LoRAWAN Coverage Drive Test Report

The following document is a summary of the measurement campaign in order to examine what the coverage of the RAK7249 Gateway would be in urban settings. The route taken is of approximately 25km and is a mixture of oven road space, areas near large bodies of water, and such that are in the vicinity of tall vegetation and buildings. Thus, propagation characteristics vary greatly and are a good mixture of different scenarios (both LoS and non-LoS).

Testing Setup

1. Gateway

RAK7249 Industrial Outdoor Gateway was the LoRaWAN Gateway provisioning connectivity. It was positioned on a hilltop on top of a structure, approximately 500 m higher than the road over which the drive test was performed. The antenna used was the RAKwireless 5.8dBm Second Gen. LoRa Antenna.
A summary of the parameters can be found in Table 1. For detailed information and purchase of the Gateway and Antenna use the links below:

RAK7249 Documentation

RAK7249 Shop

LoRa Antenna 3dBi Shop

RAK7249	
Band	430 – 923 MHz
Sensitivity	-139 dBm
Antenna Gain	5.8 dBi
Altitude	540 m
Location	E116.2940, N40.2620

Table 1

2. Nodes

There was only one node, the RAK7205 (based on the RAK5205 Trarcker Board). Due to the nature of the measurements, we there were practically 4 nodes.
For the EU868MHz band, one with a 3dBi and one with a 0dBi antenna (very low gain, integrated patch, so practically negligible).
For the CN470MHz band, one with a 3dBi and one with a 0dBi antenna (very low gain, so practically negligible).
Note that the node was working in Class A and transmitting a message of 15 bytes, approximately every 60s.

Measurements were performed both while driving in a vehicle with the node mounted on top and in stationary settings. Note that movement did not degrade performance. These can be seen in Picture 1 and Picture 2 below:

Picture 1

Picture 2

A summary of the parameters can be found in Table 2. For detailed information and purchase of the Node, Node Board, and Antennas use the links below:

[RAK5205/7205 Documentation]

[RAK5205 LoRa Tracker Shop]

[RAK5205 Enclosure Shop]

[LoRa Antenna 3dBi Shop]

	Node 1	Node 2	Node 3	Node 4
Band	868.3 MHz	868.3 MHz	487.3 MHz	487.3 MHz
Tx Power	17/23 dBm	17/23 dBm	17/23 dBm	17/23 dBm
Antenna Gain	3 dBi	1.5 dBi	3 dBi	1.5 dBi
Altitude	~ 20 – 50 m	~ 20 – 50 m	~ 20 – 50 m	~ 20 – 50 m

Table 2

Testing Results

1. EU868MHz Band

The parameters of the measurement were as follows:

Spreading Factor – from SF7 to SF12 Distance – 7km, 10km, 14km, and 20km Node Tx Power – 17dBm, 23dBm

Thus, we have the following notable results for Node 1 and Node 2 (EU868MHz)

Node 1						
Distance	Rate (SF)	Tx Power	Packet Loss	RSSI AVG	SNR AVG	Antenna Gain
7 km	SF12	17 dBm	0%	-94.5 dBm	8.5	3 dBm
	SF7	17 dBm	0%	-94.9 dBm	9.3	3 dBm
10 km	SF12	17 dBm	0%	-96.6 dBm	5.0	3 dBm
	SF7	17 dBm	0%	-99.0 dBm	4.7	3 dBm
14 km	SF7	17 dBm	0%	-107.6 dBm	-3.1	3 dBm
20 km	SF12	17 dBm	0%	-112.1 dBm	-11.6	3 dBm
Node 2						
20 km	SF12	17 dBm	75%	-113 dBm	-16.5	1.5 dBm

Table 3

As expected as the distance increases the RSSI drops and the SNR becomes negative. Finally transmission needs to shift from SF7 to SF12 in order to have a successful reception at the Gateway.
With the 3dBi antenna, we still have 0% packet loss at 20km from the gateway. With the 0dBi antenna, packet loss is unacceptable at 75%.

Naturally, in the case where the TX power is increased from 17dBm to 23dBm, we have the same trand of the results, with a slight positive shift due to the increased gain.
See Table 4 for reference

Node 1						
Distance	Rate (SF)	Tx Power	Packet Loss	RSSI AVG	SNR AVG	Antenna Gain
7 km	SF12	23 dBm	0%	-92.3 dBm	10.7	3 dBm
	SF7	23 dBm	0%	-92.7 dBm	11.0	3 dBm
10 km	SF12	23 dBm	0%	-98.6 dBm	7.0	3 dBm
	SF7	23 dBm	0%	-99.0 dBm	6.9	3 dBm
14 km	SF7	23 dBm	0%	-108.5 dBm	-4.2	3 dBm
20 km	SF12	23 dBm	0%	-113.3 dBm	-9.9	3 dBm
Node 2						
20 km	SF12	23 dBm	65%	-113.0 dBm	-15.6	1.5 dBm

Table 4

2. CN470MHz Band

The parameters of the measurement were as follows:

Spreading Factor – from SF7 to SF12 Distance – 7km, 10km, and 22km Node Tx Power – 17dBm, 23dBm

Thus, we have the following notable results for Node 3 and Node 4 (CN470MHz)

Node 3						
Distance	Rate (SF)	Tx Power	Packet Loss	RSSI AVG	SNR AVG	Antenna Gain
7 km	SF12	17 dBm	0%	-85.1 dBm	9.5	3 dBm
	SF7	17 dBm	0%	-90.9 dBm	8.1	3 dBm
10 km	SF12	17 dBm	0%	-88.6 dBm	9.2	3 dBm
	SF7	17 dBm	0%	-91.0 dBm	8.7	3 dBm
Node 4						
22 km	SF7	17 dBm	0%	-119.8 dBm	-4.8	1.5 dBm

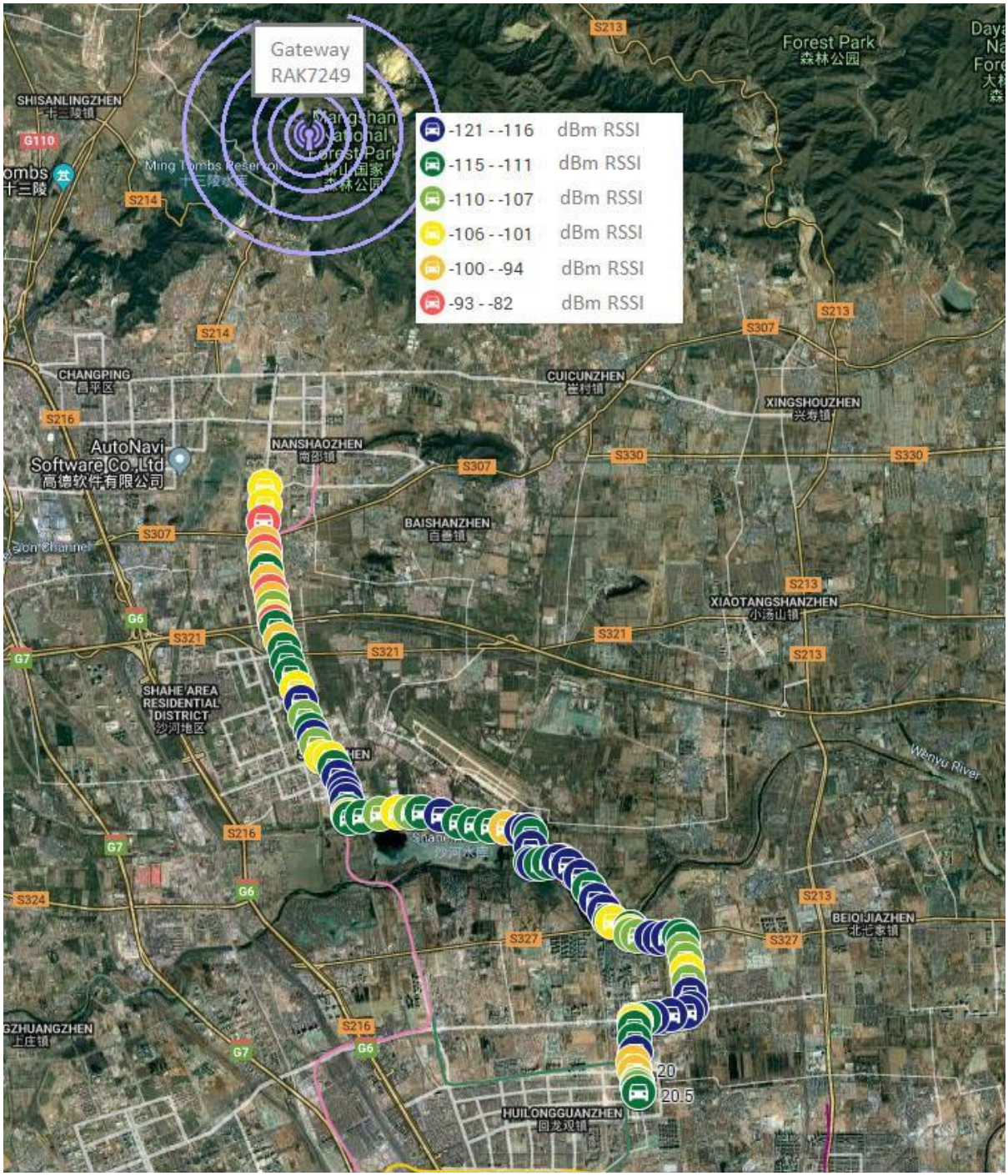
Table 5

Node 3						
Distance	Rate (SF)	Tx Power	Packet Loss	RSSI AVG	SNR AVG	Antenna Gain
7 km	SF12	23 dBm	0%	-80.5 dBm	19.6	3 dBm
	SF7	23 dBm	0%	-78.6 dBm	20.5	3 dBm
10 km	SF12	23 dBm	0%	-88.6 dBm	15.4	3 dBm
	SF7	23 dBm	0%	-91.5dBm	14.1	3 dBm
Node 4						
22 km	SF7	23 dBm	0%	-119.2 dBm	-5.0	1.5 dBm

Table 6

The results for the CN470MHz band follow the same trend as those for the EU868MHz Band. The only notable exception is that at 22km both Node 3 and Node 4 have no trouble having their packets received (at worst there is a 1% packet loss with Node 4 at Tx@17dBm), and this is with SF7 !!!

You can see a map of the measurements done with Node 3 on Picture 3 on the next page:



Picture3