

EEBus UC Technical Specification

Visualization of Aggregated Photovoltaic Data

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93

94

95 **1 Scope of the document**

96 This document describes the Use Case "Visualization of Aggregated Photovoltaic Data" (short-name:
97 VAPD). Chapter 2 specifies the High-Level Use Case. Chapter 3 details the technical solution for SPINE
98 for this Use Case. Within this document, a top-down approach is used to derive the requirements for
99 the technical solution from the High-Level description.

100

101 **1.1 References**

102 **1.1.1 EEBUS documents**

103 **[UseCaseBaseSpecification]** EEBus_UC_TS_UseCaseBaseSpecification.pdf

104 **[ProtocolSpecification]** EEBus_SPINE_TS_ProtocolSpecification.pdf

105 **[ResourceSpecification]** EEBus_SPINE_TS_ResourceSpecification.pdf

106 **[SHIP]** SHIP_Specification_v1.0.0.pdf

107

108 **1.1.2 Normative references**

109 **[RFC2119]** IETF RFC 2119: 1997, Key words for use in RFCs to indicate requirement levels
110 Please see section 1.3.1 for details.

111

112 **1.2 Terms and definitions**

113 **AC**

114 Abbreviation for alternating current

115 **Active sign convention**

116 An electrical current is positive if the current is flowing out of device or component. In this case, the
117 device or component produces electrical power and the active power is greater than zero. An
118 electrical current is negative if the current is flowing into a device or component. In this case, the
119 device or component consumes electrical power and the active power is smaller than zero.

120 **Actor**

121 An Actor models a role within a Use Case definition (e.g. an energy manager or an electric vehicle).

122 **Passive sign convention**

123 An electrical current is positive if the current is flowing into a device or component. In this case, the
124 device or component consumes electrical power and the active power is greater than zero. An
125 electrical current is negative if the current is flowing out of a device or component. In this case, the
126 device or component produces electrical power and the active power is smaller than zero.

127 **PV**

128 Abbreviation for Photovoltaic

129 **Scenario**

130 Part of a Use Case. Splitting a Use Case into Scenarios helps to understand the Use Case more

131 quickly. Some Scenarios are mandatory for a Use Case, whereas others may be recommended or
132 optional.

133 **Specialization**

134 Reusable data collection for a specific functionality.

135 **SPINE**

136 **Smart Premises Interoperable Neutral-message Exchange: Technical Specification of EEBus Initiative**
137 **e.V.**

138 **VAPD**

139 Visualization of Aggregated Photovoltaic Data (short name of this Use Case)

140 **Visualization Appliance**

141 The Actor Visualization Appliance displays particular data of another Actor.

142

143 **1.3 Requirements**

144 **1.3.1 Requirements wording**

145 The following keywords are used:

- 146 - SHALL
- 147 - SHALL NOT
- 148 - SHOULD
- 149 - SHOULD NOT
- 150 - MAY

151 Note: They apply only if written in capital letters.

152 For the meaning of the keywords, please refer to [RFC2119].

153

154 **1.3.2 Mapping of High-Level requirements**

155 Within the High-Level Use Case description, the following abbreviation is used:

156 [VAPD-xyz]

157 e.g.: [VAPD-007]

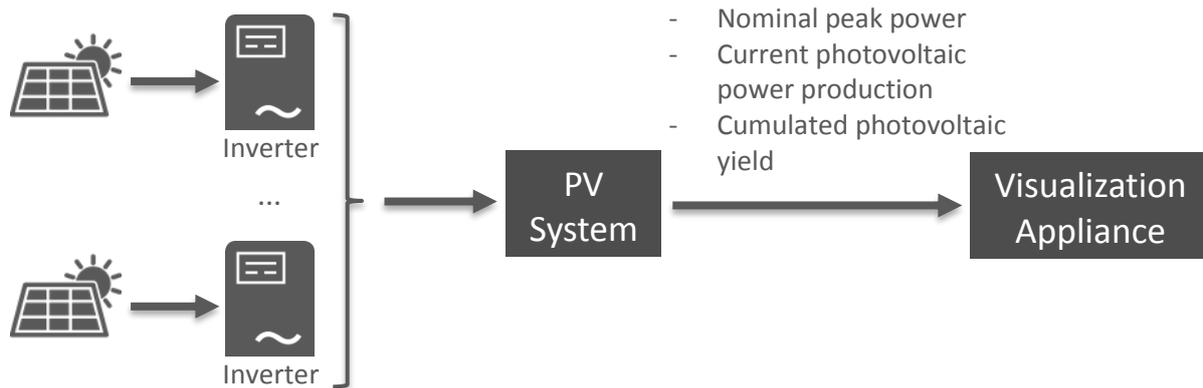
158 The abbreviation is used to mark High-Level requirements or rules of this Use Case with a unique
159 number xyz. These requirements are referenced throughout the technical solution to show how each
160 High-Level requirement is realised in the technical part.

161

162 2 High-Level description

163 2.1 Introduction

164 The Visualization Appliance receives electrical energy data or electrical power data from a
 165 Photovoltaic System (PV System). The Actor PV System aggregates the data from the AC (alternating
 166 current) side of one or more PV inverters. Within this Use Case, the power production of the PV
 167 System can be visualized as well as the nominal peak power. In addition, the cumulated energy yield
 168 since reset may be visualized.



169

170 *Figure 1: High-Level Use Case functionality overview*

171

172 *Added value:* The Visualization Appliance may read the most important power and energy values of a
 173 PV System for user information.

174

175 2.2 User Story as an example

176 A user wants to have an overview over the available PV production in the local grid, e.g. to start the
 177 washing cycle of a washing machine manually.

178

179 2.3 Actors

180 2.3.1 Visualization Appliance

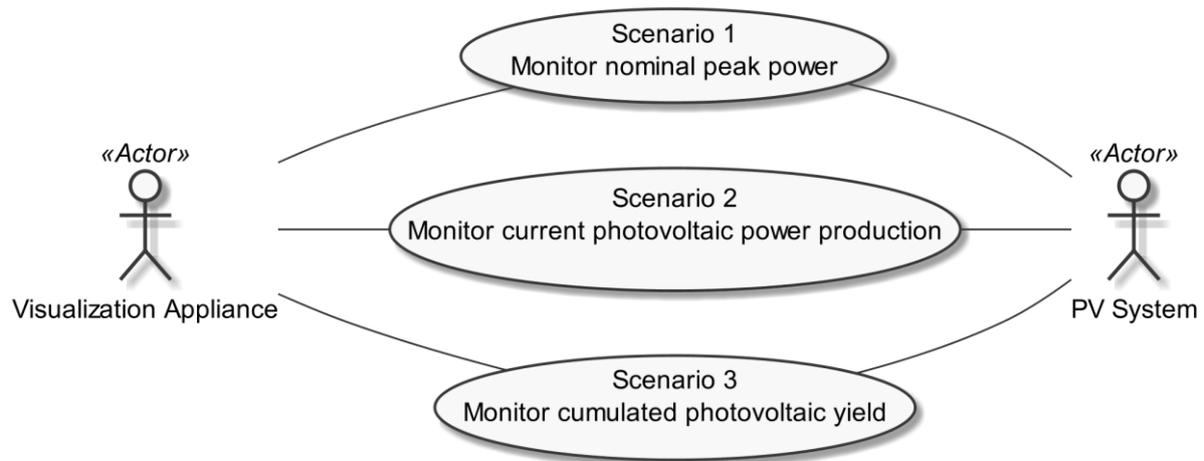
181 The Actor Visualization Appliance visualizes electrical data from the Actor PV System to the
 182 customer.

183

184 2.3.2 PV System

185 The Actor PV System aggregates PV related values from one or more inverters with attached PV
 186 modules.

187

188 **2.4 Scenarios**

189

190 *Figure 2: Scenario overview*

191

Scenario number	Scenario name	Visualization Appliance	PV System
1	Monitor nominal peak power	R	M
2	Monitor current photovoltaic power production	M	M
3	Monitor cumulated photovoltaic yield	M	M

192 *Table 1: Scenario implementation requirement for Actors*

193

194 **2.4.1 Scenario 1 - Monitor nominal peak power**195 **2.4.1.1 Description**

196 The nominal peak power of the PV System ($P_{nom, max}$) is the theoretical aggregated peak power the
 197 connected PV inverters can produce with their modules [VAPD-001]. This value is (e.g.) of interest
 198 when regulatory rules are based on the peak power of all installed inverters at the premises.

199

200 **2.4.1.2 Conditions**201 **Triggering Event:**

202 The Actor Visualization Appliance is interested in the nominal peak power value of the Actor PV
 203 System.

204 **Pre-condition:**

205 The Actor Visualization Appliance does not know the nominal peak power value of the Actor PV
206 System.

207 **Post-condition:**

208 The Actor Visualization Appliance knows the nominal peak power value of the Actor PV System.

209

210 **2.4.2 Scenario 2 - Monitor current photovoltaic power production**

211 **2.4.2.1 Description**

212 The aggregated photovoltaic power production (P_{PV}) of all inverters [VAPD-002a] may be visualized.
213 Only the latest value is exchanged, i.e. no historical values are available [VAPD-002b].

214

215 **2.4.2.2 Conditions**

216 **Triggering Event:**

217 The Actor Visualization Appliance is interested in the current photovoltaic power production of the
218 Actor PV System.

219 **Pre-condition:**

220 The Actor Visualization Appliance does not know the current photovoltaic power production of the
221 Actor PV System.

222 **Post-condition:**

223 The Actor Visualization Appliance knows the current photovoltaic power production of the Actor PV
224 System.

225

226 **2.4.3 Scenario 3 - Monitor cumulated photovoltaic yield**

227 **2.4.3.1 Description**

228 The cumulated photovoltaic yield ($P_{PV, yield}$) of all aggregated inverters [VAPD-003a] indicates the
229 overall produced energy of the PV System since installation time (or the last reset of this value). Only
230 the latest value is exchanged, i.e. no historical values are available [VAPD-003b].

231

232 **2.4.3.2 Conditions**

233 **Triggering Event:**

234 The Actor Visualization Appliance is interested in the cumulated photovoltaic yield of the Actor PV
235 System.

236 **Pre-condition:**

237 The Actor Visualization Appliance does not know the cumulated photovoltaic yield of the Actor PV
238 System.

239 **Post-condition:**

240 The Actor Visualization Appliance knows the cumulated photovoltaic yield of the Actor PV System.

241

242 **2.5 Dependencies to other Use Cases**

243 None.

244

245 **2.6 Assumptions and Prerequisites**

246 For a given PV System it must be known whether the "generator convention" (i.e. "active sign
247 convention") or the "load convention" (i.e. "passive sign convention") applies for electrical data. In
248 case of the "load convention", power and energy are measured with negative values in case of
249 energy production [VAPD-004].

250

251 **3 Technical SPINE solution**

252 **3.1 General rules and information**

253 **3.1.1 Underlying technology documents**

254 This technical solution relies on the SPINE Resources Specification version 1.1.0
255 [ResourceSpecification].

256 For interoperable connectivity this technical solution relies on:

- 257 - SPINE Protocol Specification version 1.1.0 [ProtocolSpecification] as application protocol.
- 258 - SHIP Specification version 1.0.0 [SHIP] as transport protocol.

259 Further applicable documents:

- 260 - EEBUS Use Case Base Specification version 1.0.0 [UseCaseBaseSpecification].

261

262 **3.1.2 Use Case discovery rules**

263 Use Case discovery SHOULD be supported by each Actor. If Use Case discovery is supported the
264 following rules SHALL apply:

- 265 - The string content for the Element "nodeManagementUseCaseData. useCaseInformation.
266 useCaseSupport. useCaseName" within the Use Case discovery (please refer to
267 [ProtocolSpecification]) SHALL be "visualizationOfAggregatedPhotovoltaicData". The string
268 content SHALL only be defined by this Use Case (regardless of the Use Case version).
- 269 - The string content of the Element "nodeManagementUseCaseData. useCaseInformation.
270 actor" within the Use Case discovery (please refer to [ProtocolSpecification]) SHALL be set to
271 the according value stated within the corresponding Actor's section.
- 272 - An Actor A that is implemented to support this Use Case specification SHALL set the Element
273 "nodeManagementUseCaseData. useCaseInformation. useCaseSupport. useCaseVersion"
274 within the Use Case discovery (please refer to [ProtocolSpecification]) to "1.0.0" (for details
275 on the structure of the Use Case version number please refer to [UseCaseBaseSpecification]).
- 276 - If an Actor A supports multiple versions of this Use Case with the same major version
277 number, only the highest one SHOULD be set within the Use Case discovery.
- 278 - If an Actor A finds a proper counterpart Actor B for this Use Case that supports multiple
279 versions of this Use Case with the same major version number as supported by Actor A, the
280 Actor A SHOULD evaluate from these versions of Actor B only the highest version number.
- 281 - If an Actor A supports multiple versions of this Use Case with different major version
282 numbers, for each major version number only the highest version number SHOULD be set
283 within the Use Case discovery.
- 284 - If an Actor A finds a proper counterpart Actor B for this Use Case that supports only versions
285 with a major version number not implemented by Actor A, it still might be possible to run the
286 Use Case or parts of the Use Case. Therefore, the Actor A should try to evaluate the Actor B
287 as a valid partner for this Use Case.

288

289 3.1.3 Rules for "Content of Specialization..." tables and "Content of Function..." tables

290 3.1.3.1 General presence indication definitions

291 Abbreviations for the presence indication of Elements listed in the tables are defined as follows:

Abbreviation	Meaning	Link to requirement keywords
M	Mandatory	SHALL
R	Recommended	SHOULD
O	Optional	MAY

292 *Table 2: Presence indication description*

293 An Actor MAY support Elements that are not listed in the tables. However, another Actor MAY ignore
294 these Elements.

295 The presence indications "M", "R" and "O" are always meant relative to the respective parent
296 Element. I.e. if a parent Element is optional ("O") and a child is mandatory ("M") the child Element
297 can only be present if the parent Element is present as well.

298 Note: The indications and the aforementioned rules apply for "complete messages" (so-called "full
299 function exchange", please refer to [ProtocolSpecification]). In contrast, the so-called "restricted
300 function exchange" is designed to permit exchange of specific excerpts of data, i.e. fewer Elements
301 than potentially available from the data owner (partially even not all "mandatory" Elements).

302

303 3.1.3.2 Presence indications for "Content of Specialization..." tables

304 This section only defines rules for the client side.

305 Elements that are marked with "M" SHALL be supported by the client in case of readable as well as
306 writeable data. This Element may be optional on the server side.

307 The following applies for readable data that is exchanged in a "read/reply" or "notify" operation:

- 308 - "R" means that the data SHOULD be supported by the client. In other words: If the server
309 responds with the according Element, the client SHOULD be able to interpret the according
310 Elements.
- 311 - "O" means that the data MAY be supported by the client. In other words: If the server
312 responds with the according Element, the client MAY be able to interpret the according
313 Elements.

314 The following applies for writeable data that is exchanged in a "write" operation:

- 315 - "R" means that the data SHOULD be written by the client.
- 316 - "O" means that the data MAY be written by the client.
- 317 - "F" means that the data SHALL NOT be written by the client.

318 The following applies for Elements that are not listed in the Actor section:

- 319 - In case of a received "reply" message: The client MAY ignore the Element.
- 320 - In case of a "write" operation to be created: The client MAY set the Element but SHALL
321 consider that the server may ignore the Element.

322 - In case of a received "notify" message: The client MAY ignore the Element.

323 M, R or O may be combined with the suffix "(event)" to express that a supported Element or value
324 only has to be supported during a certain event and hence does not need to be present at all times. If
325 the event is not active the Element may be omitted or another value may be set. In most cases a
326 High-Level requirement reference for the event is given in the rules column.

327

328 **3.1.3.3 Presence indications for "Content of Function..." tables**

329 This section only defines rules for the server side.

330 Elements that are marked with "M" SHALL be supported by the server in case of readable as well as
331 writeable data. In case of writeable data (marked with "M \W") the server does not need to set the
332 Element, because the Element is set only by the client.

333 The following applies for readable data that is exchanged in a "read/reply" or "notify" operation:

- 334 - "R" means that the data SHOULD be provided by the server.
- 335 - "O" means that the data MAY be provided by the server.
- 336 - "F" means that the data SHALL NOT be provided by the server.

337 The following applies for writeable data that is exchanged in a "write" operation:

- 338 - "R" means that the data SHOULD be supported. In other words: If the client writes the
339 Element, the server SHOULD accept those messages and the contained Elements.
- 340 - "O" means that the data MAY be supported. In other words: If the client writes the Element,
341 the server MAY accept those messages and the contained Elements.

342 The following applies for Elements that are not listed in the Actor section:

- 343 - In case of a received "read" request: The according Element MAY be set in the reply.
- 344 - In case of a received "write" operation: The server MAY ignore the Element.
- 345 - In case of a "notify" operation to be created: The server MAY set the Element.

346 Note: The server will only accept write operations if the result fulfils the server Function
347 requirements (permitted values, e.g.). Write operations on Elements that are not writeable MAY
348 result in an error message.

349 M, R or O may be combined with the suffix "(event)" to express that a supported Element or value
350 only has to be supported during a certain event and hence does not need to be present at all times. If
351 the event is not active the Element may be omitted or another value may be set. In most cases a
352 High-Level requirement reference for the event is given in the rules column.

353

354 **3.1.3.4 Cardinality indications on Elements and list items**

355 A cardinality indication on an Element or list item expresses constraints on the number of
356 occurrences of a given Element or data set. In this section we use "X" as representation for such an
357 Element or data set. Furthermore, "a" and "b" represent constraints. The following rules apply for
358 the occurrence of "X" and its content related to a specific Scenario (see note underneath the list):

- 359 1. X
- 360 No cardinality indication.
- 361 2. X (a..b)
- 362 This means "X" SHALL occur at least "a" times and at maximum "b" times.
- 363 3. X (a..)
- 364 This means "X" SHALL occur at least "a" times and MAY occur more than "a" times.
- 365 4. X (..b)
- 366 This means "X" SHALL occur at maximum "b" times and MAY occur less than "b" times (even
- 367 zero occurrences are permissive).

368 Note: These rules apply only under consideration of presence indications and with regards to the
 369 given Scenario or Function definition for this Use Case.

370 The following table is an example to explain this for two different placements.

Scenario [...]: M/R/O [W][C]	Element	Value	[High Level Mapping] Element and value rules
..
2: M \W	xFeatureType. xListData. xData. (1..3)		
2: M \W	xId	<*(1..)>	PRIMARY IDENTIFIER
2: M \W	timePeriod		...
2: M \W	timePeriod. startTime	<xs:duration>	
2: M \W	xSlot. (1..)		
2: M \W	xSlot. xSlotId		...
2: M \W	xSlot. duration	<xs:duration>	...
...

371 Table 3: Example table for cardinality indications on Elements and list items

372 The field

373 xFeatureType. xListData. xData. (1..3)

374 introduces a data pattern (required Elements and values) for "xData" instances used for Scenario 2.
 375 The field itself specifies that such an "xData" instance SHALL occur at least 1 time and at maximum 3
 376 times within "xListData" of Feature Type "xFeatureType". However, this constraint holds only for
 377 Scenario 2 and only if such "xData" are required. In this case, they are required, as the left field

378 2: M \W

379 denotes that this data set is mandatory for Scenario 2.

380 The field

381 xSlot. (1..)

382 expresses that the Element "xSlot" SHALL occur at least one time within its "xData", but MAY occur
 383 more than one time.

384 For the expression "<*(1..)>" of Element "xId" please see section 3.1.3.6.

385 The remaining fields do not have an explicit cardinality indication.

386 Note: Cardinality expressions are also used within placeholder expressions as defined in section
387 3.1.3.6. In many cases such placeholder expressions define the number of required or permitted
388 Elements or list items as they explicitly define how many different values for a given Identifier are
389 required or permitted for a given Scenario.

390

391 **3.1.3.5 Writability and changeability indication**

392 In the same column where the presence indications are denoted, a mark is used to distinguish
393 between writeable, changeable or readable Elements:

- 394 - Elements that are marked with "\W" are written by a client and SHALL be writeable at the
395 server according to their presence indications. The client is not obliged to read the according
396 data. Received notifications do not need to be evaluated.
- 397 - Elements that are marked with "\C" are changed by a client and SHALL be changeable at the
398 server according to their presence indications. The client is not obliged to read the according
399 data. Received notifications do not need to be evaluated.
- 400 - Elements that are marked with "\RW" are read and written by a client and SHALL be
401 writeable and provided by the server according to their presence indications. Received
402 notifications SHALL be evaluated according to their presence indications.
- 403 - Elements that are marked with "\RC" are read and changed by a client and SHALL be
404 changeable and provided by the server according to their presence indications. Received
405 notifications SHALL be evaluated according to their presence indications.
- 406 - Elements that are not marked are only read by a client and SHALL be provided by the server
407 according to their presence indications. Received notifications SHALL be evaluated according
408 to their presence indications.

409 "Writeable" means that the Element and its value may be written by a client. This includes the
410 possibility to modify (if the Element is already present), create (if the Element is not present yet), and
411 delete the Element. The server SHALL adjust its Function according to the received "write" operation
412 (unless the server cannot accept the "write" operation according to section 3.1.3.3).

413 "Changeable" means that the Element's value may be changed by a client. If the Element is not
414 present at the resource before, it probably **cannot** be created by the client via the "write" operation.
415 In this case the server MAY decline such a message.

416 Note: "\W" includes "\C" already.

417 Note: Depending on the resource a client might need to request a proper binding before the server
418 accepts a "write" operation.

419

420 **3.1.3.6 "Value" placeholders**

421 3.1.3.6.1 Introduction

422 Specializations may use placeholders to model relations between different Elements or even list
423 items of different Functions. The main purpose is to declare which Identifier values relate to each
424 other. As a Use Case does not prescribe specific values to be used for a given Identifier, a placeholder
425 like "<x1>" can be used in "Value" columns to express the intended relations.

426 There are two styles placeholders that can be referenced:

- 427 1. <xM>
- 428 2. <xM#S>

429 where

- 430 1. "x" is any alphabetical prefix like "m", "t", "ec", "cc", etc.
- 431 2. "M" is a (major) number like "1", "2", "15", etc.
- 432 3. "S" is a sub-number like "1", "7", "10", etc.

433 Examples for the first style are "<ec1>", "<z12>". Examples for the second style are "<p4#2>",
434 "<m22#3>". For a given placeholder, only one of the styles can be used.

435 In addition, there are also styles for placeholders that do not need to be referenced:

- 436 1. <*>
- 437 2. <*#S>

438 The second style is only used with so-called cardinality expressions.

439

440 3.1.3.6.2 Uniqueness of placeholders

441 A given placeholder <xM> or <xM#S> represents the same value throughout a given Use Case
442 specification for a given set of its parent Identifier values. This shall be explained in a brief example:

443 We assume a list item with PRIMARY IDENTIFIER "pId". It also has a SUB IDENTIFIER "sId" with
444 placeholder "<s1>". Then, each occurrence of "<s1>" represents the same value for a given value of
445 pId. This means that "<s1>" of a list item with pId=1 can differ from "<s1>" of a list item with pId=2.
446 But it also means that "<s1>" represents the same value in all list items with pId=1.

447 Note: Typically, parent Identifiers like "pId" will also be expressed with a placeholder like "<p5>", e.g.
448 In this case, the uniqueness rule applies for "<p5>" likewise.

449 Note: The uniqueness also applies for placeholders used as FOREIGN IDENTIFIER.

450

451 3.1.3.6.3 Placeholder expressions with cardinalities

452 For some Identifiers, more than one placeholder is needed. Several notations are used for this
453 purpose, which make use of cardinality expressions. The general notation is as follows:

- 454 1. <xM#(a..b)>

455 This is equivalent to this explicit definition:

456 At least a and at maximum b placeholders of this list: <xM#1> <xM#2> ... <xM#b>

457 This means that the implementation of a given Use Case (or Scenario) requires a minimum of "a"
458 distinct values of the respective Identifier. In total, there can be up to "b" distinct values of the
459 respective Identifier.

460 Additionally, the following notations may occur:

461 2. <xM#(a..)>

462 This is equivalent to "<xM#(a..b)>" with "b" equal to infinity.

463 3. <xM#(..b)>

464 This is equivalent to "<xM#(a..b)>" with "a" equal to zero.

465 "<xM#(a..)>" has only a lower bound of "a" distinct values, but no upper bound. "<xM#(..b)>", on the
466 other hand, expresses that the Identifier may not be required at all, but it is permitted to have up to
467 "b" distinct values.

468 Similarly, the cardinality can be used for placeholders that are not referenced, i.e. <*#(a..b)> etc.

469 Note: The cardinality does NOT express which of the sub-numbers have to be used! I.e., it does NOT
470 mean that the Identifiers <xM#1> ... <xM#a> are always used and just those with larger sub-numbers
471 (<xM#a+1> ... <xM#b>) are optional. If, for instance, a placeholder expression "<xM#(3..5)>" is given,
472 it may well happen that an implementation makes use of <xM#2>, <xM#4>, and <xM#5> (i.e., it does
473 NOT use <xM#1>, <xM#3>). Which sub-numbers are used usually depends on other parts of a
474 Specialization and their references to required placeholders, which is explained in section 3.1.3.6.4.

475

476 3.1.3.6.4 *References to placeholders and relations*

477 According to the styles for placeholders that can be referenced, an enumeration value "e" can refer
478 to a particular placeholder:

479 1. e(-><xM>)

480 2. e(-><xM#S>)

481 This denotes that "e" is to be used with "<xM>" or "<xM#S>", resp.

482 Example: A Specialization contains the Elements "mId" and "phase". "mId" is an Identifier with
483 placeholder definition <m2#(1..3)>. "phase" is a string that permits the values "a", "b", and "c" using
484 this expression:

485 "a"(-><m2#1>)

486 "b"(-><m2#2>)

487 "c"(-><m2#3>)

488 This expresses that the enumeration value "a" is to be used with the placeholder <m2#1>, "b" is to
489 be used with <m2#2> and "c" with <m2#3>.

490 Similarly, a placeholder "yN" can refer to a particular placeholder:

- 491 3. <yN->xM>
 492 4. <yN->xM#S>
 493 5. <yN#T->xM>
 494 6. <yN#T->xM#S>

495 where "T" is a sub-number of "yN".

496 It is also feasible to associate placeholders with cardinalities:

- 497 7. <yN#(a..b)-><xM#(a..b)>

498 denotes that <yN#1> is to be used with <xM#1>, <yN#2> is to be used with <xM#2>, etc.

499 Note: In this case, the placeholder expressions of yN and xM must have the same cardinality.

500 In some cases, there is a need to express that multiple list items with similar values are feasible or
 501 required, but only particular combinations of these different data are permitted. The following
 502 example shows that several "fData" list items with different "phase" value are required, but that
 503 these list items may only express either the "phase" value combination { "a", "b", "c" } or the "phase"
 504 value combination { "a", "abb", "neutral" }. The permitted combinations are defined in a note below
 505 a table:

Scenario [...]: M/R/O [W]\C]	Element	Value	[High Level Mapping] Element and value rules
2: M	F. fListData. fData.		
2: M	zld	<z3#(3..5)>	
2: M	phase	"a"(-><z3#1>)	
		"b"(-><z3#2>)	
		"c"(-><z3#3>)	
		"abc"(-><z3#4>)	
		"neutral"(-><z3#5>)	

506 *Table 4: Content of an example Specialization*

507 Note: One of the following combinations SHALL be used at least: {<z3#1>, <z3#2>, <z3#3>} or
 508 {<z3#1>, <z3#4>, <z3#5>}.

509

510 3.1.3.7 Rules for content of "Value" column

511 For a given Scenario, the "Value" column may restrict the permitted content of a Function's Element
 512 to one or more particular values. This means that Elements with values deviating from the restriction
 513 (i.e. from the permitted values) do not belong to the respective Scenario and need to be considered
 514 as if the Element is not set. If more than one particular value is permitted for an Element, the values
 515 are in a single line each.

516 If a presence indication is set for the value (in an additional column before the value), the following
 517 rules SHALL be applied:

- 518 - "M" means that the value SHALL be supported. This means the value needs to be set at a
 519 certain point in time (depending on the value rules) or for a certain Element within a list
 520 entry.
 521 - "R" means that the value SHOULD be supported.
 522 - "O" means that the value MAY be supported.

523 If all possible values of a given mandatory Element are optional or recommended and this Element is
 524 used for the purpose of the respective Scenario, one of the values SHALL be set. If all possible values
 525 of a given optional or recommended Element are optional or recommended, this Element MAY
 526 contain also other values, but then this Element SHALL NOT be considered as part of the respective
 527 Scenario.

528 M, R or O may be combined with the suffix "(event)" to express that a supported value only has to be
 529 supported during a certain event and hence does not need to be present at all times. If the event is
 530 not active another value may be set. In most cases a High-Level requirement reference for the event
 531 is given in the rules column.

532 If no presence indication is set for the value, the following rules SHALL be applied:

- 533 - In case of Elements where the server may set or change an Element on its own (see section
 534 3.1.3.5):
 535 o within the tables in the "Server data - Resources" sections:
 536 ▪ the server SHALL support at least one of the listed values.
 537 o within the tables in the "Client data - Specializations" sections:
 538 ▪ the client SHALL support all listed values.
 539 - In case of Elements that are writable or changeable (see section 3.1.3.5):
 540 o within the tables in the "Server data - Resources" sections:
 541 ▪ the server SHALL support all listed values.
 542 o within the tables in the "Client data - Specializations" sections:
 543 ▪ the client SHALL support at least one of the listed values.

544 Depending on the Element, different values may be used during runtime. If this is the case, those
 545 rules are described within the value rules.

546 If a value is placed in parenthesis, the corresponding value is a recommendation. The actual value
 547 MAY deviate from this, e.g. "(1024)".

548

549 **3.1.3.8 General information on how to interpret the "Content of Function..." and "Content of** 550 **Specialization..." tables**

551 Within the "Client data - Specializations" sections each Specialization is described in an own sub-
 552 section with the name "Specialization "<name of the Specialization>" (e.g. "Specialization
 553 "Measurement_GridFeedInEnergy"). It contains only one table that includes all Elements needed for
 554 this Specialization. The different Functions are mentioned in a continuous row, highlighted with grey
 555 background colour. This row contains the following parts:

556 <Feature Type>. <Function>.[<list entry instance name>.]

557 The <list entry instance name> is only included if the <Function> is a list-based Function. An example
558 could be:

559 DeviceConfiguration. deviceConfigurationKeyValueDescriptionListData.
560 deviceConfigurationKeyValueDescriptionData.

561 In the following rows, only the names of the Elements are stated, without the prefix described above.

562

563 Within the "Server data - Resources" sections each Feature Type is described in an own sub-section
564 with the name "Feature Type "<name of the Feature Type>"" (e.g. "Feature Type "Measurement"").
565 It contains sub-sections for each Function named "Function "<name of the Function>"" (e.g.
566 "Function "measurementListData""). These sections contain one table with all Elements needed for
567 this resource. The list entries are mentioned in a continuous row, highlighted with grey background
568 colour. This row contains the following parts:

569 <Feature Type>. <Function>.[<list entry instance name>.]

570 The <list entry instance name> is only included if the <Function> is a list-based Function. An example
571 could be:

572 Measurement. measurementDescriptionListData. measurementDescriptionData.

573 In the following rows, only the names of the Elements are stated, without the prefix described above.

574

575 For both kinds of tables, the following applies:

576 - Parent Elements are marked with a dot at the end of the name:

577 <parent Element>.

578 E.g.:

579 value.

580 - If there are sub-Elements, they are described in own rows with the name of the parent

581 Element as prefix, separated by a dot and a blank space:

582 <parent Element>. <sub-Element>

583 E.g.:

584 value. number

585

586 3.1.4 Rules for "Feature Types and Functions..." tables

587 3.1.4.1 Presence indications for "Feature Types and Functions..." tables

588 The following presence indications are used:

Abbreviation	Meaning	Link to requirement keywords
M	Mandatory	SHALL
R	Recommended	SHOULD
O	Optional	MAY

589 *Table 5: Presence indication of Feature Types and Functions support*

590 If at least one Function of a Feature has the presence indication "M", it is mandatory to support the
591 Feature.

592

593 **3.1.4.2 Rules for "Possible operations" column**

594 Within the "Feature Types and Functions..." tables the column "Possible operations" state whether
595 the Function is read- or writeable (as defined in the detailed discovery mechanism, see
596 [ProtocolSpecification]).

597 If the "partial" concept (also called "restricted function exchange") SHALL be supported, the
598 following notation is used (separated for read and write access):

599 read (M). partial (M)

600 write (M). partial (M)

601 If the "partial" concept SHOULD be supported, the following notation is used:

602 read (M). partial (R)

603 write (M). partial (R)

604 If the "partial" concept MAY be supported, the following notation is used:

605 read (M). partial (O)

606 write (M). partial (O)

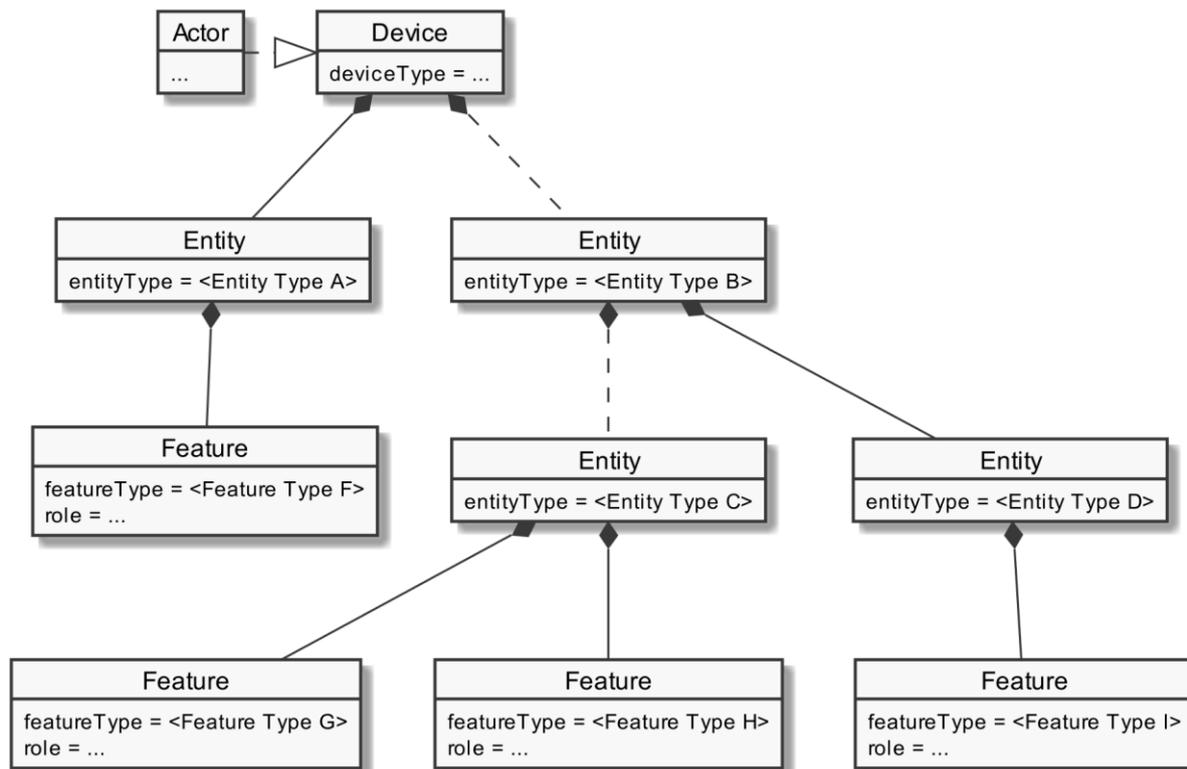
607 The server can decide whether a notification is submitted complete or partial (as described in
608 [ProtocolSpecification]) if not defined differently within this Use Case Specification.

609

610 **3.1.5 "Actor ... overview" diagram rules**

611 Within the "Actor [...] overview" diagrams in the "Actors" sub-sections the complete functionality of
612 this Use Case is provided, including optional Scenarios. Which Scenarios are optional can be found in
613 Table 1. The Actor MAY have more functionality implemented than needed for this Use Case.

614 For the following Actor overview example, a brief description of the graphical symbols will be
615 described.



616

617 *Figure 3: Actor overview example*

618 The solid lines in the figure represent an immediate parent-childhood relation: The Entity with
 619 "<Entity Type A>" is a direct child of "Device". The Entity with "<Entity Type D>" is a direct child of the
 620 Entity with "<Entity Type B>". All Features are immediate child of the respective Entity.

621 The dashed lines in the figure express that there MAY be additional Entities between the shown
 622 Entities: A vendor's implementation MAY have one or more Entities between "Device" and the Entity
 623 with "<Entity Type B>". Likewise, a vendor's implementation MAY have one or more Entities between
 624 the Entity with "<Entity Type B>" and the Entity with "<Entity Type C>".

625

626 3.1.6 Specializations

627 Within the "Actors" sub-sections Specializations are referenced. A Specialization describes a dataset
 628 necessary to fulfil the specific requirements of a High-Level Use Case and its Scenarios. Often data
 629 from multiple different Features and Functions are needed to fulfil the requirements. Therefore, a
 630 Specialization defines a dataset that may encompass multiple related Functions from one or more
 631 different Features.

632 As different Use Cases sometimes share similar requirements, Specializations are also important
 633 from a re-usability perspective. This approach is used to improve consistency across Use Cases and
 634 avoid multiple variances of basically the same dataset. This is especially important in the case when
 635 an implementation supports multiple Use Cases. E.g. if a power measurement is necessary in two
 636 different Use Cases, both Use Cases could define slightly different datasets. In this case the server as
 637 well as the client functionality would have to implement both variances if both Use Cases are
 638 supported. This means, depending on the number of Use Cases, two or more datasets need to be

639 generated, transmitted and stored instead of one. Therefore, already existing Specializations
640 specified within [UseCaseBaseSpecification] are used in this Use Case to avoid such problems.

641 If a Feature server can provide the data of a Specialization, the data does not necessarily always need
642 to be available at the Feature server. There might be situations where the user deactivates a Use
643 Case. There may also be other reasons why Use Case data cannot be provided currently. Therefore, a
644 client always needs to be subscribed (as described in section 3.3.4) on the corresponding dataset to
645 stay updated.

646 The SPINE resource description given in the "SPINE resources of the Actor" sections are derived from
647 the Specializations given in the Actor's overview diagram. Please refer to [UseCaseBaseSpecification]
648 for a detailed description of all Specializations.

649

650 **3.1.7 Order of messages within the sequence diagrams**

651 There are several sequence diagrams in this document describing message flows. The order of the
652 messages SHOULD be kept by the communications partners, but there might be cases where a
653 different order makes sense. The communications partners SHALL be able to handle the Scenario
654 functionalities even if the messages are transmitted in a different order by the other Actor(s). The
655 sequence diagrams can be seen as examples.

656

657 **3.1.8 Further information and rules**

658 **3.1.8.1 Frequently used Element rules for the Resource and Specialization tables**

659 This section serves as a collection of rules frequently used by Resource and Specialization tables of
660 the subsequent sections. Each rule applies only where referenced explicitly in the tables.

661 Note: The purpose of this collection is just to reduce the size of the tables. As such, no rule has a
662 meaning without a reference indicating the required rule. A reference looks like "See [Measurement
663 value rules]", e.g.

664

665 **[Measurement value rules]:**

666 SHALL be set if a value is available. Otherwise, the whole list entry SHALL be omitted or the Element
667 *valueState* SHALL be set to "error".

668 If *valueState* is set to "error", but *value* is set, the content of *value* SHALL be ignored.

669 If *valueState* is set to "outOfRange", but *value* is set, the content of *value* SHALL be interpreted as
670 being out of range.

671 If *valueState* is set to "outOfRange", *measurementConstraintsListData.valueRangeMax* is set and
672 *value* is equal or bigger than *valueRangeMax*, *value* SHALL be interpreted as above *valueRangeMax*.

673 If *valueState* is set to "outOfRange", *measurementConstraintsListData.valueRangeMin* is set and
674 *value* is equal or smaller than *valueRangeMin*, *value* SHALL be interpreted as below *valueRangeMin*.

675 If set, *measurementDescriptionListData*. *measurementType* SHALL be set, too.

676

677 **[Scaled number rules]:**

678 The sub-Elements "number" and "scale" represent a value according to the following formula:

679 $\text{number} * 10^{\text{scale}}$

680

681 **[Value state rules]:**

682 The Element *valueState* SHALL be set if its content differs from "normal". This means, if the state of
683 the value is "outOfRange" or "error" this SHALL be denoted in the *valueState* Element. A client side
684 SHALL always consider the content of *valueState*, if set. If omitted, a value of "normal" is assumed.

685

686 **3.1.8.2 Further rules**

687 A server SHOULD NOT add or remove Entities and Features used within this Use Case during runtime
688 in the detailed discovery.

689

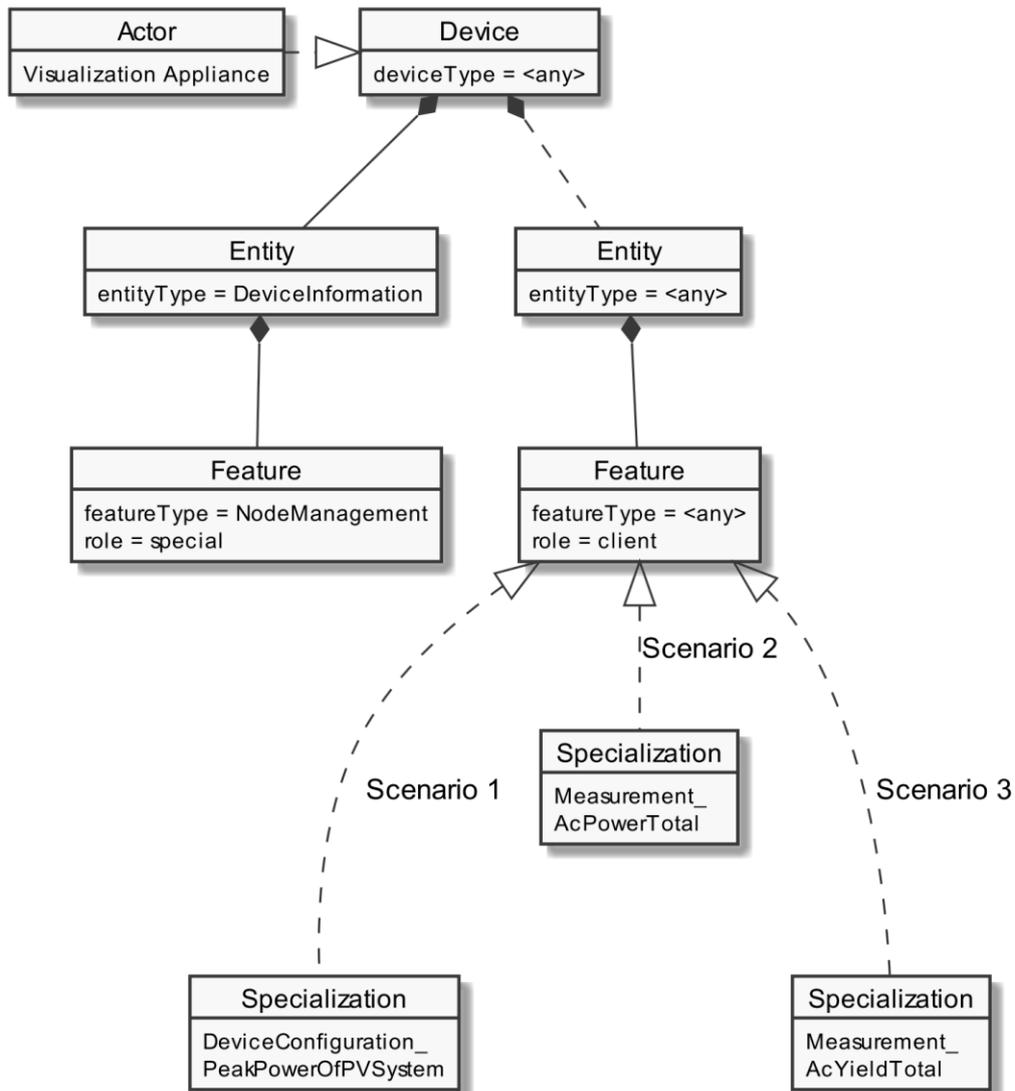
690 **3.2 Actors**

691 **3.2.1 Visualization Appliance**

692 **3.2.1.1 Resource hierarchy**

693 If Use Case discovery is supported (see section 3.1.2) this Actor SHALL be denoted as
694 "VisualizationAppliance" in the Element "nodeManagementUseCaseData. useCaseInformation.
695 actor".

696 The following diagram provides an overview of the Actor Visualization Appliance's resource
697 hierarchy.



698

699 *Figure 4: Actor "Visualization Appliance" overview*

700 The "Actor ... overview" diagram rules" section describes how to interpret the diagram above. See
 701 the "Specializations" section for more information regarding the Specializations given in the diagram
 702 above.

703 Note: The entityType "DeviceInformation" with the featureType "NodeManagement" is required by
 704 the SPINE protocol and therefore SHALL be supported. Both types are added in the figure for
 705 completeness but are not directly linked to the Use Case.

706 The Use Case specific data follows behind any entityType. The Specializations represent the Scenario
 707 specific data that must be supported for each Scenario and are realized through the corresponding
 708 featureTypes.

709 If a Specialization is connected to a Feature with the role "client", the Actor has a client role for this
 710 data. This means that the Actor accesses the data set described by the Specialization at a
 711 corresponding server Feature. Further details are described in the sub-section "Client data -
 712 Specializations".

713 If a Specialization is connected to a Feature with the role "server", the Actor has the server role for
 714 this data. This means that the Actor must provide the corresponding data set of the Specialization as
 715 part of its Features. Further details are described in the sub-section "Server data - Resources".

716

717 3.2.1.2 Server data - Resources

718 As this Actor has only client functionality, no resources are described within this section.

719

720 3.2.1.3 Client data - Specializations

721 3.2.1.3.1 Topic "DeviceConfiguration"

722 3.2.1.3.1.1 Specialization "DeviceConfiguration_PeakPowerOfPVSystem"

Scenario [...]: M/R/O [W][C]	Element	Value	[High Level Mapping] Element and value rules
1: M	DeviceConfiguration. deviceConfigurationKeyValueDescriptionListData. deviceConfigurationKeyValueDescriptionData.		
1: M	keyId	<k1#{1..1}>	SHALL be set as PRIMARY IDENTIFIER.
1: M	keyName	"peakPowerOfPvSystem"	[VAPD-004]
1: M	valueType	"scaledNumber"	
1: M	unit	"W"	The unit SHALL be applied to the value of the key.
1: M	DeviceConfiguration. deviceConfigurationKeyValueListData. deviceConfigurationKeyValueData.		
1: M	keyId	<k1#{1..1}>	SHALL be set as PRIMARY IDENTIFIER.
1: M	value.		Exactly one of the child Elements SHALL be set. This SHALL match with the content of <i>valueType</i> Element within the key value description part (see above).
1: M	value. scaledNumber.		[VAPD-001], [VAPD-004] SHALL be used. See [Scaled number rules].
1: M	value. scaledNumber. number		SHALL be used.
1: M	value. scaledNumber. scale		SHALL be interpreted. If absent, a default value of "0" applies.

723 Table 6: Content of Specialization "DeviceConfiguration_PeakPowerOfPVSystem" at Actor Visualization Appliance

724

725 3.2.1.3.2 Topic "Measurement"

726 3.2.1.3.2.1 Specialization "Measurement_AcPowerTotal"

Scenario [...]: M/R/O [W][V]	Element	Value	[High Level Mapping] Element and value rules
2: M	Measurement. measurementDescriptionListData. measurementDescriptionData.		
2: M	measurementId	<m1#{1..1}>	SHALL be set as PRIMARY IDENTIFIER.
2: M	measurementType	"power"	
2: M	commodityType	"electricity"	
2: M	unit	"W"	
2: M	scopeType	"acPowerTotal"	
2: R	Measurement. measurementConstraintsListData. measurementConstraintsData.		
2: M	measurementId	<m1#{1..1}>	SHALL be set as PRIMARY IDENTIFIER.
2: R	valueRangeMin.		[VAPD-004] SHOULD be used. See [Scaled number rules].
2: M	valueRangeMin. number		SHALL be used.
2: M	valueRangeMin. scale		SHALL be interpreted. If absent, a default value of "0" applies.
2: R	valueRangeMax.		[VAPD-004] SHOULD be used. See [Scaled number rules].
2: M	valueRangeMax. number		SHALL be used.
2: M	valueRangeMax. scale		SHALL be interpreted. If absent, a default value of "0" applies.
2: R	valueStepSize.		SHOULD be used. See [Scaled number rules].
2: M	valueStepSize. number		SHALL be used.
2: M	valueStepSize. scale		SHALL be interpreted. If absent, a default value of "0" applies.
2: M	Measurement. measurementListData. measurementData.		
2: M	measurementId	<m1#{1..1}>	SHALL be set as PRIMARY IDENTIFIER.
2: M	valueType	"value"	SHALL be set as SUB IDENTIFIER.
2: O	timestamp	<t#{1..1}->m1#1>	[VAPD-002b] MAY be used. Only the newest measurement value SHALL be stated. Additional historical values are forbidden.
2: M	value.		[VAPD-002a], [VAPD-004] See [Measurement value rules]. See [Scaled number rules].
2: M	value. number		SHALL be used.
2: M	value. scale		SHALL be interpreted. If absent, a default value of "0" applies.
2: R	valueSource	"measuredValue"	
		"calculatedValue"	
		"empiricalValue"	

2: M	valueState		[Value state rules]
2: M	ElectricalConnection. electricalConnectionDescriptionListData. electricalConnectionDescriptionData.		
2: M	electricalConnectionId	<ec1#(1..1)>	SHALL be set as PRIMARY IDENTIFIER.
2: M	powerSupplyType	"ac"	
2: M	positiveEnergyDirection	"consume"	[VAPD-004]
2: M	ElectricalConnection. electricalConnectionParameterDescriptionListData. electricalConnectionParameterDescriptionData.		
2: M	electricalConnectionId	<ec1#(1..1)>	SHALL be set as PRIMARY IDENTIFIER.
2: M	parameterId	<p1#(1..1)->ec1#1>	SHALL be set as SUB IDENTIFIER.
2: M	measurementId	<m1->p1#1>	SHALL be set as FOREIGN IDENTIFIER.
2: M	voltageType	"ac"	
2: M	acMeasurementType	"real"	

727 Table 7: Content of Specialization "Measurement_AcPowerTotal" at Actor Visualization Appliance

728

729 3.2.1.3.2.2 Specialization "Measurement_AcYieldTotal"

Scenario [...]: M/R/O [W][C]	Element	Value	[High Level Mapping] Element and value rules
3: M	Measurement. measurementDescriptionListData. measurementDescriptionData.		
3: M	measurementId	<m2#(1..1)>	SHALL be set as PRIMARY IDENTIFIER.
3: M	measurementType	"energy"	
3: M	commodityType	"electricity"	
3: M	unit	"Wh"	
3: M	scopeType	"acYieldTotal"	
3: R	Measurement. measurementConstraintsListData. measurementConstraintsData.		
3: M	measurementId	<m2#(1..1)>	SHALL be set as PRIMARY IDENTIFIER.
3: R	valueRangeMin.		[VAPD-004] SHOULD be used. See [Scaled number rules].
3: M	valueRangeMin. number		SHALL be used.
3: M	valueRangeMin. scale		SHALL be interpreted. If absent, a default value of "0" applies.
3: R	valueRangeMax.		[VAPD-004] SHOULD be used. See [Scaled number rules].
3: M	valueRangeMax. number		SHALL be used.
3: M	valueRangeMax. scale		SHALL be interpreted. If absent, a default value of "0" applies.
3: R	valueStepSize.		SHOULD be used. See [Scaled number rules].
3: M	valueStepSize. number		SHALL be used.
3: M	valueStepSize. scale		SHALL be interpreted. If absent, a default value of "0" applies.

3: M	Measurement. measurementListData. measurementData.		
3: M	measurementId	<m2#{1..1}>	SHALL be set as PRIMARY IDENTIFIER.
3: M	valueType	"value"	SHALL be set as SUB IDENTIFIER.
3: O	timestamp	<t#{1..1}->m2#1>	[VAPD-003b] MAY be used. Only the newest measurement value SHALL be stated. Additional historical values are forbidden.
3: M	value.		[VAPD-003a], [VAPD-004] See [Measurement value rules]. See [Scaled number rules].
3: M	value. number		SHALL be used.
3: M	value. scale		SHALL be interpreted. If absent, a default value of "0" applies.
3: R	valueSource	"measuredValue"	
		"calculatedValue"	
		"empiricalValue"	
3: M	valueState		[Value state rules]
3: M	ElectricalConnection. electricalConnectionDescriptionListData. electricalConnectionDescriptionData.		
3: M	electricalConnectionId	<ec1#{1..1}>	SHALL be set as PRIMARY IDENTIFIER.
3: M	powerSupplyType	"ac"	
3: M	positiveEnergyDirection	"consume"	[VAPD-004]
3: M	ElectricalConnection. electricalConnectionParameterDescriptionListData. electricalConnectionParameterDescriptionData.		
3: M	electricalConnectionId	<ec1#{1..1}>	SHALL be set as PRIMARY IDENTIFIER.
3: M	parameterId	<p2#{1..1}->ec1#1>	SHALL be set as SUB IDENTIFIER.
3: M	measurementId	<m2->p2#1>	SHALL be set as FOREIGN IDENTIFIER.
3: M	voltageType	"ac"	
3: M	acMeasurementType	"real"	

730 Table 8: Content of Specialization "Measurement_AcYieldTotal" at Actor Visualization Appliance

731

732 **3.2.2 PV System**733 **3.2.2.1 Resource hierarchy**

734 If Use Case discovery is supported (see section 3.1.2) this Actor SHALL be denoted as "PVSystem" in
735 the Element "nodeManagementUseCaseData. useCaseInformation. actor".

736 The following diagram provides an overview of the Actor PV System's resource hierarchy.

746 The Use Case specific data follows behind the entityType "PVSystem". The Specializations represent
 747 the Scenario specific data that must be supported for each Scenario and are realized through the
 748 corresponding featureTypes.

749 If a Specialization is connected to a Feature with the role "client", the Actor has a client role for this
 750 data. This means that the Actor accesses the data set described by the Specialization at a
 751 corresponding server Feature. Further details are described in the sub-section "Client data -
 752 Specializations".

753 If a Specialization is connected to a Feature with the role "server", the Actor has the server role for
 754 this data. This means that the Actor must provide the corresponding data set of the Specialization as
 755 part of its Features. Further details are described in the sub-section "Server data - Resources".

756

757 **3.2.2.2 Server data - Resources**

758 3.2.2.2.1 Overview

759 Behind the entityType "PVSystem", the Actor PV System SHALL offer the Feature Types and Functions
 760 given in the table below.

Feature Type	Scenario: M/R/O	Function	Possible operations
DeviceConfiguration	1: M	deviceConfigurationKeyValueDescriptionListData	read (M). partial (R)
	1: M	deviceConfigurationKeyValueListData	read (M). partial (R)
Measurement	2: M 3: M	measurementDescriptionListData	read (M). partial (R)
	2: R 3: R	measurementConstraintsListData	read (M). partial (R)
	2: M 3: M	measurementListData	read (M). partial (R)
ElectricalConnection	2: M 3: M	electricalConnectionDescriptionListData	read (M). partial (R)
	2: M 3: M	electricalConnectionParameterDescriptionListData	read (M). partial (R)

761 *Table 9: Feature Types and Functions used within this Use Case by the Actor PV System*

762 For each of these Feature Types, the following rule applies: There SHALL be at maximum one Feature
 763 with the Feature Type in the Entity.

764 Note: As a consequence of the previous rule, an implementation may need to have Feature data
 765 from different Scenarios/Specializations or even Use Cases in a given Feature.

766 The Scenario number shows in which Scenarios the PV System acts as server and which Feature
 767 Types and Functions are relevant in each Scenario.

768 A detailed definition of the Elements and values that shall be supported in each Function is given in
 769 the following sub-sections.

770 Note: If in the table above "partial" read is not mentioned or is only optional, it still might be
 771 mandatory to support partial notifications. The details of "partial" support are described within the
 772 Scenario sections.

773 Note: The presence indications stated above are meant relative to the ones of the according Scenario
 774 stated in Table 1. I.e., if a Scenario is optional ("O") and a Feature Type is mandatory ("M"), the
 775 Feature Type need only be supported if the Scenario is supported, too.

776 Note: Further Features MAY be implemented on the same Entities; also further Functions MAY be
 777 implemented in the used Entities.

778

779 3.2.2.2.2 Feature Type "DeviceConfiguration"

780 3.2.2.2.2.1 Function "deviceConfigurationKeyValueDescriptionListData"

Scenario [...]: M/R/O [\W][\C]	Element	Value	[High Level Mapping] Element and value rules
1: M	DeviceConfiguration. deviceConfigurationKeyValueDescriptionListData. deviceConfigurationKeyValueDescriptionData.		
1: M	keyId	<k1#{1..1}>	SHALL be set as PRIMARY IDENTIFIER.
1: M	keyName	"peakPowerOfPvSystem"	[VAPD-004]
1: M	valueType	"scaledNumber"	
1: M	unit	"W"	The unit SHALL be applied to the value of the key.

781 Table 10: Content of Function "deviceConfigurationKeyValueDescriptionListData" at Actor PV System

782

783 3.2.2.2.2.2 Function "deviceConfigurationKeyValueListData"

Scenario [...]: M/R/O [\W][\C]	Element	Value	[High-Level mapping] Element and value rules
1: M	DeviceConfiguration. deviceConfigurationKeyValueListData. deviceConfigurationKeyValueData.		
1: M	keyId	<k1#{1..1}>	SHALL be set as PRIMARY IDENTIFIER.
1: M	value.		Exactly one of the child Elements SHALL be set. This SHALL match with the content of <i>valueType</i> Element within the key value description part (see above).
1: M	value. scaledNumber.		[VAPD-001], [VAPD-004] SHALL be used. See [Scaled number rules].

1: M	value. scaledNumber. number		SHALL be used.
1: O	value. scaledNumber. scale		MAY be used. If absent, a default value of "0" applies.

784 Table 11: Content of Function "deviceConfigurationKeyValueListData" at Actor PV System

785

786 3.2.2.2.3 Feature Type "Measurement"

787 3.2.2.2.3.1 Function "measurementDescriptionListData"

Scenario [...]: M/R/O [\W][\C]	Element	Value	[High Level Mapping] Element and value rules
2: M	Measurement.	measurementDescriptionListData.	measurementDescriptionData.
2: M	measurementId	<m1#(1..1)>	SHALL be set as PRIMARY IDENTIFIER.
2: M	measurementType	"power"	
2: M	commodityType	"electricity"	
2: M	unit	"W"	
2: M	scopeType	"acPowerTotal"	
3: M	Measurement.	measurementDescriptionListData.	measurementDescriptionData.
3: M	measurementId	<m2#(1..1)>	SHALL be set as PRIMARY IDENTIFIER.
3: M	measurementType	"energy"	
3: M	commodityType	"electricity"	
3: M	unit	"Wh"	
3: M	scopeType	"acYieldTotal"	

788 Table 12: Content of Function "measurementDescriptionListData" at Actor PV System

789

790 3.2.2.2.3.2 Function "measurementConstraintsListData"

Scenario [...]: M/R/O [\W][\C]	Element	Value	[High Level Mapping] Element and value rules
2: R	Measurement.	measurementConstraintsListData.	measurementConstraintsData.
2: M	measurementId	<m1#(1..1)>	SHALL be set as PRIMARY IDENTIFIER.
2: R	valueRangeMin.		[VAPD-004] SHOULD be used. See [Scaled number rules].
2: M	valueRangeMin. number		SHALL be used.
2: O	valueRangeMin. scale		MAY be used. If absent, a default value of "0" applies.

2: R	valueRangeMax.		[VAPD-004] SHOULD be used. See [Scaled number rules].
2: M	valueRangeMax. number		SHALL be used.
2: O	valueRangeMax. scale		MAY be used. If absent, a default value of "0" applies.
2: R	valueStepSize.		SHOULD be used. See [Scaled number rules].
2: M	valueStepSize. number		SHALL be used.
2: O	valueStepSize. scale		MAY be used. If absent, a default value of "0" applies.
3: R	Measurement. measurementConstraintsListData. measurementConstraintsData.		
3: M	measurementId	<m2#(1..1)>	SHALL be set as PRIMARY IDENTIFIER.
3: R	valueRangeMin.		[VAPD-004] SHOULD be used. See [Scaled number rules].
3: M	valueRangeMin. number		SHALL be used.
3: O	valueRangeMin. scale		MAY be used. If absent, a default value of "0" applies.
3: R	valueRangeMax.		[VAPD-004] SHOULD be used. See [Scaled number rules].
3: M	valueRangeMax. number		SHALL be used.
3: O	valueRangeMax. scale		MAY be used. If absent, a default value of "0" applies.
3: R	valueStepSize.		SHOULD be used. See [Scaled number rules].
3: M	valueStepSize. number		SHALL be used.
3: O	valueStepSize. scale		MAY be used. If absent, a default value of "0" applies.

791 Table 13: Content of Function "measurementConstraintsListData" at Actor PV System

792

793 3.2.2.2.3.3 Function "measurementListData"

Scenario [...]: M/R/O [W][C]	Element	Value	[High Level Mapping] Element and value rules
2: M	Measurement. measurementListData. measurementData.		
2: M	measurementId	<m1#(1..1)>	SHALL be set as PRIMARY IDENTIFIER.
2: M	valueType	"value"	SHALL be set as SUB IDENTIFIER.
2: O	timestamp	<t#(1..1)->m1#1>	[VAPD-002b]

			MAY be used. Only the newest measurement value SHALL be stated. Additional historical values are forbidden.
2: M	value.		[VAPD-002a], [VAPD-004] See [Measurement value rules]. See [Scaled number rules].
2: M	value. number		SHALL be used.
2: O	value. scale		MAY be used. If absent, a default value of "0" applies.
2: M	valueSource	"measuredValue"	
		"calculatedValue"	
		"empiricalValue"	
2: R	valueState		[Value state rules]
3: M	Measurement. measurementListData. measurementData.		
3: M	measurementId	<m2#(1..1)>	SHALL be set as PRIMARY IDENTIFIER.
3: M	valueType	"value"	SHALL be set as SUB IDENTIFIER.
3: O	timestamp	<t#(1..1)->m1#1>	[VAPD-003b] MAY be used. Only the newest measurement value SHALL be stated. Additional historical values are forbidden.
3: M	value.		[VAPD-003a], [VAPD-004] See [Measurement value rules]. See [Scaled number rules].
3: M	value. number		SHALL be used.
3: O	value. scale		MAY be used. If absent, a default value of "0" applies.
3: M	valueSource	"measuredValue"	
		"calculatedValue"	
		"empiricalValue"	
3: R	valueState		[Value state rules]

794 Table 14: Content of Function "measurementListData" at Actor PV System

795

796 3.2.2.2.4 Feature Type "ElectricalConnection"

797 3.2.2.2.4.1 Function "electricalConnectionDescriptionListData"

Scenario [...]: M/R/O [W]\C]	Element	Value	[High Level Mapping] Element and value rules
2: M 3: M	ElectricalConnection. electricalConnectionDescriptionListData. electricalConnectionDescriptionData.		
2: M 3: M	electricalConnectionId	<ec1#(1..1)>	SHALL be set as PRIMARY IDENTIFIER.
2: M 3: M	powerSupplyType	"ac"	
2: M 3: M	positiveEnergyDirection	"consume"	[VAPD-004]

798 Table 15: Content of Function "electricalConnectionDescriptionListData" at Actor PV System

799

800 3.2.2.2.4.2 Function "electricalConnectionParameterDescriptionListData"

Scenario [...]: M/R/O [W][V]	Element	Value	[High Level Mapping] Element and Value rules
2: M	ElectricalConnection. electricalConnectionParameterDescriptionListData. electricalConnectionParameterDescriptionData.		
2: M	electricalConnectionId	<ec1#{1..1}>	SHALL be set as PRIMARY IDENTIFIER.
2: M	parameterId	<p1#{1..1}->ec1#1>	SHALL be set as SUB IDENTIFIER.
2: M	measurementId	<m1->p1#1>	SHALL be set as FOREIGN IDENTIFIER.
2: M	voltageType	"ac"	
2: M	acMeasurementType	"real"	
3: M	ElectricalConnection. electricalConnectionParameterDescriptionListData. electricalConnectionParameterDescriptionData.		
3: M	electricalConnectionId	<ec1#{1..1}>	SHALL be set as PRIMARY IDENTIFIER.
3: M	parameterId	<p2#{1..1}->ec1#1>	SHALL be set as SUB IDENTIFIER.
3: M	measurementId	<m2->p2#1>	SHALL be set as FOREIGN IDENTIFIER.
3: M	voltageType	"ac"	
3: M	acMeasurementType	"real"	

801 Table 16: Content of Function "electricalConnectionParameterDescriptionListData" at Actor PV System

802

803 3.2.2.3 Client data - Specializations

804 As this Actor has only server functionality, no Specializations are described within this section.

805

806 3.3 Pre-Scenario communication

807 3.3.1 General information

808 The Pre-Scenario communication is needed if a client does not know the corresponding addresses on
809 the server or if the required subscriptions or bindings are not active. In this case certain general
810 communication mechanisms SHALL be used within SPINE:

- 811 a) Detailed discovery: allows to discover resource addresses.
- 812 b) Binding: allows to bind to resource address, which is frequently necessary to obtain write
813 privileges.
- 814 c) Subscription: allows to subscribe to resource addresses, which is necessary to receive
815 unsolicited notifications if a resource changes during runtime.

816 It is possible to combine those steps for multiple Scenarios or also multiple Use Cases:

- 817 - E.g. if multiple Scenarios in multiple Use Cases use the same Feature, only one subscription
818 needs to occur.
819 - E.g. a complete detailed discovery or a subscription to the NodeManagement Feature needs
820 to occur only once for all Use Cases.

821 Depending on which Entity, Feature and Functions are used within a Scenario the payload of the
822 corresponding messages may slightly differ, but the basic principles and messages used stay the
823 same.

824 The subsequent messages SHALL be exchanged for those parts that have not already been performed
825 since the current connection is established or if those parts are outdated for another reason (e.g. if
826 the detailed discovery is needed, but the bindings and subscriptions are still active from a previous
827 connection only the detailed discovery messages need to be exchanged). If all Pre-Scenario
828 communication parts are up-to-date, this section MAY be skipped, and the implementation can
829 proceed as described in the corresponding "Scenario communication" sections.

830 After the connection is re-established (e.g. due to a power loss or a firmware update) the Pre-
831 Scenario communication SHALL be performed as well. There may be circumstances where messages
832 from the Pre-Scenario communication may be exchanged again.

833 Often the necessary messages of different Scenarios can be combined, so that only one single
834 message is needed instead of multiple messages for the different Scenarios. This also is the case for
835 the Pre-Scenario communication. In most cases only one "read" operation on the detailed discovery
836 is necessary, as well as only one subscription request or binding request is needed for each Feature.
837 Often multiple Scenarios within a Use Case access the same Feature, so only one subscription or
838 binding is necessary.

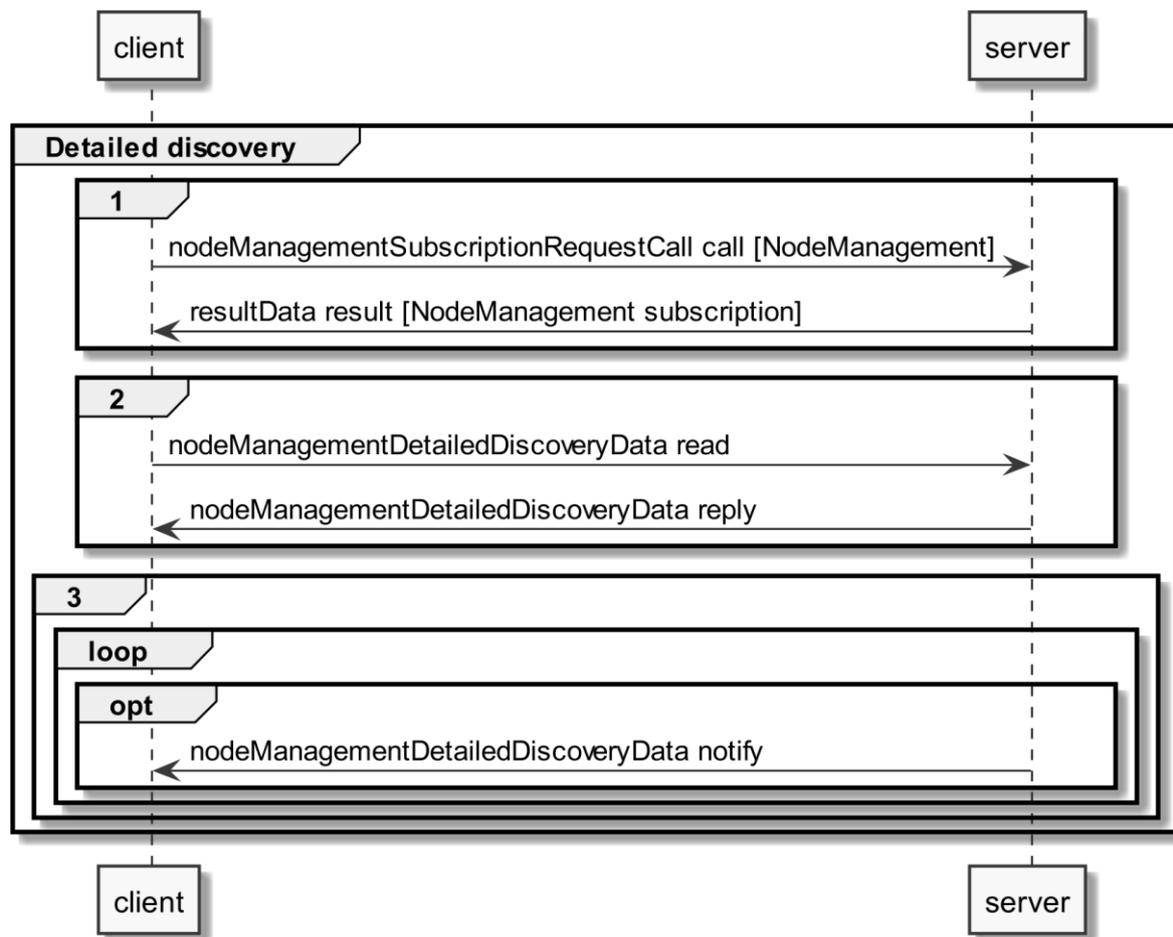
839

840 **3.3.2 Detailed discovery**

841 For the functionality where a client already has current detailed discovery information (i.e.
842 independent of this Use Case or any Scenario of it) the remainder of this section SHOULD be skipped.

843 Otherwise, the following procedure SHALL be performed in the given order:

- 844 1. If a client is not subscribed to the primary NodeManagement instance, the client SHALL
845 acquire a subscription according to the figure provided within this sub-section.
- 846 2. A client SHALL read the detailed discovery information according to the figure provided
847 within this sub-section. It SHALL keep the received information as far as it concerns
848 mandatory and supported optional Entity Types, Feature Types and Functions of this Use
849 Case that are needed by the client. This means that a client may choose how to store the
850 necessary information. E.g. a client Actor can store the information how to address the
851 necessary Features of the implemented Scenarios but may discard the Entity information.
- 852 3. If and as long as a client has a subscription to the detailed discovery information of an Actor
853 and receives proper notifications, it SHALL consider (i.e. integrate into the kept detailed
854 discovery information) the received information as far as it concerns mandatory and
855 supported optional Entity Types, Feature Types and Functions of this Use Case.



856

857 *Figure 6: Pre-Scenario communication - Detailed discovery sequence diagram*

858 If the "nodeManagementDetailedDiscoveryData read" fails, the client SHOULD retry to read the
 859 detailed discovery information until the "nodeManagementDetailedDiscoveryData reply" message
 860 was received successfully.

861 If all functionality is present at all times: The "nodeManagementDetailedDiscoveryData reply"
 862 message contains at least the mandatory Entities and Features given in the "Actor [...] overview"
 863 diagrams as well as the used Functions and their "possible operations" described in section 3.2 and
 864 its sub-sections.

865 If functionality is added or removed dynamically: The "nodeManagementDetailedDiscoveryData
 866 reply" message does not need to contain all mandatory Entities and Features given in the "Actor [...]
 867 overview" diagrams as well as all needed Functions and their "possible operations" described in
 868 section 3.2 and its sub-sections. However, as soon as the functionality is available it will be
 869 announced via a "nodeManagementDetailedDiscoveryData notify" message.

870 For the nodeManagementDetailedDiscoveryData read Function it is recommended to use a partial
 871 read with separated Selectors that may use one of the following Elements:

- 872 - entityType
- 873 - featureType

874 Note: Even with the usage of Selectors Features and Entities that are not relevant for this Use Case
 875 may be discovered. However, only Features and Entities that fulfil the hierarchical order as described
 876 within the Actors' sections shall be considered for this Use Case.

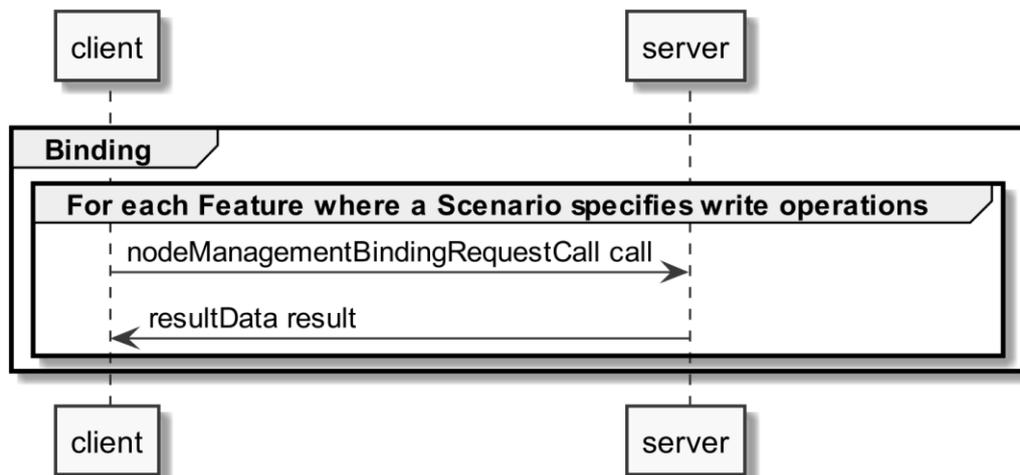
877 A "partial" notify SHALL be supported without using Selectors and Elements. Partial "delete" notify
 878 SHOULD also be supported with separated Selectors that may use one of the following Elements:

- 879 - entityAddress
- 880 - featureAddress

881

882 3.3.3 Binding

883 A server SHALL support binding for all Features that contain writeable or changeable data. Before a
 884 write on a Function of a Feature occurs, the client SHALL create a binding to the corresponding
 885 Feature. For this the nodeManagementBindingRequestCall Function is used as shown in the following
 886 sequence diagram:



887

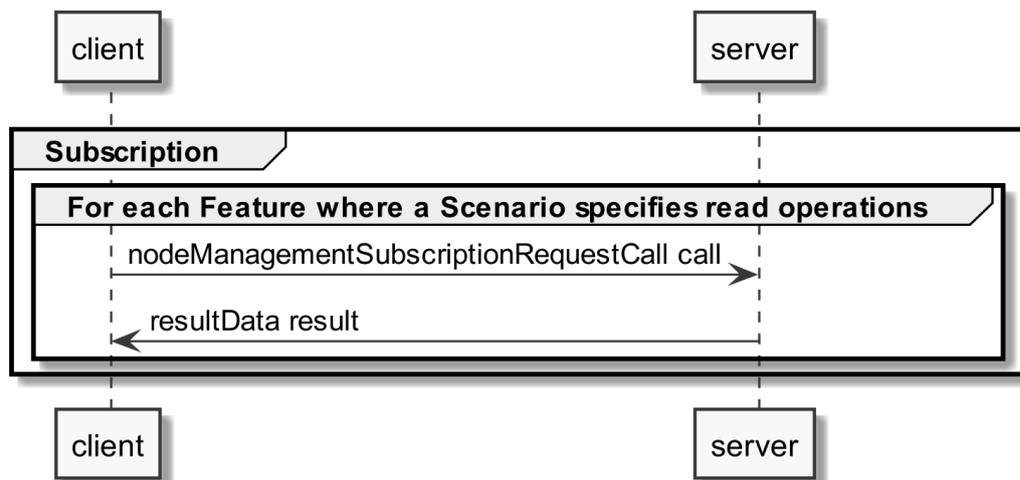
888 *Figure 7: Pre-Scenario communication - Binding sequence diagram*

889 If functionality is added or removed dynamically, binding may not be possible at all times on the
 890 required Functions. A client SHALL retry to create a binding again when receiving according updated
 891 detailed discovery information.

892

893 3.3.4 Subscription

894 A server SHALL support subscription for all Features that contain readable data that may change
 895 during runtime. The client SHALL create a subscription for all Features that the client wants to read.
 896 For this the nodeManagementSubscriptionRequestCall Function is used as shown in the following
 897 sequence diagram:



898

899 *Figure 8: Pre-Scenario communication - Subscription sequence diagram*

900 If the subscription request fails (e.g. because it is not supported by the server or the maximum
 901 number of possible subscriptions is reached), the client SHOULD read the data periodically (so-called
 902 "polling").

903 If functionality is added or removed dynamically, subscription may not be possible at all times on the
 904 required Functions. A client SHALL retry its subscription procedure again when receiving according
 905 updated detailed discovery information.

906

907 3.3.5 Dynamic behaviour

908 In case Entities or Features are removed, a nodeManagementDetailedDiscoveryData "notify" is
 909 transmitted that informs about the deleted Entities and Features. All existing binding or subscription
 910 entries on the deleted Features SHALL be deleted by each device.

911 In case Entities or Features are added the Pre-Scenario communication starts with transmitting a
 912 nodeManagementDetailedDiscoveryData "notify" that contains the added Entities and Features.

913

914 3.4 Scenarios

915 3.4.1 Scenario 1 - Monitor nominal peak power

916 3.4.1.1 Pre-Scenario communication

- 917 1. **Detailed discovery:** Actors that act as client within this Scenario need to know the addresses
 918 of the server Features used in the Initial Scenario communication. If the address of a
 919 particular server Feature is not known, the detailed discovery must be used, as described in
 920 section 3.3.2.
- 921 2. **Binding:** Binding SHOULD NOT be used for this Scenario.
- 922 3. **Subscription:** Actors SHALL create a subscription for each server Feature that is relevant for
 923 the corresponding Actor within this Scenario, as described in section 3.3.4.

924 The Initial Scenario communication SHALL start at the latest when the required resources on an Actor
 925 are known and the necessary binding and subscription procedures have been finished. However, as

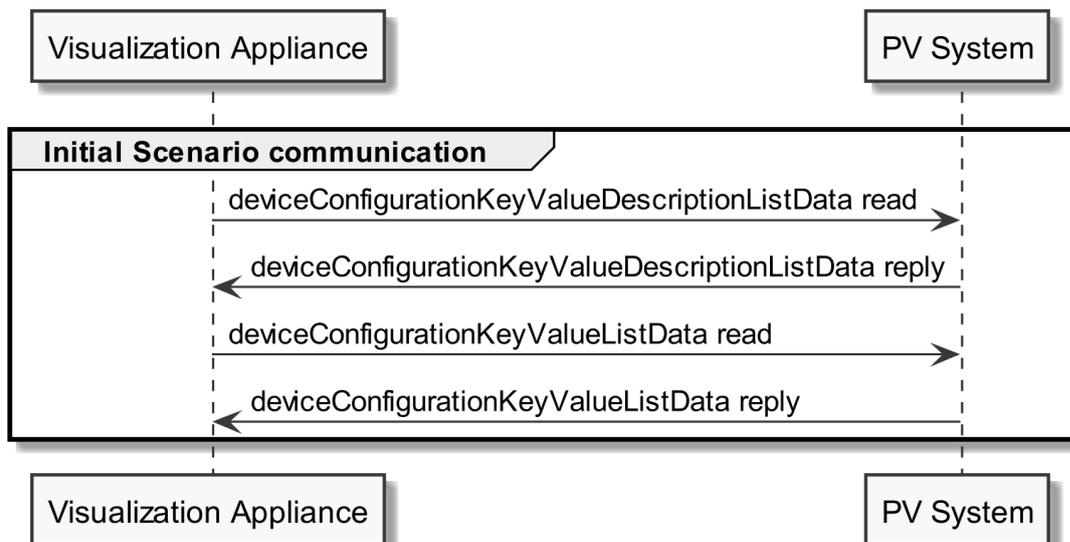
926 soon as the address of a required resource is known, the Initial Scenario communication for this
 927 resource MAY start already, even if the addresses of other required resources are not known yet.

928 If required resources are removed and added again, they are re-discovered, and the Initial Scenario
 929 communication is triggered again for those resources.

930

931 **3.4.1.2 Initial Scenario communication**

932 Each time a (re-)connection is established, even if the Pre-Scenario communication phase is skipped,
 933 the messages shown in the following sequence diagram SHALL be exchanged, as the corresponding
 934 resources may have changed in the meantime:



935

936 *Figure 9: Scenario 1 - Initial Scenario communication sequence diagram*

937 The deviceConfigurationKeyValueDescriptionListData read SHOULD be a "partial" read operation
 938 with the following Selectors:

- 939 - keyName = "peakPowerOfPvSystem"

940 The deviceConfigurationKeyValueListData read SHOULD be a "partial" read operation with the
 941 following Selectors:

- 942 - keyId (derived from the deviceConfigurationKeyValueDescriptionListData reply)

943 Note: If partial read is not supported a full read SHALL be performed.

944

945 The following table shows where the required content of the messages from the sequence diagram is
 946 described:

Message name from sequence diagram	Content description in table	Scenario number in table
deviceConfigurationKeyValueDescriptionListData reply	Table 10	1
deviceConfigurationKeyValueListData reply	Table 11	1

947 *Table 17: Initial Scenario communication content references for Scenario 1*

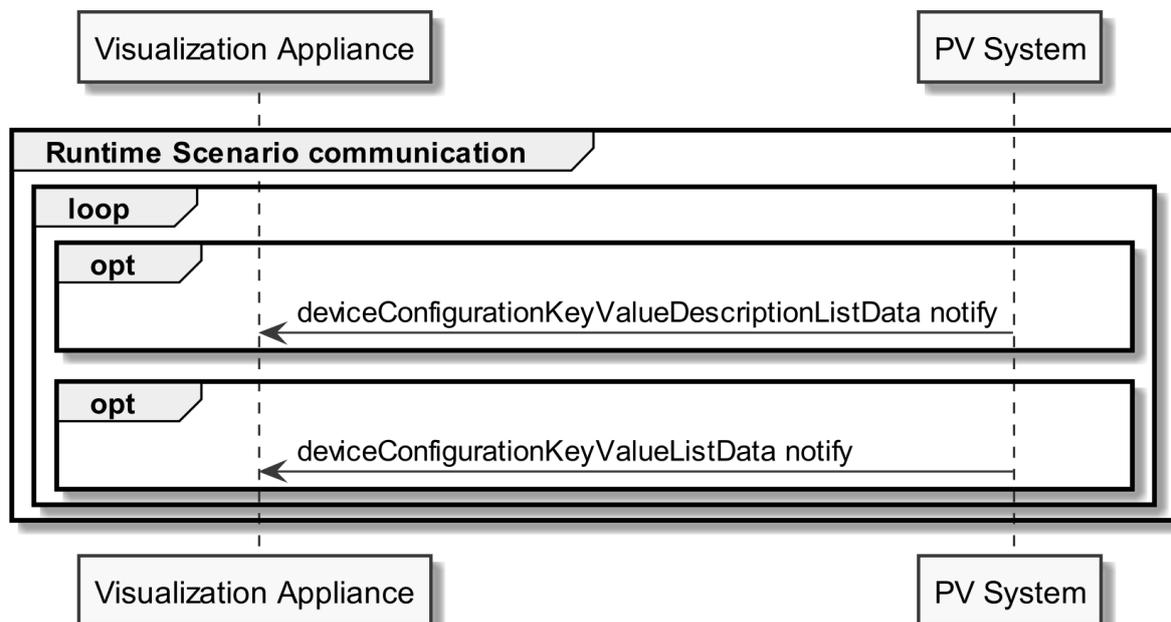
948 Note: Within the Initial Scenario communication, the content required by this Scenario MAY not be
 949 provided completely but later during Runtime Scenario communication.

950

951 **3.4.1.3 Runtime Scenario communication**

952 Based on the Initial Scenario communication, the Runtime Scenario communication provides updates
 953 during runtime.

954 If one of the referenced server Functions' data change, the server SHALL submit the change as shown
 955 in the following figure:



956

957 *Figure 10: Scenario 1 - Runtime Scenario communication sequence diagram*

958 Note: Normally, in this Scenario the configuration parameter does not change during runtime. Hence,
 959 usually no notifications are sent during runtime in this Scenario.

960 Partial notifications without Selectors or Elements SHALL be supported for all Functions used in this
 961 Scenario.

962 For deviceConfigurationKeyValueDescriptionListData notify and
 963 deviceConfigurationKeyValueListData notify "partial" delete notifications SHOULD be supported with
 964 the Selector:

965 - keyId

966 Note: To interpret partial notification messages correctly the information obtained during the Initial
 967 Scenario communication phase is required.

968 Note: A read operation ("polling") on all Functions is possible at any time, e.g. if a notification could
 969 not be evaluated.

970

971 The following table shows where the required content of the messages of the sequence diagram is
 972 described:

Message name from sequence diagram	Content description in table	Scenario number in table
deviceConfigurationKeyValueDescriptionListData notify	Table 10	1
deviceConfigurationKeyValueListData notify	Table 11	1

973 *Table 18: Runtime Scenario communication content references for Scenario 1*

974

975 **3.4.1.4 Additional information**

976 Note: In this Scenario solution, the "generator convention" (i.e. "active sign convention") is applied.
 977 This means power and energy values are expressed with positive values in case of energy production
 978 [VAPD-004]. Please note that other Scenario solutions may apply different conventions!

979

980 **3.4.2 Scenario 2 - Monitor current photovoltaic power production**

981 **3.4.2.1 Pre-Scenario communication**

- 982 1. **Detailed discovery:** Actors that act as client within this Scenario, need to know the addresses
 983 of the server Features used in the Initial Scenario communication. If the address of a
 984 particular server Feature is not known, the detailed discovery has to be used, as described in
 985 section 3.3.2.
- 986 2. **Binding:** Binding SHOULD NOT be used for this Scenario.
- 987 3. **Subscription:** Actors SHALL create a subscription for each server Feature that is relevant for
 988 the corresponding Actor within this Scenario, as described in section 3.3.4.

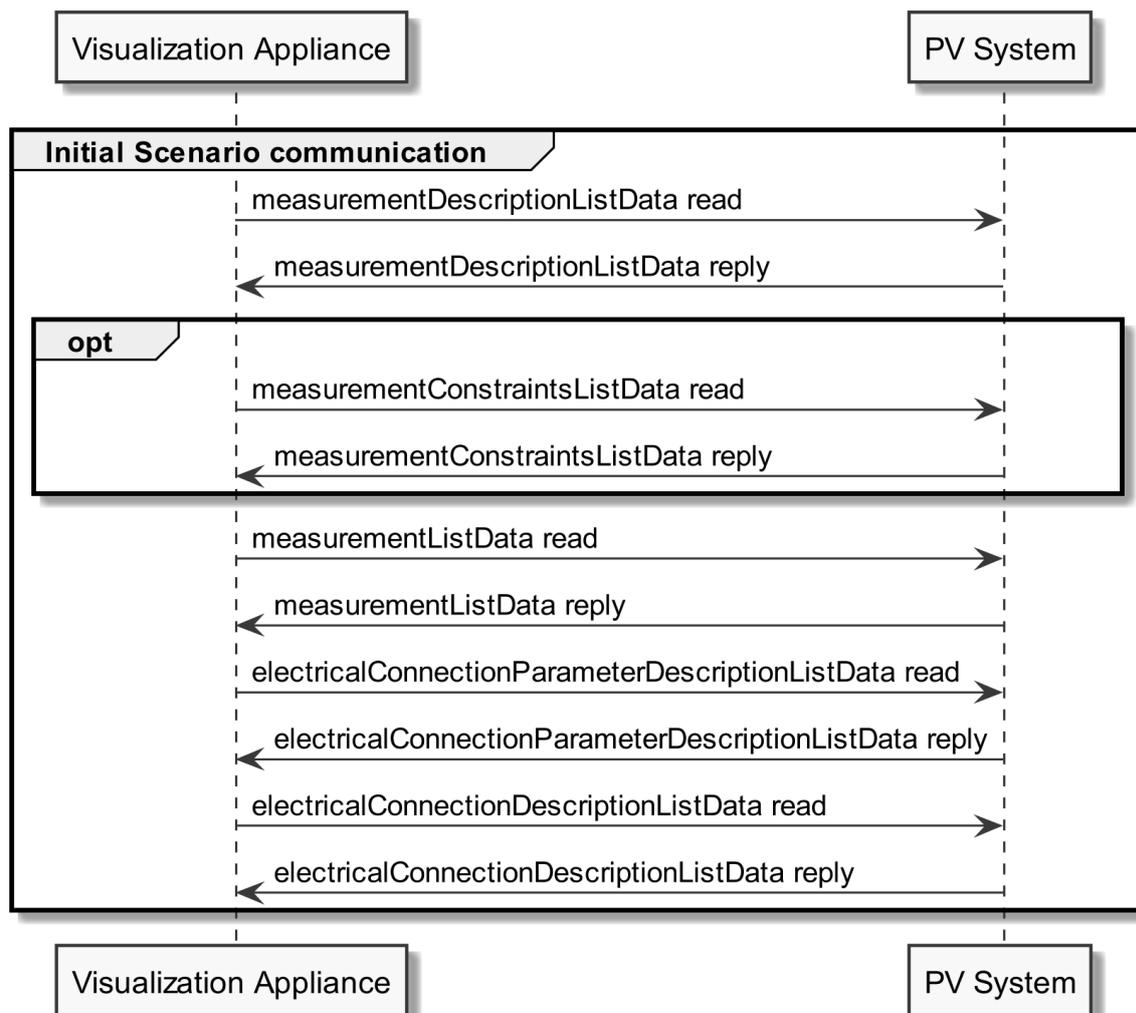
989 The Initial Scenario communication SHALL start at the latest when the required resources on an Actor
 990 are known and the necessary binding and subscription procedures have been finished. However, as
 991 soon as an address of a required resource is known, the Initial Scenario communication for this
 992 resource MAY start already, even if the addresses of other required resources are not known yet.

993 If required resources are removed and added again, they are re-discovered, and the Initial Scenario
 994 communication is triggered again for those resources.

995

996 **3.4.2.2 Initial Scenario communication**

997 Each time a (re-)connection is established, even if the Pre-Scenario communication phase is skipped,
 998 the messages shown in the following sequence diagram SHALL be exchanged, as the corresponding
 999 resources may have changed in the meantime:



1000

1001 *Figure 11: Scenario 2 - Initial Scenario communication sequence diagram*

1002 Note: The initiation of the optional sequence part (marked with "opt" in the figure) is optional for the
 1003 "Visualization Appliance" even if the "PV System" can provide the requested Function.

1004 The measurementDescriptionListData read SHOULD be a "partial" read operation with the following
 1005 Selectors:

1006 - scopeType = "acPowerTotal"

1007 The measurementConstraintsListData read, measurementListData read and
 1008 electricalConnectionParameterDescriptionListData read SHOULD be "partial" read operations with
 1009 the following Selectors:

1010 - measurementId (derived from the measurementDescriptionListData reply)

1011 The electricalConnectionDescriptionListData read SHOULD be a "partial" read operation with the
 1012 following Selectors:

1013 - electricalConnectionId (derived from the electricalConnectionParameterDescriptionListData
 1014 reply)

1015 Note: If partial read is not supported a full read SHALL be performed.

1016

1017 The following table shows where the required content of the messages from the sequence diagram is
 1018 described:

Message name from sequence diagram	Content description in table	Scenario number in table
measurementDescriptionListData reply	Table 12	2
measurementConstraintsListData reply	Table 13	2
measurementListData reply	Table 14	2
electricalConnectionDescriptionListData reply	Table 15	2
electricalConnectionParameterDescriptionListData reply	Table 16	2

1019 *Table 19: Initial Scenario communication content references for Scenario 2*

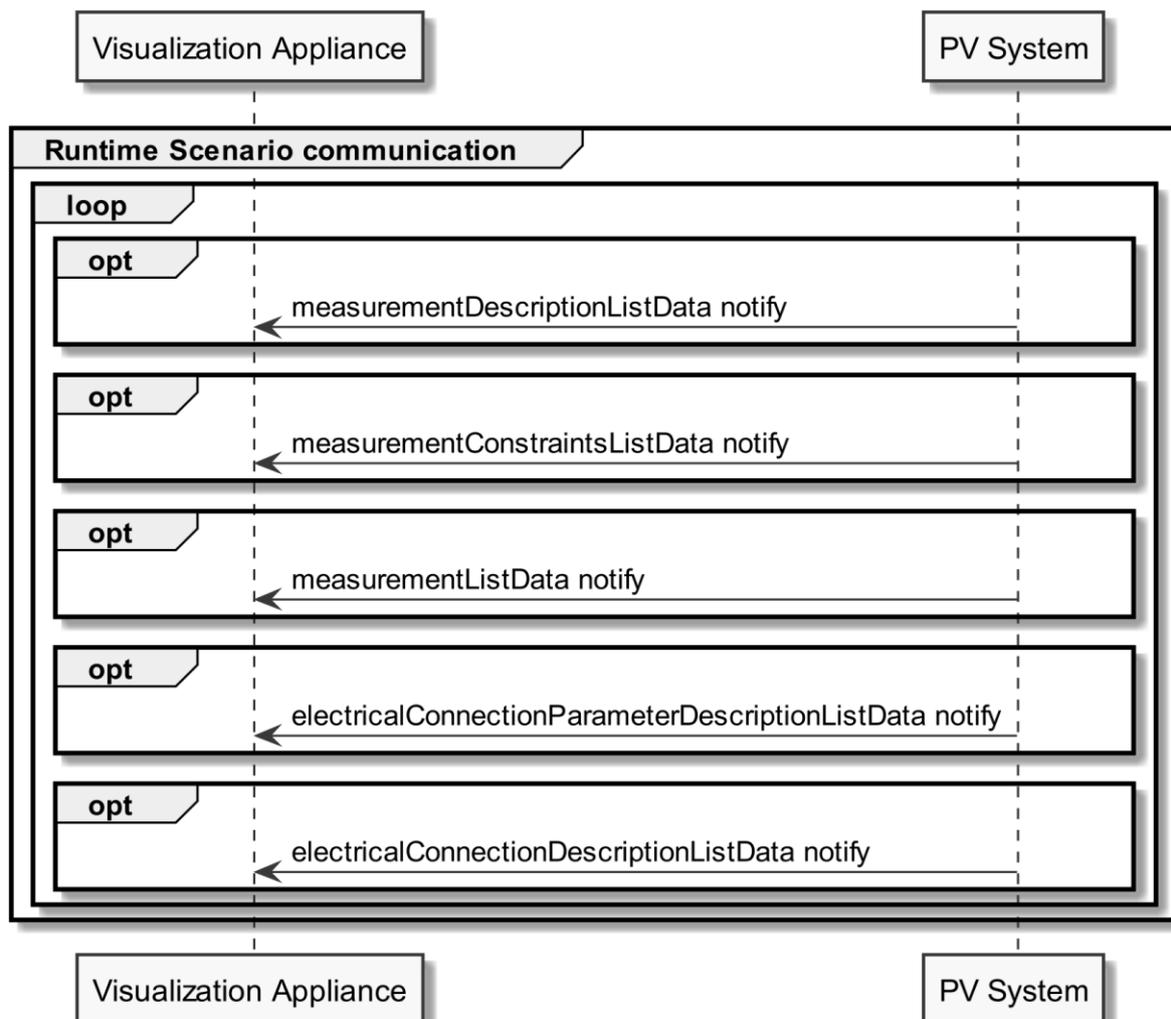
1020 Note: Within the Initial Scenario communication, the content required by this Scenario MAY not be
 1021 provided completely, but later during Runtime Scenario communication.

1022

1023 **3.4.2.3 Runtime Scenario communication**

1024 Based on the Initial Scenario communication, the Runtime Scenario communication provides updates
 1025 during runtime.

1026 If one of the referenced server Functions' data change, the server SHALL submit the change as shown
 1027 in the following figure:



1028

1029 *Figure 12: Scenario 2 - Runtime Scenario communication sequence diagram*

1030 Note: Normally, in this Scenario only the "measurementListData" Function changes during runtime.
 1031 Hence, usually no notifications of the other Functions of this Scenario are sent during runtime.

1032 Partial notifications without Selectors or Elements SHALL be supported for all Functions used in this
 1033 Scenario.

1034 For measurementDescriptionListData notify, measurementConstraintsListData notify and
 1035 measurementListData notify "partial" delete notifications SHOULD be supported with the Selector:

1036 - measurementId

1037 For electricalConnectionParameterDescriptionListData notify "partial" delete notifications SHOULD
 1038 be supported with the Selectors:

1039 - electricalConnectionId

1040 - parameterId

1041 - measurementId

1042 Note: To interpret partial notification messages correctly the information obtained during the Initial
 1043 Scenario communication phase is required.

1044 Note: A read operation ("polling") on all Functions is possible at any time, e.g. if a notification could
1045 not be evaluated.

1046

1047 The following table shows where the required content of the messages of the sequence diagram is
1048 described:

Message name from sequence diagram	Content description in table	Scenario number in table
measurementDescriptionListData notify	Table 12	2
measurementConstraintsListData notify	Table 13	2
measurementListData notify	Table 14	2
electricalConnectionDescriptionListData notify	Table 15	2
electricalConnectionParameterDescriptionListData notify	Table 16	2

1049 *Table 20: Runtime Scenario communication content references for Scenario 2*

1050

1051 **3.4.2.4 Additional information**

1052 Note: In this Scenario solution, the "load convention" (i.e. "passive sign convention") is applied. This
1053 means power and energy values are expressed with positive values in case of energy consumption
1054 whereas negative values are used in case of energy production [VAPD-004]. Please note that other
1055 Scenario solutions may apply different conventions!

1056 Note: Within this Scenario, only the latest measurement value SHALL be stated ([VAPD-002b]).
1057 Additional historical values are forbidden.

1058

1059 **3.4.3 Scenario 3 - Monitor cumulated photovoltaic yield**

1060 **3.4.3.1 Pre-Scenario communication**

- 1061 1. **Detailed discovery:** Actors that act as client within this Scenario need to know the addresses
1062 of the server Features used in the Initial Scenario communication. If the address of a
1063 particular server Feature is not known, the detailed discovery must be used, as described in
1064 section 3.3.2.
- 1065 2. **Binding:** Binding SHOULD NOT be used for this Scenario.
- 1066 3. **Subscription:** Actors SHALL create a subscription for each server Feature that is relevant for
1067 the corresponding Actor within this Scenario, as described in section 3.3.4.

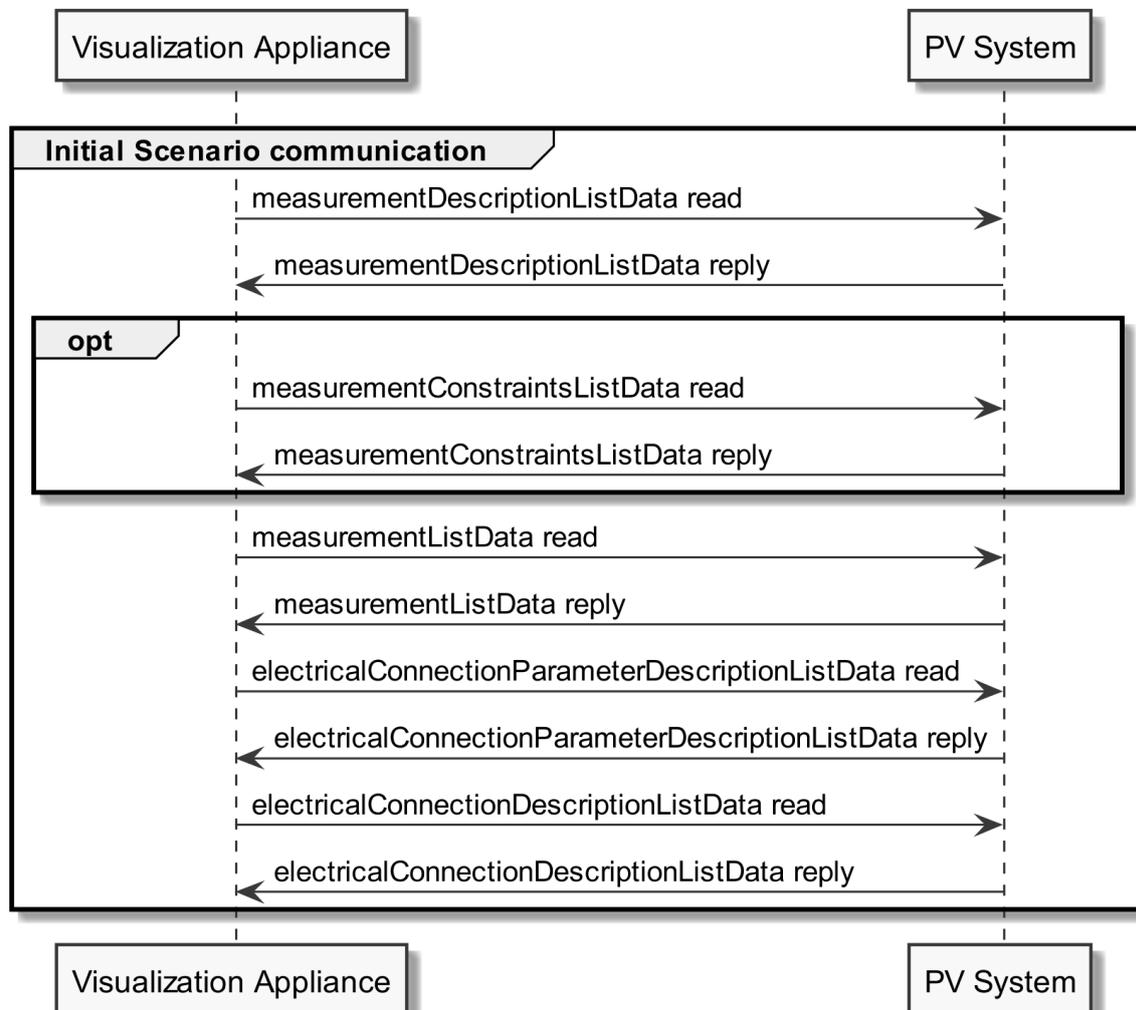
1068 The Initial Scenario communication SHALL start at the latest when the required resources on an Actor
1069 are known and the necessary binding and subscription procedures have been finished. However, as
1070 soon as the address of a required resource is known, the Initial Scenario communication for this
1071 resource MAY start already, even if the addresses of other required resources are not known yet.

1072 If required resources are removed and added again, they are re-discovered, and the Initial Scenario
1073 communication is triggered again for those resources.

1074

1075 **3.4.3.2 Initial Scenario communication**

1076 Each time a (re-)connection is established, even if the Pre-Scenario communication phase is skipped,
 1077 the messages shown in the following sequence diagram SHALL be exchanged, as the corresponding
 1078 resources may have changed in the meantime:



1079

1080 *Figure 13: Scenario 3 - Initial Scenario communication sequence diagram*

1081 Note: The initiation of the optional sequence part (marked with "opt" in the figure) is optional for the
 1082 "Visualization Appliance" even if the "PV System" can provide the requested Function.

1083 The `measurementDescriptionListData read` SHOULD be a "partial" read operation with the following
 1084 Selectors:

- 1085 - `scopeType = "acYieldTotal"`

1086 The `measurementConstraintsListData read`, `measurementListData read` and
 1087 `electricalConnectionParameterDescriptionListData read` SHOULD be "partial" read operations with
 1088 the following Selectors:

- 1089 - `measurementId` (derived from the `measurementDescriptionListData reply`)

1090 The electricalConnectionDescriptionListData read SHOULD be a "partial" read operation with the
1091 following Selectors:

- 1092 - electricalConnectionId (derived from the electricalConnectionParameterDescriptionListData
1093 reply)

1094 Note: If partial read is not supported a full read SHALL be performed.

1095

1096 The following table shows where the required content of the messages from the sequence diagram is
1097 described:

Message name from sequence diagram	Content description in table	Scenario number in table
measurementDescriptionListData reply	Table 12	3
measurementConstraintsListData reply	Table 13	3
measurementListData reply	Table 14	3
electricalConnectionDescriptionListData reply	Table 15	3
electricalConnectionParameterDescriptionListData reply	Table 16	3

1098 *Table 21: Initial Scenario communication content references for Scenario 3*

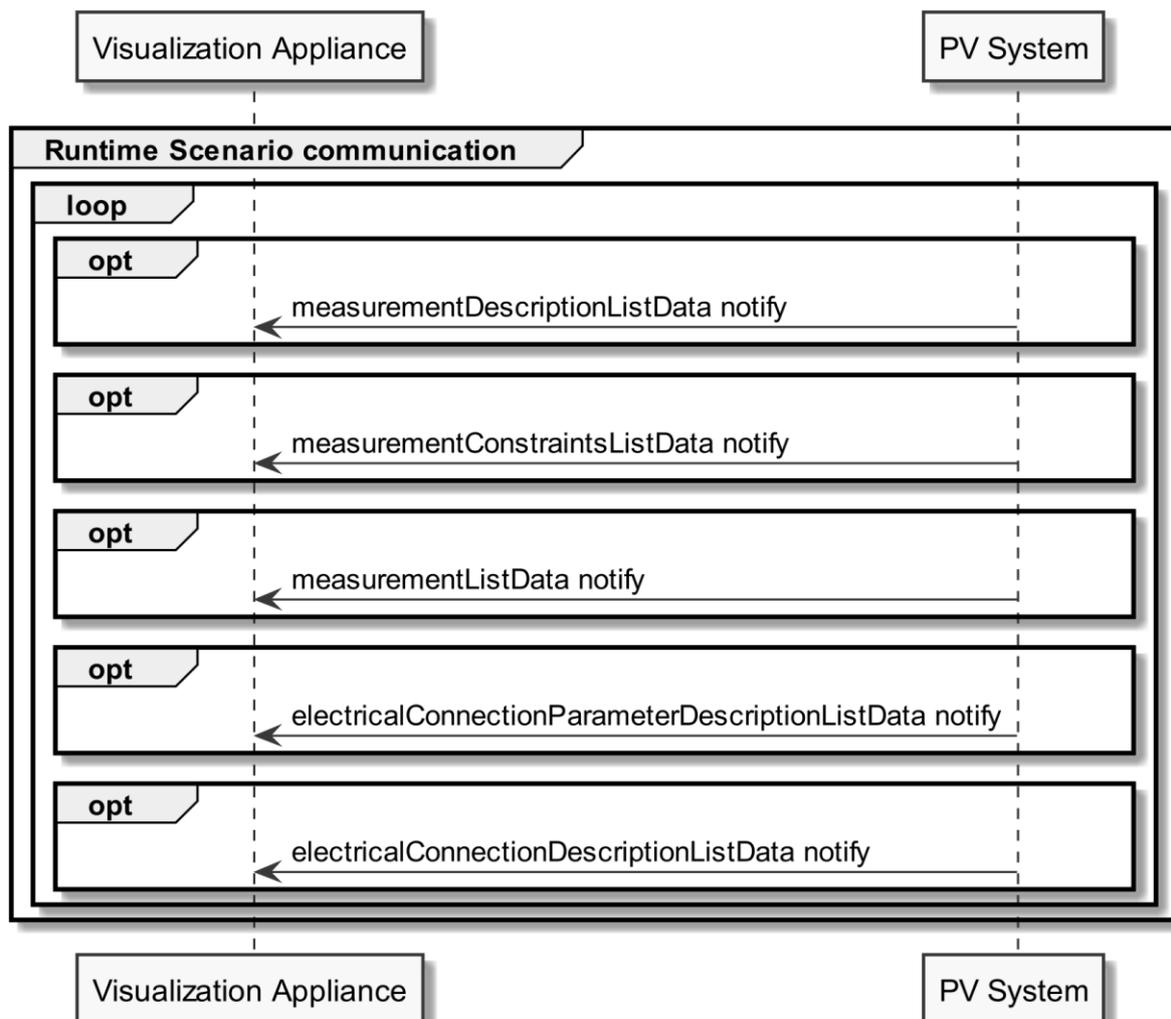
1099 Note: Within the Initial Scenario communication, the content required by this Scenario MAY not be
1100 provided completely, but later during Runtime Scenario communication.

1101

1102 **3.4.3.3 Runtime Scenario communication**

1103 Based on the Initial Scenario communication, the Runtime Scenario communication provides updates
1104 during runtime.

1105 If one of the referenced server Functions' data change, the server SHALL submit the change as shown
1106 in the following figure:



1107

1108 *Figure 14: Scenario 3 - Runtime Scenario communication sequence diagram*

1109 Note: Normally, in this Scenario only the "measurementListData" Function changes during runtime.
 1110 Hence, usually no notifications of the other Functions of this Scenario are sent during runtime.

1111 Partial notifications without Selectors or Elements SHALL be supported for all Functions used in this
 1112 Scenario.

1113 For measurementDescriptionListData notify, measurementConstraintsListData notify and
 1114 measurementListData notify "partial" delete notifications SHOULD be supported with the Selector:

1115 - measurementId

1116 For electricalConnectionParameterDescriptionListData notify "partial" delete notifications SHOULD
 1117 be supported with the Selectors:

1118 - electricalConnectionId

1119 - parameterId

1120 - measurementId

1121 Note: To interpret partial notification messages correctly the information obtained during the Initial
 1122 Scenario communication phase is required.

1123 Note: A read operation ("polling") on all Functions is possible at any time, e.g. if a notification could
 1124 not be evaluated.

1125

1126 The following table shows where the required content of the messages of the sequence diagram is
 1127 described:

Message name from sequence diagram	Content description in table	Scenario number in table
measurementDescriptionListData notify	Table 12	3
measurementConstraintsListData notify	Table 13	3
measurementListData notify	Table 14	3
electricalConnectionDescriptionListData notify	Table 15	3
electricalConnectionParameterDescriptionListData notify	Table 16	3

1128 *Table 22: Runtime Scenario communication content references for Scenario 3*

1129

1130 **3.4.3.4 Additional information**

1131 Note: In this Scenario solution, the "load convention" (i.e. "passive sign convention") is applied. This
 1132 means power and energy values are expressed with positive values in case of energy consumption
 1133 whereas negative values are used in case of energy production [VAPD-004]. Please note that other
 1134 Scenario solutions may apply different conventions!

1135 Note: Within this Scenario, only the latest measurement value SHALL be stated ([VAPD-003b]).

1136 Additional historical values are forbidden.

1137