silex technology

When it **Absolutely Must** Connect

Understanding Internet-of-Things Wi-Fi® Designs – Hosted & Hostless

The terms “Hosted” and “Hostless” are widely used but not well defined. They are based on the needs of customers’ application. These two different approaches are popular in the rapidly growing Internet-of-Things (IoT) connectivity space.

This white paper explains the differences between hosted and hostless Wi-Fi IoT connectivity designs.

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Executive Summary

The Internet of Things (IoT) or the Internet of Everything (IoE) is a fast growing market segment that has many unique connectivity requirements beyond what is demanded by a typical wireless customer. Traditional Wi-Fi connectivity is provided by Wi-Fi modules that communicate with external host micro controllers (MCUs). This is traditionally called a hosted solution. IoT applications require smaller size, lower cost, and low power consumption to address many battery operated applications such as home automation controls, sensors, medical devices, etc. These connected IoT devices are an ideal place to use a hostless solution. In a hostless solution, the module's internal MCU can act as a host with the application running from the internal memory. Peripherals and sensors connect to the MCU using any of the popular interfaces, for example UART, SPI, I2C, I2S, ADC, PWM, and GPIOs. Wi-Fi connectivity is also included as an integral part of a hostless solution.

As an IoT connectivity provider, how do you choose between hosted solution and a hostless solution? This guide was written specifically for IoT professionals looking to add connectivity to their low power low cost applications and products.

"IoT to Account for 28% of Wireless Connectivity IC Market by 2021; Driven by Fast-Growing Smart Home, Wearables, and Beacons."
- ABI Research, 2016

Part 1: Introduction to Connectivity for IoT

IoT devices can range from smart appliances to wearables, home automation to factory/industrial automation controls, medical devices, sensor networks, etc. The challenge of managing these devices is commonly overcome by making them connected via some form of wired or wireless method to a cloud service. Wired connectivity has its limitations in many scenarios, whereas wireless connectivity has its own challenges such as battery life. One common theme however is that all IoT devices require connectivity.

This paper will focus on Wi-Fi connectivity for IoT devices. There is a very large Wi-Fi eco-system widely adopted by the industry for connecting to the internet. There are many other technologies and standards also used for connectivity, but those are beyond the scope of this white paper. Many customers demand Wi-Fi connectivity for their IoT devices because of the ease of interoperability of products from different vendors.

Wi-Fi Connectivity for IoT

For all those IoT devices that require cloud connectivity using Wi-Fi, the size, cost, and power consumption become important factors in deciding their system architecture. Wi-Fi connectivity can be added to IoT devices in two ways. One is hosted using a micro controller unit (MCU) paired with a Wi-Fi solution, and the other is hostless in which the MCU and Wi-Fi are integrated into a single solution. Both options have different benefits and challenges which must be well understood in order to decide which option is best suited for a given application/product. This paper will describe these in detail to help you through this process.

Most IoT connected devices talk to the cloud where their data is analyzed, or their configuration is updated by a centrally managed system. As these IoT devices make their way into people's everyday lives, and they start impacting how people depend on these devices for their critical needs, there are many requirements that get put on the Wi-Fi connectivity for IoT

- **Simple onboarding and provisioning –** Whether an IoT device is a hosted solution or hostless, it always requires a simple mechanism to join a Wi-Fi network, and get authenticated and provisioned on that network with the proper credentials.

- **Security –** IoT devices available on the market today are vulnerable to unauthorized attacks. There are many examples available where hackers gained access to network

by exploiting security holes in the implementation of the Wi-Fi solution. Thus security is a very important aspect to consider in both hosted and hostless solutions, both must be able to provide strong security mechanisms to prevent unauthorized attacks.

- **Cost –** We take Wi-Fi for granted in our smartphones, tablets, laptops, etc. This is because the cost of adding Wi-Fi has dropped significantly in the past few years as silicon providers are offering Wi-Fi at lower price points. However, when you have to add Wi-Fi to an already low cost IoT device, the percentage of the bill-of-materials (BOM) that Wi-Fi adds becomes an important deciding factor for what type of solution you will choose for your IoT application. Hosted solutions are more expensive than hostless solutions, however they can potentially offer enterprise security and other features like dual band operation in 2.4 and 5 GHz bands.

Part 2: Hosted and Hostless Mode Description

Traditional Wi-Fi connectivity is provided by Wi-Fi modules that communicate with external host micro controllers (MCUs). This is called a hosted solution. IoT applications require smaller size, lower cost, and low power consumption to address many battery operated applications such as home automation controls, sensors, medical devices, etc. These connected IoT devices are an ideal place to use a hostless solution. In a hostless solution, the module's internal MCU can act as a host with the application running from the internal memory. Peripherals and sensors connect to the MCU using any of the popular interfaces, for example UART, SPI, I2C, I2S, ADC, PWM, and GPIOs. Wi-Fi connectivity is also included as an integral part of a hostless solution.

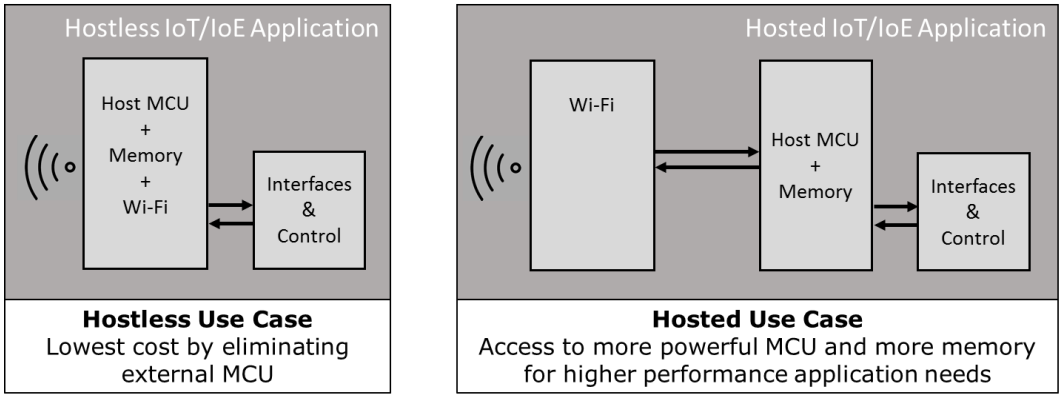

Diagram Showing the Differences between Hosted and Hostless Solutions

As an IoT connectivity provider, how do you choose between hosted solution and a hostless solution? This guide was written specifically for IoT professionals looking to add connectivity to their low power low cost applications and products.

When and Why Choose Hosted Mode & Hostless Mode

Hosted Mode – When your application requires an MCU that performs some necessary functions of your application that cannot be run on any available hostless solutions, then you can choose to use a hosted mode where you pick a Wi-Fi connectivity solution that suits your needs. Your host MCU typically has some interfaces that can be used to communicate with the Wi-Fi module to exchange the data that you want to send/receive over Wi-Fi from your host MCU. This data exchange typically happens over UART, SPI, SDIO, PCIe, or USB. All these interfaces have their own special characteristics that help decide which interface to use. The details of these interfaces are beyond the scope of this white paper.

In hosted mode, the host MCU acts as the master and the Wi-Fi module acts as a slave under the control of the host. However, the host MCU can go to sleep after completing its tasks, and the Wi-Fi module can wake the host MCU up when data comes in over Wi-Fi. Therefore, the Wi-Fi module stays connected to an AP, and sleeps in between intervals where it periodically wakes up to check for new data. This way the Wi-Fi system allows host to sleep to save power. A good example of a Wi-Fi module for hosted solutions is the Silex SX-ULPAN which supports UART and SPI interfaces to talk to external hosts. Refer to our white paper "Wi-Fi Connectivity for Freescale Kinetis Microcontrollers" that goes into the details of connecting a host MCU with the SX-ULPAN.

Silex SX-ULPAN Module

Hostless Mode – When your application requires the lowest cost connectivity solution and you are also considering saving area and power consumption, then you can eliminate the host MCU board and its associated cost by opting for a hostless mode. In this case you can use a pre-certified Wi-Fi module such as the Silex SX-ULPGN which includes an internal MCU for your application, as well as many peripheral interfaces like I2C, SPI, I2S, PWM, ADC, GPIO, UART. To use a hostless module, there needs to be enough memory to run your entire application locally, thus eliminating the need for external memory or MCU. The antenna is also usually integrated into the module, and your whole application uses a small footprint in your device, it can run from battery power, and it costs much less than a hosted solution.

Silex SX-ULPGN Module

The table below summarizes the benefits and challenges with each approach

	Benefits	Challenges
Hosted Mode	More Flexible and Expanded Set of Peripheral Interfaces Large Number of Extra General Purpose Input/Output Pins Large Amount of Memory Higher Performance CPU/MCU High Level Operating System	Need a Host Wi-Fi Interface Driver (SPI, SDIO, PCIe, or USB) Higher Cost Larger Footprint Area Higher Power Consumption
Hostless Mode	Lowest Total Cost Solution No Driver Porting Required Lower Power Consumption Smaller Footprint	Limited Memory Size Lower Performance CPU/MCU Fewer Peripheral Interfaces Fewer Number of General Purpose Input/Output Pins Embedded Real Time Operating System

Part 3: Step by Step Process of adding Wi-Fi

An important aspect that can affect whether you choose hosted versus hostless solution is the step-by-step process of adding Wi-Fi in both cases. You should carefully consider the following steps required to add Wi-Fi to your application during your development process for both cases, as there are differences between the two.

Steps Required to Choose a Suitable Wi-Fi Solution for Hosted Mode

Hardware:

1. Identify the type of data that needs to be sent over Wi-Fi
2. Power consumption, how much does your design allow for the Wi-Fi module
3. What bus interfaces are supported on your MCU
4. Throughput and quality requirements for the Wi-Fi
5. Connector type supported by your host board? Surface Mount, Board-to-Board, and what Connector type for B2B
6. Memory available on the Wi-Fi module to embed the drivers and sometimes third party applications, for example sniffer functionality.
7. The physical space (area) that will be occupied by the Wi-Fi module system
8. Consider the antenna requirements (Gain, Connector type, External vs Internal) for your application and choose a Wi-Fi module that can support them

Software:

1. Choose a Wi-Fi module based on the Kernel version running on your MCU
2. Time & Resources required to develop or port the driver

3. Functions and services supported by the driver

Steps Required to Choose a Suitable Hostless Wi-Fi Module

Hardware:

1. Identify the type of data that needs to be sent over Wi-Fi
2. Power consumption, how much does your design allow for the Wi-Fi module
3. What peripheral interfaces are available on the hostless Wi-Fi module
4. Throughput and quality requirements for the Wi-Fi
5. Memory available on the Wi-Fi module for embedded application (For Example the SX-ULPGN has 800 KB application memory available).
6. The physical space (area) that will be occupied by the Wi-Fi module system
7. Consider the antenna requirements (Gain, Connector type, External vs Internal) for your application and choose a Wi-Fi module that can support them

Software:

1. Time & Resources required to develop the hostless application
2. Existing functions and services provided by the hostless module vendor

Part 4: SX-ULPGN from Silex Technology

In this section we will focus on the hostless solution as this is becoming more and more popular with many IoT use cases such as home automation sensors etc. In these cases, the device is running from battery power, and the size must be small. These applications do not require a high performance MCU or large amount of memory. We will use the SX-ULPGN from Silex as our hostless Wi-Fi solution example.

A Low Cost Hostless IoT Wi-Fi Module

The SX-ULPGN is ideal for embedded wireless products including smart home and smart city devices, systems used in factory automation, appliances, sensors, wearables, medical devices, and products used for security, remote control and remote sensing. The SX-ULPGN module is an excellent choice for device OEMs looking to design Wi-Fi connected products in a cost-effective way.

Based on Qualcomm Technologies' QCA4010 solution integrating embedded CPU, full networking stack, support for multiple connectivity ecosystems and application-level security, the SX-ULPGN module further incorporates a PCB antenna and 2MB flash memory into a ready-to-go solution for Silex's customers to design into their IoT products.

UART AT Command Set for Hosted Mode

Using our UART AT command option, customers can quickly add a serial-to-Wi-Fi converter for existing MCU-based designs without porting any host driver.

Having a UART AT command set for the SX-ULPGN enables Silex to expand the market reach of the SX-ULPGN into hosted solutions in addition to the hostless market. The UART AT command set is comprehensive & flexible, it runs on the debug UART and on the high speed HSUART. It is based on Hayes AT serial modem command syntax, and it supports IPv4, IPv6, & Configuration Save/Load. Customers can perform OTA Firmware Update in addition to many other features.

Evaluation Support

Silex Technology's Wi-Fi evaluation and development kit, the SX-ULPGN-EVK, helps designers easily evaluate all of the SX-ULPGN hardware and software features and develop IoT applications using an SDK supplied by Qualcomm Technologies. Our technical support representatives will assist you in installing and operating our evaluation kits (EVKs).

Next Step: Learn more about Silex America's Internet-of-Things Connectivity Solutions http://silexamerica.com/campaign/iot-connectivity-solutions/

www.silexamerica.com