Software Release Note

Z/IP GW SDK 2.81.03

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REVISION RECORD

Doc. Rev	Date	By	Pages affected	Brief description of changes
1	20180122	JRM	ALL	Version set to mature 2.81.00 CC table formats updated
2	20180305	BBR	All	Added Silicon Labs template
3	20181220	DEWASSIE	3, 4.1, 4.2, 4.15, & 4.17	Updated to 2.81.01 maintenance release Removed Application Capability command class support Updated Z/IP command class to V4
4	20190304		ALL	Updated to 2.81.02 maintenance release
5	20190523		ALL	Updated to 2.81.03 maintenance release

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1 ABBREVIATIONS

The following terms and abbreviations are used throughout the document

Abbreviation	Explanation
CC	Command Class
FLiRS	Frequently listening Routing Slave A battery-powered node type which may be reached within a few 100 ms. Typically used for applications such as door bells, networked smoke alarms, etc.
NWI	Network-wide Inclusion With network-wide inclusion, nodes may be scattered all over a house and still be included without being in direct range. This simplifies creation of bigger networks and allows a central static controller to handle the inclusion process without the need for a special inclusion controller carried around the house.
NWA	Network-wide Association The natural companion to Network-wide Inclusion. With NWA, Z-Wave networks may be managed from a central light controller in a hotel or from a remote call center supporter. NWA is purely IP-based and works over any physical layer. Several use cases in this document address this feature.
Remote network management	The Primary controller is in the heart of Z-Wave. With Z-Wave remote network management, it is possible to remotely manage a Z-Wave network by remote controlling the primary controller. Several use cases in this document address this feature.
Wake-up Node	A battery-powered node type which stays in low power mode for long periods. When waking up, it may just do a single measurement before returning to sleep. The node autonomously decides when to send a report or a WakeUpNotification to a mailbox node. WakeUpNotifications may be sent at very long intervals.
Z/IP	Z-Wave for IP. A framework defining mechanisms for • Transport of IP packets over a physical Z-Wave infrastructure • Transport of Z-Wave application commands in IP packets
Z/IP Node	A Z-Wave node capable of exchanging and processing IP packets
Z/IP Packet	A Z/IP packet is a UDP packet carrying a Z-Wave command with a pre-pended Z/IP header.

2 INTRODUCTION

The Z/IP Gateway Software Development Kit enables developers to write applications for the Z/IP Framework.

2.1 Purpose

The Z/IP framework extends the application scope of Z-Wave services from a classic Z-Wave wireless network to the networked world of IP; including the Internet.

This document provides an architectural overview of the Z/IP design philosophy and the mechanisms developed.

2.2 Audience and prerequisites

The audience of this document is Z-Wave Partners and Silicon Labs interested in evaluating the Z/IP Framework. The reader must be familiar with:

- Basic IP terminology such as routing, ping, UDP, subnet, etc.
- Basic Z-Wave network creation and maintenance

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 SDK DESCRIPTION

The Z/IP Gateway Software Developers Kit contains the following software components:

- **Z/IP Gateway.** Allows Z-Wave nodes to be controlled from an IP environment and appear as IP hosts in an IP network.
    - **Binary for BeagleBone Black platform**
    - **Linux x64 Debian Package**
    - **Source code**
- **Ubuntu 16.04 LTS 64-bit Virtual Machine** with environment setup for compilation.
- **Python Graphical Z/IP Client:** Test Sample application for testing Network Management functionality of the Z/IP Gateway.
- **Documentation, Framework and Guide.**

IMPORTANT NOTE:

- The Z/IP Gateway for this SDK MUST use DevKit 6.81.x or newer SerialAPI Bridge running on a 500-series chip. (Static Controller is NOT usable).
- A minimum of 32K NVM MUST be available for the SerialAPI.
- When operating as a secondary controller the Z/IP Gateway will not provide access to & from the Z-Wave PAN, it will however allow Network Management from the LAN to put it into Learn Mode to upgrade it to SIS. No other operations can be guaranteed to work.
- When implementing Multi Command Command Class support in the Z/IP Client at the unsolicited destination the Z/IP Client MUST forward commands encapsulated in the Multi Command to the Z/IP Gateway if it implements that specific Command Class. The Z/IP Client MUST then aggregate the responses and send the responses to device sending the original Multi Command.
- EEPROM.dat file format has changed and upgrading may require manual action:
    - 2.2x -> 2.6x / 2.8x requires the use of a conversion tool to convert from 2.2x format to 2.6x format. Please refer to Doxygen documentation.
    - 2.6x -> 2.8x will automatically convert eeprom.dat from 2.6x format.

- The APPLICATION_NODEINFO_OPTIONAL_FUNCTIONALITY flag is always set on both NIFs since the gateway supports other command class than mandatory ones. If the gateway only supports generic/specific device class, the flag has to be removed.
- The Z/IP gateway will send Wake Up No More Information (WUNMI) to newly included wake-up node when a Z/IP client has completed probing the node if Mailbox Command Class version 2 is supported. The Z/IP client should only send WUNMI if the gateway only supports Mailbox Command Class version 1.

4 Z/IP GATEWAY SDK 2.81.03 FEATURES

The Z/IP Gateway emulates the behavior of IP enabled Z-Wave devices so that IP applications may interact with Z-Wave devices via normal IP routing principles.

The Z/IP Gateway 2.81.03 provides the following features:

- Smart Start Auto-inclusion
  - Supports only Add Node, no support for Smart Start Learn Mode
- Transparent gateway; IP applications reach Z-Wave nodes via IP addresses. Z/IP Packets originating from LAN IP applications are terminated and forwarded as Z-Wave commands to Z-Wave Nodes. See the Z/IP Command Class Specification
  - Supports only Z-Wave Singlecast, no support for Multicast or Broadcast.
- Z-Wave nodes are identified by IPv6 and IPv4 host addresses
- IPv6 and IPv4 Ping (ICMP Echo) support
- SIS support
- Security 0 and Security 2 support
- Z/IP-ND: IPv6 and IPv4 address resolution for Z/IP Applications.
- Remote Access & Configuration
- Unsolicited forwarding to two destinations
- Resource & Service Discovery (mDNS) [2] [3]
- IP Association Proxy
  - Max 232 still apply for PAN (including IP Nodes)
- Mail Box Service – Support for Non-Listening
  - Configurable through CC
- Z/IP LAN Security using DTLS
- Installation and Maintenance framework
  - EEPROM Backup
  - Firmware Update of Z-Wave module attached to the Z/IP Gateway
  - Historical and current transmission statistics.
- WiFi support

The Z/IP Gateway implements two sets of command, one for the IP / LAN side and one for the Z-Wave / PAN side.

4.1 PAN-side Node Information Frames

The Node Information frame always comes in sets of 2 NIFs – one non-secure NIF and one Security Commands Supported Report (sometimes referred to as the “Secure NIF").

Technically there are four NIFs: A non-secure plus four secure NIFs for S0, S2 Unauthenticated, S2 Authenticated and S2 Access. The four Secure NIFs can be treated as one because all of them will be empty except the one for the highest security level the GW has in common with the node requesting the Secure NIF. So in practice, the gateway always presents a set of two NIFs, and which NIF set depends on the state of the gateway,

This section is only concerned with the PAN-side NIFs, there is also a LAN-side NIF. Please refer to Table 2 for information on the LAN-side NIF.

The Securely Added state is active when the GW has started its own network, is alone in the network or has been added to another secure network.

The Not Added NIF is presented while the GW is in Learn mode and is waiting to join another network. After the GW has joined a network, the NIF set changes to either Securely Included or Non-securely Included. If the Learn Mode is disabled without the GW joining a new network, the NIF set is reverted to its previous state.

Table 1, Node Information Frame contents

Command Class	Version	Not Added	Non-Secure added	Securely Added	
				Non-Secure	Secure
Security	1	X		X	
Security 2	1	X	X	X	
Transport Service	2	X	X	X	
Multi Channel[1]	4				
CRC16	1	X	X	X	
Supervision	1	X	X	X	
Network Management Basic	2				X
Network Management Inclusion[2]	3				X
Network Management Proxy	2				X
Network Management Installation Maintenance	2				X
Inclusion Controller[2]	1	X	X	X	
Node Provisioning[3, 4]	1				X
Wake Up[1]	2				
Z/IP	4				
Z/IP Portal	1				
Z/IP Gateway	1				
Z/IP Naming	1				
Z/IP ND	1				
IP Association	1				
Firmware Update	5				X
Mailbox	2				
Application Status	1	X	X	X	
Power Level	1	X	X		X
ZWavePlus Info	2	X	X	X	
Manufacturer Specific	2	X	X		X
Version	2	X	X		X
Association[1]	2				
Multi Channel Association[1]	3				

[1] These command classes are only controlled by the Z/IP Gateway and not listed in any NIF and will not answer to Version requests.

[2] Command classes that will be removed when not operating as an inclusion controller

[3] Command classes that are only supported on the PAN side with Access security level.

[4] Command classes that are only supported when GW is SIS

NOTE: When operating in Secondary mode, the Z/IP Gateway must be defaulted to operate again.

4.2 LAN-side Node Information Frame

Table 2 describes the Node Information Frames presented on the LAN side of the Gateway. CCs marked "LAN NIF" are supported in the LAN NIF of the Gateway itself. CCs marked "Controlled" are controlled by the Gateway. Command classes marked "Appended to PAN Node NIF" are added to the LAN NIF of Z-Wave nodes in the PAN.

Table 2 Z/IP Side Command Classes and controlled.

Command Class	Controlled	LAN NIF	Appended PAN Node NIF
Security	X	X	
Security 2	X	X	
Transport Service	X	X	
Multi Channel[1]	X		
CRC16	X	X	
Supervision		X	
Network Management Basic		X	
Network Management Inclusion[2]		X	
Network Management Proxy		X	
Network Management Installation Maintenance		X	
Inclusion Controller[2]	X	X	
Node Provisioning[3, 4]		X	
Wake Up[1]	X		
Z/IP	X	X	X
Z/IP Portal		X	
Z/IP Gateway		X	
Z/IP Naming		X	X
Z/IP ND		X	
IP Association			X
Firmware Update		X	
Mailbox	X	X	
Application Status	X	X	
Power Level		X	
ZWavePlus Info	X	X	
Manufacturer Specific	X	X	
Version	X	X	
Association[1]	X		
Multi Channel Association[1]	X		

For an explanation of the footnotes, please refer to section 4.1.

4.1 Transparent Gateway

Z/IP Packets are carried in UDP packets on port 4123. The Z/IP Gateway MUST be able to decode Z/IP Packet headers and forward extracted Z-Wave commands to the node identified by the given IPv6 or IPv4 address.

4.1.1 IP Support for Z-Wave Nodes

The Z/IP Gateway MUST perform an inspection of each IP Packet received to check if the receiving node is a classic Z-Wave node. In the case of a Z-Wave node, the Z/IP Gateway MUST intercept all IP packets and if possible, emulate the requested service by using equivalent features of Z-Wave.

- The Z/IP Gateway MUST emulate IP Ping (ICMP/ICMPv6 Type 8: Echo Request). If a Ping request is received by the Z/IP Gateway for a Z-Wave node, the Z/IP Gateway MUST use the Z-Wave NOP command to emulate the ping, and respond using ICMP reply to the requesting address. See [1].
- The Z/IP Gateway MUST forward the Z-Wave payload of any Z/IP Packet received for a classic Z-Wave node to the node. It MUST also handle Z/IP ack, and perform same ACK check on Z-Wave if requested. See [1].

4.2 Smart Start

Smart Start inclusion uses Network-Wide Inclusion (NWI) mechanisms to include new nodes. The Z/IP Gateway maintains a Provisioning List that enables touch-free inclusion of any device added to the list.

Smart Start devices MUST carry a QR code, which, when scanned contains a number of meta data that allows a UI to present relevant information to the installer, such as device type, product id etc. The QR code also contains the S2 DSK, which is now also used by Smart Start to determine if the device is in the provisioning list.

Z/IP Gateway provides the following:

- API for maintaining a Provisioning List, of DSKs and Provisioning Strings of Smart Start and S2 devices that may be included to the network
    - Provisioning List may be used for S2 and Smart Start inclusion
- Respond to Smart Start inclusion requests based on their presence in the Provisioning List
- Smart Start devices are automatically removed from network if Smart Start / S2 bootstrapping did not complete successfully.
    - Devices will self-reset, and request inclusion again
- As long as there are entries in the Provisioning List that are pending inclusion, Smart Start mode will be enabled, and Z/IP Gateway will be listening for inclusion requests.
- Smart State Mode is determined based on entries in the Provisioning List

The Z/IP Gateway supports Smart Start through the Node Provisioning Command Class and version 3 of Network Management Inclusion Command Class.

4.3 SIS support

The Z/IP Gateway MAY act as a SIS in a Z-Wave network, but it will not relinquish its role to another controller. SIS MUST be enabled by default by the Z/IP Gateway. A SerialAPI with SIS support MUST be used.

There are no controls available for managing the SIS functionality.

4.4 Unsolicited Forwarding

The Z/IP Gateway provides a remote and local configuration option for forwarding unsolicited Z-Wave frames to an IPv6 address. This allows a network administrator to create a message sink somewhere in an IP infrastructure. The Z/IP Gateway MUST forward all Z-Wave frames to the configured address unless the Z-Wave frame appears to be a response to some request which previously entered the Z-Wave network via the Z/IP Gateway.

Z/IP Gateway supports a secondary unsolicited destination to be configured through the configuration file. The secondary destination cannot be configured remotely.

4.5 WiFi Support

The Z/IP Gateway supports running in WiFi client mode, through a customized relay configuration.

4.6 Security Mechanisms

A number of mechanisms are in place to protect the communication other the different communication channels, such as over Z-Wave, LAN and WAN.

4.6.1 Security Command Class

The Z/IP Gateway MUST communicate securely to Z-Wave nodes that support the Z-Wave Security Command Class. All security is terminated in the Z/IP Gateway and never leaves the Z-Wave network. If a LAN Z/IP Client wishes to communicate with a secure Z-Wave node, it MAY transmit the normal Z/IP Packet to the Z/IP Gateway, which MUST perform the security encapsulation to the end node. It is up to the LAN administrator to ensure that communication on the LAN is secure or use appropriate measures as described in 4.6.3 and 4.6.4.

4.6.2 Security 2 Command Class

Security 2 provides amongst others, the following key features:

- Authenticated Elliptic Curve Diffie-Hellman key-exchange
- Single Frame security
- Secure Multicast

The Z/IP Gateway MUST communicate using Security 2 to Z-Wave nodes that support Z-Wave Security 2 Command Class. All Security is terminated in the Z/IP Gateway and never leaves the Z-Wave network. If a LAN Z/IP Client wishes to communicate with a secure Z-Wave node, it MAY transmit the normal Z/IP

Packet to the Z/IP Gateway, which MUST select the highest known common security encapsulation to the end node. It is up to the LAN administrator to ensure that communication on the LAN is secure.

4.6.3 Z/IP LAN Security

Z/IP LAN security provides a secure connection for clients, and other Z/IP Gateways, connecting to the Z/IP Gateway. The Z/IP LAN Security framework MUST provide a means of securing the communication paths between:

- Z/IP Clients
- Z/IP Clients and Z/IP Gateways
- Z/IP Gateways.

Secure Z/IP UDP frames are ordinary Z/IP frames wrapped in a DTLS 1.0 wrapper. DTLS is the datagram version of TLS. Z/IP LAN Security default UDP port number is 41230.

Z/IP LAN Security currently only supports the Pre-Shared-Key (PSK) Key Exchange Algorithm.

4.6.4 Remote Access

The Z/IP Gateway provides a means of Remote Access through a secure Transport Layer Security (TLS) v1.1 based Transmission Control Protocol (TCP)/IPv4 connection over port 44123 to a portal, with a Domain Name System (DNS) resolvable Uniform Resource Locator (URL), outside the home network, synchronized by an internal Network Time Protocol (NTP) client.

The Z/IP Gateway MUST initiate this connection to the portal; attempting connection every 5 seconds on failure. On connection, the Z/IP Gateway sends a keep-alive every 5 seconds. On some platforms it may take a considerable amount of time to establish the secure tunnel, as it uses a 2-way handshake with RSA-1024 certificates with Secure Hash Algorithm (SHA) -1 digest. If the connection breaks down, the Z/IP Gateway MUST support session resumption within 24 hours in less than 10 seconds. After connection has been set up, Z/IP packets over this connection MUST be encrypted with Advanced Encryption Standard (AES) 128.

The Remote Access capabilities of the Z/IP Gateway are described in detail in [5].

4.6.4.1 Remote Configuration

In addition to local configuration it is possible to push Z/IP Gateway configuration remotely. It is possible to specify the following (see [5]):

- Stand-alone or Portal – if the Z/IP Gateway should connect to a Portal through a Remote Access connection.
- Setting the peer address of the Portal
- Lock / Unlock configuration
- Configuration of LAN and Z-Wave IPv6 and IPv4 prefixes and addresses

4.7 Network Management Command Classes

Control of the Z-Wave network is carried out through a number of Network Management Command Classes.

The Z/IP Gateway supports the following Network Management Command Classes:

- **Network Management Inclusion:** Support for Adding/Removing, Set Default, Failed Node Replacement and Removal and Requesting Node Neighbor Update
- **Network Management Basic:** Support for entering Learn Mode, Node Information Send and Request Network Update
- **Network Management Proxy:** Support for Node List Get and Node Info Cached Get

These three command classes enable network management and access to simple network topology information.

4.8 Z/IP Discovery

A Non-DTLS encapsulated Z/IP Node Info Cached Get command may be used to discover the IPv6 or IPv4 address of the Z/IP Gateway, by sending the request as Broadcast, requesting Node ID #0. Any Z/IP Gateway on the network MUST reply with Z/IP Node Info Cached Report and their IP address contained.

4.9 Resource & Service Discovery (mDNS)

The mDNS service allows an IP application automatically discover all Z-Wave nodes available on any Z/IP Gateway on the backbone. The application will receive information about all nodes added to the network as well as any changes that may be made.

The mDNS discovery service MUST announce all nodes and node endpoints as individual mDNS resources (see IETF RFC 6763). As new nodes are added and removed from the Z-Wave network the mDNS resource changes MUST be dynamically multi-casted on the LAN backbone. The mDNS resource announcements MUST contain detailed information about the underlying node/endpoint such as its device type and supported command classes and IPv6 address(es).

The names of the mDNS resources MAY be statically generated.

4.10 Z/IP Neighbor Discovery: IPv6 and IPv4 Address resolution for Z/IP Applications

To allow Z/IP applications to understand the concept of Z-Wave Node IDs a translation service MUST be provided by the Z/IP Gateway to translate the Node ID into the appropriate IPv6 and IPv4 address.

Node IDs may reach a Z/IP application which for example uses the Network Management Command Classes, and can thus be translated into an IPv6 or IPv4 address that the Z/IP application is capable of communicating with. Refer to the Z/IP ND Command Class.

4.11 IP Association Proxy

The IP Association Proxy extends the Z-Wave addressing domain, by allowing Z-Wave devices to communicate with any IPv6 enabled device that supports the Z/IP Framework on either another Z-Wave network or a separate IP application.

Z-Wave IP Associations are created between two Z/IP resources identified by an IP address and an endpoint ID. The Z/IP Gateway MUST emulate the IP properties of Z/IP Nodes for Z-Wave nodes:

- Association from one Z-Wave node to another: Send Association Set Command to the association source in a Z-Wave frame.
- Association from a Multi Channel End Point to another Multi Channel End Point: Send a Multi Channel Association Set Command to the association source encapsulated in a Multi Channel frame.
- Association from a Multi Channel End Point to a node: Send an Association Set Command to the association source encapsulated in a Multi Channel frame.
- Association from a node to a Multi Channel End Point: Send an Association Set Command to the association source encapsulated in a Z-Wave frame. The association targets a virtual node in the Z/IP Gateway. Create a companion association from the virtual node to the Multi Channel End Point.

Note: IP Association Proxy uses the Node IDs of the Z-Wave PAN, so any association against an IP address will allocate and use a Z-Wave Node ID, leaving less Node IDs for physical devices.

4.12 Mail Box Command Class – Support for Not Always Listening Nodes

The Mail Box MUST provide support for any IP application to communicate with nodes support the Wake Up Command Class without them having to implement or understand the Wake Up Command class. The principle of the mail box functionality means that sending application does not need any knowledge about the receiving node sleeping state. The sending application MUST receive a “Delayed” packet each minute, indicating that ACK is expected at a later point, and that the application SHOULD NOT attempt retransmission.

The queue size of the mailbox is currently limited to 500 entries.

In addition, the Mailbox supports the Mailbox Command Class, which allows a lightweight Z/IP Gateway to offload the mailbox functionality to a more powerful mailbox service such as a portal.

4.13 Installation and Maintenance Framework

The Installation and Maintenance Framework provides a method for gathering statistics and perform network maintenance. The following statistics and maintenance may be carried out through this framework:

- Last Transmission:
  - Transmission Time
  - Route Changes
  - Last Working Route
- All Transmissions / Route Information:
  - Packet Error Count
  - Transmission Counter
  - Neighbors
  - Last Working Route max transmit power reduction
  - Network Management - Priority Route Set
  - Network Management - Priority Route Get
  - Network Management - Priority Route Report

In addition it is possible for a Z/IP Client to perform a backup for the EEPROM attached to the Z/IP Gateway for backup purposes.

Firmware update for the Z-Wave module attached to the Z/IP Gateway, can be performed through the Firmware Command Class, through the Z/IP Gateway.

4.14 Transport Service

The Transport Service Command Class version 2 provides the following features:

- Reliable Checksum
- Transport protocol style transmission, providing means for fragmentation of frames exceeding the PHY frame length, re-transmission of missing fragments and robust error handling

4.15 Z/IP Packet Command Class Version 4

The Encapsulation Format Info Header Extension is added to the Z/IP Packet Command Class Version 2. The extension serves two purposes:

1. Indication of the encapsulations used when the frame was received by the Z/IP Gateway
2. Which encapsulations should be used by the Z/IP Gateway when sending a frame

The extension is marked as Critical which means a receiving Z/IP Client MUST interpret the extension or drop the entire frame.

This extension MUST be used to ensure Answer-As-Asked policy is adhered to.

4.16 Network Management Command Classes Version 2

Version 2 of the following Network Management Command Classes is added, to provide required Security 2 functionality:

- Network Management Inclusion
  - Updated Add / Remove / Replace
- Network Management Basic
  - Updated Learn Mode
  - New DSK Get/Report
- Network Management Proxy
  - Updated Node Info Cached Get / Report

4.17 Z/IP Gateway SDK 2.81.03 DevKit Contents

The Z/IP Gateway 2.81.03 Development Kit MUST contain the following components:

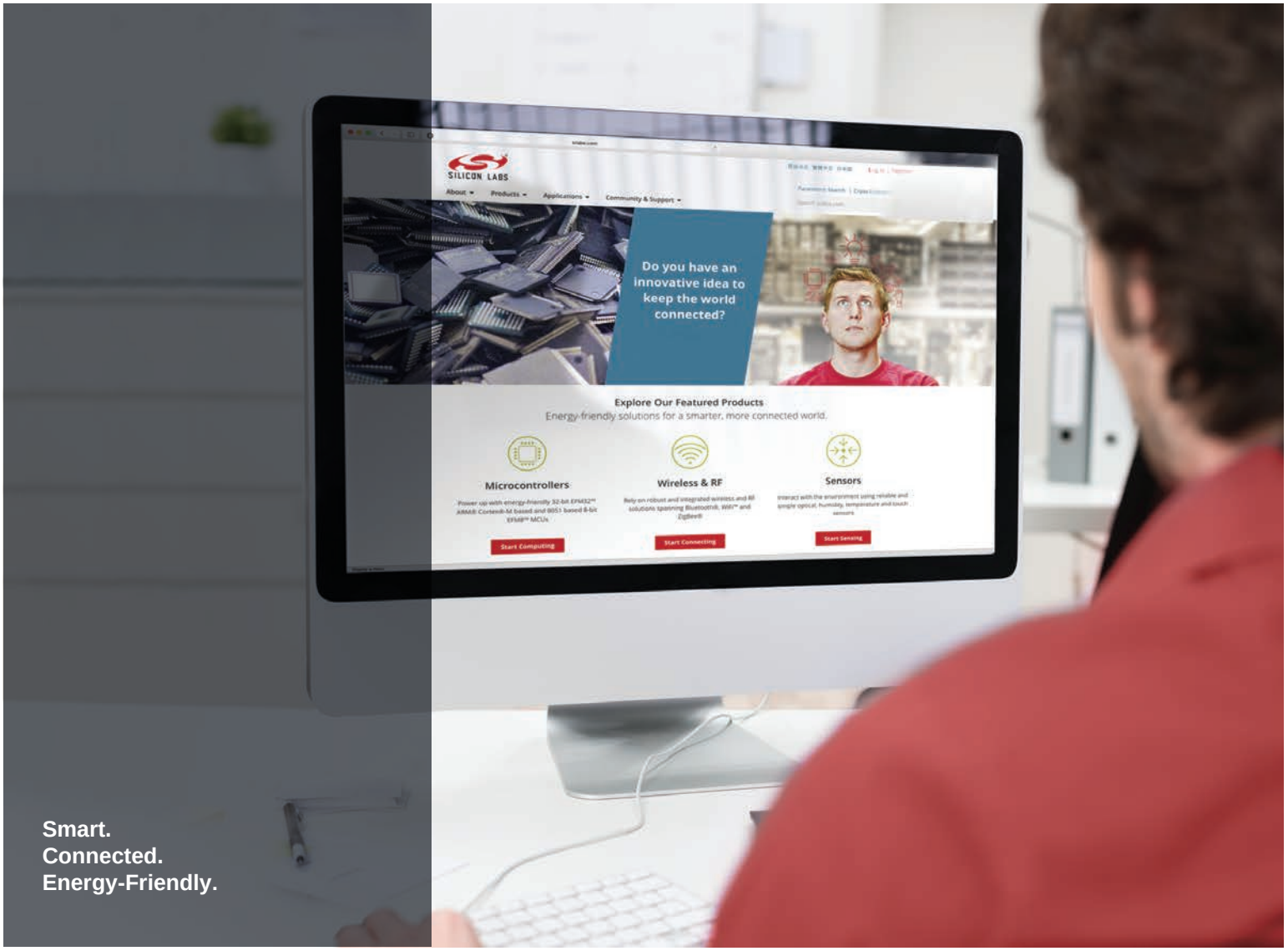
- Documentation:
  - ZTS, Z/IP Security 2 in Z/IP Gateway
  - ZTS, Z/IP Gateway Source Code Documentation
  - ZTS, Z/IP Gateway Tutorial
    - Z-Wave & IP Basics
    - Compilation
    - Installation
    - Troubleshooting
    - Sample Code
    - PyZIP User Guide
  - ZTS, Z-Wave Command Class specifications
  - INS12503, Z/IP Gateway Porting Process
  - SDS12938, Z/IP LAN Security
  - SDS12089, Z/IP Gateway Bootstrapping
  - SDS11756, Z/IP DNS Discovery support (DNS-SD, mDNS)
  - SDS11633, Z/IP Resource Directory (RD, DNS-SD, mDNS)
  - SDS11445, IP Architecture Framework for Z-wave (Z/IP)
- Binary:
  - Z/IP Gateway 2.81.03, for BeagleBone Black, Linux 32-bit
  - Z/IP Gateway 2.81.03, for Linux x64
- Source:
  - Z/IP Gateway 2.81.03
  - PyZIP 1.21 – Python Graphical Z/IP Client for testing

5 CERTIFICATION

Z/IP Gateway must undergo certification as part of a system. It cannot be certified as a standalone product.

REFERENCES

[1] SDS11445, Silicon Labs, IP Architecture Framework for Z-Wave (Z/IP)
[2] SDS11756, Silicon Labs, Z/IP DNS Discovery support (DNS-SD, mDNS)
[3] SDS11633, Silicon Labs, Z/IP Resource Directory (RD, DNS-SD, mDNS)
[4] SDS12938, Silicon Labs, Z/IP LAN Security
[5] SDS12089, Silicon Labs, Z/IP Gateway Bootstrapping (ZIP,IPv4, IPv6, Router, NAT, DHCP, tunnel, remote access)
[6] INS12503, Silicon Labs, Z/IP Gateway Porting Process



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