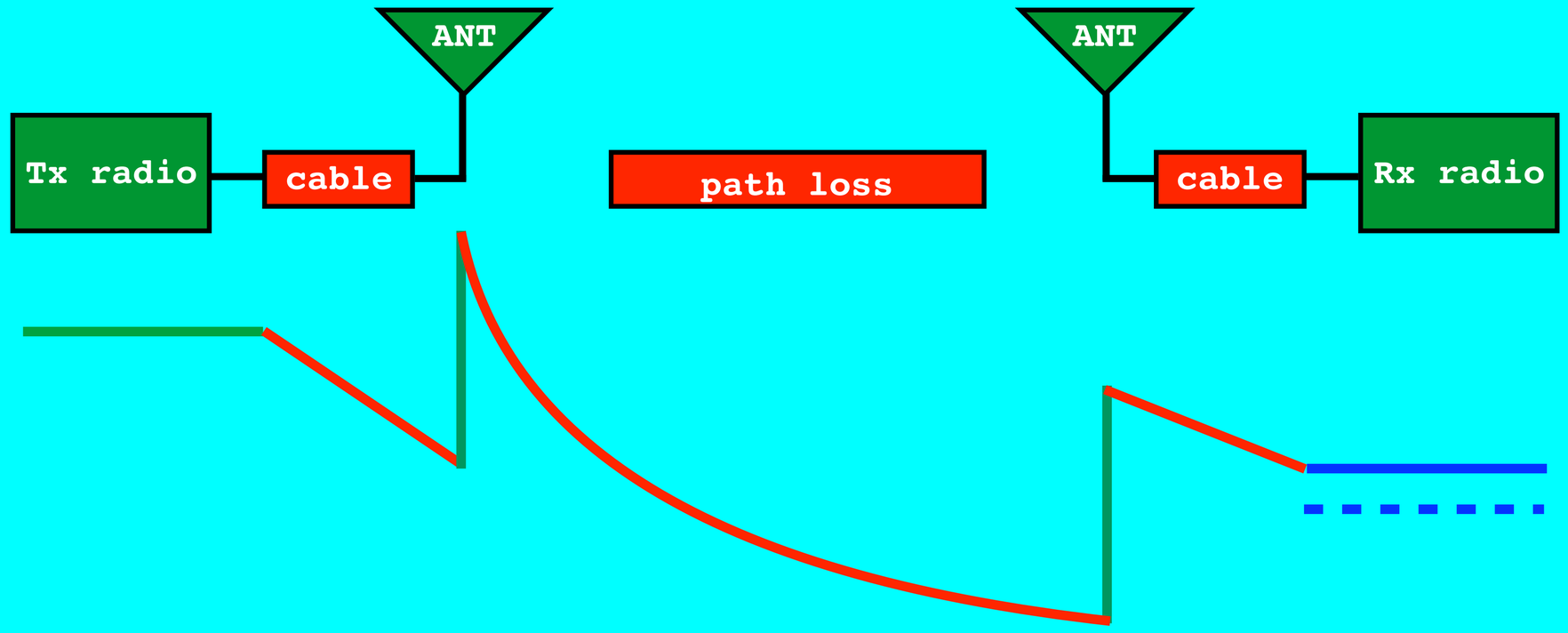
LORA / LORAWAN TUTORIAL 8

Link Budget & Link Margin



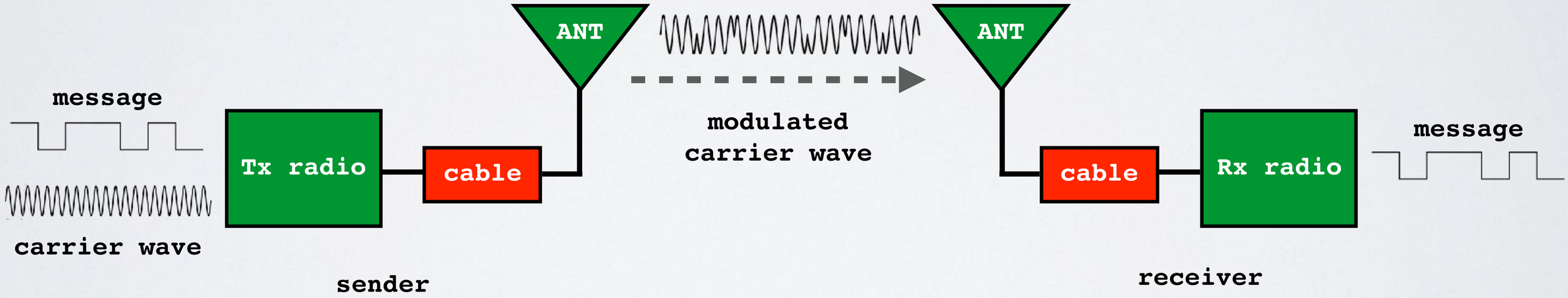
INTRO

- In this tutorial I will explain what link budgets, maximum link budgets and link margins are.

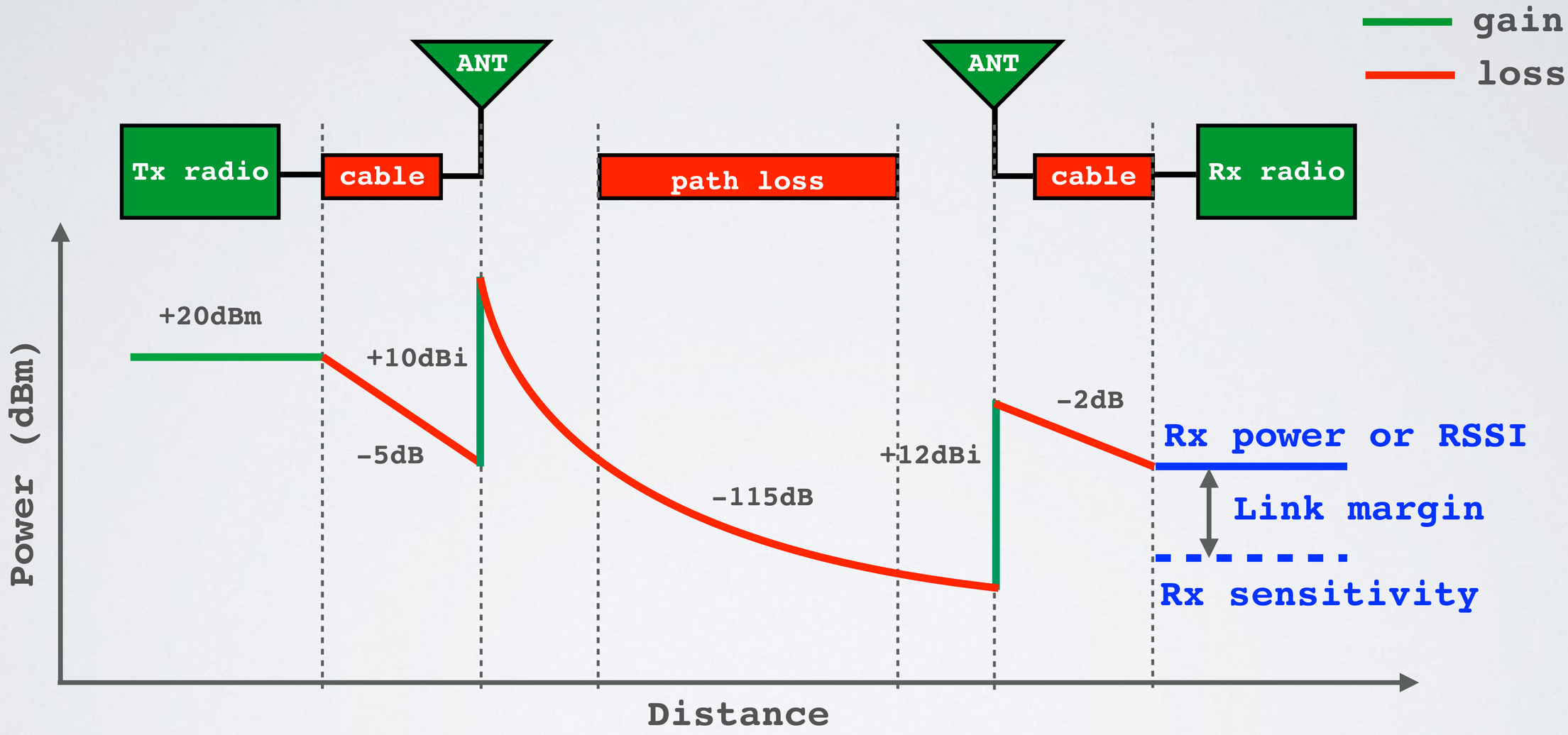
MODULATION & DEMODULATION

- If an input signal (=message) is imposed onto a carrier signal this process is called modulation. The modulated signal is broadcasted to the receiver.

- Demodulation is the opposite, where the original signal (= message) is recovered from the modulated carrier wave.



LINK BUDGET AND LINK MARGIN



LINK BUDGET AND LINK MARGIN

- A link budget is the sum of all of the gains and losses from the transmitter, through the medium (aka free space), to the receiver in a telecommunication system.
  It is a way of quantifying the link performance.

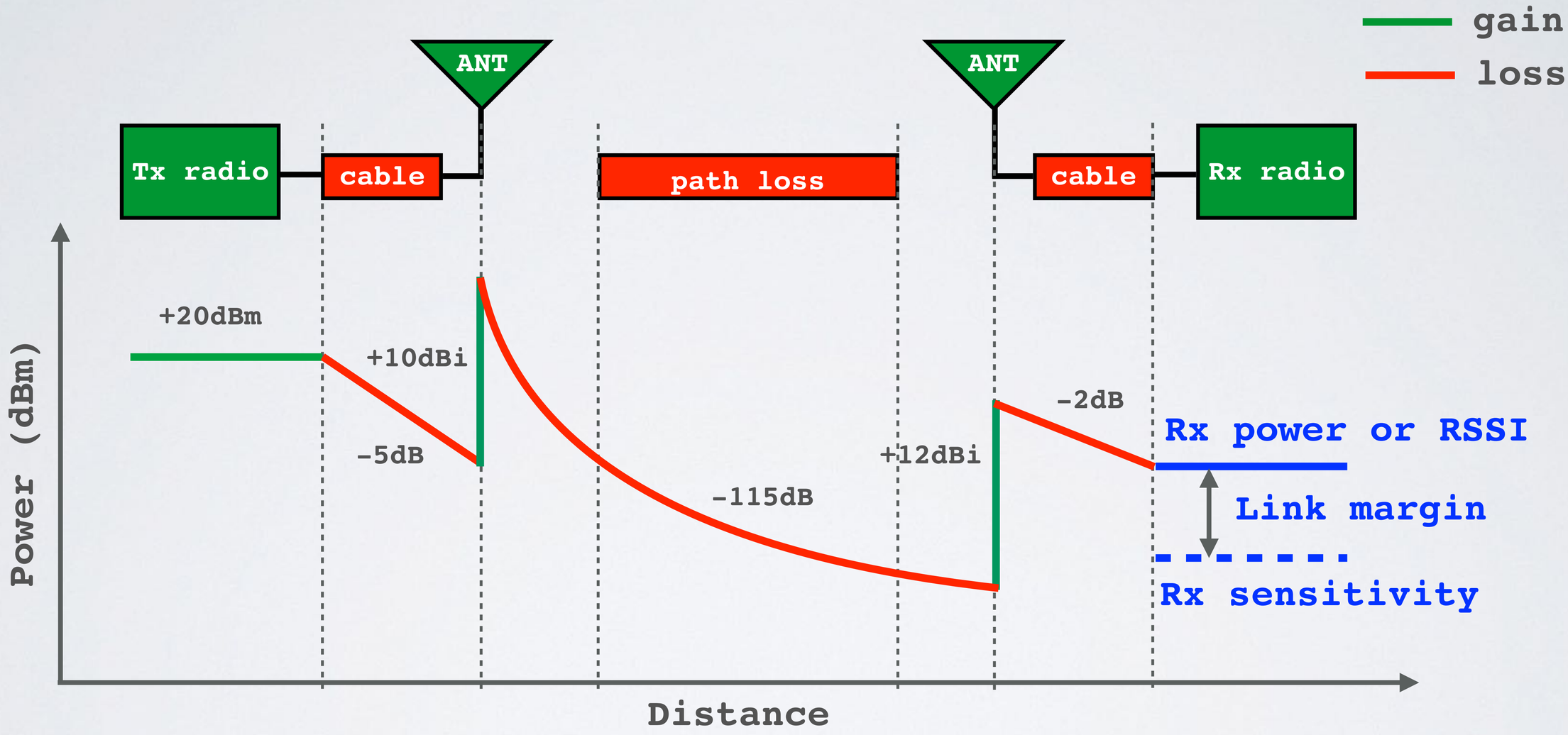
- Transmitter: The radio transmitter value must be specified in dbm, otherwise you do not know its absolute value.

- Gains: Antenna (Unit: dbi)

- Losses: cables, connectors, signal propagating thru the medium (Unit: db)

- When a signal propagates thru the medium, the signal loses strength.
  This is called the path loss or path attenuation.

LINK BUDGET AND LINK MARGIN



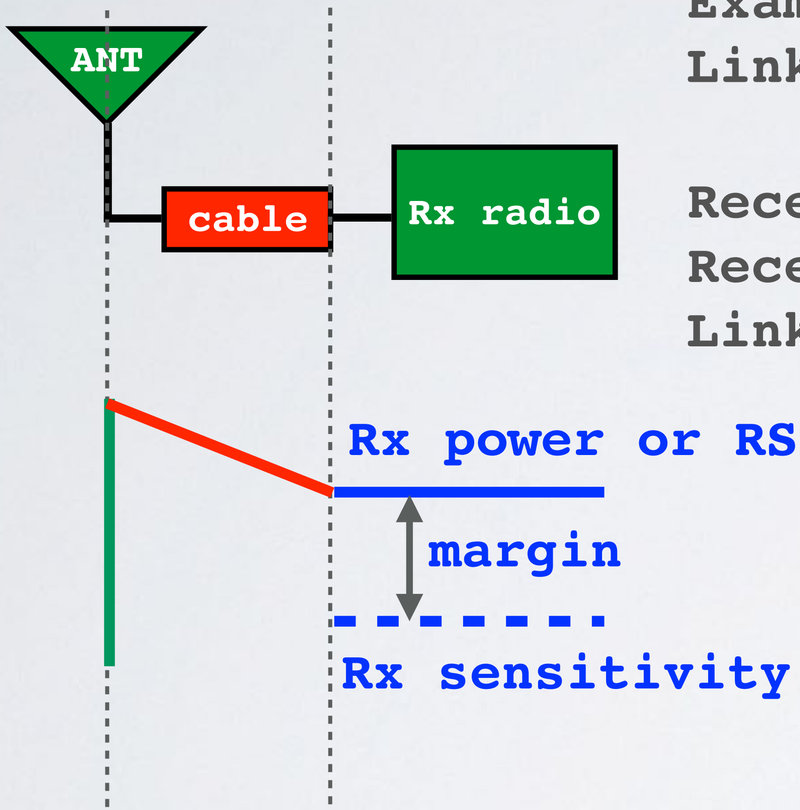
LINK BUDGET AND LINK MARGIN

- A simple link budget equation looks like this:
  Received Power = Transmitted Power + Gains – Losses
  For example: Received Power = 20 - 5 + 10 - 115 + 12 - 2 = -80 dBm

- The receiver sensitivity is the lowest power level at which receiver can receive or demodulate the signal.
  For example: Receiver sensitivity = -90 dBm

- The link margin is the difference between the received power and receiver sensitivity.
  Link margin = Received power - Receiver sensitivity
  Link margin in dBm
  Received power in dBm
  Receiver sensitivity in dBm

LINK BUDGET AND LINK MARGIN



Example:
Link margin = Received power - Receiver sensitivity

Received power = -80dBm
Receiver sensitivity = -90dBm
Link margin = -80 - (-90) = 10 dBm = 10 mW

LINK BUDGET AND LINK MARGIN

- Question:
  There are two receivers:
  Receiver A with receiver sensitivity = -120 dBm
  Receiver B with receiver sensitivity = -130 dBm
  Which receiver is better?

- Answer:
  Receiver B is better because it can demodulate a RF signal at a lower power level.

LINK BUDGET AND LINK MARGIN

- If the link margin is too big, or too small, corrective actions can be applied to ensure the system will operate satisfactorily.

- The link margin must be positive (Received Power > Receiver sensitivity) and should be at least a few dB for the receiver to successfully demodulate the signal.

- LoRa receivers are very sensitive and are offering a sensitivity down to -148 dBm [2], due to the use of Chirp Spread Spectrum.

- More information:
  https://www.semtech.com/products/wireless-rf/lora-transceivers/SX1276

MAXIMUM LINK BUDGET

- The maximum link budget can be used as a baseline value to compare one radio to the next.

- **Maximum link budget = Maximum transmitter power - Lowest receiver sensitivity**
  Maximum link budget in dBm
  Maximum transmitter power in dBm
  Lowest receiver sensitivity in dBm

- For example:
  Max transmitter power = 20 dBm [2], Lowest receiver sensitivity = -148 dBm [2]
  Max link budget = Max transmitter power - Lowest receiver sensitivity
  Max link budget = 20 - (-148) = 168 dBm [2]

MAXIMUM LINK BUDGET