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Table of Contents

| | |
|---|-----------|
| Release History | 2 |
| Executive Summary | 5 |
| 1 The ProACT Platform (2nd Release) | 6 |
| 2 ProACT Platform Components | 8 |
| 2.1 The ProACT Sensing Kit..... | 11 |
| 2.2 CareApps..... | 13 |
| 2.2.1 Design Process..... | 13 |
| 2.2.2 PwM ProACT Health and Wellbeing CareApp..... | 14 |
| 2.2.3 Care Network CareApps..... | 18 |
| 2.3 CABIE+ | 20 |
| 2.4 SIMS (Subject Information Management System)..... | 20 |
| 2.5 The InterACT Cloud..... | 22 |
| 2.6 CareAnalytics..... | 22 |
| 3 Development Process and Progress..... | 24 |
| 4 Platform Demonstrations | 26 |
| Disclaimer | 27 |



Acronyms and Abbreviations

| | |
|---------------------|---|
| API | Application Programming Interface |
| Bluetooth LE | Bluetooth Low Energy |
| CABIE | Context-aware Brokering and Inference Engine |
| FC | Formal Carer |
| HCP | Health Care Professional |
| IC | Informal Carer |
| ICT-AT | Information Communication Technology-Assistive Technology |
| PoC | Proof of Concept (trial) |
| PI | Personal Information |
| PIR(s) | Passive Infrared Sensor(s) |
| PHS | Personal Health Suite |
| PwM(s) | Person(s) with Multimorbidity |
| RESTful | Representational State Transfer |
| SIMS | Subject Information Management System |



Executive Summary

The **overall aim of ProACT** is to develop an open web application programming interface (API) ecosystem to integrate a wide variety of new and existing technologies to pull, aggregate and analyse data for the purposes of higher order inference, and to improve and advance integrated care for multimorbidity (including associated comorbidities). The ecosystem will connect four key care and support models central to understanding and implementing effective, continued and coordinated patient centric care (including self-management). These models are: 1) homecare (including informal care) 2) hospital care 3) community and social care and 4) social support networks.

The second release of the ProACT platform brings together component systems from ProACT consortium members, newly developed systems to support future development of a scalable and extendable platform, and early integration of user-driven development. This platform release will be deployed and evaluated within the Proof of Concept (PoC) trials in 2018.

Development of the ProACT platform is an iterative process which will see updates to the system continue throughout the life of the PoC trial, with updates and new features being deployed during the second and third action research cycles, and with major release milestones in M9 (1st release of platform for friendly trial, detailed in D2.5), M24 (version for PoC trial), and M39 (version beyond the project's timeframe). For this second release of the platform, a focus has been put on describing the components of the ecosystem that will be deployed in the first action research cycle of the PoC trials.

This document has been compiled to accompany the second release of the platform (D2.12) and associated demonstrations. As a public release, the purpose of this document is not to provide detailed technical descriptors of the system—these are available in other internal deliverables, including D2.6—but is, instead, to give readers a high-level overview of the developed system, its component parts, its methods of operation, its current state of readiness, and the next planned development stages.

Section 1 describes the integrated ProACT platform. Section 2 provides details on each of the component parts. Section 3 presents a table of core components, listing their development and integration status, and any in-progress or planned updates to be delivered during the PoC trial.

1 The ProACT Platform (2nd Release)

The ProACT project brings together a multidisciplinary consortium of 12 European partners for the purpose of developing and evaluating an open application interface to empower home-based, person-centred care and proactive self-management of multimorbidity, for people aged 65 and over.

To achieve these aims, the ProACT platform combines a wide range of both new and existing technologies to create a single, interoperable system which is sufficiently flexible to adapt to ever-evolving target-user requirements, and sufficiently open to allow for the incorporation of new components on an as-needed basis. On top of this technology infrastructure, the ProACT project will make use of innovative, person-centric modelling and analytics to inform and augment behavioural change techniques, and will deliver tools to educate and assist PwMs, and their wider care networks, in condition management.

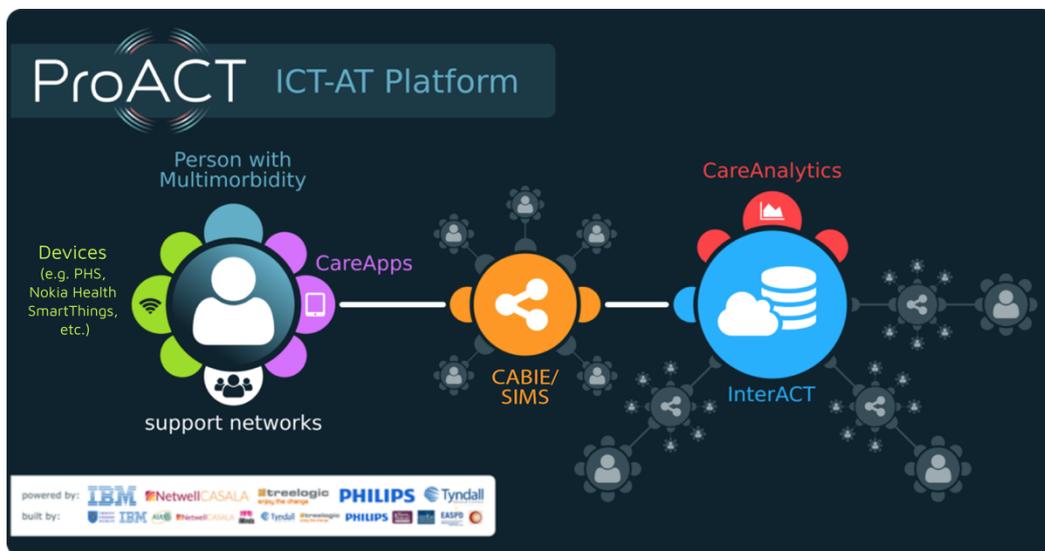


Figure 1: Overview of the ProACT ICT-AT Platform (2nd Release)

The ProACT platform is comprised of the following technologies:

- A kit of home-based healthcare support tools including novel and “off-the-shelf” measurement and sensing devices.
- A source-agnostic data collection system (CABIE+).
- A suite of end-user applications and support tools (CareApps).
- A platform to support researcher management of the ProACT PoC trials and participants of the trials (SIMS).
- A cloud-based storage and analytics platform (InterACT).
- Innovative analytics to inform behaviour change and support person-centric self-management (CareAnalytics).

Technology components for the ProACT platform have been developed by partners NetwellCASALA at DKIT (DKIT), IBM, Philips and Treelogic.

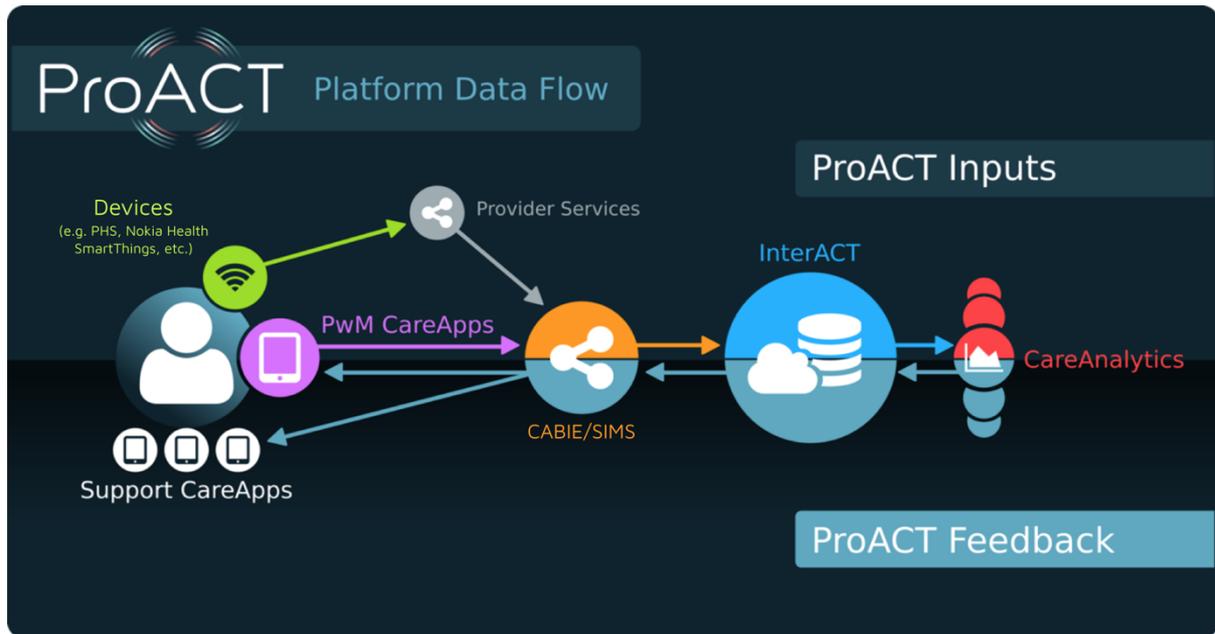


Figure 2: Data flow in the ProACT platform

The flow of data through the ProACT platform (Illustrated in Figure 2, above) starts and ends with the PwM and other relevant stakeholders. The following steps occur in the data transfer process:

- Measurement and sensing devices (e.g. SmartThings, NokiaHealth etc.) collect PwM data.
- Data is stored by device providers (surveys go directly to CABIE).
- CABIE collects data from provider stores for local PwM clusters.
- CABIE de-identifies data and forwards to the InterACT cloud.
- Analytics operate on data in the InterACT cloud (global store read and write).
- CABIE retrieves analytics results from the InterACT cloud, and re-identifies results for local PwM clusters.
- CareApps read data from local CABIE stores.

From the PwM perspective, measurement and sensing devices and CareApps will be the only system technologies visible and interacted with on a regular basis. For other end-users (formal and informal carers, health care professionals (HCPs), etc.), CareApps tailored to their requirements will be their point of interaction with system technologies.

2 ProACT Platform Components

This section provides an overview of the various components that comprise the ProACT platform. General details are provided, with more detailed, technical descriptions available in D2.6 Technical Report (restricted access). A Friendly Trial (FT) was carried out at the trial sites, the purpose of which was to test all aspects of the ProACT system to facilitate modification and adjustment of the application and processes prior to deployment in the PoC trial. The first phase of the FT (FT1) was conducted over 12 weeks and included the application of a range of scenario-based evaluations of a selection of devices for possible deployment as part of the PoC trial. A number of positive and negative aspects of the various devices were identified during FT1. These are provided in detail in D5.1 Evaluation Report on Outcomes from the Friendly Trial. Phase two of the FT (FT2) is ongoing and continues the evaluation of devices and sensors (including those tested in FT1 as well as newly identified or integrated devices) to ensure maximum interoperability, usability and connectivity. This process will be ongoing up until the PoC trial begins.

The objective of the complete FT (FT1 & FT2) is to identify a final list of devices for potential deployment in the PoC trial. Key factors considered in the selection process included:

- Ease of usability for PoC trial participants.
- Reliability of connectivity.
- Effectiveness of data transfer.
- Complete integration with the ProACT system (CABIE+SIMS, InterACT, CareApps).
- Cost and reliability of devices (including peripheral supplies required for devices).

Based on the comprehensive device testing conducted to date, a number of devices have been identified for inclusion in the PoC trial while some have been excluded. These devices are highlighted in Section 2.1 below. Table 1 lists these devices and highlights some outcomes from the FT testing. Full detail on the outcomes of the FT phase 1 can be found in D5.1 Evaluation Report on Outcomes from the Friendly Trial.

Table 1 - Devices tested in FT and selected for inclusion in PoC trial

| Device | Usability | Connectivity | Deployment Implications |
|--|---|--|---|
|  <p>Nokia Blood Pressure Monitor</p> | <p>Overall easy to use, though somewhat bulky and may be difficult for some PwMs to use alone.</p> <p>Repositioning may occasionally be required for correct reading but device app provides alert and instructions.</p> <p>Battery replacement easy.</p> | <p>No issues arising. Easy to connect and data transferring as expected from device to CareApps.</p> | <p>User protocol should include correct use instructions.</p> <p>4x AA batteries required</p> |

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| <p>Nokia (Withings) Activité Pop Watch</p>  | <p>Device is easy to use. No user action required beyond wearing the watch.</p> <p>There may be issues for some PwMs who prefer not to wear a watch at night.</p> <p>Watch strap can cause a skin rash. Replacement straps need to be available if this watch is used in the PoC trial.</p> | <p>Easy to connect and data transferring as expected when the user opens the Nokia Health Mate app to sync data.</p> <p>Background syncing without the need for the user to open the HealthMate App didn't work reliably during FT1, but appears to have resolved since Withings became Nokia. Testing continuing.</p> | <p>Training material may be required for PwM if background syncing is not reliable (i.e. to train them to open the HealthMate App to force syncing)</p> <p>Replacement straps (leather and nylon) will need to be available in researcher's toolkit in case a participant experiences a rash.</p> |
| <p>Nokia (Withings) Body Analyser Weight Scale</p>  | <p>Device is easy to use.</p> <p>Potential issue may arise for some PwMs with balance and/or stability when using device.</p> <p>PwM may not be able to read device display requiring redirection to app for data display.</p> | <p>Does not require opening app to use device, only to view reading if unable to read directly from device screen.</p> | <p>Protocol for deployment should include guidance on ensuring device is set up with stability and in a location where user can have physical support for balance while using.</p> |
| <p>iHealth Blood Oximeter</p>  | <p>Easy to set up and use.</p> <p>Provides pulse data and perfusion index (PI) as well as blood oxygen levels.</p> <p>Easy to read values on the device and on the app.</p> | <p>Data transferred to CareApp ok, once iHealth app is opened.</p> | <p>Protocol for deployment should include assessment of the best site (finger) for use of the device, based on the highest PI reading.</p> |

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| <p>iHealth Align Smart Gluco-monitoring System</p>  | <p>Initial set-up is a little complicated but once set up it is easy to use the device.</p> <p>Requires to be connected to the earphone port on the phone (tested on an iPhone).</p> | <p>Data transferred to CareApp ok, once iHealth app is opened.</p> | <p>A number of additional parts are required for use of this device including test strips, lances device cleaning wipes and a sharps disposal container.</p> |
| <p>iHealth Smart Glucometer</p>  | <p>Set up and use is easy and straightforward.</p> | <p>Data transferred to CareApp ok, once iHealth app is opened.</p> | <p>A number of additional parts are required for use of this device including test strips, lances, device cleaning wipes and a sharps disposal container.</p> |
| <p>SmartThings</p>  | <p>Ambient sensors requiring no direct engagement by users.</p> | <p>Some issues identified with sensor reliability requiring resets and battery changes with mixed success.</p> <p>Door sensors ineffective but fob functions effectively for time/location data.</p> | <p>Reassurance and information on the nature of the sensors must be provided in user manual and during orientation.</p> <p>Placement of sensors should be unobtrusive.</p> <p>Door sensors deemed too unreliable for the PoC trial.</p> |
| <p>Philips Health Watch</p> | <p>Watch considered too large and bulky for wearability during FT1. Accessing information was considered as potentially too complex for the PoC trial participant population. Short battery life and recharging requirements were also deemed</p> | <p>Integration with CABIE was completed mid-October 2017. However, there is no access to sleep data and further work is needed on the PHS side to deliver step count data in a format useful for PwMs.</p> | <p>This device will be offered to some participants monitoring heart conditions from the second ARC, once integration is completed. Given the complexity of interacting with the watch, later introduction will allow early</p> |

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| | potentially too onerous for PwMs. | | training for PwMs to focus on other elements of ProACT. |
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2.1 The ProACT Sensing Kit

Measurement and sensing devices in the ProACT platform are used to collect clinical, non-clinical, and ambient parameters from PwMs. Additionally, a dedicated tablet device will be provided to PwMs participating in ProACT trials. Among other uses (see section 2.2, *CareApps*), this device will be used to collect scheduled survey responses from PwMs.

Following detailed testing during the second phase of the FT with trial site researchers, the following sensing devices have been identified to support PwMs monitoring ProACT’s targeted conditions (please also refer to D2.6 *Technical Report* (restricted access) and D2.8 *Deployment Plan for PoC Trial* (restricted access) for further details). All devices currently integrate with CABIE. In addition to these automatic readings, PwMs can manually enter readings through the PwM Health and Wellbeing CareApp, for example if they already use a glucometer and do not want to change device.

- **Nokia Health - Wireless Blood Pressure Cuff:** Captures diastolic and systolic blood pressure, and heart rate. This is a connected device. This device does not feature an on-device interface for activation, the Nokia HealthMate application on a paired tablet (or phone) must be opened to take a reading. This device will synchronise each time it is used.
- **Nokia Health - Wi-Fi Body Scale:** Captures weight and BMI readings. This is a connected device which can be paired directly through a Wi-Fi network, or via Bluetooth to a tablet or phone (iOS or Android). When paired through a Wi-Fi network, this device will synchronise each time it is used. This device is activated when an individual steps onto it.
- **iHealth - Smart Glucometer:** Provides blood glucose level readings. The iHealth Gluco application must be used to take the reading. The glucometer connects to the iHealth application over Bluetooth. It synchronises each time it is used.
- **iHealth - Air Smart Pulse Oximeter:** Provides blood oxygen saturation levels (SpO2). The iHealth Vitals application must be used to take the reading. The oximeter connects to the iHealth application over Bluetooth. It synchronises each time it is used.
- **Manual Vitals Readings -** The PwM can enter any of the above values through their CareApp. Once connected to Wi-Fi, these readings are automatically sent to CABIE.
- **Nokia Health - Steel Smart Watch:** Tracks the number of steps a wearer has taken in a day. It also tracks time asleep, time awake, wake-up count and stages of sleep, inclusive of time spent in light, and deep states. This is a connected device. When paired with an iOS tablet or phone which features Bluetooth LE (Low Energy), this



device will automatically synchronise in the background. When paired with an Android tablet or phone, this device will synchronise each time the Nokia HealthMate application is opened. This device is water resistant, and can store 38 hours of data before needing to synchronise with a paired tablet or phone. The battery lasts approximately 8 months.

- **Philips – Personal Health Suite (PHS) Health Watch:** Tracks steps, sleep and continuous heart rate. This device will be offered to PwMs interested in monitoring heart rate. This is a connected device. It requires the user to open the companion PHS application on their tablet or phone to synchronise the data. The battery lasts approximately 4-5 days.
- **Smart Things - Ambient Sensing Kit:** This kit includes a network-connected “hub” to connect all ambient devices in a home, passive infrared sensors (PIRs) for a common set of rooms (living room, main bedroom, bathroom (including ensuite), kitchen) and multi-use (contact) sensors for front and back doors. These are connected devices. PIR devices are activated on movement within their sensing zone. Contact sensors are activated on state changes (going from open to closed; closed to open). These devices automatically synchronise with the home-based SmartThings hub.
- **Tablet -** An iOS tablet featuring Bluetooth or Bluetooth LE technology to pair connected devices. This device will host any required provider applications (e.g. the Nokia HealthMate application). This device will also host the PwM Health and Wellbeing CareApp which will deliver scheduled self-reporting surveys.

Data from the above devices is collected by the CABIE aggregation system (see section 2.3) at regular intervals throughout each day, or as data is received by provider systems (collection methods and frequency are provider- and device-dependent). Survey responses and manually-input readings are sent directly to CABIE. For daily metrics (such as step counts, sleep summaries), collected data is de-identified and forwarded to the InterACT cloud when a finalised reading for each day has been collected. For point-in-time measurements (such as blood pressure readings) from connected devices, data will be forwarded to the InterACT cloud as it is received and de-identified by CABIE. Raw readings data on CABIE will be available to CareApps as soon as it has been received by the system.

2.2 CareApps

2.2.1 Design Process

CareApps in ProACT are interactive dashboards which provide tailored interfaces for multiple ProACT ecosystem stakeholders, and facilitate all user-facing interactions with software components of the ProACT platform. The design process for all CareApps began following the requirements gathering phase of ProACT. The main aim was to identify the CareApps needed for ProACT and their key functionalities. The design team worked from the list of user requirements, presented in D1.2 Stakeholder Report – user requirements from the main trial sites in Ireland and Belgium can be found in Section 4.4.5, while requirements from the Italian transferability site can be found in Section 5.2.2.

Some key decisions and design principles emerged from these discussions. In addition, the following CareApps were identified for inclusion within ProACT:

- PwM Health and Wellbeing CareApp (the core ProACT application).
- PwM Medication CareApp.
- PwM Social Connectedness CareApp.
- Informal Carer (IC) CareApp.
- Formal Carer (FC) CareApp.
- Healthcare Professional (HCP) CareApp (including pharmacists).

The design process was built around a series of Co-Design workshops with PwM and Care Network users. A subset of the participants from the requirements gathering phase were invited to take part in the co-design workshops in Ireland and Belgium, which took place from February 2017. Analysis of the requirements gathering phase took place first, and a number of themes were derived (see D1.2 Stakeholder Report). Co-design workshops were conducted to validate these findings and explore some of these themes further, to aid with design of the ProACT system (for example, to further explore and understand needs around certain topics, such as goal-setting, and how best to integrate these into the design of the system. Co-design workshops were audio and video recorded. For interactive parts of the workshops (such as choosing dashboard designs), researchers reviewed the recordings and made detailed notes. Lengthier discussion sections of the workshops were transcribed verbatim. Both notes and transcripts were used in analysis.



Figure 3: PwM participants choosing preferred colour schemes



Figure 4: PwM choosing dashboard designs

2.2.2 PwM ProACT Health and Wellbeing CareApp

This application will be used by individual PwMs and will be deployed on the tablet as part of the PwM kit during ProACT trials. PwMs can use this CareApp to view their collected and generated ProACT data (sensor readings and analytics, respectively); to view condition-relevant and general wellness tips and training; and to engage with scheduled self-reporting surveys. Additionally, this application will allow PwMs to input readings from non-connected devices.

This interface in Figure 5 represents the user's Home screen. The flower acts as a quick-glance overview of the PwM's current status (for example, their current step count, their last Blood Pressure reading). Each petal of the flower can be either blue or pink – with pink representing a 'nudge' to the user to further explore the petal.

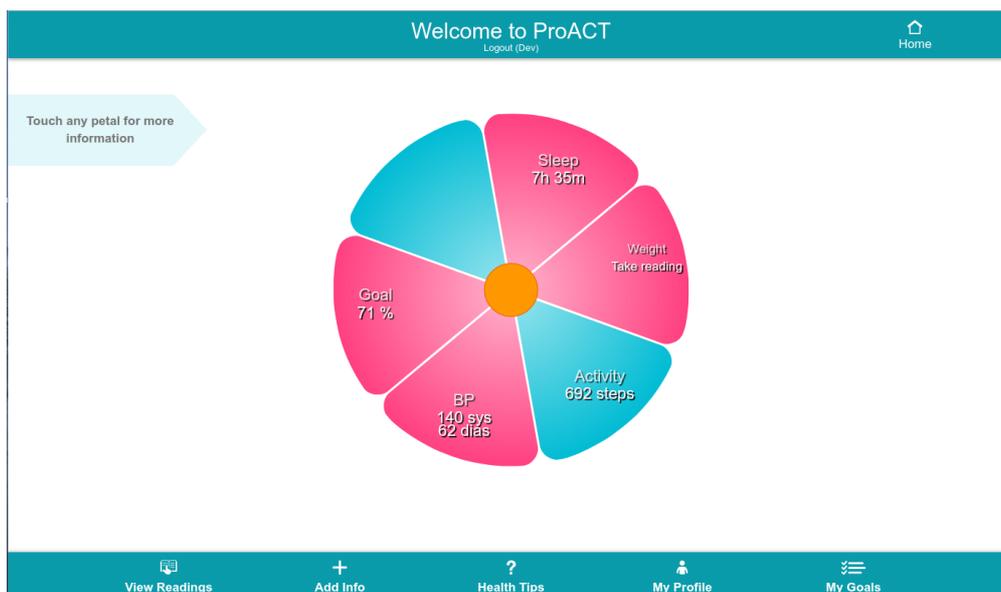


Figure 5: PwM Dashboard

Within the View Readings section, users can choose one of four options – Symptoms, Sleep, Activity, Mood and Wellbeing. Mood and Wellbeing shows data over time from the Daily Questions section of the CareApp (see Figure 7 below). Symptoms, Sleep and Activity show data coming from devices. Each section has the following key features (Figure 6):

- Ability to view data in chart format or table format.
- Ability to view data in Day, Week or Month format.
- Calendar navigation to previous data.
- Ability to switch between different types of graphs (e.g. blood pressure, blood glucose).
- An ‘Explain This’ section, which links to a popover explaining about the data in the graph (for example what device it came from, help with interpreting the graph).



Figure 6: View Readings Section

Within the Add Info section, PwMs can enter manual vitals readings and also answer Daily Questions (Figure 7) – which include questions around general wellbeing, anxiety, satisfaction with sleep and social interactions, as well as COPD symptom monitoring questions (for example, breathlessness, sputum colour).

← Back Daily Questions Home

How do you feel today?

Great ✓

So-so

Not so great

Next

View Readings Add Info Health Tips My Profile

Figure 7: Add Info Section showing number of Daily Questions to answer today

Within the Tips section, there are two main categories:

- **Did You Know?:** This section contains educational content relating to conditions and self-management. There are a number of sub-categories personalised to each PwM (for example, COPD, Hypertension, Activity).
- **How Do I?:** This section contains educational content on how to use devices, (including the iPad) and the CareApp(s).

There is also a Favourites section for easy access to content that the PwM has marked as 'Favourite'. Within each sub-category, archived educational content is available to the PwM (Figure 8).

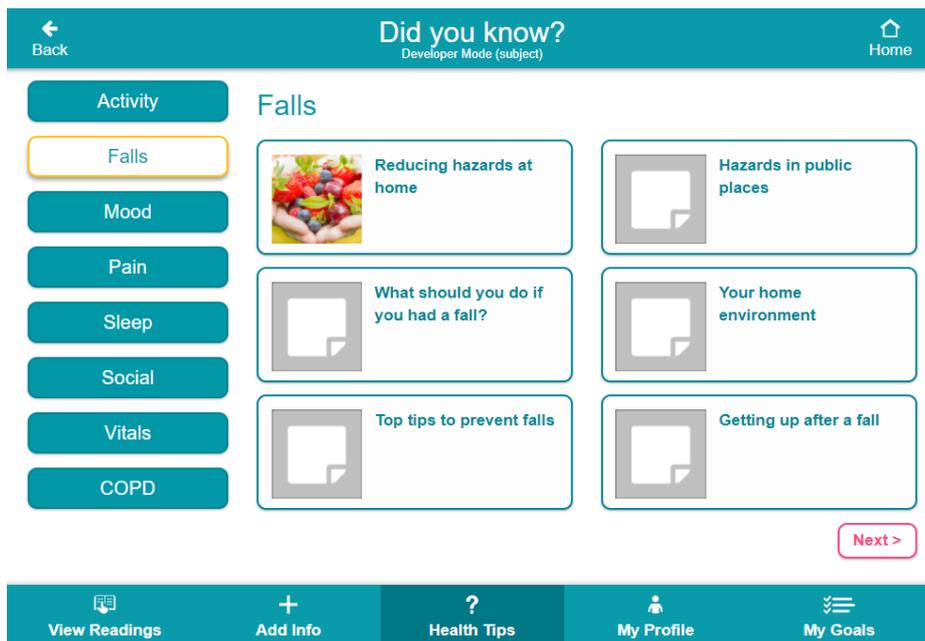


Figure 8: Educational Content

The My Profile section of the application supports the PwM in having control over various aspects of their CareApp, including who they would like to share their data with and how often they would like reminders to take readings. There are two key sections: My Settings and My Network. Within My Settings, the PwM can see what conditions they are managing with ProACT. Within My Network, people can be added to the care network, and the PwM can decide what data to share with each care network member.

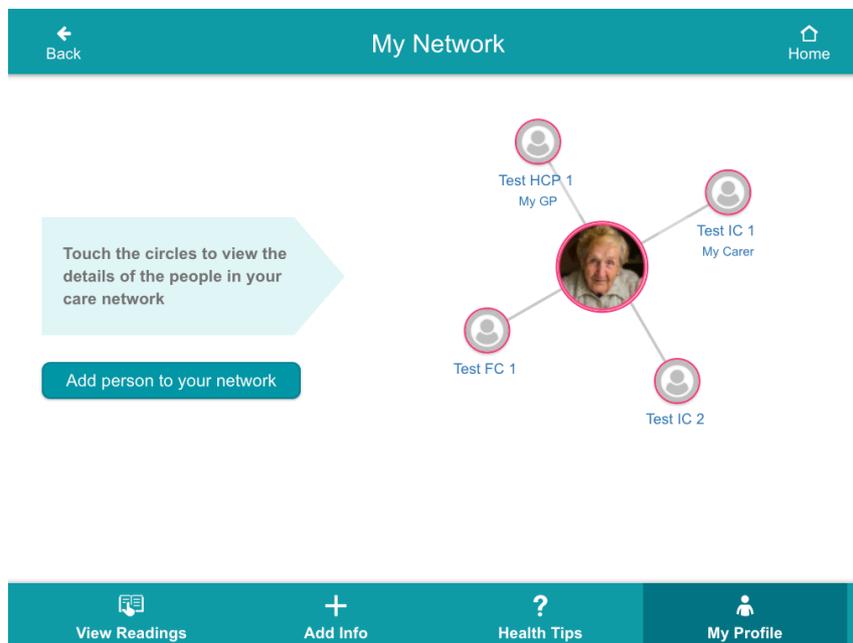


Figure 9: Participant's Care Network

A 5th key section of the CareApp relates to supporting the PwM in setting Goals and feedback on their goal attainment. This feature will be released in the second action

research cycle of the trial, but the design process of this feature has already begun (Figure 10).

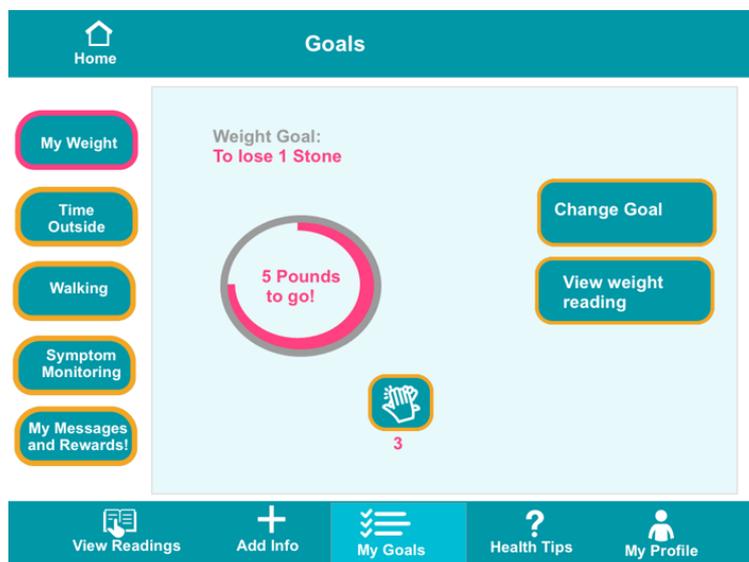


Figure 10: Overview of goals and goal progress

Additional CareApps for the PwM, namely a Medication CareApp and Social Connectedness CareApp are currently in the design phase and will be introduced in later action research cycles of the trial, to support our phased approach to feature introduction and training. All CareApps for the PwMs have been designed following accessibility guidelines and good practice in design for older adults.

2.2.3 Care Network CareApps

Different versions of the PwM Health and Wellbeing CareApp have been designed and developed for care network members. These have a very similar look and feel and are described briefly below. It should be noted that the PwM decides whom they add to their care network and what data is shared with each person. The CareApps have been designed to be responsive and thus can be used on multiple platforms.

- **Informal Carer CareApp:** This application will closely resemble the functionality of the PwM Health and Wellbeing CareApp, but with content tailored toward informal carers. Informal Carers can use this application to view data relating to the PwM in their care, and to view relevant training and tips material. As with the PwM Health and Wellbeing CareApp, this application will only display data for a single PwM. This application will be available through a tablet, phone or browser interface (device agnostic).
- **Formal Carer CareApp:** This application will be used by formal carers to view wellbeing data from multiple PwMs, and to view training materials relevant to the formal care process. This application will be available through a tablet, phone or browser interface (device agnostic).
- **Health Care Professional (HCP) CareApp:** This application will be used by health care professionals to view health and wellbeing data from multiple PwMs. Training materials on how to use the ProACT system will also be included. This application will be available through a tablet, phone or browser interface (device agnostic).

These CareApps are to be deployed for the platform's second release, and evaluated during the first action research cycle of the project. As feedback is received, it is anticipated that further functionalities will be added.

The design process of the CareApps is led by TCD and DkIT while development is led by partners Treelogic, Philips and DkIT.



2.3 CABIE+

The Context-aware Brokering and Inference Engine (CABIE) is a source-agnostic data aggregation platform developed by NetwellCASALA, DkIT. The latest update of the CABIE platform, known as CABIE+, has been developed in conjunction with ProACT timelines, and is now powered by 2 central components: CABIE+ Core (described in this section), and CABIE+ SIMS (described in Section 2.4).

CABIE+ Core is the main data repository, collection management, and dissemination broker in CABIE+. This component aggregates data from a wide variety of sources, inclusive of connected commercial API services, cloud-based development platforms, analytic engines, and web applications, among others.

CABIE+ Core is an API-only application, where all interactions take place through access-controlled APIs or server-side management utilities. As such, CABIE+ Core is not a user-facing application, and instances are always abstracted behind a CABIE+ SIMS instance.

CABIE+ Core normalises data inputs to maintain a persistent, real-time, searchable store of PwM data which originates from a wide variety of devices and services. This data is stored under coded identifiers, with no personal data retained on the individuals the data is being collected on behalf of. The storage of low-resolution demographic information, such as gender or year of birth, is allowed on an opt-in basis.

Within ProACT, CABIE+ Core is the primary exchange mechanism used to connect the distinct technology components provided by various partners. This component is used to collect, centrally, data from all connected devices used by PwMs (smart watches, blood pressure monitors, weight scales, ambient sensing devices, etc.), to normalise this data for storage, to make this data available to additional CABIE+ and ProACT components (SIMS, InterACT), to organise data into logical groupings, and to provide a configurable processing pipeline which allows incoming data to be inspected and reacted to in close-to-real-time.

2.4 SIMS (Subject Information Management System)

The Subject Information Management System (SIMS) has been developed by DkIT as an administrative tool to facilitate management of trial site technologies, provide an abstraction layer for managing multiple CABIE+ Core instances, and to provide research and technical teams with a user-friendly, centralised service for monitoring and inspecting various elements of the ProACT platform. In addition to these features, SIMS also provides a user-facing API which has been used by ProACT partners in the creation of ProACT CareApps.

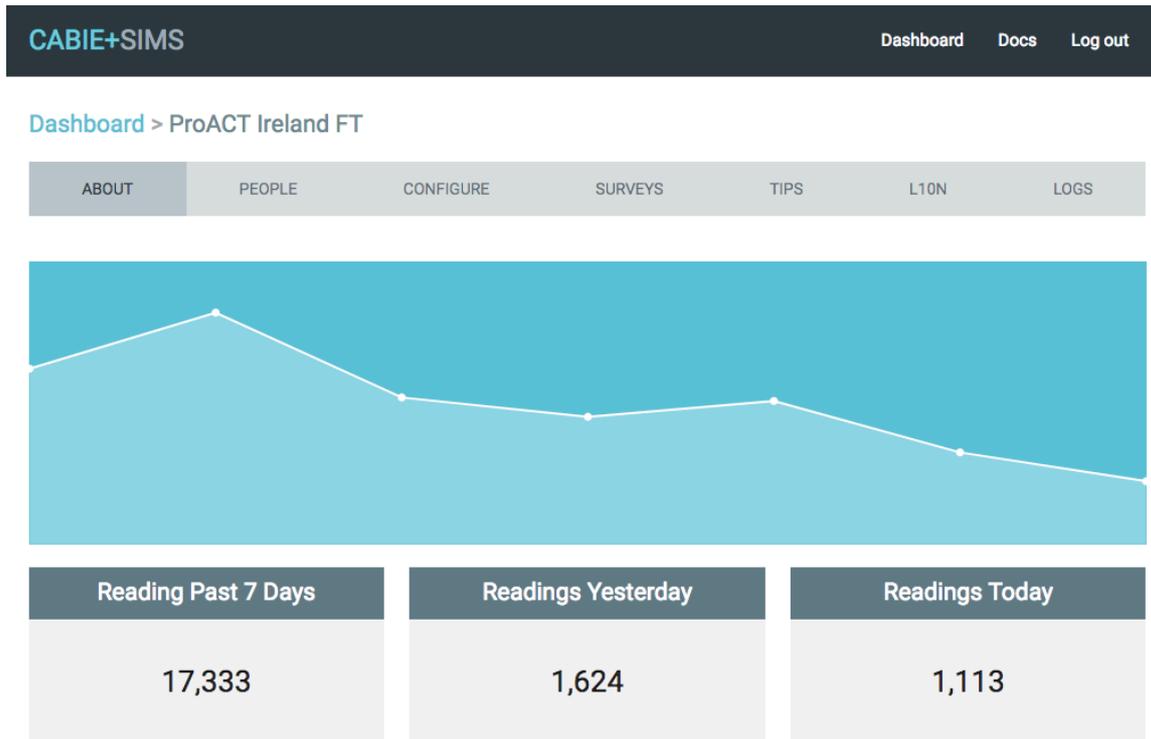


Figure 11: SIMS Web Interface

SIMS has been developed as an in-house extension to DkIT’s CABIE platform. As such, the terminologies used within CABIE have been extended into SIMS—Individuals involved in trials, referred to within all ProACT documents as “Persons with Multimorbidity” are instead identified as “Subjects”. For elements that make their way to PwM CareApps, the system features tools for translating these into project-appropriate language.

The SIMS web interface acts as an administrative tool for those involved in the management of trial sites, and in the evaluation of the ProACT project objectives. In brief, some of the features include:

- Add participants and their demographic details.
- Assign sensing kits to participants, and link these to ensure data flows from PwM devices, through ProACT and back to PwM CareApps.
- Setup and schedule Daily Questions for PwMs to answer through the CareApp.
- Setup, store and schedule the delivery of education and training content to PwMs via the CareApp.
- Inspect PwM data.
- Manage Care Network permissions.

The SIMS API acts as a feature enhancement for those developing components for the core ProACT systems (in particular, those developing CareApp dashboards). As such, it should be understood that end-users of the SIMS system are the research and development teams involved in the creation of the ProACT platform, not end-users of the platform itself. This is not a directly user-facing component.

2.5 The InterACT Cloud

ProACT's global data store, the InterACT cloud, has been developed by partners IBM to act as an efficient, secure platform for the storage, mining, and analysis of de-identified PwM data. The InterACT cloud acts as a nexus for local data aggregators (CABIE) and provides a platform for analytics services to make use of collected data in a secure and privacy-conscious manner.

The InterACT cloud has been designed to be easily extended, features dynamic storage allocation, and is exposed as a set of services to manage anonymised health data, and to coordinate collaboration between data provider services, data analytics services, and data consumer services. The platform features a role-based authentication system which controls access to various data stages, and can be interacted with through a Representational State Transfer (RESTful) API.

External systems (e.g. CABIE, CareAnalytics providers) which register with the InterACT cloud through the role-based access system will only have access to the data states their roles permit. PwM data stored in the InterACT cloud undergoes a de-identification process before reaching the service. This process ensures that data available to analytics providers (one of the available roles) does not contain personal information (PI), and also that it has been disassociated from programmatic identifiers which might be used to re-identify individuals through inference from access to public components of partner systems—for example, individual identifiers within the InterACT cloud are not the same identifiers used for a PwM within CABIE or CareApps. More details on the architecture of InterACT and how to interface with it are available in deliverable D3.4 *"The InterACT Cloud infrastructure"* and its update D3.13, which are restricted deliverables.

2.6 CareAnalytics

A *CareAnalytic* in ProACT is defined as a contextually-aware procedure or algorithm which can detect and react to patterns in current or historic data available to ProACT systems. CareAnalytics are one element of the person-centric analytics platform being developed for the ProACT ICT-AT solutions.

Advances in other WPs have allowed progress in the specification of the CareAnalytics. These specifications have been made as an iterative process, the more natural and evidence-based way to converge to the optimal analytics, and they will be implemented over the coming months, as the PoC trial proceeds and data is gathered from PwM users.

The current catalogue of *CareAnalytics* in ProACT is:

- Probabilistic Health and Wellness Profile Builder - IBM leads the development of a model for the PwM that takes into account a plurality of dimensions. The main goal of the model is to give a comprehensive overview on the PwM and their health and wellbeing state in the different dimensions. It will be able to provide a wide range of outputs, from missing data computing, to wellness score evaluation, and predictions outcome. The first version of the model is available and working.

- **Data Cleaner** - This *CareAnalytic* will classify the type of data in terms of quality (or reliability) and those analytics that use vitals as input will work on the results of the data cleaner instead of working on raw data. Additionally, it will calculate the thresholds (normal ranges) for the vitals that will serve as input into the education recommender. It will be available for the start of the PoC trial.
- **Goal Recommender** - A flexible approach has been taken to set goals in ProACT, since the literature for digital behaviour change interventions is not conclusive. With the aim of having an extra way of setting goals, the development of an automatic **goal recommender** will be made by Treelogic (M29).
- **Education Recommender** - This *CareAnalytic* will facilitate training material (tip of the day, videos or other tagged content) using a smart approach: on one side, it will use thresholds on vitals so if any parameter has reached a value out of the normal range (statistical normal range per PwM), the PwM will be presented with specific training material. On the other side, this smart approach will use the output of the user engagement analyser to detect a low engagement level and will guide the PwM in the usage of the system. The first version of this *CareAnalytic* will be available in M33.
- **User Engagement Analyser** - In order for participants to become engaged in device data gathering, key person-centred issues relating to usefulness in care, motivation, the safety and privacy of information, and clinical integration need to be addressed. To that aim, a *CareAnalytic* based on the user engagement analysis will be developed by Treelogic and will be available in M29.

Detailed descriptions of the *CareAnalytics*, along with timeline justifications, can be found in D3.9 *A Set of Person-centred Analytical Methods for Risks and Outcomes* (restricted deliverable) for the user's engagement analyser, the goal recommender, the education recommender and the data cleaner, and in D3.7 *Machine-processable representation of individual and the analytical model* (restricted deliverable) specifically for Probabilistic Health and Wellness Profile Builder. Partners Treelogic and IBM will have primary responsibility for the creation of ProACT *CareAnalytics*.

3 Development Process and Progress

The ProACT platform has been, and will continue to be, developed in direct consultation with PwMs and key identified stakeholders in their care networks. As a first step in this process, extensive engagement with stakeholders has taken place in WP1 to identify and better understand care pathways and requirements. The findings from this process will be augmented throughout the life of the project by continued stakeholder engagement and feedback, all of which will directly influence future development and refinement of the ProACT platform. This second platform release has focused on the ProACT components to be deployed in the first action research cycle of the PoC trial. However, realisation of the full platform is an ongoing process where iterative updates and augmentation will continue throughout the project’s lifetime, and through the trial action research cycles. A final major update will be delivered in M39 (prior to the project’s completion).

Table 2 below, lists the core components of the ProACT system, their current state of development and integration, and any works currently ongoing or planned throughout the PoC trial:

Table 2 - ProACT Technical Components, Status and Roadmap

| New Tech. Component | Developer(s) | Current Status | Roadmap |
|---------------------------|-------------------|--|--|
| InterACT Cloud | IBM | PoC Complete | User management, Testing, Deployment |
| CareAnalytics | IBM/Treelogic | In Development | IBM are working on the Health and Wellness Profile Builder. A PoC ready to be deployed for the main trial has been developed, further updating to the model/parameters will be carried out during the trial. More details can be found in D3.7. TREE are working on a goal recommender (ARC 2), education recommender (ARC 3), user engagement analyser (ARC 2) and data cleaner (ARC 1). |
| CareApps Platform | Philips/Tree/DKIT | In Development. First versions for PoC 1 st action research cycle (ARC) complete and undergoing constant testing, bug fixing and refinement | Philips and TREE are co-developing the CareApps based on designs from DkIT and TCD. DkIT are making additions to CABIE to provide support for new functionality required by the CareApps and have made an API available. Philips has also written a user management solution. |
| SIMS | DKIT | PoC Release 2 Complete | PoC Release 1 utilised for FT. PoC R2 currently complete. |
| Novel Measurement Devices | Tyndall | Need not yet identified. | Under constant evaluation. Aim to introduce into action research cycles 2 and/or 3. |



| | | | |
|----------------------------|----------------|-------------|---|
| InterACT/CABIE Integration | IBM/DKIT | In progress | 1-way data-sharing complete (CABIE->InterACT). All tools required for bi-directional sharing in place for 1 st ARC with partial tested. Final integration awaiting availability of all analytic data (ARC 3 following deployment of final set of analytics). |
| CABIE/SIMS Integration | DkIT | Complete | N/A |
| Device Integration | Philips / DkIT | In progress | Third party device provider devices are all integrated (iHealth, NokiaHealth, Smart Things, PHS). |



4 Platform Demonstrations

Demonstrations of the ProACT platform (second release) will be available at trial sites in Ireland, Belgium, and in the transfer feasibility site in Italy throughout the PoC trial. Where appropriate, out-of-trial demonstrations of the system or component parts can be arranged on request to the Project Coordinator in Trinity College, Dublin.



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