happening so they can focus on social interaction during visits
  - Providing additional information to reduce stress when emergency call out triggered

# Key points and considerations

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- Not trying to set generic routine for all, or tell them how to live, simply monitoring and acting to support their independence
- Not trying to reduce or replace human contact
- Installations would be customised through discussion with those involved
- Acting to maintain privacy and data security
- Co-developed through stakeholder engagement



# Smart Home Lab Opportunities

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- Facility for testing and evaluating technologies
- Space for training
- Showcase facility
- Adapt or develop technologies
- Collaborate on projects for addressing real problems, engaging with range of stakeholders

# Plans and Developments

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- Holistic view of home activity producing diary of daily activities
- Long term monitoring of behaviours, tracking changes in activities
- Robotic assistants to help with tasks around the house
- and more



# Thank you

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