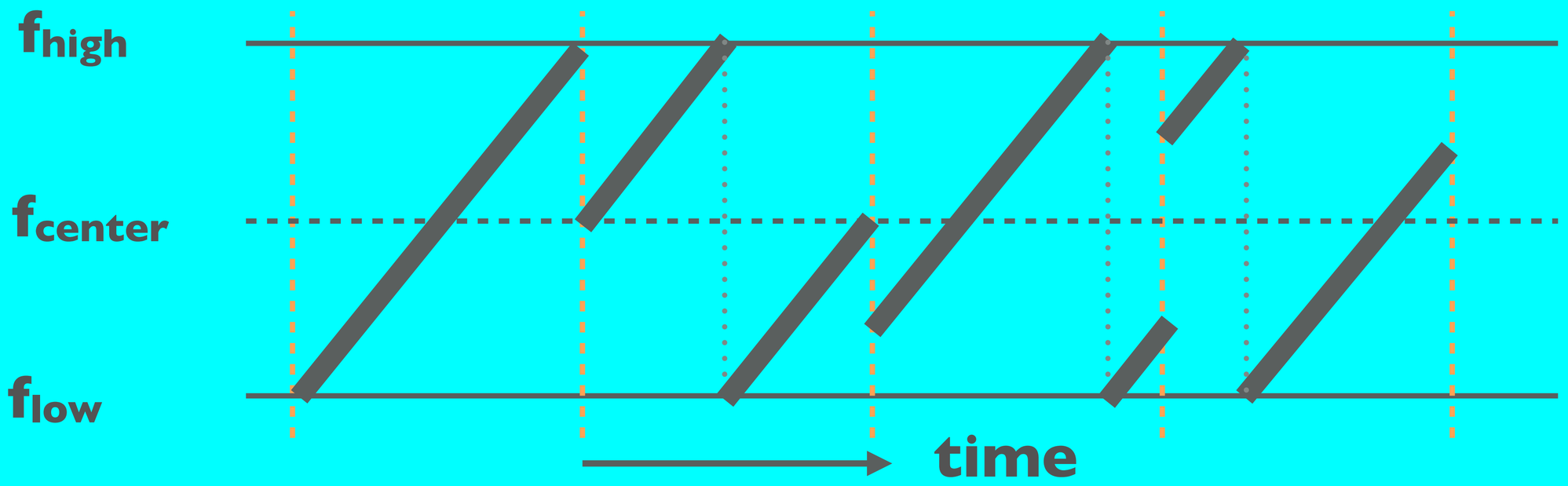
LORA / LORAWAN TUTORIAL 13

SYMBOL, SPREADING FACTOR & CHIP

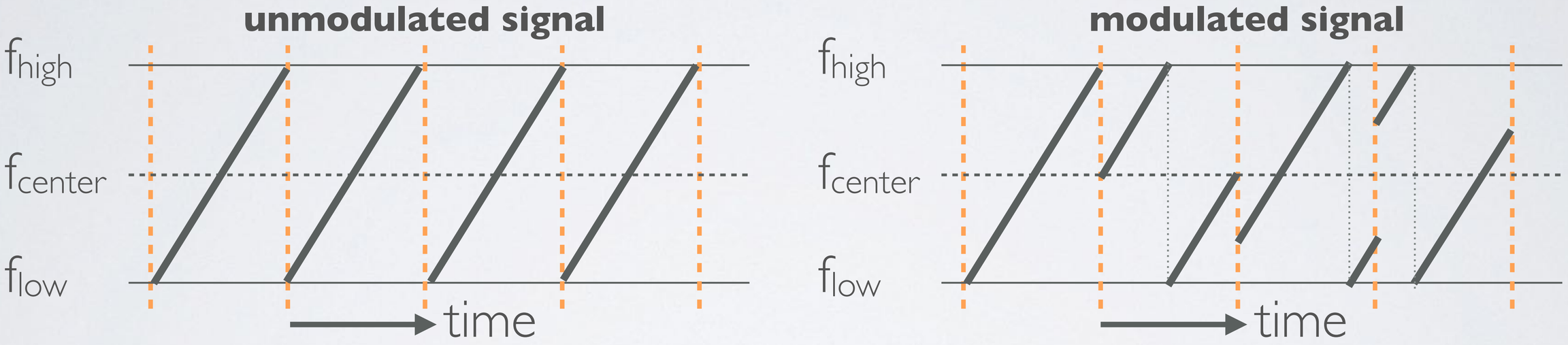


INTRO

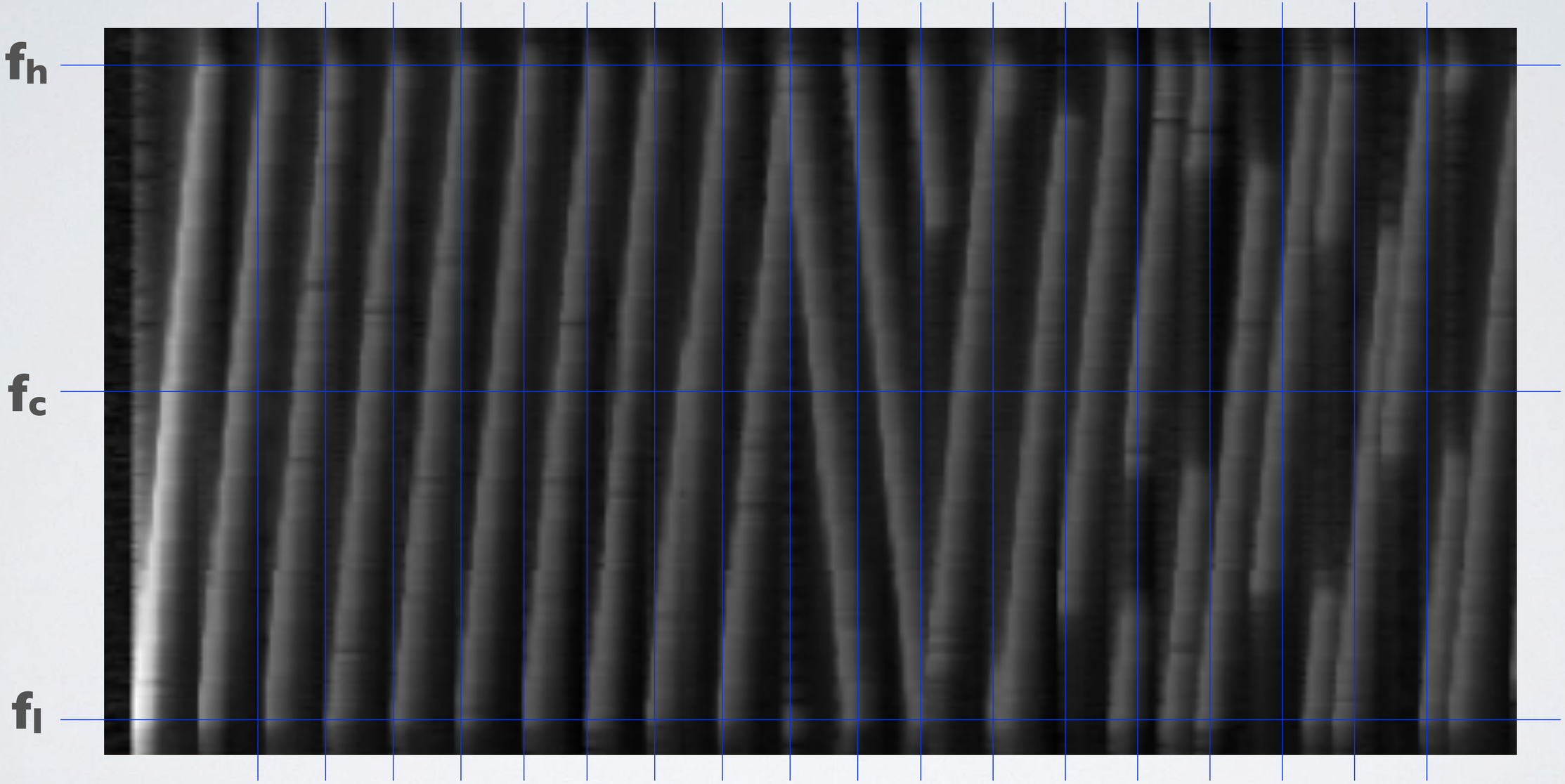
- In this tutorial I will explain what symbols, spreading factors and chips are.

LORA MODULATION

- The chirps are cyclically-shifted, and it is the frequency jumps that determines how the data is encoded onto the chirps, aka LoRa modulation.



LORA MODULATION

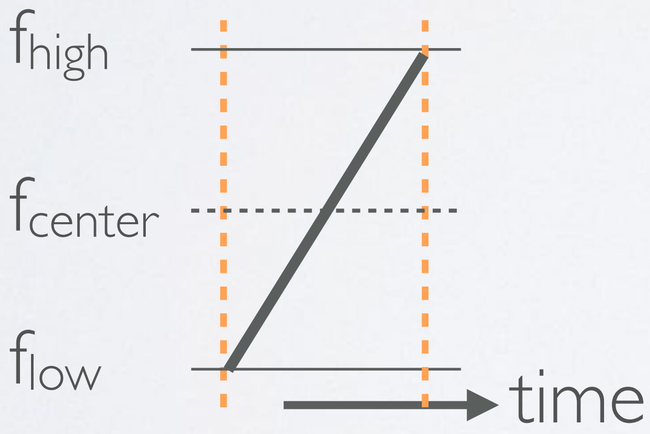


SYMBOL, SPREADING FACTOR AND CHIP

- A symbol represents one, or more bits of data, for example:
  Symbol = 1011111 (decimal = 95)

- In the example above the number of raw bits that can be encoded by the symbol is 7.
  This is the same as saying: Spreading Factor (SF) = 7

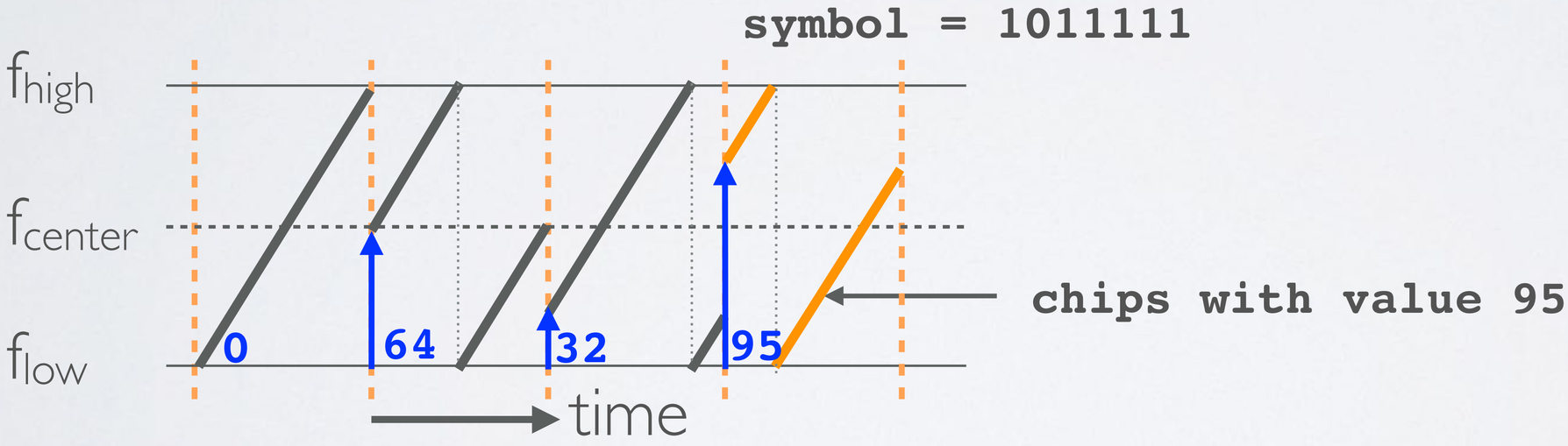
- The symbol has 2^{SF} values. If SF=7, the values ranges from 0 - 127.
  The symbol value is encoded onto a sweep signal (up-chirp).



SYMBOL, SPREADING FACTOR AND CHIP

- The sweep signal is divided into 2^{SF} steps or chips.

- For example the symbol is: 1011111 (decimal value = 95)
  The number of raw bits that can be encoded by this symbol is 7 (SF=7)
  The sweep signal is divided in $2^{SF} = 2^7 = 128$ chips.



SYMBOL, SPREADING FACTOR AND CHIP

- Another example, lets assume SF=12
  Each symbol can carry 12 raw bits of information and there are $2^{12} = 4096$ unique chip values ranging from 0 to 4095.

- **The Spreading Factor (SF) defines two values:**
  - The number of raw bits that can be encoded by that symbol: SF
  - Each symbol can hold 2^{SF} chips

- Please be aware of the difference between a **chirp** and a **chip**.
  A symbol holds 2^{SF} chips.
  Chirps are simply a ramp from f_{low} to f_{high} (up-chirp) or f_{high} to f_{low} (down-chirp).