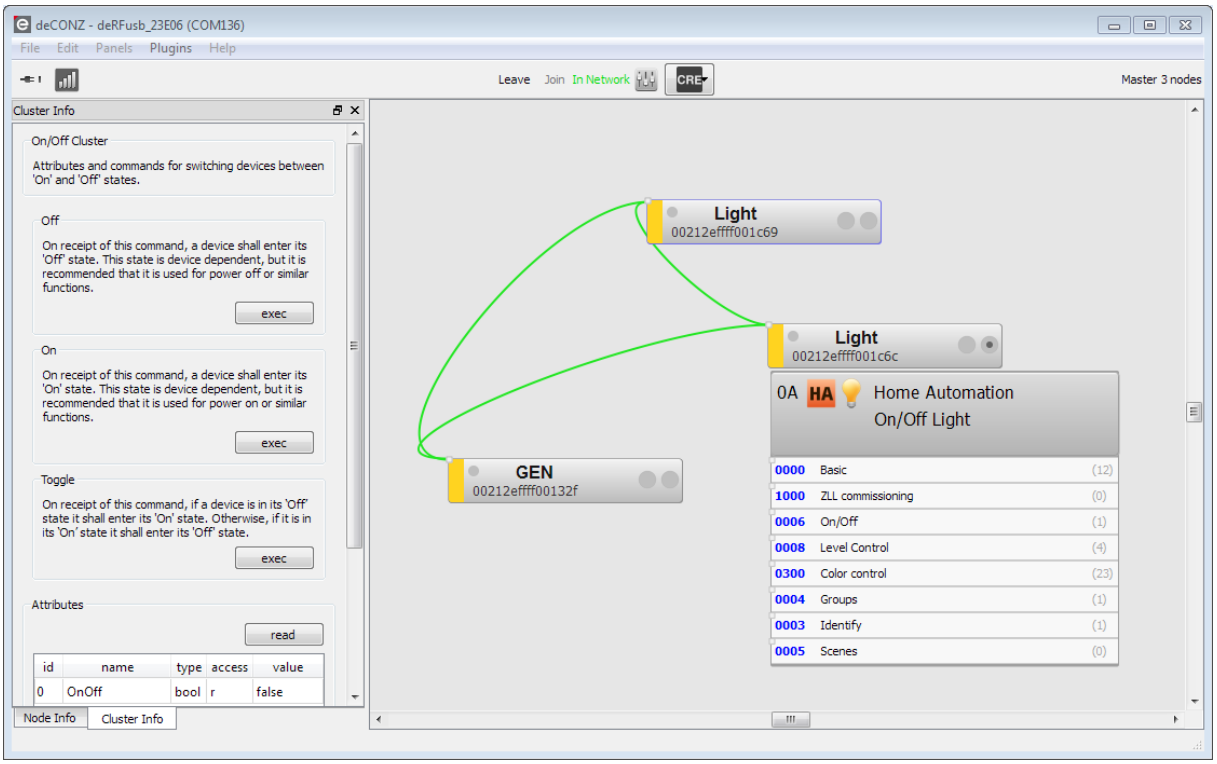
dresden elektronik

User Manual
deCONZ



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Document history

Date	Version	Description
2012-06-29	1.01	Initial version
2012-10-31	1.06	Revision of sections 3, 4 and 7

Abbreviations

Abbreviation	Description
APS	Application Support
CRE	Control Automatic Discovery
GUI	Graphical User Interface
IEEE 802.15.4	Standard, applicable to low-rate wireless personal area networks (WPAN)
LQI	Link Quality Indicator
NWK	Network
TC	Trust Center
(W)PAN	(Wireless) Personal Area Network
ZCL	ZigBee Cluster Library
ZCL(DB)	ZigBee Cluster Library (Data Base)
ZDP	ZigBee Device Profile
ZigBee	Wireless networking standard targeted at low-power applications

1. Overview

ZigBee is a technology which offers a powerful solution to a wide range of low-power, low-cost wireless sensor network applications. Some popular application profiles are Home Automation, Smart Energy and Health Care; beside them and other public profiles ZigBee PRO provides the possibility to easily develop special purpose applications.

In many stages of a product development process it is necessary to interact with the devices in order to verify their correct operation. To achieve this in an efficient way extra PC tools are often built around the related application first for the developer and later for deployment, for operation and for maintenance. The deCONZ application from dresden elektronik is a powerful graphical tool addressing all those stages. The deCONZ provides comprehensive monitoring, control and commissioning capabilities based on the ZigBee PRO specification. The application core is kept completely generic and is therefore not limited to a specific application profile. All ZigBee application specifics like devices, profiles and clusters are described in XML files. Based on this information, the deCONZ application can generate a full functional graphical user interface for each device and any application.

2. Application

The main applications for the deCONZ application are:

- Operation of ZigBee® PRO networks
- Device application monitoring & control
- Create/remove bindings between devices
- Commissioning

3. Getting connected

Before running a device inside a network it has to be integrated; at first it has to get connected to the host PC and then it has to be configured to be able to join the network.

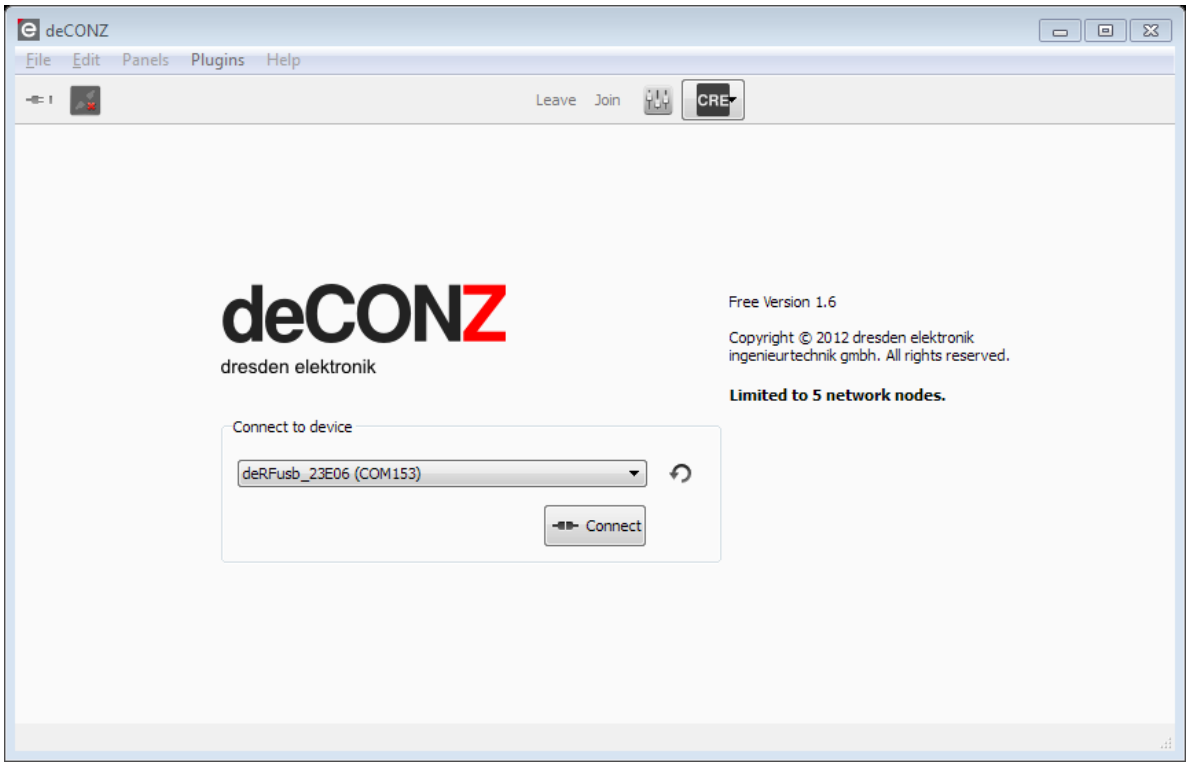


Figure 1: deCONZ start screen

3.1. Connect device to PC

When starting the deCONZ application a start screen appears wherefrom a generic device can be selected and a connection to it established.

Connect the device to a PC USB port and press the button to reload the list of devices. Choose your device from the list (deRFnode/gateway or deRFusb_*) and press the *Connect* button.

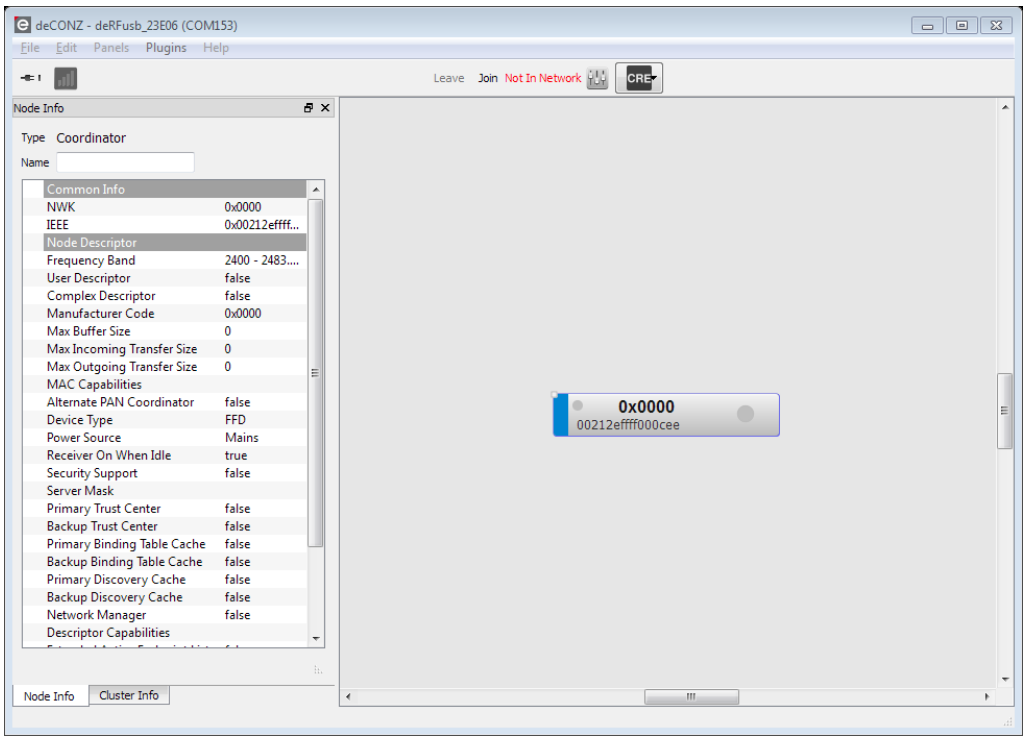


Figure 2: Generic device connected to PC

On success the start screen changes to the node view and the connection status  indicates that the device is connected to the PC but not yet integrated in a network.

3.2. Create/join a network

Note: Before starting network operation the device must be configured (for details please refer to **section 4)**.

After the device has been configured click on the *Join* button to create a new network (coordinator) or join an existing network (router).

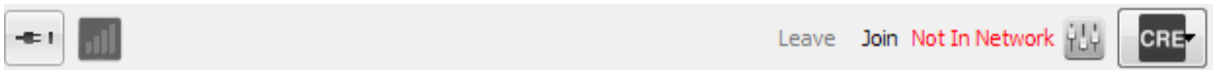


Figure 3: Device connected to PC but not in a network

This process may take a few seconds until status changes from *Joining* to In Network (or Not Connected if an error occurs). The bars in the status icon should indicate the connection status, too.

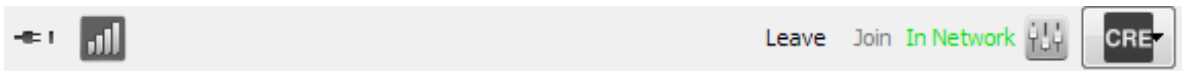


Figure 4: The device is part of a network

4. Device configuration

The local device configuration can be viewed and changed in the Network Settings dialog to open it click on *Edit* | *Network Settings*. To view the current settings press the *Read* button in the network tab.

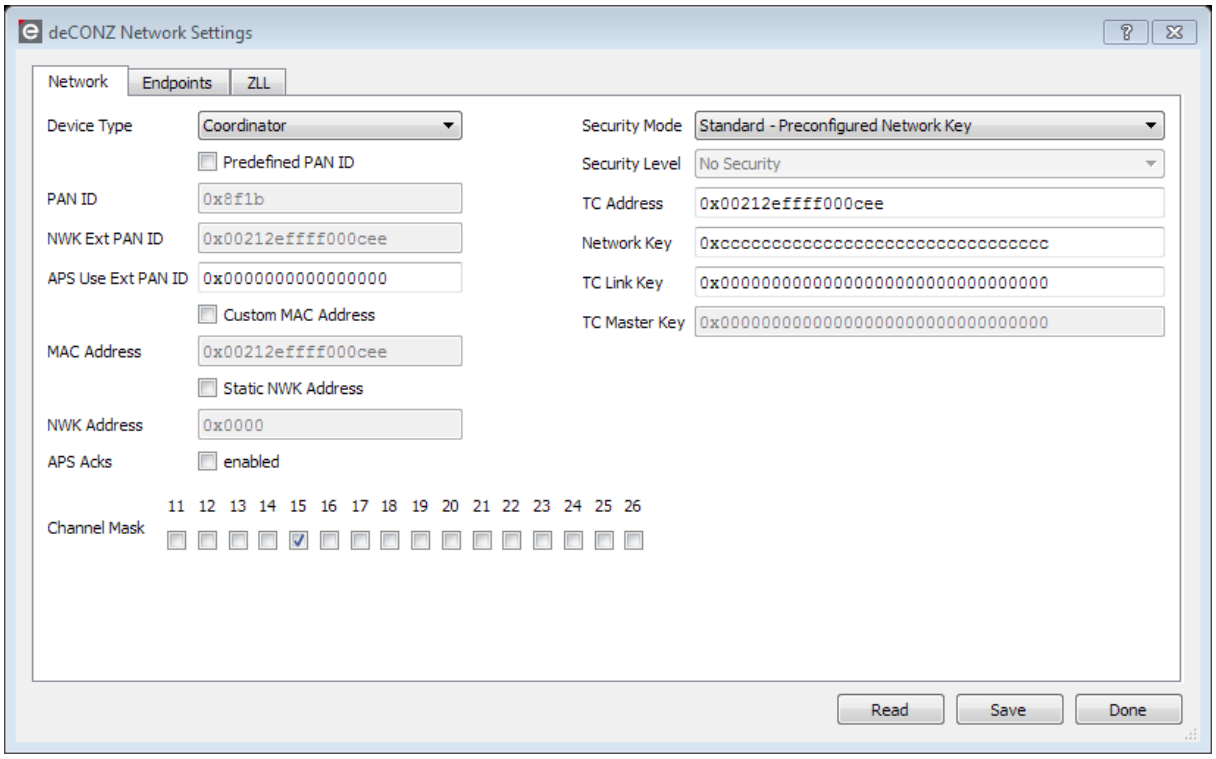


Figure 5: Network Settings

4.1. Changing parameters

Before making any changes always press the *Read* button to load the current configuration. After modifying parameters press the *Save* button to upload the changes to the device.

Note: Parameter changes can be done while in a network or not. But they become active only the next time the device creates/joins a network.

Note: The device stores all parameters to non-volatile memory. This does however not happen when pressing *Save* but only the next time the device creates/joins a network. So after having pressed *Save* you still can change settings – and correct possible mistakes. To make your changes permanent you need to press *Leave* (if connected to a network) and *Join* again.

4.2. Parameter Description

Parameter	Description
Device Type	Specify if the device creates or joins a network.
Predefined PANID	ZigBee PANID are dynamic by default, however it is possible to set a custom PANID here.
PANID	Reflects the currently active network PANID.
NWK Ext PANID	Reflects the currently active network extended PANID.
APS Use Ext PANID	For a coordinator this will be the extended PANID of the new network. If it is set to 0 the extended PANID will get the MAC address of the coordinator. A router will only join a network which matches with the extended PANID. If it is set to 0 the router will join any network.
Custom MAC Address	This allows to specify a MAC address and to set the MAC address after firmware flashing. (In this case the address might get lost and will be displayed as 0) The MAC address must be non-zero.
MAC Address	Reflects the currently set MAC address. The MAC address must be non-zero.
Static NWK Address	NWK addresses in ZigBee are dynamic by default; however it is possible to specify a static NWK address. (only Router) Note that this address must be unique for each device in the network.
Channel Mask	ZigBee offers 11 channels. A coordinator will search a channel from the active channels with the least interference to create a network. Routers only search active channels to join a network. That means the mask should be identical to all devices in the network.
Security Mode	Currently the following modes are supported: • No Security • Standard - Preconfigured Network Key • Standard - Network Key from Trust Center
Security Level	Reflects the currently underlying security level.
TC Address	The address of the trust center. (might be the coordinator for example)
Network Key	The global 128-bit network key.
TC Link Key	A link key used to retrieve the network key safely from the trust center if the security mode is set to “Standard – Network Key from Trust Center”. (and for other communication with the trust center)
TC Master Key	Used in high security. (not supported in this release)
APS Acks	Using APS layer acknowledgments for outgoing requests of cluster info panel.

4.3. Endpoints

Endpoints represent the device application interfaces to the network and may be required to receive data and establish bindings.

All endpoint parameters must be written as HEX values. The in/out clusters must be separated by comma.

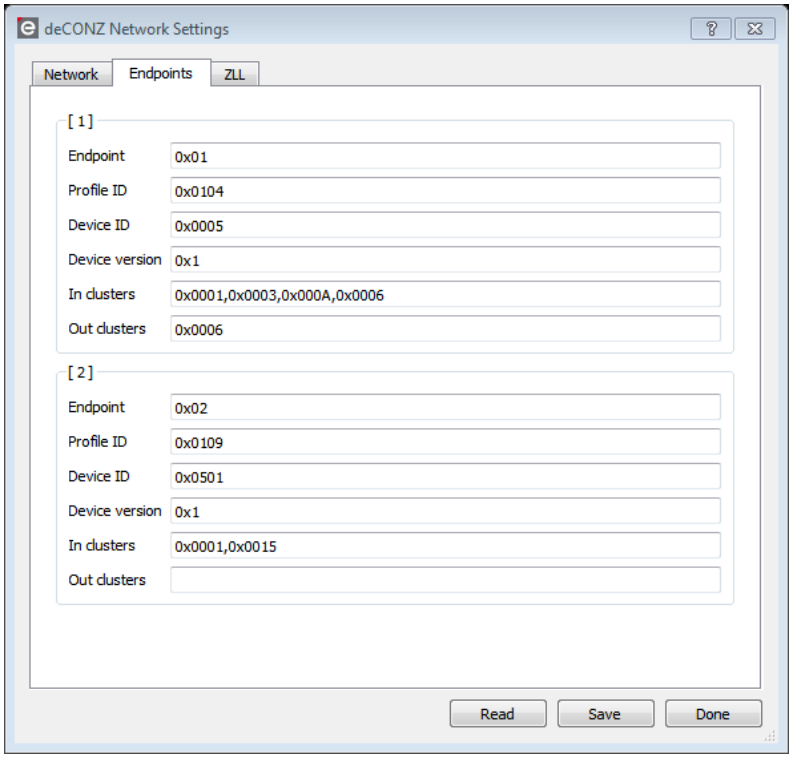


Figure 6: Endpoint editor

After pressing the *Save* button all endpoint configurations will be uploaded to the device and are immediately active.

5. Automatic discovery

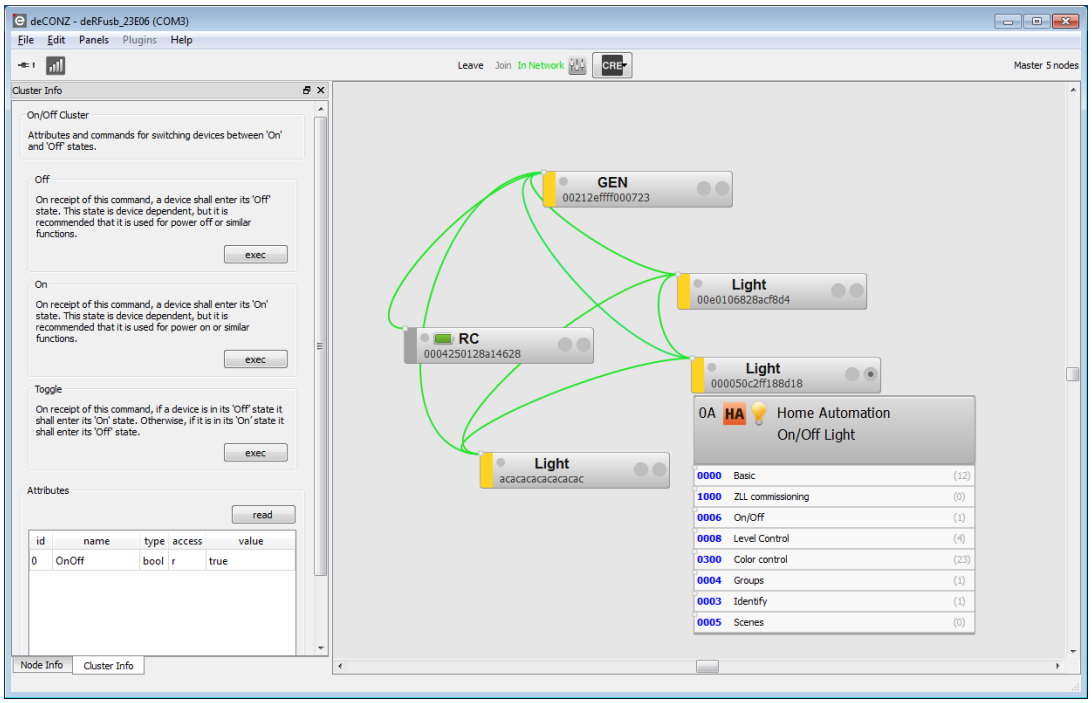


Figure 7: Discovered network

5.1. Device discovery

The network will be discovered by the application automatically. This is done by standard ZigBee requests and guarantees that all nodes will be discovered even if they are not in the signal range of the generic node. Also nodes which might be sleeping will be discovered by their parent router device.

Coordinator
Router
End-device

The discovery itself will be repeated periodically and only involves non-sleeping devices. Each device has a color code which represents the ZigBee device type as shown on the left.

5.1.1. Neighbor links

The links between the nodes visualize the single hop neighborhood. The color of a link represents the Link Quality Indicator (LQI) value between two nodes, the color changes from green (good signal quality) to yellowish/red (weak signal quality).

Because of the dynamic nature of ZigBee new links might appear and existing links disappear or change their color at any time. The same applies to nodes.

5.1.2. Dynamic NWK addresses

A special case is rejoining devices. If a discovered node rejoins the network it gets a new 16-bit network address (the exceptions are static addressing and silent rejoin; there the address stays the same). The application will detect this and updates the internal address in the node cache; so all future requests to the device will use the correct address.

5.2. Service discovery

While the network device discovery only delivers the information about *who* is in the network, the network service discovery will figure out *what* a device is. As with the device discovery, this process also is handled automated by the deCONZ application.

By only using ZigBee standard requests the following information will be fetched from each node.

Descriptor Name	Description
User descriptor	Name or description of a node
Node descriptor	Common node information
Power descriptor	Information about power status and source
Simple descriptors	The generic interface for each application a device runs

The user, node and power descriptors are common to all ZigBee PRO devices. The simple descriptors are individual for each node and will be discovered as follows:

Each node can provide up to 240 endpoints where each represents one application. The interfaces of the endpoints are discovered automatically by requesting the *simple descriptor* for each active endpoint. In order to know which endpoints are active the deCONZ application will send an *active endpoints request* to the node.

5.3. Control automatic discovery

Fetching from sleeping end-devices may take a while and can be disabled over the CRE button menu. If the whole network has been discovered disabling routers and coordinator from automatic discovery shall be considered to gain more bandwidth for sending manual user commands.

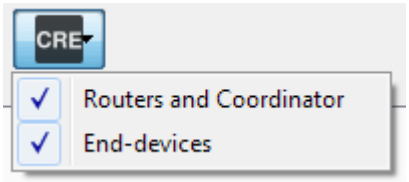


Figure 8: Discovery control switch

Each node has a discovery control drop-down menu as shown on the right. The number in parentheses is the timeout in seconds until the next periodic request will be send.

A request can be enabled and disabled. Enabling a request will reset the timeout to 1 and the request will be sent immediately to the node.

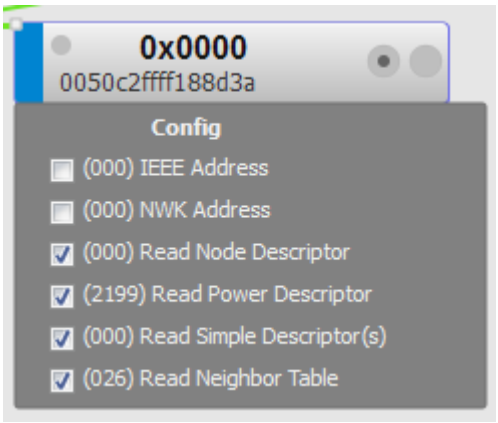


Figure 9: Discovery control menu

6. Node info panel

The user, node and power descriptors are visible over the *Node Info* panel. If the panel is not visible select it from the upper-left *Panels menu.*

To display the descriptors, open the *Node Info* panel and click on a node. Except the name (User Descriptor) of a node all parameters are read only.

6.1. Setting the node name

To change the user descriptor just type into the *Name* field and hit the return key. A *Set User Descriptor Request* will be sent to the node and on success the name will stay; otherwise it will switch to the previous value.

Note it's up to the device to store the user descriptor in a persistent way.

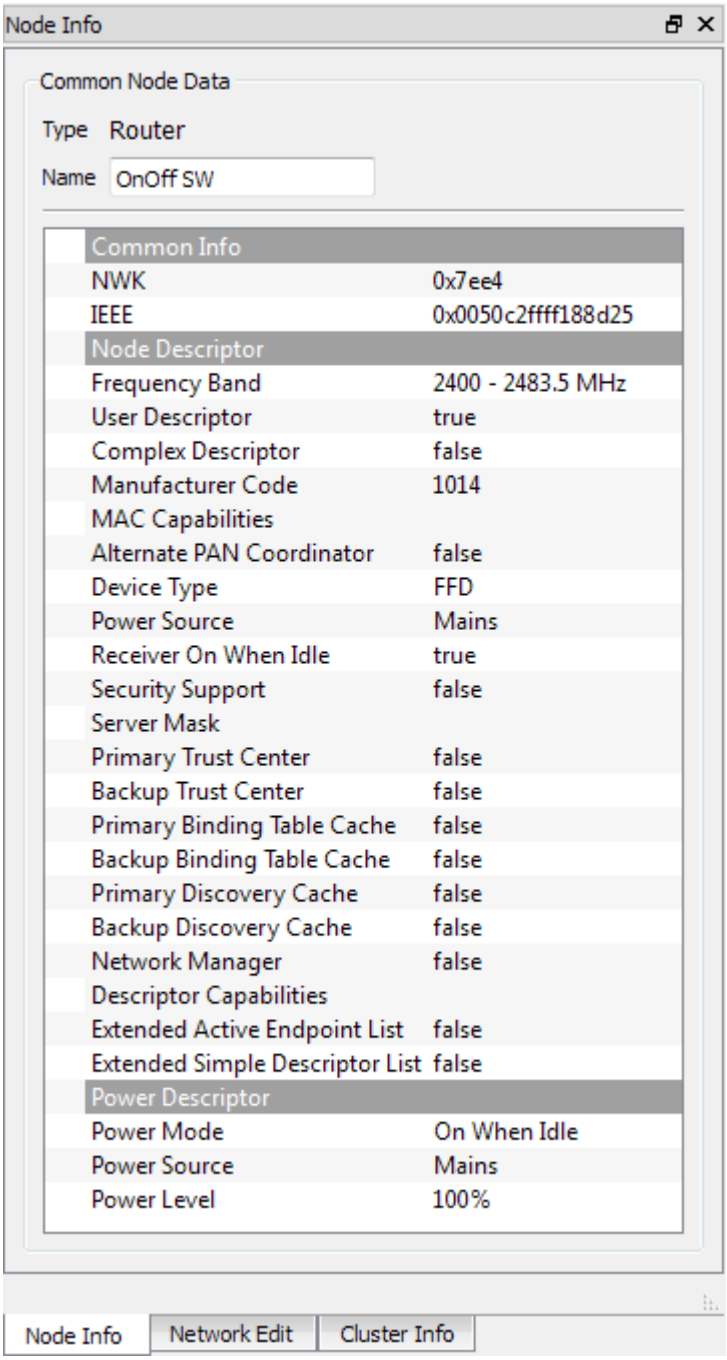


Figure 10: Node info panel

6.2. Automatic endpoint discovery

The deCONZ application uses the results of the service discovery to generate a full functional control interface for each node. The profile, device and clusters IDs are checked against the ZCLDB which is a set of XML files with further descriptions of the profiles, devices and clusters. To extend the ZCLDB read the **section 9 Extending the ZCLDB** of this document.

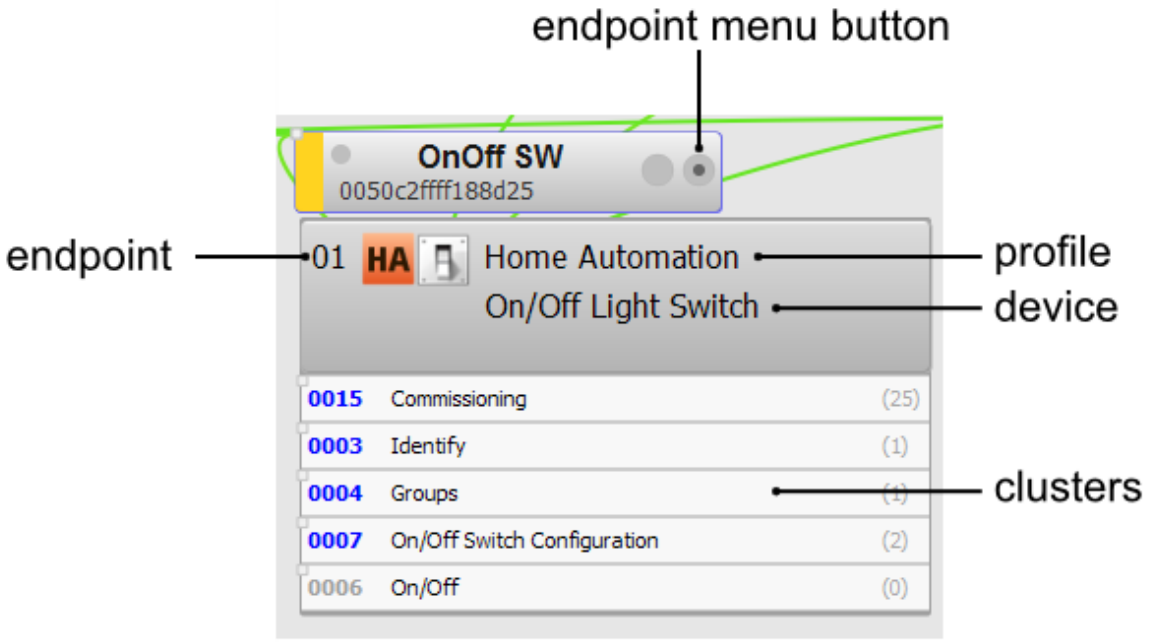


Figure 11: Endpoint drop-down menu

6.3. Endpoint drop-down menu

Each node has one *Endpoint Menu Button* which becomes available as soon as the simple descriptors are fetched and the interface is built. The menu provides basic information about the endpoints like endpoint number, profile and device name as well as server and client clusters.

In **Figure 11** the On/Off SW node has only one endpoint. Some devices like the sensor node in **Figure 12** have more than one endpoint available; in that case they will be appended to the drop-down menu.

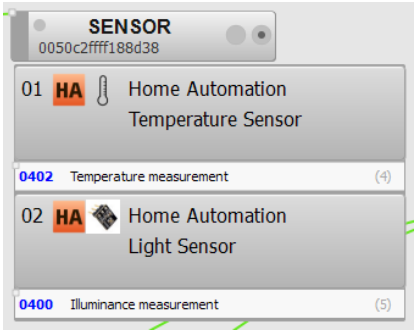


Figure 12: Multiple endpoints

The cluster list contains both server clusters (blue) and client clusters (grey). If you single-click on a cluster its control interface will be loaded into the *Cluster Info* panel.

7. Cluster info panel

The control interface of a cluster (if there is one) is visible over the *Cluster Info* panel. If the panel is not visible select it from the upper-left *Panels menu.* To display a cluster open the endpoint drop-down menu of a node and click on a cluster.

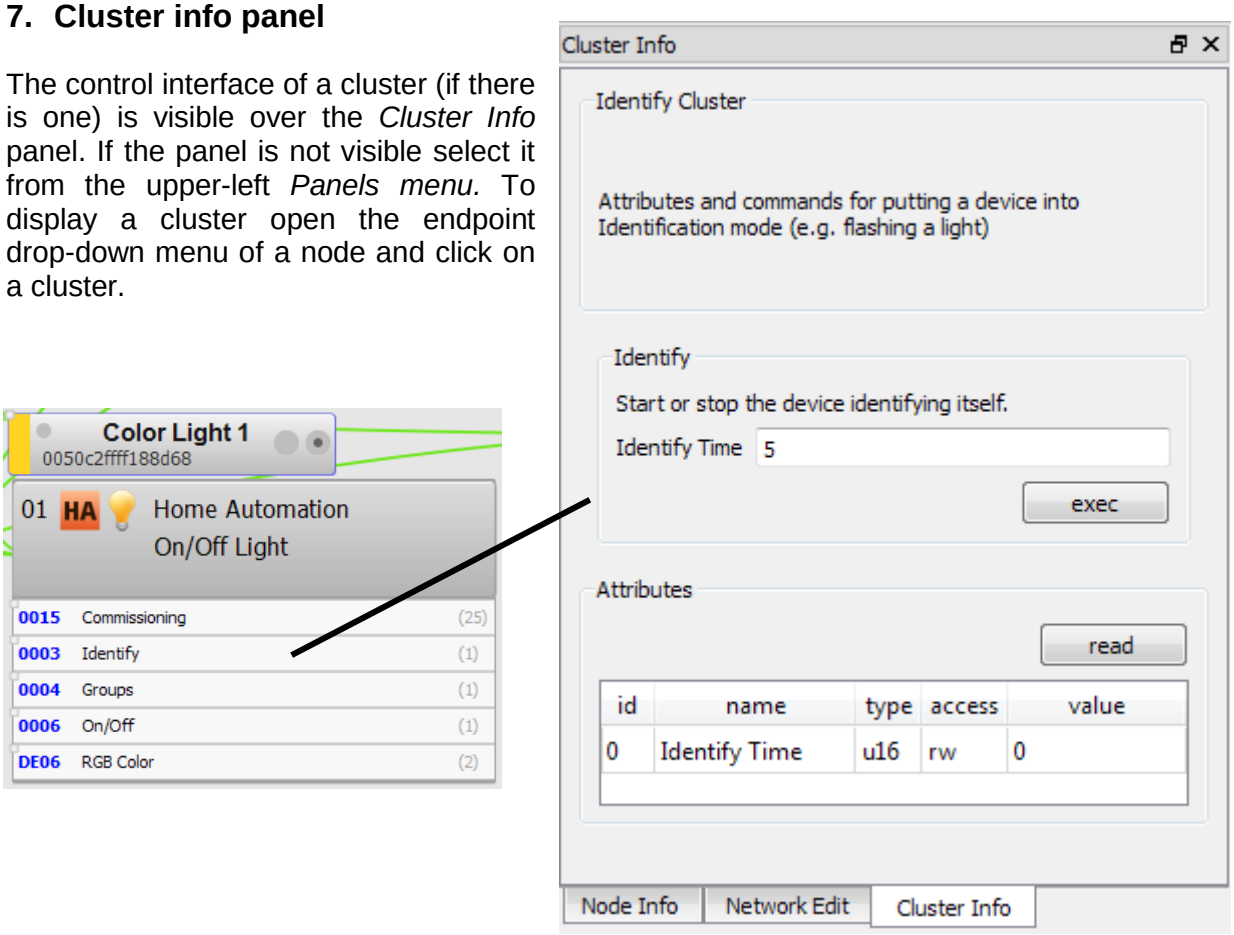


Figure 13: Select and show a cluster interface

7.1. Commands

The cluster Info panel provides access to all commands which are defined for a cluster. Each command has a short description saying what it does. Some commands like the *Identify* command (**Figure 14**) may take one or more parameters. In **Figure 13** the identify time parameter specifies how long a device will stay in the identify mode.

7.1.1. Execute a command

Use the *exec* button to send the command to a node. If the command is a ZCL command and has no defined response the return state (also called default response) will be displayed beside the exec button.

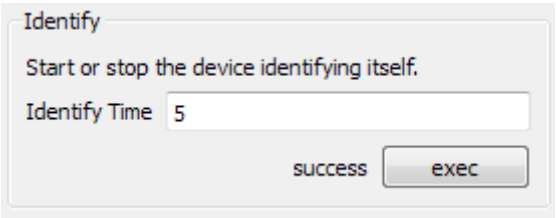


Figure 14: Command default response

7.1.2. Command response

If the application receives a defined response (that is a command itself with one or more parameters) it will be displayed below the command.

Figure 15 for example shows the *Get group membership* command from the groups cluster which has a response command with three parameters.

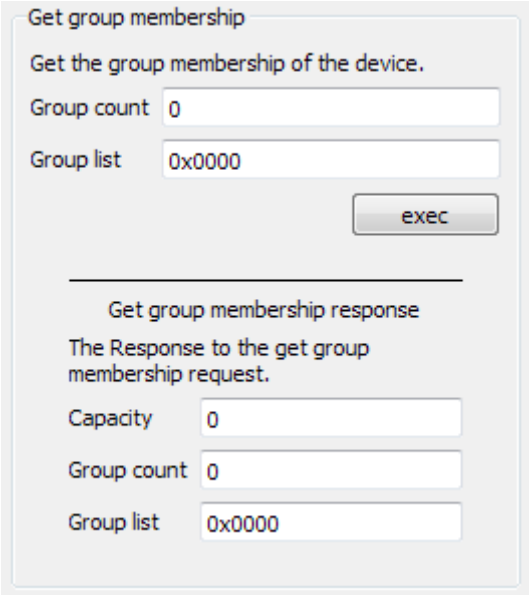


Figure 15: Command response

7.1.3. Payload data types

The ZCL defines more than 20 data types which can be used for attributes and commands. The deCONZ application handles most of them with help of the ZCLDB.

Dependent on the data type different GUI widgets will be generated to make it as easy as possible to specify and read values in a human readable format.

Note: Numeric data types may be represented as hex values (prefix 0x) or binary values (prefix 0b), otherwise values are presented in decimal base 10 by default. When holding the mouse over a numeric input field a tooltip with the exact data type will appear.

The commissioning clusters *Restart Device* command is shown in **Figure 16**. The request takes three parameters the 8-bit bitmap options and the two 8-bit unsigned int numbers delay and jitter. The restart device response has an 8-bit enumeration parameter which will be presented as text.

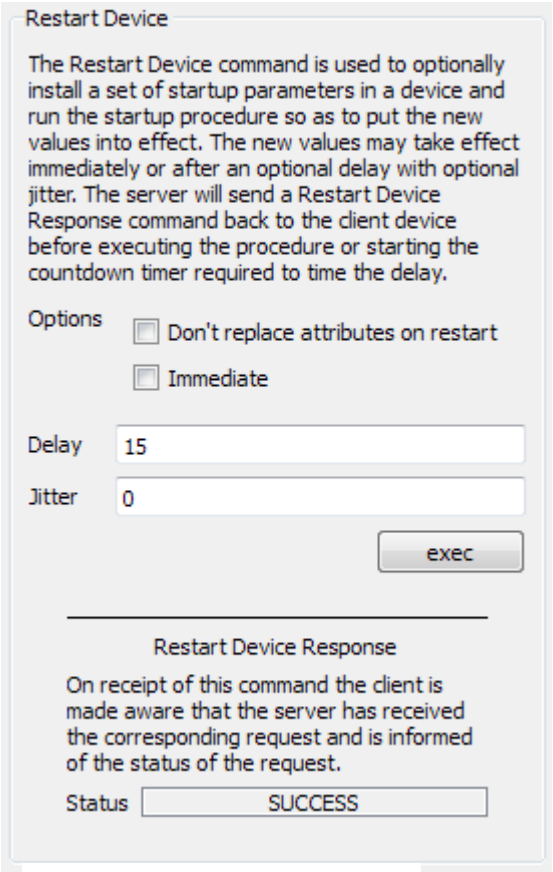


Figure 16: Different data types in a response

7.1.4. Using group and broadcast

By default all commands are sent as unicast to the selected node only. To send a command to all nodes or a group of nodes, open the *Destination Settings* from the edit menu (or simply press F6).

The address and endpoint fields are filled automatically when clicking on a cluster in the endpoint dropdown menu of a node. For group cast addressing a group address must be provided by the user.

Note: Remember to switch back to unicast addressing after using group or broadcasts.

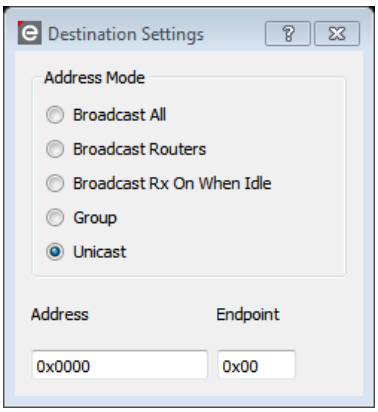


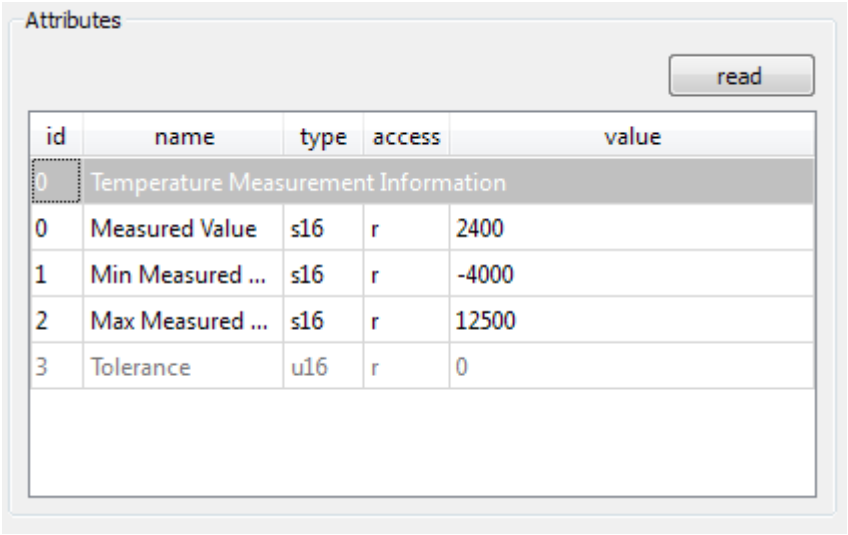
Figure 17: Destination settings

7.2. Attributes

ZCL related clusters may have attributes which represent values or states. Like the command parameters attributes can have different data types which will be presented in a human readable format.

7.2.1. Reading attributes

The attributes of a cluster can be read by using the *read* button in the *Attributes* sections.



id	name	type	access	value
0	Temperature Measurement Information			
0	Measured Value	s16	r	2400
1	Min Measured ...	s16	r	-4000
2	Max Measured ...	s16	r	12500
3	Tolerance	u16	r	0

Figure 18: Attribute table

The attributes will be requested from the node. When a response is received the values will be displayed in the attribute table.

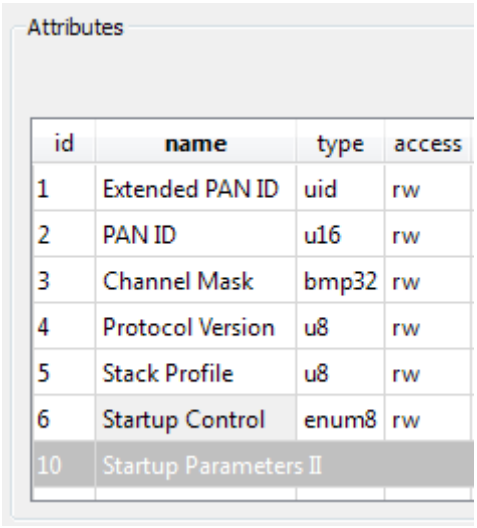
Depending on the number of attributes of a cluster multiple *read attribute* requests might be generated in order to read all attributes.

Some attributes are optional and may not be available. In that case the *read attribute* request will return unsupported attribute status. In the attribute table the attributes font color will turn into a light grey as the *Tolerance* attribute shown in **Figure 18**.

7.2.2. Writing attributes

Some attributes are flagged as writeable and may be changed by the user. This can be done by a double click on the attribute which will open the *Attribute Editor*.

To write a modified value, click the *write* button. A *write attribute* command will be sent to the device. As result a response will be received which tells if the process was successful or an error occurred.



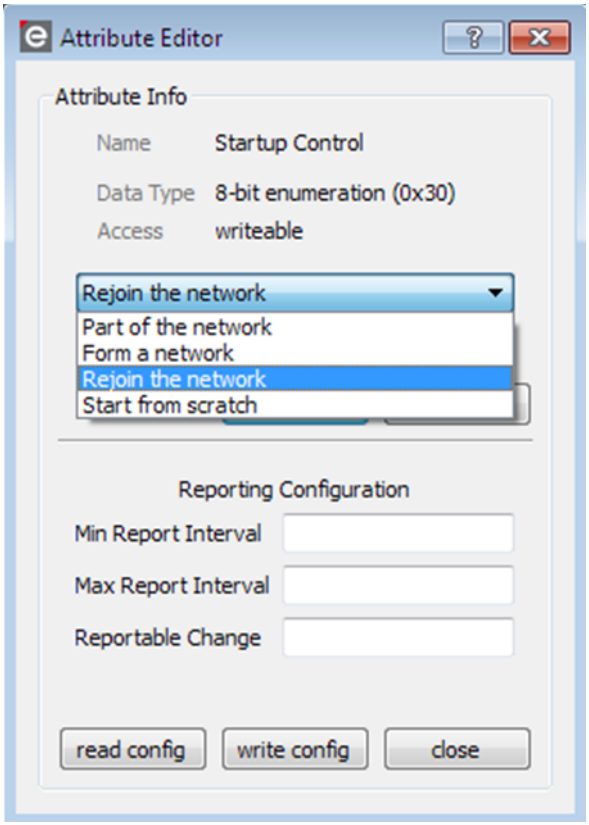


Figure 19: Attribute editor

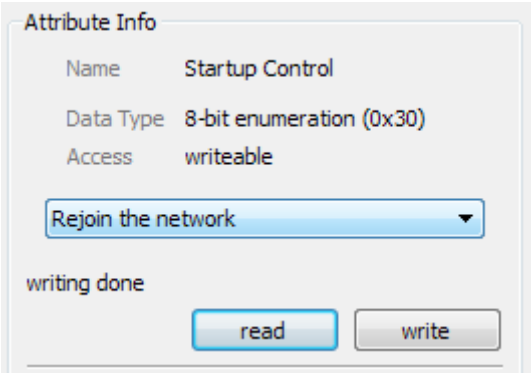


Figure 20: Attribute written

After successful writing the status *writing done* will be displayed next to the *read* button.

7.2.3. Configure attribute reporting

Some attributes support reporting, meaning that the current value will be sent to all bound devices either after a reporting timeout is reached or the value has changed by a reporting threshold.

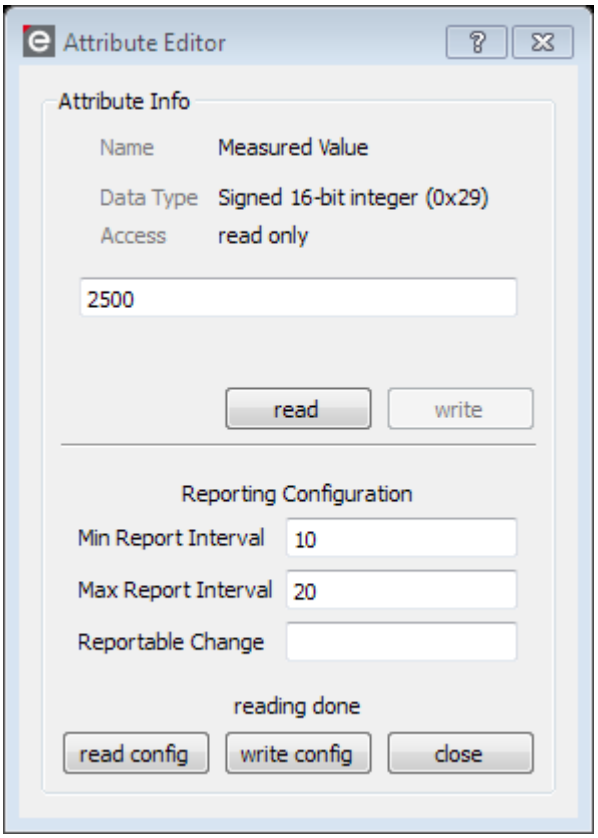


Figure 21: Read reporting configuration

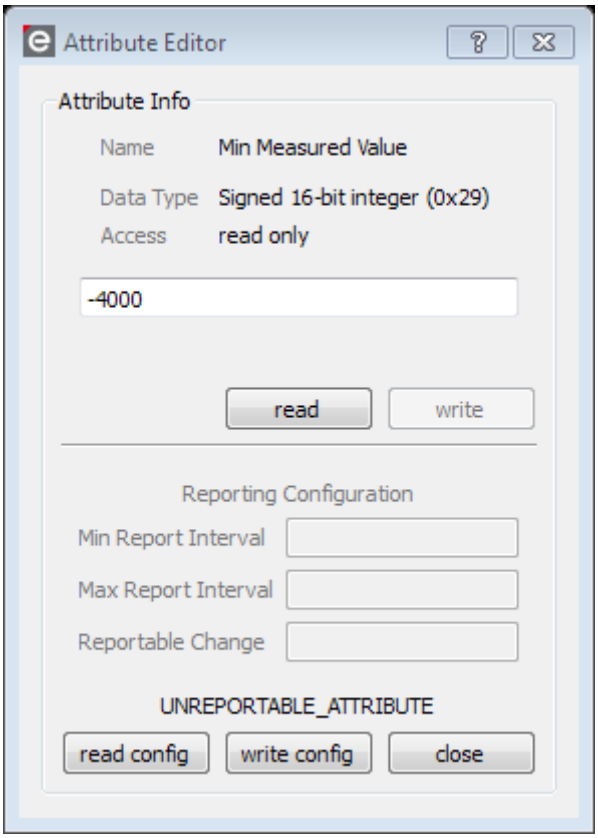


Figure 22: Unreportable attribute response

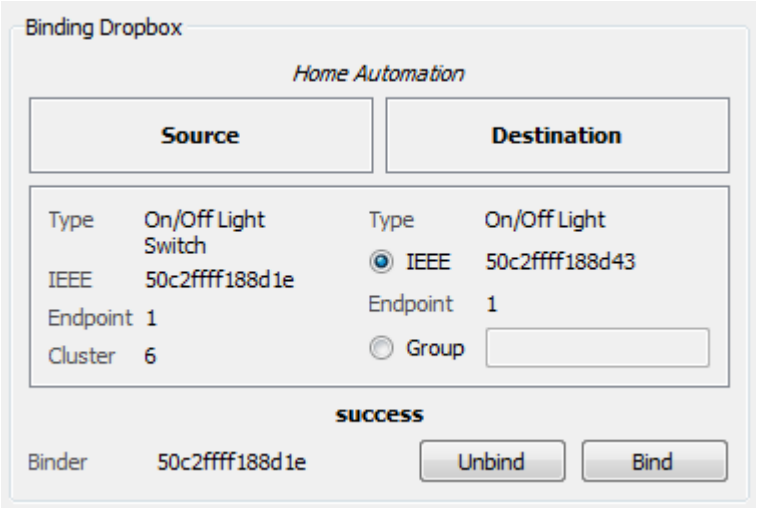
To load the current reporting configuration of the attribute click the *read config* button in the *Attribute Editor*. If the attribute supports reporting the configuration will be shown and could be changed and written to the device.

Attributes which don't support reporting will return the status UNREPORTABLE_ATTRIBUTE as shown in **Figure 22**.

8. Binding dropbox

The *Binding Dropbox* allows the creation and removal of binding between devices. If the binding dropbox is not visible select it from the upper-left *Panels menu.*

In the following example a binding between a light switch and a light has been created in three steps.



8.1. Unicast bindings

1. The light switch client On/Off cluster (grey) was dragged to the source field.
2. The LIGHT server On/Off cluster (blue) was dragged to the destination field.
3. The *Bind* button was pressed.

8.2. Group bindings

To create a group binding instead of specifying the destination by drag and drop, select the *Group* radio button and specify the group as 16-bit hex value (for example 0x000a).

8.3. Unbinding

Unbinding works exactly like binding; just use the *Unbind* instead of the *Bind* button.

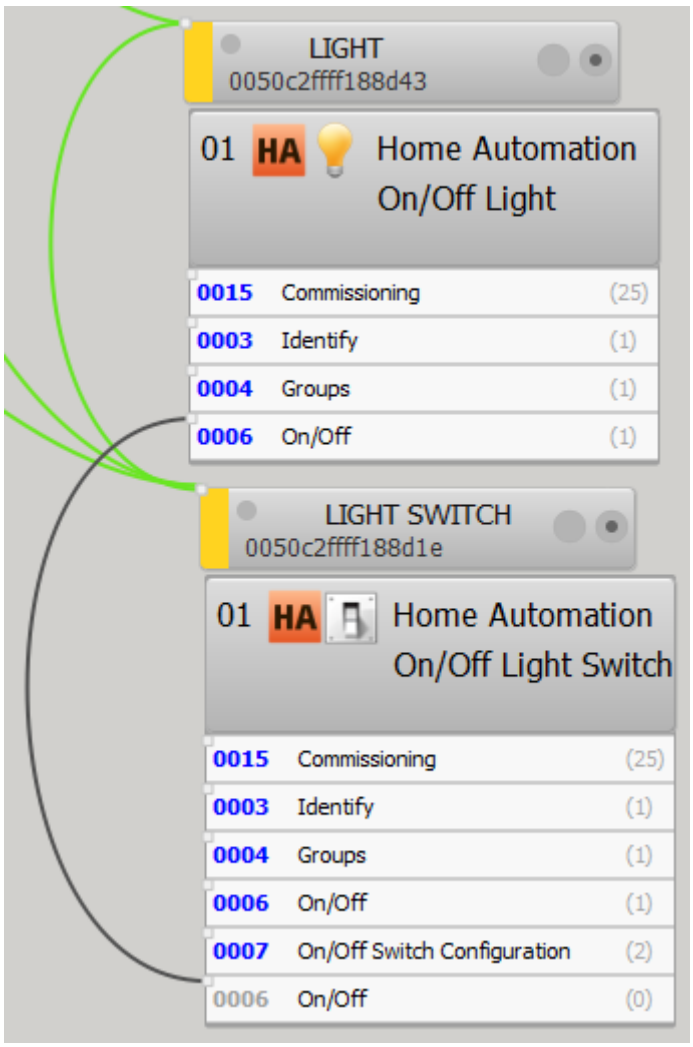


Figure 23: Binding dropbox and example

9. Extending the ZCLDB

The XML structures to describe ZigBee PRO profiles and clusters which will be interpreted by the deCONZ application are kept simple and easy to understand. This section serves as introduction to enhance the shipped XML data base (which is called ZCLDB from now on) with custom or newer ZigBee PRO profiles or clusters.

A ZigBee PRO profile contains various definitions about clusters, data types and logical devices. The information must be described in the ZCLDB so that the application can understand and communicate with the network devices. Beside the parsing and generating of ZigBee application layer messages the ZCLDB is used to build a user friendly GUI at runtime as soon as a device is detected and matched with the ZCLDB.

9.1. Adding custom XML files

The XML files which come with the application must not be modified since they will be updated by newer versions in future releases. However it is possible to redefine any element and add arbitrary profiles and clusters into a custom XML file. To load additionally XML files into the application open the *Preferences* dialog in the *Edit* menu and choose the *ZCLDB* section.

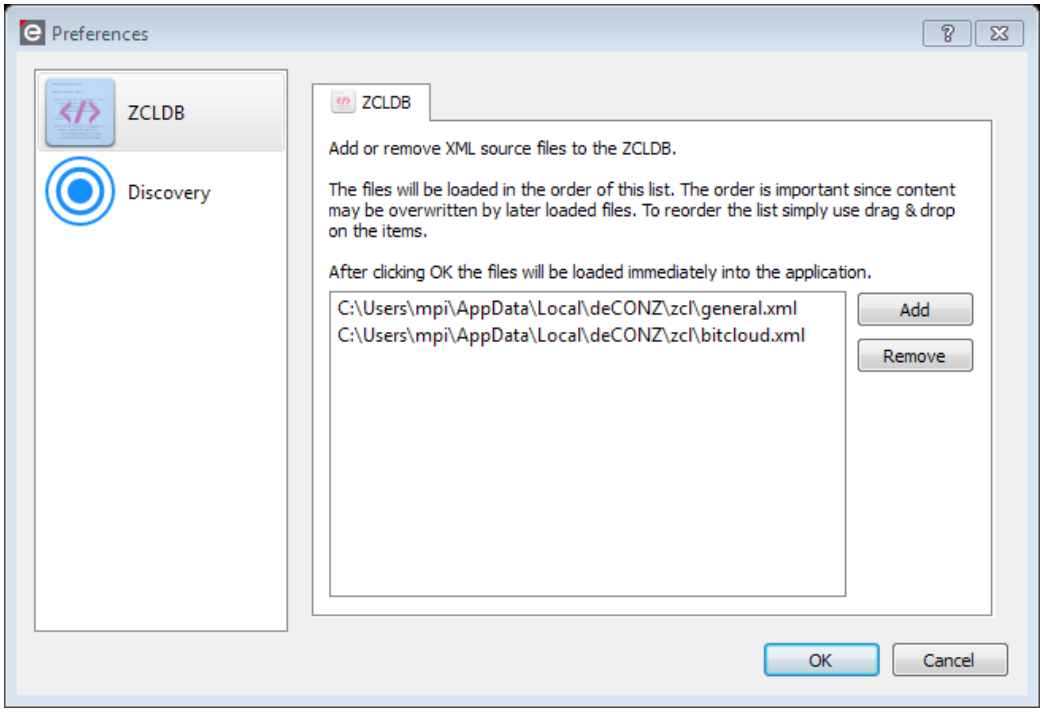


Figure 24: Preferences dialog

Click the *Add* button to specify the XML file. Note that the order of XML files matters and can be changed by drag & drop the items accordingly.

After pressing the OK button, all files will be reloaded. Nodes which were already fetched by the application must be re-fetched in order to reflect the new ZCLDB content (Edit/Reset selected nodes). Otherwise the changes will be visible only after application restart.

9.2. ZCLDB profiles and functional domains

A profile contains various clusters which in the ZigBee specification are bundled into functional domains. A cluster is not necessarily bound to a single profile; for example clusters in the general domain are used in different profiles like Home Automation and Healthcare. In the ZCLDB shared domains are expressed by defining the domains; just reference them by name in the profiles.

The attribute *useZcl* of a domain element should be set to true if the domain clusters are using the ZCL. If *useZcl* is set to false then no ZCL data frames will be generated but plain APS data frames.

```
<domain name="General" description="…" useZcl="true">

    <!--  Here follows the cluster list -->

</domain>

<profile id="0x0104" name="Home Automation" description="…" icon="ha_profile.svg">

    <domain-ref name="General" />

    <domain-ref name="Lighting" />

    …

</profile>
```

The profile is identified by the 16-bit profile-ID. The name, description and icon attributes will be used to present a human readable interface to the user. This is a common pattern for most elements in the ZCLDB.

Table 1: The XML attributes of the domain element

XML Attribute	Type	Description	Mandatory
name	Text	The domain name.	Yes
description	Text	The domain description.	No
useZcl	true or false	If the domain uses ZCL. If this attribute is not given ZCL will be assumed.	No

Table 2: XML attributes of the profile element

XML Attribute	Type	Description	Mandatory
id	16-bit attribute-ID	The profile identifier.	Yes
name	Text	The profile name.	Yes
description	Text	The profile description.	No
icon	Image	The profile icon in the format svg, png or jpg	No

9.3. ZCLDB clusters

The clusters are kept in functional domains and may contain a server and client section. A cluster is identified by the 16-bit cluster-ID which will be compared against the IDs found in the simple descriptors of a device.

```
<cluster id="0x0003" name="Identify" description="…">

    <server>

        <!--  Attributes and commands -->

    </server>

    <client>

        <!--  Attributes and commands -->

    </client>

</cluster>
```

Table 3: XML attributes of the cluster element

XML Attribute	Type	Description	Mandatory
id	16-bit cluster-ID	The cluster identifier.	Yes
name	Text	The cluster name.	Yes
description	Text	The cluster description.	No
oppositeId	16-bit cluster-ID	The cluster identifier of the opposite if client and server don't share the same cluster-ID.	No

9.4. ZCLDB attributes

The server and client section of a cluster may contain one or more attributes. Attributes define how data is treated and which GUI widgets will be presented to the user.

```
<server>

<attribute id="0x0000" name="Identify Time" type="u16" access="rw" required="m">

</attribute>

</server>
```

As shown in **Figure 25** attributes are listed in the attribute table from the *Cluster Info Panel.*

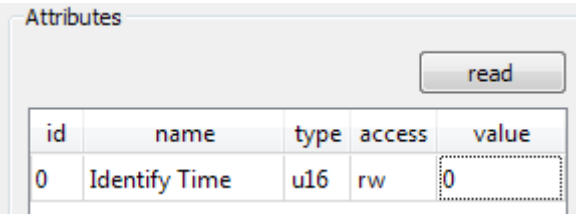


Figure 25: The resulting attribute table

Table 4: XML attributes of the attribute element

XML Attribute	Type	Description	Mandatory
id	16-bit attribute-ID	The attribute identifier.	Yes
name	Text	The attribute name.	Yes
description	Text	The attribute description.	No
type	Short name of a data type	The attribute data type.	Yes
access	Read write (rw) or read only (r)	The attribute access rights.	Yes
required	Mandatory (m) or optional (o)	Specifies if mandatory or not.	Yes
showas	hex, bin, slider	Specifies how the attribute will be shown. In the case that *slider* is used a range shall be given.	No
range	Numeric range	Specifies a valid range for a numeric attribute. For example range="0,255".	No

The attributes may contain further *value*-elements to describe the bits of a bitmap or a enumeration data type. The following example shows a 8-bit bitmap attribute with 3 possible flags; each bit is defined by a value element with a name and the bit position starting at 0. In the GUI the bits will be shown as checkboxes.

```
<attribute id="0x0002" name="Options" type="bmp8" access="rw" required="m">

    <value name="Custom Flag 1" value="0"></value>

    <value name="Custom Flag 2" value="1"></value>

    <value name="Custom Flag 3" value="5"></value>

</attribute>
```

Besides bitmaps enumerations could be represented as follows. In the GUI the single values will be shown in a Combobox.

```
<attribute id="0x0006" name="Startup Control" type="enum8" access="rw" required="m">

    <value name="Part of the network" value="0"></value>

    <value name="Form a network" value="1"></value>

    <value name="Rejoin the network" value="2"></value>

    <value name="Start from scratch" value="3"></value>

</attribute>
```

9.5. ZCLDB commands

ZCL commands represent the functions of a cluster. Both server and client clusters may send and receive commands. To define a command with parameters the element *payload* must be used which shall contain one ZCLDB attribute definition for each parameter.

```
<server>

<command id=”0x00” dir=”recv” name=”Identify” required=”m” description=”Start or stop …”>

    <payload>

        <attribute id="0x0000" type="u16" name="Identify Time" required="m"

                    default="5" description=”…”>

        </attribute>

    </payload>

</command>

<server>
```

The resulting widget is shown on the left. All names and descriptions are visible to the user. The description and data type of parameters will be shown as tooltip in the line edit.

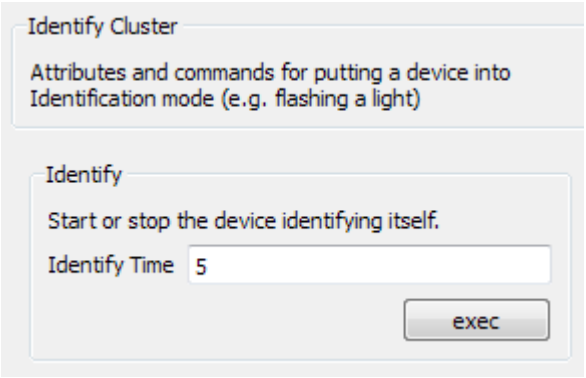


Figure 26: The resulting widget

Table 5: XML attributes of the command element

XML Attribute	Type	Description	Mandatory
id	8-bit command-ID	The command identifier.	Yes
name	Text	The command name.	Yes
description	Text	The command description.	No
required	Mandatory (m) or optional (o)	Specifies if mandatory or not.	Yes
dir	recv or send	Specifies if the command direction is to or from server or client.	Yes

9.6. ZCLDB data types

The data types are used by all attributes and command parameters. Currently only a sub-set of often used data types from the ZCL specification are implemented in the application.

ID	Name	Shortname	Length (bytes)	Analog/Discrete
0x00	No data	ndat	0	-
0x08	8-bit data	dat8	1	D
0x09	16-bit data	dat16	2	D
0x0A	24-bit data	dat24	3	D
0x0B	32-bit data	dat32	4	D
0x0C	40-bit data	dat40	5	D
0x0D	48-bit data	dat48	6	D
0x0E	56-bit data	dat56	7	D
0x0F	64-bit data	dat64	8	D
0x10	Boolean	bool	1	D
0x18	8-bit bitmap	bmp8	1	D
0x19	16-bit bitmap	bmp16	2	D
0x1A	24-bit bitmap	bmp24	3	D
0x1B	32-bit bitmap	bmp32	4	D
0x1C	40-bit bitmap	bmp40	5	D
0x1D	48-bit bitmap	bmp48	6	D
0x1E	56-bit bitmap	bmp56	7	D
0x1F	64-bit bitmap	bmp64	8	D
0x20	Unsigned 8-bit integer	u8	1	A
0x21	Unsigned 16-bit integer	u16	2	A
0x22	Unsigned 24-bit integer	u24	3	A
0x23	Unsigned 32-bit integer	u32	4	A
0x24	Unsigned 40-bit integer	u40	5	A
0x25	Unsigned 48-bit integer	u48	6	A
0x26	Unsigned 56-bit integer	u56	7	A
0x27	Unsigned 64-bit integer	u64	8	A
0x28	Signed 8-bit integer	s8	1	A
0x29	Signed 16-bit integer	s16	2	A
0x2A	Signed 24-bit integer	s24	3	A
0x2B	Signed 32-bit integer	s32	4	A
0x2C	Signed 40-bit integer	s40	5	A
0x2D	Signed 48-bit integer	s48	6	A
0x2E	Signed 56-bit integer	s56	7	A
0x2F	Signed 64-bit integer	s64	8	A
0x30	8-bit enumeration	enum8	1	D
0x31	16-bit enumeration	enum16	2	D
0x41	Octed string	ostring	-	D
0x42	Character string	cstring	-	D
0xE2	UTC time	utc	4	A
0xE8	Cluster id	cid	2	D
0xE9	Attribute id	aid	2	D
0xEA	BACnet oid	oid	4	D

0xF0	IEEE address	uid	8	D
0xF1	Security key	seckey	16	D

9.7. ZCLDB devices

The definition of devices in the ZCLDB is only needed to show the name and icon of a device in the endpoint drop-down menu.

All devices must be placed in the devices-element.

```
<devices>

    <device id="0x0301" name="Thermostat" description="…" icon="dev-thermostat.png">

    </device>

</devices>
```

Some devices might be specific to a profile, in that case the device shall be placed into the related profile element.

```
<profile id=“0x0104“ name=“Home Automation“>

    <!-- Here follows the domain refs -->

    <device id="0x0333” name="Custom Device1" description="…">

    </device>

</profile>
```

Table 6: XML attributes of the device element

XML Attribute	Type	Description	Mandatory
id	16-bit device-ID	The device identifier.	Yes
name	Text	The device name.	Yes
description	Text	The device description.	No
icon	Image	The device icon in the format svg, png or jpg	No

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