

ZCL over IP (dotdot) – Basics

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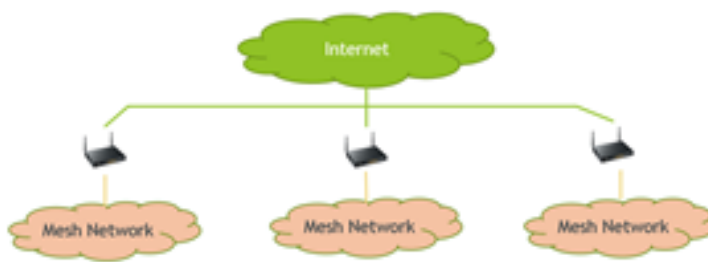
What is dotdot?

“**Dotdot** is the universal language of the Internet of Things, making it possible for smart objects to **work together on any network**” (<https://www.speakdotdot.com>).

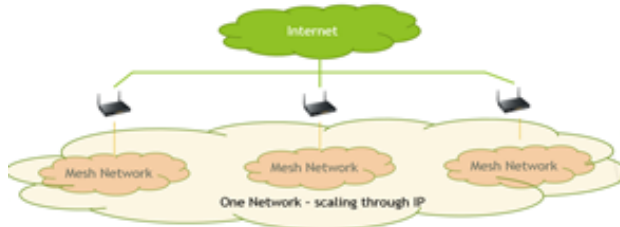
In other words, is a generalization of the application layer functionality developed by ZigBee Alliance, including parts of the ZigBee Cluster Library and ZigBee PRO functionality.

IP vs non-IP wireless mesh architecture

Non-IP mesh architecture. Individual mesh networks. Mesh design scaled by duplication (e.g short Address); Complex network management for each Gateway



IP mesh architecture. Simplified network management. Synchronized operations across subnets. Shared gateway connections to a plant network. One network scaling through IP.



Concepts. ZigBee to ZCL over IP

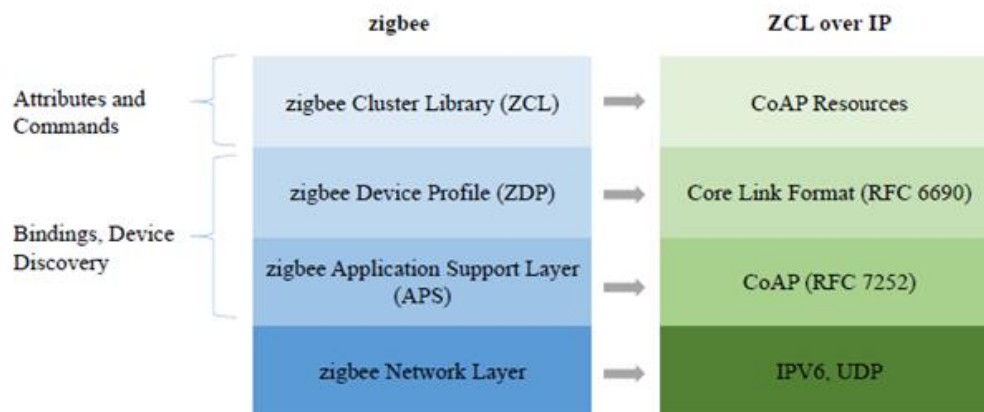
Node -> Endpoints -> Clusters -> attributes and commands:

- A node contains an 802.15.4 radio and is defined by one or more application endpoints;
- A device, in ZCL terms, resides to an endpoint (e.g. OnOffLight, DimmableLight); This includes a list of input and output clusters;
- Each cluster is a collection of commands and attributes used to act and store a specific state of a device. In programming terms, a cluster is an object (e.g – DimmableLight device contains Level Control Cluster);
- Attributes are the state of the cluster, or the data;

Addressing methods:

- Direct addressing, binding and group (multicast) methods;
- Unique Identifier is introduced because the IPv6 address can change any time;

ZigBee to ZCL over IP mapping:



Application layer security (ZCL over IP)

- Unique Identifier. This is associated to a certificate provided by manufacturer.
- All devices must support handling of operational certificates;
- DTLS based on pre-shared key raw public key or certificates;

ZCL Commands and CoAP

- The concept of transactions: request, followed by response. In ZCL over IP each transaction consists in a request, CoAP method (GET/PUT/POST/DELETE) and a corresponding CoAP response (e.g 2.05 Content, 4.05 Method not Allowed, 2.04 Changed).
- ZCL over IP resource table:

Resource	Methods	URI
Resource discovery	GET	/zcl
Endpoints	GET	/e
Attributes	GET, PUT, POST	/a
Commands	GET, POST	/c
Bindings	GET, PUT, POST, DELETE	/b
Report Configuration	GET, PUT, POST, DELETE	/r
Report Notification	POST	/n
Group Notification	POST	/g
EZ-Mode Commissioning	GET, POST	/m

- ZCL commands and CoAP options
 - Read Attributes = CoAP GET -> /a/<attributeId>;
 - Write Attributes = CoAP PUT/POST -> /a/<attributeId>;
 - Discover Attributes = CoAP GET /a;
 - Configure Reporting instance = CoAP PUT/POST/DELETE -> /r/<reportId>
 - Configure Reporting collection = CoAP PUT/POST/DELETE -> /r
 - Read configure reporting = CoAP GET -> /r/<reportId>
 - Report attributes = CoAP POST -> /n
- Examples of commands:

- ZDP discovery commands (e.g, discover endpoints implementing the client side of the onoff cluster - Id = 0x006 -):

Request - multicast query:

GET COAP://[FF03::FD]/.well-known/core?rt=urn:zcl:c:6:c

Reply – CoAP reponse code 2.05 Content:

2.05 Content (Content format: application/link format (40))

<coap: //fd01:3ead:0001::dece:0001]/zcl/e/1/c6>;rt-

urn:zcl:c:6.c;ze=urn:z:cl:d.103.1

- Read attribute (e.g OnOff attribute, Id = 0x000, cluster Id = 0x0006, Endpoint = 0x08)

Request – CoAP GET

GET COAP://[fd01:3ead:0001::dece:00002]/zcl/e/8/s6/a/0

Reply – CoAP reponse code 2.05 Content:

2.05 Content with a CBOR map payload {0:0} (indicating that the OnOff attribute is currently in the Off state);

- Cluster Commands (e.g: On command, cluster Id = 0x0006, endpoint id = 0x08, command Id = 0x01):

Request – CoAP POST

POST COAP://[fd01:3ead:0001::dece:00002]/zcl/e/8/s6/c/1

Reply – CoAP reponse code 2.04 Changed:

2.04 Changed with no payload (indicating a Default response with status Success)

- Wireshark capture (configure reporting command):

Capturing from Ethernet 7 [Wireshark 2.10-Thread (v2.1.0rc0-2606-ga0c516d from master)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
41	42.265173	::35a4:9150:5d92:ad	::e1e5:9d69:7cd3:4645	CoAP	84	CON, MID:57492, POST, /zcl/e/1/s6/c/1
42	42.265453			IEEE 802.15.4	19	Ack
43	42.291194	::e1e5:9d69:7cd3:4645	::35a4:9150:5d92:ad	CoAP	66	ACK, MID:57492, 2.04 changed
44	42.291568			IEEE 802.15.4	19	Ack
45	55.407809	fe80::9d8b:276:9a11:3957	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement
46	62.534231	fe80::c4d:934:fa4e:8adc	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement
47	63.552177	fe80::303a:b8f5:a4c0:da19	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement
48	86.508641	fe80::303a:b8f5:a4c0:da19	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement
49	87.084212	fe80::9d8b:276:9a11:3957	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement
50	87.727560	fe80::c4d:934:fa4e:8adc	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement
51	104.029824	fe80::303a:b8f5:a4c0:da19	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement
52	111.984947	fe80::c4d:934:fa4e:8adc	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement
53	117.423695	fe80::9d8b:276:9a11:3957	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement
54	127.144639	fe80::303a:b8f5:a4c0:da19	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement
55	142.812885	fe80::c4d:934:fa4e:8adc	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement
56	145.163687	fe80::9d8b:276:9a11:3957	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement
57	159.091985	fe80::303a:b8f5:a4c0:da19	ff02::1	Mesh Link Exchange	85	MLE Secured Advertisement

Constrained Application Protocol, Confirmable, MID:57492, POST

01.. = Version: 1
 ..00 = Type: Confirmable (0)
 0000 = Token Length: 0
 Code: POST (2)
 Message ID: 57492
 Opt Name: #1: Uri-Path: zc1
 Opt Name: #2: Uri-Path: e
 Opt Name: #3: Uri-Path: 1
 Opt Name: #4: Uri-Path: s6
 Opt Name: #5: Uri-Path: c
 Opt Name: #6: Uri-Path: 1

0000 60 04 3b 71 00 1b 11 fe 00 00 00 00 00 00 00 00 .:q....
 0010 35 a4 91 50 5d 92 00 ad 00 00 00 00 00 00 00 00 5..P]
 0020 e1 e5 9d 69 7c d3 46 45 db 05 16 33 00 1b 3e c0 ...1.FE...3...>
 0030 40 02 e0 94 b3 7a 63 6c 01 05 01 31 02 73 36 01 8...zc1.c.1.s6.
 0040 63 01 31 c.1]