THERE ARE MANY PATHS BUT ONLY ONE JOURNEY TOWARDS YOUR IOT APPLICATION

Bluetooth® vs Wi-Fi and System on Chip (SoC) vs. Single Board Computer (SBC)

The universal reliance on networking in business, as well as the growth of the Internet of Things and online services, collectively testify to the benefits of shared data and resources. Smart, inter-connected products represent the future, and the creation and execution of a realistic, well-structured plan can ensure your company makes a successful transition into this exciting new world. In virtually every industry today, companies are looking to wireless technology to connect serial devices with the added benefit of avoiding the exorbitant cost of installing cable. Nonetheless, electronic engineers are faced with a difficult challenge: wireless requires a far more sophisticated design than that needed for wired connections, since one size does not fit all. There are a number of differing wireless protocols, as well as several proprietary technologies. At this stage, there exists no all-encompassing solution to rule and bind them all. Or to put it another way: no single communication technology ideally suits all IoT applications. Increased range comes at the cost of higher power. Higher data ranges increase protocol complexity and require more processing and memory. Moreover, there are design specifications e.g. applications operating on coin-cell batteries, which have size and power constraints, while other applications demand as much bandwidth as possible. These different requirements make it an unavoidable necessity to have multiple connectivity options to support the individual demands of the many possible IoT applications.

Panasonic's secure wireless solutions have helped companies worldwide improve the management of their assets and operations through more effective monitoring and control. By providing customized wireless solutions, Panasonic has accumulated extensive experience in driving market entry strategies for OEM or Alliance partners.

Wi-Fi

Wi-Fi is based on the IEEE 802.11 standard. Fully integrated with the TCP/IP stack, Wi-Fi's success is largely attributable to its interoperability, simplicity and affordability to consumers. Wi-Fi output power is sufficiently high for complete, in-home coverage, but can be vulnerable to 'dead spots' in large concrete structures, necessitating the installment of antennas.

Though Wi-Fi and TCP/IP software is certainly rather large and complex, its use in laptops and smartphones with powerful MPUs and large amounts of memory is fortunately not a practical issue. These days, ICs and modules embed both the Wi-Fi software and the TCP/IP software inside the device itself. These new products eliminate most of the overheads from the MPU and enable wireless internet connectivity using only a tiny MCU.

Wi-Fi has historically had a relatively-high power consumption - around 300 mA, in comparison to 3 mA for *Bluetooth®*. Idle power is also an important factor, considering that IoT devices actively communicate for a short time. When IoT devices run on batteries that cannot be regularly re-charged, Wi-Fi can be too power-hungry for effective use. To overcome this issue however, silicon-based devices are now employing advanced sleep protocols and fast on/off time, reducing power consumption significantly.

Panasonic's fully-embedded, stand-alone 2.4GHz 802.11 b/g/n Wi-Fi module PAN9420 has an integrated stack and API that minimizes firmware development and includes a full security suite. Featuring a fully shielded case, integrated oscillators and antenna, the module combines a high-performance CPU, high-sensitivity wireless radio, baseband processor, medium access controller, encryption unit, boot ROM with patching capability, internal SRAM and in-system programmable flash memory. The integrated memory enables the storage of web content such as HTML pages or image data. The parallel supports of access point and infrastructure mode allow for easy setup.

Bluetooth®

Bluetooth is generally used for short-range, low-power radio communication, eliminating the need for cables. However, the devices must be within approximately 30 meters of each other (BLE 4.2) for it to be operable.

Bluetooth networks, or 'piconets', employ a master/slave model. A single master may be connected to up to seven different slaves and any slave can connect to a single master. *Bluetooth* utilizes spread spectrum frequency hopping (SSFH) technology to limit interference when using multiple devices. Devices now operate at only 2 percent power duty-cycle, consuming approximately 50 nA while still remaining available for device discovery and connection setup.

The very latest iteration, *Bluetooth* 5 (Low Energy), provides a higher data rate, a data range of up to 1.000 m and rapid connection setup. Recent enhancements include:

- Twice the data rate
- Four times the range
- Eight times the broadcast capacity
- Higher available transmitting power (to +20 dBm)
- Recent adoption of *Bluetooth* mesh 1.0, allowing a mesh network topology

The addition of *Bluetooth* mesh introduces a new method of communication; many-to-many allowing a mesh-enabled device to talk to many *Bluetooth* devices simultaneously. Mesh networks also extend the range of a wireless network, as communications can hop between devices. They can also improve the robustness of a network: if a signal can't reach its destination on the first try, another device on the network can re-transmit the message to the device it's trying to get in touch with.

This makes *Bluetooth* mesh very useful for the smart home, as it enables a device in one corner of the home to send a message that can reach any other part. For example, automatically switching on the kettle in the kitchen when the light is turned on in the bedroom in the morning.

DESIGNING WITH WIRELESS MODULES OR WIRELESS SoC's

The moment you choose to add wireless functionality to your products, one of the first questions you must ask yourself is whether to use a System-on-Chip (SoC) or a wireless module. A SoC consists of a single chip whereby the vendor has packaged all the features one will usually require to address a specific market. There are a number of *Bluetooth* Low Energy SoCs on the market which integrate into a single chip - or more microcontrollers - the following features: static RAM memory; Flash memory; *Bluetooth* controller; RF transceiver; voltage regulators as well as a lot of extra peripherals (analog to digital converters, timers, cryptographic processors, etc.) A BLE module is available either with a fully-contained BLE transceiver plus embedded controller and built-in antenna which is pre-programmed to handle all a design's radio interactions. Alternatively it is available as a BLE module that serves strictly as an IO device for a host controller (HCI module), making the BLE connection the logical equivalent of a serial port for design purposes. Other modules are also able to operate in a stand-alone (hostless) manner and make available their processor and other IO resources to developers to run application code. Both module types come pre-certified with both the *Bluetooth* SIG (for interoperability) as well as various regulatory agencies. Sometimes a single-chip solution is neither always possible nor the preferred option. Many semiconductor companies have brought out highly integrated devices (modules) to support new IoT products. For instance, the new low-power System-on-Chip (SoC) integrated module supports both wireless protocols, as well as external sensing and communication technologies. The complexity inherent in RF design, wireless connectivity and *qualifying compliances* can be easily overcome by using these integrated modules. Or to put it another way: Modules drive "Rapid-time-to-market, Wide range of products" while ICs move with "Less expensive, Custom Design products". In most cases, an SoC-based design can be cost-optimized, size-optimized and configured to the specific requirements of the end product. Conversely, a module approach is likely to be easier to implement; additionally, it will be pre-certified and require less resources. In the end, only the individual consumer can effectively judge which approach best meets their particular needs.

Every project is different. So therefore, are the costs involved, which can obviously vary enormously depending on the available expertise and equipment, and its application. The chip-based design cost, for instance, is particularly suitable for a company seeking to build up a team with the requisite expertise. Subsequent design should then work out to be considerably cheaper. The costs also make the assumption that each design will be correct the first time around, and not have to go through multiple iterations or product tests. Chip-based designs carry a greater risk of re-spins, particularly if the design is a company's first attempt at RF. In practice, designs with total production volumes of fewer than 50,000 units will normally benefit from using a module. Above 200,000 units, it is likely that a chip-based design will turn out to be more economical (however, it is of course not only a question of quantity but also know-how) - as demonstrated in the figure on the next page.

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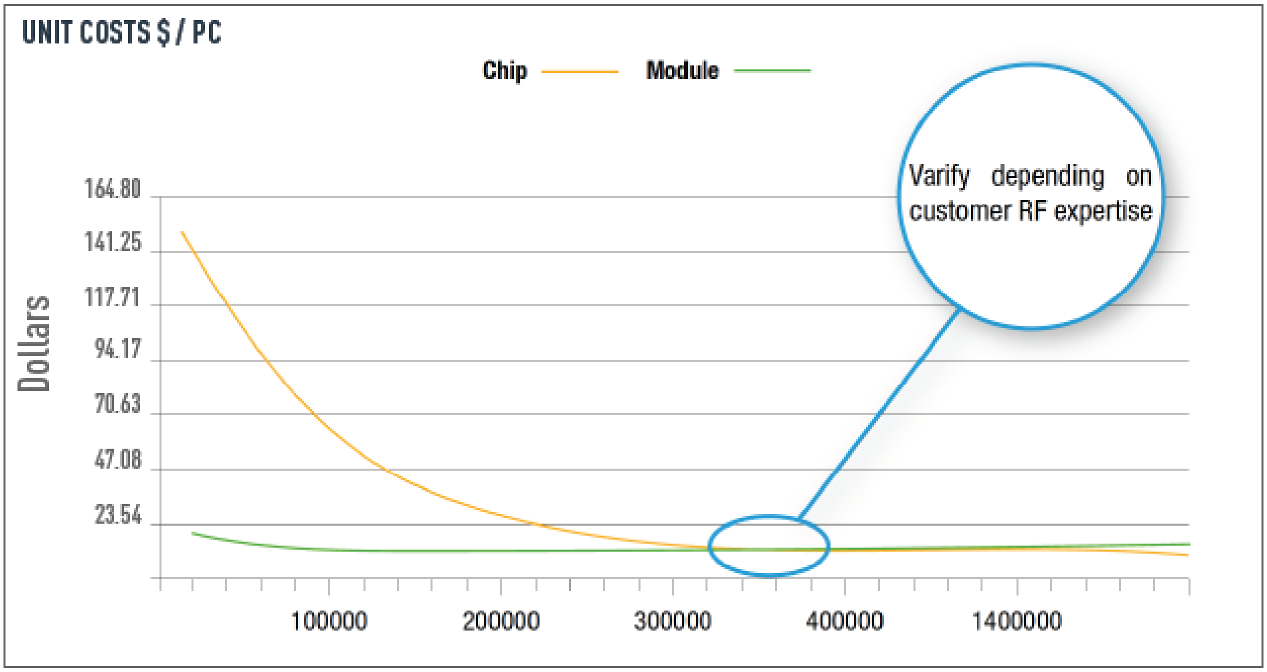

PANASONIC'S WIRELESS SOLUTIONS

Panasonic's line of Wireless Connectivity products have helped companies worldwide to improve the management of their assets and operations through more effective monitoring and control with the company's secure wireless solutions. The company has extensive experience in driving market entry strategies for OEM or Alliance partners by providing tailored wireless solutions. Two of its most recent wireless solutions modules stand out in this regard: PAN1760A and PAN9420.

As usage of smart phones and tablets continue to gain in popularity, the trend towards BYOD (bring your own device) continues to gain momentum. Pansonic's next generation *Bluetooth* module PAN1760A with the industry's lowest power *Bluetooth* Low Energy SoC is the company's state of the art solution for those applications which are targeting exactly that market. With its small size (only 15.6mm x 8.7mm x 1.9mm) and *Bluetooth* SIG Mesh v1.0 certification it is ideally suited for mobile, remote and battery-powered applications built around the smartphone / tablet as a remote display or data conduit device to the Cloud without the need for an external processor saving cost, complexity, and space. Devices for these applications include the exploding array of healthcare and fitness wearables, through business productivity devices and smart home/smart building products such as remote sensors and devices that must run for long periods of time without recharging or needing a battery change. While some of these applications still require a gateway, the smartphone has become the mobile computing device that consumers depend on to conveniently access IoT data and services and manage their surroundings. The small SMD device SMD module is based on Toshiba's single chip TC35678 *Bluetooth* semiconductor device with embedded Toshiba *Bluetooth* 4.2 LE stack and embedded flash for user applications in stand-alone operation. The PAN1760A product can either be operated in AT-Command or Host mode for very simple integration of *Bluetooth* connectivity into existing products, or in Stand-Alone mode. In Stand-Alone mode, with 256 kB flash memory and 83 kB RAM for user application, the PAN1760A can be used for many applications without the need for an external processor, saving cost, complexity, and space.

In the Internet of Things (IoT) paradigm, many of the objects that surround us will be on the network in one form or another. For doing so, data transmission and sensor network technologies will rise to meet new challenges, in which information and communication systems are invisibly embedded in the environment around us. IoT might represent the convergence of advances in miniaturization, increased data storage capacity and batteries but wouldn't be possible without remote access to data provided by sensor information (temperature, humidity, light level, presence of carbon monoxide etc.) as well as the designed application to that information (switch on an LED, trigger an alarm, switch on an emergency exhaust fan, turn on a coolant pump). What better way to achieve generic, consistent, device independent, designer-independent remote access than the ubiquitous HTTP protocol, over the even more ubiquitous IP network? That is why web servers on embedded devices are being done and that's why Panasonic's PAN9420 comes with an integrated webserver which provides up to 2 MB for content.

Is your design based around easy connection and configuration, such as a smart appliance, industrial control and monitoring? For those applications, the device typically does not have a display and keyboard, making the initial Wi-Fi set-up complicated and not user friendly. With Panasonic's PAN9420, the AP/STA dual mode feature enables mobile wireless devices like laptops, tablets and smart phones to connect to the target device easily. In addition, PAN9420 supports built-in web server under AP mode, which greatly simplifies the target device control.

Or are you planning on building something bigger and want to save the trouble of using an active internet connection for the application and its devices but need a personal Wi-Fi network to go with you wherever you are? Let's say you want to print from your laptop or smartphone to a wireless printer, share and transfer content. None of these things require an active internet connection, or an internet connection at all, but they do need to connect - to the printer, or to the other person's hardware, or to the TV. Panasonic's PAN9420 supports Wi-Fi Direct and that makes that task for you way easier. Wi-Fi Direct can connect the different devices, one of the Wi-Fi devices only needs to be compliant with Wi-Fi Direct to establish the connection that transfers the data directly between them with greatly reduced setup.

CONCLUSION

Bluetooth and Wi-Fi are both platforms that provide Wireless communication, but the difference between the two mainly stems from what they are designed to do and how they are used. The key difference is that *Bluetooth* is primarily used to connect devices without the use of cables, while Wi-Fi provides high-speed access to the internet. Due to the short range and low power consumption of *Bluetooth*, it is best suited to formats such as portable devices, smart health, body sensor network (BSN), smart vehicle application etc. Wi-Fi is best suited for standalones (mostly in smart home applications) and mobile devices because it can implement TCP/IP and therefore the devices or nodes can connect to the Internet directly. Thus, both the functionality and nature of use determines whether *Bluetooth* or Wi-Fi will be the best solution in a given context.

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