Exhaustive List of Unique Hardware and Firmware Applications Developable with Zephyr RTOS on the Nordic nRF52840 Dongle

January 2026

1 Wireless Communication Applications

- Bluetooth Low Energy (BLE) Peripheral: Device advertising sensor data or status to BLE centrals.
- BLE Central: Scanner discovering and connecting to BLE peripherals for data collection or control.
- BLE Beacon: Implementation of iBeacon or Eddystone for location-based services.
- BLE Mesh Node: Node in a Bluetooth Mesh network for smart lighting or home automation.
- BLE HID Device: Wireless keyboard, mouse, or game controller over BLE.
- BLE Heart Rate Monitor Simulator: Fitness tracker emulation sending heart rate data.
- BLE Battery Service Provider: Reporting battery levels and device status over BLE.
- BLE Over-the-Air (OTA) Update Client: Firmware updates via custom BLE services.
- Thread Network End Device: Low-power node in a Thread mesh for IoT sensors.
- Thread Border Router: Gateway bridging Thread to IP networks.
- Zigbee End Device: Zigbee-compatible sensor or switch for smart home systems.
- Zigbee Coordinator: Network coordinator for managing Zigbee devices.
- IEEE 802.15.4 Packet Sniffer: Capture and analysis of 802.15.4 packets.
- IEEE 802.15.4 MAC Layer Tester: Low-level protocol testing tools.
- ANT Protocol Sensor: Fitness or sports sensors using ANT.
- Multiprotocol Radio Switcher: Dynamic switching between BLE, Thread, and Zigbee.

2 USB Device Applications

- USB CDC ACM Virtual Serial Port: USB-to-serial bridge for console or data logging.
- USB HID Keyboard Emulator: Simulated keyboard inputs for automation.
- USB HID Mouse Emulator: Virtual mouse or gesture-based input device.
- USB HID Gamepad: Custom game controller with button/joystick mapping.
- USB Mass Storage Device: Emulated flash drive using internal flash.
- USB Device Firmware Update (DFU): Custom USB-based firmware upgrades via MCUboot.
- USB Composite Device: Combination of multiple USB classes (e.g., HID + CDC).
- USB Audio Class Device: Simple USB microphone/speaker (with external hardware).
- USB Vendor-Specific Device: Proprietary USB protocols for custom interactions.

3 Sensor and Peripheral Control Applications

– LED Blinker (Blinky Sample): Basic onboard RGB LED toggling.
– PWM LED Dimmer: Brightness control for dimmable lights or effects.
– Button Input Handler: Detection of button presses for user interaction.
– GPIO Pin Controller: Digital I/O control for hardware extensions.
– ADC Voltage Reader: Monitoring battery voltage or external analog sensors.
– I2C Master Device: Interface with temperature, humidity, or accelerometer sensors.
– I2C Slave Device: Acting as an I2C peripheral in larger systems.
– SPI Master Controller: Connection to displays or SD cards.
– SPI Slave Mode: Responding as an SPI peripheral.
– UART Serial Console: Debug console or serial bridge.
– UART Data Logger: Logging external UART data.
– RTC-Based Timer: Scheduling tasks or timekeeping.
– Watchdog Timer Monitor: System reliability with crash recovery.
– MPU Memory Protection Demo: Protected memory regions for secure execution.

4 NFC Applications

– NFC Tag Emulator: Emulation of NFC tags for URLs or contact data.
– NFC Type 2 Tag Simulator: Read/write NFC tag functionality.
– NFC-Enabled Access Control: Simple authentication via NFC.
– NFC Data Exchange Format (NDEF) Handler: Parsing/generating NDEF messages.

5 Security and Cryptography Applications

– Hardware Crypto Accelerator Demo: Encryption/decryption using nRF52840 crypto hardware.
– Secure Boot Verification: Signed firmware verification with MCUboot.
– Cryptographic Key Generator: Secure key generation with hardware RNG.
– Secure Storage Manager: Encrypted flash storage for sensitive data.
– Attestation Service: Device attestation for IoT security.

6 Networking and IoT Applications

– MQTT Client over BLE/Thread: Publish/subscribe to cloud brokers.
– CoAP Server: Lightweight RESTful resource server.
– HTTP Client: Web data fetching over IP-enabled protocols.
– IPv6 Node over BLE/Thread: Direct internet connectivity in mesh networks.
– WebUSB Interface: Browser-based device control.
– SNTP Time Synchronization: Network time syncing.
– DNS Resolver Demo: Basic DNS lookups.

7 Display and User Interface Applications

– OLED Display Driver (e.g., SSD1306): Status display via I2C/SPI.

– LCD Controller: Text/graphical output on small LCDs.

– E-Ink Display Updater: Low-power persistent displays.

8 Audio and Multimedia Applications (with External Hardware)

– I2S Audio Interface: Streaming to external DACs/speakers.

– PDM Microphone Reader: Voice activation or recording.

9 Power Management and Optimization Applications

– Low-Power Sleep Mode Demo: Deep sleep for battery operation.

– Power Profiling Tool: Consumption monitoring via ADC/RTC.

– Dynamic Frequency Scaling: CPU clock adjustment for power/performance.

10 Testing and Debugging Applications

– Segger RTT Console: Real-time logging without UART.

– Fault Injection Simulator: Error handling testing.

– Peripheral Stress Tester: Hardware stability verification.

11 Hybrid and Advanced Applications

– BLE-to-USB Gateway: Bridging BLE devices to USB hosts.

– Thread-to-BLE Translator: Multi-protocol conversion.

– Smart Watch Simulator: Wearable prototype with display and notifications.

– Environmental Sensor Node: Multi-sensor air quality/weather monitoring.

– Asset Tracker: Location tracking with BLE beacons and NFC.

– Robotic Controller: GPIO control with wireless commands.

– Home Automation Hub: Central management of lights/sensors via Zigbee/Thread.

– Fitness Tracker Emulator: Activity monitoring simulation.

– Wireless Game Controller: HID over BLE/USB with inputs.