

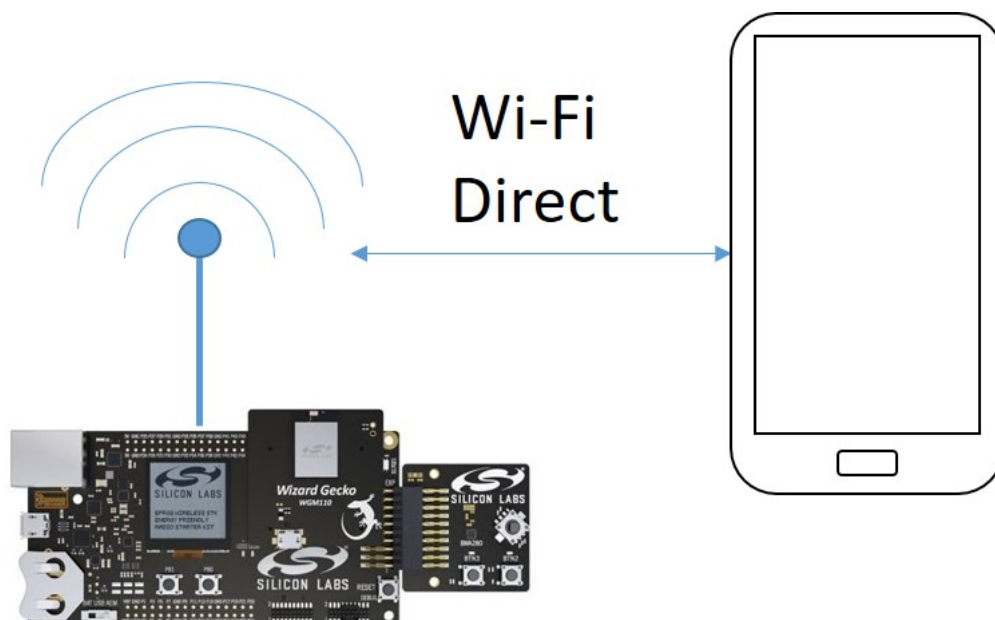
# AN1080: Wi-Fi Direct



This application note describes the Wi-Fi Direct feature in the Wizard Gecko WGM110 Wi-Fi module and the Wi-Fi Direct example application in the SDK.

## KEY FEATURES

- A complete application example
- Showcased features:
  - Project configuration
  - Hardware configuration
  - HTTP Server
  - Establishing a Wi-Fi Direct Group
  - Accepting connection attempts over Wi-Fi Direct



## 1. Introduction

Wi-Fi Direct allows two devices to connect directly to each other, without the need for a traditional infrastructure Wireless Access Point (AP). The role of the access point is replaced by the so called Group Owner which is a role typically negotiated during the connection setup. The Wi-Fi Direct implementation on WGM110 ensures that WGM110 is always the group owner.

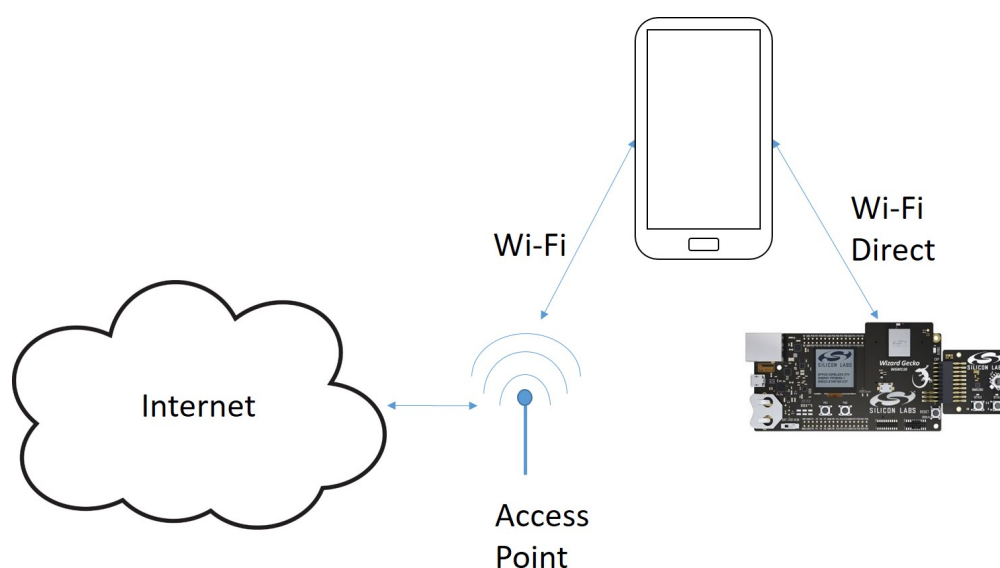
Once the Wi-Fi Direct connection is established all the higher layer protocols (TCP/UDP/HTTP) are available in the same way as with a traditional Wi-Fi connection.

One of the advantages of Wi-Fi Direct is that it can exist alongside a traditional Wi-Fi connection as well as a cellular connection. In practice this means that a smartphone can be connected to an AP with internet access and at the same time connect to WGM110 via Wi-Fi Direct, without losing the connection to the AP, and thus continues to stay connected to the internet.

In terms of security, it uses Wi-Fi Protected Setup where the “pairing” is generally via a button press on one or all the devices.

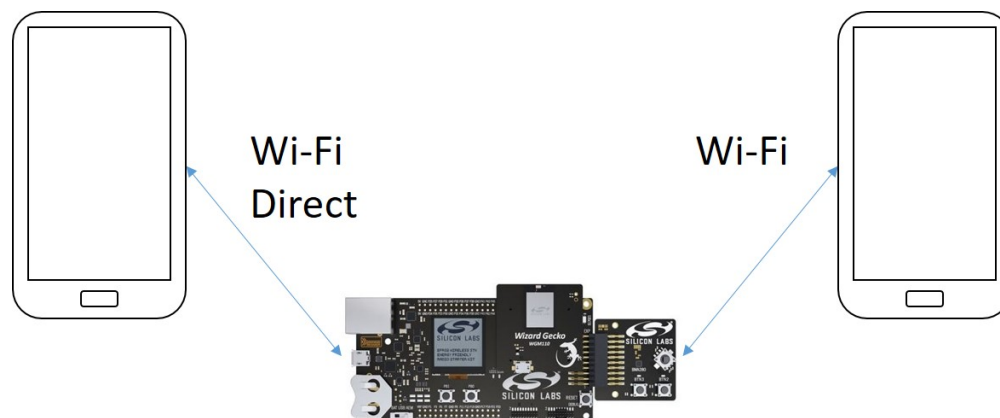
**Note:** Apple iOS devices do not support Wi-Fi Direct.

Connecting to the WGM110 via Wi-Fi Direct allows you to maintain the Internet connection provided via a traditional infrastructure Access Point, whereas if you had to connect to WGM110 using a traditional Wi-Fi connection then the internet connectivity would be lost.



**Figure 1.1. Wi-Fi Direct Allows Maintaining the Internet Connection**

The WGM110 supports concurrent Wi-Fi Direct and “traditional” Wi-Fi connections (in AP mode) of up to 10 combined clients.



**Figure 1.2. WGM110 can Accept Concurrent Connections through both Traditional Wi-Fi and Wi-Fi Direct**

## 2. Wi-Fi Direct Commands on WGM110

There are three commands on WGM110 to control the Wi-Fi Direct feature:

<code>cmd_sme_start_p2p_group</code>	This command will start the Wi-Fi Direct group and make the WGM110 visible as a Wi-Fi Direct device. After this command is issued it will raise the event <code>evt_sme_p2p_group_started</code> confirming that the group has been created.
<code>cmd_sme_stop_p2p_group</code>	This command will stop the Wi-Fi Direct group and the WGM110 will no longer be visible as a Wi-Fi Direct device. After this command is issued it will raise the event <code>evt_p2p_group_stopped</code> confirming that the group has been stopped.
<code>cmd_sme_p2p_accept_client</code>	This command will accept the connection from a pending client. When a client wants to join the group the event <code>evt_sme_p2p_client_wants_to_join</code> is raised. It is then up to the application to implement the security mechanism to confirm that the client can join (e.g., by pressing a button connected to a GPIO on the WGM1100.)

### 3. Wi-Fi Direct Example Application

The Wi-Fi Direct example application in the WGM110 SDK "wifi\_direct" allows you to connect to the WGM110 using Wi-Fi Direct while keeping your smartphone's internet access, whether through a Wi-Fi AP or cellular connection.

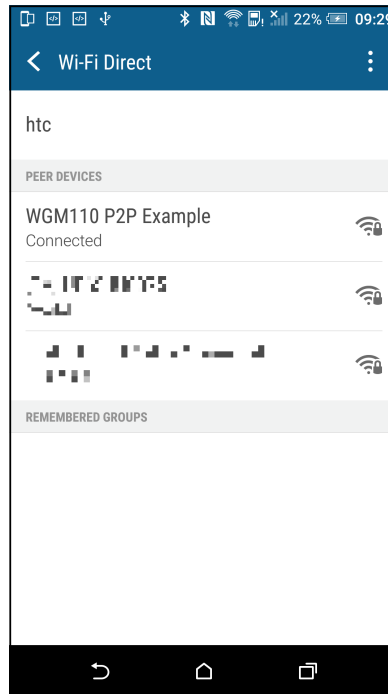
#### 3.1 Testing the Example Application

On Android devices you should find the Wi-Fi Direct option on the Wi-Fi menu.



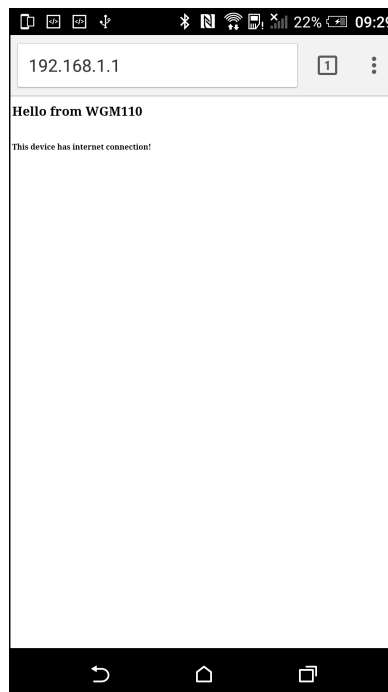
Figure 3.1. Wi-Fi Direct on Android Smartphone

After selecting Wi-Fi Direct it will display all the Wi-Fi Direct devices in range where you should see “WGM110 P2P Example” listed. When you click on it the smartphone will ask to connect to WGM110. Once the WGM110 receives the connection request (for which the event `evt_sme_p2p_client_wants_to_join` is raised), the application has five seconds to accept the connection which in practice means calling the command `cmd_sme_accept_client`. In this example, LED0 on the WSTK will start blinking when the device requests connection and the user must press PB0 within those five seconds so that the connection can be established.

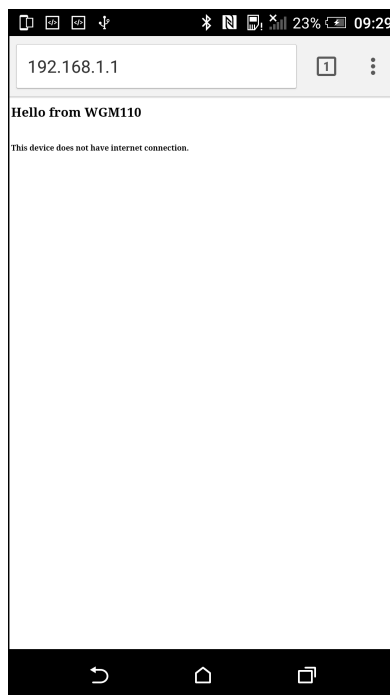


**Figure 3.2. Android Device Connected to WGM110 via Wi-Fi Direct**

Once connected you can open the browser and type the WGM110 IP 192.168.1.1 or wgm110.local (resolved via mDNS) to access the WGM110 HTTP server. The webpage in the HTTP server contains a script that checks if there is an internet connection or not and will display “This device has internet connection!” or “This device does not have internet connection.” depending on the internet connection status of the phone.



**Figure 3.3. Webpage on a Device with Internet Connection**



**Figure 3.4. Webpage on a Device without Internet Connection**

Note that in this example it is also possible to connect to the WGM110 as a traditional Wi-Fi client and this can be done in parallel with Wi-Fi Direct connected devices. You will see the WGM110 listed as “DIRECT-WGM110-WGM110 P2P Example” access point in the available Wi-Fi networks.

### 3.2 Project Configuration

Building a Wi-Fi project always starts by making a project file, which is a simple XML file defining all the resources used in the project. The project file of this example is shown below. The following table lists each part of the project with detailed descriptions of each configuration element.

The project file is shown below:

```
<?xml version="1.0" encoding="UTF-8"?>
<project>
  <scripting>
    <script in="main.bgs"/>
  </scripting>
  <hardware>
    <uart channel="0" baud="115200" api="true" handshake="false"/>
    <kit vcom="true"/>
  </hardware>
  <image out="wifi_direct.bin" out_hex="wifi_direct.hex"/>
  <files>
    <file path="index.html"/>
  </files>
</project>
```

**Table 3.1. Project File Tags**

<code>&lt;project&gt;</code>	This tag starts the project definition and the project file must end in <code>&lt;/project&gt;</code> tag.
<code>&lt;scripting&gt;</code> <code>&lt;script in="main.bgs" /&gt;</code> <code>&lt;/scripting&gt;</code>	Inside the <code>&lt;scripting&gt;</code> tags the main BGScript code file is defined.
<code>&lt;hardware&gt;</code> <code>&lt;uart channel="0" baud="115200"</code> <code>api="true" handshake="false" /&gt;</code> <code>&lt;kit vcom="true" /&gt;</code> <code>&lt;/hardware&gt;</code>	<p>The <code>&lt;hardware&gt;</code> tag contains the device configuration and it can be embedded in the project definition or created as a separate file. In this project it defines:</p> <p>The <code>&lt;uart&gt;</code> tag configures UART0 with baud-rate 115200, BGAPI enabled and handshake/flow-control disabled</p> <p>The <code>&lt;kit&gt;</code> tag enables the WSTK virtual serial communication</p>
<code>&lt;image out="wifi_direct.bin"</code> <code>out_hex="wifi_direct.hex" /&gt;</code>	The <code>&lt;image&gt;</code> tag defines the name of the BGBuild compiler output files in both bin and hex formats. The generated files contain the Wi-Fi stack, hardware configuration and BGScript application they and can be loaded into the module's flash.
<code>&lt;files&gt;</code> <code>&lt;file path="index.html" /&gt;</code> <code>&lt;/files&gt;</code>	The <code>&lt;files&gt;</code> tags lists all the files to be embedded in the flash. These files are included in the hex/bin files generated by BGBuild compiler.

## 4. BGScript Code Walkthrough

The way that the Wi-Fi Direct group is setup is similar to establishing an access point (e.g., `wifi_ap` example in the SDK). In this section, we will discuss the main considerations in establishing a Wi-Fi Direct group.

### 4.1 Setting the Operating Mode

Before turning ON the Wi-Fi, the correct operating mode must be selected. For Wi-Fi Direct, the operating mode is 4 (`MODE_WIFI_DIRECT` is a constant declared at the beginning of *main.bgs* with value 4):

```
# Set operating mode
call sme_set_operating_mode(MODE_WIFI_DIRECT)
```

### 4.2 Starting the Wi-Fi Direct Group

When the Wi-Fi is turned on the event `sme_wifi_is_on` is raised and within this event we can start the Wi-Fi group by calling `sme_start_p2p_group`.

```
# Event received after Wi-Fi has been switched on.
event sme_wifi_is_on(state)
  # Start AP mode
  call sme_start_p2p_group(ap_channel, ap_ssid_len, ap_ssid(0:ap_ssid_len))
end
```

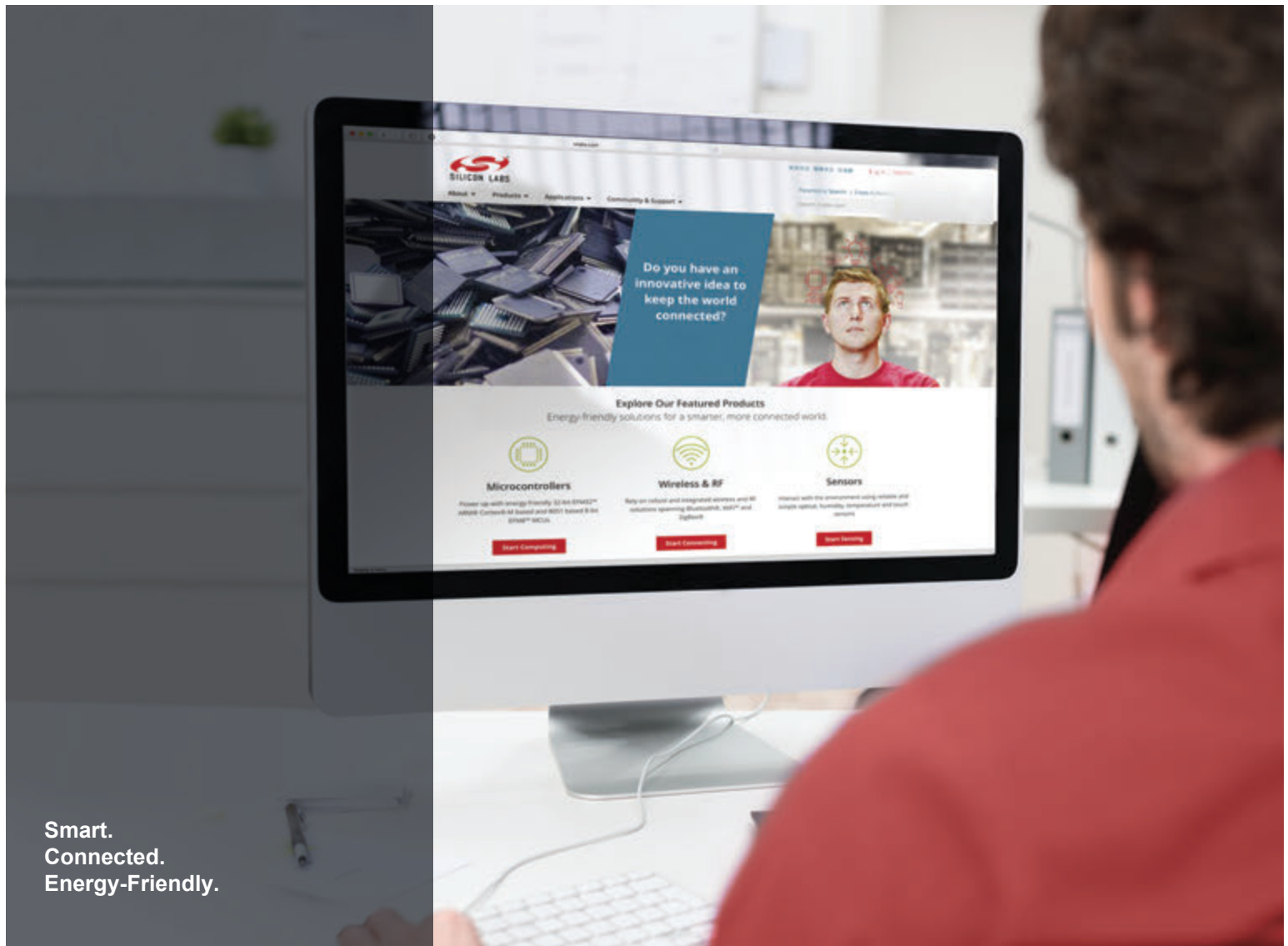
### 4.3 Accepting Wi-Fi Direct Client Connections

When a client wants to join the event `p2p_client_wants_to_join` is raised. Once that happens, there is five seconds to accept the client or a new connection attempt must be initiated from the client side.

To alert users, LED0 will start blinking. The user must then press PB0 to accept the connection which will trigger an interrupt in the WGM110 where the connection acceptance command is called.

```
event hardware_interrupt(interrupts, timestamp)
  # PA2 is interrupt 2 which bit-mask is binary 100 and decimal 4
  if (interrupts & 4)
    if p2p_client_join_attempted = 1
      call sme_p2p_accept_client(p2p_client_mac_address(0:6))(result)
      call hardware_set_soft_timer(0, 0, 0)
      call hardware_write_gpio(GPIO_PORTC, $0001, $0001)
      if result = 0
        # Accepting succeeded
        p2p_client_join_attempted = 2
      else
        # Timeout, etc.
        p2p_client_join_attempted = 0
        call hardware_write_gpio(GPIO_PORTC, $0003, $0000)
      end if
    end if
  end if
end
```





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