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D1.5
DELTA Requirements, Business Scenarios and Use Cases v2

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Executive Summary

This document is the conclusion of the final stage of activities conducted during the first 18 months of the DELTA project under Task 1.1 – *User and Business Requirements Definitions* – This involved applying strategies such as stakeholder management; frameworks such as UML diagrams and Volere templates; and the application of tools used to document outputs such as JIRA. Undertaking these activities, it was possible to then identify specific actors involved in the use cases as well as specific communication channels used to collect feedback.

We present the results of stakeholder engagement through interviews and online questionnaires to validate the business scenarios. We document a number of business scenarios and associated use cases, which we supplement with activity diagrams. The respective use cases are also mapped to partners and pilot sites for future reference of the validation activities. The document also presents a list of business and user requirements that have been collected from the stakeholders and have been cross referenced to the relevant use cases.

This report presents our conclusions of this document including feedback we received from the advisory board (Please refer at section 10 - Appendix). The advisory board raised some concerns regarding the IEM regulations (2019/943/EU) for non-discriminatory approach & to comply with 2018/2001/EU Directive (article 21-24) for data protection of the involved parties which we have included them as a non-function requirement (number 12).As you will see from the appendix the feedback from the advisory board help us expand the functional and non-function requirements of Delta and try to deliver a platform that meets all current market and future market specifications.

The revision of this document has added new functional requirements (From number 38-47) and non-function requirements (From number 10-17)

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List of Acronyms and Abbreviations

Term	Description
ADE	Association of Distributed Energy
BEIS	Department for Business, Energy and Industrial Strategy
BMS	Building Management System
BRP	Balance Responsible Player
DELTA	Future tamper-proof Demand rEsponse framework through seLf-configured, self-opTimized and collAborative virtual distributed energy nodes
DER	Distributed Energy Resources
DNO	Distribution Network Operator
DR	Demand Response
DSO	Distribution System Operator
DSR	Demand Side Response
DSS	Decision Support System
DuOS	Distribution Use of System DuoS charges
DVN	Delta Virtual Node
DVNP	Delta Virtual Node Platform
EFR	Enhanced Frequency Response
EU	European Union
ENTSO-E	European Network of Transmission System Operators for Electricity
ESCO	Energy Service Company
FCDM	Frequency Control by Demand Management
FEID	Fog Enabled Intelligent Devices
FFR	Fast Frequency Response
FM	Facility Management
GIS	Geographic Information System
IoT	Internet of Things
JRC	Joint Research Centre
OFGEM	Office of Gas and Electricity Markets
RES	Renewable Energy System
SCADA	Supervisory control and data acquisition
SME	Small Medium Enterprise
SO	System Operator
STOR	Short Term Operating Reserve
TSO	Transmission System Operator
VPP	Virtual Power Plant

1. Introduction

1.1 Scope and objectives of the deliverable

This document aims to capture and distil the main business and user requirements for the DELTA platform. The goal of the activities developed in Task 1.1 are meant to help partners to map out the main stakeholder groups and engage with those groups via relevant communication channels to extract and validate business and user requirements. Using a combination of methodologies and frameworks such as stakeholder engagement models and requirements digitisation and prioritisation, this document will create a synthetic view of the main business scenarios and associated use cases that will be deployed in the pilot sites to validate specific functionalities.

1.2 Structure of the deliverable

This report logically covers relevant markets, the methodology of how business cases were derived with their corresponding stakeholders for the DELTA project. It then goes into the details of the business scenarios, use cases and user requirements. As there will be a revision of this document later in the project timeline, the report is concluded with next steps.

1.3 Relation to other tasks and deliverables

The first version of this document, delivered in Month 9 of the project, will provide information to other tasks in WP1 such as *T1.2 – Architectural Design, Functional & Technical Specifications* which *T1.3 – Data Ontology and Data Framework Definition* is built on. This deliverable will be updated in Month 18 of the project to account for further findings, refinements, and any major changes in the markets or regulatory requirements in the European marketplace that may have an impact in the design and implementation of the DELTA platform.

2. Relevant Markets

With the DELTA project aiming to provide innovative solutions to some of the gaps in Demand Response (DR) schemes, it is important to consider the current market to ensure that DELTA appropriately builds the correct solutions for these gaps.

Demand Side Response (DSR) is vital in ensuring that the electricity system is both sustained and secure so that supply and demand are equally matched. In order to manage supply and demand, various DR schemes or programmes [1] have been designed. There are differences country to country, however the general goal is the same.

The common way to participate in such programmes is via an aggregator which aggregates sites according to generation capacity to participate in the various programmes. Further details of actors involved in the market are introduced in later chapters of this report. Entry into such DR programmes is dependent on a certain set of requirements which the site will have to meet, including:

- At what time a site is available to dispatch – turning up or down electricity consumption
- The capacity available to dispatch
- How long a site can dispatch for
- The period of time the site will take to respond to a dispatch

Currently in majority of DR programmes participating sites will be rewarded based on their availability to dispatch and how they performed in a dispatch, if requested to do so.

Below is a table giving an overview of the DSR market in the UK which is one of the project's pilot site locations:

Table 1 UK DSR Markets

DSR Markets	Programmes
Balancing Services – Frequency	1. Static FFR 2. Dynamic FFR 3. EFR 4. FCDM
Balancing Services - Reseve Market	1. STOR 2. Capacity Market 3. Fast Reserve 4. Demand-Side Balancing Reserve
Price-based DR	**1. Peak Avoidance** -Triad -DUoS Red Zone Charges **2. Variable Costs** -Wholesale Day Ahead Trading Intra-day Trading -Imbalance

3. Methodology

3.1 Description of tools and methods to be used

We used a stakeholder management model to identify, recognize, and acknowledge the stakeholders, determine their influence and interest, establish a communication management plan and, finally, engage with the stakeholders in order to develop a process that will accurately gather business and user requirements.

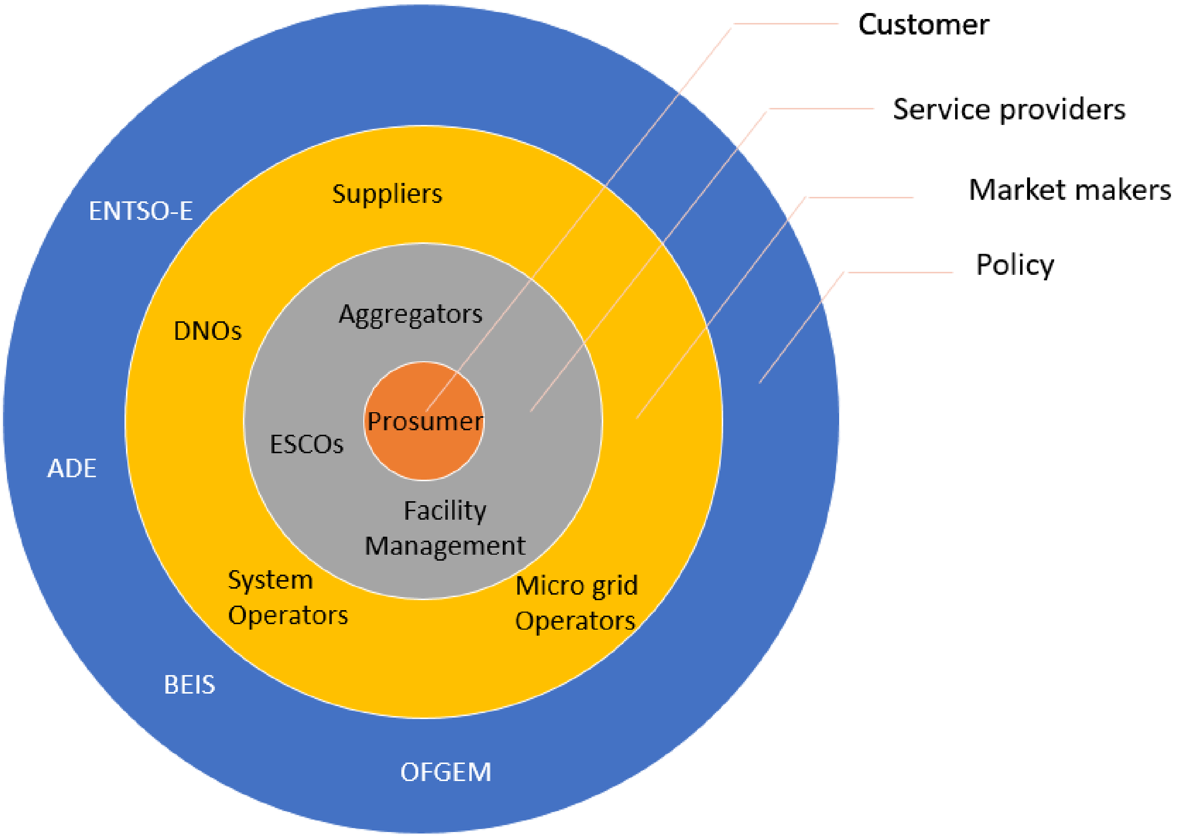


Figure 1 - Stakeholders involvement model - Adapted from R. Edward Freeman "Strategic Management: A Stakeholder Approach"

We also gained inspiration from existing processes inside some of the consortium partners (CERTH, KiWi Power) – who use modern and agile frameworks to document and manage user requirements. More specifically, the methodology that we employed involved a combination of elaborate processes, such as questionnaires that were filled either online or during face-to-face meetings, telephone interviews, workshops and direct feedback from Transmission System Operators (TSO), Distribution System Operators (DNO), Facility Management (FM), aggregators and regulatory bodies. In addition, we employed a MoSCoW prioritisation tool (must haves, should haves, could haves and won't haves) to rank and identify the features to be implemented in DELTA. Furthermore, we combined line templates derived from the enhanced Volere methodology and online tools aiming to make the set of business and user requirements standardised, trackable and prioritised. As such, a JIRA framework was deployed by CERTH to allow for business and user requirement management.

3.2 Deriving business cases from project objectives

At the proposal stage, the project consortium had identified some clear shortcomings of the existing DR platforms deployed in various markets.

The participation of European residential and small commercial/industrial users, which accounts for about 70% of final electricity consumption has been limited, not only by the absence of real time metering infrastructure and smarter electricity grids, but also due to the non-availability of a robust regulatory framework in most EU member states, that allows small demand units to team up, aggregate their flexibilities and bid aggregated/large volumes of flexibility in the energy markets as a highly competitive and attractive commodity. Most EU countries which have opened their product requirements to Demand Response have enabled aggregated load to participate (e.g., France, Belgium, Switzerland, Great Britain, etc.). However, market penetration remains extremely low due to both technological and market operation barriers. In the UK, which has the most mature paradigm of demand response around the EU, focus still remains on utilizing the flexibility offered by large industrial consumers. Other European countries, e.g., Slovenia and Poland, have opened some of their markets to load participation, but not to aggregated load, therefore disqualifying all except the largest industrial consumers from accessing these markets.

As such, the DELTA platform is aiming to deliver added value for all the stakeholders in the value chain on the following aspects:

- To relieve aggregators from complex and resource-heavy tasks, based on the innovative proposed 'Virtual Node Platform' concept
- To propose and implement a game-changing DR framework, for effectively exploiting energy flexibility of small and medium-scale consumers as well as Distributed Energy Resources, for ensuring optimal energy balance coordination in the Smart Distribution Grid
- To propose the appropriate mechanisms and interoperable interfaces for secure, bi-directional information flow along the different energy stakeholders in DELTA eco-system
- To improve customers' awareness and DR engagement through collaboration, gamification and innovative user interfaces
- To deliver real-time intelligent monitoring and control through a fog-enabled lightweight toolkit at customer level
- To propose, demonstrate and validate innovative and viable business models and offerings for next generation DR aggregators who pursue their portfolio expansion with small and medium scale prosumers, while improving customer engagement, loyalty and mindshare.

Based on these objectives, an initial set of macro-functionalities was derived, based on the methodology and tools of Section 2.1. Some of the main findings are summarised below:

1. There is a wide consensus among the participants in our survey that the macro functionalities that the DELTA platform aims to deliver to its users are needed in the market place. The need for load forecasting tools is leading with 76.19% of the respondents stating that this can improve the performance of DR programmes both in terms of revenues and reliability, while the need for price signalling came in second with 71.43% of the respondents' votes. The other two main macro functionalities named in the survey also scored above the 50% mark, with user profiling tools accumulating 61.9% of the votes, while customer clustering tools obtained 52.38%.

Q6 In your opinion, what type of tools can improve the performance of DR programmes both in terms of revenues and reliability?

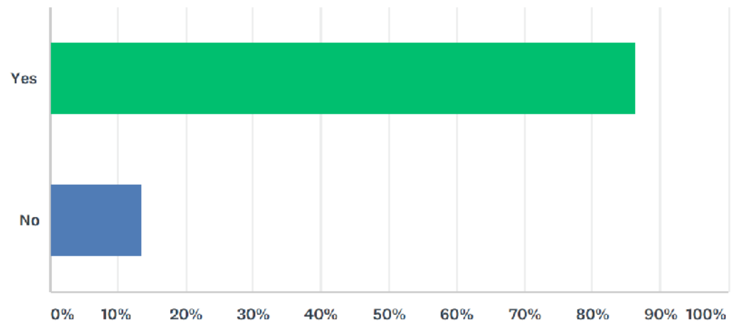
Answered: 21 Skipped: 1

ANSWER CHOICES	RESPONSES	
Load forecasting	76.19%	16
User profiling	61.90%	13
Customer clustering	52.38%	11
Price signaling	71.43%	15
Other (please specify)	0.00%	0
Total Respondents: 21		

2. A significant percentage of the participating stakeholders (86.38%) also believe that a new type of device interfacing with the existing metering and control infrastructure is needed to facilitate DSR actions. This is in support of the creation of Fog Enabled Intelligent Devices (FEID) and the associated virtual nodes, which allow real time intelligent monitoring and control of the participating assets.

Q7 Do you believe a new type of device interfacing with existing metering and control infrastructure to facilitate DSR action is needed?

Answered: 22 Skipped: 0

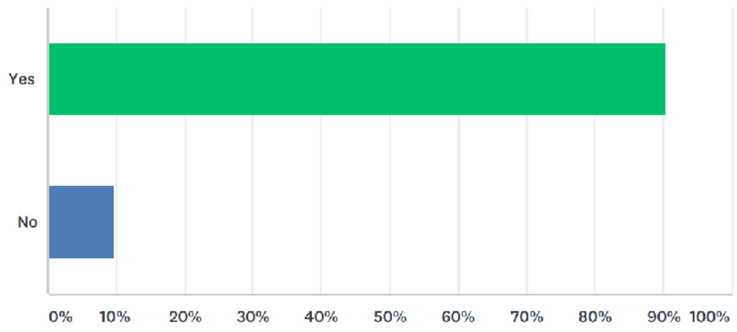


ANSWER CHOICES	RESPONSES	
Yes	86.36%	19
No	13.64%	3
TOTAL		22

3. The need for a platform featuring FEID and virtual nodes to allow fast system response time and access to real time metering data is also reflected in the fact that 90.48 % of respondents believe this type of tools can facilitate an increase in revenues from DR services.

Q8 Do you believe fast system response time and real time metering data are important to increase revenues from DR programmes?

Answered: 21 Skipped: 1

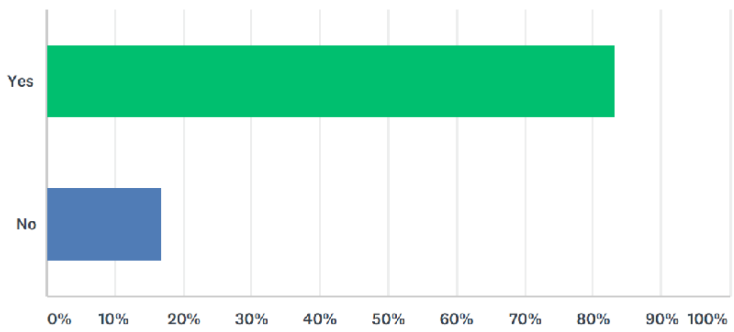


ANSWER CHOICES	RESPONSES	
Yes	90.48%	19
No	9.52%	2
TOTAL		21

4. There is an increasing need for aggregators to diversify revenue streams as a result of ever eroding prices for existing explicit DSR services. This need is reflected throughout the entire value chain and the respondents' answers also reflects this - 83.33% believe better Energy Market price forecasting tools can improve revenues for aggregators and clients by trading flexibility in different markets.

Q12 Do you believe better price forecasting tools can improve revenues by trading flexibility services in different markets?

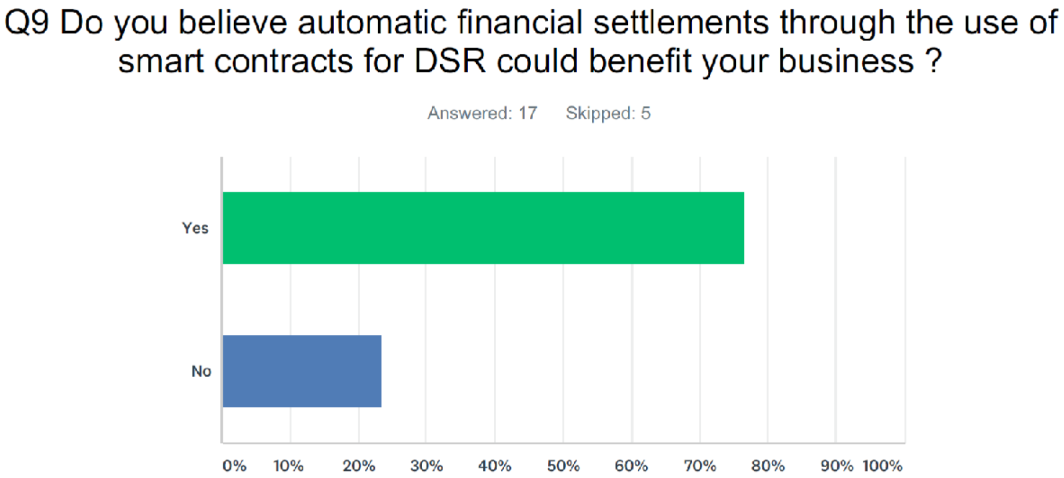
Answered: 18 Skipped: 4



ANSWER CHOICES	RESPONSES	
Yes	83.33%	15
No	16.67%	3
TOTAL		18

5. The need for a real time, secure and automated way to settle transactions (in DELTA this is done through blockchain-based smart contracts) is also confirmed by the stakeholders, with 76.47% responding they believe automatic financial settlements through the use of smart contracts for DSR would benefit their business. Furthermore, 2 out 3 (66.67%) respondents

on another question believe that data security / asset hijacking is a potential risk for their business because of DSR enabled assets, something that can also be mitigated through the use of a blockchain platform.



ANSWER CHOICES	RESPONSES	
Yes	76.47%	13
No	23.53%	4
TOTAL		17

The validation of main macro functionalities and tools to be delivered by the DELTA platforms by the stakeholders enabled the consortium to build up the narrative around four main business scenarios, described in Chapter 4.

The below figure shows the logical flow of the deliverables outputs when the above mentioned methodologies have been applied.

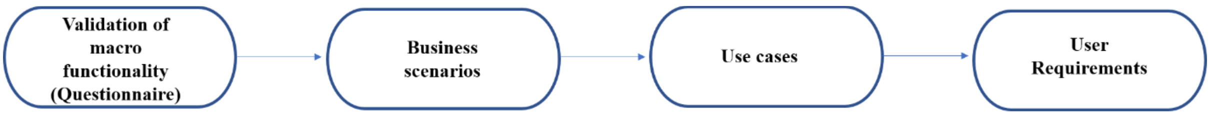


Figure 2 – Output logical flow

4. DELTA User Requirements gathering process

4.1 Stakeholders definition

The energy market is in constant change and traditional roles and business models are evolving and adapting to a constantly changing landscape. As such, it is important to define the main real-world entities/stakeholders involved in this market which is shown in the following table.

Table 2 Stakeholders' Definition

Actor	Description	Actor type	Use Cases
System Operator (SO)	The main responsibility of this entity is to balance the supply and demand of electricity in real time. Based on specific country regulations and market arrangement, this can be the TSO or DSO, with attributions over the planning, building and operation of the transmission system / distribution system.	Organisation	5.1.1 5.2.1
DNO	These are companies licensed to distribute electricity from the transmission grid to homes and businesses. In some countries their role is merged with the SO. The DNO will have increasing roles in balancing parts of the network and in managing network constrains through flexibility services.	Organisation	5.3.2
Supplier	A company selling electricity to consumers (end users). Specific functions of a supplier service will include: purchasing electricity on wholesale market, billing, customer management, meter data reconciliation.	Organisation	5.1.2
Aggregator	A company that assists the SO and other flexibility buyers (such as suppliers or DNOs) in procuring the flexibility required by cumulating flexibility services from clients such as commercial and industrial users, prosumers, micro-grids, and increasingly from SMEs and residential users.	Organisation	5.1.1 5.1.2 5.3.1 5.3.2 5.4.1 5.4.2 5.5.1 5.5.2
Energy Service Company (ESCO)	Offers auxiliary energy-related services to Prosumers such as design and implementation of energy saving projects, retrofitting, energy conservation, energy infrastructure outsourcing, power generation, energy supply and risk management.	Organisation	
Prosumer	An entity that consumes and produces energy. There is no distinction between residential end-users, small and medium-sized enterprises or industrial users.	Organisation / Person	5.1.1 5.1.2 5.2.1 5.3.1 5.3.2 5.4.1 5.4.2 5.5.1

Consumer	An entity connected to the grid that consumes energy, i.e. a Prosumer without any production capabilities. IN the case of residential users, this is usually a single household. As a business, it can represent a small or large business	Organisation / Person	5.3.2 5.4.1
Virtual Power Plant (VPP) Energy Manager	An entity responsible for managing the output of the VPP. For instance, can decide in which mode the VPP should function – maximise revenue or maximising local energy usage (can shift between the two). Responsible for assuring the revenue stream for the actors owning the assets participating in the VPP.	Organisation	

In the next table, software components that will feature as actors in our business scenarios and use cases are introduced with a brief description of their functionality, as well as in which layers of DELTA's architecture they reside, to provide a more detailed and concise specification of business scenarios and use cases.

Table 3 Software Components

Tool	Description	Architectural Layer
FEID OpenADR	This component is installed on customer FEIDs and allows for aggregating metering from multiple IoT devices that are connected to customer assets, report issuance and handling of control actions	Customer
FEID Generation, Consumption, Flexibility Forecasting Tool	This component is installed on customer FEIDs, receives as input data from the FEID's Supervisory control and data acquisition (SCADA) and is responsible for forecasting generation, consumption and flexibility. The latter data are transmitted to the DVN's Consumer/Prosumer Flexibility Data Monitoring and Profiling component to allow for metric aggregation at the DVN's layer.	Customer
Blockchain and Smart Contract Tool	This component is installed on every layer of DELTA's architecture and provides the necessary means to interface with DELTA's Cyber Security Services. For instance, this component allows the retrieval of membership information from DELTA's Blockchain, issuing and monitoring the status of energy-related transactions, as well as interacting with smart contracts deployed on DELTA's Blockchain, which is a vital part of participating in, e.g., an explicit DR scheme.	Aggregator, DVN, Customer
DELTA Blockchain	The DELTA Blockchain facilitates secure, auditable and verifiable energy-related transactions and logging of information. The DELTA Blockchain also supports smart contracts, i.e., computer programs that encode, execute, enforce and mediate arbitrary agreements amongst the entities in DELTA's ecosystem in an inexpensive and automated manner.	Application
DELTA Repository	The DELTA Repository stores data, which are represented according to the DELTA ontology, and allows access to information such as multi-level KPIs, aggregated energy-related metrics, DVN profiles and others. DVNs and the DVNP push and pull data from the DELTA Repository to provide their respective functionalities.	Application

DELTA Virtual Node (DVN)	The DVN is a cluster of customers (small, medium or large consumers, producers or prosumers) that was formulated based on key common characteristics among the customers.	Application
DELTA Virtual Node Platform (DVNP)	The DVNP will manage the DELTA Virtual Nodes on a "local" level before engaging with an Aggregator. The initial clustering of Nodes will be performed by the DVNP Platform based on historical values and hardcoded constrains. The DVNP encompasses a collection of tools that allow the Aggregator to monitor, interface and, in some cases, directly control components of DELTA's architecture.	Application
DELTA Aggregator	The DELTA aggregator engages in bi-directional DR communication with the DELTA Virtual Nodes, after applying advanced segmentation algorithms. It is supported by a Decision Support System (DSS) that will analyse current energy information by profiling every available node, evaluating the flexibility and availability of functional energy assets, while also running simulations for effective and efficient DR, flexibility and price forecasting, rendering feasible to exploit existing and research DR strategies.	Application

We stress that SOs, DNOs, Suppliers and ESCOs are treated by DELTA as external oracles, i.e., they are not explicitly modelled in DELTA's architecture, they are agnostic of DELTA's internals and functionalities and they are assumed to provide out-of-band inputs to the Aggregator who, subsequently, employs the tools provided by the DVNP to respond with the appropriate output.
In addition to the list of actors presented, there are wider groups of stakeholders which, while not directly involved in specific business or use cases, may have a significant influence over the results through indirect intervention. While not exhaustive, some of the most important groups of stakeholders to be considered in our project are:

1. **Regulatory bodies -** typically, these entities set the legal framework and specific rules for the overall electricity market in each country (with significant efforts at European level for harmonisation). They have significant impact on how each specific national market is structured, how flexibility service providers can access various markets, how the products are priced etc.
2. **Industry associations** – typically these will help their members lobby their interest in a more efficient manner. They will provide input for industry consultation rounds, help their members raise awareness about new services or major industry problems / shifts, will provide input to the government for long term policy and strategies.
3. **Settlement bodies** – in the electricity market, metering and billing are very complex processes, sometimes with more than two actors involved. As such, there are separate bodies that help actors involved in the value chain to settle their positions in the markets. They process huge amounts of data from all parties involved and ensure specific escalations procedures are in place for cases were parties involved need to escalate.

4.2 JIRA platform for digitisation of user requirements

To enable easy logging and tracking of business and user requirements from definition to actual implementation, we opted for a specialised online platform – JIRA. Consortium partner CERTH has created a dedicated JIRA environment that will help partners create, assign, define dependencies and track business and user requirements. The template provided by the online platform was also linked to the Volere enhanced template used (see Chapter 7.1). A sample of the format use in JIRA to log Business and User Requirements is presented below:

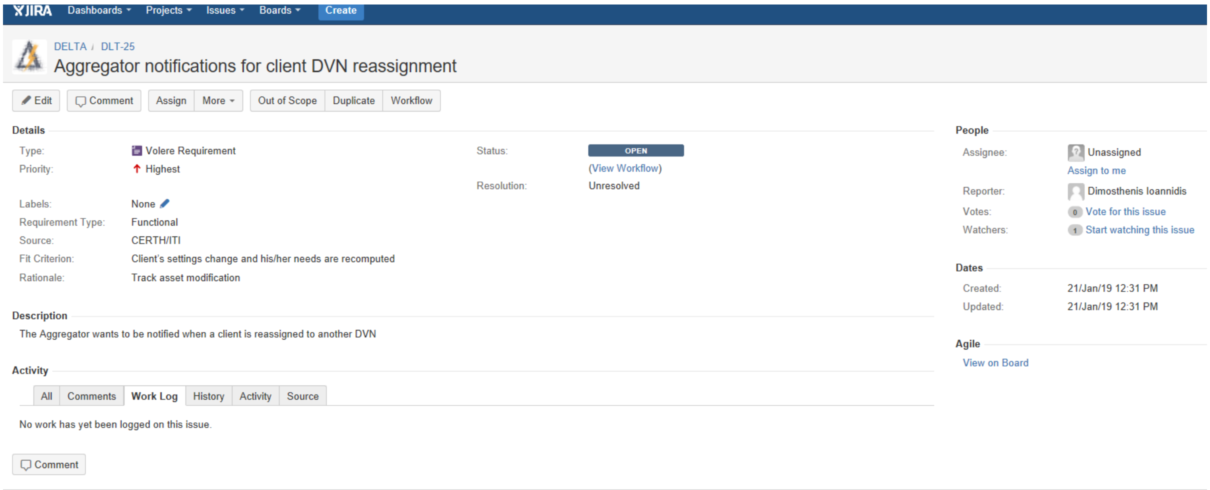


Figure 3 - Sample of user requirements in JIRA

5. DELTA Business Scenarios Definition

5.1 DELTA Business Scenario 1 – Provision of high efficiency Demand Response services through the user of Delta Virtual Node Platform and associated services layer

The focus of this business case will be around the use of DVNP and the associated services layer for increasing the efficiency of delivering demand response services towards the flexibility market. The increased efficiency for deploying and delivering demand response will focus on the following key areas:

- **Improving DSR revenues by improving availability declarations for assets and portfolios**. Typically, a turndown asset will be "sized" based on a couple of SPOT tests - which measure the assets actual performance in real life conditions to see if the asset performs as expected. The expected turndown figure may be further decreased by the Aggregator and SO for portfolio risk management. However, the actual turndown potential of assets may vary significantly based on a number of factors such as seasonality, weather, and variations in exploitation conditions (i.e. higher or lower than usual occupancy in a building). By enabling the near real time monitoring, reporting and forecasting of assets energy consumption, the DELTA platform will allow near real time updates on assets availability, increasing the potential revenues for the consumers and aggregators and improving the reliability of the DSR services for the SO.
- **Improving DSR revenues** through allocation of flexibility resources towards the highest paying services. This will be supported by the energy market price forecasting tool and by the flexibility and DR forecasting. As DSR services can be monetised in different markets and with each market having specific methods regarding measurement and verification of delivery, trading periods, availability declarations etc., it is currently extremely hard to re-allocate flexibility services to the best paying opportunity in close-to real time. The energy market price forecasting tool will allow the Aggregators to spot opportunities ahead of time, so they can enable the operational procedures to allow them to monetise the available flexibility in the best paying programmes.
- **Maximise savings on client side** by participating into implicit DR schemes such as time of use tariffs. The virtual nodes will be able to take autonomous decisions in real time based on complex structure of tariffs pre-defined by the retailers or DSOs.

In this generic business scenario, the user of the flexibility service can be either the SO, the DNO or a supplier, depending on the market into which DSR services are sold.
Considering the UK pilot site current DR-related regulations, DSR services that can be relevant to the DELTA platform would be:

- Dispatching committed DSR contracts through aggregators, i.e. reserve products such as Short-Term Operating Reserve (STOR) through direct communication with Aggregators who in turn activate specific STOR contracts / sites.
- Automatically dispatching DSR contracts for Frequency programs – such programmes are automatically activated when the system frequency goes below or above certain thresholds, i.e. Static Firm Frequency Response contracts which require a response time within 30 seconds from the triggering event
- Matching bids and offers placed by the suppliers in the wholesale or imbalance markets by the aggregators.
- Using the flexibility and DR forecasting component of DELTA to size each type of portfolio in real time and update availability declarations in each type of market accordingly.
- Energy market price forecasting will inform the aggregators when is more likely for the trading prices to go above a certain strike price and therefore is more profitable to undeclare contracts in the reserve market and wait for the right bid in the imbalance market.

- Asset handling (start/stop signals) is done via the FEID devices interfaces directly with the assets or via the local Building Management System (BMS). At the end of the dispatch / trading period an automated performance report highlighting the energy volumes delivered per assets and per contract is generated by the DVNP.

5.2 DELTA Business Scenario 2 – Secure, automated Demand Response services via blockchain enabled smart contracts

While the business cases for blockchain implementation in various industries are still being debated, we believe the energy sector holds a great deal of potential for blockchain-based services. There are several use cases suitable for the energy sector, such as executing energy supply transactions, as well as forming the basis of metering, billing and clearing processes. Other relevant areas of application are in the documentation of ownership and the state of assets (asset management), guarantees of origin, emission allowance and renewable energy certificates.
Within the DELTA project the business case for the use of blockchain-based smart contracts for automated DSR is driven by some generic business objectives such as:

- **Increase customer base and adoption rates** by providing a secure platform. Security concerns amongst DSR end-users is a significant barrier for adoption of such services. Providing a secure way to communicate and deploy control strategies to assets as well as audit transactions should give adoption rates a boost especially in the market segments targeted by the DELTA project – small and medium prosumers.
- **Decrease the cost of DSR delivery for aggregators and end users** by reducing transactional cost and duration for the settlement process. Smart contracts will automatically audit the energy delivered for each event and will trigger payment from beneficiaries in near real time, reducing the time and cost for providing the service to the system operator or other market participants.
- **Increase the efficiency of the aggregation service** by enabling autonomous, computer to computer contracting. As the DSR services and market become more dynamic, there is an increased need for automation of decision making for allocation of flexibility services to the best paying markets, however in the absence of an audit trail this can be risky. Blockchain based smart contracts will enable the DELTA platform to extract maximum value from existing assets without unnecessarily derating capacity to reduce operational risk.

There is also scope to explore wider applications of blockchain based technologies with a view to provide more value-added services to stakeholders involved in the delivery of DSR services, no matter which role they have in the value chain:

- A **blockchain-based data sharing mechanism** (data trading market) for the secure sharing, querying and analysis of data between the stakeholders and creating a novel business model around the trading of anonymised data.
- **Application of blockchain-based smart contract design** and settlement mechanism to use them as a risk mitigation (hedging) mechanism for the risk associated with the fluctuation in price, demand and supply of electricity, as well as for some, if not all, of the cyber risk associated with data sharing.

5.3 DELTA Business Scenario 3 – Optimal self-portfolio management via DVN and DR services

Historically, demand response aggregators and service providers started offering services using off the shelf equipment and integrating with existing infrastructure on the client side. As technology and market maturity developed, some companies moved to using specialised hardware and supporting infrastructure in an effort to optimise cost and market fit. Other providers maintained the legacy hardware focusing their efforts on integration and interoperability with a number of existing systems in the market place.

While both approaches seem to work, there is an obvious and increased need for automation and integration to allow aggregators and flexibility services providers to maintain costs under control and lower minimum capacity barriers all the way to the point of being able to integrate residential users into their offering. To this extent, partners have identified a need from all market players for platforms able to provide the following functionalities:

- **Improved Aggregator Portfolio Energy Balancing** to be employed in real time operation regardless of the incoming DR signals (either from the TSO/DNO or from DVNP) to ensure stability and optimal distribution of electrical energy within the DELTA energy network. An autonomous tool will constantly monitor the portfolio in terms of flexibility and stability and will provide feedback to the DSS for creating DR signals for scenarios that the self-balancing at Node level is not able to cope with, or for large customers not included in the DVNP. This will also address the issue of reducing operational risks when specific assets / sites are not available for dispatch and will reduce the number of cases when the SO/DNO may charge penalties for under-performance. As a result, this functionality will decrease operational cost for the SO and aggregator while increasing the reliability of the services.
- In addition, when imbalance is predicted to deviate from the day-ahead schedule, the aggregator would have the possibility to re-dispatch available units either intra or inter node, before resolving into the intra-day and balancing markets, therefore avoiding Balance Responsible Player (BRP) related penalties.
- **A DSS** responsible for analysing real-time historical data and forecasting information towards creating the optimal DR strategy per node. The most important subcomponents of the DSS will include:
    - **Monitoring and profiling** engine. As data will flow two ways in the aggregator – prosumer scheme, the aggregator will need to monitor each Node's flexibility and contextual data in order to activate profiling mechanism for each node and decide on their DR strategy.
    - **Asset Handling.** The DELTA aggregator will integrate existing and new customers and generation facilities with the DVNP. For this reason, a supervisory asset system will be responsible for optimising the mechanism that will control each element of the portfolio and which DR strategy should be used in each case towards achieving the best case in terms of energy distribution.
    - **Flexibility and DR Forecasting.** This is a crucial component in the DELTA architecture for the Aggregator to conform to their balance responsibility. The aggregator needs to forecast the energy consumption profiles of the prosumer Nodes in their portfolio, before and after a DR dispatch. Similar methods as those used for price forecasting will be used in this case. To improve the accuracy of the forecasting tool, a simulation suite will be running all possible scenarios utilizing the Joint Research Centre (JRC) test bed for more effective and robust results.
- **Energy Portfolio Segmentation and classification**. This component analyses all the information provided by the overall energy portfolio, the existing infrastructure of the DVNP and creates guidelines/strategies which will define the way that each node will create the customer clustering. Moreover, these strategies deployed to each available node, will also include information about reporting intervals, pricing ranges, DR potential strategies, as well as other related and essential restrictions/suggestions that will facilitate the DR communication and maximise the accessibility to distributed energy resources.

In summary, the deployment of these tools will see business improvements in the following areas:

- Improve operational efficiency on the aggregator side by reducing operational costs reducing the need of personnel necessary to manually configure and supervise portfolios.

- Improve reliability of the portfolios by reducing the negative performance element (assets or sites not delivering during a dispatch event) and thus improving the reliability of the revenue streams.
- Increase the revenues on the Aggregator and flexibility provider side by always having the right sized portfolio for each type of assets and market.
- Increase revenues by integration of smaller sites (e.g. SMEs and residential) which now can be deployed and managed via FEID/virtual nodes.

5.4 DELTA Business Scenario 4 – Secure, real time asset metering and control through FEID and DELTA Virtual Nodes

Existing demand response service providers have different approaches to deliver their services. Some of the market players decided to make extensive use of existing metering and control infrastructure at the client site, thus reducing the need to deploy new equipment and preserving the value of infrastructure investment for the end users. However, this means that the DSR provider will need to interface with a wide variety of metering and control systems via the back end and also help end-users interfacing their own platforms – sometimes with high costs involved. Other DSR service providers are using purpose- built devices and platforms to deliver their services. This approach also comes in two versions, with companies opting for proprietary hardware and software solutions while others use third party infrastructure providers. While each approach has its advantages and disadvantages, the DELTA platform will deliver a purpose-built device for each DSR site (although some sites can be managed just with virtual nodes). The DELTA FEID will provide real time information, through fog computing, regarding energy related data such as consumption, generation, emissions, available flexibility based on specific strategies imposed on the controlling node by the aggregator. The FEID will be fully configurable by the clients or their third-party contractors such as FM companies to reflect the business as usual scenarios – such as preservation of occupants' comfort levels in a commercial building, or process automation constrains in an industrial deployment. The FEID will be connected either directly to specific loads or indirectly (through the BMS).
The overarching business scenario for the optimisation of DSR services through the use of FEID and Virtual Nodes has the following characteristics:

- **Reducing Demand Side Response deployment cost** through the use of DELTA FEID. Custom-built equipment will be cheaper and deliver the exact set of functionalities needed by the aggregator / DSO / client without compromising on quality of data, accuracy or security. The cost of deploying new features will also be greatly reduced as the system will allow for new firmware / application layer add-ons to be developed by consortium partners / interested third parties based on a standard documentation.
- **Reducing Demand Side Response deployment cost** by reducing site engineering time for the configuration and deployment of FEID devices. FM/end-users will be able to configure the FEID, that will be automatically taken into consideration when applying a DR signal. This will allow devices to be pre-configured off-site before being deployed in a production environment, therefore reducing the engineering time and cost – which is a major cost component of any new site deployment for DSR.
- **Reducing Demand Side Response operation cost** through dedicated hardware management functionality – having a purpose-built device will enable dedicated hardware monitoring services with dashboard and heartbeat functions, enabling automated fault detection and triggering actions on the support function before issues become critical, saving engineering time and support time for the delivery and operations teams. Having hot swap preconfigured devices also helps reduce operational cost and downtime for any type of faulty equipment, allowing third parties such as FM personnel or approved contractors to replace faulty equipment quickly.

- **Reduce operational cost on the client side** by providing real time energy consumption and analytics dashboards to enable end-user document their decisions in real time and creating scope for wider energy efficiency actions.
- **Respect end-users' preferences,** by giving them the ability to configure the FEIDs in terms of their optimal comfort-to-reward ratio.

6. DELTA Use Case Definition

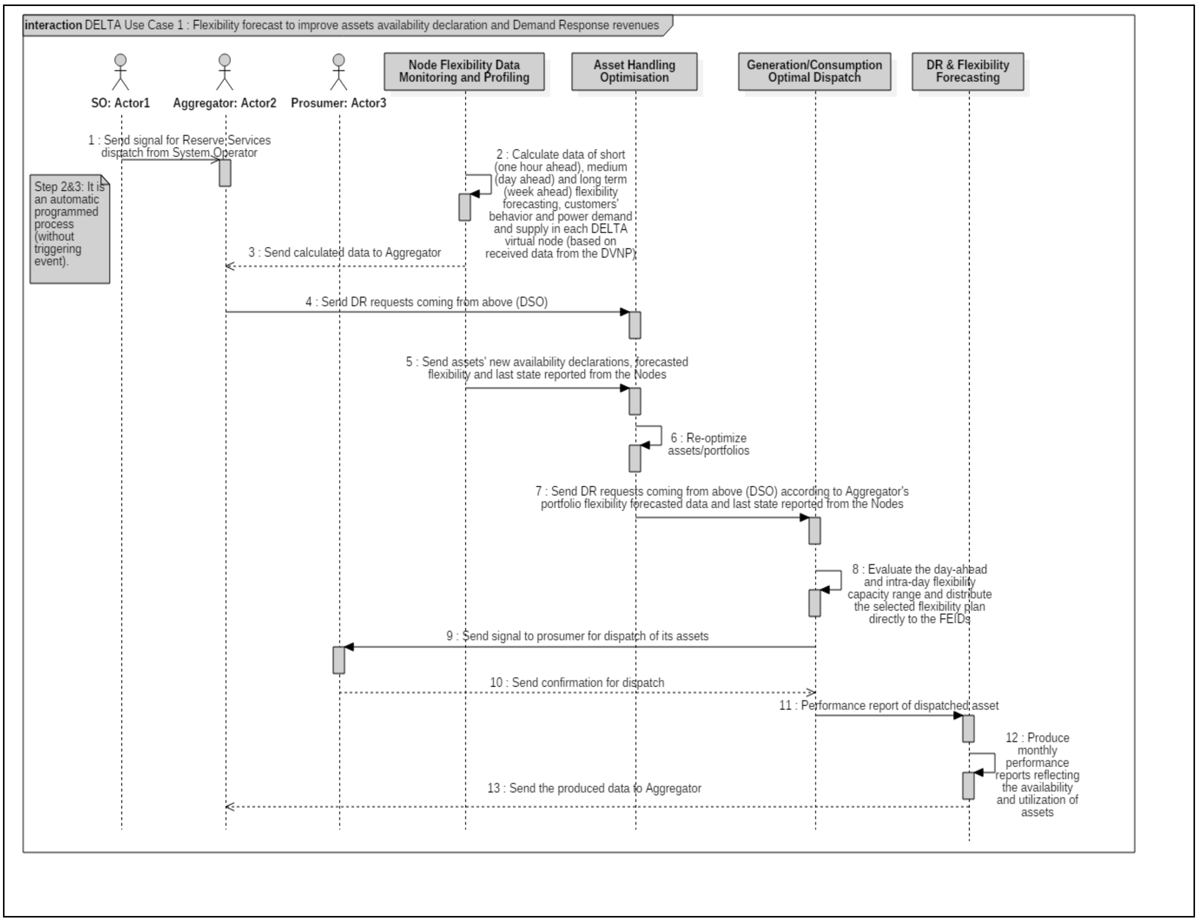
6.1 Use cases association with provision of enhanced Demand Response services through the use of Delta Virtual Node platform and associated services layer

Following the enumeration of D1.1 the DELTA use cases are presented:

6.1.1 DELTA BS1-UC1: Flexibility forecast to improve assets availability declaration and maximise Demand Response revenues

Description:	
Use Case Name	More accurate flexibility forecast to improve assets availability declaration and maximise Demand Response revenues
Version	V0.1
Last Update	14/09/2018
Authors	KiWi Power Ltd
Brief Description	Accurate flexibility forecasts are produced for 2 hours / daily / weekly profiles to allow aggregators dynamic availability declaration and maximise DR revenues.
Assumptions & Preconditions	Sites / assets in the aggregator's portfolio are managed via DVN
Objective	Maximise availability and utilisation revenues from a given portfolio of turndown assets or from an existing portfolio of prosumers.
Effects/Post Conditions	Increased availability and utilisation revenues from existing portfolios
Involved Actors	Aggregator, SO, Prosumer, DVN
Use Case Initiation	Reserve services dispatch from the SO.
Main course	1. The aggregator, via the node flexibility data monitoring and profiling component of the DVNP, receives data of short (one hour ahead), medium (day ahead) and long term (week ahead) flexibility forecasting, and power demand and supply in each DVN. 2. The aforementioned data is used by the same component to readjust each asset's availability declaration as permitted by each market programme. 3. The newly computed asset availability declarations are input to the asset handling optimisation component of the DVNP to maximise revenues and improve overall reliability.

	4. When an asset is dispatched, which is handled by the asset handling optimization component of the DVNP, a performance report is fed back into the DR & flexibility forecasting tool to allow for future improvements of the algorithm. 5. Monthly performance reports will reflect the availability and utilisation based on the values forecasted by the DVNP via the DR & flexibility forecasting tool and based on the metered value for the assets that have been dispatched. 6. Settlements with the SO will be based on the new availability data provided by the FEID generation, consumption, flexibility and forecasting tool.
Alternate Courses	● Assets / sites with baselines under declared values (assessed via spot tests every 6 months) are undeclared from contracts. ● Assets / sites with baselines over the declared values will perform based on the declared values.
Relationships with other Use Cases	BS1 – UC2, BS2 – UC3, Sub-UC1 of BS2 – UC3, Sub-UC2 of BS2 – UC3, Sub-UC3 of BS2 – UC3, BS3 – UC1, BS3 – UC2
Architectural Elements/Services Involved	● Node Flexibility Data Monitoring and Profiling ● Consumer/Prosumer Flexibility Data Monitoring and Profiling ● FEID OpenADR ● FEID Generation, Consumption, Flexibility Forecasting Tool ● DR & Flexibility Forecasting ● Asset Handling Optimisation ● Generation/Consumption Optimal Dispatch
UML Sequence Diagram	

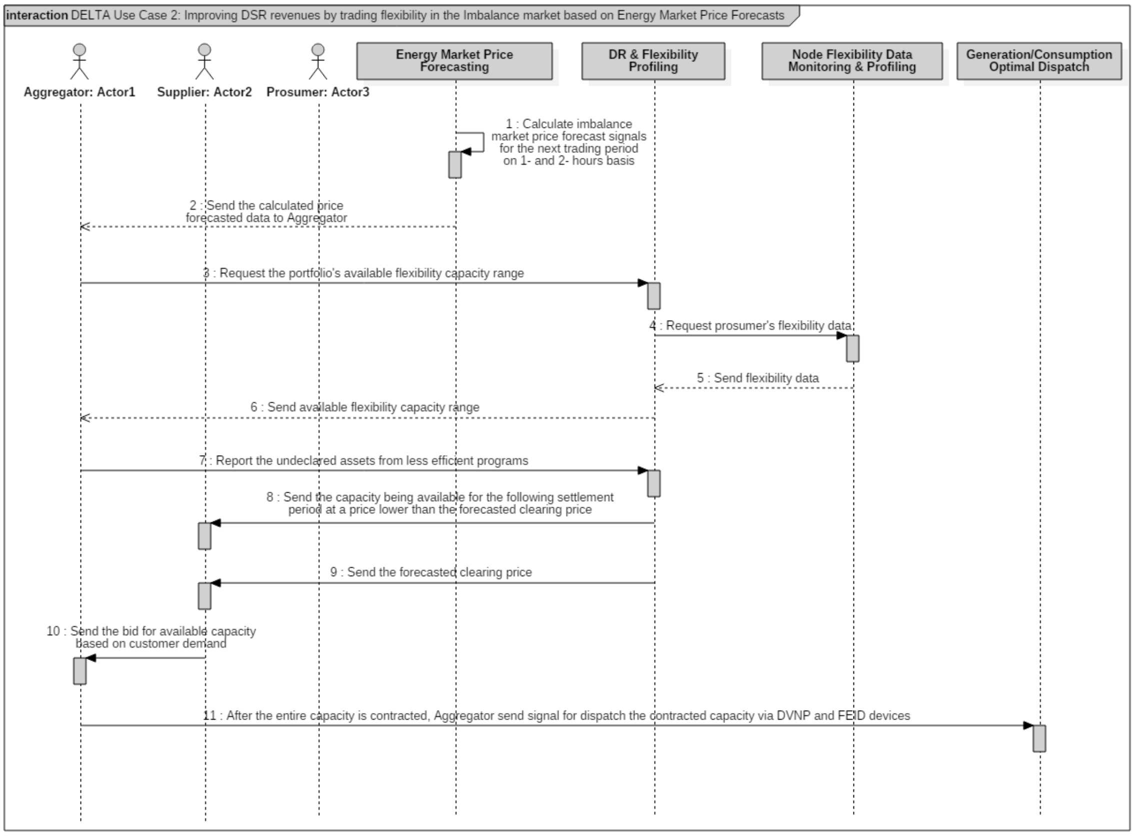


6.1.2 DELTA BS1 – UC2: Improving Demand Response revenues by trading flexibility in the Imbalance market based on Energy Market Price Forecasts

Description:	
Use Case Name	Improving DSR revenues by trading flexibility in the Imbalance Market based on Energy Market Price Forecasts
Version	V0.1
Last Update	25/09/2018
Authors	KiWi Power Ltd
Brief Description	The energy market price forecast module allows the aggregator to spot opportunities in the Imbalance Market and shift flexibility towards that market when prices are likely to go above certain values.
Assumptions & Preconditions	Each site/asset in the aggregator's portfolio is managed via DVN; price forecasts for the imbalance market are made on 1- and 2-hours base to allow the aggregator to un-declare capacity in other operational programmes; bilateral agreements are in place with participants in the Imbalance Market or the aggregator is qualified to

	bid directly in the Imbalance Market.
Objective	Maximise MWh revenues from flexibility services.
Effects/Post Conditions	Increase DSR revenues for customers and the aggregator.
Involved Actors	Aggregator, Suppliers, Prosumer
Use Case Initiation	Forecasted clearing price on the imbalance market exceeds a certain threshold (i.e., 20% over the price paid in a STOR contract).
Main course	1. The aggregator receives imbalance market price forecast signals from the energy market price forecast tool for the next trading period and the energy volumes likely to clear at that price. 2. The aggregator, via the DR & flexibility forecasting component of the DVNP, forecasts future availability and decides how much capacity can be made available to the Imbalance Market. 3. Assets/portfolios are undeclared from less efficient programmes. 4. Suppliers with bilateral agreements active in the imbalance market are made aware of the capacity being available for the following settlement period at a price lower than the forecasted clearing price. 5. One or more suppliers will issue counter offers for the available capacity until the entire capacity is contracted and prices locked down. 6. At the beginning of the settlement period, the aggregator will dispatch contracted capacity via the generation/consumption optimal dispatch component of the DVNP.
Alternate Courses	• Capacity is fixed to a contract/programme without the ability to move in/out of high paying markets unless undeclared the day ahead. If capacity is still traded in the higher paying market but not undeclared in other programmes there is a high operational risk of asset being dispatch in multiple programmes and trigger heavy penalties.
Relationships with other Use Cases	BS1 – UC1, BS2 – UC3, BS3 – UC1
Architectural Elements/Services Involved	• Node Flexibility Data Monitoring and Profiling • DR & Flexibility Forecasting • Energy Market Price Forecasting • Generation/Consumption Optimal Dispatch • FEID OpenADR • FEID Generation, Consumption, Flexibility Forecasting Tool

	• Asset Handling Optimisation
UML Sequence Diagram	

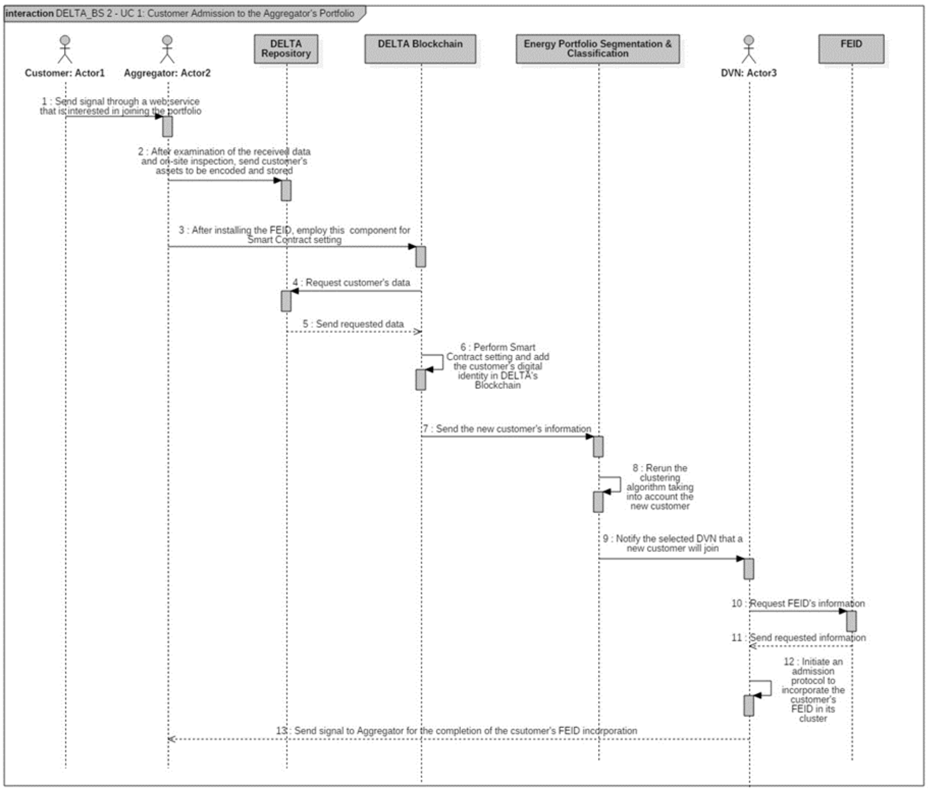


6.2 Use cases association with Business Scenarios 2: Secure, automated Demand Response services via block chain enabled smart contracts

6.2.1 DELTA BS2 – UC1: Customer Admission to the Aggregator Portfolio

Description:	
Use Case Name	Customer Admission to the Aggregator Portfolio
Version	V0.1
Last Update	17/01/2018
Authors	CERTH/ITI
Brief Description	The aggregator's personnel will be able to document the digital identity and the assets of the new customer and integrate to DELTA.
Assumptions & Preconditions	There is a web service that allows customers to express their interest in joining the aggregator's portfolio.
Objective	Automate as much as possible the admission of new customers to the

	aggregator's portfolio.
Effects/Post Conditions	The aggregator will have a detailed overview of the assets and equipment that are available at the customer's site. The customer will be able to fully participate in the processes of DELTA, such as explicit DR schemes.
Involved Actors	Aggregator, Customer, DVN, DELTA Repository, DELTA Blockchain
Use Case Initiation	The customer that is interested in joining the Aggregator's portfolio connects to the aggregator's admission web service.
Main course	1. The customer fills and submits a form with the following data: a. Basic personal and contact information. b. An elaborate description of the assets available on site. 2. The aggregator's personnel examine the submitted data and decides on the staff members that will handle this application. 3. The aggregator's personnel contact the customer and arranges an appointment for on-site inspection. 4. During on-site inspection, the aggregator's personnel verifies the customer's claims, documents any inconsistencies and other relevant information. 5. The aggregator's personnel, at this point, should have all the necessary data available that will allow: a. The customer's assets to be encoded and stored in the DELTA repository according to the DELTA information model b. Proper configuration of the FEID that will be installed at the customer's site c. Determining the appropriate billing plan for the customer 6. The aggregator's personnel contact the customer and shares relevant information in regards to, e.g., the aforementioned billing plan. 7. Assuming that the customer accepts the aforementioned billing plan, a second appointment is arranged for on-site installation of the FEID and other necessary equipment from the aggregator's personnel. 8. Following the installation of the FEID, the aggregator pulls from the DELTA repository the data pertaining to this customer and employs the blockchain and smart contract tool to add the customer's digital identity in DELTA's blockchain, which allows, among others, for the customer to interface with DELTA. 9. The aggregator, via the energy portfolio segmentation & classification component reruns the clustering algorithm and outputs the DVN to which the customer will join. 10. The energy portfolio segmentation & classification component notifies the

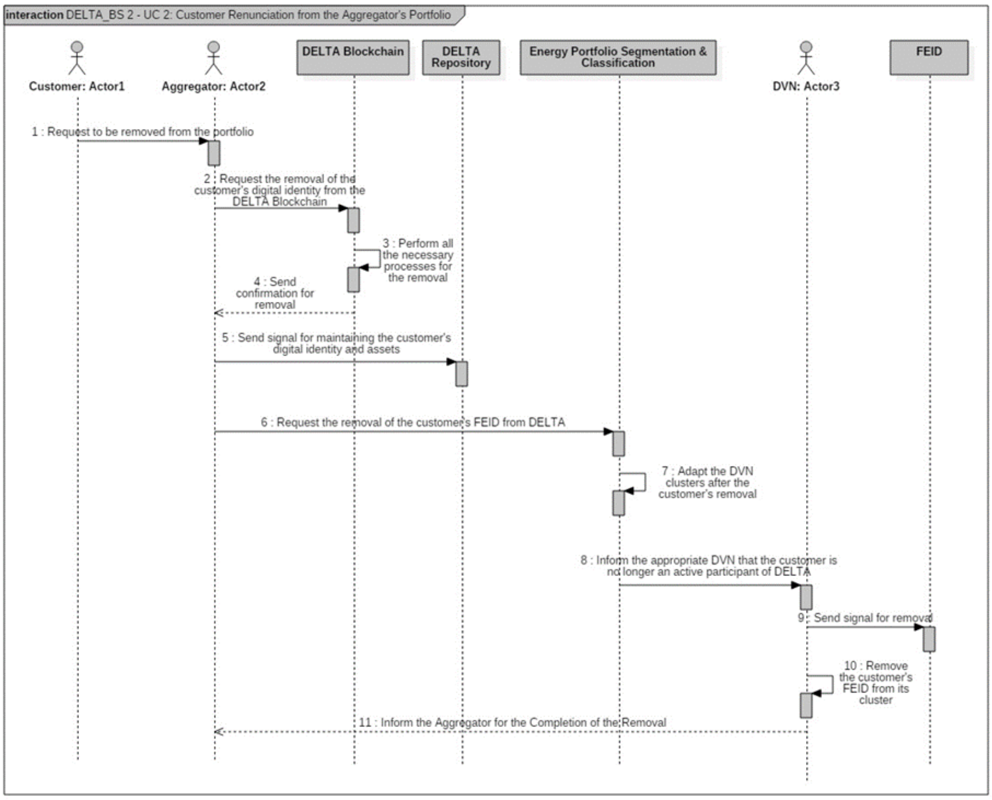
	selected DVN about the admission of a new customer. 11. The DVN initiates an admission protocol to incorporate the customer's FEID in its cluster.
Alternate Courses	It is possible to assume that the aggregator does not have an online Web Service that allows customers to express their interest to join his portfolio. Alternatively, this could be handled by having the customer do so at the aggregator's office.
Relationships with other Use Cases	BS3 – UC1, BS3 – UC2, BS4 – UC1, BS4 – UC2
Architectural Elements/Services Involved	• Aggregator Admission Web service • DELTA Repository • DVN • DELTA Blockchain • Blockchain and Smart Contract Tool • Energy Portfolio Segmentation & Classification • FEID
UML Sequence Diagram	

6.2.2 DELTA BS2 – UC2: Customer Renunciation from the Aggregator's Portfolio

Description:	
Use Case Name	Customer Renunciation from the Aggregator's Portfolio

Version	V0.1
Last Update	17/01/2018
Authors	CERTH/ITI
Brief Description	This use case documents the required steps to remove a customer from the aggregator's portfolio.
Assumptions & Preconditions	A customer is part of the aggregator's DELTA network.
Objective	Remove the customer's ability to access or interface with the aggregator's DELTA network.
Effects/Post Conditions	The customer will no longer be able to interact with the aggregator's DELTA network, however, prior interactions/transactions with the aggregator will remain logged to guarantee DELTA's auditability.
Involved Actors	Aggregator, Customer, DVN, DELTA Blockchain, DELTA Repository
Use Case Initiation	The customer requests to be removed from the aggregator's portfolio.
Main course	1) The aggregator's personnel prepare all the necessary paperwork involved in this procedure. 2) An on-site appointment is arranged with the customer to: a) Verify the integrity and recover the equipment that was installed by the aggregator's personnel (potential extra fees may apply here in case of, e.g., damaged equipment). b) Have the customer sign the physical documents that terminate the contractual relationship between customer and the aggregator. 3) The aggregator, via the blockchain and smart contract tool removes the customer's digital identity from the DELTA blockchain, indicating that she is no longer an active participant. 4) The aggregator marks the removal, but does not delete the data pertaining to the customer's digital identity and assets to the DELTA repository. The customer's data need to be archived to preserve DELTA's auditability. 5) The aggregator, via the energy portfolio segmentation & classification tool, issues the removal of the customer's FEID from DELTA. 6) The energy portfolio segmentation & classification tool

	informs the appropriate DVN that the prosumer is no longer an active participant of DELTA. 7) The DVN removes the customer’s FEID from its cluster.
Alternate Courses	It is possible to assume that the step 1 can be done automatically
Relationships with other Use Cases	BS3 – UC2, BS4 – UC2
Architectural Elements / Services Involved	• DVN • FEID • DELTA Blockchain • DELTA Repository • Blockchain and Smart Contract Tool • Energy Portfolio Segmentation & Classification
UML Sequence Diagram	

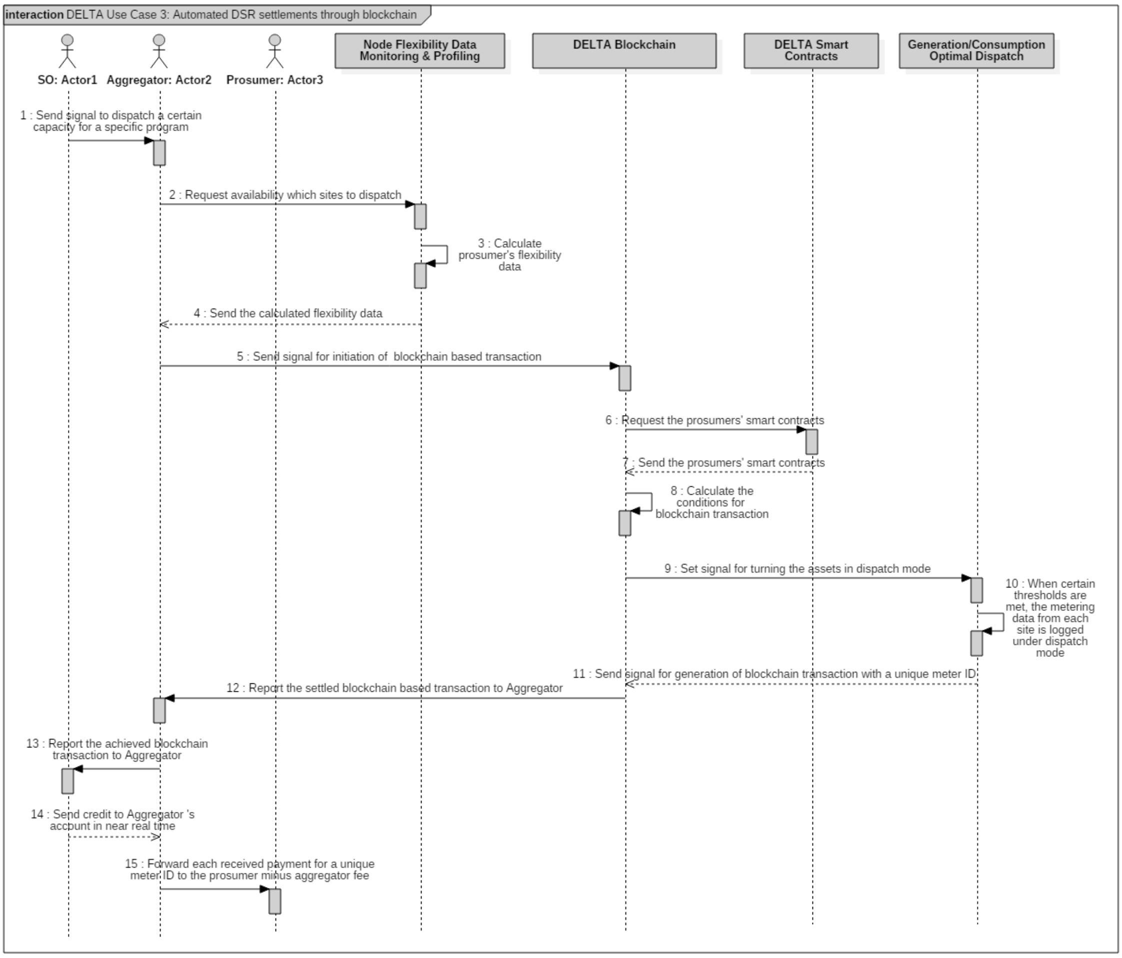


6.2.3 *DELTA BS2 – UC3: Automated Demand Side Response settlements through blockchain*

Description:	
Use Case Name	Automated Demand Side Response settlement through blockchain
Version	V0.1

Last Update	10/10/2018
Authors	KiWi Power Ltd
Brief Description	Energy delivered to the grid / usage turn down is documented through a blockchain-based transaction initiated by a FEID connected to a meter with a unique ID stored in a distributed ledger. Once the DSR event is finished, contribution is documented for each unique meter ID and validated through blockchain and payment from the SO is triggered.
Assumptions & Preconditions	Each asset or group of assets participating into a DSR programme are metered and the meter unique ID is stored in a distributed ledger; all actors can validate the blockchain transaction.
Objective	Reduce cost and time for financial settlement.
Effects/Post Conditions	DSR payment follow DSR events in near real time.
Involved Actors	Aggregators, SO, Prosumer
Use Case Initiation	A DSR event is triggered by the SO and DVNP starts monitoring delivery via FEID.
Main course	1. Aggregator receives metering data from each site in a constant rate that is logged under dispatch mode. 2. Aggregator receives a signal from SO to dispatch a certain capacity for a specific programme. 3. Aggregator checks availability and if pre-agreed thresholds are met and decides which sites to dispatch. 4. Control strategies are executed via DVNP/ FEID devices. 5. Blockchain transactions with the unique meter ID, volumes of energy and prices are generated. 6. For each blockchain transaction, the SO will credit the aggregator's account in near real time. 7. Each payment received by the aggregator for a unique meter ID is forwarded to the consumer minus aggregator fee.
Alternate Courses	Metering data for each asset is stored by the aggregators. Delivery reports are issued to the SO end of each calendar month and metering data sent for reconciliation to the settlement body. The settlement body will compare metering data against fiscal metering data and confirm validity of data to the SO (up to 60 days). The SO will issue payment to the aggregator. The aggregator will issue payment to consumer.
Relationships with other Use Cases	Sub-UC1 of BS2 – UC3, Sub-UC2 of BS2 – UC3, Sub-UC3 of BS2 – UC3

Architectural Elements/Services Involved	• DELTA Smart Contracts • DELTA Blockchain • Node Flexibility Data Monitoring & Profiling • Generation Consumption Optimal Dispatch
UML Sequence Diagram	

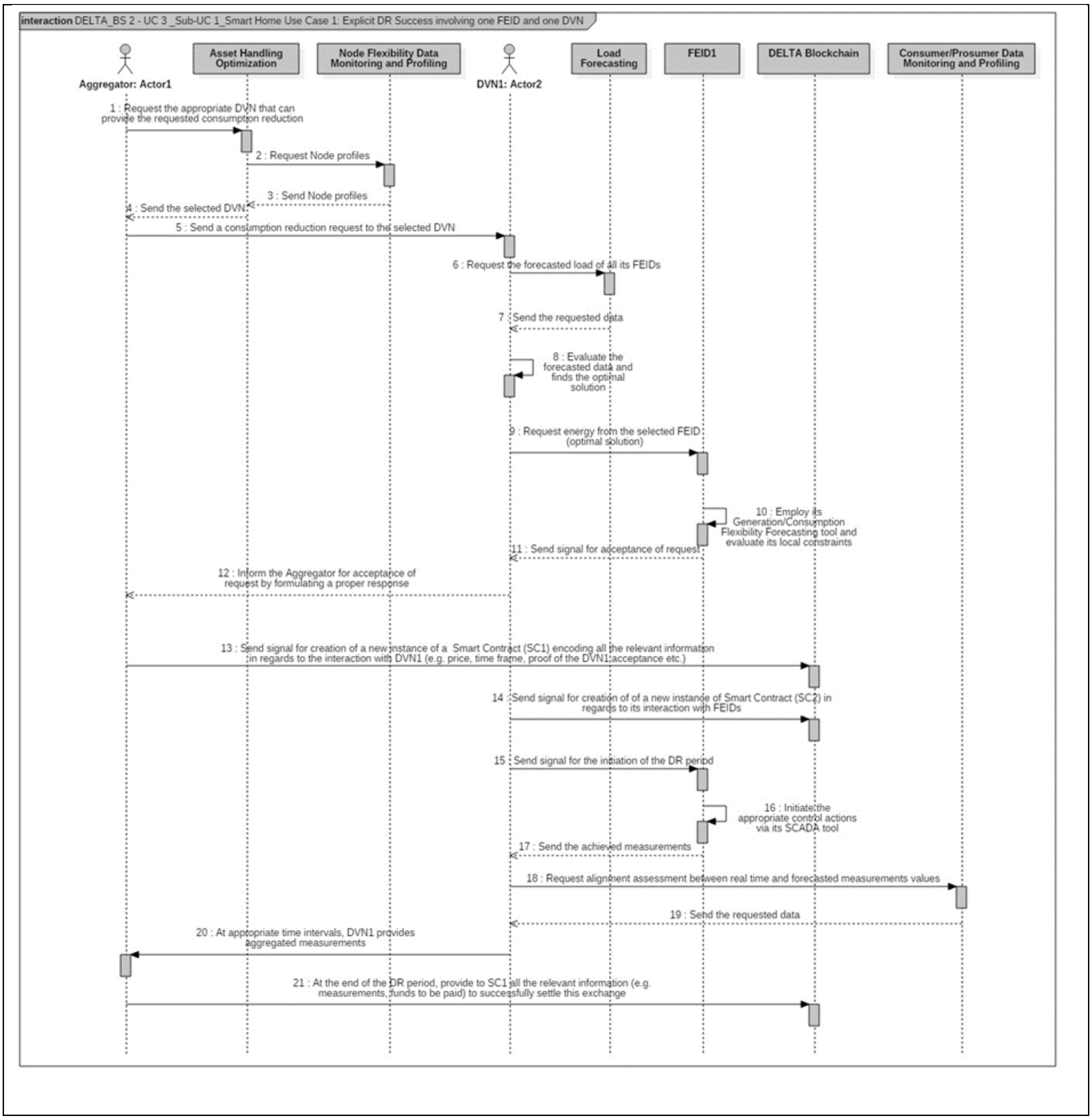


DELTA Indicative Sub-UC1 of BS2 – UC3_SmartHome Use Case 1: Incentive-based Demand Response signal activation involving one Fog Enabled Intelligent Device and one DELTA Virtual Node

Description:	
Use Case Name	DELTA SmartHome Use Case 1: Incentive-based Demand Response signal activation involving one Fog Enabled Intelligent Device and one DELTA Virtual Node (SUCCESS SCENARIO)
Version	V0.1
Last Update	28/01/2019
Authors	CERTH/ITI

Brief Description	An overview of the procedure that will be followed to handle an explicit DR scheme between one FEID and one DVN in CERTH's SmartHome
Assumptions & Preconditions	Sites/assets in the aggregator's portfolio are managed via DVNs. A FEID is installed at each site that runs a lightweight blockchain node.
Objective	A secure and auditable procedure for handling and settling explicit DR schemes.
Effects/Post Conditions	Increase DR revenues for customers and the aggregator.
Involved Actors	Aggregator, FEID, DVN, DELTA Blockchain
Use Case Initiation	The aggregator receives a signal from SO requesting consumption reduction of X kWh within a particular time frame.
Main course	1. The aggregator, by employing the DSS, decides on the appropriate DVN which can provide reduced consumption (e.g., DVN_1). 2. The aggregator sends a consumption reduction request to DVN_1. 3. On receipt, DVN_1, via its load forecasting tool, evaluates the forecast of all its FEIDs and decides that the optimal solution is to request energy from $FEID_1$. 4. On receipt, $FEID_1$ via the FEID generation, consumption, flexibility forecasting tool, evaluates its local constraints and decides to accept the DVN's request. 5. In addition, DVN_1 accepts the aggregator's request by formulating a proper response. 6. The aggregator, via its blockchain and Smart Contract tool, creates a new instance of a smart contract (SC_1) in DELTA's Blockchain that encodes all the relevant information in regards to his interaction with DVN_1 (e.g., price, time frame, proof of the request's acceptance from DVN_1, as well as a list of other DVNs that can assist if needed). 7. DVN_1, via its blockchain and smart contract tool, creates a new instance of smart contract (SC_2) in DELTA's blockchain in regards to its interaction with $FEID_1$. 8. At the start of the DR period, $FEID_1$ initiates the appropriate control actions via its FEID OpenADR tool (e.g., turning off relays, dimming down lights). 9. DVN_1, via its consumer/prosumer flexibility data monitoring and profiling tool, assesses the alignment of real time and

	forecasted measurement values. 10. At appropriate time intervals, DVN_1, via its consumer/prosumer flexibility data monitoring and profiling tool, provides aggregated measurements to the aggregator. 11. At the end of the DR period, the aggregator, via its blockchain and mart contract tool, provides to SC_1 all the relevant information (e.g., measurements, funds to be paid) to successfully settle this exchange. 12. SC_2 among other actions handles the transfer of funds to the account of the client who has $FEID_1$ installed in on site.
Alternate Courses	-
Relationships with other Use Cases	BS2 – UC3, Sub-UC2 of BS2 – UC3, Sub-UC3 of BS2 – UC3, BS3 – UC2
Architectural Elements/Services Involved	• Node Flexibility Data Monitoring and Profiling • Load Forecasting • FEID Generation, Consumption, Flexibility Forecasting Tool • Consumer/Prosumer Flexibility Data Monitoring and Profiling Tool • Blockchain and Smart Contract Tool • FEID OPENADR • DELTA Blockchain • DR & Flexibility forecasting • Asset Handling & Optimization

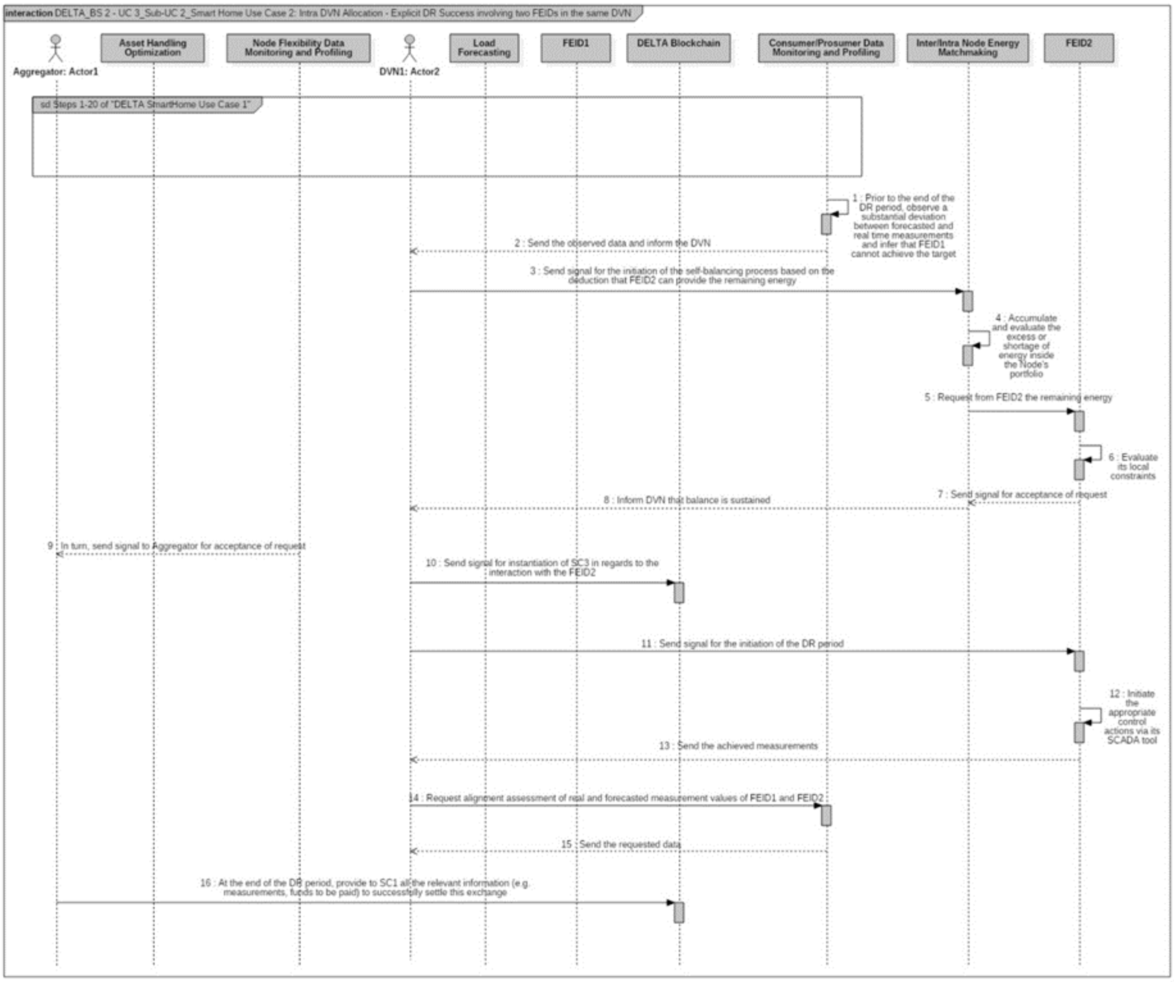


6.2.4 DELTA Indicative Sub-UC2 of BS2 – UC3_SmartHome Use Case 2: Intra Delta Virtual Node Allocation – Incentive-based Demand Response signal activation involving two Fog Enabled Intelligent Devices in the same Delta Virtual Node (SUCCESS via intra- Delta Virtual Node Allocation re-allocation)

Description:	
Use Case Name	DELTA SmartHome Use Case 2: Intra Delta Virtual Node Allocation – Incentive-based Demand Response signal activation involving two Fog Enabled Intelligent Devices in the same Delta Virtual Node (SUCCESS via intra- Delta Virtual Node Allocation re-allocation)
Version	V0.1
Last Update	28/01/2019

Authors	CERTH/ITI
Brief Description	An overview of the procedure that will be followed to handle an explicit DR scheme between two FEIDs and one DVN in CERTH's SmartHome.
Assumptions & Preconditions	Sites/assets in the aggregator's portfolio are managed via DVN. A FEID is installed at each site that runs a lightweight blockchain node.
Objective	A secure and auditable procedure for handling and settling explicit DR.
Effects/Post Conditions	Increase DR revenues for customers and the aggregator.
Involved Actors	Aggregator, FEID, DVN, DELTA Blockchain
Use Case Initiation	The Aggregator receives a signal from SO requesting consumption reduction for X kWh within a particular time frame.
Main course	• Follow steps 1-10 of "DELTA SmartHome use case 1". • At some point, prior to the end of the DR period, DVN_1, via its consumer/prosumer flexibility data monitoring and profiling tool, observes a substantial deviation between forecasted and real time measurements and infers that $FEID_1$ cannot achieve the target. • DVN_1, via its latest forecast which is output by the load forecasting tool, employs its inter/intra node energy matchmaking and deduces that $FEID_2$ can provide the remaining energy. • Steps 4 and 5 of "DELTA SmartHome Use Case 1" are repeated involving DVN_1 and $FEID_2$ which, among others, lead to the instantiation of SC_3. • $FEID_2$ initiates the appropriate control actions via its FEID OpenADR tool. • DVN_1, via its flexibility data monitoring and profiling tool, assesses the alignment of real time and forecasted measurement values of $FEID_1$ and $FEID_2$. • At the end of the DR period, the aggregator, via the blockchain and smart contract tool, provides to SC_1 all the relevant information (e.g., measurements, funds to be paid) to successfully settle this exchange. • SC_1 calls SC_2 which, among others, handles the settlement with the appropriate involved penalties. • SC_1 calls SC_3 which, among others, handles the transfer of funds to the account of the client who has $FEID_2$ installed on site.
Alternate Courses	-

Relationships with other Use Cases	BS2 – UC3, Sub-UC1 of BS2 – UC3, Sub-UC3 of BS2 – UC3, BS3 – UC2
Architectural Elements/Services Involved	● Node Flexibility Data Monitoring and Profiling ● DELTA Blockchain ● Load Forecasting ● FEID Generation, Consumption, Flexibility Forecasting Tool ● Consumer/Prosumer Flexibility Data Monitoring and Profiling Tool ● Blockchain and Smart Contract Tool ● FEID OpenADR ● DR & Flexibility forecasting ● Asset Handling & Optimization ● Inter/Intra Node Energy Matchmaking
UML Sequence Diagram	

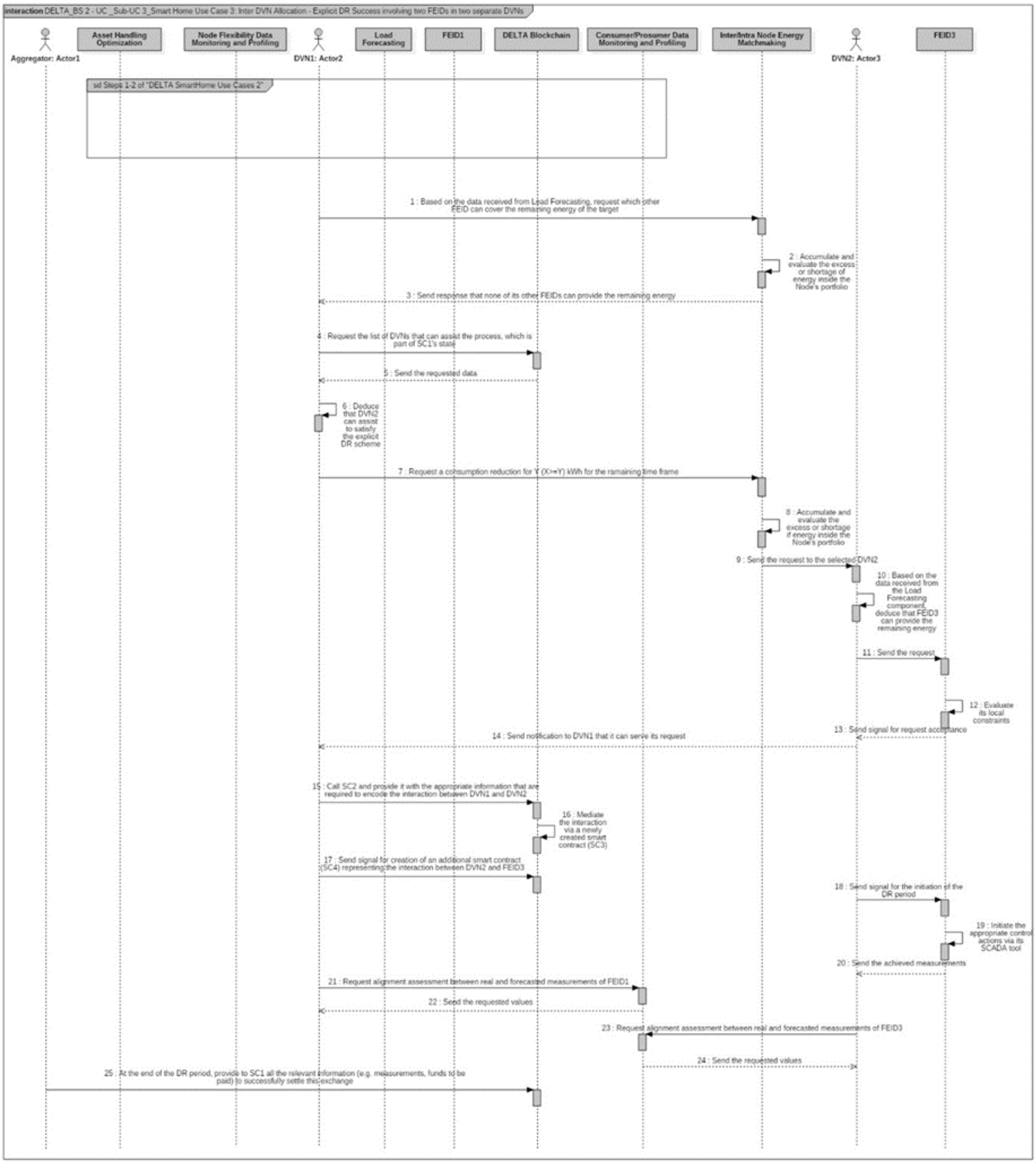


6.2.5 DELTA Indicative Sub-UC3 of BS2 – UC3_Smart Home Use Case 3: Inter DELTA Virtual Node Allocation – Explicit Demand Response Success Involving two Fog Enabled Intelligent Devices in two separate DELTA Virtual Node

Description:	
Use Case Name	DELTA Smart Home Use Case 3: Inter DELTA Virtual Node Allocation – Explicit Demand Response Success Involving two Fog Enabled Intelligent Devices in two separate DELTA Virtual Node
Version	V0.1
Last Update	28/01/2019
Authors	CERTH/ITI
Brief Description	An overview of the procedure that will be followed to handle an explicit DR scheme between two FEIDs and two DVNs in CERTH's Smart Home.
Assumptions & Preconditions	Sites/assets in the aggregator's portfolio are managed via DVN. A FEID is installed at each site that runs a lightweight blockchain node.
Objective	A secure and auditable procedure for handling and settling explicit DR
Effects/Post Conditions	Increase DR revenues for customers and the aggregator
Involved Actors	Aggregator, FEID, DVN, DELTA Blockchain
Use Case Initiation	The aggregator receives a signal requesting consumption reduction for X kWh on a particular time frame.
Main course	• Follow steps 1-2 of "DELTA SmartHome Use Case 2". • At some point, prior to the end of the DR period, DVN_1, via its consumer/prosumer flexibility data monitoring and profiling tool, observes a substantial deviation between forecasted and real-time measurements and infers that $FEID_1$ cannot achieve the target. • DVN_1, via its latest forecast which is output by the load forecasting tool, employs its inter/intra node energy matchmaking and deduces that none of its other FEIDs (e.g., $FEID_2$) can provide the remaining energy. • DVN_1 consults the list of DVNs which can assist the process, which is part of SC_1's state via its Blockchain and smart contract tool. • DVN_1 deduces that DVN_2 can assist in an attempt to satisfy the explicit DR scheme. • DVN_1, via its inter/intra node energy matchmaking, sends a request to DVN_2 requesting a consumption reduction for Y ($X \geq Y$) kWh for the remaining time frame. • DVN_2, via its latest forecast which is output by the Load Forecasting tool, deduces that $FEID_3$ can provide the

	remaining energy. ● $FEID_3$, via its FEID generation, consumption, flexibility forecasting tool, evaluates its local constraints and decides to accept the DVN_2's request. ● DVN_2, via its inter/intra Node Energy Matchmaking, notifies DVN_1 that it can service its request. ● DVN_1, via its blockchain and smart contract tool, calls SC_2 and provides it with the appropriate information that are required to encode the interaction between DVN_1 and DVN_2. This interaction is mediated via a newly created smart contract (SC_3). ● As in previous use cases, an additional smart contract (SC_4) is created, which will act as the intermediary between DVN_2 and $FEID_3$. ● Once SC_4 is created, $FEID_3$ is notified via its blockchain and smart contract tool and initiates the appropriate control actions via its FEID OPENADR tool. ● DVN_1 and DVN_2, via their flexibility data monitoring and profiling tool, assess the alignment of real time and forecasted measurement values of $FEID_1$ and $FEID_3$, respectively. ● At the end of the DR period, the aggregator, via its blockchain and smart contract tool, provides to SC_1 all the relevant information (e.g., measurements, funds to be paid) to successfully settle this exchange. ● SC_1 calls SC_2 which, among others, handles the settlement with the appropriate involved penalties. ● SC_1 calls SC_3 which, among others, handles the transfer of funds, by calling SC_4, to the account of the client who has $FEID_3$ installed in her site.
Alternate Courses	-
Relationships with other Use Cases	BS2 – UC3, Sub-UC1 of BS2 – UC3, Sub-UC2 of BS2 – UC3, BS3 – UC2
Architectural Elements/Services Involved	● Node Flexibility Data Monitoring and Profiling ● DELTA Blockchain ● Load Forecasting ● FEID Generation, Consumption, Flexibility Forecasting Tool ● Consumer/Prosumer Flexibility Data Monitoring and Profiling Tool ● Blockchain and Smart Contract Tool ● FEID OpenADR ● DR & Flexibility forecasting ● Asset Handling & Optimization ● Inter/Intra Node Energy Matchmaking

UML Sequence Diagram



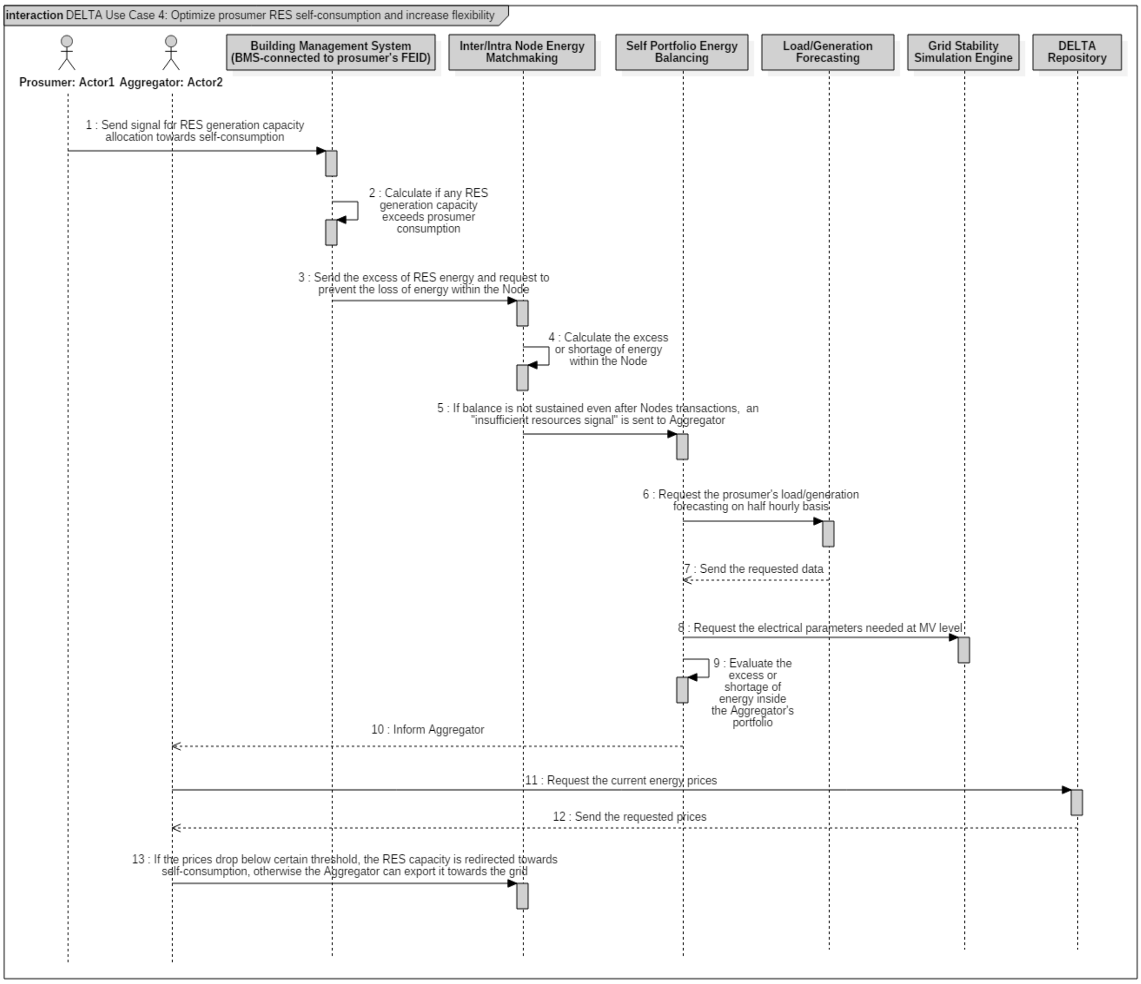
6.3 Use cases association with Business Case 3: Self optimised Demand Response services via DELTA Virtual Node and portfolio management

6.3.1 DELTA BS3 – UC1: Optimise prosumer Renewable Energy Systems self-consumption and increase flexibility

Description:	
Use Case Name	Optimise prosumer Renewable Energy Systems (RES) self-consumption and increase flexibility

Version	V0.1
Last Update	2/11/2018
Authors	KiWi Power Ltd and UCY
Brief Description	Integrate existing RES and consumption points via DVN to maximise self-consumption and reduce energy cost while maximising flexibility services.
Assumptions & Preconditions	Existing RES control systems are connected to DVNP Existing consumption devices are connected to DVNP
Objective	To maximise self-utilisation of RES generation while increasing flexibility
Effects/Post Conditions	Prosumer is able to reduce energy cost / increase flexibility revenue
Involved Actors	Prosumer, Aggregator, DVNP
Use Case Initiation	Auto-triggered process.
Main course	1. Prosumer allocates RES generation capacity towards self-consumption as the main business rule on the DVNP. 2. Any RES generation capacity that exceeds Prosumer consumption need is made available to an Aggregator via the DVNP. 3. Load/Generation Forecasting tool generates forecasts for the Prosumer load curves and generation capacity on half hourly basis. 4. DELTA Aggregator allocates any extra capacity to the best paying services in the market. 5. If prices in specific market exceed a certain threshold, DELTA Aggregator can redirect the entire RES generation capacity to export towards the grid. 6. When prices drop below certain threshold, the RES capacity is redirected towards self-consumption.
Alternate Courses	RES generation capacity is entirely used either for self-consumption, or entirely for export. The only flexibility that is being monetised is fixed capacity turndown services based on equipment specification and turndown tests.
Relationships with other Use Cases	BS1 – UC1, BS1 – UC2, BS2 – UC1
Architectural Elements/Services	• Building Management System (BMS – connected to prosumer’s FEID)

Involved	• Inter/Intra Node Energy Matchmaking • Self-Portfolio Energy Balancing • Load/Generation Forecasting • Grid Stability Simulation Engine • DELTA Repository
UML Sequence Diagram	

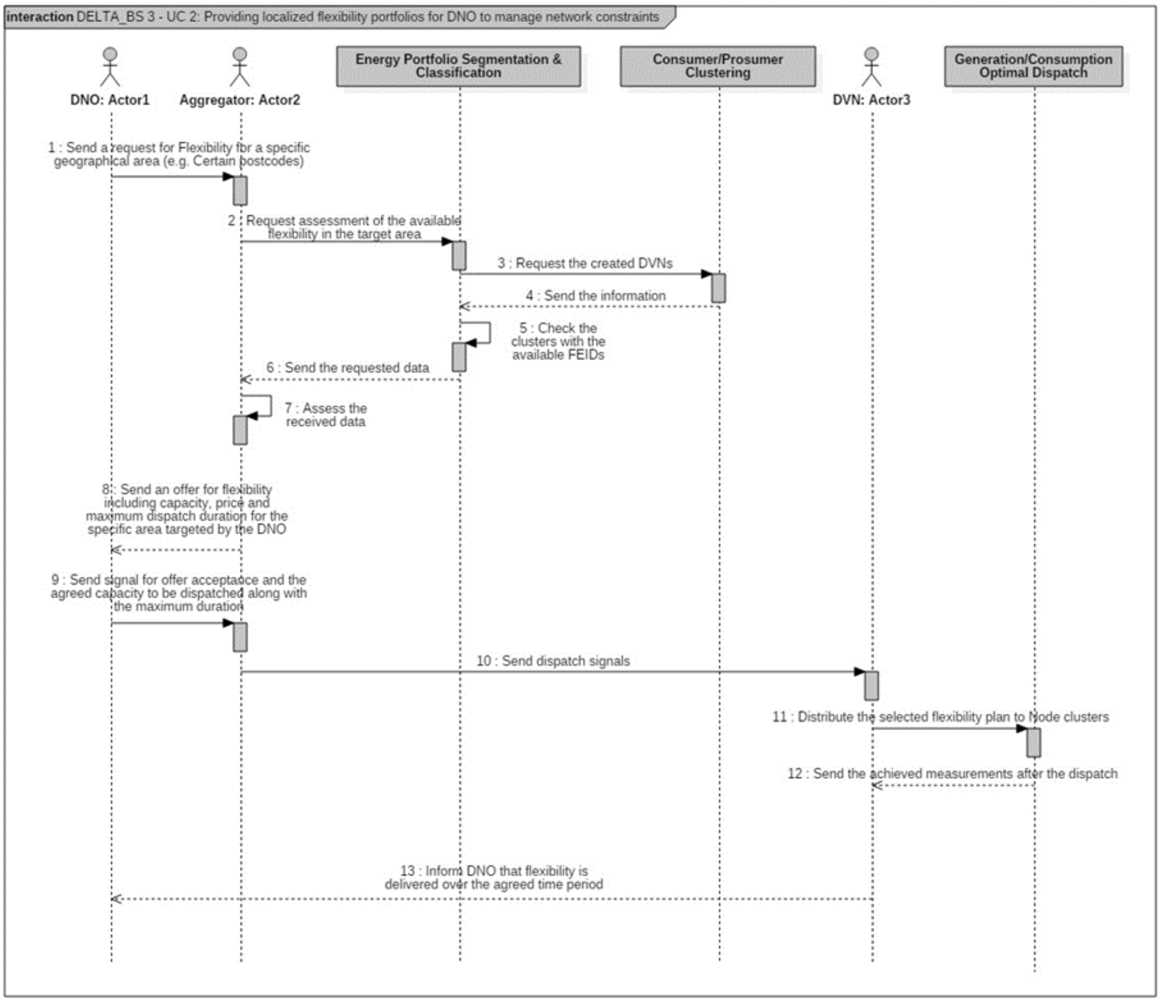


6.3.2 DELTA BS3 – UC2: Providing localised flexibility portfolios for Distribution Network Operator to manage network constraints.

Description:	
Use Case Name	Providing localised flexibility portfolios for Distribution Network Operator to manage network constraints.
Version	V0.1
Last Update	21/01/2018
Authors	KiWi / UCY
Brief	Allow flexibility clustering based on location to enable DNO to deal with specific

Description	network constraints locally.
Assumptions & Preconditions	Consumer provides consent for asset geotagging; DNO provides basic Geographic Information System (GIS) network model or special aggregation criteria.
Objective	To enable network constraint management for DNO.
Effects/Post Conditions	Flexibility resources can be aggregated and dispatched based on location.
Involved Actors	Aggregator, Prosumer, Consumer, DNO
Use Case Initiation	Aggregator receives a request from DNO for flexibility for a specific part of the network.
Main course	1. DNO sends a request for flexibility to the aggregator for a specific geographical area (e.g. Certain postcodes). 2. Aggregator is assessing the available flexibility in the target area via the energy portfolio segmentation and classification engine. 3. Aggregator sends back to the DNO an offer for flexibility including capacity, price and maximum dispatch duration for the specific area targeted by the DNO. 4. DNO accepts the offer and sends aggregator the agreed capacity to be dispatched and the maximum duration. 5. The Aggregator sends dispatch signals to the DVNs. 6. Flexibility is delivered over the agreed time period (initiated smart contracts are satisfied and certain flexibility capacity vs price is settled between the aggregator and prosumers). 7. At the end of the dispatch, performance report is issued highlighting the geographical area covered by the dispatch, the total Energy delivered over the period and the price agreed.
Alternate Courses	4a. DNO rejects the flexibility offer. 5a. Aggregator can either go back to step 3 and issue a new offer with a new price or close the process. 1b-7b DNO is using their own control system to manage constraints.
Relationships with other Use Cases	BS1 – UC1, BS2 – UC1, BS2 – UC2, Sub-UC1 of BS2 – UC3, Sub-UC2 of BS2 – UC3 , Sub-UC3 of BS2 – UC3
Architectural Elements/Services Involved	Smart Meter, Virtual Node, Energy Portfolio Segmentation and Classification.

UML Sequence Diagram

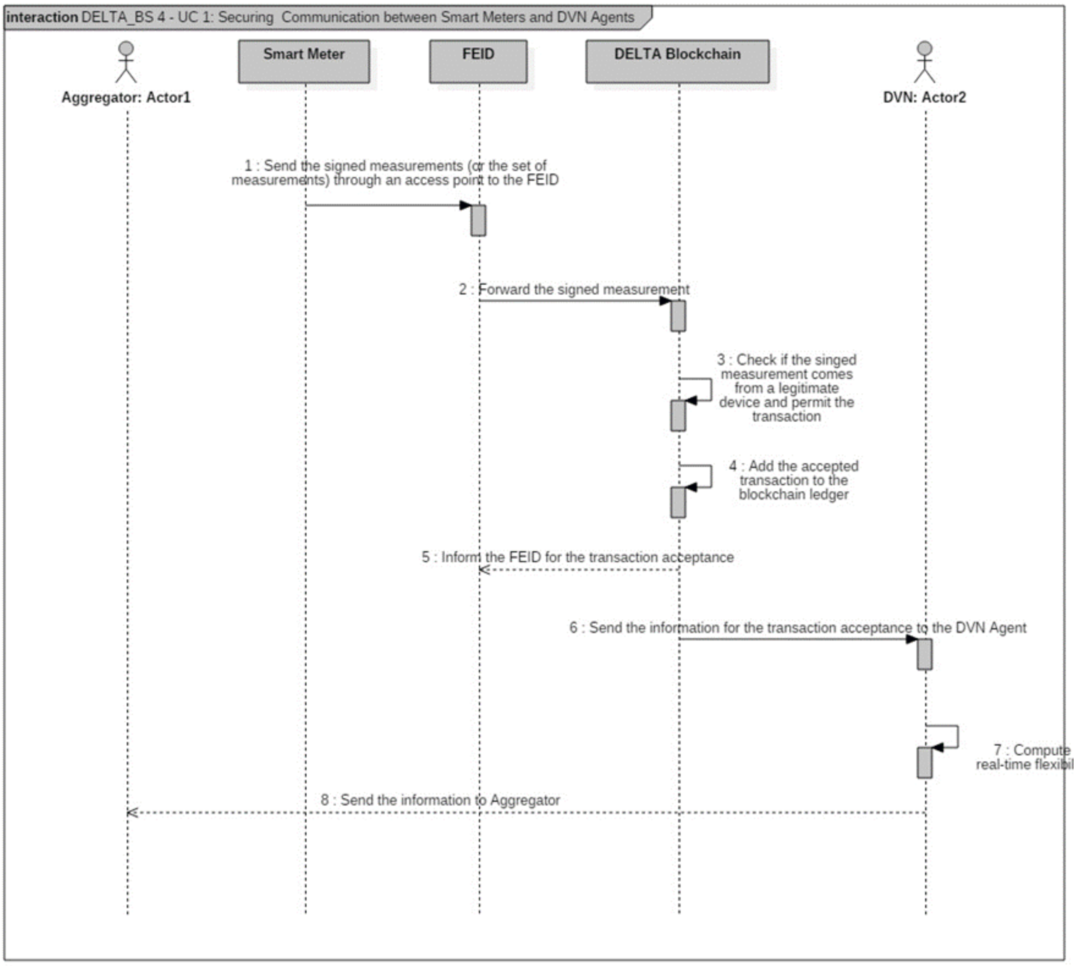


6.4 Use cases association with Business Case 4

6.4.1 DELTA BS4 – UC1: Securing communication between Smart Meters and DELTA Virtual Node Agents

Description:	
Use Case Name	Communication between Smart Meters and DELTA Virtual Node Agents
Version	V0.1
Last Update	16/01/2018
Authors	CERTH/ITI
Brief Description	Real time monitoring and control of smart meters to secure communication and compute real-time flexibility.

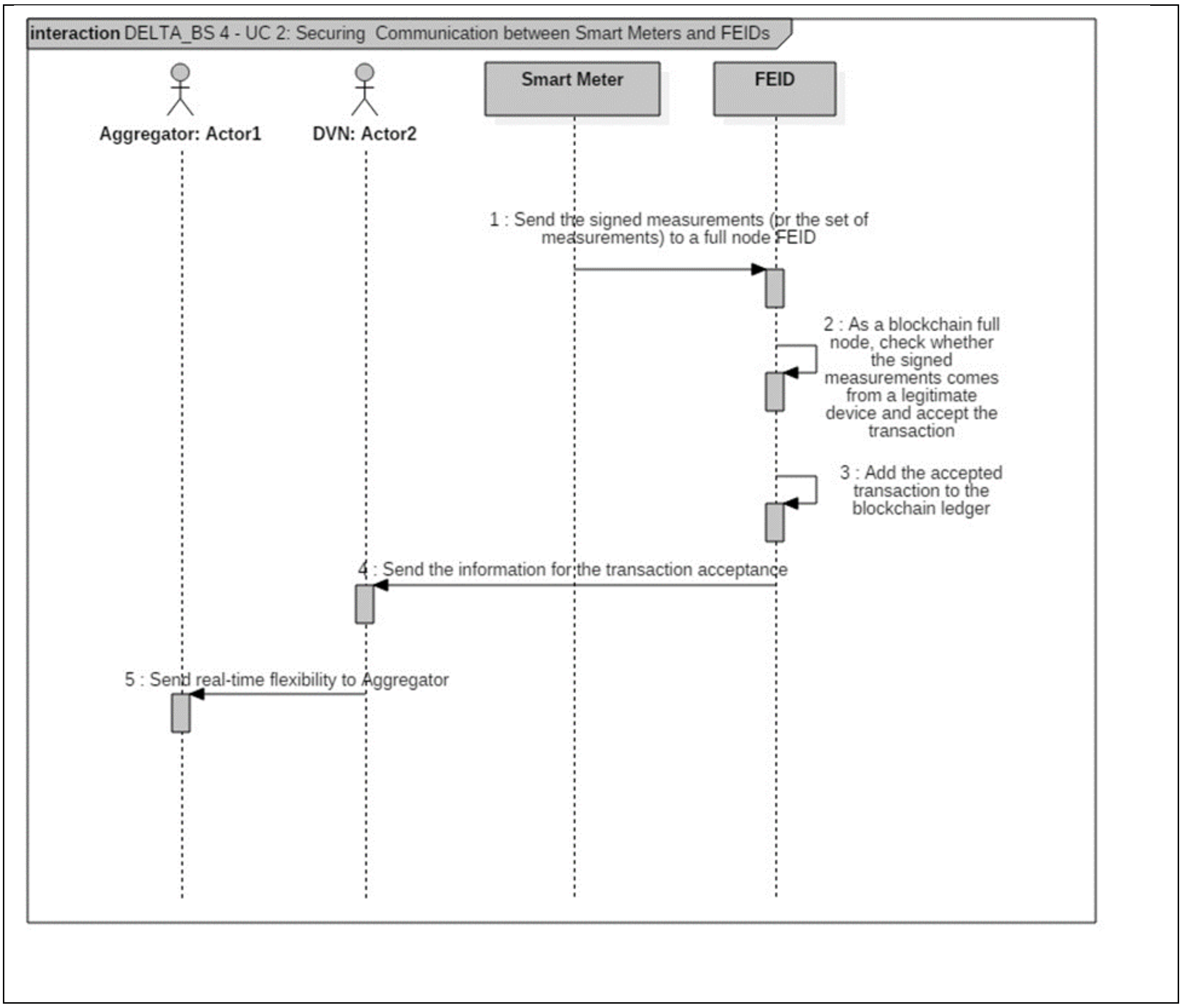
Assumptions & Preconditions	Connect FEID to smart technologies and/or to building management system or to power lines and sensors within the hosting infrastructure.
Objective	To secure the communication between smart meters and FEIDs.
Effects/Post Conditions	Aggregator can be sure of the data integrity of the measurements and prevent fraud from prosumers.
Involved Actors	Aggregator, Prosumer
Use Case Initiation	A smart meter sends a measurement to a light node FEID.
Main course	1. An Internet of Things (IoT) device with a private key sign a measurement (or set of measurements). 2. The measurement is sent to an access point in order to be transmitted to a FEID. 3. The FEID acting as proxy service and as a blockchain lightweight client receives the signed measurement and forwards it to a blockchain full node. 4. The blockchain full node ensures that this request comes from a legitimate device and permits the transaction. 5. The full node accepts the transaction and adds it to the blockchain ledger informing the FEID and the DVN Agent. 6. The DVN Agent service computes the flexibility.
Alternate Courses	2a. The measurement is sent directly to the FEID. 4a. The FEID can be a blockchain full node and authenticate the. device itself. 5a. The full node rejects the transaction because it has been tampered during the transmission or comes from a non-legit device.
Relationships with other Use Cases	BS2 – UC1
Architectural Elements/Services Involved	Smart Meter, FEID, DVN Agent, Proxy service
UML Sequence Diagram	



6.4.2 DELTA BS4 – UC2: Securing communication between Smart Meters and Fog Enabled Intelligent Device

Description:	
Use Case Name	Securing communication between Smart Meters and Fog Enabled Intelligent Device
Version	V0.1
Last Update	17/01/2018
Authors	CERTH/ITI
Brief Description	Real time monitoring and control of smart meters to secure communication and compute real-time flexibility.
Assumptions & Preconditions	Connect FEID to smart technologies and/or to BMS or to power lines and sensors within the hosting infrastructure.

Objective	To secure the communication between smart meters and FEIDs.
Effects/Post Conditions	Aggregator can be sure for the data integrity of the measurements and prevent fraud from prosumers.
Involved Actors	Aggregator, Prosumer
Use Case Initiation	A sensor sends a measurement to a full node FEID.
Main course	1. An IoT device with a private key signs a measurement (or set of measurements). 2. The measurement is sent to a full node FEID. 3. The FEID as a blockchain full node checks whether this comes from a legitimate device. 4. The FEID accepts the transaction and adds it to the blockchain ledger informing the DVN Agent. 5. The DVN Agent service computes the flexibility.
Alternate Courses	4a. The full node rejects the transaction because it has been tampered during the transmission or comes from a non-legit device.
Relationships with other Use Cases	BS2 – UC1, BS2 – UC2
Architectural Elements / Services Involved	Smart Meter, FEID, DVN Agent
UML Sequence Diagram	



6.5 Mapping the use cases against the demonstration sites

As all of the use cases will be tested in one or more demo sites (Cyprus, Greece and United Kingdom), we created a summary of how the use cases will be deployed with project partners:

ID	Use Case Description	Pilot Sites to Demo the Use Case
5.1.1	Flexibility forecast to improve assets availability declaration and maximise DR revenues.	CERTH/ITI, KiWi, UCY/EAC
5.1.2	Improving DSR revenues by trading flexibility in the Imbalance Market based on energy market price forecasts.	CERTH/ITI, KiWi
5.2.1	Automated DSR settlements through blockchain.	CERTH/ITI
5.2.2	Explicit DR success involving one FEID and one DVN.	CERTH/ITI

5.2.3	Intra DVN allocation – explicit DR success involving two FEIDs in two separate DVNs.	CERTH/ITI
5.2.4	Inter DVN allocation – explicit DR success involving two FEIDs in two separate DVNs.	UCY/EAC
5.3.1	Optimise prosumer RES self-consumption and increase flexibility.	KiWi
5.3.2	Provision of ancillary services for network constraint management.	KiWi
5.4.1	Securing communication between smart meters and DVN agents.	KiWi
5.4.2	Securing communication between smart meters and FEIDs.	CERTH/ITI, UCY/EAC
5.5.1	Prosumer admission in the aggregator's portfolio.	CERTH/ITI, UCY/EAC
5.5.2	Prosumer admission in DELTA.	CERTH/ITI, UCY/EAC
5.5.3	Prosumer renunciation from DELTA.	CERTH/ITI, UCY/EAC

An example of how the above Use Cases will be aligned in the UK Pilot sites is presented below:

Table 4 Use cases Kiwi Power Moor House

Description:	
Use Case Name	Demand response through self-configured, self-optimized and collaborative virtual distributed energy nodes Static Frequency response and TRIAD warnings notifications
Pilot site	Moor House, 120 London Wall, London EC2Y 5ET
Authors	Kiwi Power
Brief Description	FEID will be installed to the asset of Moor House and with Kiwi Power they will response to real Static Frequency responses events
Assumptions & Preconditions	Connect FEID to the chiller of Moor House of turn-down capacity 367KW to provide a Non-dynamic response to the frequency fluctuation. Kiwi Power has already installed their own technology and will be a back-up in case the FEID doesn't give the command in time. Moor House will also receive Triad warning notification to reduce the import and usage of electricity during the winter period with the heist energy peaks to relief the network constraint.

	FEID must comply with the Cybersecurity Act (2019/881/EU).Its important to safeguard the solidity of the Project excluding possible data breaches. Site has via the BMS cybersecurity protocols so we need to ensure that DELTA technology complies with the Act
Objective	To prove that FEID and DVN can collect the consumption data of the asset to optimise it for DR events and also response to a real time Frequency event.
Effects/Post Conditions	Client will continue his participation to SFFR via DELTA and receive revenue from NG
Involved Actors	Kiwi Power, DELTA, Moor House
Main course	1. An FEID device to measurement (or set of measurements). 2. The FEID as a blockchain full node checks whether this comes from a legitimate device. 3. The FEID accepts the transaction and adds it to the blockchain ledger informing the DVN Agent.
Alternate Courses	The asset fails to response to the event and no payments are made to Moor house.

Table 5 Use cases Kiwi Power Ernest Dence Estate – Greenwich

Description:	
Use Case Name	Demand response through self-configured, self-optimized and collaborative virtual distributed energy nodes TRIAD warnings notifications
Pilot site	Ernest Dence Estate – Greenwich
Authors	Kiwi Power
Brief Description	Automatic settlements via smart block chain enabled smart contracts to improve chas flows and reduce settlement period.End user will get Triad avoidance suggestions(phone app notifications) to reduce consumption
Assumptions & Preconditions	Connect FEID to the smart meters of the houses to monitor electrical consumption. During the trial period will send push notifications via the DELTA phone application to suggest to the end users to reduce the electrical consumption to avoid higher electrical tariffs
Objective	DELTA technology to improve the electrical consumption and reduce the energy bills
Effects/Post Conditions	End user will receive push notifications with valid suggestions in order to reduce the electrical bills. Delta can only suggest the electrical turn down of the end user
Involved Actors	Kiwi Power, DELTA, Ernest Dence Estate – Greenwich

Main course	1. An FEID device to measurement (or set of measurements). 2. The FEID as a blockchain full node checks whether this comes from a legitimate device. 3. The FEID accepts the transaction and adds it to the blockchain ledger informing the DVN Agent.
Alternate Courses	The end user doesn’t accept the suggestion of DELTA and consumptions are not reduced.

7. DELTA User Requirements Definition

7.1 User requirements template

As described in the proposal, to document the user requirements the partners have opted for an enhanced template derived from the Volere methodology. This methodology adds more depth to the standard functional / non-functional classification by adding four more categories.
Functional requirements are the fundamental or essential subject matter of the product. They describe what the product has to do or what processing actions it is to take.
Non-functional requirements are the properties that the functions must have, such as performance, usability, data security needs (IS assessment).
Project constraints are restrictions on the project due to the budget or the time available to build the product.
Design constraints impose restrictions on how the product must be designed. For example, it might have to be implemented in the hand-held device being given to major customers, or it might have to use existing servers and desktop computers, or any other hardware, software, or business practice.
Project drivers are the business-related forces. For example, the purpose of the project is a project driver, as are all of the stakeholders—each for different reasons.
Project issues define the conditions under which the project will be done. Our reason for including them as part of the requirements is to present a coherent picture of all factors which contribute to the success or failure of a project and to illustrate how managers can use requirements as input when managing a project.

As a result, the template used for the collection of the user requirements included

- Requirement ID
- Description
- Type
- Rationale
- Originator
- Fit Criteria /Test Case
- Priority
- Conflicts
- Supporting Materials
- History
- Stakeholders Happiness
- Stakeholders Unhappiness
- Group dependencies
- Reference Use Case

For the simplicity of format, in this document we are using an abbreviated list of parameters for each requirement documented. A summary of the requirements documented so far can be found in chapter 7.2

7.1 User functional requirements inventory

ID	Description	Rationale	Originator	Fit Criterion/ Test Case	Priority	Use Case
1	As an aggregator, I need to see site or asset minute by minute energy metering data on a chart via a simple user interface	To ensure site metering data is reliable for reserve programmes	KiWi Power	Minute by minute energy metering data is displayed live on a simple user interface	Must Have	5.1.1 5.1.2
2	As an aggregator, I need to see site or asset second by second power readings data on a chart via a simple user interface	To ensure site metering data is reliable for frequency response programmes	KiWi Power	Second by second power readings are displayed live on a simple user interface	Must Have	5.1.1 5.1.2
3	As an aggregator, I want to receive alerts when site metering data has delays	To allow for timely troubleshooting of any communication problems that may have impact on ability to dispatch assets	KiWi Power	Alerts are generated when delay in communication with site metering equipment is higher than 1 minute	Must have	5.1.1 5.1.2
4	As an aggregator, I need to receive audio alerts about reserve programme dispatch notification	To notify operations (ops) team when SO triggers a reserve programme dispatch	KiWi Power	On a live or test dispatch, an audio recording is played for 5 minutes or until manually stopped by a member of ops team	Must have	5.1.1
5	As an aggregator, I need to receive email alerts about reserve programme dispatch notification	To notify operations team when SO triggers a reserve programme dispatch	KiWi Power	On a live or test dispatch, an email alert is triggered to all members of the ops team	Must Have	5.1.1
7	As an aggregator, I need to see site name/assets name displayed on a simple user interface next to the live metering data	To allow the operator to identify the site or the asset to whom the metering data is referring to	KiWi Power	Site or asset name are displayed on a simple user interface next to live metering data	Must Have	5.1.1
8	As a prosumer, I need to select on a simple user interface availability windows for the week ahead for the reserve programmes	To enable prosumer to declare/undeclare site/asset availability for the week ahead	KiWi Power	Assets start/stops operating when contract conditions are met	Must have	5.1.1
9	As a SO, I need to see live energy metering data from all assets in the reserve program received through a dedicated terminal	To ensure sites enlisted in reserve programmes are available as contracted	System Operator	Live minute by minute energy consumption data for all sites enlisted in reserve programmes is streamed through a dedicated interface	Must have	5.1.1
10	As a SO, I need to dispatch reserve contracts through a dedicated interface	To allow secure dispatch communication with aggregators/prosumers	System Operator	Dispatch notification is received by the aggregators/prosumers via a dedicated interface	Must have	5.1.1
ID	Description	Rationale	Originator	Fit Criterion/ Test Case	Priority	Use

						Case
11	As an aggregator, I need to group assets/sites into contracts than can be treated as a single entity	To allow capacity aggregation at contract level to meet minimum requirements from the SO	KiWi Power	Dispatch a contract and ensure all assets/sites within the contract respond as per DR strategy	Must have	5.1.1
12	As an aggregator, I need to receive a load forecast with accuracy within 10% of actual every hour for the hour ahead for an asset running in a reserve programme	To ensure there are no penalties risk linked to site under performance; to identify opportunities for trading/imbalance markets	KiWi Power	Load forecast for each asset is received on an hourly basis for the hour ahead. Forecast is then compared with real metering data; deviation should not exceed 10%	Must have	5.1.1
13	As an aggregator, I need to receive notification when a smart contract triggers a settlement	To monitor status of smart contracts	KiWi Power	On the start of a dispatch event, the aggregator ops team is notified that a smart contract is activated for a specific site	Must have	5.2.1
14	As an aggregator, I need to receive a summary of an automated settlement through a smart contract including duration of dispatch, energy delivered/turndown, price and total earnings for the event	To monitor transactions through smart contracts	KiWi Power	On the completion of a smart contract settlement, a transaction summary is sent to aggregator ops team via email including duration of dispatch, energy delivered/turndown, price and total earnings for the event	Must have	5.2.1
15	As a client, I want to be able to declare assets unavailable through a simple user interface	To avoid penalties if assets are not available due to maintenance or other reasons	KiWi Power	When client declares an asset unavailable, it shows as such in portfolio/contract level	Must have	
16	As a client, I want to receive dispatch notification for any start dispatch under the reserve programme via email and phone	To alert site maintenance and any other relevant personnel	KiWi Power	When an automatic dispatch of a reserve contract is triggered, phone calls and emails are received by the site primary and secondary contacts	Must have	
17	As a client, I want to receive dispatch notification for any stop dispatch under the reserve programme via email and phone	To alert site maintenance and any other relevant personnel	KiWi Power	When an automatic dispatch of a reserve contract is ended, phone calls and emails are received by the site primary and secondary contacts	Must have	
18	As a client, I want to receive a performance report after an asset dispatch including event duration, energy delivered / turndown, price and estimated earnings for the event	To monitor operational and financial performance of the contract	KiWi Power	Within 24 hours from a dispatch event, operational and financial performance report is submitted to the client	Must have	
ID	**Description**	**Rationale**	**Originator**	**Fit Criterion/ Test Case**	**Priority**	**Use Case**

19	As a client, I want to have access to a live dashboard showing each asset live energy consumption chart	To check on asset live status as seen by the aggregator/SO	KiWi Power	Provide a simple chart on the dashboard user interface displaying asset real time energy consumption	Must Have	
20	As a client, I want to have access to each asset historical energy consumption data on a day, week, month and year basis	To enable performance reporting on a monthly, and yearly basis	KiWi Power	Provide the dashboard user interface with an option to select historical data granularity by day, week, year	Must have	
21	As a client, I want the DSR dashboard to provide heating and cooling degree days data	To monitor correlation between weather and assets used in heating or cooling	KiWi Power	Display hourly heating or cooling degree days on the client dashboard	Could have	
22	As a client, I want to be asked for consent prior to any personal data access by any stakeholders	To protect personal data from viewing or distributing	CERTH/ITI	A prosumer from the DVN to which the client belongs to wants to access shared data	Must Have	
23	As a client, I want to be notified whenever a smart contract is applied and completed	To track smart contract execution	CERTH/ITI	A smart contract with an aggregator is triggered	Must have	
24	As an aggregator, I want to be notified when a client is reassigned to another DVN	To track asset modification	CERTH/ITI	Client's settings change and needs are recomputed	Must have	
25	As a client, I want to be able to monitor the RES generation capacity	To check the available RES capacity, so as to compare this with power consumption and schedule the consumption if possible, towards achieving self-consumption	CERTH	Provide the dashboard user interface with an option to display the RES generation capacity	Must have	5.3.1
26	As an aggregator, I would like to receive the prosumers' generation capacity on half hourly basis.	To monitor the available flexibility of the prosumers	CERTH	Half hourly prosumers' generation data can be monitored via user interface	Could have	5.3.1
27	As an aggregator, I would like to receive prices for specific market programs and their respective thresholds.	To enable the participation in different market programmes	CERTH	Provide market price data along with their thresholds on the dashboard user interface with a standard rate	Must have	5.3.1
28	As an aggregator, I would like to monitor the issued offers of the suppliers	To monitor the settlements in the imbalance market and dispatch contracted capacity at the beginning of the settlement	CERTH	Provide the state of the issues offers and the price that are locked down on the dashboard user interface	Must have	5.1.2
ID	**Description**	**Rationale**	**Originator**	**Fit Criterion/ Test Case**	**Priority**	**Use Case**
29	As an aggregator, I want control over a	To avoid dispatch over periods	KiWi Power	Monitor asset dispatch time vs start	Could	5.1.1

	parameter called start notification period for every reserve contract to define the period between start notification and event start time	longer than needed (e.g. reserve programmes with response time of 20 minutes)		notification time to measure appropriate response	have	5.1.2
30	As an aggregator, I want to be able to add phone call content for start and stop notification for each system operator.	To allow customisation of automated voice messages based on SO triggering the event	KiWi Power	Different voice messages are played based on which SO triggered the event	Could have	5.1.1 5.1.2 5.2.1 5.3.2
31	As an aggregator, I want to be able to add SMS content for start and stop notification for each system operator.	To allow customisation of automated SMS messages based on SO triggering the event	KiWi Power	Different SMS are sent based on which SO triggered the event	Could have	5.1.1 5.1.2 5.2.1 5.3.2
32	As an aggregator, I need to be able to manually stop a dispatch under any programme at asset level	To account for specific site issues highlighted by the client	KiWi Power	When the manual stop dispatch function is used, the asset returns to pre-dispatch condition	Must have	All
33	As an aggregator, I need to configure FEID to locally trigger frequency dispatch when grid frequency drops below defined value	To allow participation in frequency response programmes	KiWi Power	When a frequency injection test is performed, dispatch is triggered under certain frequency values	Must have	
34	As an aggregator, I want to be able to list all past dispatches based on selected dates	To generate performance analysis	KiWi Power	When dates are selected from a calendar menu the dispatch events are filtered accordingly	Should have	
35	As a client, I need a data export facility to allow export of historical metering data for each asset/site metered	To allow for metering data reconciliation	KiWi Power	When data export function is selected with a timeframe, a csv file with the relevant metering data is produced for the asset selected	Should have	
36	As a client, I want to be able to select the language on the client user interface	To allow deployment in different geographies	KiWi Power	When language is selected from a menu, the UI language will change accordingly	Should have	
37	As an aggregator, I want to filter DSR programmes by country	To allow filtering by country for Aggregators operating in multiple countries	KiWi Power	When country is selected, only country specific DSR programmes are listed	Must have	
ID	**Description**	**Rationale**	**Originator**	**Fit Criterion/ Test Case**	**Priority**	**Use Case**
38	As Aggregator I want to manually approve bids before submission to trading platform or bilateral partners	To allow human supervision for the markets bidding process	KiWi Power	When bids prices and volumes are submitted, a pop-up window asks for operator approval	Must have	

39	Integrated control of multiple assets	To ensure that flexibility of distributed assets can be aggregated as a single unit to sell services.	UCY	Single control requests communicate appropriately with all BEMs	Must have	5.1.1
40	Offering of Ancillary Services	To increase revenue and support grid stability	UCY	Calculation and offering of flexibility	Must Have	5.1.1
41	Reduction of total cost of electricity	To decrease expenditure	UCY	Provable demonstration that strategies employed avoided cost and/or generated revenue	Must have	
42	Maintain Comfort Levels	To ensure that occupants are not negatively affected	UCY	Feedback on occupants' comfort	Must have	
43	Automated Operation	To reduce investment of time and expertise	UCY	Setting of bounds for automated operation and demonstration of automated functioning	Could have	
44	Provision of effective feedback	To demonstrate operation and allow adaptation	UCY	Provision of real-time data and future operation and strategy planning with integrated user control options	Must have	
45	Zoned control within buildings	To enable sectioning off areas of buildings (zones within BEMS) for operation and integration with DR	UCY	DR call ran with zoned sections of building participating	Could have	
46	Executive control	To cancel activation of assets in a DR call	UCY	To commit to a call and cancel prior to or within activation	Must have	
46	Executive control with financial analytics for cancellation	To cancel activation of assets in a DR call with full information provided for cancellation analytics	UCY	To commit to a call and cancel prior to or within activation with financial information provided.	Must have	
47	Compliance with the Frequency Containment Reserves	To comply with all the regulations and requirements in order to participate to FCR which are regulation parameters to join Balancing programmes out of the UK and Cypriot Market	KiWi	Frequency containment reserve (FCR) in the European Union Internal Electricity Balancing Market means operating reserves necessary for constant containment of frequency deviations (fluctuations) from nominal value in order to constantly maintain the power balance in the whole synchronously interconnected system.	Must have	

Table 6 - User Non-Functional Requirement Inventory

ID	Description	Rationale	Originator	Fit Criterion/ Test Case	Priority	Use

						Case
1	As Aggregator I want to be able to have information related to the type of asset,MPAN,size	To allow with this information to produce a accurate client profile	KiWi Power	Be able to document information types produced, consumed and transformed in an information model which shall include the relationships between information types	Must have	
2	AS Aggregator I want to be able to have access to historical data of the asset during a DR and normal operation of the asset	To be able to provide data to DSO/ESO for data accuracy	KiWi Power	Store transactions in a secured and tamperproof manner	Must have	
3	As Aggregator the platform needs to be accessed only to authorized user	To increase security and disclosure between the users	KiWi Power	Grant access to data only to authorized users	Must have	
4	As Aggregator the platform needs to ensure scalability with high number of energy transactions	To increase the data collection and improve the profile of the portfolio	KiWi Power	Ensure scalability with high number of energy transactions	Could have	
5	As Aggregator the platform needs to be simple in design to ensure that is user friendly to the aggregator and customer	To increase interaction between the user and the platform	KiWi Power	The User Interface shall have a user-friendly look, fully customized to the needs of different stakeholders	Must have	
6	As Aggregator the platform needs to provide multiply options for actions	To increase the interaction between the users	KiWi Power	The User Interface shall be able to allow an easy discoverability of the actions available	Must have	
7	As Aggregator I must send alerts	To increase the capacity for DR windows	KiWi Power	To ensure the availability alerts give a better DR profile	Must have	
8	As Aggregator I must notify the client	To increase awareness regarding DR events	KiWi Power	To ensure the asset are armed for the upcoming event	Must have	
9	As Aggregator I must produce performance reports	To notify the user for the performance for the latest DR event	KiWi Power	To ensure the clients performance and in case of a fail event to have a survey to improve the action	Must have	
10	As Aggregator I must pay quarterly the client	To ensure a transparent transition between the aggregator and user	KiWi Power	To produce a payment performance report	Must have	
11	As aggregator I must have a performance overview of the past month	To ensure that the aggregator is performing according to the portfolio he is aggregating	KiWi Power	To ensure the Aggregation portfolio is meeting the expectations of the DNO/ESO	Must have	
12	FEID must comply with the established	To ensure data protection and non-	KiWi Power	To ensure compliance with 2018/2001/EU	Must Have	

	framework about energy communities, Peer2Peer schemes as per 2018/2001/EU Directive (articles 21-24)	discriminatory approach by members and aggregators on the implementation phase		Directive (article 21-24) & IEM Regulation (2019/943/EU) article 6 & 12		
13	GHG abatement metrics	To document CO2e savings embedded in actions	UCY	To report CO2e savings associated with actions for documentation	Could have	
14	Alternative tariff analysis	To analyse potential profitability	UCY	To analyse the potential savings or otherwise of shifting to different electricity tariffs	Could have	
15	Hardware security measures in FEIDs	To ensure that measurement data submitted to DELTA blockchain are valid	NTNU	An end-user cannot tamper with the FEID to falsify measurement data	Must have	
16	Energy efficient blockchain deployment	To ensure that the DELTA blockchain will not require excessive energy resources to function	NTNU	During deployment and functioning the DELTA blockchain will server multiple nodes (e.g. 100) with manageable energy requirements	Must have	
18	Access to prosumers data	Prosumers measurement data are only accessible by the aggregator. Other prosumers do not have access to that data	NTNU	To analyse the potential savings or otherwise of shifting to different electricity tariffs	Must have	
18	Prosumers data sharing	Aggregator does not share prosumers data with other actors in the ecosystem (e.g. DSO) if this is not required	NTNU	Other actors do not have access to prosumers data	Must have	
19	Privacy in multiple aggregators scenario	In a multiple aggregator scenario the blockchain deployment shall protect data privacy	NTNU	To analyse the potential savings or otherwise of shifting to different electricity tariffs	Must have	
20	General Data Protection Regulation	Delta project is dealing with prosumers data in different levels and we need to have process in place to secure transparency and protection of data	KiWi	Controllers of personal data must put in place appropriate technical and organizational measures to implement the data protection principles. Business processes that handle personal data must be designed and built with consideration of the principles and provide safeguards to protect data (for example,	Must have	

				using pseudonymization or full anonymization where appropriate), and use the highest-possible privacy settings by default, so that the datasets are not publicly available without explicit, informed consent, and cannot be used to identify a subject without additional information (which must be stored separately)		

8. Conclusions and Next Steps

The engagement with the main stakeholders have produced sufficient documentation to support a collection of business scenarios and use cases that reflects equally some of the existing constraints in the flexibility markets but also some of the opportunities that the new platform will unlock for its actors. This work plan, reflects the very dynamic nature of the marketplace. This allows partners to reflect on some of the technical challenges, refine use cases, user stories and add new use cases as they emerge through continuous interactions with the stakeholders. This past dedicated months partners spend updating this document by receiving feedback and interactions with stakeholder in the first 18 months of DELTA. Continuous monitoring of the legal and regulatory space in Europe in general and the UK and Cyprus in particular will also allow us to capture any major change that may impact the way DELTA platform delivers services to its future clients.

9. References

[1]. Coalition, S. S. E. D. (2017). Explicit demand response in europe-mapping the markets 2017. *SEDC: Brussels, Belgium*.

[2]. Freeman, R. Edward and McVea, John, A Stakeholder Approach to Strategic Management (2001). Darden Business School Working Paper No. 01-02. Available at SSRN: https://ssrn.com/abstract=263511 or http://dx.doi.org/10.2139/ssrn.263511

10. Appendix

Following the comments of the DELTA Ethics Advisory Board are presented as provided when given the DELTA requirements. With red the questions and in line the respective answers.

Comments from Advisory Board – Member 1

Q: In that blockchain-based scenario, it is vital to collect data streams from decentralized electricity feed-in. Validity of this data is best ensured by using **tamper-proof cryptography-enabled hardware** as well as an algorithm cross-checking various data sources against each other. Based on such validated data sources, a blockchain-based electricity marketplace cannot only match the demand and supply side for energy purchases, but also immediately settle the transactions, including monitoring the delivery of electricity and processing of corresponding payments.

A: Every blockchain network is as secure as its less secure node is. In the DELTA context, while blockchain infrastructure ensures the secure handling of the data exchanged, it is true that the procedure of producing the measurement data in FEID have to be also secure. In that sense, it is important to add hardware-based security mechanisms in the FEIDs in order to prevent any accidental or malicious falsification of measurement data send to the DELTA blockchain. Cross-checking measurement data is not applicable as these are produced locally in FIEDs.

To address this comment, a new non-functional requirement (15) has been added to Table 4 – User Non-Functional Requirement Inventory

Q: Since from a legal perspective the smart contracts' environment is about to formally settled in the next period of time, advisory of the *Ethereum* environment regarding the Smart Contracts, would also be a safeguarding approach from a legal perspective

A: Any blockchain legal framework that is going to be settled in the next period of time is going to be taken into account into designing and implementing the DELTA blockchain platform. Currently, no such framework is in place.

Q: *Ethereum* is an innovative blockchain-based virtual machine and Cloud 2.0 platform that comes with an embedded programming language that allows users to create their own applications that run on top of blockchain architectures. Ethereum enables user-created smart contracts and aims to build an all-purpose technology platform, on which transaction-based application concepts may be built. According to a recent report by Eurelectric, the Union of the electricity industry, more than 1000 projects are currently using Ethereum.

A: While we have also studied Ethereum as a candidate for the blockchain platform used for the DELTA project, we ended up with the choice of Hyperledger Fabric. The main reason behind that is that Ethereum is more appropriate for public blockchain networks. In such cases, Ethereum can be employed, in order to create very secure networks of multiple nodes with zero trust between them. On the other hand, in cases of networks where the number of nodes is not so large, the security guarantees offered by Ethereum are not so robust. Additionally, Ethereum platform in its current state, still requires nodes to devote significant processing power, to secure the network. This would trigger resources consumption issues, while at the same time it would limit the transactions throughput in the network and create scalability issues. For the DELTA platform we opted for Hyperledger Fabric because it offers similar functionality to Ethereum, in terms of smart contracts. It has a higher transaction throughput than Ethereum and it also offers access control and data privacy mechanisms that do not exist in Ethereum.

Q: Application of the **Cybersecurity Act's (2019/881/EU**) applicable provisions also to the DELTA environment; it is important to safeguard the solidity of the Project excluding possible data breaches etc.This framework (Articles 46-58) of the 2019/881 regulation, covers a broad area of ICT products, processes and services that might need to be examined as soon as the DELTA Project is about to concluded

A: The Cybersecurity Act **(2019/881/EU**) will be taken into account in the designing and implementation of DELTA platform.

Q: Alongside with Kiwi, examine the necessity at that stage of the Project of obtaining cybersecurity certification framework, as from 7.6.2019, the abovementioned Regulation has been entered into force.

A: This would be a significant advancement for DELTA project. We will examine the possibility to do that in latter stage of the project, as currently a lot of the functionality is still being developed.

Q: Examine additionally recently published report of KPMG (February 2019) about *Cybersecurity in Smart Cities*, as you can find it here https://assets.kpmg/content/dam/kpmg/in/pdf/2019/02/Cybersecurity-in-smart-cities.PDF

A: The report has been examined. While it is quite high level, we will take into account any useful findings.

Comments from Advisory Board – Member 2

Q: As I mentioned in the call, I could not find a single instance of the word GDPR in the deliverables. Since the project deals with consumers data, I believe it is imperative to consider GDPR and include it your work.

A: To address this comment, a new non-functional requirement (20) has been added to Table 4 – User Non-Functional Requirement Inventory

Q: Hardware security module leads to an ambiguity and variety of interpretations. Why is it that you do not use standardized technologies such as Trusted Platform Module (TPM)? Remote attestation (if TPM were used) would be also a solution to enhance the level of security of the fog enabled devices. Of note, an HSM costs much more than a TPM.

A: The hardware security mechanisms that are going to be used are currently being researched. The general Hardware security module term has been used in order to leave all options open.

Q: A debatable topic in using blockchain is the energy consumption. Have you considered the fact that the very own use of blockchain in the smart gird is not energy efficient? You could consider consensus algorithms which are optimized and will not deplete energy resources.

A: The option made for the blockchain platform is Hyperledger Fabric, which offers the option to use different approaches for consensus algorithm. Blockchain technology has been connected to excessive energy consumption due to proof of work consensus algorithm used in Bitcoin and Ethereum networks. In Hyperledger, specific nodes, named endorsing peers, check the validity of each transaction, while an ordering service manages the creation of the blocks and the ordering of transactions in a fault tolerant way. The described scheme has very low processing requirements and thus it is energy efficient.

To address this comment, a new non-functional requirement (16) has been added to Table 4 – User Non-Functional Requirement Inventory.

Q: In many projects, I have stumbled upon deliverables that define security properties of the proposed system without defining a threat model. It would be beneficial to include a threat model, security assumptions and the attacker's capabilities in your security model of the system.

A: A threat model is going to be defined in Task 5.3. While it seems a bit out of order, we are going to review the security properties of the system in the coming months.

Q: In deliverable D1.2, you mention that you will define several requirements including privacy (second paragraph of section 1.1). However, the table of section 4, in which you define functional and nonfunctional requirements, does not mention anything about privacy requirements

A: Privacy aspect shall be embedded to User requirements, as it is significant for all participating actors. To address this comment, three new non-functional requirement (17-19) have been added to Table 4 – User Non-Functional Requirement Inventory.

Q: In the same deliverable, smart contracts security can be also considered at the software level. In the past, software bugs have been the root cause of several attacks in the Ethereum network.

A: The smart contracts (chaincodes in Hyperledger Fabric) that are going to be developed, are also going to be validated with respect to possible bugs.

Q: User could win energy points as awards (also visualized at GUI), which they could be exploited as loyalty. So, a user would be able to have a discount or awards according to his/her energy points

A: Currently, we are exploring methods to incentives pilot participants to respond to implicit and non-implicit DR requests by providing energy points which will be translate either to cash cards/giftcards.

Q: You could have an energy price (wholesale market energy prices) monitoring tool at all DELTA energy markets, so as the contract concept has a meaning

A: To address this comment, a new non-functional requirement (14) has been added to Table 4 – User Non-Functional Requirement Inventory

Q: Compliance with the newly established framework about energy communities, Peer-to-peer schemes etc, as it is described in 2018/2001/EU Directive (articles 21-24), especially with an eye to the aggregator's provisions.What about the compatibility of the project with the Frequency Containment Reserves? Since the common market for procurement and exchange of FCR (FCR Cooperation) aims at the integration of balancing markets in order to foster, but not limit to, effective competition, non-discrimination, transparency, new entrants and increase liquidity while preventing undue distortions. These objectives must be met in consideration of secure grid operation and security of supply.
The guideline on electricity balancing including the establishment of common principles for the procurement and the settlement of frequency containment reserves, frequency restoration reserves and replacement reserves and a common methodology for the activation of frequency restoration reserves and replacement reserves. (2017/2195/EU). It is about a document that should be taken into account especially due to the fact that is closely related to the demand-response services DELTA is about to implement, especially on the context of Business Model 2 and 3.

A: To address this comment, a new Functional requirement (47) has been added to Functional Requirement Inventory, however, the UK market doesn't participate in the FCR and has its own rules regarding the Balancing of the frequency which we have to comply with the UK regulations. The Cypriot pilot site will have to foster a market model in order to work with-in regulatory environment. Delta project would be good to meet the criteria as it explores the future of aggregation and how to unlock the full potential of Demand Response