

**MDEK1001 Kit User Manual  
Module Development &  
Evaluation Kit for the  
DWM1001**

**Version 1.0**

**This document is subject to change without  
notice**

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## DOCUMENT INFORMATION

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  - (b) The **Decawave DRTLS Manager** which is an Android™ application for configuration of DRTLS nodes (nodes based on the Module) over Bluetooth™.
  - (c) The **Decawave DRTLS Gateway Application** which supplies a gateway function (on a Raspberry Pi ®) routing DRTLS location and sensor data traffic onto an IP based network (e.g. LAN), and consists of the following components:
    - DRTLS Gateway Linux Kernel Module
    - DRTLS Gateway Daemon
    - DRTLS Gateway MQTT Broker
    - DRTLS Gateway Web Manager
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## 1 INTRODUCTION

### 1.1 Overview

The MDEK1001 is a development and evaluation kit that allows the user to evaluate the Decawave DWM1001 module.

MDEK1001 stands for **Module Development & Evaluation Kit** for the Decawave DWM**1001**.

### 1.2 The DWM1000 module and RTLS

The DWM1001 is a module product that comes complete with firmware to allow system developers to quickly implement an RTLS to suit their particular end application, or add RTLS capability to an existing system. The module may be configured to behave as an “anchor” one of the fixed nodes in the system or a “tag” one of the mobile located nodes in the system. The module configuration may be achieved either via Bluetooth using the companion application (Decawave DRTLS Manager) or via an SPI or UART connection from an external host.

The module incorporates Decawave’s DW1000 UWB transceiver which the module’s on-board firmware drives to implement the network of anchor nodes and perform the two-way ranging exchanges with the tag nodes enabling each tag to compute its own location.

The module also incorporates the Nordic Semiconductor NRF52832 IC providing the Bluetooth connectivity used for configuration and the microprocessor that runs the firmware which drives the DW1000 and provides the RTLS enabling functionality. A more complete description of this may be found in DWM1001 System Overview.

The module is typically mounted on a PCB, such as the DWM1001-DEV product. The MDEK1001 kit provides 12 DWM1001 modules already mounted on “development” boards enabling system developers evaluate the product and/or begin their system development before embarking on their own designs.

### 1.3 Main Features of the MDEK1001

- Out-of-the-box wireless Real-Time Location System (RTLS), including anchors and tags (and gateway support) without designing any hardware or writing a single line of code
- Quick and easy installation and setup
- 12 RTLS units (DWM1001-DEV) configurable as 4 to 11 anchors and 1 to 8 tags
- Configure and control the module via APIs via UART/SPI/Bluetooth
- Modify the module firmware to customise your application
- Configuration & location application for tablets/smartphones (Android 6.0 or 7.0)
- Configuration & location web client (Q1 2018)

### 1.4 Analytics

Note: the Android application (Decawave DRTLS Manager) reports application crash diagnostics back to Decawave (and design partner) in order to improve future versions.

### 1.5 More Information

More information about the MDEK1001, the DWM1001-DEV Development Board, the DWM1001 module and the DW1000 IC can be found on the Decawave website.









## 2 KIT CONTENTS

### 2.1 Supplied in the MDEK1001 Box

The following items are included in the box.









**Table 1: Kit Contents**

Description	Quantity	Image
RTLS units - Containing DWM1001-DEV Development Boards	12	
1.0 m USB Cable	1	
Adhesive Pads	8	
Right-Angled USB Connectors	4	
Colored Stickers	8	
Quick Start Guide	1	

## 2.2 Items Not Included

Other items, not included in the box are listed below.

**Table 2: Also Required or Useful, Not Provided in the Box**

Description	Quantity	Image	Notes
Android Tablet or Smartphone (to run the configuration/location application)	1	 OS should be Android 6.x or 7.x	Required
Raspberry PI 3, Model B	1		To act as a gateway (Q1 2018)
PC (Windows 7 or 10)	1		For visualisation of gateway data (Q1 2018)
Tripods (to mount the anchors)	4+		Useful
<b>Options for Powering RTL S Units</b>			
<b>Note:</b> for long duration tests it is recommended to power anchors from mains or larger power banks rather than low capacity batteries			
USB Battery			
OR			
3.7V RCR123a or 16340 rechargeable battery. Note: overcharge protection not necessary.		 <a href="https://www.amazon.com/Eagletac-16340-RCR123A-Protected-Rechargeable/dp/B00YAVB7U2">https://www.amazon.com/Eagletac-16340-RCR123A-Protected-Rechargeable/dp/B00YAVB7U2</a>	
Connect mobile battery to board via mating battery connector: JST: A02SR02SR30K51B		 <a href="https://www.digikey.com/products/en?keywords=455-3009-ND">https://www.digikey.com/products/en?keywords=455-3009-ND</a>	
OR			
Power Adaptor to USB or PC to USB (USB micro type B)			

## 2.3 Available from the Decawave Website

**Table 3: Available on the Decawave Website**

Description	Details
Decawave DRTLS Manager: tablet/smartphone application	Android application file (.apk) for configuration & location (Note: configuration and logging of locations can also be done on a PC terminal)
PC Configuration/Location Application	Available: Q1 2018
Links To	Battery connectors Raspberry PI Raspberry PI connectors
Documentation	
MDEK1001: Module Development & Evaluation Kit for the Decawave DWM1001	MDEK1001 System User Manual
	MDEK1001 Quick Start Guide
DWM1001-DEV: DWM1001 Module Development Board	DWM1001-DEV Product Brief
	DWM1001-DEV Hardware Datasheet
DWM1001: Module	DWM1001 Product Brief
	DWM1001 Hardware Datasheet
	DWM1001 System Overview
	DWM1001 Firmware User Guide
DW1000: IC	DWM1001 API Guide
	DW1000 Datasheet
	DW1000 User Manual

### 3 THE DWM1001-DEV DEVELOPMENT BOARD

The image below shows the key features of a DWM1001-DEV development board.

The key features of this board are:

- Decawave DWM1001 module soldered in place
- Li-Po/Li-ion battery charging circuit
- Connectors:
  - Battery connector for Li-Ion or Li-Po rechargeable batteries, or non-rechargeable batteries
  - USB connector for power, flashing and debug
  - Raspberry PI connector footprint for expansion and host interface control

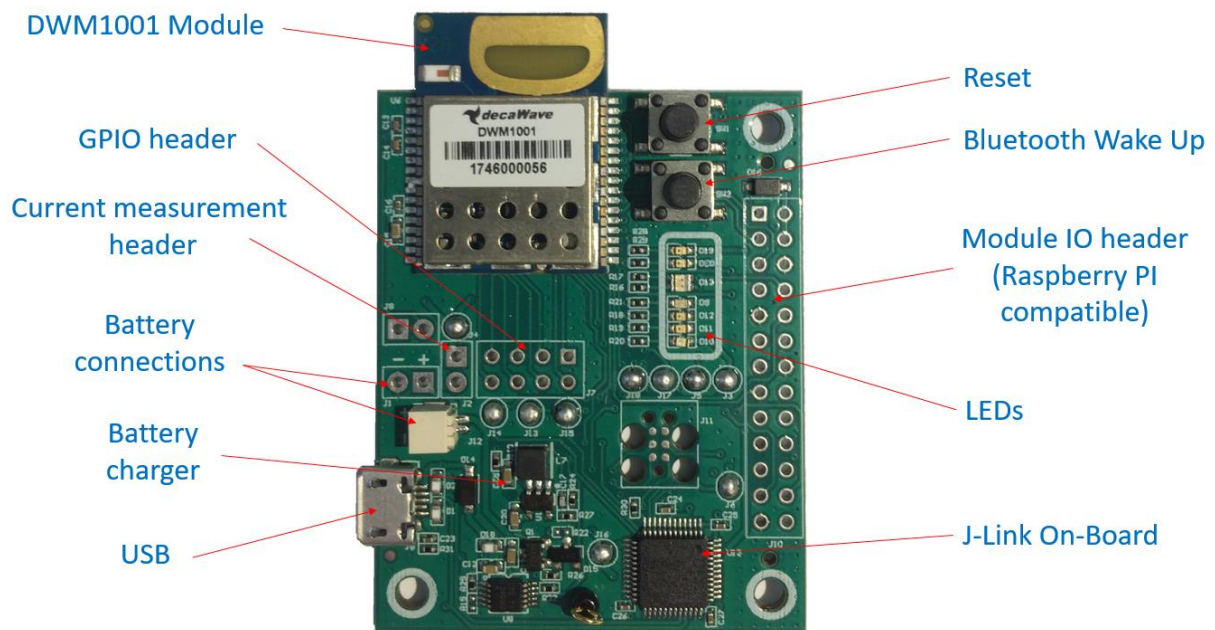


Figure 1: Front View of the DWM1001-DEV Module Development Board

## 4 THE DWM1001-DEV DEVELOPMENT BOARD LEDs



Figure 2: Front View of the DWM1001-DEV Module Development Board

**NOTE:** Details of the functions of these LEDs are given in the DWM1001-DEV Datasheet.

## 5 SYSTEM SETUP & PREPARATION

### 5.1 Prepare the Anchors

- Select some of the RTLS units as anchors – 3 is the minimum for RTLS but at least 4 is recommended for accuracy
- Mount the anchors on the wall or on tripods (as shown in the figure below)
  - Mounting them high will give better performance (due to Line-of-Sight)
- Power the anchors using USB batteries or USB power supplies

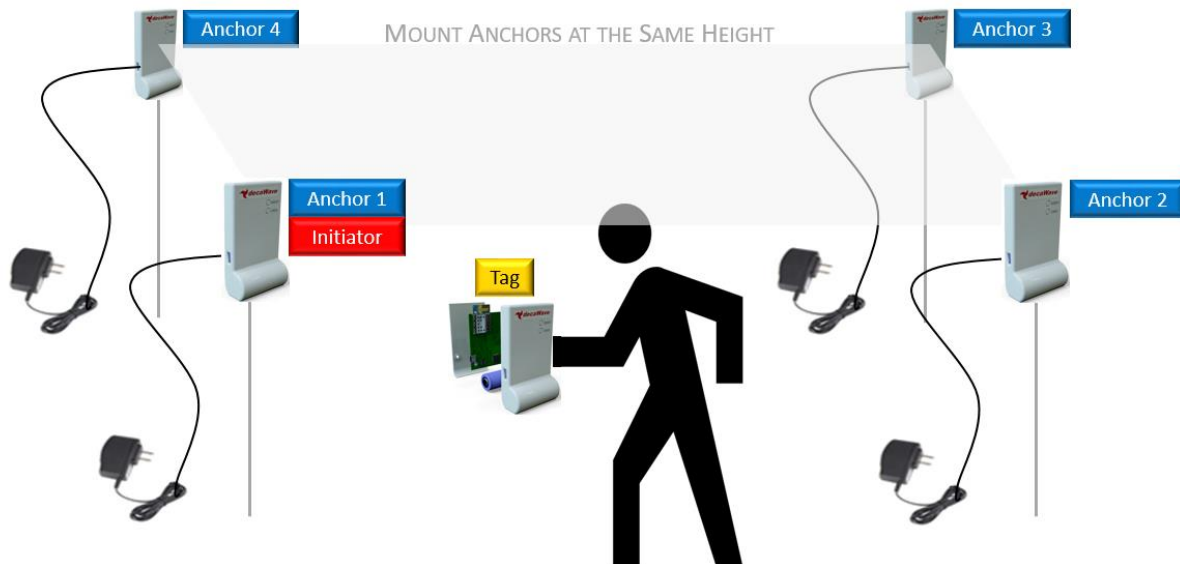


Figure 3: Positioning of Anchors and Tags

### 5.2 Prepare the Tags

- Select the remaining RTLS units as tags - at least 1 is required
- Battery Power
  - Open the plastic enclosure of each unit
  - Insert the rechargeable battery (purchased separately)
  - Close the plastic enclosure
- USB Power Supply
  - Power the tags using USB power supply or USB battery

### 5.3 Prepare the Android Tablet

- Download the latest Android .apk file for the “RTLS System Manager” application from the Decawave website
- Install the file on your Android device by tapping the APK file in the Downloads section

## 6 SYSTEM CONFIGURATION EXAMPLES

### 6.1 1 Anchor + 1 Tag

This configuration can be used for a simple proximity demonstration:

- Configure 1 RTLS unit as an initiator anchor by using the tablet (section 7) or PC (section 8)
- Configure 1 RTLS unit as a tag by using the tablet (section 7) or PC (section 8)
- The PC can capture the ranges between the 2 devices into a log-file using a terminal

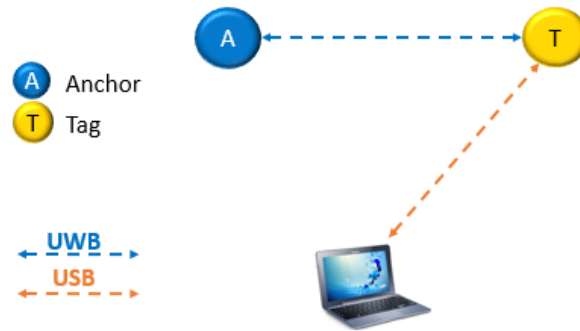


Figure 4: System Configuration Option: 1 Anchor, 1 Tag

### 6.2 Configure 4 Anchors + 8 Tags

This configuration is the minimum recommended anchor configuration for an RTLS system:

- Configure 4 RTLS units as anchors
- Configure 8 RTLS units as tags
- The tablet shows the tablet positions of up to 2 tags

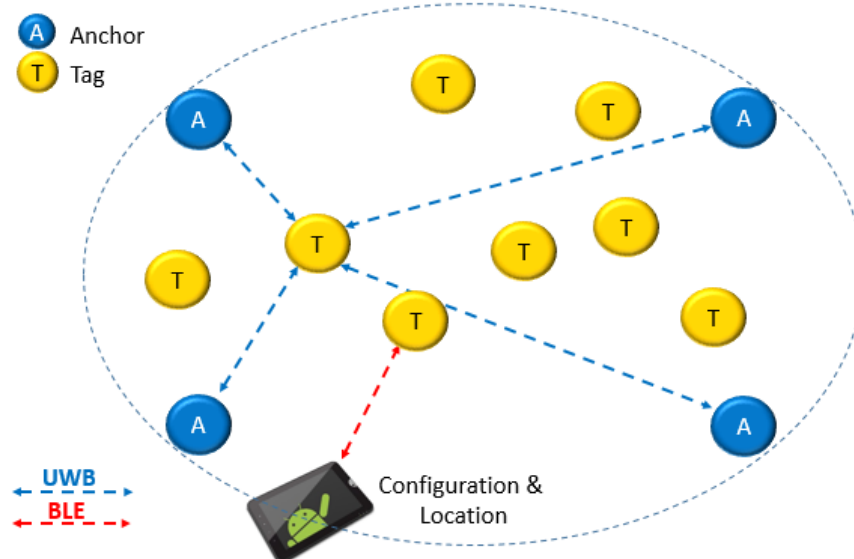
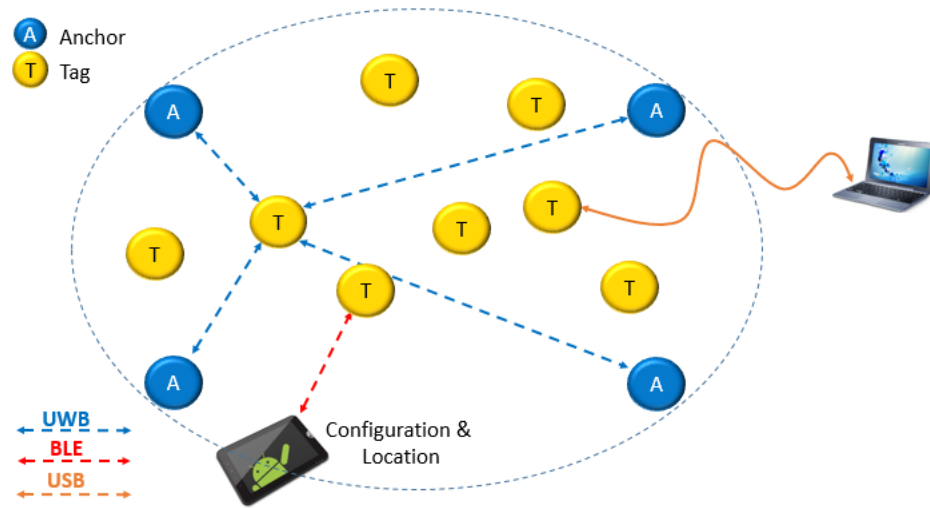


Figure 5: System Configuration Option: 4 Anchors, 8 Tags

- The number of open Bluetooth connections to the tablet will be limited to 3
- All RTLS units in this demonstration system must be in Bluetooth range of the tablet
- A tag can also be connected to a PC as shown in Figure 6



**Figure 6: System Configuration Option: 4 Anchors, 8 Tags & PC logging**



### 6.3 11 Anchors + 1 Tag

This configuration uses as many anchors as possible (in this kit) to show how the anchors scale and a tag can dynamically select the best anchors, as it traverses through the area covered by the anchors.

- Configure 11 RTLS units as anchors
- Configure 1 RTLS unit as a tag

The tag that is being tracked on the tablet must be in Bluetooth range of the tablet.

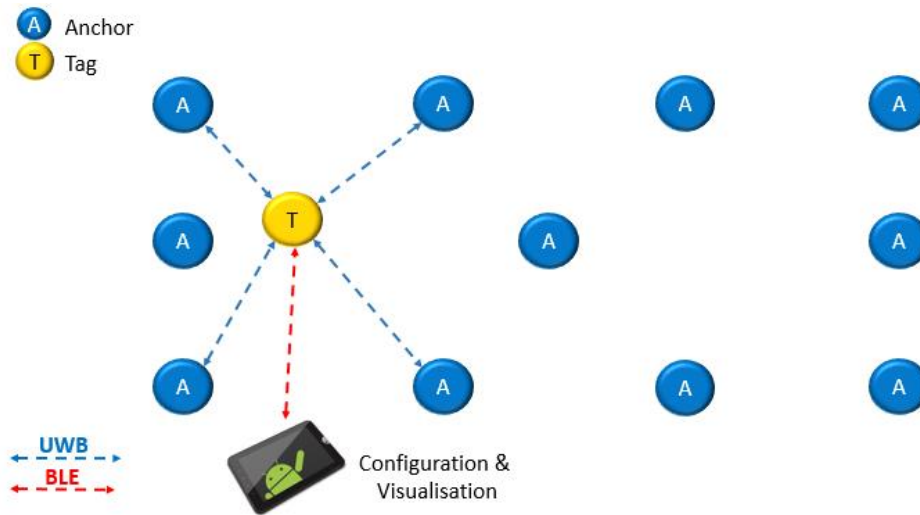


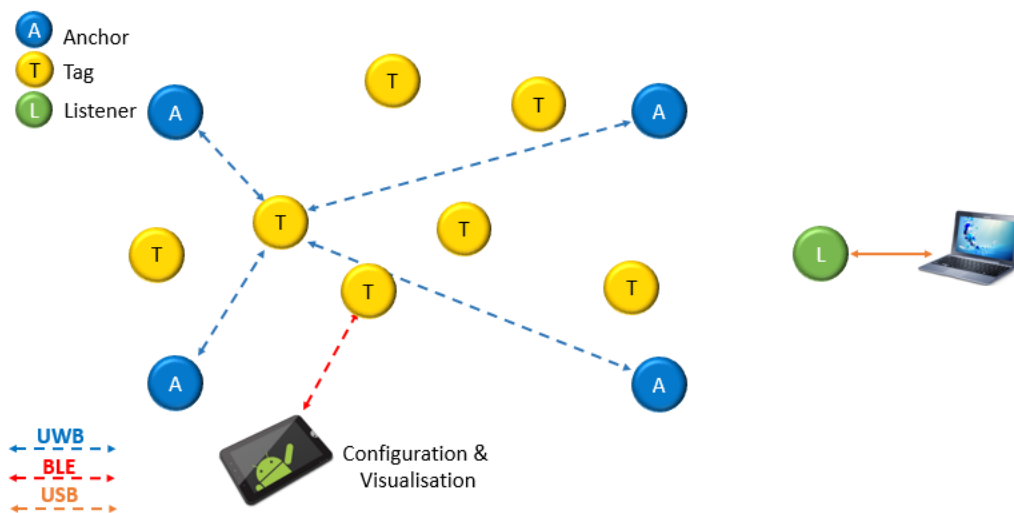
Figure 7: System Configuration Option: 11 Anchors, 1 Tag

## 6.4 4 Anchors + 7 Tags + 1 Listener

By configuring one of the devices as a listener device, the data can be captured to a PC directly.

- Set one of the RTLS units (tag or anchor) into PASSIVE mode. In this mode the UWB is enabled but it is not participating in the network
- Connect a PC to this RTLS unit via a USB cable
- On the PC open a shell terminal
- To report the position of all tags that the listener can hear
  - Type the command “les” (location-engine-show: ASCII format)
    - or type: “lec” (location-engine-show: csv format) –
  - Save data from terminal to log file
- In this mode, only position is printed (not individual ranges)

The tag that is being tracked on the tablet must be in Bluetooth range of the tablet.



**Figure 8: System Configuration Option: 4 Anchors, 7 Tags, 1 Listener**

## 7 USAGE GUIDE

Follow the steps below to get the DWM1001 Two-Way-Ranging Real Time Location System (DRTLS) up-and-running.

### 7.1 Open the Android Application

- Open the Decawave DRTLS Manager
- If no networks have been previously saved the application will open on the home screen
- If a network was previously saved the application will open on the last viewed network screen
- The home screen will show:
  - “Decawave DRTLS Manager”
  - Application version
  - Button to “Start Device Discovery”
  - Button to go to the “Instructions” page

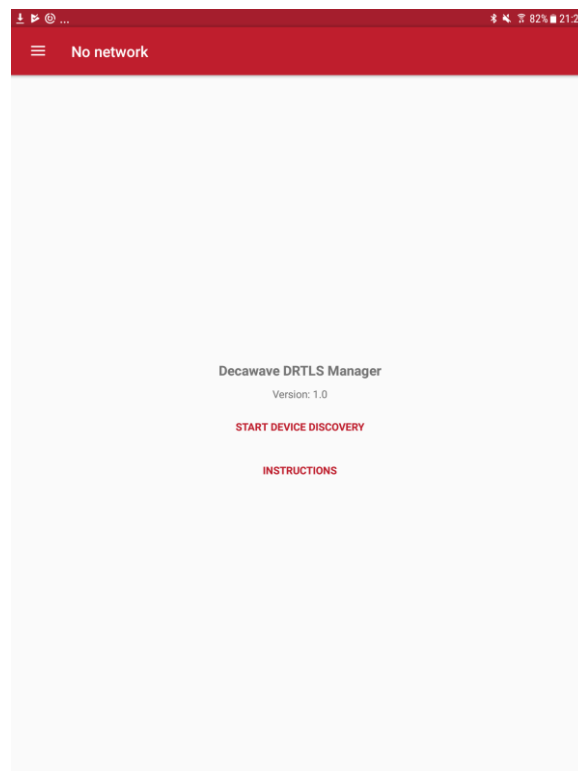


Figure 9: Decawave DRTLS Manager Home Screen

## 7.2 Start Device Discovery

- Tap “Start Device Discovery”
- The application will automatically discover all devices that are in range and powered on

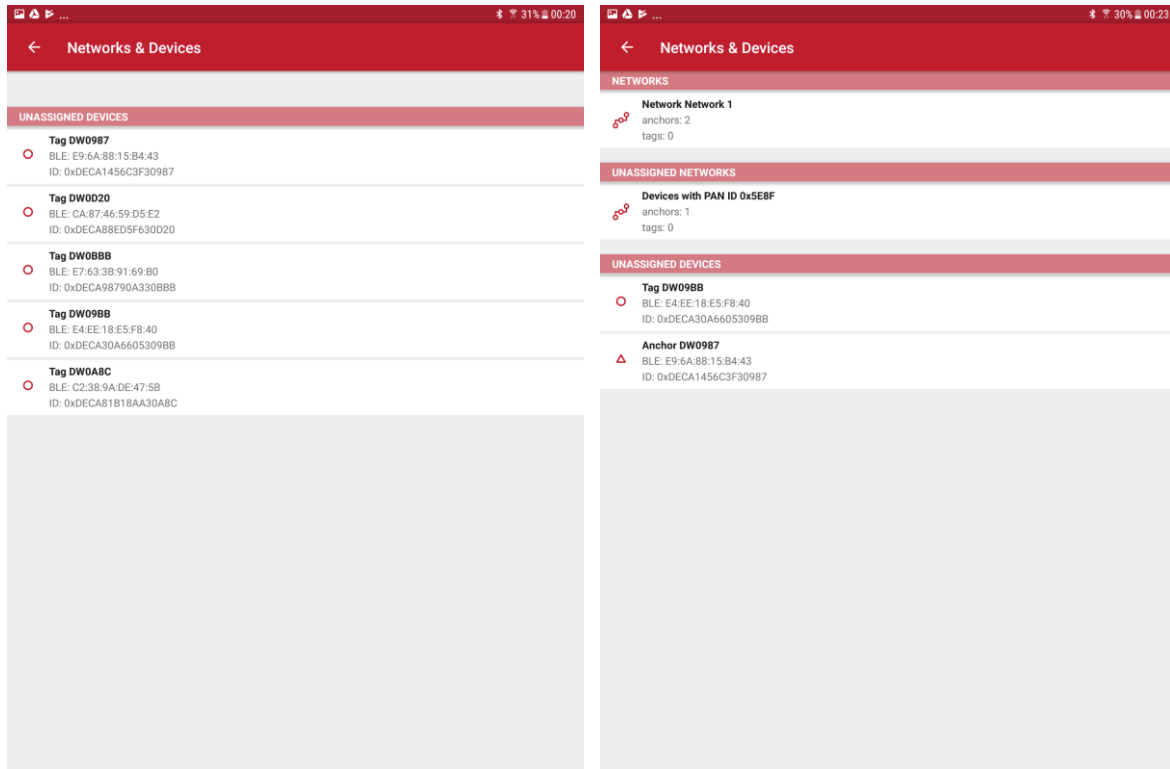



Figure 10: Device Discovery Screen

- Devices will be grouped into
  - ‘NETWORKS’
  - ‘UNASSIGNED DEVICES’
  - ‘UNASSIGNED NETWORKS’
- The following information is shown under each device:
  - Device Type (Anchor or Tag)
  - Device Name in the form DW1234
  - Network
  - Bluetooth address
  - Device ID
- The user can select a specific device by tapping an individual device
  - The user will get the option to create a New Network name
- Alternatively, to select multiple devices:
  - Tap-and-hold a single device
  - The checkmark symbol  will be shown on the left of that device
  - Other devices can be tapped and added to the selection
  - Once selected, the button “ASSIGN” in the upper right-hand corner can be tapped to add these devices to a new (or existing) network

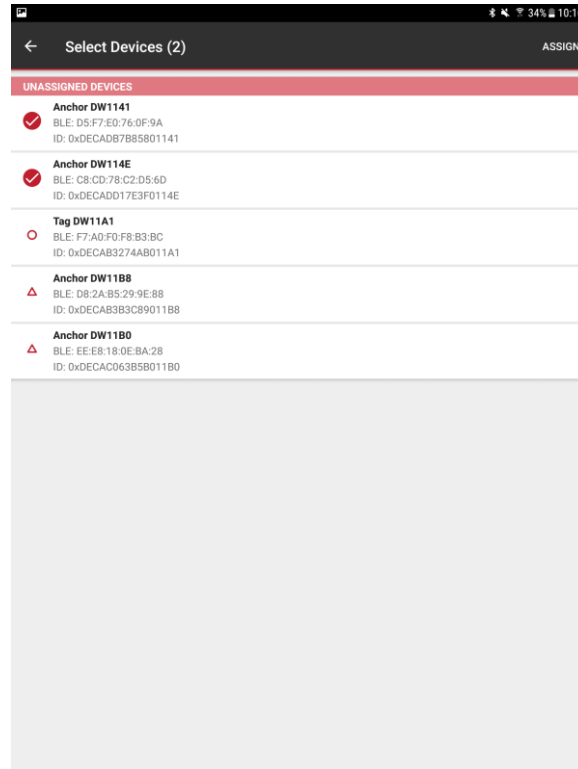


Figure 11: Device Discovery Screen – Select Multiple Devices

### 7.3 Create a Network

- Name the Network e.g. “Network 1” and
- Tap ‘Save’

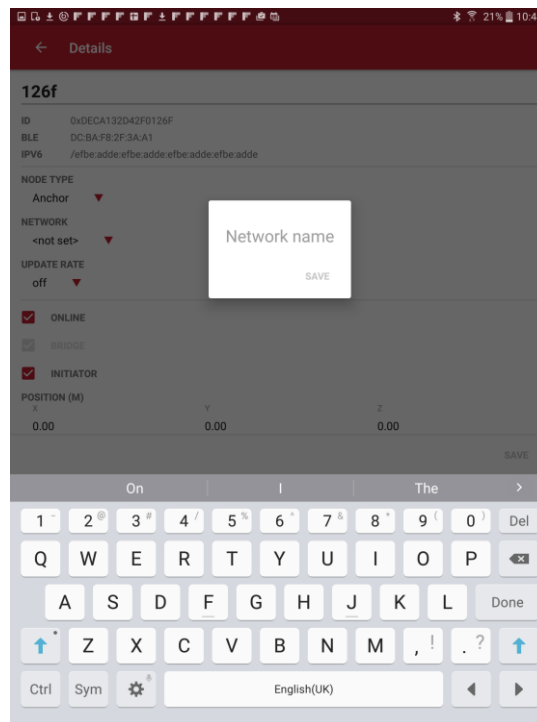


Figure 12: Name Network Screen

- The new network will appear in the ‘NETWORKS’ group and the devices will move from the ‘UNASSIGNED DEVICES’ into that network

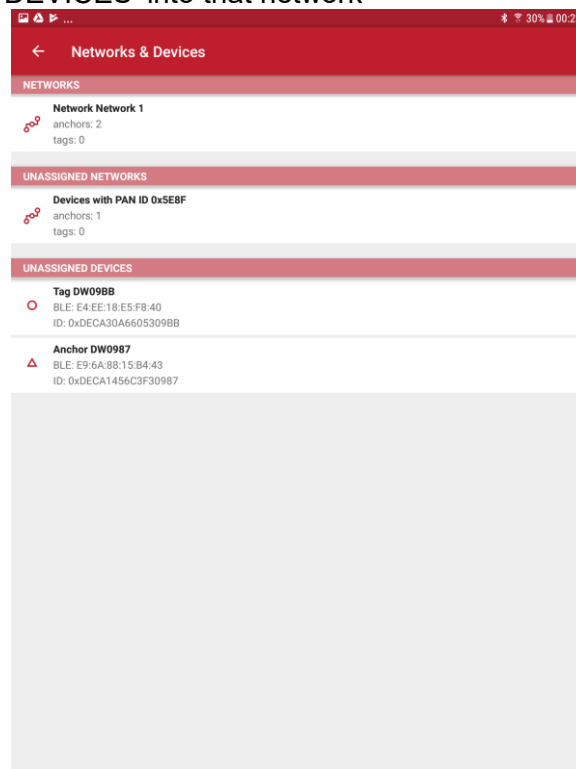


Figure 13: Networks& Devices List

## 7.4 Network Device Configuration

### 7.4.1 'Networks & Devices page'

- Tap a network to see the list of devices in that network

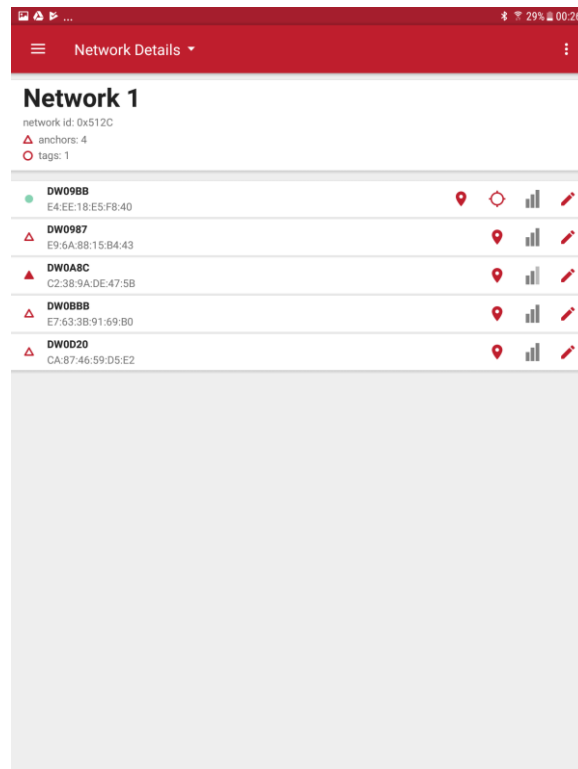















Figure 14: Network Details Screen

Each device in the list shows information about that device.



Figure 15: Network Details Screen: Device Information

- Device Type: A symbol to the left indicates the device type:
  -  Filled circle: Tag. Each tag uses a different color
  -  Empty triangle: Anchor
  -  Filled triangle: Initiator Anchor
- Anchor icons:
  -  Location icon - jumps to the grid screen and zooms to this anchor
  -  Bluetooth Signal strength icon
  -  Edit icon – goes to the 'Details' screen for that device

- Tag icons:
  -  Location icon - jumps to the grid screen and zooms to this tag
  - Ranging Display icons:
    -  Do not show the device on the grid
    -  Show on grid
    -  Show on grid with ranging lines
  -  Bluetooth Signal strength icon
  -  Edit icon – goes to the 'Details' screen for that device
- Warning icon:
  -  If the warning icon appears beside a device it can indicate an issue. It will show up if the module has UWB off or UWB passive or when there are two anchors with the same position.
- Tap a device to see a list of parameters of this device

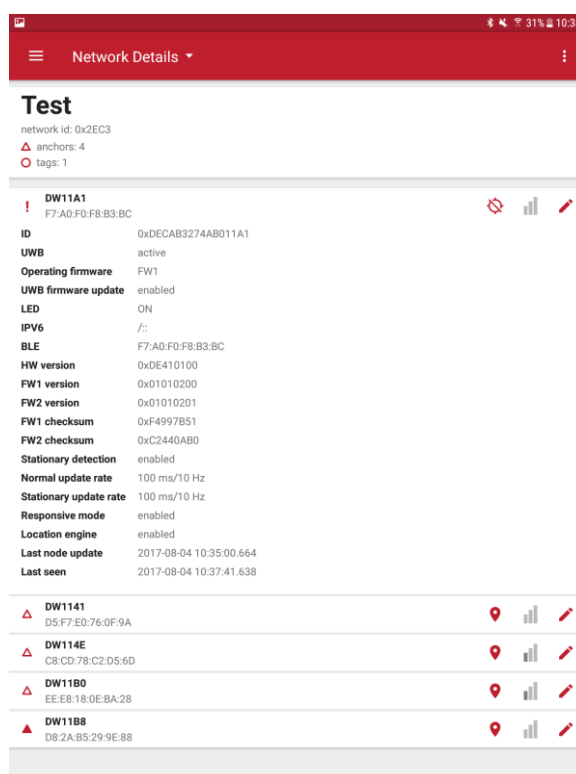


Figure 16: Network Details Screen: Expanded Device Parameters

#### 7.4.2 Remove a Device from a Network

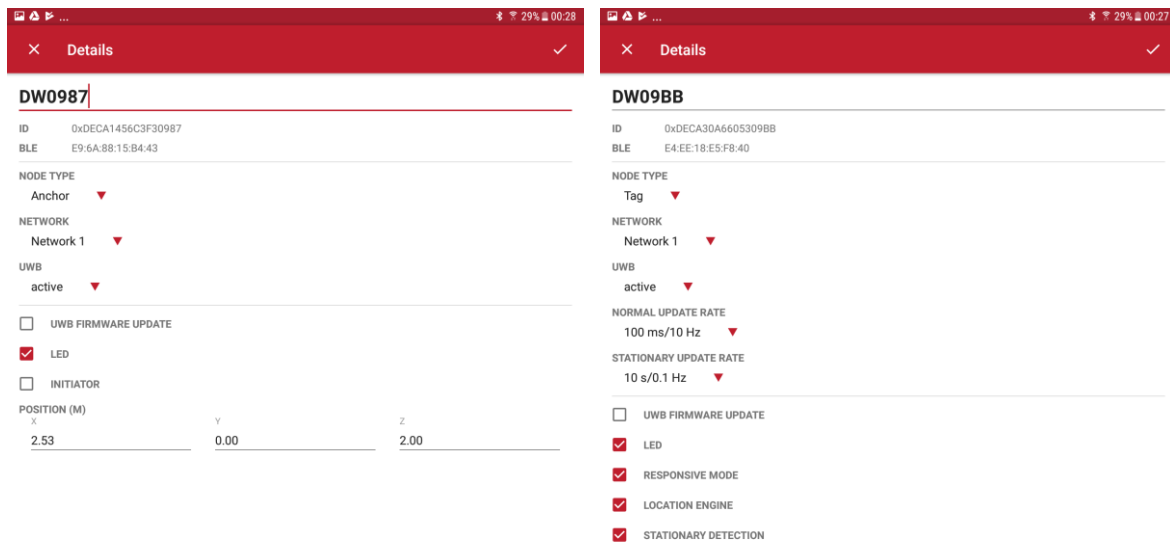
- To remove a device from a network, swipe the device left-to-right.
- The device will disappear from the list and re-appear in the unassigned devices list on the 'Networks & Devices' screen

#### 7.4.3 Device 'Details' page

The user can edit the parameters of this device. Note after changing a parameter, the new



setting needs to be saved by tapping  in the upper-right of the screen.



**Figure 17: Device Details Screen – Anchor & Tag**

The following parameters are displayed:

- Device Name
- **ID** Device ID
- **BLE** Device Bluetooth address
- **NODE TYPE:** Set Node to be either “Anchor” or “Tag”. All devices will have a factory-default of ‘tag’ mode. Once the configuration is changed, and saved, the device will remember the new setting.
- **NETWORK:** Add the Node to a network (either a previously created network or, if none exists, the option to create a new network will appear)
- **UWB:** ‘off’, ‘passive’ or ‘active’.
  - Set to ‘active’ to range in the network.
  - Set to ‘passive’ if used as a listener.
- If in tag mode:
  - **NORMAL UPDATE RATE:** Set the location update rate. The default is 10 Hz (calculates a location 10 times per second) but can be changed to other rates
  - **STATIONARY UPDATE RATE:** Set the location update rate to be used when the device is stationary (detected by the motion sensor)
- **UWB FIRMWARE UPDATE:** Allows firmware update to propagate to this device
- **LED:** Disables/enables the LEDs on the board. May be used by a user to help identify which device is referenced.
- If in anchor mode:
  - **INITIATOR** Configure this anchor as an initiator. At least one of the anchors must be an initiator in the network. The initiator will start and control the network

- **POSITION**                      Position: The x,y,z co-ordinate of the anchor in the grid. Will be automatically populated if this device participated in auto-positioning.
  - X position
  - Y position
  - Z position
- If in tag mode:
  - **STATIONARY DETECTION:** Enables/disables motion sensor operation. If disabled, then the stationary update rate will not be available.
  - **RESPONSIVE MODE:**
  - **LOCATION ENGINE:**

#### 7.4.4 Tip: Label your Devices

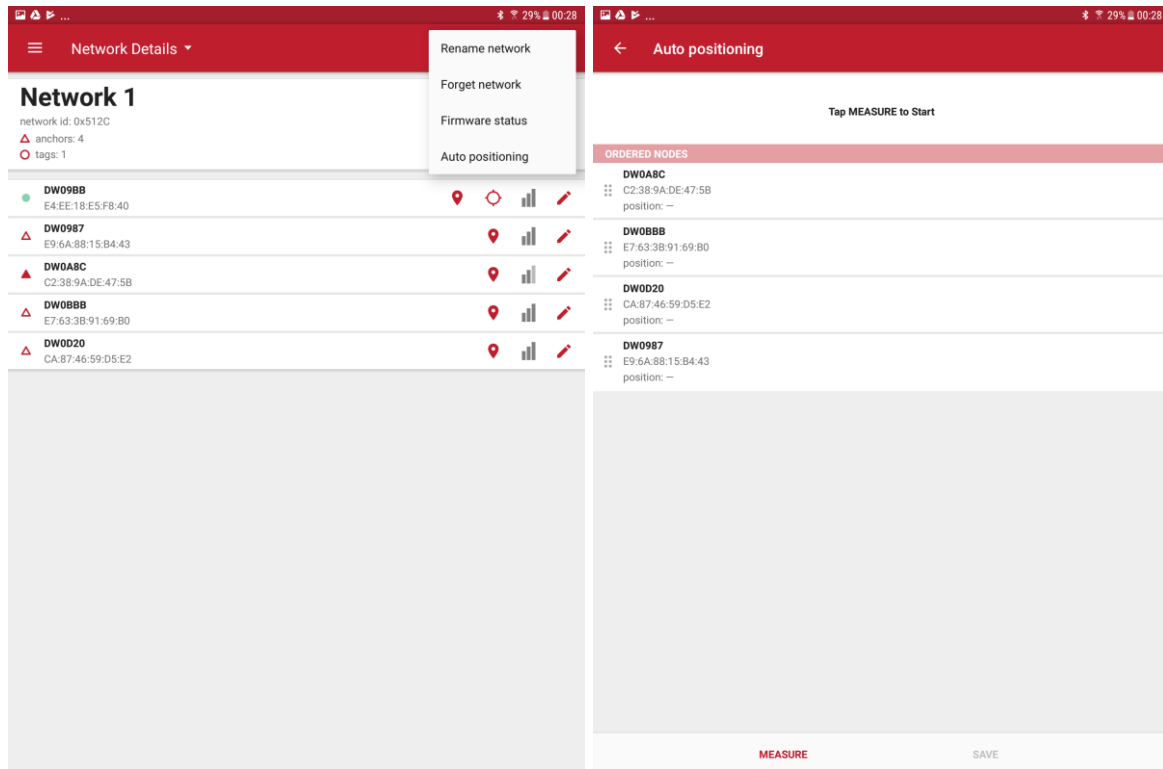
- It is often useful to label your devices so they can be easily identified on the Android application
- To do this uncheck the LED parameter  LED and tap 'SAVE'. This will disable the LEDs on that device, and enable the user to locate it in the room
- The user can place a label on the enclosure of that device with an identifier such that it can be quickly found in the application e.g. the device ID
- When completed, the user can check the LED parameter and tap 'SAVE' to enable the LEDs again.

## 7.4.5 Position the Anchors

### 7.4.5.1 By using the Auto-Positioning Feature (for up to 4 anchors)

**Note 1:** *The Auto-Positioning function is a quick setup feature to automatically determine the anchor locations. Note that this feature may result in a small error in anchor location, making reported tag locations less accurate. For best results it is recommended that anchor positions are measured to cm accuracy and manually entered (see below)*

**Note 2:** *Ensure Line-of-Sight between the anchors during these steps*



**Figure 18: Auto-Positioning Screen**

- **START** On the 'Network Details' screen, tap the "Auto-Position" button in the upper right pull-down menu (anchors within Bluetooth range appear)
  - **RE-ORDER** Re-order the anchors in the list to match their locations in the room:
    - Order the anchors anti-clockwise in the room (as shown above)
    - The 1<sup>st</sup> anchor in the list is the (0,0) co-ordinate
  - **MEASURE** Tap "Measure" to start the auto-positioning
  - **PREVIEW** Tap 'PREVIEW' to check locations before saving
  - **SET HEIGHTS** Enter heights of the anchors by tapping 'Z-AXIS'
  - **SAVE** Save the anchors setup by tapping 'SAVE'
- The location of the other anchors are calculated from the initial 3 anchor locations
  - Errors will propagate through the anchors so the usage is confined to small-scale systems e.g. up to 4 anchors
  - Auto-positioning can only be used on the anchors that are within Bluetooth range of the android device.

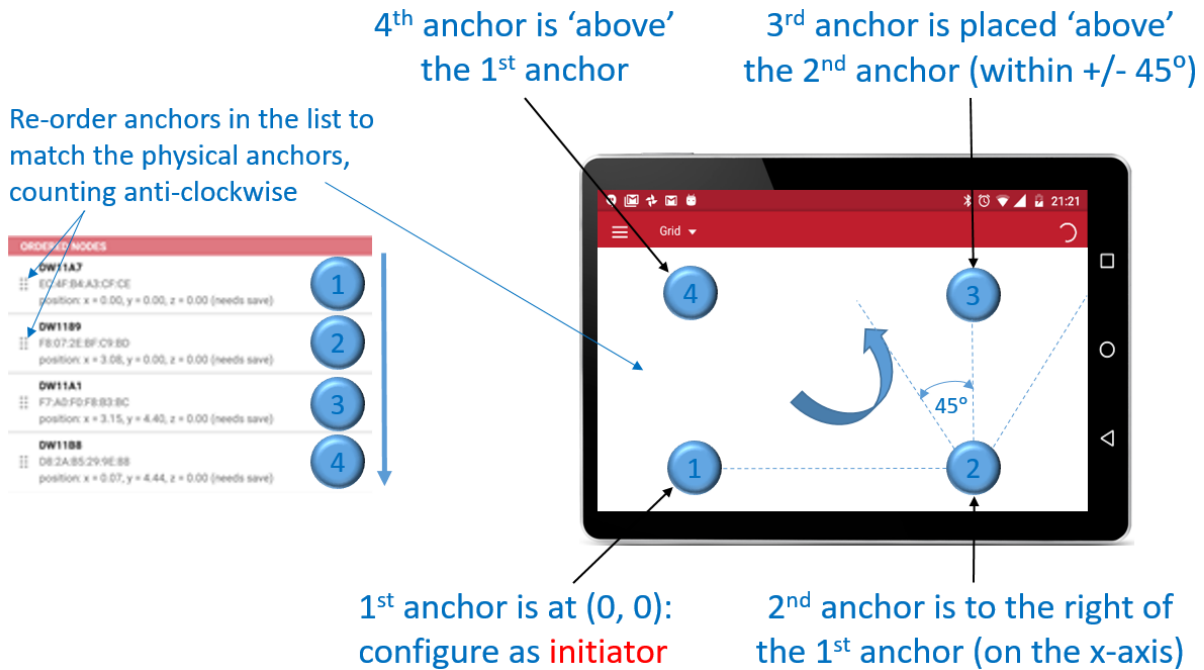



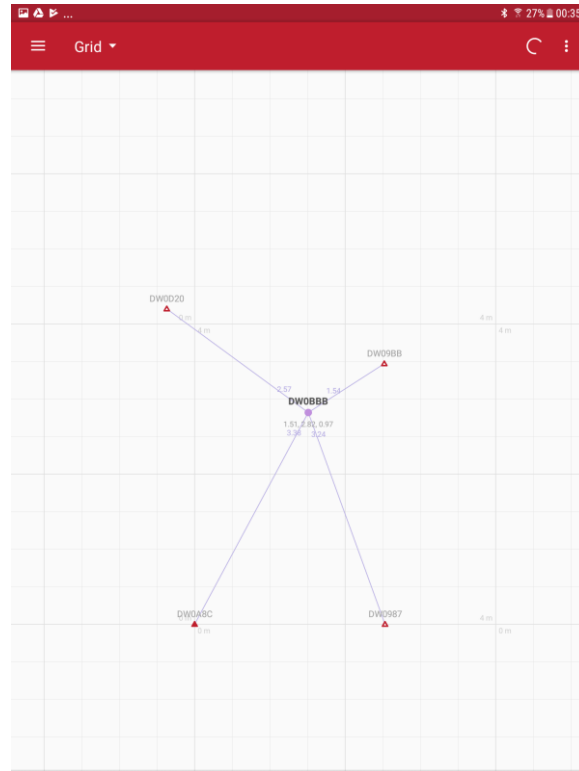
Figure 19: Auto-Positioning: Anchor Positioning Rules

#### 7.4.5.2 By Manual Positioning

- In turn, open each anchor's device configuration screen
- Enter the x, y, z co-ordinates of the anchors

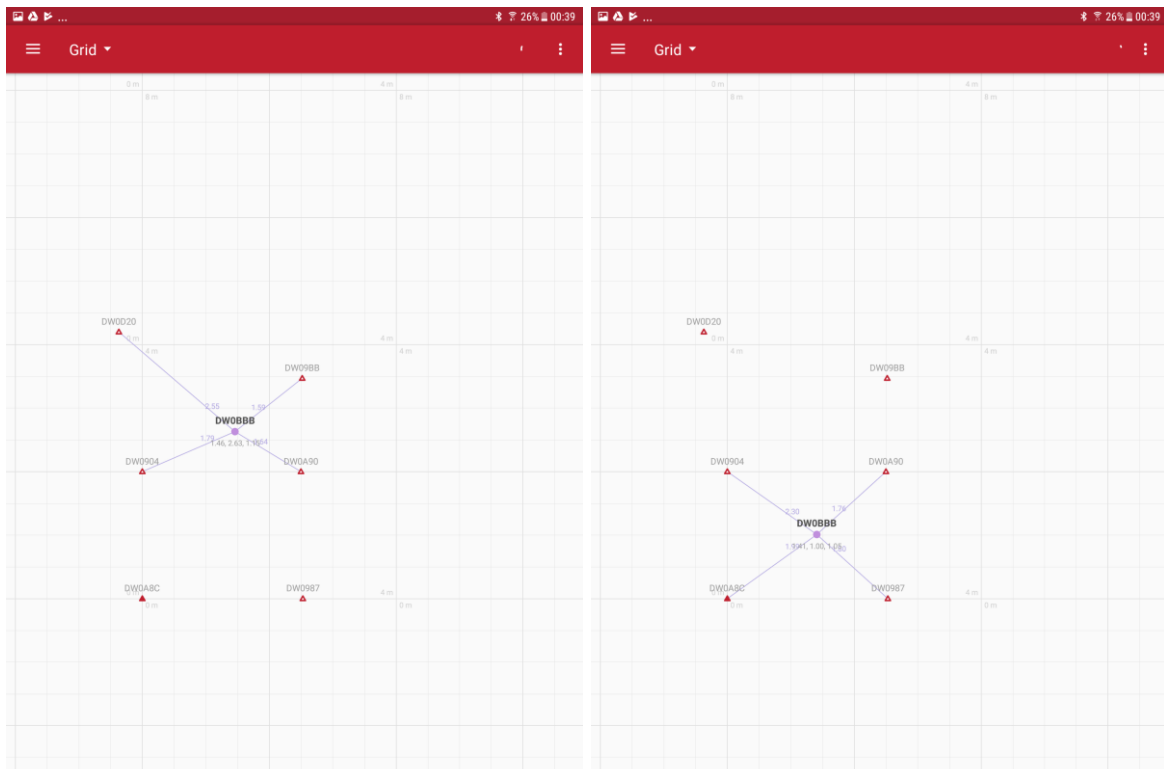
### 7.5 Show Location

- Ranging starts automatically once devices have been added to the network and the display option has been tapped  (it defaults to off)
- From the Network Details screen, tap the "Grid" option at the top of the screen to see the grid
- Pinch to zoom in or out
- Tags automatically select the optimum 4 anchors for ranging
- A floorplan can be uploaded into the application from the device's gallery



**Figure 20: Grid Screen – Anchor Placement & Tag Tracking**

In networks where there are more than 4 anchors, the anchor selection can be viewed on the grid by moving the tag from one position to another.



**Figure 21: Grid Screen – Anchor Selection**

In the upper-right pulldown menu – there are 2 options:

- Floor plan
- Show grid

## 7.6 Side Menu Options

Tap the menu icon on the top left of the home screen.

This will display the following options:

- A list of previously saved networks
- “Networks & Devices”
- “Position log”
- “Development tools”
  - Only visible if enabled in the Settings menu
- “Settings”

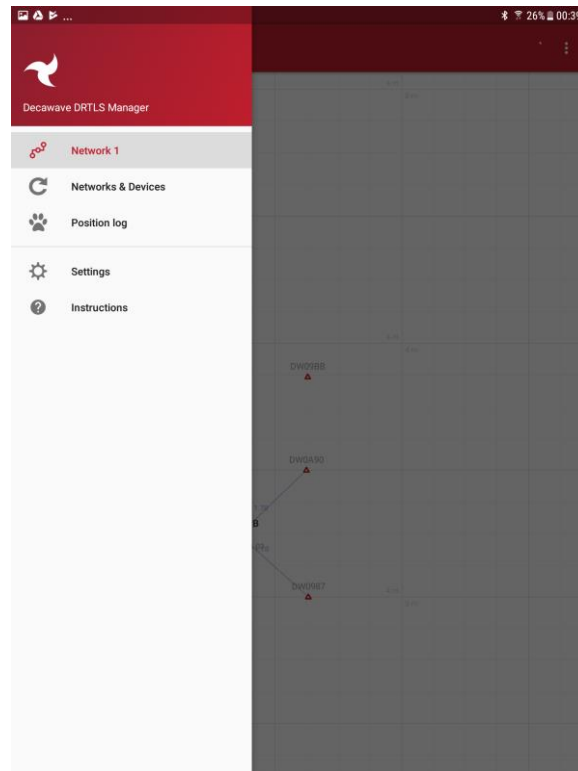


Figure 22: Decawave DRTLs Manager Side Menu Screen

### 7.6.1 Position Log

Shows ranges and locations for all devices



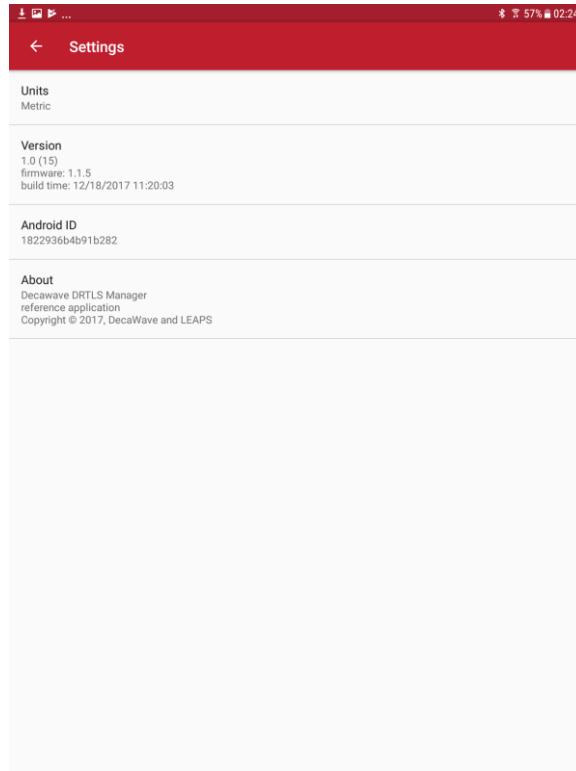
Figure 23: Decawave DRTLs Manager Position Log

### 7.6.2 Settings

The following settings are available

- Units “Imperial” (yards) or “Metric” (metres)
- Version Application version
- About General information





**Figure 24: Decawave DRTLS Manager Settings Screen**

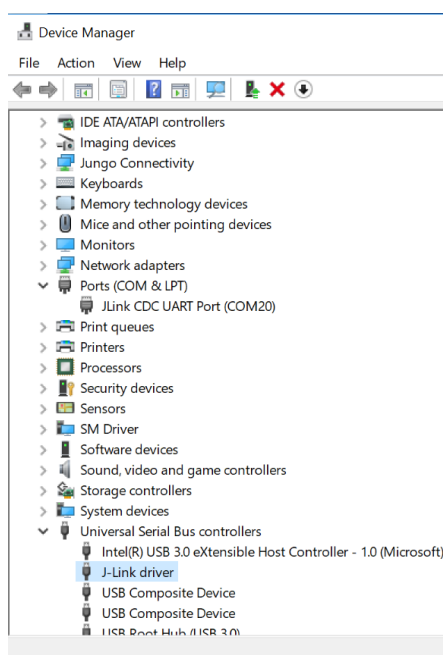
## 8 LOGGING DATA VIA THE USB PORT

Tag location data can be logged using a USB connection instead of using the Android application.

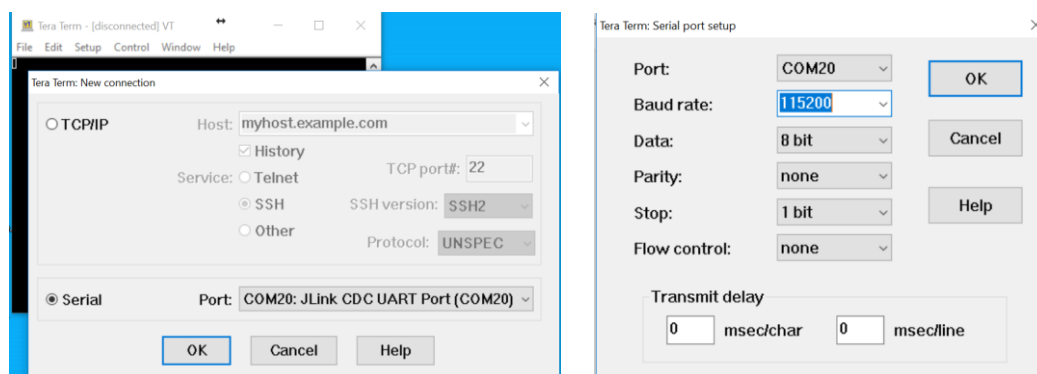
Note also that the PC terminal can be used to configure the anchors and tags – the Android application is not necessarily needed.

### 8.1 Instructions

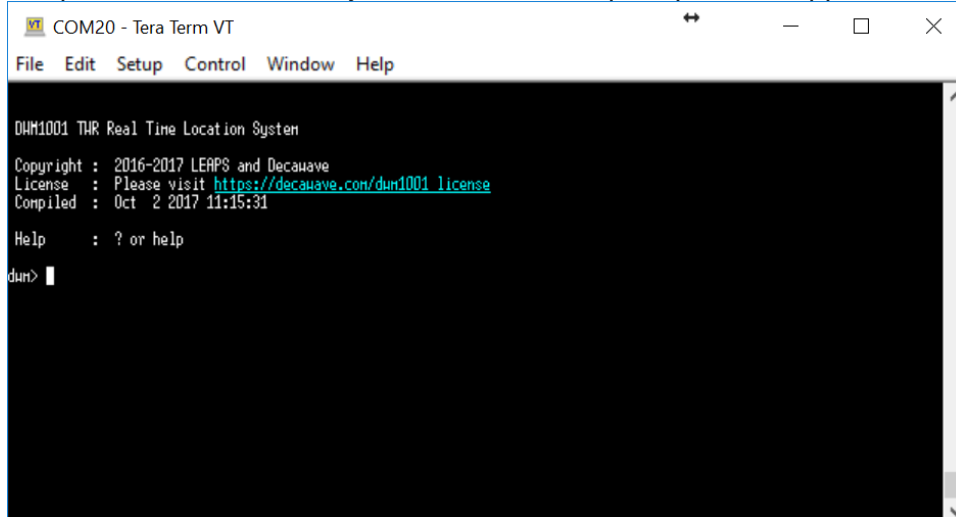
1. Setup the anchors and tags network via the Android application (see section 7)
2. Download and install the J-Link software pack from Segger
  - <https://www.segger.com/downloads/jlink/#J-LinkSoftwareAndDocumentationPack>
3. Download and install a common PC terminal program e.g. Tera Term
  - [http://download.cnet.com/Tera-Term/3000-2094\\_4-75766675.html](http://download.cnet.com/Tera-Term/3000-2094_4-75766675.html)
4. Connect the tag to the PC via USB cable
5. Open the device manager to identify what com port is assigned to the Tag, in this case COM20



6. Once the com port has been identified open up Tera Term. Select the appropriate COM port as shown, and set the terminal baud rate to 115200. The tag should now be connected.



7. Next press the PC Enter key two times and the prompt below appears:



```

COM20 - Tera Term VT
File Edit Setup Control Window Help

DHM1001 THR Real Time Location System
Copyright : 2016-2017 LEAPS and Decauwave
License : Please visit https://decauwave.com/dum1001_license
Compiled : Oct 2 2017 11:15:31
Help : ? or help
dum>

```

8. Enter the command 'nmt' and press the return key **twice** which sets the tag into Active mode
9. Enter 'les' to display the location estimates of the tag

## 8.2 Example Output

```

08AF[0.50,0.50,1.97]=1.14 0A90[5.02,0.50,1.97]=4.04
0916[5.02,3.50,1.97]=4.80 0987[0.50,3.50,1.97]=2.67 le_us=2624
est[1.05,1.04,1.15,92]

08AF[0.50,0.50,1.97]=1.14 0A90[5.02,0.50,1.97]=4.04
0916[5.02,3.50,1.97]=4.75 0987[0.50,3.50,1.97]=2.64 le_us=2654
est[1.06,1.04,1.16,94]

08AF[0.50,0.50,1.97]=1.14 0A90[5.02,0.50,1.97]=4.03
0916[5.02,3.50,1.97]=4.77 0987[0.50,3.50,1.97]=2.66 le_us=2654
est[1.06,1.04,1.16,92]

08AF[0.50,0.50,1.97]=1.14 0A90[5.02,0.50,1.97]=4.04
0916[5.02,3.50,1.97]=4.78 0987[0.50,3.50,1.97]=2.66 le_us=2654
est[1.07,1.04,1.16,94]

```

In the example above, '08AF' is an Anchor ID:

- '[0.5,0.5,1.97]' is the Anchor coordinate for Anchor '08AF' in the form of [x,y,z].
- '1.14' is the estimated range between the Tag and Anchor '08AF'
- 'est[1.05,1.04,1.15,92]' is the estimated location of the Tag. In the form of [x,y,z,quality factor]. (The quality factor is a measure of confidence of the accuracy of the location estimate based on the ranges received)

## 8.3 Other Commands

Once tag is connected to tera term press '?' and then the return key to obtain a list of the executable commands. These commands are listed below.

Usage: <command> [arg0] [arg1] ...

Built-in commands:

\*\* Command group: Base \*\*

?: this help

help: this help  
quit: quit

**\*\* Command group: GPIO \*\***

gc: GPIO clear  
gg: GPIO get  
gs: GPIO set  
gt: GPIO toggle

**\*\* Command group: SYS \*\***

f: Show free memory on the heap  
ps: Show running threads  
pms: Show PM tasks  
reset: Reboot the system  
si: System info  
ut: Show device uptime  
frst: Factory reset

**\*\* Command group: SENS \*\***

twi: General purpose TWI read  
aid: Read ACC device ID  
av: Read ACC values

**\*\* Command group: LE \*\***

les: Show meas. and pos.  
lec: Show meas. and pos. in CSV  
lep: Show pos. in CSV

**\*\* Command group: UWBMAC \*\***

nmg: Get node mode  
nmp: Set UWB mode to passive  
nmo: Set UWB mode to off  
nma: Set mode to AN  
nmi: Set mode to ANI  
nmt: Set mode to TN  
nmtl: Set mode to TN-LP  
bpc: Toggle BW/TxPWR comp  
la: Show AN list  
stg: Get stats  
stc: Clear stats

**\*\* Command group: API \*\***

tlv: Send TLV frame  
aurs: Set upd rate  
aurg: Get upd rate  
apg: Get pos  
aps: Set pos  
acas: Set anchor config  
acts: Set tag config

**\*\* Tips \*\***

Press Enter to repeat the last command  
dwm>

## 9 REFERENCES

### 9.1 Listing

Reference is made to the following documents in the course of this document:

**Table 4: Table of References**

Ref	Author	Date	Version	Title
[1]	Decawave		Current	MDEK1001 Quick Start Guide
[2]	Decawave		Current	DWM1001-DEV Product Brief
[3]	Decawave		Current	DWM1001-DEV Datasheet
[4]	Decawave		Current	DWM1001 Product Brief
[5]	Decawave		Current	DWM1001 Datasheet
[6]	Decawave		Current	DW1000 Datasheet
[7]	Decawave		Current	DW1000 User Manual

## 10 DOCUMENT HISTORY

### 10.1 Revision History

Table 5: Document History

Revision	Date	Description	Revised By
1.0		Release for publication	DB

### 10.2 Major changes

#### Revision 1.00

Page	Change Description
All	Initial Release

## 11 ABOUT DECAWAVE

Decawave is a pioneering fabless semiconductor company whose flagship product, the DW1000, is a complete, single chip CMOS Ultra-Wideband IC based on the IEEE 802.15.4-2011 UWB standard. This device is the first in a family of parts that will operate at data rates of 110 kbps, 850 kbps and 6.8 Mbps.

The resulting silicon has a wide range of standards-based applications for both Real Time Location Systems (RTLS) and Ultra Low Power Wireless Transceivers in areas as diverse as manufacturing, healthcare, lighting, security, transport, inventory & supply chain management.

### Further Information

For further information on this or any other Decawave product contact a sales representative as follows: -

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w: [www.decawave.com](http://www.decawave.com)