Mobile Health Technologies: From Wearables to Real-World Evidence

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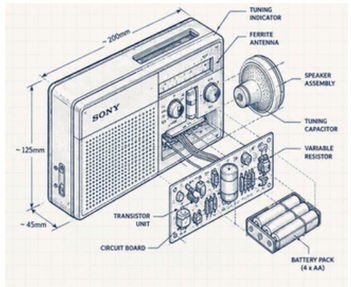
The History of Wearable Technology

Sony iconic 1955 TR-55 transistor radio

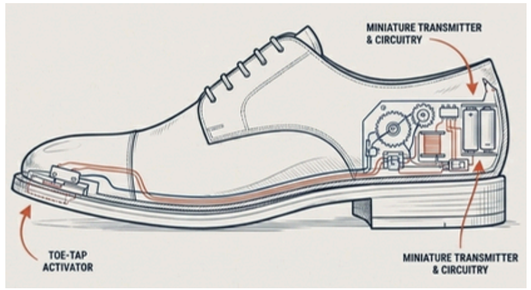
Foundation of miniaturised electronics



1955

Roulette-predicting computer hidden in a shoe by MIT

From bulky and task-specific to digital timekeeping, health tracking tool



1961

HP-01: the first wearable "smart" device

Onboard memory and an LED display to calculate time and distance, store data

1975–1977

Original 2015 Apple Watch

Force touch; Taptic Engine; Communication

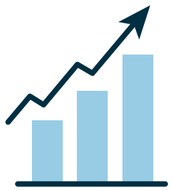
2015

611.5M+ wearable devices shipped globally per year

2025+

2.2%

The total wearable device shipments are projected to grow 2.2% in 2026



46%

of Americans own a wearable device

(93% smartwatch, 18% ring)

83%

wear their devices more than 5 days a week

(59% wear them nearly always)

Activity **35%**

Sleep **26%**

HR **21%**

59%

have actively discussed wearable data with a healthcare provider

(30% regularly, another 20% wants to)

Rock Health 2025

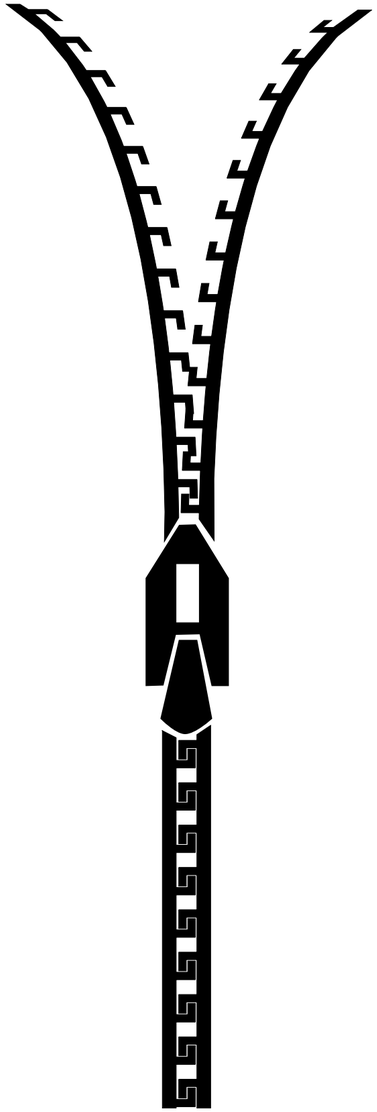
Healthcare is changing

Ageing population

Rising long-term conditions

Sever workforce shortages

Increasingly capacity demand



Research is changing

Rise of decentralised trials

Demand for remote monitoring

Need for continous longitudinal data

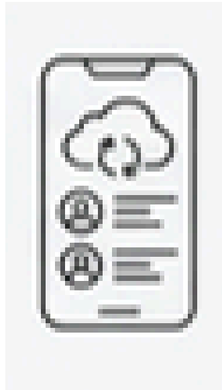
Pursuit of real-world evidence

Wearable Device

An electronic device worn continuously on the body to sense, record, process, or transmit record data.

Smartphone Integration

The hub for connectivity, patient-reported outcomes, and passive data relay



Digital Biomarker

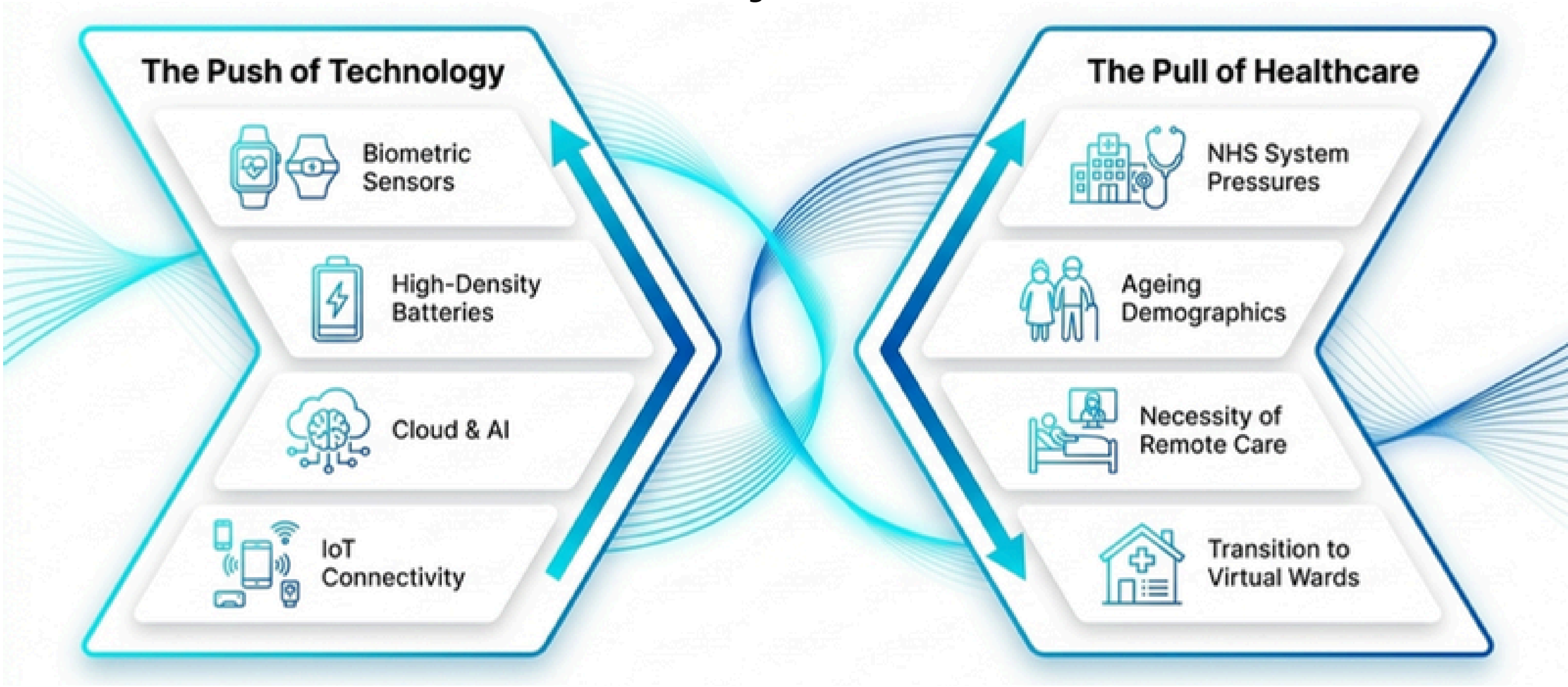
Objective, quantifiable physiological or behavioural data collected via digital devices used as an indicator of biological processes

Remote Monitoring

The clinical or research framework that utilises these tools to track patients outside traditional healthcare settings

Wearables + Smartphones + Cloud + Analytics = REAL-WORLD EVIDENCE

Why Now


The Push of Technology
Biometric Sensors
High-Density Batteries
Cloud & AI
IoT Connectivity
The Pull of Healthcare
NHS System Pressures
Ageing Demographics
Necessity of Remote Care
Transition to Virtual Wards

NHS Digital Transformation

"Wearables are expected to become standard in preventive care, chronic disease management and post-acute recovery by 2035."

— NHS 10-Year Health Plan

Step 1:
Consumer Wearables

Step 2:
NHS App Integration

Step 3:
Electronic Health Records (EHR) Linkage

Step 4:
Large-scale Clinical Care & Research

Traditional vs Mobile Research

Traditional Research	Mobile Research
Clinic visit snapshots (Episodic)	Continuous real-world monitoring
Small, limited datasets	Big, longitudinal data
Questionnaires subject to recall bias	Passive, objective sensing
Artificial clinical settings	Genuine real-world environments
Expensive per participant	Highly scalable and cost-effective

The Power of Wearable Data

Continuous, real-world data across the body and beyond

TYPES OF WEARABLES USED IN HEALTHCARE

Smartwatches
Activity, heart rate, ECG, sleep, SpO_2

Fitness Trackers
Steps, activity, sleep, heart rate, calories

Smart Rings
Sleep, HRV, temperature, activity, recovery

Medical Patches
ECG, heart rhythm, respiration, temperature

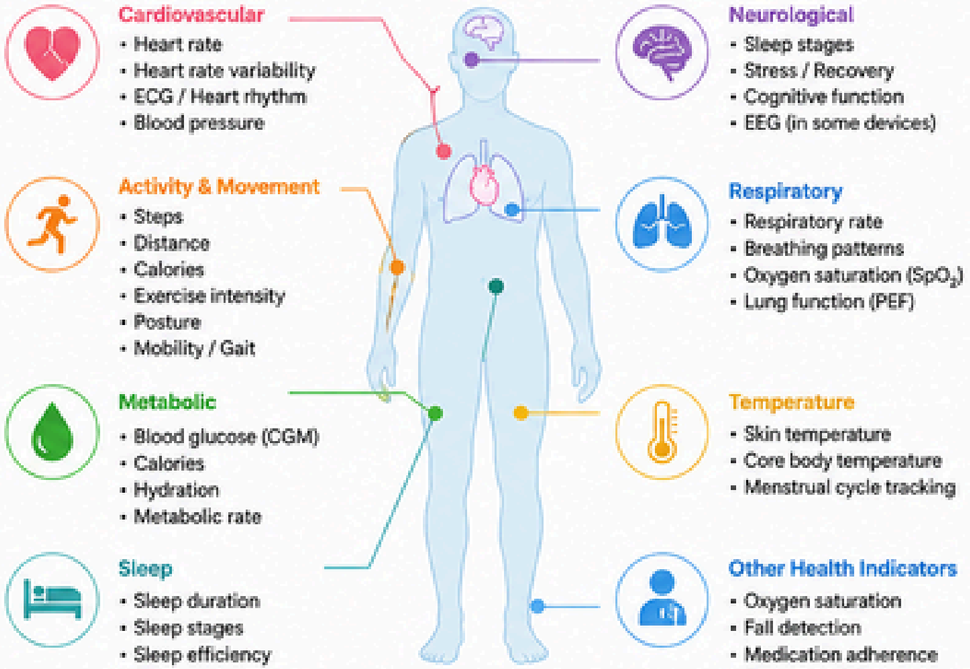
Continuous Monitors
Glucose (CGM), blood pressure

Smart Garments
Heart rate, respiration, movement, posture

Hearables
Hearing activity, communication, falls

Specialist Sensors
EMG, EEG, SpO_2, movement, hydration

DATA THAT CAN BE COLLECTED



Cardiovascular
- Heart rate
- Heart rate variability
- ECG / Heart rhythm
- Blood pressure

Activity & Movement
- Steps
- Distance
- Calories
- Exercise intensity
- Posture
- Mobility / Gait

Metabolic
- Blood glucose (CGM)
- Calories
- Hydration
- Metabolic rate

Sleep
- Sleep duration
- Sleep stages
- Sleep efficiency
- Sleep quality

Neurological
- Sleep stages
- Stress / Recovery
- Cognitive function
- EEG (in some devices)

Respiratory
- Respiratory rate
- Breathing patterns
- Oxygen saturation (SpO_2)
- Lung function (PEF)

Temperature
- Skin temperature
- Core body temperature
- Menstrual cycle tracking

Other Health Indicators
- Oxygen saturation
- Fall detection
- Medication adherence
- Pain levels (via proxies)

HOW THIS DATA IS USED

Remote Patient Monitoring
Track health in real time outside the clinic

Chronic Disease Management
Detect changes early and personalise care

Preventive Health
Identify risks early and promote healthy behaviours

Post-Acute & Rehabilitation
Support recovery and monitor progress remotely

Clinical Research
Collect real-world evidence at scale

Patient Empowerment
Help individuals understand and manage their health

FROM DEVICE TO INSIGHT

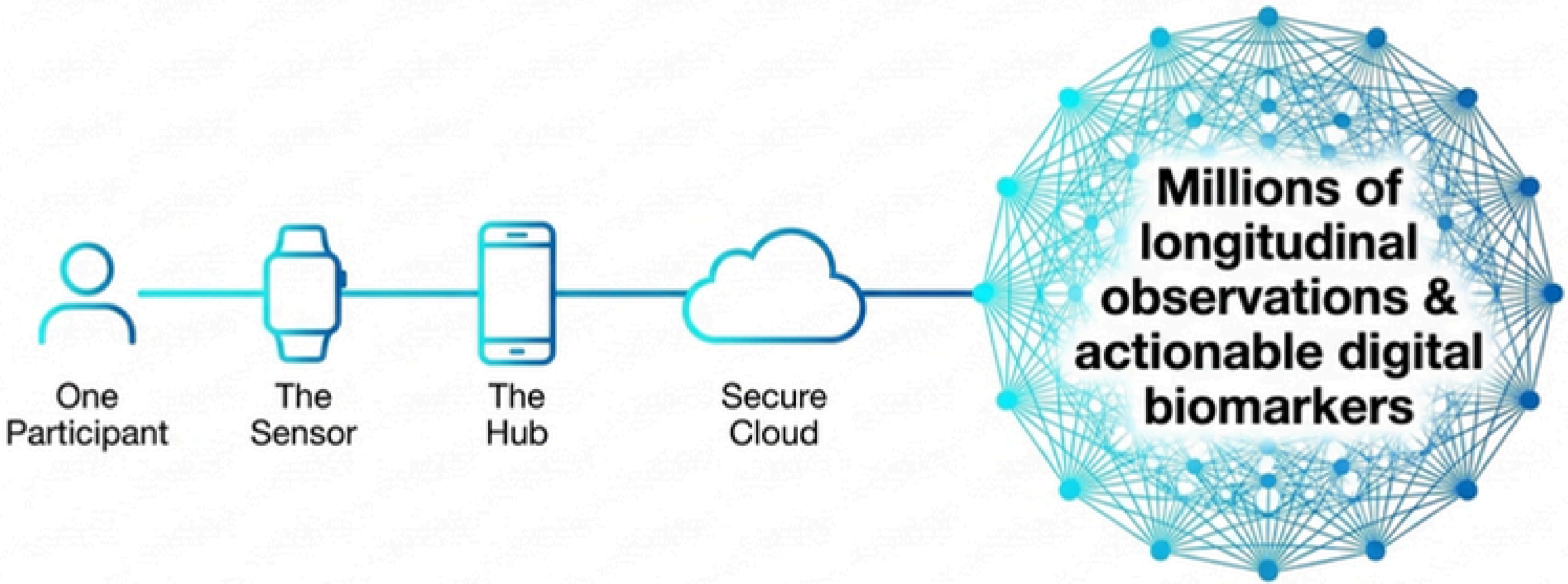
Data captured by wearable → Data transmitted securely → Stored securely in the cloud → Analysed with AI and analytics → Insights for clinicians and patients

ENABLERS FOR SAFE & EFFECTIVE USE

Data privacy & security | Clinical validation & regulation | Interoperability & standards | Equity & access for all | Education & digital health literacy

Wearables generate continuous, real-world data that can transform healthcare delivery, improve outcomes and empower people.

The Data Flow Pipeline



The Open-Source RADAR-base platform: A Case Study

Open-Source

Transparent and accessible for global research.

Scalable

From small pilots to massive decentralised trials.

RADAR-BASE

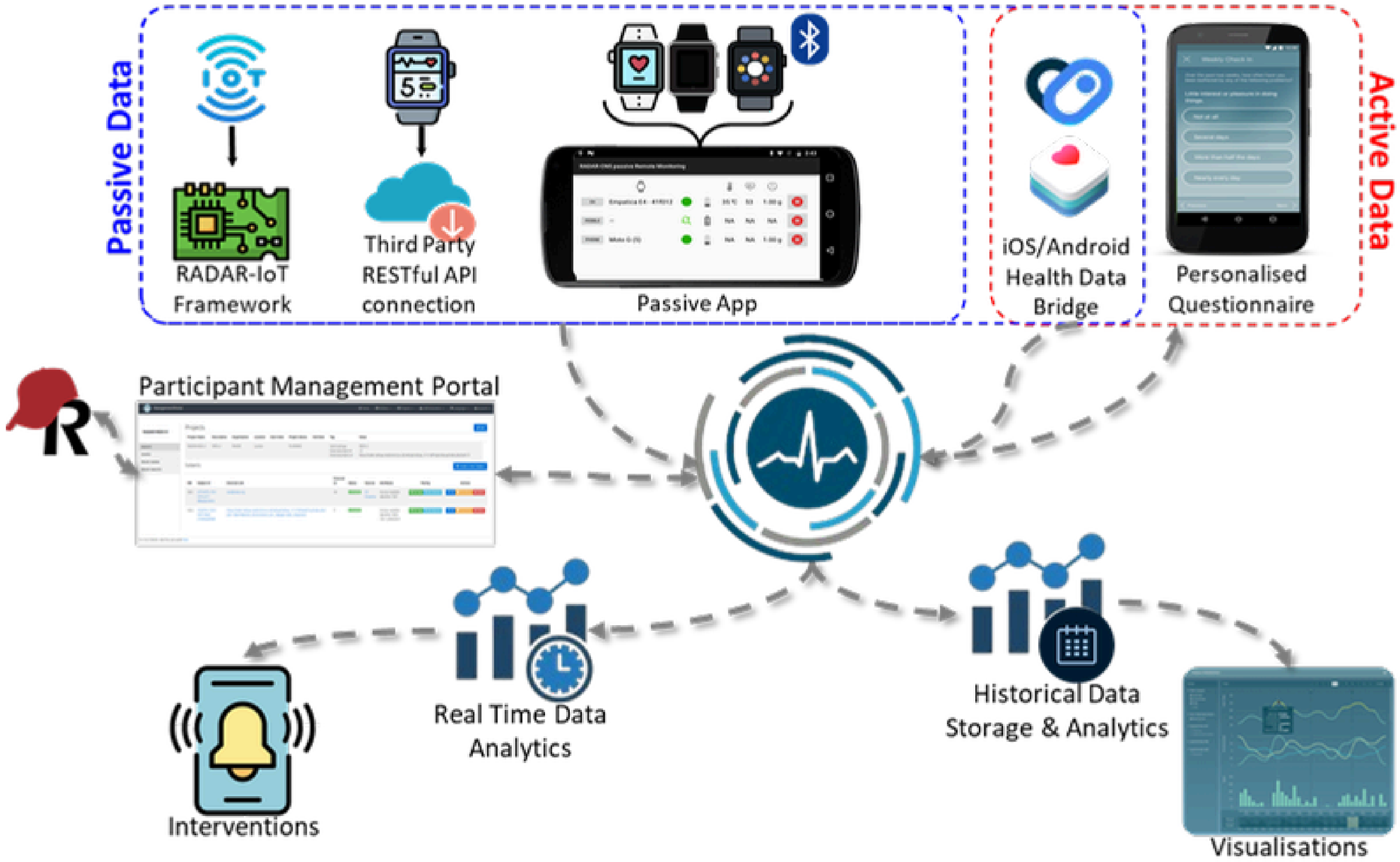
Secure

Built for robust data governance, compliance, and privacy.

Research-Ready

Specifically designed to integrate wearables into clinical workflows.

How RADAR works



Designed to support the broadest possible range of data sources

via 3rd Party Data APIs

fitbit

GARMIN

POLAR

ŌURA

dexcom

HUAWEI

Google … and more

via Smartphones

iPhone

WATCH

HealthKit

SAMSUNG Health

xiaomi

SUUNTO

WHOOP

STRAVA

myfitnesspal

… and hundreds more

Health Connect

RADAR-base Passive App → **low level raw data from phone sensors**

via Bluetooth SDKs

low level raw data

POLAR empatica Bittium

GARMIN pebble microphones

Apple SensorKit

WATCH

via Upload Connector

Axivity ax3

CanEdge 2

Fibaro

NuvoAir

…And potentially any non-integrated data source

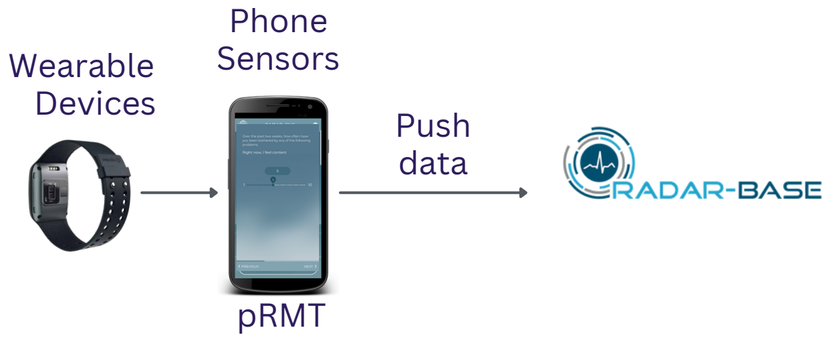
Data source catalog

aRMT

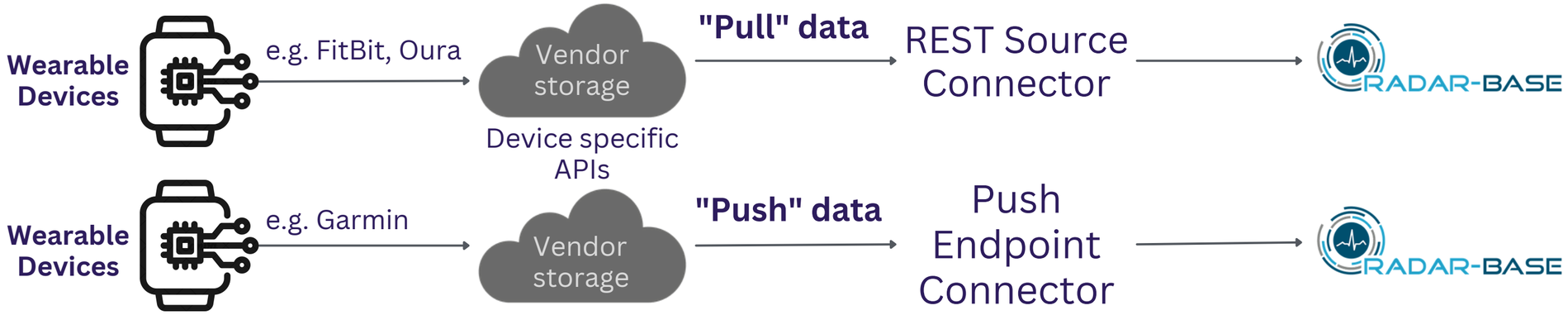
- Various questionnaires types
- Validated cognitive questionnaires
- Speech questionnaires
- Integration with phone camera and speaker
- Notifications / Reminders
- Tailored based on researchers' preferences
- Tracks engagement

pRMT

- Collect data from native phone sensors
- SDK Plugin architecture for integration of wearable devices over Bluetooth
  - e.g. Empatica E4, Faros, etc
- Easy onboarding via QR code scanning
- Real-time streaming
- Customizable plugins per study
- Network partition tolerance
- Presently Android (alpha on iOS)



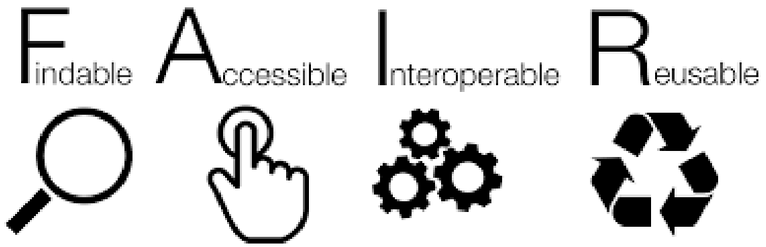
REST-API Sources: Data Collection from 3rd Party Portals



Passive data collection via wearable devices **without** Bluetooth SDK

- Plugin integrations of 3rd party APIs.
  - e.g. Fitbit, Oura (Pull) and Garmin (Push)
- Easy device authorisation and integration to a study participant via Authentication Portal
- Server-to-Server data transfer
- Collect data in vendor-determined latency or retrospectively

Data harmonization and standardisation in RADAR-base



Open and harmonized data schemas;
Inspired by Open mHealth;
Automatically transformed and structured with pseudonymised identifiers.

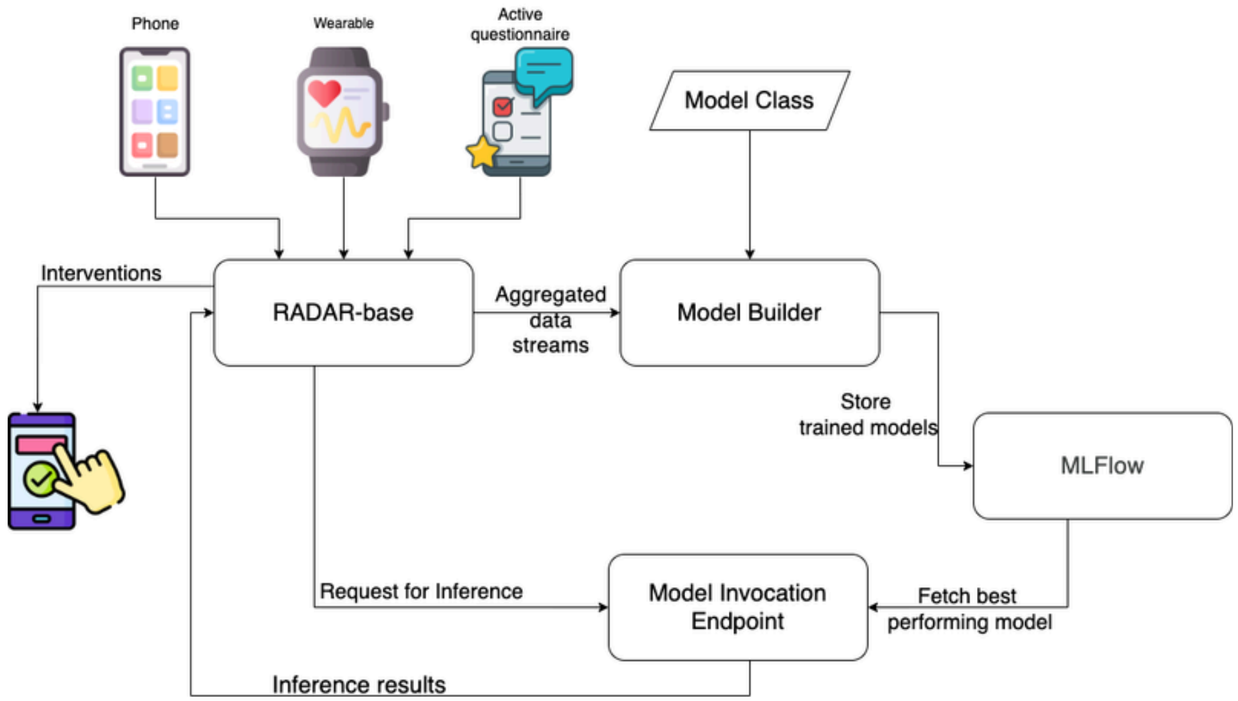
```
{
  "namespace": "org.radarcns.passive.phone",
  "type": "record",
  "name": "PhoneAcceleration",
  "doc": "Data from 3-axis accelerometer sensor with gravitational constant g as unit.",
  "fields": [
    { "name": "time", "type": "double", "doc": "Device timestamp in UTC (s)." },
    { "name": "timeReceived", "type": "double", "doc": "Device receiver timestamp in UTC (s)."
},
    { "name": "x", "type": "float", "doc": "Acceleration in the x-axis (g)." },
    { "name": "y", "type": "float", "doc": "Acceleration in the y-axis (g)." },
    { "name": "z", "type": "float", "doc": "Acceleration in the z-axis (g)." }
  ]
}
```

```
{
  "namespace": "org.radarcns.passive.empatica",
  "type": "record",
  "name": "EmpaticaE4Acceleration",
  "doc": "Data from 3-axis accelerometer sensor with gravitational constant g as unit.",
  "fields": [
    { "name": "time", "type": "double", "doc": "Device timestamp in UTC (s)." },
    { "name": "timeReceived", "type": "double", "doc": "Device receiver timestamp in UTC (s)."
},
    { "name": "x", "type": "float", "doc": "Acceleration in the x-axis (g)." },
    { "name": "y", "type": "float", "doc": "Acceleration in the y-axis (g)." },
    { "name": "z", "type": "float", "doc": "Acceleration in the z-axis (g)." }
  ]
}
```

RADAR-Flash: pipeline for real-time data processing, analysis & intervention

Core Capability

RADAR-Flash moves beyond retrospective analysis to enable immediate, automated actions based on incoming streaming data from wearables and smartphones.



Architectural Components

- Real-Time Stream Processing: Uses KSQL to run continuous queries and aggregations on live data streams.
- ML Model Integration: Integrates with MLflow for model management and real-time inference via User Defined Functions (UDFs).
- Trigger-Action Framework: Connects model outputs to effectors, like sending a targeted questionnaire or alert via the AppServer.

RADAR-IoT: integration of environmental factors for a holistic view of Health

Smartphones

detect behavioural data, phone usage, and with the active app, cognition, mood, and any questionnaire-led data

+

Wearable Devices

detect physiological & behavioural data (physical activity, stress, sleep)

+

IoT Sensors

integrates data from various environmental sensors (air quality, motion, temperature) directly into the RADAR-Base platform

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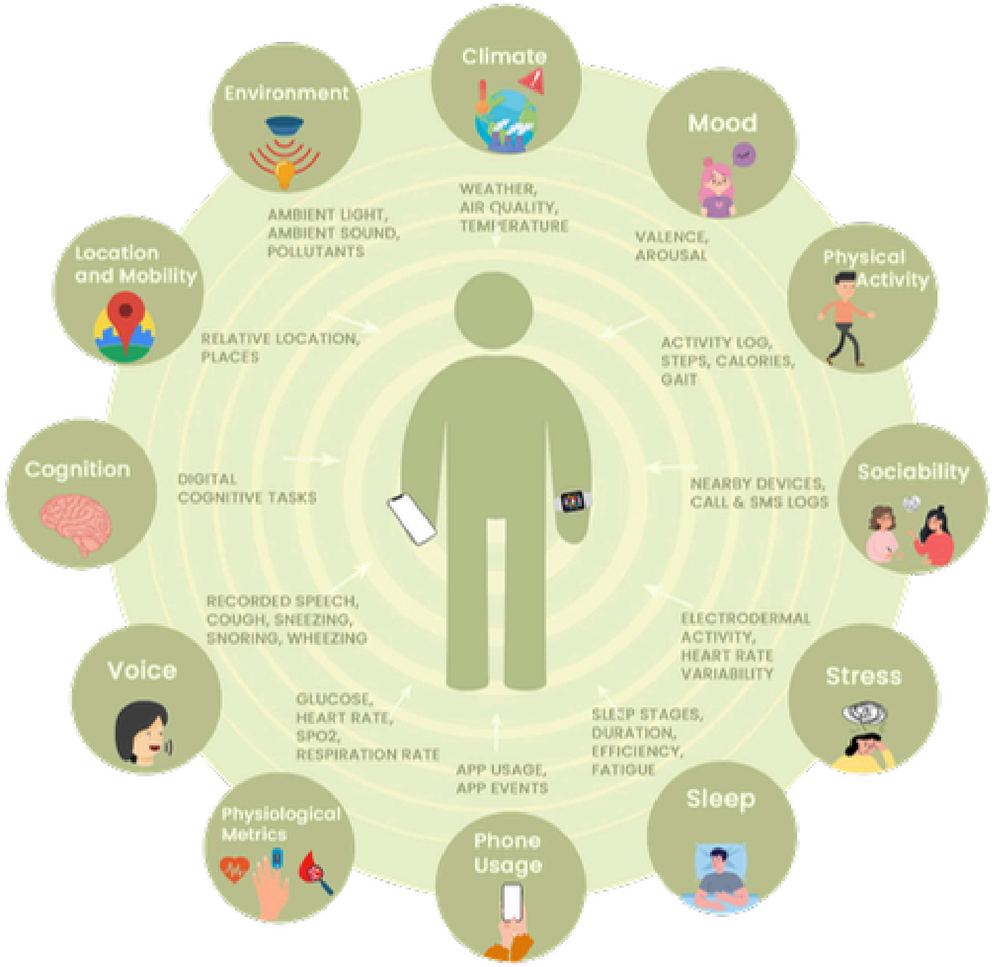
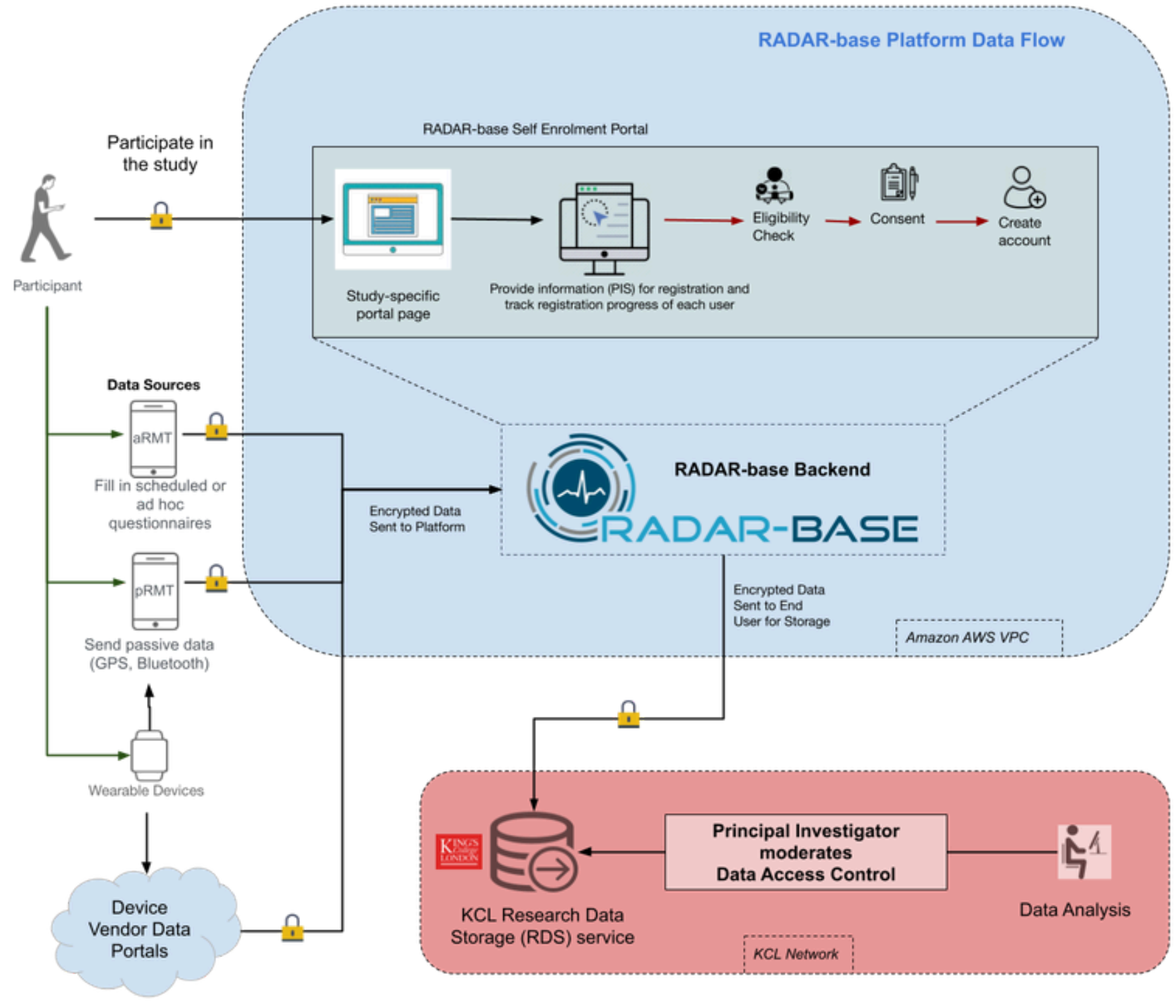
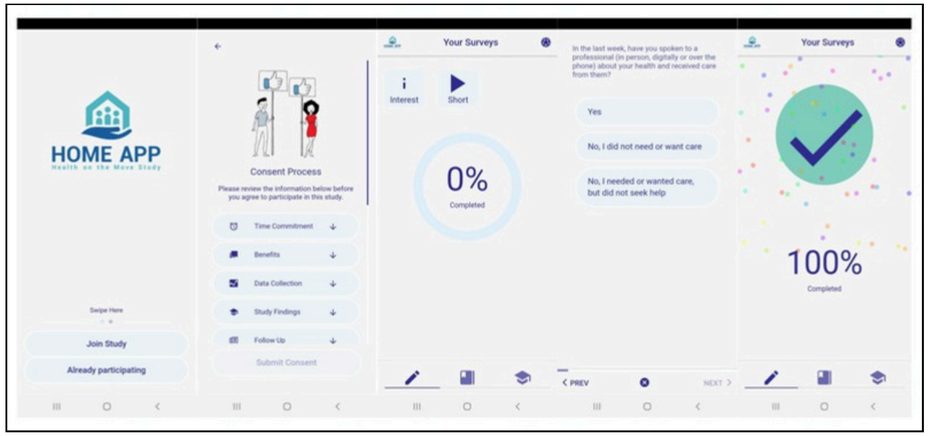
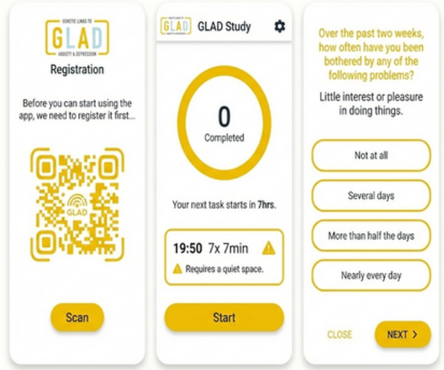


Self Enrolment Portal: From Enrolment to Data in Minutes

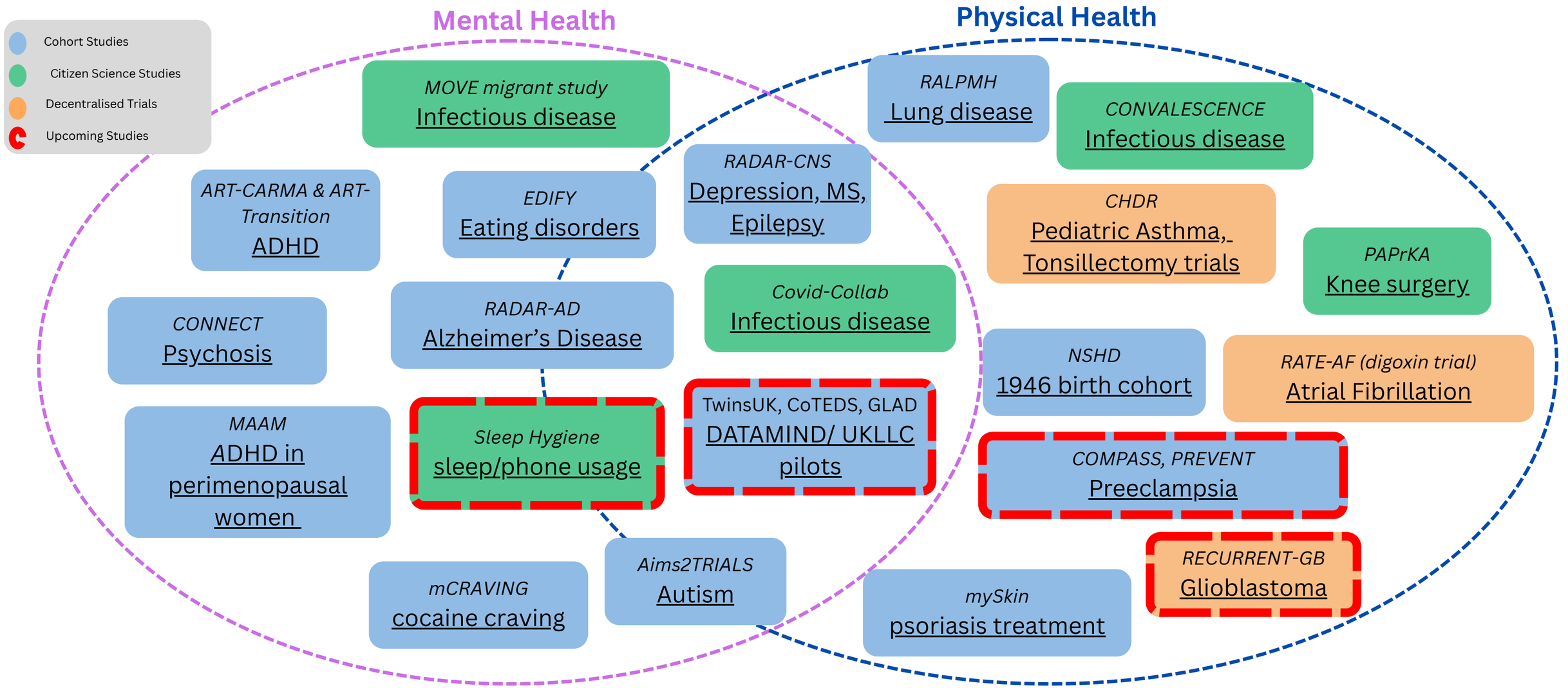


One platform, infinite shapes: aRMT can be tailored





One platform, infinite applications: Examples of Use Cases



Funded by the Horizon 2020 Framework Programme of the European Union
NIHR | National Institute for Health Research
MRC Medical Research Council
UKRI
wellcome
HDRUK Health Data Research UK

Ways to Collaborate with RADAR-base

Open Source

Deploy the public version independently

SaaS

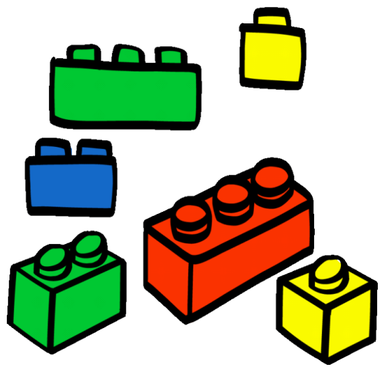
Leveraging academic partnerships and treating the deployment of the platform and the support of the RB team as SaaS

Grant Collaboration

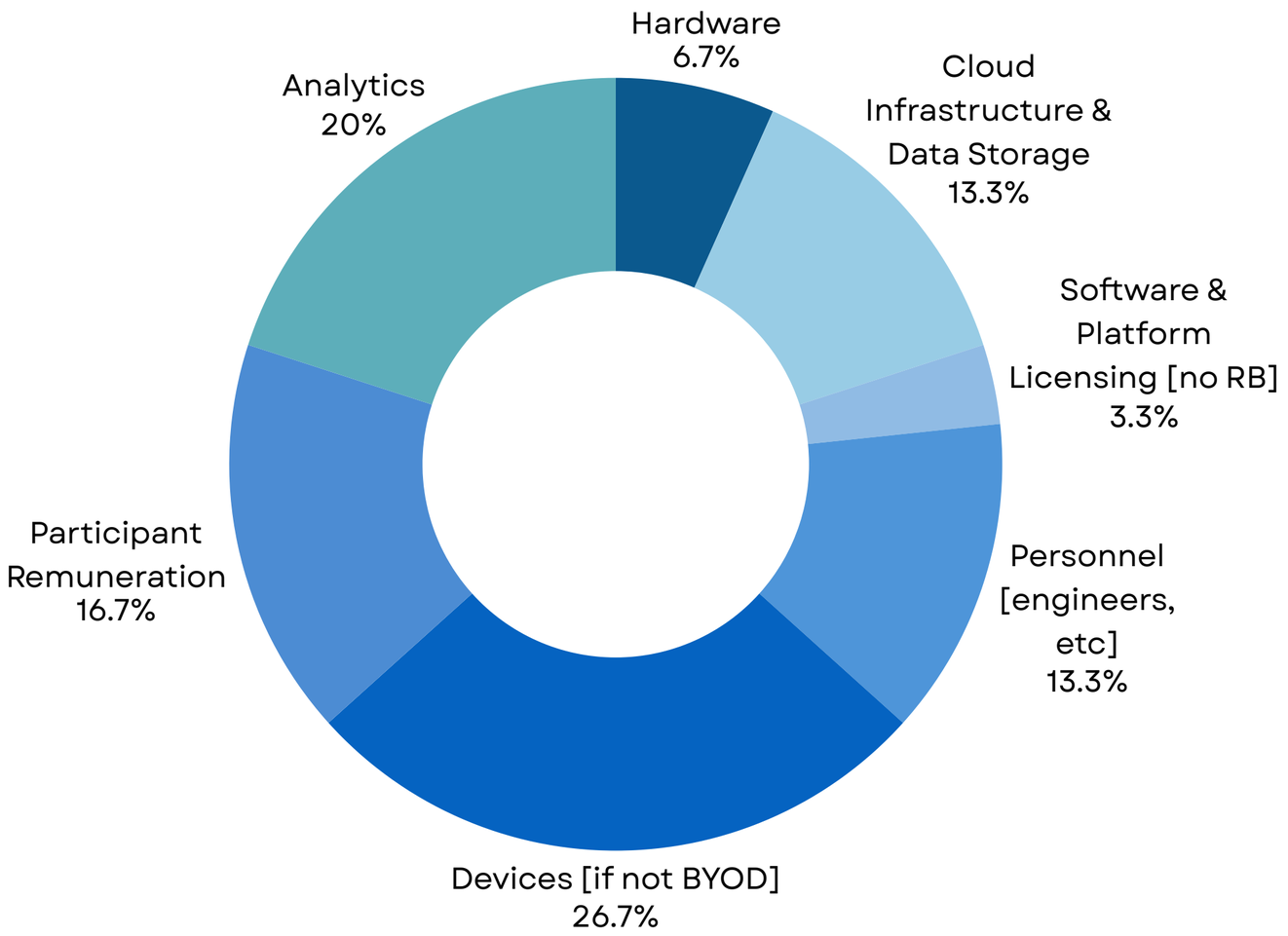
Submit joint bids with the RB team

Consulting

Utilise a fully managed, enterprise-grae service



Budget & Costing



Budget & Quotation Examples

RADAR-base Project Quotation Scoping

RADAR-base AWS Cost Calculator

What funders want to see

1 **Clinical Need**
Start with the medical problem, not the shiny technology.

2 **Feasibility**
Proven architecture like RADAR-base to handle the data.

3 **Patient Benefit**
Acceptability, comfort, and direct value to the participant.

4 **Governance**
Bulletproof data security and ethical compliance.

5 **Sustainability**
Long-term viability of the tech infrastructure.

Innovate UK Funding Example

Next Wave: Breakthrough Wave 1 Funding Guide

Innovate UK offers a £10 million fund for industrial research projects aligned with Createch innovation. This guide outlines the critical timeline, eligibility, and the four-part application process required for UK registered businesses to secure a share of the funding.

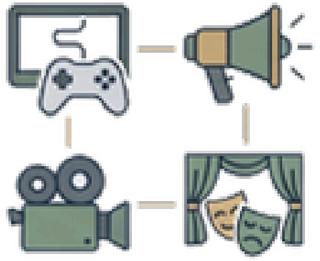
COMPETITION ESSENTIALS

£10 Million
Funding Pool
Available for UK registered businesses conducting industrial strategy aligned Createch research.

Key Competition Dates

Opens:
June 23, 2026

Closes:
August 11, 2026, at 11:00 am



Creative Industry Focus
Priority themes include video games, advertising, film/TV, and the performing arts.

APPLICATION ROADMAP

Four-Part Application Structure
Includes Project Details, 17 Application Questions, Finance breakdowns, and Project Impact.

Scored vs. Non-Scored Content

Non-Scored
Questions 1–7 provide essential non-scored background.

Scored
Questions 8–17 are scored

Project Plan

Risk Register

Mandatory PDF Appendices
Applicants must upload a Project Plan, Risk Register, and Team Summary.

APPLICATION PART FOCUS AREAS

Part 2: Scored Questions
Need/Challenge, Approach, Team, Market Awareness, Risks, and Value for Money

Part 3: Finances
Eligible project costs and funding requests per partner

Part 4: Project Impact
Economic, environmental, and social benefits outside the project team

Technology should solve a problem, not create one.

Start with the clinical question, then choose the technology.

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THANK YOU!

Get in Touch

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