

Deliverable 2.1

Requirement specification for communication infrastructure



D2.1 Requirement specification for communication infrastructure

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Executive Summary

This deliverable provides the requirement specification for the communication infrastructure that will be used for OS4ES platform deployment. The structure of the deliverable is as follows:

- Section 1 provides an introduction and shows the scope of this document.
- Section 2 analyses communication requirements of the network equipment (latency, data traffic, reliability, etc.) and provides a summary table of communication requirements.
- Section 3 analyses communication protocol characteristics (information service types and communication patterns).
- Section 4 provides analysis of the OS4ES use cases that have been identified in D1.1. Each of the communication sequence diagrams has been annotated according to the communication requirements identified in Section 2 and Section 3.
- Section 5 provides a summary of communication requirements for the use cases analysed in Section 4 according to the communication protocol functions and required information service types.

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1 Introduction

1.1 Scope of the document

This deliverable defines communication requirements for the communication infrastructure that will be used in the OS4ES project. The communication requirements are based on several criteria taking into account physical network (latency, data traffic, reliability, etc.) and communication protocol characteristics (data exchange patterns, information types). Each of the use cases defined in D1.1 [1] is analysed according to these criteria. The analysis results are presented in the summary tables in the last section of the document.

1.2 Notations, abbreviations and acronyms

AN	Announcement
CO	Command
COM	Communication patterns
CP	Cyclic poll
DM	Data Model
FL	File
GM	Generic Message
INF	Information service type
LAT	Latency
MV	Measurement
QR	Query
PD	Physical Device
PU	Push
RD	Recovery Delay
RR	Request response
RT	Real time
SP	Set Point
ST	Status
TT	Transfer Time
UNAV	Unavailability

Table 1: Acronyms list

2 Communication requirements – network equipment

Communication requirements criteria are based on industrial standards [2] [3], characteristics of the widely accepted network equipment and commonly applied communication middleware patterns.

2.1 Transfer time constraint

Transfer time is the complete transmission time of a message including the necessary handling at both ends of the communicating entities. The time counts from the moment the sender puts the data content on top of its transmission communication stack up to the moment the receiver extracts the data from its transmission stack. Data delivery latency classes are based on IEC 61850-5 standard (Figure 1, Table 2).

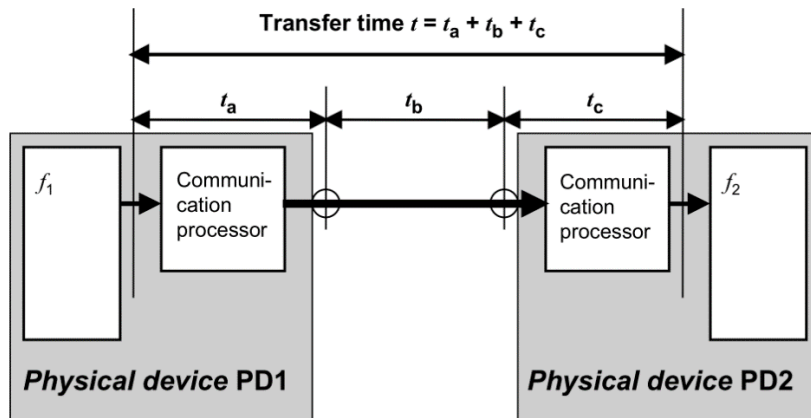


Figure 1: Transfer time defined in IEC 61850-5

Class	Latency	Application example
TT0	> 1000 ms	File, events, log contents
TT1	≤ 1000 ms	Alarms and Events
TT2	≤ 500 ms	Operator commands
TT3	≤ 50 ms	Slow automatic interaction
TT4	≤ 20 ms	Fast automatic interaction
TT5	≤ 10 ms	Releases, status changes
TT6	≤ 3 ms	Trip, blockings

Table 2: Summary of latency classes from IEC 61850-5

2.2 Real time constraint

Guarantee of the time delivery influences systems which require timely response. Not fulfilling time limits for the specific systems can cause system instability or failure.

1. Hard-real time - meet all timing constraints exactly
2. Soft-real time - meet timing constraints most of the time

2.3 Availability

Availability applies to a repairable system that oscillates between up-time and down-time. The up-time includes the time during which the network is still operating, but impaired (due to redundancy loss). Also, maintenance itself can cause downtimes.

2.4 Recovery delay

The recovery delay stems from recovery from network breakdown. Depending on the technology, it may vary from zero to several seconds or even minutes. When non-zero, this delay depends strongly on the topology.

2.5 Network bandwidth

Network bandwidth is a measurement of bit-rate of available or consumed data communication resources expressed in bits per second or multiples of it.

2.6 Communication requirement classes

Table 3 shows a summary table of the communication requirements applicable for the OS4ES project use cases.

	Class A	Class B	Class C	Class D
Latency	< 50 ms (TT3)	< 500 ms (TT2)	< 1000 ms(TT1)	1000 ms < (TT0)
Real time requirement	Hard-real time	Soft-real-time		
Unavailability	10^{-7} to 10^{-6}	10^{-5} to 10^{-4}	10^{-3}	
Recovery delay (interruption)	0 (Parallel redundancy)	100 ms	1 s	10 s

Table 3: Classification of communication requirements

3 Communication requirements – communication protocol

3.1 Information service type

Each communication interaction utilizes information with a particular service type that is exchanged between communicating entities. This criteria is used to outline applicability of specific application-level communication protocols and services. The possible service types of the information exchanged are extracted from the commonly used remote control protocols [4], [5], [6].

1. Measurement (MV)
(e.g. single measurement or series of measurements)
2. Status or status change (ST)
(e.g. breaker position has been changed)
3. Command (CO)
(e.g. request breaker to open)
4. Set-point (SP)
(e.g. change reference set point to 5)
5. Data-model (DM)
(e.g. data structure of an IED, specific info about IED)
6. Query (QR)
(e.g. searching the DER registry database)
7. File (FL)
(e.g. DER-DSO contract, SCL file)
8. Announcement (AN)
(e.g. register a DER with a set of information)
9. Generic Message (GM)
(e.g. ask for tender proposal)

3.2 Communication patterns

Communication patterns are used to emphasize common application level interactions between communicating entities in order to outline features provided by the communication protocol or the middleware that can be used for establishing communication. The following communication patterns have been identified [7]:

1. Request–response (RR) - Synchronous single operation (e.g. change setpoint and get immediate information if it was successful).
2. Cyclic poll (CP) - Cycled synchronous request-response pattern.
3. Push (PU) - Event-based, unsolicited, spontaneous delivery (e.g. get notified when status of breaker changes).

4 Use case analysis

This chapter provides an analysis of the communication related sequence diagrams for each of the OS4ES use cases. The detailed description of the use cases can be found D1.1 Annex C [1]. The diagrams have been annotated according to the communication requirements described in chapter 2 and chapter 3 of this document according to the following symbols:

Requirement	Annotation acronym	Possible values
Latency	LAT	A, B, C or D (Table 3)
Real time requirement	RT	A or B (depending on the class - Table 3)
Unavailability	UNAV	A, B or C (depending on the class - Table 3)
Recovery delay (interruption)	RD	A, B, C or D (depending on the class - Table 3)
Information service type	INF	MV, ST, CO, SP, DM, QR, FL, AN, GM (chapter 3.1)
Communication patterns	COM	RR, CP, PU (chapter 3.2)

Table 4: Annotation symbols

4.1 Certified Energy Market

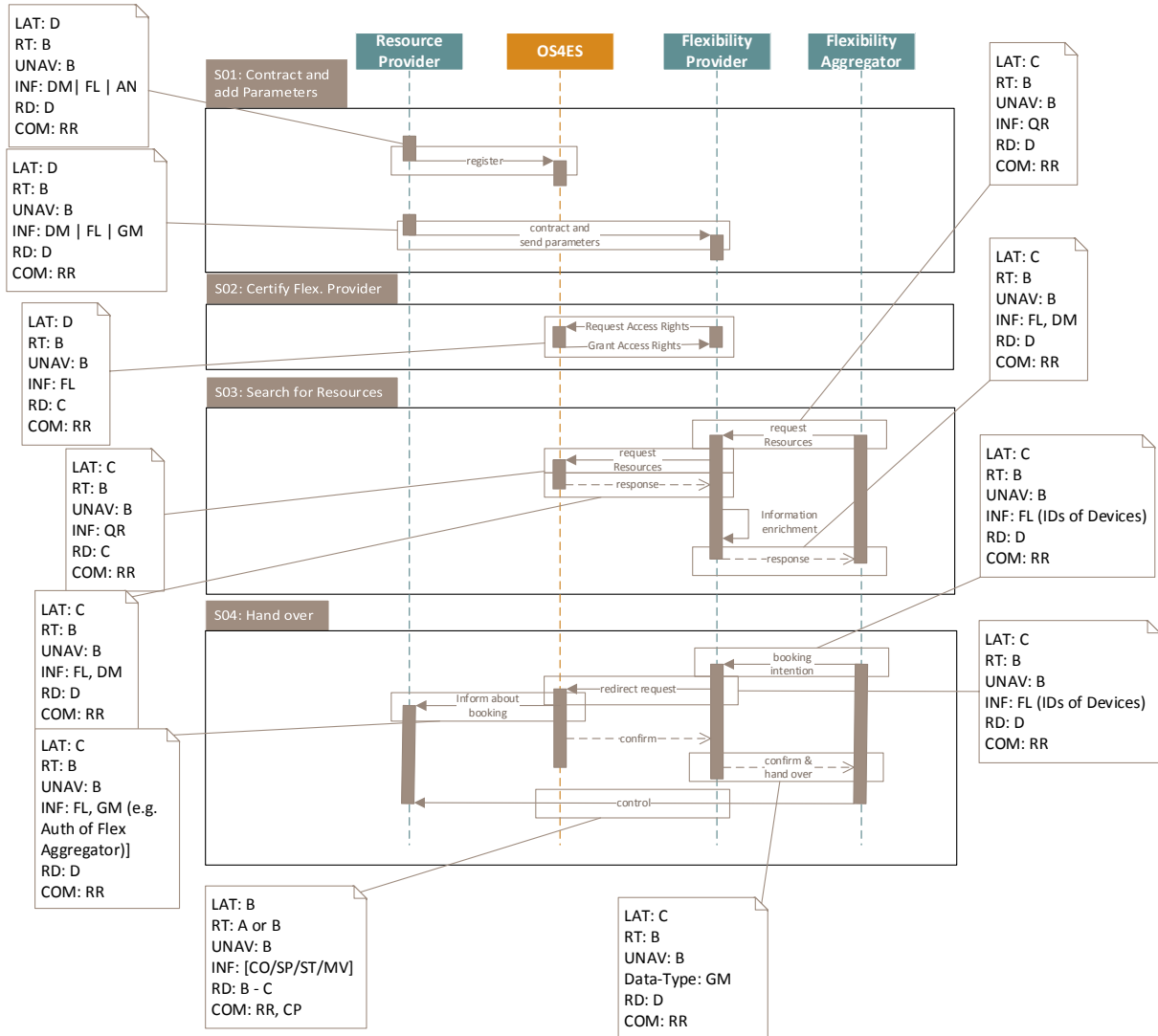


Figure 2: Certified Energy Market – annotated sequence diagram

4.2 Energy Management using VPP

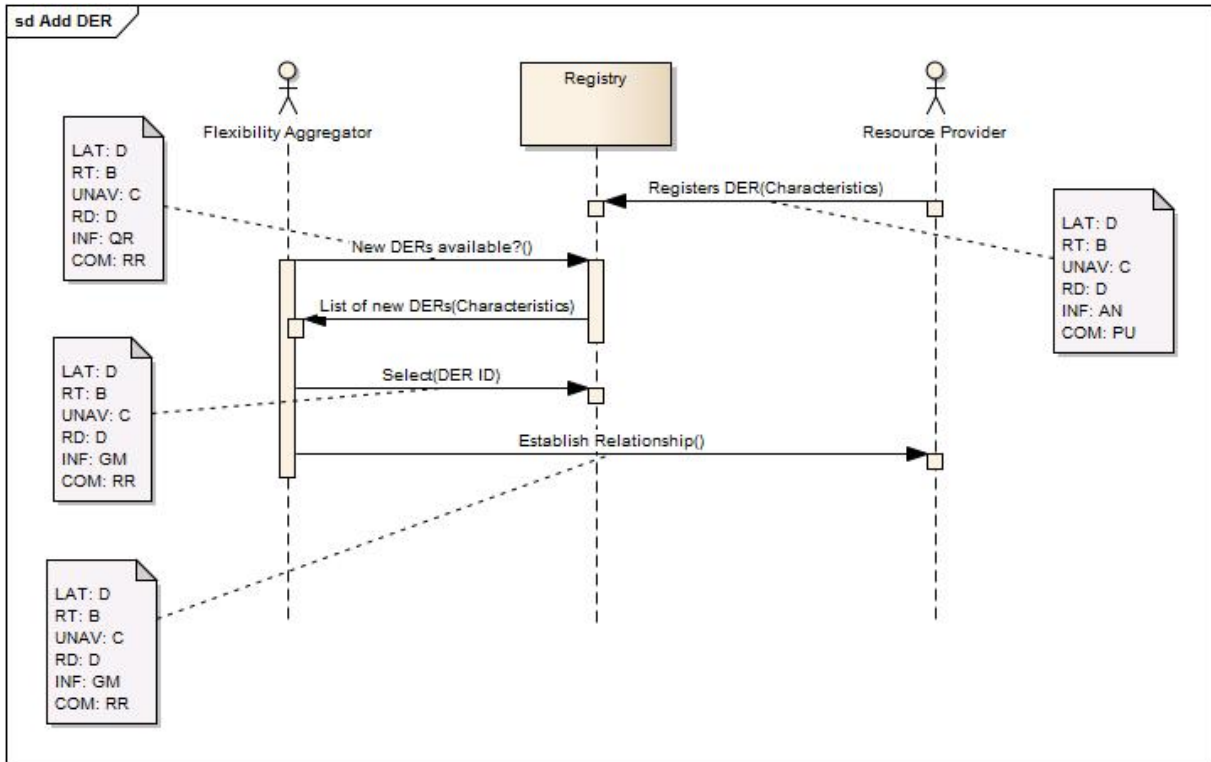


Figure 3: Energy Management using VPP (Add DER) – annotated sequence diagram

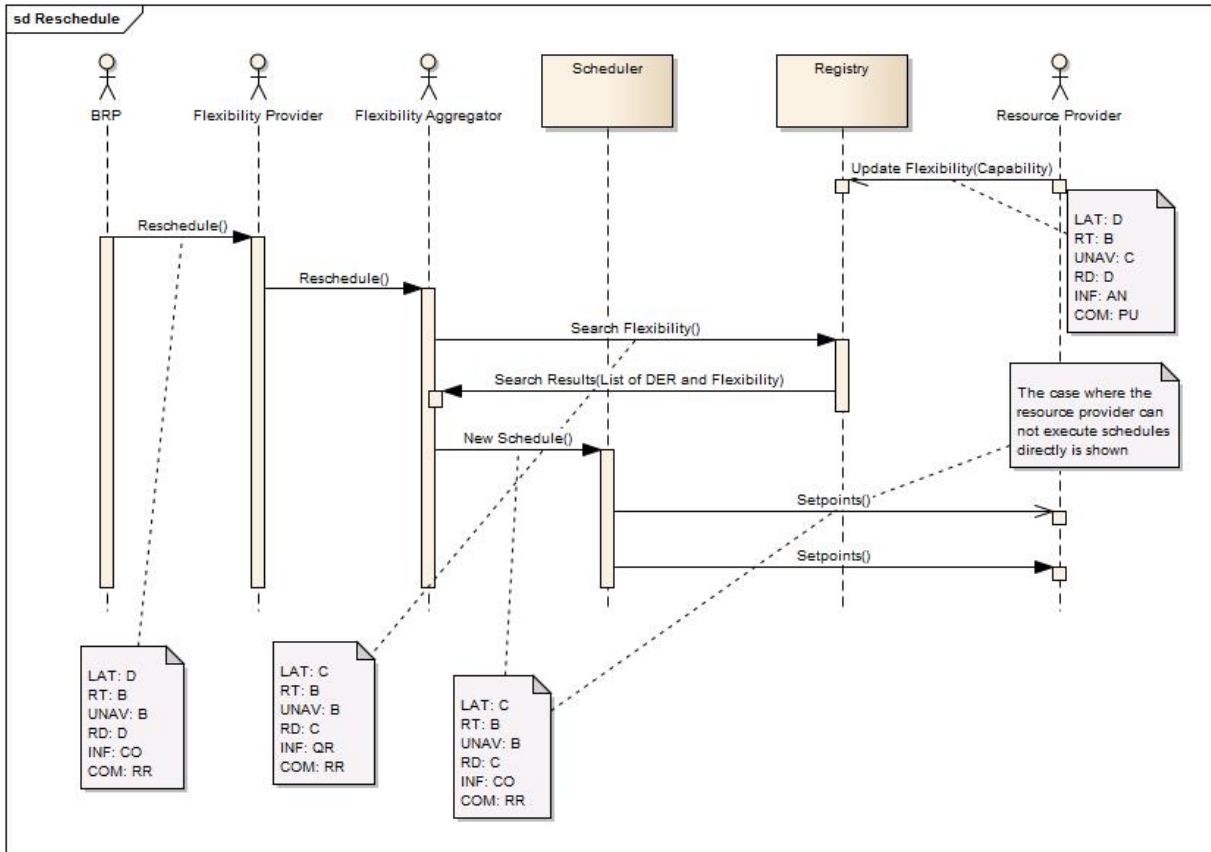


Figure 4: Energy Management using VPP (Reschedule) – annotated sequence diagram

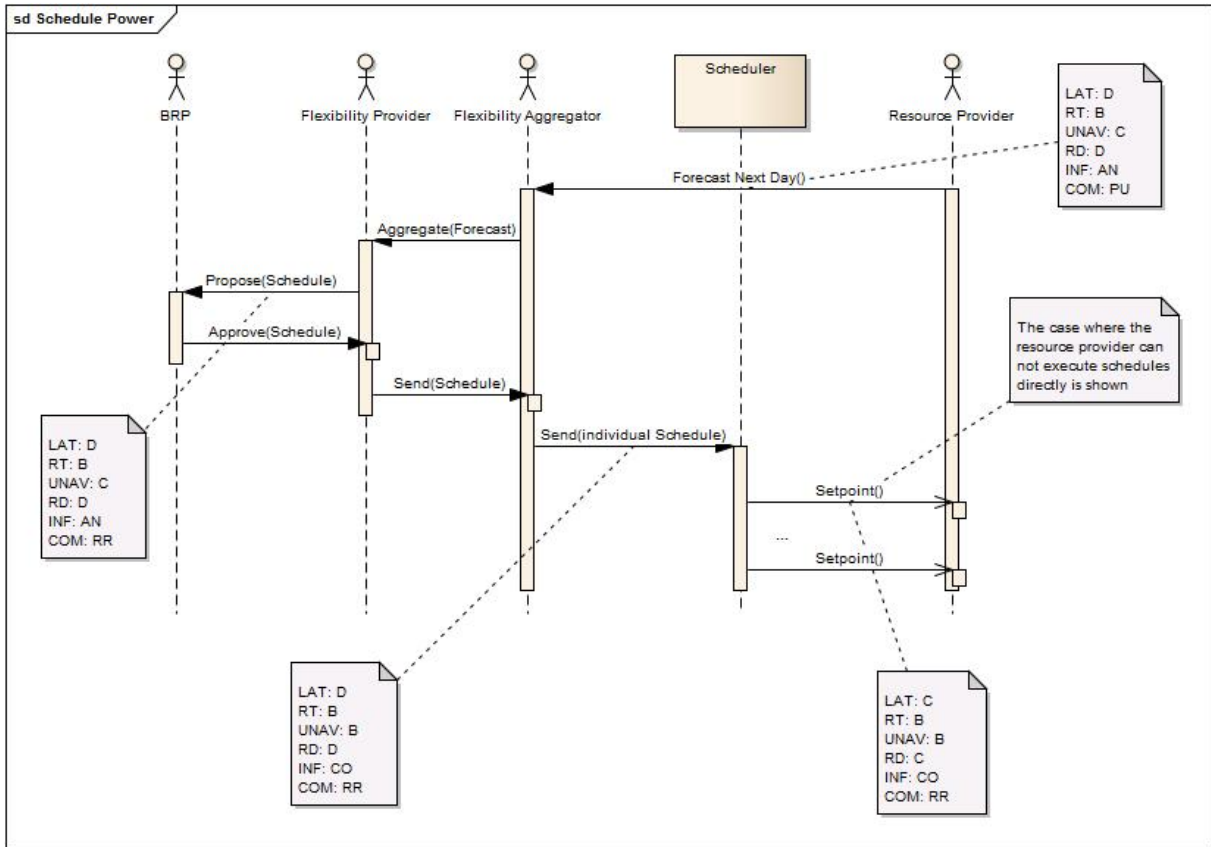


Figure 5: Energy Management using VPP (Schedule Power) – annotated sequence diagram

4.3 Dwelling Information Exchange

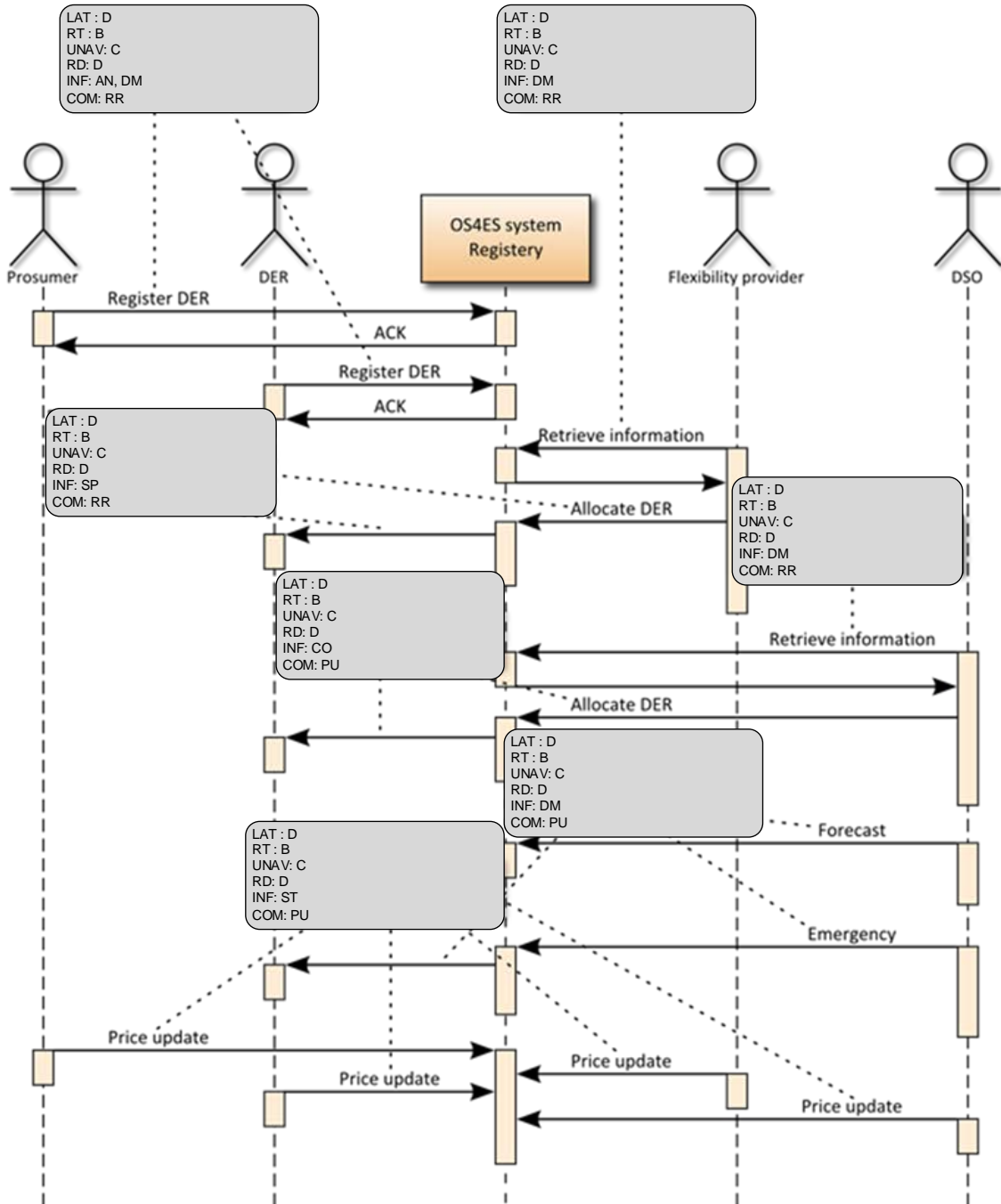


Figure 6: Dwelling Information Exchange – annotated sequence diagram

4.4 Marketization of Balance Group Management

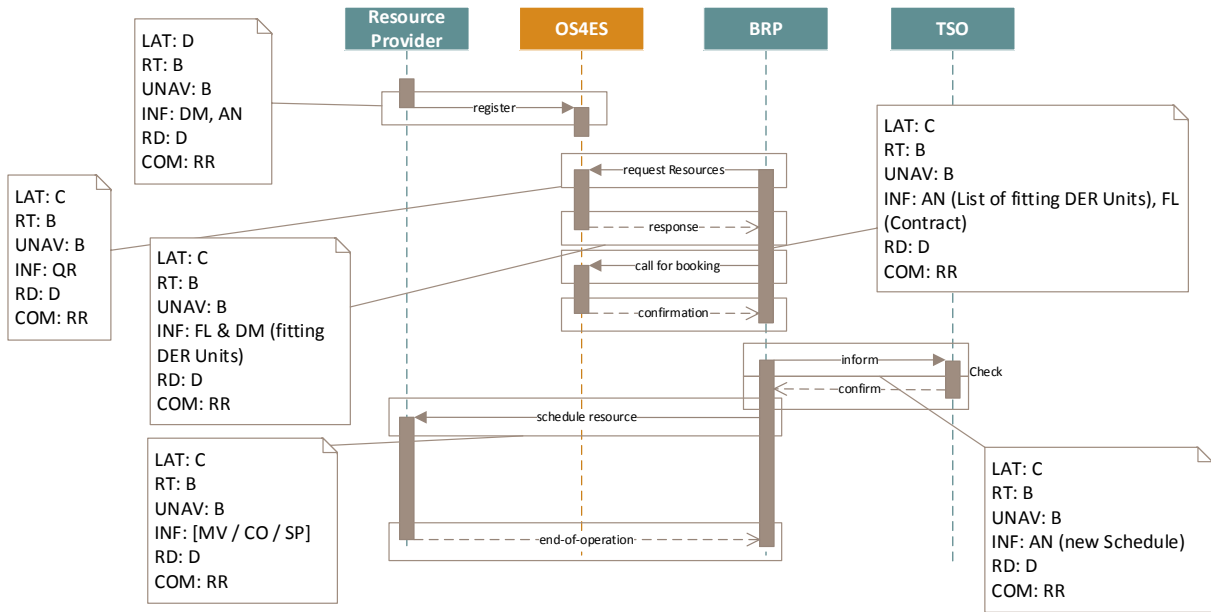


Figure 7: Marketization of Balance Group Management – annotated sequence diagram

4.5 Frequency Control – Primary Control

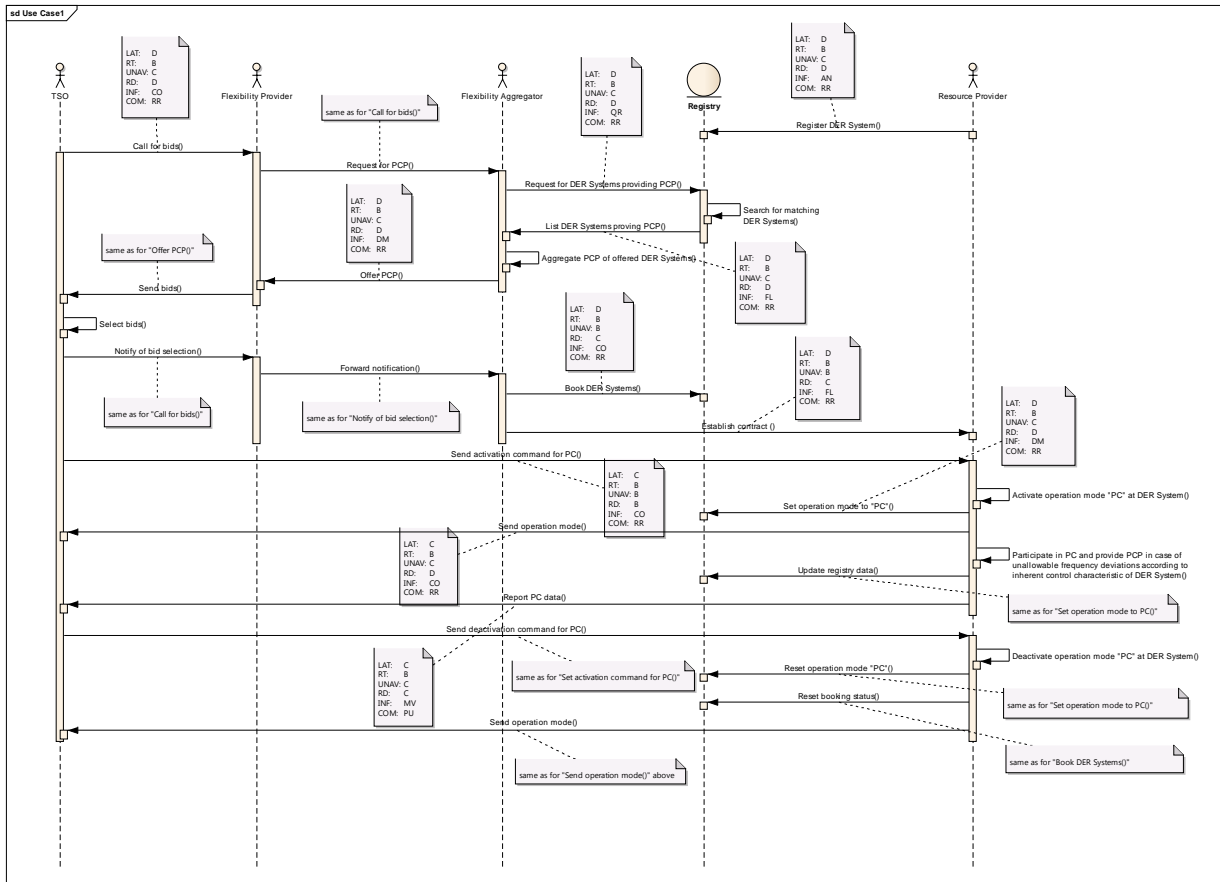


Figure 8: Frequency Control (Primary Control) – annotated sequence diagram

4.6 Frequency Control – Secondary Control

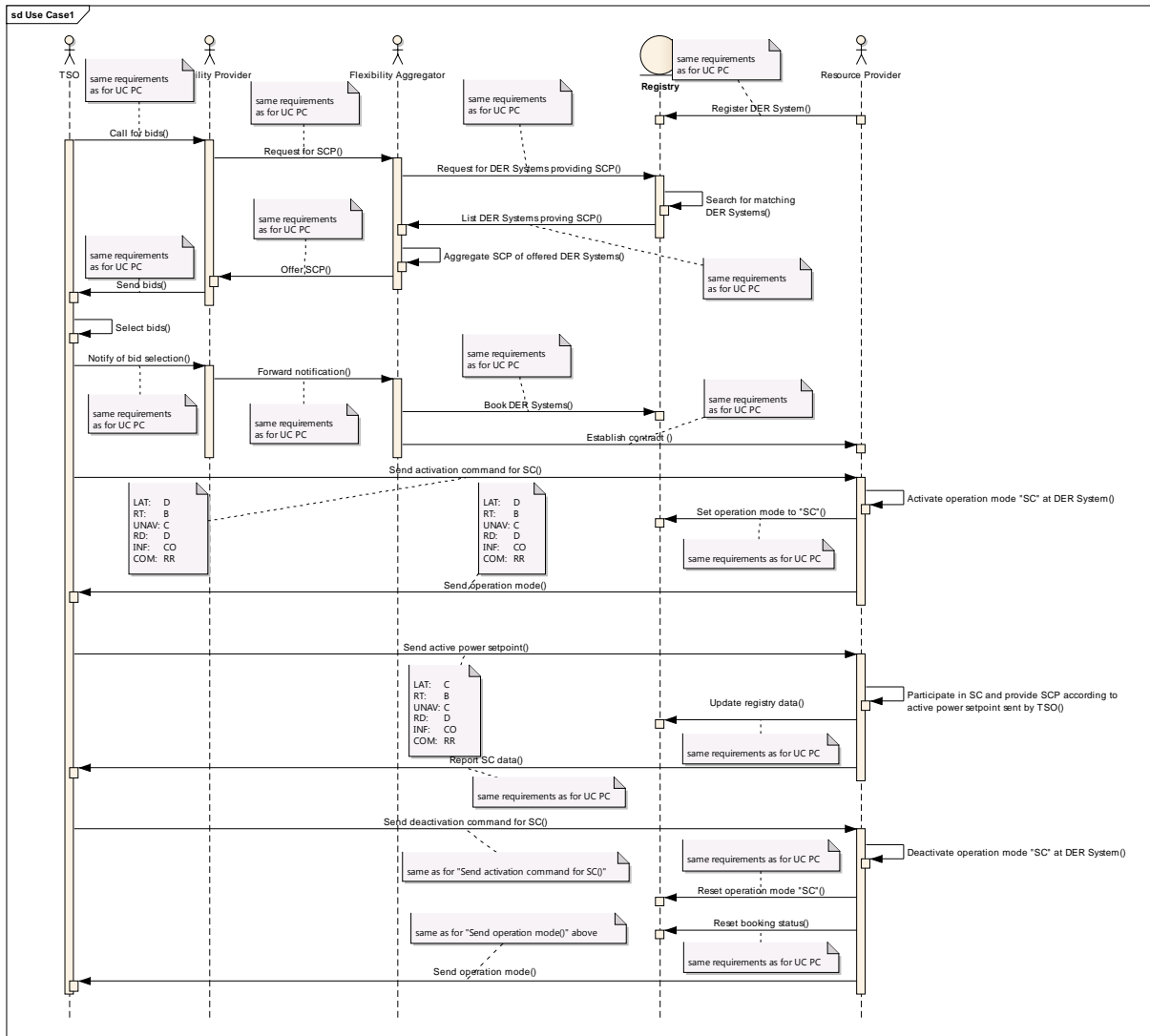


Figure 9: Frequency Control (Secondary Control) – annotated sequence diagram

4.7 Frequency Control – Tertiary Control

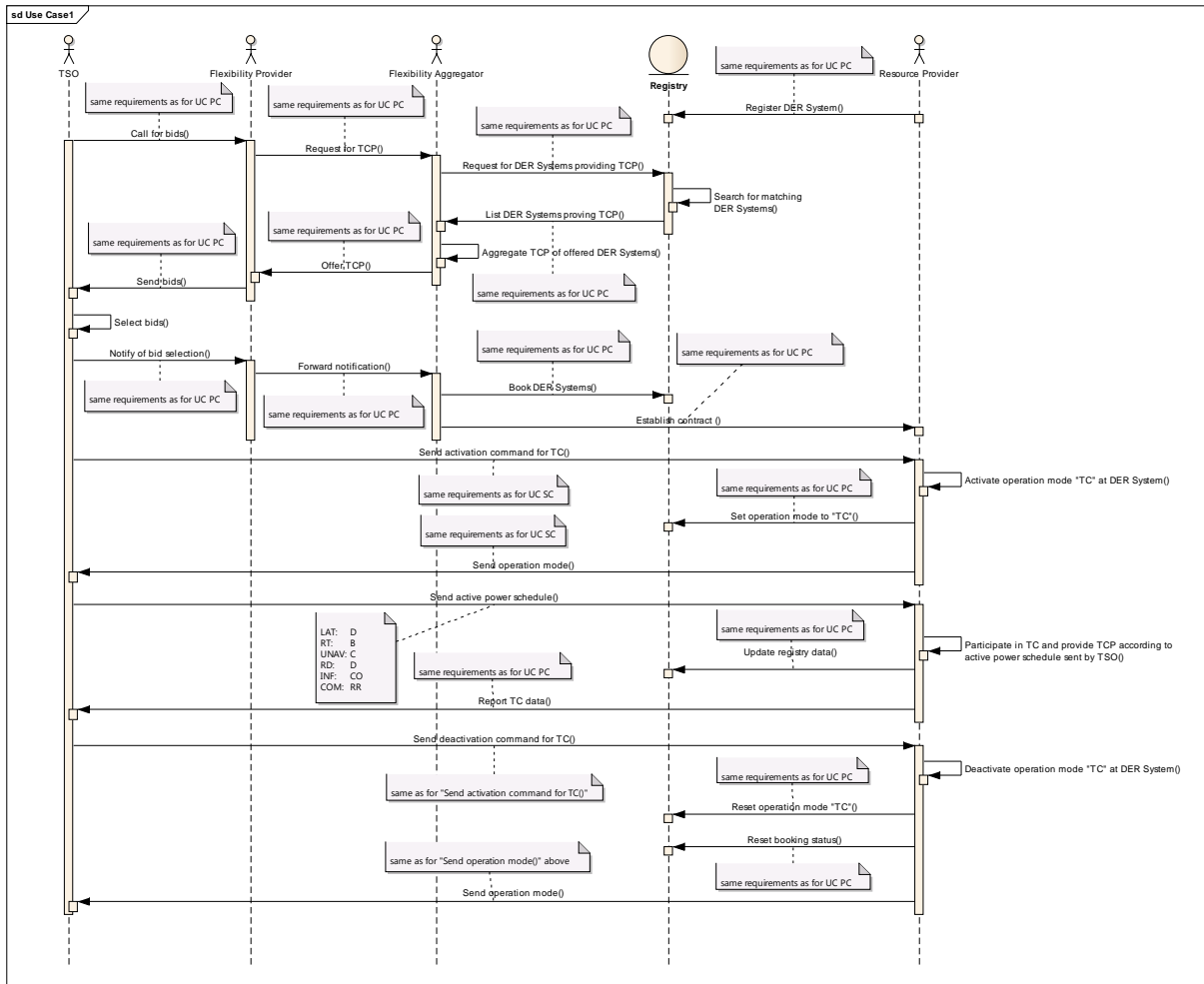


Figure 10: Frequency Control (Tertiary Control) – annotated sequence diagram

4.8 Volt / Var Control - Dynamic

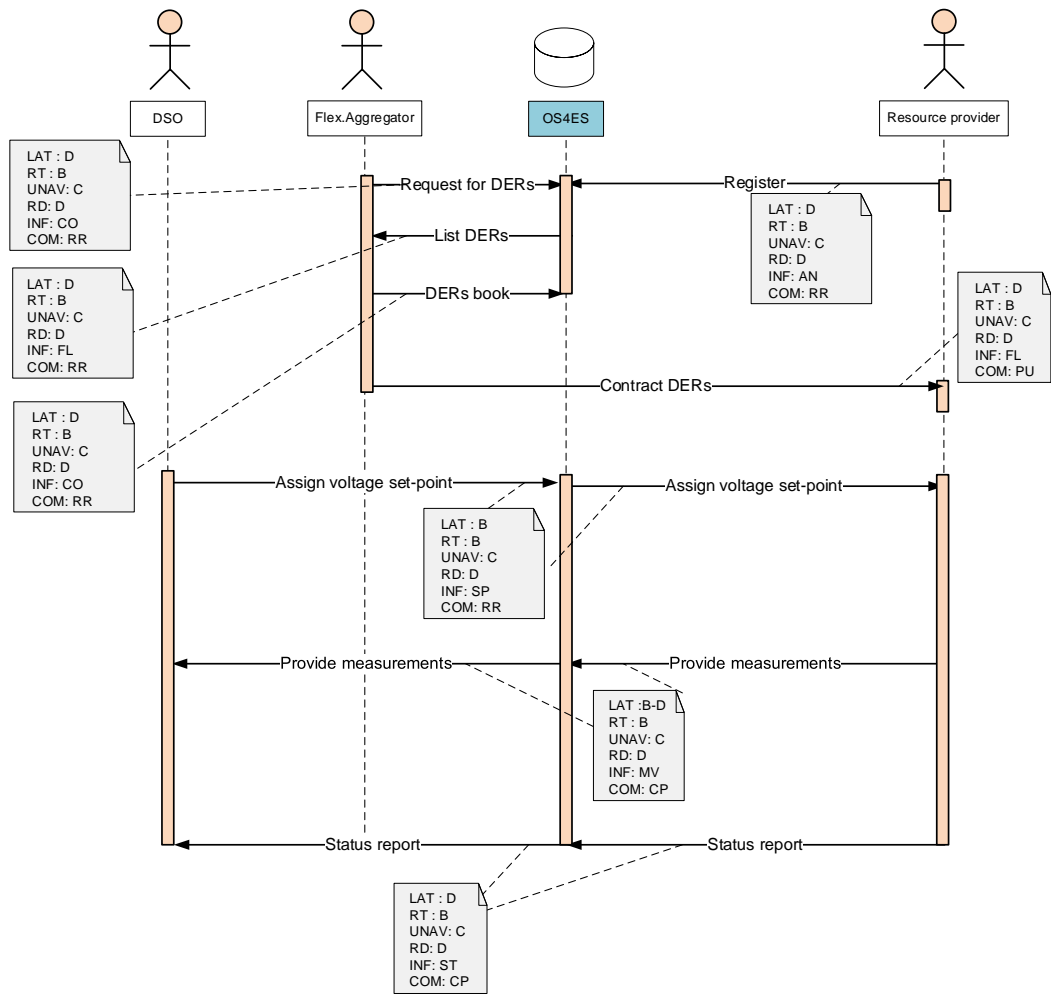


Figure 11: Volt / Var Control (Dynamic) – annotated sequence diagram

4.9 Volt / Var Control - Static

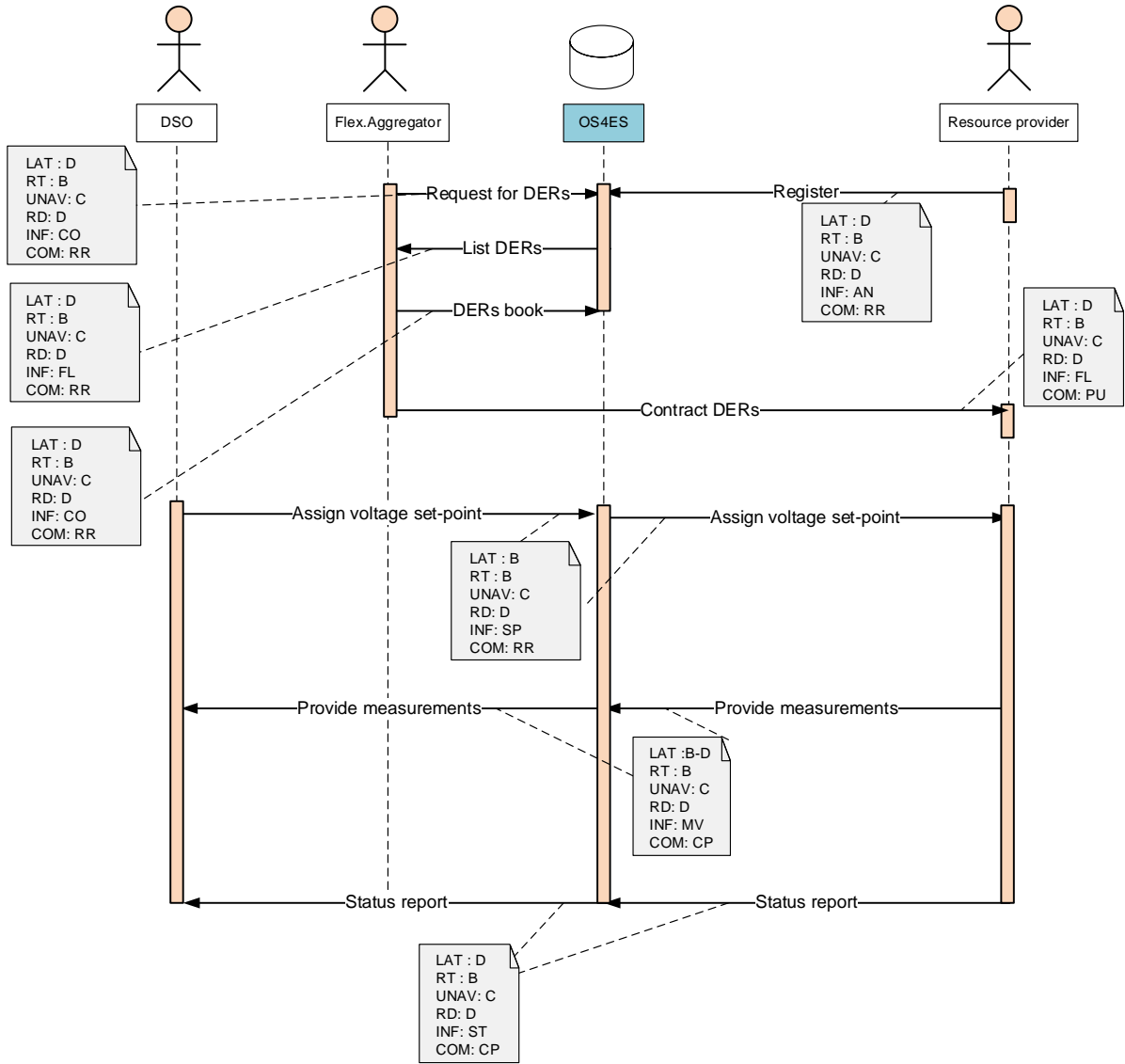


Figure 12: Volt / Var Control (Static) – annotated sequence diagram

4.10 Volt / Var Optimization

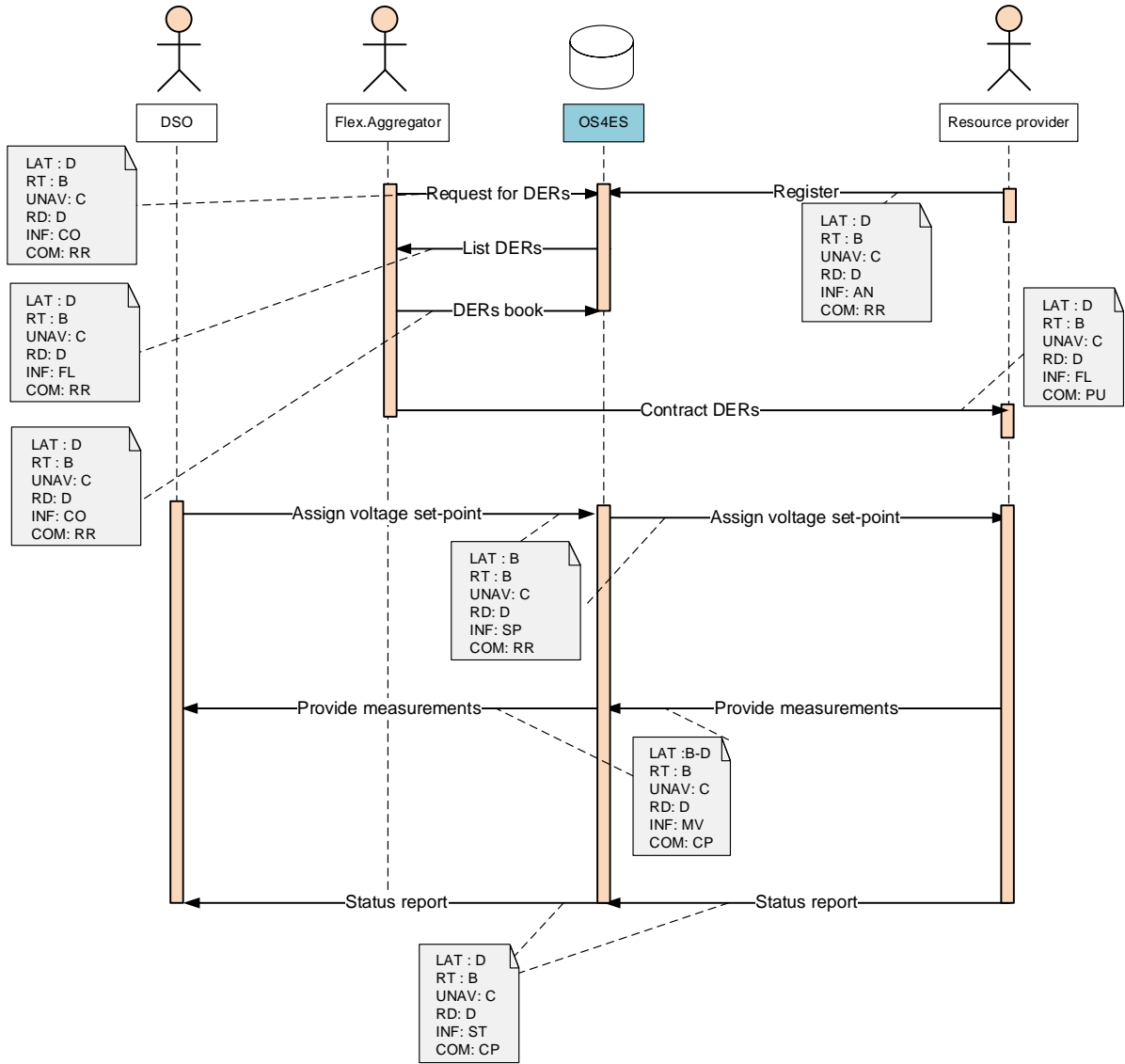


Figure 13: Volt / Var Optimization – annotated sequence diagram

4.11 Dynamic Virtual Power Plant

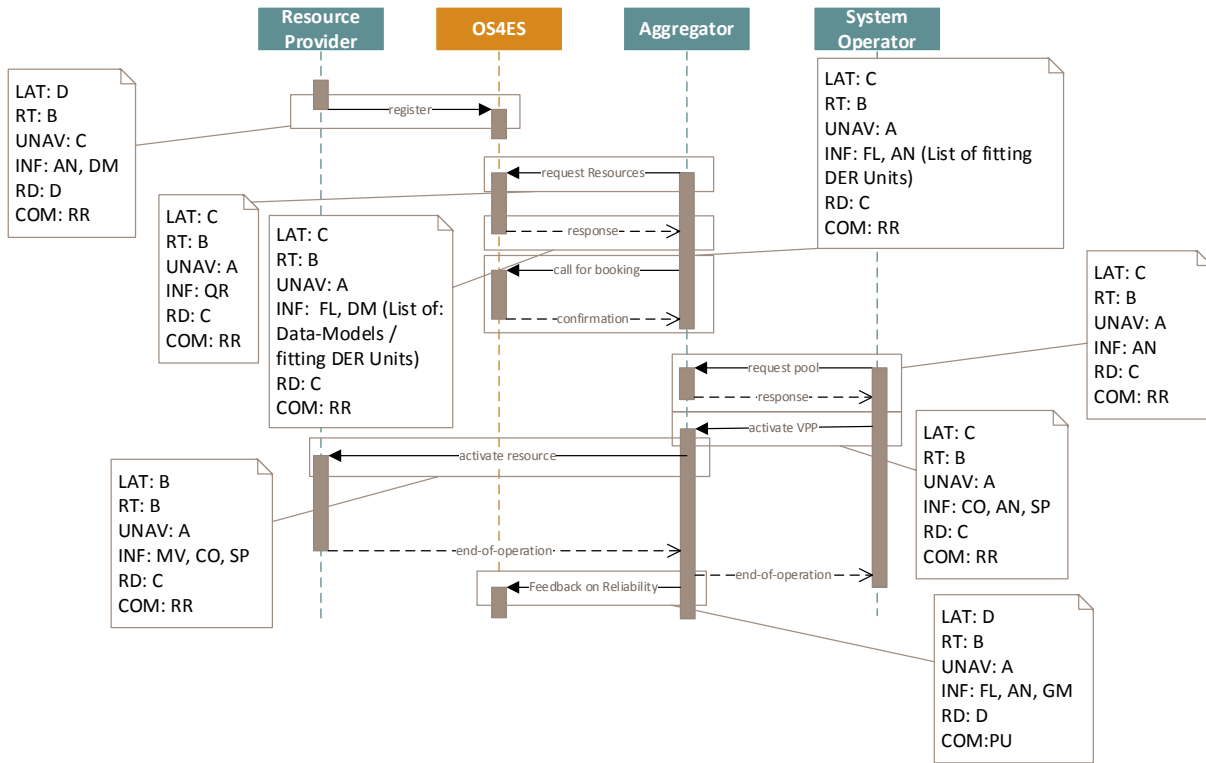


Figure 14: Dynamic Virtual Power Plant – annotated sequence diagram

4.12 Demand Response

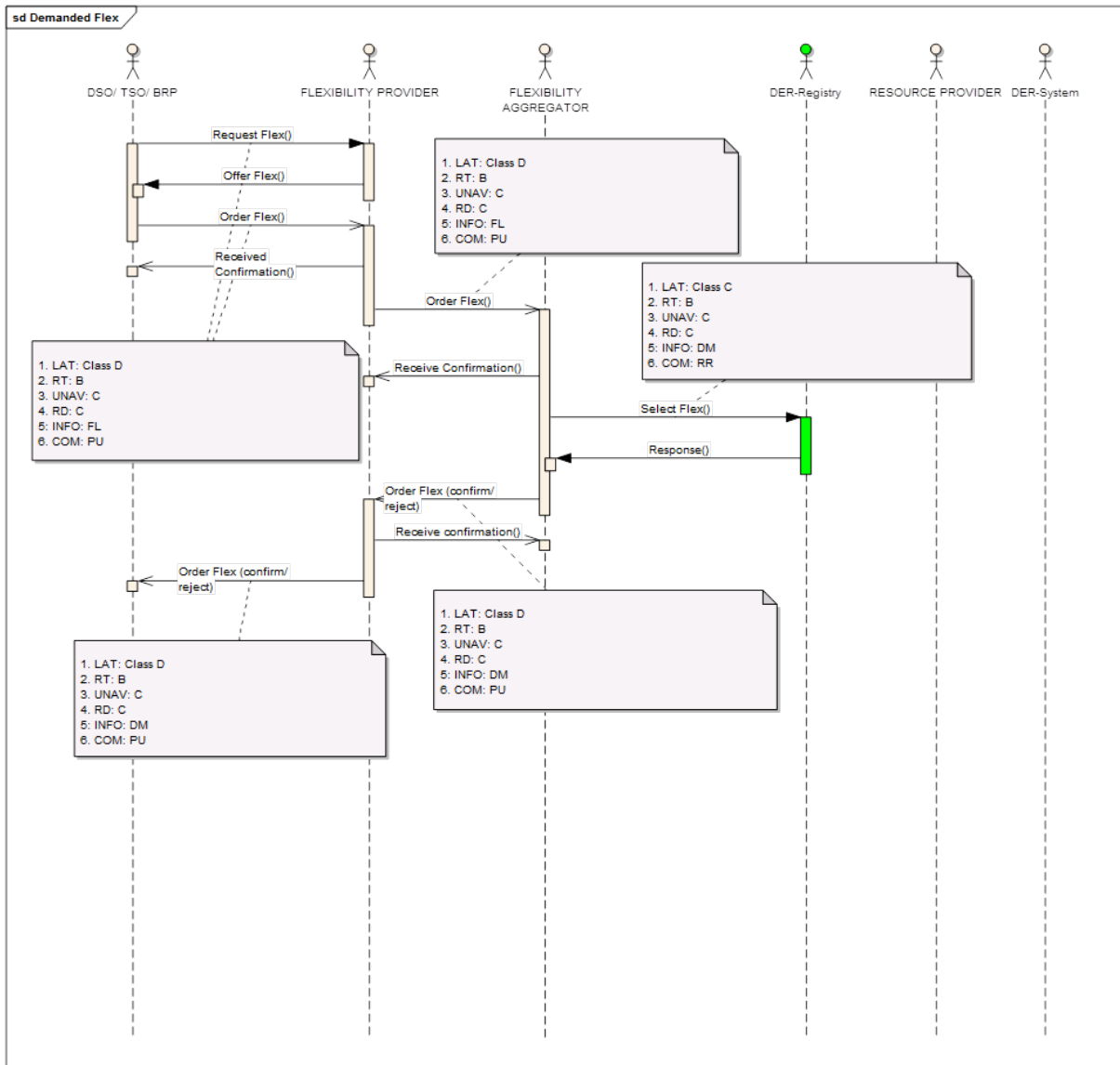


Figure 15: Demand Response (Demand Flex) – annotated sequence diagram

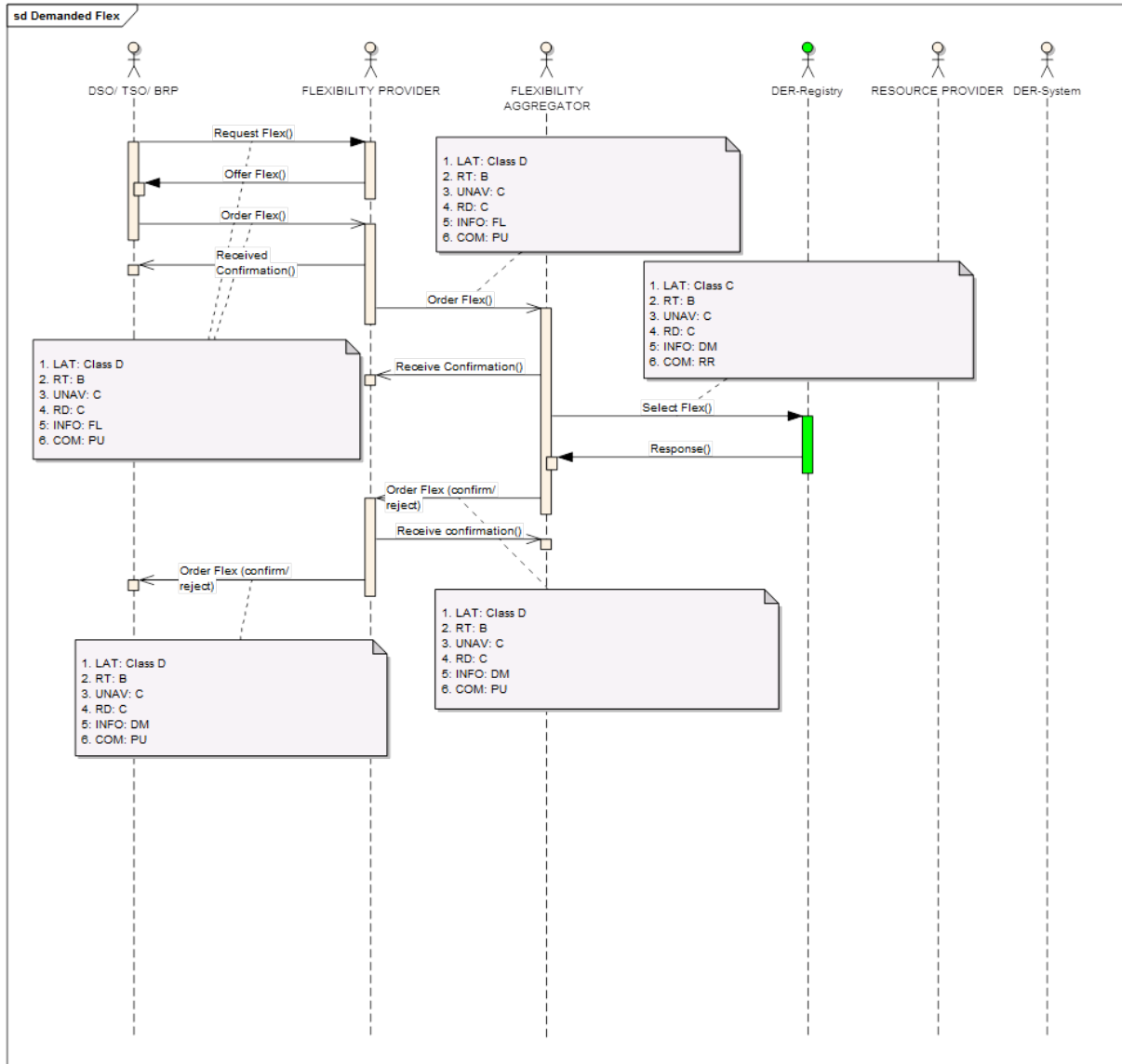


Figure 16: Demand Response (Activate Flex) – annotated sequence diagram

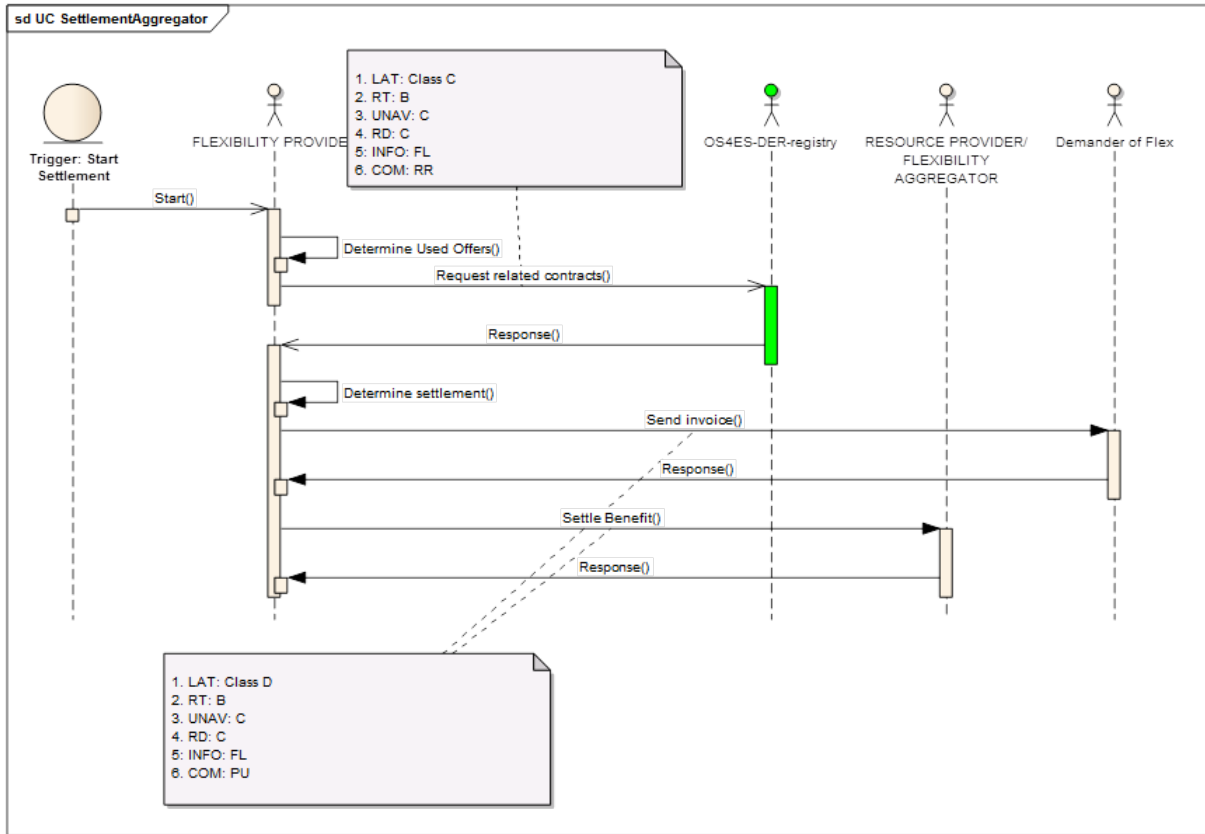


Figure 17: Demand Response (Settlement aggregator) – annotated sequence diagram

4.13 Demand Response Management of EVs

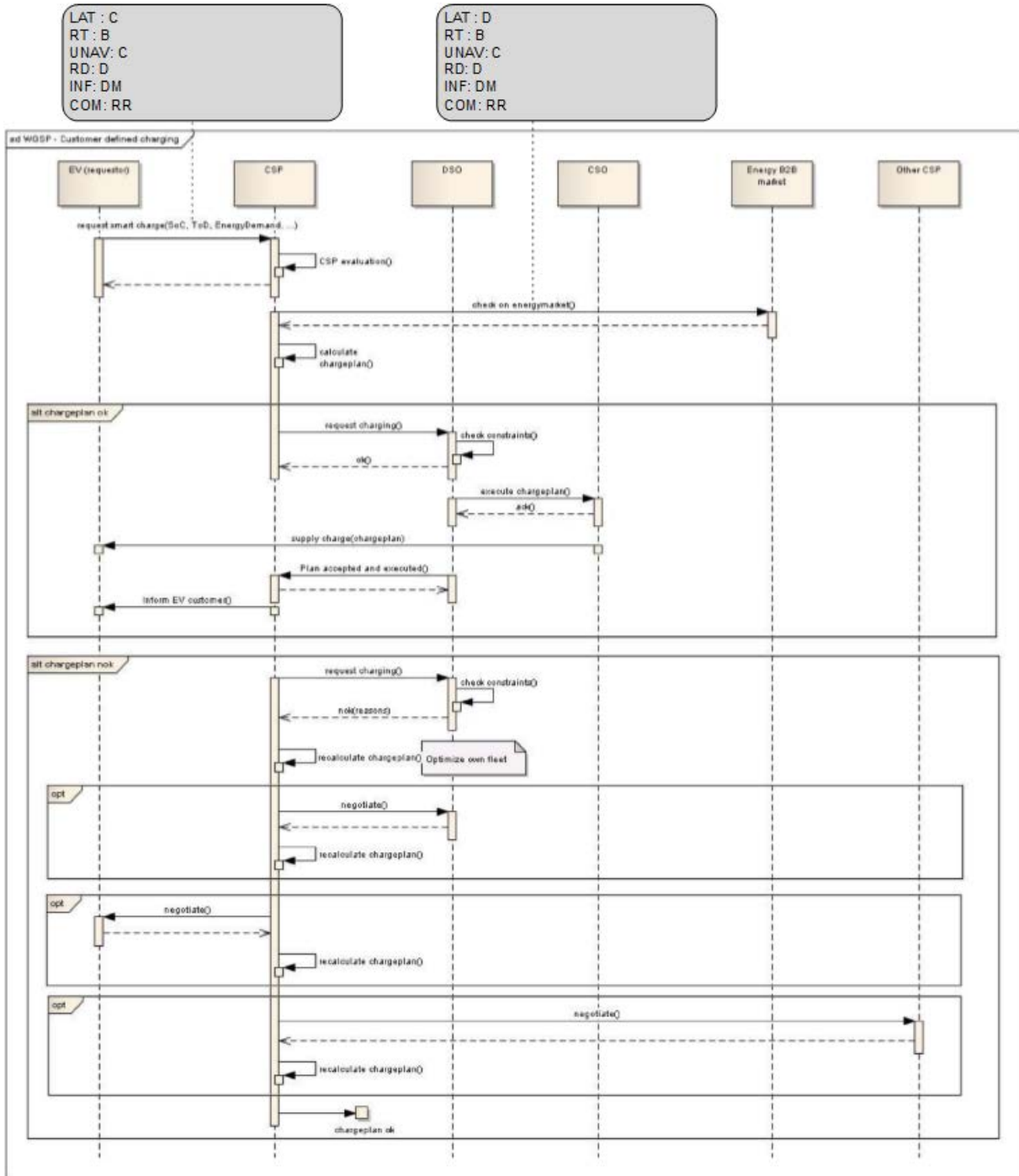


Figure 18: Demand Response Management of EVs – annotated sequence diagram

5 Summary of communication requirements

This chapter provides summary tables for the communication requirements including mapping OS4ES use cases to the specific communication requirements classes (Table 5), Application-level communication protocol functions (Table 6), required information service types (Table 7) and communication patterns (Table 8).

Use cases / Requirement classes	Bandwidth [kbit/s]	Latency	Real time requirement	Unavailability	Recovery delay
Certified Energy Market	10 to 10000	C	B	B	A
Energy Management using VPP	10 to 1000	C	B	B	C
Dwelling Information Exchange	10 to 1000	D	B	C	D
Marketization of Balance Group Management	10 to 1000	C	B	B	D
Frequency Control – Primary Control	1 to 10000	C	B	B	C
Frequency Control – Secondary Control	1 to 10000	C	B	B	C
Frequency Control – Tertiary Control	1 to 10000	C	B	B	C
Volt / Var Control – Dynamic	1 to 10000	C	A	B	A
Volt / Var Control – Static	1 to 10000	C	B	B	C
Volt / Var Optimization	1 to 10000	C	B	B	C
Dynamic Virtual Power Plant	10 to 1000	B	B	A	C
Demand Response	1 to 10000	C	B	B	B
Demand Response Management of EVs	1 to 10000	C	B	C	D

Table 5: Communication requirements for OS4ES use cases

Use case / Application-level communication functions	Device registration	Device search	Contract management	Access rights management	Control command / Setpoint change	Status update / Measurement update	Data model management
Certified Energy Market	X	X	X	X	X	X	
Energy Management using VPP	X	X	X	X	X	X	X
Dwelling Information Exchange	X	X	X	X	X	X	X
Marketization of Balance Group Management	X	X		X	X	X	X
Frequency Control – Primary Control	X	X	X	X	X	X	X
Frequency Control – Secondary Control	X	X	X	X	X	X	X
Frequency Control – Tertiary Control	X	X	X	X	X	X	X
Volt / Var Control – Dynamic	X	X	X	X	X	X	
Volt / Var Control – Static	X	X	X	X	X	X	
Volt / Var Optimization	X	X	X	X	X	X	
Dynamic Virtual Power Plant	X	X	X	X	X	X	
Demand Response	X	X	X	X	X	X	
Demand Response Management of EVs			X	X	X	X	X

Table 6: Application-level communication protocol functions

Information service type / Application-level communication functions	Device registration	Device search	Contract management	Access rights management	Control command / Setpoint change	Status update / Measurement update	Data model management
Measurement						X	
Command					X		X
Set-point					X		
Data-model	X	X		X		X	X
Query		X					X
File			X	X			
Announcement	X	X					
Generic Message			X				

Table 7: Information service types

Use case / Communication patterns	Request –response	Cyclic poll	Push
Certified Energy Market	X	X	
Energy Management using VPP	X		X
Dwelling Information Exchange	X		X
Marketization of Balance Group Management	X		
Frequency Control – Primary Control	X		X
Frequency Control – Secondary Control	X		X
Frequency Control – Tertiary Control	X		X
Volt / Var Control – Dynamic	X	X	X
Volt / Var Control – Static	X	X	X
Volt / Var Optimization	X	X	X
Dynamic Virtual Power Plant	X		X
Demand Response	X		X
Demand Response Management of EVs	X		

Table 8: Communication pattern requirements

References

- [1] C. Brunner, W.Renz; Deliverable 1.1: Requirement specification for an OS4ES, 2014.
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