flextalk

FlexTalk: OpenADR® Technical Insights

Electricity Engineers' Association

TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

MAY 2024

ISBN (PDF): 978-1-0670105-1-5

Contents

SOLAR HOME EV WIND CHARGE

SECTION ONE

1

Introduction

In 2022, the Electricity Engineers' Association (EEA) and the Energy Efficiency and Conservation Authority (EECA) came together with industry partners to form the FlexTalk (Demand Flexibility Common Communications Protocol Project).

The aim of the project was to explore how to better enable customer flexibility to be utilised by testing the interoperability of a two-way common communication protocol between an electricity distribution company and flexibility supplier.

The systems based, OpenADR® (Open Automated Demand Response) communications protocol was selected and used for testing. The pilot tested the feasibility of OpenADR and developed the procedures needed for the active management of electric vehicle (EV) charging in near real-time.

The completion of the project saw two documents published.

» The first, *FlexTalk – The Demand Flexibility Common Communications Protocol Project Final Report – OpenADR Assessment and Findings*, is a summary of the project itself, the methodology, research inputs and conclusions.
» The second, this *OpenADR Technical Insights* document, discusses what is needed to implement OpenADR, how OpenADR was implemented in this pilot project and the programs that were tested.

SECTION TWO

Purpose and scope

This document should serve as a starting point for electricity distribution businesses (EDBs) and flexibility suppliers (aggregators, commercial/industrial customers, retailers etc.) to leverage the programs tested during the FlexTalk project.

It has been written for:

» EDBs and flexibility suppliers planning to implement demand flexibility programs that utilise the systems based, OpenADR 2.0 for communicating demand response events and related messaging between the EDB and flexibility suppliers or downstream entities.

Within this document we:

» Explain the OpenADR protocol and the OpenADR 2.0 standard and how it works.

» Outline what is needed to implement OpenADR with a discussion on four possible pathways.

» Use what we learnt from the FlexTalk project to:

1. Define typical technical architectures (deployment scenarios) and roles and actors, modelled after real world deployments.
2. Define a small set of standard demand response programs (templates) designed by industry as a starting point for managing EV charging and battery resources.
3. Define best practice recommendations for OpenADR characteristics specific to each of the demand response programs.
4. Provide a list of potential Virtual Top Node (VTN) and Virtual End Node (VEN) solutions that EDBs and flexibility suppliers can purchase and implement.

The OpenADR profile specifications discussed in this document, define the expected behaviour when exchanging demand response event messages between an EDB and a flexibility supplier.

For a comprehensive set of demand response program templates developed by OpenADR, please see the OpenADR 2.0 Demand Response Program Guide, available on the OpenADR website:

> www.openadr.org/openadr-2-0-program-guide.

SECTION THREE

What is OpenADR and how does it work?

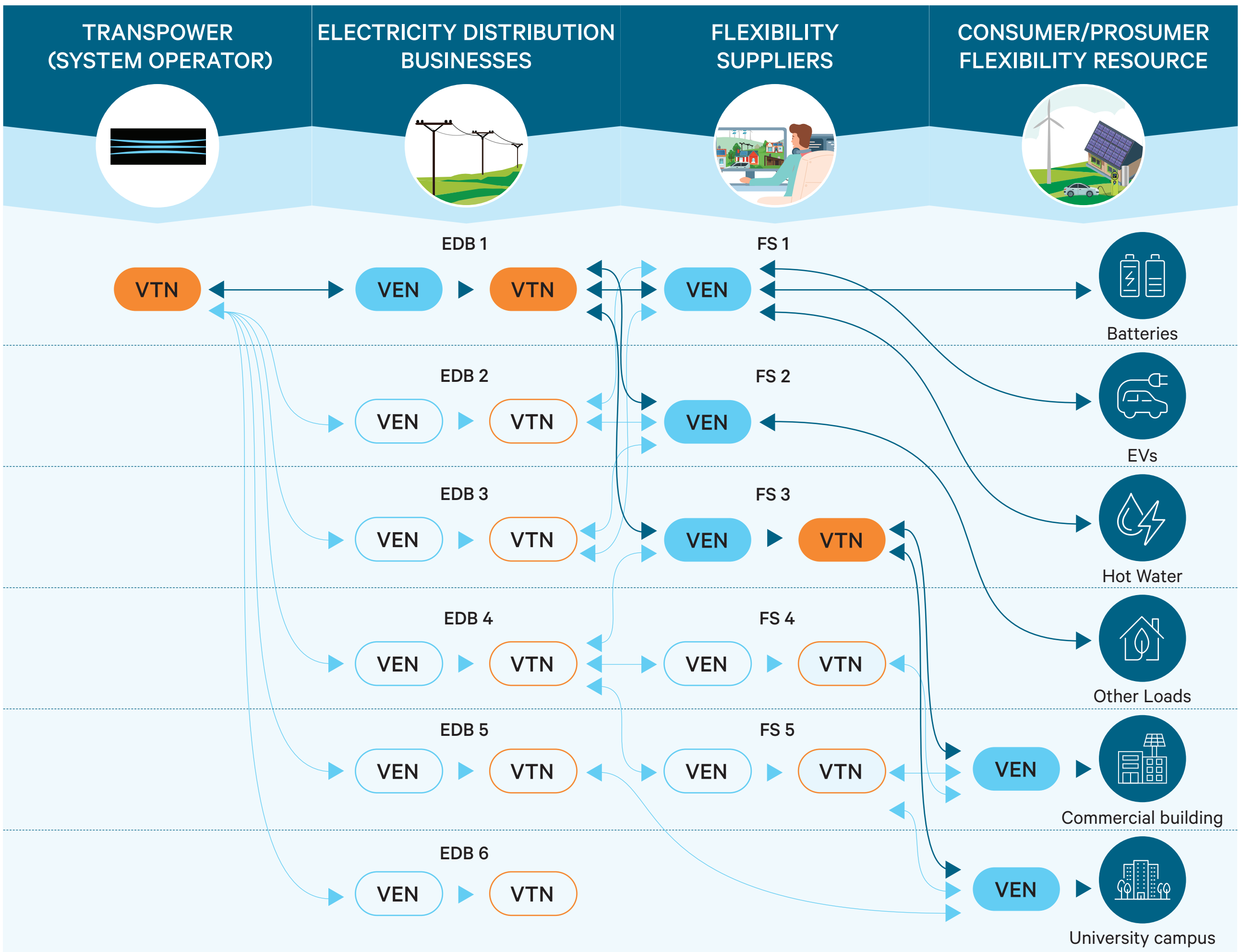
OpenADR provides a non-proprietary, open, standardised and secure demand and distributed energy resource (DER) management interface that allows electricity providers to communicate directly to flexibility suppliers using a common language and existing channels such as the internet.

The OpenADR standard provides an implementable framework that describes all aspects of the OpenADR interface, including servers (or VTNs) and clients (or VENs). It describes services, interactions, transport protocols and security combined with strict conformance statements that enable scalability and interoperability. VTNs have a one-to-many relationship with VENs, while VENs have a one-to-one relationship with VTNs.

A System Operator VTN could send signals to multiple EDBs' VENs. The EDBs decide on any necessary actions and use their VTN to signal flexibility suppliers' VENs at targeted locations in their network. The aggregators and commercial or industrial customers use their control systems to manage their load directly based on the received VEN event message. The retailers who received the message via their VEN use their VTN to signal customer VENs to target building management systems, university campuses, and industrial complexes in their customer portfolio.

This creates a scalable tree of VTN-to-VEN messages through different interoperable parties.

FIGURE 1: SCALABLE OpenADR TREE STRUCTURE



A STANDARD OR A PROTOCOL?

A protocol defines a set of rules used by two or more parties to interact with each other. A standard is a formalised protocol accepted by the parties that implement it.

The OpenADR protocol standardises the communication format used for automated demand response and distributed energy management so that dynamic price, load, and reliability signals can be exchanged in a uniform and interoperable fashion among utilities, flexibility suppliers and energy management and control systems. The OpenADR Alliance enforces standardisation and interoperability through testing and certification.

In 2018, the International Electrotechnical Commission (IEC) approved the OpenADR 2.0 profile specification as an international standard (IEC 62746–10–1). It is publicly available, free and can be downloaded from the OpenADR Alliance website, openadr.org.

The FlexTalk project utilised this OpenADR 2.0 standard in its testing.

COORDINATION OR CONTROL?

OpenADR should be considered a coordination protocol rather than a control protocol. In the FlexTalk project, it did not talk directly to an end device, although it can, and products such as hot water cylinders and heat pumps can have OpenADR connections built-in or attached.

Each demand management event sent to a VEN is replied to with an 'opt-in' or 'opt-out' message. Defined software logic generally decides to opt in or out; for example, in the FlexTalk project, flexibility suppliers had simple price decision software that opted out of price-responsive events if the offered price did not meet pre-determined criteria. However, opt-in may be compulsory in the case of emergency signals or events that the flexibility supplier is contractually bound to deliver.

The benefit of opt-in or opt-out is that the use of the flexibility resource is in the hands of a flexibility supplier or owner who can decide where and how to use their assets (including value stacking) to maximise their investment return.

TARGETING ASSETS

A VEN could have just one flexibility asset associated with it, for example, a building. The signal from the VTN may just be instructing the building management system to, for example, move from its current running program to a different one that reduces energy use, discharges battery storage, or starts a standby generator. The VTN, in this case, may be a retailer, a flexibility supplier, or an EDB.

If the VTN is an EDB, it's more likely that the VEN resides with a flexibility supplier or a retailer, who would have many flexibility assets in different geographical locations on the EDB network. Suppose the EDB only wants to signal a need for demand management to a specific network asset location. In this scenario, the OpenADR message can contain more granular, targeted information (as opposed to targeting the entire VEN). These target names, geographical areas or even specific ICPs would be pre-agreed targets and included in the messages between the VTN and VEN so that the VEN knew which of its flexibility assets it needs to instruct.

REPORTING

OpenADR supports comprehensive reporting between the VTN and VEN in near real-time. Reports can be created for multiple use cases, including straight telemetry, device status, load forecasts, load availability, asset lists etc. A list of available reports is one standard report a VEN passes to a VTN on request. A VTN can request any of the available reports as a one-off report or as a repeating scheduled report.

A VTN AND VEN ARE CERTIFIED SETS OF SERVICES

The OpenADR standard defines a set of services that the VTN and VEN software components must provide. Because VTN and VEN software is certified by the OpenADR Alliance to conform to the published standard, all services must be completely represented in each VTN and VEN software component and pass conformance tests from a certified test house. A certified VTN or VEN is secure and behaves in a known (standardised) manner and, therefore, will be interoperable.

3

THE OpenADR 2.0B SERVICES ARE:

- **Event Service** – used by OpenADR servers or VTNs to send demand management events to clients or VENs and used by VENs to indicate whether resources will participate in the event. Events can contain one or many segments (intervals) for different prices, curtailment levels, or other signals pertinent to the demand management program.
- **Report Service** – used by VENs and VTNs to exchange historical, telemetry, and forecast reports. Resources can report their status, availability, and forecasts, as well as real-time energy and curtailment readings.
- **Opt Service** – used by VENs to communicate temporary availability schedules to VTNs or to qualify the resources participating in an event. This helps both the demand management program operators and the participants to plan their resources better.
- **Registration Service** – initiated by the VEN and used by both VEN and VTN to exchange information required to ensure interoperable exchange of payloads.
- **Poll Service** – used by VENs to poll the VTN for payloads from other services. This is important for simpler devices such as OpenADR 2.0a devices, that cannot fully support additional messaging . Also, the poll service is used by 2.0b devices in ‘PULL’ mode (eliminating the need to open ports on the VEN for use with ‘PUSH’).

Additionally, OpenADR 2.0 defines transport mechanisms and security.

- **Simple HTTP Transport** – this transport mechanism is ideal for implementations that let the VENs (clients) PULL or PUSH information from the VTNs (servers).
- **XMPP Transport (Extensible Messaging and Presence Protocol)** – this transport protocol is used by many messaging applications that require close to real-time information exchange. Although not widely used, where it is implemented, it is well suited for bidirectional exchanges of OpenADR messages.
- **TLS Security** – OpenADR 2.0 uses TLS with digital certificates on both the server and client sides. The OpenADR Alliance has established their own certificate authority management system with a third-party vendor to ensure system-wide secure communication.
- **Digital Signatures** – If additional non-repudiation is needed, each message can also be encrypted with individual digital signatures.

THE DIFFERENCE BETWEEN OpenADR 2.0A AND 2.0B

OpenADR 2.0a is a lightweight version of the protocol and only supports

- Event Service
- Simple HTTP Transport
- TLS Security

The Event Service only supports one ‘simple signal’; that signal payload is 0, 1, 2, or 3. This signal can be mapped to mean any agreed action, but in general, the following mapping is the most common for a demand management event.

- 0 – normal operation
- 1 – minimum load reduction
- 2 – moderate load reduction
- 3 – full load reduction

OpenADR V3.0

In November 2023, the OpenADR Alliance released version 3.0 of the specification. The 3.0 standard is not intended to replace the OpenADR 2.0a/b profile specifications, rather, it provides a simplified way to add OpenADR functionalities in current and potentially new scenarios. All VTN software must be backward compatible. An OpenADR 3.0 VTN must also conform to the OpenADR 2.0b protocol to be certified.

At the time of writing, there are no certified OpenADR 3.0 VTNs or VENs, although suppliers like Cortexo (the technical lead company for FlexTalk) are working on a v3.0 addition to their VTN.

SECTION FOUR

What is needed to implement OpenADR?

STEP 1: CHOOSE AN OPTION FOR PROVISIONING A VTN OR VEN.

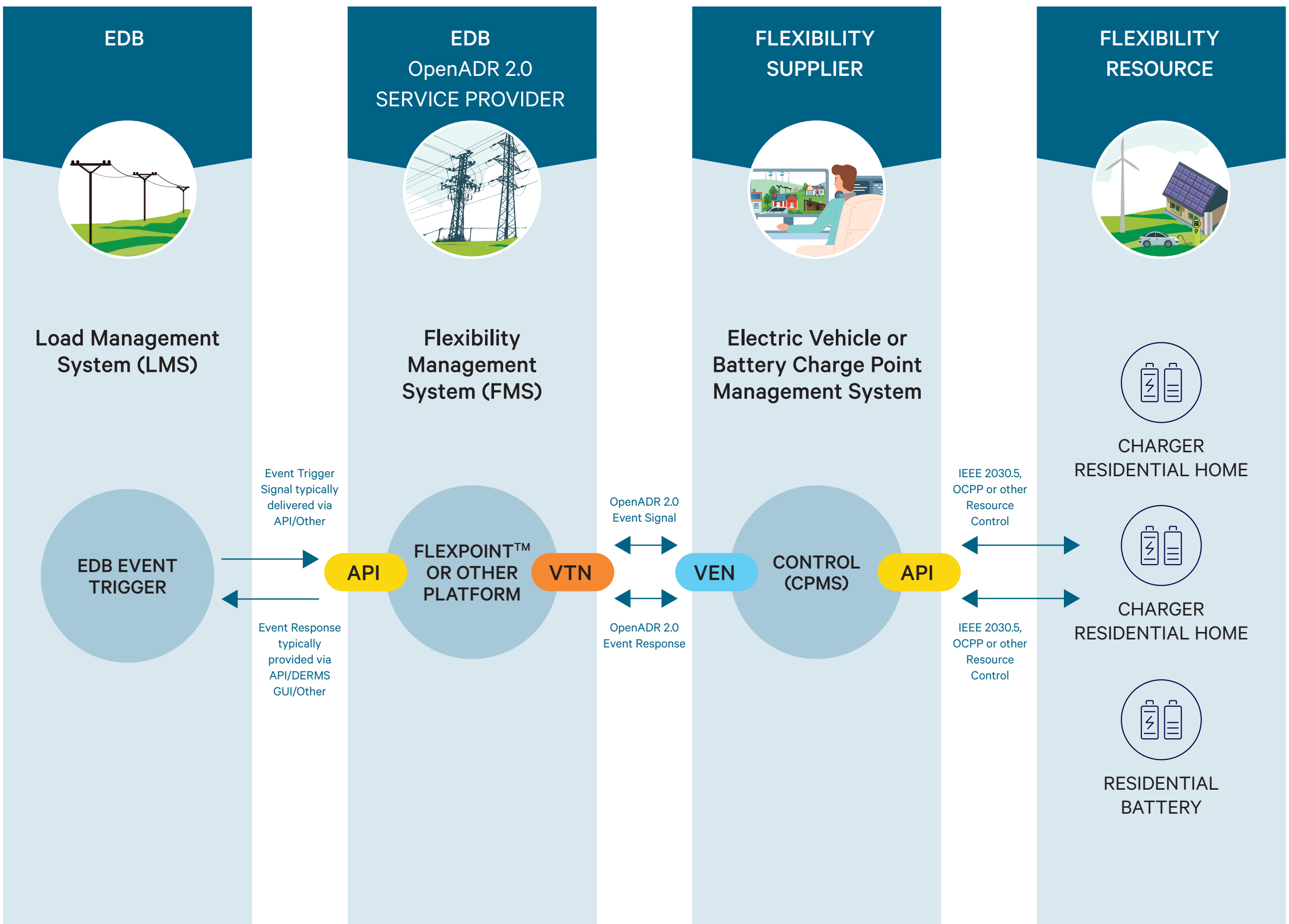
Options are:

1. Purchase a certified OpenADR module as part of an existing Advanced Distribution Management System (ADMS) or flexibility management platform,
2. License a cloud service from a certified vendor and connect via a simpler RESTful API,
3. Purchase or license certified VTN or VEN software to run on existing business systems, or
4. Build VTN or VEN software from the specification.

The VTN (server) or VEN (client) can be considered the software at either end of a communications pipe. The purpose of the software is to use the services described above (see section 3 , *A VTN and VEN are certified sets of services*) to manage the connection, security, message flow, event detail and reporting content of demand response communication. The software needs a way of connecting to the external systems that provide it with either the details of messages to be sent, or to receive responses to requests and reports.

At the most basic level, an EDB may have an API connection from its Load Management system or an ADMS connection to its VTN. A flexibility supplier may have an API connection from the VEN to its control system for its flexibility assets, for example, a battery control system or an EV charger management system. As depicted in figure 2 below.

FIGURE 2: THE PROJECT MODEL – TRIAL CONFIGURATIONS



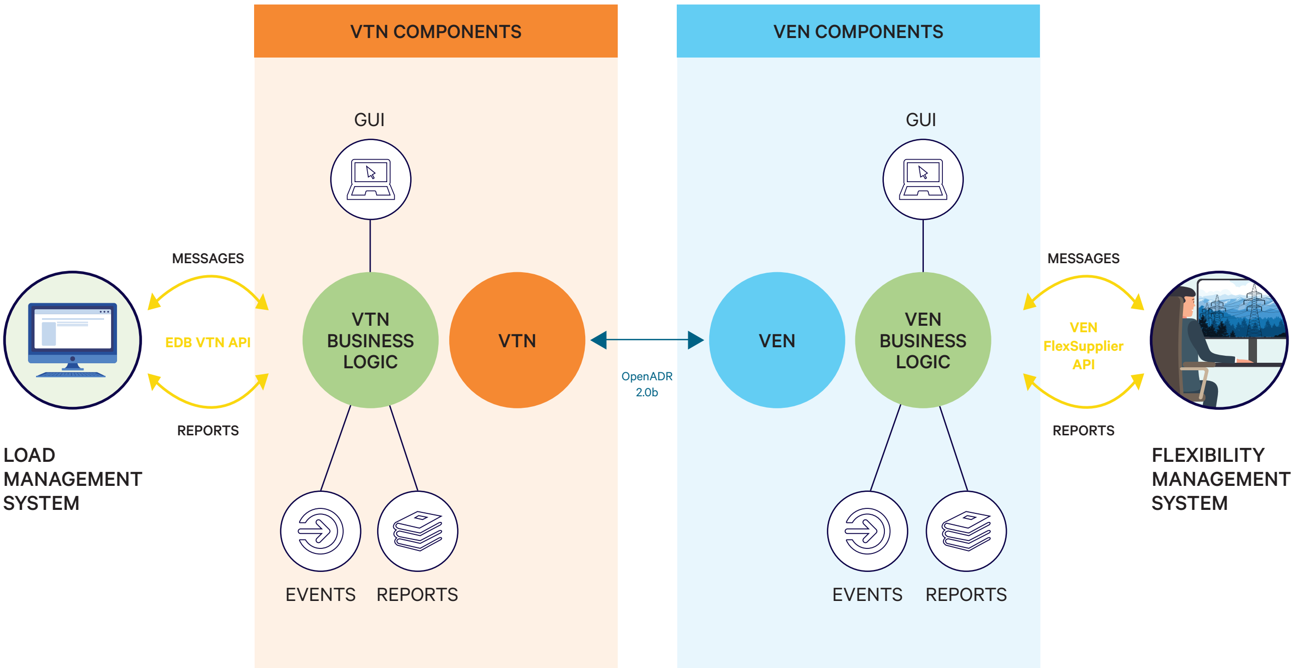
STEP 2: DETERMINE BUSINESS LOGIC

Business logic should reside at the VTN or VEN API connection point to manage those external-facing connections. This middleware may provide a database that lists events and statuses as well as report formats and data, all of which may, in addition to the API connection, have user access via a Graphical User Interface (GUI) to manage programs and events manually (review/create/edit/update/cancel) and request and display reports.

The business logic layer is particularly important. For the EDB, decisions may be made in the ADMS or in some specific software at the VTN that gets information from load management systems, ripple control signals etc. EDB's need to implement a business logic connection via API from an existing flexibility signalling system. All business logic would be specific to each EDB and implemented by their internal IT capability or an external software company. For the flexibility supplier, the VEN to VTN connection is one-to-one. If a flexibility supplier received signals from multiple VTNs, for example, multiple EDBs, there would be a separate VEN for each. However, the business logic layer can abstract the multiple VENs, making them look like one virtual VEN that talks to all VTNs. It makes the API connection from the flexibility device control system simple to implement.

The business logic middleware could also have rulesets that automatically decide the response to the exchanged messages. For example, the business logic layer may have rules relating to the required minimum and maximum prices acceptable for price-responsive events based on current spot prices.

FIGURE 3: PROJECT FLEXTALK EVENTS / REPORTS DATABASE AND GUI COMPONENTS OF BUSINESS LOGIC



Note: Only the core VTN and VEN software must be certified by the OpenADR Alliance through conformance testing.

OPTIONS FOR IMPLEMENTING A VTN OR VEN

There are four options for provisioning a VTN or VEN.

Note that in all four cases, an API connection will be required to connect Load Management/ADMS/Flexibility Management System to the VTN or device control systems to the VEN unless the user manually operates the connection via a GUI that talks directly to the VTN or VEN.

Consideration also needs to be given to the purchase of separate user acceptance testing or a quality assurance system and the need to connect to the ‘other end’ of the OpenADR pipe (be it the VTN or VEN) to test messages, programs, etc.

1) Purchase a certified OpenADR module as part of an existing ADMS or flexibility management platform.

Some ADMS systems like GE Opus One have certified OpenADR modules that can be plugged in providing VTN capability. It would be necessary to check the range of demand management programs they were configured for and how easy it was to create individual programs and signal sets. An early discussion with the vendor regarding configuration requirements including the integration of an EDB’s systems or equivalent flexibility suppliers’ systems and the plug-in for FlexTalk designed flexibility programs, would quickly indicate the product’s suitability . Project FlexTalk did not test this option.

2) License a cloud service from a certified vendor.

Several international vendors provide certified VTN and VEN cloud software modules that can be accessed as a service. In New Zealand and as far as the FlexTalk project is aware, only Transpower and Cortexo provide certified OpenADR products.

The FlexTalk project also utilised Canvas Cloud, a product by US-based Grid Fabric.

Considerations when assessing a licensed cloud service from a certified vendor include:

» Assessing what additional functionality comes with the cloud service other than an API.

» If the product has a GUI available.

» Does the cloud service hold historical, current, and future event data?

» Does the cloud service hold report information? Or will the provision of business logic be needed at the user’s end of the connection?

3) Purchase or license certified VTN or VEN software to run on existing business systems.

Like option 2 above, the vendor offers the software to be installed on existing internal IT infrastructure.

Considerations for users include:

» The level of external support and maintenance needs (and what that may mean for total cost of ownership and access security).

» The upgrade path for updates to the standard.

4) Build your own VTN or VEN

The VTN and VEN are just software (which may be physical hardware or cloud based). The specification is what defines the message flow and payload requirements.

There is an example open-source project for an OpenADR VTN and VEN written in the Python software language and maintained by the Linux Foundation called openLEADR. At the time of writing, this product is at v0.5.26, last updated in May 2022. The product is not complete and not certified but could form the base code for a user’s own development.

Based upon FlexTalk project estimates, VEN to certification level requires between six-eight developer months, while the VTN would be eight-10 months although internal software teams or external development companies may have different estimations after reviewing the codebase.

It is worth noting that in the event of regulation, open charge point protocols are a likely requirement at both the device and system level. This should be factored into consideration.

Certification*

Software certification is a significant part of the effort to build a certified VEN or VTN product. To apply for certification, you must be a member of the OpenADR Alliance.

Certification is provided by several international test houses approved by the OpenADR Alliance, and indicative costs are in the order of NZ$10,000 to certify a VEN and NZ$20,000 to certify a VTN. To assist with certification, a test harness is available that runs all the required tests so users can confirm that the product will pass. The cost for the test harness is approximately NZ$9,000.

Testing also requires the VEN or VTN to be put in specific known ‘states’ to enable the test to run. When submitting a VTN or VEN for certification, the user must also provide a software tool to enable the test house to put the VTN or VEN into a particular known state. Developing the specific VTN or VEN state tool is estimated to take one additional month of development time.

Section 5 provides more information about the VTN and VEN approach and the suppliers used during the FlexTalk project, including indicative pricing for the products explored.

*Note, certification costs indicative as at time of writing this report (March 2024)

SECTION FIVE

The FlexTalk project

The FlexTalk pilot project used certified VTN products from Transpower (FlexPoint™), Gridfabric (Canvas Cloud) and Cortexo's (FlexSplice Hub). FlexPoint was used for Part A, which tested one-way communication while Gridfabric and Cortexo's products were used for Part B where two-way communication was tested. Cortexo provided the certified VENs (FlexSplice Edge) for both parts of the pilot trial.

Three participating EDBs decided on seven common demand management programs to use on their networks with the three participating flexibility suppliers. Those programs were:

» In Advance.

» Dynamic.

» Emergency.

» Price Responsive (PR) Bid.

» Price Responsive (PR) Discovery.

» Dynamic Operating Envelope.

» Battery Charge.

Parties can create other programs if the program messages conform to the OpenADR 2.0b specification. For example, a 'day ahead price' program could be created that sends distribution price signals for specific asset locations on a future date such as, tomorrow. This signal would have multiple intervals corresponding to off-peak, shoulder, or peak periods or every wholesale market trading period.

The essential point is that both the flexibility user (EDB) and the flexibility supplier must understand what the programs are and what the signals contained in the program messages mean. This is the purpose of the market context element of an OpenADR signal relating to a particular program. The market context is a URL linked to each program's specific rules - what the signals mean, what is expected of the flexibility supplier and potentially, contract and payment details. That URL could be part of an EDB's website or, if the programs are standard across the country, hosted by a central authority.

TARGETING FLEXIBILITY ON A NETWORK

In FlexTalk, an EDB would target flexibility suppliers with assets on its network. The assets were grouped at a specific network location, and the location was used as the target name. The EDB only needed to know what flexibility* was available at the target point and then send events to specific (or all) flexibility suppliers targeting one or more network locations.

5

*Flexibility was calculated as 'current consumption in kW' for target areas on the proviso that this could then be changed up or down.

FLEXTALK PRODUCTS

During the FlexTalk project, the following products were explored and utilised as potential VTN and VEN solutions. Please note this table is indicative only and is not an exhaustive list of the products available, it is for ballpark understanding only. Costs can change based on specific customer needs/ scope of deployment. Each user of OpenADR is recommended to do their own vendor research.

FIGURE 4: INDICATIVE OpenADR CERTIFIED PRODUCT COSTS

VTN / VEN	PRODUCT NAME	DESCRIPTION	COMMERCIAL AVAILABILITY	INDICATIVE COST
VTN	**Transpower – FlexPoint**	FlexPoint is Transpower's Distributed Energy Resources (DER) Management System coordinating distributed energy resources and managing the grid effectively together with DER providers. FlexPoint was provided to FlexTalk in support of Part A.	N	N/A
	Cortexo – FlexSplice Hub VTN	FlexSplice Hub VTN is a licensed OpenADR VTN software solution that customers have hosted on their behalf. Intended to integrate with existing load management systems and managed through API or GUI.	Y	$14,400 NZD per annum *Note cost estimate does not include initial customisation costs.
	Grid Fabric – Canvas Cloud	Canvas Cloud is the simplest Grid Fabric solution for testing VENs and running small OpenADR pilots. Note, this license type is not intended for operational use. Grid Fabric's Canvas Server solution is recommended	Y	Test Plan $900 USD per annum (2 VEN limit) Pilot Plan $2700 USD per annum (10 VEN limit)
	Grid Fabric – Canvas Server	Canvas Server is a licensed OpenADR VTN software solution that customers host themselves, intended to integrate with existing load management systems and managed through API or GUI.		Canvas $15,000 - $35,000 USD *Note cost estimate does not include initial customisation costs
	GE Opus One DERMS/FMS – Gateway module	GE's "Gateway" module is a licensed OpenADR VTN software solution that integrates with GE's PowerOn Advantage (SCADA). Gateway module also encompasses IEEE 2030.5 functionality for direct device control.	Y	$300,000 – $500,000 USD per annum $500K USD initial customisation costs
VEN	**Cortexo – FlexSplice Edge VEN**	FlexSplice Edge is a Virtual End Node with additional flexibility management tools and reporting functionality, intended to integrate with flexibility suppliers internal flexibility management systems (charge point management system, battery management system etc)	Y	$6,000 NZD per annum
	For further VEN solutions, a comprehensive list can be found at **https://products.openadr.org/**			

5

FLEXTALK PROGRAMS

Throughout the course of the FlexTalk pilot, the following programs were designed and tested alongside industry users. They remain as options for participants to leverage in their own application of OpenADR.

IN ADVANCE

The In Advance program is generally used for planned demand management events. In Advance and Dynamic programs use the same signals but are differentiated by market context. The concept of the In Advance program is to indicate to the flexibility supplier that a flexibility event is expected in the future (typically days) and the details of event time and payload will be updated prior to the event starting. Usually the event modification message will occur (for example) say the evening before the event is due to start.

Market Context: https://openadr.flexibility.nz/advance

Signal Name	Signal Type	Payload
load_dispatch	delta	An increase or decrease of a specified amount of powerReal in kW.

DYNAMIC

The Dynamic program is generally used for unplanned demand management events in the immediate future. In Advance and Dynamic programs use the same signals and are differentiated by the market context. The concept of the Dynamic program is to indicate to the flexibility supplier that this event is in the near future (typically hours) and the details of the event time and payload will probably not change, although they could.

Market Context: https://openadr.flexibility.nz/dynamic

Signal Name	Signal Type	Payload
load_dispatch	delta	An increase or decrease of a specified amount of powerReal in kW.

5

EMERGENCY

The Emergency message would normally correspond to the System Operator issuing a Customer Advice Notice (CAN) or Grid Emergency Notice (GEN). The signal indicates a predefined load reduction with 3 being the highest level (100%) and 0 being no reduction or maintaining normal operation. The flexibility supplier must action an Emergency event.

Market Context: https://openadr.flexibility.nz/emergency

Signal Name	Signal Type	Payload
simple	level	3 = 100% load reduction

PRICE RESPONSIVE BID

The Price Responsive Bid event contains a load amount and a price. If the flexibility supplier can achieve the event requirements and accepts the bid price, they respond with an 'opt-in' message. If they cannot, they respond with an 'opt-out' message.

Market Context: https://openadr.flexibility.nz/bid

Signal Name	Signal Type	Payload
load_dispatch	delta	An increase or decrease of a specified amount of powerReal in kW.
electricity_price	price	A price in $/kWh.

PRICE RESPONSIVE DISCOVERY

The Price Responsive Discovery event contains a load amount and a price. The price is the maximum bid acceptable, lower offers are requested. If the flexibility supplier can achieve the event requirements they respond with an 'opt-in' message and the offer price they are willing to pay. If they cannot achieve the event at or below the bid price they respond with an 'opt-out' message. Unsuccessful offers receive event 'cancellation' messages. If the event remains live, the offer has been accepted.

Market Context: https://openadr.flexibility.nz/discovery

Signal Name	Signal Type	Payload
load_dispatch	delta	An increase or decrease of a specified amount of powerReal in kW.
electricity_price	price	A price in $/kWh.

DYNAMIC OPERATING ENVELOPE

The Dynamic Operating Envelope program alerts the flexibility supplier to import and export limits for the network at a particular asset point. The event will contain multiple time periods (intervals) to represent peak, shoulder, off-peak or at the extreme, trading periods typically defined over a 24-hour period.

Market Context: https://openadr.flexibility.nz/doe

Signal Name	Signal Type	Payload
x-import_upper_limit	TBA	TBA
x-export_lower_limit	TBA	TBA

BATTERY LEVEL

The Battery Level event is used to charge or discharge storage resources. The resources could be one or many storage resources at a target location.

Market Context: https://openadr.flexibility.nz/battery_level

Signal Name	Signal Type	Payload
load_dispatch	setpoint	An increase or decrease of a specified amount of powerReal in kW.

5

REPORTING

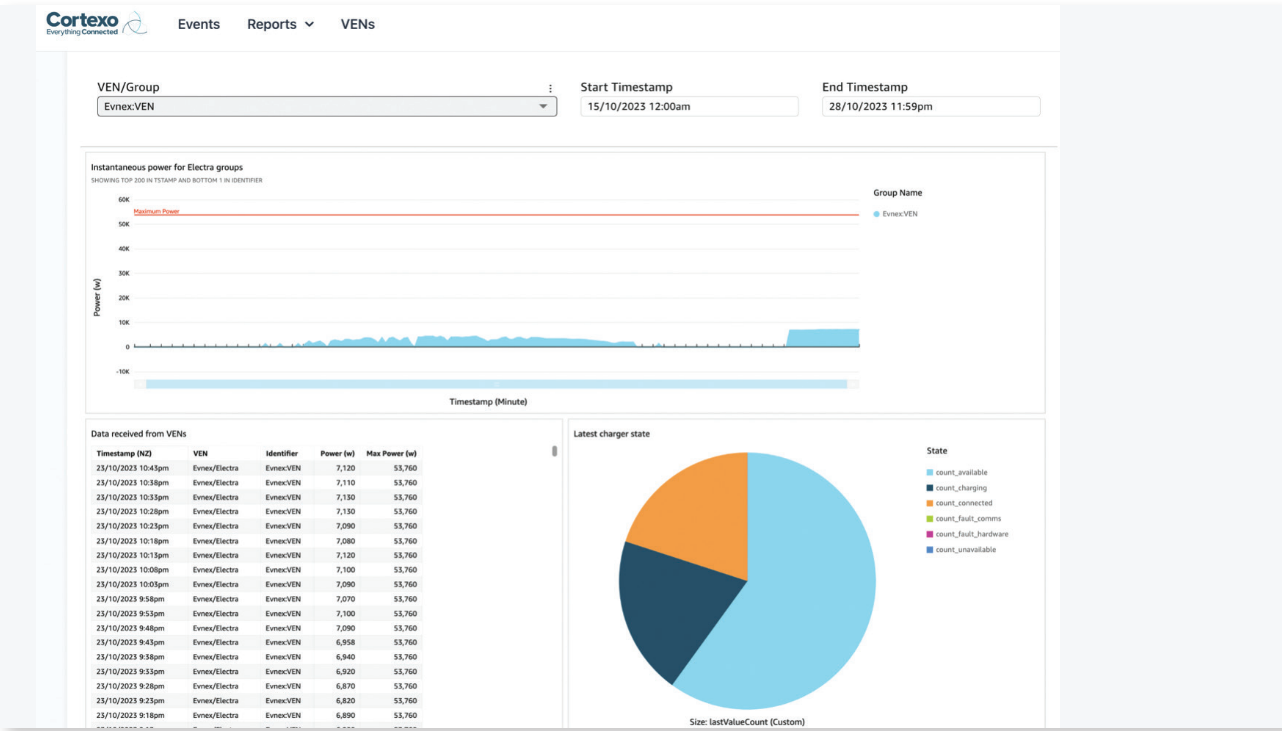
During Part A of FlexTalk pilot, reporting was not implemented; however, in Part B, reporting from the flexibility suppliers to the EDBs occurred every five minutes, utilising the OpenADR 2.0b's scheduled reporting capability.

Reporting was granular and could be for all flexibility supplier assets or specific to a target location. In OpenADR reports are defined by a VEN and offered to a VTN as part of a regular exchange of messages.

The reports used by the EV charging flexibility suppliers (Evnex and Openloop) contained:

FIELD	DESCRIPTION
group_id	Optional. Used where the record belongs to a group (such as GXP or other aggregate grouping).
resource_id	Optional. Used to indicate a specific resource. This may be an ICP or a unique identifier of a charger.
max_rated_power	Optional. Maximum rated power load. If multiple devices are reported this should be an aggregate.
power	Required. Present load power. If multiple devices are reported this should be an aggregate.
charger_state	Optional. Present charger status of an individual charger. Valid values are AVAILABLE (no faults and not connected to a vehicle), CONNECTED (connected to a vehicle but not charging), CHARGING, FAULT_COMMS, and FAULT_HARDWARE.
voltage	Optional. Present voltage.
frequency	Optional. Present frequency.

FIGURE 5: AN EXAMPLE REPORT DASHBOARD FOR EV CHARGING



The reports provided by the battery flexibility supplier (SolarZero) were based on the existing API used by Aurora and SolarZero and contained:

FIELD	DESCRIPTION
group_id	Optional. Used where the record belongs to a group (such as GXP or other aggregate grouping).
resource_id	Optional. Used to indicate a specific resource. This may be an ICP or a unique identifier of a charger.
solar_output_actual	This is the total amount of solar generation from the flexibility supplier. This is zero or a positive value. Expressed in watts (W).
battery_output_actual	This is the total battery output from the flexibility supplier. When charging this would be a negative value. For discharge it would be positive value. Expressed in watts (W).
battery_energy_remaining	The remaining energy in the battery until fully discharged. Expressed in watthours (Wh).
battery_energy_to_fill	Remaining energy required to fully charge the battery from actual state expressed in watthours (Wh).
battery_charge_minutes	Remaining time to fully charged the battery at the current charge rate. Time changes in accordance to rate from Event Instruction. Expressed in minutes.
battery_discharge_minutes	Running time to fully discharge the battery at the current charge rate. Time changes in accordance to rate from Event Instruction. Expressed in minutes.
battery_charge_percent	Expressed as an integer in percentage (%).
battery_max_charge_power	Maximum rate the battery could charge depending on the capability of the network at that time. Expressed in watts (W).
battery_max_discharge_power	Maximum rate the flexibility supplier could dispatch. Expressed in watts (W).
battery_state	Optional. The state of the battery expressed as CHARGING, DISCHARGING, IDLE or FAULT.

The battery status report was not presented in a dashboard but sent to the Aurora load management system via an existing API.

SECTION SIX

Appendix A – Terms and definitions

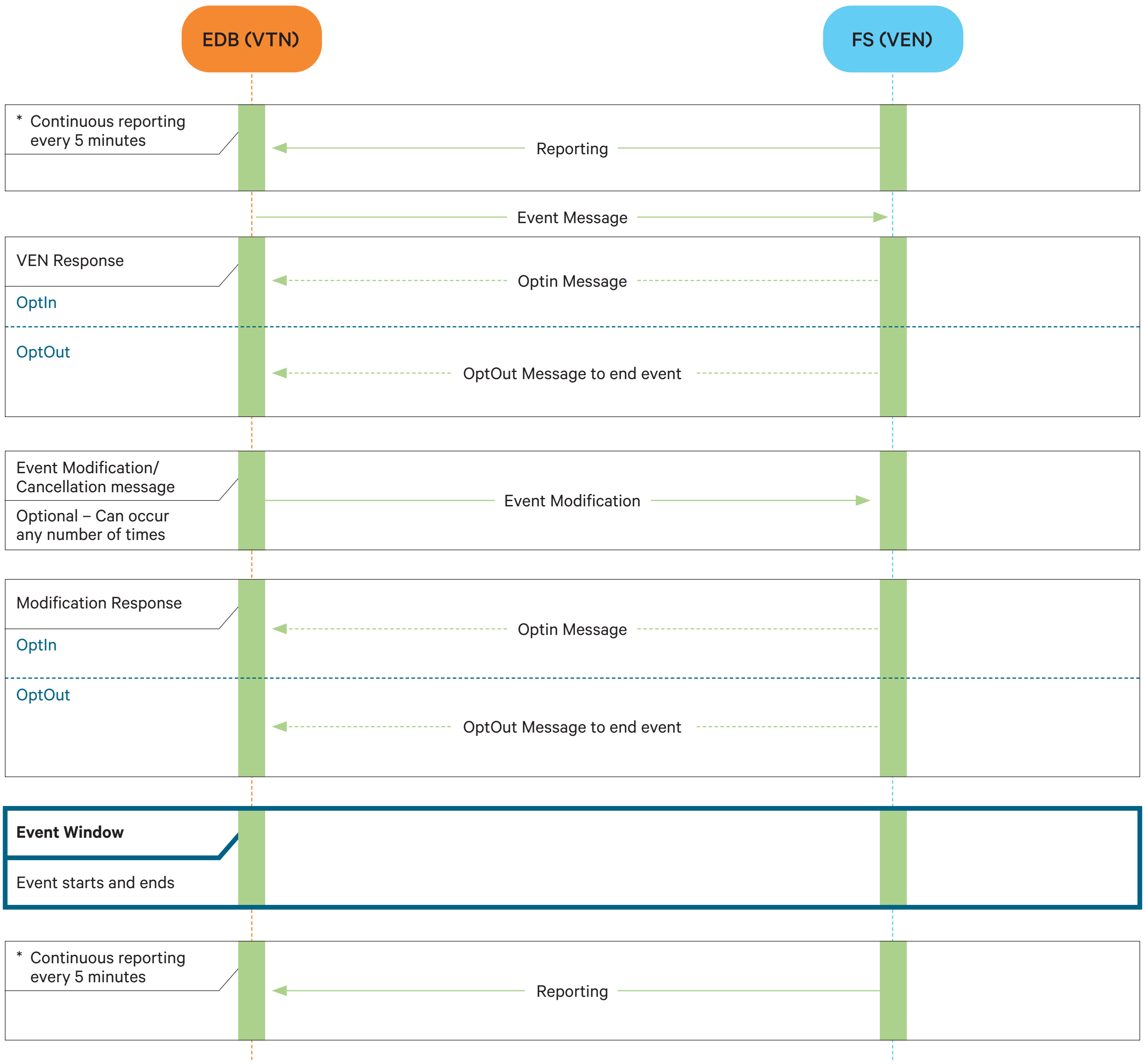
TERM	DEFINITION
Active Managed Charging	This form of managed charging, also known as direct load control, supersedes customer charging behaviour and imposes utility preferences on charger functionality. Charging is controlled by communication signals sent from an EDB or aggregator to a vehicle or charger. Active managed charging can be event-based, where load is controlled during a limited number of events in a given time period. Active managed charging can also be continuous, which enables more constant control that is responsive to grid conditions on a more granular scale.
Advanced Distribution Management System (ADMS)	The software platform that supports the full suite of distribution management and optimisation. An ADMS includes functions that automate outage restoration and optimise the performance of the distribution grid. ADMS functions being developed for electric utilities include fault location, isolation, and restoration; volt/volt-ampere reactive optimisation; conservation through voltage reduction; peak demand management; and support for microgrids and EVs.
Application Programming Interface (API)	A set of defined rules that enable different applications to communicate with each other. It acts as an intermediary layer that processes data transfers between systems, letting companies open their application data and functionality to external third-party developers, business partners, and internal departments within their companies.
Consumer Energy Resources (CER) also referred to as Distributed Energy Resources (DER) (see below)	Consumers' resources that generate or store electricity and includes flexible loads that can alter demand in response to external signals. CER includes: » rooftop solar » batteries » EV chargers » controlled loads such as water heaters and air conditioners. Distributed energy resources (DER) are sometimes used to describe CER, but also includes larger assets such as community batteries installed in the distribution network.
Charge Point Management System (CPMS)	Charge point management software simplifies charge point operations by representing an entire charging network digitally and managing communications and data exchanges with individual charging stations.
Demand Response (DR)	The voluntary reduction or shift of electricity use by customers, which can help to keep a power grid stable by balancing its supply and demand of electricity. It can help to make electricity systems flexible and reliable, which is beneficial if they contain increasing shares of variable renewable energy.
Distributed Energy Resources (DER)	Technologies used to generate, store, or manage energy are referred to as distributed energy resources (DER). DER are smaller–scale devices that can either use, generate, or store electricity and form a part of the local distribution system, which primarily serve homes and businesses. DERs can include renewable generation, energy storage, EVs, and technology to flexibly manage loads (such as water heaters or pool pumps) at the premises. Generation or storage DERs operate for the purpose of supplying all or a portion of the customer's electrical load and may also be capable of supplying power into the system or alternatively providing a load management service for customers. DER can also include front-of-meter small generation or storage located in lower-voltage parts of the network.
Distributed Energy Resource Management System (DERMS)	The software and digital information flows that enable DERM by controlling distributed energy resources.
Demand Flexibility (DF)	The modification of generation or consumption patterns in response to an external signal, to provide a service within the energy system.
Electricity Distribution Business (EDB)	Lines companies (or distribution companies) that provide and maintain the power lines that carry electricity via power poles and lines from the national transmission grid to homes and businesses.

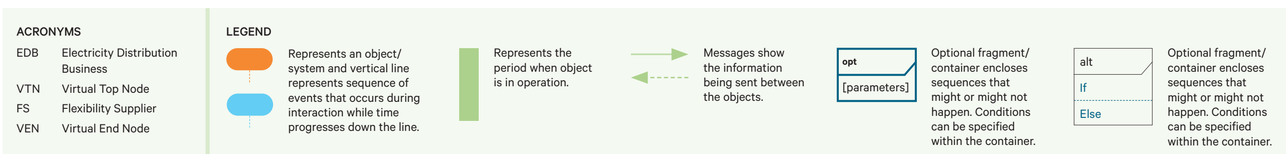
TERM	DEFINITION
Flexibility Management System	Software-based platforms used to communicate, manage, and orchestrate distributed energy resources.
Flexibility Supplier / Aggregator	An entity providing flexibility to perform a service for an electricity participant. A flexibility supplier may act as an aggregator. An aggregator means a person who contracts with one or more consumers so that the person is able to deal with the electricity otherwise required by those consumers in any way, including putting in place agreements under which those consumers voluntarily change their consumption level, so that the person is able to offer the combined increase or reduction in the interruptible load of all those consumers as collective demand, either in the wholesale electricity market or under any other bilateral agreement or contract.
Flexibility Resource	Resources like generators, consumers, and electricity storage connected to the distribution network.
Flexibility Services	The offer of modifying generation or consumption patterns in reaction to an external signal (such as a change in price) to provide a service within the energy system.
Grid Exit Point (GXP)	Grid exit points are the points of connection where electricity flows out of the national grid from large substations to local networks or direct to industrial consumers.
Load Management System (LMS)	EDBs' internal IT infrastructure (systems) responsible for controlling load. This may be referred to as DERMs, ripple system, load management system or other.
OpenADR 2.0	An open, highly secure, and two-way information exchange model and global Smart Grid standard. OpenADR standardises the message format used for Auto-DR and DER management so that dynamic price and reliability signals can be exchanged in a uniform and interoperable fashion among utilities, ISOs, and energy management and control systems. While previously deployed Auto-DR systems are automated, they are not standardised or interoperable. OpenADR was created to automate and simplify DR and DER for the power industry with dynamic price and reliability signals that allow end users to modify their usage patterns to save money and optimise energy efficiency, while enhancing the effectiveness of power delivery across the Smart Grid.
IEEE 2030.5	A standard for communications between the smart grid and consumers. The standard is built using Internet of Things concepts and gives consumers a variety of means to manage their energy usage and generation.
Open Charge Point Protocol (OCPP)	A communication protocol that enables EV charging stations to communicate with central systems, such as network management platforms or billing systems. It was first developed by the Open Charge Alliance, a non-profit organisation dedicated to promoting open standards in EV charging. OCPP is an open-source protocol, meaning that it is freely available for anyone to use and modify. This makes it an attractive option for charging network operators and manufacturers, as it allows them to build their own charging stations and systems without being locked into proprietary solutions.
Open Charge Point Interface (OCPI)	The OCPI protocol is designed to facilitate interaction between charge point operators and the many networks that provide electricity for EVs. This enables instantaneous two-way communication between the two sets of interested parties. OCPI facilitates information such the location, cost, and accessibility of charging stations, as well as individual charge point details. OCPI enables EV drivers to use a common language while connecting to various EV charging networks.
Quality Assurance (QA)	Any systematic process of determining whether a product or service meets specified requirements.
RESTful API	An interface that two computer systems use to exchange information securely over the internet.
Virtual End Node (VEN)	Typically, a client end device that accepts a signal from a server (VTN).
Virtual Top Node (VTN)	Typically, a server that transmits OpenADR signals to end devices (VEN) or other intermediate servers.

Appendix B – Program Sequence Diagrams

EVENT TYPE: IN ADVANCE

Note:* Reporting continues every 5 min regardless of events

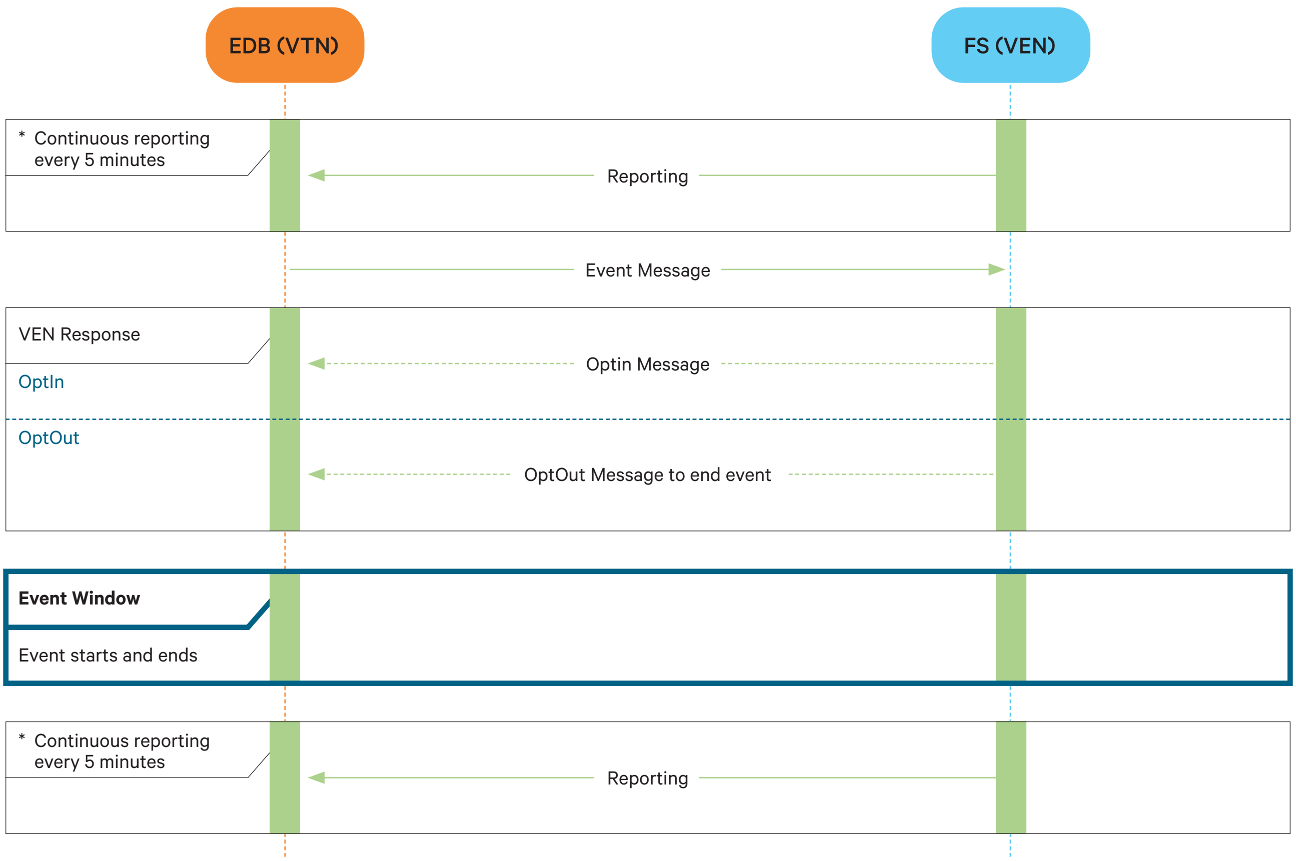




6

EVENT TYPE: DYNAMIC OR EMERGENCY

Note:* Reporting continues every 5 min regardless of events



ACRONYMS

EDB	Electricity Distribution Business
VTN	Virtual Top Node
FS	Flexibility Supplier
VEN	Virtual End Node

LEGEND

Represents an object/system and vertical line represents sequence of events that occurs during interaction while time progresses down the line.

Represents the period when object is in operation.

Messages show the information being sent between the objects.

opt [parameters] Optional fragment/container encloses sequences that might or might not happen. Conditions can be specified within the container.

alt If Else Optional fragment/container encloses sequences that might or might not happen. Conditions can be specified within the container.

EVENT TYPE: PRICE RESPONSIVE BID

Note:* Reporting continues every 5 min regardless of events

ACRONYMS

EDB Electricity Distribution Business
VTN Virtual Top Node
FS Flexibility Supplier
VEN Virtual End Node

LEGEND

Represents an object/ system and vertical line represents sequence of events that occurs during interaction while time progresses down the line.

Represents the period when object is in operation.

Messages show the information being sent between the objects.

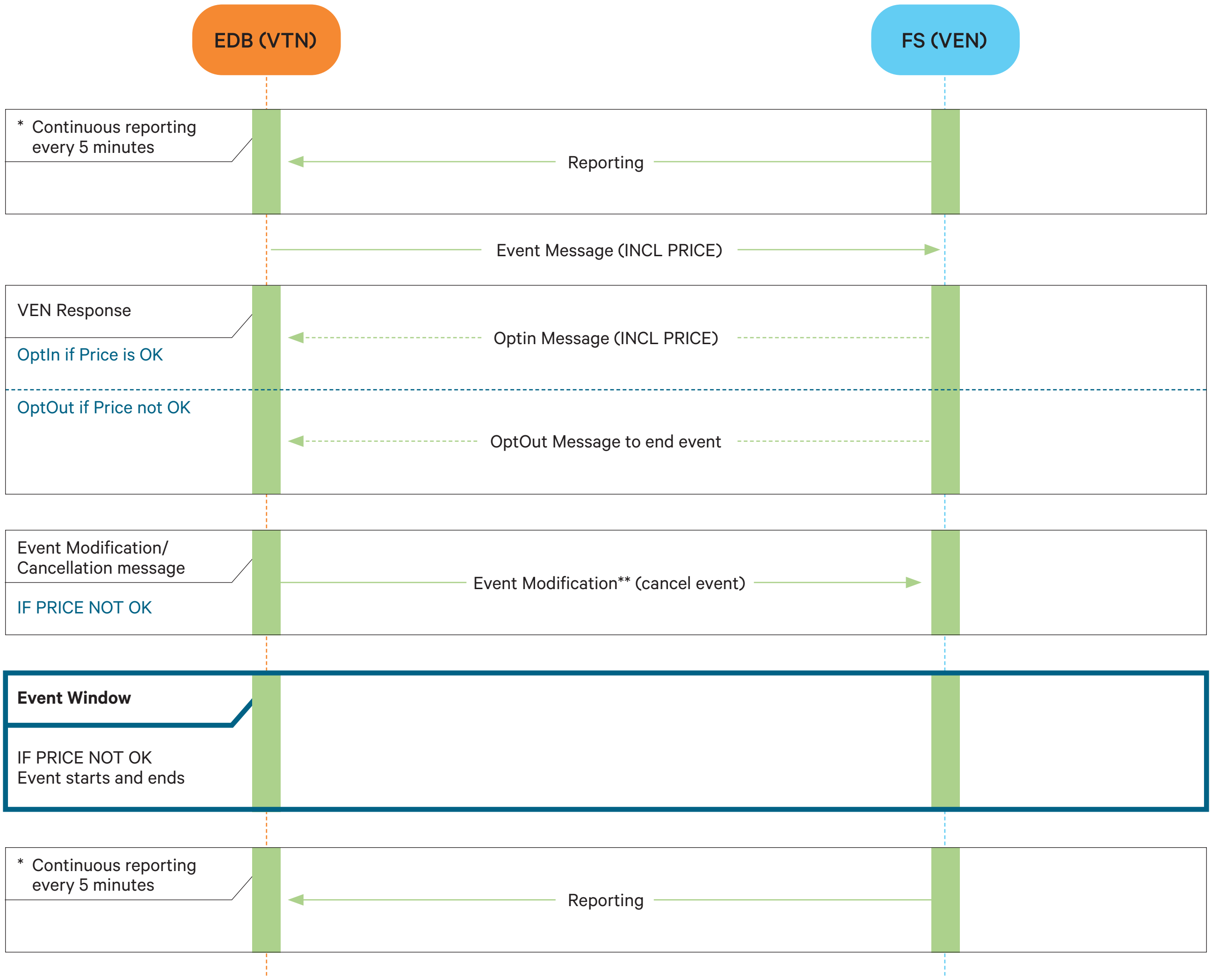
opt [parameters] Optional fragment/ container encloses sequences that might or might not happen. Conditions can be specified within the container.

alt If Else Optional fragment/ container encloses sequences that might or might not happen. Conditions can be specified within the container.

6

EVENT TYPE: PRICE RESPONSIVE DISCOVERY

Note:* Reporting continues every 5 min regardless of events



**Event modification could be a cancellation message

ACRONYMS

EDB	Electricity Distribution Business
VTN	Virtual Top Node
FS	Flexibility Supplier
VEN	Virtual End Node

LEGEND

Represents an object/ system and vertical line represents sequence of events that occurs during interaction while time progresses down the line.

Represents the period when object is in operation.

Messages show the information being sent between the objects.

opt [parameters] Optional fragment/ container encloses sequences that might or might not happen. Conditions can be specified within the container.

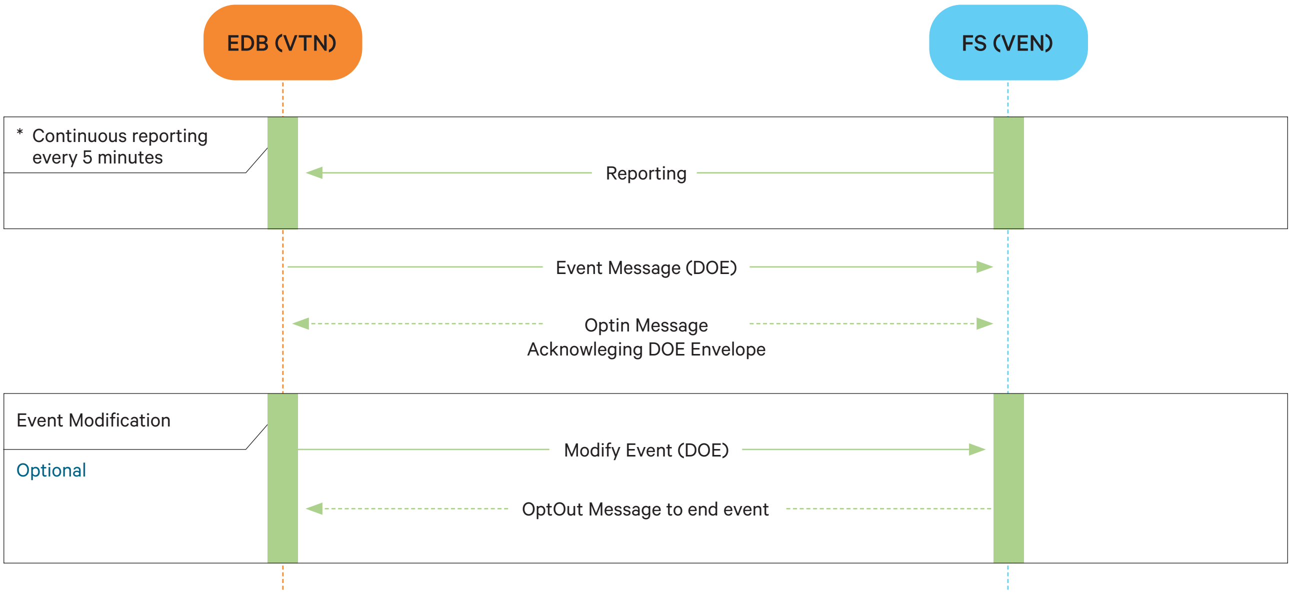
alt If Else Optional fragment/ container encloses sequences that might or might not happen. Conditions can be specified within the container.

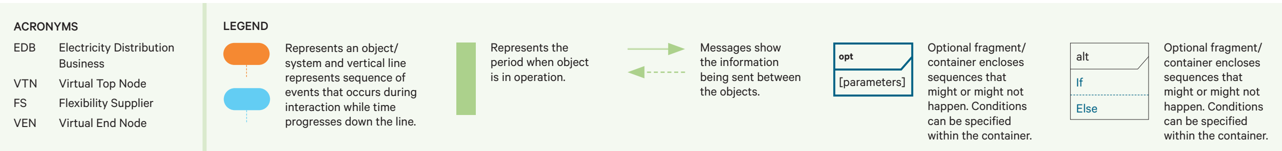
6

EVENT TYPE: DOE

NO ASSOCIATED EVENT

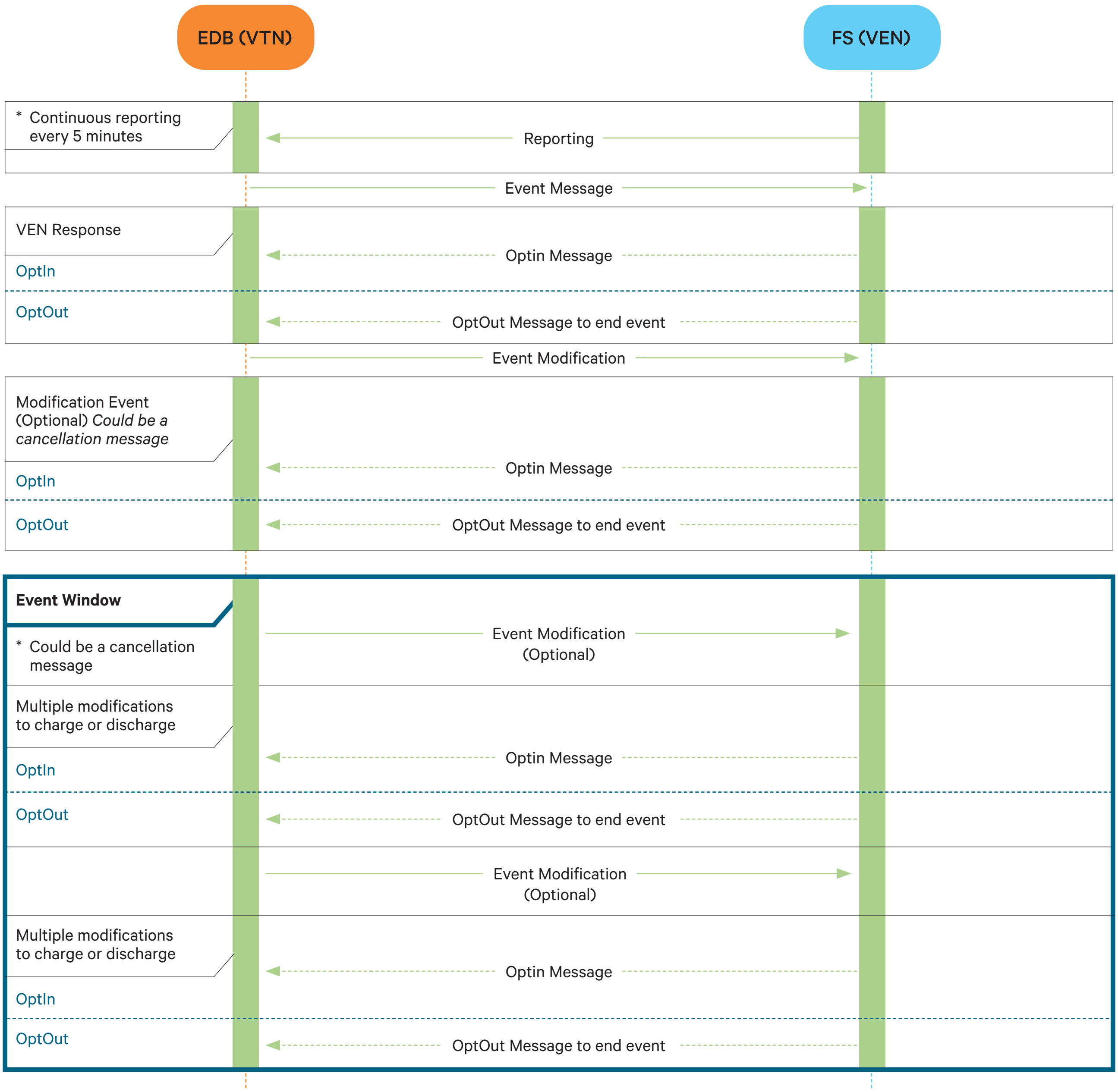
Note:* Reporting continues every 5 min regardless of events





EVENT TYPE: BATTERY PROGRAMME

Note:* Reporting continues every 5 min regardless of events



ACRONYMS

EDB	Electricity Distribution Business
VTN	Virtual Top Node
FS	Flexibility Supplier
VEN	Virtual End Node

LEGEND

Represents an object/system and vertical line represents sequence of events that occurs during interaction while time progresses down the line.

Represents the period when object is in operation.

Messages show the information being sent between the objects.

opt [parameters] — Optional fragment/container encloses sequences that might or might not happen. Conditions can be specified within the container.

alt If Else — Optional fragment/container encloses sequences that might or might not happen. Conditions can be specified within the container.

SECTION SEVEN

References

Amazon, (2024) What is RESTful API
https://aws.amazon.com/what-is/restful-api/

Australian Government, Department of Climate Change, Energy, the Environment and Water, Energy and Climate Change Ministerial Council, Consumer Energy Resources Working Group
https://www.energy.gov.au/energy-and-climate-change-ministerial-council/working-groups/consumer-energy-resources-working-group

Australian Renewable Energy Agency, what is demand response
https://arena.gov.au/renewable-energy/demand-response/

Chargecloud, what is a Charge Point Management System
https://www.chargecloud.de/en/blog/charging-management-software/

Congressional Research Service (CRS), (2019) Variable Renewable Energy
https://crsreports.congress.gov/product/pdf/IF/IF11257

Current, what is Open Charge Point Interface
https://www.current.eco/ev-glossary/open-charge-point-interface-ocpi

Electricity Authority
» About distribution: https://www.ea.govt.nz/industry/distribution/
» Online glossary: https://www.emi.ea.govt.nz/Glossary

Electricity Industry Act, 2010
https://www.legislation.govt.nz/act/public/2010/0116/latest/whole.html

Energy Networks Association
https://www.energynetworks.org/work/open-networks/
» Open Networks Project, Flexibility Market Principles, July 2019
» Open Networks Project, Terms and definitions, September 2019

Flexforum, Flexibility Plan
https://flexforum.nz/flexibility-plan/

Gartner online glossary
https://www.gartner.com/en/glossary/all-terms

IEEE Smart Grid, IEEE 2030.5 (Smart Energy Profile 2.0): An Overview and Applicability to Distributed Energy Resources (DER), 2016
https://smartgrid.ieee.org/resources/webinars/non-bulk-generation/ieee-2030-5-smart-energy-profile-2-0-an-overview-and-applicability-to-distributed-energy-resources-der

IPAG review of the Transpower Demand Response Programme, July 2021
https://www.ea.govt.nz/documents/527/IPAG_review_of_the_Transpower_demand_response_programme.pdf

IBM, what is an API
https://www.ibm.com/topics/api

Law insider, online dictionary
https://www.lawinsider.com/dictionary/flexible-resource

OpenADR Profile Specification and schema
www.openadr.org

Smart Electric Power Alliance: The State of Managed Charging in 2021
https://sepapower.org/resource/the-state-of-managed-charging-in-2021-executive-summary/

Transpower, Whakamana i Te Mauri Hiko
https://static.transpower.co.nz/public/publications/resources/TP%20Whakamana%20i%20Te%20Mauri%20Hiko.pdf

Electricity Engineers' Association

TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY