IEC 61968-5

Edition 1.0 2020-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Application integration at electric utilities – System interfaces for distribution management –
Part 5: Distributed energy optimization

Intégration d'applications pour les services électriques – Interfaces système pour la gestion de distribution –
Partie 5: Optimisation de l'énergie distribuée

IEC 61968-5:2020-08(en-fr)

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FOREWORD

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The text of this International Standard is based on the following documents:

FDIS	Report on voting
57/2223/FDIS	57/2252/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61968 series, published under the general title *Application integration at electric utilities – System interfaces for distribution management*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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INTRODUCTION

Technology advancements in various types of distributed energy resources (DER), have driven increases in their evaluation and employment by utilities, consumers, and third parties. These DER are often connected to the grid at the distribution level where their presence in large scale or volume could be disruptive if not designed, integrated, and managed properly.

Inverters, the power converter circuits that integrate DER to the grid, are highly-capable devices with fast power controls and no inherent inertia such that they can respond quickly to commands and local conditions. Even small-scale inverters tend to have processing and memory resources and can support a variety of communication protocols and advanced functions. Over the last few years, industry efforts have defined a wide range of standard grid-supportive functions that inverters may provide and standard communication protocols that allow these functions to be remotely monitored and managed.

If these inverter capabilities can be properly exposed and integrated into traditional utility system operations, high penetration DER can be transformed from problematic uncertainties to beneficial tools for distribution management. To achieve these potential benefits, it needs to be possible not just to communicate to individual DER devices using standard protocols, but also for the systems that manage DER, referred to herein as DER Management System or "DERMS", to effectively inform other software applications regarding the resources available and to exchange information that allows the DER to be managed effectively. Additionally, due to scale of some devices, to optimize the management of DER they are managed in aggregate, referred hereafter as "DER group management".

Traditionally, distribution systems have been operated without extensive controls or centralized management. More advanced systems may have On-Load Tap Changing transformers (LTCs) at substations, line regulators, and/or capacitor banks that operate to help optimize distribution voltage and reactive power flow. In many cases, these devices may be fixed or configured to operate autonomously. In a growing number of cases, however, a more central Distribution Management System (DMS) has been used to coordinate their behaviour for a more optimized overall effect. DMS functionality may reside at the utility operations centre, where single, large-scale software manages many circuits, or it may reside in a more limited fashion at the substation or other level, where smaller-scale systems act to manage individual feeders or circuits.

Regardless of the scenario, the present generation of DMS systems is not designed to take advantage of the capabilities that DER may offer. In most cases, DER support within a DMS is limited to monitoring the output of "utility scale" DERs (> one megawatt). In addition, existing industry standards define advanced functions for DER only at the individual device level, and lack the more aggregated, feeder-level representations that are useful for enterprise integration.

This document develops appropriate enterprise-level functions for the integration of distributed energy resources. These functions are intended to work in conjunction with the common functions for smart inverters that have previously been defined.

The high-level use cases that are covered include management of DER group membership, DER group status monitoring, DER group forecasting, and dispatching of real andreactive power and other capabilities of managing DER as aggregated groups.

The IEC 61968 standard, taken as a whole, defines interfaces for the major elements of interface architecture for Distribution Management Systems (DMS). Part 1: *Interface Architecture and General Recommendations*, identifies and establishes requirements for standard interfaces based on an Interface Reference Model (IRM). Parts 3-9 of this standard define interfaces relevant to each of the major business functions described by the Interface Reference Model.

As used in IEC 61968, a DMS consists of various distributed application components for the utility to manage electrical distribution networks. These capabilities include monitoring and control of equipment for power delivery, management processes to ensure system reliability, voltage management, demand-side management, outage management, work management, automated mapping and facilities management.

This set of standards is limited to the definition of interfaces and is implementation independent. They provide for interoperability among different computer systems, platforms, and languages. Methods and technologies used to implement functionality conforming to these interfaces are considered outside of the scope of these standards; only the interface itself is specified in these standards.

APPLICATION INTEGRATION AT ELECTRIC UTILITIES – SYSTEM INTERFACES FOR DISTRIBUTION MANAGEMENT –

Part 5: Distributed energy optimization

1 Scope

The scope of this part of IEC 61968 is the description of a set of functions that are needed for enterprise integration of DERMS functions. These exchanges are most likely between a DERMS and a DMS. However, since this is an enterprise integration standard which may leverage IEC 61968-100:2013 for application integration (using web services or JMS) or other loosely-coupled implementations, there are no technical limitations for systems with which a DERMS might exchange information. Also, it should be noted that a DERMS might communicate with individual DER using a variety of standards and protocols such as IEC 61850, IEEE 2030.5, Distribution Network Protocol (DNP), Sunspec Modbus, or perhaps Open Field Message Bus (OpenFMB). One role of the DERMS is to manage this disparity and complexity of communications on the behalf of the system operator. However, the communication to individual DER is out of scope of this standard. Readers are invited to look to those standards to understand communication to individual DERs' smart inverter.

The scope will be limited to the following use case categories:

- DER group creation – a mechanism to manage DER in aggregate
- DER group maintenance – a mechanism to add, remove, or modify the members and/or aggregated capabilities of a given group of DER
- DER group deletion – removing an entire group
- DER group status monitoring – a mechanism for quantifying or ascertaining the current capabilities and/or status of a group of DER
- DER group forecast – a mechanism for predicting the capabilities and/or status of a group of DER for a given time period in the future
- DER group dispatch – a mechanism for requesting that specified capabilities of a group of DER be dispatched to the grid
- DER group voltage ramp rate control – a mechanism for requesting that a DER group following a ramp rate curve
- DER group connect/disconnect – a mechanism to request that DER either isolate themselves, or reconnect to the grid as needed

To support use cases in the preceding categories, this document specifies the following data requirements (profiles) as shown in Table 1:

Table 1 – IEC 61968-5 Profiles

DERGroups	DERGroupQueries
DERGroupStatuses	DERGroupStatusQueries
DERGroupForecasts	DERGroupForecastQueries
DERGroupDispatches	DERGroupQueries

The profiles in the left column of Table 1 are the "base" DER profiles and appear in the Payload section of IEC 61968-100 compliant messages. Those in the right column of Table 1 are the "query" profiles that appear in the Request section of IEC 61968-100 compliant messages and are used to specify the query parameters when using the "get" CIM verb.

Additionally, this specification uses existing IEC 61968-9:2013, *Application integration at electric utilities - System interfaces for distribution management - Part 9: Interfaces for meter reading and control profiles*, as shown in Table 2, which are used for passing event information and for the DER group connect/disconnect use cases. There are no extensions made to these profiles, only the data specific to these use cases is passed.

Table 2 – IEC 61968-9 Profiles

EndDeviceControls
EndDeviceEvents

In a departure from prior IEC 61968 standards, this document supports specification of both a "constrained" and an "unconstrained" version of each of the "base" profiles. The "constrained" versions have a greater number of non-optional data elements and are intended for use with the "create" and "created" CIM verbs. The "unconstrained" versions have all or almost all of the CIM elements defined as optional, which is required to support operations involving the "change", "changed", "delete", "deleted" and "get" CIM verbs.

This part of IEC 61968 contains the clauses listed in Table 3.

Table 3 – Document overview for IEC 61968-5

Clause	Title	Purpose
1	Scope	The scope and purpose of the document are described.
2	References (Normative and Informative)	Documents that contain provisions which, through reference in this text, constitute provisions of this International Standard.
3	Terms, definitions, and abbreviations	Establish the common terms used in this specification.
4	Document Conventions	Message types related to the exchange of information for documents related to maintenance and construction.
5	DER Enterprise Integration Use Cases	The specific requirements for and details of the message exchanges based on the use cases. Description of general approach to the DER enterprise integration message type terms and the static information.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-300, *International Electrotechnical Vocabulary (IEV) - Part 300: Electrical and electronic measurements and measuring instruments - Part 311: General terms relating to measurements - Part 312: General terms relating to electrical measurements - Part 313: Types of electrical measuring instruments - Part 314: Specific terms according to the type of instrument*

IEC TS 61968-2, *Application integration at electric utilities - System interfaces for distribution management - Part 2: Glossary*

IEC 61968-9:2013, *Application integration at electric utilities - System interfaces for distribution management - Part 9: Interfaces for meter reading and control*

IEC 61968-11, *Application integration at electric utilities - System interfaces for distribution management - Part 11: Common information model (CIM) extensions for distribution*

IEC 61968-100:2013, *Application integration at electric utilities - System interfaces for distribution management - Part 100: Implementation profiles*

IEC TR 62051, *Electricity metering - Glossary of terms*

IEC 62055-31, *Electricity metering - Payment systems - Part 31: Particular requirements - Static payment meters for active energy (classes 1 and 2)*

IEC TR 62357-1:2016, *Power systems management and associated information exchange - Part 1: Reference architecture*

IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC 60050-300, IEC TS 61968-2, IEC TR 62051 and IEC 62055-31, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

Where there is a difference between the definitions in this document and those contained in other referenced IEC standards, then those defined in IEC TS 61968-2 shall take precedence over the others listed, and those defined in this document shall take precedence over those defined in IEC TS 61968-2.

3.1 Terms and definitions

3.1.1
Distributed Energy Resource Management System (DERMS)
The system which, on the behalf of other interested systems, manages the communications and control of individual Distributed Energy Resource (DER (and may do this with a variety of field message protocols), and aggregates this information and communicates with other utility systems, such as a DMS.

3.2 Abbreviated terms

CIM	Common Information Model
DER	Distributed Energy Resource(s)
DERMS	Distributed Energy Resources Management System
DMS	Distribution Management System
EMS	Energy Management System
IEC	International Electrotechnical Commission
UML	Unified modelling language
UUID	Universally unique identifier
XSD	XML Schema Definition
AMI	Advanced Metering Infrastructure

4 Conventions

4.1 UML diagrams

This document uses standard UML behavioural diagrams, specifically, sequence diagrams to illustrate the integration between the DERMS and other enterprise or hosted systems that desire to exchange information with the DERMS, or from enterprise systems to hosted or distributed DERMS.

4.2 Units of measure in DER enterprise integration profiles

The IEC 61968-5 profiles contain elements specifying active, reactive, apparent power, and voltage. The units of measure for these quantities are kW, kVAr, kVA, and V respectively.

DERMS characteristics

At a high level a DERMS has four characteristics:

- Aggregation – The DERMS facilitates the grouping of individual DER, into an aggregated resource.
- Simplication – The DERMS handles the granular details of DER settings and presents simple services to the system operator.
- Optimization – The DERMS should optimize the use of DER within various groups to get the desired outcome at minimal cost and maximum power quality. Additionally, if managing heterogenous types of DER within a group, the DERMS should know how to best leverage the individual DER to get a specified outcome. This may involve equally spreading a request across all the individual DER in a group, or having an algorithm that determines how to best serve a request
- Translation – Individual DER may speak different languages, depending on their type and scale. DERMS should handle these diverse languages, and present to the upstream calling entity in a cohesive way.

However, the reader should remember that the scope of this specification is not for how the DERMS behaves, or how it manages communication to individual DER, but is specifically the communication between a DERMS and other enterprise systems or third-parties in a business-to-business (B2B) mode of operation. Further, the reader should not impute any business logic within these messages. This specification makes no recommendation as to the soundness of any given implementation. For example, no recommendation is made as to the worthiness of any given DER to be in group with other types of DER based-on location or capability. This sort of business logic should be contained within a DERMS, and not proscribed in the associated messages.

5 DER enterprise integration use cases

5.1 General

The DERMS works with groups of DER so that requests made of the DERMS for behaviour in the power system can be handled in aggregate. This aggregation relieves the system operator from having to manage each DER individually, a situation that becomes more problematic as DER penetration in the power system continues to increase. To that end these use cases focus on the creation and maintenance of groups of DER, capability discovery, DER connect/disconnect, status monitoring and forecasting of these groups, and dispatching of power and voltage.

Nominally, in a traditional utility, the DERMS may be an edge system similar to an AMI Head-End. Like the AMI Head-End which gets status, events, and measurement data from meters and may send control messages to the meters, a DERMS gets status from a smart inverter and may send control messages (dispatch requests) to the smart inverter. While this is the nominal configuration, this specification is not prescriptive as to architecture. The DERMS could be a traditional edge system, it could be subsumed into a DMS, it could be hosted by an aggregator in the cloud, or it could be a "DERMS in a box" in a substation per Figure 1.

This architecture assumes that there is a smart inverter that can be communicated with. There are instances where DER is in the distribution network but is "dumb", with no ability to be communicated with. Those types of DER are outside of the scope of this specification.

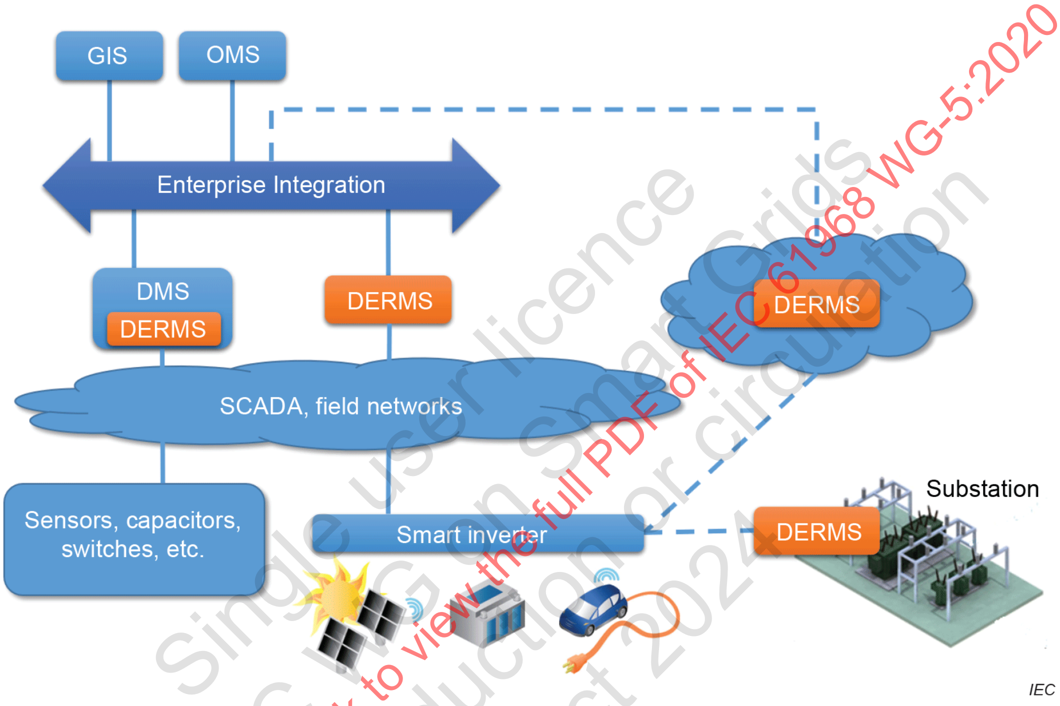


Figure 1 – Architectural options for DERMS deployments

It should also be emphasized that this specification for enterprise integration is the appropriate domain per the reference architecture. See Figure 2.

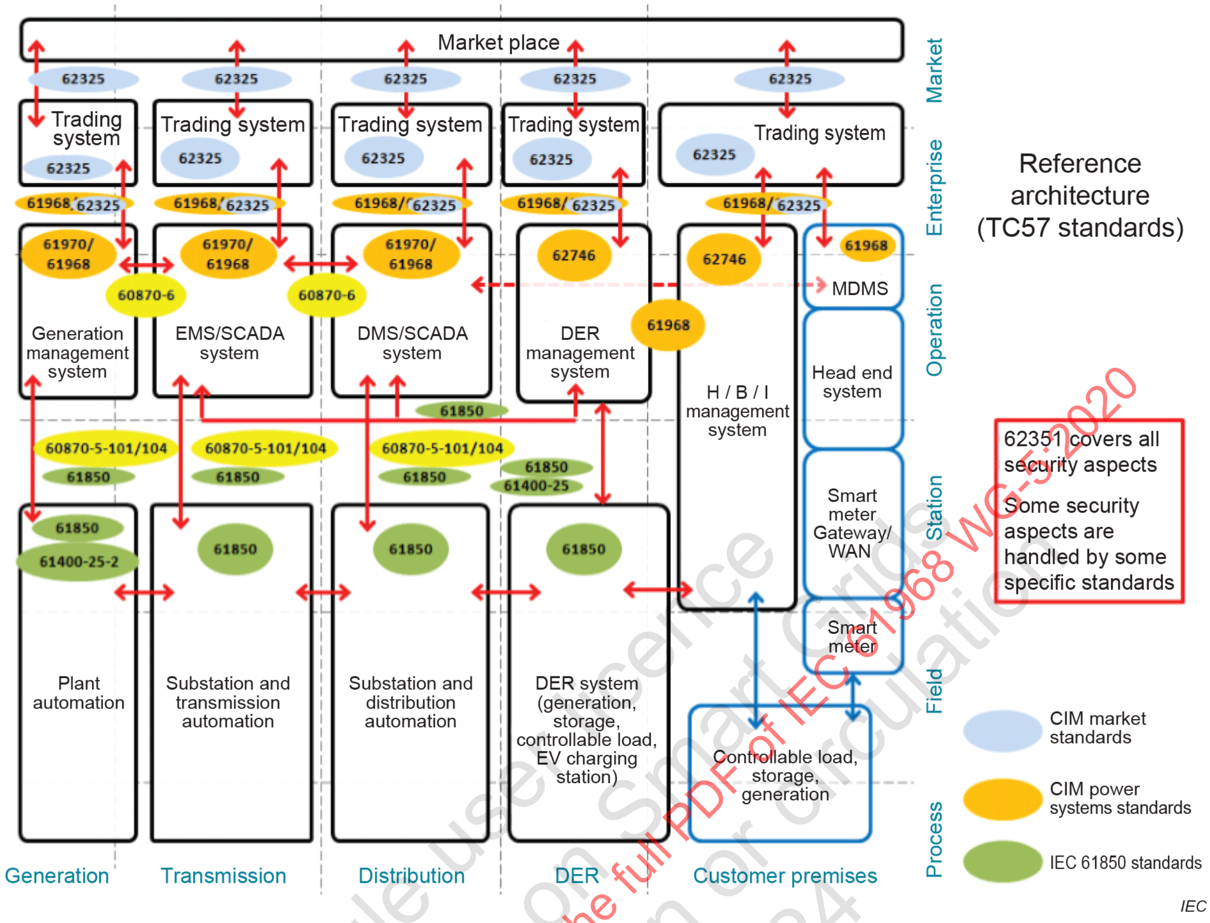


Figure 2 – Reference architecture, IEC TR 62357-1:2016

Additionally, the scope of this standard is limited to the control functions of DER in aggregate, and not the market-based motivations or event that might lead to such control.

As Figure 2 of IEC TR 62357-1:2016 illustrates, the enterprise communication between a DERMS and other enterprise systems falls into the IEC 61968 domain while communication between a DERMS and the actual DER (or specifically) the smart inverters attached to the DER, within the IEC, is the realm of IEC 61850, although other standards and protocols are also used such as IEEE 1815 (DNP), IEEE 2030.5, Sunspec Modbus, and OpenFMB. CIM-based integration could also be accomplished as documented in IEC 62325-301 and IEC 62361-100.

As the work that led to the creation of IEC 61850-90-7 concluded, a group of industry stakeholders was convened to determine the needs of distribution operators. It was determined that operators, as DER penetration in the distribution grid increased, did not want to manage the communication with individual DER, but rather, communicate with a management system to manage DER in aggregate; that managing the DER in aggregate would require enterprise integration to facilitate "conversations" with other enterprise systems such as a DMS or GIS.

The use cases covered in this document are:

- DER group creation
- DER group maintenance
- DER group status and monitoring
- DER group forecasting
- DER group dispatch
- DER group voltage ramp rate control
- DER group connect/disconnect
- DER group capability discovery

5.2 DER Group creation

5.2.1 General

The process for identifying the intended set of DER is a necessary precursor to the other DER group functions. Maintenance of this grouping is also necessary so that it becomes possible to monitor and manage DER at a higher level, with a focus on the attributes, impacts, and opportunities as they relate to the distribution system rather than individual DER plants or devices.

5.2.2 Grouping requirements

The enterprise integration interest group identified the requirements and constraints shown in Table 4 for the identification of sets of DER.

Table 4 – DER Grouping functional requirements

Requirement	Description
GR:1 Group Size	"Groups" of one or of many must be possible.
GR:2 Grouping by power system level	Under various circumstances and use cases, the ability to monitor and manage DER at varying levels of the power system may be needed, including: • By Substation • By Circuit/Bus • By Feeder • By Feeder Segment (contiguous conductor between switches) • By Island or micro-grid (campus, industrial facility) • By Individual Device • By Lat/Lon Rectangle
GR:3 Grouping according to other attributes	Under various circumstances and use cases, the ability to monitor and manage DER at varying levels of the power system may be needed, including: • By Circuit Phase - For example, a DMS could define separate groups for single phase DER that are connected to A, B, and C phases, and could request the status of these individually. • By DER Type – For example a DMS could create separate groups for PV systems, battery storage systems, EVs, or any other DER type. • By DER Owner – For example, all the DER owned by the utility, or a particular customer, could be viewed and managed collectively. • By program enrolment or contractual arrangement. • Any combination of aggregation level or additional attributes.

5.2.3 Challenges posed by dynamic distribution system configurations

Initially, it was considered that within each monitoring request or management command, one could pass information identifying the power system level-of-aggregation, such as substation, feeder, etc, as identified in Table 4. This consideration was based on the notion that each DER could be associated with a certain substation, feeder, segment, etc. However, this approach was found to be impractical in many circumstances due to the potentially dynamic nature of distribution circuit configurations. The problem is illustrated in the following figures.

Figure 3 illustrates a simple radial feeder that emanates from a single substation and continues, through a series of switches, to an end-of-line. In such a case, it would be possible to associate, for example, DER2 with Substation 1, Feeder 100, and Line Segment 2000.

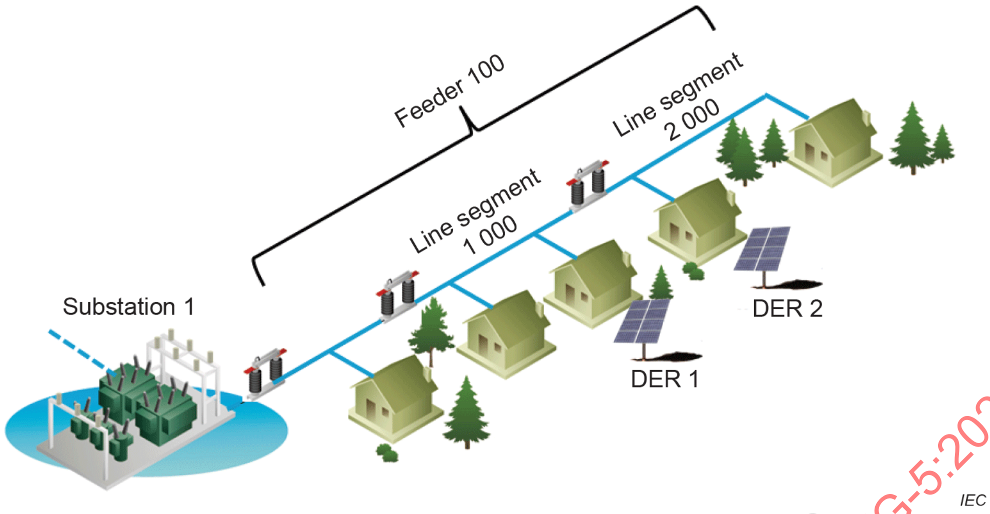


Figure 3 – Example of simple radial feeder

Figure 4 illustrates a more complex arrangement in which two substations are involved. As shown, an open switch is separating the system into two sections, one associated with each substation. In arrangements of this type, different switches can be opened or closed, shifting segments of line (load and DER) from one substation to another. In scenarios such as this, DER cannot be statically associated with a given substation, and the concept of a "feeder" is dynamically defined by the switch positions.

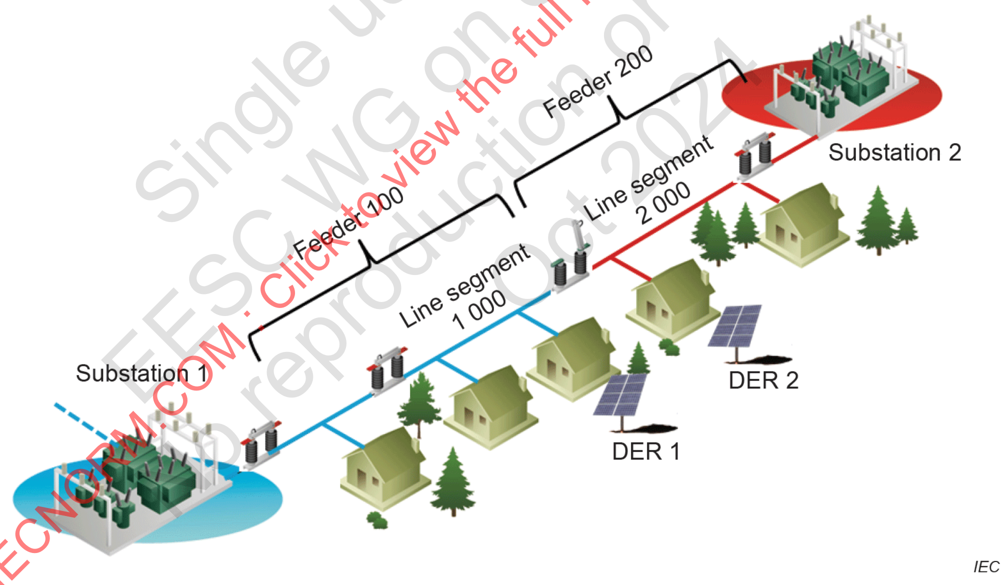


Figure 4 – Example of feeder with alternate substation

Figure 5 presents a further degree of complexity; a distribution network in which multiple substations are involved and the distribution grid may be fed by any one or even multiple substations. Arrangements of this type are not yet common but do exist and further illustrate the difficulty faced in attempting to associate DER with a particular substation, feeder, or line segment.

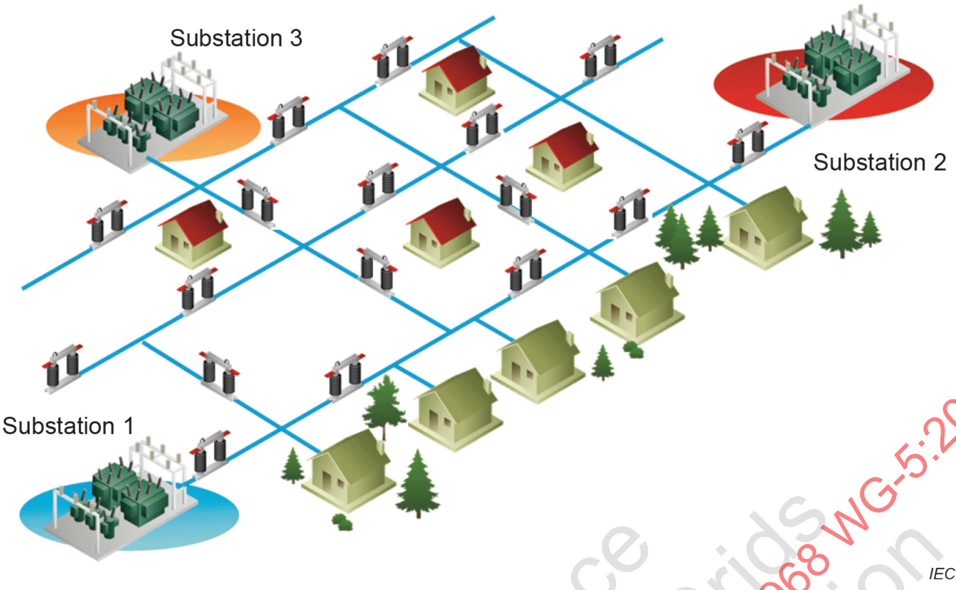


Figure 5 – Example of an interconnected distribution network

Entities wishing to monitor or manage DER will pass information that can be used by the providing entity to determine which DER should be impacted or represented in the response. Status responses will provide information aggregated for the range of DER indicated by the request.

5.2.4 Challenges posed by enterprise information models

An inspection of the IEC Common Information Model (CIM) indicated that the dynamic nature of distribution circuit configurations has been recognized previously and that devices, whether DER or other, are normally identified only with the immediate terminal to which they connect. Figure 6 illustrates some of the model concepts.

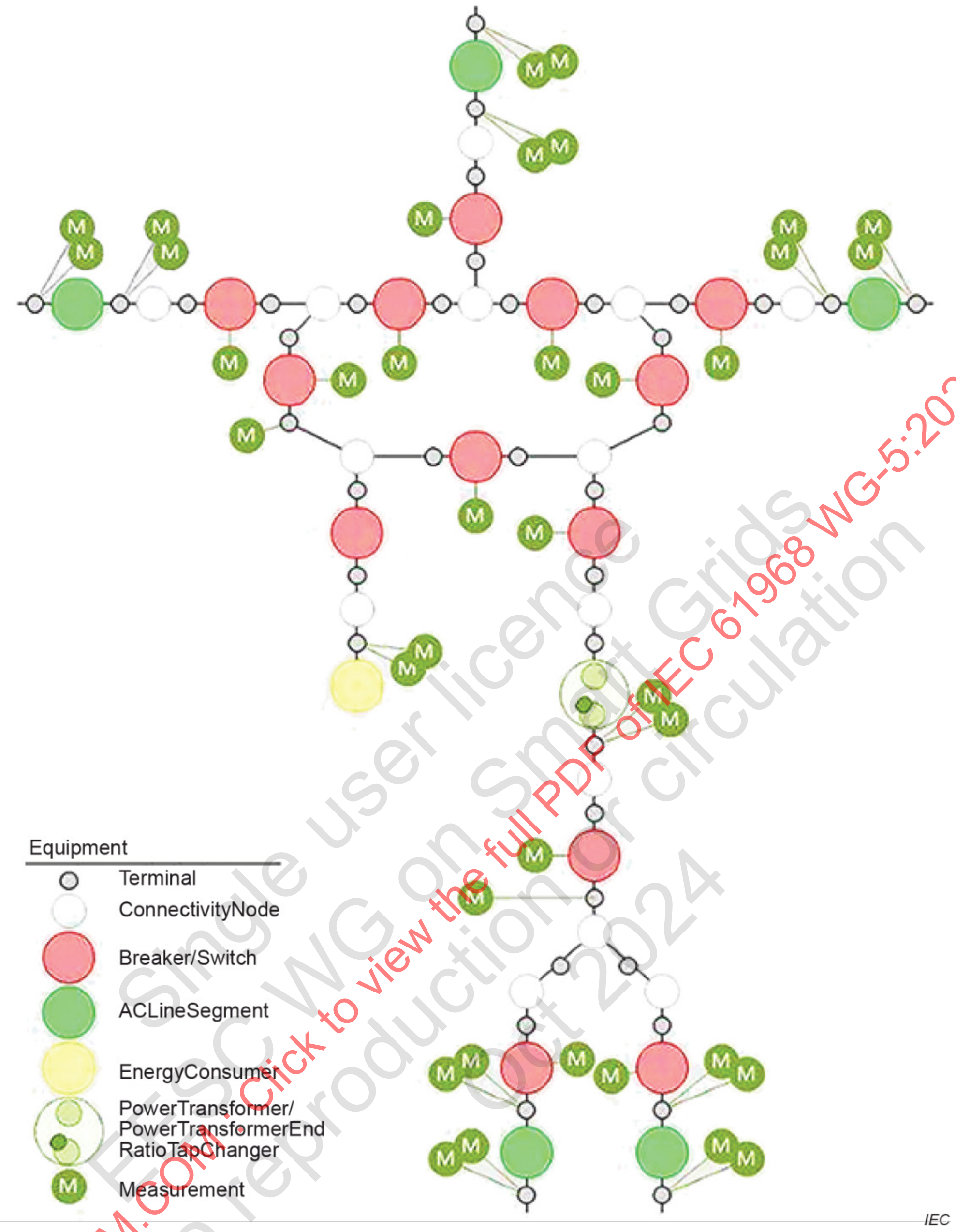


Figure 6 – Common Information Model illustration

Although DER are not shown in this diagram, they may be thought of similarly to the yellow circle which represents an Energy Consumer. As shown in the diagram legend, the electrical connections to an element of the model are called "Terminals" and terminals are connected together by "Connectivity Nodes".

The CIM defines an "AC line segment", but this is not the same as what was discussed as line segments in Figures 3 through 5. In the CIM, an "AC Line Segment" is a length of conductor carrying the same current throughout its length, with no load or generation along the way. In other words, at each point where a load or generation device is connected, a "Connectivity Node" exists in the model, with separate AC Line Segments before and after the node. This level of detail allows the model to include impedances and to be used for power flow analysis.

In this way, the terminals of individual elements are constant attributes, and the sense of being part of a "feeder" or "substation" is computed only dynamically, by processing the model from one connectivity node to another.

5.2.5 Using arbitrarily-defined groups for DER aggregation

In view of the challenges identified in the previous section, an approach using arbitrarily-definable groups was developed. The basic idea is to precede DER monitoring or management messages with a process to define a grouping of DER. This will make it possible for any application to define groupings of DER according to whatever rationale is of interest to that application. It also makes it possible for the entity providing the DER service (e.g. a DERMS) to not be required to read-in and process the real-time connectivity model.

The approach illustrated in Figure 7 involves a request/reply interaction in which a DERGroup is defined by one entity (e.g. the Group Forming entity such as a DMS) and provided to one or more Group Acknowledging entities (e.g. one or more DERMS).

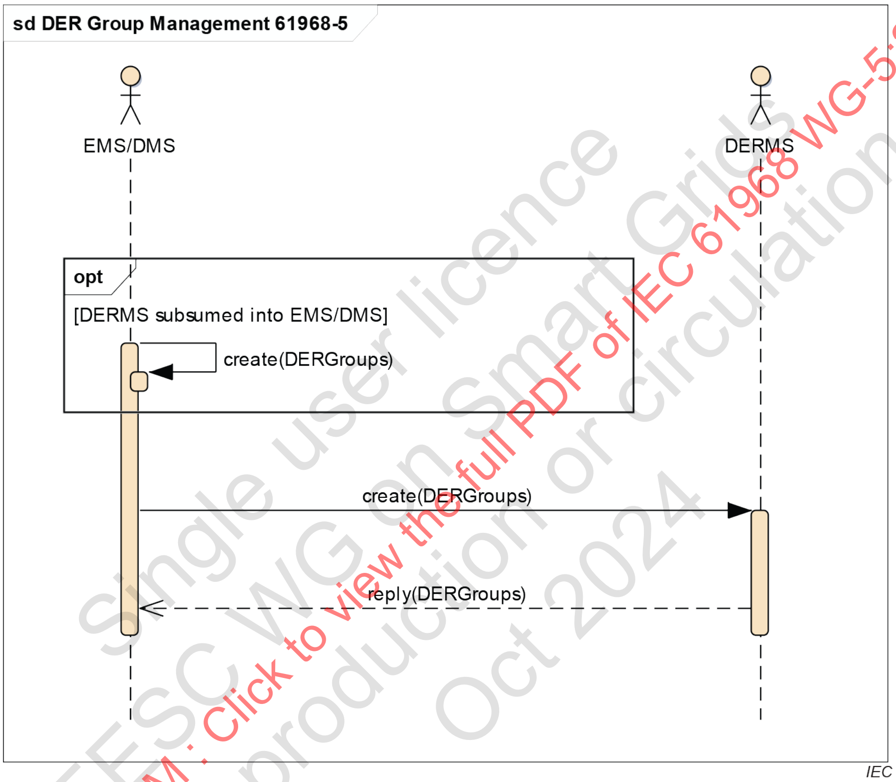


Figure 7 – Request/Reply message exchange pattern for the creation of a DERGroup

This interaction, which is accomplished using the "constrained" version of the DERGroups profile found in Clause A.2 could occur immediately before another transaction, such as a DER Status request and reply, or any time prior.

Figure 8 depicts an alternate messaging approach for the same scenario. This example uses a notification message (referred to in IEC 61968-100 as an Event Stereotype message) rather than a request/reply message interaction.

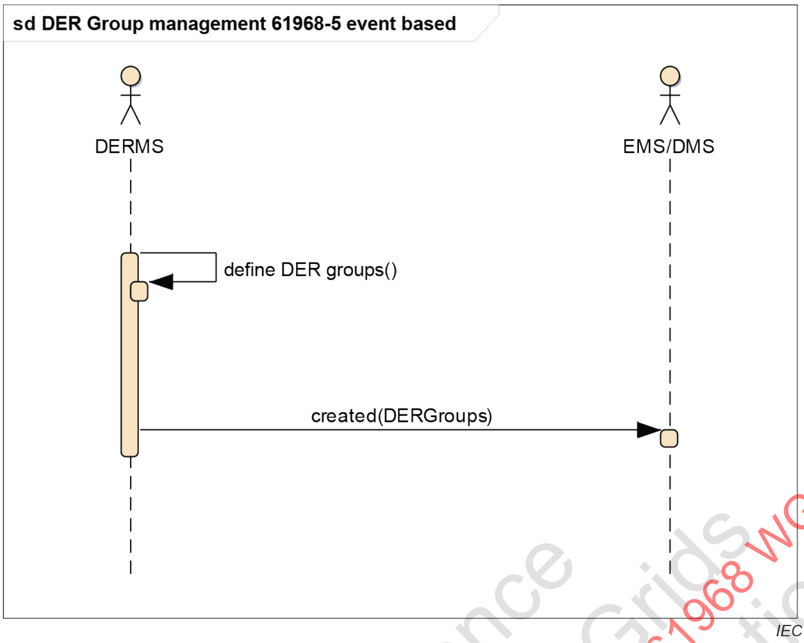


Figure 8 – Notification message exchange pattern for the creation of a DERGroup

Once again, this transaction is accomplished using the "constrained" version of the DERGroups profile found in Clause A.2. Note that the CIM verb has changed from "create" to "created". Presumably, the Group Acknowledging Entity (in this case an EMS or DMS) would instantiate the DER Group following receipt of the notification message; however, in this interaction pattern the Group Forming Entity does not receive confirmation that the Group Acknowledging Entity successfully instantiated the group.

Either of the illustrated messaging patterns supports the creation of groups that relate to any level of aggregation desired, including by substation, feeder, line segment, or other, as required in Table 4. This approach is not prescriptive of a specific integration approach, allowing, for example:

- A DERMS could process the system model and define its own groupings but does not require it to do so.
- A DMS could define the specific groups that are of interest to its processes. This could include different groupings that would be associated with various power system configurations. For example, in the circuit arrangement illustrated in Figure 4, a DMS could define one group for all DER connected to Substation 1 (along the blue line) and another for all DER connected to Substation 2 (along the red line). If the open switch along this line is then closed and a different switch opened, then two different groups could be defined to represent that alternative circuit configuration.

Please note that in the CIM and in IEC 61968-5 profiles, DERGroups are instances of the CIM EndDeviceGroup object. Likewise, individual DER (the members of a group) are instances of the CIM EndDevice object. The EndDevice class is a generic representation of field devices, and the EndDeviceGroup class provides a mechanism to group them. These classes were originally defined in IEC 61968-9 and leveraged for DER group management.

A note on the use of mRID, timestamp, or other header elements in the XML "snippets": These header attributes are used for identification of the data profile that is exchanged between sending and receiving systems. For the definition, use, and components of well-formed message integration patterns, the reader is referred to IEC 61968-100:2013.

5.3 Maintenance of DERGroups

5.3.1 General

Once a group is created then any system could initiate an action to update the DER Group by adding, removing, or updating information about one or more members or capabilities. This is accomplished using the "unconstrained" version of the DERGroups profile found in Clause A.3. The unconstrained version is used so that only the elements of the DERGroup that are added, modified or deleted need be included in the message.

Adding and or modifying members and/or capabilities is a straightforward process using the CIM "change" verb and the DERGroups profile, as illustrated in the first of the two interactions in Figure 9.

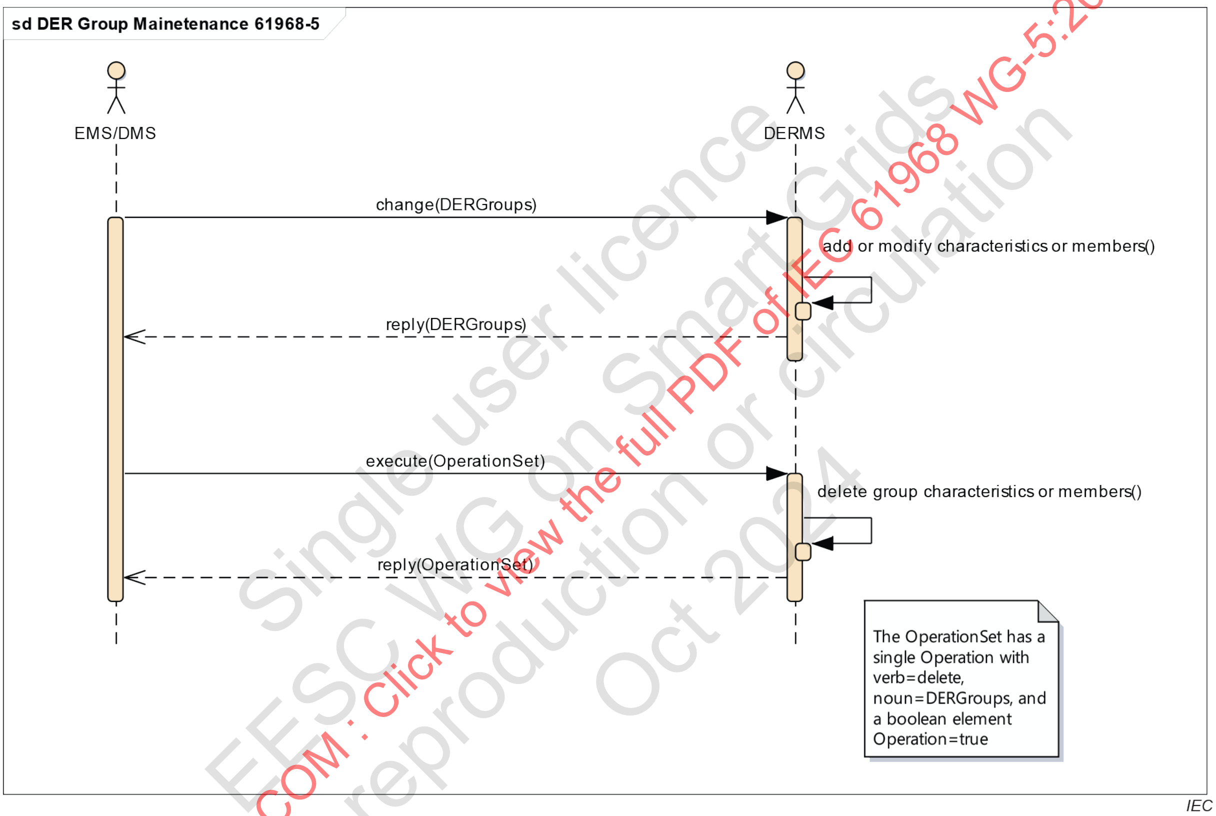


Figure 9 – Message exchange patterns to support adding or modifying DERGroup membership or capabilities, or deleting a group member

Removing an individual DER or a capability from a DER group requires the use of the "execute" CIM verb and the OperationSet, as illustrated in the second of the two interactions in Figure 9. Additional information concerning the use of Operation Sets can be found in Annex C.

Deleting an entire DER group is another straightforward process, this time using the CIM "delete" verb and the DERGroups profile, as illustrated in Figure 10.

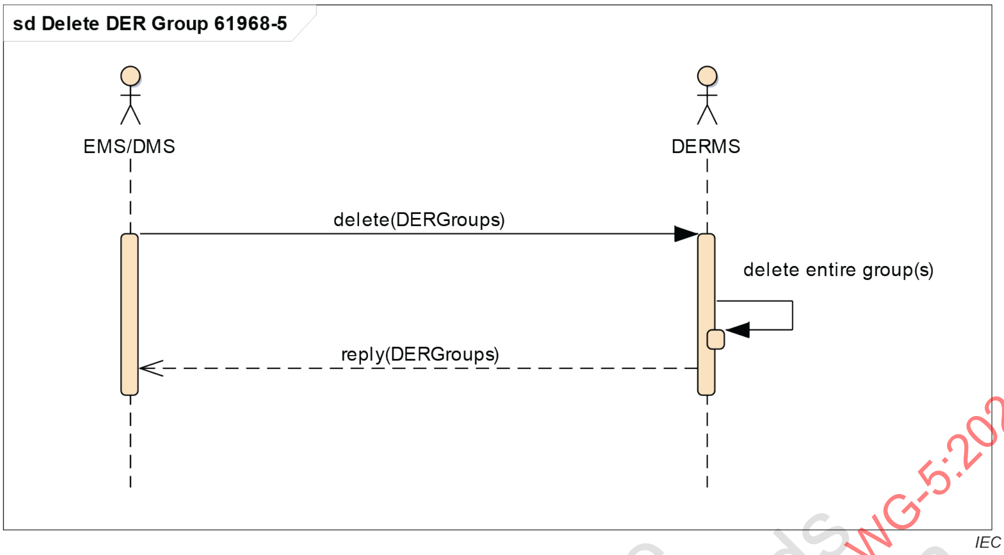


Figure 10 – Message exchange pattern reflecting deleting an entire DER group (delete)

Please note that although not illustrated, the DER group maintenance functions can also utilize event stereotype messages, like the example in 5.1.

5.3.2 DER Group maintenance example

Assume that a DER group exists with a Names.name value of "Group A". This group has three members, for the purposes of this example; they have the mRIDs and active power capabilities as shown in Table 5. The total active power capability of Group A would therefore be 19,5 kW.

Table 5 – Example DER Group A membership before update

DER member mRID	Maximum Capability
cabb102d-4ab6-42ff-b30b-b2a70922a929	2.5 kW
2cb43245-ed67-4751-b09c-028a0e65e004	5 kW
94928710-2ad2-4a0f-8f12-c6304c1e5b19	12 kW

The record of this group and respective members is stored in the DERMS. A system operator of a DMS determines that a new DER has been installed in the distribution network and decides to add this DER to Group A. This new DER has an mRID of "3092d3ae-c57e-4079-a4d4-543d024eea8c" and a maximum active power capability rated as 5 kW. The DMS would send a message using the change verb and the DERGroups noun, as illustrated in the first interaction in Figure 9.

If XML is being used as the data serialization format, the following is an example XML snippet for this change request message is as follows:


```
<?xml version="1.0" encoding="UTF-8"?>
<!--Sample XML file generated by XMLSpy v2015 rel. 4 sp1 (x64) (http://www.altova.com)-->
<RequestMessage xmlns="http://iec.ch/TC57/2011/schema/message"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:n1="http://www.altova.com/samplexml/other-
namespace" xsi:schemaLocation="http://iec.ch/TC57/2011/schema/message Message.xsd">
    <Header>
        <Verb>change</Verb>
        <Noun>DERGroups</Noun>
        <Timestamp>2016-07-21T12:31:01-06:00</Timestamp>
        <MessageID>9f5e5644-7b5f-491a-b69a-077b6807b8c8</MessageID>
        <CorrelationID>a9aca27b-1bc1-4749-a729-c7cf40c86c4b</CorrelationID>
```

```xml
    </Header>
    <Payload>
        <DERGroups xmlns="http://iec.ch/TC57/2016/DERGroups#"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://iec.ch/TC57/2016/DERGroups# DERGroups.xsd">
            <EndDeviceGroup>
                <DispatchablePowerCapability>
                    <maxActivePower>24.5</maxActivePower>
                </DispatchablePowerCapability>
                <EndDevices>
                    <mRID>3092d3ae-c57e-4079-a4d4-543d024eea8c</mRID>
                </EndDevices>
                <Names>
                    <name>Group A</name>
                </Names>
            </EndDeviceGroup>
        </DERGroups>
    </Payload>
</RequestMessage>
```


The Names.name identifier of "Group A" is used so that the DERMS will know which DER group is being updated. Upon receipt of the message the DERMS would examine the contents, see that a new member was being added (by virtue of a new DER identifier that does not exist in the current group) and update the group with this new member capturing the identifier and adding this member's capability to the group's capability. DER Group A would now have four members and a total maximum active power capability of 24,5 kW, as illustrated in Table 6.

Table 6 – Example DER Group A after adding a fourth member

DER member mRID	Capability
cabb102d-4ab6-42ff-b30b-b2a70922a929	2.5 kW
2cb43245-ed67-4751-b09c-028a0e65e004	5 kW
94928710-2ad2-4a0f-8f12-c6304c1e5b19	12 kW
3092d3ae-c57e-4079-a4d4-543d024eea8c	5 kW

As a further example suppose that the DMS operator has received notice that DER with mRID cabb102d-4ab6-42ff-b30b-b2a70922a929, has been taken out of service. The DMS would send a message to the DERMS to notify it of this action. As previously described, removing a member requires the use of an OperationSet (if using IEC 61968-100:2013 compliant SOAP messages).

If XML is being used as the data serialization format, the following is an example XML snippet for this change request message:


```xml
<?xml version="1.0" encoding="UTF-8"?>
<!--Sample XML file generated by XMLSpy v2015 rel. 4 sp1 (x64) (http://www.altova.com)-->
<RequestMessage xmlns="http://iec.ch/TC57/2011/schema/message"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:n1="http://www.altova.com/samplexml/other-namespace" xsi:schemaLocation="http://iec.ch/TC57/2011/schema/message Message.xsd">
    <Header>
        <Verb>execute</Verb>
        <Noun>OperationSet</Noun>
        <Timestamp>2016-07-21T12:48:33-06:00</Timestamp>
        <MessageID>63154f89-9fed-47f1-9a22-f3394e2aac8a</MessageID>
        <CorrelationID>88a34023-22a5-4c5c-85cc-518a4644e1d3</CorrelationID>
    </Header>
    <Payload>
        <OperationSet>
            <Operation>
                <operationId>1</operationId>
                <noun>delete</noun>
```

```
                <verb>DERGroups</verb>
                <elementOperation>false</elementOperation>
        <DERGroups xmlns="http://iec.ch/TC57/2016/DERGroups#"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://iec.ch/TC57/2016/DERGroups# DERGroups.xsd">
            <EndDeviceGroup>
                <EndDevices>
                    <mRID>cabb102d-4ab6-42ff-b30b-b2a70922a929</mRID>
                </EndDevices>
                <Names>
                    <name>Group A</name>
                </Names>
            </EndDeviceGroup>
        </DERGroups>
            </Operation>
        </OperationSet>
    </Payload>
</RequestMessage>
```


The request message contains the mRID of the DER being deleted and the Names.name identifier of the group (Group A) being modified. Within the OperationSet payload the delete verb is used and the elementOperation Boolean is set to true.

Please note that the single Operation within the OperationSet does not provide a mechanism for updating the maxActivePower capability (which in the example would now be 22,0 kW) when the DER member is deleted. Updating the capability could be accomplished with a second Operation within the OperationSet or with a second standalone "change DERGroups" transaction similar to that shown in the previous example.

Following execution of the OperationSet transaction, the membership of Group A would be as shown in Table 7.

Table 7 – Example DER Group A membership after delete

DER member mRID	Capability
2cb43245-ed67-4751-b09c-028a0e65e004	5 kW
94928710-2ad2-4a0f-8f12-c6304c1e5b19	12 kW
3092d3ae-c57e-4079-a4d4-543d024eea8c	5 kW

5.4 DER Group queries

Once a group is created then any system may query to get information about group, including its membership and capabilities. This is accomplished using a "get DERGroups" transaction, as illustrated in Figure 11.

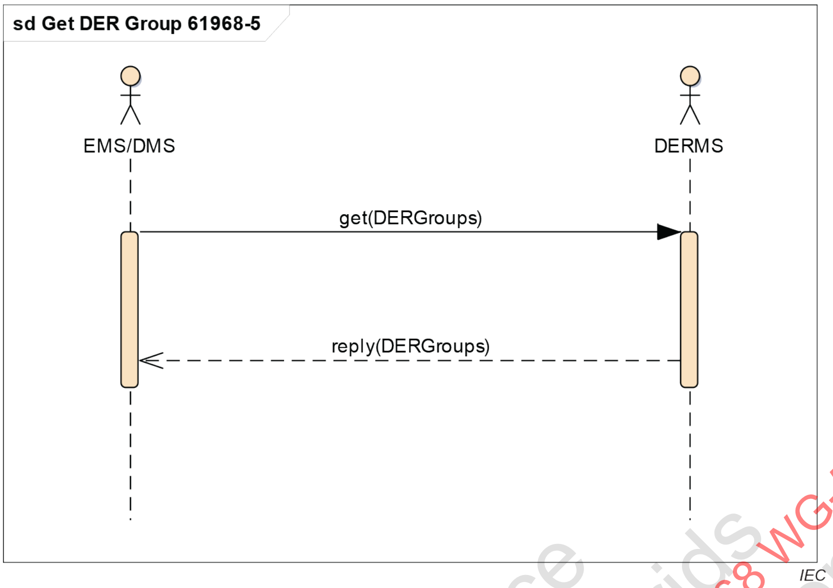


Figure 11 – Message exchange pattern to support querying a DER group

When using the CIM "get" verb, the query parameters are provided in a special "query profile" that is placed in the Request rather than the Payload section of the IEC61968-100 message. The DERGroupQueries profile can be found in Annex A.

If XML is being used as the data serialization format, the following is an example XML snippet for this query message:


```xml
<?xml version="1.0" encoding="UTF-8"?>
<!--Sample XML file generated by XMLSpy v2015 rel. 4 sp1 (x64) (http://www.altova.com)-->
<RequestMessage xmlns="http://iec.ch/TC57/2011/schema/message"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:n1="http://www.altova.com/samplexml/other-namespace" xsi:schemaLocation="http://iec.ch/TC57/2011/schema/message Message.xsd">
    <Header>
        <Verb>get</Verb>
        <Noun>DERGoups</Noun>
        <Timestamp>2016-07-21T13:22:54-06:00</Timestamp>
        <MessageID>94df9ce0-74c3-47ac-b8be-a5f3b0c68447</MessageID>
        <CorrelationID>debcb642-562b-417b-8c9e-4b7c30d3e0c8</CorrelationID>
    </Header>
    <Request>
        <DERGroupQueries xmlns="http://iec.ch/TC57/2016/DERGroupQueries#"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://iec.ch/TC57/2016/DERGroupQueries# DERGroupQueries.xsd">
            <EndDeviceGroup>
                <Names>
                    <name>Group A</name>
                </Names>
            </EndDeviceGroup>
        </DERGroupQueries>
    </Request>
</RequestMessage>
```


The response message returns the details of the DER Group(s) using the same DERGroups profile used in the create DERGroups examples previously described.

5.5 DER Group status monitoring

DER group status is reported using the DERMonitorableParameter class. One or more of these parameters may be passed in a message, each with a specific DERParameter, and optionally, a set of corresponding DERCurveData for the respective DERParameter.

Figure 12 illustrates the messaging interaction for requesting the status of a DER group.

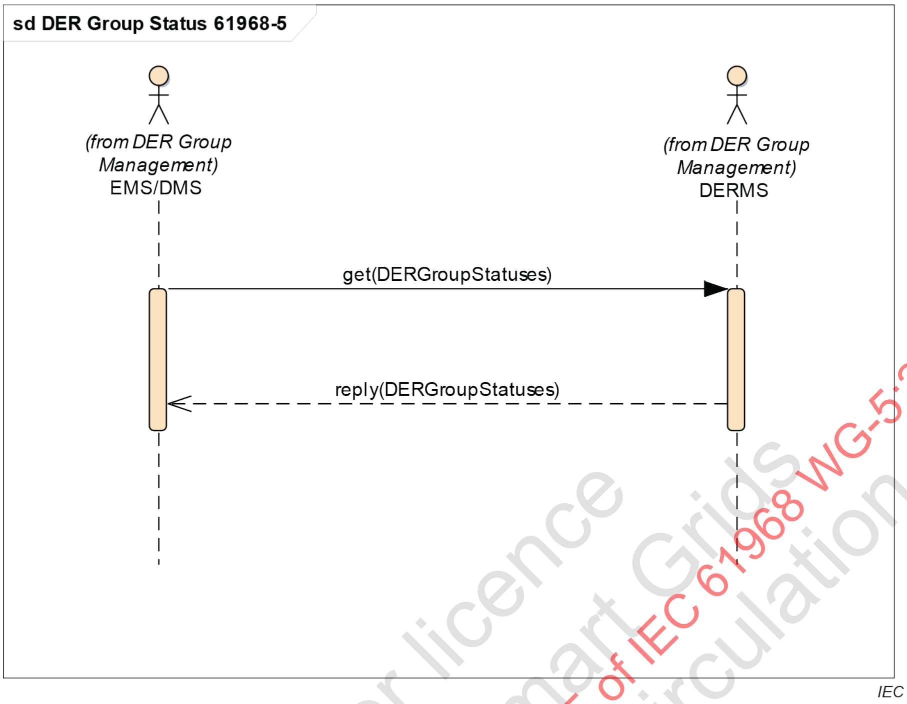


Figure 12 – Message exchange pattern for DER Group status monitoring (PULL)

The objective in this approach is that a requesting entity (a DMS for example) could request the status (for a group of DER), and the values for each of the group's capabilities. This request portion of this transaction is accomplished using the DERGroupStatusQueries profile, found in Clause A.7. The response is returned using the unconstrained version of the DERGroupStatuses profile found in Clause A.6.

Alternatively, the DERMS may choose to broadcast status changes to interested systems, as illustrated in Figure 13.

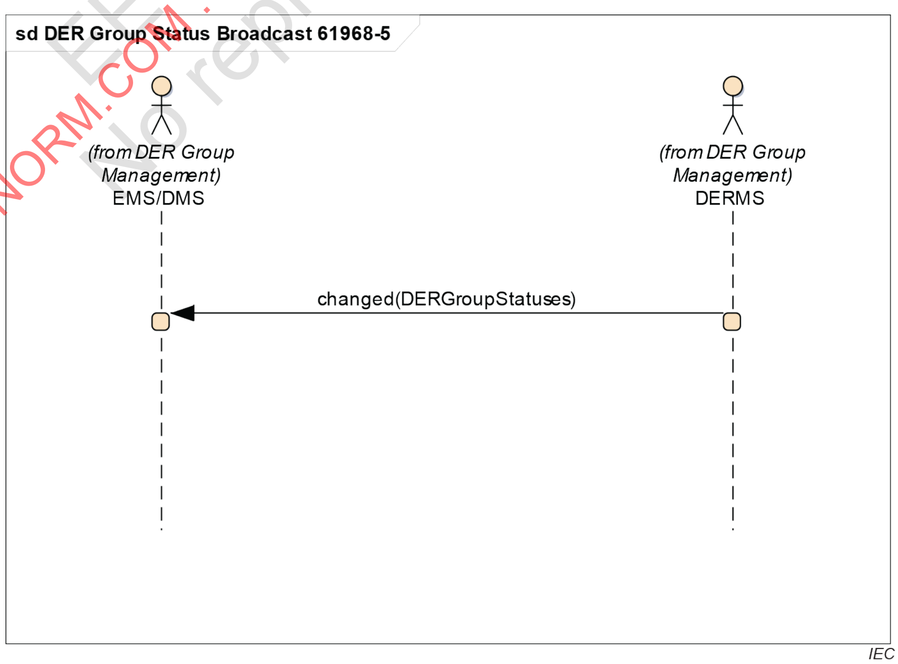


Figure 13 – Message exchange pattern for DER Group status monitoring (PUSH)

This transaction also utilizes the unconstrained version of the DERGroupStatuses profile found in Clause A.6.

5.6 DER Group forecast

This subclause describes a method by which forecasts of DER availability may be exchanged between software applications. Forecasts can be provided for any or all of a DER group's dispatchable power capabilities.

This function only defines how DER forecast data is exchanged and does not specify how forecasts are determined. Some DER forecast-providing entities could, for example, have access to detailed weather forecast information, including satellite or sky-viewing capabilities to enable prediction of solar variability. Others could monitor DER health or analyse historical data in order to determine forecasts with greater accuracy. Regardless of the forecasting methods that may be used, this function only addresses the exchange of the forecast of the DER availability (e.g., real, reactive and apparent power) and does not address the exchange of weather or other related data.

As described in a previous section, the present status for real, reactive and apparent power and other capabilities may include three parts: a present value, a maximum, and a minimum range of adjustability. Forecasting is relevant for the maximum and minimum values. Forecasting is not relevant for the present value because it is dispatchable and bounded only by the maximum and minimum.

Forecasts may involve varying degrees of uncertainty. To represent this, the forecast for a given parameter can be described as an envelope, a range of uncertainty, possibly widening further into the future as the forecast becomes less certain. The concept is illustrated in Figure 14.

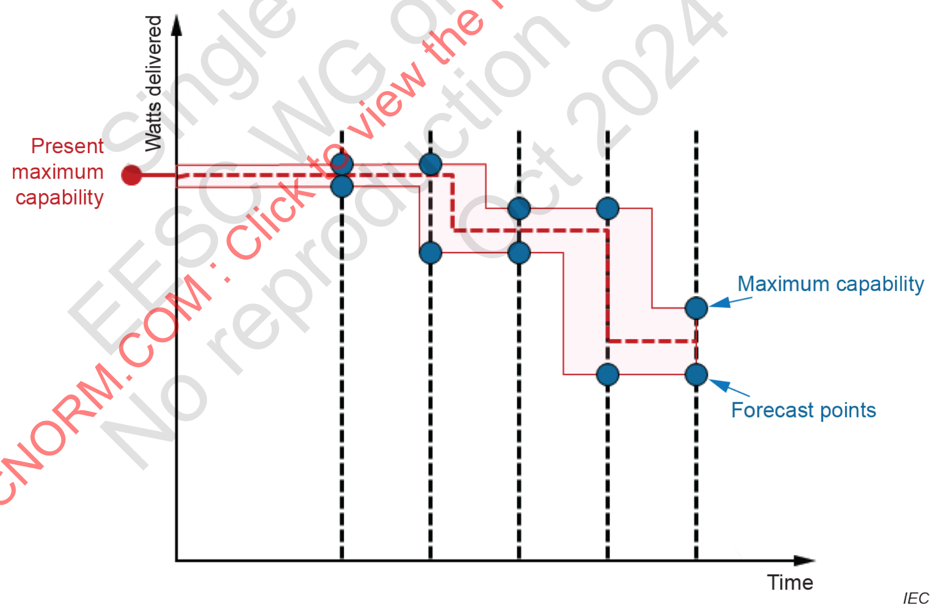


Figure 14 – Example of points to represent battery storage group forecast

The present maximum and minimum values are labelled at the left-hand side. Because they reflect the present state, they are specific, known values. But looking into the future, the forecasts for these quantities may be represented through a widening envelope, as illustrated by the red shaded areas.

Forecast consideration of storage systems:

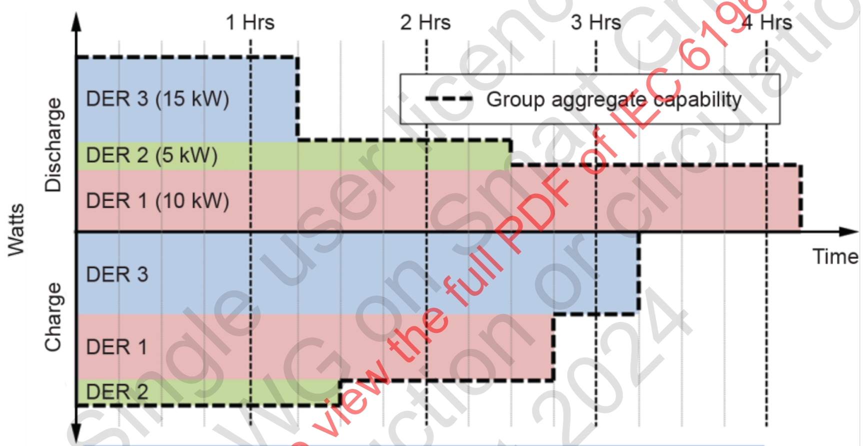
Forecasts for the availability of groups of battery storage DER may also be represented by the approach described above. The forecasted availability of these groups, however, may have a different appearance and would naturally be dependent on the level of dispatch.

As an example, consider a group comprised of three battery storage devices:

- DER1 10kW 70kWh
- DER2 5kW 20kWh
- DER3 15kW 65kWh

For simplification, this example assumes that each device can charge at the same rate at which it discharges.

Figure 15 illustrates how the individual charge availability and discharge availability of these three devices might appear when viewed as a group. The aggregate capability of the group to either charge or discharge is shown to drop in steps as each device's storage capacity is filled or depleted.



Power available		
Duration	Discharge	Charge
1 hour	30 kW	30 kW
2 hours	15 kW	25 kW
3 hours	10 kW	15 kW
4 hours	10 kW	0 kW

IEC

Figure 15 – Battery DER Group availability example

For battery storage groups, the forecast is inherently a function of the level of dispatch. In view of this, the entity making the request for a DER forecast will be able to do so, based on a hypothetical level of dispatch that is passed in the request.

Figure 16 illustrates the messaging interaction for requesting a forecast for a DER group.

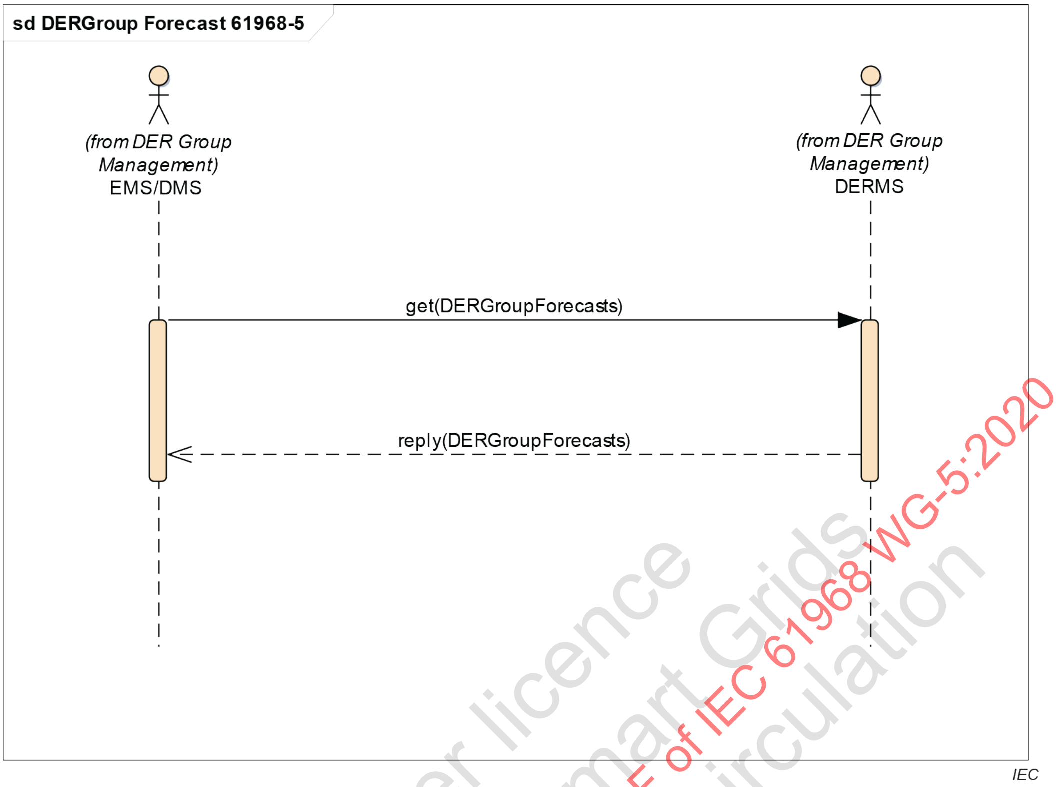


Figure 16 – Message exchange pattern for DER Group forecasting (PULL)

The objective in this approach is that a requesting entity (DMS for example) could request the forecast (for a group of DER) and get predicted minimum and maximum values for each of the group's capabilities for a time period in the future. This request portion of this transaction is accomplished using the DERGroupForecastQueries profile, found in Clause A.10. The response is returned using the constrained version of the DERGroupForecasts profile found in Clause A.8.

Alternatively, the DERMS may choose to broadcast status changes to interested systems, as illustrated in Figure 17.

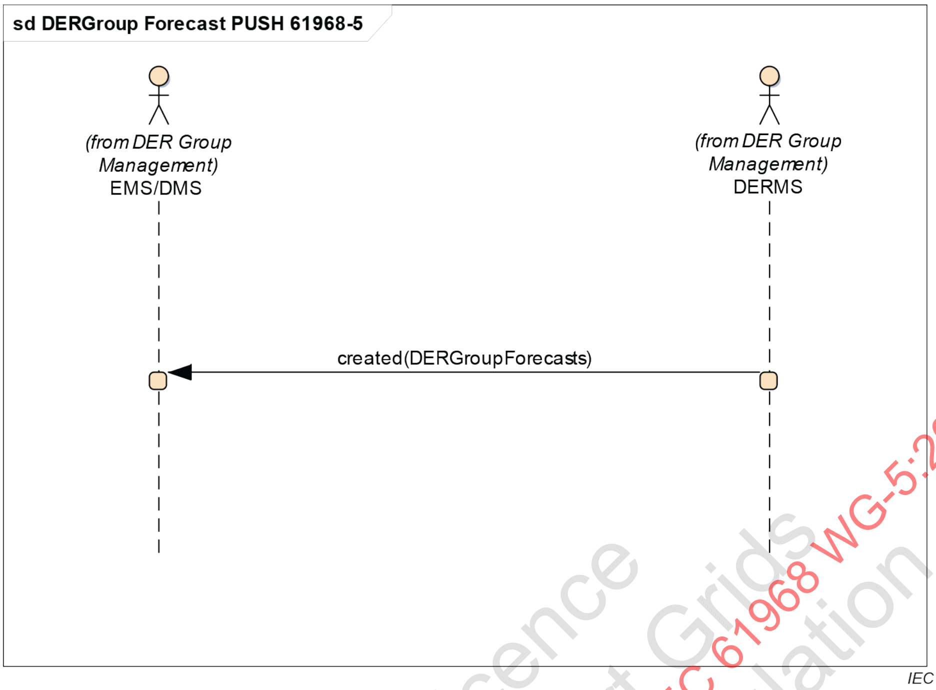


Figure 17 – Message exchange pattern for DER Group forecasting (PUSH)

This transaction also utilizes the constrained version of the DERGroupForecasts profile found in Clause A.8.

A forecast will identify the DER group for which the forecast has been made and using the DERMonitorableParameter in conjunction with the DispatchSchedule and DERCurveData, min/max values of the interval for the forecast, as well as the associated confidence (how likely the forecast will fall within the predicted min/max values).

For more information on forecasts, please see IEC 62325-451-5:2015, Framework for energy market communications.

5.7 DER Group dispatch

This paragraph describes a method by which the power level of a DER group may be managed. This method is in the form of a request that the power for the group be set to a specified level and dispatched to the grid.

This function is intended to apply between software applications in an enterprise integration environment. As such, it does not have direct bearing on how individual DERs within the group are managed. For example, if this function requests that the power output from a group of 10 DER be reduced to a level that is 100 kW less than the present value, it may be satisfied by each DER being reduced by 10 kW, one DER being reduced by the whole 100 kW, or any other distribution across the group. The algorithms and methods by which individual DER are managed is out of scope of this standard and is viewed as the responsibility of the entity directly managing the DER, such as a DERMS.

The previously-defined method of using arbitrarily-defined groups is also used for this function. It requires that the referenced DER group definition (i.e. the list of which DER make up the group) is known and agreed-to by both the power-requesting and power-providing entities. As described previously, the makeup of the group could have been defined by the requestor, the provider, or any other entity, and it creation could have been a manual or automated process.

Figure 18 illustrates a power dispatch sequence. In addition, this example shows that a status monitoring request may also follow the dispatch request (shown as the UML "rectangle" referencing the status monitoring use case); or preceeded by a forecast, so that the requesting entity may know what range of adjustability is presently possible, and status monitoring tracks the response to the dispatch. Group creation (required) and status monitoring (optional) could occur immediately before the power dispatch (request and reply) or any time prior. Additionally, although out of scope of IEC 61968, this example shows how the DERMS communicates with individual DER using whatever protocol the smart inverter for the particular DER uses.

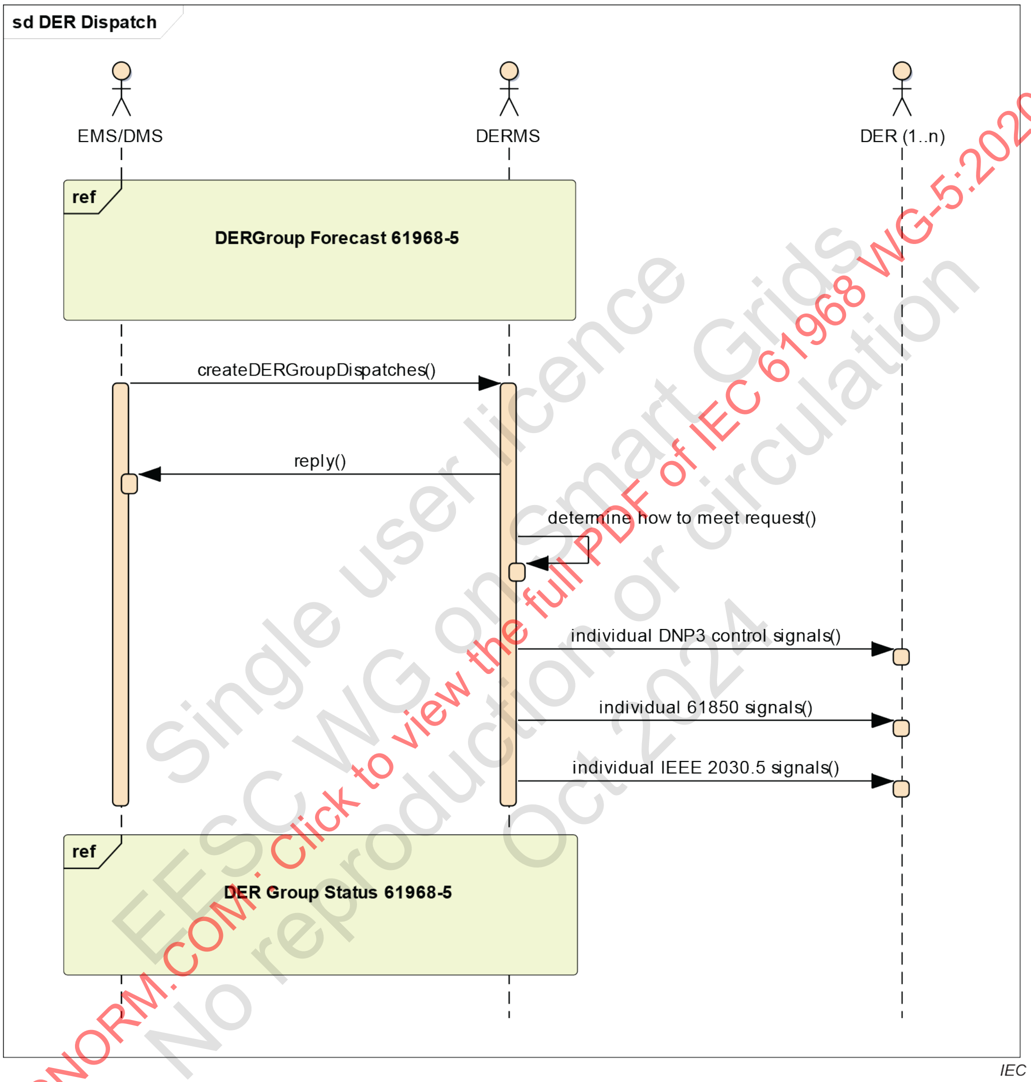


Figure 18 – Example Message exchange pattern for DER Group dispatch

The objective in this approach is that a requesting entity (DMS for example) could request the dispatch of power from a DER group. This request portion of this transaction is accomplished using the constrained version of the DERGroupDispatches profile, found in Clause A.10. Note that each dispatch is for a single capability.

To make the dispatch request the system passes a valid identifier for the DER Group, and the capability and quantity that is desired. For example, if 100 kW of active power was desired, the requesting system would send the DERMS a request (create DERGroupDispatches) that had the mRID or Names.name of the DER group (e.g. "Group A"), and a RequestedCapability with a capabilityKind of "activePower" and a value of 100.

There would normally also be a DERGroupDispatch.mRID or a DERGroupDispatch.Names.name to identify this request for tracking purposes. The response is simply an indication of success or failure.

5.8 DER Group Connect/Disconnect

This is a control function by which all DER in a given group may be disconnected-from or reconnected-to the grid. Notionally, a DERMS or other entity providing this service could do so by leveraging the standard "Connect/Disconnect" function that has been identified for individual DER in the IEC standards (specifically EndDeviceControl; IEC 61968-9 Meter Reading and Control)

Use cases for this function could include lockout for grid maintenance, soft shutdown or restart around planned outages.

Technical approach:

The Connect/Disconnect request shall include a simple Boolean indicator of which state is required.

The connect/disconnect request shall include the following timing parameters:

- A start date/time for the action, or a "now" indicator
- A delay time over which a random delay is to be placed prior to starting the connect/disconnect action
- A time-window over which the DER group members are to be disconnected or connected (as linearly as possible given DER sizes) DER Group function discovery

5.9 DER group capability discovery

This system has information regarding the installed capabilities of individual DER, and the intelligence to translate this into the functions supported by the group. At some point in time, a separate application, such as a Distribution Management System seeks to understand the supported functions of a particular group of DER, and this message is utilized.

Based on a request for supported functions, a DERMS would pass a set of Boolean values for the following functions:

- Connect/Disconnect
- frequencyWattCurveFunction
- maxRealPower Limiting
- rampRateControl
- reactivePowerDispatch
- realPowerDispatch
- voltageRegulation
- voltVarCurveFunction
- voltWattCurveFunction

Additionally, the DERNamePlate class has been added to support consistency with IEEE 1547, wherein DER capabilities such as min/max Active Power, Reactive Power, Voltage, and other operational characteristics are indicated. See Appendix B, DERNameplate class table for more details.

5.10 DER group voltage regulation function

This is a control function by which DER support for various voltage needs may be requested. Requesting entities could specify a target voltage or an increase/decrease adjustment. Requests could be made at any group-level; such as an entire circuit, an individual feeder (or segment thereof), or a microgrid.

The entity providing this service, for example, a DERMS, could use a variety of settings of individual DER in order to provide this service. This includes, for example, adjustments to the target voltage of various DER, for example, Vnom in IEC 61850-90-7), and turning on/off or adjusting reactive power functions. Use cases for this function include feeder-level conservation voltage reduction which might be turned on/off in a dispatchable way to reduce peak loading.

The "Voltage Regulation" function specifies only the intended result, and not the control method by which the result is obtained.

Similar to the other dispatch functions, the DERMS can specify a series of X and Y values in a ramp rate curve, which would allow for changing values over a period of time, or a single value that would represent a constant state.

Annex A
(normative)

Data requirements for DERMS profiles

A.1 General

Table A.1 to Table A.11 are the normative data requirements for the DERGroup related profiles.

Complete data definitions can be found in IEC 61968-11, *Application integration at electric utilities – System interfaces for distribution management – Part 11: Common information model (CIM) extensions for distribution.* For a graphical representation of the data model, see CIM version iec61970cim17v22_iec61968cim13v11_iec62325cim03v14.

The following profiles may have many types of serialization such as XSD, RDF, XML, JSON, or protobuf. For SOAP or JMS based integration guidance the reader is referred to IEC 61968-100:2013.

All classes inherit from identifiedObject. The mRID attribute is defined as a string, but leading practice is that mRID should be constrained to a globally unique ID (GUID).

In Tables A.1 to A.11, some will be labelled as "constrained" and some will be labelled as "unconstrained". This differs from profile development in the past where attempts were made to create "one size fits all" profiles. Recognizing however, that tighter constraints improves the chance for interoperability, in some instances constrained profile, which have fewer optional elements, will be required. Typically unconstrained profiles are used in the response to a request and since all data elements might not be populated, having more optional elements allows for an appropriate level of flexibility.

Table A.1 – IdentifiedObject

Core: IdentifiedObject			
Attribute	**Type**	**Cardinality**	**Comments**
aliasName	string	[0..1]	
description	string	[0..1]	
mRID	string	[0..1]	While a string, the string should be restricted to a GUID
name	string	[0..1]	

In Tables A.2 to A.11, profiles are detailed with a combination of attributes and super classes. A super class is an attribute which is itself, a class, e.g. Status.

A.2 DERGroups profile (constrained version)

The DERGroups profile contains one-to-many DERGroup. DERGroup is a specialization of the EndDeviceGroup class. In the constrained version of this profile, the element DERFunction is mandatory.

Table A.2 – DERGroups profile

DERGroups			
Attribute	**Data Type**	**Cardinality**	**Comments**
DERGroups	EndDeviceGroup	[1..*]	
Profile Attributes			
mRID	string	[0..1]	While a string, the string should be restricted to a GUID
description	string	[0..1]	
DERFunction	DERFunction	[1..1]	See Annex B
EndDevice	EndDevice	[0..*]	See Annex B
Names	Names	[0..*]	See Annex B
version	Version	[0..1]	

A.3 DERGroups profile (unconstrained version)

In the unconstrained version of this profile, DERFunction is optional.

Table A.3 – DERGroups (Unconstrained) Profile

DERGroups			
Attribute	**Data Type**	**Cardinality**	**Comments**
DERGroups	EndDeviceGroup	[1..*]	
Profile Attributes			
mRID	string	[0..1]	While a string, the string should be restricted to a GUID
description	string	[0..1]	
DERFunction	DERFunction	[0..1]	See Annex B
EndDevices	EndDevices	[0..*]	See Annex B
Names	Names	[0..*]	See Annex B
version	Version	[0..1]	See Annex B

A.4 DERGroupDispatches profile (constrained version)

In the constrained version of this profile, the attribute EndDeviceGroup is mandatory. DERMonitorableParameter is also mandatory. (See Annex B, EndDeviceGroup for dispatches).

Table A.4 – DERGroupDispatches (Unconstrained) Profile

DERGroupDispatches contains 1-to-many DERGroupDispatch			
Attribute	**Data Type**	**Cardinality**	**Comments**
DERGroupDispatches	DERGroupDispatch	[1..*]	
Profile Attributes			
DERGroupDispatch contains the following elements			
mRID	string	[0..1]	While a string, the string should be restricted to a GUID
EndDeviceGroup	EndDeviceGroup	[1..1]	See Annex B, EndDeviceGroup for Dispatches
Names	Names	[0..*]	See Annex B

A.5 DERGroupDispatches profile (unconstrained version)

In the unconstrained version of this profile, EndDeviceGroup is optional. DERMonitorableParameter is also option (See Annex B, EndDeviceGroup for Dispatches).

Table A.5 – DERGroupDispatches (unconstrained) profile

DERGroupDispatches contains 1-to-many DERGroupDispatch			
Attribute	**Data Type**	**Cardinality**	**Comments**
DERGroupDispatches	DERGroupDispatch	[1..*]	
Profile Attributes			
DERGroupDispatch contains the following elements			
mRID	String	[0..1]	While a string, the string should be restricted to a GUID
EndDeviceGroup	EndDeviceGroup	[0..1]	See Annex B, EndDeviceGroup for Dispatches
Names	Names	[0..*]	See Annex B

A.6 DERGroupForecasts (constrained)

Used to ask a DERMS for DERGroup forecasts. In the constrained version of this profile, predictionCreationDate and EndDeviceGroup are mandatory.

Table A.6 – DERGroupForecast (constrained) profile

DERGroupForecasts contains 1-to-many DERGroupForecast			
Attribute	**Data Type**	**Cardinality**	
DERGroupForecast	DERGroupForecast	[1..*]	
Profile Attributes			
DERGroupForecast contains the following elements			
mRID	String	[0..1]	While a string, the string should be restricted to a GUID
predictionCreationDate	dateTime	[1..1]	
EndDeviceGroup	EndDeviceGroup	[1..1]	See Annex B, EndDeviceGroup
Names	Name	[0..1]	

A.7 DERGroupForecasts (unconstrained)

In the unconstrained version of this profile, predictionCreationDate and EndDeviceGroup are optional.

Table A.7 – DERGroupForecast (unconstrained) profile

DERGroupForecasts contains 1-to-many DERGroupForecast			
Attribute	**Data Type**	**Cardinality**	
DERGroupForecast	DERGroupForecast	[1..*]	
Profile Attributes			
DERGroupForecast contains the following elements			
mRID	String	[0..1]	While a string, the string should be restricted to a GUID
predictionCreationDate	dateTime	[0..1]	
EndDeviceGroup	EndDeviceGroup	[0..1]	See Annex B, EndDeviceGroup
Names	Name	[0..1]	

A.8 DERGroupStatuses profile

Table A.8 – DERGroupStatuses profile

DERGroupStatuses contains 1-to-many DERGroupStatus			
Attribute	**Data Type**	**Cardinality**	
DERGroupStatuses	EndDeviceGroup	[1..*]	
Profile Attributes			
mRID	string	[0..1]	While a string, the string should be restricted to a GUID
DERMonitorableParameter	DERMonitorableParameter	[1..*]	See Annex B, DERMonitorableParameter
Names	Name	[0..*]	See Annex B, Names
status	Status	[0..1]	

A.9 EndDeviceControls

The EndDeviceControls is used for control functions such as indicating to an entire group of DER to connect or disconnect. This profile is the same as the source profile in IEC 61968-9:2013, Meter Reading and Control.

A.10 DERGroupQueries

This profile is used to request information about a DERGroup. The requesting system simply passes along the identifier (mRID, or Names) and the responding systems returns all data for that DERGroup. If no identifier is passed, then the responding system is to respond with the data for ALL DERGroups. This is the special "bootstrap" case that can be used to populate a system with DERGroup data so that a basis for further transaction may occur.

Table A.9 – DERGroupQueries

DERGroupQueries contains 1-to-many EndDeviceGroup			
Attribute	**Data Type**	**Cardinality**	
Profile Attributes			
EndDeviceGroup	EndDeviceGroup	[1..*]	See Annex B, EndDeviceGroup

A.11 DERGroupStatusQueries

This profile is used to request data about the status (power related) of a DERGroup. While the query has the same structure of a DERGroupQueries profile, the response is with the DERGroupStatuses profile.

Table A.10 – DERGroupStatusQueries

DERGroupQueries contains 1-to-many EndDeviceGroup			
Attribute	**Data Type**	**Cardinality**	
Profile Attributes			
EndDeviceGroup	EndDeviceGroup	[1..*]	See Annex B, EndDeviceGroup

A.12 DERGroupForecastqueries

This profile is used to query a system such as a DERMS, for data related to forecasts.

Table A.11 – DERGroupForecastQueries

DERGroupForecastQueries contains 1-to-many DERMonitorableParameter, 1-to-many DispatchSchdule, and 1-to-many EndDeviceGroup			
Attribute	**Data Type**	**Cardinality**	
Profile Attributes			
DERMonitorableParameter	DERMonitorableParameter	[1..*]	See Annex B, DERMonitorableParameter
DispatchSchedule	DispatchSchedule	[1..*]	See Annex B, DispatchSchedule
EndDeviceGroup	EndDeviceGroup	[1..*]	See Annex B, EndDeviceGroup

Annex B
(normative)

Super classes

B.1 General

These are classes (shown in Table B.1 to Table B.15) that are used as attributes in other classes for constructing a profile.

B.2 CurveStyle class

Table B.1 – CurveStyle class

Core: CurveStyle	
Attribute	**Data Type**
constantYValue	string = "constantYValue"
straightLineYValues	string = "straightLineYValues"

B.3 DERCurveData class

Table B.2 – DERCurveData class

DERCurveData		
Attribute	**Data Type**	**Cardinality**
intervalNumber	Integer	[0..1]
maxYValue	float	[0..1]
minYValue	float	[0..1]
nominalYValue	float	[0..1]
timestamp	dateTime	[0..1]

B.4 DERFunction class

The DERFunction class is used to share information with a requesting system about which DER functions the responding system can support.