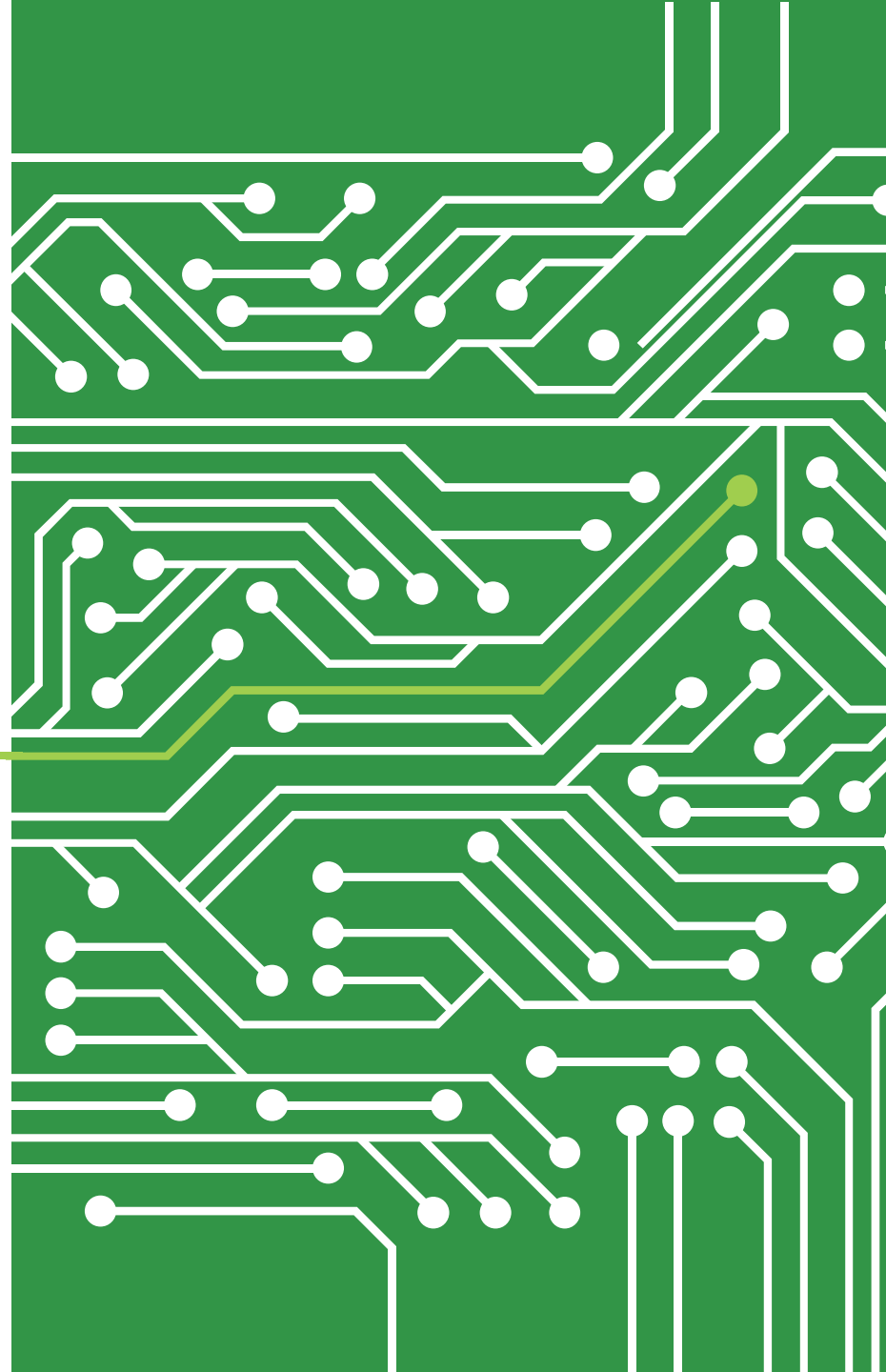


CrowdCell: Inside the Box and General overview

Lime Microsystems| FPRF company

Guildford, Surrey, United Kingdom

LimeNET intro

LimeNET network in a box solutions are built on the field proven LimeSDR platform.

LimeNET offers an array of qualified hardware solutions by combining the LimeSDR boards with commodity computing platforms and additional components such as power amplifiers and duplexers.

LimeNET replaces proprietary specialized and custom equipment and software with open source commodity hardware and software, thereby providing a radical alternative model to the closed wireless network equipment offered by incumbent vendors today.

LimeNET is the next step in the evolution of software defined radio. Broadly speaking, LimeNET can be used in any application that is a convergence of wireless technologies or as a test bed in areas, such as IoT, media streaming, test & measurement, cellular base stations and many more.

Inside the Box – LimeNET CrowdCell

LimeNET CrowdCell is fully fledged, open-access small cell network-in-a-box solution.

Complete with an integrated LimeSDR card and a dedicated front-end board that covers nearly all LTE bands, this technology uses existing macro 4G networks as backhaul and can be utilised for any network as a service deployment.

LimeNET CrowdCell can also provide extended coverage and/or increase capacity of an existing network or accelerate and cost-optimize new network infrastructure developments.

Inside the Box – LimeNET CrowdCell

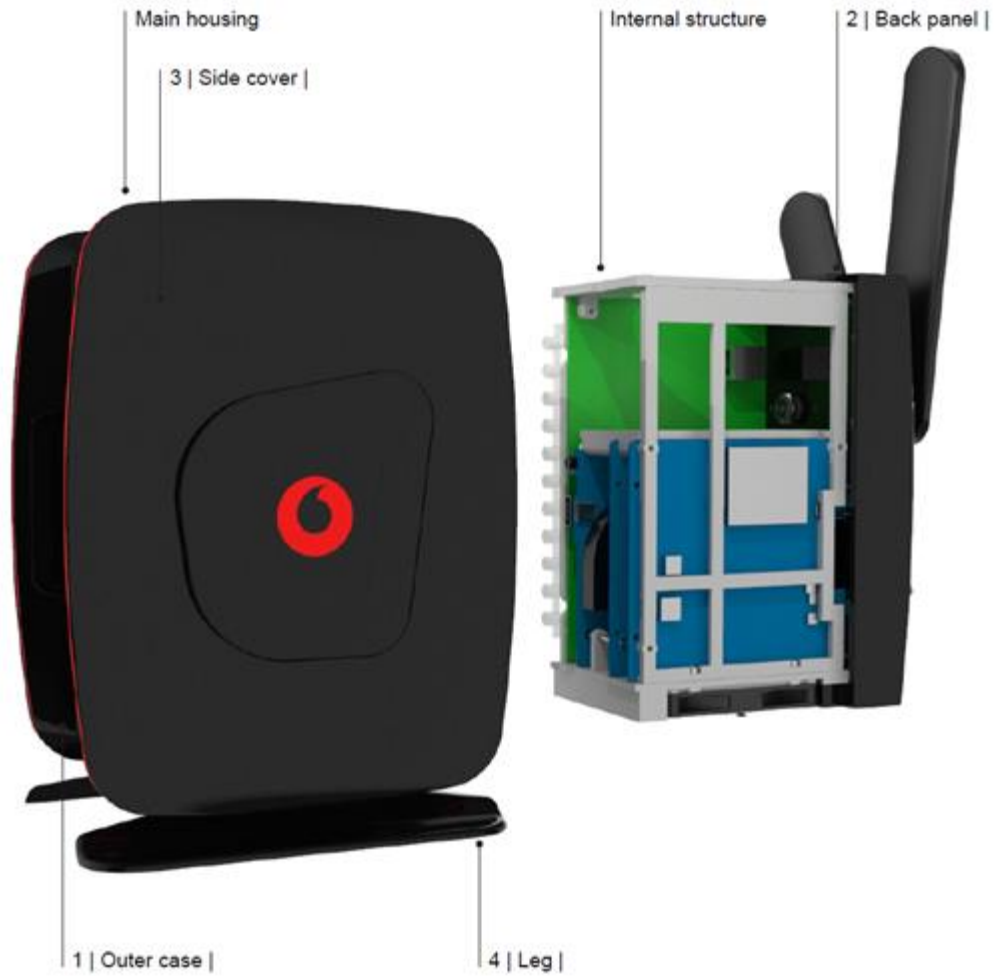
Typical contents for a CrowdCell box:

1. One CrowdCell unit (configured);
2. Two LTE antennas;
3. One GPS antenna;
4. One Power Supply unit and cable.

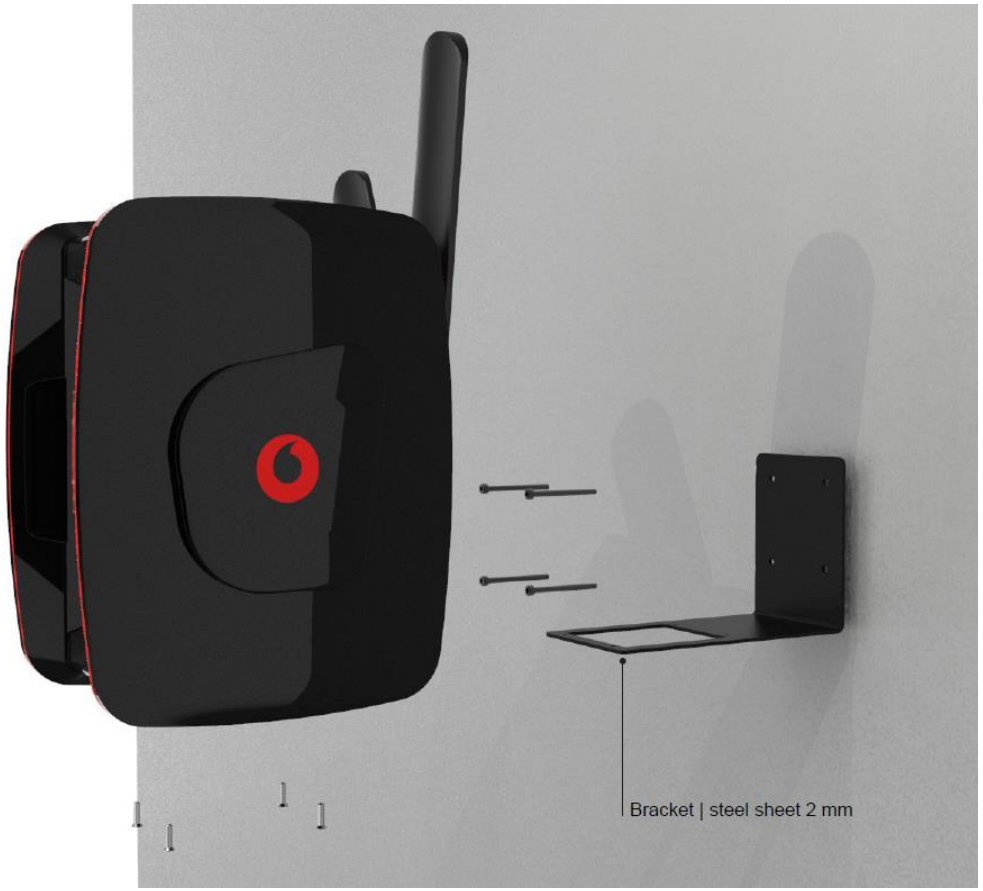
Optional:

1. Test SIM cards for closed network application;
2. User equipement;
3. USB and/or display cables.

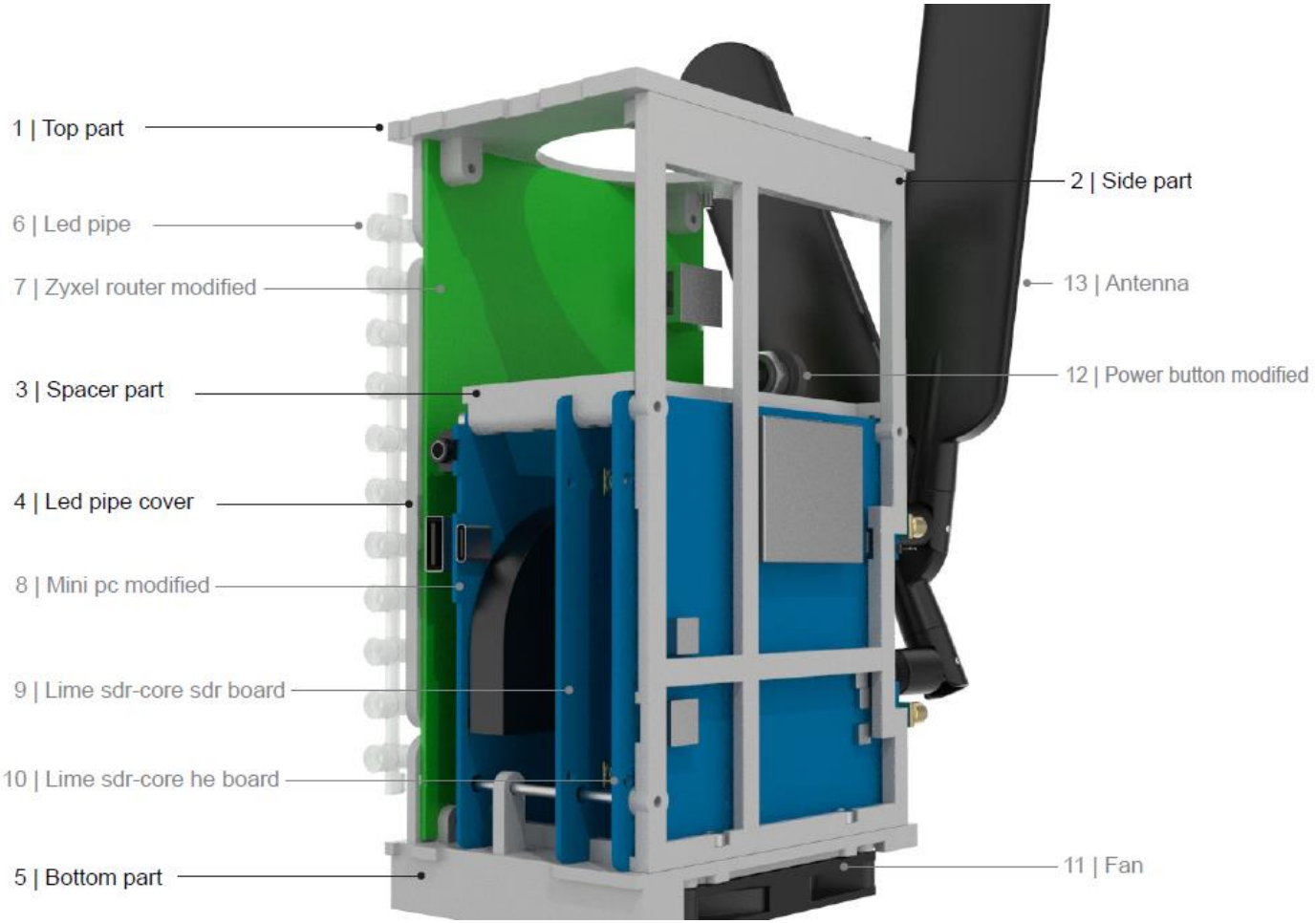
Inside the Box – LimeNET CrowdCell

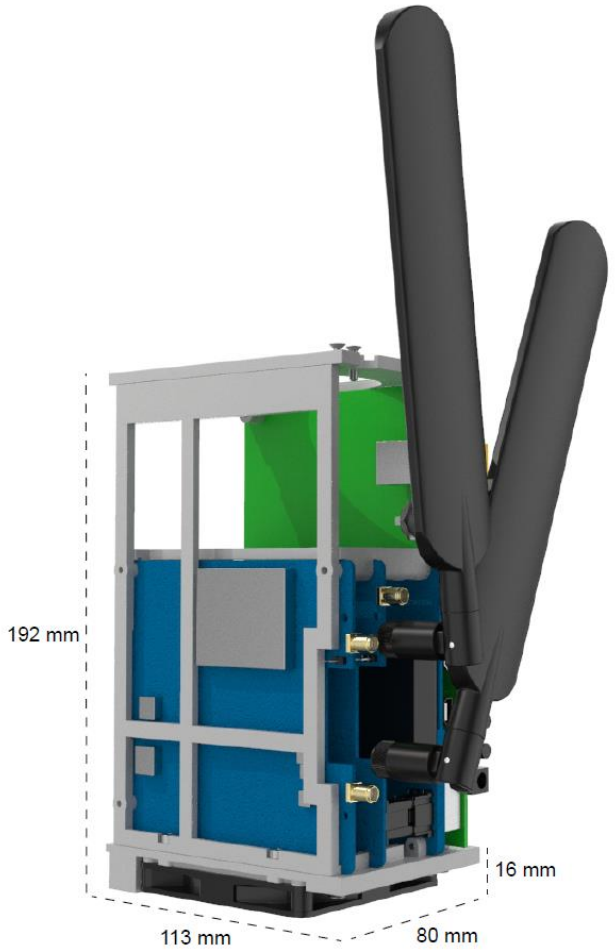


Inside the Box – LimeNET CrowdCell



Inside the Box – LimeNET CrowdCell





Inside the Box – LimeNET CrowdCell

LimeNET CrowdCell uses a modular architecture that can be delivered in a variety of configurations that meets case-specific requirements. It consists of four main modules, each of which can be easily upgraded:

1. Backhaul unit – connects or backhauls the LimeNET CrowdCell to an existing macro network using either wired or wireless connectivity. It can be configured for any specific band requirement and is fully integrated in the product.

4G backhaul module features	
Feature	Specification
Peak data rates	downlink: up to 150Mbps uplink: up to 50 Mbps
FDD band support[1]	1, 3, 7, 8, 20, 28
TDD band support[1]	38, 40, 41
Bandwidth	up to 20 MHz
Other interfaces	UMTS/HSPA GSM/GPRS/EDGE IEEE 802.11 b/g/n RJ-45 10/100 Mbps
MIMO[1]	up to 2 x 2
[1] depends on specific backhaul module options	

Inside the Box – LimeNET CrowdCell

2. General purpose processor (GPP) unit – used to run and manage software and applications on the LimeNET CrowdCell. Thus, each cell can have its own configuration that could be changed and upgraded seamlessly. Since LimeNET CrowdCell functionality is defined by software, this enables not only different voice/data services, but also act as a last-mile service server for traffic offload and management, video or data storage and other services that are well beyond the capabilities of existing solutions. The software and its distribution tools are supplied by our community of developers through our dedicated App store.

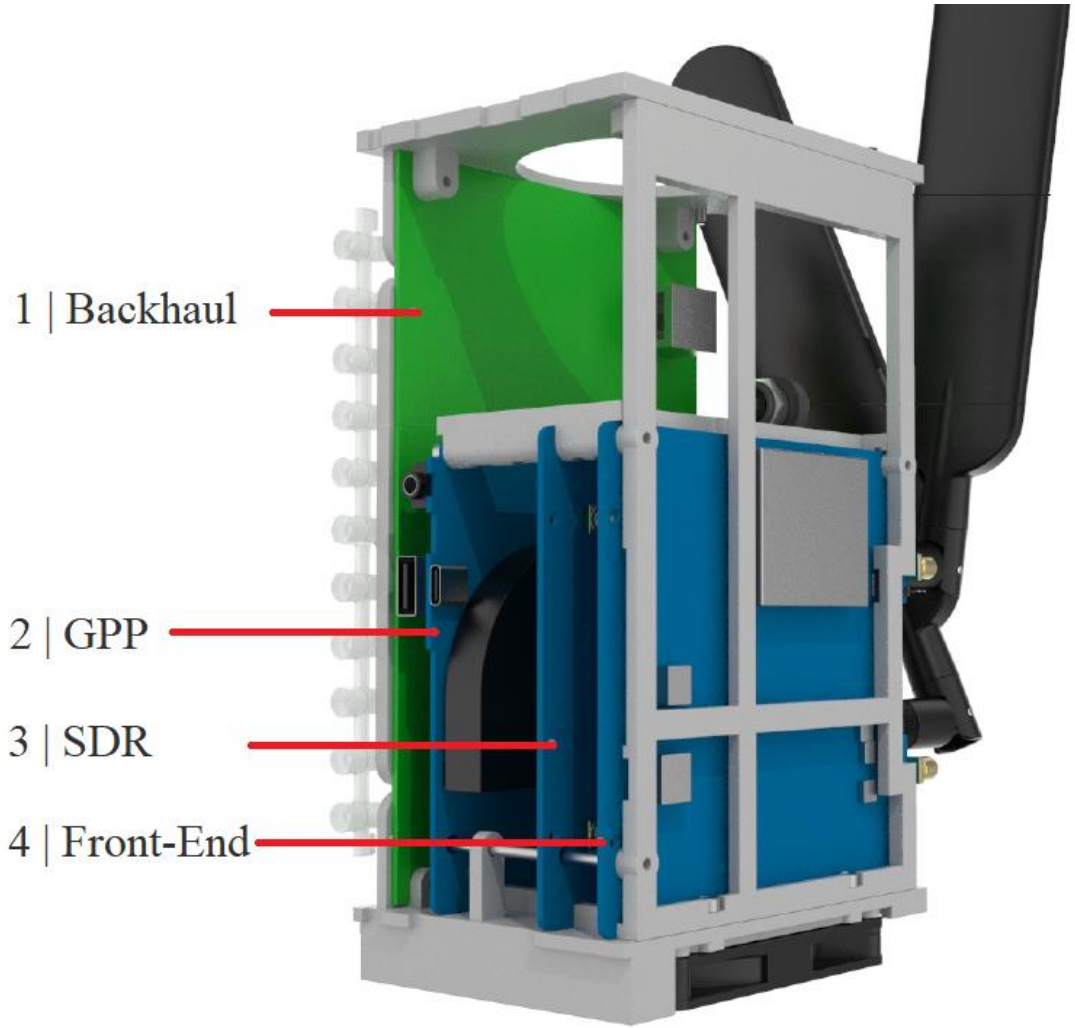
LimeNET CrowdCell GPP module features	
Feature	Specification
Processor[1]	Intel Core i7-8550u
Memory[2]	16 GB (max 64 GB)
Storage[2]	512 GB SSD
Video	Intel HD Graphics
Display ports	Mini Display Port 1.2 HDMI 2.0
Audio	Integrated chipset
Connectivity	1 x USB 3.1 Type-C 1 x USB 3.1 2 x USB 3.0[3] 1 x Gigabit Ethernet[4]
Wireless connectivity	Wi-Fi Bluetooth
Power	Input 100-240 VAC Output 19 VDC, up to 65 W
OS[5]	Ubuntu (pre-installed)
[1] processor depends on specific GPP model	
[2] values can be changed according to specific requirements	
[3] two USB3.0 used by other modules	
[4] ethernet used for wired backhaul connectivity	
[5] Ubuntu required for LimeNET app store support	

Inside the Box – LimeNET CrowdCell

3. Software defined radio (SDR) and flexible front end – LimeNET CrowdCell builds upon the ground-breaking LimeSDR software-defined radio technology to deliver an app-enabled path covering any standard from IoT to 5G. Use of Limes SDR platform provides the most flexible radio hardware solution that enables LimeNET CrowdCell to be setup in numerous varieties of small-cell configurations. Thus, it is an on-demand network solution, where services could easily shift to data, voice, IoT or any other Telco centric services. LimeNET CrowdCell comes pre-equipped with a flexible front-end module that provides signal duplexing, filtering and amplification.

LimeNET Mini SDR/RF features*	
Feature	Specification
RF transceiver	LMS7002M
FPGA	Altera Cyclone IV
Memory	256 MBytes DDR2 SDRAM
Connectivity	USB 3.0, Cypress controller
RF frequency range[1]	10 MHz – 3.8 GHz
Bandwidth	up to 61.44 MHz
RF connectors	two SMA female jack
Power Output[2]	up to 23 dBm
Noise figure[3]	0.6 dB
LTE band support[4]	2 FDD and 1 TDD
MIMO	2 x 2
[1] SDR programmable frequency range	
[2] LTE modulated output	
[3] input stage only, optimized for 2.6 GHz	
[4] two FDD and one TDD band support with a single front end board. Band selection done via software. A wide front-end board configuration list.	
* Customers are reminded that any equipment that transmits wireless signals needs to comply with the relevant regulations for that region. This may require that the final equipment is submitted for testing and verification.	

Inside the Box – LimeNET CrowdCell

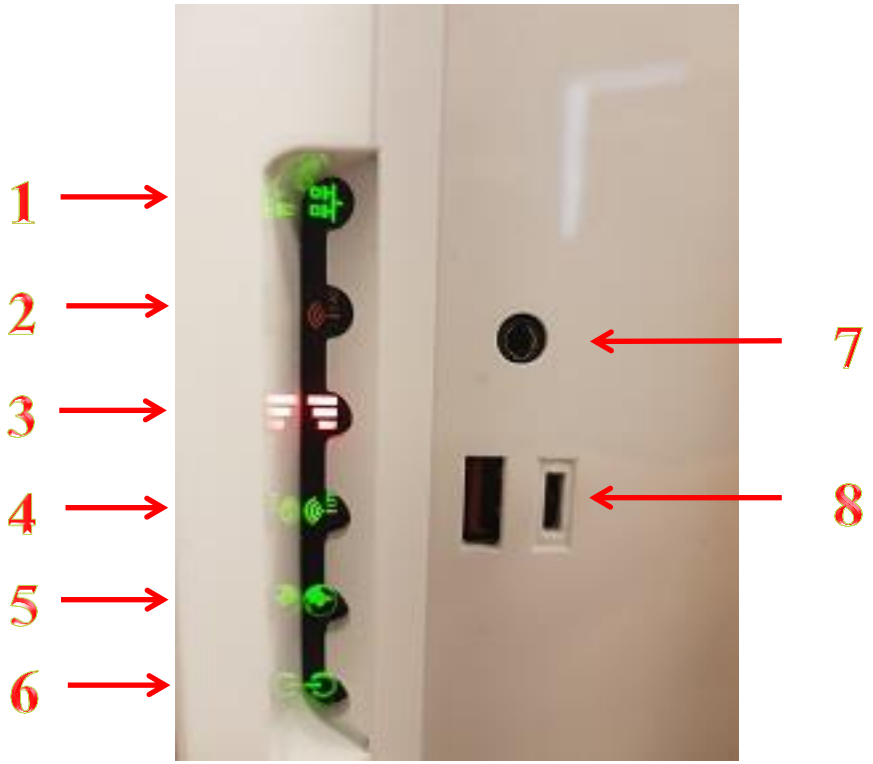


Inside the Box – LimeNET CrowdCell

Backhaul unit LED description

1. Ethernet connection status;
2. Wi-Fi service status;
3. LTE signal strength;
4. LTE service status;
5. Internet access;
6. Power status.

LimeNET CrowdCell front view



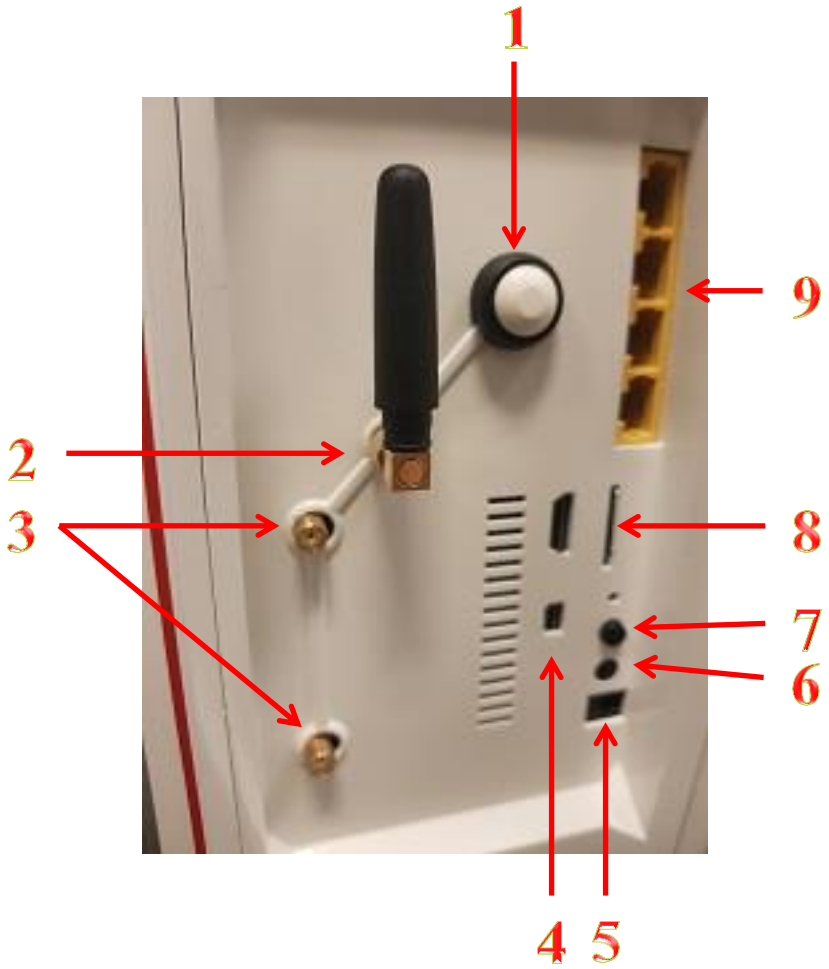
GPP front side connection

7. Dual Array Microphone and Headphone Jack;
8. 1 x USB 3.1 Type-C and 1 x USB 3.1;

Inside the Box – LimeNET CrowdCell

1. Power button for CrowdCell;
2. GPS antenna SMA jack;
3. LTE antenna SMA jacks;
4. Mini Display port 1.2 and HDMI 2.0;
5. Power socket for CrowdCell;

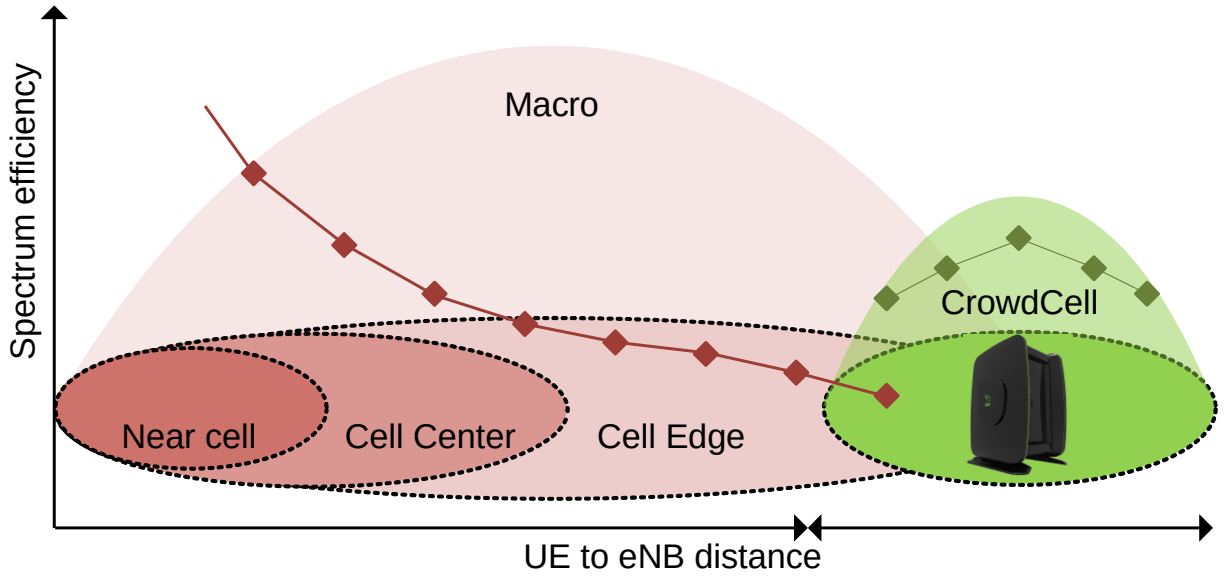
LimeNET CrowdCell back view

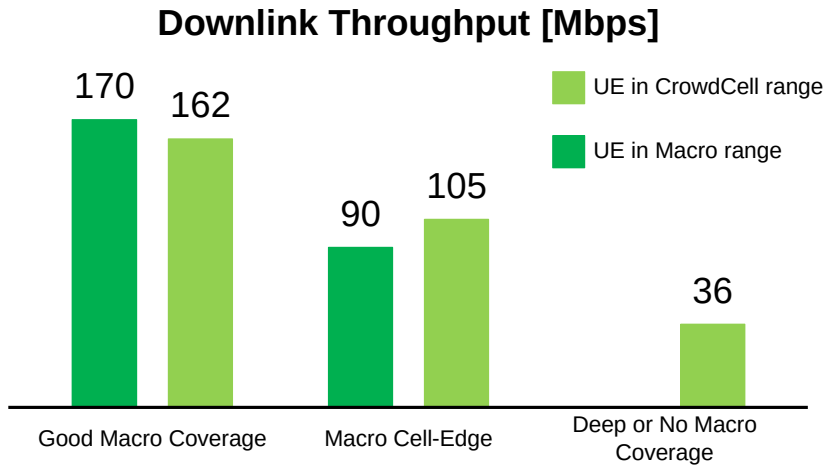


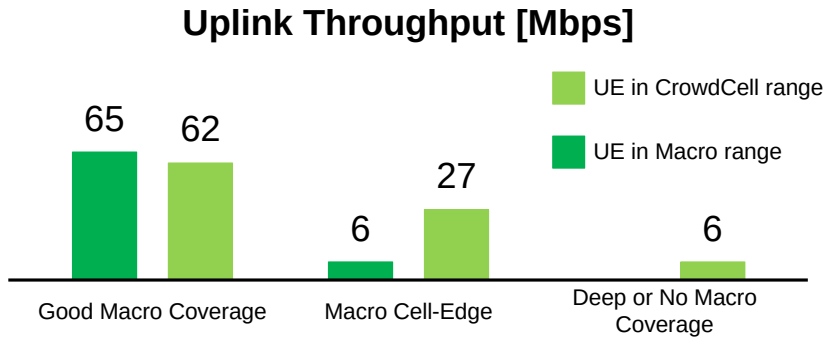
6. Backhaul Enable button;
7. Backhaul Wi-Fi enable button;
8. SIM slot card for Backhaul;
9. Backhaul Ethernet ports.

CrowdCell use cases

The CrowdCell can be seen as a relay technology, whereby an intermediate “Crowd” enabled device relays traffic between a customer UE and the macro network.

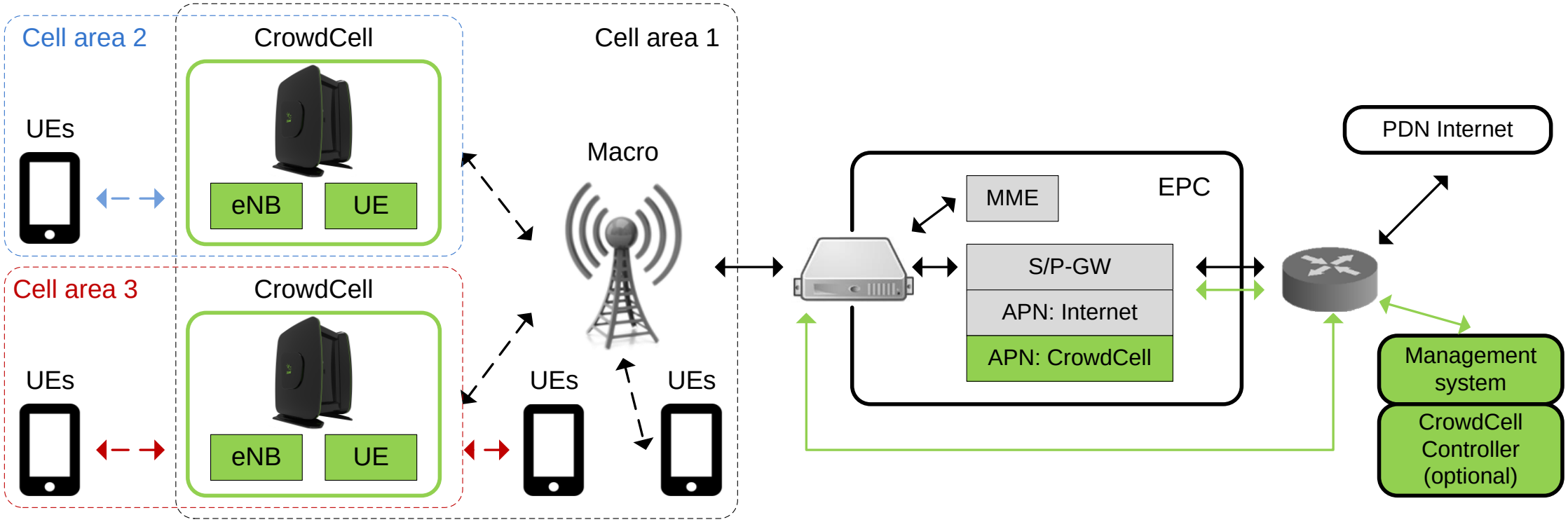






CrowdCell use case 1 – integration to an existing network

- Purpose: CrowdCell can be used to extend the current coverage, dynamically distribute and increase network capacity through data caching, and reduce the reliance on the expensive high OPEX spend of the Macro BTS
- Architecturally, CrowdCell is an eNB that is backhauled through the macro network.
- To the end users, the CrowdCell looks like an eNB, but to the macro network, it looks like a UE using a SIM to identify itself to the network.



CrowdCell use case 1 – integration to an existing network

- On the Radio part, the access bands need to be added to the macro re-selection list as high priority layer if not done before.
- It is important to consider that the CrowdCell can have a number of devices connected to it, and their traffic will be backhauled through the macro as a normal UE. Therefore, the CrowdCell SIM and APN should have high priority from the other users of the network, as it will be carrying the traffic of all those UEs connected to the CrowdCell. This is especially important in the case of high load in the macro.
- CrowdCell Controller is new network node, initially sitting alongside CrowdCell OSS, providing automatic configuration capabilities for CrowdCells in the event that multiple CrowdCells are located in the same area, causing interference and sub-optimum cell selection. CrowdCell Controller deployment is optional when the number of CrowdCells is low.

CrowdCell use case 2 – self-contained network deployment

- Purpose: CrowdCell can be used as a self-contained network, where eNB and EPC functions are implemented into the CrowdCell. This feature can used for Private Network deployment.
- CrowdCell is still seen as an eNB to the UE, but in this case, local data routing can be implemented more easily. In turn, this provides the ability to easily add additional services that run at the very edge of the wireless network.
- Multiple CrowdCell can be meshed together to form a bigger network.
- Internet access can be access through wired or wireless (Wi-Fi, existing 3G/4G networks).