Part of Energy Queensland

SEP2 Client Handbook

This handbook created and made available are for the development of software clients for use with Energy Queensland's IEEE 2030.5 server infrastructure. This handbook ensures meeting of Energy Queensland's requirements.

If this document is a printed version, to ensure compliance, reference must be made to the Energy Queensland internet site www.energyq.com.au to obtain the latest version.

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Abstract: This handbook is an Application Programming Interface (API) implementation guide to Smart Energy Profile 2.0 (SEP2) and how it is applied in Queensland. It applies to dynamic connections to the Ergon Energy and Energex distribution networks.

Keywords: SEP2, 2030.5, Utility Server, Dynamic Connection, API

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1 Overview

1.1 Purpose

The implementation of a suitable and common communication standard is a critical building block in enabling dynamic connections for the continued uptake of DER to maximise the utilisation of customer and network assets. Energex and Ergon Energy have chosen the IEEE Standard for Smart Energy Profile Application Protocol IEEE 2030.5-2018 [1], also known as SEP2, as a first protocol to enable dynamic connections. In Australia, it can also be referred to as AS 5385:2023.

In June 2016, the California Public Utilities Commission accepted the recommendation to mandate IEEE 2030.5 as the default standard for communication with smart inverters under California Rule 21. They released the Common Smart Inverter Profile - IEEE 2030.5 Implementation Guide for Smart Inverters [2] or CSIP. CSIP outlines a subset of SEP2 that is required to be considered a "Smart Inverter" in California. CSIP contains various requirements around autonomous functions, which in Australia are already covered by AS/NZS 4777.2 [3] Inverter requirements.

CSIP-AUS [4] is a smaller subset of CSIP, containing only the functions required by Australia and developed by the Australian DER API Working Group and Standards Australia. The guide also introduces the concept of connection point limits rather than the per-device generation limits used in CSIP.

1.2 Scope

This handbook is an implementation guide to Smart Energy Profile 2.0 (SEP2) and how it is applied in Queensland. It applies to dynamic connections to the Ergon Energy and Energex distribution networks. For more information on dynamic connections, please refer to previous consultations facilitated by Energex and Ergon Energy.

- Dynamic Connections Consultation 1 (2021) [5]
- Dynamic Connections Consultation 2 (2021) [6]

This document is intended to assist manufacturers, aggregators, and installers in ensuring dynamic connections meet the expectations of Energex and Ergon Energy. This handbook is not a connection contract or standard. The applicable standards for a given connection should be used in consultation with this handbook:

- STNW3510 Dynamic Standard for Small IES Connections [7]
- STNW3511 Dynamic Standard for LV EG Connections [8]

2 References

2.1 Energy Queensland controlled documents

[5]	Energy Queensland Limited, "Enabling Dynamic Customer Connections for DER," 2020. [Online]. Available: https://www.talkingenergy.com.au/dynamicder
[6]	Energy Queensland Limited, "Enabling Dynamic Customer Connections for DER 2,"2021. [Online]. Available: https://www.talkingenergy.com.au/dynamicconnections
[7]	Energy Queensland Limited, "STNW3510 Dynamic Standard for Small IES Connections," 2023.
[8]	Energy Queensland Limited, "STNW3511 Dynamic Standard for LV EG Connections," 2023.

2.2 Other sources

[1]	Standards Australia, "AS 5385:2023 Smart Energy Profile Application Protocol," 2023.
[2]	SunSpec Alliance, "SunSpec Common Smart Inverter Profile (CSIP) Conformance Test Procedures," 2019.
[3]	Standards Australia, "AS/NZS 4777.2:2020 Grid connection of energy systems via inverters," 2020.
[4]	Standards Australia, "SA HB 218:2023 Common Smart Inverter Profile — Australia with Test Procedures," 2023.
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[10]	Cloudflare, "What is mutual TLS (mTLS)?," [Online]. Available: https://www.cloudflare.com/en-gb/learning/access-management/what-is-mutual-tls/.
[11]	Queensland Legislation, "Professional Engineers Act," [Online]. Available: https://www.legislation.qld.gov.au/view/pdf/inforce/current/act-2002-054.
[12]	QualityLogic, "IEEE 2030.5 Test Tools - IEEE 2030.5 Conformance Testing," 2021. [Online]. Available: https://www.qualitylogic.com/what-we-test/smart-energy-standards/ieee-2030-5-test-tools-qa-services/.
[13]	Common Smart Inverter Profile Working Group, "SunSpec Common Smart Inverter Profile (CSIP)," 2018. [Online]. Available: https://sunspec.org/2030-5-csip/.
[14]	Standards Australia, "AS/NZS 61000.4.30:2012 Electromagnetic compatibility (EMC) Testing and measurement techniques - Power quality measurement methods," 2012.
[15]	DER Integration API Technical Working Group, "Common Smart Inverter Profile – Australia – Test Procedures," 2023. [Online]. Available: https://bsgip.com/wp-content/uploads/2023/09/CSIP-AUS-Comms-Client-Test-Procedures-v1.0-final.pdf

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this standard, the following definitions apply.

Utility Server	SEP2/IEEE 2030.5 Communications Server
SEP2 Client	The client system (either on device or via gateway device or cloud proxy) that communicates with the Utility Server.
Operating Envelope	The envelope formed between maximum export capacity and maximum import capacity at the customer connection point. This is normally represented as two values.
Compliant Provider	An aggregator or device manufacturer who has been deemed compliant with the Energex and Ergon Energy Utility Server.
EndDevice	A resource representing a Connection Point

3.2 Abbreviations

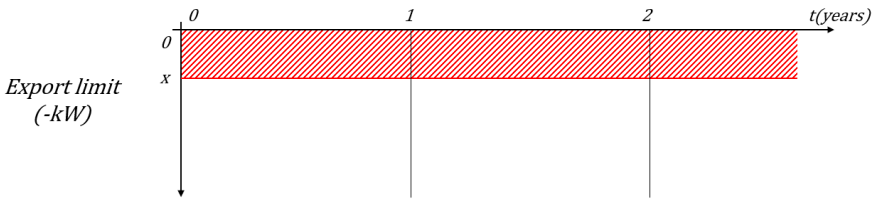
This list does not include well-known unambiguous abbreviations, or abbreviations defined at their first occurrence within the text.

DOE	Dynamic Operating Envelope
CSIP	Common Smart Inverter Profile
CSIP-AUS	Australian Implementation of CSIP
SEP2	Smart Energy Profile 2.0 (IEEE 2030.5)
DER	Distributed Energy Resource or Distinguished Encoding Rules (in the context of a TLS certificates)
DERMS	Distributed Energy Resource Management System
REST	Representational state transfer
API	Application Programming Interface
PV	Solar Photovoltaic
EQL	Energy Queensland
BESS	Battery Energy Storage System
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
LFDI	Long Form Device Identifier
SFDI	Short Form Device Identifier
SERCA	Smart Energy Root Certificate Authority
MCA	Manufacturer's Certificate Authority
MICA	Manufacturing Issuing Certificate Authority
PEN	Private Enterprise Number
PKI	Public Key Infrastructure
IANA	Internet Assigned Numbers Authority

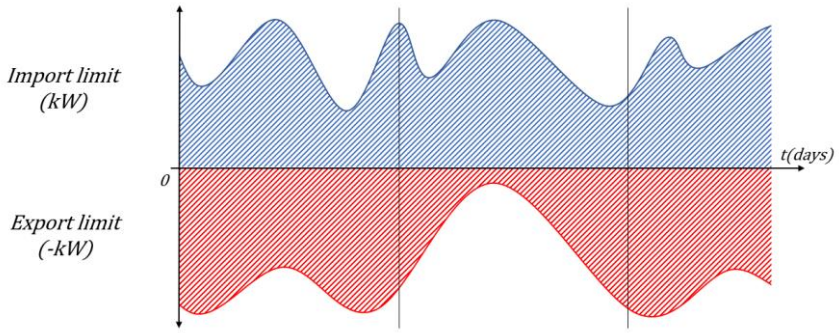
MRID	Master Resource Identifier
HEMS	Home Energy Management System
RPEQ	Registered Professional Engineer of Queensland
XML	Extensible Markup Language
URL	Uniform Resource Locator

4 Dynamic Operating Envelopes

Operating envelopes are the limits that an electricity customer can import and export to the electricity grid. These limits are agreed between networks, customers, and regulators as part of the customer connection or regulatory process. Historically, operating envelopes were mostly fixed at conservative levels regardless of the capacity of the network because they are static and need to account for 'worst case scenario' conditions.



Dynamic operating envelopes (DOE) are where import and export limits can vary over time and location. Dynamic rather than fixed export limits could enable higher levels of energy exports from customers' solar and battery systems by allowing higher export limits when there is more hosting capacity on the local network.



For more information on Dynamic Operating Envelopes, please refer to the DEIP Dynamic Operating Envelopes Workstream: Outcomes Report [9].

It is important to consider that Energex and Ergon Energy are primarily concerned with the power flows at the site or connection point level. Installations with dynamic connection agreements must therefore have the necessary equipment to accurately measure and control flows at the connection point in accordance with the dynamic operating envelope for the site.

Energex and Ergon Energy will only provide a single operating envelope to a single SEP2 Client per connection point. It is the responsibility of the vendor and installers to architect and co-ordinate downstream systems in accordance with that envelope. More detail on valid connection pathways is provided in Section 5.1 below.

Export Limit

Historically, when customers applied to connect a solar PV system to the network, a static export limit was calculated. A limit represents the maximum amount of power that can be exported to the grid at any time. To ensure that no damage to the network or plant occurs, a static limit must be calculated at the time when the network is in its worst-case scenario. Dynamic limits on the other hand are constantly calculated throughout the day based on the latest information available.

Import Limit

For actively managed loads, dynamic limits also apply. To reduce load during peak times, appliances like hot water systems are controlled by turning them off avoid network constraints. Dynamic import limits provide a more granular way of responding at times of network constraints for flexible loads like home batteries and electric vehicles, slowing or stopping charging (unless supplied by enough behind-the-meter generation). While unmanaged loads such as cooking equipment may still exceed a sites dynamic import limit, loads under a dynamic connection agreement may only consume while the import limit is not exceeded.

Generation Limit

For managed generation covered under a dynamic connection agreement, a generation limit can also be specified to limit the amount of behind-the-meter generation by managed DER. Whilst not currently used, this may be used in future for use cases such as emergency backstop under a Minimum System Load (MSL) direction from AEMO.

Load Limit

For managed loads covered under a dynamic connection agreement, a load limit can also be specified to limit the amount of behind-the-meter load by managed DER. This limit does not apply to loads that aren't managed by the dynamic connection agreement. Whilst not currently used, this may be used in future for use cases such as emergency load shedding under a Lack of Reserve (LOR) direction from AEMO.

5 Site Configurations

A Home Energy Management System (HEMS) is a technology platform through which a household can monitor their energy generation and consumption in real-time. It should be able to control and coordinate managed energy resources from multiple manufacturers (such as a battery, Solar PV, or EV charger). Advanced HEMS should additionally be able respond to external control and price signals; providing additional value to households.

The SEP2 Client or End Device can be considered a HEMS, as it is required to manage all DER at a connection point. A valid SEP2 client can be a physical device or a virtual representation of downstream devices through a single client. The HEMS may be software built into the inverter itself, a physical hardware device, or exist completely in software running in the cloud.

5.1 Connection Pathways

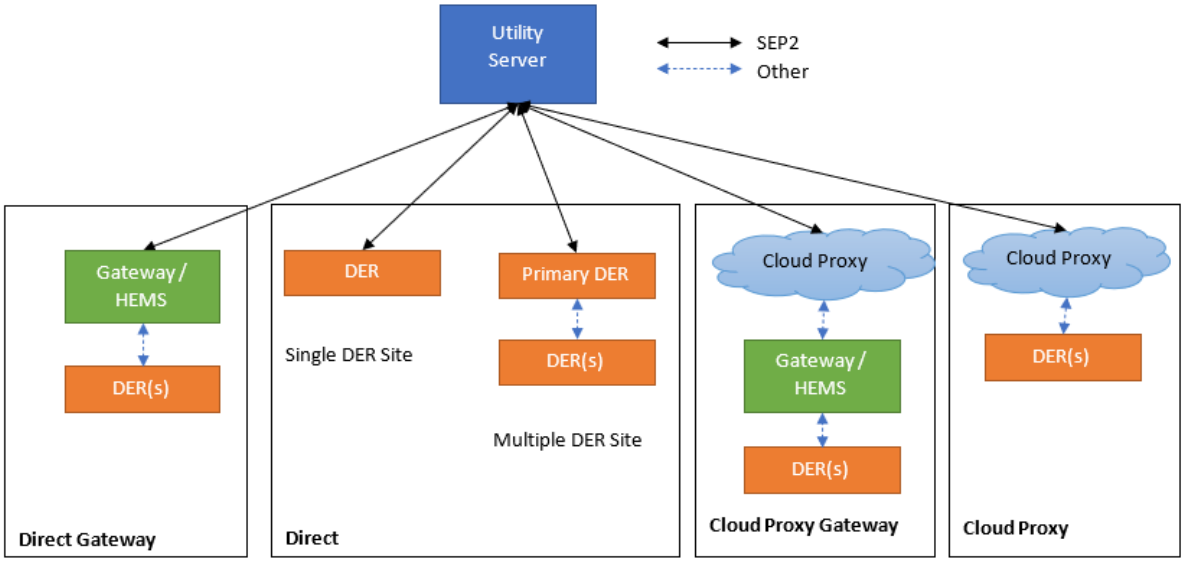


Figure 1: Connection pathways for site to Utility Server

5.1.1 Direct Connection via DER

If a DER supports SEP2 natively and has the necessary measurement equipment at the site connection point, it may be able to connect directly to the Utility Server. If a site has multiple DERs, this 'master' DER will need to be additionally capable of coordinating the remaining DERs at the site. For example, a compliant BESS may manage site power flows and in turn control PV generation for maximum customer benefit.

5.1.2 Direct Connection via Gateway Device

A gateway device such as a HEMS that natively supports SEP2 communications can be used to interface directly with the Utility Server and coordinate downstream DER(s) for a site. This option may allow for retrofitting existing DER that do not yet support SEP2. It also provides a central point of coordination for sites with multiple DER.

5.1.3 Cloud Proxy / Aggregator

A third-party cloud proxy or aggregator can offer a cloud or centralised service that can be used as a 'virtual' gateway device to control DER at a site in accordance with the provided envelope. In principle this pathway works similarity to the other pathways but allows for new or existing gateway devices to support vendor specified protocols at a site level, rather than SEP2.

5.1.4 Cloud Proxy / Aggregator via Gateway Device

The final pathway is the same as a cloud proxy but requires additional physical hardware (such as a gateway or HEMS) at the site in addition to the DER.

5.2 Multiple DER

For a connection point with multiple DER, the SEP2 Client is required to manage all the DER at the site. Only one EndDevice for receiving CSIP-AUS communications is permitted per connection point.

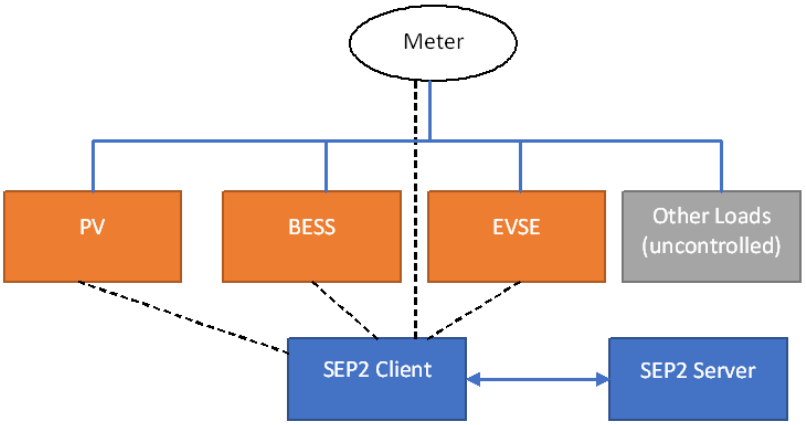


Figure 2: A SEP2 Client should control all DER at a connection point.

The mechanism that the SEP2 Client uses to communicate with subordinate DER is outside of the scope of CSIP-AUS and this document, but some possible behind-the-meter communication methods could include:

- SEP2 (IEEE 2030.5)
- SunSpec Modbus (IEEE 1547)
- Open Charge Point Protocol (OCPP)
- Demand Response Enabling Devices (DRED / AS4755)
- Open Automated Demand Response (OpenADR)
- Proprietary APIs

Ideally, the SEP2 Client that is installed should be able to communicate directly with all DER at a site. However, in circumstances where customers have DER installed that are unsupported by the SEP2 Client, the site may be brought into compliance by setting the unsupported DER to a non-export and non-import configuration. Telemetry for these DER still needs to be included in the DER aggregation of power flows reported by the SEP2 Client.

A physical breaker may still be required for sites that are required to respond to generation, load or disconnect controls. The requirements of the connection standard relevant to the connection point must be considered when determining the appropriate site configuration and control mechanisms for an individual site.

6 Server Details

Energex and Ergon Energy's SEP2 Utility Servers can be connected to via the following URLs.

Table 1: Energex and Ergon Energy SEP2 Server Details

Instance	URL
Test	https://sep2-test.energyq.com.au/api/v2/dcap
Production	https://sep2.energyq.com.au/api/v2/dcap

NOTE

These endpoints are geo-blocked and are only accessible from Australian based IP addresses.

Assuming full chain, enrolled, certificates are correctly provided during connection, this endpoint will then provide the relative URIs of additional API endpoints as per the SEP2 standard. The LFDI of the client certificate is used to identify the connection request and return the associated *EndDeviceList*. Note direct connection devices or gateways will only be able to see itself in the end device list, representing the connection point to the electrical network. Cloud proxies will be able to see all end devices associated with that cloud proxy.

6.1 Queensland Test Server

The Energex and Ergon Energy test server is not an interactive testing tool or test harness, but a test environment matching the implementation of the production instance.

A rolling set of *DERControls* will be published to the Utility Server for test devices. There will also be periods where no *DERControls* have been published, so that fallback to the *DefaultDERControl* can be tested at these times. These *DERControls* should be used to validate that the inverter(s) are operating correctly.

The following *DERControls* will be published as part of the random rolling schedule:

- Connect/Disconnect: opModConnect
- Energize/De-energize: opModEnergize
- Site Export Limit (in Watts): csipaus:opModExpLimW
- Site Import Limit (in Watts): csipaus:opModImpLimW
- Max generation limit (in Watts): csipaus:opModGenLimW
- Max load limit (in Watts): csipaus:opModLoadLimW

7 Test Procedures

Testing should be performed as per the national CSIP-AUS Test Procedures [15]. Until such time as a national testing authority is established, compliance with these test procedures must be assessed by a Registered Professional Engineer of Queensland (RPEQ) (or otherwise permitted under section 7.4). Evidence of testing by the providers responsible RPEQ should be provided to Energex and Ergon Energy.

Energex and Ergon consider the testing of a SEP2 client and integration with associated inverter hardware to be a professional engineering service under the Professional Engineers Act (2002 (Qld)) [11]. Please note that under this Act, it is an offence for individuals who are not a RPEQ to carry out unsupervised professional engineering services in Queensland, or to claim to be a RPEQ when they are not.

Testing of compliance can be completed against any SEP2 Utility Server or Test Harness – however the communications software client MUST additionally establish a connection with the Energex and Ergon Utility Server as part of the testing process to ensure there are no compatibility issues. Energex and Ergon Energy will ensure that data received by the utility server matches expectations as part of the approval process.

7.1 Test Scope

Testing should be performed in such a way that it adequately represents a typical customer installation. It is recommended full end-to-end testing is undertaken; however, the scope of testing verification for CSIP-AUS is the communication client and not the physical response of the inverter.

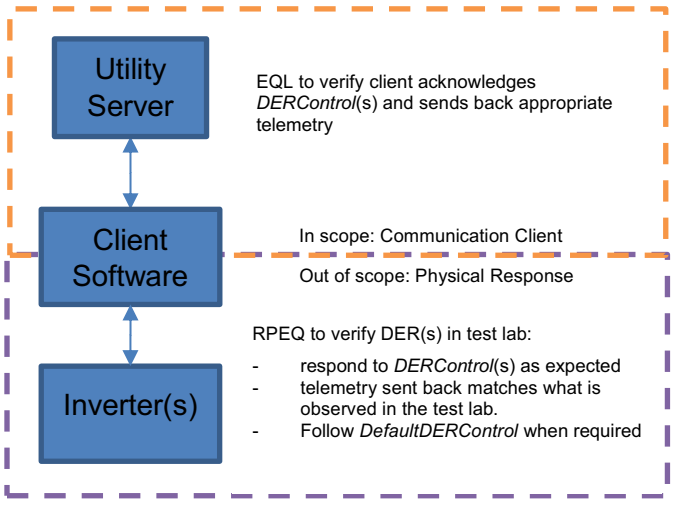


Figure 3: Communication vs Physical Response Scope

7.2 Test Conformance

When submitting evidence of test conformance, the supported functions of the SEP2 Client should also be clearly indicated, as per the test designations in Table 3 of the national CSIP-AUS Test Procedures [15].

The most relevant test designations are:

G: Generation L: Load C: In-Band Registration S: Subscription Notifications

For example:

- A SEP2 Client that supports export (but not import) would be [G]
- A SEP2 Client that supports import (but not export) would be [L]
- A SEP2 Client that supports both import and export, as well as optional extensions and subscriptions, would be [GLCS]

7.3 Test Harness

Testing of compliance can be completed against any SEP2 Utility Server or CSIP-AUS Test Harness.

The Energex and Ergon Energy test server instance is not considered a CSIP-AUS Test Harness. Until a nationally endorsed test harness is available, the test server may be used as a substitute for a test harness for most tests, noting that the test procedures will not be able be performed exactly as prescribed.

7.4 Mutual Recognition

Notwithstanding the requirement in section 7.1 that test procedures must be assessed by a RPEQ, where the compliance testing has been performed outside of Queensland and in accordance with either section 7.4.1 or 7.4.2 (with supporting evidence of such to be provided to Energex or Ergon Energy's satisfaction), Energex and Ergon Energy will waive the requirement for assessment by an RPEQ. For the avoidance of doubt, this waiver does not extend to any changes or modifications to the SEP2 client that need to be made to meet the Queensland context, which will still require assessment by a RPEQ.

The SEP2 Client will also be required to send telemetry to the test instance of the Queensland Server and make use of a Queensland PKI Certificate (until such time as a national PKI is available).

7.4.1 South Australia

Where the SEP2 Utility Server has been tested, and complied with, the SA Power Networks (SAPN) Dynamic Export Test Procedures this will be accepted as suitable evidence of test conformance (with compliance category of GC). Please note that these test procedures are not considered evidence of import compliance, which is required for BESS and EVSE.

7.4.2 Victoria

Where the SEP2 Utility Server has been tested and complied with the national CSIP-AUS Test Procedures, as carried out in Victoria by a suitably registered electrical engineer (being a Registered Professional Engineer of Victoria (RPEV)), will be accepted as suitable evidence of test conformance.

8 Compliance Process

This section details the process by which a third-party provider can apply to Energex and Ergon Energy to develop and connect a compliant SEP2 client to the Utility ServerCertification Process

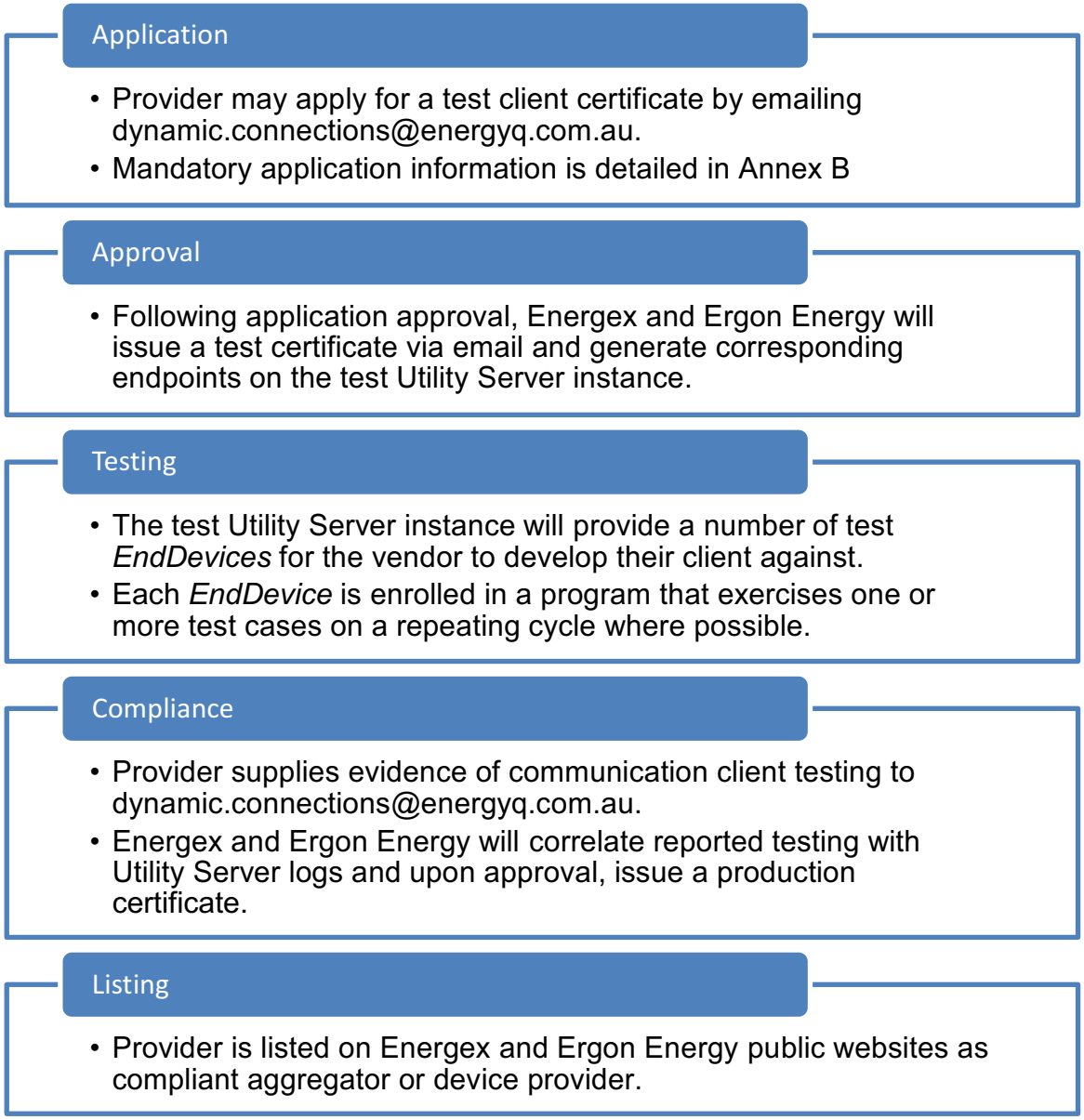
For a DER device to be compliant with dynamic connections in Queensland it must have been certified via one of the below certification paths and provided with the necessary certificates to authenticate.

- Energex and Ergon Energy Compliant Provider
- National CSIP-AUS Certification (future entity currently being established)

8.1.1 Energex and Ergon Energy Compliant Provider

The process for becoming a 'Compliant Provider' is the same for both aggregators and device manufacturers, with the only difference being the type of certificate issued on completion.

Compliance testing is for the SEP2 software client only, and so ensuring compatibility with subsequent inverters to an existing compliant SEP2 client will be the responsibility of the vendor or installer.



8.2 Ongoing Compliance

In addition to the initial compliance checks, Energex and Ergon Energy will run continuous audits on telemetry and billing data to ensure that sites are operating in accordance with their applicable customer connection contract.

This may include periodically invoking test programs or controls to validate responses. These are anticipated to be executed with as little impact on customers as possible however any significant planned testing will incorporate the notification of compliant providers.

8.3 Server Updates

It is recommended that providers maintain test clients connected to the test environment in an ongoing manner. Notifications will be issued for server updates and upgrades that may impact clients. Following successful deployment, updates will be pushed to production within 60 days depending on criticality. It is the responsibility of the provider to ensure during this period that clients are compatible with any changes.

9 Registration Process

A key requirement of dynamic connection agreements is the need for a clear registration process for end devices and aggregators. It is anticipated that a large part of this process will initially be manual, with increasing levels of automation as the initiative and corresponding standards advance and the number of connections scales to larger numbers.

Only one client and therefore provider is allowed to be registered for each connection point / NMI.

Note that the Energex and Ergon Energy Utility Server does not currently support the CSIP-AUS Connection Point Registration Extension introduced in v1.1 of the guide[1].

9.1 Device Identity

The connection pathway chosen impacts the device registration type due to the way that clients are identified to the Utility Server.

9.1.1 Direct Connections

For direct connections, the LFDI is determined by the device certificate. As this is generated by the OEM – this LFDI will need to be manually associated with the NMI as part of the out-of-band registration process.

9.1.2 Cloud Proxy Connections

Aggregators generating LFDIs shall use the technology provider's Private Enterprise Number (PEN) as the last 8 hex digits with leading zeros. This ensures the technology provider can manage global uniqueness without concern of clashing with other aggregators. If an aggregator does not already have a PEN allocated, they may request one from the IANA for free.

To simplify the connection process for aggregator mediated clients, it is preferable that aggregator generated LFDI's are deterministically calculable from the information provided at the time of dynamic connection application. This removes the need in most cases for aggregators to notify

[1] As of Aug 2024, the anticipated release date of this functionality into the test instance is after Oct 2024.

Energex and Ergon Energy of the site identification and allows improved automation of the overall registration process.

When generating virtual LFDIs, the preferred method is as follows. The first 32 hex digits should be a truncated SHA256 hash of the 10-digit NMI. The last 8 hex digits shall be the provider's Private Enterprise Number (PEN) with leading zeros.

A python example demonstrating this calculation is provided below.

```
import hashlib

pen, nmi = 57269, "NMI0001234"
nmi = nmi[:10]
nmi_hash = hashlib.sha256(nmi.encode("utf-8")).hexdigest().upper()
lfdi = f"{nmi_hash[0:32]}{pen:08}"
print(lfdi)  # B538D9942C7B5B831AED81A1FEC46B3D00057269
```

Alternative methods for virtual LFDI generation may be permitted by mutual agreement (such as using 11-digit NMIs).

For in-band-registration (once supported) identifiers other than the NMI may be used to generate the first 32 hex digits (such as device serial number). Regardless of the registration method, the last 8 hex digits must be the provider's PEN.

10 Common Interactions

This section provides samples of the anticipated common interactions with the server, however the CSIP, CSIP-AUS and IEEE 2030.5 standards should be referred to for full detail.

10.1 Overview

An overview of the various controls and telemetry requirements are provided in Figure 4.

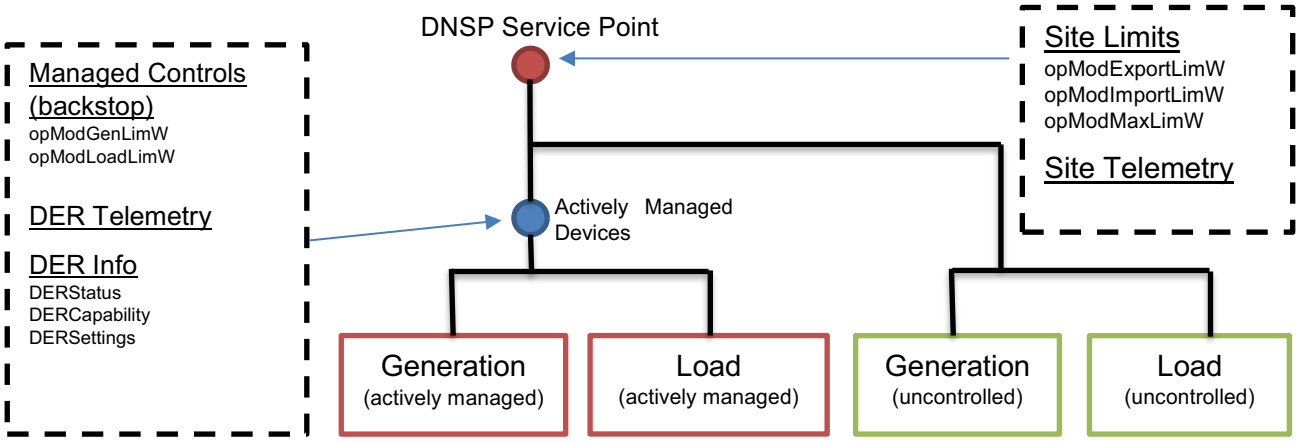


Figure 4: Summary of topological location of controls and telemetry

10.2 Defaults

Upon initial discovery, and if unspecified otherwise by the Utility Server, the following default poll and post rates for resources should be used:

Table 2: Default poll and post rates

Resource	Type	Value (secs)
DeviceCapability	Poll	300
EndDeviceList	Poll	300
FunctionSetAssignmentsList	Poll	300
DERProgramList	Poll	300
MirrorUsagePoint	Post	300

10.3 DER List

The *DERList* resource allows for clients to send site information back to the Utility Server.

10.3.1 DER Status

The following attributes of *DERStatus* are of particular interest:

`operationalModeStatus` (Operational mode currently in use.)
`0 = Not applicable/Unknown; 1 = Off; 2 = Operational mode; 3 = Test mode`

Note that for multiple DER on a single site, the Off status should represent that ALL managed DER are off, otherwise a status of 2 should be used if at least one device is operational.

`genConnectStatus` (Connect/status value for generator DER.)
`0 = Connected; 1 = Available; 2 = Operating; 3 = Test; 4 = Fault/Error`

Note that for multiple DER on a single site, the following interpretation should be used:

```
0 = Connected: applies if any device is connected but not in any of the
subsequent states
1 = Available: applies if any device is available but not in any of the
subsequent states
2 = Operating: applies if any device is operating but not in any of the
subsequent states
4 = Fault/Error: applies if any device is in Fault/Error state
```

For example: If a device is connected, available and operating it should return a 2 for genConnectStatus. The following attributes are only relevant if a storage device is installed on site:

`storConnectStatus` (Connect/status value for storage DER.)
`0 = Connected; 1 = Available; 2 = Operating; 3 = Test; 4 = Fault/Error`
`stateOfChargeStatus` (State of charge status.)
`0 = Storage charging; 1 = Storage discharging; 2 = Storage holding`

10.3.2 DER Capability

The *DERCapability* resource allows the posting back of DER nameplate ratings to the Utility Server. Note that for multiple DER on a single site, the posted values should be a summation of total controllable capacities for the site.

`modesSupported` (Bitmap indicating the *DERControls* implemented by the device.)

For example, if a client supports the modes *opModEnergize*, *opModFixedW*, *opModMaxLimW* and *opModTargetW* then the bitmap value would be:

`00000000010100000000000010001000 5243016  0x00500088`

`csipaus:doeModesSupported` (Bitmap indicating the CSIP-AUS controls implemented)

```
0 = opModExpLimW; 1 = opModImpLimW; 2 = opModGenLimW; 3 = opModLoadLimW
```

For example, if a client supports all modes, the bitmap value would be:
`0000000000001111 15 0000000F`

type (Type of DER) Integer

```
0 - Not applicable / Unknown;
1 - Virtual or mixed DER;
2 - Reciprocating engine;
3 - Fuel cell;
4 - Photovoltaic system;
5 - Combined heat and power;
6 - Other generation system;
80 - Other storage system;
81 - Electric vehicle;
82 - EVSE;
83 - Combined PV and storage
```

rtgMaxVA (Maximum continuous apparent power output capability of the DER, in voltamperes)

rtgMaxVar (Maximum continuous reactive power delivered by the DER, in var.)

rtgMaxVarNeg (Maximum continuous reactive power received by the DER, in var. If absent, defaults to negative rtgMaxVar.)

rtgMaxW (Maximum continuous active power output capability of the DER, in watts. Represents combined generation plus storage.)

rtgMaxWh (Maximum energy storage capacity of the DER, in watt hours.)

10.3.3 DER Settings

The *DERCapability* resource allows the posting back of DER settings. Note that for multiple DER on a single site, the posted values should be a summation of total controllable capacities for the site.

setMaxVA (Set limit for maximum apparent power capability of the DER (in VA). Defaults to rtgMaxVA.)

setMaxVar (Set limit for maximum reactive power delivered by the DER (in var). SHALL be a positive value. Defaults to rtgMaxVar.)

setMaxVarNeg (Set limit for maximum reactive power received by the DER (in var). If present, SHALL be a negative value. rtgMaxVarNeg (default). If absent, defaults to negative setMaxVar.)

setMaxW (Set limit for maximum active power capability of the DER (in watts). Defaults to rtgMaxW.)

10.4 DER Programs

Each connection point will be associated to one or more *DERPrograms*. A program contains a link to a *DERControlList* which contains the actual DOE. Each program is given a primacy which indicates which program should be followed if there is a conflict and two events overlap. A poll rate is also specified indicating how often the program is likely to be updated.

```
<DERProgramList xsi:schemaLocation="urn:ieee:std:2030.5:ns sep.xsd" xmlns="urn:ieee:std:2030.5:ns"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" href="/derp" all="3" results="3" pollRate="300">
 <DERProgram href="/derp.//0">
     <mRID>80020000000000000000004a1b2c3b4</mRID>
     <description>Example DER Program</description>
     <DERControlListLink all="1" href="/derp/0/derc"/>
     <primacy>4</primacy>
 </DERProgram>
</DERProgramList>
```

10.5 DER Control Events

A list of *DERControl* Events is published to a *DERProgram* and represents the DOE applicable to a particular site for a given time range.

```
<DERControlList all="2" href="/derp/0/derc" results="1" xmlns="urn:ieee:std:2030.5:ns"
xmlns:csipaus="https://csipaus.anu.edu.au/csipaus">
<DERControl>
     <mRID> ABCDEF0123456789 </mRID>
     <description>Example DERControl 1</description>
     <creationTime>1639545523</creationTime>
     <EventStatus>
               <currentStatus>1</currentStatus>
               <dateTime>1639545638</dateTime>
               <reason>event active</reason>
     </EventStatus>
     <interval>
            <start>1605621600</start>
            <duration>86400</duration>
     </interval>
     <randomizeStart>10</randomizeStart>
     <DERControlBase xmlns="urn:ieee:std:2030.5:ns" xmlns:csip-sus="https://csipaus.org/ns">
            <csipaus:opModImLimW>20000</csipaus:opModImLimW>
            <csipaus:opModExLimW>5000</csipaus:opModExLimW>
     </DERControlBase>
</DERControl>
</DERControlList>
```

10.5.1 Forecasts

Energex and Ergon Energy will aim to send events at the following fidelity:

- five-minute interval envelope events for the next hour (12 events)
- thirty-minute interval events for the following 23 hours (46 events)

Scheduled events will be updated as frequently as every five minutes. Where a future event has changed, the previous event will be Superseded and a new one Scheduled. Under normal operation, an event that has already started, or is scheduled to start in the next 30 seconds will not be superseded or modified.

Forecast limits may taper or decay from the actual expected limit such that they trend towards the default control at the end of the forecast period. An example of what this may look like is shown in Figure 5.

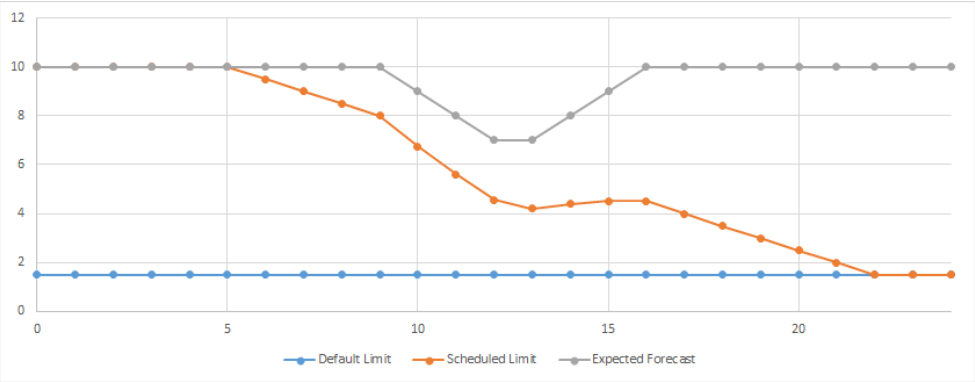


Figure 5: Tapered schedule of forecast limits

10.5.2 DER Control Event Attributes

The following attributes of *DERControl* events are of particular interest:

`EventStatus:currentStatus` (The status of the event)
`0 = Scheduled; 1 = Active; 2 = Cancelled; 3 = Cancelled with Randomization; 4 = Superseded`
`interval:start` (The start time of the event in UTC seconds)
`interval:duration` (The length of the event in seconds. By default, this will generally be set to 300s (5 minutes) or 1800s (30 minutes).)
`randomizeStart` (The number of seconds boundary inside which a random value must be selected to be applied to the associated interval start time, to avoid sudden synchronized demand changes. By default, this will generally be set to 10s but could be different, including negative.)

10.5.3 DER Control Event Responses

The communications software client shall support the following control responses from IEEE 2030.5 Table 27. All other responses are excluded.

Table 3: DERControl Responses

Enumeration Value	Description
1	Event received
2	Event started
3	Event completed
6	The event has been cancelled
7	The event has been superseded

10.6 DER Control Modes

The DER control modes themselves are set in the DERControlBase within the DERControl.

10.6.1 Export Limit

`DERControlBase:csipaus:opModExpLimW(Watts)`
This is the CSIP-AUS constraint on the exported active power at the connection point. This limitation may be met locally, for example, by reducing PV output or by using excess PV output to charge associated storage.

10.6.2 Import Limit

`DERControlBase:csipaus:opModImpLimW`

This is the CSIP-AUS constraint on the imported active power at the connection point. It only applies to nominated downstream device(s) so that they reduce or cease consumption or charging when the site import limit is exceeded.

10.6.3 Load Limit

`DERControlBase:csipaus:opModLoadLimW`

This is a CSIP-AUS constraint on the maximum allowable consumption or charge rate, in Watts, specifically for a single physical device (or aggregation of devices, excluding uncontrolled devices) such as an EV charge station.

10.6.4 Generation Limits

In Queensland, explicit generation limit controls are predominately to enable isolated networks use cases and contracted network support DER.

`DERControlBase:csipaus:opModGenLimW`

This is a CSIP-AUS constraint on the maximum allowable generation or discharge rate, in Watts, specifically for a single physical device (or aggregation of devices, excluding uncontrolled devices) such as a BESS.

10.7 Default DER Control

The *DefaultDERControl* will be in effect until it is changed or a *DERControl* event occurs. The utility server will utilise the *DefaultDERControl* to control the desired failsafe behaviour of the DER client.

The Ramp Rate Setting function is used to control the ramp rate of the *DefaultDERControl* controls and is used to manage the rate of application of the failsafe controls.

`setGradW(PerCent)`

Set default rate of change (ramp rate) of active power output due to command or internal action, defined in %setWMax/second. Resolution is in hundredths of a percent/second. A value of 0 means there is no limit. Interpreted as a percentage change in output capability limit per second when used as a default ramp rate.

If unspecified, a value of 28 should be assumed for setGradW. This corresponds with the default ramp rate (W_{Gra}) specified in AS 4777 (0.278 % per second).

The *DefaultDERControl* will also have a *DERControlBase*. This will be set to the minimum approved limit for the connection:

```
<csipaus:opModExpLimW>
  <value>1500</value>
  <multiplier>0</multiplier>
</csipaus:opModExpLimW>
```

NOTE

Default settings or modes for autonomous functions shall not be changeable via IEEE 2030.5. The autonomous functions should be configured per existing national standards or comply with jurisdictional requirements.

10.8 Telemetry

Energex and Ergon Energy require devices to report telemetry as per Annex A of CSIP-AUS [4] at 5-minute intervals.

Table 4: Minimum telemetry required from DER clients to serve

Measurement	Data Qualifier	UoM	Site	DER[2]
Real Power (per phase, if applicable)	Average	W	Mandatory	Mandatory
Reactive Power (per phase, if applicable)	Average	Var	Mandatory	Mandatory
Voltage (per phase)	Average	V	Mandatory	Optional[3]
Frequency	Maximum	Hz	Optional	Optional
Frequency	Minimum	Hz	Optional	Optional

NOTE

Sending 5-minute telemetry is expected to use less then 5MB of data per day. Data usage may be significantly less if compression is utilised by the client.

10.8.1 Averages

Average readings should be calculated as per the measurement aggregation algorithm set out in AS/NZS 61000.4.30. That is, the time tag is the time at the conclusion of the 5 min aggregation. Each 5 min interval shall begin on an RTC 5 min tick.

For example, a measurement reading should be sent at 13:30 representing the average value of samples taken during the period 13:25 to 13:30.

As per the standard, samples should be taken every 200ms (10 cycles). If not capable of sampling this frequently, 1 second samples may be sufficient.

10.8.2 Flow Direction

The SEP2 standard specifies that sub-metered DER accumulates positive energy usage when the DER is delivering power, and that for premise aggregation meters (site readings), generation should be negative. That is:

- For Site readings: Negative values for generation, positive for consumption
- For DER readings: Positive values for generation, negative for consumption

10.8.3 Usage Point

A suggested naming pattern for the Usage Point mRID(s) could include a truncated LFDI with the role flags, in addition to a PEN. The following values for the role flag should be used:

- 0003 (0,1) = If measurement is for the site
- 0049 (0,3,6) = If measurement is for a specific DER

[2] DER telemetry is assumed to be the aggregation of sub DER

[3] At least one site or device voltage must be reported. Where site voltage is available, it must be reported.

For example:

```
<MirrorUsagePoint xmlns="urn:ieee:std:2030.5:ns">
   <mRID>01E0F2357FF85E4B7EE6C60300057269</mRID>
   <description>NMI123567 Site Readings</description>
   <roleFlags>03</roleFlags>
   <serviceCategoryKind>0</serviceCategoryKind>
   <status>1</status>
<deviceLFDI>01E0F2357FF85E4B7EE6C60ED43B22DF278F17E0
</deviceLFDI>
</MirrorUsagePoint>
```

```
<MirrorUsagePoint xmlns="urn:ieee:std:2030.5:ns">
   <mRID>01E0F2357FF85E4B7EE6C64900057269</mRID>
   <description>NMI123567 DER Readings</description>
   <roleFlags>49</roleFlags>
   <serviceCategoryKind>0</serviceCategoryKind>
   <status>1</status>
<deviceLFDI>01E0F2357FF85E4B7EE6C60ED43B22DF278F17E0
</deviceLFDI>
</MirrorUsagePoint>
```

The description should also include whether the readings are for a Site or Device as per example strings above.

10.8.4 Meter Reading

Meter readings are then posted the appropriate *UsagePoint* endpoint. The mRID of each *MeterReading* needs to be unique for that *EndDevice*.

For example:

```
<MirrorMeterReading xmlns="urn:ieee:std:2030.5:ns">
    <mRID>AA00007301</mRID>
    <description>Average W Reading - Phase A (Site)</description>
    <lastUpdateTime>1659656880</lastUpdateTime>
    <nextUpdateTime>1659657180</nextUpdateTime>
    <version>0</version>
    <Reading>
        <qualityFlags>0001</qualityFlags><!-- valid -->
        <value>1500</value>
    </Reading>
    <ReadingType>
        <commodity>1</commodity><!--1 = Electricity secondary metered-->
        <kind>37</kind><!-- 37 = Power -->
        <dataQualifier>2</dataQualifier><!-- 2 = Average -->
        <flowDirection>19</flowDirection><!-- 1 = Forward (delivered to customer) -->
        <phase>128</phase><!-- 128 = Phase A (and S1) -->
        <powerOfTenMultiplier>0</powerOfTenMultiplier>
         <intervalLength>300</intervalLength >
        <uom>38</uom><!-- 38 = W (Real power in Watts) -->
    </ReadingType>
</MirrorMeterReading>
```

10.9 Forecast Events

Energex and Ergon Energy will aim to send forecasts at the following fidelity:

- 5 min intervals for first hour (12 events)
- 30 min intervals for next 23 hours (46 events)

As such, client should expect to have up to 58 scheduled events specified for each connection point. Noting that clients are only required to store the first 24 scheduled events for each connection point, and so future events past beyond this may be ignored until closer to the event.

10.10 Isolated Networks

Ergon Energy owns and operates isolated power stations, with stand-alone electricity networks, that supply communities too remote to connect to the national grid. These stand-alone micro-grids supply 39 communities throughout western Queensland, the Gulf of Carpentaria, Cape York, on numerous Torres Strait Islands, and on Palm and Mornington Islands.

In the future, we may offer Dynamic Connections to these networks, which would have the following differences to the national grid:

- A poll and post rate of 60 s instead of 300 s
- Events at 1 min intervals – forecast for 30 minutes (30 events)
- Generation and Load Limits in addition to Export and Import Limit

11 Failure Modes

The following requirements of the standards are important to consider as they ensure that widespread impacts to the network do not occur because of the following uncommon but expected events:

- SEP2 Utility Server Outages
- Widespread Communication Outages
- Power Outages

WARNING

These requirements must be carefully followed and tested to protect the integrity of the network during major events.

11.1 Loss of Communications

Should a communications failure occur and all forecast DERControl events have been exhausted, the utility server will utilise the DefaultDERControl to specify the desired failsafe behaviour of the DER client.

It is a CSIP requirement that clients can store at least 24 scheduled events for each DER. Should there be a loss of communications, sites must complete any scheduled events until exhausted, and then revert to default settings (or fixed limits if a default is not specified).

An outage of the Utility Server, or unexpected error messages from the Utility Server, should be considered as equivalent to a loss of communications.

11.2 Re-establishment of communications following power outage

Following a connection point power outage, the client MUST remove all existing *DERControls*, revert to the *DefaultDERControl* and re-poll all associated *DERPrograms* to establish if any *DERControl* events have been added or changed whilst offline.

This is in addition to the connection and reconnection procedure outlined in AS/NZS 4777.2.

Note that this scenario applies to a lack of grid supply, and not to a communications outage.

11.3 Ramp rates

The ramp rate for transitioning to an active control is specified by the rampTms attribute of the upcoming control. If absent, the default ramp rate (setGradW) applies for transitioning to the active control.

When transitioning from an active control back to a default control, the setGradW specified in the default control applies.

If setGradW has not been specified in the default control, it should be assigned as per the ramp rate specified in AS 4777 (0.278% per second). For systems with multiple DER, the ramp rate applies to the total aggregate DER capacity when converting to kW.

In an example scenario shown in Figure 6 and Figure 7, there is a 10 kW DER, with a default export limit of 1.5 kW. There is an active control of 5 kW from 30-350s, and an active control of 10 kW from 350-650s. At 650s the system will revert to the default limit as there are no further events.

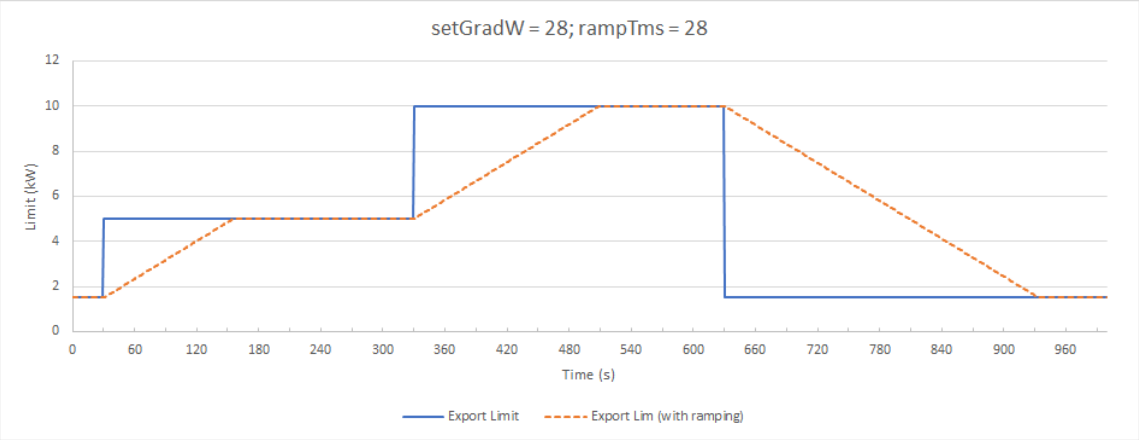


Figure 6: Example where rampTms and setGradW are the same, or rampTms not set.

Figure 7: Example where rampTms and setGradW differ.

It is noted that it may not be possible to comply with decreasing ramp rates for all DER types (such as DER controlled only by an on/off switch). As the values represent limits – all values less than the ramped limit are deemed compliant, however values above the ramped value are non-compliant.

11.4 Default Limits

It is important to consider that default controls apply to a connection point and not an individual DER, and that the fixed import and export limits specified in the connection agreement for that site will apply if the client is unable to register with the Utility Server, or if a DefaultDERControl is not specified by the Utility Server. Where limits specified in a DefaultDERControl are different to the fixed limits of a contract, the default controls specified by the Utility Server should be applied.

For sites with multiple DER, all DER at the site must be installed and configured such that they have access to the site-level power flow data to ensure they are able to follow the fixed limits correctly. The requirements of the connection standard relevant to the connection point must be considered when determining the appropriate site configuration to meet these fixed limits. Export limits apply to generation-only DER, such as PV. Import limits apply to consumption-only DER, such as EVSE that is capable of charging only. Both import & export limits apply to bi-directional DER, such as BESS and EVSE that is capable of reverse power flow.

12 Conflicting or Overlapping Events

As per the SEP2 standard, differing DERControl Modes (e.g.,opModExpLim, opModImpLim) within DERControls Events are independent and are allowed to overlap without superseding. That means an Overlapping Event will supersede the original Event strictly for the DERControl Modes specified in that event. The priority of a DERControl is determined by the primacy setting of its containing DERProgram with a lower primacy value indicating higher priority.

<table>
<tr><td>Time</td><td>00:00 - 00:05</td><td>00:05 - 00:10</td><td>00:10 - 00:15</td><td>00:15 - 00:20</td><td>00:20 - 00:25</td><td>00:25 - 00:30</td><td>00:30 - 00:35</td></tr>
<tr><td>DERProgram B
(Primacy #2)</td><td></td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td><td></td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td><td></td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td></tr>
<tr><td>DERProgram A
(Primacy #1)</td><td></td><td></td><td colspan="2">ExpLimW = 0.0 kW</td><td></td><td></td><td>GenLimW = 0.0 kW
Connect = False</td></tr>
<tr><td>DefaultControl</td><td></td><td colspan="6">ExpLimW = 1.5 kW
ImpLimW = 4.0 kW</td></tr>
<tr><td>Fixed Limits</td><td colspan="7">ExpLimW = 1.5 kW ImpLimW = 1.5 kW</td></tr>
<tr><td>Implied Mode Defaults</td><td colspan="7">GenLimW = ∞ kW LoadLimW = ∞ kW
Connect = True Energize = True</td></tr>
<tr><td>Site Behaviour</td><td>ExpLimW = 1.5 kW
ImpLimW = 1.5 kW</td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td><td>ExpLimW = 0.0 kW
ImpLimW = 15.0 kW</td><td>ExpLimW = 0.0 kW
ImpLimW = 4.0 kW</td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td><td>ExpLimW = 1.5 kW
ImpLimW = 4.0 kW</td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW
GenLimW = 0.0 kW
Connect = False</td></tr>
<tr><td>Notes</td><td>Adhere to fixed limits when no controls or default</td><td></td><td colspan="2">Export overridden by event with primacy #1
Import of the overlapped event still applies
Defaults apply for modes not set</td><td></td><td>Revert to default limit when no active controls</td><td>No consumption or generation allowed due to Connect=False despite still having Exp/Imp Limits</td></tr>
</table>

Figure 8: Example of overlapping events and expected behaviour

CSIP (and therefore CSIP-AUS) states that a DER should not execute a lower priority event that is overlapped by a higher priority (lower primacy) event – even if they have a different start and end time. The draft release of IEEE 2030.5:2023 specifies that the overlapped event shall be completed for the time periods for which the higher priority event is not active. The preferred behaviour of Energex and Ergon Energy is to resume the event in line with the upcoming standard clarification (in contradiction of CSIP), although both methods are acceptable due to the inconsistency. Energex and Ergon Energy will make best efforts to avoid this scenario by not issuing events that overlap in this manner.

<table>
<tr><th>Time</th><th>00:00 - 00:05</th><th>00:05 - 00:10</th><th>00:10 - 00:15</th><th>00:15 - 00:20</th></tr>
<tr><td>DERProgram B
(Primacy #2)</td><td colspan="4">ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td></tr>
<tr><td>DERProgram A
(Primacy #1)</td><td></td><td colspan="2">ExpLimW = 0.0 kW</td><td></td></tr>
<tr><td>DefaultControl</td><td colspan="4">ExpLimW = 1.5 kW
ImpLimW = 1.5 kW</td></tr>
<tr><td>Site Behaviour
(Preferred)</td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td><td rowspan="2">ExpLimW = 0.0 kW
ImpLimW = 15.0 kW</td><td rowspan="2">ExpLimW = 0.0 kW
ImpLimW = 15.0 kW</td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td></tr>
<tr><td>Site Behaviour
(Alternative)</td><td>ExpLimW = 1.5 kW
ImpLimW = 1.5 kW</td><td>ExpLimW = 1.5 kW
ImpLimW = 1.5 kW</td></tr>
</table>

Figure 9: Example of overlapped events of different duration and expected behaviour.

As per SEP2, when a client detects an overlapping event in the same program, the event with the latest creation time will take precedence over the older event. Energex and Ergon Energy will make best efforts to avoid this scenario by cancelling any superseded events.

<table>
<tr><th>Time</th><th>00:00 - 00:05</th><th>00:05 - 00:10</th><th>00:10 - 00:15</th><th>00:15 - 00:20</th></tr>
<tr><td>DERProgram B
(Primacy #2)</td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td><td>ExpLimW = 5.0 kW
ImpLimW = 5.0 kW</td></tr>
<tr><td>DERProgram B
(Primacy #2)
more recently created</td><td></td><td>ExpLimW = 5.0 kW
ImpLimW = 5.0 kW</td><td>ExpLimW = 5.0 kW
ImpLimW = 5.0 kW</td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td></tr>
<tr><td>DefaultControl</td><td colspan="4">ExpLimW = 1.5 kW
ImpLimW = 1.5 kW</td></tr>
<tr><td>Site Behaviour</td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td><td>ExpLimW = 5.0 kW
ImpLimW = 5.0 kW</td><td>ExpLimW = 5.0 kW
ImpLimW = 5.0 kW</td><td>ExpLimW = 10.0 kW
ImpLimW = 15.0 kW</td></tr>
</table>

Figure 10: Example of duplicate events and expected behaviour.

13 Scaling Considerations

As many thousands of SEP2 Clients could be expected to communicate with the Utility Server at the same poll or post rate, consideration should be made when designing clients to handle intermittent communication issues with the server. This scenario is often referred to as the ‘thundering herd problem’.

13.1 Timing of requests

Regular tasks such as sending telemetry at the post rate (e.g., every 5 minutes) could result in the server being overloaded if clients all send the requests at the exact same time (at the top of the hour). Whilst the task needs to be performed at the poll or post rate, a random offset should be applied such that clients do not send all their requests to the server at the same time.

Posting rates should be met within a range of up to 50% of the relevant post or poll rate i.e., if a post rate is set to 60 seconds posting shall occur within 30 seconds of the intended time.

13.2 Retrying Requests

When a server does receive too many simultaneous requests, it will respond with an error such as '429 Client Error: Too Many Requests'. Clients should attempt to retry any failed requests after an appropriate delay. Retries should also be attempted for any 5xx Server errors. When determining the delay time, exponential backoff with jitter should be used. The client should make 2 attempts to retry within the polling period, with a minimum of 10 seconds between attempts.

13.3 Telemetry Buffering

If clients are unable to successfully send telemetry back to the server due to communication issues, it should buffer these telemetry readings locally and attempt to resend when communications are re-established. Like storing scheduled events, clients should be able to store at least 6 or more telemetry readings locally, discarding the oldest readings first should the local buffer be exceeded. When sending multiple readings from a buffer, the oldest readings should be sent first.

Informative

Frequently Asked Questions

Why am I getting a *timeout error*?

A timeout error is expected if connecting from a non-Australian IP address. Alternatively, if connecting from within Australia, the timeout period of the client may be set too low.

Why am I getting a *"Remote end closed connection without response" error*?

This error is expected when you have not provided a valid PKI certificate as part of the request.

Why am I getting a *404 (Not Found)* error for a valid URL?

The SEP2 Utility Server returns a *404 (Not Found)* error for pages that do not exist and also when it does not want to confirm the pages existence (what would normally be a *401 (Unauthorized)* error). As such, an unexpected *404 (Not Found)* is most likely because the certificate is not authorised for that resource.

What does a 429 Client Error: Too Many Requests error mean?

If the server receives too many simultaneous requests from a client, it will return this error. A client should be capable of retrying with exponential backoff after a short period of time.

Why am I getting a *404 (Not Found)* error for a newly created resource?

If the resource has been recently created (such as a new MUP), it may take a few seconds for the resource to become available. The client should retry after a few seconds.

Why is my mRID not being accepted?

Generated mRIDs need to have an even number of characters, and in most cases must be 32 characters. The PEN should be included in generated mRIDs to ensure uniqueness.

0xFFFFFFFFFFFFFFFFFFFFFFFF[XXXXXXXX], where [XXXXXXXX] is the PEN.

The characters should also be in uppercase and only include the characters A-F and 0-9.

Why is there no endpoint for DefaultDERControl?

If a DefaultDERControl has not been set for a particular DER then the attribute is not included in the payload. This may occur after server maintenance or patching until Default DER Controls are re-published for all DERs.

Why is the opModMaxLimW DERControl percentage more than 100?

The opModMaxLimW function sets the export limit as a percentage of set capacity (%setMaxW, in hundredths). As the value is expressed as hundredths of a percent you will need to divide by 100.

Why are some telemetry readings not accepted?

Telemetry reading values are a signed Int16 (-32768 to +32767). Values larger than this should make use of the multiplier attribute.

Annex A

Informative

Request for access to test server

An example of required information to be provided to receive access to the test instance of the SEP2 Utility Server. These should be emailed to Dynamic.Connections@energyq.com.au.

Entity Name	ENERGY QUEENSLAND LIMITED
Australian Business Number (ABN)	96 612 535 583
IANA Private Enterprise Number (PEN)	57269
Address	26 Reddacliff Street Newstead QLD 4006
Client Product Name	Product Name
Client Type	Cloud / Direct
Equipment Type	Gateway / Inverter
Targeted Inverter Products	Inverter Series A Inverter Series B
Technical Contact Name (for communications and outage notifications)	First Last
Technical Contact Email	first.last@providerexample.com
Technical Contact Number	0412 345 678
Certificate Signing Request (CSR) (refer to Annex C for more info)	-----BEGIN CERTIFICATE REQUEST----- MIG5MGICAQAwADBZMBMGByqGSM49AgEGCCqGSM49AwEHA0IABAGh2Qzty1LPAq8U I6IXVl3158K3fKSWZJCiOJBKBs1MvNb5dYJokWWpOXPZy3fFtGAYRpJ+dN194gQW cSK6FTagADAKBggqhkjOPQQDAgNHADBEAiALzRxp5b1Or0rk76mYO8IVPGFxcCf0 p+7Un5xS8GnmaAlgDYAkQw726KdAuAsrS8ynqEHBd5mmu2HqwtNofa9T9Dk= -----END CERTIFICATE REQUEST-----
Reviewed and accepted server access agreement?	*To be sent to the below signatory via Adobe Sign*
Name of authorised signatory	Authorised Name
Title of authorised signatory	General Manager
Email of authorised signatory	general.manager@providerexample.com

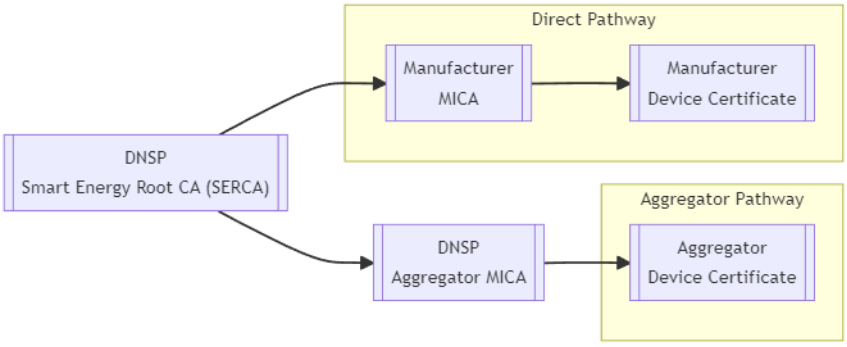
Annex B

Informative

PKI Certificates

SEP2 makes use of mutual TLS [10] to authenticate and identify clients through the use of client certificates. Each EndDevice must be issued a unique DER[4]-Encoded X.509 certificate that can be used to securely identify the site or aggregator. The device certificate is used to generate unique identifiers in the form of a LFDI and SFDI via hashing. In the case of cloud proxy connections, a 'virtual' LFDI is used.

The device certificate can only be issued via an approved provider, as the certificate must be signed by the Smart Energy Root CA (SERCA). Currently, the only supported SERCA provider in Queensland is Energex and Ergon Energy. This is subject to change as the national certification process matures.



The certificate file should include the full certificate chain of trust. That is, the file should also include the MICA and SERCA certificates.

[4] Note that in this instance, the abbreviation DER refers to Distinguished Encoding Rules and not Distributed Energy Resource

Generating a Private Key and CSR

When generating the Private Key, the SEP2 Standard stipulates that the ECC cipher suite SHALL use elliptic curve secp256r1. (This curve is also known as prime256v1 or NIST P-256.)

An example of how to generate this with openSSL is provided below.

```
openssl ecparam -name secp256r1 -genkey -noout -out private_key.pem
```

The private key is sensitive information, ensure that is stored securely and not shared.

Once your private key is generated, you can then generate a Certificate Signing Request (CSR). Note that traditional internet certificates include mandatory fields like the domain name of the website, but for SEP2 these must be left blank. To avoid openSSL prompting for these, you need to pass these as empty upfront.

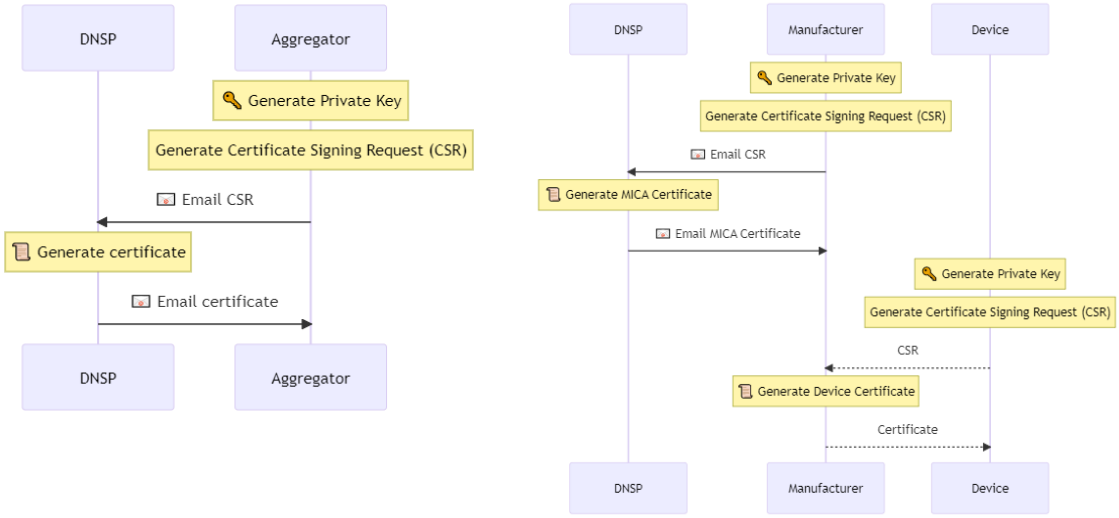
```
openssl req -new -key private_key.pem -out cert_req.csr -sha256 -subj "/CN= /O= "
```

Other methods of generating these files are also available.

Requesting a certificate

Once Energex and Ergon Energy have received the CSR, a certificate can be issued.

The process will vary slightly depending on whether a MICA certificate is required.



Determining the LFDI

The Long Form Device Identifier (LFDI) is used to identify a site and is calculated based on the device certificate.

The LFDI for a particular certificate can be displayed using the following OpenSSL command:

```
openssl x509 -outform der -in client-cert.pem | sha256sum | head -c 40 | tr '[a-f]' '[A-F]'
```

Or on Windows, the following PowerShell commands:

```
openssl x509 -outform der -in client-cert.pem -out client-cert.der
(Get-FileHash client-cert.der).Hash.Substring(0, 40)
```

Annex C

Informative

Example Client Code

The following example python code provides an example of how a very basic client program might work. This code is incomplete and not intended to constitute a working client program. It is intended to help with initial development but should not be used as-is in a production client.

```
import logging
import uuid
from datetime import datetime, timedelta
from pathlib import Path
from time import sleep

import requests
from dateutil import tz
from lxml import etree as ET
from tenacity import before_sleep_log, retry, stop_after_attempt, wait_random

from .example_cert import get_certificate_lfdi

log = logging.getLogger(__name__)
USER_AGENT = "python-sep2client"

def usage_point_mrid(pen: str, lfdi: str, role_flags):
    """Generate an MRID"""
    return f"{lfdi[0:22]}{role_flags}{pen:08}"

def reading_mrid(pen: str):
    """Generate an MRID"""
    random_hex = uuid.uuid4().hex
    return f"{random_hex[0:24]}{pen:08}"

class SEP2Server:
    """Connection to the SEP2 Utility Server"""

    def __init__(
        self,
        host: str = "http://example.com",
        dcap_uri: str = "/dcap",
        cert_path: str = "cert.pem",
        key_path: str = "key.pem",
        pen: int = 0,
    ) -> None:
        self.host = host
        self.dcap_uri = dcap_uri
        self.cert_path = Path(cert_path)
        self.key_path = key_path
        self.pen: str = f"{int(pen):08}"
        self.lfdi = get_certificate_lfdi(self.cert_path).replace("-", "")
        print(self.lfdi)

        self.nsmap = {
            "sep2": "urn:ieee:std:2030.5:ns",
            "csipaus": "https://csipaus.org/ns",
        }

        self.sesh = requests.Session()
        self.sesh.cert = (str(self.cert_path), self.key_path)
        self.sesh.headers = {
            "user-agent": USER_AGENT,
            "accept": "application/sep+xml",
            "Content-Type": "application/sep+xml",
        }
        self.sesh.verify = False  # Skip certificate check for now

        tm_uri, edev_uri, mup_uri = self.get_device_capabilities()
```

```
        self.tm_uri: str = tm_uri
        self.edev_uri: str = edev_uri
        self.mup_uri: str = mup_uri
        self.check_time_link()

    def __repr__(self):
        return f"<SEP2Server {self.host} as LFDI {self.lfdi}>"

    @retry(
        reraise=True,
        stop=stop_after_attempt(2),
        wait=wait_random(1, 3),
        before_sleep=before_sleep_log(log, logging.WARNING),
    )
    def get_response(self, link: str, params: dict = {}):
        """Get the response from the Utility Server"""
        log.info("GET %s %s", link, params)
        url = f"{self.host}{link}"
        r = self.sesh.get(url, params=params)
        r.raise_for_status()
        sleep(0.1)  # Avoid rate limiting errors
        return r

    def put_response(self, link: str, xml: str):
        """Get the response from the Utility Server"""
        url = f"{self.host}{link}"
        r = self.sesh.put(url, data=xml)
        r.raise_for_status()
        sleep(0.1)  # Avoid rate limiting errors
        return r

    def post_response(self, link: str, xml: str):
        """Get the response from the Utility Server"""
        url = f"{self.host}{link}"
        r = self.sesh.post(url, data=xml)
        location = r.headers.get("location")
        r.raise_for_status()
        sleep(0.1)  # Avoid rate limiting errors
        return r

    def get_xml(self, link: str, params: dict = {}):
        """Get the XML from the Utility Server"""
        r = self.get_response(link, params)
        tree = ET.fromstring(r.content)
        xmlstr = ET.tostring(
            tree, encoding="utf8", method="xml", pretty_print=True
        ).decode()
        return tree

    def get_device_capabilities(self) -> tuple[str, str, str]:
        "Get URLs to start crawling"
        xml = self.get_xml(self.dcap_uri, {})
        tm_uri = xml.find("sep2:TimeLink", self.nsmap).attrib["href"]
        edev_uri = xml.find("sep2:EndDeviceListLink", self.nsmap).attrib["href"]
        mup_uri = xml.find("sep2:MirrorUsagePointListLink", self.nsmap).attrib["href"]
        return tm_uri, edev_uri, mup_uri

    def check_time_link(self):
        """Raise an error if clock is not synced with server"""
        xml = self.get_xml(self.tm_uri, {})
        time_utc = int(xml.find("sep2:currentTime", self.nsmap).text)
        dt = datetime.utcfromtimestamp(time_utc).replace(tzinfo=tz.UTC)
        now = datetime.now(tz=tz.UTC)
        delta = now - dt
        log.info("Client %s Server %s Diff %s", dt, now, delta)
        if delta > timedelta(minutes=1):
            raise RuntimeError("Clock is not synced with Utility Server")
```

Annex D

Informative

Example Client Flow

The following example XML payloads are provided to assist with client development.

GET */api/v2/dcap*

```
<DeviceCapability xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns">
  <TimeLink href="/api/v2/tm"/>
  <EndDeviceListLink all="5" href="/api/v2/edev"/>
  <MirrorUsagePointListLink all="2" href="/api/v2/mup"/>
</DeviceCapability>
```

GET */api/v2/tm*

```
<Time xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" href="/api/v2/tm">
  <currentTime>1682475024</currentTime>
  <dstEndTime>1699174800</dstEndTime>
  <dstOffset>3600</dstOffset>
  <dstStartTime>1678615200</dstStartTime>
  <localTime>1682453424</localTime>
  <quality>5</quality>
  <tzOffset>-25200</tzOffset>
</Time>
```

GET */api/v2/edev {'s': 0, 'l': 255}*

```
<EndDeviceList xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" all="5" results="5"
subscribable="1">
  <EndDevice subscribable="0" href="/api/v2/edev/_EQLDEV3">
  <DERListLink all="1" href="/api/v2/edev/_EQLDEV3/der"/>
  <lFDI>4075DE6031E562ACF4D9EAA765A5B2ED00057269</lFDI>
  <LogEventListLink all="0" href="/api/v2/edev/_EQLDEV3/lel"/>
  <sFDI>173034634270</sFDI>
  <changedTime>1682464970</changedTime>
  <enabled>true</enabled>
  <FunctionSetAssignmentsListLink all="2" href="/api/v2/edev/_EQLDEV3/fsa"/>
  <RegistrationLink href="/api/v2/edev/_EQLDEV3/rg"/>
  </EndDevice>
  <EndDevice subscribable="0" href="/api/v2/edev/_EQLDEV1">
  <DERListLink all="1" href="/api/v2/edev/_EQLDEV1/der"/>
  <lFDI>4AECA0BBB7FE3A29920E6B0643348B2200057269</lFDI>
  <LogEventListLink all="0" href="/api/v2/edev/_EQLDEV1/lel"/>
  <sFDI>201123460434</sFDI>
```

```
  <changedTime>1682464970</changedTime>
  <enabled>true</enabled>
  <FunctionSetAssignmentsListLink all="2" href="/api/v2/edev/_EQLDEV1/fsa"/>
  <RegistrationLink href="/api/v2/edev/_EQLDEV1/rg"/>
  </EndDevice>
  <EndDevice subscribable="0" href="/api/v2/edev/E-AGGREQL">
  <lFDI>B1857F74B5DA25E82E78BE34877221CB89D55F45</lFDI>
  <LogEventListLink all="0" href="/api/v2/edev/E-AGGREQL/lel"/>
  <sFDI>476530583793</sFDI>
  <changedTime>1682464920</changedTime>
  <RegistrationLink href="/api/v2/edev/E-AGGREQL/rg"/>
  <SubscriptionListLink all="0" href="/api/v2/edev/E-AGGREQL/sub"/>
  </EndDevice>
</EndDeviceList>
```

GET */api/v2/edev/_EQLDEV3/rg*

```
<Registration   xmlns="urn:ieee:std:2030.5:ns"   xmlns:ns2="https://csipaus.org/ns"   pollRate="300"
href="/api/v2/edev/_EQLDEV3/rg">
  <dateTimeRegistered>1682464854</dateTimeRegistered>
  <pIN>1234</pIN>
</Registration>
```

GET */api/v2/edev/_EQLDEV3*

```
<EndDevice   xmlns="urn:ieee:std:2030.5:ns"   xmlns:ns2="https://csipaus.org/ns"   subscribable="0"
href="/api/v2/edev/_EQLDEV3">
  <DERListLink all="1" href="/api/v2/edev/_EQLDEV3/der"/>
  <lFDI>4075DE6031E562ACF4D9EAA765A5B2ED00057269</lFDI>
  <LogEventListLink all="0" href="/api/v2/edev/_EQLDEV3/lel"/>
  <sFDI>173034634270</sFDI>
  <changedTime>1682464970</changedTime>
  <enabled>true</enabled>
  <FunctionSetAssignmentsListLink all="2" href="/api/v2/edev/_EQLDEV3/fsa"/>
  <RegistrationLink href="/api/v2/edev/_EQLDEV3/rg"/>
</EndDevice>
```

GET */api/v2/edev/_EQLDEV1/rg*

```
<Registration   xmlns="urn:ieee:std:2030.5:ns"   xmlns:ns2="https://csipaus.org/ns"   pollRate="300"
href="/api/v2/edev/_EQLDEV1/rg">
  <dateTimeRegistered>1682464854</dateTimeRegistered>
  <pIN>1234</pIN>
</Registration>
```

GET */api/v2/edev/_EQLDEV1*

```
<EndDevice xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" subscribable="0" href="/api/v2/edev/_EQLDEV1">
  <DERListLink all="1" href="/api/v2/edev/_EQLDEV1/der"/>
  <lFDI>4AECA0BBB7FE3A29920E6B0643348B2200057269</lFDI>
  <LogEventListLink all="0" href="/api/v2/edev/_EQLDEV1/lel"/>
  <sFDI>201123460434</sFDI>
  <changedTime>1682464970</changedTime>
  <enabled>true</enabled>
  <FunctionSetAssignmentsListLink all="2" href="/api/v2/edev/_EQLDEV1/fsa"/>
  <RegistrationLink href="/api/v2/edev/_EQLDEV1/rg"/>
</EndDevice>
```

GET */api/v2/edev/_EQLDEV2/rg*

```
<Registration xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" pollRate="301" href="/api/v2/edev/_EQLDEV2/rg">
  <dateTimeRegistered>1682464854</dateTimeRegistered>
  <pIN>1234</pIN>
</Registration>
```

GET */api/v2/edev/_EQLDEV2*

```
<EndDevice xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" subscribable="0" href="/api/v2/edev/_EQLDEV2">
  <DERListLink all="1" href="/api/v2/edev/_EQLDEV2/der"/>
  <lFDI>7264E5CDFBF2C3E145B2489C464459A300057269</lFDI>
  <LogEventListLink all="0" href="/api/v2/edev/_EQLDEV2/lel"/>
  <sFDI>307074408638</sFDI>
  <changedTime>1682464970</changedTime>
  <enabled>true</enabled>
  <FunctionSetAssignmentsListLink all="2" href="/api/v2/edev/_EQLDEV2/fsa"/>
  <RegistrationLink href="/api/v2/edev/_EQLDEV2/rg"/>
</EndDevice>
```

GET */api/v2/edev/_EQLDEV4/rg*

```
<Registration xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" pollRate="301" href="/api/v2/edev/_EQLDEV4/rg">
  <dateTimeRegistered>1682464854</dateTimeRegistered>
  <pIN>1234</pIN>
</Registration>
```

GET */api/v2/edev/_EQLDEV4*

```
<EndDevice xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" subscribable="0" href="/api/v2/edev/_EQLDEV4">
  <DERListLink all="1" href="/api/v2/edev/_EQLDEV4/der"/>
  <lFDI>C1862AD7780DAF866A837405E15C974600057269</lFDI>
```

```
  <LogEventListLink all="0" href="/api/v2/edev/_EQLDEV4/lel"/>
  <sFDI>519487276713</sFDI>
  <changedTime>1682464970</changedTime>
  <enabled>true</enabled>
  <FunctionSetAssignmentsListLink all="2" href="/api/v2/edev/_EQLDEV4/fsa"/>
  <RegistrationLink href="/api/v2/edev/_EQLDEV4/rg"/>

</EndDevice>
```

GET */api/v2/edev/E-AGGREQL/rg*

```
<Registration xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" pollRate="301" href="/api/v2/edev/E-AGGREQL/rg">
  <dateTimeRegistered>1682439677</dateTimeRegistered>
  <pIN>111115</pIN>
</Registration>
```

GET */api/v2/edev/E-AGGREQL*

```
<EndDevice xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" subscribable="0" href="/api/v2/edev/E-AGGREQL">
  <lFDI>B1857F74B5DA25E82E78BE34877221CB89D55F45</lFDI>
  <LogEventListLink all="0" href="/api/v2/edev/E-AGGREQL/lel"/>
  <sFDI>476530583793</sFDI>
  <changedTime>1682464920</changedTime>
  <RegistrationLink href="/api/v2/edev/E-AGGREQL/rg"/>
  <SubscriptionListLink all="0" href="/api/v2/edev/E-AGGREQL/sub"/>
</EndDevice>
```

GET */api/v2/mup {'s': 0, 'l': 255}*

```
<MirrorUsagePointList xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" all="2" results="2" href="/api/v2/mup">
  <MirrorUsagePoint href="/api/v2/mup/85a3f3a1-8fdf-4952-bdf6-cdf405e33127">
  <mRID>4075DE6031E562ACF4D9EA4900057269</mRID>
  <description>Device Measurement</description>
  <roleFlags>49</roleFlags>
  <serviceCategoryKind>0</serviceCategoryKind>
  <status>1</status>
  <deviceLFDI>4075DE6031E562ACF4D9EAA765A5B2ED00057269</deviceLFDI>
  </MirrorUsagePoint>
  <MirrorUsagePoint href="/api/v2/mup/86e73745-8a19-4ece-86c8-78a6852964a5">
  <mRID>4075DE6031E562ACF4D9EA0B00057269</mRID>
  <description>Site Measurement</description>
  <roleFlags>0B</roleFlags>
  <serviceCategoryKind>0</serviceCategoryKind>
  <status>1</status>
```

```
  <deviceLFDI>4075DE6031E562ACF4D9EAA765A5B2ED00057269</deviceLFDI>
  </MirrorUsagePoint>
</MirrorUsagePointList>
```

Get DERControls

GET */api/v2/edev/_EQLDEV3/fsa {'s': 0, 'l': 255}*

```
<FunctionSetAssignmentsList xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" all="2"
results="2" subscribable="1">
  <FunctionSetAssignments subscribable="1" href="/api/v2/edev/_EQLDEV3/fsa/2">
  <DERProgramListLink all="1" href="/api/v2/edev/_EQLDEV3/fsa/2/derp"/>
  <ResponseSetListLink all="0" href="/api/v2/rsps"/>
  <TimeLink href="/api/v2/tm"/>
  <mRID>DE045D141A8B335F96AFDE5AFECDBA09</mRID>
  <description>FSA 2</description>
  <version>1</version>
  </FunctionSetAssignments>
  <FunctionSetAssignments subscribable="0" href="/api/v2/edev/_EQLDEV3/fsa/1">
  <DERProgramListLink all="1" href="/api/v2/edev/_EQLDEV3/fsa/1/derp"/>
  <ResponseSetListLink all="0" href="/api/v2/rsps"/>
  <TimeLink href="/api/v2/tm"/>
  <mRID>5B58B532F06F361382ECF6F2FECDBA09</mRID>
  <description>Inverter - _EQLDEV3 FSA</description>
  <version>0</version>
  </FunctionSetAssignments>
</FunctionSetAssignmentsList>
```

GET */api/v2/edev/_EQLDEV3/fsa/2/derp {'s': 0, 'l': 255}*

```
<DERProgramList  xmlns="urn:ieee:std:2030.5:ns"  xmlns:ns2="https://csipaus.org/ns"  pollRate="301"
all="1" results="1" subscribable="1">
  <DERProgram subscribable="0" href="/api/v2/derp/TESTPRG3">
  <mRID>C7170E2F587E43EE98E51043FECDBA09</mRID>
  <description>Test Program 3</description>
  <version>1</version>
  <DefaultDERControlLink href="/api/v2/derp/TESTPRG3/dderc"/>
  <DERControlListLink all="5" href="/api/v2/derp/TESTPRG3/derc"/>
  <DERCurveListLink all="0" href="/api/v2/derp/TESTPRG3/dc"/>
  <primacy>1</primacy>
  </DERProgram>
</DERProgramList>
```

GET */api/v2/edev/_EQLDEV3/fsa/1/derp {'s': 0, 'l': 255}*

```
<DERProgramList  xmlns="urn:ieee:std:2030.5:ns"  xmlns:ns2="https://csipaus.org/ns"  pollRate="301"
all="1" results="1" subscribable="1">
  <DERProgram subscribable="0" href="/api/v2/derp/P-_EQLDEV3">
  <mRID>C882D1F83246441786FB8278FECDBA09</mRID>
```

```
  <description>_EQLDEV3 Program</description>
  <version>1</version>
  <DERControlListLink all="0" href="/api/v2/derp/P-_EQLDEV3/derc"/>
  <DERCurveListLink all="0" href="/api/v2/derp/P-_EQLDEV3/dc"/>
  <primacy>102</primacy>
  </DERProgram>
</DERProgramList>
```


GET */api/v2/derp/TESTPRG3/dderc {'s': 0, 'l': 255}*


```
<DefaultDERControl xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" subscribable="0"
href="/api/v2/derp/TESTPRG3/dderc">
  <mRID>E6F3A83FC1E64929BB4502AA0CEA0FDB</mRID>
  <version>0</version>
  <DERControlBase>
  <ns2:opModImpLimW>
    <multiplier>2</multiplier>
    <value>15</value>
  </ns2:opModImpLimW>
  <ns2:opModExpLimW>
    <multiplier>2</multiplier>
    <value>15</value>
  </ns2:opModExpLimW>
  <opModEnergize>true</opModEnergize>
  </DERControlBase>
  <setSoftGradW>1</setSoftGradW>
</DefaultDERControl>
```


GET */api/v2/derp/TESTPRG3/derc {'s': 0, 'l': 255}*


```
<DERControlList xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" all="5" results="5"
subscribable="1">
  <DERControl      subscribable="0"      replyTo="/api/v2/rsps/res-ms/rsp"      responseRequired="03"
href="/api/v2/derp/TESTPRG3/derc/DC1B27AC943B44AC87DAF7E162B6F6D4">
  <mRID>DC1B27AC943B44AC87DAF7E162B6F6D4</mRID>
  <version>0</version>
  <creationTime>1682511010</creationTime>
  <EventStatus>
    <currentStatus>0</currentStatus>
    <dateTime>1682511010</dateTime>
    <potentiallySuperseded>false</potentiallySuperseded>
    <potentiallySupersededTime>1682511010</potentiallySupersededTime>
    <reason/>
  </EventStatus>
  <interval>
    <duration>300</duration>
```

```
    <start>1682475300</start>
  </interval>
  <DERControlBase>
    <ns2:opModImpLimW>
    <multiplier>0</multiplier>
    <value>3512</value>
    </ns2:opModImpLimW>
    <ns2:opModExpLimW>


<multiplier>0</multiplier>
    <value>2512</value>
    </ns2:opModExpLimW>
    <ns2:opModGenLimW>
    <multiplier>4</multiplier>
    <value>3</value>
    </ns2:opModGenLimW>
    <ns2:opModLoadLimW>
    <multiplier>4</multiplier>
    <value>3</value>
    </ns2:opModLoadLimW>
  </DERControlBase>
  </DERControl>
  <DERControl      subscribable="0"      replyTo="/api/v2/rsps/res-ms/rsp"      responseRequired="03"
href="/api/v2/derp/TESTPRG3/derc/737A28BE154F4050BFB61D24202C0983">
  <mRID>737A28BE154F4050BFB61D24202C0983</mRID>
  <version>0</version>
  <creationTime>1682511011</creationTime>
  <EventStatus>
    <currentStatus>0</currentStatus>
    <dateTime>1682511011</dateTime>
    <potentiallySuperseded>false</potentiallySuperseded>
    <potentiallySupersededTime>1682511011</potentiallySupersededTime>
    <reason/>
  </EventStatus>
  <interval>
    <duration>300</duration>
    <start>1682475600</start>
  </interval>
  <DERControlBase>
    <ns2:opModImpLimW>
    <multiplier>1</multiplier>
    <value>251</value>
    </ns2:opModImpLimW>
```

```
    <ns2:opModExpLimW>
    <multiplier>2</multiplier>
    <value>25</value>
    </ns2:opModExpLimW>
  </DERControlBase>
  </DERControl>
  <DERControl      subscribable="0"      replyTo="/api/v2/rsps/res-ms/rsp"      responseRequired="03"
href="/api/v2/derp/TESTPRG3/derc/B449BA6254B54629824DD5A8483FDC85">
  <mRID>B449BA6254B54629824DD5A8483FDC85</mRID>
  <version>0</version>
  <creationTime>1682511011</creationTime>
  <EventStatus>
    <currentStatus>0</currentStatus>
    <dateTime>1682511011</dateTime>
    <potentiallySuperseded>false</potentiallySuperseded>
    <potentiallySupersededTime>1682511011</potentiallySupersededTime>
    <reason/>
  </EventStatus>
  <interval>
    <duration>300</duration>
    <start>1682475900</start>
  </interval>
  <DERControlBase>
    <ns2:opModImpLimW>
    <multiplier>3</multiplier>
    <value>5</value>
    </ns2:opModImpLimW>
    <ns2:opModExpLimW>
    <multiplier>3</multiplier>
    <value>5</value>
    </ns2:opModExpLimW>
  </DERControlBase>
  </DERControl>
  <DERControl      subscribable="0"      replyTo="/api/v2/rsps/res-ms/rsp"      responseRequired="03"
href="/api/v2/derp/TESTPRG3/derc/13F80DFABADB421088DFC77B7C05AA7E">
  <mRID>13F80DFABADB421088DFC77B7C05AA7E</mRID>
  <version>0</version>
  <creationTime>1682511012</creationTime>
  <EventStatus>
    <currentStatus>0</currentStatus>
<dateTime>1682511012</dateTime>
    <potentiallySuperseded>false</potentiallySuperseded>
    <potentiallySupersededTime>1682511012</potentiallySupersededTime>
    <reason/>
```

```
  </EventStatus>
  <interval>
    <duration>300</duration>
    <start>1682476200</start>
  </interval>
  <DERControlBase>
    <ns2:opModImpLimW>
    <multiplier>3</multiplier>
    <value>12</value>
    </ns2:opModImpLimW>
    <ns2:opModExpLimW>
    <multiplier>4</multiplier>
    <value>1</value>
    </ns2:opModExpLimW>
  </DERControlBase>
  </DERControl>
  <DERControl      subscribable="0"      replyTo="/api/v2/rsps/res-ms/rsp"      responseRequired="03"
href="/api/v2/derp/TESTPRG3/derc/295BB93B19464FC99501B8AB04689F87">
  <mRID>295BB93B19464FC99501B8AB04689F87</mRID>
  <version>0</version>
  <creationTime>1682511013</creationTime>
  <EventStatus>
    <currentStatus>0</currentStatus>
    <dateTime>1682511013</dateTime>
    <potentiallySuperseded>false</potentiallySuperseded>
    <potentiallySupersededTime>1682511013</potentiallySupersededTime>
    <reason/>
  </EventStatus>
  <interval>
    <duration>300</duration>
    <start>1682476500</start>
  </interval>
  <DERControlBase>
    <ns2:opModImpLimW>
    <multiplier>0</multiplier>
    <value>0</value>
    </ns2:opModImpLimW>
    <ns2:opModExpLimW>
    <multiplier>0</multiplier>
    <value>0</value>
    </ns2:opModExpLimW>
    <ns2:opModGenLimW>
    <multiplier>0</multiplier>
    <value>0</value>
```

```
    </ns2:opModGenLimW>
    <ns2:opModLoadLimW>
    <multiplier>0</multiplier>
    <value>0</value>
    </ns2:opModLoadLimW>
  </DERControlBase>
  </DERControl>
</DERControlList>
```

POST */api/v2/rsps/res-ms/rsp*

```
<DERControlResponse xmlns="urn:ieee:std:2030.5:ns">
        <createdDateTime>1682475000</createdDateTime>
        <endDeviceLFDI>4075DE6031E562ACF4D9EAA765A5B2ED00057269</endDeviceLFDI>
        <status>1</status>
        <subject>DC1B27AC943B44AC87DAF7E162B6F6D4</subject>
      </DERControlResponse>
```

201 Location: /api/v2/rsps/res-ms/rsp/84DF3781D2A8424191AB38C77B70C226

POST */api/v2/rsps/res-ms/rsp*

```
<DERControlResponse xmlns="urn:ieee:std:2030.5:ns">
        <createdDateTime>1682475000</createdDateTime>
        <endDeviceLFDI>4075DE6031E562ACF4D9EAA765A5B2ED00057269</endDeviceLFDI>
        <status>1</status>

        <subject>737A28BE154F4050BFB61D24202C0983</subject>
      </DERControlResponse>
```

201 Location: /api/v2/rsps/res-ms/rsp/DD9AF838F48A4B1AA9064029B86EECCD

POST */api/v2/rsps/res-ms/rsp*

```
<DERControlResponse xmlns="urn:ieee:std:2030.5:ns">
        <createdDateTime>1682475000</createdDateTime>
        <endDeviceLFDI>4075DE6031E562ACF4D9EAA765A5B2ED00057269</endDeviceLFDI>
        <status>1</status>
        <subject>B449BA6254B54629824DD5A8483FDC85</subject>
      </DERControlResponse>
```

201 Location: /api/v2/rsps/res-ms/rsp/16EAFDCC35184C54B0A7E679EAF45429

POST */api/v2/rsps/res-ms/rsp*

```
<DERControlResponse xmlns="urn:ieee:std:2030.5:ns">
        <createdDateTime>1682475000</createdDateTime>
        <endDeviceLFDI>4075DE6031E562ACF4D9EAA765A5B2ED00057269</endDeviceLFDI>
        <status>1</status>
        <subject>13F80DFABADB421088DFC77B7C05AA7E</subject>
      </DERControlResponse>
```

201 Location: /api/v2/rsps/res-ms/rsp/CE89D628455E4A899CBE8BFC7C5540A2

POST */api/v2/rsps/res-ms/rsp*

```
<DERControlResponse xmlns="urn:ieee:std:2030.5:ns">
        <createdDateTime>1682475000</createdDateTime>
        <endDeviceLFDI>4075DE6031E562ACF4D9EAA765A5B2ED00057269</endDeviceLFDI>
        <status>1</status>
        <subject>295BB93B19464FC99501B8AB04689F87</subject>
      </DERControlResponse>
```

201 Location: /api/v2/rsps/res-ms/rsp/BEB2BE756A484F9E9B890C756DBFA117

GET */api/v2/derp/P-_EQLDEV3/derc {'s': 0, 'l': 255}*

```
<DERControlList xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns" all="0" results="0"
subscribable="1"/>
```

Send DER Values

GET */api/v2/edev/_EQLDEV3/der {'s': 0, 'l': 255}*

```
<DERList  xmlns="urn:ieee:std:2030.5:ns"  xmlns:ns2="https://csipaus.org/ns"  pollRate="301"  all="1"
results="1">
  <DER subscribable="0" href="/api/v2/edev/_EQLDEV3/der/_EQLDEV3">
  <DERAvailabilityLink href="/api/v2/edev/_EQLDEV3/der/_EQLDEV3/dera"/>
  <DERCapabilityLink href="/api/v2/edev/_EQLDEV3/der/_EQLDEV3/dercap"/>
  <DERSettingsLink href="/api/v2/edev/_EQLDEV3/der/_EQLDEV3/derg"/>
  <DERStatusLink href="/api/v2/edev/_EQLDEV3/der/_EQLDEV3/ders"/>
  </DER>
</DERList>
```

PUT */api/v2/edev/_EQLDEV3/der/_EQLDEV3/ders*

```
<DERStatus xmlns="urn:ieee:std:2030.5:ns">
  <readingTime>1682475028</readingTime>
  <operationalModeStatus>
    <dateTime>1682475028</dateTime>
    <value>2</value>
  </operationalModeStatus>
  <genConnectStatus>
    <dateTime>1682475028</dateTime>
    <value>0</value>
  </genConnectStatus>
  </DERStatus>
```

PUT */api/v2/edev/_EQLDEV3/der/_EQLDEV3/dercap*

```
<DERCapability xmlns="urn:ieee:std:2030.5:ns" xmlns:csipaus="https://csipaus.org/ns" >
    <modesSupported>00500088</modesSupported>
    <csipaus:doeModesSupported>0000000F</csipaus:doeModesSupported>
```

```
    <type>1</type>
    <rtgMaxVA>
      <multiplier>3</multiplier>
      <value>52.5</value>
    </rtgMaxVA>
    <rtgMaxW>
      <multiplier>3</multiplier>
      <value>50.0</value>
    </rtgMaxW>
    <rtgMaxVar>
      <multiplier>3</multiplier>
      <value>2.5</value>
    </rtgMaxVar>
    <rtgVNom>
      <multiplier>0</multiplier>
      <value>230</value>
    </rtgVNom>
  </DERCapability>
```

PUT */api/v2/edev/_EQLDEV3/der/_EQLDEV3/derg*

```
<DERSettings xmlns="urn:ieee:std:2030.5:ns">
    <updatedTime>1682475029</updatedTime>
    <modesEnabled>00500088</modesEnabled>
    <setGradW>1</setGradW>
    <setMaxVA>
      <multiplier>3</multiplier>
      <value>52.5</value>
    </setMaxVA>
    <setMaxW>
      <multiplier>3</multiplier>
      <value>50.0</value>
    </setMaxW>
    <setMaxVar>
      <multiplier>3</multiplier>
      <value>2.5</value>
    </setMaxVar>
  </DERSettings>
```

Send Telemetry

POST */api/v2/mup*

```
<MirrorUsagePoint xmlns="urn:ieee:std:2030.5:ns">
    <mRID>4075DE6031E562ACF4D9EA0B00057269</mRID>
    <description>Site Measurement</description>
```

```
    <roleFlags>03</roleFlags>
    <serviceCategoryKind>0</serviceCategoryKind>
    <status>1</status>
    <deviceLFDI>4075DE6031E562ACF4D9EAA765A5B2ED00057269</deviceLFDI>
  </MirrorUsagePoint>
```

204 Location: /api/v2/mup/86e73745-8a19-4ece-86c8-78a6852964a5

POST */api/v2/mup/86e73745-8a19-4ece-86c8-78a6852964a5*

```
<MirrorMeterReading xmlns="urn:ieee:std:2030.5:ns">
    <mRID>33b710b2e8c2424997f8ea1e00057269</mRID>
    <description>Average W Reading - Phase A</description>
    <lastUpdateTime>1682475000</lastUpdateTime>
    <nextUpdateTime>1682475300</nextUpdateTime>
    <version>0</version>
    <Reading>
      <qualityFlags>00</qualityFlags><!-- 0 - valid -->
      <value>48</value>
    </Reading>
    <ReadingType>
      <commodity>1</commodity><!--1 = Electricity secondary metered-->
      <kind>37</kind><!-- 37 = Power -->
      <dataQualifier>2</dataQualifier><!-- 2 = Average -->
      <flowDirection>19</flowDirection><!-- 1 = Forward (delivered to customer) -->
      <phase>128</phase><!-- 128 = Phase A (and S1) -->
      <powerOfTenMultiplier>3</powerOfTenMultiplier>


      <uom>38</uom><!-- 38 = W (Real power in Watts) -->
    </ReadingType>
  </MirrorMeterReading>
```

201 Location: /api/v2/upt/86e73745-8a19-4ece-86c8-78a6852964a5/mr/33B710B2E8C2424997F8EA1E00057269

GET */api/v2/upt/86e73745-8a19-4ece-86c8-78a6852964a5/mr/33B710B2E8C2424997F8EA1E00057269*

```
<MeterReading xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns">
  <mRID>33B710B2E8C2424997F8EA1E00057269</mRID>
  <description>Average W Reading - Phase A</description>
  <version>0</version>
  <ReadingLink                                          href="/api/v2/upt/86e73745-8a19-4ece-86c8-
78a6852964a5/mr/33B710B2E8C2424997F8EA1E00057269/r"/>
  <ReadingTypeLink                                      href="/api/v2/upt/86e73745-8a19-4ece-86c8-
78a6852964a5/mr/33B710B2E8C2424997F8EA1E00057269/rt"/>
</MeterReading>
```

POST */api/v2/mup/86e73745-8a19-4ece-86c8-78a6852964a5*

```
<MirrorMeterReading xmlns="urn:ieee:std:2030.5:ns">
```

```
    <mRID>8842561f1a9a4d2abc8c66dc00057269</mRID>
    <description>Average Var Reading - Phase A</description>
    <lastUpdateTime>1682475000</lastUpdateTime>
    <nextUpdateTime>1682475300</nextUpdateTime>
    <version>0</version>
    <Reading>
      <qualityFlags>00</qualityFlags><!-- 0 - valid -->
      <value>30000</value>
    </Reading>
    <ReadingType>
      <commodity>1</commodity><!--1 = Electricity secondary metered-->
      <kind>37</kind><!-- 37 = Power -->
      <dataQualifier>2</dataQualifier><!-- 2 = Average -->
      <flowDirection>19</flowDirection><!-- 1 = Forward (delivered to customer) -->
      <phase>128</phase><!-- 128 = Phase A (and S1) -->
      <powerOfTenMultiplier>0</powerOfTenMultiplier>
      <uom>63</uom><!-- 63 = var (Reactive power) -->
    </ReadingType>
  </MirrorMeterReading>
```

201 Location: /api/v2/upt/86e73745-8a19-4ece-86c8-78a6852964a5/mr/8842561F1A9A4D2ABC8C66DC00057269

GET */api/v2/upt/86e73745-8a19-4ece-86c8-78a6852964a5/mr/8842561F1A9A4D2ABC8C66DC00057269*

```
<MeterReading xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns">
  <mRID>8842561F1A9A4D2ABC8C66DC00057269</mRID>
  <description>Average Var Reading - Phase A</description>
  <version>0</version>
  <ReadingLink                                          href="/api/v2/upt/86e73745-8a19-4ece-86c8-
78a6852964a5/mr/8842561F1A9A4D2ABC8C66DC00057269/r"/>
  <ReadingTypeLink                                      href="/api/v2/upt/86e73745-8a19-4ece-86c8-
78a6852964a5/mr/8842561F1A9A4D2ABC8C66DC00057269/rt"/>
</MeterReading>
```

POST */api/v2/mup/86e73745-8a19-4ece-86c8-78a6852964a5*

```
<MirrorMeterReading xmlns="urn:ieee:std:2030.5:ns">
    <mRID>445246eaba7a4806bbff6dbe00057269</mRID>
    <description>Average V Reading - Phase A</description>
    <lastUpdateTime>1682475000</lastUpdateTime>
    <nextUpdateTime>1682475300</nextUpdateTime>
    <version>0</version>
    <Reading>
      <qualityFlags>00</qualityFlags><!-- 0 - valid -->
      <value>240</value>
    </Reading>
    <ReadingType>
```

```
      <commodity>1</commodity><!--1 = Electricity secondary metered-->
      <kind>9</kind><!-- 37 = Power -->
      <dataQualifier>2</dataQualifier><!-- 2 = Average -->
      <flowDirection>19</flowDirection><!-- 0 = Not Applicable -->
      <phase>128</phase><!-- 128 = Phase A (and S1) -->
      <powerOfTenMultiplier>0</powerOfTenMultiplier>
      <uom>29</uom><!-- 29 = Voltage -->
    </ReadingType>
  </MirrorMeterReading>
```

201 Location: /api/v2/upt/86e73745-8a19-4ece-86c8-78a6852964a5/mr/445246EABA7A4806BBFF6DBE00057269

GET */api/v2/upt/86e73745-8a19-4ece-86c8-78a6852964a5/mr/445246EABA7A4806BBFF6DBE00057269*

```
<MeterReading xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns">
  <mRID>445246EABA7A4806BBFF6DBE00057269</mRID>
  <description>Average V Reading - Phase A</description>
  <version>0</version>
  <ReadingLink                                          href="/api/v2/upt/86e73745-8a19-4ece-86c8-
78a6852964a5/mr/445246EABA7A4806BBFF6DBE00057269/r"/>
  <ReadingTypeLink                                      href="/api/v2/upt/86e73745-8a19-4ece-86c8-
78a6852964a5/mr/445246EABA7A4806BBFF6DBE00057269/rt"/>
</MeterReading>
```

POST */api/v2/mup*

```
<MirrorUsagePoint xmlns="urn:ieee:std:2030.5:ns">
    <mRID>4075DE6031E562ACF4D9EA4900057269</mRID>
    <description>Device Measurement</description>
    <roleFlags>49</roleFlags>
    <serviceCategoryKind>0</serviceCategoryKind>
    <status>1</status>
    <deviceLFDI>4075DE6031E562ACF4D9EAA765A5B2ED00057269</deviceLFDI>
  </MirrorUsagePoint>
```

204 Location: /api/v2/mup/85a3f3a1-8fdf-4952-bdf6-cdf405e33127

POST */api/v2/mup/85a3f3a1-8fdf-4952-bdf6-cdf405e33127*

```
<MirrorMeterReading xmlns="urn:ieee:std:2030.5:ns">
    <mRID>8eb98baa49b14058850126c300057269</mRID>
    <description>Average W Reading - Phase A</description>
    <lastUpdateTime>1682475000</lastUpdateTime>
    <nextUpdateTime>1682475300</nextUpdateTime>
    <version>0</version>
    <Reading>
      <qualityFlags>00</qualityFlags><!-- 0 - valid -->
      <value>48</value>
    </Reading>
    <ReadingType>
      <commodity>1</commodity><!--1 = Electricity secondary metered-->
```

```
      <kind>37</kind><!-- 37 = Power -->
      <dataQualifier>2</dataQualifier><!-- 2 = Average -->
      <flowDirection>19</flowDirection><!-- 1 = Forward (delivered to customer) -->
      <phase>128</phase><!-- 128 = Phase A (and S1) -->
      <powerOfTenMultiplier>3</powerOfTenMultiplier>
      <uom>38</uom><!-- 38 = W (Real power in Watts) -->
    </ReadingType>
  </MirrorMeterReading>
```

201 Location: /api/v2/upt/85a3f3a1-8fdf-4952-bdf6-cdf405e33127/mr/8EB98BAA49B14058850126C300057269

GET */api/v2/upt/85a3f3a1-8fdf-4952-bdf6-cdf405e33127/mr/8EB98BAA49B14058850126C300057269*

```
<MeterReading xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns">
  <mRID>8EB98BAA49B14058850126C300057269</mRID>
  <description>Average W Reading - Phase A</description>
  <version>0</version>
  <ReadingLink                                          href="/api/v2/upt/85a3f3a1-8fdf-4952-bdf6-
cdf405e33127/mr/8EB98BAA49B14058850126C300057269/r"/>
  <ReadingTypeLink                                      href="/api/v2/upt/85a3f3a1-8fdf-4952-bdf6-
cdf405e33127/mr/8EB98BAA49B14058850126C300057269/rt"/>
</MeterReading>
```

POST */api/v2/mup/85a3f3a1-8fdf-4952-bdf6-cdf405e33127*

```
<MirrorMeterReading xmlns="urn:ieee:std:2030.5:ns">
    <mRID>e3cd0c6a3b5045a58b786e2b00057269</mRID>
    <description>Average Var Reading - Phase A</description>
    <lastUpdateTime>1682475000</lastUpdateTime>
    <nextUpdateTime>1682475300</nextUpdateTime>
    <version>0</version>
    <Reading>
      <qualityFlags>00</qualityFlags><!-- 0 - valid -->
      <value>30000</value>
    </Reading>
    <ReadingType>
      <commodity>1</commodity><!--1 = Electricity secondary metered-->
      <kind>37</kind><!-- 37 = Power -->
      <dataQualifier>2</dataQualifier><!-- 2 = Average -->
      <flowDirection>19</flowDirection><!-- 1 = Forward (delivered to customer) -->
      <phase>128</phase><!-- 128 = Phase A (and S1) -->
      <powerOfTenMultiplier>0</powerOfTenMultiplier>
      <uom>63</uom><!-- 63 = var (Reactive power) -->
    </ReadingType>
  </MirrorMeterReading>
```

201 Location: /api/v2/upt/85a3f3a1-8fdf-4952-bdf6-cdf405e33127/mr/E3CD0C6A3B5045A58B786E2B00057269

GET */api/v2/upt/85a3f3a1-8fdf-4952-bdf6-cdf405e33127/mr/E3CD0C6A3B5045A58B786E2B00057269*

```
<MeterReading xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns">
```

```
  <mRID>E3CD0C6A3B5045A58B786E2B00057269</mRID>
  <description>Average Var Reading - Phase A</description>
  <version>0</version>
  <ReadingLink                                          href="/api/v2/upt/85a3f3a1-8fdf-4952-bdf6-
cdf405e33127/mr/E3CD0C6A3B5045A58B786E2B00057269/r"/>
  <ReadingTypeLink                                      href="/api/v2/upt/85a3f3a1-8fdf-4952-bdf6-
cdf405e33127/mr/E3CD0C6A3B5045A58B786E2B00057269/rt"/>
</MeterReading>
```

POST */api/v2/mup/85a3f3a1-8fdf-4952-bdf6-cdf405e33127*

```
<MirrorMeterReading xmlns="urn:ieee:std:2030.5:ns">
    <mRID>559afd6bfbfc43d6b2de0a0500057269</mRID>
    <description>Average V Reading - Phase A</description>
    <lastUpdateTime>1682475000</lastUpdateTime>
    <nextUpdateTime>1682475300</nextUpdateTime>
    <version>0</version>
    <Reading>
      <qualityFlags>00</qualityFlags><!-- 0 - valid -->
      <value>240</value>
    </Reading>
    <ReadingType>
      <commodity>1</commodity><!--1 = Electricity secondary metered-->
      <kind>9</kind><!-- 37 = Power -->
      <dataQualifier>2</dataQualifier><!-- 2 = Average -->
      <flowDirection>19</flowDirection><!-- 0 = Not Applicable -->
      <phase>128</phase><!-- 128 = Phase A (and S1) -->
      <powerOfTenMultiplier>0</powerOfTenMultiplier>
      <uom>29</uom><!-- 29 = Voltage -->
    </ReadingType>
  </MirrorMeterReading>
```

201 Location: /api/v2/upt/85a3f3a1-8fdf-4952-bdf6-cdf405e33127/mr/559AFD6BFBFC43D6B2DE0A0500057269

GET */api/v2/upt/85a3f3a1-8fdf-4952-bdf6-cdf405e33127/mr/559AFD6BFBFC43D6B2DE0A0500057269*

```
<MeterReading xmlns="urn:ieee:std:2030.5:ns" xmlns:ns2="https://csipaus.org/ns">
  <mRID>559AFD6BFBFC43D6B2DE0A0500057269</mRID>
  <description>Average V Reading - Phase A</description>
  <version>0</version>
  <ReadingLink                                          href="/api/v2/upt/85a3f3a1-8fdf-4952-bdf6-
cdf405e33127/mr/559AFD6BFBFC43D6B2DE0A0500057269/r"/>
  <ReadingTypeLink                                      href="/api/v2/upt/85a3f3a1-8fdf-4952-bdf6-
cdf405e33127/mr/559AFD6BFBFC43D6B2DE0A0500057269/rt"/>
</MeterReading>
```