DEIP
DISTRIBUTED ENERGY INTEGRATION PROGRAM

DEIP Interoperability Steering Committee

REFERENCE ARCHITECTURE FOR CONSUMER ENERGY RESOURCES

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Version 1.0

ABOUT DEIP

The Distributed Energy Integration Program (DEIP) is a collaborative network of government agencies, market bodies, peak industry bodies and consumer associations working together to maximise the value of distributed energy resources (DER) for all Australian consumers.

The DEIP members exchange insights, seek industry consensus, and focus attention on priority activities to provide the necessary pre-policy evidence needed to support informed decision making in the Australian energy transition.

DISCLAIMER

This report was commissioned by the Australian Renewable Energy Agency (ARENA), on behalf of the Distributed Energy Integration Program (DEIP). This report has been written by Tim Moore with input from Deborah Taylor and Lachlan Blackhall and assistance in development from a collective of stakeholders from across the energy industry. The report presents the findings of the authors, which was prepared in accordance with the contractual requirements of the ARENA funding agreement. ARENA and the DEIP have not endorsed the contents of this report, nor does the report necessarily represent the views or opinions of ARENA or the DEIP. The views expressed herein are also not necessarily the views of the Australian Government, and the Australian Government does not accept responsibility for any information or advice contained herein.

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To the best of ARENA and the authors knowledge, no conflict of interest arose during the course of preparing this report.

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INTRODUCTION

STATEMENT OF PURPOSE

This document is intended to describe current and potential future communication architectures relating to the management of consumer energy resources (CER). The document is broken into a series of diagrams, each of which represents either a current architecture or a potential (future) usecase, as highlighted in the title of each diagram.

The intent of this document is not to dictate or promote specific architectures for future consideration; rather it is intended to provide a visual understanding of architectures that exist (and may be commonly used) currently, or are predicted to emerge over the next 1 to 3 years. The intent is to support the evaluation of technical and cyber security requirements of such architectures, and for emerging use-cases consider their feasibility both technically and from a policy & regulatory perspective.

EXPLANATORY NOTES

- Due to the breadth of systems involved in CER management the scope of these architectures go beyond simply the CER, and into areas including market interactions, DNSP operations and cloud based third-party/vendor platforms.
- The scope of this document is systems relating to or engaging with Consumer Energy Resources (as opposed to Distributed Energy Resources); as such some systems relevant for DER are not considered in scope for these architecture diagrams.
- Systems, devices and actors described in the architecture diagrams indicate functional & logical concepts rather than physical ones. A single physical device may constitute numerous functional systems shown in these architectures; similarly a single functional system may be distributed across a number of physical devices.
- Some of these diagrams demonstrate how CER devices may be managed or controlled by external systems or actors. In such programs consumer control over their devices must be paramount; they may relinquish operational control to third-parties of their own volution because they deem it to be in their interest, and this may be rescinded at any time.
- A number of architecture include roles relating to cloud-based systems. It should be noted that such platforms (of all types – including OEM platforms, VPPs and broader aggregators) may be based offshore, and that this may have ramifications for sovereign oversight of such systems, as well as cyber security.
- In current public key infrastructure implementations (particularly flexible export programs) an individual DNSP / utility server may take on the role of SERCA, however work is currently underway to identify an alternative national approach to managing this.

DEFINITIONS

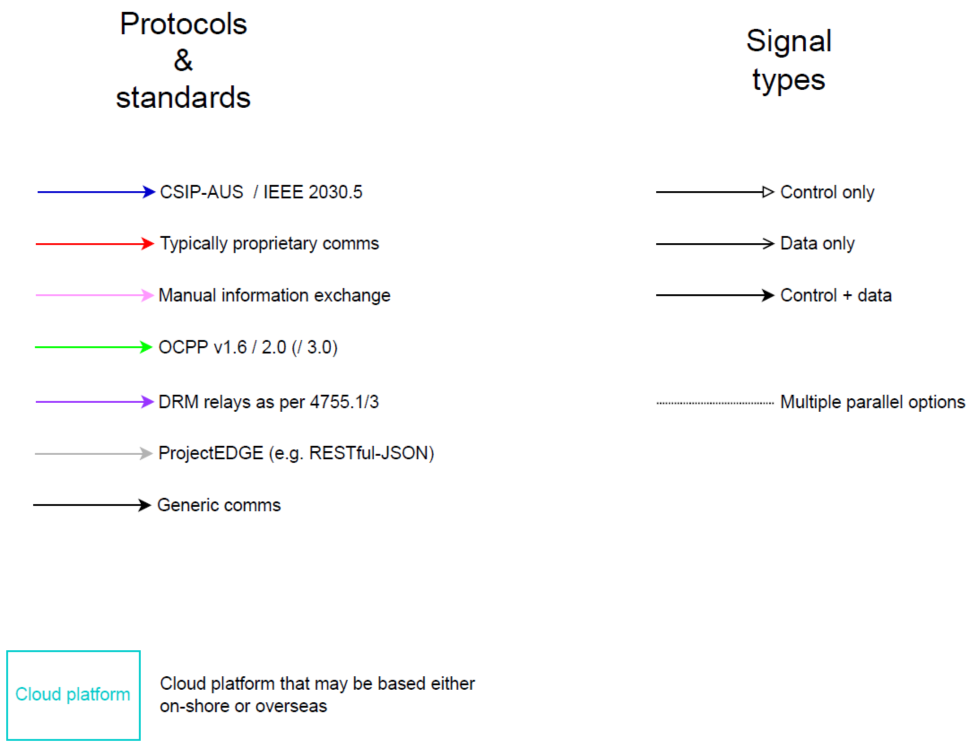
Consumer energy resources (CER): residential-scale energy resources often situated behind the revenue meter. Includes local generation (i.e. rooftop solar PV and battery storage) as well as large and/or flexible loads, such as electric vehicle chargers and typical demand response devices (e.g. pool pumps, electric hot water systems and air conditioners). In some cases CER may be metered separately and potentially operate on a different tariff to the main site tariff (e.g. off-peak hot water).

Gateway: A communications and/or control system typically located on a local network, which is able to manage one or more local CER devices. Additional functionality may include the ability to meter site generation & load, and to receive and interpret communications signals from external agents to manage CER (note that they may also provide further additional functionality to the consumer). Gateway devices may be integral to other local systems (e.g. battery or solar inverter integrated for charge & export control). Common examples include Home Energy Management Systems (HEMS), Building/Energy Management Systems (BMS/EMS) and site controllers.

ABBREVIATIONS

AGC	Automated Generator Control
AMI	Advanced Metering Infrastructure
BTM	Behind The Meter
CSIP-AUS	Common Smart Inverter Profile for Australia
DLC	Direct Load Control
DNSP	Distribution Network Service Provider
DOE	Dynamic Operating Envelope(s)
DRED	Demand Response Enabling Device (as per AS/NZS 4755.1)
DRM	Demand Response Mode (as per AS/NZS 4755.1)
DSO	Distribution System Operator
EDGE	(Project) Energy Demand and Generation Exchange
EVSE	Electric Vehicle Supply Equipment
HEMS	Home Energy Management System
HWS	(electric) Hot Water System
ICCP	Inter-Control Centre Communications Protocol
OCPP	Open Charge Point Protocol
OEM	Original Equipment Manufacturer
OPC	Open Platform Communications
SERCA	Smart Energy Root Certificate Authority (for public key infrastructure)
VPP	Virtual Power Plant

LEGEND

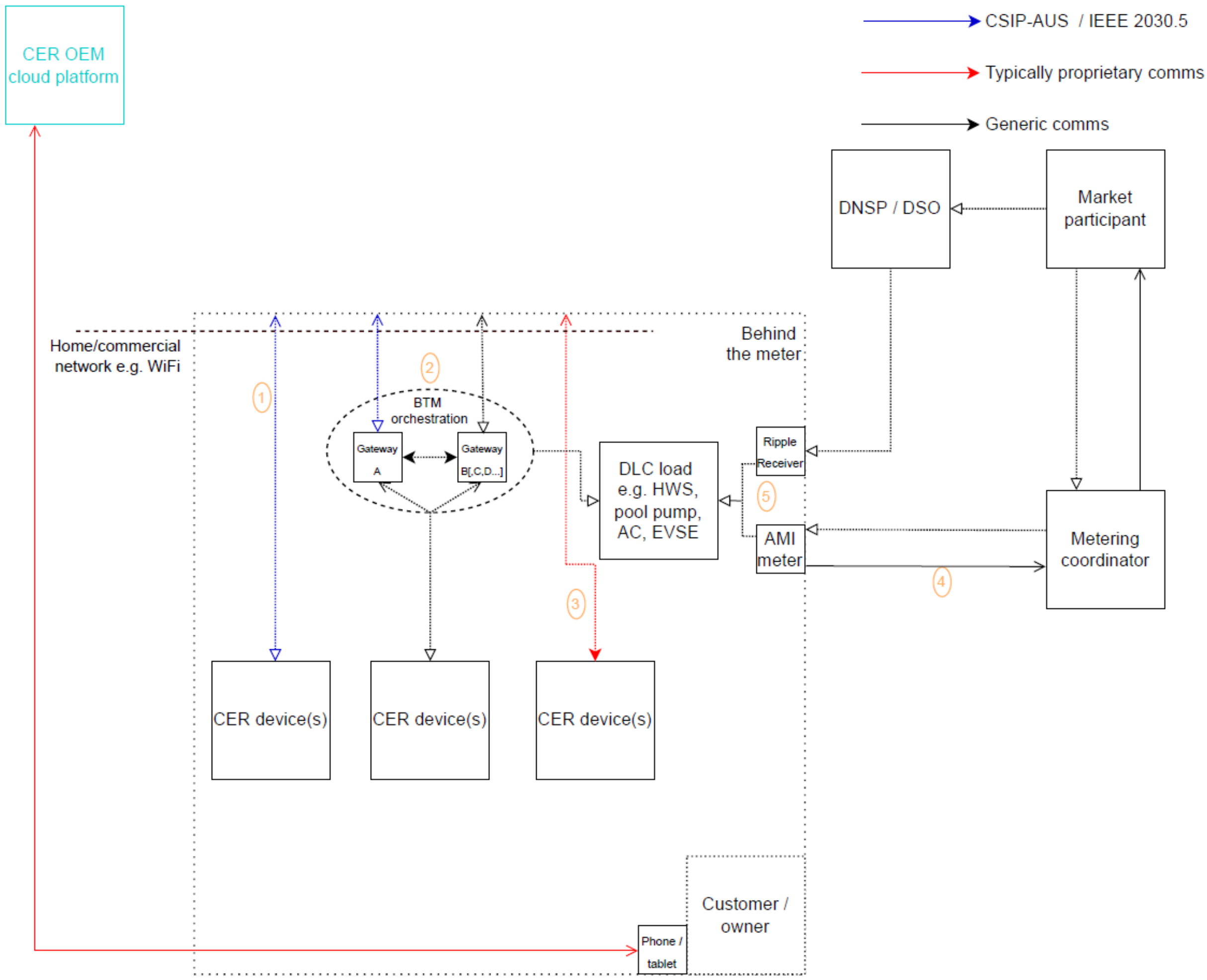


NOTES

a) In the signal types definition, control signals represent information that is intended to be acted upon e.g. a dispatch set-point, de-energise command or price signal. Data signals represent information only, with no explicit request to act on it (although it may trigger control actions there or elsewhere in the respective system).

A – BEHIND THE METER COMMUNICATIONS

Existing System



KEY

1. CSIP-AUS native device comms.
2. Gateway BTM comms (many options, including SunSpec Modbus, IEEE 2030.5 / CSIP-AUS, DNP3, MQTT, OpenADR, OPC, etc.).
3. Proprietary device comms (e.g. vendor/cloud control) which may also include firmware upgrades.
4. Metering data.
5. DNSP- or market-driven direct load control e.g. off-peak hot water.

NOTES

a) Ongoing discussions around metering arrangements (e.g. FTA rule-change) may require BTM to be modified to 'behind the connection point'.

b) A given DER device may simultaneously support multiple of the communications paths illustrated in this diagram.

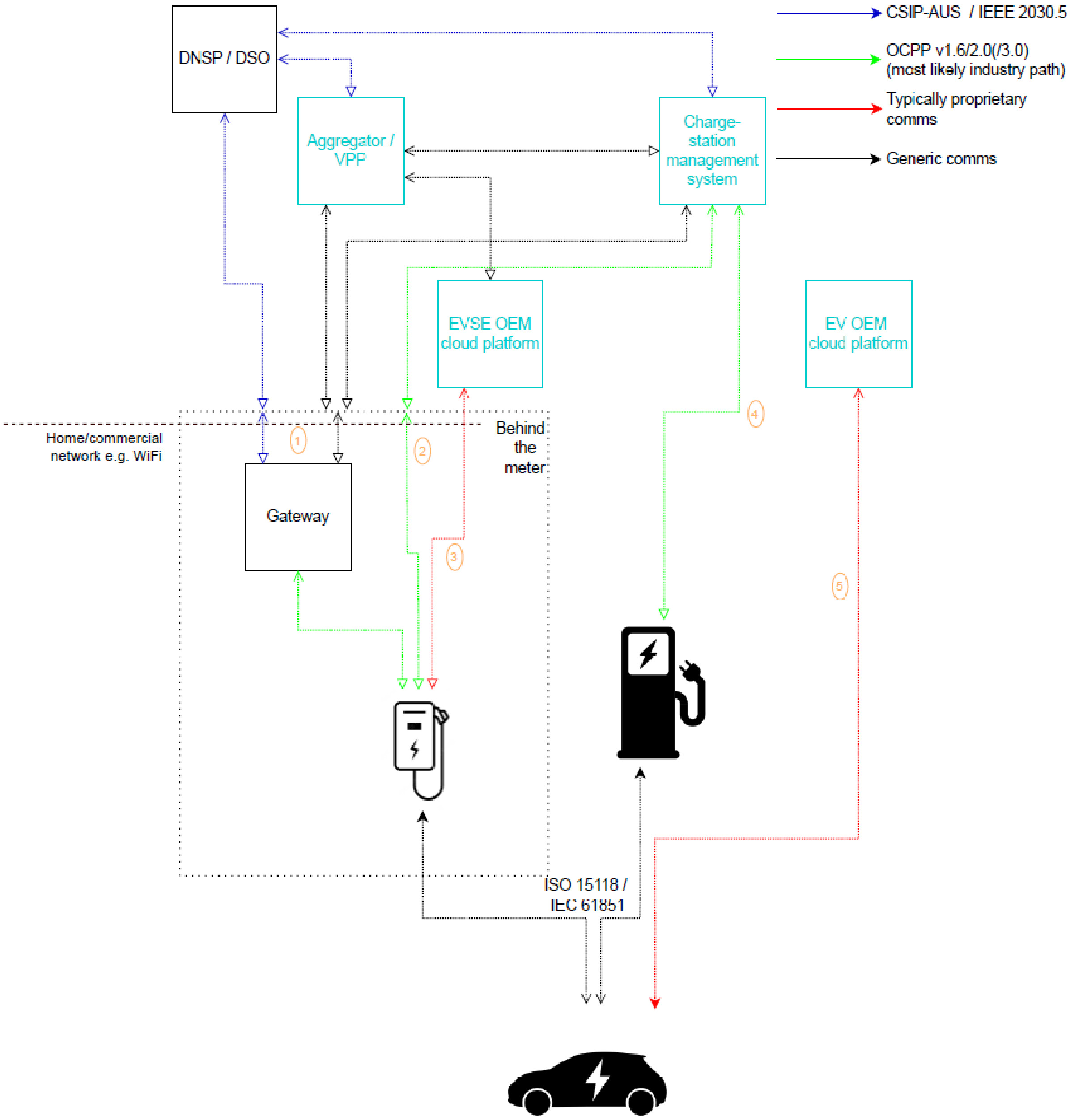
c) Open communications options are encouraged where practical to avoid consumer lock-in and enable churn.

d) A given site may include one or more gateway devices (e.g. HEMS, site controllers etc.) that may intercommunicate, and manage disparate CER (ideally in a coordinated fashion for the consumer's benefit).

e) Several of the following diagrams refer to a "BTM System"; this diagram describes the detailed comms flows that can occur within a BTM system on those architectures, including e.g. the presence or absence of gateways etc.

B – ELECTRIC VEHICLE SMART CHARGING

Existing System



KEY

1. Gateway-mediated EV charging (DOE or direct dispatch).
2. CSMS direct control of behind-the-meter EVSEs.
3. OEM control of EVSEs using proprietary comms.
4. Public charging.
5. On-board EV charger managed via OEM platform.

NOTES

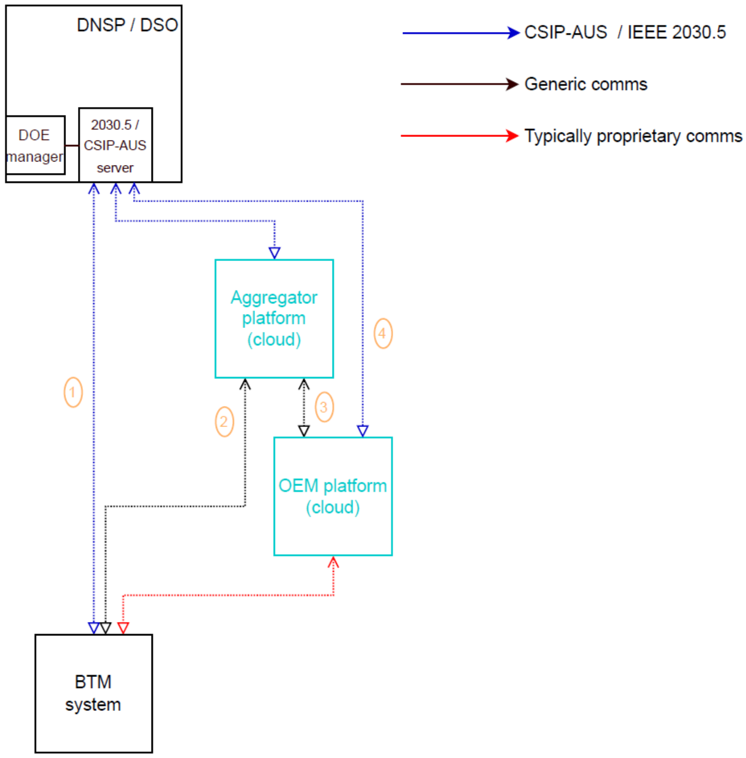
a) Diagram illustrates communication signals relating to EVSE control, however in current implementations the vehicle determines the actual power drawn from the EVSE.

b) A gateway may be integral to the EVSE or a separate device.

c) CSMS directly managing BTM EVSEs are unlikely to occur in standalone residential systems, however may be prominent in apartment carpark and related applications.

C – DOE DISPATCH USING CSIP-AUS

Existing System



NOTES

a) CSIP-AUS communicates a site-level control signal that may need to be managed behind-the-meter – see Diagram A for more details on how this can be performed.

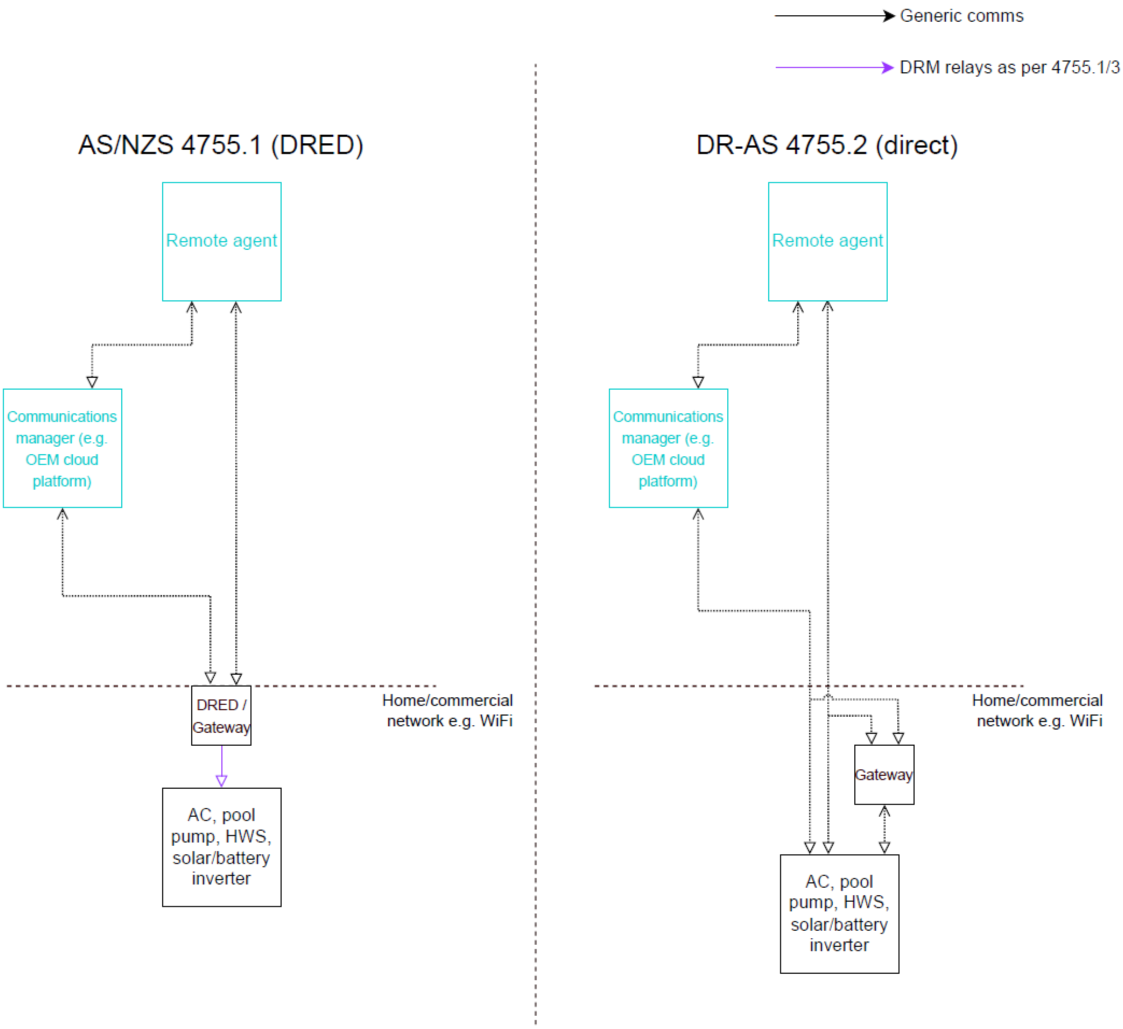
b) DNSP DOEs may incorporate system limitations derived from TNSPs and/or AEMO, which are not typically provided via active online protocols.

c) CSIP-AUS supports a limited capability to program settings (e.g. frequency and voltage limits, ramp-rates) into CER. Alternative mechanisms for programming settings such as power quality mode parameters exist and may see further adoption in the future.

d) A BTM gateway is optional in this workflow (i.e. signals may be sent via a gateway or directly to the CER).

D – DEMAND RESPONSE VIA AS[/NZS] 4755.1/2

Existing System



NOTES

a) The DR-AS 4755.2 system describes communication protocols that already exist (e.g. IEEE 2030.5, OpenADR), noting that the relevant standard is still in draft.

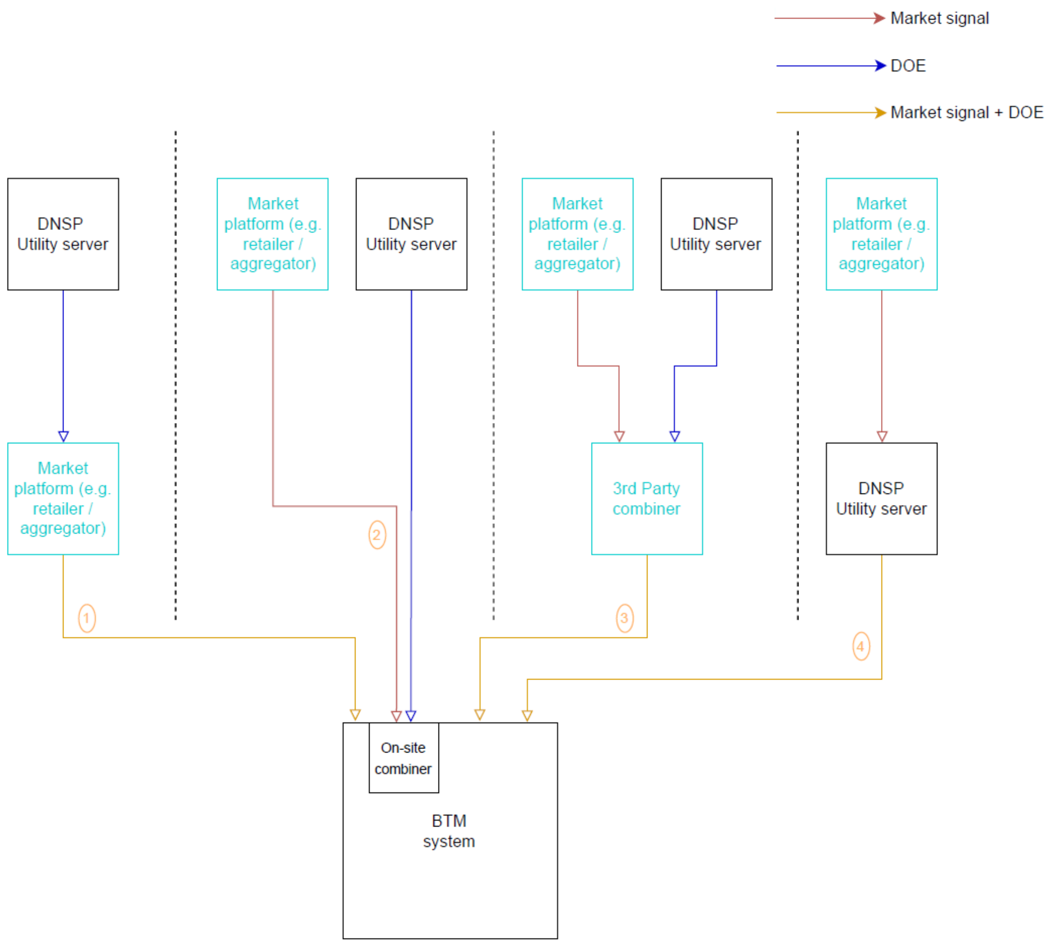
b) While the paths described here support a variety of open and proprietary comms standards, in all cases it would be typical that at least one stage of the comms path would operate on a 4755-compliant protocol (e.g. OpenADR, CSIP-AUS Annex C etc.).

c) In the majority of existing programs the DNSP / DSO takes on the role of remote agent, however future expansions of these approaches may introduce alternative uses including market applications and HEMS.

d) Both AS/NZS4755.1 and DR-AS4755.2 support but do not mandate return communications to the remote agent.

E – CSIP-AUS DOE + MARKET-SIGNAL MERGING

Potential Use-Case



KEY

1. Market platform DOE pass-through.
2. On-site signal combining.
3. Third-party signal combining.
4. DNSP DOE pass-through.

NOTES

a) These high-level concepts intend to represent a situation where the end user needs both a dispatch/price-signal and a DOE, recognising that current applications the majority of customers will have a DOE-only solution.

b) It's recognised that in actual solutions other actors are likely to play roles in some or all of these use-cases (e.g. OEM cloud platforms).

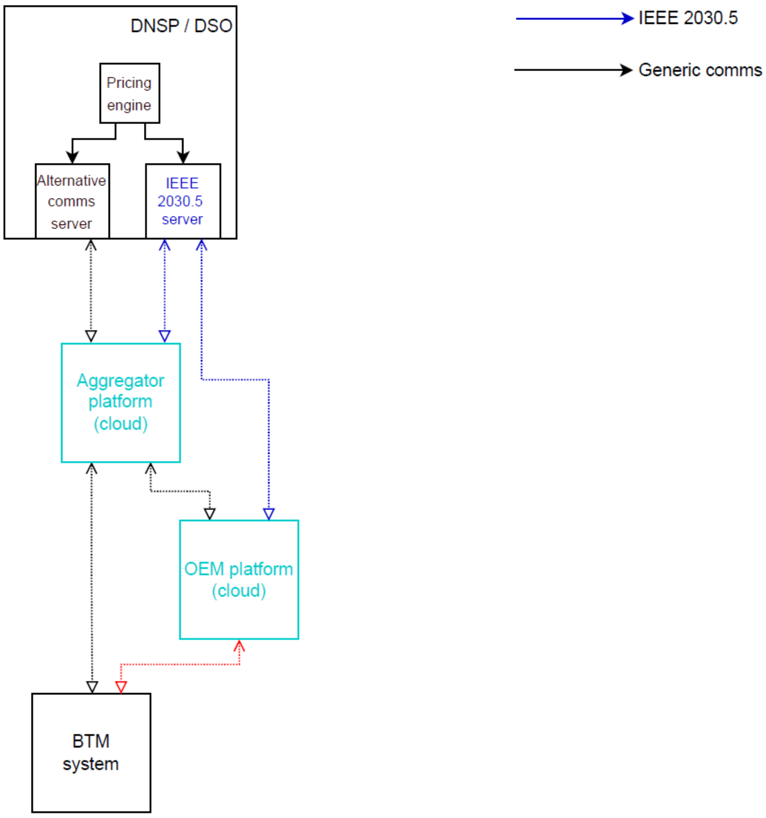
c) The use-cases described here have been deemed technically feasible under IEEE 2030.5 & CSIP-AUS, however they may not all be suited to the Australian market & regulatory environment.

d) DOE signals are supplied by a utility server; these do not have to be operated by a DNSP/DSO, however the values are likely to be sourced from a DERMS or similar system operated by the relevant DNSP.

e) While these use-cases describe DOE limits alongside market-signals intended to influence the dispatch of CER, operation of devices will be influenced by other exogenous factors including consumer behaviour and third-party signals.

F – DYNAMIC NETWORK PRICING

Potential Use-Case



NOTES

a) This use-case is primarily based on the communications architecture used in Project Edith. In the current design this is used to communicate dynamic pricing signals for network support, which operate in parallel to traditional tariffs (which will typically also include a fixed network charge component). Future developments of this approach may enhance dynamic network pricing to incorporate conventional tariff network charges.

b) In Project Edith price signals are likely to be sent alongside DOEs via the mechanism described in Diagram C.

c) A BTM gateway is optional in this workflow (i.e. signals may be sent via a gateway or directly to the CER).

ROADMAP

Version 1.0 of the ISC Reference Architecture for CER includes the following:

Existing systems

- Diagram A – Behind the Meter Communications
- Diagram B – Electric Vehicle Smart Charging
- Diagram C – Dynamic Operating Envelope Dispatch using CSIP-AUS
- Diagram D – Demand Response via AS[/NZS] 4755.1/2

Potential use-cases

- Diagram E – CSIP-AUS DOE + Market Signal Merging
- Diagram F – Dynamic Network Pricing

Version 1.1 is intended for release in the coming months, with the following additions planned:

Existing systems

- Market Dispatch
- Network Services

Potential use-cases

- Energy Marketplace / Data Hub (as per ProjectEDGE)
- Data Exchange as per Project Symphony

For questions, comments and suggestions please contact Tim Moore at timothy.moore1@anu.edu.au.