HESG Next Generation
– Pre-Market Engagement

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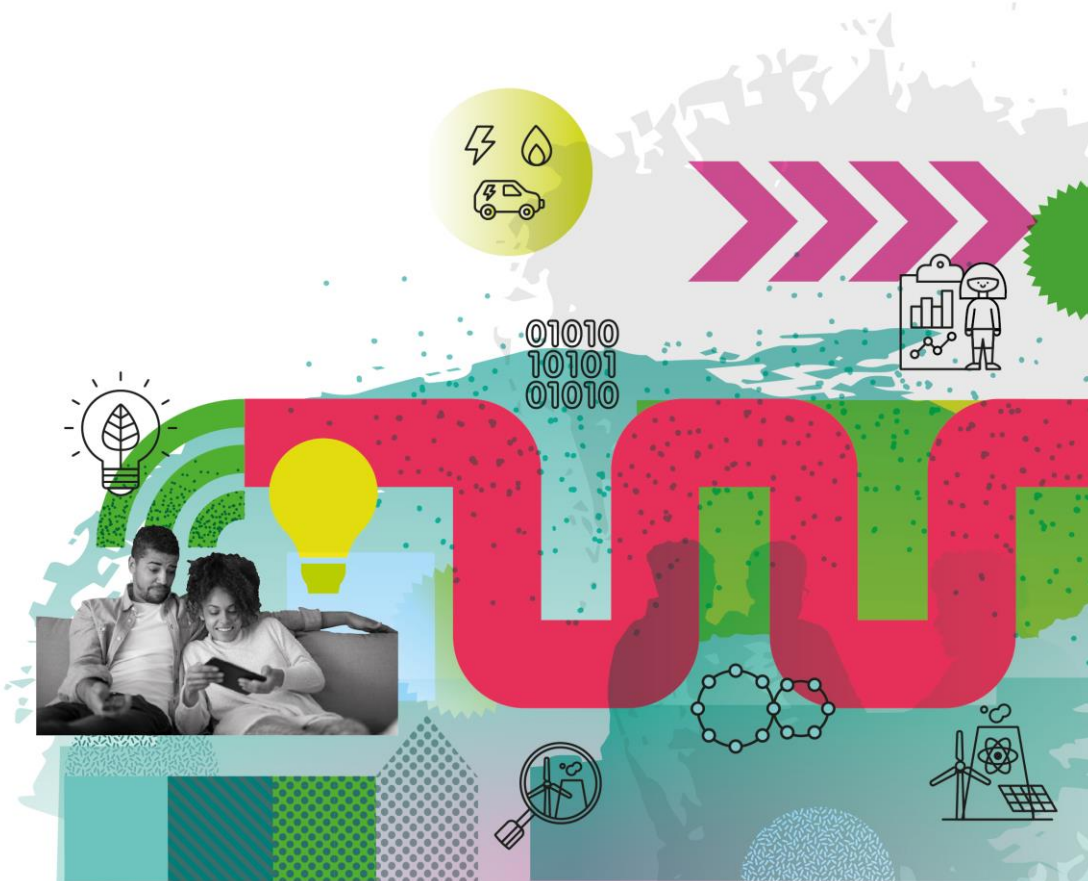
Publication date



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* Refer to the Information Classification Policy

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Date	Version	Comments
03/05/19	0.1	Release to reviewers and approvers for comment
23/05/19	0.2	Updated with review comments.
28/05/19	0.3	Updated after discussion with SP &GM.
28/05/19	0.4	Updated with PIN response section
30/05/19	0.5	Updated with comments from SP
30/05/19	0.6	Minor changes to section 1 to include SP's comments
30/05/19	0.7	Updates to reflect early market engagement via PIN after discussion with Procurement

Contents

1. Guidance on Responding to this Pre-Market Engagement

1.1. Context and Purpose of the Pre-Market Engagement

The Energy Systems Catapult (ESC) have developed a Home Energy Services Gateway (HESG) Digital Platform as part of their Living Lab research capability which has been in active service since 2016 for energy product and service trials. ESC is now seeking to develop a "Next Generation" version of the HESG platform to address the more complex, diverse and scalable market requirements for future energy product and services trials.

ESC has developed the high-level requirements and a conceptual level design for the Next Generation HESG platform, with intent to issue an Invitation To Tender (ITT) to select a delivery partner with experience of delivering similar platforms, with a view to implement a proof of concept system for the winter 20/21 heating season.

The purpose of this Prior Information Notice (PIN) is to receive elicit feedback on the conceptual design of the HESG, understand if there is any existing solution that can deliver the scale, flexibility and openness that is required, if an existing solution can be modified or if it is recommended to build something new. In all cases we are seeking feedback regarding indicative costs, timescales and challenges associated with implementing the proposed solution.

This information will be used by the ESC to develop more detailed requirements for the system which will be used in our (ITT), subject to obtaining funding.

1.2. Response Timelines

The following time scales are required to enable ESC to gauge the market and assist ESC with defining the next steps and with the intent to undertake a formal tender to find a suitable & capable delivery partner.

Activity	**Window**
PIN Issued	31st May 2019
Clarification questions window, to the ESC by email only	3rd to 10th June 2019
Initial responses required	14th June 2019
Response to be reviewed	17th to 28th June 2019
Clarification questions from ESC	17th to 28th June 2019
Initial process to be concluded	July 2019

1.3. Communication with ESC

Clarification questions and the response should be sent to the following ESC email account.

procurement@es.catapult.org.uk

All responses received will be treated in strict confidence and used to develop our understanding of the possible solutions and delivery approaches to inform the ITT process.

Please note that responses received after the initial response deadline may not be reviewed

Clarification questions and their answers will be distributed to all interested parties unless deem commercially sensitive or confidential.

At this stage, ESC has not made any decision on whether or not to proceed with the project and in the event ESC does decide to undertake a formal tender all interested parties who have responded to this PIN will be notified and invited to participate in a tender process.

1.4. Response

The response should be in one of the following formats, Microsoft Word, Excel or Adobe PDF

It should contain information on the following:

- Technical Development of the HESG concept.
    - Is ESC's concept feasible and if so, what concerns, and difficulties are foreseen?
    - What technologies might be used? Are these readily available or is significant development required?
- Development Process of the HESG
    - Is the stated development process appropriate or are there alternative approaches?
    - Are the outline timescales in the RFI reasonable?
    - What are the likely timescales for development of each phase?
- Operation of HESG
    - Are there any operational difficulties foreseen?
- What are the indicative estimated costs of HESG for each phase?
    - Proof of Concept (A Sample) 30 homes
    - Development Release (B-Sample) 150 homes
    - Production Release (C-Sample) 10,000 homes

The above indicative estimates should be broken down into Professional Services, Development, Software / Licensing, Hosting / Infrastructure, Operational and any other relevant costs.

Your submission should not include the following:

- Sales, marketing or other promotional information
- Organisation structure
- Work Breakdown Structure
- Detailed project plans

1.5. Next Steps

ESC will review all suitable responses to inform the further development of the requirements, conceptual design and delivery approach with the intent to develop and issue an Invitation To

Tender (ITT) for a Delivery Partner for the development, deployment and operation of the Next Generation HESG digital platform as a critical component of the ESC Living Lab capability.

2. Introduction

The Energy Systems Catapult (ESC) is supporting the UK government and industry in transforming the energy sector to deliver on the promise of zero carbon by 2050. An important challenge is reducing the carbon from domestic energy use, in particular heating. The ESC believe that this can be achieved most effectively by the energy sector working very closely with consumers and industry to deliver energy propositions that provide benefit to consumers in terms of comfort, convenience and cost and are commercially viable for industry. Such propositions will be enabled through the application of digital technologies, connected home products, innovative energy service models and interoperability across the energy system to deliver CO2 reductions and consumer benefits.

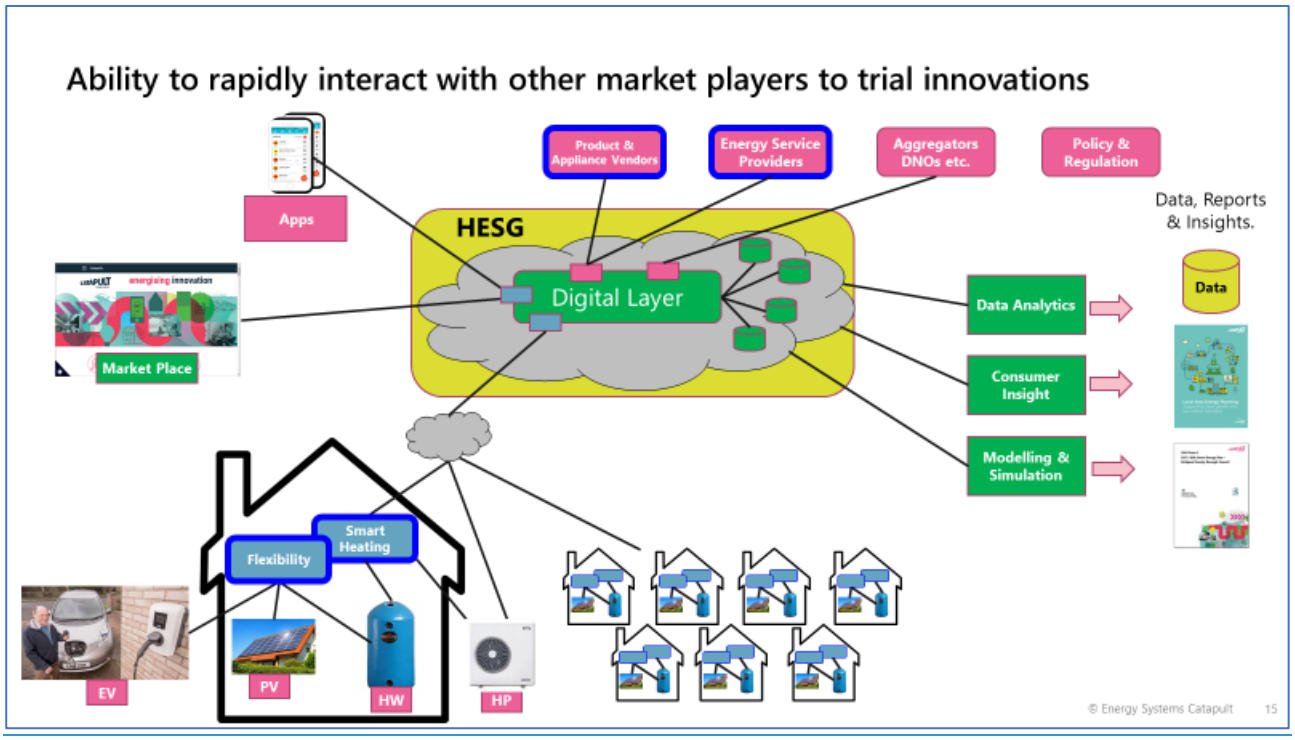
The current approach to this transition to digital technologies is piecemeal and consists of technology islands. Testing of new ideas by innovators is difficult and costly requiring significant cost in the creation of field trials with consumers. The ESC can reduce the cost and risk of trialling new products and services using our "Living Lab" with 100's of homes where innovators can market test ideas, products and services.

At the heart of this living lab is the "Home Energy Services Gateway" (HESG) which will allow innovators to rapidly connect with many consumers and homes containing a diverse range of smart home devices and energy appliances (Heating; Solar PV, Electric Vehicles, Energy Storage etc.) to develop and test new service offerings to facilitate the transition to clean low-carbon energy system. The development of HESG is the scope of this request for information.

The ESC already has experience with developing and operating a living lab, having run service trials in a 100-home lab for the last 3 years. However, the software used in the current version was designed as a Proof of Concept (PoC) for a specific research purpose and to operate with bespoke in-home hardware. This version of HESG is not sufficiently flexible or scalable and the insertion of additional sensors, or integration with third party smart home systems, requires significant development effort. As such, this version is unable to support the goals of the Living Lab.

The following section provide a high-level overview of the HESG conceptual system. It provides context and an outline of the solution sufficient to enable RFI recipients to understand our proposed approach and provide meaningful responses and information. It is not intended to provide a complete description of the Living Lab or all the requirements associated with HESG. Only those that are considered relevant to the technical realisation of the HESG platform have been included. We are aware there may be multiple options to develop the HESG capability and the presented interpretation is also only one view, ESC is open to all and any alternative suggestions as to how the same goal may be achieved.

The ESC is looking for a solution that, wherever possible, makes use of commercially available software platforms that will provide flexibility to build new adaptors, APIs and integrations with minimal constraints. The objective is to have an open platform that is not tied to any proprietary platform and does not inhibit the level of integration that can be achieved.


Ability to rapidly interact with other market players to trial innovations
Apps
Product & Appliance Vendors
Energy Service Providers
Aggregators DNOs etc.
Policy & Regulation
HESG
Digital Layer
Market Place
Data, Reports & Insights.
Data
Data Analytics
Consumer Insight
Modelling & Simulation
Flexibility
Smart Heating
EV
PV
HW
HP
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3. Need Analysis

The need for the system has been generated by many differing sources and the first step in the analysis of the need is to pull these various inputs into a single use case diagram. From here, the various needs are analysed in more detail by considering them from the perspective of each stakeholder in the system. The overall objective is to try and construct a complete view of what it is expected the system shall be able to do.

3.1. Need Description

The highest-level need is to provide a flexible digital integration/gateway platform that will allow different types of innovators to rapidly test products and services related to the domestic energy sector. This could be energy service providers who are interested in testing new energy service offerings or device vendors, be that smart devices such as a smart thermostat or smart systems such as Nest, that have new devices that they wish to test and offer to support energy services.

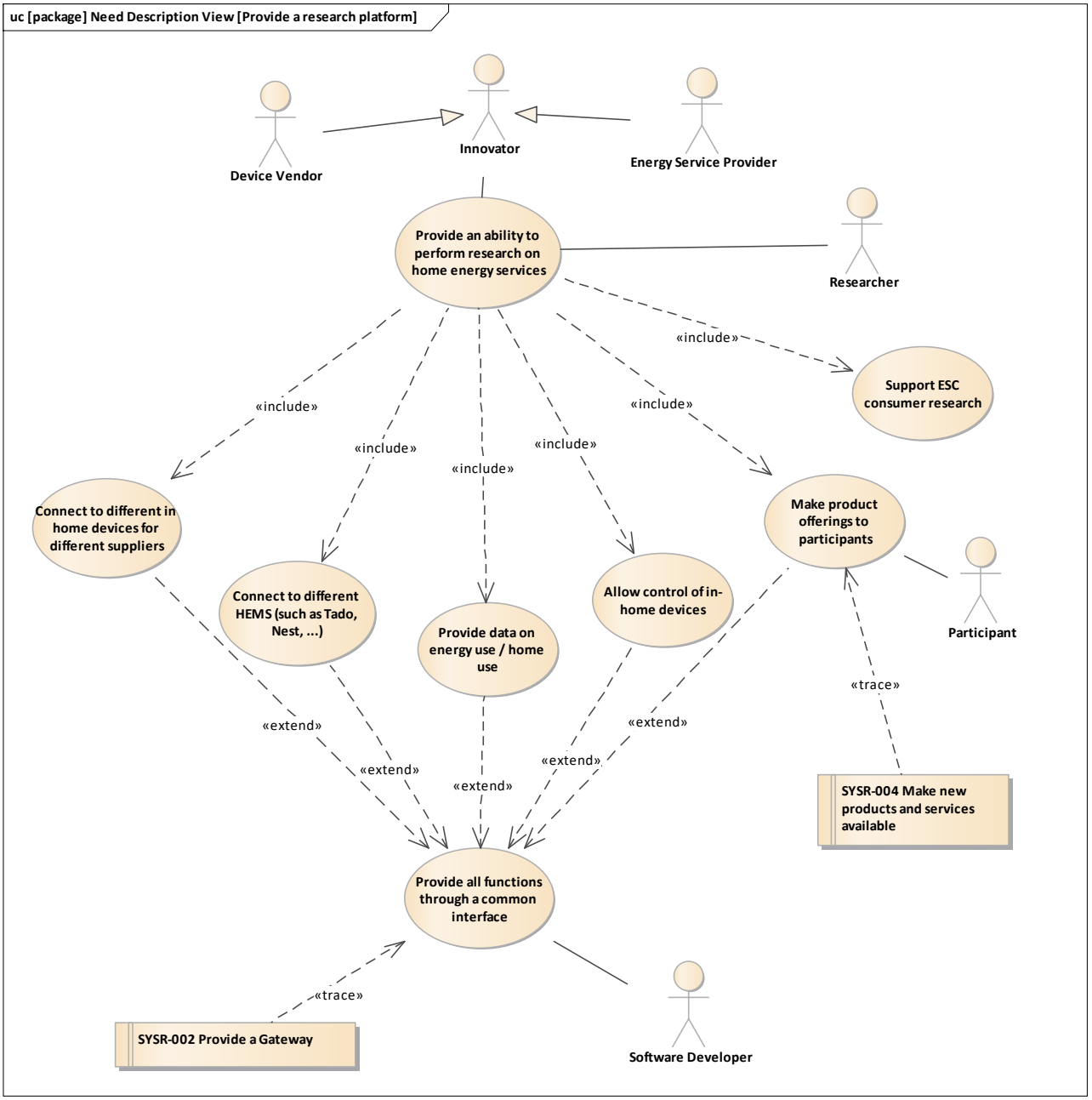
At the same time, there are numerous research teams who are interested in the data collected on energy use in real homes and how smart devices and services are really used.

Clearly, participants in any trial are also a key stakeholder as the smart devices will be installed in their home and they are the ones using the new products and services.

The final stakeholder is the software developer who requires that all this is achieved as far as possible through common interfaces and protocols to simplify the task of offering service to homes with different types of smart devices.

From the analysis of this high-level need, the more detailed need to provide a gateway has been identified. This is a facility that allows ESPs, researches and others to be connected to devices within a range of homes and test with them product offerings. In addition, a need to offer new

products and services to home owners has also been identified.



3.2. Need Analysis – Innovator Context

The need to "Provide a Gateway" is analysed from the perspective of the Innovator. The needs that this identifies are then analysed further.

3.2.1. Innovator – Provide a Gateway

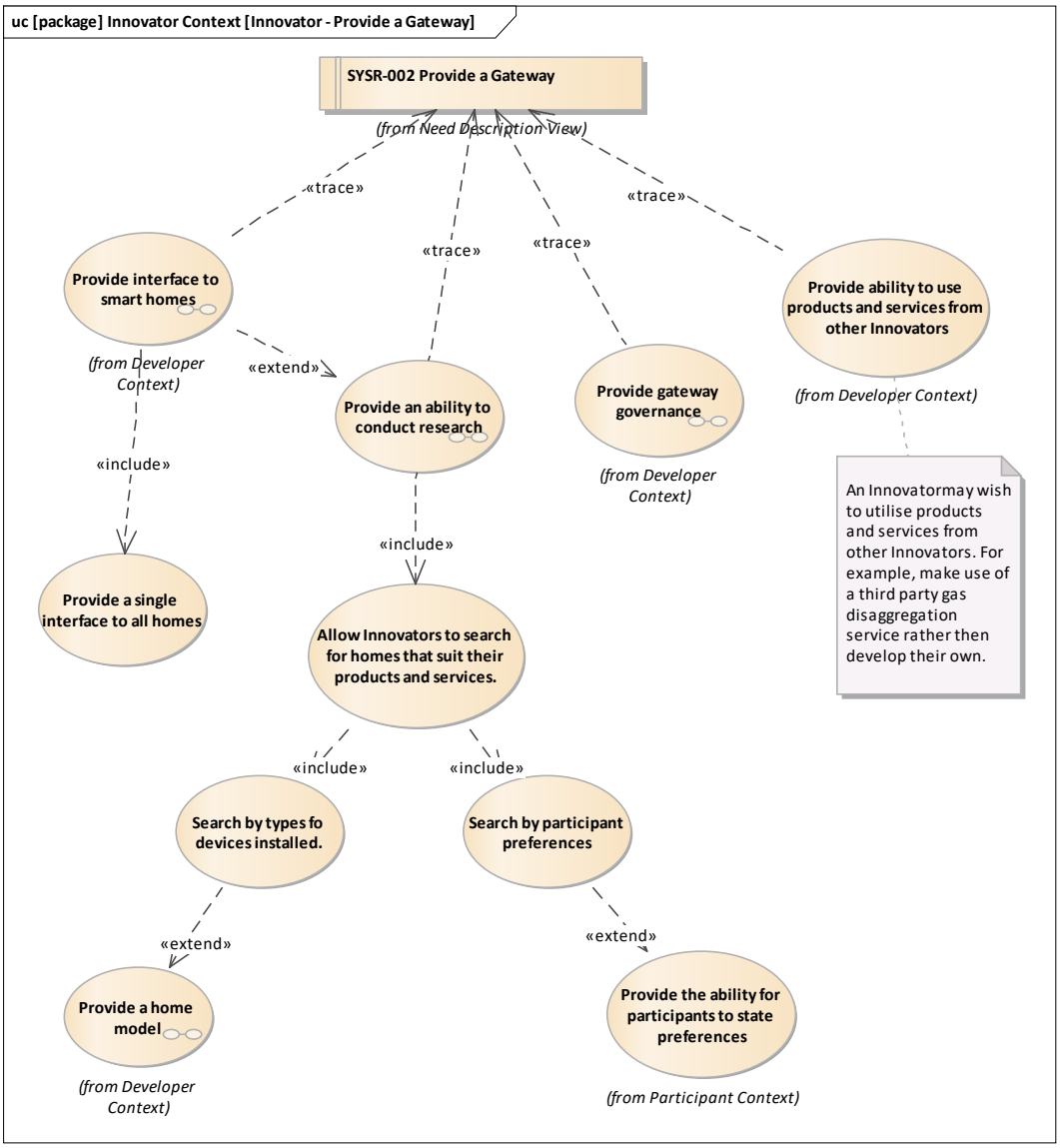
By considering the need to provide a gateway from the perspective of the Innovator stakeholder, a number of more detailed needs can be identified.

The gateway has to provide a interface to smart homes that the Innovator can use to obtain data and create services tailored to a consumer or home. To make this viable, ideally there should be a single interface to all homes irrespective of the type of hardware or system that is installed.

Innovators want to be able to conduct research to determine if their product or service will be of value. Their offerings may require either specific types of participant or smart homes with specific types of hardware installed. They will want to be able to review all the participants in the Living Lab to find those that fit their criteria.

In addition to selling their own products and services, Innovators may want to use products and services from other Innovators where this will reduce the development cost for their own products and services.

Innovators will have an interest in the operation and rules governing the use of HESG, but they will probably not be directly involved.



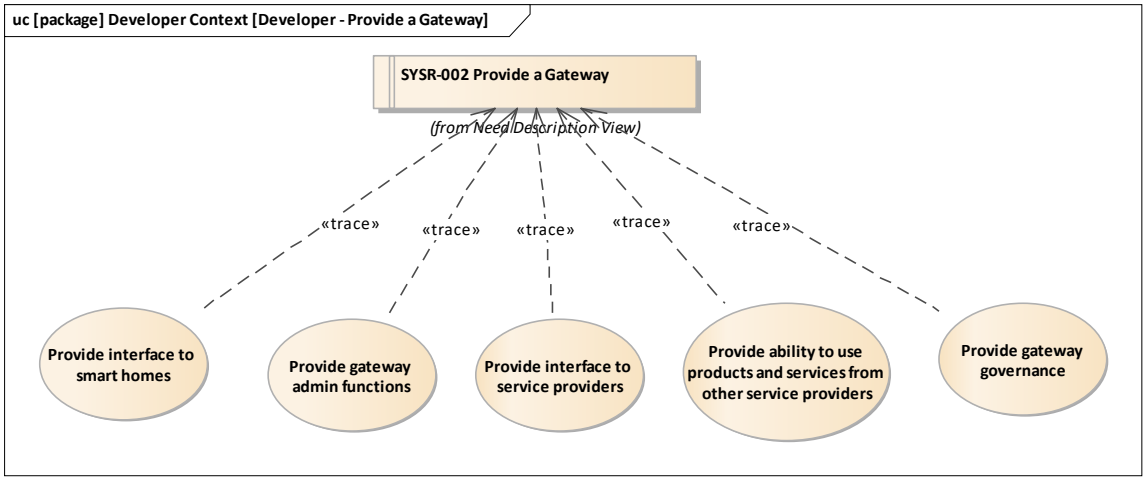
3.3. Need Analysis – Developer Context

The need to "Provide a Gateway" is analysed from the context of a developer. This identifies a set of high level needs that are relevant to the developer that are then developed further.

3.3.1. Developer – Provide a Gateway

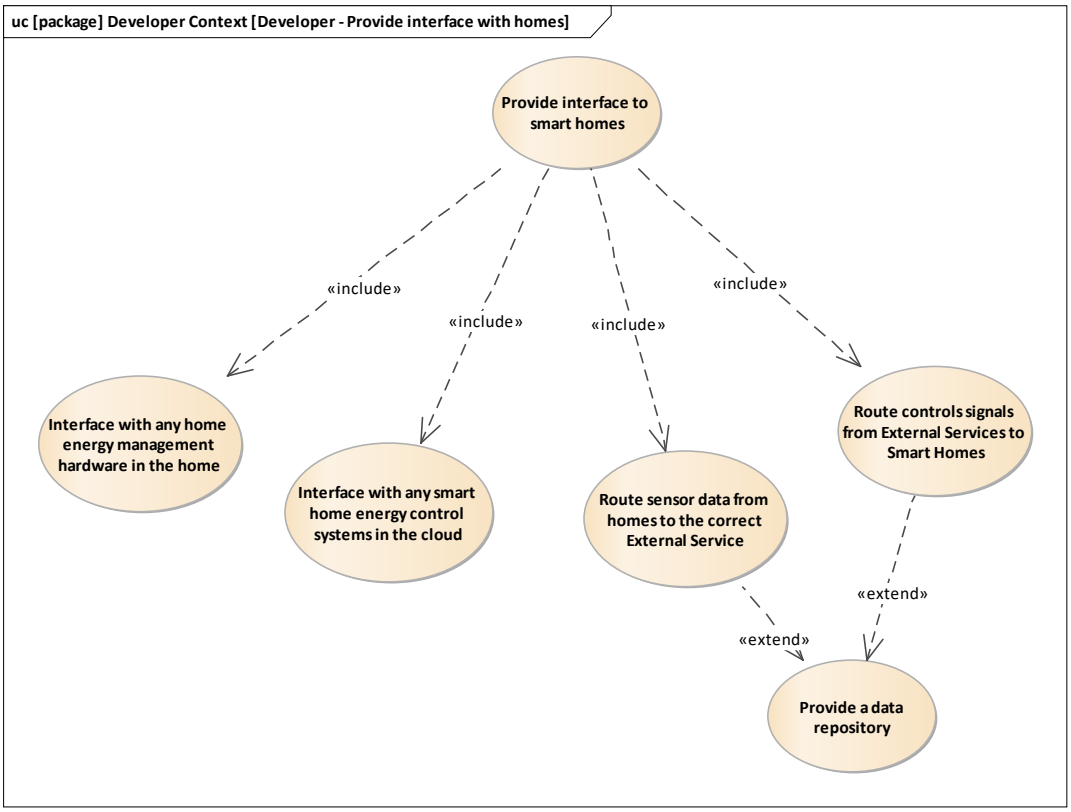
The Developer stakeholder is interested in a number of aspects of the gateway. The provision of the interface to the smart homes is clearly relevant as is the provision of the interface to the Innovators. The ability to share products and services between Innovators will impact the design of the system and the implications understood.

The Developer will also be interested in the admin functions that are required to support the system as well as the way that the system is governed as both may require functionality to be implemented in software.



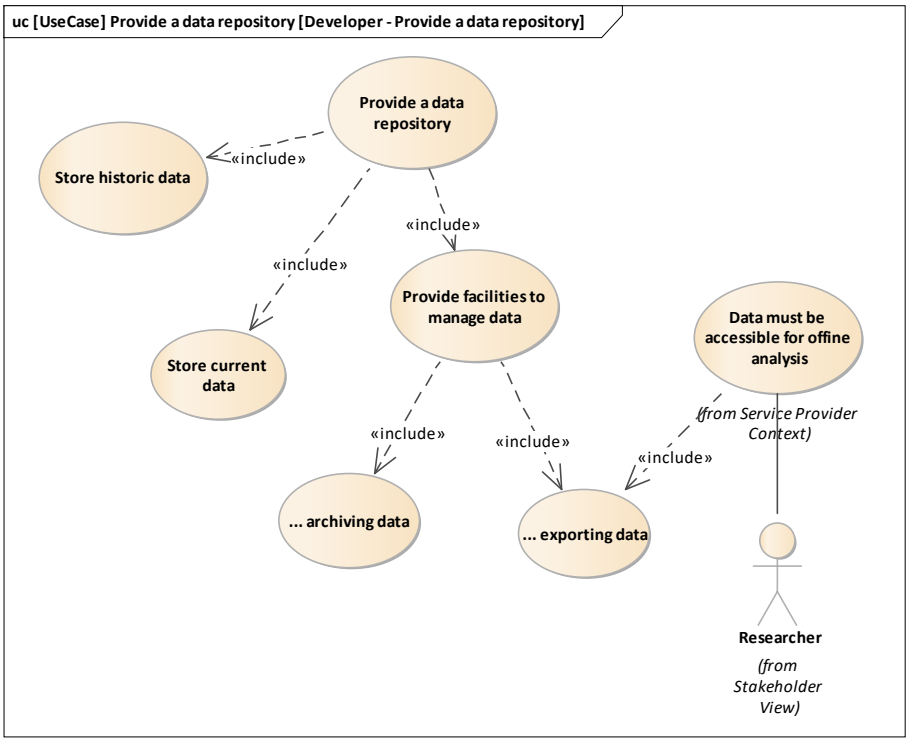
3.3.2. Developer – Provide interface with smart homes

The need for the system to interface with smart homes is further expended to identify that this should include any home energy management hardware and interface with home energy control systems in the cloud such as Nest and Tado. The interface must also route data to and from the home to the appropriate Innovators based on the services that the participant has purchased. If the system contains all this data, then it makes sense to collect it. This will support the need of researchers who want to analyse the data offline and at a later date.



3.3.2.1. Developer – Provide a data repository

The need to "Provide gateway governance" is developed further by considering the scenarios that a developer may need to address. The repository has to be able to store data as it comes in and has to retain all the historic data. This data will be time series data from sensors as well as relational data on the home structure, the user, ... The repository will also have to provide facilities for managing the stored data which should at least include archiving the data and exporting the data out of the system to allow researchers or other stakeholders to manipulate it as they see fit.

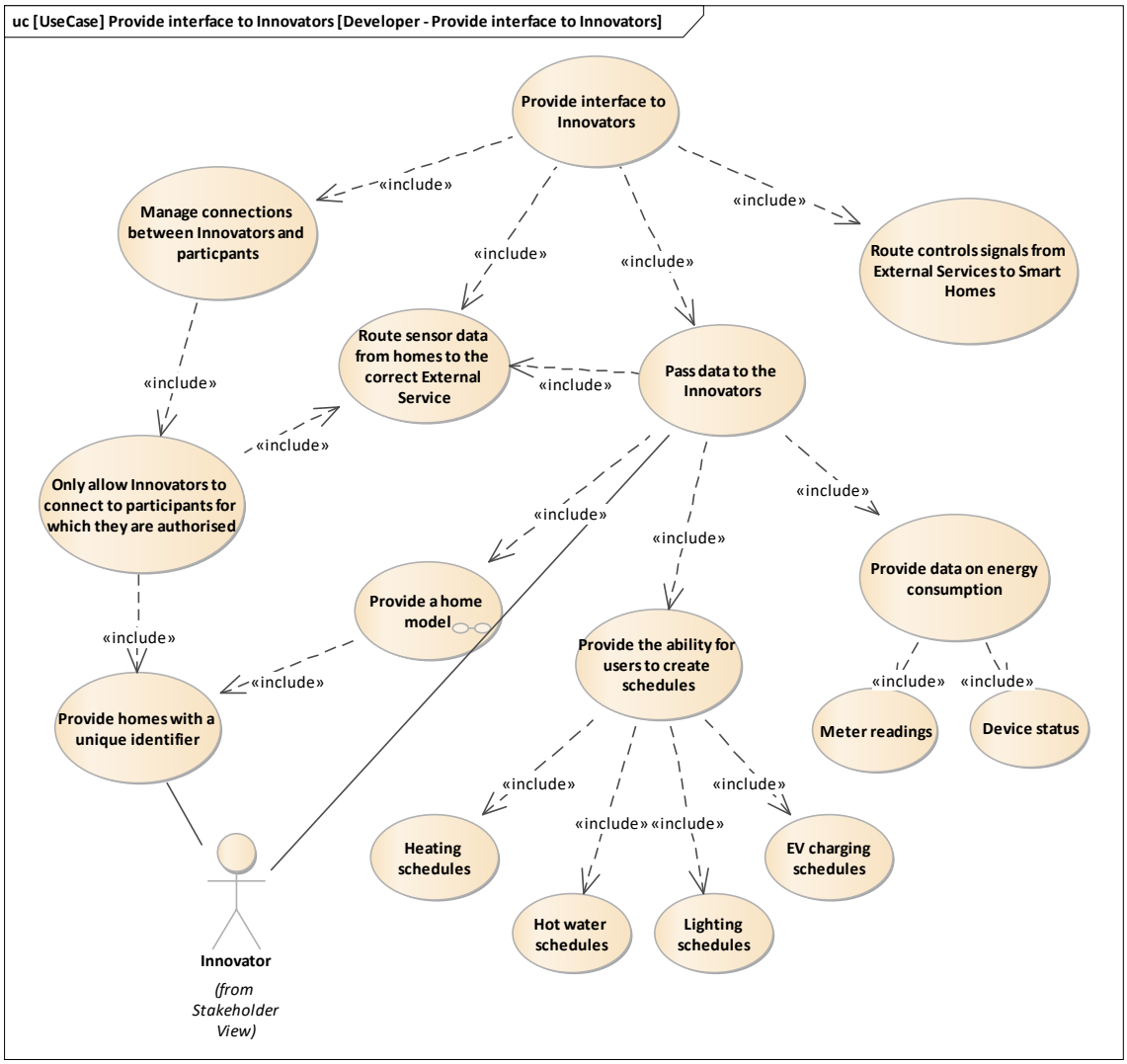


3.3.3. Developer – Provide interface to Innovators

When the Developed considers the need to provide an interface to Innovators, there are a number of elements to consider. Firstly, each participants data has to be managed and access controlled. Innovators should only be able to see data from participants who have given their permission for them to see the data so this functionality must be included.

Once permission has been granted the data must be passed to the Innovator, which raises questions about what sort of data is needed. It is likely that the Innovators will want to offer functionality where participants can schedule operation of a device such as heating or charging and it is likely that Innovators will want information on energy use such as room temperatures, device states, meter readings, ... If there are numerous devices, and potentially varied devices, then it would suggest that the system much contain some form of description of the home - a home mode.

Finally, the interface to the Innovator must allow the Innovator to send commands to homes to activate or deactivate devices based on the requirements of their product or service.

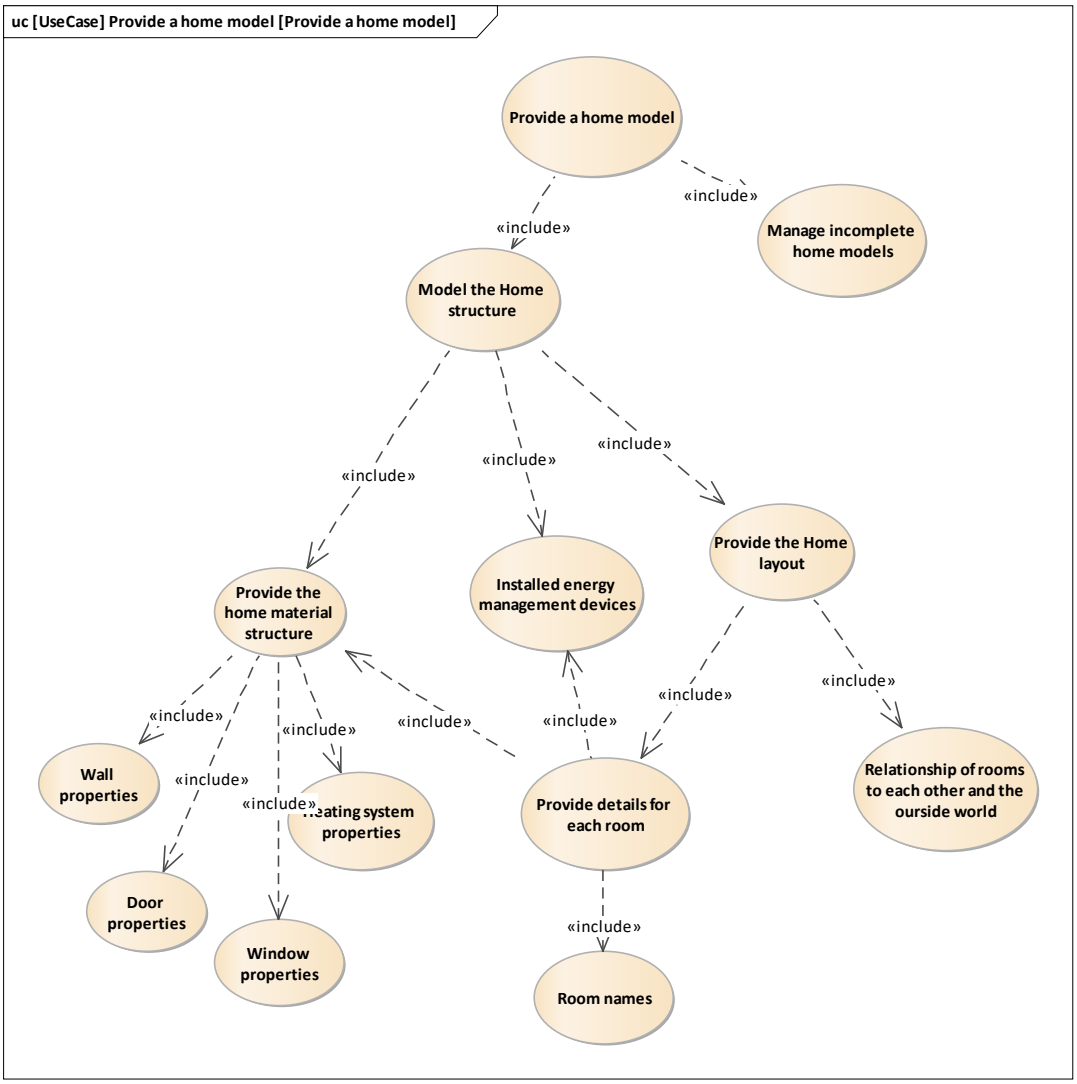


3.3.3.1. Developer – Provide a Home Model

The home model must be a consistent description of the home that captures the structure of the home in terms of the materials that have been used in the construction, the energy devices that are installed and the layout of the home.

The construction of the home will be important to allow Innovators to understand the current state of the home. Different services may be offered depending on insulation level for example, or different prices attached to the same service. Knowledge of the layout of the home may also help with the definition of services but will be important in some algorithms - such as time to warm - and when performing consumer research.

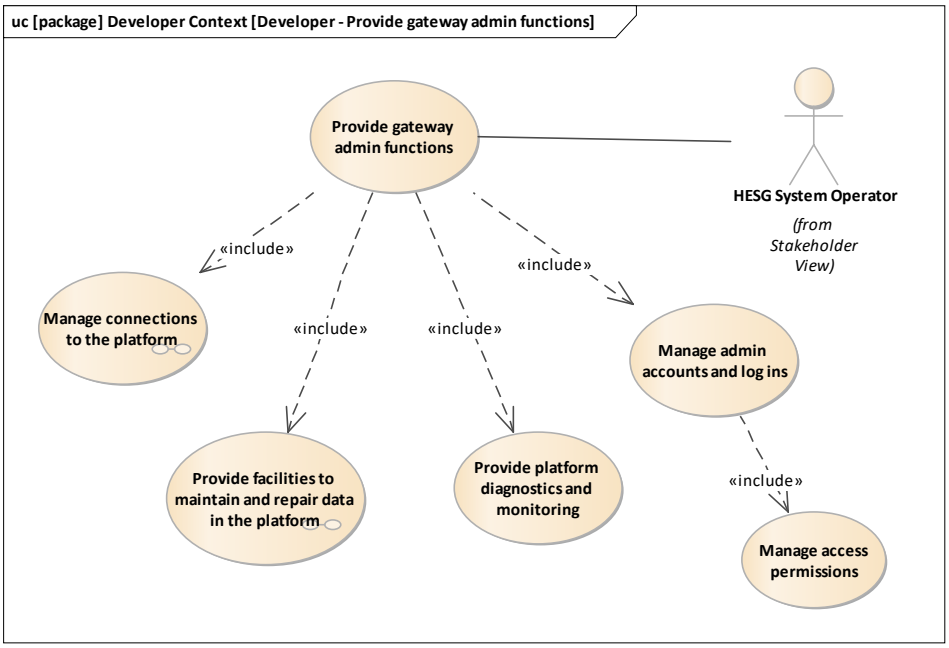
The types and locations of installed energy management devices is also critical as this may impact services that are offered or may suggest alternative service offerings.



3.3.4. Developer – Provide gateway admin functions

During the lifetime of the platform it will be necessary to provide some level of administration. At the very least that could be:

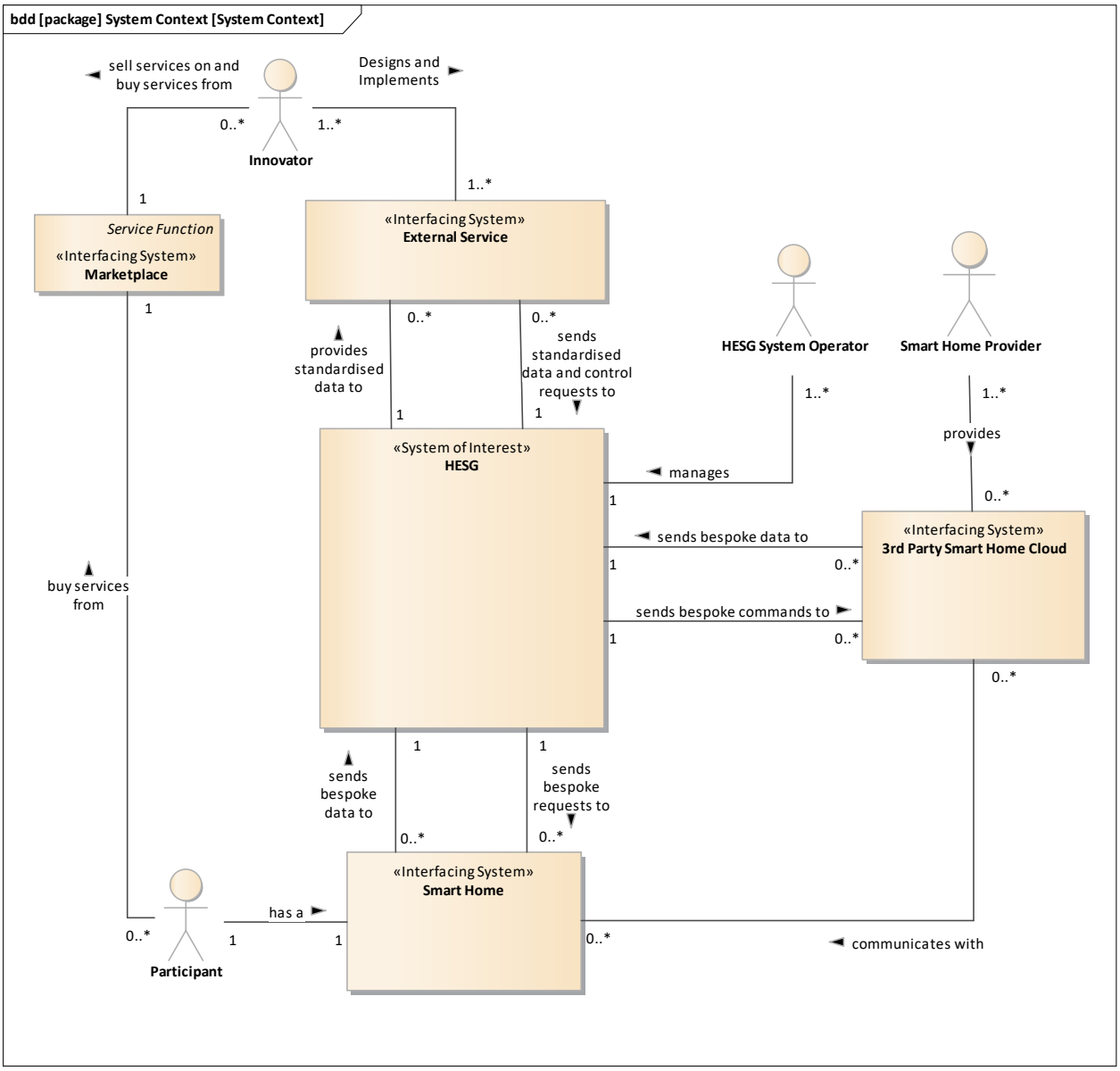
- Managing connections to the platform in terms of adding and removing participants and Innovators and connecting to homes.
- Provide facilities to maintain and repair data that is stored in the platform which should also include the ability to extract data from the platform
- Provide diagnostics and monitoring so the system operator who is responsible for the operation and maintenance of the system is informed of any issues and provided with sufficient data to be able to resolve them in a timely manner
- Manage the accounts of system operators including applying appropriate permissions.


uc [package] Developer Context [Developer - Provide gateway admin functions]
Provide gateway admin functions
HESG System Operator
(from Stakeholder View)
«include»
«include»
«include»
«include»
«include»
Manage connections to the platform
Provide facilities to maintain and repair data in the platform
Provide platform diagnostics and monitoring
Manage admin accounts and log ins
Manage access permissions

4. System Context

HESG forms a gateway between smart homes and external services provided by Innovators routing data and commands from one to the other. HESG will be able to connect to any form of smart home such as smart devices with an internet connection, aggregation of in-home smart devices though an internet connected hub or indirectly with a smart home through a 3rd party smart home cloud. Clearly, all these systems will operate in different ways and with different data formats. HESG will translate all these different formats into a single standard format. This standardized information is then made available to the external service so that Innovators can use it to create service offerings. By having a standardized interface to the external service, Innovators are isolated from the complexities of different smart home implementations and are able to offer a product or service to any consumer or home irrespective of the smart home implementation.

HESG is required to store all data it receives from a smart home as well as all data and commands it receives from an external service. This is to allow research into the use of energy in the home and the effectiveness of external services as well as providing an audit trail in the event of concerns being raised either by a participant or an Innovator.



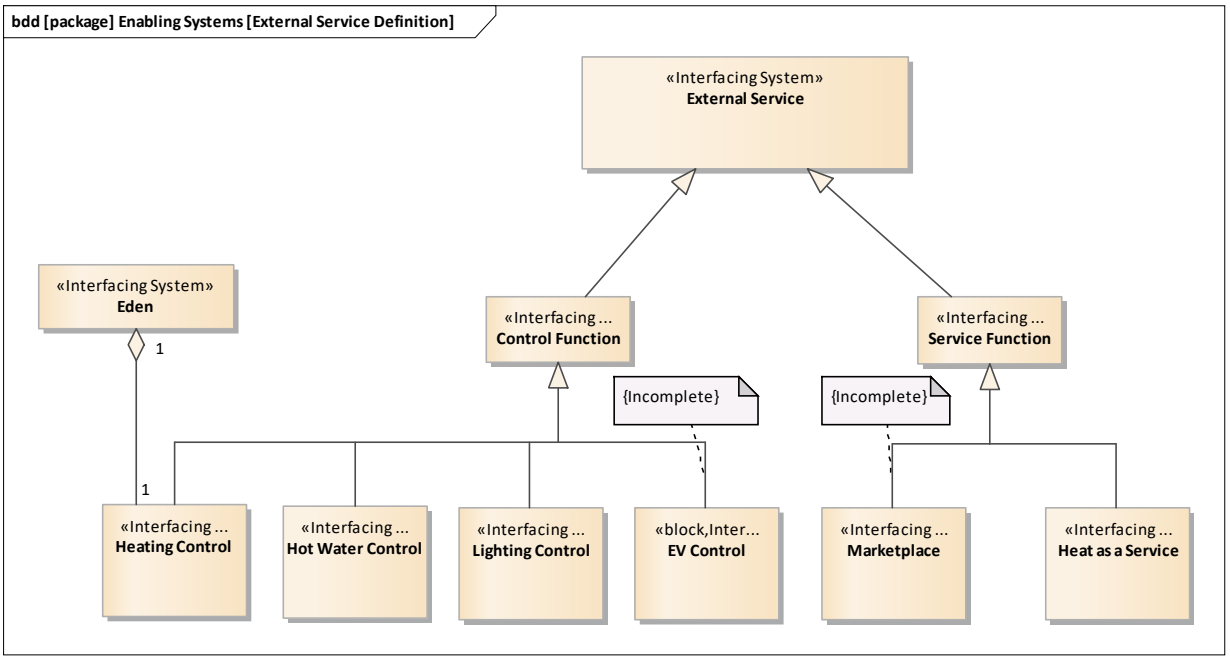
4.1. Interfacing Systems

4.1.1. External Service

The main objective of HESG is to facilitate Innovators in the provision of services, referred to as external services to distinguish them from services in the software architecture sense. An external service can be one of two types of things:

- Control function. A control function purely provides a level of control over some element of a smart home. This may include the presentation of appropriate data to assist the occupier with the control function such as room temperatures or the status of lights or electrical sockets.
- Service function. A service function provides an additional service or product to an occupier or another Innovator. This could be a service such as the Marketplace or the provision of an algorithm for use by other Innovators or an energy service offering such as heat as a service.

It is assumed that both types of external services would be offered / advertised in the Marketplace.

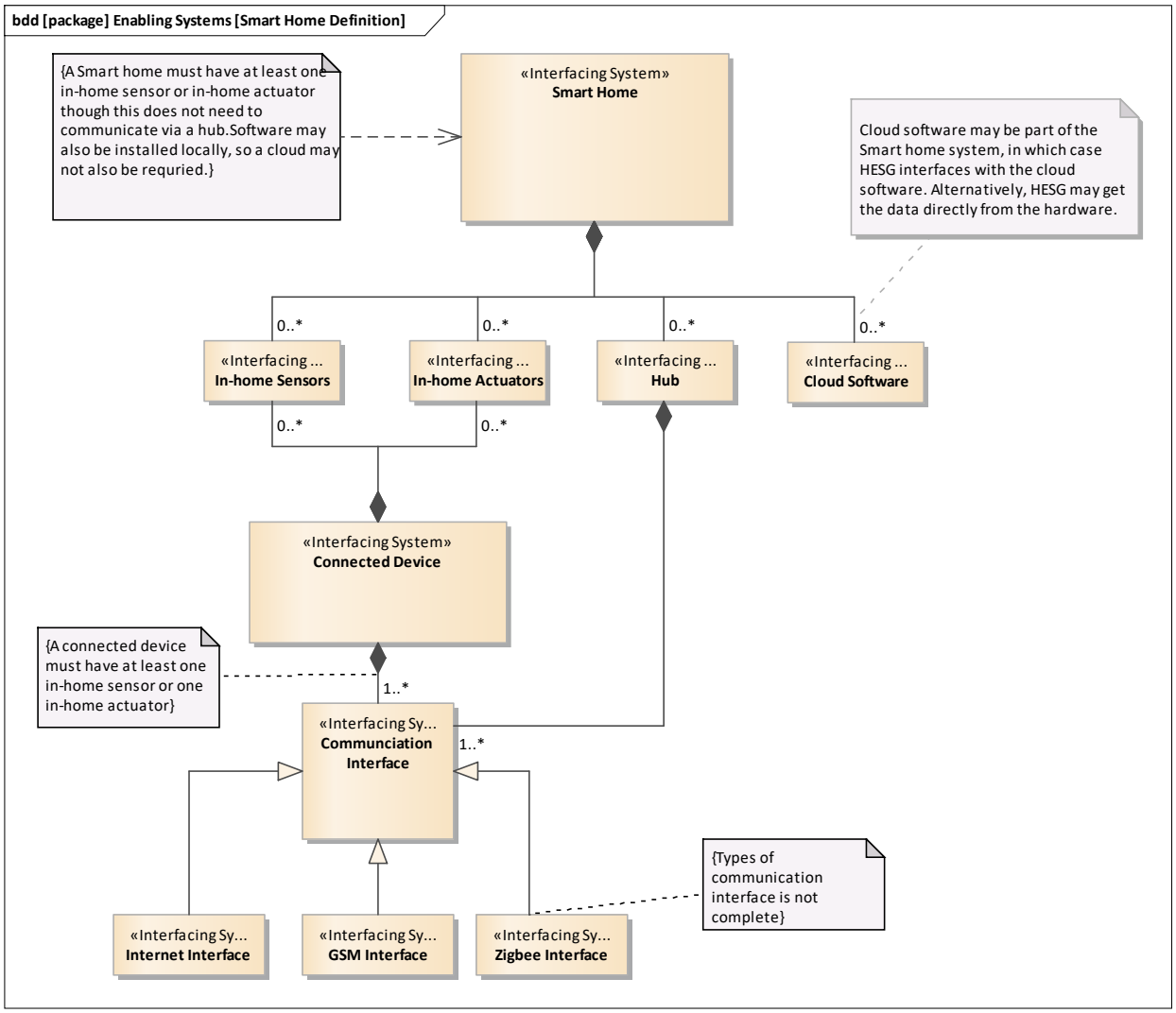


4.1.2. Smart Home

A Smart Home is a home that contains at least one device that is connected in some manner to the internet and is able to either monitor or control some in-home parameter that is related to energy. For example, a thermostat that delivers a temperature signal to the internet would be considered sufficient to be a Smart home, as would an internet enabled electrical socket that could be turned on or off by a remote signal. These are included as they measure a parameter that is related to energy use (room temperature) or allow control of a device that can impact energy consumption (turn off a socket). Such devices may communicate directly with the internet either through a wi-fi interface with a participant's internet router or directly with a cloud through a mobile communications connection.

A smart speaker on its own is not considered sufficient to create a smart home, but if it is used as a hub to connect to devices that can monitor or control the energy in the home, then this would create a smart home.

Smart meters on their own are not considered sufficient to create a smart home as it is unlikely that this information on its own will be enough to allow offering energy services.



4.1.3. 3rd Party Smart Home Cloud

A 3rd party smart home cloud provides standalone smart home functionality. It will connect to devices in the home, typically provided by the third party, and use the cloud to provide functionality such as heating or lighting control. HESG access data and actuation from these homes by connecting to the 3rd party smart home cloud rather than connecting directly to the devices in the home.

Tado and Nest are examples of this, but also smart meters fall into this category as HESG will typically access them through a third-party interface - usually in the cloud - and not directly.

4.1.4. Marketplace

The Marketplace is a location that is accessible by all Stakeholders where Innovators can advertise products and services and other stakeholders can purchase them. It is a special type of External Service as it also is the place where participants and Innovators can join the Living Lab. Only HESG System Admins and software engineers developing services interact directly with HESG. All other interactions occur through the Marketplace.

5. System Operation

The following section presents the requirements as a series of sequence diagrams which explain how the system is intended to be used. These diagrams are a representation of one or many requirements for the system. Execution of the sequence identified in the sequence diagram on the real system therefore constitutes verification of the requirements associated with that diagram.

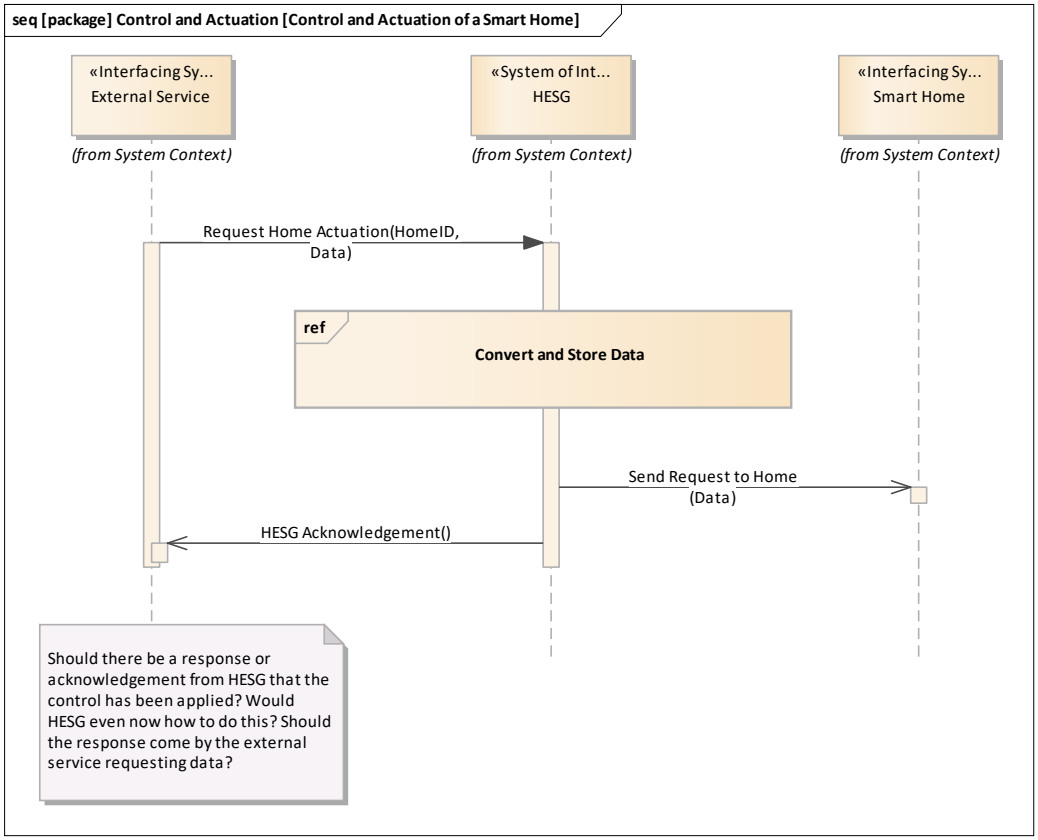
Each sequence diagram represents a specific scenario for how the system should be used and contains an explanation of the scenario, the pre-conditions that define the state the system should be in at the start of the scenario and the post-conditions or the state the system should be in after completion of the scenarios. The scenarios will eventually cover all operating conditions - rainy day as well as sunny day scenarios.

5.1. Control and Actuation of a Smart Home

Scenario: An external service wants to send a request to a smart home. The sequence is probably the same for a request that has to go through a smart home cloud.

Pre-condition: HESG is setup with at least one home with device that can accept a request and with an external service that has writes to access that home.

Post-condition: The required device in the desired home has accepted and acted upon the request from the external service. HESG has acknowledged the request back to the external service.

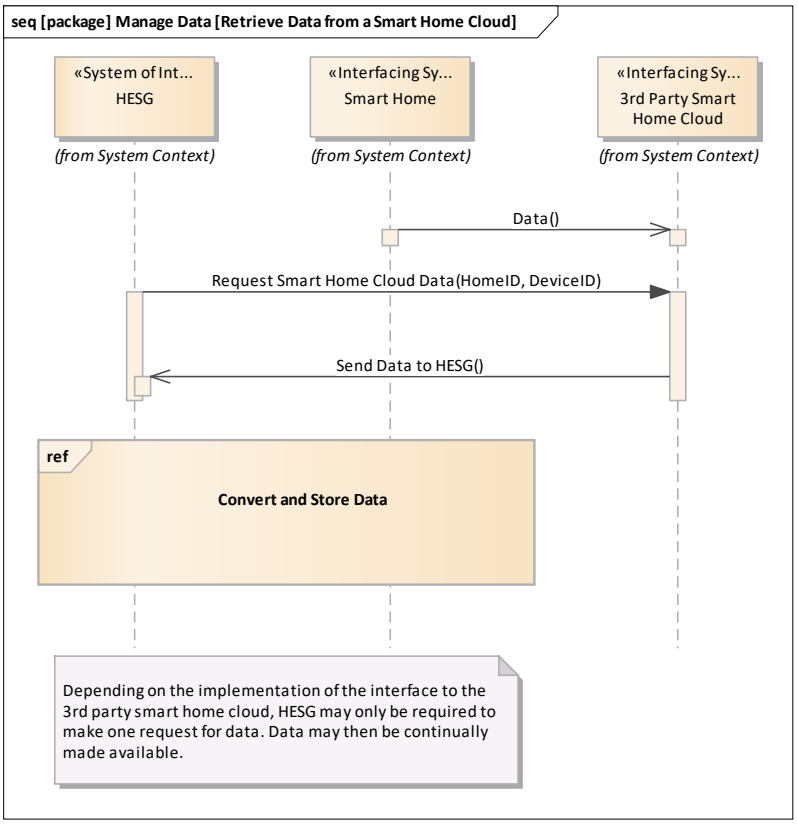


5.2. Retrieve Data from a Smart Home Cloud

Scenario: HESG retrieves data for a smart home but from a third parties smart home cloud

Pre-condition: HESG is set up with access rights for the required home via the 3rd party's cloud.

Post-condition: HESG has retrieved the required data, converted it to the standard format and stored it.

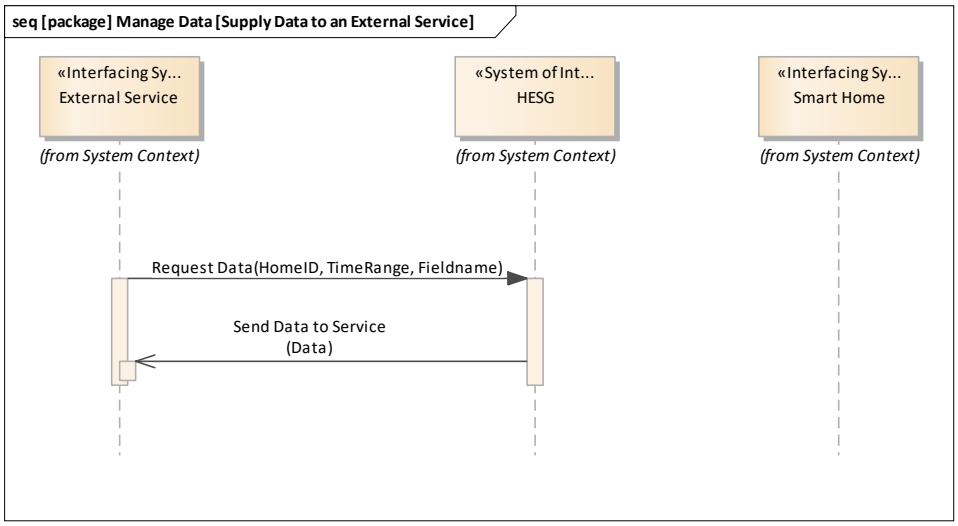


5.3. Supply Data to an External Service

Scenario: Specific data for a specific home over a defined time range is requested by an external service. This is limited to small amounts of data that is used for the support of features that the external service has implemented. Large data sets for analysis and research (>1 week) should be accessed as indicated in "Supply Offline Data".

Pre-condition: HESG is setup with data for at least one home. An external service is available that has access to at least one home for which HESG has data.

Post-condition: The external service has the data for which it asked.

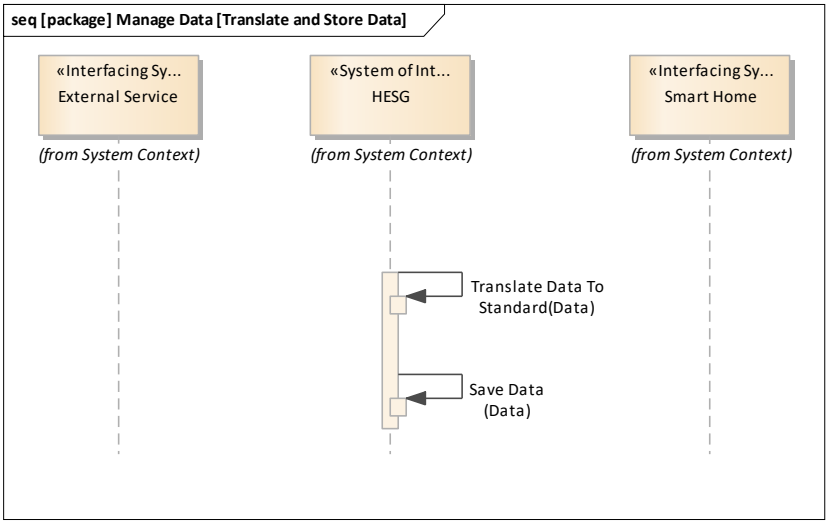


5.4. Translate and Store Data

Scenario: HESG translates data from a proprietary format to a standard format based around a canonical data model.

Pre-condition: HESG has data to translate and store

Post-condition: The data has been translated to the standard format and stored.

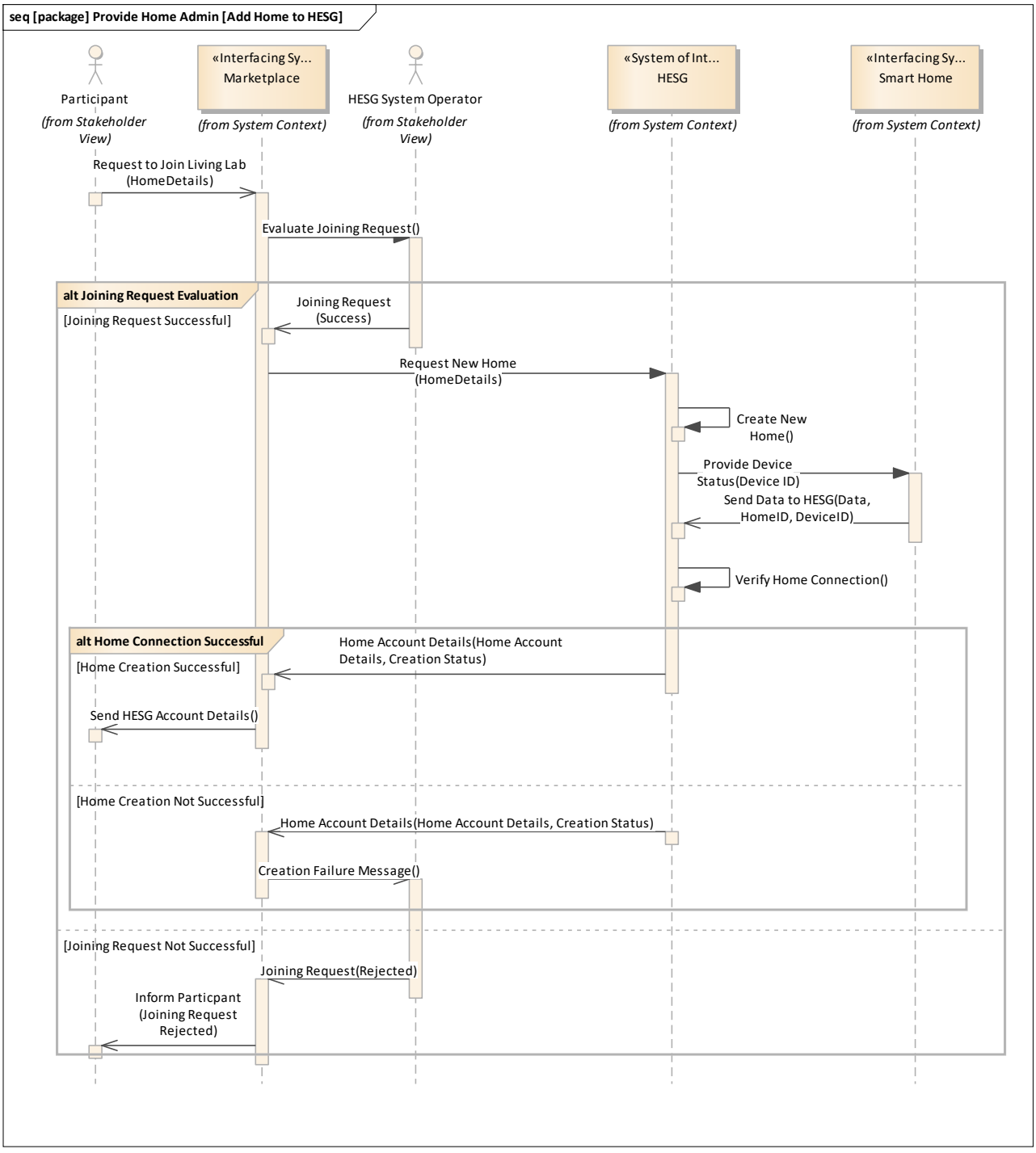


5.5. Add a Home to HESG

Scenario: A new home is added to the platform.

Pre-conditions: The home has the appropriate smart hardware installed including a hub to communicate with the cloud. The survey is successful.

Post-conditions: The home is visible in the platform, data is being recorded.


seq [package] Provide Home Admin [Add Home to HESG]
Participant
(from Stakeholder View)
«Interfacing Sy...
Marketplace
(from System Context)
HESG System Operator
(from Stakeholder View)
«System of Int...
HESG
(from System Context)
«Interfacing Sy...
Smart Home
(from System Context)
Request to Join Living Lab (HomeDetails)
Evaluate Joining Request()
alt Joining Request Evaluation
[Joining Request Successful]
Joining Request (Success)
Request New Home (HomeDetails)
Create New Home()
Provide Device Status(Device ID)
Send Data to HESG(Data, HomeID, DeviceID)
Verify Home Connection()
alt Home Connection Successful
Home Account Details(Home Account Details, Creation Status)
[Home Creation Successful]
Send HESG Account Details()
[Home Creation Not Successful]
Home Account Details(Home Account Details, Creation Status)
Creation Failure Message()
[Joining Request Not Successful]
Joining Request(Rejected)
Inform Particpant (Joining Request Rejected)

6. Non-functional Requirements

The following are some of the key non-functional requirements that the system is expected to comply with.

6.1. Scalability

HESG shall be able to support an increasing number of homes. This could be as small as 5 and will reach a maximum of 10,000.

HESG also has to support up to 100 external services.

6.2. Response time

HESG shall respond to request for data from a service in <100ms. It is assumed that this is the maximum that would give an acceptable round-trip time for a request from an app via the external service and into HESG.

6.3. Data stores

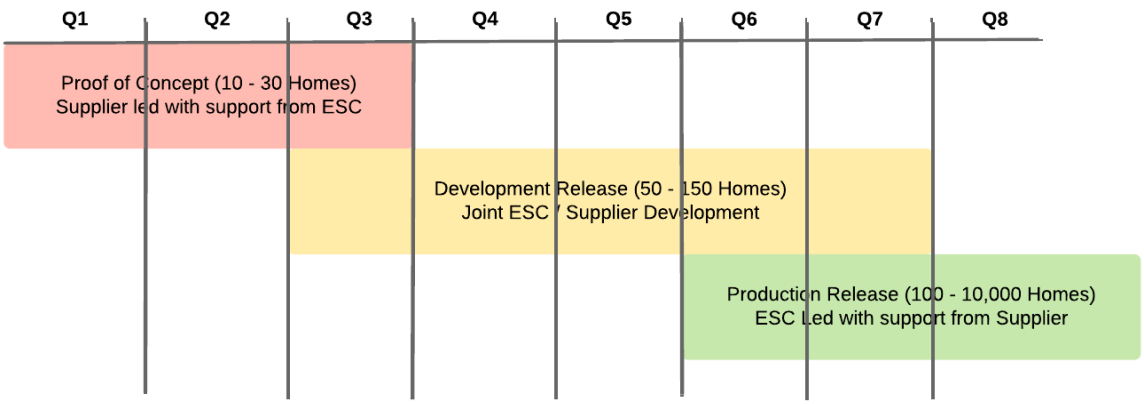
HESG shall record all the data sent to and from a home and all the requests and commands from an external service. For a fully instrumented home, this could be up to 100,000 data points per home per day.

6.4. Availability

HESG shall have an availability of 99.5% or better. This corresponds to around 1 hour of downtime per week which is high but as this is a prototype system may be acceptable. This may be reviewed upwards in future especially as the system is scaled up.

7. Delivery Phases

The ESC believes that the development of HESG NG may follow the phases as identified in the diagram below. The ultimate objective is for the ESC to be able to maintain and update HESG including the addition of future adaptors, APIs and integrations and as such the ESC need to be involved in all stages of the development. The proposal is for an increasing level of ESC involvement as the project moves to production. Suggestions on the form of the engagement are desired, but the engagement must be technical and must be more than simply oversight or reviews.



7.1. Proof of Concept (A-sample)

The Proof of Concept development will establish the general principles, allow User Acceptance Testing to confirm the requirements and identify omissions and test the system in a realistic environment without exposing significant numbers of consumers to any issues that may arise. The PoC wil be deployed to a small number of homes (<30) that are already installed in the Living Lab. This release should be capable of testing all the main functionality including:

- Integration with an ESC bespoke in-home hub
- Integration with at least one 3rd party smart home supplier
- All system operator functions
- Sufficient support for at least a heating controller service, a heat plan service and the Living Lab Energy Services Marketplace (ESM)

7.2. Development Release (B-sample)

The Development Release will build on the findings from the PoC release incorporating fixes and updates to produce a system that functions as required. This will be tested on a larger number of homes, up to 150, that are already in the Living Lab.

This release should be capable of expanding the functionality created for the Proof of Concept release to include:

- All functionality from the Proof of Concept release
- Integration with at least two additional third party smart home suppliers
- Fully implemented services interface

7.3. Production Release (C-sample)

The Production Release will resolve any issues and updates discovered during testing of the Development Release and deploy all functionality satisfying all agreed requirements. All remaining homes in the Living Lab will be moved to this release. This release will form the basis for all future development and any future expansion of the Living Lab.

8. Appendix

Insert text

8.1. Glossary

Living Lab	A persistent collection of homes connected to a single platform where Innovators trial new products and services.

8.2. Acronyms

ESC	Energy Systems Catapult
ESM	Energy Services Marketplace
HESG	Home Energy Services Gateway
PoC	Proof of Concept

8.3. References

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Energy Systems Catapult supports innovators in unleashing opportunities from the transition to a clean, intelligent energy system.

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