OCF Device Specification

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1 Scope

ISO/IEC 30118-5 is an Application Profile specification.

The Device definitions use Resource definitions from the ISO/IEC 30118-4:2018.

This document is built on top of ISO/IEC 30118-1:2018. ISO/IEC 30118-1:2018 specifies the core architecture, interfaces protocols and services to enable the implementation of profiles for IoT usages and ecosystems. ISO/IEC 30118-1:2018 also defines the main architectural components of network connectivity, discovery, data transmission, device & service management and ID & security. The core architecture is scalable to support simple devices (constrained devices) and more capable devices (smart devices).

2 Normative references

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

ISO/IEC 30118-1:2018 Information technology -- Open Connectivity Foundation (OCF) Specification -- Part 1: Core specification
https://www.iso.org/standard/53238.html
Latest version available at: https://openconnectivity.org/specs/OCF_Core_Specification.pdf

ISO/IEC 30118-2:2018 Information technology -- Open Connectivity Foundation (OCF) Specification -- Part 2: Security specification
https://www.iso.org/standard/74239.html
Latest version available at: https://openconnectivity.org/specs/OCF_Security_Specification.pdf

ISO/IEC 30118-4:2018 Information technology -- Open Connectivity Foundation (OCF) Specification -- Part 4: Resource Type specification
https://www.iso.org/standard/74241.html
Latest version available at:
https://openconnectivity.org/specs/OCF_Resource_Type_Specification.pdf

ISO/IEC 61850-7-1:2011 Communication networks and systems for power utility automation --Part 7-1: Basic communication structure -- Principles and models
https://webstore.iec.ch/publication/6014

OpenAPI specification, fka *Swagger RESTful API Documentation Specification*, Version 2.0
https://github.com/OAI/OpenAPI-Specification/blob/master/versions/2.0.md

IETF RFC 4566, SDP: Session Description Protocol, July 2006
https://tools.ietf.org/html/rfc4566

Draft Report: A Basic Classification System for Energy-Using Products--Universal Device Classification, December 2013
https://eta-intranet.lbl.gov/sites/default/files/lbnl-classification-v1.pdf

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 30118-1:2018 and ISO/IEC 30118-2:2018 and the following apply.

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

– ISO Online browsing platform: available at https://www.iso.org/obp

– IEC Electropedia: available at http://www.electropedia.org/

3.1.1
Actuator
resource with support of the UPDATE operation.

3.1.2
Sensor
resource without support of the UPDATE operation.

3.1.3
Healthcare Device
a Device that is conformant to the normative requirements contained in Annex C of this document.

3.2 Abbreviated terms

3.2.1
CGM
Continuous Glucose Monitor
Device that continuously measures patient's glucose information throughout the day and night, and notifies highs and lows for control of patient blood sugar levels.

3.2.2
CRUDN
Create Retrieve Update Delete Notify
This is an acronym indicating which operations are possible on the Resource.

3.2.3
CSV
Comma Separated Value
Comma Separated Value is a construction to have more fields in 1 string separated by commas. If a value itself contains a comma, then the comma can be escaped by adding "\" in front of the comma.

3.2.4
NREM
Non Rapid Eye Movement
Type of sleep including 3 to 4 stages of the sleep cycle defining Light Sleep and Deep Sleep, which are cycled through before the REM type of sleep.

3.2.5
REM
Rapid Eye Movement
Type of sleep where the eyes are moving rapidly from side to side beneath the closed eyelids.

3.2.6
Representational State Transfer
REST
REST is an architecture style for designing networked applications that relies on a stateless, client-server, cacheable communications protocol.

3.2.7
SDP
Session Description Protocol
SDP describes multimedia sessions for the purposes of session announcement, session invitation, and other forms of multimedia session initiation. It is fully defined in IETF RFC 4566.

3.2.8
UDC
Universal Device Classification
An enumeration of device types published as A Basic Classification System for Energy-Using Products--Universal Device Classification

4 Document conventions and organization

4.1 Conventions

In this document a number of terms, conditions, mechanisms, sequences, parameters, events, states, or similar terms are printed with the first letter of each word in uppercase and the rest lowercase (e.g., Network Architecture). Any lowercase uses of these words have the normal technical English meaning.

4.2 Notation

In this document, features are described as required, recommended, allowed or DEPRECATED as follows:

Required (or shall or mandatory).

These basic features shall be implemented. The phrases "shall not", and "PROHIBITED" indicate behaviour that is prohibited, i.e. that if performed means the implementation is not in compliance.

Recommended (or should).

These features add functionality supported by a Device and should be implemented. Recommended features take advantage of the capabilities a Device, usually without imposing major increase of complexity. Notice that for compliance testing, if a recommended feature is implemented, it shall meet the specified requirements to be in compliance with these guidelines. Some recommended features could become requirements in the future. The phrase "should not" indicates behaviour that is permitted but not recommended.

Allowed (or allowed).

These features are neither required nor recommended by a Device, but if the feature is implemented, it shall meet the specified requirements to be in compliance with these guidelines.

Conditionally allowed (CA).

The definition or behaviour depends on a condition. If the specified condition is met, then the definition or behaviour is allowed, otherwise it is not allowed.

Conditionally required (CR).

The definition or behaviour depends on a condition. If the specified condition is met, then the definition or behaviour is required. Otherwise the definition or behaviour is allowed as default unless specifically defined as not allowed.

DEPRECATED

Although these features are still described in this document, they should not be implemented except for backward compatibility. The occurrence of a deprecated feature during operation of an implementation compliant with the current document has no effect on the implementation's operation and does not produce any error conditions. Backward compatibility may require that a feature is implemented and functions as specified but it shall never be used by implementations compliant with this document.

Strings that are to be taken literally are enclosed in "double quotes".

Words that are emphasized are printed in *italic*.

4.3 Data types

See ISO/IEC 30118-1:2018.

4.4 Document structure

This document describes specific requirements governing the indication of Device Types on Devices and the requirements that are associated with specific Device Types themselves. The document makes use of functionality defined in the ISO/IEC 30118-1:2018 and ISO/IEC 30118-4:2018.

Annex A specifies the Device Types that shall be used by an OCF Device.

Annex B specifies the profiles that that shall be used by an OCF Device that is part of the Smart Home vertical.

Annex C specifies the profiles that shall be used by an OCF Device that is part of the Healthcare vertical.

Annex D specifies the profiles that shall be used by an OCF Device that is part of the Industrial vertical.

This document further describes which constructs are used for a Device and which Resources are mandated to be implemented for each Device. A typical Device consisting of data elements defined in the referenced documents is depicted in Figure 1.

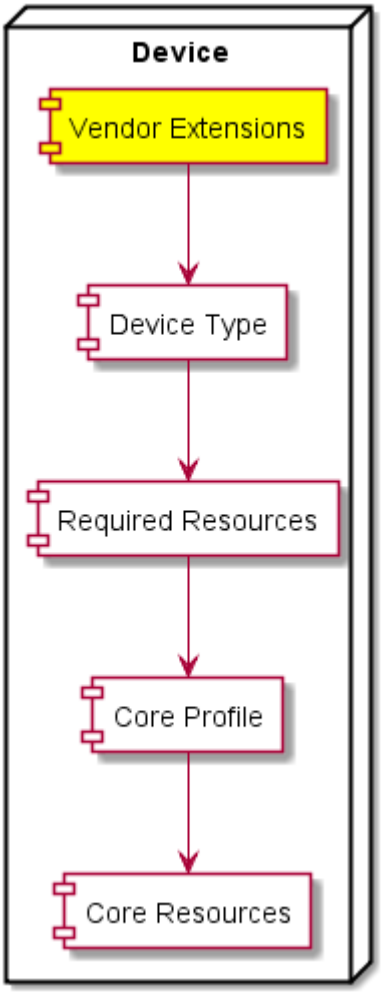


Figure 1 – Device building blocks

5 Operational scenarios

5.1 Document version

All Devices conformant to this document shall add the string "ocf.sh.1.3.0" to the dmv Property in oic.wk.d. This Property is for legacy Device support only and will no longer be revised in alignment with document versions.

6 Core resource model

6.1 Introduction

The Core Resource model is described in ISO/IEC 30118-1:2018.

6.2 Device type

The Device Types of all devices shall have a Resource Type name ("rt") prefixed with "oic.d."

Examples of Device Types are:

– oic.d.fan

– oic.d.thermostat

The full list of defined Device names and types are in Table A.2, Annex B, Annex C, Annex D, and Annex E detail the minimal Resource(s) that a Device shall implement for a specific Device Type where required by a vertical. A Device may expose additional OCF and 3rd party defined Resources other than those indicated in these Annexes.

ISO/IEC 30118-1:2018 defines a Device Resource with a URI of "/oic/d". A Device shall include in the "Resource type" Property of "/oic/d" the Device Type (or Device Types) from Table A.2 of the physical device hosting the Server; the inclusion of the Device Type shall be done using one of the methods provided by clause 11.3.4 of ISO/IEC 30118-1:2018 (i.e. add to the array of values).

ISO/IEC 30118-1:2018 supports the inclusion of a Device Type as part of the Resource Type of a Collection (see also clause 7.4), in such cases the Collection shall include the Resource Types defined as mandatory for the Device Type by this document. For example, if a Collection Resource has an "rt" value of ["oic.d.light"], the Collection includes an instance of "oic.r.switch.binary" which is mandatory for an "oic.d.light" as per clause B.1.

Therefore a Device may be discovered by adding a query for the "rt" of the Device Type itself (e.g. "?rt=oic.d.fan") to the multicast Endpoint discovery method (see 8.1).

6.3 Profile of ISO/IEC 30118-1:2018

This clause describes the profiling of the Core Resources and transport mechanisms and functions that are defined in ISO/IEC 30118-1:2018.

The required ISO/IEC 30118-1:2018 Resources are also required for a profile implementation.

In addition to the required Resources the optional ISO/IEC 30118-1:2018 Resources in Table 1 shall be required.

Table 1 – Required resources for devices

Resource ("rt")	Required in Profile
Intentionally left blank	Intentionally left blank

For each of the Resources listed in Table 1, Table 2 details the Properties within those Resources that shall be required.

Table 2 – Required properties in resource

Resource ("rt")	Property name	Required in Profile
Intentionally left blank	Intentionally left blank	Intentionally left blank

A Device shall support CoAP based endpoint discovery as defined in clause 10.3 of ISO/IEC 30118-1:2018.

The messaging protocol for a Device shall be CoAP (see ISO/IEC 30118-1:2018).

A Device shall support a network layer as defined in clause 9 of ISO/IEC 30118-1:2018 including any necessary defined bridging functions that ensure inter-operability with IPv6.

6.4 Third (3rd) party specified extensions

This clause describes how a 3rd party may add Device Types, Resource Types, 3rd party defined Properties to an existing or 3rd party defined Resource Type, 3rd party defined enumeration values to an existing enumeration and 3rd party defined Parameters to an existing defined Property.

A 3rd party may specify additional (non-OCF) Resources within an OCF Device. A 3rd party may also specify additional Properties within an existing OCF defined Resource Type. Further a 3rd party may extend an OCF defined enumeration with 3rd party defined values.

A 3rd party defined Device Type may expose both 3rd party and OCF defined Resource Types. A 3rd party defined Device Type must expose the mandatory Resources for all OCF Devices defined within this document.

A 3rd party defined Resource Type shall include any mandatory Properties defined in this document and also any vertical specified mandatory Properties. All Properties defined within a 3rd party defined Resource Type that are part of the OCF namespace that are not Common Properties as defined in this document shall follow the 3rd party defined Property rules in Table 3.

Table 3 defines the syntax rules for 3rd party defined Resource Type elements. Within the table the term "Domain_Name" refers to a domain name that is owned by the 3rd party that is defining the new element.

Table 3 – 3rd party defined Resource elements

	Resource Element	Vendor Definition Rules
New 3rd party defined Device Type	"rt" Property Value of "/oic/d"	"x.<Domain_Name>.<Resource identification>"
New 3rd party defined Resource Type	"rt" Property Value	"x.<Domain_Name>.<Resource identification>"
New 3rd party defined Property within the OCF namespace	Property Name	"x.<Domain_Name>.<Property>"
Additional 3rd party defined values in an OCF specified enumeration	Enumeration Property Value	"x.<Domain_Name>.<enum value>"
Additional 3rd party defined Parameter in an OCF specified Property	Parameter key word	x.<Domain_Name>.<parameter keyword>

With respect to the use of the Domain_Name in this scheme the labels are reversed from how they appear in DNS or other resolution mechanisms. The 3rd party defined Device Type and Resource Type otherwise follow the rules defined in ISO/IEC 30118-1:2018. 3rd party defined Resource Types should be registered in the IANA Constrained RESTful Environments (CoRE) Parameters registry.

For example:

```
x.com.samsung.galaxyphone.accelerator
x.com.cisco.ciscorouterport
x.com.hp.printerhead
x.org.allseen.newinterface.newproperty
```

7 Modelling of multiple logical devices

7.1 Introduction

A physical Device may be modelled as a single Platform and Device, a single Platform with multiple Devices, multiple separately discoverable discrete Platforms and Devices, or as a single Platform and Device where the Device is represented as a composition of other Devices.

For example, a door that includes the functionality of a contact sensor, a lock and a camera may be modeled as a single-Platform, a multi-Platform, or a Composite Device. Each of these three options will be detailed in clauses 7.2, 7.3, and 7.4.

7.2 Single platform model

The physical Device exposes one or more logical Devices that are independently discoverable (i.e. they separately respond to multicast discovery request messages as defined in clause 11.3 of ISO/IEC 30118-1:2018). Given the door example there could be a single discovery response with an instance of "/oic/d" that exposes a single Device Type (such as "oic.d.door") or multiple

discovery responses, each response having a single Device Type in the "rt" of "/oic/d" that represents the logical Device. The common denominator being that for all discovered logical Devices the Properties of "/oic/p" have the same values.

7.3 Multi-platform model

Just like the single-Platform model, one or more logical Devices that make up a physical Device respond independently to multicast discovery request messages and expose their own Resources. Like the single-platform model, each logical Device exposes a single Device Type in the "rt" value of "/oic/d". The difference from the single-platform model is that each logical Device does not have the same values for the Properties of "oic/p".

7.4 Composite device model

When modelling a Server as a Composite Device there shall be a single Platform which represents the Composite Device. The Resource Type Property Value of "/oic/d" exposed should contain all of the Device Types of the Devices that compose the Composite Device. For each Device that is part of the Composite Device when using this approach there shall exist a Collection that represents one of the distinct Devices in the composition. Further each Collection shall have a Resource Type that at a minimum includes the Device Type that the Collection represents (e.g. ["oic.d.door"]).

Figure 2 illustrates the response to a discovery request using the baseline Interface on "/oic/res" for a Composite Device modeled as described in this clause. Figure 3 illustrates the response to a unicast RETRIEVE request using the baseline Interface to the Collection that represents the door Device.


```
[
 {
  "rt": ["oic.wk.res"],
  "if": ["oic.if.baseline", "oic.if.ll" ],
  "links":
   [
    {
     "anchor": "ocf://dc70373c-1e8d-4fb3-962e-017eaa863989",
     "href": "/oic/d",
     "rt":   ["oic.wk.d","oic.d.door","oic.d.sensor","oic.d.lock","oic.d.camera"],
     "if":   ["oic.if.r","oic.if.baseline"],
     "p":    {"bm": 3},
     "eps": [{"ep": "coap://[fe80::b1d6]:1111"}]
    },
    {
     "anchor": "ocf://dc70373c-1e8d-4fb3-962e-017eaa863989",
     "href": "/mydevice/mydoor",
     "rt":   ["oic.d.door"],
     "if":   ["oic.if.ll","oic.if.baseline","oic.if.r"],
     "p":    {"bm": 3},
     "eps": [{"ep": "coaps://[fe80::b1d6]:1111"}]
    },
    {
     "anchor": "ocf://dc70373c-1e8d-4fb3-962e-017eaa863989",
     "href": "/mydevice/mysensor",
     "rt":   ["oic.d.sensor"],
     "if":   ["oic.if.ll","oic.if.baseline","oic.if.r"],
     "p":    {"bm": 3},
     "eps": [{"ep": "coaps://[fe80::b1d6]:1111"}]
    },
    {
     "anchor": "ocf://dc70373c-1e8d-4fb3-962e-017eaa863989",
     "href": "/mydevice/mylock",
     "rt":   ["oic.d.lock"],
     "if":   ["oic.if.ll","oic.if.baseline","oic.if.r"],
     "p":    {"bm": 3},
     "eps": [{"ep": "coaps://[fe80::b1d6]:1111"}]
    },
    {
     "anchor": "ocf://dc70373c-1e8d-4fb3-962e-017eaa863989",
     "href": "/mydevice/mycamera",
     "rt":   ["oic.d.camera"],
     "if":   ["oic.if.ll","oic.if.baseline","oic.if.r"],
     "p":    {"bm": 3},
     "eps": [{"ep": "coaps://[fe80::b1d6]:1111"}]
    }
   ]
 }
]
```

403 **Figure 2 – Example composite device model**


```
{
"rt": ["oic.d.door"],
"if": ["oic.if.ll","oic.if.r","oic.if.baseline"],
  "id": "unique_example_id",
  "di":   "dc70373c-1e8d-4fb3-962e-017eaa863989",
  "icv":  "ocf.1.3.0",
  "dmv":  "ocf.res.1.3.0, ocf.sh.1.3.0",
  "piid": "6F0AAC04-2BB0-468D-B57C-16570A26AE48",
  "links": [
   {
     "href": "/mydoor/openlevel",
     "rt":   ["oic.r.openlevel"],
     "if":   ["oic.if.a", "oic.if.baseline"],
      "p": {"bm": 2},
     "eps": [
       {"ep": "coaps://[fe80::b1d6]:1122"}
     ]
   }
  ]
}
```

Figure 3 – RETRIEVE response to example door from composite device model

8 Discovery

8.1 Endpoint discovery

Clients may discover Servers by using the mechanisms defined by ISO/IEC 30118-1:2018 clause 10. A Client may populate an "rt" query parameter with the Device Types that the Client wants to discover, or if no "rt" query parameter is provided then the search is for all available Device Types irrespective.

Devices may be discovered by Device Type or implemented Resource Type. This difference is conveyed by the population of any "rt" query parameter included as part of discovery (see clause 11.3 of ISO/IEC 30118-1:2018).

The values that may be used for discovering a specific Device Type are listed in Table A.2. The values that may be used to discover a specific Resource Type are listed in clause 6 of ISO/IEC 30118-4:2018.

The discovery process provides the base URI of the Device that is acting as a Server to the Client. The structure of the detected Device can then be retrieved by Resource Discovery.

8.2 Resource discovery

Clause intentionally left blank

9 Security

A Device shall implement the mandated Security Virtual Resources specified in the ISO/IEC 30118-2:2018. Additionally, all exposed ISO/IEC 30118-4:2018 defined Resources shall be accessible via at least one secure Endpoint (i.e. use of a "coaps" or "coaps+tcp" scheme locator within the "eps" Parameter exposed by /oic/res; see ISO/IEC 30118-1:2018 clause 10.2.4). A Device shall not expose ISO/IEC 30118-4:2018 defined Resources using unsecured Endpoints (i.e. "coap" or "coap+tcp" scheme locator in the "eps" Parameter).

With the exception of those Resources related to Discovery that are explicitly identified by the ISO/IEC 30118-1:2018 as not requiring secured access (see ISO/IEC 30118-1:2018 clause 11.3.4), all other Resources defined in ISO/IEC 30118-1:2018 implemented in the Smart Home Device shall be accessible via at least one secure Endpoint (i.e. use of a "coaps" or "coaps+tcp" scheme locator within the "eps" Parameter exposed by /oic/res). Similarly, any Resources defined in ISO/IEC 30118-1:2018 that do not require unsecured access that are not listed in /oic/res shall also be accessible via "coaps" or "coaps+tcp".

Annex A
(normative)

Device categories and device types

A.1 Device categories

Devices are grouped into Device Categories based on the Universal Device Classification (UDC) (see A Basic Classification System for Energy-Using Products--Universal Device Classification), all Device Categories are listed in Table A.1.

Table A.1 – List of device categories

Device Category Name	Description
Space Conditioning	Heating and cooling systems
Lighting	
Appliance	Also known as "white goods"; covers major appliances only.
Electronics	Personal electronics
Miscellaneous	Small appliances, other
Infrastructure	Physical building and infrastructure
Transportation	Vehicles, fixed devices that provide movement (e.g. Escalators)
Fitness	Includes lifestyle
Medical	
Personal Health	
Other	

A.2 Device types

The complete Universal Device Classification with Device Types per Device Category is provided in Table A.2. Note that not all Devices within the UDC classification have equivalent OCF defined Device Types. All defined Device Types are of the form "oic.d.<thing>" where <thing> is a single alphanumeric string (lower case [a..z],[0..9] only) no more than 24 characters in length giving a total maximum length of the Device Type of 32 characters. Where an abbreviated form of the Device Type is required (applicable only to population of a Wi-Fi beacon IE) then the "oic.d." portion of the Device Type may be omitted.

Table A.2 does not specify the mandatory resources that are implemented by an instance of such a Device Type; the set of applicable mandatory Resources is dependent on the application domain. In this document the following domains are specified: Smart Home, Healthcare. The "Reference" column in the table references vertical specific annexes where the Device Type is further refined (e.g. mandatory Resources).

Table A.2 – Per category list of device types

Device Category Name	UDC Device Name	Device Name	Device Type (Normative)	Reference
Space Conditioning	Unitary System	Air Conditioner	oic.d.airconditioner	B.1
	Boiler	Water Heater	oic.d.waterheater	B.1
	Furnace	Furnace	oic.d.furnace	

	Pump	Pump	oic.d.pump	
	Fan	Fan	oic.d.fan	B.1
	Condensing Unit	Condensing Unit	oic.d.condensingunit	
	Condenser	Condenser	oic.d.condenser	
	Humidifier	Humidifier	oic.d.humidifier	B.1
	Dehumidifier	Dehumidifier	oic.d.dehumidifier	B.1
	HVAC – Control	Thermostat	oic.d.thermostat	B.1
	HVAC - Other	HVAC	oic.d.hvac	
		Air Purifier	oic.d.airpurifier	B.1
		Air Quality Monitor	oic.d.airqualitymonitor	B.1
Lighting	Lighting - Controls	Lighting Controls	oic.d.lightingcontrol	
	Lighting - Other	Light	oic.d.light	B.1
Appliance	Clothes Dryer	Dryer (Laundry)	oic.d.dryer	B.1
	Clothes Washer	Washer (Laundry)	oic.d.washer	B.1
		Clothes Washer Dryer	oic.d.washerdryer	B.1
	Dishwasher	Dishwasher	oic.d.dishwasher	B.1
	Freezer	Freezer	oic.d.freezer	B.1
	Ice Machine	Ice Machine	oic.d.icemachine	
	Oven	Oven	oic.d.oven	B.1
	Range	Range	oic.d.range	
	Refrigerator	Refrigerator	oic.d.refrigerator	B.1
	Water Heater	Water Heater	oic.d.waterheater	B.1
	Water Purifier	Water Purifier	oic.d.waterpurifier	B.1
	Appliance - Other	Cooker Hood	oic.d.cookerhood	B.1
		Cooktop	oic.d.cooktop	B.1
		Steam Closet	oic.d.steamcloset	B.1
Electronics	Audio System	Audio System	oic.d.audiosystem	
	A/V Player	AV Player	oic.d.avplayer	
	Camera	Camera	oic.d.camera	B.1
	Computer – Desktop	Desktop PC	oic.d.desktoppc	
	Computer - Notebook	Notebook PC	oic.d.notebookpc	
	Computer - Server	Server	oic.d.server	

	Computer – Other	Computer	oic.d.pc	
	Data Storage	Data Storage Unit	oic.d.datastorageunit	
	Display	Display	oic.d.display	
	Electronics - Portable	Portable Electronics	oic.d.portableelectronics	
	Game Console	Game Console	oic.d.gameconsole	
	Imaging Equipment	3D Printer	oic.d.3dprinter	B.1
		Printer	oic.d.printer	B.1
		Printer Multi-Function	oic.d.multifunctionprinter	B.1
		Scanner	oic.d.scanner	B.1
	Musical Instrument	Musical Instrument	oic.d.musicalinstrument	
	Networking Equipment	Networking Equipment	oic.d.networking	
	Phone Handset	Handset	oic.d.handset	
	Receiver	Receiver	oic.d.receiver	B.1
	Set Top Box	Set Top Box	oic.d.stb	B.1
	Telephony	Telephony	oic.d.telephonydevice	
	Television	Television	oic.d.tv	B.1
	A/V - Other	Active Speaker	oic.d.speaker	
	Electronics – Other	Electronics	oic.d.smallelectrical	
Miscellaneous	Air Compressors	Air Compressor	oic.d.aircompressor	
	Bathroom Device	Bathroom General	oic.d.bathroomdevice	
	Battery Charger	Battery Charger	oic.d.batterycharger	
	Business Equipment	Business Equipment	oic.d.businessequipment	
	Cleaning Equipment	Robot Cleaner	oic.d.robotcleaner	B.1
	Cooking – Portable	Portable Stove	oic.d.portablestove	
	Exercise Machine	Exercise Machine	oic.d.exercisemachine	
	HVAC – Portable	Portable HVAC	oic.d.hvacportable	
	Industrial	Optical augmented RFID Reader	oic.d.orfid	D.1
	Kitchen	Coffee Machine	oic.d.coffeemachine	B.1

		Food Probe	oic.d.foodprobe	B.1
		Grinder	oic.d.grinder	B.1
		Kettle	oic.d.kettle	B.1
	Lighting – Decorative	Decorative Lighting	oic.d.lightdecorative	
	Lighting – Emergency	Emergency Lighting	oic.d.lightemergency	
	Microwave Oven	Microwave Oven	oic.d.microwave	B.1
	Vending Machine	Vending Machine	oic.d.vendingmachine	
	Water Dispenser	Water Dispenser	oic.d.waterdispenser	
	Miscellaneous - Other	Battery	oic.d.battery	B.1, E.3
Infrastructure	Breakers	Water Valve	oic.d.watervalve	B.1
	Doors/Windows	Blind	oic.d.blind	B.1
		Door	oic.d.door	B.1
		Garage Door	oic.d.garagedoor	B.1
		Smart Lock	oic.d.smartlock	B.1
		Window	oic.d.window	B.1
	Fireplace	Fireplace	oic.d.fireplace	
	Pump	Pump	oic.d.pump	
	Power - Portable	Energy Generator	oic.d.energygenerator	B.1
		Smart Plug	oic.d.smartplug	B.1
	Power - Fixed	Circuit Breaker	oic.d.circuitbreaker	E.3
		Inverter	oic.d.inverter	E.3
		PV Array System	oic.d.pvarraysystem	E.3
		Switch	oic.d.switch	B.1
	Security	Security Panel	oic.d.securitypanel	B.1
	Sensors	Generic Sensor	oic.d.sensor	B.1
	Meter	Electric Meter	oic.d.electricmeter	B.1
		Energy Monitor	oic.d.energymonitor	B.1
Transportation	Transport - Other	Electric Vehicle Charger	oic.d.electricvehiclecharger	B.1
Fitness		Fitness Device	oic.d.fitnessdevice	
		Activity Tracker	oic.d.activitytracker	C.4
		Blood Pressure Monitor	oic.d.bloodpressuremonitor	C.4

		Body Thermometer	oic.d.bodythermometer	C.4
		Cycling Power Meter	oic.d.cyclingpowermeter	C.4
		Cycling Speed Sensor	oic.d.cyclingspeedsensor	C.4
		Cycling Cadence Sensor	oic.d.cyclingcadencesensor	C.4
		Heart Rate Monitor	oic.d.heartratemonitor	C.4
Medical		Medical Device	oic.d.medicaldevice	
		Blood Pressure Monitor	oic.d.bloodpressuremonitor	C.4
		Glucose Meter	oic.d.glucosemeter	C.4
		Body Scale	oic.d.bodyscale	C.4
		Body Thermometer	oic.d.bodythermometer	C.4
		Heart Rate Monitor	oic.d.heartratemonitor	C.4
		Pulse Oximeter	oic.d.pulseoximeter	C.4
		Sleep Monitor	oic.d.sleepmonitor	C.4
		CGM	oic.d.cgm	C.4
Personal Health		Personal Health Device	oic.d.personalhealthdevice	
		Blood Pressure Monitor	oic.d.bloodpressuremonitor	C.4
		Glucose Meter	oic.d.glucosemeter	C.4
		Body Scale	oic.d.bodyscale	C.4
		Body Thermometer	oic.d.bodythermometer	C.4
		Heart Rate Monitor	oic.d.heartratemonitor	C.4
		Pulse Oximeter	oic.d.pulseoximeter	C.4
		Sleep Monitor	oic.d.sleepmonitor	C.4
		Activity Tracker	oic.d.activitytracker	C.4
		CGM	oic.d.cgm	C.4
Other	Other		oic.d.unknown	
		Access Management Service	oic.d.ams	
		Credential Management Service	oic.d.cms	
		Device Ownership Transfer Service	oic.d.dots	

Annex B
(normative)

Smart home device types

B.1 Smart home required resources per device type

Device Types may mandate that specific Resources be implemented. The required Resource per Device Type where mandated is listed in Table B.1. Additionally, specific Resources that use enumeration values to indicate supported states or modes may mandate usage of standardized enumeration values. The mandated allowed values are indicated for each applicable Resource Type, the Property of interest on that Resource Type and to which Device Type it applies.

Per Table B.1, some Device types support two instances of the same Resource Type. When this is the case, the Resources shall support different CRUDN actions, e.g. one Resource acts as a Sensor (CRUDN action write not supported) and the other Resource acts as an Actuator (CRUDN actions read and write supported at a minimum) unless otherwise specified.

Table B.1 – Alphabetical list of device types ("rt"), including required resources for smart home

Device Name (informative)	Device Type ("rt") (Normative)	Required Resource name	Required Resource Type
3D Printer	oic.d.3dprinter	Binary Switch	oic.r.switch.binary
		3D Printer	oic.r.printer.3d
		Operational State	oic.r.operational.state
		Temperature	oic.r.temperature
		Print Queue	oic.r.printer.queue
Active Speaker	oic.d.speaker	Binary Switch	oic.r.switch.binary
		Audio Controls	oic.r.audio
Air Conditioner	oic.d.airconditioner	Binary Switch	oic.r.switch.binary
		Temperature	oic.r.temperature
Air Purifier	oic.d.airpurifier	Binary Switch	oic.r.switch.binary
Air Quality Monitor	oic.d.airqualitymonitor	Air Quality Collection	oic.r.airqualitycollection
Battery	oic.d.battery	Battery	oic.r.battery
Blind	oic.d.blind	Open Level	oic.r.openlevel
Camera	oic.d.camera	Media	oic.r.media
Clothes Washer Dryer	oic.d.washerdryer	Binary Switch	oic.r.switch.binary
		Operational State	oic.r.operational.state
Coffee Machine	oic.d.coffeemachine	Binary Switch	oic.r.switch.binary
		Operational State	oic.r.operational.state
Cooker Hood	oic.d.cookerhood	Airflow Control	oic.r.airflowcontrol
		Binary Switch	oic.r.switch.binary
		Mode	oic.r.mode
Cooktop	oic.d.cooktop	Heating Zone Collection	oic.r.heatingzonecollection

Dehumidifier	oic.d.dehumidifier	Binary Switch	oic.r.switch.binary
		Humidity	oic.r.humidity
Dishwasher	oic.d.dishwasher	Binary Switch	oic.r.switch.binary
		Mode	oic.r.mode
Door	oic.d.door	Open Level	oic.r.openlevel
Dryer (Laundry)	oic.d.dryer	Binary switch	oic.r.switch.binary
		Operational State	oic.r.operational.state
Electric Vehicle Charger	oic.d.electricvehiclecharger	Binary Switch	oic.r.switch.binary
		Operational State	oic.r.operational.state
		Battery	oic.r.battery
		Vehicle Connector	oic.r.vehicleconnector
Electric Meter	oic.d.electricmeter	Energy Consumption	oic.r.energy.consumption
Energy Generator	oic.d.energygenerator	Energy Generation	oic.r.energy.generation
Energy Monitor	oic.d.energymonitor	One of: Energy Consumption, Gas Consumption	oic.r.energy.consumption or oic.r.gas.consumption
Fan	oic.d.fan	Binary Switch	oic.r.switch.binary
Food Probe	oic.d.foodprobe	Temperature (Sensor)	oic.r.temperature
Freezer	oic.d.freezer	Temperature(2)(1 Sensor and 1 Actuator)	oic.r.temperature
Garage Door	oic.d.garagedoor	Door	oic.r.door
Generic Sensor	oic.d.sensor	Any Resource Type that supports and exposes in "/oic/res" the oic.if.s interface.	oic.r. <x> Where this equates to any Resource Type that supports the oic.if.s Interface.
Grinder	oic.d.grinder	Operational State	oic.r.operational.state
		Grinder Settings	oic.r.grinder
Humidifier	oic.d.humidifier	Binary Switch	oic.r.switch.binary
Kettle	oic.d.kettle	Binary Switch	oic.r.switch.binary
Light	oic.d.light	Binary Switch	oic.r.switch.binary
Oven	oic.d.oven	Binary Switch	oic.r.switch.binary
		Temperature (2) (1 Sensor and 1 Actuator)	oic.r.temperature
Printer	oic.d.printer	Binary Switch	oic.r.switch.binary
		Operational State	oic.r.operational.state
Printer Multi-Function	oic.d.multifunctionprinter	Binary switch	oic.r.switch.binary
		Operational State (2)[a]	oic.r.operational.state
		Automatic Document Feeder	oic.r.automaticdocumentfeeder[b]
Receiver	oic.d.receiver	Binary Switch	oic.r.switch.binary
		Audio Controls	oic.r.audio

		Media Source List (2)	oic.r.media.input, oic.r.media.output
Refrigerator	oic.d.refrigerator	Temperature (2) (1 Sensor and 1 Actuator)	oic.r.temperature
Robot Cleaner	oic.d.robotcleaner	Binary Switch	oic.r.switch.binary
		Mode	oic.r.mode
Scanner	oic.d.scanner	Binary Switch	oic.r.switch.binary
		Operational State	oic.r.operational.state
		Automatic Document Feeder	oic.r.automaticdocumentfeeder
Security Panel	oic.d.securitypanel	Mode	oic.r.mode
Set Top Box	oic.d.stb	Binary Switch	oic.r.switch.binary
Smart Lock	oic.d.smartlock	Lock Status	oic.r.lock.status
Smart Plug	oic.d.smartplug	Binary Switch	oic.r.switch.binary
Steam Closet	oic.d.steamcloset	Operational State	oic.r. operational.state
		Time Period	oic.r.time.period
Switch	oic.d.switch	Binary Switch	oic.r.switch.binary
Television	oic.d.tv	Binary Switch	oic.r.switch.binary
		Audio Controls	oic.r.audio
		Media Source List	oic.r.media.input
Thermostat	oic.d.thermostat	Temperature (2) (1 Sensor and 1 Actuator)	oic.r.temperature
Washer (Laundry)	oic.d.washer	Binary Switch	oic.r.switch.binary
		Operational State	oic.r.operational.state
Water Heater	oic.d.waterheater	Binary Switch	oic.r.switch.binary
		Temperature(2) (1 Sensor and 1 Actuator)	oic.r.temperature
Water Purifier	oic.d.waterpurifier	Operational State	oic.r.operational.state
		Water Info	oic.r.waterinfo
Water Valve	oic.d.watervalve	Open Level	oic.r.openlevel
Window	oic.d.window	Open Level	oic.r.openlevel

[a] A Multi-Function Printer shall expose two instances of an Operational State resource; each in discrete Collections, one for the Printer specific operational state information and one for the Scanner specific operational state information. The friendly name for the Collections should indicate the device modality (printer or scanner).

[b] A Multi-Function Printer shall only expose an Automatic Document Feeder resource if the device has the Automatic Document Feeder capability.

B.2 Standardized enumeration values

B.2.1 Introduction

Resource Types may have a list of supported enumeration values. The supported enumeration values may differ when applied in different devices. In this clause the affected Resource Types are described by:

– Generic list of supported values

- Mandated list of supported values when applied to a specific Device

B.2.2 Alphabetical list of standardized enumeration types

This clause lists the standardized enumeration types that are used in the "oic.r.mode", "oic.r.operational.state", and "oic.r.consumable" Resources.

- aborted
  - An internal device, communication or security error
- active
  - Unit is active
- airClean
  - unit is in air clean mode or state
- airDry
  - unit is air drying
- ambient
  - unit is in ambient mode or state
- armedAway
  - unit is armed for away
- armedInstant
  - unit is armed instantly
- armedMaximum
  - unit is armed at maximum level
- armedNightStay
  - unit is armed in night stay
- armedStay
  - unit is armed in stay mode
- aroma
  - unit is armed in aroma mode
- artificalintelligence
  - unit is in artificial intelligence mode
- auto
  - unit is in auto mode or state
- baking
  - unit is in baking mode or state
- babyCare
  - unit is in baby care mode or state
- boiling
  - unit is in boiling state or mode
- brewing
  - unit is in brewing state or mode
- cancelled
  - the job was cancelled either by the remote client or by the user

- circulating
  - unit is in circulating model or state
- cleaning
  - unit is in cleaning mode or state
- clothes
  - unit is in clothes mode
- completed
  - job finished successfully
- cool
  - unit is in cooling mode or state
- delicate
  - unit is in delicate mode or state
- diagnosis
  - unit is in diagnosis mode or state
  - when an error occurs, a device is in diagnosis mode (state) for identifying causes and finding solutions.
- disabled
  - unit’s current operational mode is disabled
- down
  - unit is unavailable
- dual
  - unit is in dual mode
- dry
  - unit is dry mode
- edge
  - unit is edge mode or state
- enabled
  - unit’s current operational mode is enabled
- extended
  - unit is in extended mode or state
- fan
  - unit is in fan mode or state
- fast
  - unit is in fast mode or state
- filterMaterial
  - filter material that is used by a device
- focused
  - unit is in focused mode or state
- grinding
  - unit is in grinding state or mode

- heating
  - unit is in heating mode or state
- heavy
  - unit is in heavy mode or state
- homing
  - unit is in homing state
  - produces a special signal so that it can be found using electronic equipment
- hot
  - unit is in hot mode or state
- humidify
  - unit is in humidify mode or state
- ice
  - unit is in ice mode or state
- idle
  - new jobs can start processing without waiting
- initializing
  - unit is in initializing state
  - a Device resets its values set by a Client to initial values set by manufacturer
- ink
  - generic ink cartridge for a device
- inkBlack
  - black ink cartridge for a device
- inkCyan
  - cyan ink cartridge for a device
- inkMagenta
  - magenta ink cartridge for a device
- inkTricolour
  - tricolour ink cartridge for a device
- inkYellow
  - yellow ink cartridge for a device
- keepwarm
  - unit is in keep warm state or mode
- mapping
  - unit is in mapping mode or state
- macro
  - unit is in macro mode or state
  - client manually input a rule or pattern of operation
- mineral
  - unit is in mineral mode
- monitoring

- unit is in monitoring mode or state
    - one of security functions detecting strange movements in an empty place for a camera-mounted device
- monitoringInitializing
    - unit is in initializing state in monitoring mode
    - a device resets its values of monitoring mode to initial values set by manufacturer
- monitoringMoving
    - unit is in moving state in monitoring mode
    - following a specific target that client select while the device is in monitoring mode
- monitoringPreparation
    - unit is in preparation state in monitoring mode
    - a device is getting ready for its monitoring operation.
- moving
    - unit is in moving state
    - the action of going to a different place
- none
    - unit is in an undefined mode or state
- normal
    - unit is in a normal operational state
- notsupported
    - ability to set a specific operational mode by a client is not supported
- pause
    - unit is paused (by user)
- pending
    - job initiated, engine is preparing
- pendingHeld
    - job is not a candidate for processing for any number of reasons, will return to pending state if reasons are solved.
- permapress
    - unit is in permanent press mode or state
- preHeat
    - unit is in pre-heat mode or state
- preparation
    - unit is in preparation mode or state
    - a device is getting ready for its operation
- preSteam
    - unit is in pre-steam mode or state
- preWash
    - unit is pre wash mode
- processing

642 – processing the job
643 – pure
644 – unit is in pure mode or state
645 – quick
646 – unit is in quick mode or state
647 – quiet
648 – unit is in quiet mode
649 – refresh
650 – unit is in refresh mode or state
651 – reserve
652 – unit is in reserve mode or state
653 – reserving
654 – unit is in reserving state
655 – restart
656 – unit is in re-start mode or state
657 – rinse
658 – unit is in rinse mode or state
659 – sectored
660 – unit is in sectored mode or state
661 – select
662 – unit is in select mode or state
663 – silent
664 – unit is in silent mode or state
665 – sleep
666 – unit is in sleep mode or state
667 – smart
668 – unit is in smart mode or state
669 – soda
670 – unit is in soda mode
671 – spot
672 – unit is in spot mode or state
673 – start
674 – unit is in start mode or state
675 – steam
676 – unit is in steam mode or state
677 – sterilize
678 – unit is in sterilize mode or state
679 – stopped
680 – error condition occurred
681 – spin

682 – unit is in spin mode or state
683 – testing
684 – calibrating, preparing the unit
685 – toner
686 – generic toner cartridge for a device
687 – tonerBlack
688 – black toner cartridge for a device
689 – tonerCyan
690 – cyan toner cartridge for a device
691 – tonerMagenta
692 – magenta toner cartridge for a device
693 – tonerYellow
694 – yellow toner cartridge for a device
695 – turbo
696 – unit is in turbo mode or state
697 – update
698 – unit is in update mode or state
699 – warm
700 – unit is in warm mode or state
701 – wash
702 – unit is in wash mode or state
703 – wet
704 – unit is in wet mode or state
705 – wind
706 – unit is in wind mode
707 – wrinklePrevent
708 – unit is in winkle prevent mode
709 – zigzag
710 – unit is in zigzag mode or state

711 ### B.2.3 Standardized list of supported values for mode resource type (oic.r.mode)

712 Table B.2 lists the enumeration values that apply to both the supportedModes and modes
713 Properties within the Mode Resource Type.

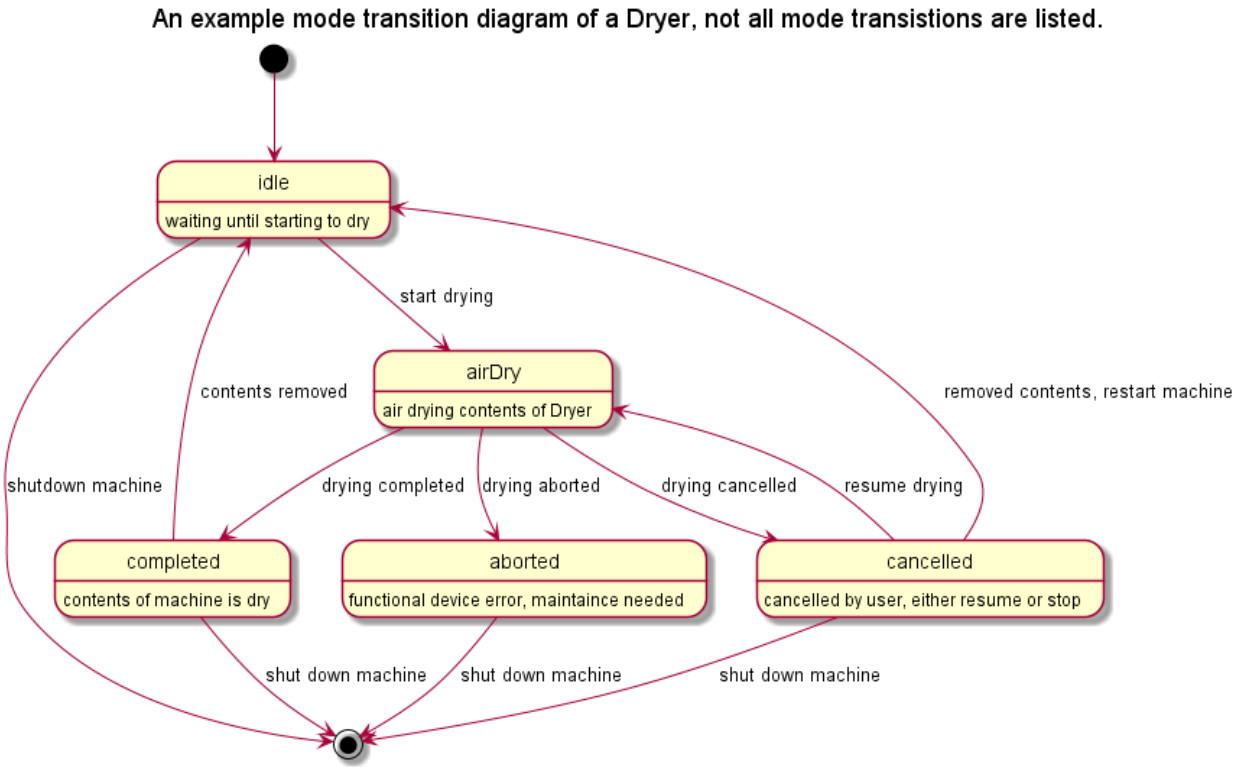
714 **Table B.2 – List of required oic.r.mode supported values per Device Type ("rt")**

Device Name (informative)	Device Type (rt) (Normative)	Required enumeration value
Security Panel	oic.d.securityPanel	active
		armedAway
		armedInstant
		armedMaximum
		armedNightStay

		armedStay

The modes can be viewed upon as mode changes of the device. However, this document does not impose any relationship between the different modes of a Device. Hence all mode changes are expected to occur from a Client point of view.

Figure B.1 provides an illustrative example of a possible set of modes and the transitions between them for a Dryer Device Type (oic.d.dryer).



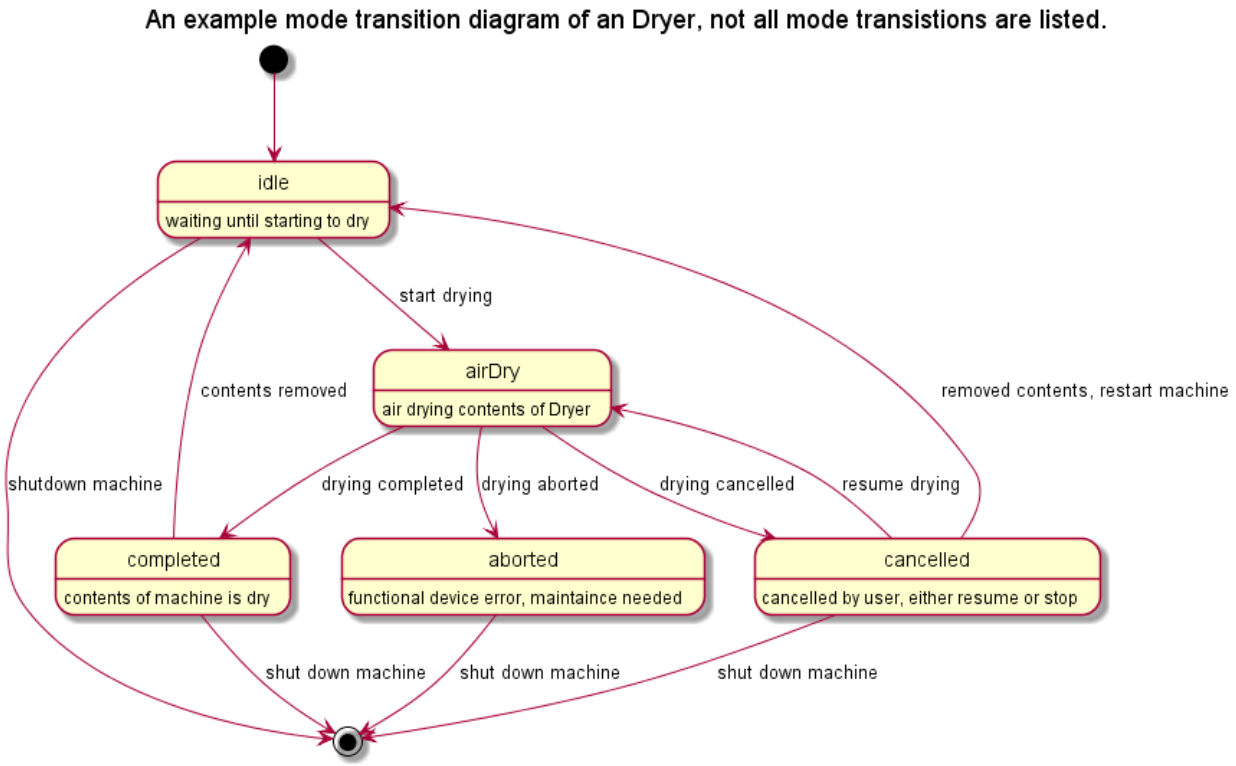


Figure B.1 – Example of mode transitions of a dryer

B.2.4 Standardized list of supported values for operational state resource type (oic.r.operational.state)

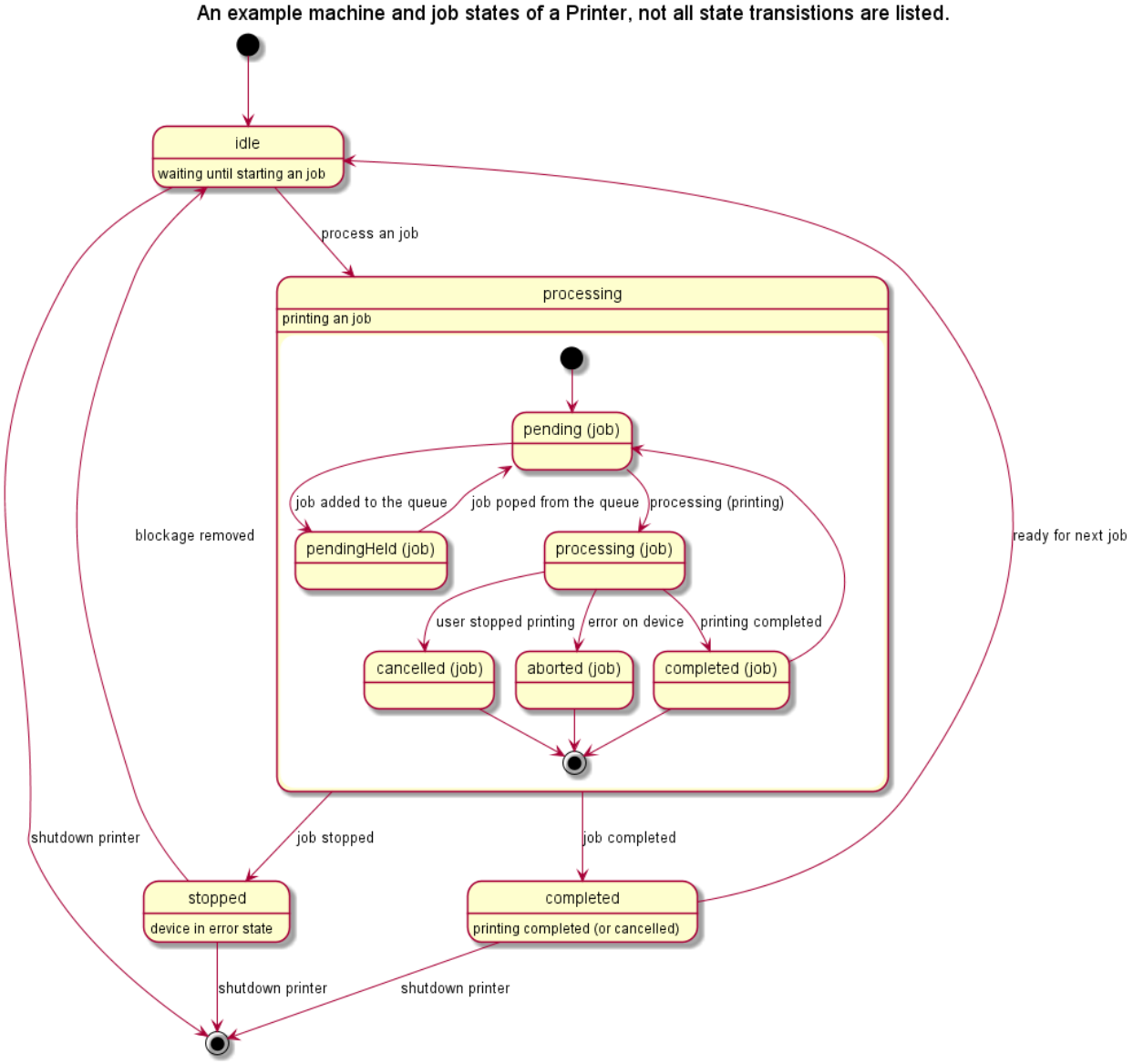
Table B.3 lists the enumeration values that apply to the "jobStates" and "machineStates" Properties within the operational state Resource Type.

Table B.3 – List of required oic.r.operational.state supported values per Device Type ("rt")

Device Name (informative)	Device Type (rt) (Normative)	Required enumeration value machineStates	Required enumeration value jobStates
Printer	oic.d.printer	idle	pending
		processing	pendingHeld
		stopped	processing
			cancelled
			aborted
			completed
Printer Multi-Function	oic.d.multifunctionPrinter	See printer	See printer
		See scanner	See scanner
scanner	oic.d.scanner	idle	cancelled
		processing	aborted
		testing	completed
		stopped	pending
		down	processing

The operational state can be viewed as state changes of the device that includes separate handling of jobs within the overall machine state. However, this document does not impose any relationship between the different machine or job states of a device. Hence all "machinestate" and or "jobStates" changes are expected to occur from a Client point of view.

Figure B.2 provides an illustrative example of a possible set of job states and the transitions between them for a Printer Device Type ("oic.d.printer").



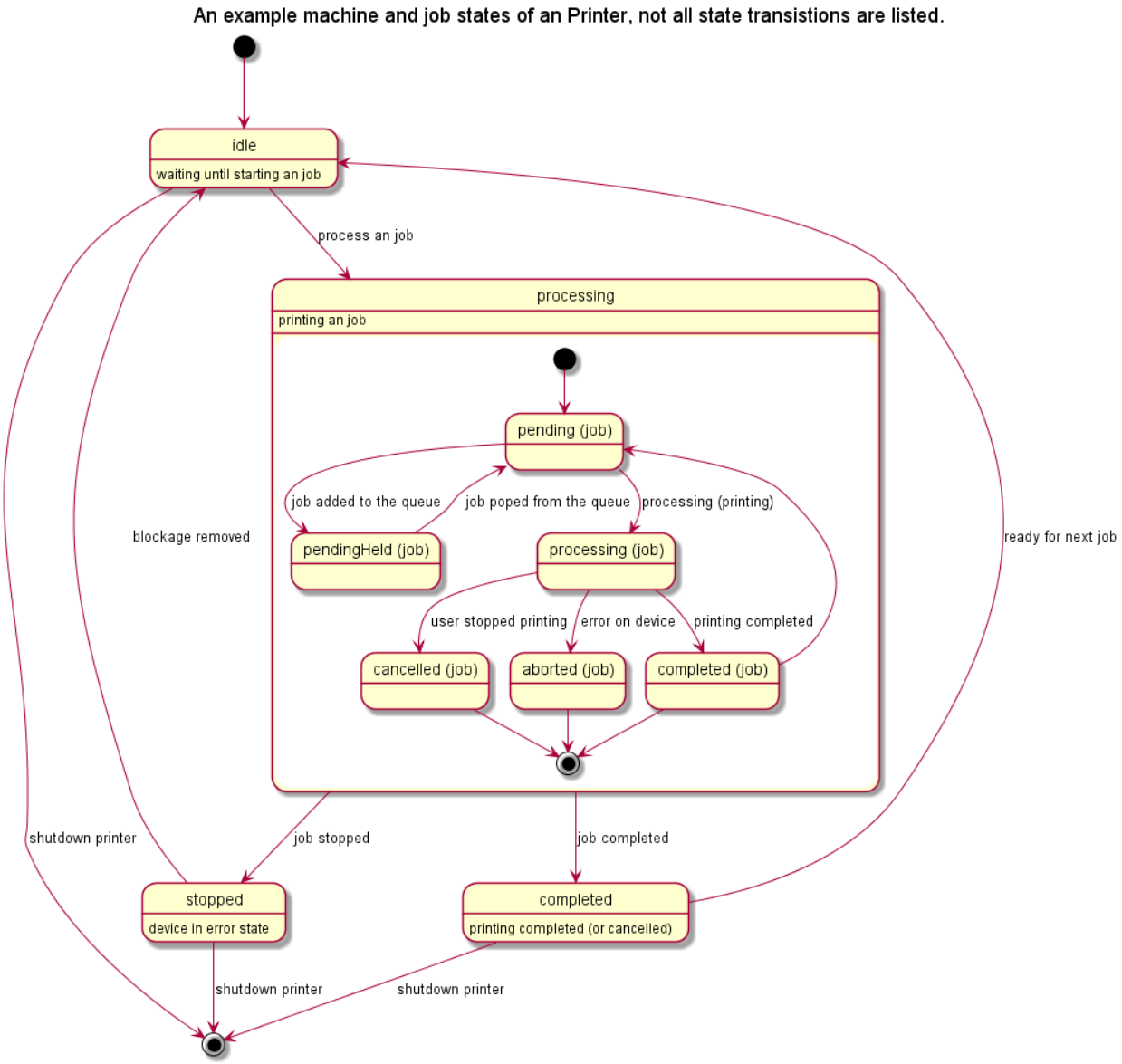


Figure B.2 – Example of job state transitions of a printer

B.2.5 Standardized list of supported values for consumable and consumable collection resource types (oic.r.consumable, oic.r.consumablecollection)

Table B.4 lists the enumeration values that may be populated in both the supportedconsumables (in oic.r.consumablecollection) and typeofconsumable (in oic.r.consumable) Properties within the Consumable and Consumable Collection Resource Types. The typeofconsumable Property shall only be populated with a value exposed within the supportedconsumables Property in a specific instance of the Consumable Collection Resource Type.

This constitutes the known set of possible values for these Properties in the Consumable and Consumable Collection Resources. A vendor may extend this set by providing vendor defined enumerations following the convention defined in ISO/IEC 30118-4:2018.

748 **Table B.4 – List of defined enumeration values for oic.r.consumable,**
749 **oic.r.consumablecollection**

Friendly Name (informative)	Enumeration Value (Normative)	Description (Informative)
Toner Cartridge	toner	Generic toner cartridge.
Black Toner Cartridge	tonerBlack	Black toner cartridge
Cyan Toner Cartridge	tonerCyan	Cyan toner cartridge
Magenta Toner Cartridge	tonerMagenta	Magenta toner cartridge
Yellow Toner Cartridge	tonerYellow	Yellow toner cartridge
Filter Material	filterMaterial	Any replaceable or reusable filter material; such as water filters, air filters, dust filters etc.
Ink Cartridge	ink	Generic ink cartridge
Black Ink Cartridge	inkBlack	Black ink cartridge
Cyan Ink Cartridge	inkCyan	Cyan ink cartridge
Magenta Ink Cartridge	inkMagenta	Magenta ink cartridge
Yellow Ink Cartridge	inkYellow	Yellow ink cartridge
Tricolour Ink Cartridge	inkTricolour	Tri-colour ink cartridge; typically Cyan plus Magenta plus Yellow.

750

751 ## B.3 Camera media format (oic.r.media)

752 The supported camera media formats can be discovered by looking at the SDP (see IETF RFC
753 4566) list of the media Resource Type. The recommended list of supported media formats are listed
754 in Table B.5.

755 **Table B.5 – Recommended media profiles**

Mediatype	codec	Content container format	transport	Additional information
Audio	AAC		RTP	
Video	H.264		RTP	Recommended minimal resolution 1920x1080 (width, height)
Video	H.264/AAC	MPEG-2 TS	RTP	Recommended minimal resolution 1920x1080 (width, height)
Still image	JPEG	JPEG	RTP	Recommended minimal resolution 1920x1080 (width, height)

756

757 ## B.4 Additional requirements per device type

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Annex C
(normative)

Healthcare device types

C.1 Scope

This Annex defines Device Types for use in the healthcare and fitness vertical, and describes general use cases to which OCF Healthcare Devices apply, along with common functional requirements.

Although some common requirements are defined in this document, implementation is responsible for checking appropriate security, safety, environmental, and health practices, and applicable regulatory requirements from national health authorities.

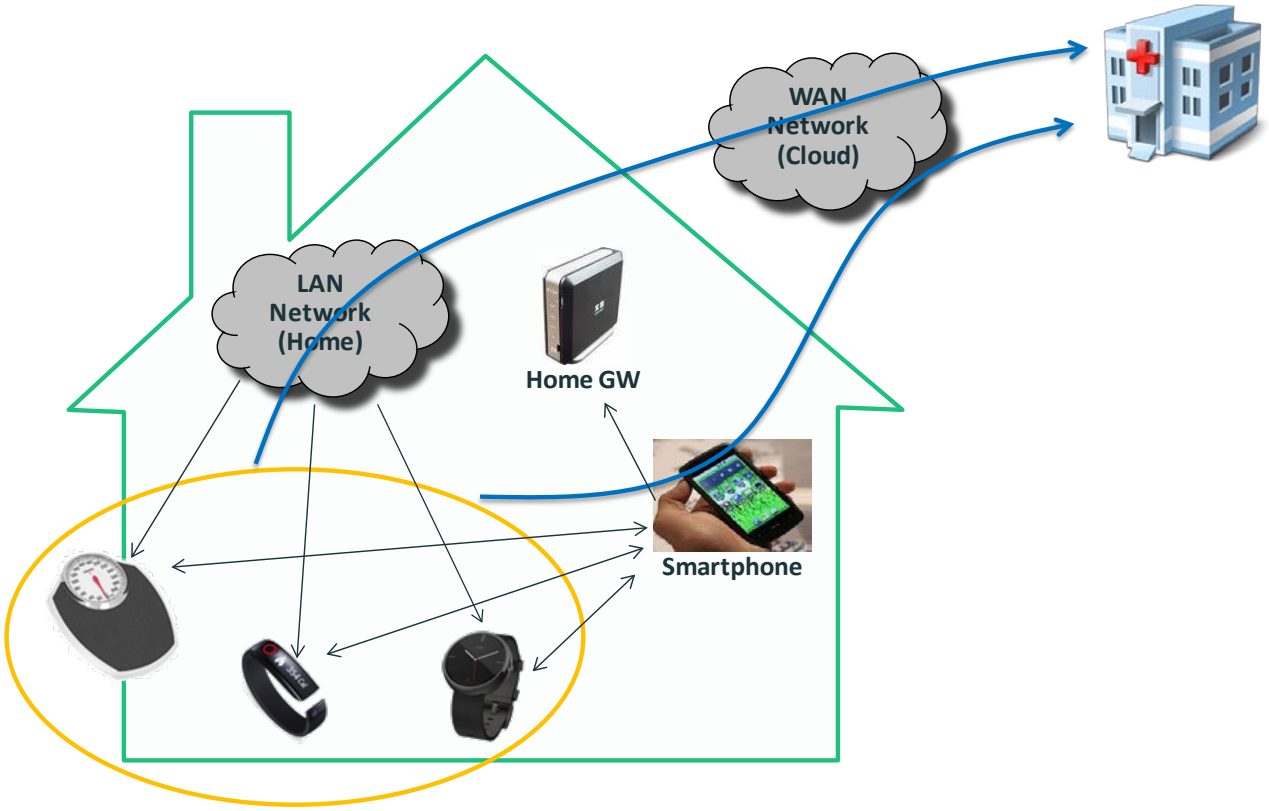
C.2 Introduction to OCF healthcare devices

This Annex references and inherits data models defined in the ISO/IEC 30118-4:2018, to define OCF Healthcare Device Types in clause C.4.

C.3 Operational scenarios

Personal fitness and/or medical data are read by a monitoring Device (OCF Client role) from Healthcare Devices (OCF Server role), and the monitoring Device triggers appropriate actions based on the data collected. Many of the target usages are for personal health or fitness, although clinical use cases can be realized with similar modelling.

As shown in Figure C.1, data from various fitness and healthcare devices can be gathered on a smart phone for monitoring and can be transmitted to the healthcare services through a gateway or through the smartphone. The protocol to be used for transmission is defined in ISO/IEC 30118-1:2018. Collected personal fitness and/or medical data are used for condition monitoring or medical research, receiving advice from a trainer/doctor, or triggering an emergency notification.



783

784 **Figure C.1 – Schematic diagram of healthcare usages**

785 ## C.4 Standardized device types

786 ### C.4.1 Introduction

787 OCF Healthcare Device Types specify Devices in the healthcare and fitness domains of the OCF
788 ecosystem. The Device Type exposed by the "rt" value of /oic/d of all Healthcare Devices shall
789 have a Resource Type value (“rt”) prefixed with "oic.d." The Healthcare Device Types are listed in
790 Table C.1.

791 **Table C.1 – Alphabetical list of healthcare device types**

Clause	Device Name	Device Type ("rt")
C.4.9	Activity Tracker	oic.d.activitytracker
C.4.2	Blood Pressure Monitor	oic.d.bloodpressuremonitor
C.4.4	Body Scale	oic.d.bodyscale
C.4.5	Body Thermometer	oic.d.bodythermometer
C.4.10	CGM(Continuous Glucose Monitor)	oic.d.cgm
C.4.11	Cycling Power Meter	oic.d.cyclingpowermeter
C.4.12	Cycling Speed Sensor	oic.d.cyclingspeedsensor
C.4.13	Cycling Cadence Sensor	oic.d.cyclingcadencesensor
C.4.3	Glucose Meter	oic.d.glucosemeter
C.4.6	Heart Rate Monitor	oic.d.heartratemonitor
C.4.7	Pulse Oximeter	oic.d.pulseoximeter

C.4.8	Sleep Monitor	oic.d.sleepmonitor

The remainder of this Annex defines Resource Types for each Device Type, but for full definitions of Resource Types, see ISO/IEC 30118-4:2018.

Each Device Type defines a minimal set of Resource Types that are implemented by that Device Type as required Resource Types. A Healthcare Device may expose additional OCF-defined optional Resource Types. It should be noted that all Resource Types are commonly available for all Device Types, but if a Device Type aims to implement optional Resource Types related to healthcare, it shall expose such Resource Types using the definitions provided in this annex.

When a Resource Type is listed as Mandatory (M) in this Annex, the Device shall:

– expose that Atomic Measurement Resource Type in /oic/res

– expose that Resource Type as a Link in the Atomic Measurement

The mandatory Resource Types for an Atomic Measurement shall be listed in the "rts-m" Property Value.

When a Resource Type is listed as Optional (O) in this Annex, a Device may expose that Resource Type as a Link in the Atomic Measurement, or may also expose that Resource Type as a discretely discoverable Resource outside of the Atomic Measurement. For example, if a blood pressure monitor (i.e. "oic.d.bloodpressuremonitor") measures pulse rate and chooses to expose that feature over OCF, it exposes the "oic.r.pulserate" Resource Type as a Link in the blood pressure monitor Atomic Measurement ("oic.r.bloodpressuremonitor-am"). The allowed Resource Types for an instance of an Atomic Measurement (which includes both the M and O Resource Types that are implemented) shall be listed in the "rts" Property Value.

Some Resource Types are commonly used for all Healthcare Device Types; these are provided in Table C.2. Users may want to associate timestamps to the measurements when they access their healthcare information (in RFC3339 date and time format, oic.r.time.stamp). A Healthcare Device may be used by different users, so identifying a specific user with an ID may be appropriate ("oic.r.userid"). These Resource Types are exposed as Conditionally Required Resource Types of an Atomic Measurement (as defined per clause 7.8.4 of ISO/IEC 30118-1:2018) of a specific Healthcare Device. The "rt" value of Resource Types that use Atomic Measurements are suffixed by -am (Atomic Measurements). When present in an Atomic Measurement, "oic.r.time.stamp" and "oic.r.userid" indicate the time when a sample of data is measured by a certain user.

Table C.2 – Commonly used resource types of healthcare device types

Resource Type Name	Resource Type Value	Requirement (M, S, O, CA, CR)
Observed Time	oic.r.time.stamp	O
User ID	oic.r.userid	O

It should also be noted that Resource-level and Property-level requirements can be different. All OCF Resource Types are specified using OpenAPI 2.0 and the Properties which are defined in a specific schema can either be mandatory or optional. In other words, even if a Resource Type is mandatory for a Device Type, some of its Properties may not be mandatory.

C.4.2 Blood pressure monitor

C.4.2.1 Introduction

A blood pressure monitor measures blood pressure [i.e., systolic, diastolic, and mean arterial pressure (MAP)]. Blood pressure is most frequently measured using the units of millimetres of mercury (mmHg). Blood pressure is often denoted as 120/80 mmHg, which means systolic blood pressure of 120 and diastolic blood pressure of 80.

Table C.3 describes the Device Type for a blood pressure monitor. Table C.4 describes the Atomic Measurement that is present in all instances of a blood pressure monitor.

Table C.3 – Healthcare device type of blood pressure monitor

Device Type (rt)	Resource Type Name	Resource Type Value	Requirement level
oic.d. bloodpressuremonitor	Blood pressure monitor Atomic Measurement	oic.r.bloodpressuremonitor-am	M

Table C.4 – Atomic measurement of blood pressure monitor

Atomic Measurement Resource Type Value	Resource Type Name	Resource Type Value	Requirement level
oic.r. bloodpressuremonitor-am	Blood pressure	oic.r.blood.pressure	M
	Pulse rate	oic.r.pulserate	O

C.4.2.2 Required resource types

A blood pressure monitor shall expose "oic.r.blood.pressure" to report the blood pressure (systolic and diastolic) and optionally MAP.

C.4.2.3 OCF-defined optional resource types

A blood pressure monitor measures pulse rate using the "oic.r.pulserate" Resource Type.

See Table C.2 for additional commonly used Resource Types that could be used here.

C.4.3 Glucose meter

C.4.3.1 Introduction

A glucose meter measures the concentration of glucose in the blood. Glucose, or blood sugar, is the human body's primary source of energy. The blood glucose level is a key parameter that diabetics measure multiple times per day.

Table C.5 describes the Device Type for a glucose meter. Table C.6 describes the Atomic Measurement that is present in all instances of a glucose meter.

Table C.5 – Healthcare device type of glucose meter

Device Type (rt)	Resource Type Name	Resource Type Value	Requirement level
oic.d.glucosemeter	Glucose meter Atomic Measurement	oic.r.glucosemeter-am	M

Table C.6 – Atomic measurement of glucose meter

Atomic Measurement Resource Type Value	Resource Type Name	Resource Type Value	Requirement level
oic.r.glucosemeter-am	Glucose	oic.r.glucose	M
	Context Carbohydrates	oic.r.glucose.carb	O
	Context Exercise	oic.r.glucose.exercise	O
	Hemoglobin Bound to Glucose A1c Form (HbA1c)	oic.r.glucose.hba1c	O
	Context Health	oic.r.glucose.health	O
	Context Meal	oic.r.glucose.meal	O

	Context Medication	oic.r.glucose.medication	O
	Context Sample Location	oic.r.glucose.samplelocation	O
	Context Tester	oic.r.glucose.tester	O

C.4.3.2 Required resource types

A glucose meter shall expose "oic.r.glucose" to report the blood glucose level in mg/dL or mmol/L.

C.4.3.3 OCF-defined optional resource types

A glucose meter measures context carbohydrates, then it shall expose the context carbohydrates using "oic.r.glucose.carb" Resource Type.

A glucose meter measures context exercise using the "oic.r.glucose.exercise" Resource Type.

A glucose meter measures Hemoglobin Bound to Glucose A1c Form (HbA1c) using the "oic.r.glucose.hba1c" Resource Type.

A glucose meter measures context health using the "oic.r.glucose.health" Resource Type.

A glucose meter measures context meal using the "oic.r.glucose.meal" Resource Type.

A glucose meter measures context medication using the "oic.r.glucose.medication" Resource Type.

A glucose meter measures context sample location using the "oic.r.glucose.samplelocation" Resource Type.

A glucose meter measures context tester using the "oic.r.glucose.tester" Resource Type.

See Table C.2 for additional commonly used Resource Types that could be used here.

C.4.4 Body scale

C.4.4.1 Introduction

A body scale measures the weight. The weight is most frequently measured using the units of kilograms (kg) or pounds (lb).

Table C.7 describes the Device Type for a body scale. Table C.8 describes the Atomic Measurement that is present in all instances of a body scale.

Table C.7 – Healthcare device type of body scale

Device Type (rt)	Resource Type Name	Resource Type Value	Requirement level
oic.d.bodyscale	Body scale Atomic Measurement	oic.r.bodyscale-am	M

Table C.8 – Atomic measurement type of body scale

Atomic Measurement Resource Type Value	Resource Type Name	Resource Type Value	Requirement level
oic.r.bodyscale-am	Weight	oic.r.weight	M
	Body Mass Index (BMI)	oic.r.bmi	O
	Height	oic.r.height	O
	Body Fat	oic.r.body.fat	O

	Body Water	oic.r.body.water	O
	Body Soft Lean Mass	oic.r.body.slm	O
	Body Fat Free Mass	oic.r.body.ffm	O

C.4.4.2 Required resource types

A body scale shall expose "oic.r.weight" to report the body weight of a person.

C.4.4.3 OCF-defined optional resource types

A body scale measures height using the "oic.r.height" Resource Type. Especially, a body scale measures the height if BMI is also reported because the height is used when a body scale measures BMI.

A body scale measures Body Mass Index (BMI) using the "oic.r.bmi" Resource Type.

A body scale measures body fat using the "oic.r.body.fat" Resource Type.

A body scale measures body water using the "oic.r.body.water" Resource Type.

A body scale measures body soft lean mass using the "oic.r.body.slm" Resource Type.

A body scale measures body fat free mass using the "oic.r.body.ffm" Resource Type.

See Table C.2 for additional commonly used Resource Types that could be used here.

C.4.5 Body thermometer

C.4.5.1 Introduction

A body thermometer measures the temperature at some point. In general, the body thermometer is placed at the measurement site for sufficient time for the measuring probe to reach the same temperature as the body site, and when stable, a direct digital reading of the probe temperature is taken.

Table C.9 describes the Device Type for a body thermometer. Table C.10 describes the Atomic Measurement that is present in all instances of a body thermometer.

Table C.9 – Healthcare device type of body thermometer

Device Type (rt)	Resource Type Name	Resource Type Value	Requirement level
oic.d.bodythermometer	Body thermometer Atomic Measurement	oic.r.bodythermometer-am	M

Table C.10 – Atomic measurement type of body thermometer

Atomic Measurement Resource Type Value	Resource Type Name	Resource Type Value	Requirement level
oic.r.bodythermometer-am	Temperature	oic.r.temperature	M
	Body Location for temperature	oic.r.body.location.temperature	O

C.4.5.2 Required resource types

A body thermometer shall expose "oic.r.body.temperature" to report the temperature level and the unit of a measured temperature is reported either in C, F or K.

C.4.5.3 OCF-defined optional resource types

A body thermometer measures temperature site using the "oic.r.body.location.temperature" Resource Type.

See Table C.2 for additional commonly used Resource Types that could be used here.

C.4.6 Heart rate monitor

C.4.6.1 Introduction

A heart rate monitor measures heart rate. Heart rate is most frequently measured using the units of beats per minute (bpm). While normal heart rate varies from person to person depending on the individual, age, body size, heart conditions, posture, medication use, etc., normal resting heart rate range for adults is from 60 to 100 according to the American Heart Association.

Table C.11 describes the Device Type for a heart rate monitor. Table C.12 describes the Atomic Measurement that is present in all instances of a heart rate monitor.

Table C.11 – Healthcare device type of heart rate monitor

Device Type (rt)	Resource Type Name	Resource Type Value	Requirement level
oic.d.heartratemonitor	Heart Rate Monitor Atomic Measurement	oic.r.heartratemonitor -am	M

Table C.12 – Atomic measurement of heart rate monitor

Atomic Measurement Resource Type Value	Resource Type Name	Resource Type Value	Requirement level
oic.r.heartratemonitor -am	Heart Rate	oic.r.heartrate	M

C.4.6.2 Required Resource Types

A heart rate monitor shall expose "oic.r.heartrate" to report the heart rate of a person.

C.4.6.3 OCF-defined Optional Resource Types

See Table C.2 for additional commonly used Resource Types that could be used here.

C.4.7 Pulse oximeter

C.4.7.1 Introduction

A pulse oximeter measures peripheral capillary oxygen saturation (SpO2), an estimate of the amount of oxygen in the blood. Oxygen saturation is most frequently measured using percentage (%). Normal oxygen saturation is 95% or above according to the World Health Organization (WHO).

Table C.13 describes the Device Type for a pulse oximeter. Table C.14 describes the Atomic Measurement that is present in all instances of a pulse oximeter.

Table C.13 – Healthcare device type of pulse oximeter

Device Type (rt)	Resource Type Name	Resource Type Value	Requirement level
oic.d.pulseoximeter	Pulse Oximeter Atomic Measurement	oic.r.pulseoximeter-am	M

928 **Table C.14 – Atomic measurement of pulse oximeter**

Atomic Measurement Resource Type Value	Resource Type Name	Resource Type Value	Requirement level
oic.r.pulseoximeter-am	SpO2	oic.r.spo2	M
	Pulse Rate	oic.r.pulserate	M
	Pulsatile Occurrence	oic.r.pulsatileoccurrence	O
	Pulsatile Characteristic	oic.r.pulsatilecharacteristic	O

929 ### C.4.7.2 Required Resource Types

930 A pulse oximeter shall expose "oic.r.spo2" to report the oxygen saturation of a person.

931 A pulse oximeter shall expose "oic.r.pulserate" to report the pulse rate of a person.

932

933 ### C.4.7.3 OCF-defined Optional Resource Types

934 A pulse oximeter measures pulsatile occurrence using the "oic.r.pulsatileoccurrence" Resource
935 Type.

936 A pulse oximeter measures pulsatile characteristic using the "oic.r.pulsatilecharacteristic"
937 Resource Type.

938 See Table C.2 for additional commonly used Resource Types that could be used here.

939 ## C.4.8 Sleep monitor

940 ### C.4.8.1 Introduction

941 A sleep monitor measures the duration of each one of the sleep stages, and can also compute a
942 “Sleep Score” from these data. The stages of sleep are: NREM stage 1 (Light Sleep stage 1),
943 NREM stage 2 (Light Sleep stage 2), NREM stage 3 (Deep Sleep stage 1), NREM stage 4 (Deep
944 Sleep stage 2), REM.

945 A night of sleep is composed of several sleep cycles, with each sleep cycle progressing from
946 Light Sleep to Deep Sleep, before reversing back from Deep Sleep to Light Sleep, ending with
947 REM.
948 The first cycle takes about 90 minutes. After that, the cycles average between 100 minutes and
949 120 minutes. Typically, an individual will go through 4 to 5 sleep cycles per night. Dreams occur
950 during REM stages.

951 NREM stage 4 is not recognized in every country: in 2007, the USA merged NREM stages 3 and
952 4 into only one stage, NREM stage 3, thus effectively removing NREM stage 4.

953 Light Sleep consists of NREM stages 1 and 2. Deep Sleep consists of NREM stages 3 and 4.

954 Table C.15 describes the Device Type for a sleep monitor. Table C.16 describes the Atomic
955 Measurement that is present in all instances of a sleep monitor.

956 **Table C.15 – Healthcare device type of sleep monitor**

Device Type (rt)	Resource Type Name	Resource Type Value	Requirement level

oic.d.sleepmonitor	Sleep Monitor Atomic Measurement	oic.r.sleepmonitor-am	M

Table C.16 – Atomic measurement of sleep monitor

Atomic Measurement Resource Type Value	Resource Type Name	Resource Type Value	Requirement level
oic.r.sleepmonitor-am	Sleep	oic.r.sleep	M
	Heart Rate	oic.r.heartrate	O

C.4.8.2 Required Resource Types

A sleep monitor shall expose "oic.r.sleep" to report the time spent in the Awake, NREM1, NREM2, NREM3 and REM stages, and optionally the time spent in the NREM4, Light Sleep, Deep Sleep stages, and the sleep score.

C.4.8.3 OCF-defined Optional Resource Types

A sleep monitor measures the heartrate using the "oic.r.heartrate" Resource Type.

See Table C.2 for additional commonly used Resource Types that could be used here.

C.4.9 Activity tracker

C.4.9.1 Introduction

An Activity Tracker measures a user's activities. An Activity Tracker shows a user's current activity type, accumulated step counts per day since the beginning of the day (or last reset), consumed calories per day since the beginning of the day (or last reset), and alarm status.

Table C.17 describes the Device Type for an activity tracker. Table C.18 describes the Atomic Measurement that is present in all instances of an activity tracker.

Table C.17 – Healthcare device type of activity tracker

Device Type (rt)	Resource Type Name	Resource Type Value	Requirement level
oic.d.activitytracker	Activity Tracker Atomic Measurement	oic.r.activitytracker-am	M
	Clock	oic.r.clock	O
	Battery	oic.r.energy.battery	O
	Alarm	oic.r.alarm	O

Table C.18 – Atomic measurement of activity tracker

Atomic Measurement Resource Type Value	Resource Type Name	Resource Type Value	Requirement level

oic.r.activitytracker-am	Activity	oic.r.activity	M
	Heartrate	oic.r.heartrate	O

C.4.9.2 Required Resource Types

An activity tracker shall expose "oic.r.activity" to report the activity of a person, and optionally the number of steps per day or since last reset, plus the consumed calories per day or since last reset.

C.4.9.3 OCF-defined Optional Resource Types

An activity tracker manages the alarm status using the "oic.r.alarm" Resource Type.

An activity tracker measures heart rate using the "oic.r.heartrate" Resource Type.

An activity tracker measures time using the "oic.r.clock" Resource Type.

An activity tracker measures battery status using the "oic.r.energy.battery" Resource Type.

See Table C.2 for additional commonly used Resource Types that could be used here.

C.4.10 CGM (Continuous Glucose Meter)

C.4.10.1 Introduction

A CGM is a device that measures the concentration of glucose in the blood, typically measured from interstitial fluid (ISF). The glucose concentration is available on a continual basis at a periodic interval from a sensor. Glucose, or blood sugar, is the human body's primary source of energy. Frequent measurements provided by a CGM give a patient greater insight as to the fluctuations in blood glucose levels throughout the day, and in turn, can reduce the risk of developing diabetic complications.

Table C.19 describes the Device Type for a CGM. Table C.20 describes the Atomic Measurement that is present in all instances of a CGM.

Table C.19 – Healthcare device type of CGM

Device Type (rt)	Resource Type Name	Resource Type Value	Requirement level
oic.d.cgm	CGM Atomic Measurement	oic.r.cgm-am	M
	CGM Sampling Interval	oic.r.cgm.samplinginterval	M
	CGM Calibration	oic.r.cgm.calibrate	M
	CGM Threshold	oic.r.cgm.threshold	M
	CGM Status	oic.r.cgm.status	O
	Battery	oic.r.energy.battery	O

997 **Table C.20 – Atomic measurement of CGM**

Atomic Measurement Resource Type Value	Resource Type Name	Resource Type Value	Requirement level
oic.r.cgm-am	Glucose	oic.r.glucose	M
	CGM Sensor	oic.r.cgm.sensor	O

998 ### C.4.10.2 Required Resource Types

999 A CGM shall expose "oic.r.glucose" to report the blood glucose level in mg/dL or mmol/L.
1000 A CGM shall manage (RETRIEVE and UPDATE) the CGM Sampling Interval using the
1001 "oic.r.cgm.samplinginterval" Resource Type.

1002 A CGM shall manage (RETRIEVE and UPDATE) CGM Calibration using the "oic.r.cgm.calibrate"
1003 Resource Type.

1004 A CGM shall manage (RETRIEVE and UPDATE) CGM Threshold using the "oic.r.cgm.threshold"
1005 Resource Type.

1006 ### C.4.10.3 OCF-defined Optional Resource Types

1007 A CGM measures CGM sensor information using the "oic.r.cgm.sensor" Resource Type.

1008 A CGM measures CGM Status using the "oic.r.cgm.status" Resource Type.

1009 A CGM measures Battery using the "oic.r.energy.battery" Resource Type.

1010 See Table C.2 for additional commonly used Resource Types that could be used here.

1011 ## C.4.11 Cycling power meter

1012 ### C.4.11.1 Introduction

1013 A cycling power meter is a sensor that is mounted on a bicycle and that allows the cyclist to
1014 measure his or her power output, which is used to move the bike forward and is measured in Watts.
1015 The meter transmits the information to OCF Clients. A cycling power meter uses different
1016 measurements to determine power:

1017 – measure power directly

1018 – measure torque and rotational velocity at the crank

1019 – measure torque and rotational velocity at the wheel

1020 Possible methods used by a cycling power meter for information updates include:

1021 – Event-Synchronous Update e.g. the power information is updated each time the power sensor
1022 detects a new crank rotation.

1023 – Time-Synchronous Update e.g. the power information is updated at 1Hz.

1024 Table C.21 describes the Device Type for a cycling power meter.

1025 **Table C.21 – Healthcare device type of cycling power meter**

Device Type (rt)	Resource Type Name	Resource Type Value	Requirement level
oic.d.cyclingpowermeter	Cycling power	oic.r.cyclingpower	M
	Torque	oic.r.torque	O

	Cadence	oic.r.cadence	O

C.4.11.2 Required Resource Types

A cycling power meter shall expose "oic.r.cyclingpower" to report the measured power output (which is the power used to move the bike forward).

C.4.11.3 OCF-defined Optional Resource Types

A cycling power meter measures the torque at the crank or the wheel using the "oic.r.torque" Resource Type.

A cycling power meter measures the cadence, which is the number of revolutions of crank per minute when cyclists pedal the pedals, at the crank or the wheel using the "oic.r.cadence" Resource Type.

See Table C.2 for additional commonly used Resource Types that could be used here.

C.4.12 Cycling speed sensor

C.4.12.1 Introduction

Cycling speed sensors are devices mounted on a bicycle that measure the speed the bicycle is travelling. This is typically done using a magnet mounted on the wheel spokes and a sensor on the bicycle frame that senses the magnet passing.

Table C.22 describes the Device Type for a cycling speed sensor.

Note: The notion ‘Sensor’ of the Device Name (Cycling Speed Sensor) is not associated with ‘sensor’, which is an OCF standard OCF Interfaces defined in ISO/IEC 30118-1:2018.

Table C.22 – Healthcare device type of cycling speed sensor

Device Type (rt)	Resource Type Name	Resource Type Value	Requirement level
oic.d.cyclingspeedsensor	Speed	oic.r.speed	M

C.4.12.2 Required Resource Types

A cycling speed sensor shall expose "oic.r.speed" to report the speed the bicycle is travelling.

C.4.12.3 OCF-defined Optional Resource Types

See Table C.2 for additional commonly used Resource Types that could be used here

C.4.13 Cycling cadence sensor

C.4.13.1 Introduction

Cycling cadence sensors measure the speed at which the user is pedaling, typically using a magnet attached to the pedal shaft and a sensor mounted on the frame.

Table C.23 describes the Device Type for a cycling speed sensor.

Note: The notion ‘Sensor’ of the Device Name (Cycling Cadence Sensor) is not associated with ‘sensor’, which is an OCF standard OCF Interfaces defined in ISO/IEC 30118-1:2018.

Table C.23 – Healthcare device type of cycling cadence sensor

Device Type (rt)	Resource Type Name	Resource Type Value	Requirement level

oic.d. cyclingcadencesensor	Cadence	oic.r.cadence	M

C.4.13.2 Required Resource Types

A cycling cadence sensor shall expose "oic.r.cadence" to report the cadence, which is the number of revolutions of crank per minute when cyclists pedal the pedals.

C.4.13.3 OCF-defined Optional Resource Types

See Table C.2 for additional commonly used Resource Types that could be used here

Annex D
(normative)

Industrial device types

D.1 Operational scenarios

The Optical RFID Tag and Optical RFID Station Resource Types describe the attributes associated with an optical augmented RFID system of a smart factory environment for integrating the observation and the actuation in production lines of plants.

Commercial observation is the real-time monitoring to collect broad series of data from each product on the production line and machineries from the plant floor. This collected big data can be sent to OCF cloud and/or manufacturer's internal OCF network where it is analysed and used to estimate overall production flow, productivity and identify failure parts.

Commercial actuation is the real-time interaction to take actions on system failures such as defected product's isolation, possibly sending the product into a repair line, alarming, such as production line status, display panels and hazard issues such as fire and flood of the Commercial environment by sending actuation requests to actuators directly and/or to client(s).

Optical augmented RFID reader and tag assist in production line control utilizing the OCF ecosystem for smart factory environment. The optical augmented RFID reader is represented by the RFID Station Resource Type, the tag by the RFID Tag Resource Type.

In the RFID Tag Resource Type, the tagid is an integer showing the currently read optical augmented RFID tag's identity information.

In the RFID Station Resource Type, the process represents the stage of the product in the product line which has an optical RFID tag on its body. Event is represented by a Boolean value set to "True" or "False" alarming the issue when additional action is requested for the tagged product. actionrequest represents necessary actions like the isolation of the product, to send the product back to another specific line to modify or fix an issue.

Figure D.1 shows a normal, non-error case process flow in the smart factory. Blue arrow lines are where OCF communication exists. ORFID tag ID is only readable to maintain consistent identity.

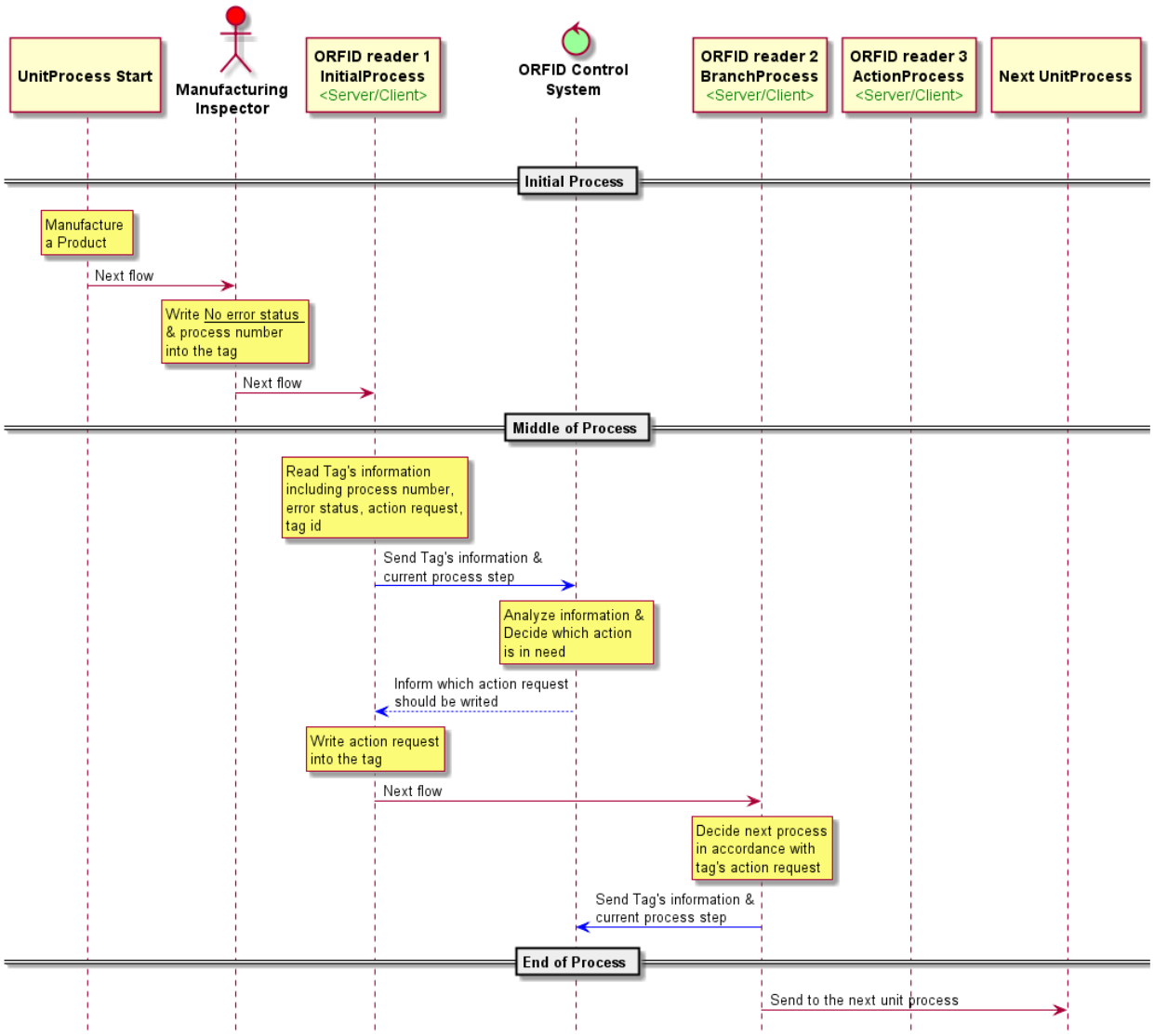


Figure D.1 – Normal process scheme of optical augmented RFID in smart factory environment

Figure D.2 shows product error control scheme in the smart factory. Blue arrow lines are where OCF communication exists. ORFID tag ID is only readable to maintain consistent identity.

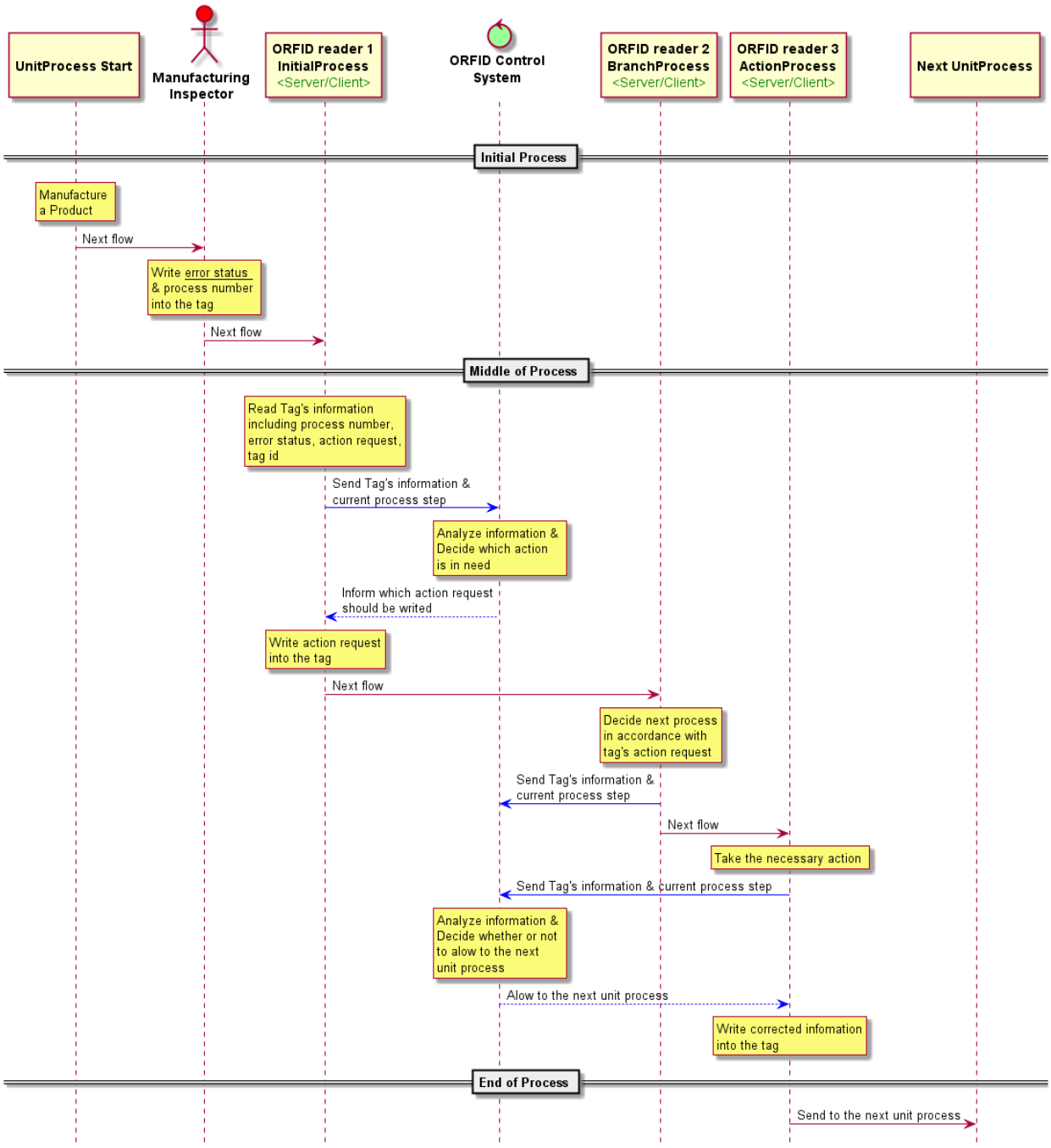


Figure D.2 – Abnormal process scheme of optical augmented RFID in smart factory environment

Manufacturing Inspector writes "error status" and "process number" into the tag after manufacturing a product. ORFID reader1 reads Tag's information and sends the information including current process step to ORFID Control System. Then ORFID reader1 waits until ORFID Control System replies. When ORFID reader1 receives "action request" from ORFID Control System. ORFID reader1 writes "action request" into the tag.

ORFID reader2 located at the "BranchProcess" line decides next flow in accordance with tag's "action request" information then it sends Tag's information and current process step to ORFID Control System, and sends the product to the right flow.

If the product has an error, the product gets necessary action at "ActionProcess" line. Then ORFID reader3 sends repaired product's information. Then ORFID reader3 waits until ORFID Control System replies. When ORFID reader3 receives instruction from ORFID Control System for the next flow, ORFID reader3 sends the product according to instruction.

D.2 Industrial required resources per device type

Device Types may mandate that specific Resources be implemented. The required Resource per Device Type where mandated by the Industrial vertical is listed in Table B.1.

Table D.1 – Alphabetical list of device types ("rt"), including required resources for Industrial

Device Name (informative)	Device Type ("rt") (Normative)	Required Resource name	Required Resource Type
Optical augmented RFID Reader	oic.d.orfid	Optical RFID Tag	oic.r.orfid.tag
		Optical RFID Station	oic.r.orfid.station

Annex E
(normative)

PV (Photovoltaic) system device types

E.1 Scope

This Annex defines Device Types for use in PV (Photovoltaic) systems and describes general use cases to which OCF PV system Devices apply, along with common functional requirements. This Annex considers one of the typical PV system configurations, which is composed of one or more PV array systems, battery systems, inverters, and circuit breakers.

E.2 Operational scenarios

An electrical grid facility can be classified into utility side and customer sides. The utility side facility includes electricity generation, transmission, and distribution. The customer side facility includes high and low voltage equipment, distributed renewable energy equipment, and so on. Figure E.1 shows the overall classification of an electrical grid facility. The utility side facility is generally managed by using IEC 61850 (Communication networks and systems for power utility automation) series standards. Especially, IEC 61850-7-1:2011 defines the data models for electrical equipment for the utility side. OCF defines the data models for devices in the residential environment, so electrical equipment in the customer side of the electrical grid facility also needs to be defined. Since electrical equipment in the utility side uses data models defined in IEC 61850 standards, customer side equipment also needs to be defined with consideration to IEC 61850 data models.

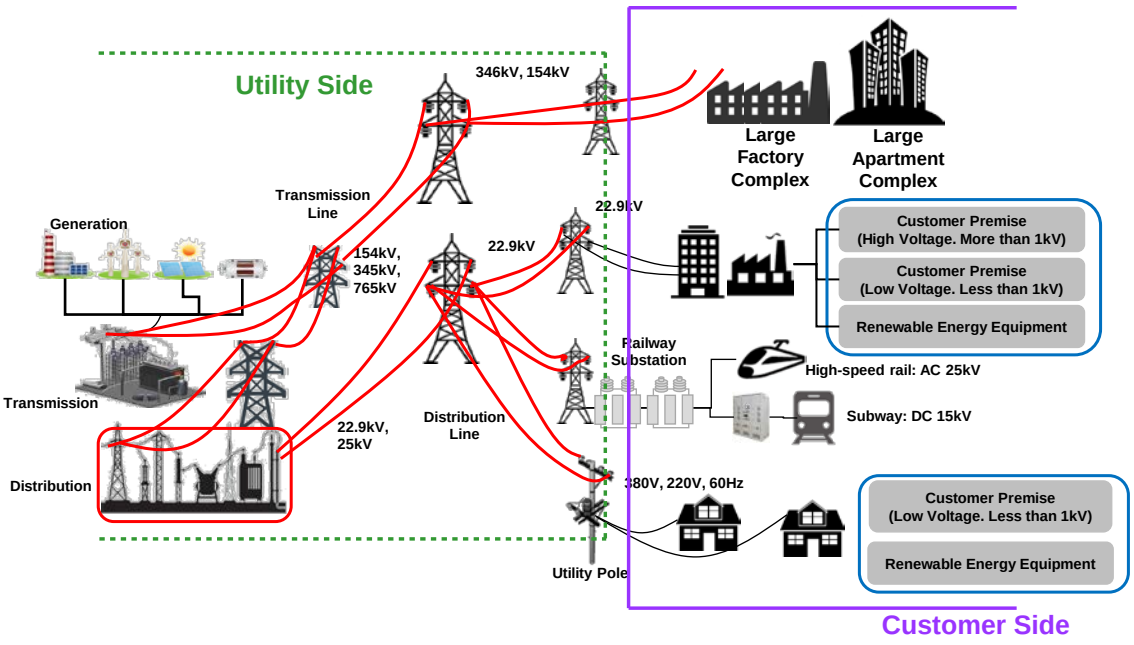


Figure E.1 – Classification of electrical grid facility

Figure E.2 depicts a typical PV system configuration. As shown in the figure, a PV system consists of one or more PV array systems, DC (Direct Current)/AC (Alternating Current) inverters, battery systems, and circuit breakers. A PV array system converts the sun's rays into electricity and the generated DC current is converted into AC current by a DC/AC inverter. A battery system may be used to store generated electricity and discharge it to the electrical grid later. A circuit breaker is

installed in order to disconnect the circuit between the PV system and the internal distribution grid. In this use case, the PV array system, battery system, DC/AC inverter, and circuit breaker are considered.

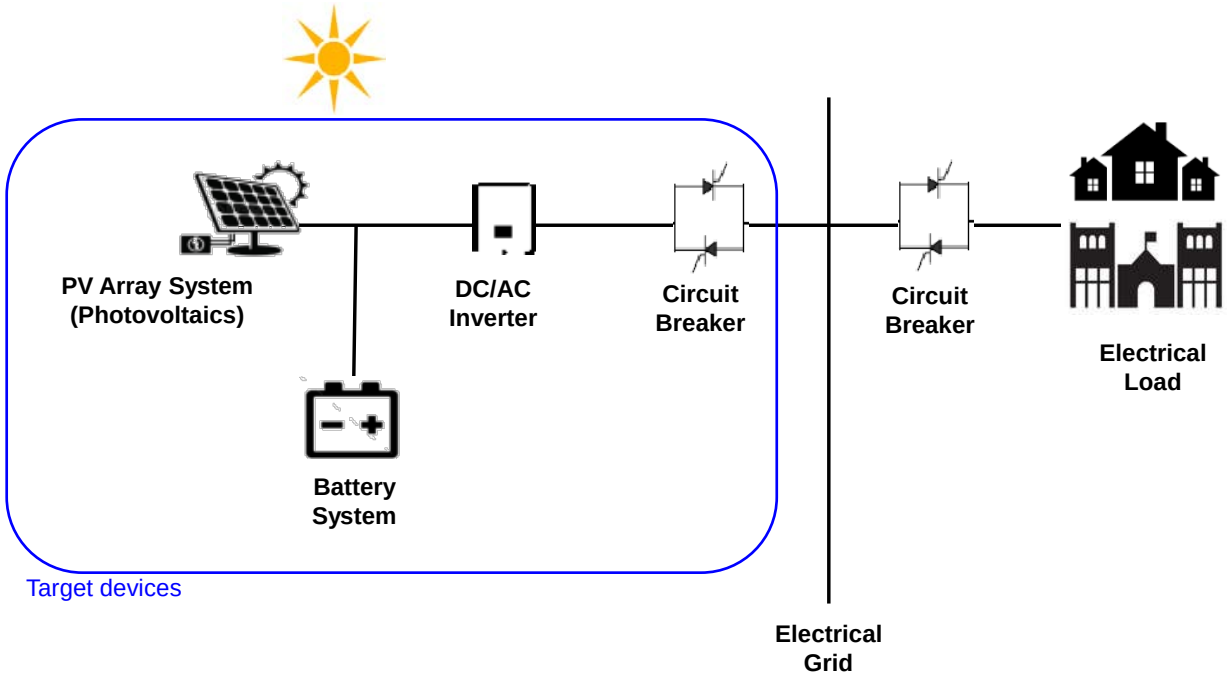


Figure E.2 – Typical PV system configuration

Figure E.3 shows the detailed configuration of the PV array system. The PV panel is composed of a durable glass panel (array) and a rigid frame made up of durable units (modules) after the unit cells are integrated and electrically connected. The PV array is connected through the connection terminal and the connection terminal monitors the status of each PV array. The connection terminal passes through the inverter before passing AC current to the electrical grid.

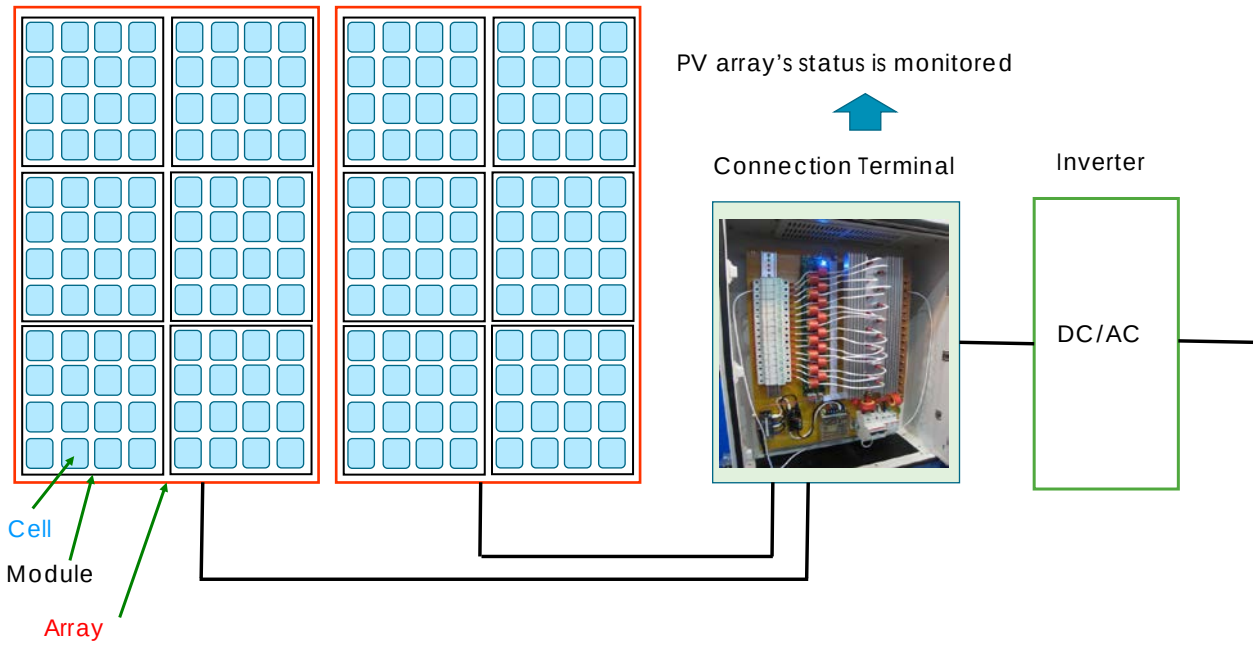


Figure E.3 – Detailed configuration of PV array system

E.3 Standard device types

Table E.1 lists the brief explanation of the function and required resources of PV system Devices. Table E.2 lists PV system Device Types. The Device Type exposed by the "rt" value of /oic/d of all PV system Devices shall have a Resource Type value ("rt") prefixed with "oic.d.".

Table E.1 – Function and required resources for PV system device types

Device Name	Roles of Device	Required Resource and Function
Circuit Breaker	Functions for the control and monitoring of circuit breakers	Circuit breaker: describes circuit breakers used in the protection of the PV system
Battery System	Functions required to store excess energy produced by the PV system. Energy storage in PV systems is usually done with batteries	Battery: battery if needed for energy storage
Inverter	Functions for the control and monitoring of the DC/AC inverter	Inverter: converts DC to AC
PV Array System	Functions to maximize the power output of the PV array	PV Connection Terminal: PV array(s) is connected and status is monitored

Table E.2 – List of PV system device types

Device Name	Device Type (rt)	Required Resource Name	Required Resource Type
Circuit Breaker	oic.d.circuitbreaker	circuit breaker	oic.r.circuitbreaker
Battery System	oic.d.battery	battery	oic.r.energy.battery
Inverter	oic.d.inverter	inverter	oic.r.inverter

PV Array System	oic.d.pvarraysystem	PV connection terminal	oic.r.pvconnectionterminal

