eShepherd

Gunnison Colorado, USA Trial

LoRa Communications Description

February 2021

AGERSENS

Table of Contents

Document Change History

Version	Author	Date	Change Description
A1	Victor Quittner	10-Feb-2021	First revision

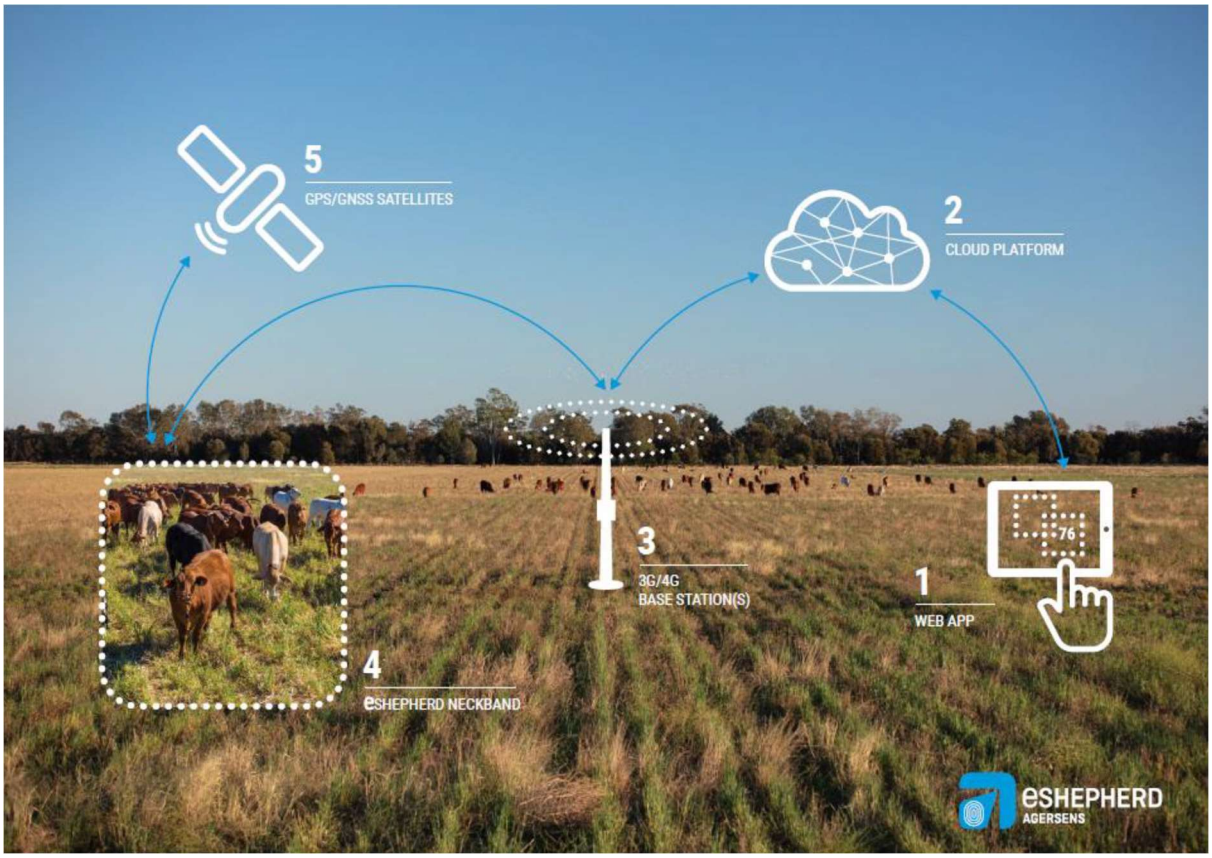
Agersens eShepherd Technical Information

This document details the technical characteristics of the LoRa communications system between Base Station and animal Neckbands, to be used in a proposed trial with the Gunnison Conservation District in Colorado.

Refer to related document eShepherd_Gunnison_CO_USA_Trial_Description_FCC_ELS_Appln_A1 for an overview of the complete eShepherd system and proposed trial.

System Summary

The key elements of the eShepherd Platform are outlined below:



1. The farmer creates a Virtual Paddock using the eShepherd web application on a computer, laptop or tablet (1)
2. The co-ordinates of the created paddock are sent via the cloud platform (2) to the Base Station (3)
3. The Base Station then communicates with each animal's eShepherd Neckband (4) sending the co-ordinates of the Virtual Paddock.
4. The eShepherd Neckband tracks the position of each animal relative to the Virtual Paddock boundary using a combination of GPS data (5) and data from internal motion sensors.
5. The system uses this information in conjunction with audio cues and a pulse stimulus to train each animal to remain within the boundary of the Virtual Paddock.
6. The Neckband then continuously monitors both the animal's GPS location and behaviour.

LoRa Communications System

LoRa is a low-power, long-range radio communications technology for low to medium data rates and small data packets. It uses a proprietary chirp spread-spectrum digital modulation scheme developed by Semtech Corporation, and is used in a wide range of IoT products and applications.

Digital modulation parameters can be adjusted over a wide range to trade-off data-rate, distance, RF-power, and average power consumption to suit particular use-cases.

LoRa is intended for use in the unlicensed ISM radio bands. The regulatory use of ISM bands varies for different regions and countries.

The LoRaWAN Alliance is an international organisation which promotes use of LoRa in IoT applications, and has published standards and guidelines for implementation to ensure interoperability between various manufacturers' equipment. Agersens eShepherd is a proprietary product and ecosystem and does not (and need not) conform to LoRaWAN Alliance standards. However, Agersens has used these standards as a guide to implementation and meeting international regulatory compliance. The most applicable ISM band is 915MHz to 928MHz in Australia, and 902MHz to 928MHz in USA.

Due to the imminent timing of the proposed Gunisson trial in May 2021, it is proposed to deploy the standard Australian system for which the selected frequencies are also within the ISM band for USA.

Agersens will develop a USA-specific version of eShepherd in due course. This experimental license is sought to allow use of the standard Australian system in the meantime for this trial.

Transmitter/Receiver Description

The Base Station utilises a LORIXone LoRa Gateway which provides a single transmitter channel and 8 (or 9) simultaneous receiver/decode channels for LoRa modulation, operating in half-duplex. The selected centre frequencies are:

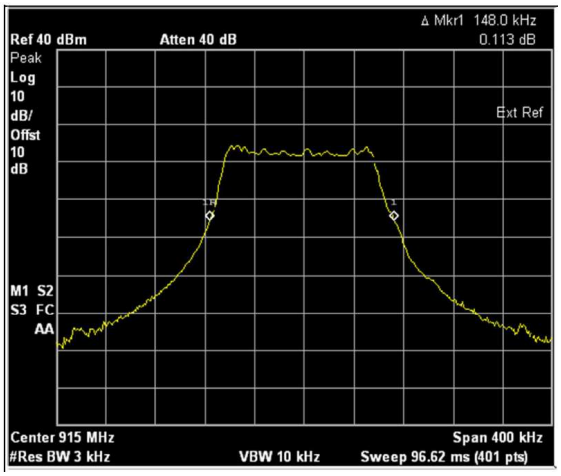
Function	Centre Frequency (MHz)
Uplink from Neckbands - Channel 1	921.4
Uplink from Neckbands - Channel 2	921.6
Uplink from Neckbands - Channel 3	921.8
Uplink from Neckbands - Channel 4	922.0
Uplink from Neckbands - Channel 5	922.2
Uplink from Neckbands - Channel 6	922.4
Uplink from Neckbands - Channel 7	922.6
Uplink from Neckbands - Channel 8	922.8
[Uplink from Neckbands - Channel 9]	923.0
Downlink to Neckbands - Channel 10	923.2

LoRa modulation bandwidth is set to 125kHz, with 200kHz channel separation as in the table above.

Summary of LoRa communication parameters:

Parameter	Value
Channel Bandwidth	125kHz
Coding Rate	4/5
Spreading Factor	9
Data Rate (indicative)	1760 bits/sec
Preamble size	20 + 4.25 symbols

Example of LoRa power spectrum for 125kHz bandwidth:



The Neckbands utilise a LoRa module with half-duplex operation of transmit and receive functions. They receive messages on the single downlink channel #10 and are each assigned one of the 8 (or 9) uplink channels for transmissions to the Base Station. The uplink channels are allocated evenly amongst the several hundred possible Neckbands in a deployment.

System Timing and Operation

LoRa supports relatively short data messages of up to 254 bytes (complete packet including CRC and optional header block). With the selected LoRa parameters a maximum sized packet transmission takes approximately 1.2 seconds, including preamble symbols. However, on average the message size is less, at 150 bytes total, requiring approximately 0.8 seconds transmit time.
In practice the addition of timing guard bands either side provides a 3 second receive window for each transmission.

Once per hour the Base Station sends a ‘universal’ message to all Neckbands. These can be for a variety of configuration or reporting purposes, and may target all Neckbands or a subset. At other times the Base Station may send additional messages to all Neckbands or a subset.

Neckbands are each allocated one of the 8 (or 9) uplink channel frequencies, together with a 3-second timeslot within a (nominally) 10 minute repeating period. Thus in any 3 second timeslot up to 8 or 9 Neckbands may simultaneously transmit (on their different frequencies) and the Base Station will receive and decode all of their uplink messages. This allows up to approximately 1000 Neckbands to report their status to the Base Station and Cloud Platform every 10 minute period.

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