Wireless Edge Connectivity with Bluetooth Integrated FPGAs

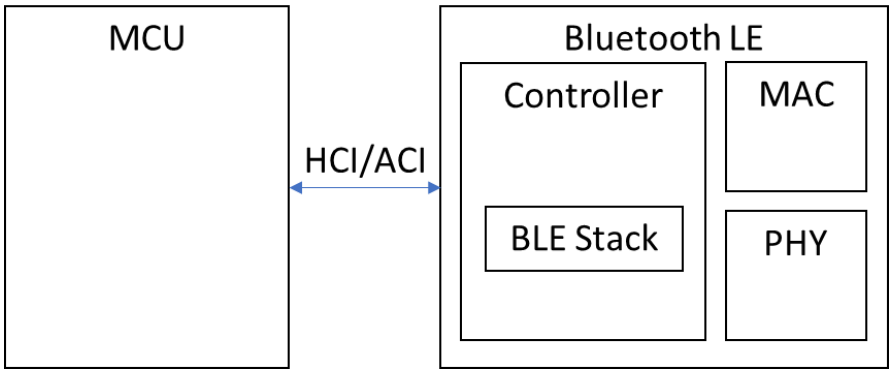
White Paper

WP894-1.0E, 2019-11-12

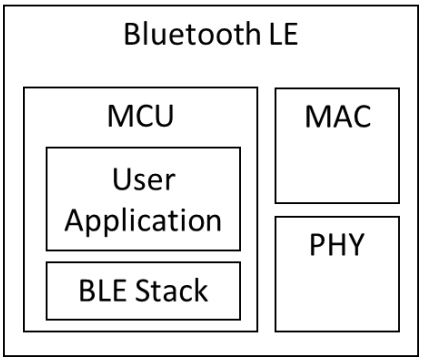
Device connectivity at the edge has become a necessity. About 4 Billion devices in 2018 shipped with Bluetooth technology according to Bluetooth SIG, which is expected to continually grow at a compound annual growth rate of 12% over the next 10 years. This high continual growth is backed with new capabilities and use cases for the standard such as point of interest broadcasting, indoor navigation, transfer and recording of sensor and communication data, control, monitor and automation systems.

Most Bluetooth devices come in two forms. The first focuses on providing only a radio with an interface that can be controlled by a separate microprocessor. The second has a Bluetooth radio as well as a microcontroller in the same device that can be used for the Bluetooth stack as well as a limited amount user applications. These integrated solutions are often limited on what capabilities the microcontroller can offer as a result of specialized market needs.

Standalone Bluetooth Device -



Integrated Bluetooth Device -



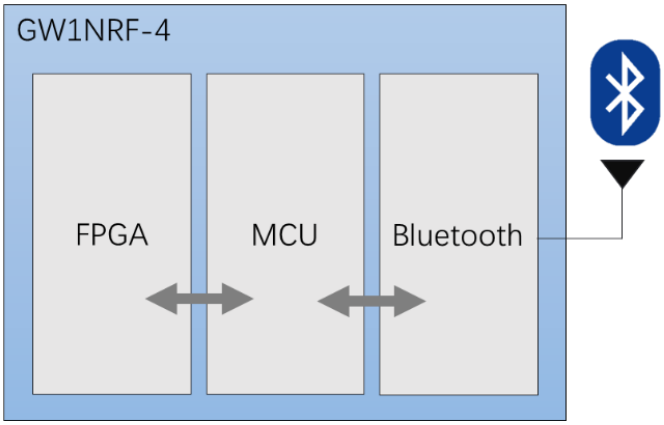
Additionally, both devices often lack flexible IO. For example, camera and display interfaces are rare at the microcontroller level and audio interfaces such as I2S may be extremely limited or non-existent. Sensor interfaces may be limited by the small number of IO available as well.

Performance can also be limited. Many times the processor in Bluetooth devices is limited to the lowest performance to save power. In cases, where the processor has more performance the power can be high for always-on use cases which require continual monitoring and control of the system such as data streaming or driving motors.

These deficiencies could be remedied by the benefits seen in edge focused FPGAs. However, there is no FPGA to date with an integrated Bluetooth radio so a two-chip solution must be used. This has board area, cost and integration issues that the developer must be concerned about when developing a new product.

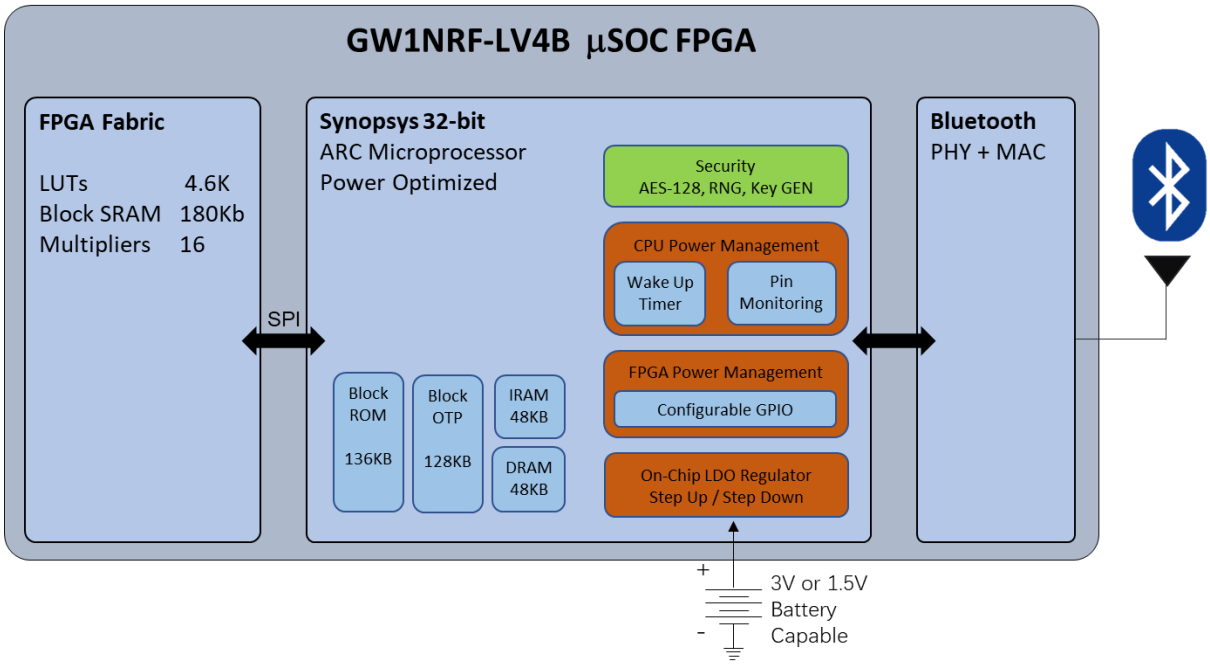
As a result, GOWIN Semiconductor has created the first FPGA with an integrated Bluetooth 5.0 Low Energy radio called the GW1NRF. This integration enables the flexible and high IO count, always-on low power, acceleration and pipelining capabilities of an FPGA with the wireless data transmission capabilities of a Bluetooth radio in a single chip.

GW1NRF High Level Block Diagram -



Additionally, integration of several other key features has been developed within the GW1NRF device. The device features a 32-bit power optimized ARC processor, which can be used for both the Bluetooth stack as well as user applications. It also features a power management unit capable of various power modes as well as power gating, reducing the total power consumption of the device down to 5nA. Additionally, the device features a step up/step down regulator to better enable the entire device to operate off a 1.5V or 3.0V battery. Security features are also provided such as a random number generator, AES-128 and a key generator.

GW1NRF-4 Device Block Diagram -

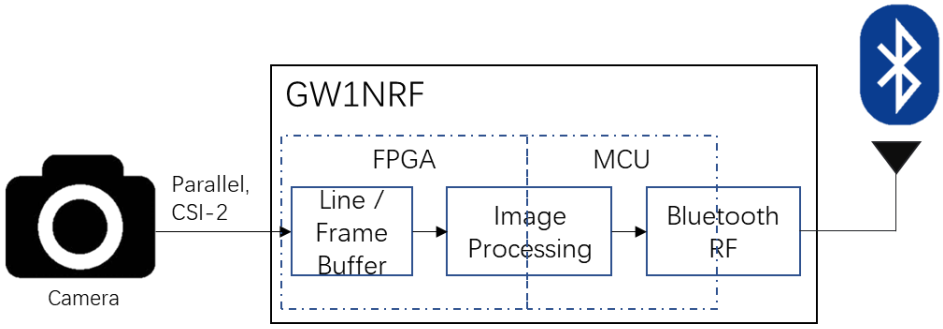


Use Cases

The GW1NRF is a completely new device which promotes the ability for end product manufactures to innovate in ways that were never before possible. As a result, some possible use cases are discussed to promote the unique capabilities the device has in order to stimulate new product ideas.

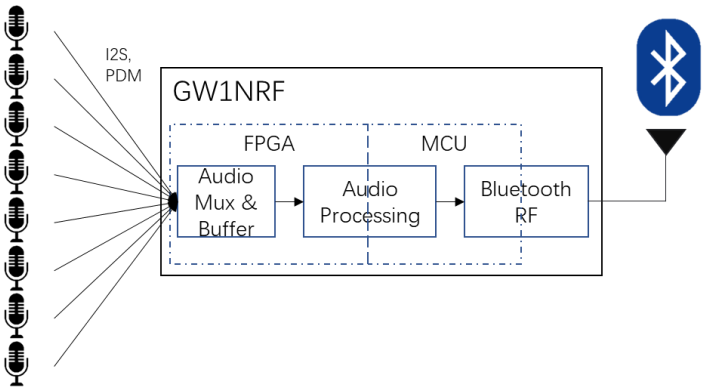
Camera to Bluetooth

Camera interfaces are often not available on most microcontrollers and Bluetooth devices. Flexible IO of FPGAs allows for many types of image sensors to be connected with interfaces such as parallel/single ended CMOS or a serialized MIPI CSI-2.



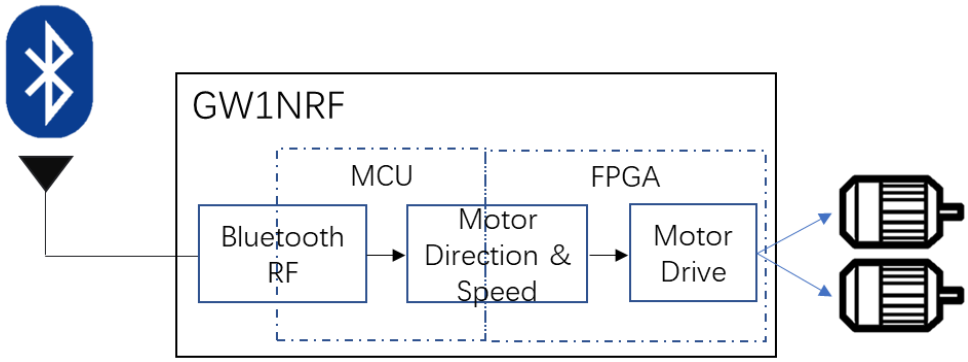
Audio hub to Bluetooth

Many microcontrollers and Bluetooth devices either do not have enough digital microphone interfaces such as I2S or PDM for microphone array applications. With the flexible FPGA IO interfacing many microphones along with data communication via Bluetooth becomes possible in a single chip.



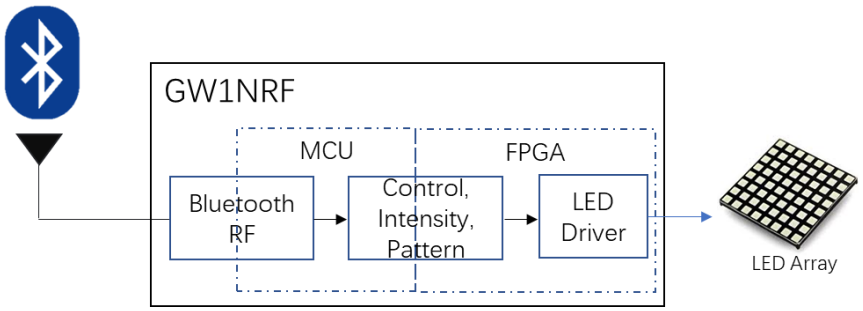
Bluetooth to Motor Control

Motor control over Bluetooth can provide control of robotic and industrial equipment from battery powered devices such as a smartphone. Having FPGA resources and flexible FPGA IO promotes control of multiple motors over Bluetooth in a singular device.



Bluetooth to LED Control

Controlling multiple LED's with FPGAs is common due to high current drive IO and IO count. Adding Bluetooth within the same device provides remote control of LED arrays along with adjustments for intensity, color and generation of sequencing patterns.



Conclusion

The need for connectivity at the edge with Bluetooth Low Energy is increasing. Programmable heterogeneous computing needs are also increasing for machine learning, computer vision and embedded graphics use case. Integration of programmable capabilities along with SoC features is also increasing in need to meet new power, size and cost requirements. As a result, the Gowin GW1NRF4 provides new capabilities with embedded Bluetooth Low Energy to enable the next generation of embedded computing devices.

Support and Feedback

Gowin Semiconductor provides customers with comprehensive technical support. If you have any questions, comments, or suggestions, please feel free to contact us directly by the following ways:

Website: www.gowinsemi.com

E-mail: support@gowinsemi.com

Tel: +86 755 8262 0391

Revision History

Date	Version	Description
11/12/2019	1.0E	Initial version published.

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