



Software Design Specification

Z/IP - Z-Wave for IP; Gateway Requirements

Document No.:	SDS11468
Version:	1
Description:	The Z/IP Gateway is a mandatory extension to the Z/IP Router. The extension allows Z-Wave nodes to be controlled from an IP environment and appear as IP hosts in an IP network.
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Restrictions:	RD Only

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REVISION RECORD

Doc. Rev	Date	By	Pages affected	Brief description of changes
1	20091210	ABR	ALL	Z/IP gateway requirements extracted from PSP10910
1	20100526	ABR	ALL	Editorial clarifications.

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1 TERMS AND ABBREVIATIONS

Term	Explanation
DIP	Destination IP address
HAN	Home Area Network (a Z-Wave network in this context)
HTTP	HyperText Transfer Protocol
IP	Internet Protocol
IP host address	The LS bits of the IP address that are not “subnet” bits
IP network address	The “subnet” part of the IP address. Also refer to “Prefix”.
LAN	Local Area Network (a local network; properly protected by firewall, etc.)
PAN	Personal Area Network – an IEEE term meaning the same as HAN.
Prefix	The bits of an IP address that identifies the subnet. Where IPv4 used prefix as well as subnet mask notations, IPv6 always uses the prefix notation.
Router	Network device operating at layer 3 in the OSI stack (e.g. IP packets)
SIP	Source IP address
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
Unsolicited frame	Z-Wave frame sent to the Z/IP Gateway by a Z-Wave node. The frame is initiated by an event in the Z-Wave node.
Z/IP	Z-Wave for IP
Z/IP Gateway	Extension to the Z/IP Router allowing native Z-Wave nodes to be controlled via IP.
Z/IP Packet	UDP packet carrying Z/IP control information and a Z-Wave command

2 INTRODUCTION

2.1 Purpose

This document describes the features of the Z/IP Gateway software module.

The Z/IP Gateway is a mandatory extension to the Z/IP Router [5]. The Z/IP Gateway allows classic Z-Wave nodes to be controlled from an IP environment and to appear as IP hosts in an IP network.

2.2 Audience and prerequisites

Zensys R&D and subcontractors under NDA.

The reader must be familiar with:

- Basic Z-Wave network creation and maintenance
- Basic IP terminology such as routing, ping, TCP, UDP, subnet, etc.
- IPv4 and IPv6 addressing principles

While not used consequently throughout the document, the guidelines outlined in IETF RFC 2119 "Key words for use in RFCs to Indicate Requirement Levels" are followed in many sections. Essentially, the key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119.

3 Z/IP GATEWAY OVERVIEW

The Z/IP Gateway specification provides definitions for interfacing IP applications with Z-Wave nodes.

The Z/IP Gateway emulates the behavior of IP enabled devices so that IP applications may interact with Z-Wave devices via normal IP routing principles. The Z/IP gateway is a functional module of the Z/IP Router architecture.

The Z/IP Gateway must provide the following features:

- Transparent gateway; IP applications reach Z-Wave nodes via IP addresses
- Mapping IPv6 host addresses to Z-Wave node IDs
- Respond to IP Ping (ICMP Echo) on behalf of Z-Wave nodes
- Terminate Z/IP Packets originated by IP applications;
forward Z-Wave commands to Z-Wave nodes



Figure 1, Z/IP Gateway terminating Z/IP Packets

Appendix A and Appendix B contains use cases and sequence diagrams outlining the features implemented by the Z/IP Gateway.

4 Z/IP GATEWAY REQUIREMENTS

4.1 Decoding Z/IP Packets

Z/IP Packets are carried in UDP packets for port 4123 [1].

The Z/IP Gateway **MUST** be able to decode Z/IP Packet headers [6] and forward extracted Z-Wave commands to relevant receivers.

4.2 IPv6 support

4.3 The Z/IP Gateway **MUST** accept IPv6 packets. IP support for Z-Wave nodes

The Z/IP Gateway **MUST** perform a Z-Wave node capability check for each IP packet received. If the IPv6 address represents a Z-Wave node, the Z/IP Gateway **MUST** intercept the IP packet and, if possible, emulate the requested IP service by making use of equivalent features offered via Z-Wave.

The Z/IP Gateway **MUST** implement the mandatory IP services outlined in the following sections.

4.3.1 Ping

IP Service	Requirement level	Comment
Ping	Mandatory	<u>ICMP Type 8: Echo request</u> The Z/IP Gateway must send a Z-Wave NOP command to a target Z-Wave node. In case the Z/IP Gateway receives an Ack for the NOP, an ICMP Echo reply is generated and returned to the IP device that originated the ICMP Echo request. The data received with the Echo request must be entirely included in the Echo reply. <i>Note: Ping works over LAN, but some ISPs filter out ICMP Echo requests over the Internet for security reasons.</i>

4.3.2 Z-Wave Control

IP Service	Requirement level	Comment
Z-Wave Control	Mandatory	<p><u>UDP Port 4123: Z-Wave Control Protocol</u></p> <p>The Z/IP Gateway must forward the Z-Wave Control command carried in the payload of the Z/IP packet.</p> <p>When the Z/IP Gateway receives a Z-Wave protocol Ack from the destination node, the Z/IP Gateway must form a Z/IP Ack packet and return it to the source IP address.</p> <p>If the Z/IP Gateway times out waiting for a Z-Wave Ack from the destination node, the Z/IP Gateway must form a Z/IP Nack packet¹ and return it to the source IP address.</p> <p><i>Note: The NACK tells the remote application that there is no need to retransmit. Z-Wave already tried retransmitting via alternative routes. It may be possible to reach the node at a later time.</i></p>

4.3.3 Web server

IP Service	Requirement level	Comment
Web server	Optional	<p><u>TCP Port 80: HTTP</u></p> <p>The Z/IP Gateway may host a web page presenting controls matching the properties of that particular node.</p> <p>The properties of a Z-Wave node are made available to the Z/IP Gateway in the Z-Wave Node Information frame in response to a Z-Wave Node Information request.</p>

4.4 Unsolicited forwarding

Z-Wave frames targeting the nodeID of the Z/IP Gateway are referred to as “unsolicited frames” if the originating HAN node did not recently receive communication from the Z/IP Gateway. Typically, unsolicited Z-Wave frames may come from a sensor or a remote control.

The Z/IP Gateway **MUST** provide a mechanism for forwarding unsolicited Z-Wave frames to a pre-defined IPv6 address. When receiving unsolicited frames, the Z/IP Gateway cannot directly determine where to send the encapsulated Z-Wave command as it carries no destination IPv6 address. The user has to specify where unsolicited Z-Wave frames should be forwarded.²

When the Z/IP Gateway forwards an unsolicited Z/IP command to an IP host, the Z/IP Gateway **MUST NOT** set the Ack Req flag in the Z/IP Packet header.

¹ A Z/IP Nack packet is a Z/IP packet carrying a Nack flag.

² Broadband access routers often offer a similar feature; allowing the user to specify a local IP address that should receive all IP traffic coming from the outside if it does not seem to be in response to traffic originated by another node on the local network.

4.5 Network management

4.5.1 HAN (Z-Wave network)

4.5.1.1 Unsolicited Z-Wave traffic

By default, forwarding of unsolicited frames from the Z-Wave network **MUST** be disabled. The IP address and port fields for the target server **MUST** be cleared to avoid any unintended traffic going into the internet without the user explicitly specifying a target address.

If the Z/IP Gateway is provided to end-customers as part of a service offering, the IP address and port fields for the target server **MAY** be preset to match the service provider's server on the internet. A reset to factory defaults **MUST** disable forwarding and clear the address of the target server.

WEB management interface requirements:

- Checkbox: "Forward unsolicited HAN traffic" (Default: disabled)
- Text field: Target server address (IP address or URL - Default: (empty))
- Text field: Target server port (Default: 4123 (UDP))

5 USE CASES

5.1 Controlling a Z-Wave node from a LAN IP application

Z/IP packets are used for transport of Z-Wave commands over IP.

The Z/IP packet may carry Z/IP-specific information between network nodes in an IP environment, such as end-to-end Z/IP Ack request.

Refer to [6] for details of the Z/IP Packet format.

Z/IP encapsulated Z-Wave commands may be sent to a Z-Wave node via the Z/IP Gateway. Sending a Z/IP packet to port 4123 of the target node's IPv6 address will cause the Z/IP Gateway to de-encapsulate the Z-Wave command and forward it to the target node in a Z-Wave frame.

The following use cases involve Z-Wave control communication via Z/IP.

5.1.1 Sending a Z-Wave command



Figure 2, Z-Wave control via Z/IP

The Z-Wave command is encapsulated in a Z/IP packet (UDP packet w. Z/IP header).

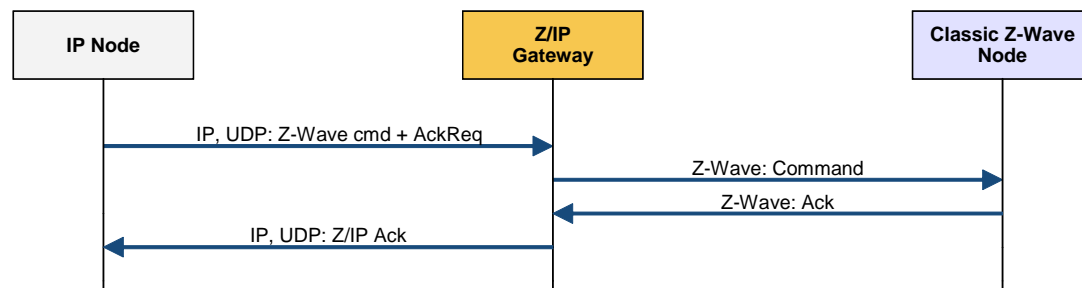


Figure 3, Z-Wave command carried via Z/IP

If a calling IP application asks for a high-level acknowledgement, the Z/IP Gateway returns a Z/IP Ack message when a Z-Wave Ack frame arrives. The Z/IP Gateway waits for a well-defined time for the Z-Wave Ack frame after sending the Z-Wave command into the Z/IP HAN. The Z/IP Gateway then either receives a Z-Wave Ack frame or it times out.

Table 1, Z/IP packet for local LAN control, command version

IP Header	
Destination Address	IPv6 address of the Z-Wave node
Source Address	IPv6 address of the IP node (the PC)
UDP Header	
Destination Port	The Z-Wave UDP control port (4123)
Source Port	Chosen by the IP node
Z/IP Packet Header	
AckRequest	Enabled
ZwCommandIncluded	Enabled
ZwCommand	Command sent to the Z-Wave device

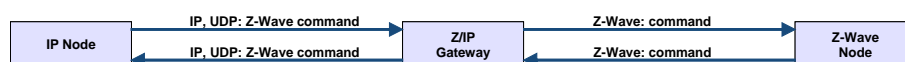
The Z/IP Gateway intercepts the Z/IP packet. The UDP header is cached in memory. The HAN IP address of the target node is mapped to a Z-Wave home ID and node ID by the Z/IP Gateway.

Table 2, Z/IP packet for local LAN control, ack version

IP Header	
Destination Address	The source IPv6 address of the original packet
Source Address	The destination IPv6 address of the original packet
UDP Header	
Destination Port	The source port of the original packet
Source Port	The destination port of the original packet
Z/IP Packet Header	
Ack	Enabled

5.1.2 Receiving Z-Wave commands in response to a Z-Wave command

An IP node may receive Z-Wave commands in response to commands sent to a Z-Wave node via a Z/IP Gateway.

**Figure 4, Z-Wave control via Z/IP w. response**

The Z-Wave command is encapsulated in a Z/IP packet (UDP packet w. Z/IP header).

A Z-Wave command is sent to a Z-Wave node.

If the Z/IP Gateway receives a Z-Wave command from that same Z-Wave node within 10 sec, that Z-Wave command is assumed to be a response to the first command.

Therefore, that Z-Wave command is relayed back to the IP node originating the previous Z-Wave command.

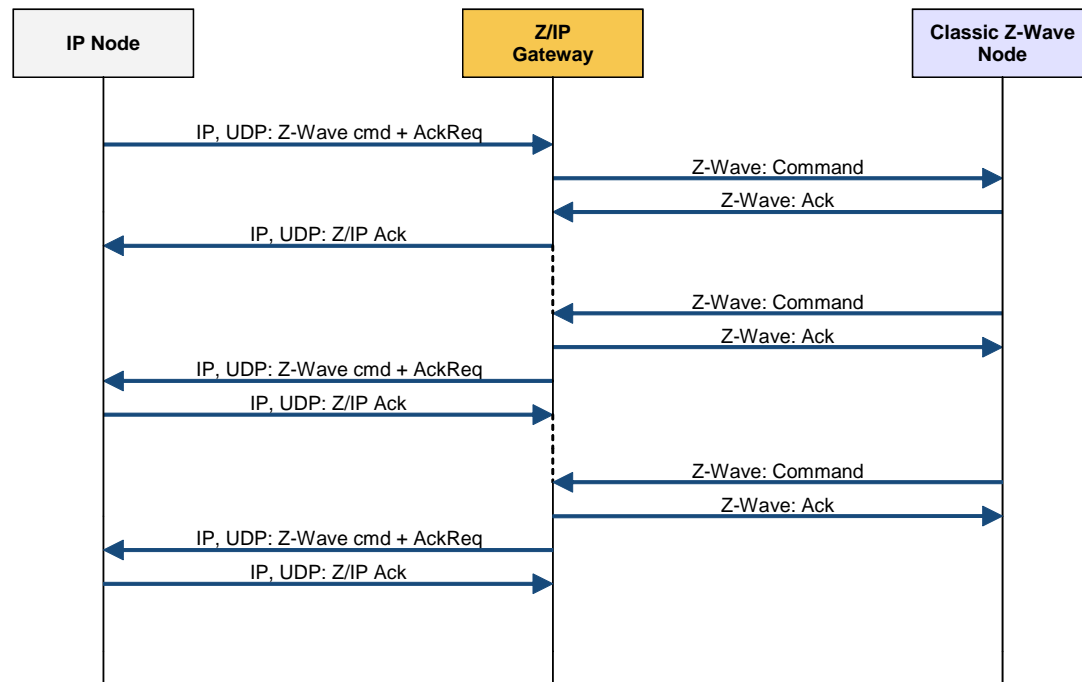


Figure 5, Z-Wave command carried in UDP w. response

Certain Z-Wave commands cause a Z-Wave node to return other commands in response to the first command. Z-Wave response commands would be considered unsolicited frames if the Z/IP Gateway was not able to match the original Z-Wave command and the associated response command. A response-waiting timer is used for this. Multiple response-waiting timer instances may exist at the same time.

Identification of the expected response frame:

The response frame is sent TO the Z/IP Gateway and comes FROM a node which received a Z-Wave command FROM the Z/IP Gateway within the last 10 seconds.

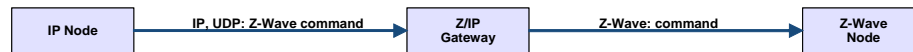
Every new frame MUST re-arm the response-waiting timer so that special applications returning more than one response frame are also supported.

The response frame MUST be returned to the source IP address and source UDP port of the original Z/IP packet.

APPENDIX A USE CASE DIAGRAMS

Diagrams are simplified, not showing low-level Z-Wave Acks, UDP Acks, etc.

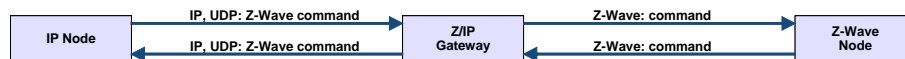
Appendix A.1 U-1: Z-Wave control via UDP



Z-Wave command is carried via UDP.

The Z-Wave command is encapsulated in a Z/IP packet (UDP packet w. Z/IP header).

Appendix A.2 U-1b: Z-Wave control via UDP w. response



Z-Wave command is carried via UDP.

The Z-Wave command is encapsulated in a Z/IP packet (UDP packet w. Z/IP header).

If the Z/IP Gateway receives a Z-Wave command from the Z-Wave node within 10sec, that Z-Wave command is assumed to be a response to the first command.

Therefore, that Z-Wave command is relayed back to the IP node.

Appendix A.3 U-2: Pinging a Z-Wave node



Ping (ICMP Echo) request is intercepted by the Z/IP Gateway.

Referring to Z-Wave node capabilities, the Z/IP Gateway sends a Z-Wave NOP to Z-Wave nodes

If the Z/IP Gateway receives a Z-Wave Ack for the NOP, a Ping (ICMP Echo) response is returned to the IP node.

Appendix A.4 U-4: Z-Wave command to LAN IP node



Z-Wave node sends a Z-Wave command to the Z/IP Gateway.

Z-Wave commands arriving spontaneously are also known as "Unsolicited frames".

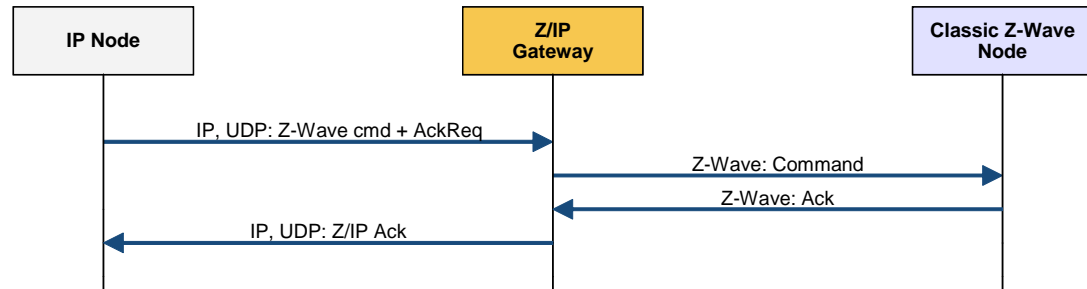
The Z/IP Gateway forwards the Z-Wave command via UDP to a pre-defined IPv6 address. The IP node may be a server or an IP-based Z-Wave control resource.

The Z-Wave command is encapsulated in a Z/IP packet (UDP packet w. Z/IP header).

APPENDIX B SEQUENCE DIAGRAMS

Sequence diagrams involving classic Z-Wave nodes are numbered Sq-1, Sq-2, ...

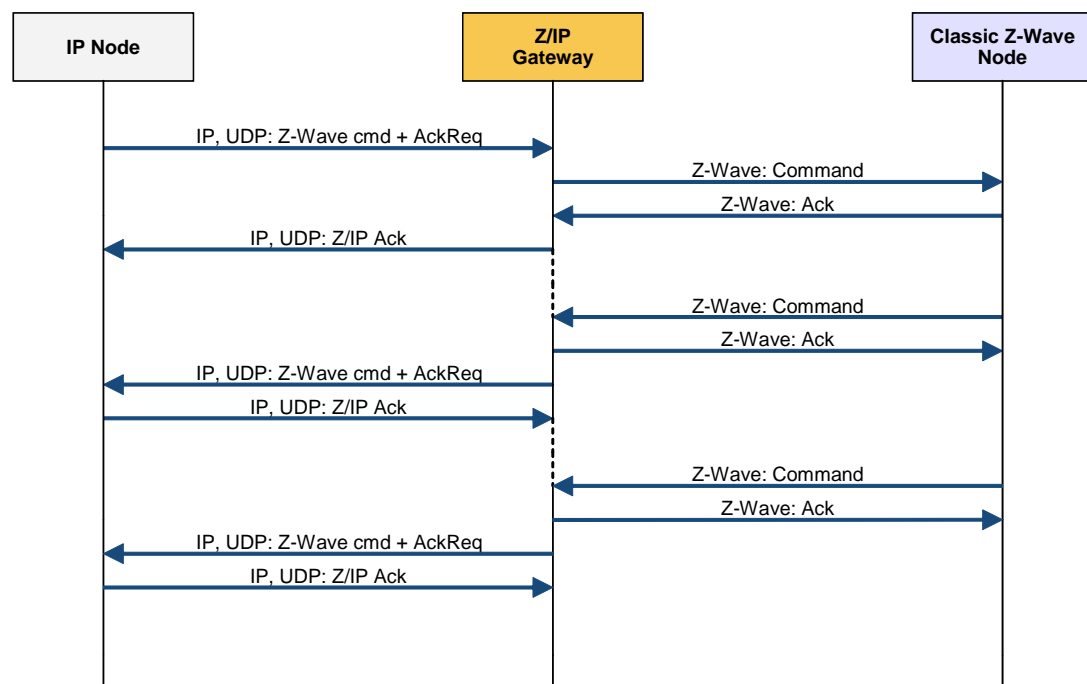
Appendix B.1 Sq-1: Z-Wave command carried via UDP



Use Case 1:

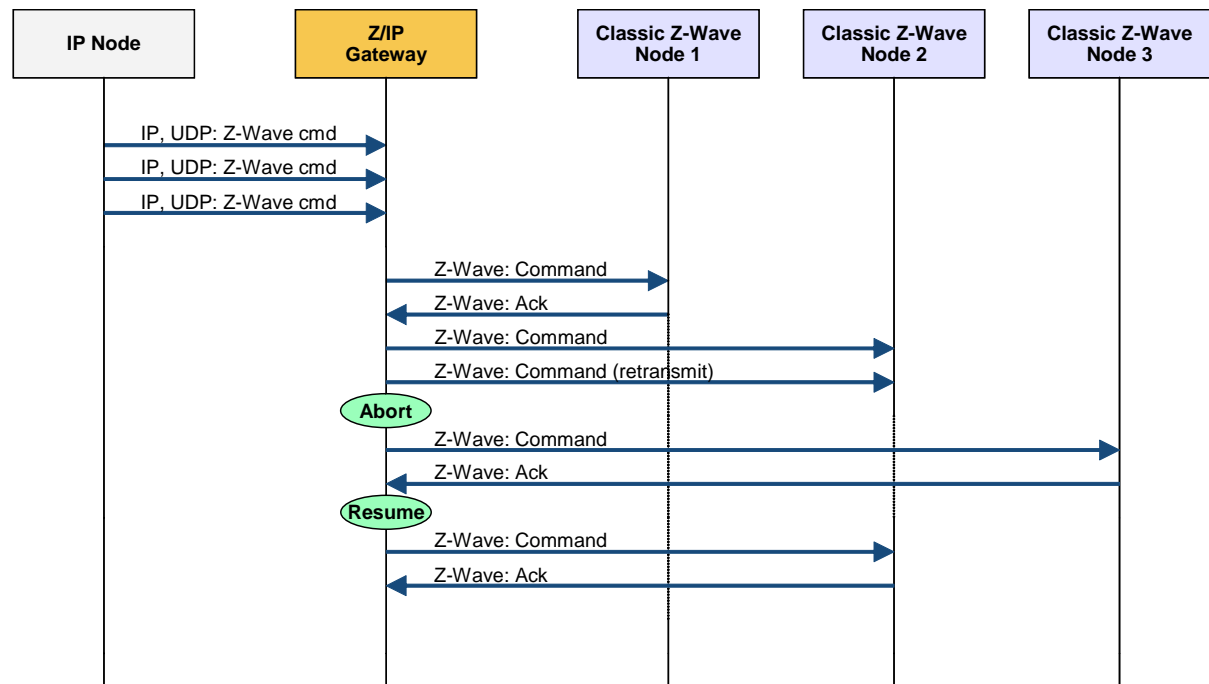
IP Node receives high-level Ack from Z/IP Gateway if command is correctly delivered

Appendix B.2 Sq- 1b: Z-Wave command carried in UDP w. response



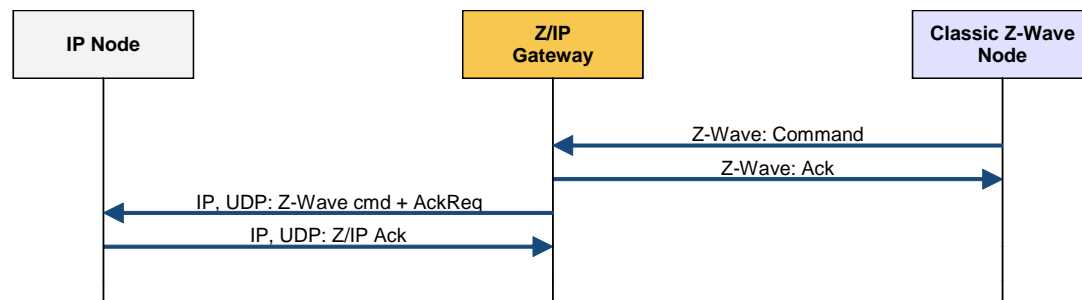
Use Case 1b:

Z/IP Gateway forwards returned Z-Wave commands to the IP node if they arrive shortly after a command was sent to that same node.

Appendix B.3**Sq-1c: Z-Wave command carried in UDP**

Use Case 1:

Z/IP Gateway must suspend transmission to nodes that do not respond if other commands are waiting.

Appendix B.4**Sq-2: Z-Wave command to IP node**

Use Case 4:

Z/IP Gateway must be able to forward unsolicited commands to predefined IPv6 address in the LAN or in the Internet.

REFERENCES

- [1] Zensys Z-Wave Control Protocol assigned number.
<http://www.iana.org/assignments/port-numbers>
- [2] IETF RFC 2119 Key words for use in RFCs to Indicate Requirement Levels
- [3] Zensys, INS10034, Instruction, Z-Wave Development
- [4] Zensys, INS11095, Application Programming Guide v4.53
- [5] Zensys, SDS11465, Z/IP Router Requirements
- [6] Zensys, SDS11814, Z/IP Command Class Specification
- [7]