## **Time Multiplexing: Concurrent Multi-standard Operation**

Using a single chip, time multiplexing enables concurrent operation of wireless protocols, and has distinct advantages and trade-offs for various use cases.



**Time Multiplexing** is a concurrent multi-standard solution in which two protocol stacks share the same radio. The radio switches between the stacks, and changes the settings, the channel, and other parameters accordingly.

TI's time multiplexing solution is called the <a href="DMM: The Dynamic Multi-protocol Manager">DMM: The Dynamic Multi-protocol Manager</a>. It is a software module that allows these two stacks to run concurrently on a single chip. A part of the DMM, the scheduler, receives the commands from both stacks and allocates radio resources based on prioritization.

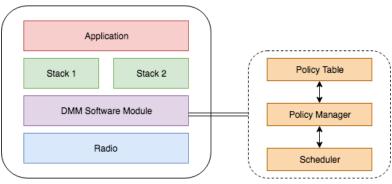


Figure 1: Dynamic Multi-protocol Manager Software Architecture

## Theoretical Use-Cases and Trade-offs

BLE (Bluetooth Low Energy) is widely adopted in industry to enable a system connection to a user's phone. With TI's time multiplexing solution, designers can operate BLE and another asynchronous protocol, such as Sub-1 GHz or Zigbee, concurrently.

BLE operates with central and peripheral roles. The peripheral will send periodic advertisement packages, and the BLE central will scan to find the peripheral and initiate a connection, Both meet at defined "connection event" intervals to exchange data. Similarly, 15.4 protocols have router and sensor roles; sensors are typically sleepy end-nodes, whereas coordinators are always on.

Figure 3 uses the term "15.4" to represent several asynchronous protocols such as Zigbee, Thread, Sub-1 GHz, or others. This diagram details the trade-offs between usecases when using the Sensor or Router roles for 15.4, and Peripheral or Central roles for BLE. The BLE peripheral and 15.4 sensor have the most optimized solution for running a concurrent, time multiplexing system due to the low data rate and connection activity from both. Alternatively, the BLE central and 15.4 router multiplexing combination is more likely to result in degradation, meaning that data can be lost in transmission when operating on a single chip.

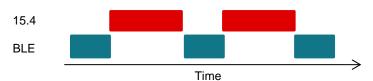


Figure 2: Radio that is time multiplexing 15.4 and BLE protocols concurrently

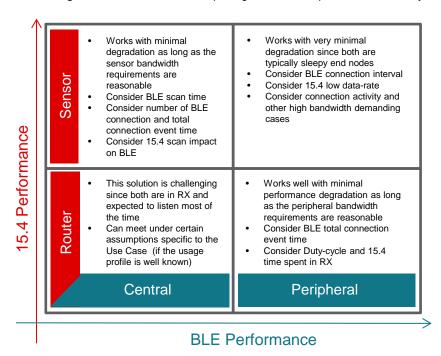


Figure 3: Performance of Time Multiplexing solutions

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