ProACT	**Acronym:** ProACT **Title:** Integrated Technology Ecosystems for ProACTive Patient Centred Care **Call:** PHC25-2015: Advancing ICT Systems and Services for Integrated Care **Duration:** 42 Months **Website:** www.proact2020.eu **Grant Agreement No.:** 689996

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Dissemination Level	
Restricted	
Public	X

The ProACT project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No. 689996.

Release History

Version	Date	Status*	Revision Comments	Author
V0.1	13/10/2017	D	Initial Draft (M22). A final update to this document will be available in M39. An initial version was made available in M10 (D3.3).	Shane Gavin
V0.2	15/10/2017	D	Version for internal review	Shane Gavin
V0.3	20/10/2017	D	Reviewer Comments	John Barton, Nuwani Edirisinghe
V0.4	20/10/2017	D	Version for final review	Shane Gavin
V1.0	23/10/2017	C	Final version for release	Shane Gavin

*Status of deliverables is indicated by abbreviations/terms as follows:

Draft (D): The deliverable is partially complete or complete but under review/revision before release.

Complete (C): The final deliverable document is 100% completed, reviewed and authorised for release by the partner responsible for the deliverable or the WP leader.

Revised (R): The final released document has been modified/updated with new content.

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Acronyms and Abbreviations

API	Application Programming Interface
CABIE	Context-aware Brokering and Inference Engine
CPU	Central Processing Unit
FT	Friendly Trial
ICT-AT	Information Communication Technology – Assistive Technology
PoC	Proof of Concept (Trial)
PwM(s)	Person(s) with Multimorbidity
RAM	Random Access Memory
RTT(s)	Round-trip Time(s)
SIMS	Subject Information Management System
VPS(s)	Virtual Private Server(s)

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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.

This document presents initial evaluations of areas in which the ProACT ecosystem's performance can be measured at a macro level, producing outputs relevant to project researchers and technical teams. **Section 1** serves as an introduction to the document scope. **Section 2** describes categorisations for analytics in the ProACT ecosystem, and identifies the areas in which analytics to measure ecosystem performance will operate. **Section 3** presents a list of 14 areas for measuring ProACT ecosystem performance. **Section 4** lists the data requirements for the area of analysis presented in section three. **Section 5** identifies those analytics which were available for integration in time for ProACT's friendly trial. Finally, **Section 6** presents an overview of the current status of remaining ecosystem analytics, and their planned deployment.

This document is an update to D3.3 (A Set of Analytic Methods to Measure Ecosystem Performance) which was delivered in M10. This revision primarily addresses relevant outcomes of the Friendly Trial process, and progress or changes made since the first deliverable version. This release should be considered an incremental update to this document.

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1 Introduction

The ProACT technology platform incorporates a wide range of hardware sensing devices, and both user-facing and infrastructural software components which intercommunicate and data-share through application programming interfaces (APIs). A core function of this technology platform is the collection and dissemination of volume data relating to individuals engaged with ProACT systems, inclusive of persons with multimorbidity (PwMs), formal and informal carers, health care professionals, and other actors providing supports for improved self-management by those living with multiple chronic health conditions. These data sets are used, and added to, by a core set of person-centric analytics which operate on available data for individual stakeholders in the ProACT ecosystem (CareAnalytics). While these analytic methods underpin the functionality and goals of the ProACT platform, their direct outputs do not facilitate inspection of the technology ecosystem at a higher level, nor are they positioned to inspect or evaluate aspects of the platform's technical performance on an on-going basis.

The analytic methods presented in this document augment these person-centric methods and can be broadly described as "aggregate", "technical", or "meta" analytics—i.e. analytics which are designed to inspect the ProACT ecosystem at a macro level, covering areas such as technical performance and availability; aggregation and comparison of person-centric analytics per trial site; and system usage and engagement levels at trial site and global levels.

While person-centric analytic methods and those described in this document may exhibit areas of conceptual overlap, the two categories are ultimately differentiated by the intended audiences for their outputs. Person-centric analytics produce outputs relevant to *users* of the ProACT ecosystem (PwMs, support actors, etc.). The analytics detailed here--those which measure ecosystem performance--by contrast, produce outputs relevant to entities involved in the *development* or *evaluation* of the ProACT system. This distinction is examined in further detail in section 2 of this document.

Analytics which measure ecosystem performance will operate on data available from, or generated by, three of the ProACT technology platform's core systems. These are:

- **CareApps:** Interactive dashboards which provide tailored interfaces and bidirectional feedback mechanisms for multiple ProACT ecosystem stakeholders. These are used to deliver scheduled surveys and behaviour change training and support to PwMs; to connect care network stakeholders; and to assist in everyday condition management tasks.

- **CABIE**: A novel data collection and aggregation system which connects to a wide range of device manufacturer data stores, through a mixture of both open and proprietary gateways and APIs. Employed for local data aggregation. CABIE includes the SIMS (Subject Information Management System) module which, among other functions, manages PwM information, and access rights for CABIE data and the APIs used for the creation of CareApps.

- **InterACT:** A cloud-based platform for secure and scalable federated storage, mining, and analysis of de-identified PwM data. Employed for global data aggregation, and the

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central location for person-centric analytic data. This platform is the primary ProACT system for generation and storage of person-centric analytic outputs.

For a full overview of the ProACT technology platform, readers are referred to D2.5 (*ProACT Platform, 1st Release*) which details all components and their interactions. While some areas of the aforementioned document have now been superseded by updated systems since its release, the document still presents a solid, high-level overview of the ProACT technology platform.

2 Categorisations of Ecosystem Performance Analytics

Analysis of ProACT ecosystem performance will be undertaken in a variety of conceptual categories targeting a number of output consumers. This section provides an overview of all analytics which will operate on ProACT data, provides general categorisations for the analytics presented in this document, and identifies target consumers for outputs from same. In addition to the initial set of categories presented below, feedback from system stakeholders will be examined throughout the course of the project to identify additional areas of desirability for ecosystem analysis. Updated categorisations for analyses will be available in the final version to this deliverable (due M39). For brevity, analytics which measure elements of ProACT ecosystem performance will, hereafter, be referred to as *Ecosystem Analytics*.

2.1 Resolution of ProACT Analytic Types

Analytics within the ProACT ecosystem will operate on a variety of data sets and in a variety of locations. At a high level, analytic methods will have access to data stored in either, or both, of the project's local or global data stores. Here, the term *local store* refers to raw PwM data stored in CABIE aggregators. The term *global store* refers to the InterACT cloud, which stores de-identified PwM data from all trial sites in a centralised location. For the purposes of this document, the datasets and PwM groupings on which analytics operate are referred to as an analytics' *resolution*. Figure 1, below, illustrates the 4 primary resolutions available within the ProACT ecosystem, and the remainder of this section details each of these, identifying the resolutions at which ecosystem analytics will operate.

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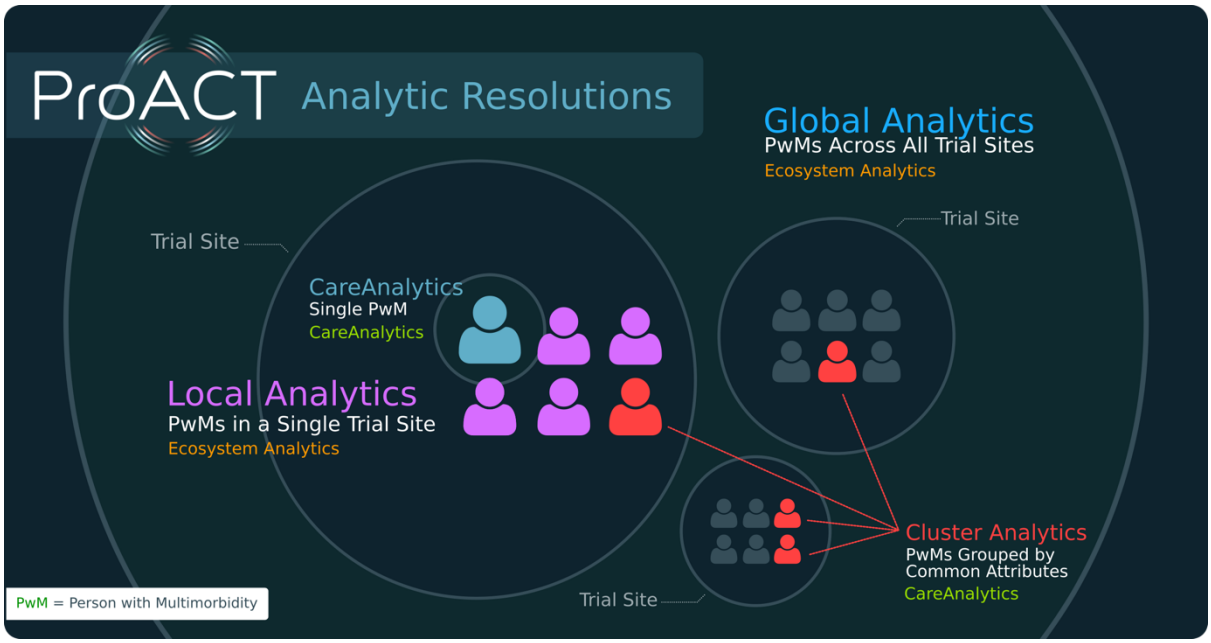

Figure 1: Categories of ProACT Analytic Resolution

2.1.1 PwM (CareAnalytics)

Person-centric analytics within the ProACT ecosystem, referred to as CareAnalytics, are contextually-aware procedures or algorithms which can detect and react to current or historic data in the ProACT system. These are used to track and monitor vital and ambient parameters for multimorbidities, condition management and condition status; and to inform learning, guidance, and care pathways for PwMs. CareAnalytics, as a general rule, operate on individual PwM data to produce output relevant to individual PwMs, or other stakeholders in their care networks. With some small exceptions (see Section 2, Table 1), Ecosystem analytics within ProACT do not operate at this level, but may make use of outputs from analytics which do. Descriptions of ProACT CareAnalytics can be found in D3.1 (*A Machine-processable Representation of the Individual and the Analytic Models*) and its update (D3.7), D3.2 (*A Set of Person-centred Analytical Methods for Risk and Outcomes*) and its update (D3.9), and D3.5 (*A Machine-processable Catalogue of CareApps*) and its update (D3.15).

2.1.2 PwM Clusters (CareAnalytics)

PwM Clusters are special-case groupings of CareAnalytics which examine PwMs who share attributes such as age, gender, or commonalities in outputs from other analytic methods. Ecosystem analytics do not operate at this level, and as a general rule will not make use of output from analytics which do. Descriptions of PwM clustering can be found in D3.2 (*A Set of Person-centred Analytical Methods for Risk and Outcomes*) and its update (D3.9) and D3.5 (*A Machine-processable Catalogue of CareApps*) and its update (D3.15).

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2.1.3 Local Ecosystem (Ecosystem Analytics)

Local Ecosystem Analytics in ProACT operate on PwM and technical data available at the individual trial site level. These analytics examine aspects of each trial site in isolation, to produce output relevant to research and technical teams directly involved with the site's operation and evaluation. These analytics aggregate data at the local level (via CABIE), however, they may also leverage data from the project's global store (InterACT), which directly relates to PwMs within a given trial site (e.g. the output from PwM CareAnalytics). While these analytics operate at the trial site level, their outputs will be available at a global level to allow for comparisons between trial sites. These analytics will mainly focus on system usage and engagement levels across a trial site.

2.1.4 Global Ecosystem (Ecosystem Analytics)

Global Ecosystem Analytics in ProACT operate on PwM data available in the project's global store (InterACT), on aggregated outputs from Local Ecosystem Analytics, and on aggregated raw data from individual trial sites. These analytics examine aspects of the overall ecosystem and produce output relevant to research and technical teams across all trial sites. These analytics aggregate data at the global level (InterACT) and will operate on a mixture of de-identified global PwM data, and the outputs from Local Ecosystem Analytics which have been made available to the global store by local aggregators (CABIE). Outputs from these analytics will most commonly take the form of comparisons between trial sites. Some analytics in this category, which involve examining local data, may do so at the local aggregator level.

2.2 Conceptual Categorisation of Ecosystem Analytics

This section defines three conceptual categories for Ecosystem Analytics which group individual analytics by intended output usage. It should be noted here that any single analytic may intersect more than one of the following categories.

2.2.1 Technical Analytics

Technical analytics examine elements of performance and reliability with regard to ecosystem technology components, specifically targeting the identification of issues which might affect availability or responsiveness of ProACT systems to end-users (PwMs and support stakeholders). As example, technical analytics might perform real-time (or more accurately, close-to-real-time) evaluations of the load being exerted on ProACT servers. Outputs from this type of analytic can be utilised to generate alerts for technical teams indicating a need to intervene during short-term periods of performance degradation, or may be utilised in historical context to identify recurring data processing bottlenecks.

2.2.2 Comparative Analytics

The comparative analytic category covers those analytics which compare two or more like elements of the ProACT ecosystem at either local or global resolution. This is a broad category

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which could, as example, include analytics which compare PwM or other stakeholder engagement levels between different CareApps, different types or makes of devices, or compare these values between trial sites. Comparative analytics can also be employed to examine the differences between PwMs in each trial site by gathering local averages of CareAnalytic outputs. As example, a comparative analytic might calculate the average "wellness" score for each trial site, locally, then evaluate the differences in average wellness between trial sites, globally. As a general rule, comparative analytics will operate on outputs from other Ecosystem and CareAnalytic methods, but will also make use of raw local data.

2.2.3 Engagement and Retention Analytics

Engagement and retention analytics measure PwM and support stakeholder engagement with technology elements of the ProACT ecosystem, and by extension with the ecosystem itself. The purpose of this category of analytics is not to make determinations on the success of stakeholder engagement or retention, or on the overall acceptance of ProACT technologies, but is, instead, to provide objective data to assist in evaluation of these areas. For example, analytics in this category will measure *who* (i.e. which stakeholder type(s)) is engaged with the system through use of provided CareApps, *how* frequently these parties engage with the system, and *how* these engagement levels change over time (as a measure of retention). As a general rule, engagement and retention analytics will operate at local resolution, but their outputs will become the subject of a comparative analytic for a global comparison between trail sites.

It should be noted that there is a planned person-centric care analytic which examines end-user engagement with the goal of calculating normalised engagement scores, and using this score to deliver behaviour-changing materials to end-users, to further promote their engagement with ProACT systems. While this analytic overlaps the engagement analytics described here, and will operate on much of the same data, their outputs are aimed at different audiences. The engagement analytics described here will provide research and technical teams with reflective data on how the ecosystem was used across a period of time (a single action-research cycle, as example), while the person-centric engagement analytic will proactively promote engagement with the system.

2.3 Target Consumers for Ecosystem Analytics

The outputs from CareAnalytics within the ProACT ecosystem are targeted at PwMs and other stakeholders in their support groups. Ecosystem analytics, by contrast, are targeted at various actors involved in the provision of the project, or beyond the life of the project, in the deployment of ProACT systems. This section identifies and describes three primary consumers for the outputs of Ecosystem Analytics.

2.3.1 The ProACT Research Team

Here, the ProACT Research Team refers to all project consortium members. This group will be a prime target for outputs from comparative analytics and engagement and retention analytics. It is hoped that these outputs will be valuable for periodic evaluations of the ProACT

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ecosystem, in providing objective data on system usage for reporting, and in better understanding patterns of system usage by all relevant stakeholders. This group does not have a comparable substitute outside of a research setting, but does overlap the Trial Site Teams grouping.

2.3.2 Trial Site Teams and Administrators

Here, Trial Site Teams and Administrators refers to those individuals directly involved in the day-to-day running of trial sites, and coordination of trial site logistics. This group will be a prime target for outputs from engagement and retention analytics, and to some extent outputs from comparative analytics. It is hoped these outputs will help this audience better understand usage within their trial site, and provide objective data for improving trial site experiences at future dates. For the life of the ProACT project this group will be comprised of a subset of ProACT research team, but beyond the project timeframe this role could, conceivably, be filled by administrative staff, or researchers, who are users of the ProACT system, but not directly involved in its development. In this scenario, these individuals would make-up the Trial Site Teams and Administrators grouping.

2.3.3 ProACT Technical Teams

Here, ProACT Technical Teams refers to those project consortium members directly contributing, and maintaining, technology components to the ProACT technology platform. This group will be the primary target for outputs of technical analytics, and will use these to refine system performance, and to debug data collection and component intercommunication issues. During the project time frame, the role of trial site system administrators will be filled by the same entities developing and maintaining core ProACT services. Beyond the life of the project, this role could, conceivably, be filled by *users* of the ProACT system not directly involved in its development. In this scenario, it may be appropriate to include third-party system administrators in the ProACT Technical Teams grouping.

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3 Areas of Ecosystem Analysis

The table below presents an initial list of fifteen target areas for analysis of ProACT ecosystem performance. The table entry for each area provides a high-level overview of requirements and potential methods of generating required outputs. The following points should be considered when examining the table:

- Each area for analysis has been categorised as being a *Technical* analytic, a *Comparative* analytic, or an *Engagement* analytic in line with Section 2 definitions. Areas for analysis may overlap multiple categories.

- The resolution to which each area of analysis will be performed has been identified as one of *Local*, *Global*, or in special cases as *PwM*. Some analytics may run in different forms at both local and global resolution.

- For each area of analysis, an appropriate data source is suggested, as is a frequency for computing or updating outputs. Analytics which were implemented for the Friendly Trial are described in Section 5. Current data availability, analytic status, and deployment plans are described in Section 6.

- For each area of analysis, primary consumers for outputs have been identified. Where a group has *not* been identified as a primary consumer, this does not imply that the group has no interest in area outputs, simply that they are not the direct target audience of the analytic.

This list should not be, at this stage, considered exhaustive and will be updated in a future revision of this deliverable (due M39) to reflect additional needs identified going forward.

<table>
<tr><th colspan="5">Area 1: Daily Identification of Data Provision and / or Collection Issues</th></tr>
<tr><td>Requirement(s):</td><td colspan="4">Trial site administrators must monitor a wide array of input devices for a large number of PwMs, to ensure each device is gathering or generating data as expected. Manual management of this process on a daily basis would be overly burdensome on trial site teams, and would be prone to human error or oversights.

An analytic method is required which can detect devices which are not working as expected, and when such defects are found, generate alerts in a timely manner.</td></tr>
<tr><td rowspan="2">Analytics Type(s):</td><td>Technical</td><td>Comparative</td><td>Engagement</td><td>Resolution</td></tr>
<tr><td>✓</td><td>×</td><td>×</td><td>Local</td></tr>
<tr><td rowspan="3">Method(s):</td><td colspan="4">Comparison of expected data providers for all PwMs in a given trial site in any daily period, and of the data sources for inputs received for the same PwMs on that day. Identifies expected providers which have not generated input across the trial site.</td></tr>
<tr><td colspan="2">Data Source</td><td colspan="2">Generated / Updated</td></tr>
<tr><td colspan="2">CABIE</td><td colspan="2">Daily</td></tr>
</table>

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<table>
<tr><td>Targets Consumer(s):</td><td>Research Team</td><td>Trial Site Admins</td><td>Technical Team</td></tr>
<tr><td></td><td>✗</td><td>✓</td><td>✓</td></tr>
<tr><td colspan="4">Area 2: Live Identification of Overloaded Local Aggregators</td></tr>
<tr><td>Requirement(s):</td><td colspan="3">Local data aggregators process high volumes of data on-demand, both in input (collection) and output (dissemination) streams. While the amount of data processed daily is relatively low when measured across a full 24-hour period, high volume bursts of data have the potential to affect overall system performance.

An analytic method is required which can detect degraded system performance, generate alerts when such occurrences are identified, and to provide technical teams with the knowledge needed to better balance rates of data processing.</td></tr>
<tr><td>Analytics Type(s):</td><td>Technical</td><td>Comparative</td><td>Engagement</td><td>Resolution</td></tr>
<tr><td></td><td>✓</td><td>✗</td><td>✗</td><td>Local</td></tr>
<tr><td>Method(s):</td><td colspan="3">Local data aggregators will take periodic snapshots of resource usage, such as CPU and system memory utilization. Where appropriate, these systems will also track the time to process all API requests. An average of these API response times will be included in the periodic snapshots.

Acceptable thresholds will be set for each recorded metric. Email alerts will be generated for system administrators when any single metric exceeds its acceptable threshold across 3 snapshot periods.

Snapshots will be taken at 5 minute intervals and will be retained for the life of the project. Each snapshot will include:

• 1, 5, and 15 minute load averages for CPU utilization (the percentage of CPU resource usage for the past 1, 5 and 15 minutes at the time of snapshot).
• Memory utilization at the time of snapshot.
• Average API response time for the 5 minutes proceeding the snapshot time.
• Cumulative number of API requests processed for the day at the snapshot time.</td></tr>
<tr><td></td><td colspan="2">Data Source</td><td>Generated / Updated</td></tr>
<tr><td></td><td colspan="2">CABIE</td><td>Every 5 minutes</td></tr>
<tr><td>Targets Consumer(s):</td><td>Research Team</td><td>Trial Site Admins</td><td>Technical Team</td></tr>
<tr><td></td><td>✗</td><td>✗</td><td>✓</td></tr>
<tr><td colspan="4">Area 3: Measurement of PwM Engagement with Core CareApps</td></tr>
<tr><td>Requirement(s):</td><td colspan="3">PwMs will be expected to engage with their primary CareApp on a regular basis (e.g. daily) to answer questionnaires, view trends in their personal data, and to view training materials relevant to their conditions. It is important, however, to understand how PwMs engage with their primary CareApp in practice. Is the app being opened daily? Are questionnaires being completed on time? Which functionalities of the app are being used regularly, and which are not, by PwMs in a given trial site. These questions should also be answered for other PwM-focused CareApps integrated into the core of the ProACT</td></tr>
</table>

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<table>
<tr><td></td><td>ecosystem. It is also important here to understand how this usage changes over time.</td></tr>
<tr><td>Analytics Type(s):</td><td>
<table>
<tr><th>Technical</th><th>Comparative</th><th>Engagement</th><th>Resolution</th></tr>
<tr><td>×</td><td>×</td><td>✓</td><td>Local</td></tr>
</table>
</td></tr>
<tr><td>Method(s):</td><td>ProACT end-user applications make use of the SIMS API for retrieving / inputting data into ProACT systems. As such, SIMS is the best central location to collect this data for this analytic.

All requests to API end-points are tracked per API user. These API users directly correlate to ProACT end-users (PwMs, Informal Carers, etc). The API end-points to which end-users connect in a given day are recorded, and the total number of calls to the SIMS API are recorded for each end-user per day.

This analytic uses this data to:

• Determine on which dates, across an inspection period, users have engaged with CareApps.
• Determine on which dates, across an inspection period, users have engaged with specific functionalities of a CareApp (viewing readings, viewing tips, etc.)

Additional, higher-resolution, data surrounding user-engagement will be collected for use in person-centric engagement analytics, but this additional data will not be used here.

All data is collected in real-time. Analytic outputs from this data are generated on demand.
<table>
<tr><th>Data Source</th><th>Generated / Updated</th></tr>
<tr><td>SIMS/CareApps</td><td>On demand</td></tr>
</table>
</td></tr>
<tr><td>Targets Consumer(s):</td><td>
<table>
<tr><th>Research Team</th><th>Trial Site Admins</th><th>Technical Team</th></tr>
<tr><td>✓</td><td>✓</td><td>×</td></tr>
</table>
</td></tr>
<tr><td colspan="2">Area 4: Measurement of PwM Engagement with Input Devices</td></tr>
<tr><td>Requirement(s):</td><td>Non-ambient sensing devices to be employed in ProACT require active engagement by PwMs (e.g. daily). It is important to understand how these devices are being interacted with in practice. Are they being used as scheduled, or are they being used less frequently? This should be tracked by device type, rather than specific devices. As example, the need here is to understand how PwMs have accepted daily use of a blood pressure monitor, rather than understanding their acceptance of a given make of blood pressure monitor. It is also important here to understand how this usage changes over time.</td></tr>
<tr><td>Analytics Type(s):</td><td>
<table>
<tr><th>Technical</th><th>Comparative</th><th>Engagement</th><th>Resolution</th></tr>
<tr><td>×</td><td>×</td><td>✓</td><td>Local</td></tr>
</table>
</td></tr>
<tr><td>Method(s):</td><td>For each data type collected by the system, which requires active engagement (e.g. blood pressure, weight, etc.), compare expected daily input types for each PwM against those actually received by the system to discover rates of adherence to schedules by type, across the entirety of a trial site.</td></tr>
</table>

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<table>
<tr><td></td><td colspan="4">PwMs within ProACT can set their own goals for how frequently they take vitals readings (e.g. take blood pressure twice daily, or three times per week, etc). CABIE tracks adherence to, or deviance from, these goals. This analytic will simply aggregate this tracking.

Existing trial site management tools (SIMS) can be used to view the outputs of goal tracking.

<table><tr><th>Data Source</th><th>Generated / Updated</th></tr><tr><td>CABIE</td><td>Daily</td></tr></table></td></tr>
<tr><td>Targets Consumer(s):</td><td colspan="4"><table><tr><th>Research Team</th><th>Trial Site Admins</th><th>Technical Team</th></tr><tr><td>✓</td><td>✓</td><td>×</td></tr></table></td></tr>
<tr><td colspan="5">Area 5: Comparison of PwM CareApp Engagement by Trial Site</td></tr>
<tr><td>Requirement(s):</td><td colspan="4">Global aggregation of Area 3 results (Measurement of PwM Engagement with Core CareApps) to allow for comparisons between trial sites. Are certain CareApp types more or less used in different trial sites?</td></tr>
<tr><td>Analytics Type(s):</td><td colspan="4"><table><tr><th>Technical</th><th>Comparative</th><th>Engagement</th><th>Resolution</th></tr><tr><td>×</td><td>✓</td><td>✓</td><td>Global</td></tr></table></td></tr>
<tr><td>Method(s):</td><td colspan="4">Simple aggregation of existing data.

<table><tr><th>Data Source</th><th>Generated / Updated</th></tr><tr><td>InterACT/CABIE</td><td>Daily</td></tr></table></td></tr>
<tr><td>Targets Consumer(s):</td><td colspan="4"><table><tr><th>Research Team</th><th>Trial Site Admins</th><th>Technical Team</th></tr><tr><td>✓</td><td>✓</td><td>×</td></tr></table></td></tr>
<tr><td colspan="5">Area 6: Comparison of PwM Device Engagement by Trial Site</td></tr>
<tr><td>Requirement(s):</td><td colspan="4">Global aggregation of Area 4 results (Measurement of PwM engagement with Input Devices) to allow for comparisons between trial sites. Are certain device types more or less used, as scheduled, in different trial sites?</td></tr>
<tr><td>Analytics Type(s):</td><td colspan="4"><table><tr><th>Technical</th><th>Comparative</th><th>Engagement</th><th>Resolution</th></tr><tr><td>×</td><td>✓</td><td>✓</td><td>Global</td></tr></table></td></tr>
<tr><td>Method(s):</td><td colspan="4">Simple aggregation of existing data.

<table><tr><th>Data Source</th><th>Generated / Updated</th></tr><tr><td>InterACT</td><td>Daily</td></tr></table></td></tr>
<tr><td>Targets Consumer(s):</td><td colspan="4"><table><tr><th>Research Team</th><th>Trial Site Admins</th><th>Technical Team</th></tr><tr><td>✓</td><td>✓</td><td>×</td></tr></table></td></tr>
<tr><td colspan="5">Area 7: Comparison of PwM Device Engagement by Device Make (Provider)</td></tr>
<tr><td>Requirement(s):</td><td colspan="4">While it is important to understand how PwMs engage with device types, it is equally important to understand how they engage with specific devices from different manufacturers. While this will not necessarily identify specific usability issues with, or reasons for resistance to, specific devices, it may help research teams identify common patterns in devices with differing usage rates. As example,</td></tr>
</table>

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<table>
<tr><td></td><td colspan="4">this may show more, or less, adherence to usage schedules when connected devices are used over manual input devices.</td></tr>
<tr><td>Analytics Type(s):</td><td>Technical</td><td>Comparative</td><td>Engagement</td><td>Resolution</td></tr>
<tr><td></td><td>×</td><td>✓</td><td>✓</td><td>Local</td></tr>
<tr><td>Method(s):</td><td colspan="4">ProACT's data aggregator, CABIE, distinguishes incoming data by manufacturer (provider)—it cannot distinguish between 2 devices of the same type from the same manufacturer. As such, analytics around this topic can only be employed to compare engagement by device makes. This method closely resembles that described in Area 4 (Measurement of PwM Engagement with Input Devices), but with input device lists filtered by manufacturer.</td></tr>
<tr><td></td><td colspan="2">Data Source</td><td colspan="2">Generated / Updated</td></tr>
<tr><td></td><td colspan="2">CABIE</td><td colspan="2">Daily</td></tr>
<tr><td>Targets Consumer(s):</td><td>Research Team</td><td colspan="2">Trial Site Admins</td><td>Technical Team</td></tr>
<tr><td></td><td>✓</td><td colspan="2">✓</td><td>×</td></tr>
<tr><td colspan="5">Area 8: Measurement of Support Stakeholder Engagement with ProACT</td></tr>
<tr><td>Requirement(s):</td><td colspan="4">Measurement of engagement with the ecosystem by PwM support stakeholders, inclusive of informal carers, formal carers, pharmacists and the full range of healthcare professionals. This should include identification of the different types of support actors engaged at the trial site level, and measurement of their engagement levels with provided CareApps. It is important to understand how this usage changes over time.</td></tr>
<tr><td>Analytics Type(s):</td><td>Technical</td><td>Comparative</td><td>Engagement</td><td>Resolution</td></tr>
<tr><td></td><td>×</td><td>✓</td><td>✓</td><td>Local</td></tr>
<tr><td>Method(s):</td><td colspan="4">This analytic works in the same way as that described in Area 3 (Measurement of PwM Engagement with Core CareApps), but is applied to a different subset of end-users. In practical terms, this analytic has now merged with the aforementioned analytic, with an allowance for filtering its outputs based on stakeholder type.</td></tr>
<tr><td></td><td colspan="2">Data Source</td><td colspan="2">Generated / Updated</td></tr>
<tr><td></td><td colspan="2">SIMS/CareApps</td><td colspan="2">Daily</td></tr>
<tr><td>Targets Consumer(s):</td><td>Research Team</td><td colspan="2">Trial Site Admins</td><td>Technical Team</td></tr>
<tr><td></td><td>✓</td><td colspan="2">✓</td><td>×</td></tr>
<tr><td colspan="5">Area 9: Comparison of Support Stakeholder Engagement by Trial Site</td></tr>
<tr><td>Requirement(s):</td><td colspan="4">Global aggregation of Area 8 results (Measurement of Support Stakeholder Engagement with ProACT) to allow for comparisons between trial sites. Are certain stakeholders more or less engaged in different trial sites?</td></tr>
<tr><td>Analytics Type(s):</td><td>Technical</td><td>Comparative</td><td>Engagement</td><td>Resolution</td></tr>
<tr><td></td><td>×</td><td>✓</td><td>✓</td><td>Global</td></tr>
<tr><td>Method(s):</td><td colspan="4">Simple aggregation of existing data.</td></tr>
<tr><td></td><td colspan="2">Data Source</td><td colspan="2">Generated / Updated</td></tr>
</table>

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	InterACT/CABIE		Daily
Targets Consumer(s):	Research Team	Trial Site Admins	Technical Team
	✓	✓	×

Area 10: Generalised Aggregation of Person-Centric Analytics per Trial Site

Requirement(s):

A wide array of person-centric analytics will be applied to all PwMs in the ProACT ecosystem, examining data at the individual level to, for example, calculate overall wellbeing scores, successfulness of behaviour change interventions, and more. It will be useful for research teams to be able to view site-level aggregations of these metrics, and to be able to compare those aggregations by trial site.

This analytic should take the form of a generalised implementation which can be applied to a wide array of person-centric analytic outputs, and which can adapt to new, future outputs.

Analytics Type(s):	Technical	Comparative	Engagement	Resolution
	×	✓	×	Local & Global

Method(s):

Simple aggregation of existing data with allowances for multiple data types.

Data Source	Generated / Updated
InterACT	Daily

Targets Consumer(s):	Research Team	Trial Site Admins	Technical Team
	✓	×	×

Area 11: Measurement of PwM Goal Achievement

Requirement(s):

As part of their behaviour change intervention, PwMs may set specific goals relating to their activity, or the frequency with which they engage with devices or certain input types. PwMs may, as example, decide that they would like to take two blood pressure readings per week. While CABIE already tracks adherence to, or deviation from, these goals on a daily basis, an aggregation of this data is required to measure how successful PwMs are at meeting their goals across an individual trial site.

This data may be beneficial in measuring the appropriateness of goal levels, and may be useful in identifying goals which are not being met by a large number of PwMs. This in turn may be helpful in identifying goals which are inherently unachievable.

Analytics Type(s):	Technical	Comparative	Engagement	Resolution
	×	×	✓	Local

Method(s):

Comparing local, up-to-date data on goal metrics to goals set by other analytic methods. These analytics can make use of InterACT or CABIE data to measure goal targets against success rates.

Data Source	Generated / Updated
InterACT/CABIE	Daily

Targets Consumer(s):	Research Team	Trial Site Admins	Technical Team
	✓	×	✓

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<table>
<tr><th colspan="5">Area 12: Comparison of PwM Goal Achievement by Trial Site</th></tr>
<tr><td>Requirement(s):</td><td colspan="4">Global aggregation of Area 11 results (Measurement of PwM Goal Achievement) to allow for comparisons between trial sites. This analytic will help determine if differences in the rates of goal achievement in specific areas across trial sites are present.</td></tr>
<tr><td rowspan="2">Analytics Type(s):</td><td>Technical</td><td>Comparative</td><td>Engagement</td><td>Resolution</td></tr>
<tr><td>×</td><td>✓</td><td>✓</td><td>Global</td></tr>
<tr><td rowspan="3">Method(s):</td><td colspan="4">Simple aggregation of existing data.</td></tr>
<tr><td colspan="2">Data Source</td><td colspan="2">Generated / Updated</td></tr>
<tr><td colspan="2">InterACT</td><td colspan="2">Daily</td></tr>
<tr><td rowspan="2">Targets Consumer(s):</td><td>Research Team</td><td>Trial Site Admins</td><td colspan="2">Technical Team</td></tr>
<tr><td>✓</td><td>×</td><td colspan="2">×</td></tr>
<tr><th colspan="5">Area 13: Measurement of Accuracy of System Alerts</th></tr>
<tr><td>Requirement(s):</td><td colspan="4">Alerts generated by ProACT systems can be updated, after the point of generation, to indicate if they were relevant, or were false alarms. This analytic should identify the accuracy of individual alert types, to help better refine ProACT systems and reduce the number of alerts which do not identify genuine issues.</td></tr>
<tr><td rowspan="2">Analytics Type(s):</td><td>Technical</td><td>Comparative</td><td>Engagement</td><td>Resolution</td></tr>
<tr><td>✓</td><td>×</td><td>×</td><td>Global</td></tr>
<tr><td rowspan="3">Method(s) and Data Availability:</td><td colspan="4">Trial site triage teams will update alert statuses to indicate whether or not an individual alert identified a genuine issue, or was a false positive.

This analytic will examine the above reporting for individual alert categories at the end of each action-research cycle. Statistics on the accuracy of each alert category will be reported.</td></tr>
<tr><td colspan="2">Data Source</td><td colspan="2">Generated / Updated</td></tr>
<tr><td colspan="2">CABIE</td><td colspan="2">Each Action-Research Cycle</td></tr>
<tr><td rowspan="2">Targets Consumer(s):</td><td>Research Team</td><td>Trial Site Admins</td><td colspan="2">Technical Team</td></tr>
<tr><td>✓</td><td>×</td><td colspan="2">✓</td></tr>
<tr><th colspan="5">Area 14: Daily Identification of Missing Inputs per PwM</th></tr>
<tr><td>Requirement(s):</td><td colspan="4">Trial site administrators, technical teams, and PwM support actors need to be alerted when expected inputs have not been collected for a given PwM in a given day. For example, an alert should be generated at the end of each day if a PwM who is scheduled to take daily blood pressure readings has not done so. This is better categorised as a person-centric analytic (a CareAnalytic), but technical requirements place it with the other technical analytics in this section.</td></tr>
<tr><td rowspan="2">Analytics Type(s):</td><td>Technical</td><td>Comparative</td><td>Engagement</td><td>Resolution</td></tr>
<tr><td>✓</td><td>×</td><td>×</td><td>PwM</td></tr>
<tr><td>Method(s) and Data Availability:</td><td colspan="4">Similar method to Area 1 (Daily Identification of Data Provision and / or Collection Issues), but with a focus on data types (e.g. blood pressure, weight, etc.) rather than data sources. Additionally, this</td></tr>
</table>

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<table>
<tr><td rowspan="4"></td><td colspan="3">analytic will operate on individual PwM data, and generate alerts relevant to individual PwMs, rather than generating alerts relevant to the wider trial site.</td></tr>
<tr><td colspan="2">Data Source</td><td>Generated / Updated</td></tr>
<tr><td colspan="2">CABIE</td><td>Daily</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>Targets Consumer(s):</td><td>Research Team</td><td>Trial Site Admins</td><td>Technical Team</td></tr>
<tr><td></td><td>✗</td><td>✓</td><td>✓</td></tr>
</table>

__Table 1:__ Overview of Areas for Analysis of Ecosystem Performance

In addition to the above identified areas, additional data may be collected by individual ProACT systems for the purposes of system refinement.

4 Required Data Points

Building on the areas for analysis and requirements identified in section three of this document, the table below lists the data points required for analysis of ProACT ecosystem performance and the areas of analysis to which each data point is relevant. The following should be considered when examining this table:

- The term “list” does not necessarily refer to a persistently stored dataset, but may instead refer to datasets which are generated “on-the-fly” from other system data as needed.

- Where need for a manually-defined baseline value is listed, these baselines are still in the process of being identified and will be itemised per relevant system in the final revision to this deliverable (M39).

As per the analysis areas listed in section 3, the list of required data points below should not, at this stage, be considered exhaustive or complete.

Data Point 1: List of Expected Providers for Each PwM			
Description:	For each PwM, a list of the providers (data sources) which are expected to generate input each day, collected from PwM records.	Required for:	Area 1 Area 7
Data Point 2: Record of Providers Actively Providing per Day			
Description:	A record of the providers which have generated data in each day.	Required for:	Area 1 Area 7
Data Point 3: API Response Times from Controlled End-points			
Description:	Round-trip response time (RTTs) from controlled end-points (core CareApps) when requesting data from ProACT backend systems.	Desirable for:	Area 2

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	It may not be practical to collect this data in a automated manner within the current topology of ProACT technical systems. Collection methods and alternatives are currently being investigated.		
Data Point 4: API Internal Processing Times			
Description:	Internal processing times for API requests in all ProACT back-end systems (as per data point 3, without taking transfer times into account). Only relevant to SIMS API request times as this is the only user-facing API.	Required for:	Area 2
Data Point 5: List of Baseline Acceptable API Response Times			
Description:	Manually-defined baselines for maximum acceptable API response times which do not affect human perception of responsiveness. Jakob Nielsen (1993), citing earlier references, presents 3 response time thresholds which should be considered when designing applications. Of these, the “reacting instantaneously” threshold is of most relevance to this section and sets a maximum target threshold of 100 milliseconds (0.1 seconds) for responsiveness to give the illusion of reaction without delay.	Required for:	Area 2
Data Point 6: Baseline Alert Thresholds for Detection of High CPU Usage			
Description:	Manually-defined baselines for CPU load averages on backend systems above which technical teams may wish to manually intervene or monitor. On Linux-based server systems, CPU load averages are available through system tools, and are measured in 1, 5, and 15 minute intervals. Load averages are calculated relative to the number of available cores in a server (as example: a load average of 1.0 on a single-core machine would indicate 100% CPU utilization average over the inspection period, as would an average of 2.0 on a dual-core machine) (Gunther, 2007). A 15 minute load average of 0.7 to 0.8 per core is generally considered high, but stable. Load averages of 1.0 per core indicate issues which need to be addressed urgently (but likely are not yet affecting performance) while load averages above 1.0 per core indicate sustained performance degradation. High 1 minute load averages, not reflected in 5 or 15 minute loads, rarely indicate performance issues, but can be useful in identifying tasks which can be spread over longer periods to reduce their impact on systems.	Required for:	Area 2

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Data Point 7: Baseline Alert Thresholds for Detection of High Memory Usage			
Description:	Manually-defined baselines for memory (RAM) usage levels on backend systems above which technical teams may wish to manually intervene or monitor. Memory monitoring on Linux-based server systems is available through system tools. These systems will generally utilise all available memory to optimise system performance (memory unused by applications will be used for disk caching). Consequently, it is important to monitor memory usage minus disk caches. Memory usage exceeding 85% of available system resources over sustained periods (15 minutes) generally indicates issues which *may* need attention.	Required for:	Area 2
Data Point 8: Timed Records of All Stakeholder Types who Access CareApps			
Description:	Records of all data access requests which identify stakeholder of origin, stakeholder categorisation (PwM, Informal Carer, etc.), time for request, and API end-point accessed.	Required for:	Area 3 Area 8
Data Point 9: Definitions of Custom Variables for Third-party Analytics Suites			
Description:	Definition of custom variables for integrated third-party analytics suites which can be used to view analytics by ProACT categories (stakeholder group, etc.) *It is now unlikely that 3rd-party analytic suites will be employed by ProACT, as all data currently identified as required can be provisioned by internal systems. In addition, use of third-party analytics systems within the trial would likely lead to insurmountable privacy issues.*	Desirable for:	Area 3 Area 8
Data Point 10: List of Expected Data Types for Each PwM (Daily)			
Description:	A list, per PwM, of the types of data which are *expected* to be collected in each day (blood pressure, weight, SpO2, etc.).	Required for:	Area 4 Area 14
Data Point 11: List of Received / Collected Data Types for Each PwM (Daily)			
Description:	A list, per PwM of the types of data which *have* been collected in each day (blood pressure, weight, SpO2, etc.).	Required for:	Area 4 Area 14
Data Point 12: Person-centric Analytics Output			
Description:	Individual PwM outputs from person centric analytics across all categories, available through analytics collections in InterACT. e.g. use of calculated wellness scores for each PwM to generate average wellness per trial site.	Required for:	Area 10

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Data Point 13: Record of Defined Goals in All Categories per PwM			
Description:	Record of all behaviour change goals set for each PwM within a trial site.	Required for:	Area 10 Area 11
Data Point 14: Record of Percentages of Goals Achieved in All Categories per PwM			
Description:	Record of percentages of behaviour change goals achieved on time / completed to compare to goals originally set.	Required for:	Area 11
Data Point 15: Record of System-generated Alerts			
Description:	Record of all alerts generated from CareAnalytics, categorised by alert type or generating analytic.	Required for:	Area 13
Data Point 16: Feedback from Alert Recipients			
Description:	Feedback from recipients of alerts generated from CareAnalytics, to measure the rate of false positives.	Required for:	Area 13
Data Point 17: Outputs from Areas 3, 4, 8, and 11			
Description:	Outputs from other ecosystem performance analytics for global comparison between trial sites. For example, are PwMs in one trial site more engaged with a certain CareApp than those in another.	Required for:	Area 5 Area 6 Area 9 Area 12

Table 2: Overview of Data Requirements for Ecosystem Performance Analysis

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5 Friendly Trial Implementations

The first release of the ProACT technology platform was evaluated in a friendly trial setting. ProACT defines a friendly trial as a trial to test the robustness of a technology ecosystem prior to its deployment to real end-users. For the purposes of this trial, ProACT research staff took on the roles of multiple ecosystem stakeholders to evaluate technology components. As part of this process a proof-of-concept subset of the analytics described in this document were deployed and evaluated by research and technical teams. These were:

- **Daily Identification of Data Provision and / or Collection Issues, and Daily Identification of Missing Inputs per PwM**

  For the duration of the Friendly Trial, a daily email was generated for Trial Site administrators which identified the number of inputs received by the system in the proceeding day, broken down by data type, and by data source (which device provider they had come from). This email reported on missing data points across a full trial site, rather than reporting by individual.

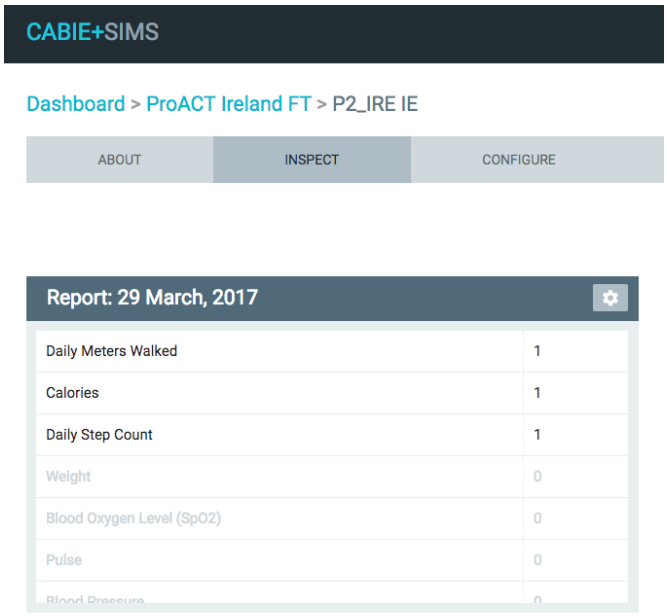

Figure 1 - *Inspecting Number of Inputs by Type for an Individual on a Given Day*

A second system put in place allowed for manual inspection of missing inputs per PwM within the SIMS interface. In addition to automatically showing missing inputs for the previous day (by type or by provider), this system could also be used to view historical reports for any given day.

The report emails operated across all PwMs in a trial site. While proving the concept, and introducing trial site administrators to daily report emails, the level of detail included in these reports was identified as being insufficient for final implementation needs. In addition, the emails were identified as being "noisy" – that is to say they

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included too much irrelevant information which made potential issues harder to distinguish.

The manual inspection system was more useful, and was capable of identifying missing inputs for an individual PwM on any given day, taking into account and ignoring types of data a PwM was not expected to collect. However, the fact that the report required manual inspection was in-and-of-itself an issue.

Since the completion of the original Friendly Trial, new goals, achievements, and alerts systems have been in development to address these issues. While the simplified reports shown above are still retained, and are of use in identifying certain data collection issues (such as data from a single provider not reaching the system), the updated implementation puts more focus on system alerts which identify, in a personalised manner, the absence of expected inputs per PwM. More details on updated implementations can be found in Section 6 of this document.

Daily report emails are currently undergoing updates to make use of these updated systems, and to reduce noise, so that only those events which require attention are included.

An additional set of analytics targeted at reporting outcomes was developed toward the end of the Friendly Trial period. This set of analytics aggregated daily data collection reports for the research team to use in their evaluation of the Friendly Trial. These analytics are run on-demand for a specified time period and, currently, have to be generated by CABIE administrators (i.e. there is no interface element for generating / viewing these outputs). Interface elements to generate and retrieve this data will be added before the end of the main PoC trial's first action-research cycle.

Data from this analytic category and its outputs have been used to collect and report on user engagement in D5.1.

- **Measurement of Stakeholder Engagement with Core CareApps**

  For the duration of the Friendly Trial period, all incoming API requests to the SIMS API were tracked, inclusive of the following information: the days on which any given API end-user accessed the system, the days on which any given API-end-user accessed a specific API end point (for example, viewing readings, or viewing tips), and the total number of times an API end-user accessed the system (across all end-points) on a given day.

  This data was collected in relation to stand-alone access credentials which were unattached to any logical system entities. The lack of a correlating entity led to a situation where some users provisioned several sets of access credentials for a given account. As a consequence, the initial implementation of the analytics in this category required some level of manual intervention to recompile fragmented data sets.

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Despite this, the initial implementation was sufficient to provide the research team with detailed statistics on how the Friendly Trial application had been used by all stakeholders (PwMs, their care network, etc).
Data from this analytic category and its outputs have been used to collect and report on user engagement in D5.1.

Updates to the underlying system have since been made to formalise access credentials and link them to logical system entities, removing the need for any manual correlation in compiling the outputs of this analytic.

The outputs of this analytic are generated on demand. Currently, trial site administrators and research teams can generate outputs relating to a single PwM (inclusive of their care network) through SIMS. Interface elements which will allow generation across a trial site are currently in development. These are expected to be in place by end of the main PoC trial's first action-research cycle (with partial implementations in place for the start of the main PoC trial).

Figure 2 - *Stakeholder Engagement with System viewed by PwM*

The data sets required for this analytic are currently complete. However, additional data is needed for the related person-centric analytic, which may result in modifications to how this data is collected.

- **Live Identification of Overloaded Local Aggregators**

As noted in D2.6 (Technical Reports), CPU and Memory utilization were tracked for the local aggregator (CABIE) throughout the Friendly Trial period. For the majority of this period, a mixture of manual and automated systems were employed for tracking. Since this period, a fully-automated system has been deployed to track these values at 5 minute intervals, and to retain data for the life of the trial. This automated system is available to all current deployments, and will be utilised throughout the main Proof of Concept trial.

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Test systems for the Friendly Trial were deployed on low-powered, single-core VPSs. Because of this, a single procedure which struggled with low RAM availability was discovered, in part due to the analytics employed in this category. This discovery allowed the development team to optimise the procedure in question, to remove the requirement for higher RAM availability.

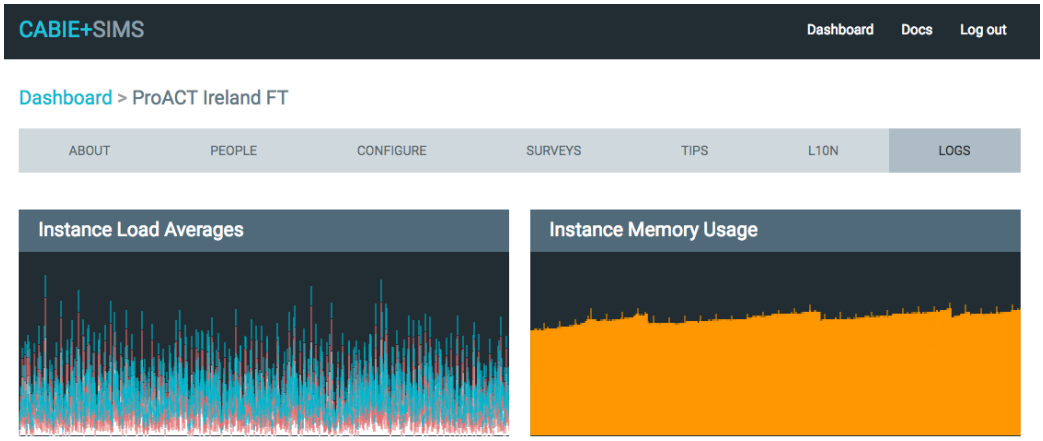

Figure 3 – *Resource Utilization Graphed over a 7 Day Period*

Originally, it was planned that these analytics would also track and aggregate local API response times for the original Friendly Trial period. Unfortunately, it was not possible to implement this feature in time for the Friendly Trial. However, this feature has now been added, and is currently in the process of being tested.

Further details on the data collected in this analytic category can be found in D2.6, or in D5.1.

Throughout the Friendly Trial period, and beyond, work has continued to provision the data sets needed to complete the analytics described in this document. This current status of this process is described further in section 6 of this document.

6 State of Ecosystem Analytics

Works are currently ongoing to deliver the full suite of analytics described in this document. This section describes the current state and deployment plans for all analytic areas described in section 3 of this document.

Where planned availability is identified as being beyond the start of the main Proof of Concept trial it should be noted that:

- Relevant analytics are not proactive and will not be required at this point.
- Relevant analytics will require a period of data collection before they can be deployed.

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- Data required for relevant analytics will be collected from the start of the main PoC trial.
- When relevant analytics are deployed, these analytics can be applied to historical data.

Area 1: Daily Identification of Data Provision and / or Collection Issues	
Current State:	• All required data currently collected. • Procedures in place to identify issues based on past data.
Future Works:	• Incorporation of issues into new report email formats • Refinement of procedures at end of first action-research cycle • Addition of SIMS interface elements to view local aggregations
Planned Availability:	• Available for report emails from start of main PoC period • Inspection tools planned for end of first action-research cycle.
Area 2: Live Identification of Overloaded Local Aggregators	
Current State:	• Sufficient data to proceed currently collected • Manual inspection possible through SIMS / backend systems • Procedures in place to identify issues
Future Works:	• Incorporation of issues into new report email formats • Refinement of procedures at end of first action-research cycle
Planned Availability:	• Available for report emails from start of main PoC period
Area 3: Measurement of PwM Engagement with Core CareApps	
Current State:	• All required data currently collected. • Inspection per PwM (inclusive of care networks) currently available
Future Works:	• Provision of SIMS interface to view local aggregations • Methods of data collection may require modification to support other analytics (person-centric CareAnalytics, not described in this document).
Planned Availability:	• PwM view currently available in SIMS • Local aggregation planned for end of first action-research cycle
Area 4: Measurement of PwM Engagement with Input Devices	
Current State:	• All required data currently collected. • Analytic not currently implemented
Future Works:	• Implementation of analytic to operate on currently collected data. • Addition of inspection tools for research team.
Planned Availability:	• Analytic planned to be in place for end of first action-research cycle (with outputs back-dated to start of main PoC trial). • Inspection tools planned for end of first action-research cycle.
Area 5: Comparison of PwM CareApp Engagement by Trial Site	

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Current State:	• All required data currently collected. • Analytic not currently implemented
Future Works:	• Implementation of analytic to operate on currently collected data. • Addition of inspection tools for research team.
Planned Availability:	• Analytic planned to be in place for end of first action-research cycle (with outputs back-dated to start of main PoC trial). • Inspection tools planned for end of first action-research cycle.
Area 6: Comparison of PwM Device Engagement by Trial Site	
Current State:	• All required data currently collected. • Analytic not currently implemented
Future Works:	• Implementation of analytic to operate on currently collected data. • Addition of inspection tools for research team.
Planned Availability:	• Analytic planned to be in place for end of first action-research cycle (with outputs back-dated to start of main PoC trial). • Inspection tools planned for end of first action-research cycle.
Area 7: Comparison of PwM Device Engagement by Device Make (Provider)	
Current State:	• All required data currently collected. • Analytic not currently implemented
Future Works:	• Implementation of analytic to operate on currently collected data. • Addition of inspection tools for research team.
Planned Availability:	• Analytic planned to be in place for end of first action-research cycle (with outputs back-dated to start of main PoC trial). • Inspection tools planned for end of first action-research cycle.
Area 8: Measurement of Support Stakeholder Engagement with ProACT	
Current State:	• All required data currently collected. • Inspection per PwM (inclusive of care networks – i.e. support stakeholders) currently available.
Future Works:	• Provision of SIMS interface to view local aggregations • Methods of data collection may require modification to support other analytics (person-centric CareAnalytics, not described in this document).
Planned Availability:	• PwM view currently available in SIMS • Local aggregation planned for end of first action-research cycle (with outputs back-dated to start of main PoC trial).
Area 9: Comparison of Support Stakeholder Engagement by Trial Site	
Current State:	• All required data currently collected. • Analytic not currently implemented

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Future Works:	• Implementation of analytic to operate on currently collected data. • Addition of inspection tools for research team.
Planned Availability:	• Analytic planned to be in place for end of first action-research cycle (with outputs back-dated to start of main PoC trial). • Inspection tools planned for end of first action-research cycle.
Area 10: Generalised Aggregation of Person-centric Analytics per Trial Site	
Current State:	• Dependant on CareAnalytics outputs. • Not currently implemented
Future Works:	• Ongoing evaluation of need.
Planned Availability:	• May not be provisioned, as the original, intended outputs may be available through simpler, real-time aggregations. • If found to be required, analytic and inspection tools will not be available until at least the end of the first action-research cycle, and may possibly not be available until the end of the second action-research cycle. However, it should be noted that if this analytic is implemented, outputs can be backdated.
Area 11: Measurement of PwM Goal Achievement	
Current State:	• Goals system in place, and required data being collected. • Person-centric implementation (operating at local resolution) currently in testing in private CABIE builds. Due to be pushed to test servers in M22/23. • Precise form of local aggregation to be decided.
Future Works:	• Final definition of aggregated form of analytic • Implementation of analytic. Please note that the reactive form of this analytic is, as mentioned above, already nearing completion and will be deployed for the start of the main PoC trial. The implementation pending is for reflective analysis.
Planned Availability:	• Analytic planned for end of the first action-research cycle (with outputs back-dated to start of main PoC trial). • Deployment date for inspection tools is to be confirmed.
Area 12: Comparison of PwM Goal Achievement by Trial Site	
Current State:	• This analytic will follow the lifecycle of Area 11, described above.
Future Works:	• This analytic will follow the lifecycle of Area 11, described above.
Planned Availability:	• This analytic will follow the lifecycle of Area 11, described above.
Area 13: Measurement of Accuracy of System Alerts	
Current State:	• Updated alert systems currently in development. • Analytic not currently developed.

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Future Works:	• Collection of required data. This will be automatic on deployment of updated alert systems. • Analytic to operate on collected data. • Addition of inspection tools for research team
Planned Availability:	• Data collection will begin at the start of the main PoC trial. A period of data collection will be required before this analytic can be fully implemented and utilised for system refinement. • Application of analytic on collected data is planned for the end of the first action-research cycle. • Use of analytic outputs is expected to begin during the second action-research cycle (with outputs back-dated to start of main PoC trial).
Area 14: Daily Identification of Missing Inputs per PwM	
Current State:	• All required data currently collected. • Procedures in place to identify issues based on past data.
Future Works:	• Incorporation of issues into new report email formats • Refinement of procedures at end of first action-research cycle
Planned Availability:	• Inspection tools already available • Available for report emails from start of main PoC period

7 Future Updates

A final update to this document will be delivered in M39. This update will detail the final implementation of the analytics described in this document, issues encountered with implementation, thresholds set, and subjective reviews of each analytic's usefulness to trial site management, research, and technical teams. It is important to note that while future updates may make use of analytic outputs for the purpose of providing implementation examples, individual outputs will not be described in detail in this document. It is expected that outputs from these analytics will be used for reporting in other deliverables.

8 References

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