Lime microsystems

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Defined by software: the future of mobile connectivity

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Mobile operators today face a wide range of challenges. Saturation, competition and regulation have all had an impact on the industry, causing a drop-off in subscriber numbers year-on-year, in mature markets. By the end of 2017, average revenue per user (ARPU) for European mobile operators had fallen to $20.40 per month, down from $30 per month in 2012[1].

Operators are fighting to retain revenues, with subscriptions either flat or falling. And they also must defend against OTT players such as Facebook and Google which have cannibalised 10 percent of global revenues from the telecoms value chain[2].

5G offers the industry a lifeline: new services and customer segments could offset this recent decline. Heavy Reading estimates that, globally, operators are expected to invest over $200 billion in CAPEX on 5G networks between 2018 and the end of 2023[3].

The challenge will be to invest this money wisely. Many operators are still suffering a hangover from their 4G LTE investment, with a PwC survey estimating operators are wasting as much as 20 percent, or $65 billion, of their CAPEX[4]. The primary reason is that investment has been led by technological capability rather than identifying commercial opportunities and using that to guide investment plans.

[1] https://blog.telegeography.com/wireless-services-subscribers-in-europe-2g-3g-4g-5g
[2] https://www.gsma.com/gsmaeurope/whats-new/the-rise-of-otts-user-trends-policy-challenges/
[3] http://www.heavyreading.com/details.asp?sku_id=3568&skuitem_itemid=1789
[4] https://www.pwc.com/gx/en/industries/tmt/telecommunications/capex.html

The 5G imperative

Since the launch of 4G LTE, operators have been under pressure to deliver more data, faster connectivity, better coverage and more functionality, to end-users who are more expectant than ever. Increasingly, these end-users will be IoT devices. IDC has forecast that by 2025, 60 percent of the world's data will be generated by enterprises[5], double its level in 2017, largely due to the growth in connected devices, sensors, automation and equipment.

To address these new market segments such as industrial automation, connected cars, smart cities, sensor networks, asset management, connected health, operators will need to rethink how the network is architected. They need to support faster connections, greater density and significantly reduced latency. They must add this functionality and flexibility, while driving down the costs of deploying and managing the network infrastructure.

Delivering more, at a lower cost

Operators must find ways to drive down costs wherever possible, and a progressive way to do that is through the commoditisation and democratisation of wireless network infrastructure. For a long time the telecoms industry has been dominated by proprietary business and operating models, but with pressure on to find innovative ways forward, operators must find a new approach.

Open source is making its mark on the telecoms industry at large, with major operators like Vodafone, Telefonica, Orange and China Mobile already embracing open source technologies to help them transform the network.

Since 2000, open source has experienced rapid growth, and today 63 percent of large enterprises say they are likely to run an open source program[6]. At the 2018 OCP Summit event, Arpit Joshipura, Linux Foundation GM of Networking, argued that open source will be central in 5G and IoT development, powering the automation of functions required to support the high speeds and low latency of 5G and the huge number of endpoints in IoT. According to Statista, the global open source services market will be worth almost $33 billion by 2022, around three times its value in 2017[7].

Evidence of the commercial shift in thinking is growing, with the operator community increasingly embracing virtualisation: AT&T is close to achieving its goal of having 75 percent of its network virtualized by 2020. There are already a number of initiatives underway designed to bring software-defined networking (SDN) into the wireless network involving major operators and wireless infrastructure vendors, while disruptive challengers and startups are making an impact too[8].

[5] https://www.seagate.com/www-content/our-story/trends/files/idc-seagate-dataage-whitepaper.pdf
[6] https://www.linuxfoundation.org/uncategorized/2018/08/corporate-open-source-programs-are-on-the-rise-as-shared-software-development-becomes-mainstream-for-businesses/
[7] https://www.statista.com/statistics/270805/projected-revenue-of-open-source-software-since-2008/
[8] https://www.sdxcentral.com/articles/news/xran-open-vran-and-openran-whats-the-difference/2018/04/

Breaking the proprietary stranglehold

The operator community is now engaged in alliances to drive uptake of open-source, and major enterprises are on board. The O-RAN Alliance includes members like AT&T, Deutsche Telekom, Intel, Verizon and SK Telecom, and has a goal of making O-RAN architecture a key platform for delivering next generation mobile applications like augmented reality (AR), IoT, connected cars, smart homes and more. O-RAN advances RAN architecture in three areas: it decouples the RAN control plane from the user plane, builds a modular eNodeB software stack that operates on off-the-shelf hardware and publishes open north and southbound interfaces to the industry.

The Open vRAN initiative is backed by Cisco and is primarily focused on specifications, recognising that today's modern communications service providers (CSPs) must be agile and flexible and that they have a software 'personality'. The Open vRAN ecosystem aims to accelerate viability and adoption of vRAN solutions into the mainstream and drive their uptake in a wider software-defined network architecture.

The Open RAN Alliance works around future RANs being built on a foundation of virtualised network elements, white-box hardware and standardised interfaces that embrace central principles of intelligence and openness. New products are already in place that form the basis of a multi-vendor, interoperable, autonomous RAN envisioned by O-RAN Alliance members and contributors.

Perhaps the most compelling is the Telecom Infrastructure Project's (TIP) OpenRAN Group[9], which was created in 2016 by Facebook, Intel, Nokia, Deutsche Telekom and SK Telecom. The focus of TIP is the disaggregation of software and hardware, development of RAN technologies based on standard processors, while also developing tangible use cases rather than specifications. A project driven by operators for operators.

The TIP CrowdCell, backed by Vodafone and Facebook among others, is designed to create 4G and 5G small cells for use in smart homes, offices, campuses and similar, to deliver enhanced connectivity quickly and easily via a plug-and-play device. Unlike a femtocell, a CrowdCell backhauls over 4G or 5G and offers a low cost small cell solution. Running on commoditised hardware and open source software, perhaps the most intriguing aspect is the software-defined radio, developed by Lime Micro and use of general purpose processors (GPPs) for the required computation power instead of proprietary Application Specific Integrated circuits. With all these qualities combined, CrowdCell is the most open, flexible and scalable mobile base station that has been created. It's a true network-in-a-box.

[9] https://openran.telecominfraproject.com/

How open source changed the software world

- Open source made building services that customers could rent simple and inexpensive
- Innovative disruptors like WhatsApp and Netflix would likely not exist in a proprietary-only world
- Modular and constantly-evolving nature ideally suits needs of today's companies, meeting their demands for faster, more flexible and more secure systems and platforms
- 72 percent of companies frequently use open source for non-commercial or internal projects, 55 percent use open source for commercial products[10]

Welcome to the era of software-defined radio

A key component and enabler of a programmable base station is software-defined radio (SDR), which can revolutionise the traditional RAN landscape and make it easier for operators to rollout tailored services to different customer segments, at a reduced cost.

By building both a field programmable RF (FPRF) and field programmable gate array (FPGA) into a small cell, operators can have flexible wireless and logic resources.

SDR uses software rather than hardware to process radio signals, and due to that, operators can easily change and select other modulations or transceiver functions such as bandwidth and frequency of operation. The FPRF takes incoming digital data and converts it into a modulated RF signal, while the FPGA sends control signals to the FPRF device to format the wireless data into streams. Both the FPRF and FPGA elements are programmable in the field, making it capable of supporting different air interfaces in one box. According to Market Insights[11], the worldwide SDR market is set to grow at a CAGR of around 8 percent over the next decade, to reach approximately $3.5 billion by 2025. The key reason for such growth is that the same hardware could be customised by software for a variety of markets and use case.

[10] https://www.linuxfoundation.org/uncategorized/2018/08/corporate-open-source-programs-are-on-the-rise-as-shared-software-development-becomes-mainstream-for-businesses/
[11] https://www.marketinsightsreports.com/reports/01241065897/global-software-defined-radio-market-size-status-and-forecast-2019-2025/inquiry?source=amarketreportsjournal&Mode=28

A radically open approach

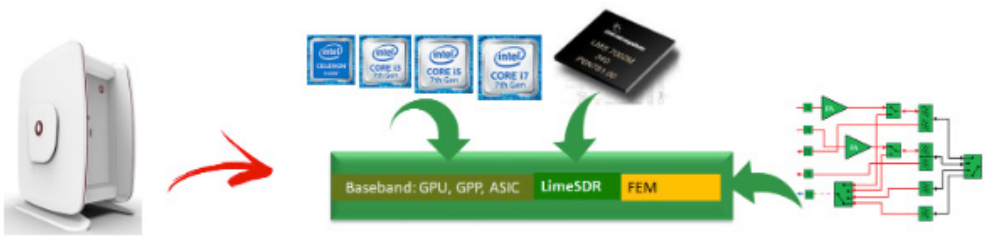
The MyriadRF open source initiative was founded by Lime Micro in 2012 with the goal of democratising wireless innovation. Over the years it has grown to include contributors ranging from hobbyists and wireless enthusiasts through to professional engineers and equipment manufacturers. As of late 2018, more than 8,000 high performance LimeSDR software-defined radio boards had been shipped to developers, with more than 4,000 commits made across 70 GitHub repositories.

MyriadRF provides a home to the LimeSDR open source hardware PCB designs, FPGA 'gateware' and microcontroller firmware, along with associated open source software driver stacks, libraries and example applications. The low cost, high performance platform has dramatically lowered the barrier to entry for SDR development, while the radically open approach taken has resulted in frictionless innovation at every layer in the stack – from derivative hardware designs for cubesats and custom FPGA gateware for hardware acceleration, to a wide array of software applications.

The power of CrowdCell: a network in a box

Lime Micro and Canonical believe in the commoditisation of network hardware, and that the future lies in shifting the value center of connectivity towards software, running on commodity hardware. A CrowdCell based on SDR and GPPs helps operators take this kind of control.

CrowdCell offers an SDR-based, high capacity network in a box designed for mobile and IoT applications and effectively extends the range of the LTE eNodeB. Openness is fundamental to the offering, with the platform architecture itself being open from the ground up: from the printed circuit board designs for LimeSDR and LimeNET to Canonical's Ubuntu Core operating system (OS) through to the Lime Suite host driver stack that offers a feature-rich and easy to use set of APIs for LimeSDR. Ubuntu Core is the OS that powers Lime products, and provides the CrowdCell snap (application) itself as well as the infrastructure for additional apps to be delivered via the store – the network infrastructure equivalent of app delivery to a smartphone.



LimeNET CrowdCell network in a box, based on GPPs, LimeSDR and software defined Front End Module (FEM).

CrowdCell supports cellular standards from 2G to 5G, but also IoT protocols like LoRa®, Sigfox, NB-IoT, LTE-M, Weightless and others – in fact, any type of wireless protocol. The commoditised nature of the base station enables greater control and flexibility and lets operators buy and deploy the vanilla CrowdCell boxes and then load them up with all the apps needed to power a specific use case. CrowdCell also empowers operator R&D departments to experiment with new ideas around industrial IoT, content broadcasting and more.

CrowdCell has the potential to entirely transform the way telecom networks run, ending the proprietary hardware hegemony and creating a world of open hardware with app stores on top. It brings the potential to effectively turn LTE, GSM or LoRa, or even 5G, into, essentially, just an app.

Ubuntu Core: bringing open source to the RAN

Canonical developed Ubuntu Core to provide a secure, lightweight and robust operating system for the IoT and embedded era. Ubuntu Core delivers security, over the air updates, isolation, and most crucially for operators, access to innovative third-party app developers via the Snap Store.

The Snap Store offers approved apps (snaps) tailored to running on Ubuntu Core, and the LimeNET app store offers certified apps from Lime partners designed to run on CrowdCell. For example, to run an LTE network in a box, operators would download and run an Amarisoft eNodeB LTE stack and a Quortus evolved packet core (EPC). As the CrowdCell initiative grows, there will be a snap for every telecoms application that operators may require such as network slicing, policy-based quality of service, traffic analysis and so on.

Crowdsourcing innovation

CrowdCell opens up a raft of new use cases for operators and enables them to go much further than being just a connectivity provider, and furthermore, brings the added benefit of having access to a developer community which is constantly creating new applications and modifying and testing existing ones.

For instance, snaps are available for intelligent autonomy, enabling fine motion detection and people counting using the LimeNET CrowdCell app and mmWave sensors, ideally-suited to enhancing shopping experiences or enabling smart building applications.

mimik edgeSDK and LimeNET Access enable extending the cloud to the edge for 5G mass adoption, turning network devices into cloud servers and enabling content management from anywhere, ensuring reliable, secure, low-cost access on-platform.

Augmented reality snap Aria 1000 Realities lets operators connect industrial and corporate employees with factory or enterprise infrastructure through a headset, enabling them to carry out tasks with reduced risk and removed human error.

Use case #1:

Vodafone and CrowdCell make networks more localised

Vodafone wanted to extend coverage and add additional services to the network they offer to customers, and use this as a means to generate new revenues. They did this by using CrowdCell with its backhaul enabled over the 4G macro, direct to the nearest cell tower. CrowdCell uses new apps like mimik edge cloud platform to provide cloud-based applications in remote areas of poor or no connectivity, creating a CloudCell that acts as a mini/micro data center for hosting services.

The result is that communication is localised, and reliance on major cloud service providers is reduced - meaning Vodafone gets greater reliability and security at a lower cost. They also have the opportunity to develop cloud hosting revenues and additional services, from which new revenues can enable 5G development and deployment. All this is underpinned by access to the app development community that ensures continuous innovation.

Use case #2:

EE and CrowdCell extending rural connectivity

Delivering connectivity and coverage to remote communities and rural IoT applications is a challenge for operators, and siting radio towers in small, isolated communities is a cost-prohibitive exercise. Operator EE, in addition to supporting the LimeSDR Hackathon campaign designed to encourage app development from developers, also deployed CrowdCell as cost-effective solution for connecting remote and mountainous locations. CrowdCell lets EE offer a low-power, customisable connectivity option for remote communities, while the app development community builds and delivers innovative services for them.

Reducing capital expenditure

The open-sourced CrowdCell gives operators greater control over hardware costs, since they are able to purchase through the supply chain offered by Lime, or alternatively use their own choice of manufacturer. Open source software apps mean companies can dramatically reduce overall software costs, and the inherent flexibility and control are again evident in companies being able to use the app "as is" or to modify it and work in their own added functionality depending on their requirements.

To disrupt the wireless infrastructure market, operators need to think completely differently. This requires embracing the lessons learned by the computing industry: the ideas and innovations that took the industry from supercomputing to smartwatches and wearables could be applied to infrastructure. The open source approach can help break the traditional stranglehold of vendor lock-in and give operators greater control of the timescale again.

Operators can even set up their own private app stores, containing only apps tested and verified by them which can be downloaded onto the CrowdCell boxes that they run.

A software-defined future for mobile connectivity

The software-defined approach and third-party app development will ensure that operators are no longer differentiated solely by coverage or subscription costs, but by the services they are able to offer. Today's operators need more to stay competitive. Further to that, SDR will help operators to drive down CAPEX and open up new seams of innovation, in a similar way to how the computer industry was transformed when it made the shift away from vertical integration. The open small cell drives cost of ownership down to practically zero, and access to third-party apps and developers drives innovation forward, helping operators become much more than providers of connectivity.

Contact us

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Resources

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Webinar An introduction to app stores
Whitepaper Moving towards a software defined IoT business model

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