Orchestration and Reconfiguration Control Architecture

SHOWCASE 2

LOW LATENCY CONTEXT-AWARE IOT CONTROL

GOALS

The main goal is to demonstrate the low latency, reliable and flexible link control of mobile nodes or robots established via SDR, including two specific building blocks:

- The concurrent multi-channel virtual transceiver (TRX) as IoT gateway (GW)

- The integrated Doppler radar with full duplex communication capability tracking robots while controlling them

Both building blocks are established upon IEEE 802.15.4 PHY; the former aims to achieve better throughput/latency performance as an IoT gateway, the latter aims to increase the reliability of each single control link with full duplex MAC (collision detection and avoidance) and a Doppler radar (environment sensor).

CHALLENGES

-The receivers of multi-channel transceiver implementation share a single radio frontend, which has an Automatic Gain Controller (AGC). However, this AGC applies a global gain setting on all the channels, which causes issues when the transmitters of different channels are located at different distances. In order to overcome this issue, a simple AGC is implemented: it applies gain on each channel individually.

- Integration of a configurable Doppler radar system into a communication device, merely by reusing its already-existing waveform and hardware, is also one of the challenges in this showcase. Unlike the traditional radar systems, the Doppler radar in this showcase has to merely use the device's self-transmit signal, while this additional functionality does not affect communication.

CONCEPT

The showcase use of a concurrent multi-channel TRX as an IoT GW. The GW is attached to a controller to steer multiple robotic arms. A radar communication system (RadCom) that makes use of signals transmitted for communication to estimate the moving object’s speed. This information is helpful to identify if the target robot is reacting to the command, or if there are external mobile objects present. This feature helps to achieve ultra-high reliability by informing the control unit about the reaction of the devices, or applies the environmental information to implement an explicit response accordingly.

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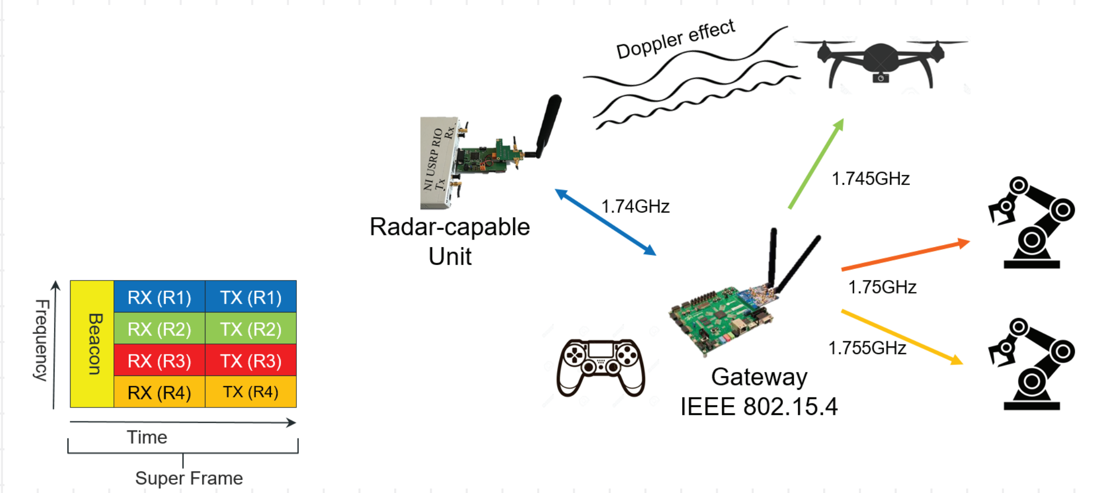
DEMO SET-UP



- A GW (zedboard) supports a 4x multi-channel Virtual transceivers. It operates on 4 channels concurrently.

- The first 2 channels are used to control 2 robotic arms, the remaining two channels are used for radio communication, and controlling a propeller (emulating a “drone”).

- The time and frequency slot used by the system is shown in the lower left corner of the figure below.

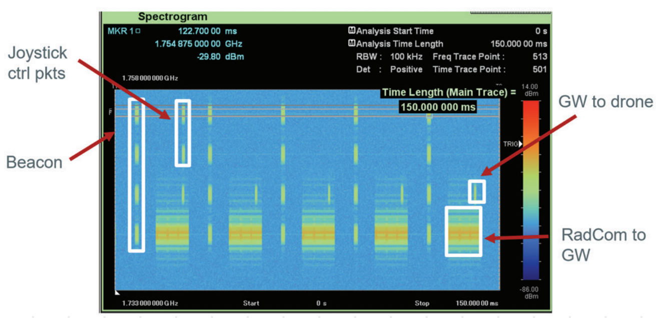
- Two additional zedboards are added as wireless interfaces of the robotic arms.

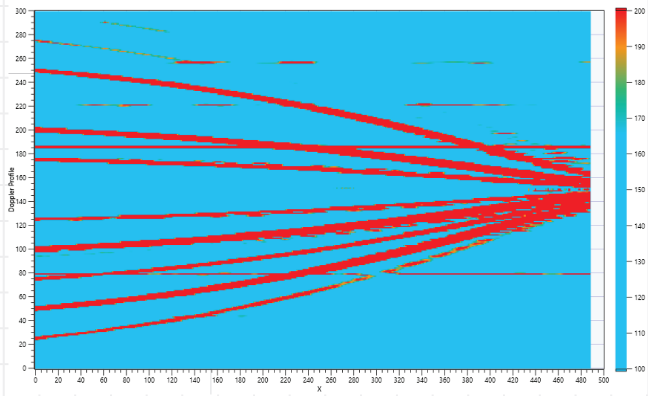
- The radar-capable unit enables simultaneous in-band full-duplex communication and Doppler radar.

- The radar-capable unit (RadCom system) controls the “drone” through the GW, and reuses the reflections of what it transmits to sense the reaction of the drone.

RESULTS

The robots are moving synchronized, the drone propeller’s angular speed is correctly controlled by the RadCom, and reflected by the Doppler profile. The spectrogram reflects the concurrent transmission capability of the GW, and the signals generated by the Doppler radar. The extracted Doppler image also shows that it is precise enough to indicate the drone's propellers rotational speed.





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