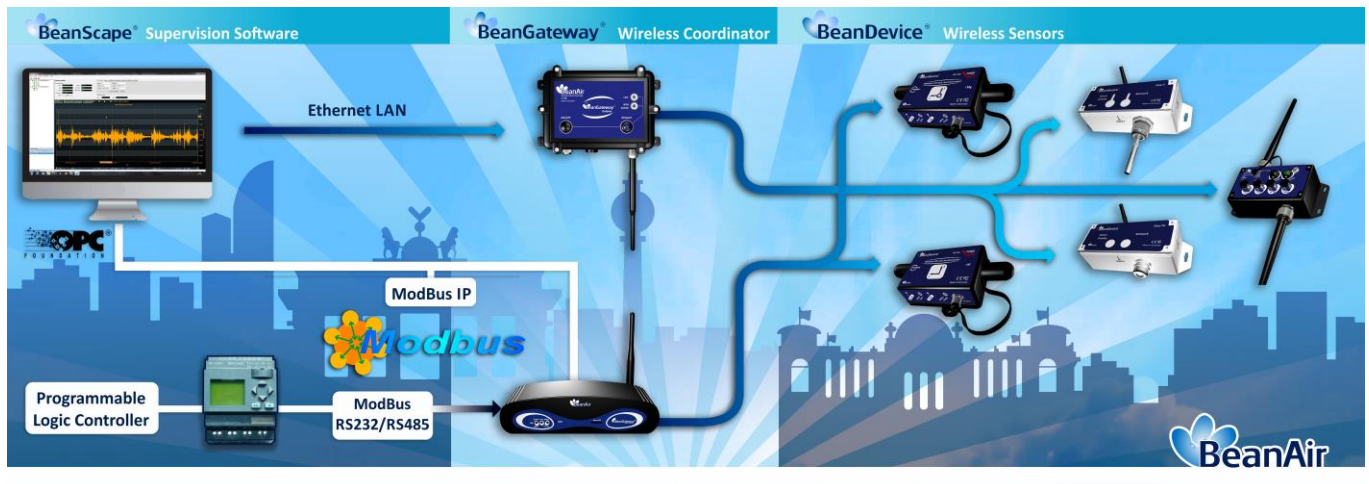




**TECHNICAL NOTE**

***Wireless range benchmarking on  
BeanDevice® products (wireless sensors)***





**DOCUMENT**

<b>Document number</b>		<b>Version</b>	V1.1
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<b>Author</b>	Maxime Obr.		
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	"Rethinking sensing technology"	Document version : 1.1
	Document Type : Technical Note	<i>Wireless Range Benchmarking</i>

## 1. AIM OF THE DOCUMENT

---

The aim of this document is to estimate the maximum wireless range on the BeanDevices products inside a building and in outdoor.

This document is not intended to study precisely the wireless range of our BeanDevices®, but gives an idea of the results you could have in your future installation.

**Please note that these computed values can change, depending strongly on your environment.**

By the way, you will find information about interferences on other BeanAir documents.



## 2. MODELLING

---

### What is the network capacity?

In this document, the network capacity is the number of packets transmitted, received or lost during a specified period.

This capacity can be modeled by the following parameters:

- **LQI**      **Link Quality Indicator**

LQI is equivalent to Received Signal Strength Indication (RSSI).

The LQI value is between 0 and 255.

The closer the LQI is to 255, the stronger becomes the signal power.

- **PER\_A**      **Absolute Packet Error Rate** = 
$$\sum_{k=0}^n \frac{\text{Packets Lost}(n)}{\text{Packets Sent}}$$

This can be local or global.

(e.g.: 3 of 1000 Packets lost on the network/on a device, approximate)

- **PER\_R**      **Relative Packet Error Rate** = 
$$\frac{\sum_{k=0}^n \frac{\text{Packets Lost}(n)}{\text{Packets Sent}}}{\text{Time}(n) - \text{Time}(0)}$$

(e.g.: 3 of 1000 Packets lost on the network Per Hour)



### 3. TESTS DESCRIPTION

---

#### 3.1 EQUIPEMENT USED

---

- PC + BeanScape® + RJ45 Cable (2m)
- BeanGateway Indoor (battery-powered)
- Beandevise SmartSensor AX-3D (battery-powered)
- BeanDevice® ONE-TIR/ONE-T/ONE-TH/ONE-BN (battery-powered)
- Antenna 5.5 dBi → ref: RF\_OM\_5
- Antenna 14 dBi → ref: RF\_PAN\_14
- Laser distance meter
- 2x pylons - 1.5 meters each
- Walkies Talkies

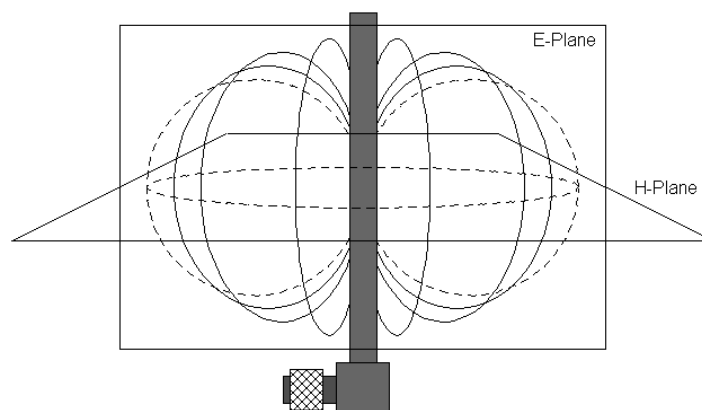
#### 3.2 BEANDEVICE® ANTENNA SPECIFICATION

---

- BeanDevice® SmartSensor AX-3D-v1.4 :
  - 2.2 dBi Antennas (x2)
- BeanDevice® ONE-TIR/ONE-T/ONE-TH/ONE-BN:
  - 2 dBi Antenna (1)

#### 3.3 BEANGATEWAY® ANTENNA CHARACTERISTICS

---



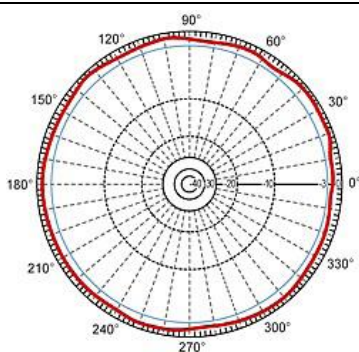
Two types of antennas were used on the BeanGateway®:

- Omnidirectional antenna with a gain of 5,5 dBi
- Directional antenna with a gain of 14 dBi

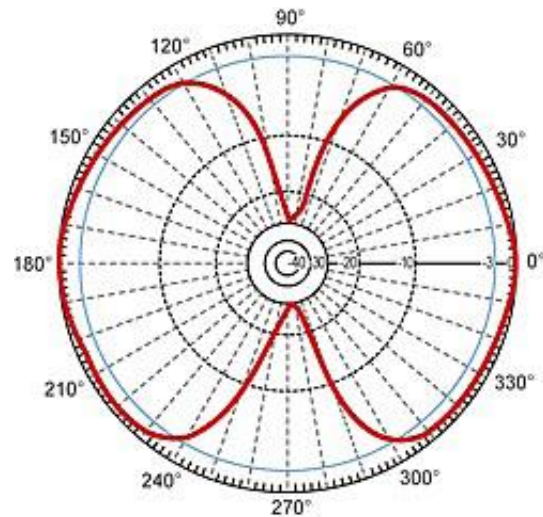


### 3.3.1 5.5 dBi antenna

- Reference : RF\_OM\_5
- Gain at 2400 MHz : 5.5 dBi
- 2.4 GHz < Frequency < 2485 MHz
- Bandwidth : 83.5 MHz
- Impedance : 50  $\Omega$
- Power max : 25 W
- VSWR < 2.0
- RP-SMA Connector



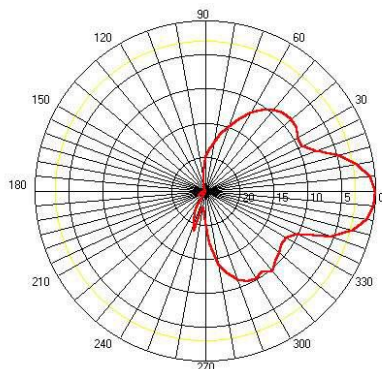
H-Plane Pattern



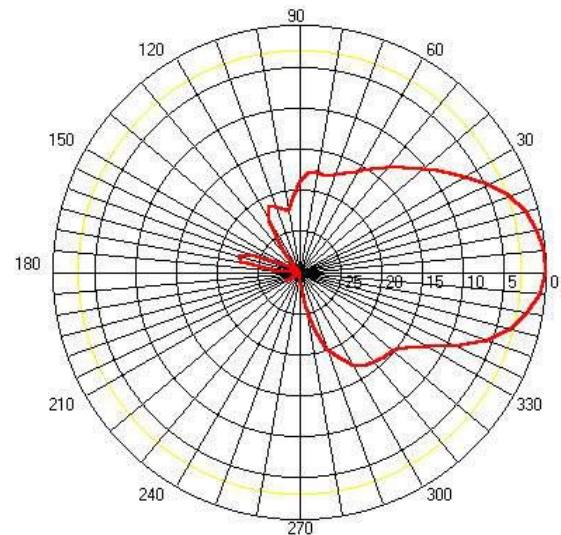
E-Plane Pattern

### 3.3.2 14 dBi antenna

- Reference : RF\_PAN\_14
- Gain at 2400 MHz : 14 dBi
- 2.4 GHz < Frequency < 2483 MHz
- Impedance : 50  $\Omega$
- Power max : 50 W
- VSWR = 1.5 :1
- Type-N Connector




H-Plane Pattern



E-Plane Pattern



	<p>“Rethinking sensing technology”</p>	<p>Document version : 1.1</p>
	<p>Document Type : Technical Note</p>	<p><i>Wireless Range Benchmarking</i></p>

## 4. WIRELESS RANGE IN A BUILDING

---

In a building, the BeanDevice® and the BeanGateway® are not installed in LOS (Line-of-sight). Several obstacles were present between these two equipments: bearing walls, doors and staircases.

For each type of battery of tests, we used different positions of the BeanDevice® and BeanGateway® in the building.

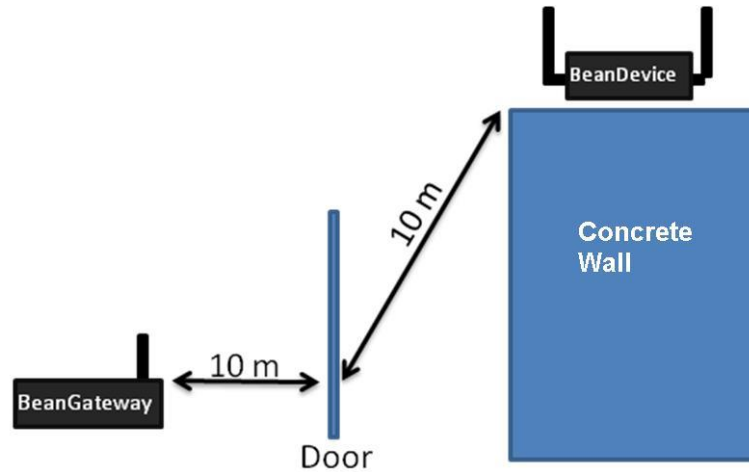
In this document, we will specify the number of bearing walls and doors present between the antenna of the BeanGateway® and the antenna of the BeanDevices®.

These tests will not represent all the end user application cases inside a building.

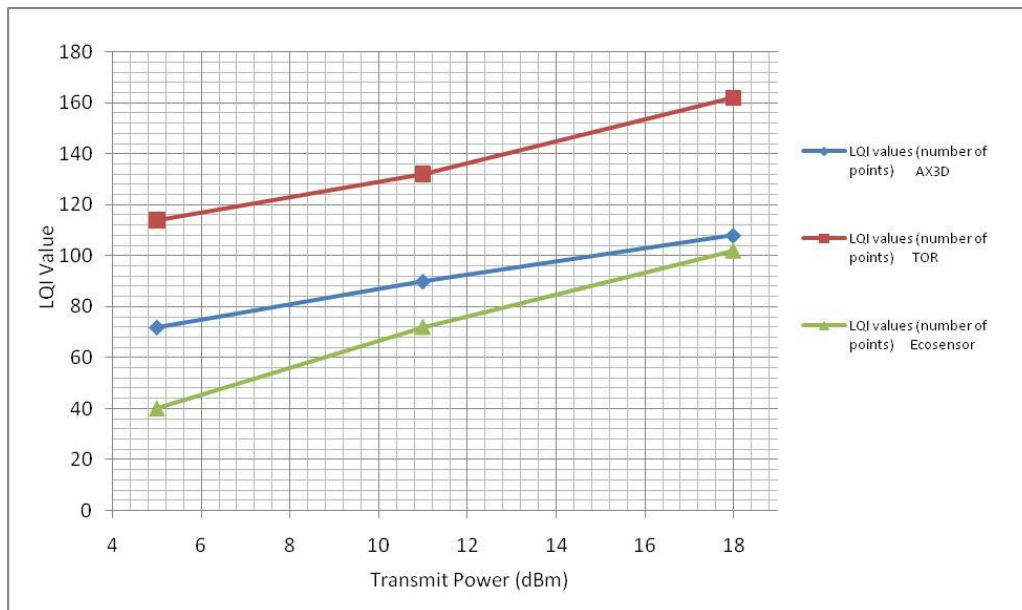


## 4.1 TEST WITH A 5.5 DBI ANTENNA

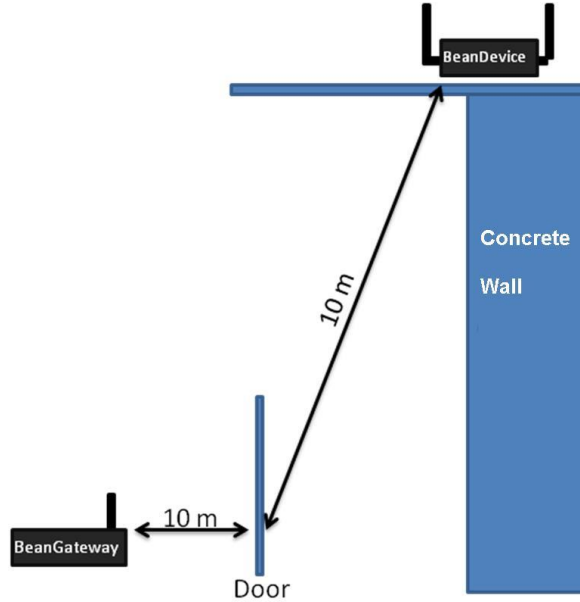
### 4.1.1 1<sup>st</sup> position



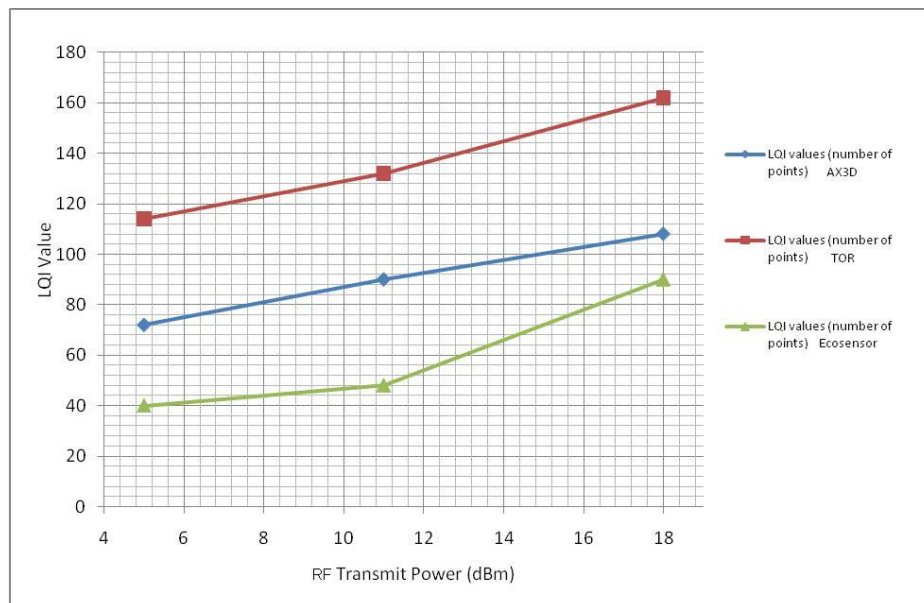
Type of BeanDevice®	RF Transmit Power (dBm)	LQI
AX-3D	18	108
	11	90
	5	72
ONE-TIR	18	102
	11	72
	5	RF link broken



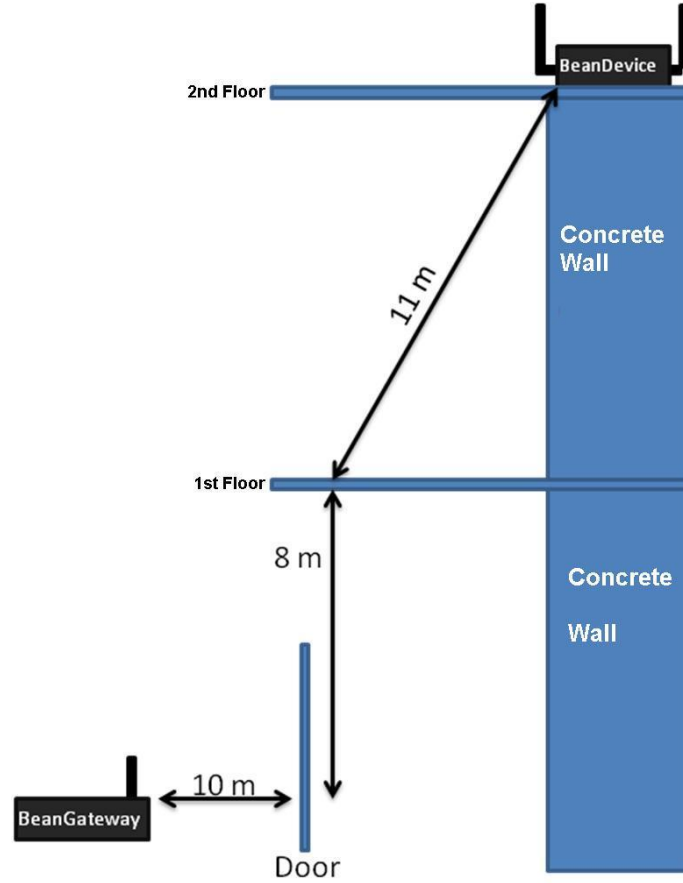
4.1.2 2<sup>nd</sup> position



Type of BeanDevice®	RF Transmit Power (dBm)	LQI
AX-3D	18	126
	11	100
	5	72
ONE-TIR	18	90
	11	48
	5	RF link broken



### 4.1.3 3<sup>rd</sup> Position

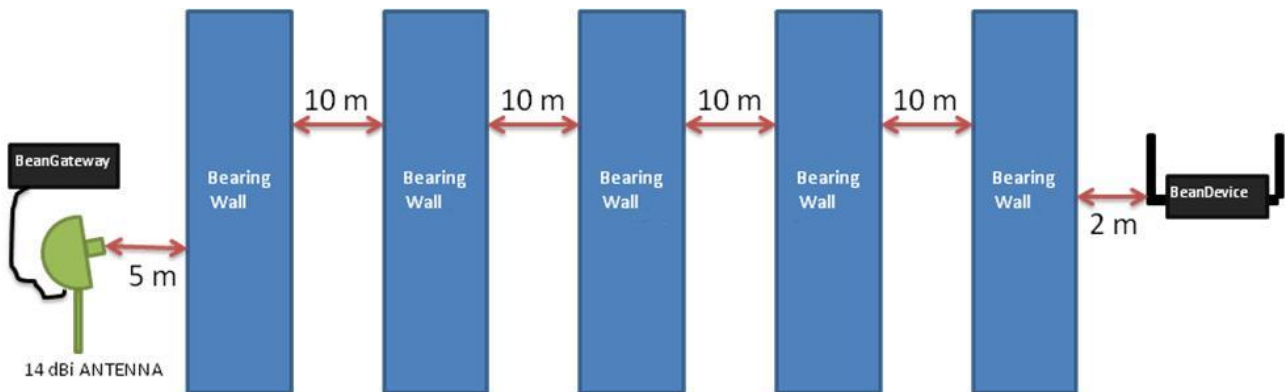


Type of BeanDevice®	RF Transmit Power (dBm)	LQI
AX-3D	18	RF link broken
	11	RF link broken
	5	RF link broken
ONE-TIR	18	RF link broken
	11	RF link broken
	5	RF link broken



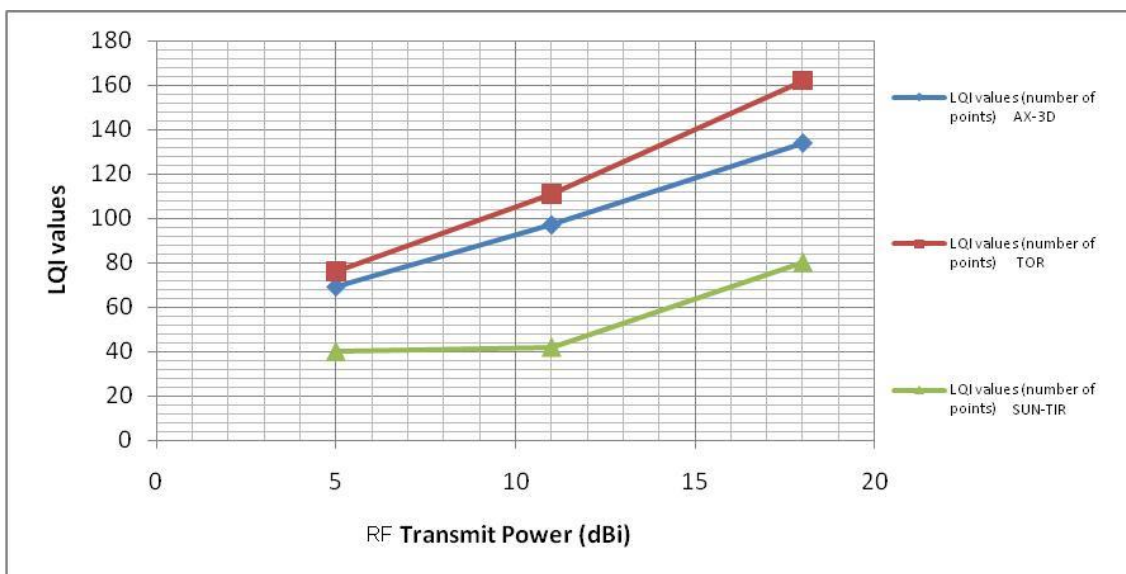
## 4.2 TEST WITH A 14 DBI DIRECTIONAL ANTENNA

### 4.2.1 Several obstacles



DRAWING NOT TO SCALE

Type of BeanDevice®	RF Transmit Power (dBm)	LQI
AX-3D	18	134
	11	97
	5	69
ONE-TIR	18	80
	11	42
	5	40



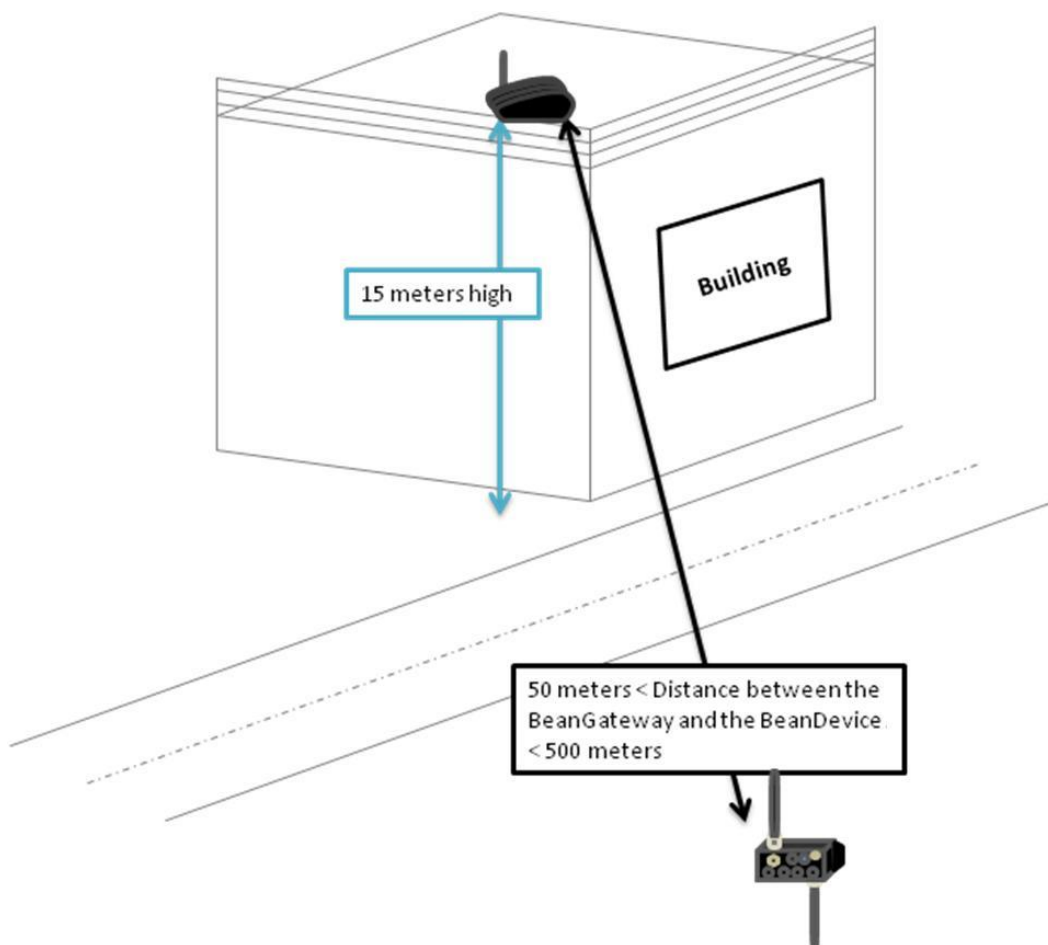
## 5. WIRELESS RANGE IN OUTDOOR CASE

---

The BeanDevices® and the BeanGateway® are practically LOS (Line-of-sight). Some obstacles were present between these two equipments: Trees, traffic lights, metal pylons and vehicles traffics.

For each type of battery of tests, we measured the LQI at different distances between the BeanDevices® and the BeanGateway®.

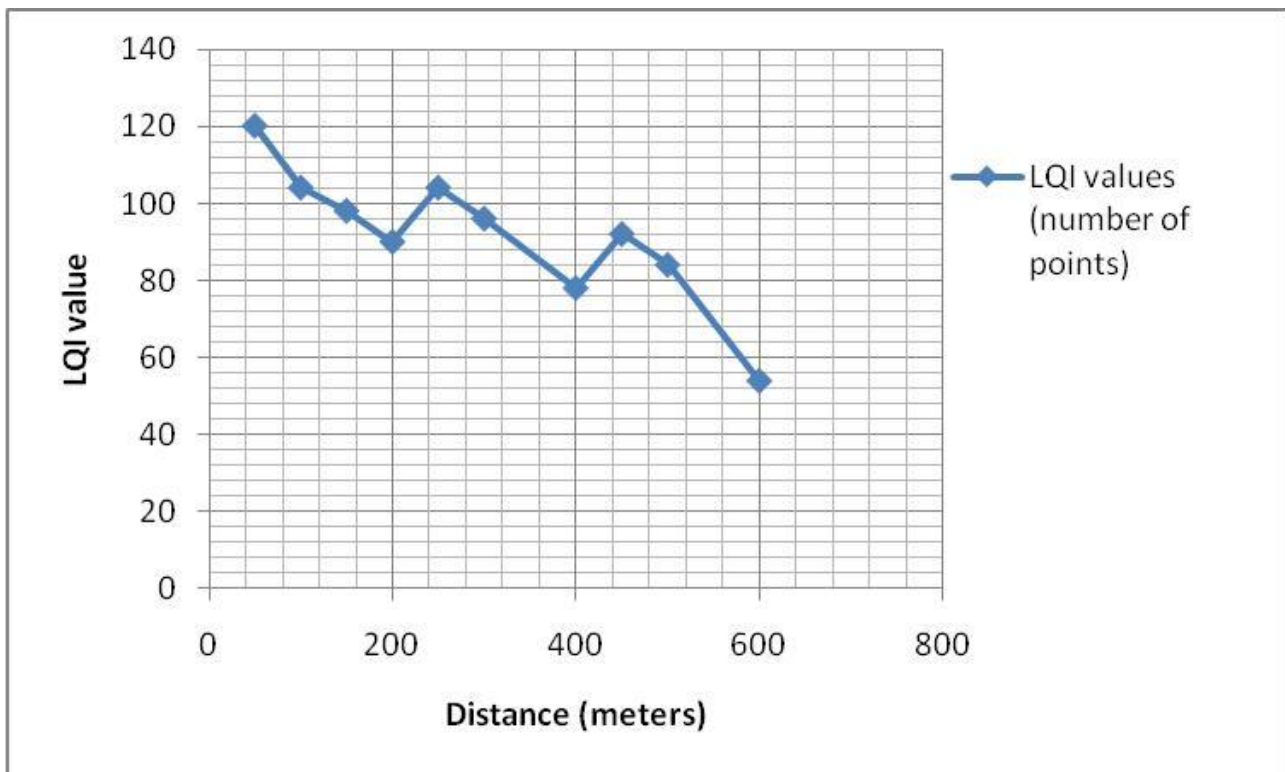
These tests will not represent all the end user application cases in outdoor.



## 5.1 TEST WITH A 5.5 DBI ANTENNA

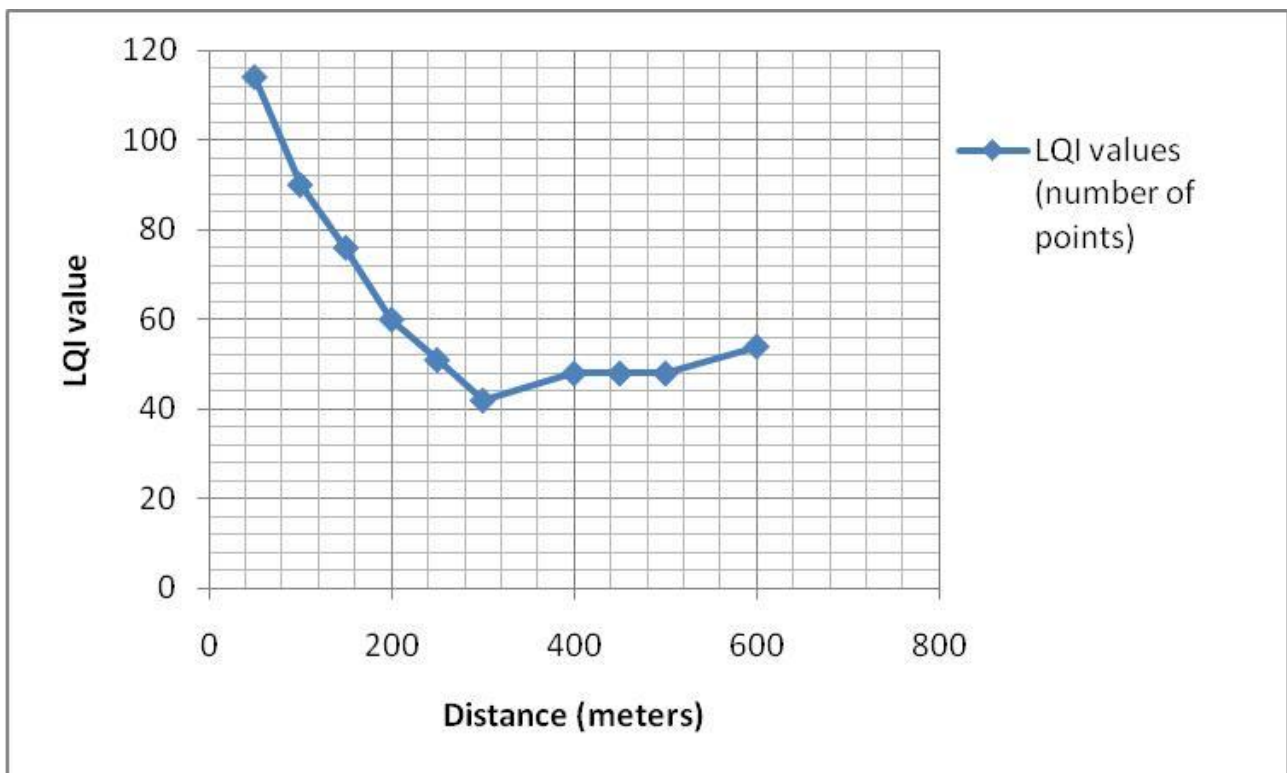
### 5.1.1 Beandevicé® AX-3D – Transmit Power = 18 dBm

Distance in meters	LQI value
50	120
100	104
150	98
200	90
250	104
300	96
400	78
450	92
500	84
600	54



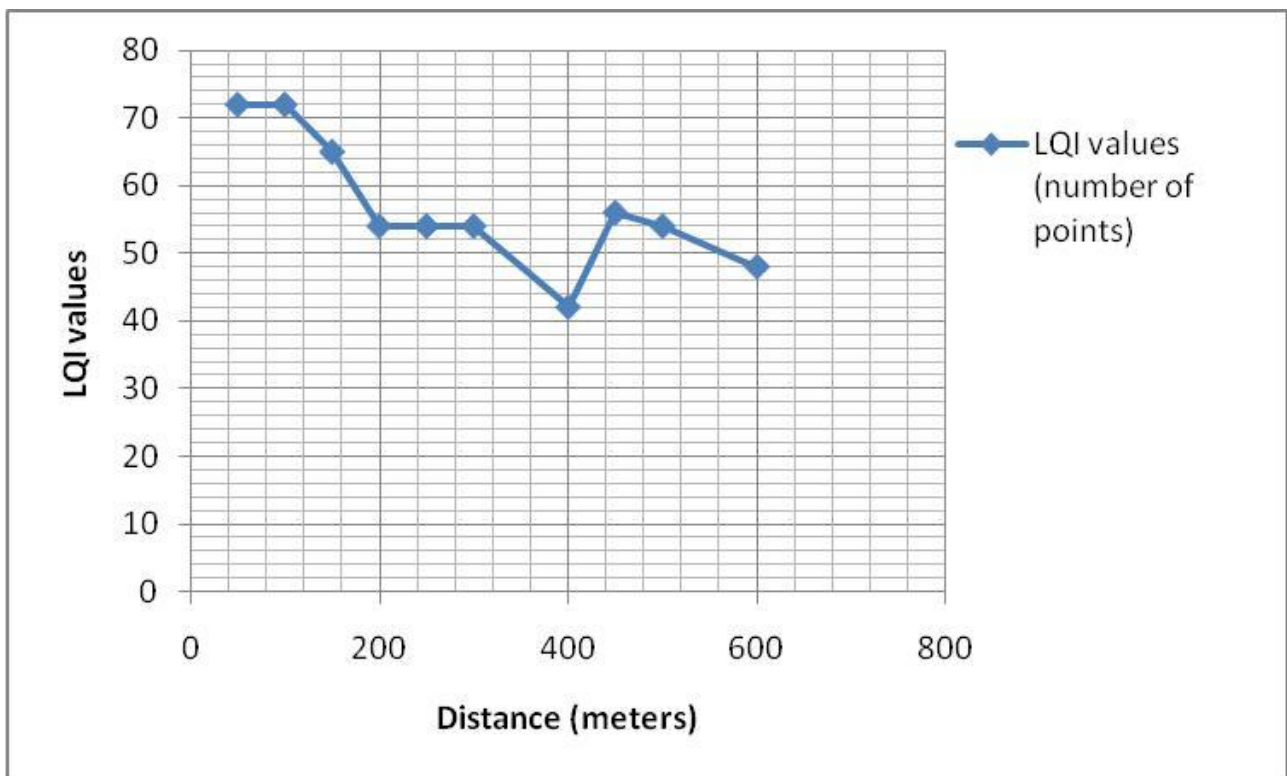
5.1.2 Beandevic<sup>®</sup> AX-3D – Transmit Power = 11 dBm

Distance in meters	LQI value
50	114
100	90
150	76
200	60
250	51
300	42
400	48
450	48
500	48
600	54



**5.1.3 Beandevicé® AX-3D – Transmit Power = 5 dBm**

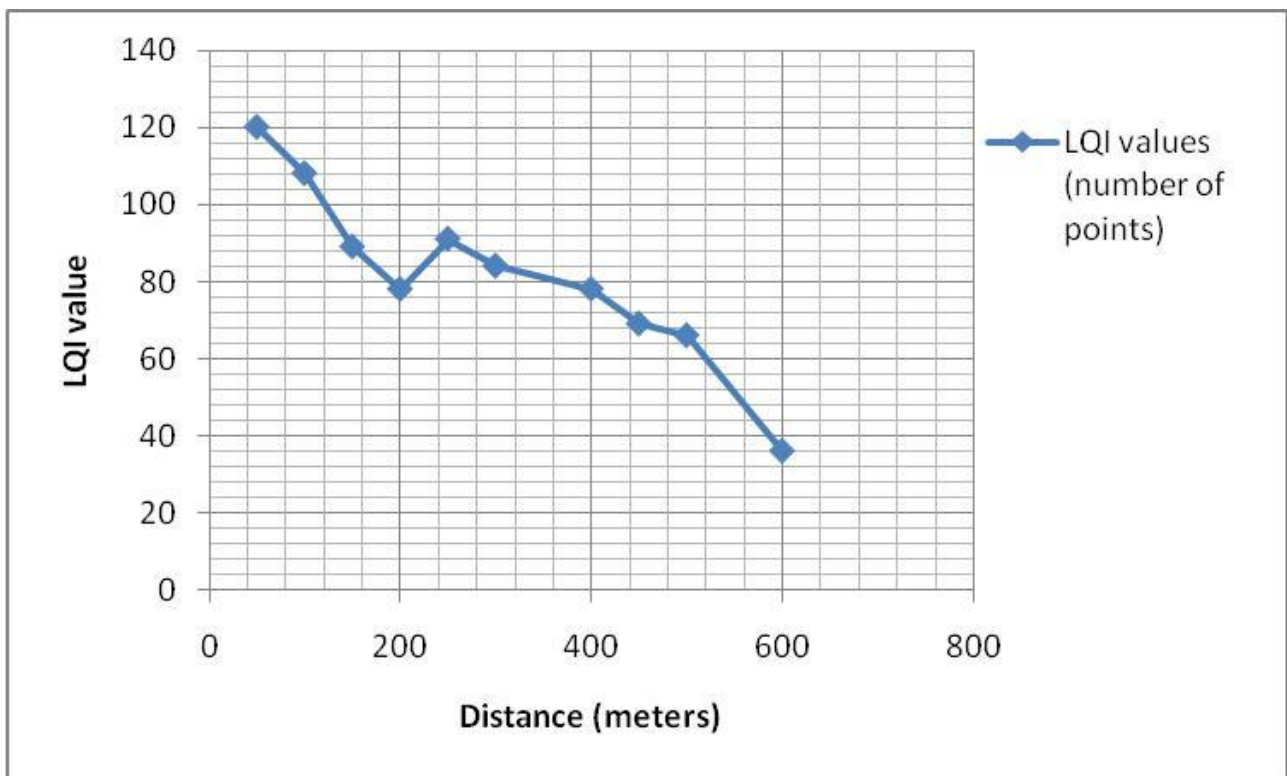
Distance in meters	LQI value
50	72
100	72
150	65
200	54
250	54
300	54
400	42
450	56
500	54
600	48





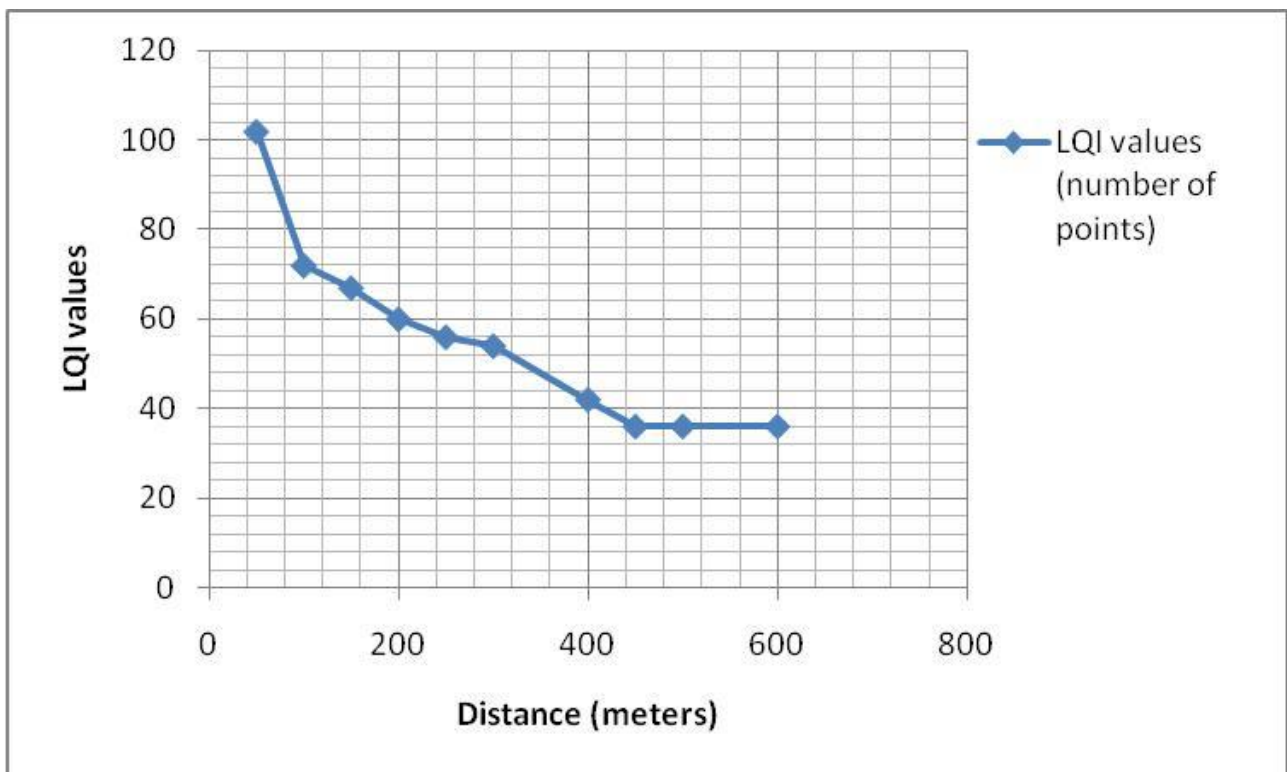
5.1.4 BeanDevice® ONE-TIR/ONE-T/ONE-TH/ONE-BN – Transmit Power = 18 dBm

Distance in meters	LQI value
50	120
100	108
150	89
200	78
250	91
300	84
400	78
450	69
500	66
600	36



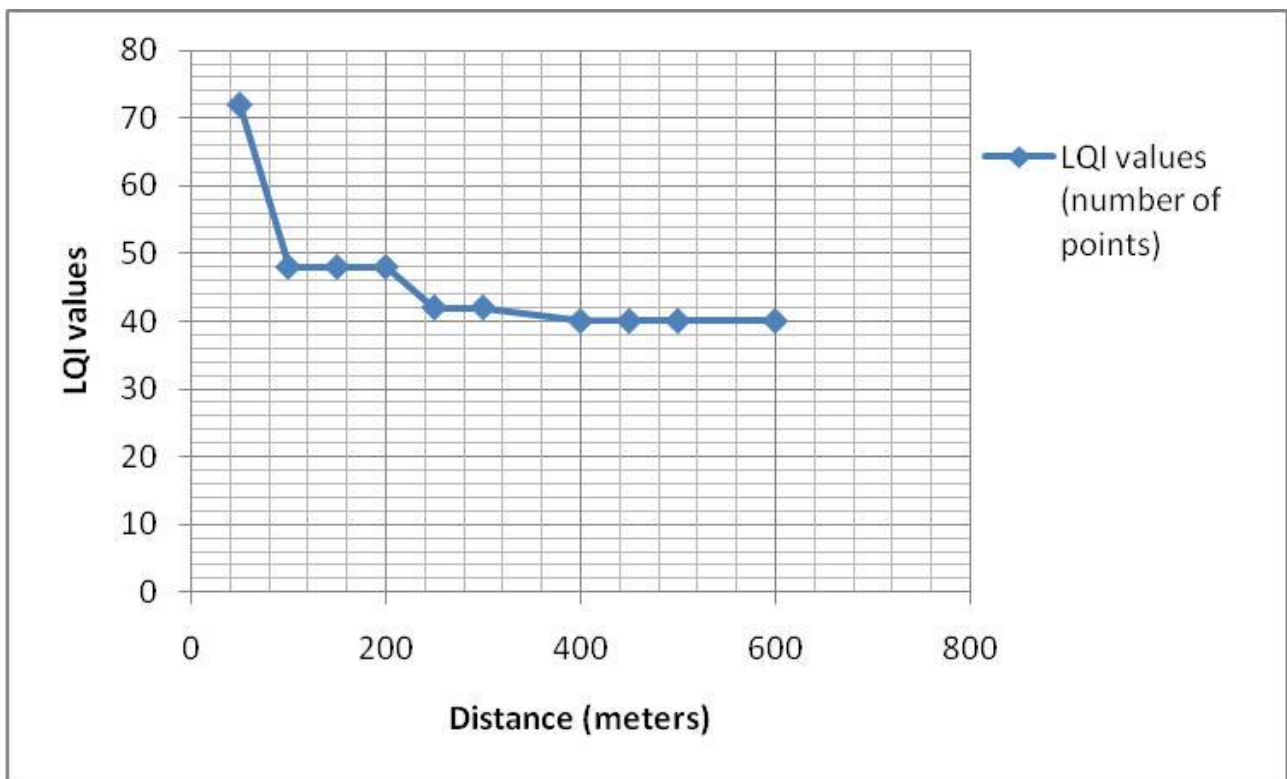
**5.1.5 BeanDevice® ONE-TIR/ONE-T/ONE-TH/ONE-BN – Transmit Power = 11 dBm**

Distance in meters	LQI value
50	102
100	72
150	67
200	60
250	56
300	54
400	42
450	36
500	36
600	36



**5.1.6 BeanDevice® ONE-TIR/ONE-T/ONE-TH/ONE-BN – Transmit Power = 5 dBm**

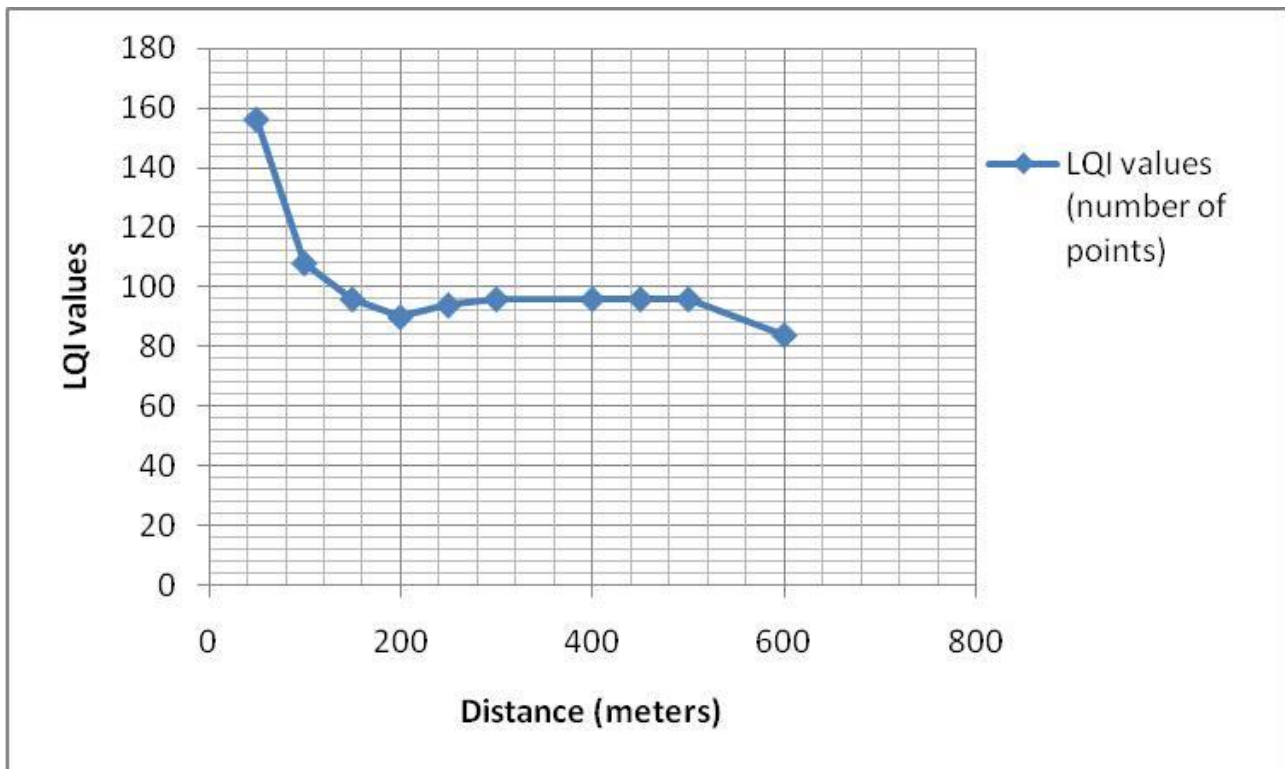
Distance in meters	LQI value
50	72
100	48
150	48
200	48
250	42
300	42
400	40
450	40
500	40
600	40



## 5.2 TEST WITH A 14 DBI ANTENNA

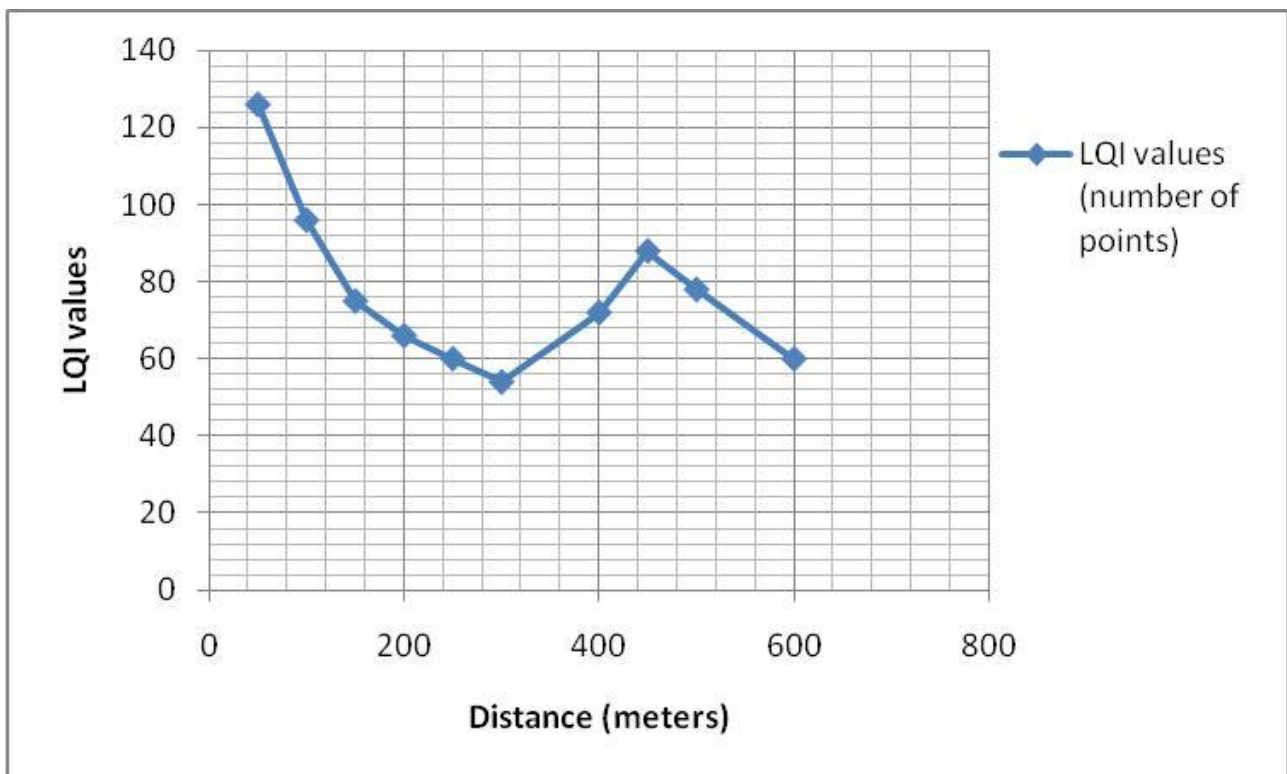
### 5.2.1 Beandevicé® AX-3D – Transmit Power = 18 dBm

Distance in meters	LQI value
50	156
100	108
150	96
200	90
250	94
300	96
400	96
450	96
500	96
600	84



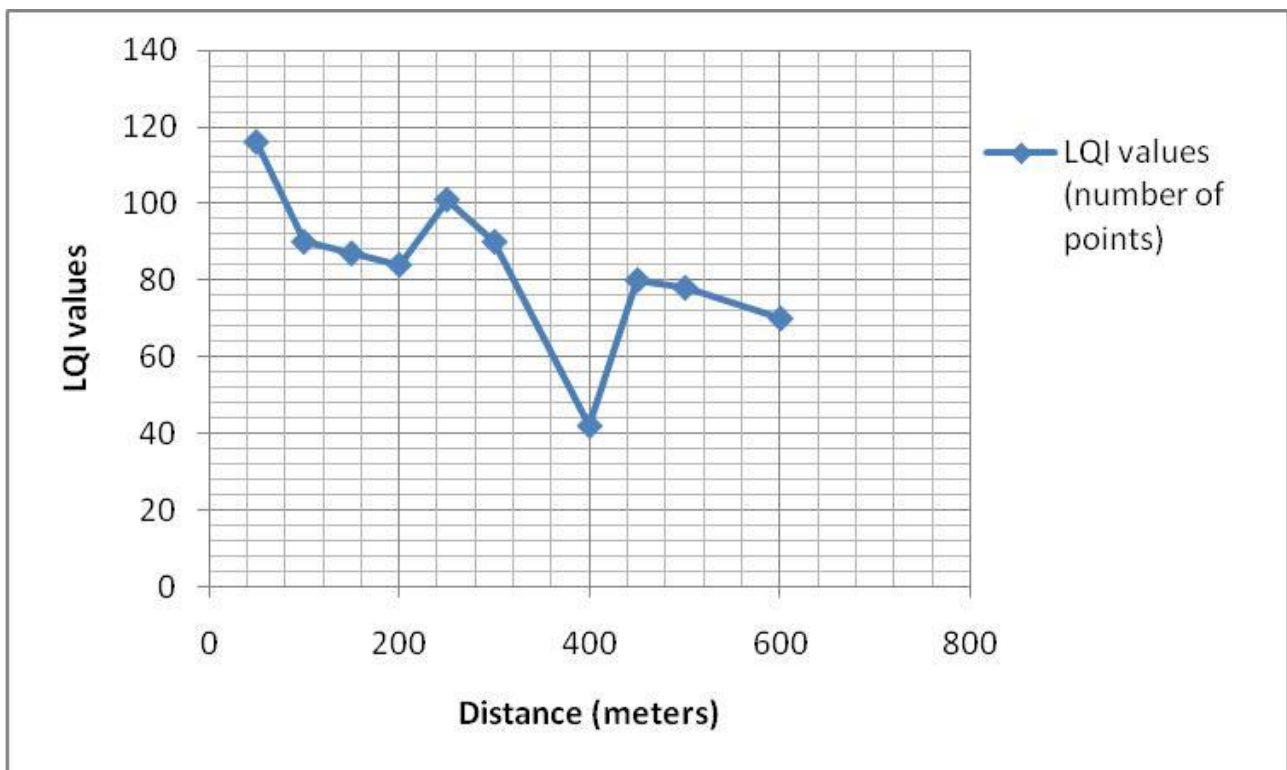
5.2.2 Beandevic<sup>®</sup> AX-3D – Transmit Power = 11 dBm

Distance in meters	LQI value
50	126
100	96
150	75
200	66
250	60
300	54
400	72
450	88
500	78
600	60



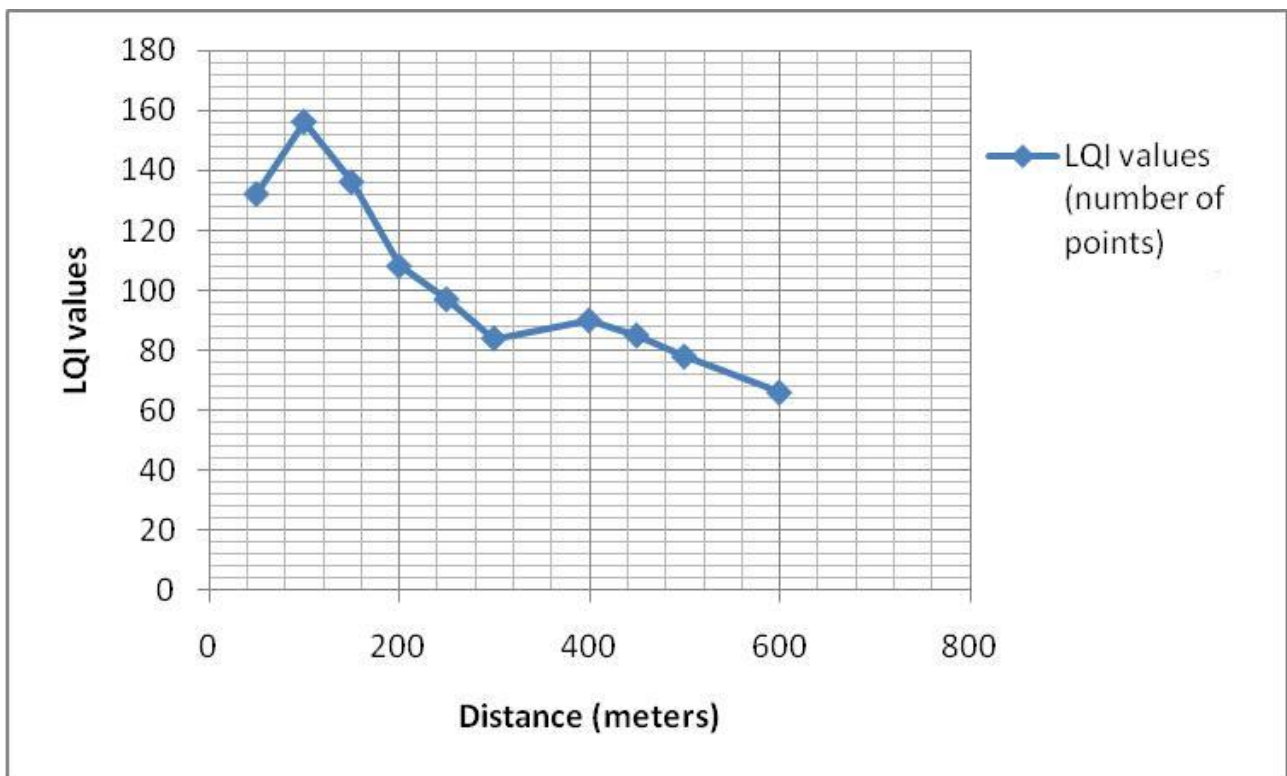
**5.2.3 Beandevicé® AX-3D – Transmit Power = 5 dBm**

Distance in meters	LQI value
50	116
100	90
150	87
200	84
250	101
300	90
400	42
450	80
500	78
600	70



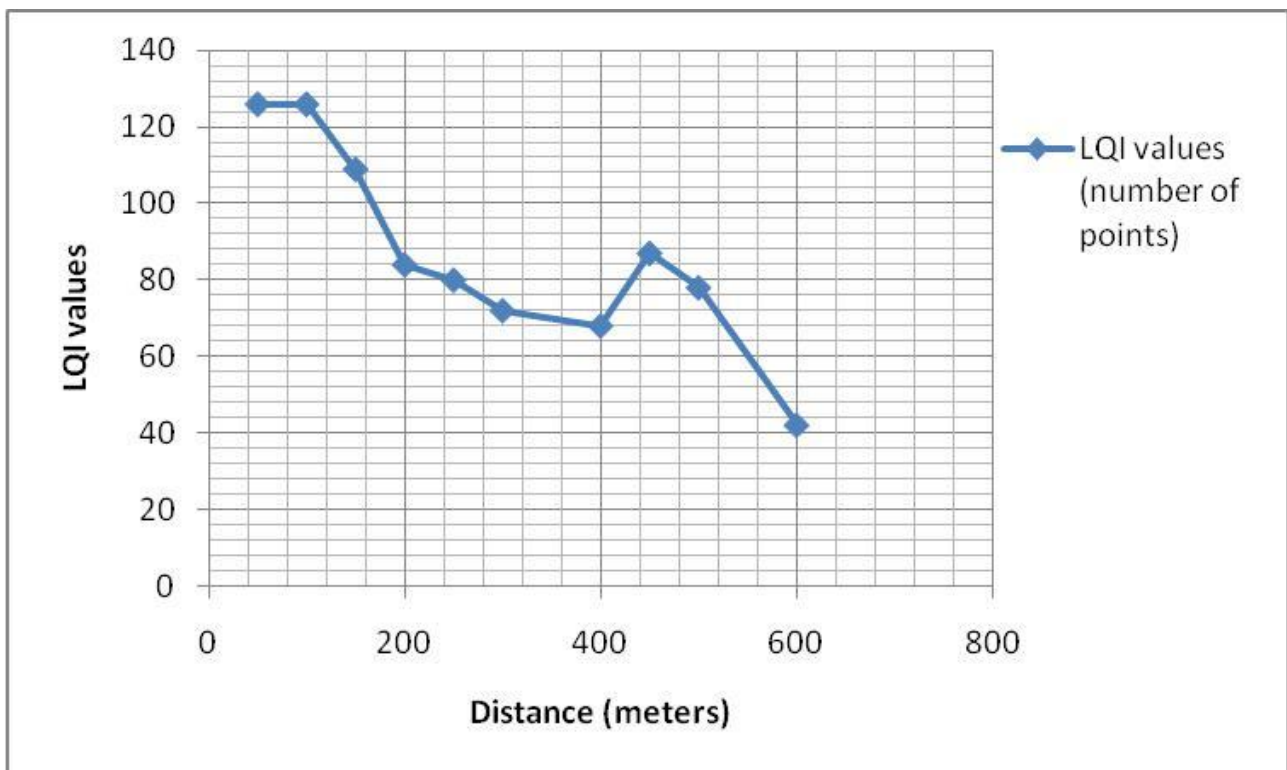
5.2.4 BeanDevice® ONE-TIR/ONE-T/ONE-TH/ONE-BN – Transmit Power = 18 dBm

Distance in meters	LQI value
50	132
100	156
150	136
200	108
250	97
300	84
400	90
450	85
500	78
600	66



**5.2.5 BeanDevice® ONE-TIR/ONE-T/ONE-TH/ONE-BN – Transmit Power = 11 dBm**

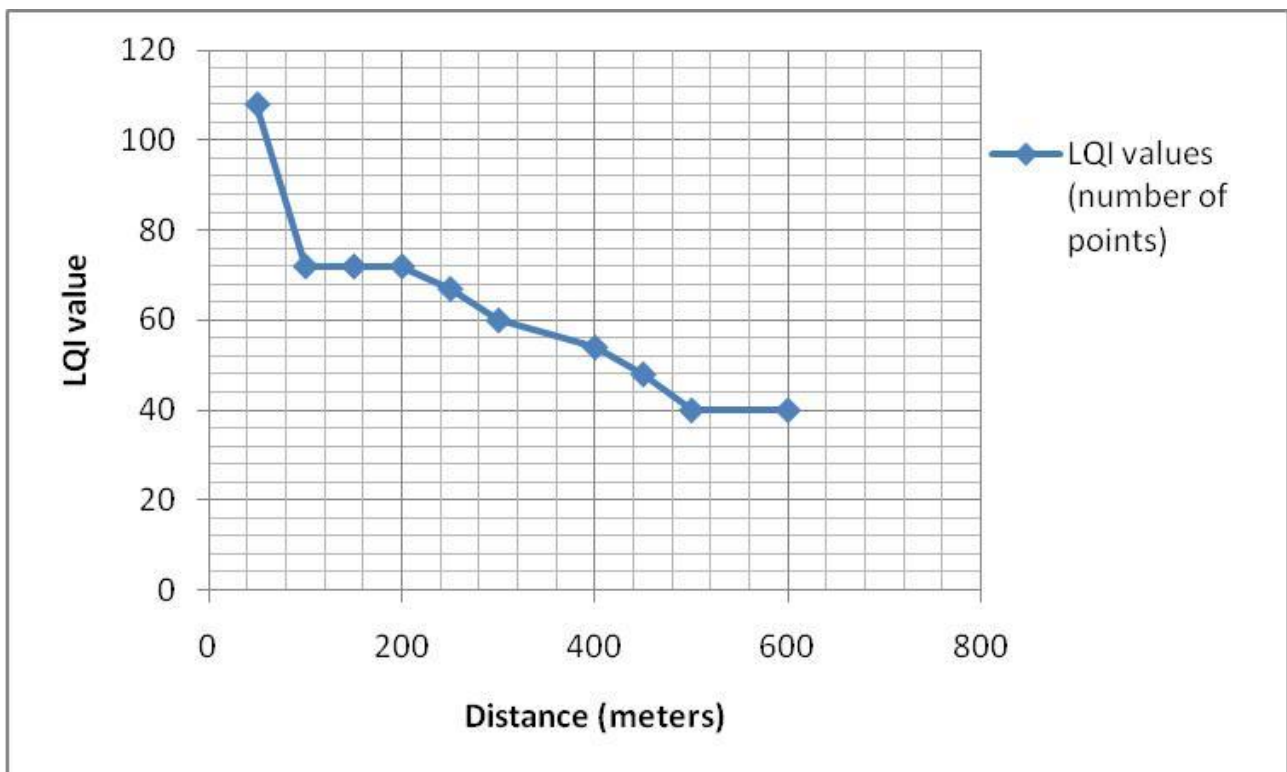
Distance in meters	LQI value
50	126
100	126
150	109
200	84
250	80
300	72
400	68
450	87
500	78
600	42





**5.2.6 BeanDevice® ONE-TIR/ONE-T/ONE-TH/ONE-BN – Transmit Power = 5 dBm**

Distance in meters	LQI value
50	108
100	72
150	72
200	72
250	67
300	60
400	54
450	48
500	40
600	40



## 6. CONCLUSION OF OUR TESTS

For a better wireless range, the different points are highly recommended:

- Use a directive antenna on the BeanGateway®;
- All the devices should be installed on the same radiation pattern;

BeanDevice® model	Type of Antenna on the BeanGateway®	RF Transmit Power (dBm)	Maximum wireless range
Beandevicé® AX-3D/AX-3DS/HI-INC/INC	5.5 dBi	18	380 m
		11	> 150 m
		5	> 50 m
	14 dBi	18	More than 600 m
		11	200 m
		5	150 m
Ecosensor products BeanDevice® ONE-T/ONE-BN/ONE-TIR/ONE-TH	5.5 dBi	18	320 m
		11	> 100 m
		5	> 50 m
	14 dBi	18	475 m
		11	250 m
		5	> 100 m

