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GOWIN Semiconductor

MIPI to Bluetooth LE: Leveraging Mobile Technology for Wireless IoT Applications
1. MIPI Standardization in mobile has made many new mobile influenced products possible
2. Many of these new products “retro-fit” MIPI sensors from other more mature markets
3. Many of these products are wireless
FPGA’s influence on MIPI Adoption

- FPGA’s have historically been a critical part of MIPI interface adoption
  - Interface and bridging
    - Mobile multi-camera, display replacement, VR, Drone, Automotive, Industrial
  - Early interface and link layer adoption
  - Prototyping

- FPGA’s have dramatically changed over the last 10 years
  - Power: Sub mW
  - Cost: Sub $1
  - Size: Sub 4mm²

- FPGA’s provide a great path to implement differentiated, non-native SoC features. Still dependent on the SoC; not a standalone solution.
New Feature Driven FPGAs

• Extended memory FPGAs
  – 4-8MB extended RAM
    • Video frame buffer
    • Audio spectrogram buffer
    • Instrumentation data buffering

• Security FPGAs
  – PUF for unclonable system firmware
  – Asynchronous Key Pairs

• SoC FPGAs
  – FPGA + Microprocessor
  – FPGA + Bluetooth + Microprocessor

FPGA’s can process high-throughput use cases
FPGA’s often used for ‘first on’ and ‘always listening’ applications since a gate array does not need to be continually clocked
Microprocessor can focus on control, monitoring and post processing while FPGA can handle throughput/time intensive computations.
Bluetooth LE Enabled FPGA Concept

SoC FPGA with Bluetooth Low Energy

- FPGA Fabric
  - Interfacing (MIPI D-PHY/CSI-2/DSI, I3C, VGI, SLIMBus/SoundWire)
  - Memory Buffering
  - High Speed Processing/Rendering
  - IO Expansion

- Microprocessor
  - Control/Data Management
  - Buffered Data Post Processing
  - BLE Stack
  - Power Control
  - Security

- Bluetooth LE 5.0 PHY/MAC
  - Wireless Communication

Global Attributes:
- Small Footprint
  - 6x6mm QFN
- Low Power
  - 5nA Power Gate
  - nA-uA Power Management
  - Built-in LDO for Battery Operation
- Security
  - AES-128, RNG, Key Generation

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MIPI CSI-2℠ Camera Application Example

![Diagram showing the components of a camera application example. The diagram includes a BLE FPGA, Processor, Bluetooth LE, and two MIPI CSI-2 interfaces connected to the FPGA Fabric.]
MIPI CSI-2 Camera Application Example
MIPI DSI℠ and Touch Display Application Examples
MIPI SoundWire/SLIMBus Audio Application Example

Soundwire
SLIMBus
I2S
PWM

FPGA Fabric
- PHY
- Spectrogram
- Audio Threshold Detect
- Machine Learning Accelerator

BLE FPGA
- Processor
  - ML Controller
  - Inference Result

Bluetooth LE

Inference Result
Buffer

Machine Learning Accelerator
Audio Threshold Detect
Spectrogram
PHY
Other Interesting Use Cases

**BLE FPGA**

BLUETOOTH RF → MCU → FPGA

- Control, Intensity, Pattern
- LED Driver

→ LED Array

**MCU** → **FPGA**

**BLE FPGA**

BLUETOOTH RF → MCU → FPGA

- Motor Direction & Speed
- Motor Drive

→ Motors
Summary – FPGAs Extend MIPI Related Use Cases

• Programmability of Mobile FPGAs enable new uses of MIPI sensors providing differentiated and innovative end products
  – High Speed Interfaces (Cameras, Displays)
  – Compute Intensive Cases (Machine Learning, FFT/Spectrogram, Computer Vision)
  – Data Buffering (Video Frame Buffering, Audio Buffering, Instrumentation and Test Equipment)
  – High IO Count (Camera Aggregation, Audio Beam Forming, Sensor Hub)
  – Always-On, Always Listening and Fast Wake-Up Cases

• SoC integration of MCU, FPGA and other key features such as Bluetooth Low Energy further extend usage of MIPI sensors
GOWIN enables MIPI by Manufacturing Unique and Differentiated FPGAs

<table>
<thead>
<tr>
<th>Product Features</th>
<th>Product Series</th>
<th>FPGA Density (LUTs)</th>
<th>LittleBee Features</th>
<th>Arora Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra Low Power Device Power Management</td>
<td>GW1N</td>
<td>1K, 4K, 9K</td>
<td>Flash-Based FPGA</td>
<td></td>
</tr>
<tr>
<td>Hard MCU ARM Cortex M3 ARC EM4</td>
<td>GW1NZ</td>
<td>1K</td>
<td>Ultra-Low Power</td>
<td></td>
</tr>
<tr>
<td>Extended Memory On-Chip SRAM / Flash</td>
<td>GW1NS</td>
<td>2K, 4K</td>
<td>Embeded Hardcore MCU</td>
<td></td>
</tr>
<tr>
<td>Security SRAM PUF Root-of-Trust</td>
<td>GW1NR</td>
<td>4K, 9K</td>
<td>Extended Memory</td>
<td></td>
</tr>
<tr>
<td>Bluetooth Low Energy RF Transceiver</td>
<td>GW1NSR</td>
<td>2K, 4K</td>
<td>MCU + Memory</td>
<td>N/A</td>
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<tr>
<td></td>
<td>GW1NSE</td>
<td>2K, 4K</td>
<td>MCU + Security</td>
<td></td>
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<td></td>
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<td>4K</td>
<td>MCU + Security + RF Transceiver</td>
<td></td>
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<tr>
<td></td>
<td>GW2A</td>
<td>20K, 55K</td>
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<td>Extended Memory</td>
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<tr>
<td></td>
<td>GW2AR</td>
<td>20K</td>
<td>RAM-Based FPGA</td>
<td></td>
</tr>
</tbody>
</table>

**GOWIN FPGA Device Family**

<table>
<thead>
<tr>
<th>LittleBee Flash-Based FPGA GW1N* 1-10K Logic Element Density</th>
<th>Arora SRAM-Based FPGA GW2A* 20-55K Logic Element Density</th>
</tr>
</thead>
</table>

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GOWIN GW1NRF Bluetooth LE 5.0 Enabled FPGA

FPGA Fabric
- LUTs: 4.6K
- Block SRAM: 180Kb
- Multipliers: 16

Synopsys 32-bit ARC Microprocessor
- Power Optimized

Security
- AES-128, RNG, Key GEN

CPU Power Management
- Wake Up Timer
- Pin Monitoring

FPGA Power Management
- Configurable GPIO

IEEE 802.15.4
- Block ROM: 136KB
- Block OTP: 128KB
- IRAM: 48KB
- DRAM: 48KB

On-Chip LDO Regulator
- Step Up / Step Down

Bluetooth PHY + MAC

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GOWIN GW1NRF Bluetooth LE FPGA Product Page:

GOWIN GW1NRF Bluetooth LE FPGA Development Kit Page:
https://www.gowinsemi.com/en/support/devkits_detail/19/

Other Inquiries:
info@gowinsemi.com

GW1NRF Available in 6x6mm QFN48 or Pre-Certified GW1NRF 20x20mm Module
THANK YOU

MOBILE & BEYOND