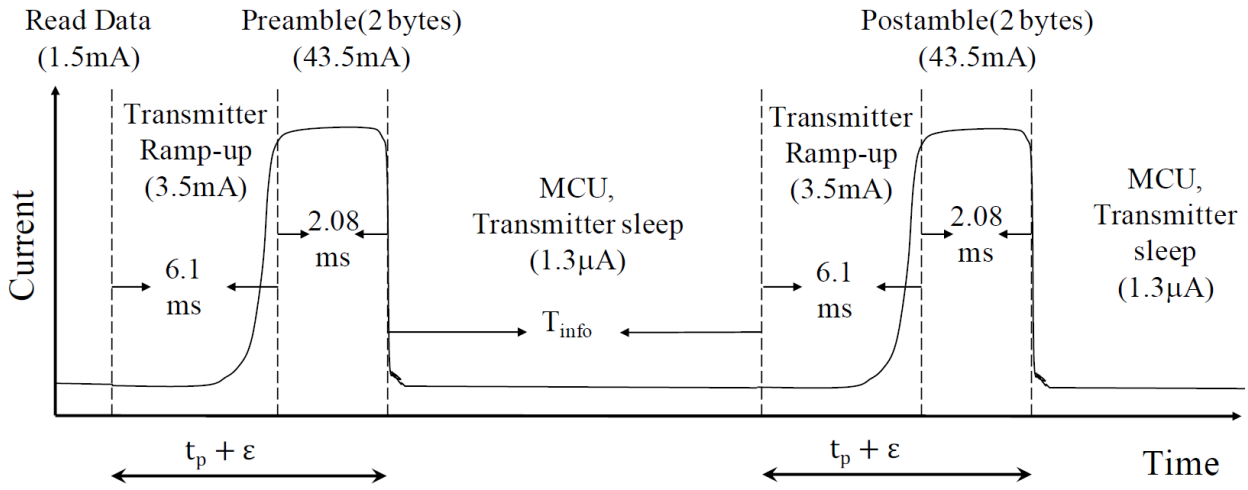
Time interval modulation:

WiChronos modulates data by mapping it to a specific number of clock cycles elapsed between two short RF symbols. The transmitter sends the start symbol and then waits for a precise number of clock cycles at a predetermined clock frequency. The mapping between data and corresponding number of clock cycles is predetermined and stored like a look up table on the devices. At the end of this wait time, the transmitter sends the stop symbol. The receiver, upon receiving the start symbol, starts counting at the same clock frequency and counts until it receives the stop symbol. The counter value at the time when the stop symbol is received is then mapped back to the data.

Anchor symbols:

The short RF symbols that denote the start and stop of a payload are called anchor symbols. Unique values of anchor symbols are assigned to all the transmitters. Hence, the length of the anchor symbols depends on the scale of the system. Further, increasing the size of anchor symbols helps in achieving a lower false positive rate. However, it also incurs more power. The optimal size is a length that is robust to false positives while still not a risk to increasing the rate of a false negative identification of an anchor symbol beyond a certain point. Please refer to the paper for more details on choosing the appropriate size of the anchor symbol.

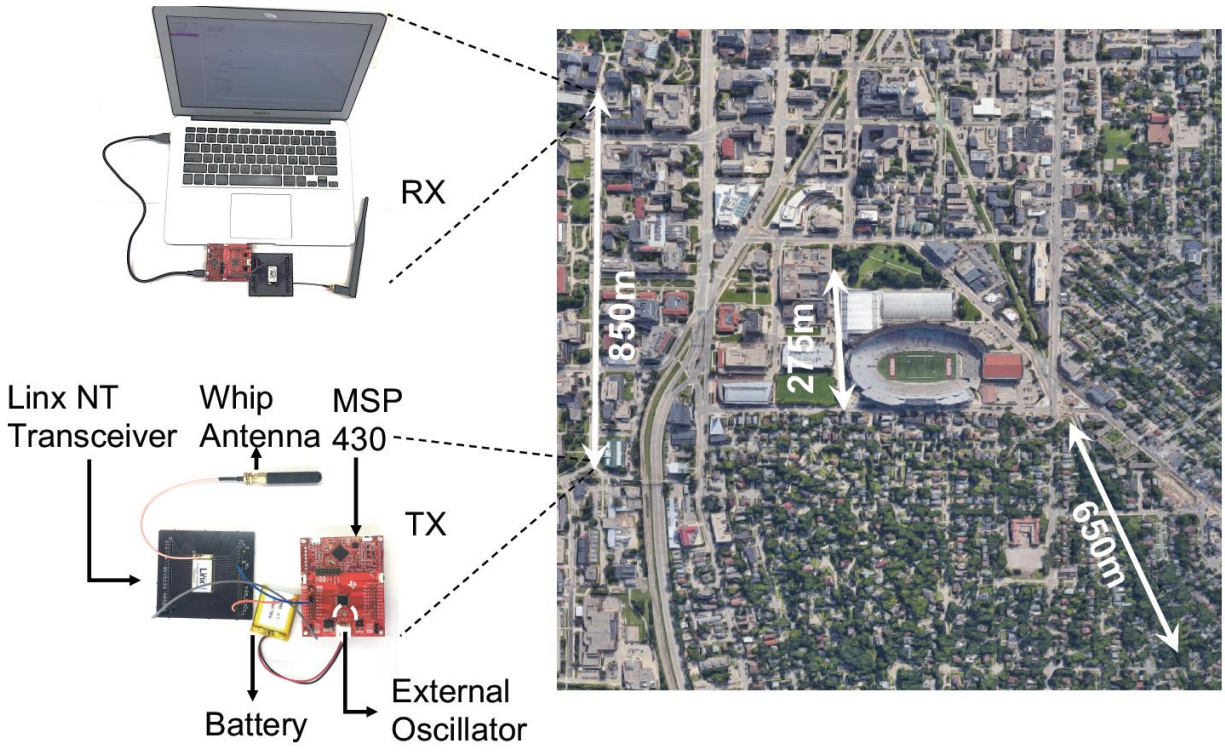
Timing Diagram:



The timing diagram above shows the precise time values implemented on the microcontroller in the code that is available in the repository. MSP430FR2355 has a 32.786kHz external clock that's the most accurate one on board. These time values were converted to an appropriate number of clock cycles at a clock rate of 32.768kHz and the numbers are reflected in the code.

The timing diagram also notes the current consumption of the set up. These were measured on a 6.5 digit multimeter at a sampling interval of 20µs. Further details and explanation of the timing diagram can be found in the paper.

Experimental set up:



The picture above shows the experimental set up as well as outdoor locations where we performed our experiments. The file Pin_Diagram.pdf explains the connections between MSP and Linx. The codes for transmitter and receiver are in the files WiChronos_TX.c and WiChronos_RX.c.

If there are any questions about any aspect of this work, please feel free to reach out to Yaman Sangar at sangar@wisc.edu.