SUPPORTING INFORMATION

1. Understanding the payload formatter

The most important aspects when monitoring data in The Cloud are the frequency acquisition rate and the reception of such values in the network. Due to limitations of the MKRWAN, the minimum period between measurements achieved is 110 ms that corresponds to a frequency of 9 Hz. This could be possible due to the creation of vector of 64 bytes that is the maximum capacity of each package sending The LoRa plaform used (The Things of Stack) that includes in the Arduino function “analogRead” a delay of 110 ms in the code. An explanation of the procedure is the following (see Figure S1):

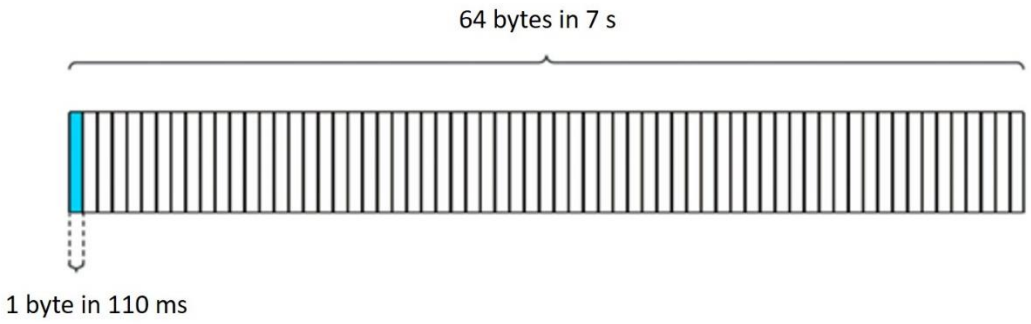

Figure S1: Vector of 64 bytes sent from MKRWAN1300 to TTS

Regarding RFM95, the maximum number of bytes of a package is 240 bytes. In addition, the minimum time achieved for the sending of packages for that size without any data loss between packages is if 2 s, with a frequency of data sending of 20 Hz (see Figure S2)

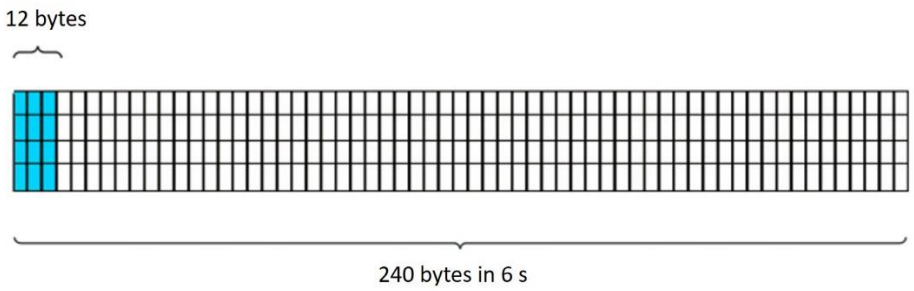

Figure S2: Vector of 240 bytes sent from RFM95 to TTS

In order to ensure continuity in the pulses, the differences from the initial and final timestamps of two continuous vectors will be approximately 170 ms, changing the range in ±20 ms (see Figure S3).

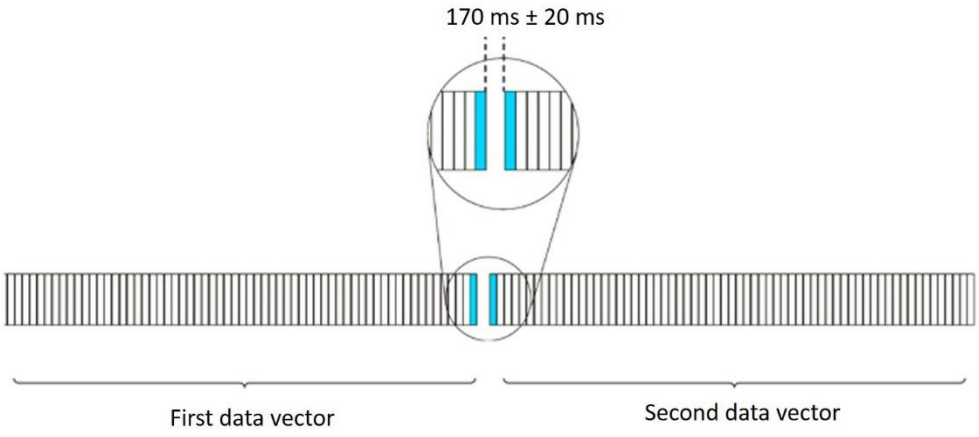

Figure S3: Time lost between packages

As an example of continuity between pulses, frequencies of 1.6 Hz, 2.5 Hz and 5 Hz are presented. Only for the case of 1.6 Hz, no pulses are lost.

FIGURES AND TABLES

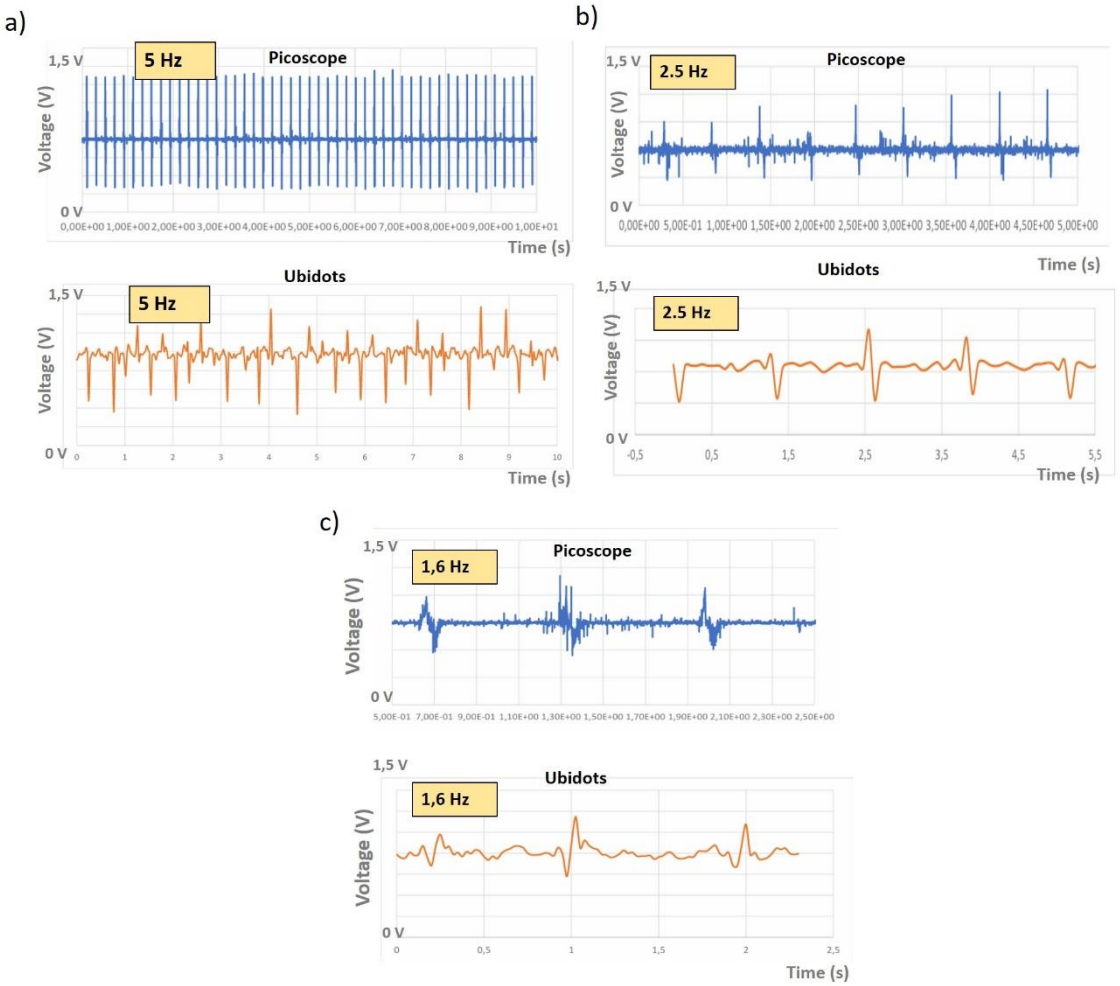

Figure S4: a) 5 Hz, b) 2.5 Hz and c) 1.65 Hz signal monitored in a) the digital oscilloscope Picoscope and b) transmitted via LoRa to the TTN platform and monitored in UBIDOTS

An example of the pulses detected with the 3D seismic sensor is shown in Figure S5 . Here, each of the ADS1115 of 16-bit voltage converters connected to three RFM95 chips generate voltage signals plotted online in Ubidots.

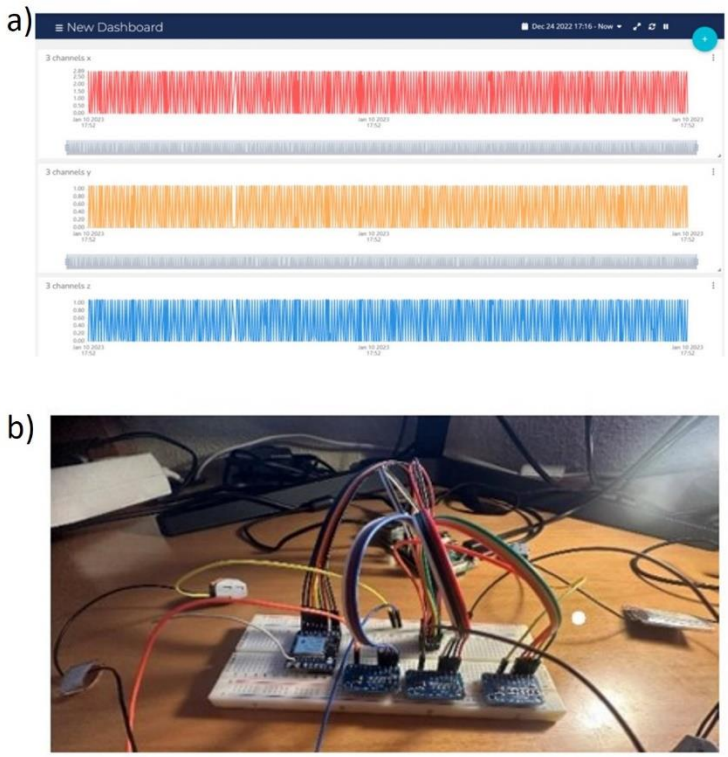

Figure S5: a) Ubidots interface online pulses b) Experimental set-up of the 3D seismic sensor DAQ.

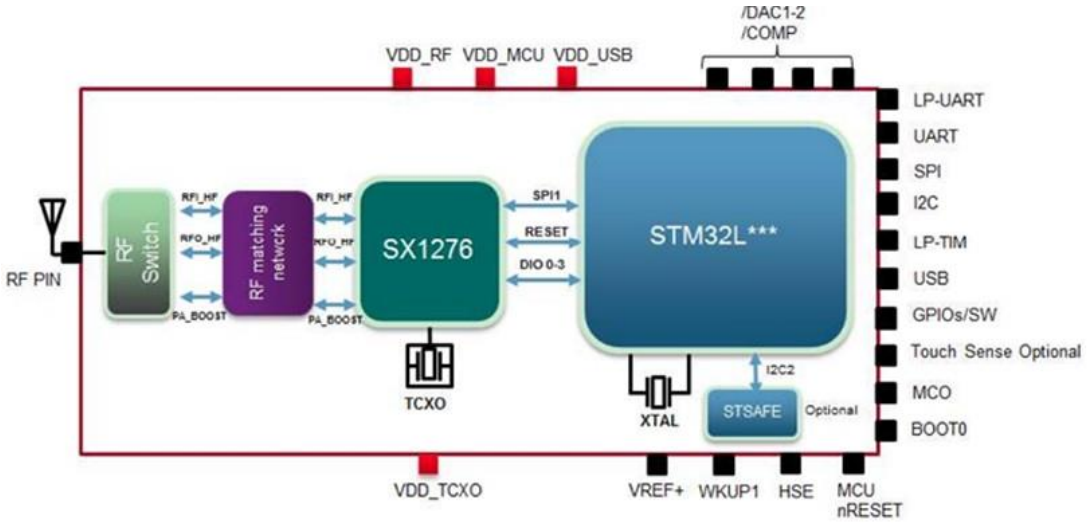

Figure S6: Pinout of the module CMWX1ZZABZ-091 [1]

DAQ (LoRa)	Max. Frequency of pulses measured (Hz)	Max. Number of bytes of each package	Bitrate (bps)	Max. Power consumption (sleeping/working)	LoRa Bandwidth (kHz) and pulse width (ΔV/t)	Sample rate (kSamples/s)
MKRWAN 1300	9 (120 ms between packages)	64	73	70 μW/70 mW	125 kHz /0.3V/0.1 s=3V/s	0.01
RFM95	20	242	320	70 μW /30 mW (Tx) and 100 mW (Rx)	125 kHz/ 0.3V/0.1s =3V/s	0.01
RAK2450	1 between packages	SF1=>51 SF11=>51 SF10=>51 SF9=>115 SF8=>242 SF7=>242	SF12=>252 SF11=>440 SF10=>980 SF9=>1760 SF8=>3125 SF7=>5470	10 W	125 kHz/-	0.05
1 RFM95+ 1 ADS1115 (1 axis) (1D)	1.7 (exp)	242	16	3μW /< 400 mW	125 kHz 0.3V/0.1s =3V/s	0.04
1 RFM95 + 2 ADS1115 (2 axis) (2D)	1.7/2=0.85(exp)	242	16	3μW /< 400 mW	125 kHz 0.3V/0.1s =3V/s	0.02
1 RFM95+ 3 ADS1115 (3D) (3 axis)	1.7/3=0.65(exp)	242	16	3μW /< 400 mW	125 kHz 0.3V/0.1s =3V/s	0.01

Table S1: Comparison chart of the remote communication devices used with the MKRWAN1300 and the RFM45 with the ADS1115 sensors.

Characteristics	Value	Unit
Supply	3.3-5	V
Maximum frequency	930	MHz
Flash memory	192	Kbytes
EEPROM memory	20	Kbytes
Standby Mode Consume	1.95	µA/MHz
Stop Mode Consume	5.5	µA/MHz
Transmitter Mode Consume	34	mA/MHz
I2C Ports	3	-
USART Ports	4	-
SPI Ports	2	-

Table S2: Electronic characteristics of the STM32L072Z-LRWAN1 kit.

Characteristics	Magnitude	Units
Supply	3.3-5	V
Dimensions	14x17	mm
Resolution (max)	16	bits
Standby mode consume	0.7	µA
Measurement mode consume	600	µA

Table S3: Electronic characteristics of the MAX30100 sensor

Characteristics	Magnitude	Units
Supply	3.3-5	V
Measurement mode consume	67	mA
Standvy mode consume	22	µA
Refresh rate	5	Hz
Max. height	50	km
Accuracy	2.5	m
Ports	UART	-

Table S4: Electronic characteristics of the NEO-6M-0-001 U-Blox with UART communication interface.

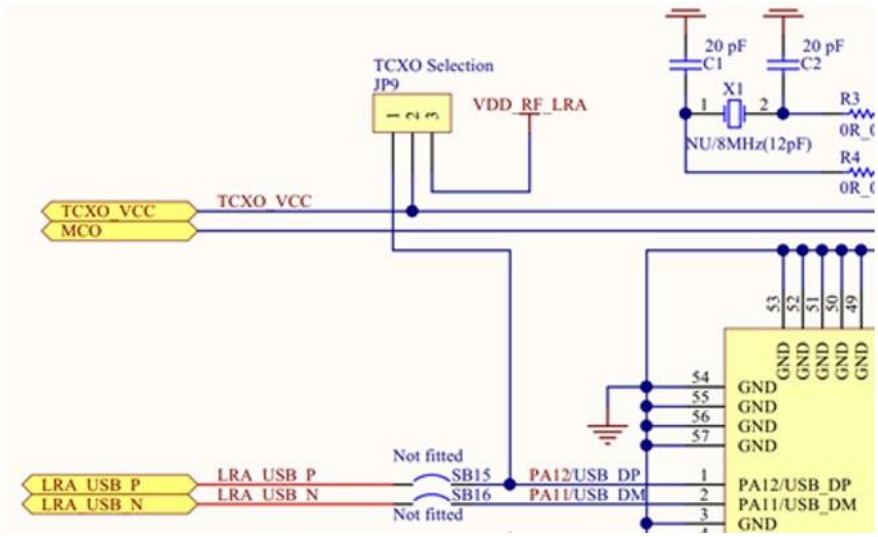

Figure S7: Connection map of the STM32L072Z-LRWAN1 Kit.

Figure S8: USB-TTL CH340E module.

Characteristics	Magnitude	Units
Supply	3.3-5	V
Measurement mode consume	20	mA
Standby mode consume	100	µA
Bauds rate supported	50-2000000	Bauds
Max. frequency	12	MHz
Ports	UART	-

Table S5: Electronic characteristics of the CH340E module.

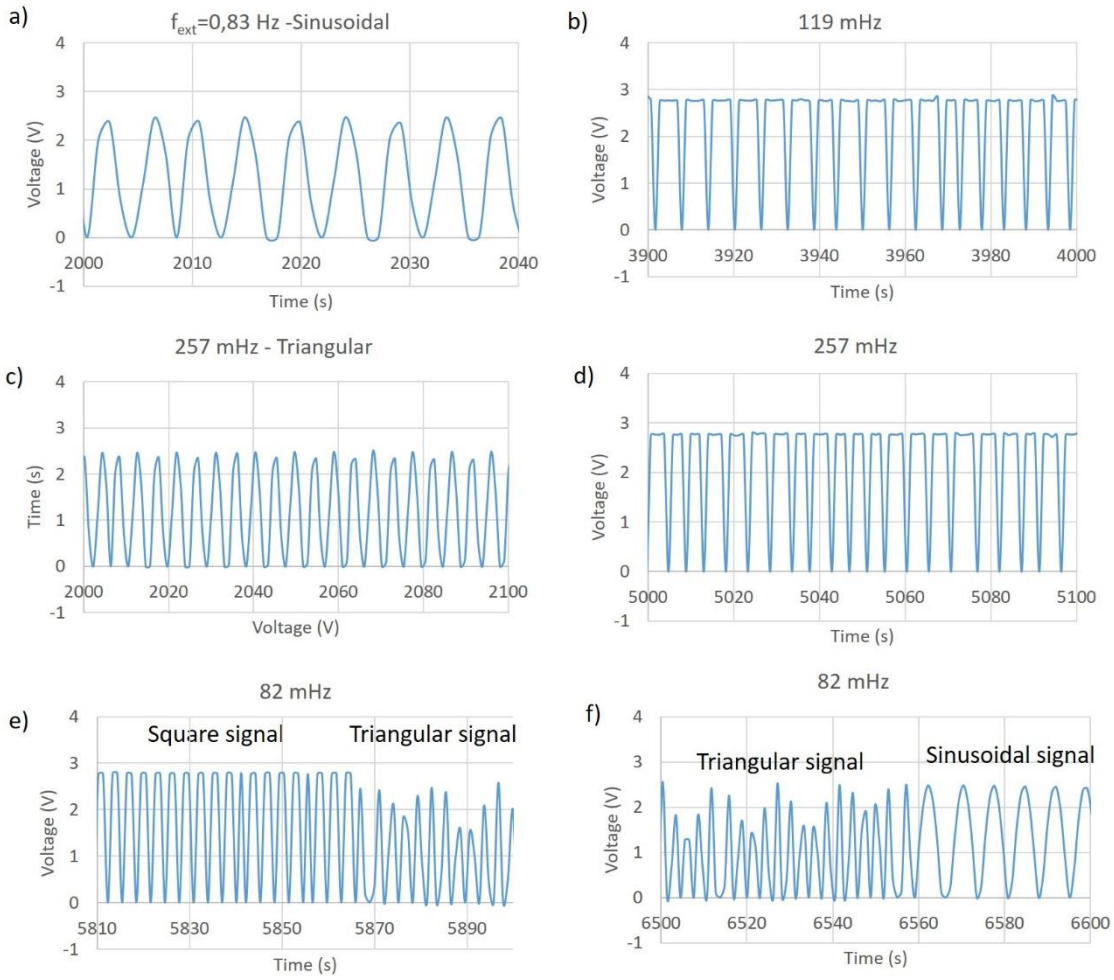

Figure S9: Different frequency waveforms in the cloud. a) Sinusodial waveform of 830 mHz. b) Square signal of 119 mHz. c) Triangular waveform of 257 mHz. d) Squared signal of 257 mHz. e) Change of waveform from square to triangular. f) Change of waveform from triangular to sinusoidal.

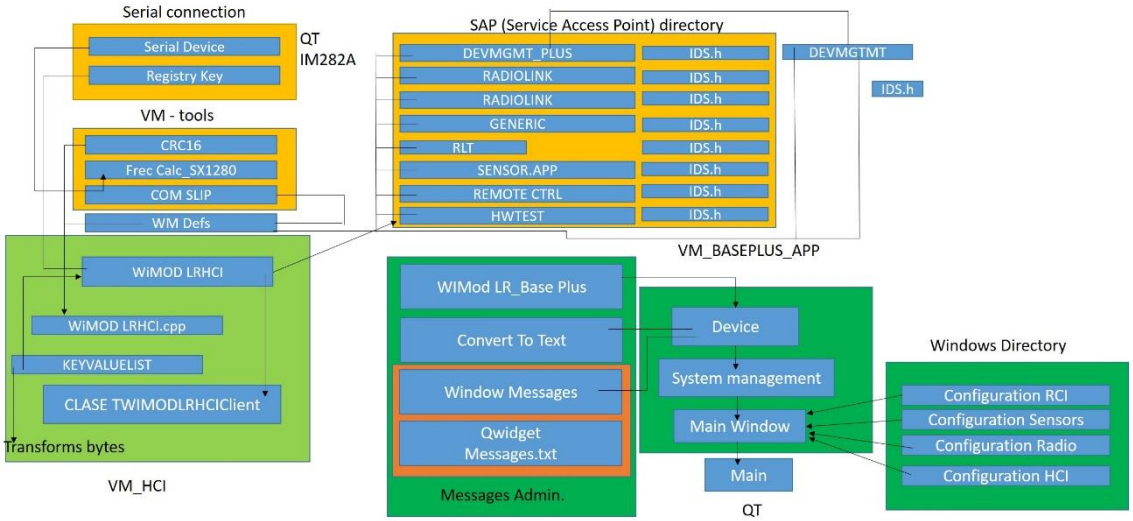

Figure S10: Different classes from the Wi-Mod libraries and IM282A needed to create an operative interface for sensor communication between modules.