

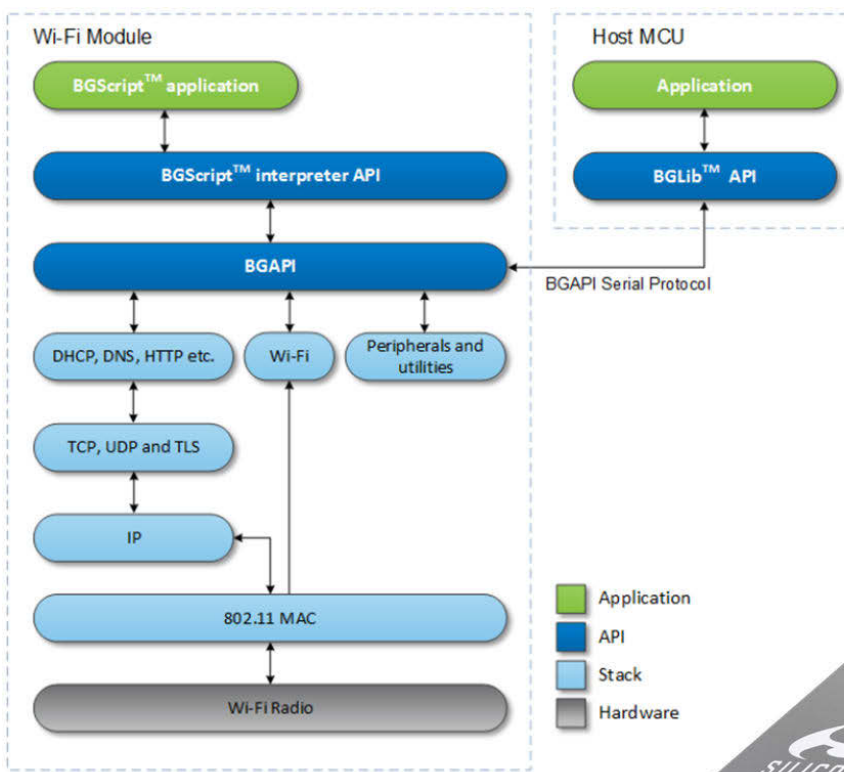
QSG122: WGM110 Wi-Fi[®] Module Software Quick-Start Guide



This document discusses how to start developing IoT applications using Silicon Labs' Wizard Gecko WGM110 Wi-Fi[®] Module, its Wi-Fi Software, and the related SDK. The document describes the WGM110 Module software features and architecture and describes how Wi-Fi applications are developed using the SDK.

KEY POINTS

- Introduction to the Wizard Gecko Wi-Fi Software
- Introduction to the Wizard Gecko SDK
- Getting started with the Wizard Gecko Software



1. Introduction to the Wizard Gecko Wi-Fi Module Software

The Wizard Gecko Wi-Fi Module Software enables developers to quickly and easily develop Wi-Fi applications without in-depth knowledge of the Wi-Fi technology. The Wi-Fi Software consists of two parts:

- The Wizard Gecko WGM110 Software
- The Wizard Gecko Software Development Kit (SDK)

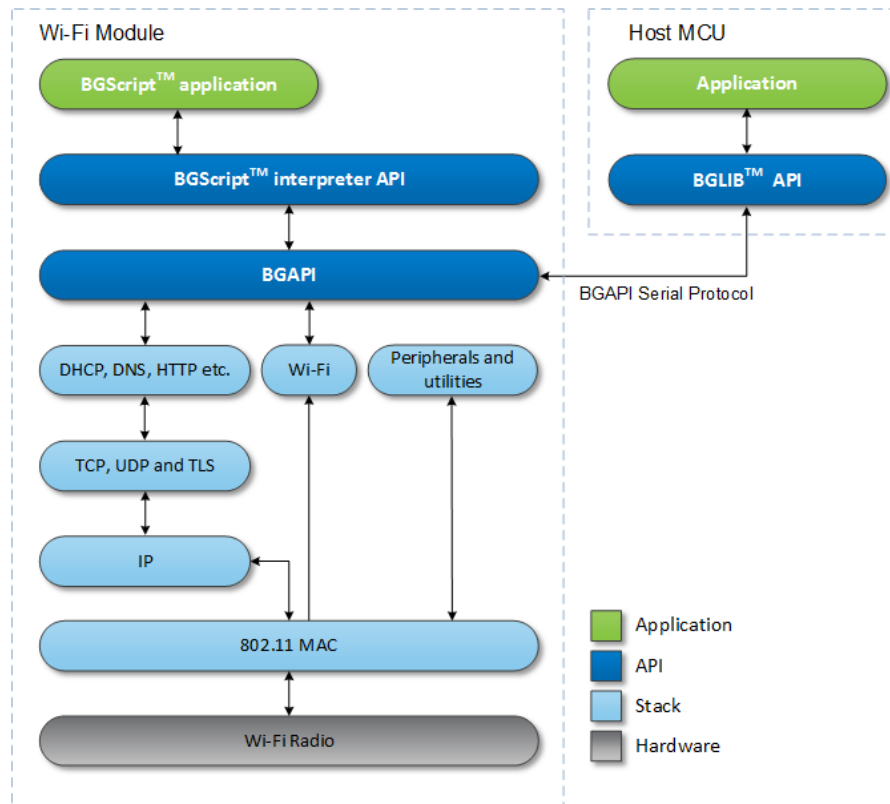


Figure 1.1. The Wizard Gecko Wi-Fi Software Architecture

The Wizard Gecko Wi-Fi Module Software architecture is illustrated above, and it consists of the following components:

- The Wizard Gecko Module Wi-Fi stack implementing the 802.11, 802.2, IPv4 and higher level protocols
- BGAPI™ APIs that enable the software developers to interface to the Wi-Fi Stack
- BGLIB™ lightweight host library which implements the BGAPI binary protocol and parser, and is the target for applications where a separate host processor is used to interface to the Wi-Fi modules over UART, USB, or SPI.
- BGScript™ Virtual Machine (VM) and scripting language which enable application code to be developed and executed directly on the Silicon Labs' Wi-Fi hardware

Each of these components are described in more detail in the following chapters.

Designing and implementing secure Wi-Fi networking is very important. The Wizard Gecko Wi-Fi Module includes a robust Wi-Fi radio and IP stack security features to support this. However, some of the included examples in the SDK have been simplified to provide focus on the showcased features.

1.1 The Wizard Gecko Module Wi-Fi Stack

The Wizard Gecko Module Wi-Fi Stack is an embedded 802.11 MAC and IPv4 stack targeted for Silicon Labs' WGM110 Wi-Fi Module. The Wi-Fi software implements full 802.11 functionality, Station and Access Point modes, Wi-Fi Direct, WPA2/WPA Enterprise, WPA2/WPA Personal and WEP and WPS security, along with various IP-based protocols, such as TCP, UDP, DHCP, DNS, ICMP and HTTP server.

The Wizard Gecko Module Wi-Fi stack provides a powerful, low-overhead, and easy-to-use Bluegiga BGAPI binary API, which can be used over UART, USB, or SPI interfaces, and provides functions, such as Access Point discovery, Access Point association, encryption, and connection establishment. The Wi-Fi stack also supports the 802.11 Access Point mode and implements an embedded HTTP server for easy development, and it offers direct connections to phones, tablets, and PC's. To simplify the software development, the Wizard Gecko Module Wi-Fi software also includes a Silicon Labs BGLIB C-library that implements the BGAPI protocol parser for various embedded systems.

For standalone applications, the Wizard Gecko Module Wi-Fi Software also provides a simple BGScript scripting language and VM environment, which enables the users to write simple applications for the WGM110 Wi-Fi Module. This enables lower cost and smaller designs to be made because there is no need to use an external MCU.

Table 1.1. Key Wi-Fi Stack Features

Wi-Fi Features	
Wi-Fi radio	802.11 b/g/n - Station mode - SoftAP with up to 5 clients - Wi-Fi Direct
Bit rate	72.2Mbps
Maximum application level throughput	Up to 2Mbps
802.11 security	WPA2/WPA Personal and Enterprise, WEP
Provisioning	WPS 1.0 (push button)

Table 1.2. Key IP Stack Features

Included IP Stack Features	Details
IP version	IPv4
TCP	client/server, up to 20 sockets
UDP	client/server
TLS/SSL	client
DHCP	client/server
ARP	-
DNS	client/server
mDNS	-
DNS-SD	-
HTTP	server

1.2 The Wizard Gecko SDK

The Wizard Gecko SDK is a full software development kit which enables device and software vendors to develop products on top of the Silicon Labs' WGM110 Wi-Fi hardware and software, using either the BGScript scripting language or BGAPI serial protocol and BGLIB host library.

To download the Wizard Gecko SDK go to <http://www.silabs.com/start-wgm>.

The SDK supports multiple development models, so software developers can decide whether the application software runs on a separate host (a low-power MCU) or whether they want to make fully standalone devices and execute their code on the MCU embedded in the Silicon Lab's Wi-Fi Modules.

The main architectural options for using the WGM110 Module are as follows:

- Network Co-Processor (NCP) mode, connecting to an external host MCU via BGLIB
- Stand-alone mode, running BGScript applications
- Mixed mode, a combination of NCP and stand-alone modes

The SDK also contains documentation, developer tools for both compiling the firmware and installing it into the Module, and lots of example applications which help speed up the development process.

The Wizard Gecko SDK includes the following APIs, components, and tools:

BGAPI and BGLIB Source Code

For BGAPI / BGLIB developers, the SDK also includes the firmware build tools, which are needed to define the hardware and software configurations for the firmware and to build the corresponding firmware image. The SDK also includes the BGLIB library in C source code, so it can be ported to the target host platform or modified if needed. Example applications demonstrating how to build applications on top of the BGLIB library are also included .

BGScript

Fully standalone applications can be developed using a simple scripting language called BGScript. The SDK contains the BGScript compiler and firmware build toolchain, which allows the script applications to be compiled into a binary firmware image. Several examples are also offered as a part of the Wizard Gecko Wi-Fi Module SDK to simplify the development of Wi-Fi compatible end products. These examples contain, for example, an embedded HTTP server, WPS and TCP to Serial applications.

BGBuild Compiler

The BGBuild compiler is used to compile the WGM110 stack, the BGScript application (optional), and the hardware and software configurations into a firmware binary that can be flashed into the Wi-Fi Module.

Flashing Tools

Flashing tools which are used to upload the firmware image into the Wi-Fi Module over the debug interface are provided with the SDK.

DFU Tools

The Device Firmware Update (DFU) protocol is an open serial protocol that can be used to perform field updates to the Wi-Fi Module. DFU protocol allows any firmware image generated with the BGBuild compiler to be installed into a WGM110 Module.

The Wizard Gecko SDK contains a command line DFU tool.

DFU protocol and available commands are described in the *WGM110 API Reference Manual*.

1.3 Wizard Gecko Wi-Fi Module APIs

This section describes the BGAPI protocol and how to use the Wi-Fi Module with an external host, using BGLIB, or via on-board applications written in BGScript.

1.3.1 The BGAPI™ Protocol

The BGAPI is a serial protocol that allows external hosts (MCUs or PCs) to interface to the Wi-Fi Module over UART, USB, or SPI interfaces. The BGAPI serial protocol is a lightweight and well-defined binary protocol which allows commands and data to be sent to the Wi-Fi Module. It also provides a way to receive responses, events, and data from the Module.

The BGAPI serial protocol is used in applications where an external host (like a lower-power MCU) is used to control the Wi-Fi Module. The BGAPI commands are sent from the host to the Wi-Fi stack where the commands are validated and executed. The BGAPI serial protocol produces a response indicating a successful command, invalid parameter, or a parse error. Some commands will also produce events, which the host application can detect.

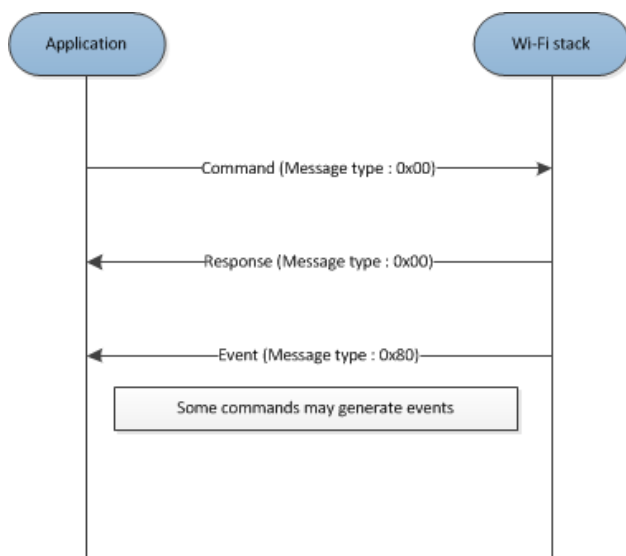


Figure 1.2. BGAPI Serial Protocol Command Exchange

BGAPI provides the following command classes to interact with the Wi-Fi Module:

- *Wi-Fi* : This interface enables access to functions like Access Point discovery, authentication, association, security management, and switching between station and access point modes.
- *Configuration*: Used to read and write the module hardware (MAC) address.
- *TCP and IP*: These functions allow the creation of TCP and UDP client and server connections.
- *Device Firmware*: Allows to perform device firmware updates over one of the host interfaces (UART, SPI or USB).
- *Endpoint*: Functions are used to perform endpoint creation, deleting and data routing from/to endpoint.
- *Hardware*: An interface to access the various hardware layers related to peripheral and hardware interfaces.
- *Persistent Store*: For accessing the parameters of the radio hardware and for reading/writing data to non-volatile memory
- *System*: Includes various system functions, such as querying the hardware status or resetting the Module
- *HTTP Server*: Enables access to the embedded HTTP, DNS and DHCP servers.
- *I2C*: Allows I2C serial communication.
- *SDCard*: Provides SD memory card operations for file and directory handling.
- *Utilities for BGScript*: Provides common helper functions for BGScript.
- *X.509*: Is used to perform X.509 cryptography certificates and keys storing operations.

1.3.2 The BGLIB™ Host Library

BGLIB host library is a reference implementation of the BGAPI serial protocol parser and is provided in C source code with the Wizard Gecko SDK. It abstracts the complexity of the BGAPI serial protocol and instead provides high-level C functions and call-back handlers to the application developer, which makes the application development easier and faster.

BGLIB library can be ported to various host systems ranging from low-cost MCUs to devices running Linux, Windows, or OSX.

C Functions

```
/* Function */
void wifi_cmd_sme_wifi_on();

/* Response id */
wifi_rsp_sme_wifi_on_id

/* Response structure */
struct wifi_msg_sme_wifi_on_rsp_t
{
  uint16 result;
};
```

Figure 1.3. BGLIB Host API

1.3.3 BGScript™ Scripting Language

BGScript is a simple BASIC-style programming language that allows end-user applications to be easily embedded into the WGM110 Module. BGScript abstracts away the complexity of Wi-Fi protocol, embedded hardware, scheduling, memory management, and provides a simple software development environment for creating Wi-Fi IoT applications quickly and easily.

The second benefit of using BGScript is that no external MCU is needed for the application, making bill of material and size savings achievable. Although a simple programming language, BGScript provides access to all the same APIs and functions as BGAPI and BGLib and can be used to create fairly complex applications.

BGScript is an event-driven programming language, and code execution is started when events such as system start-up, Wi-Fi connection, I/O interrupt, etc. occur and the application code is written into event listeners. The script code is interpreted during run time by a BGScript interpreter included as part of the WGM110 firmware.

BGScript applications can be developed with the free-of-charge Wizard Gecko SDK and the tools included in it.

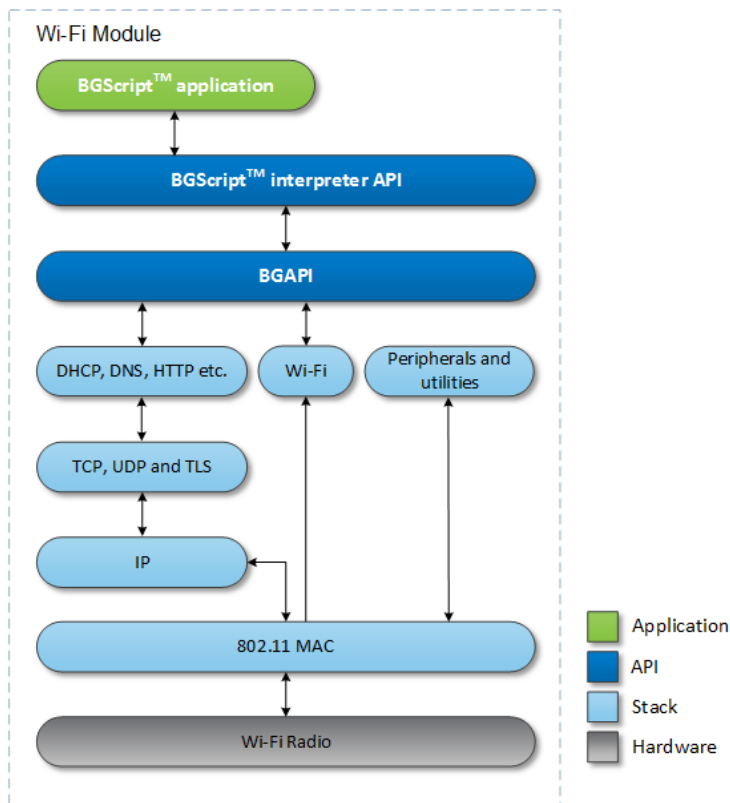


Figure 1.4. BGScript Application Model

BGScript Code Example:

```
#System boot event listener
event system_boot(major, minor, patch, build, bootloader_version, tcpip_version, hw)
# Set operating mode to AP
call sme_set_operating_mode(AP_MODE)
# Enable Wi-Fi
call sme_wifi_on()
end
```

For more information on BGScript with code examples see *UG170: Wizard Gecko BGScript™ User's Guide*.

1.3.4 BGLIB vs. BGScript

This section describes the differences between using BGLIB and BGScript. The main differences are as follows:

- BGScript is a Silicon Labs proprietary scripting language used for on-Module applications. BGScript applications run on the Wizard Gecko Wi-Fi Modules.
- BGLIB is an ANSI C reference implementation of the BGAPI serial protocol and only runs outside of the Modules. BGAPI is a serial protocol used to externally control the Modules over the host interface.

In short, BGScript allows the application to run right on the Wi-Fi Module, whereas BGLIB uses the BGAPI serial protocol API to send commands and receive events from an external device, which typically is a microcontroller. It should be noted, however, that BGScript and BGLIB both implement the same functionality. Every BGScript command, response, and event has a counterpart in the BGAPI serial protocol and in the BGLIB host library.

Another thing to keep in mind is that BGScript has some performance penalties compared to external API control, due to the fact that BGScript is an interpreted scripting language and requires extra overhead. It makes the Wi-Fi Module do the work that could otherwise be done elsewhere. If you are trying to achieve maximum performance or have a very complex application (lots of fast timers, interrupts, or communicating with many external sensors over I2C or SPI), it is a good idea to use a small external microcontroller and BGLIB/BGAPI instead.

Table 1.3. BGLIB vs. BGScript

Question	BGLib	BGScript
External host needed?	Yes	No
Host interface?	UART, SPI, or USB	No separate host needed
Wi-Fi API	BGAPI serial protocol or BGLIB APIs	BGScript API
Peripheral interface APIs and support	Host dependent - no in-Module limitation ¹	GPIO, I2C
Custom peripheral interface drivers?	Can be developed for the host	Peripheral drivers are part of the Wi-Fi stack
Application development SDK?	Host dependent + BGAPI and/or BGLIB	Wizard Gecko SDK
Wi-Fi firmware updates	DFU over UART, SPI or USB	DFU over UART, SPI or USB
Note:		
1. The Wi-Fi module peripheral interfaces are still available via BGAPI commands, and can be used to extend the host MCUs I/Os.		

2. Getting Started with the Wizard Gecko SDK

The following sections describe how to install the SDK, what the SDK contains, and which tools are included in the SDK.

2.1 Installing the Wizard Gecko SDK

To install the Wizard Gecko SDK, perform the following steps:

1. Go to <http://www.silabs.com/start-wgm> and download the *Wizard Gecko SDK*.
2. Run the installer.
3. Follow the on-screen instructions to install the SDK.
4. If not already done, download and install the latest **J-Link Debugger** drivers from <https://www.segger.com/jlink-software.html>.

2.2 SDK Folder Structure

The SDK creates the following folders within the installation directory:

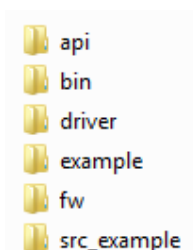


Figure 2.1. SDK Folders

Table 2.1. Folders Created by the SDK During Installation

Folder	Content
API	BGLIB for external host
BIN	All binary applications needed by the SDK
DRIVER	All drivers needed by the SDK
EXAMPLE	<ul style="list-style-type: none"> • BGScript demo applications • Wi-Fi Module configuration examples The above listed can be used to generate a firmware for the Wi-Fi Module if run through the BGBuild compiler.
FW	Wi-Fi stack firmware binaries
SRC_EXAMPLE	NCP mode host application examples using BGLIB

2.3 Tools Included in the SDK

The tools listed in the table below are installed by the SDK.

Table 2.2. Included Tools in the SDK

Executable	Explanation
BGTool	A graphical UI tool that can be used to control the Wi-Fi Module using the BGAPI serial protocol. This tool is useful for quickly trying out the features and capabilities of the Wizard Gecko Module software without the need for writing any code.
BGBuild	BGBuild compiler is a simple compiler used for building firmware images for the Wi-Fi Module.

3. Revision History

3.1 Revision 1.2

March 31st, 2017

Changed: Wi-Fi Direct support included. Frontpage diagram corrected.

3.2 Revision 1.1

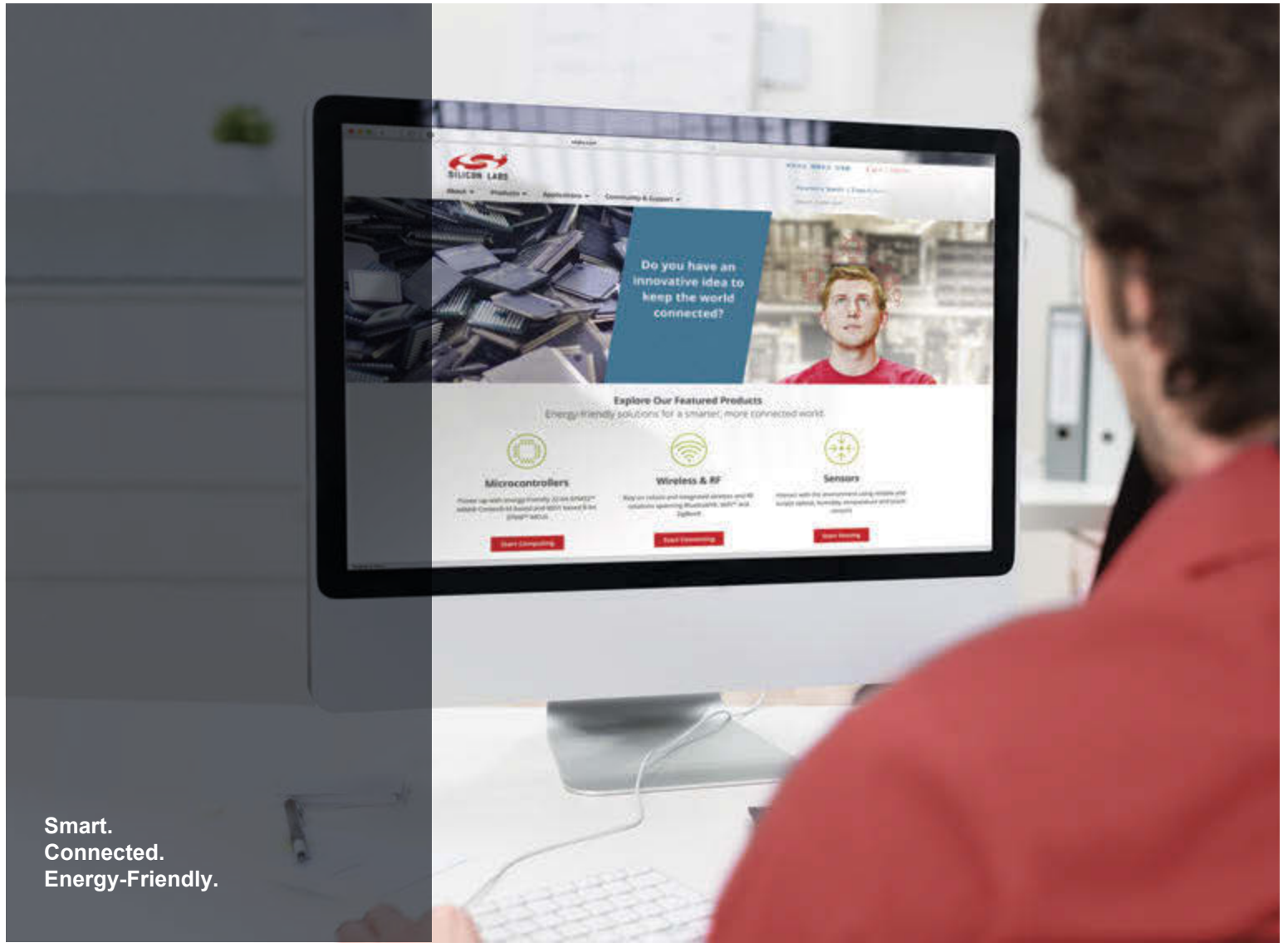
May 23rd, 2016

Changed: Some images edited and resized.

3.3 Revision 1.0

Feb. 22, 2016

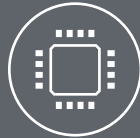
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