SPHERE

a Sensor Platform for HEalthcare in a Residential Environment

EPSRC Interdisciplinary Research Collaboration (IRC)

For SPHERE:
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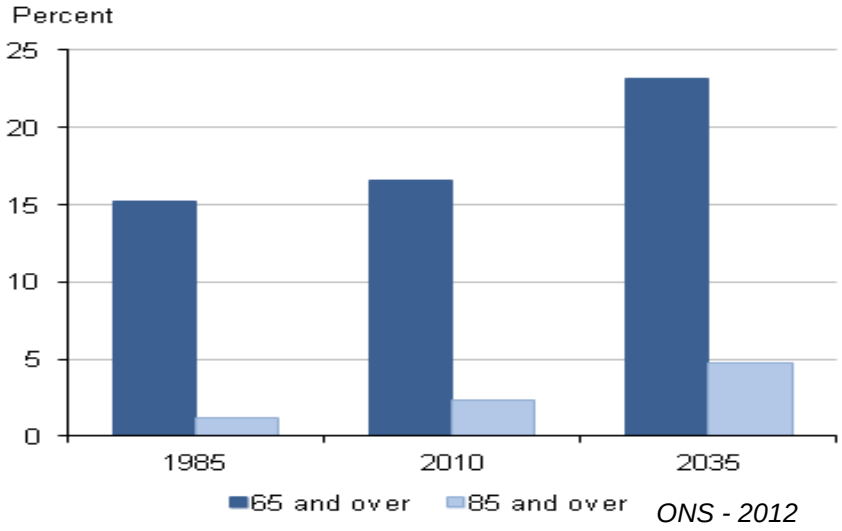
University of Bristol

Long-term Care Revolution National Challenge Launch
London 25 November 2014

Healthcare under pressure…



ONS - 2012

1. Changing Demographics, e.g.:

- 3.6m will be 85 or older in the UK by 2035 (1.4m now).
- Healthcare systems will face significant difficulties in meeting current expectations of standards of care.

2. Rise in long term health conditions, e.g.

- Antidepressants prescriptions **up by 28%** over three years.
- 25% of adults in England are obese (**5% of NHS budget**).
- **25% increase** in diabetes diagnosis between 2006 and 2011.
- **6-10% of all hospital admissions** could be prevented if medication was taken correctly.

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Home as a final frontier …

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- A large part of our lives, and increasingly so in advanced age, is spent in the home, but very little is known about our activities and behaviour in there.

- Establishing baseline activities of daily living (ADL) in the home is crucial to assist people in need of care, identify onset of conditions, and engage with them in behaviour change.

- Technology is an enabler, but its history inside the home is mixed – at best!

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Challenges

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1. **Technology : no real shortage …, but ….**
   - Neither as reliable nor as autonomous as needed/expected
   - Not context-aware → too intrusive/not intrusive enough?
   - Too heterogeneous (not interoperable)
   - Still not as efficient as needed

2. **It is not about technology or data;**
   It is what do we learn from the data, and how we use this knowledge.

3. **Privacy, trust and user acceptance**
   - Increase trust through the application of the technology the right way

4. **Need for truly multidisciplinary approaches**
   - Terminology, practices, vision and understanding differences are still very large

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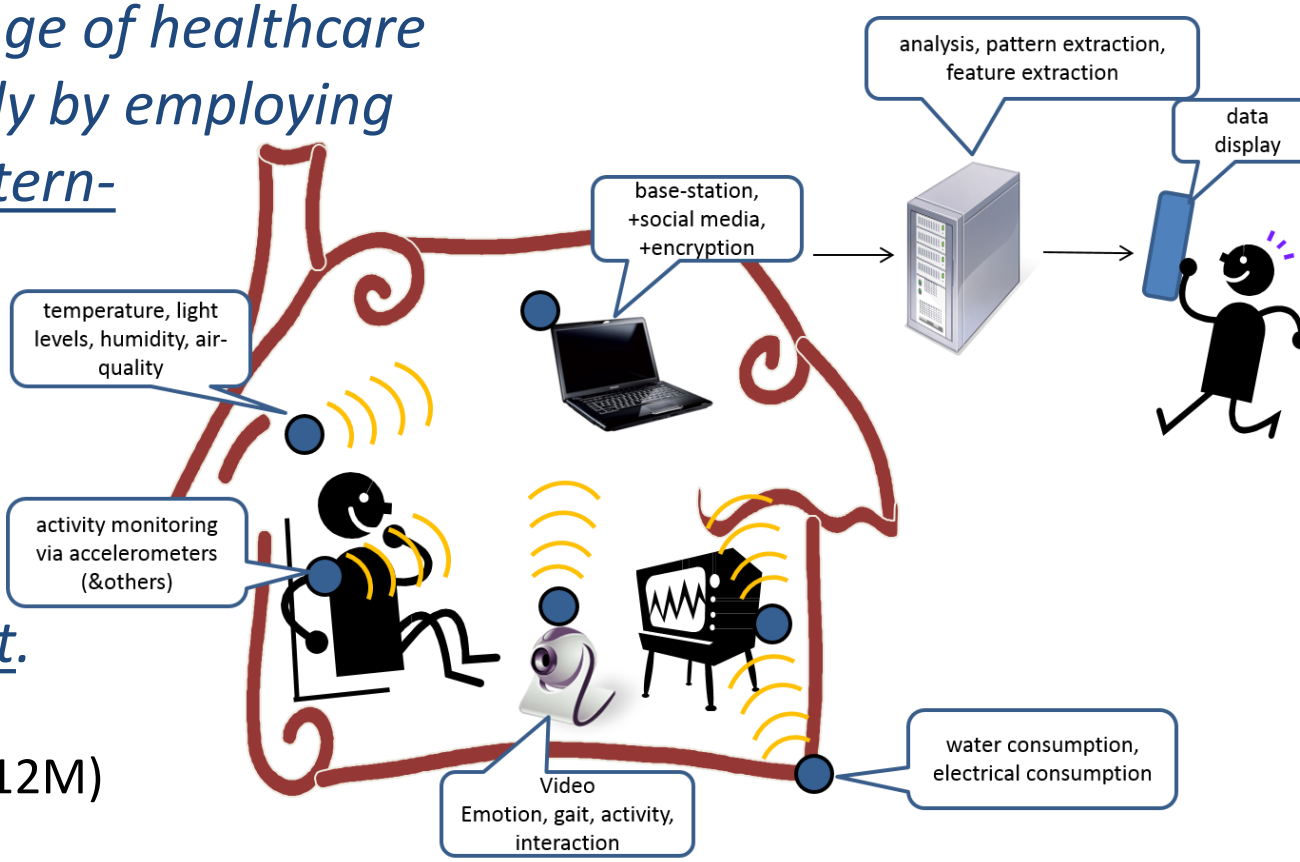
SPHERE : An EPSRC-funded Interdisciplinary Research Collaboration

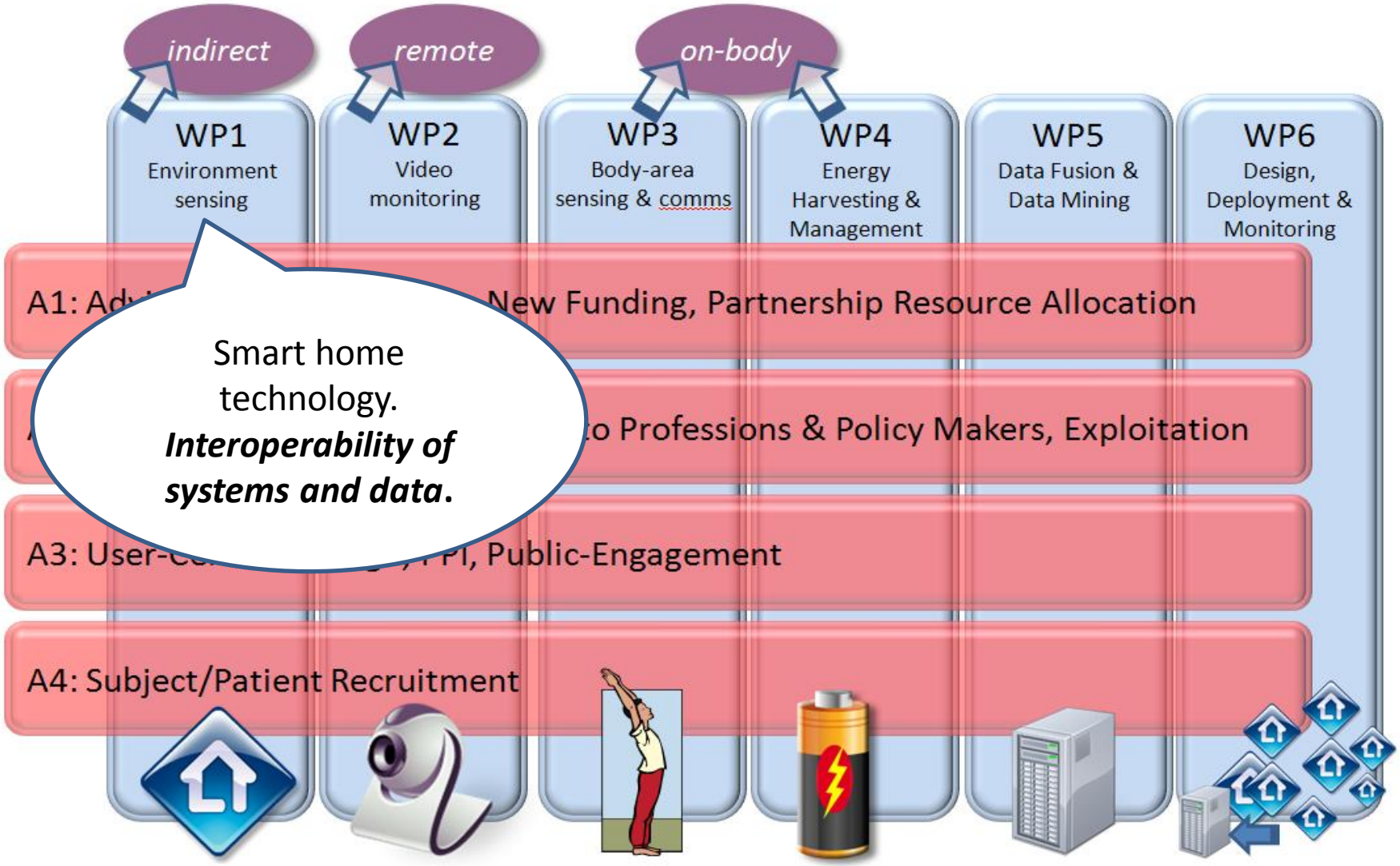
Vision: *Impact a range of healthcare needs simultaneously by employing data-fusion and pattern-recognition from a common platform of non-medical networked sensors in a home environment.*



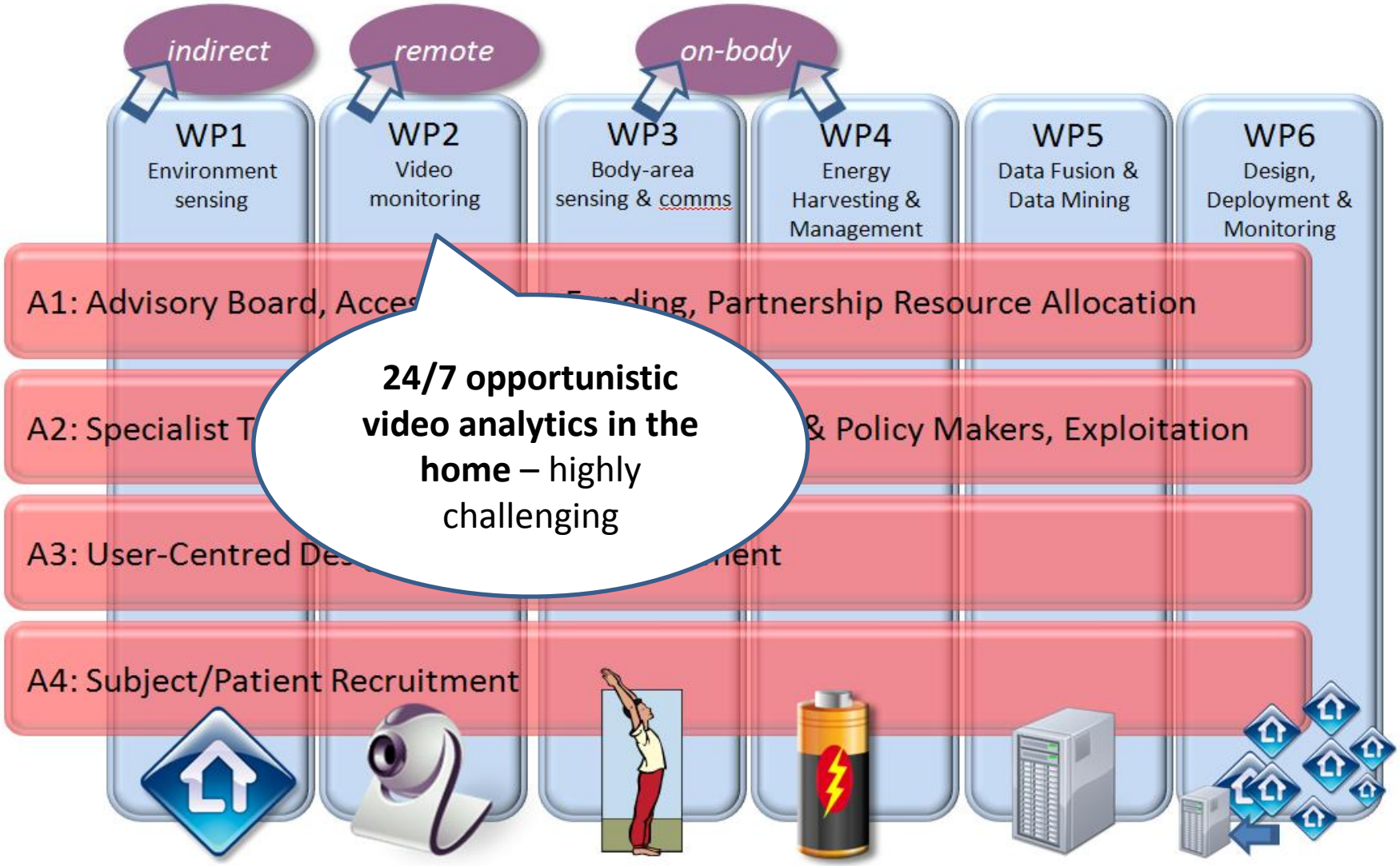
Budget: £15M (EPSRC £12M)
Duration: 5 years
30 postdoctoral researchers, 8 PhD students, 16 associated academic staff

University of BRISTOL · University of Southampton · University of Reading · IBM · TOSHIBA Leading Innovation · Bristol City Council · EPSRC Engineering and Physical Sciences Research Council

Workpackages



Workpackages



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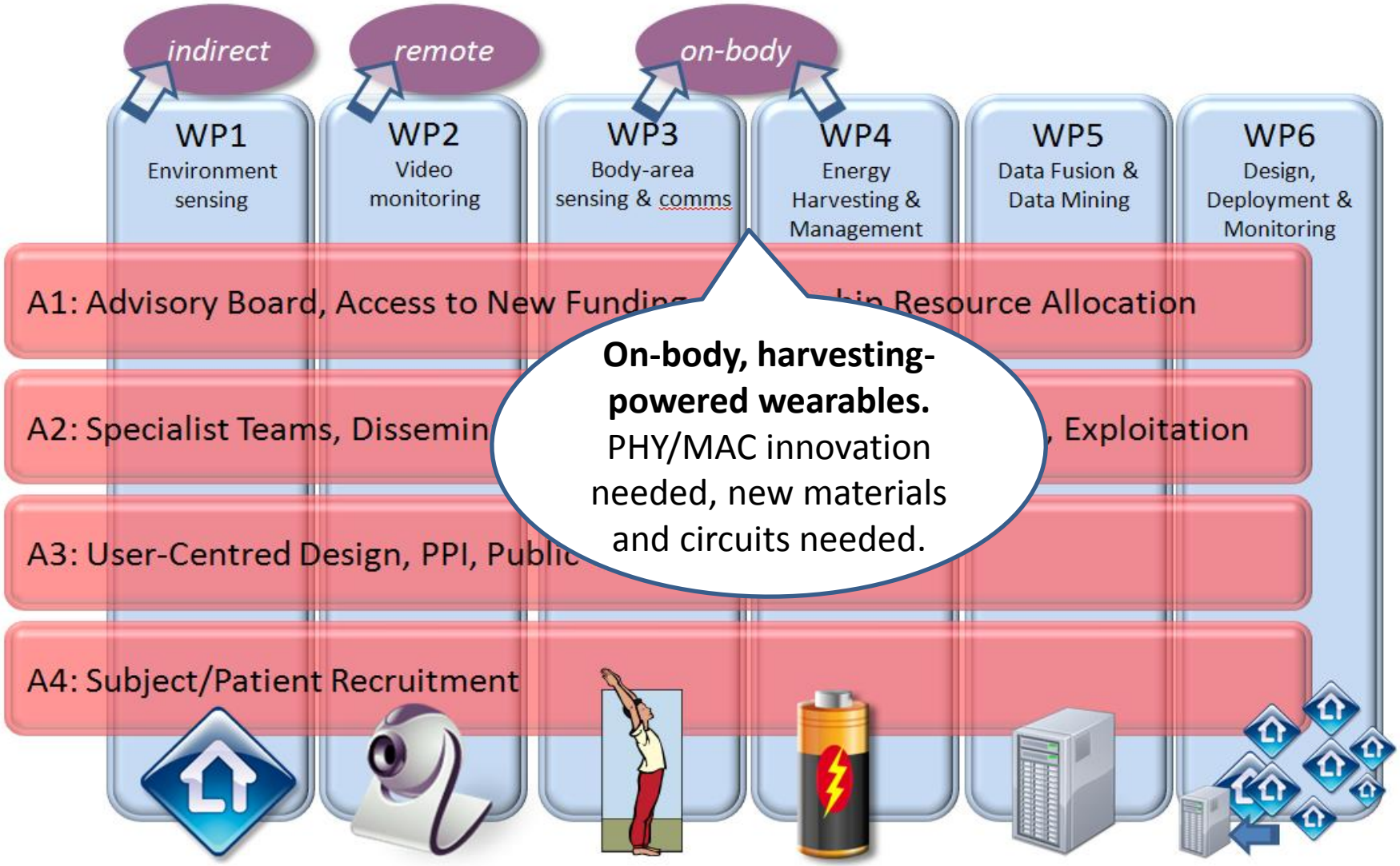

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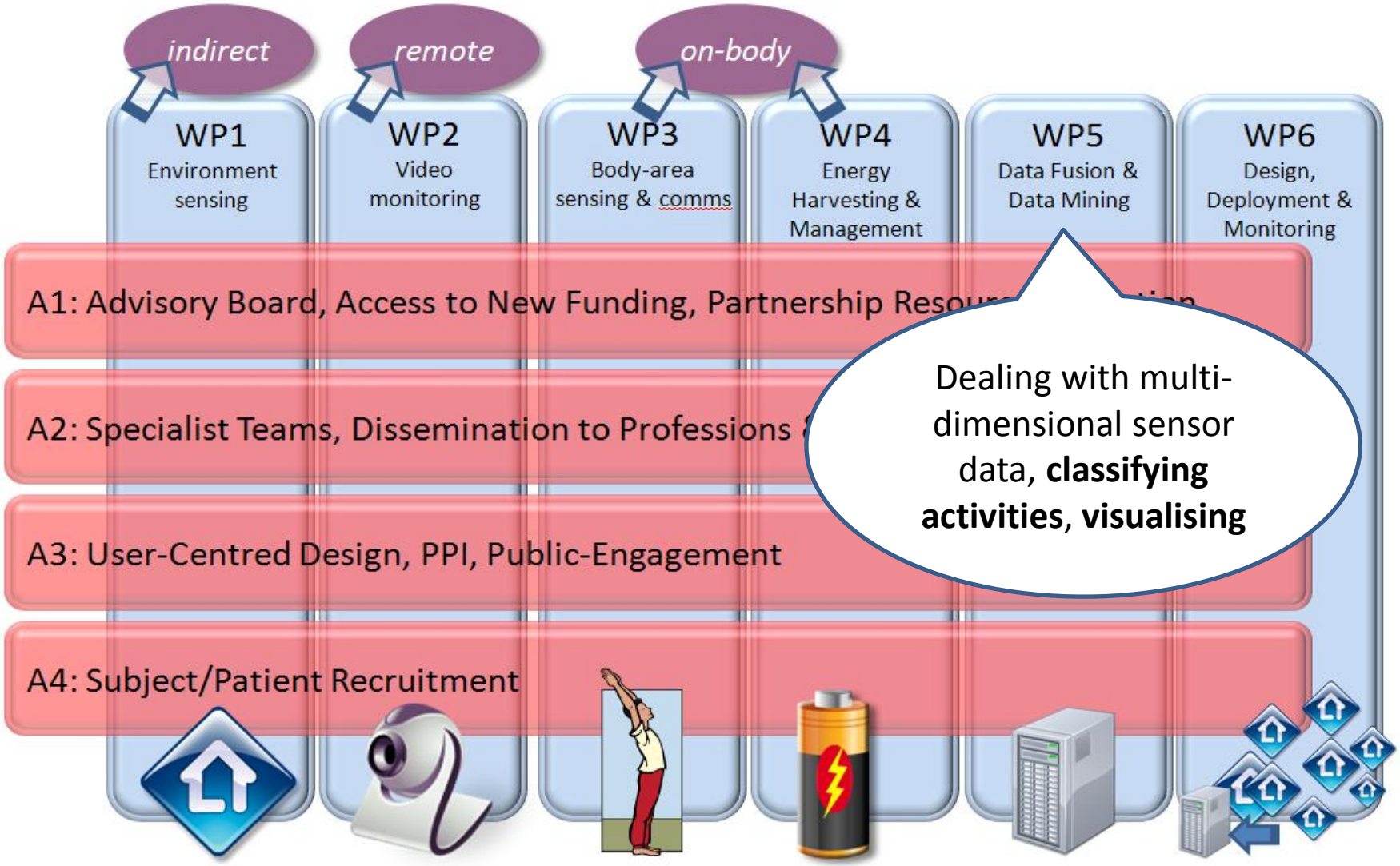

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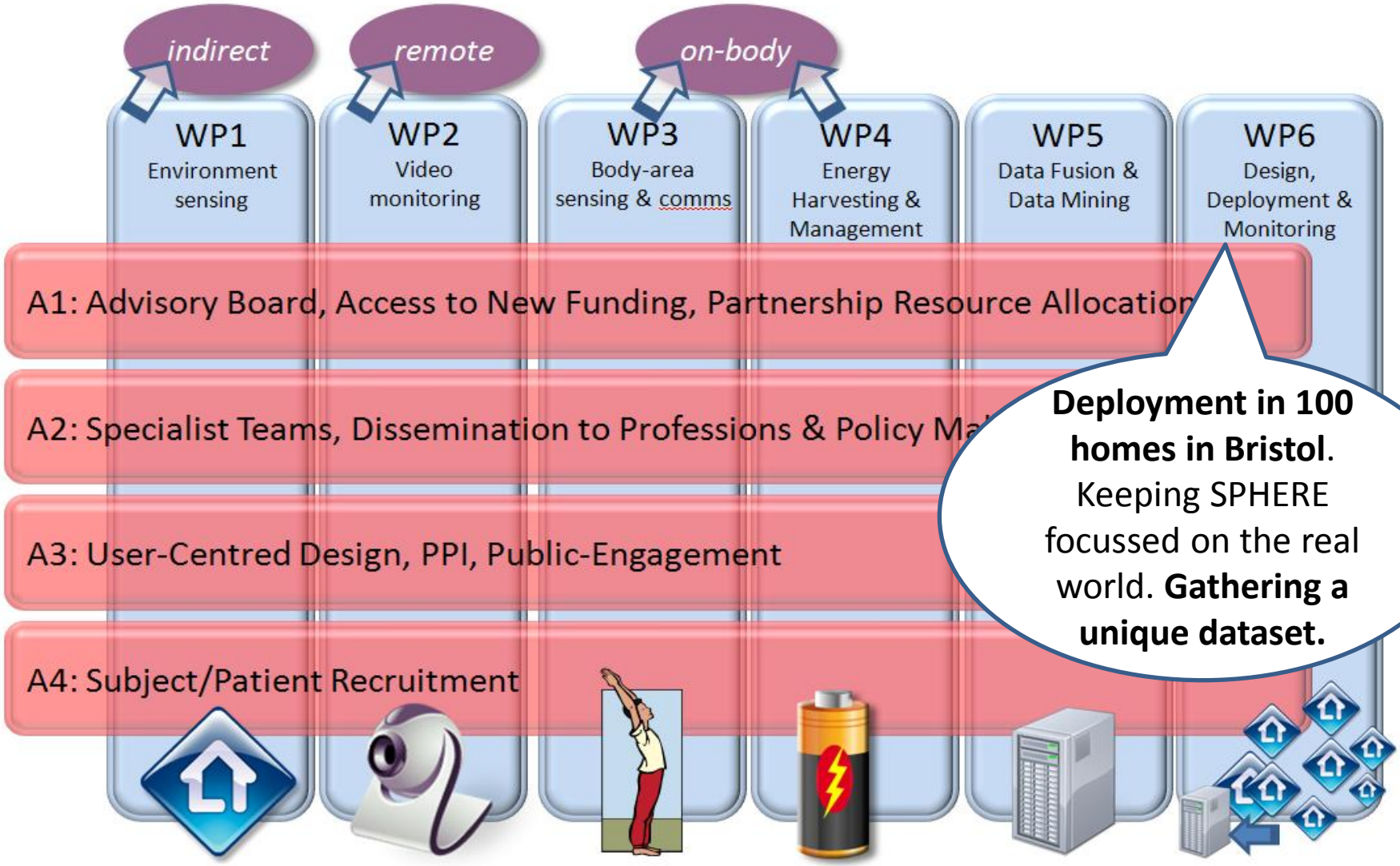

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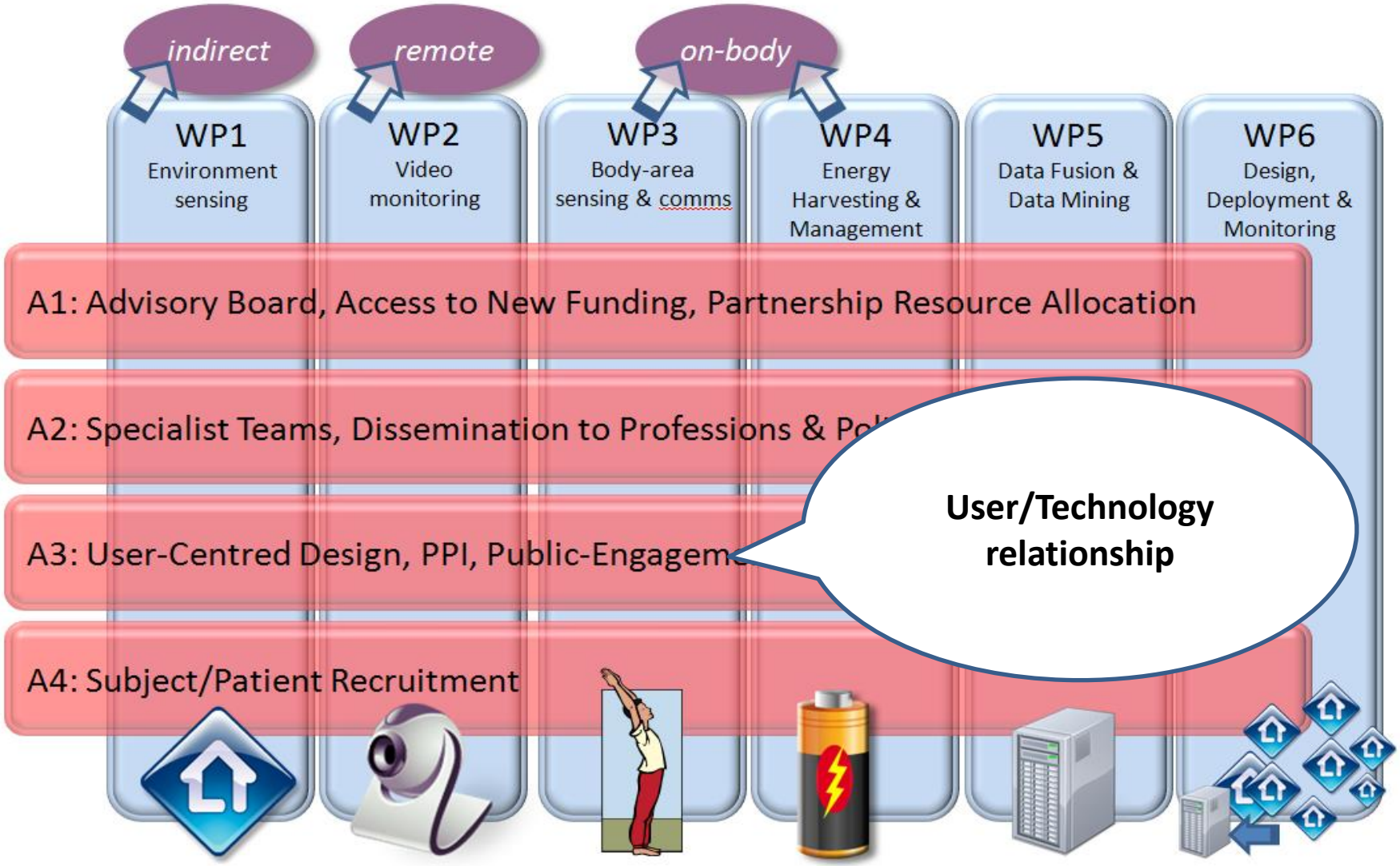

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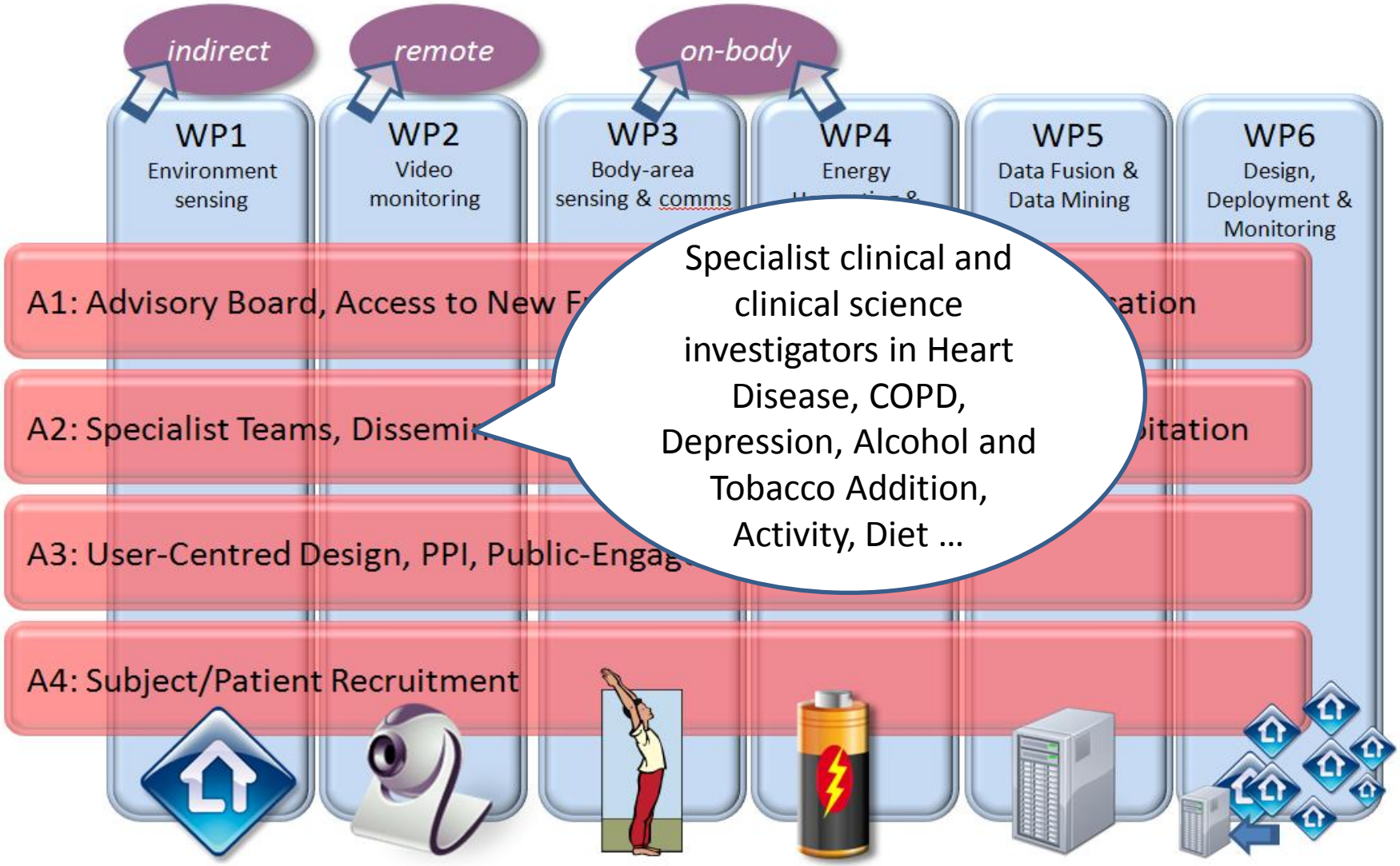

Research infrastructure

- Technology development but also measurement and small pilots in the real world.
- SPHERE's massively-sensorized house in Bristol (a true "living lab"):

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SPHERE House

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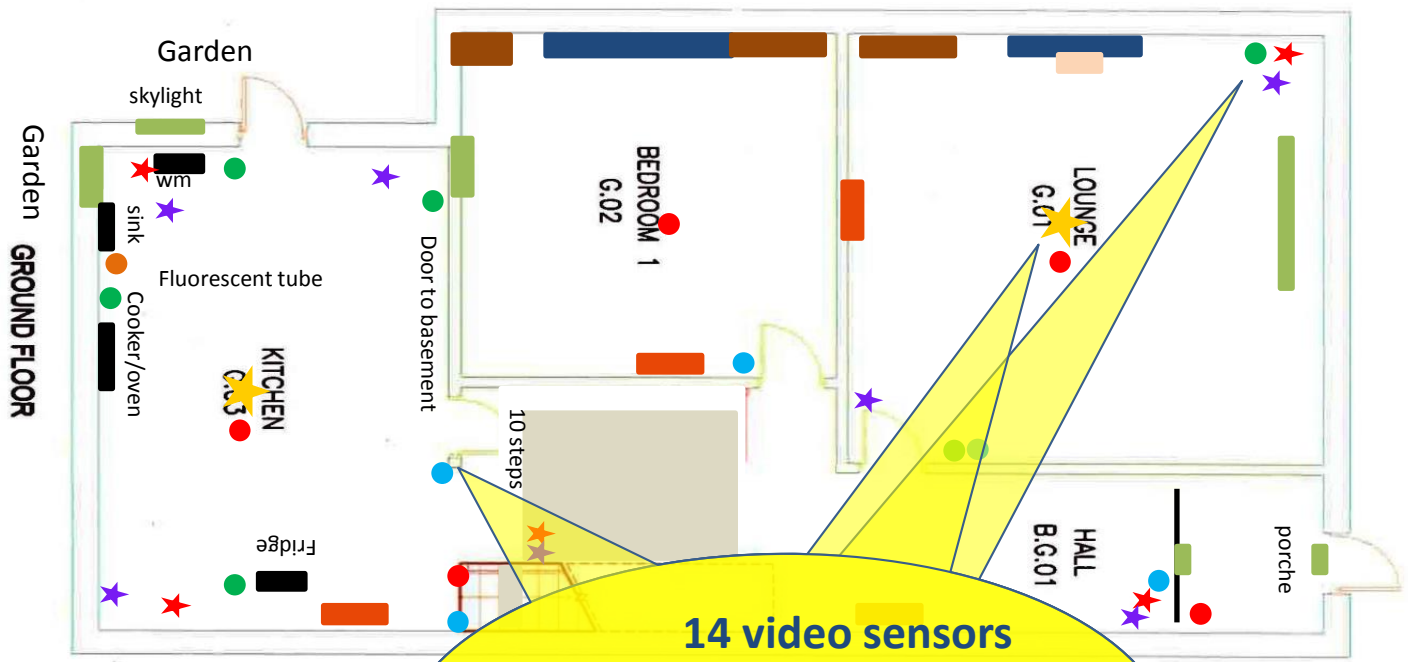
SPHERE House



Depth Sensor
Fish eye lens Camera
Wide Angle Camera

Env Sensor S1 (PIR, Door, T, I
Env Sensor S2 (AQ, T, H, L, …
Water Sensor S3
Electricity

Chimney breast
Mirror
Window
Shelves
Radiator
stairs

14 video sensors
35 environment sensors
giving >90 data points
Several on-body wireless sensor(s)

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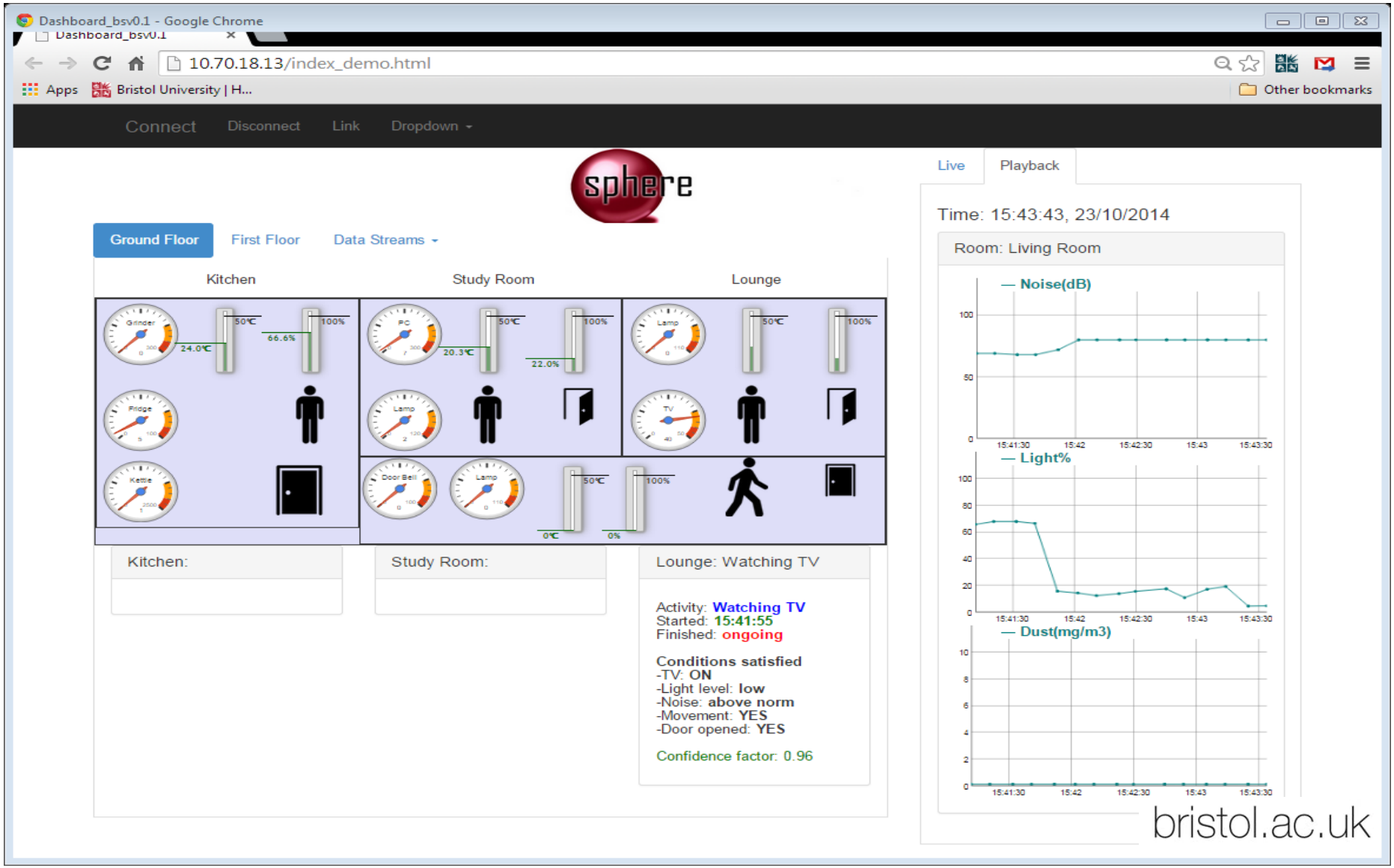
WP1: Home Environment Sensors

Sensor Type	Posting frequency	Resolution	Accuracy	Unit	Location
PIR	Instantaneous	0/1	detecting range 6-7m	N/A	All applied u
Water		0.5%	±1%	Liter/Min	Kitchen, bathro
Door Contact		0/1	N/A	N/A	All applied units
Temperature	Every Minute (Configurable to seconds or hours)	10.0 mV/°C	±1	°C	All applied units
Humidity		1%RH	<±4%RH	%RH	All applied units
Light		0.10%	Resistance in darkness: 20MΩ	%	All applied units
Noise		26 +/-1 dBSPLA	±4dB	dB	All applied units
Air quality		0.35V/(0.1mg/m3)	0.5V/(0.1mg/m3)	mg/m3	All applied units
Electricity	6 Seconds	1W		Watt	Individual applications and total consumption

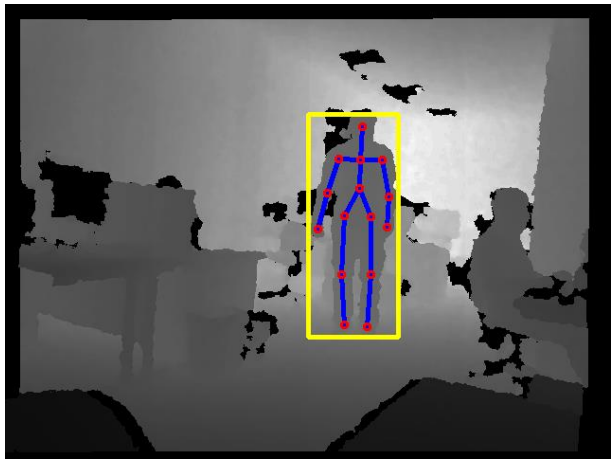
Time-stamped

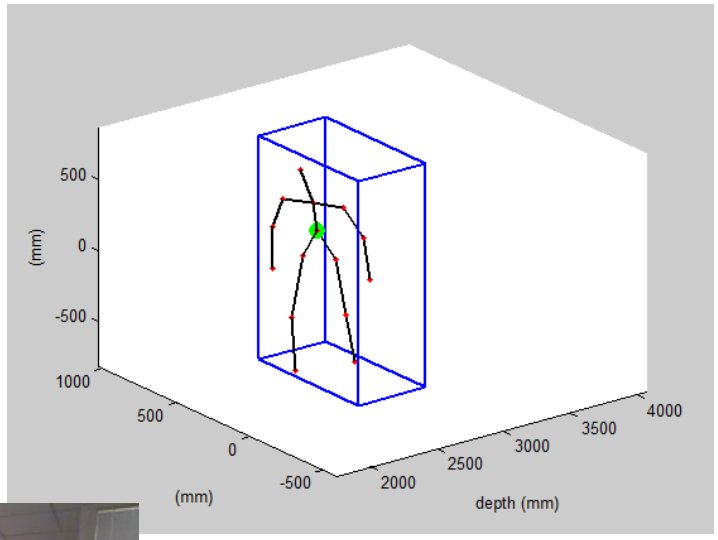
Sensor ID

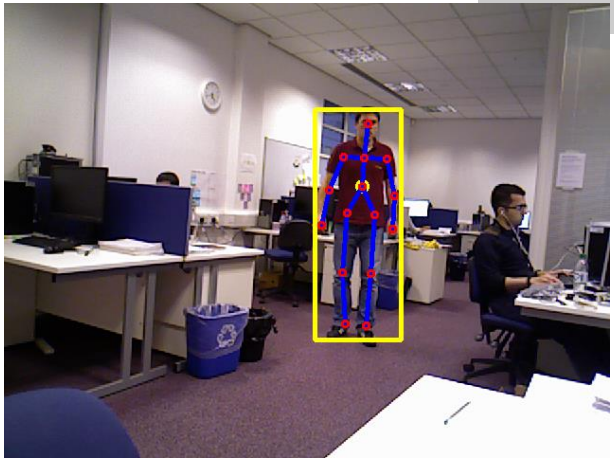
SPHERE House Dashboard



WP2: Human Tracking







- Detect and track body movements
- Extract relevant features
- Analyse/Identify specific patterns relevant for **clinicians**

WP2: Early version of skeletal dataset

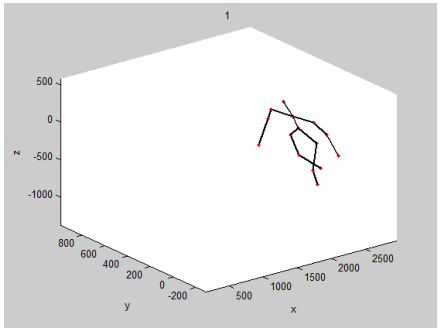
- Actions: Going up to stairs, Sitting-standing
- Devices: PrimeSense, New Kinect (Kinect 2)

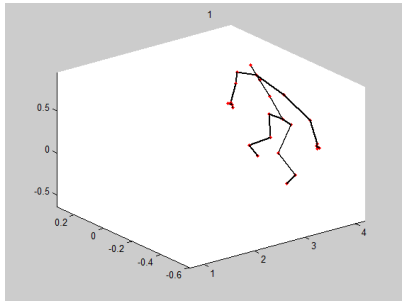
- Example data

PrimeSense

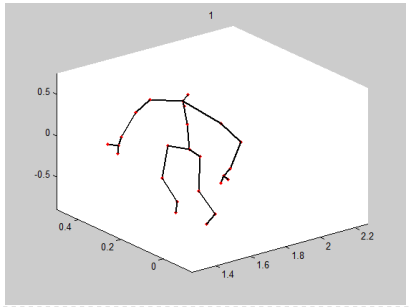
new Kinect (Kinect 2)

Staircases data

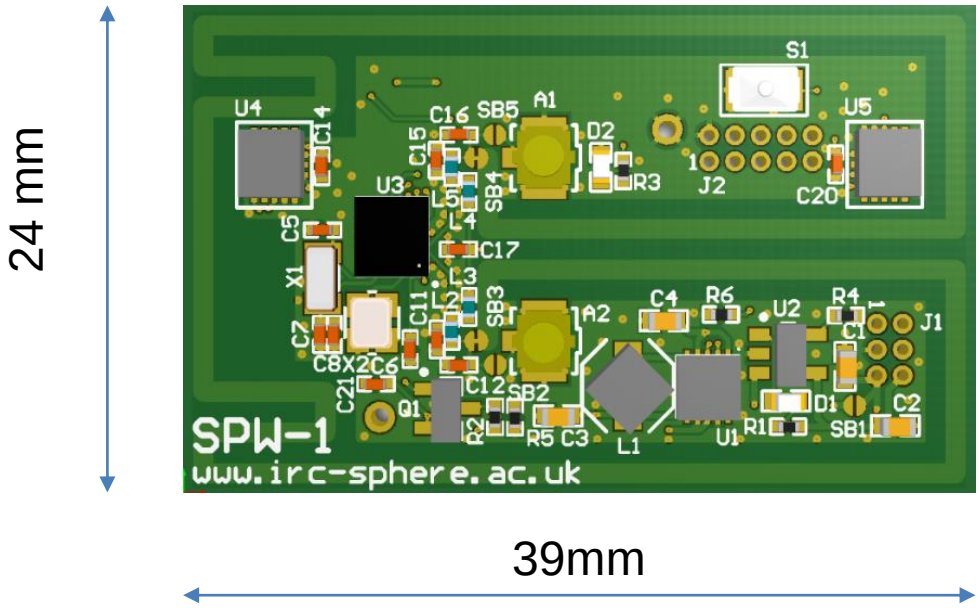




sitting-standing N/A (Skeleton is too noisy)



WP3: Ultra-efficient Wireless On-body Sensor



This is the printed circuit board layout of the very first SPHERE wearable – in manufacture at the time of writing.

SPW-1 Specifications:

- Ultra-Low Power Design
- Energy-Harvesting Ready
- Dual Accelerometers
- Efficient PCB Antenna
- External Sensor Support

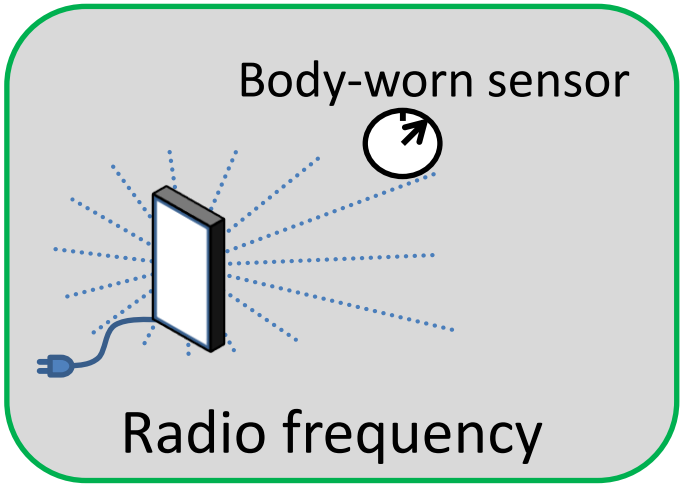
WP4: Four concepts for powering medical sensors

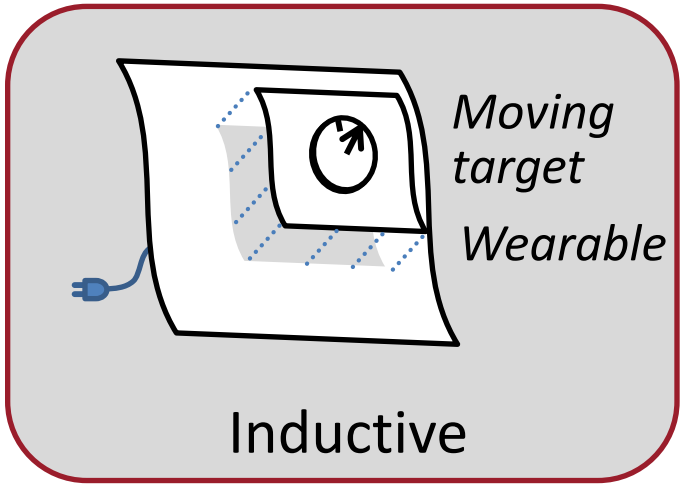
Wireless power transfer

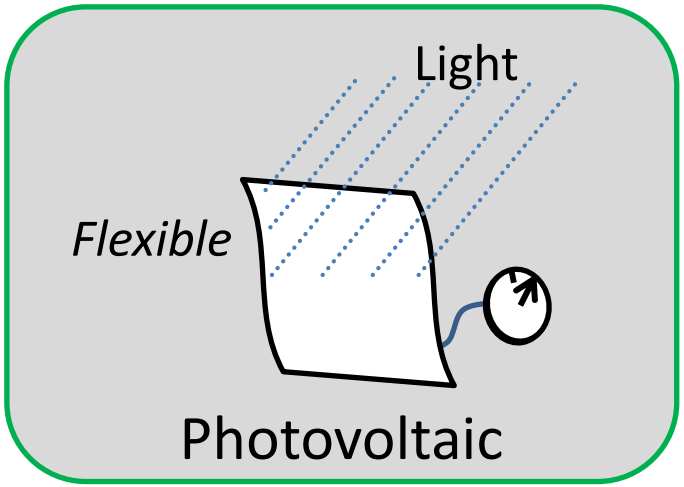
Energy harvesting

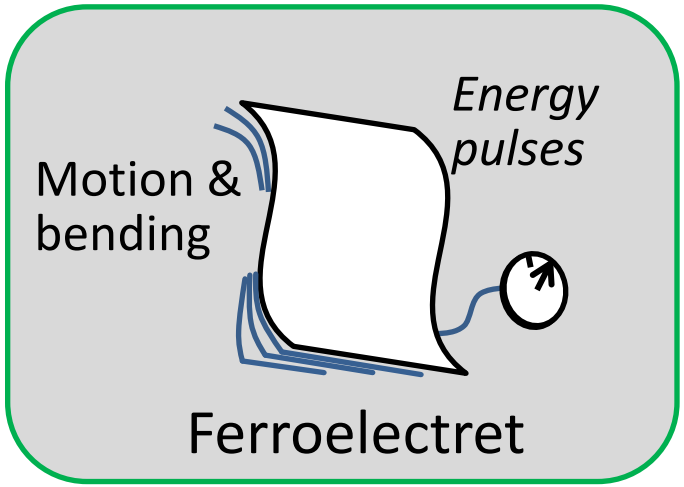
For specific sensors

For smart sensor









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Hierarchical Taxonomy for People

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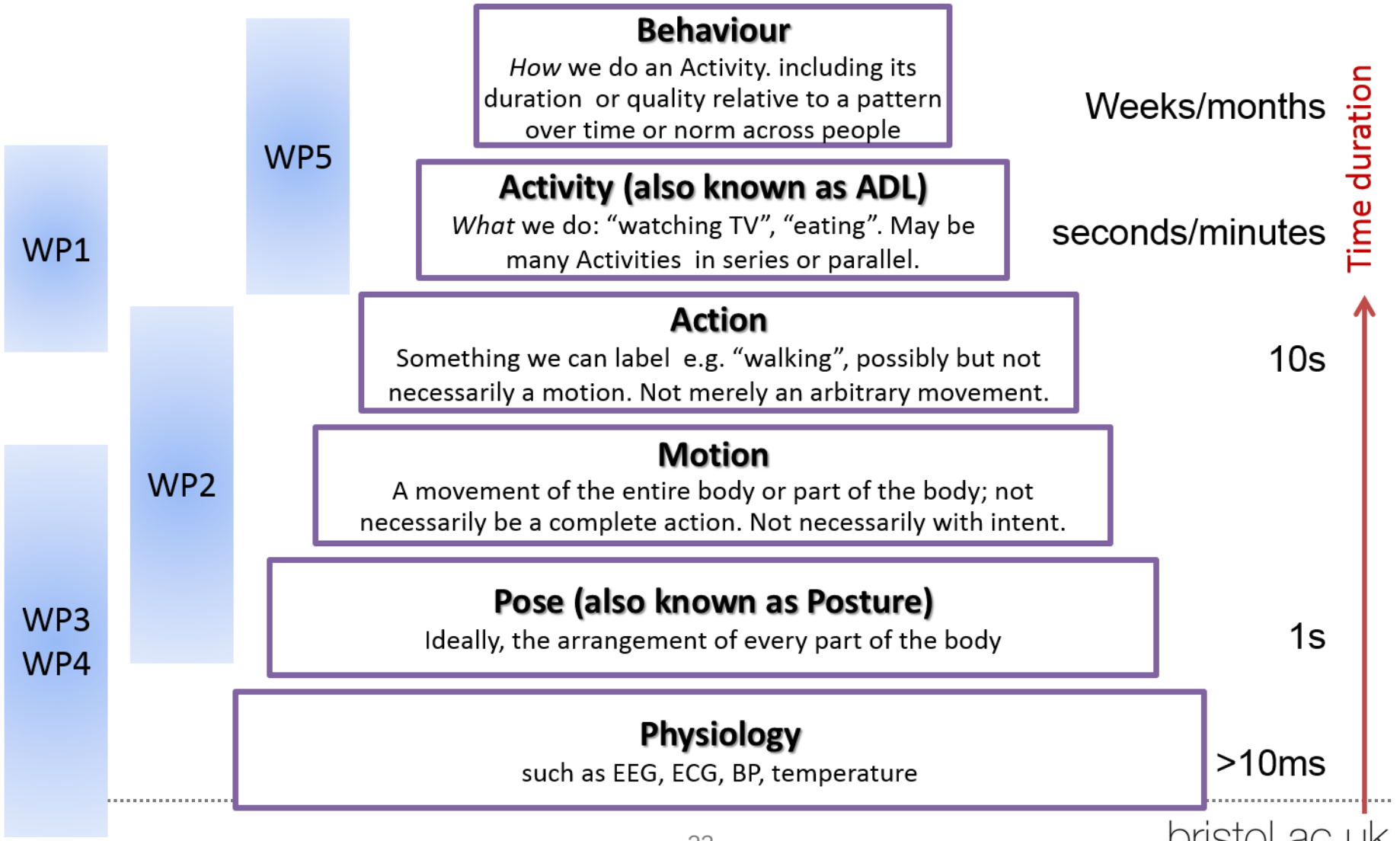
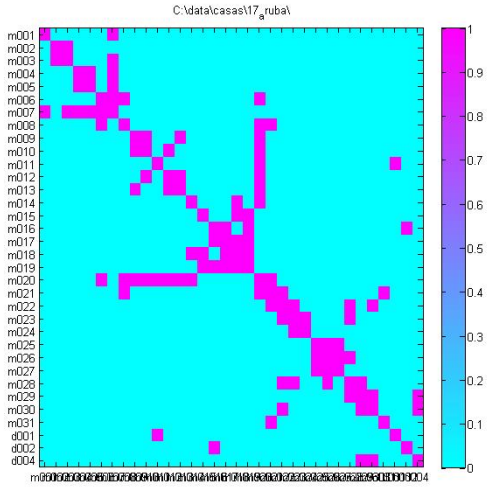
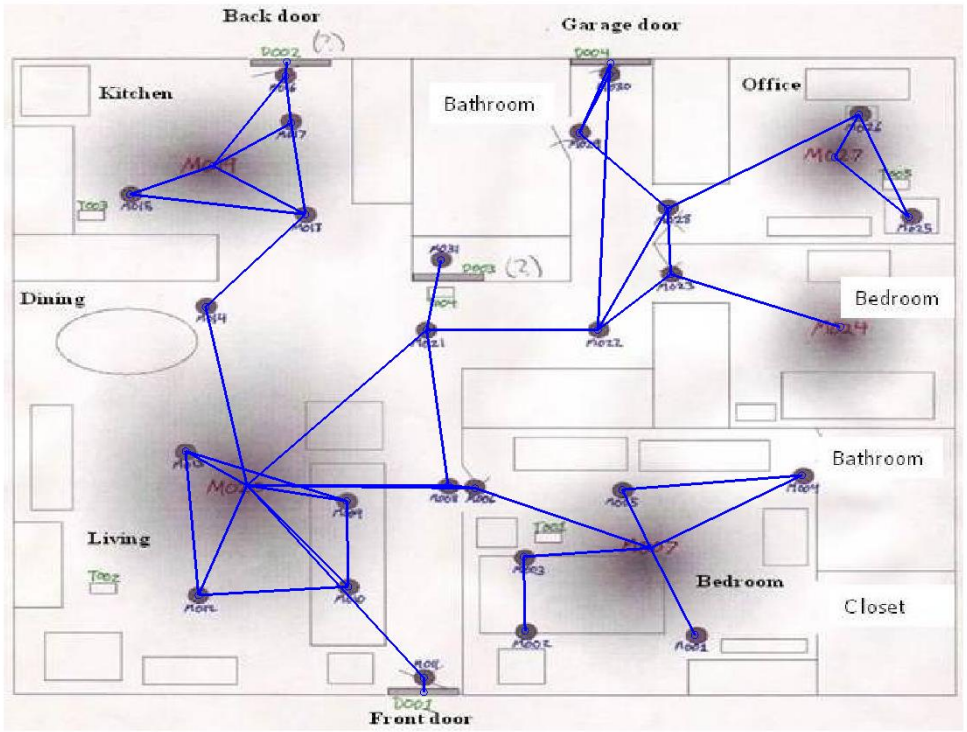


Adapted from: Chaaraoui , Climent-Pérez, and Flórez-Revuelta. "A review on vision techniques applied to human behaviour analysis for ambient-assisted living." *Expert Systems with Applications*, 2012

WP5: Learning from data





Next steps

- Answering emerging clinical questions from the Medical Faculties (e.g. Social and Community Medicine) and industry/NHS via a pre-proposal proof-of-concept requires data.
- This has all been done in lab environments already – ***the interesting questions are what we observe at home.***

SPHERE has acquired a small house in central Bristol.

This will lead us towards full-scale deployments.

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Summary:

- SPHERE has built an Internet of Things platform that provides comprehensive activities for healthcare and wellbeing monitoring in real-life home environments
- SPHERE will advance the state of the art in:
  - ultra low power communications
  - on-body energy harvesting
  - video analytics in unconstrained environments
  - extraction of meaning from complex uncertain data sets.
  - the understanding of user/technology interaction in the home for healthcare.
- SPHERE's team connects:
  - clinical need to engineers and computer scientists
  - emerging clinical research to evolving new technology.
- SPHERE is looking for collaborators to work together to address these challenges.

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Thank you !

SPHERE contacts:

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Social Media:

twitter.com/IRC_SPHERE

https://www.facebook.com/pages/Sphere