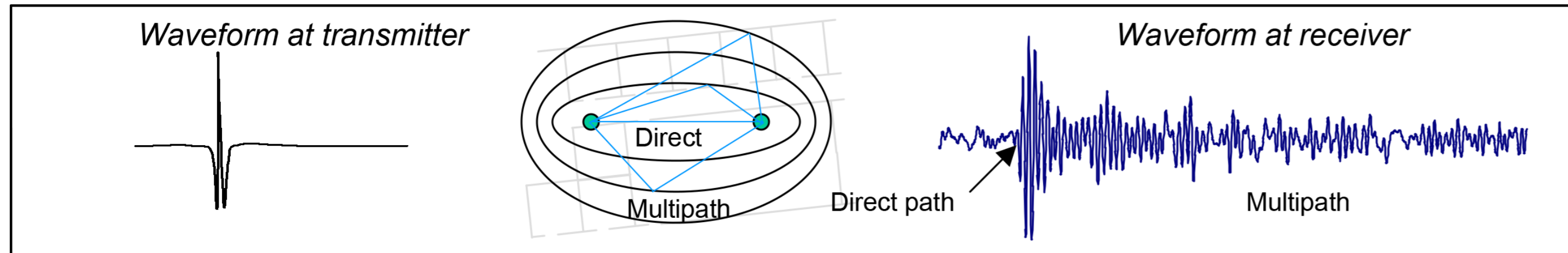


Implementation and evaluation of TSCH over UWB

Ultra Wideband (UWB)

Ultra Wideband (UWB) is a wireless technology that uses very short pulses (a few picoseconds long) to transmit data. These pulses allow very accurate measurement of the propagation time. UWB is thus a promising technology for ranging and localization applications.



Source: wlan62d

Pro

- ▶ Multiple bit rates (from 110 kbps up to 27 Mbps)
- ▶ First path detection
- ▶ Ranging & localization
- ▶ Low power spectral density

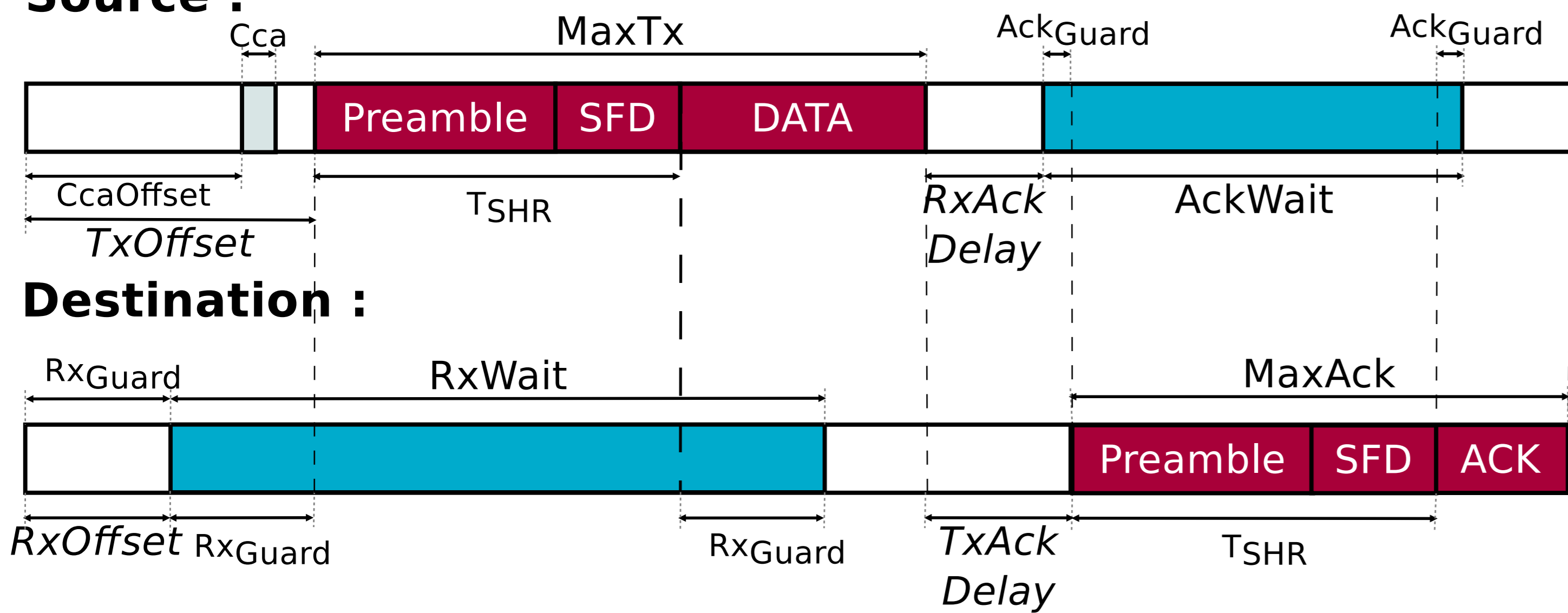
Con

- ▶ Power consumption up to 10 times higher than 2.4 GHz transceivers
- ▶ Clear Channel Assessment (CCA) not available

Slot

Slots are used to allow time synchronization. A slot is itself subdivided into 3 parts: the **CCA**, the **data** and the **ACK** transmission.

Source :

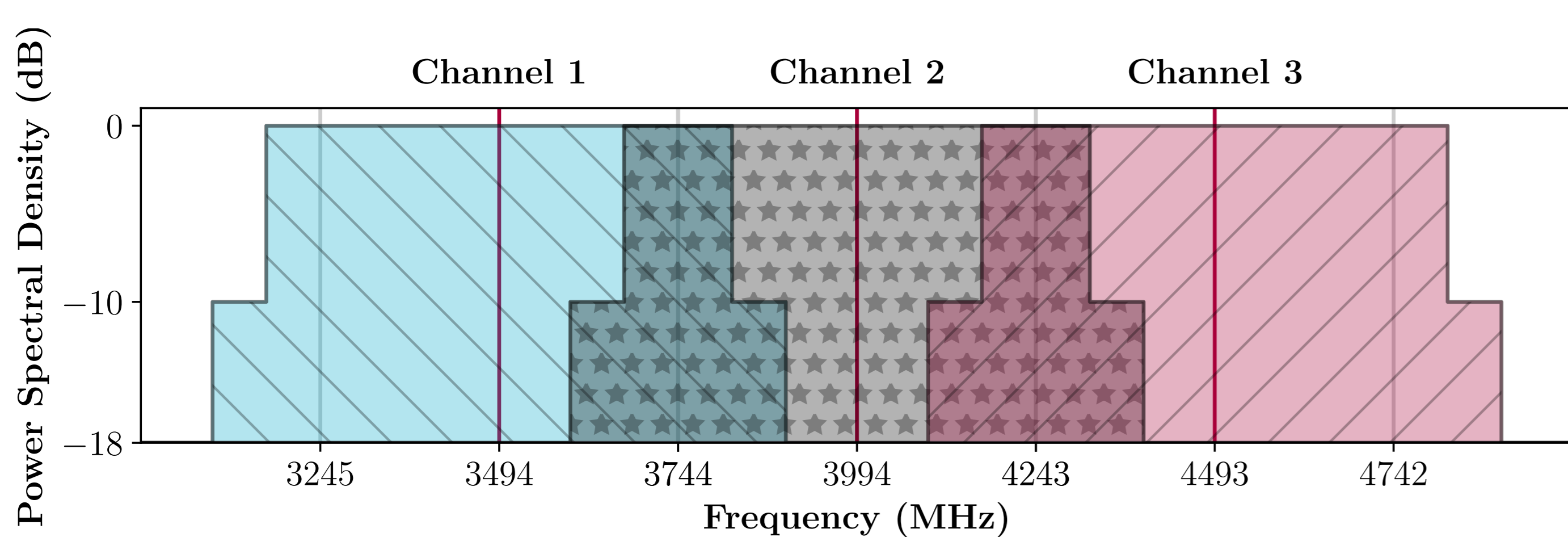


Destination :

The RxGuard is used to compensate the clock drift between two transmissions and hardware clock imprecisions.

Channel Interferences & Concurrent communications

Interferences may occur if we transmit simultaneously on two adjacent channels. The following figure shows the PSD of 3 adjacent channels. Channel 2 interferes with channels 1 and 3.

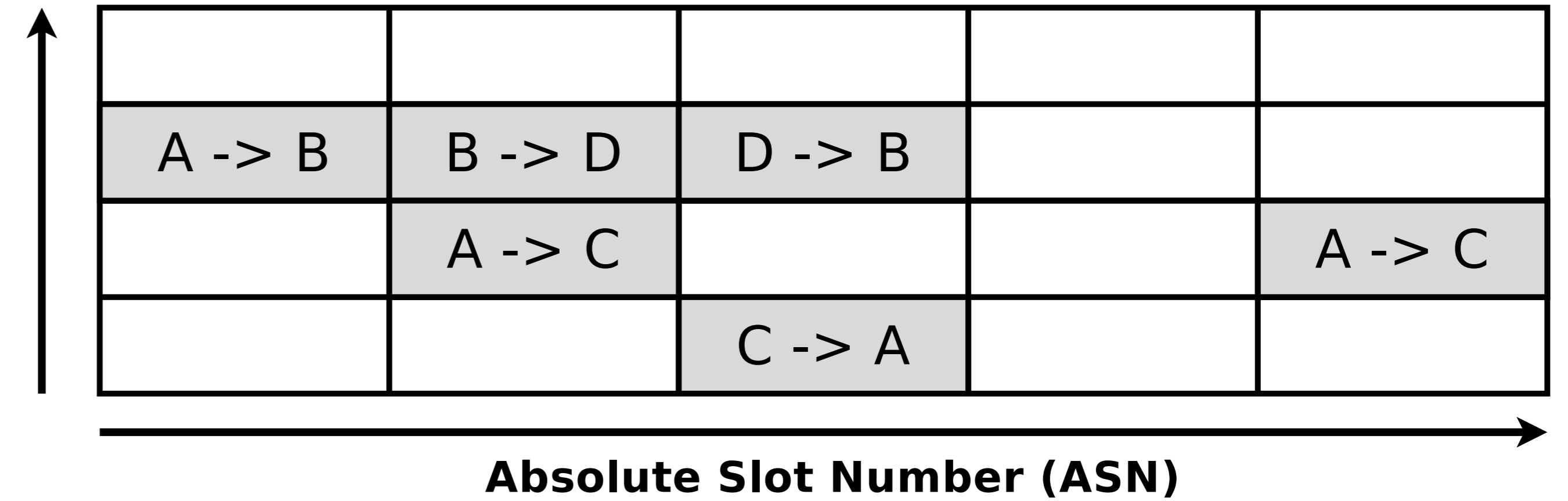


Time Slotted Channel Hopping (TSCH)

Time Slotted Channel Hopping (TSCH) is a medium access mechanism specified by IEEE 802.15.4e. TSCH relies on two different principles:

1. **Time synchronization** and **time division multiplexing** allow for deterministic medium access and low-power operation
2. **Channel hopping** enables more robust operation in presence of noise and interferences

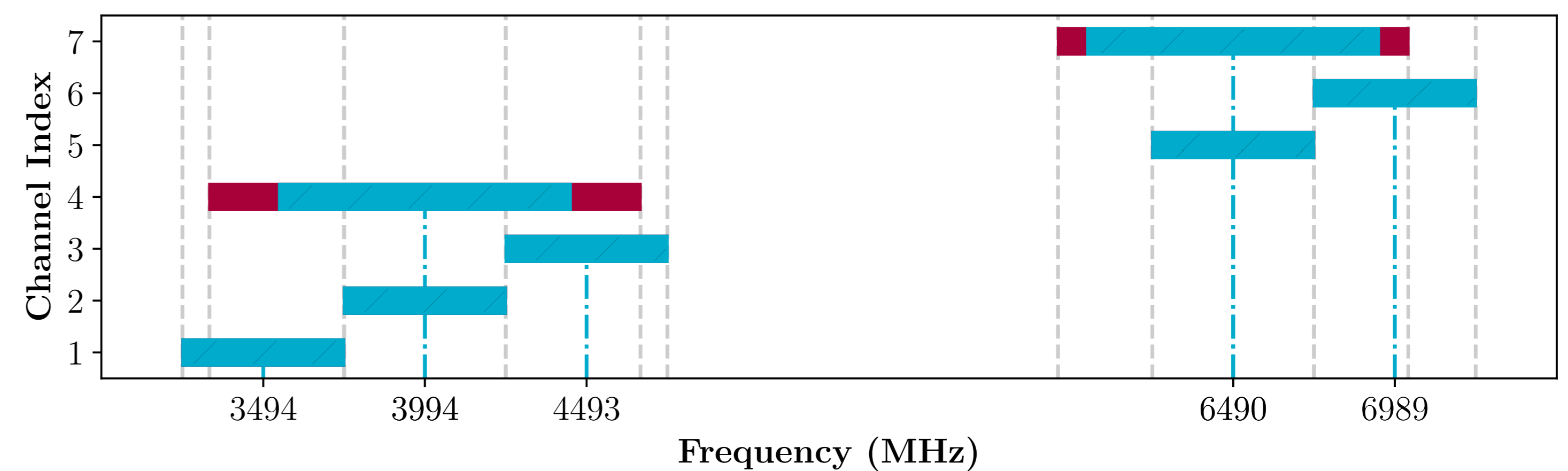
Channel Offset



Our goal for UWB is to use TSCH as a time slotted mechanism to **decrease the power consumption** and **increase the bandwidth** by using concurrent communications. The latter can be used to enable a **higher rate of localization**.

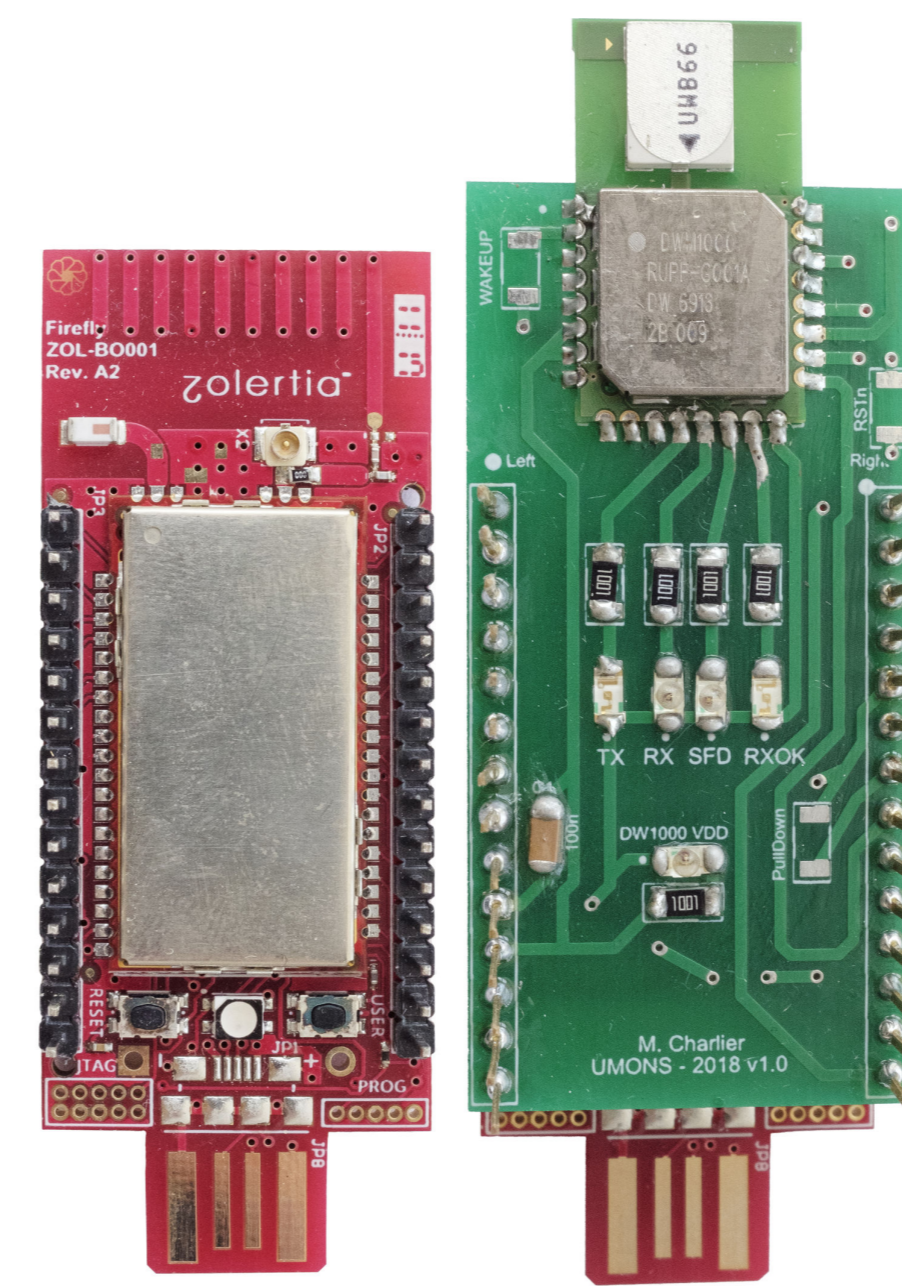
UWB Channel & Channel Hopping

IEEE 802.15.4 specifies 16 channels for the UWB PHY ranging from 249.6 MHz up to 10.16 GHz. However the commercial UWB transceiver we use only supports a subset of these channels.



UWB-TSCH implementation

Our implementation runs over Contiki OS using a 32-bit ARM platform and an off-the-shelf UWB transceiver.



- ▶ Zolertia FIREFLY
 - ▷ 32-bit ARM Cortex-M3
 - ▷ 512 KB flash and 32 KB RAM
 - ▷ Running at 16 MHz
- ▶ Decawave DWM1000 module
 - ▷ IEEE 802.15.4-UWB transceiver
 - ▷ MCU ↔ transceiver through SPI bus
 - ▷ DMA transfers for the frame payload

Result & Future Works

Results :

- ▶ Working time synchronization
- ▶ Bitrate-dependent timeslot
 - ▷ 25 ms at 110 kbps
 - ▷ 2 ms at 6.8 Mbps
- ▶ 6 TSCH channels (on 3 different UWB channels)

Future works :

- ▶ Concurrent transmissions
- ▶ Dedicated ranging slots
- ▶ Scheduling schemes