



## TECHNICAL NOTE



# Wireless Sensor Networks Association Procedure





"Rethinking sensing technology"

Document version : 2.2

Document Type : Technical Note

Wireless sensor network  
association process

## DOCUMENT

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## VALIDATION

Function	Recipients	For Validation	For information
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## Updates

Version	Date	Author	Evolution & Status
V1.0	12/07/2011	Christophe DONTEGREUIL	First version of the document
V1.1	20/10/2015	Maxime Obraztsov	
V2.0	11/11/2019	Seddik ATTIG	Time synchronization during the diagnostic cycle transmission
V2.1	01/14/2020	Seddik ATTIG	Update the cover page Energy scan
V2.2	14/04/2021	Seddik ATTIG	Screenshot update





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## 1. TECHNICAL SUPPORT

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For general contact, technical support, to report documentation errors and to order manuals, contact **Beanair Technical Support Center** (BTSC) at: [tech-support@Beanair.com](mailto:tech-support@Beanair.com)

For detailed information about where you can buy the Beanair equipment/software or for recommendations on accessories and components visit:

[www.Beanair.com](http://www.Beanair.com)




To register for product news and announcements or for product questions contact Beanair's Technical Support Center (BTSC).

Our aim is to make this user manual as helpful as possible. Please keep us informed of your comments and suggestions for improvements. Beanair appreciates feedback from the users.



## 2. VISUAL SYMBOLS DEFINITION

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<i>Visual</i>	<i>Definition</i>
	<p><b><i>Caution or Warning</i></b> – Alerts the user with important information about Beanair wireless sensor networks (WSN), if this information is not followed, the equipment /software may fail or malfunction.</p>
	<p><b><i>Danger</i></b> – This information <b>MUST</b> be followed if not you may damage the equipment permanently or bodily injury may occur.</p>
	<p><b><i>Tip or Information</i></b> – Provides advice and suggestions that may be useful when installing Beanair Wireless Sensor Networks.</p>




### 3. ACRONYMS AND ABBREVIATIONS

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AES	Advanced Encryption Standard
CCA	Clear Channel Assessment
CSMA/CA	Carrier Sense Multiple Access/Collision Avoidance
GTS	Guaranteed Time-Slot
kSps	Kilo samples per second
LLC	Logical Link Control
LQI	Link quality indicator
LDCDA	Low duty cycle data acquisition
MAC	Media Access Control
PAN	Personal Area Network
PER	Packet error rate
RF	Radio Frequency
SD	Secure Digital
WSN	Wireless sensor Network



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#### 4. AIM OF THE DOCUMENT

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This document is intended to provide a description of how a WSN is build step by step.

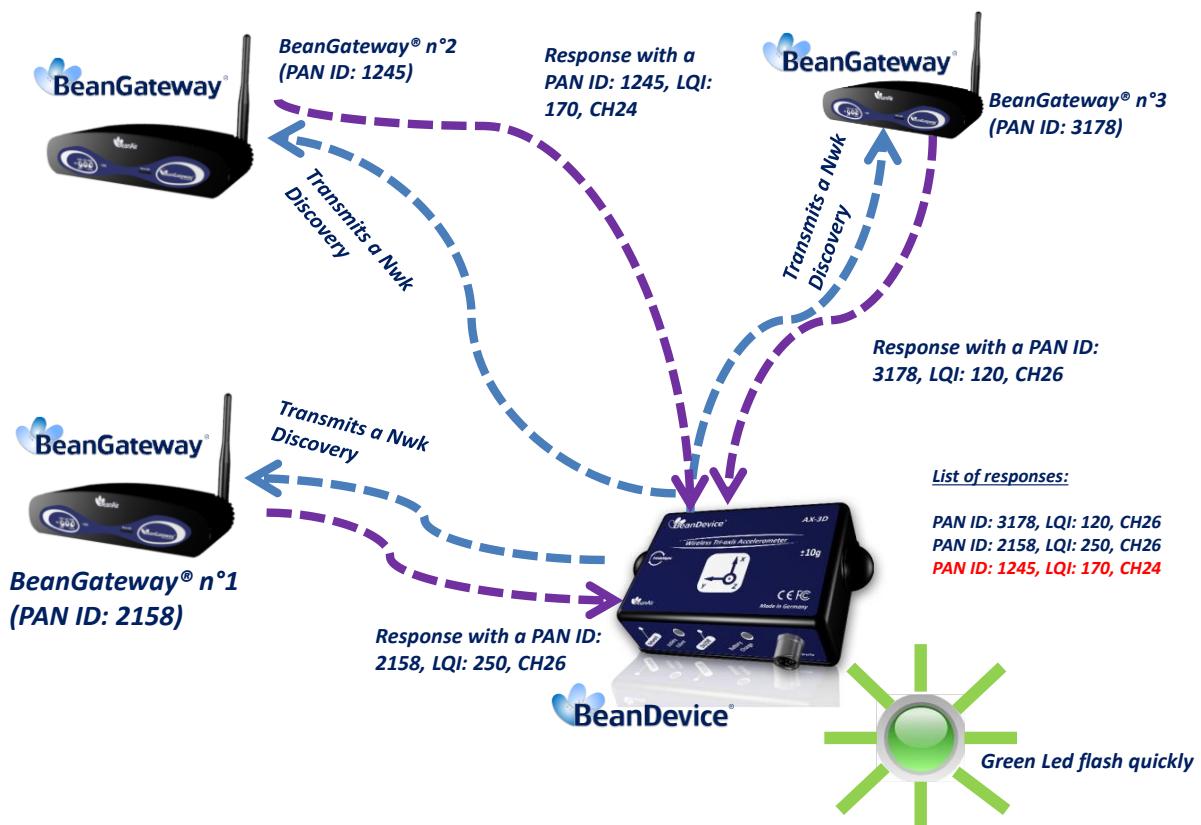


## 5. WSN ASSOCIATION PROCESS

The various network components (**BeanGateway®**, **BeanDevice®**, **BeanScope®**) have been previously installed and configured. To initialize the WSN, refer to the BeanGateway® & BeanScope®.

### First Step: Network Discovery

- The BeanDevice® sends beacon requests to be detected by one or more Beangateway®, which then send out a beacon in response ;
- This response contains the following information : PAN ID (Personal Area Network ID ) , LQI Value & Radio channel ;



Network discovery is processed only if a PAN ID is not recorded on the BeanDevice® flash memory, this occurs if factory settings are restored (by pushing on Network push button of your BeanDevice®).



*Second Step:  
Association with a  
BeanGateway®*

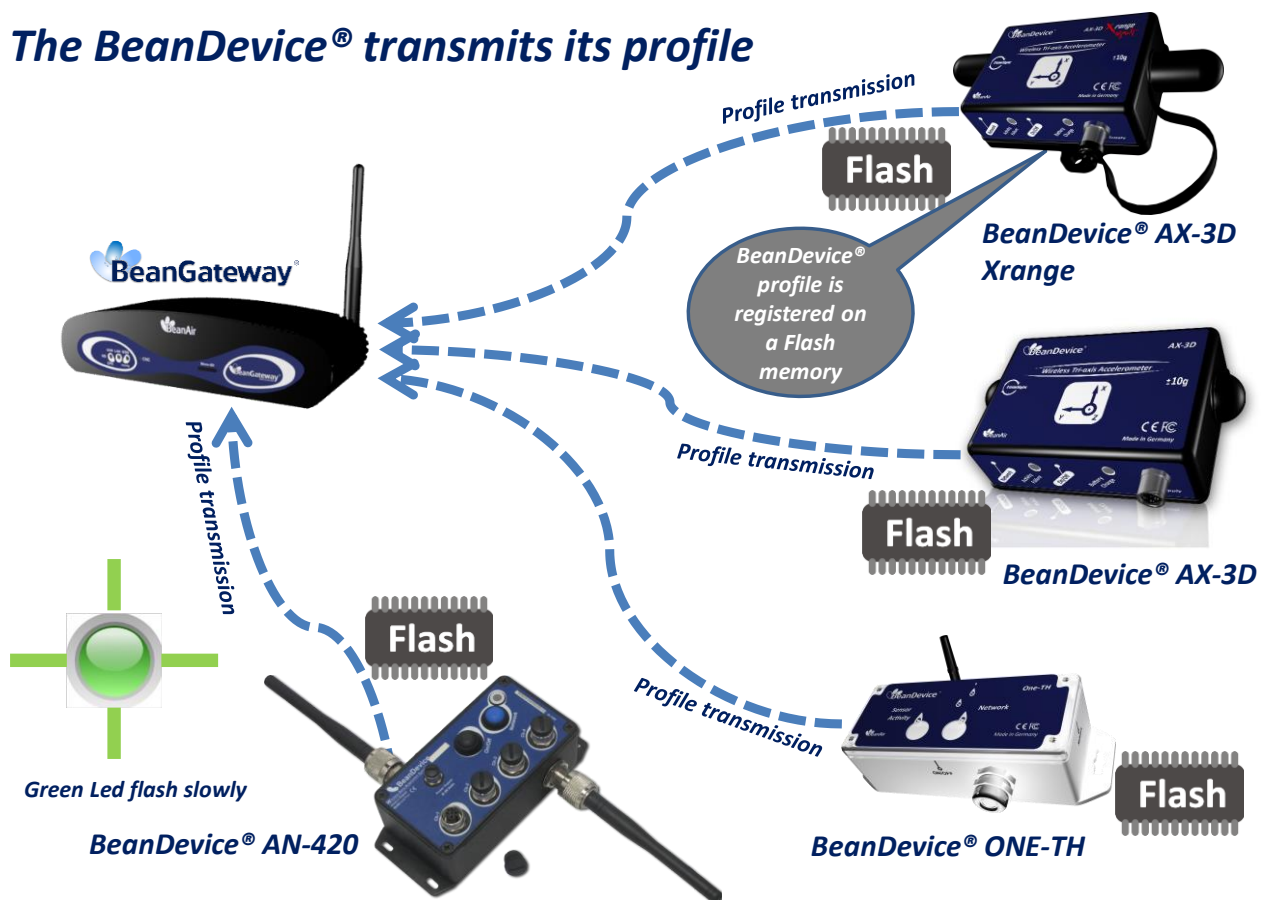
- The BeanDevice® choose to be associated with the BeanGateway® offering the highest LQI value ;
- The New PAN ID is recorded on the BeanDevice® flash memory (only if there no PAN ID recorded on the BeanDevice®)
- The BeanGateway® provides a Network address (16 bits) to the BeanDevice®



### Third Step: Profile transmission

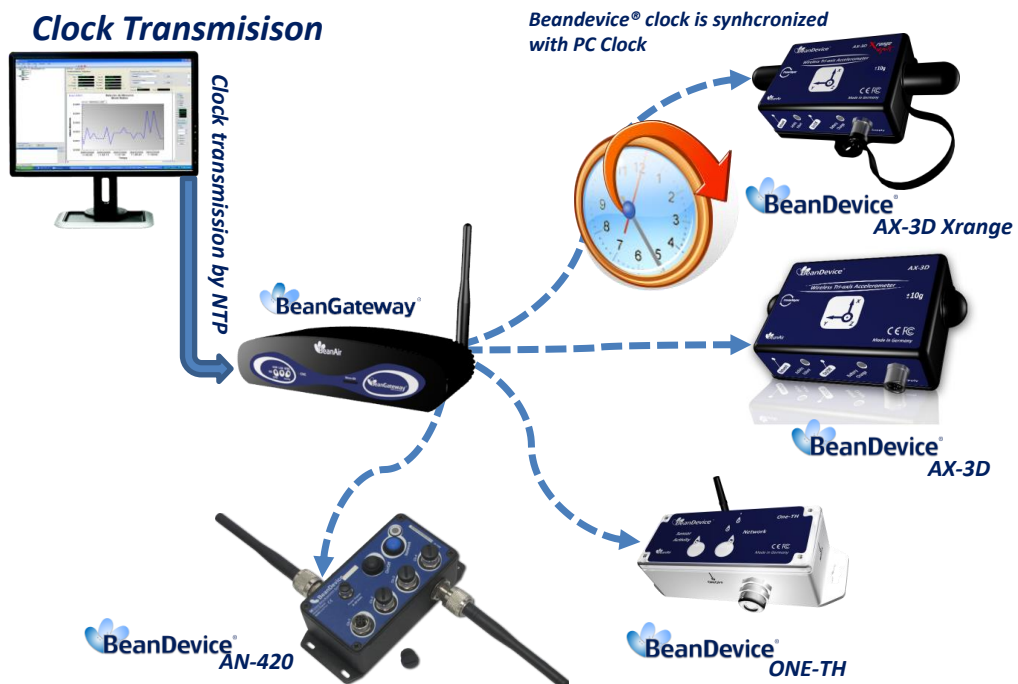
- Each BeanDevice® is recognized by its profile, which is backed up on a flash memory
- The BeanDevice® starts transmitting its profile to the BeanGateway®: MAC ID, Last Data acquisition mode, Sensors calibration, RF Power.....

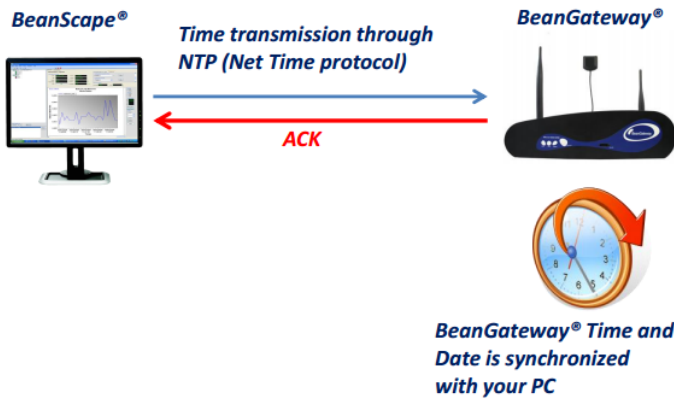
### The BeanDevice® transmits its profile



### Fourth Step: Clock Transmission

- The BeanGateway® broadcast its clock to each BeanDevice® during the association
- The BeanDevice® clock is updated when a connexion is established with the BeanGateway®



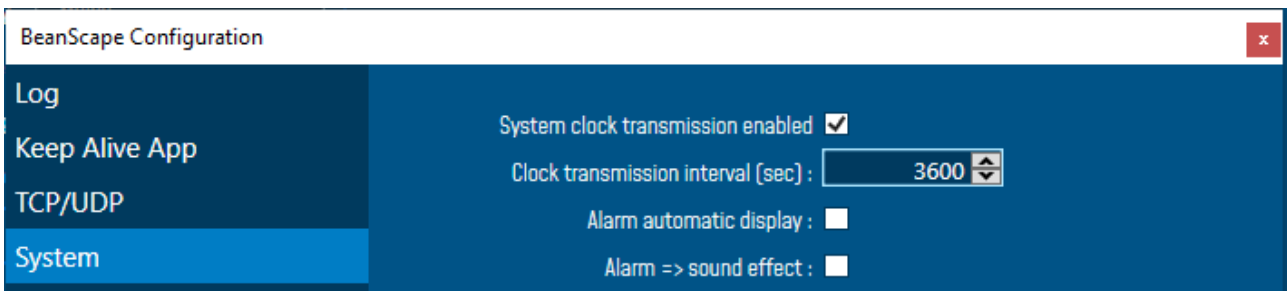


- The Date is transmitted to the BeanGateway by NTP (Net Time Protocol)
- Time & Date are updated on the BeanGateway instantly
- The BeanGateway integrates a Real-Time-Clock directly powered by the internal battery which allows to maintain the Date when the BeanGateway® is powered down
- The Date is updated instantly on the BeanGateway®

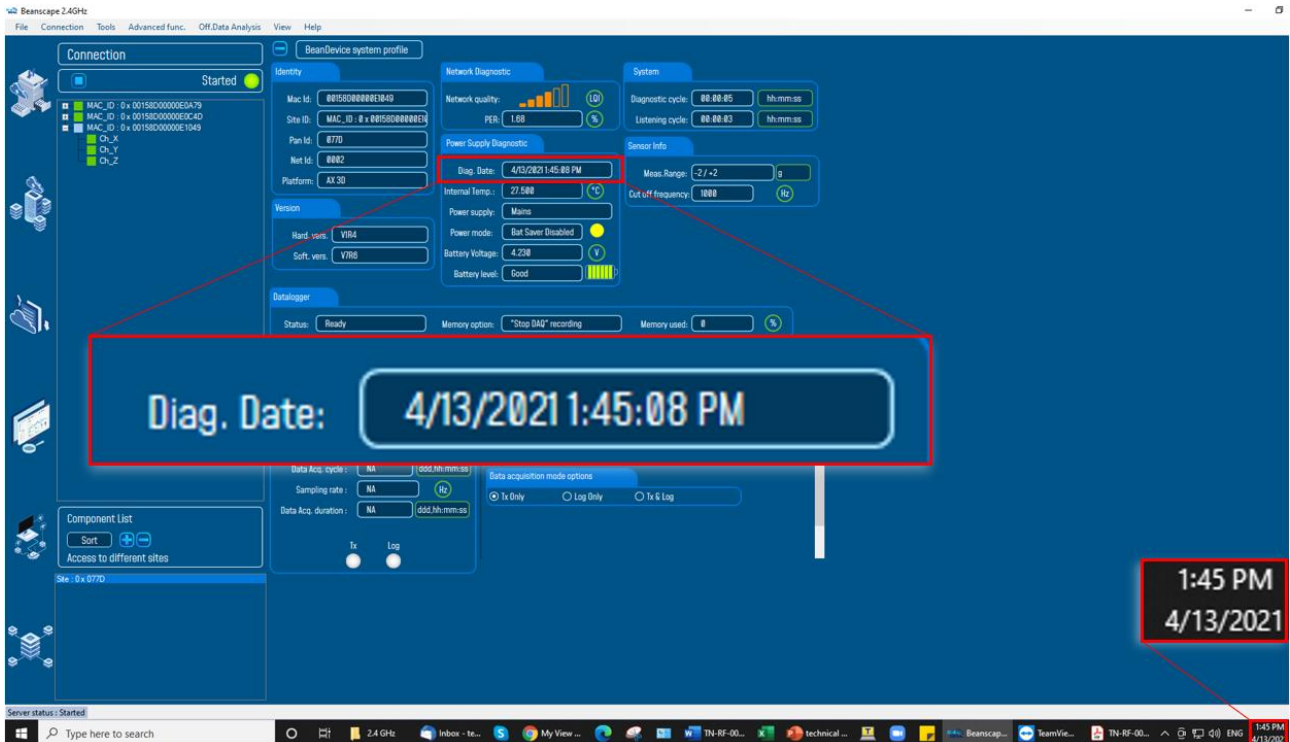
The Date is transferred from the BeanGateway to the BeanDevices after acknowledgment.



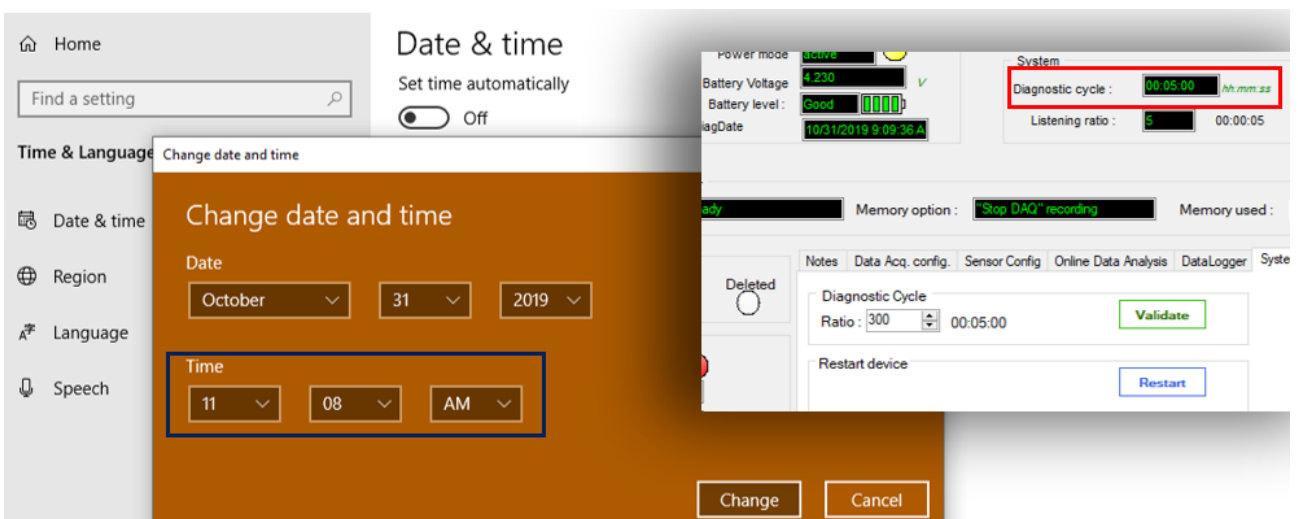
The whole Network could be synchronized via BeanScape by choosing the Clock transmission interval. In the example below, Clock is synchronized every one hour.



- The BeanDevice clock is also synchronized during the diagnostic status transmission. Therefore, when a daylight savings occurs for example, the BeanDevice clock will be automatically synchronized when a diagnostic cycle is reached.



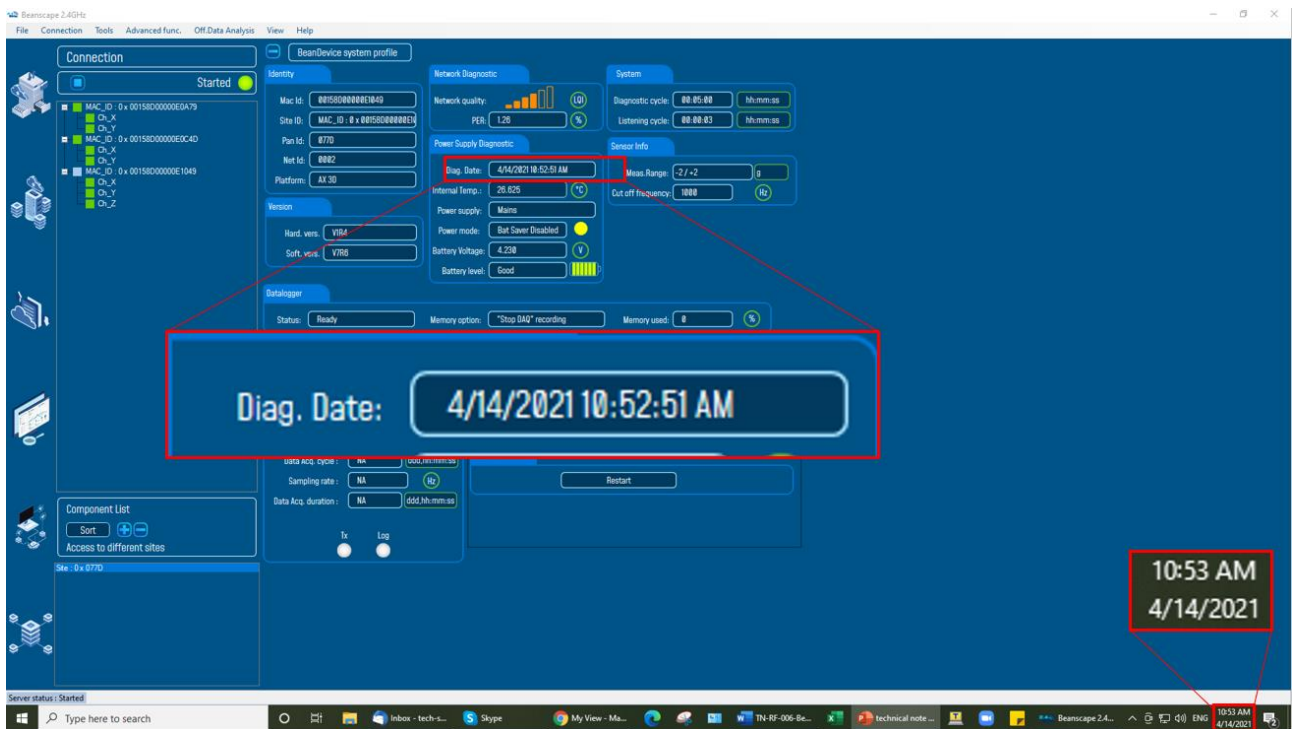
Here the BeanDevice clock is synchronized with the Pc clock on 1:45 PM.



Then we set 5 min as a diagnostic cycle on then BeanDevice and we will add 2h to the PC clock.




And after we reach the BeanDevice diagnostic cycle, the BeanDevice clock is synchronized with the PC clock.



The screenshot displays the Beanscape 2.45Hz software interface. The main window shows a 'BeanDevice system profile' with various diagnostic parameters. A red box highlights the 'Diag. Date: 4/14/2021 10:52:51 AM' field. Another red box highlights the system clock in the bottom right corner showing '10:53 AM 4/14/2021'. The interface includes sections for Connection, Identity, Network Diagnostic, Power Supply Diagnostic, System, Sensor Info, and Datalogger. The system clock is shown to be synchronized with the diagnostic date and time.



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## 6. OPERATIONAL FEATURES (FOR EXPERTS ONLY)

### 6.1 DEVICE ADDRESSING

Each device in an IEEE 802.15.4 network can have two types of address:

- **IEEE (MAC) address:** This is a 64-bit address, allocated by the IEEE, which uniquely identifies the device no two devices in the world can have the same IEEE address. It is also sometimes called the extended address.
- **Short address:** This 16-bit address identifies the node in the network and is local to that network (thus, two nodes on separate networks may have the same short address). The short address may be allocated by a BeanGateway® when a node joins a network.

The use of 16-bit short addresses rather than 64-bit IEEE addresses allows shorter packets and therefore optimizes use of network bandwidth. A short address may be requested by the device when it joins the network. If a device does not have a short address, it must be addressed using its IEEE address.

### 6.2 DATA FRAMES AND ACKNOWLEDGEMENTS

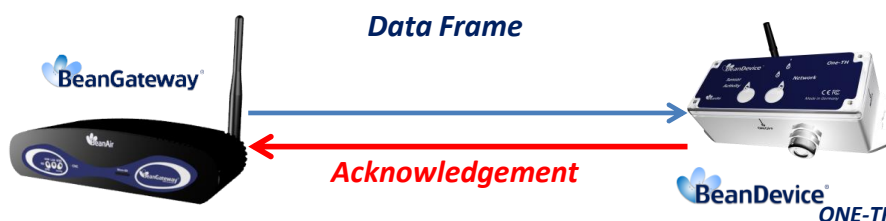
Communications in an IEEE 802.15.4 network are based on a system of data and MAC command frames, and optional acknowledgements. When a BeanDevice® sends a message to the BeanGateway®, it can return an acknowledge message – this simply confirms that it has received the original message and does not indicate that any action has been taken as a result of the message.

Acknowledgements are provided by the MAC sub-layer.

### 6.3 DATA TRANSFER

When transferring data from a node to another node where reception is likely to be guaranteed (for example, from a BeanDevice® to a BeanGateway®), it is usual to send a data frame directly (i.e. unsolicited).

The above data transfer methods are illustrated in the figure below:





## 6.4 ENERGY SCAN FUNCTION

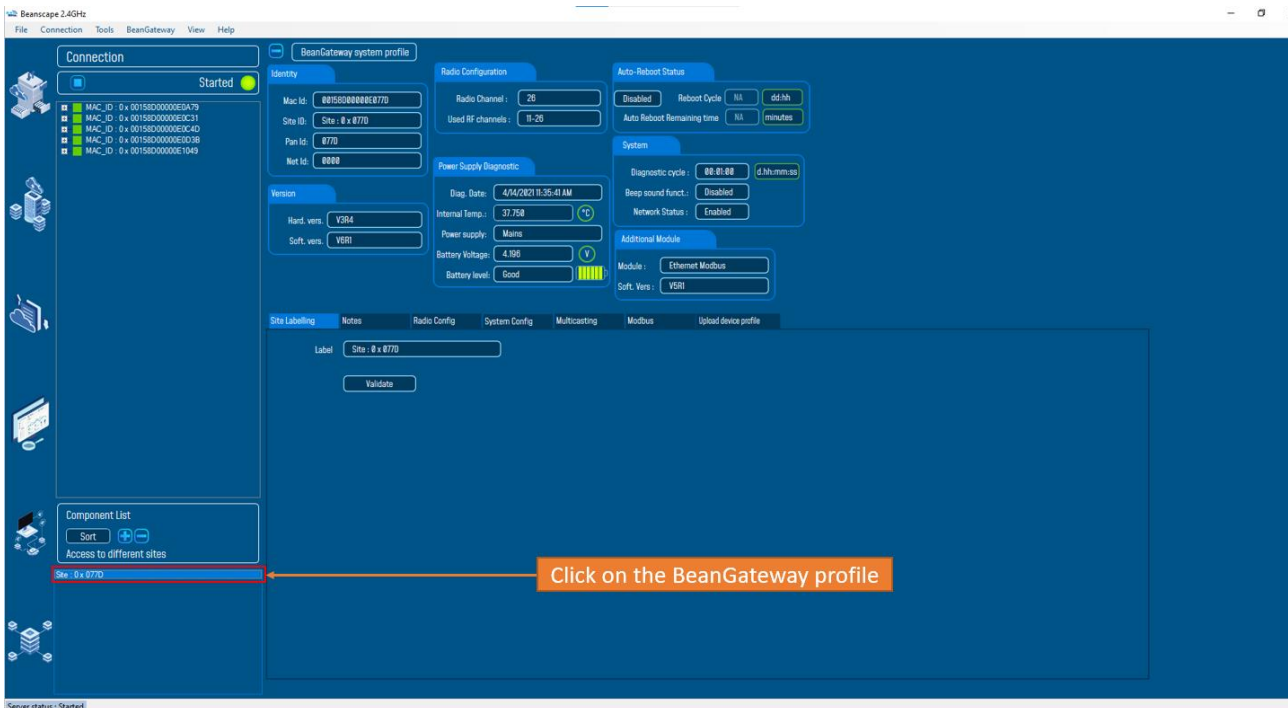
Energy scan allows the user to know the network quality on each radio channel. This operation allows the user to choose the appropriate RF channel on a site where the WSN is deployed. This value is 0 (excellent) to 255 (poor), and you can configure the scanning time means of each radio channel, by selecting the tab the scan time in ms and confirm it by pressing the "**Config**" button. A new energy scan is performed by clicking on "**Request**" button.

Step 1

- Launch the BeanScape®

Step 2

- Go on BeanGateway® profile

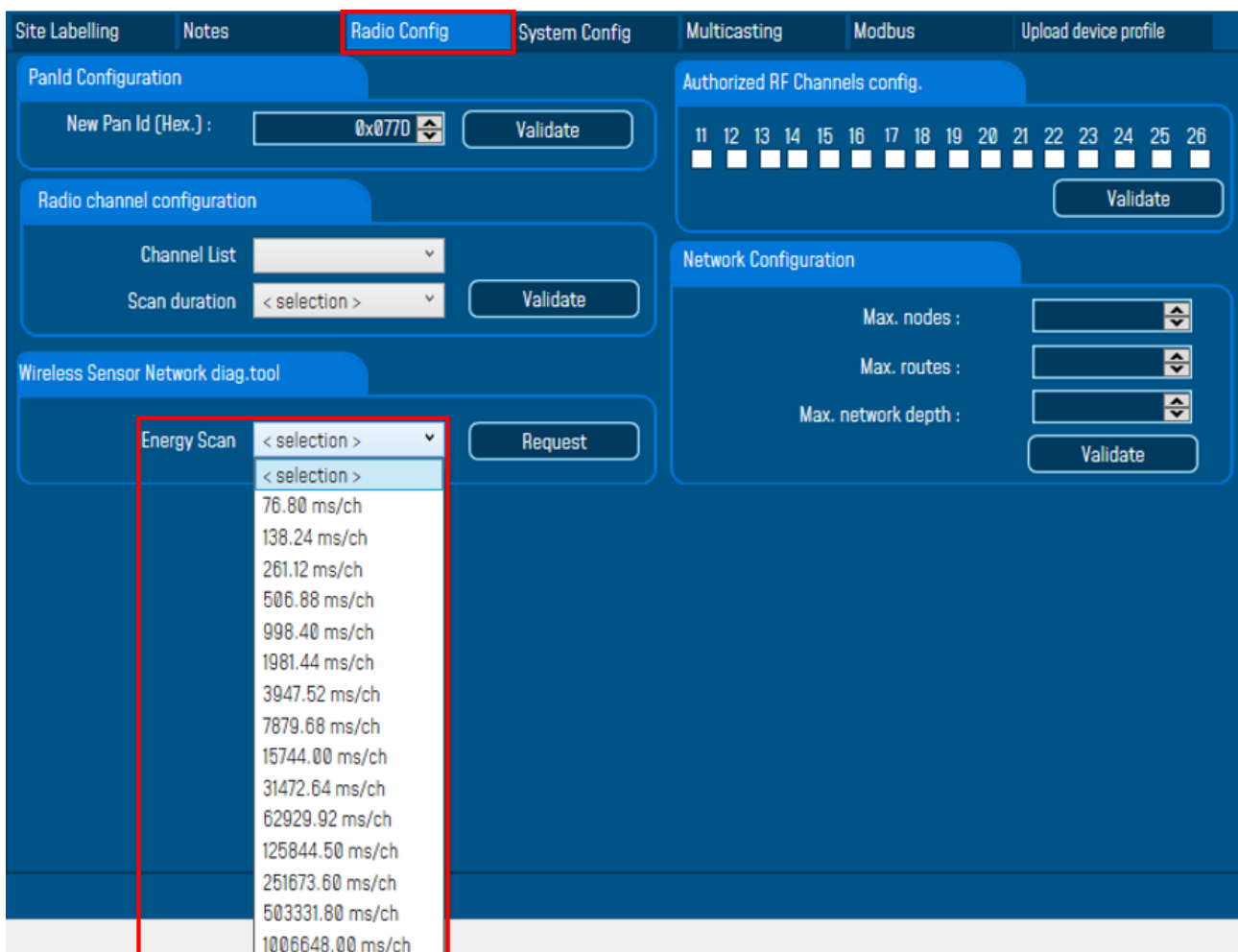


The screenshot displays the BeanScape 2.4GHz software interface. The main window shows the configuration for a 'BeanGateway system profile'. The interface is divided into several sections: 'Identity' (MAC ID, Site ID, Port ID, Net ID), 'Radio Configuration' (Radio Channel, Used RF channels), 'Auto-Reboot Status' (Disabled/Enabled, Reboot Cycle, Auto Reboot Remaining time), 'Power Supply Diagnostic' (Diag. Date, Internal Temp., Power supply, Battery Voltage, Battery level), 'System' (Diagnostic cycle, Beep sound funct., Network Status), and 'Additional Module' (Module, Soft. Vers.). At the bottom, there is a 'Site Labelling' section with a 'Label' field and a 'Validate' button. On the left side, there is a 'Component List' section with a 'Sort' button and a link to 'Access to different sites'. The 'Component List' shows a table with one entry: 'Site: 8 x 8770'. An orange callout box with an arrow points to this entry, containing the text 'Click on the BeanGateway profile'.



**Step  
3**

- Go on "**Radio Config**" Tag, choose the predefined Energy Scan Time value and click on config to validate the new value



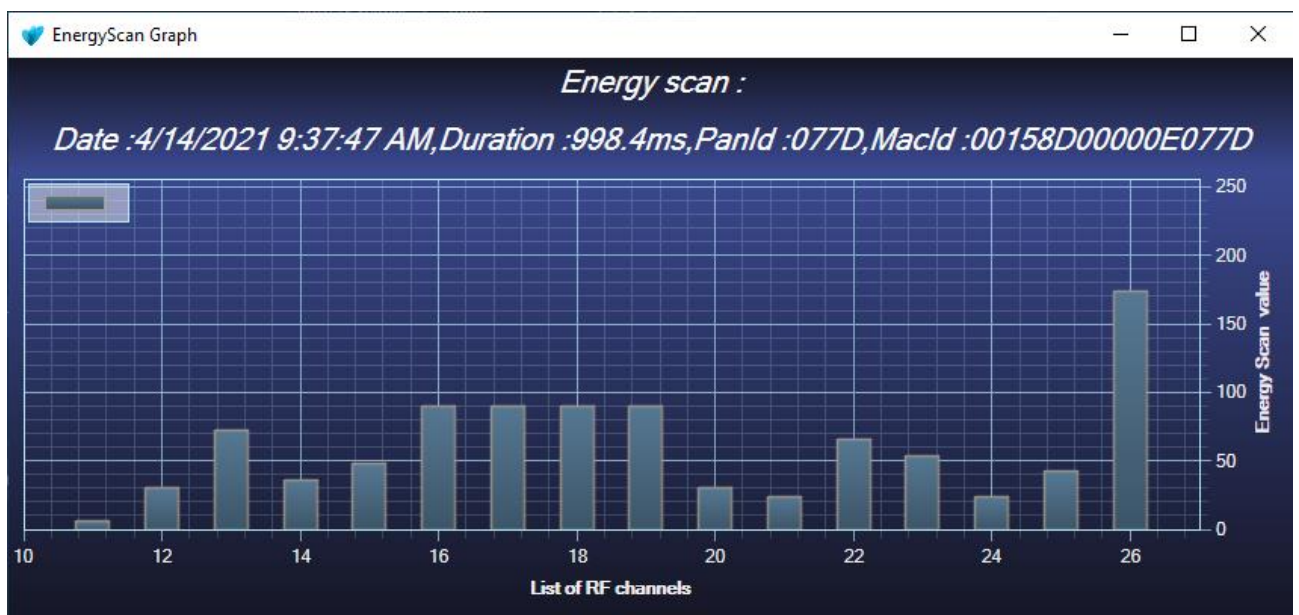
The screenshot displays the 'Radio Config' tab in the BeanAir configuration interface. The 'Energy Scan' dropdown menu is open, showing a list of predefined values in ms/ch. The values are: 76.80, 138.24, 261.12, 506.88, 998.40, 1981.44, 3947.52, 7879.68, 15744.00, 31472.64, 62929.92, 125844.50, 251673.60, 503331.80, and 1006648.00. The 'Request' button is visible next to the dropdown.

Energy Scan
< selection >
< selection >
76.80 ms/ch
138.24 ms/ch
261.12 ms/ch
506.88 ms/ch
998.40 ms/ch
1981.44 ms/ch
3947.52 ms/ch
7879.68 ms/ch
15744.00 ms/ch
31472.64 ms/ch
62929.92 ms/ch
125844.50 ms/ch
251673.60 ms/ch
503331.80 ms/ch
1006648.00 ms/ch



## Step 4

- By pressing the **Request** button will start scanning different radio channels.



*Table of Energy Scan values*



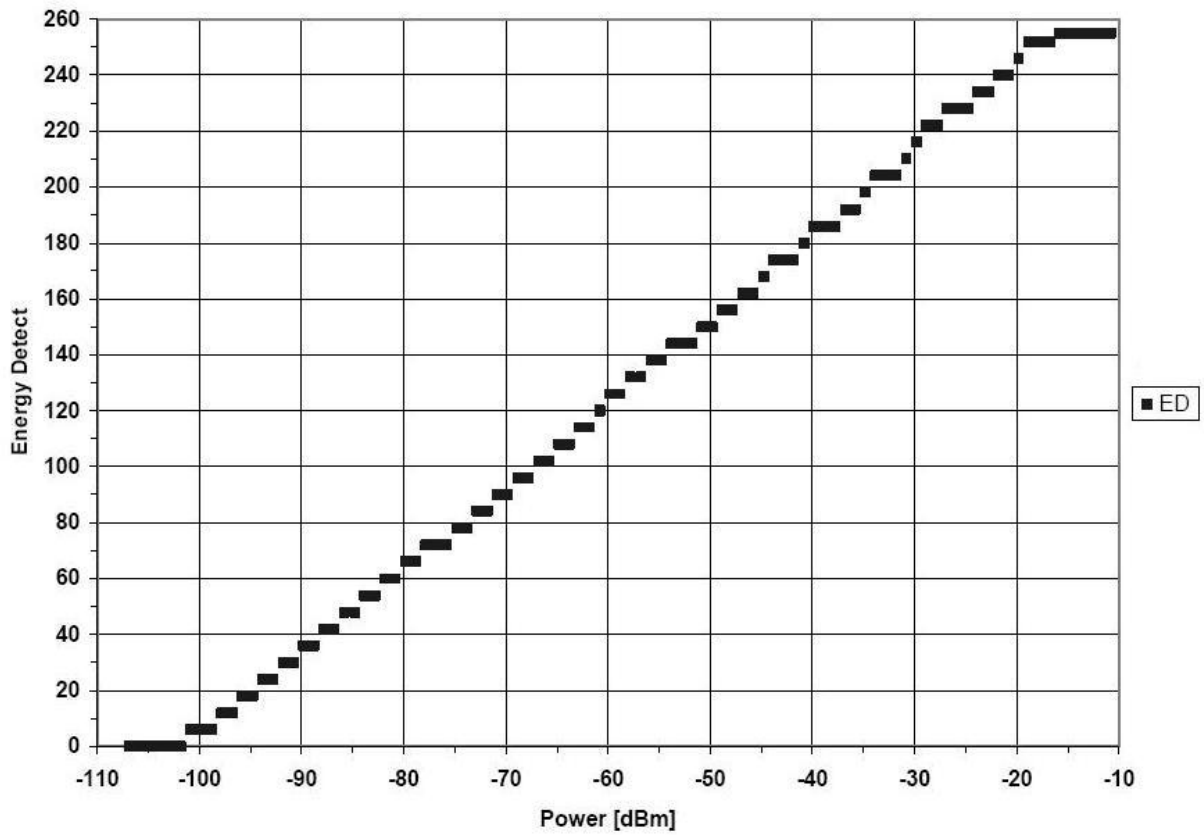



Table to convert the Energy Scan power in dBm



*It is strongly recommended to perform an Energy Scan on a site before a major deployment of wireless sensor network.*



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## 7. TROUBLESHOOTING

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If your BeanDevice® cannot join the WSN, check the following features:

- ✓ Make sure that your BeanGateway® is power on;
- ✓ The BeanDevice® shares the same PAN ID than your BeanGateway®. If several BeanGateway® are present in the same area, be sure that there is no conflict of PAN ID;
- ✓ The RF channel used on your BeanGateway® must offer the best network quality link (for more information read your BeanGateway® user manual);
- ✓ Check the wireless range between your BeanDevice® and your BeanGateway®, maybe the BeanDevice® is very far from your BeanGateway®;

