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Affordable macro base station silicon must be open RAN's urgent priority

- DT works with Cohere on software to offset high cost of RAN processors
- TIP and ORAN agree on liaison in important step for common platforms
- Evenstar open RAN programme kicks off with remote radio unit

Had Mobile World Congress gone ahead as planned this week, open RAN technologies would certainly have taken a central role. This topic has everything required to generate an MWC buzz – large operators banding together to change the industry; plucky start-ups taking on the giant vendors; the prospect of a major disruption of the industry.

Even without the giant meeting in Barcelona, many of the ingredients were present in offline announcements and debates. Huawei and Ericsson duly played their role as Goliaths, resisting the pressure to embrace open architectures. Challengers like Mavenir and Parallel Wireless announced important new partnerships and operator deals.

Companies from the data center world such as Intel, Dell and VMware, eager to penetrate the mobile networks fortress, teamed up with smaller suppliers and the open alliances to try to prove the big OEMs wrong. And large operators such as Vodafone were keen to use all this to make it clear that, if their usual vendors did not deliver something new in terms of architectures and network economics, they could go elsewhere.

All of this has happened before, of course. WiMAX, Carrier WiFi, small cells – all of these have promised a new, open ecosystem which would encourage a diverse supply chain and affordable, multivendor networks. All have been used by large MNOs to pressurize their vendors with the threat of a fully open platform – Vodafone using its MWC keynote address to tell its suppliers to get a move on with 4G, or it would adopt WiMAX instead, was a classic example.

There are still high barriers to fully open solutions in the macro RAN:

In reality, large operators have made very little real progress to an open supply chain and a multivendor network. A few have introduced new, disruptive players to the OSS/BSS and core layers, as these have gradually been virtualized, but the RAN has remained obstinately proprietary and in the hands of, actually, fewer suppliers than ever before. This is unsurprising – the RAN accounts for almost two-thirds of most operators' network capex, which on one hand provides a motivation to adopt lower cost platforms, but on the other, makes it an investment of such importance that no risk can be taken with it.

Where there have been moves towards a more open platform, these have usually been in greenfield environments – ultra-rural deployments, private networks, generally based on small cells. These are important as demonstrators, but do not help to prove the thesis on which the promise of a new market and technology structure rests – that a virtualized, open, multivendor RAN, running on merchant processors, really could match or even ex-

ceed the performance and robustness of dedicated, integrated systems, with decades of engineering behind them.

Huawei and Ericsson say the premise is flawed (even though Ericsson is a member of the O-RAN Alliance). The two main open RAN industry groups, O-RAN Alliance and Telecom Infra Project (TIP), are attracting more and more operators and innovative vendors to contribute to their specifications and bolster their arguments in support of the motion. Importantly, they have announced a way to work far more closely together, which will help to bring together an emerging sector in danger of fragmentation.

On the software front, some of the proofs are starting to be made. Virtualized network functions (VNFs) for RAN, and open interfaces and protocols, are all emerging from large and small suppliers and being tested to destruction in commercial trials.

Some of the hardware, too, is starting to look convincing, especially for 5G. The new Evenstar project within TIP, which will develop an open remote radio unit (RRU), is a promising development, as are open 5G APIs from the Small Cell Forum.

The next frontier will be to persuade the industry that, in the macro layer rather than just in smaller cells, general purpose processors, common accelerators and Ethernet really can do the job of the proprietary platforms, and that they can do it at lower cost. Intel's announcement of its first 5G base station system-on-chip is an important step forward (there will be full coverage of this in next week's Wireless Watch). But having Intel repeat its dominance of the server market in network infrastructure would not deliver an open ecosystem. Greater access to investment funds for silicon innovators, at least outside China, would help the cause a great deal; meanwhile Marvell is a strong presence, and increasingly open in focus, while few would bet against another attempt by Qualcomm to re-enter the infrastructure space.

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Is general purpose silicon too slow and expensive for the vRAN?

Amid all the rising excitement about open RAN architectures, some large suppliers have taken an 'if you can't beat them, join them' approach and are now aiming to turn open systems to their advantage by leading the charge.

Samsung and NEC have obvious motivations to leverage open architectures to improve on their very limited presence in access networks outside their home countries. Even Nokia is contributing code to the O-RAN Alliance and setting out a strong strategy to harness openness to lower its RAN costs, increase its market share, and refocus on higher margin software and services.

But the big two remain unconvinced. Ericsson has joined O-RAN Alliance but does not appear to be very active, while Huawei's main contributions to open platforms have been for China Mobile's internal projects. They are adopting the time-honoured response of incumbent mobile vendors in the face of challengers – remind operators just how much they have to lose if they implement their RAN poorly, and how much simpler, quicker and safer it would be to have a single vendor end-to-end.

Even suppliers which sign up for open platforms often adopt the latter argument in reality. Just because a network architecture allows for components and virtual network functions (VNFs) from different sources, there is no need for an MNO to take that route, argue some vendors. We have seen how companies like Cisco have disaggregated their architectures, only to tie everything to their own frameworks again.

The same will, no doubt, be attempted when open RAN deployments become big-ticket. But for now, operators which are keen to open up their networks and supply chains need to formulate good arguments against claims that open systems just won't perform adequately at all, or that the new architectures will take too long to reach maturity for primary macro networks, to align with many MNOs' 5G timelines.

Huawei stays aloof from open networks:

Ryan Ding, president of Huawei's carrier networks business group, was asked about open RAN in various conversations during what should have been the Chinese company's pre-MWC showcase, in London last week. He insisted that Huawei was discussing all its customers' and prospects' requirements, including open systems, but steered well clear of the multivendor aspect of open RAN, claiming his firm could meet all an operator's needs and was flexible enough to adapt to any particular need (and even price, was unsaid but implied).

Ding and his colleagues did say that a broader base of innovation and new entrants would be beneficial for all, and said Huawei was keen to work more closely with smaller companies for mutual R&D benefits. But he sounded a familiar warning from large mobile OEMs, that if open alliances' specifications deviated from those of 3GPP, there was a risk of fragmentation and increased complexity. In that scenario, there would be lower economies of scale and greater complexity for operators to implement the new technolo-

gies. And for the foreseeable future, performance was likely to be compromised.

Not all the big vendors' objections are just FUD:

There may be plenty of FUD (fear uncertainty and doubt) behind such words, but there is also some truth. The computing industry's journey from closed to open systems took a couple of decades, and many false starts and non-interoperable 'open' platforms, before Linux, and then the cloud technologies, became reasonably unified.

The fear that open systems means fragmentation and lack of interoperability is a real one. Organizations like the Open Networking Foundation (ONF), Telecom Infra Project (TIP) and the O-RAN Alliance are making real progress in defining quasi-standards with open processes – greater alignment with one another, and with 3GPP, ETSI and IEEE, would turn these into a genuine 5G-class platform.

And the performance issues are real too. Virtualized, disaggregated architectures undoubtedly bring agility in terms of network topology and service flexibility. And software-centric networks deployed on COTS hardware will have, once they mature, lower cost of ownership than proprietary integrated base stations. But there is a huge remaining question mark. What silicon is required to power cloud infrastructure that has sufficient capability to support the demanding processes of a macro RAN? And what does that silicon cost?

Ericsson's head of networks, Fredrik Jejdling, claimed at Ericsson's 'pre-MWC' event that the dedicated custom ASIC [application-specific integrated circuit] processors that vendors design for their base stations cannot currently be matched by general purpose processors (GPP), when it comes to supporting advanced RAN functions. If a chip supplier surrounds the CPU with enough accelerators - FPGAs, GPUs (graphical processor units) or ASICs - to offload the most demanding tasks, the solution becomes very expensive and potentially power-hungry.

Nokia famously ran into this issue itself when it moved away from ASICs to an inhouse base station system-on-chip with heavy use of FPGAs (field programmable gate arrays), which proved expensive – the company is now developing a new generation of its Reefshark chipset, working with Intel.

> "We spend significant amounts of R&D to deal with the compute power needed to handle massive MIMO and currently general processing cannot handle those types of workload. So far we have not seen any technology that can deal with performance efficiency to the extent that ASICs can"
> *Fredrik Jejdling, Ericsson*

In fact, Ericsson has been announced as a customer for Intel's new baseband system-on-chip (SoC – see separate item), along with Nokia and ZTE; and it is engaged in a major R&D initiative with Nvidia, to test a virtualized RAN platform built around GPUs. However, it is clear that these approaches are not yet ready for the intensive processes of the distributed RAN.

Distributed units are challenging for GPP:

Thomas Noren, Ericsson's head of 5G commercialization, recently used dynamic spectrum sharing (DSS) as an example of an intensive, time-sensitive RAN workload which would require very high performance chips before it could be virtualized on cloud infrastructure. DSS allows an operator to run 4G and 5G flexibly on the same band and dynamically allocate spectrum between the two - it reschedules spectrum every millisecond, and it is very challenging for the hardware to handle all the time and frequency variables.

So far, such workloads require special-purpose, fully optimized processors, argued Noren. He said: "We have a multicore baseband architecture that allows us to do parallel processing; we have the capacity to introduce 5G and DSS on the same baseband. Our purpose-built baseband unit is the fastest, most power-efficient unit in the industry. That's why we can do DSS."

Jejdling made similar comments about Massive MIMO. "We spend significant amounts of R&D to deal with the compute power needed to handle massive MIMO and currently general processing cannot handle those types of workload," he said. "So far we have not seen any technology that can deal with performance efficiency to the extent that ASICs can."

In a disaggregated vRAN, most operators will have three elements – a central unit (CU), based in the cloud; a distributed unit (DU) closer to the cell site; and the radio unit (RU). Of these, the DU is the hardest to commoditize because it needs to support very low latency actions, and because it will be deployed in large numbers, its cost and power consumption must be very low. So while Ericsson, like other vendors, is virtualizing CU functions on general purpose hardware and Intel processors, the DU is seen as a more distant prospect.

Noren added: "If you look at all the available technologies, they are too expensive, too power hungry and too big to be effective compared to our purpose-built hardware for DU."

It is a big concession, therefore, for Ericsson even to engage in an R&D project with Nvidia. Noren said: “Nvidia has a platform and development framework that we can potentially use. We will explore if we can develop a distributed baseband product (DU) with Nvidia GPU. We don’t have any committed product plans, but we think this is a very interesting idea.”

DT looks for ways to improve vRAN economics:

The view that ASICs remain cheaper and more capable for RAN was validated from a surprising source - Alex Choi, Deutsche Telekom's SVP of strategy and technology innovation and a prime mover in open networks, told LightReading: "The reason Ericsson, Huawei and Nokia are using more customized chipsets is that they give you a cheaper solution. If you have an ASIC for baseband processing, it is always cheaper than using a general purpose processor like an Intel processor."

But like Ericsson with Nvidia, DT is always looking for new ways to implement networks, which may impact on cost and effectiveness in future. The German telco is currently testing a new technology developed by Intel, VMware and Cohere at its headquarters in Bonn and this has the potential to change the game (see next item). But it will need to be tested to destruction before operators are fully convinced, and getting it to the level required for a complex, highly distributed, virtualized RAN that will handle the MNO’s main traffic loads will be a long process.

“The performance, reliability and cost structure are not quite there yet," Choi said. "The technology is progressing well but still not meeting all these key requirements from the operator side."

Nobody expects these radical new approaches to be ready for prime-time overnight, and of course long cycles of development and testing will be required to build confidence. However, if this time stretches into several years, the risk for operators is that the moment will have passed – they will be ready, commercially, to deploy their next generation vRANs, but the open platforms will not be ready, and so they will have to fall back on the virtualized, but less open, solutions being readied by the big suppliers.

These may well have open interfaces to the radio units. Just as large vendors are generally not excited by the revenues from small cells, and will work with smaller partners in that area as long as they keep control of the overall platform; so they could afford to let

> “We will explore if we can develop a distributed baseband product (DU) with Nvidia GPU. We don’t have any committed product plans, but we think this is a very interesting idea
> *Thomas Noren, Ericsson*”

radio units from small vendors, based on open specs, into their RANs via open APIs, provided they still deliver the central and distributed basebands and the integration services.

However, Jejdling was unwilling to concede even this, telling LightReading: “What we see now is that with O-RAN specifications, the performance of those interfaces is not to the extent of the interfaces that are built on CPRI standards … It might be that certain use cases evolve. As and when the cost and performance benefits become a reality, we need to be there as a player."

> “The performance, reliability and cost structure are not quite there yet. The technology is progressing well but still not meeting all these key requirements from the operator side
> *Alex Choi, Deutsche Telekom*”

But even replacing semi-proprietary CPRI with O-RAN would not fulfil the dream of a fully open, interoperable network in which each of the vRAN elements could come from a different source; even each virtual network function (VNF) might be from a different vendor; and all this would be enabled by merchant silicon.

For that to happen within the timeframes leading operators have set for vRAN (within three years for the really ambitious ones), there will have to be support from the large OEMs as well as the start-ups. While Nokia and Samsung are showing willing, the big two are holding back. And they can significantly slow the pace for operators wishing to open up their RANs.

Large OEMs fail to get behind ORAN’s preferred splits:

For instance, Ericsson has refused to support the particular options for 4G/5G coexistence that Vodafone was keen to deploy. Yago Tenorio, the operator's head of network strategy, has been lobbying the industry to support three options defined by 3GPP - Options 4, 5 and 7. The 3GPP options specify how functions are split between central and distributed units, and how 4G and 5G base stations and cores coexist. Vodafone made its preferences clear when it issued an RFQ (request for quotation) last year for all its 150,000 European radio sites, insisting that vendors supported the O-RAN open fronhaul interface and its three favored splits.

But Ericsson will only support Options 1 and 2, returning to the anti-fragmentation argument. "We prefer to standardize the development across fewer options to harness and consolidate the R&D effort into certain standards," said Jejdling. “We promote Option 1, and ultimately Option 2 in a [5G NR] Standalone scenario. And that is supported by the overall ecosystem, including chipsets." Of course, chipset makers are unlikely to stick their necks out to support a certain option if they do not see large vendors being likely to

buy the end products, setting up a vicious cycle in the macro layer – which contrasts with the small cell sector (see separate item). Here, there are fewer incumbents, less interest from the big OEMs, and limited legacy installation, so there is far greater room for innovation and new approaches – which will start to bear commercial fruit in 5G because of its greater density and its emphasis on indoor and industrial use cases.

But for now, and the foreseeable future, the networks remain macro-focused. This environment will rely on players with equal strength to that of Huawei and Ericsson to accelerate progress and push deployable solutions into the field. Intel's announcements, and the support of Dell, VMware and others, provide hope for a full open RAN, especially if Nokia puts its money where its mouth is and brings its radio expertise to bear on open specs.

The 3GPP splits in a disaggregated RAN:

The 3GPP standardizes eight options (13 including sub-options), with varying degrees of centralization, for the 4G/5G RAN. Only a few are likely to be supported on a large scale by operators and therefore vendors, but the role of alliances will be important to drive consensus and scale behind the options which will best support common 5G architectures.

The 3GPP is mainly focused on one high layer split, Option 2 (also called the F1 interface), for highly centralized RANs (with most functions virtualized in a central controller, often in the cloud). It is also working on two lower layer splits, with more functions pushed out to distributed controllers or the radio site. These two are Option 6, with a MAC/PHY split, and Option 7, with an intra-PHY split, and three different variants 7-1, 7-2, 7-3.

The main 3GPP split supported by O-RAN is Split 7.2, while another industry alliance, Small Cell Forum, has aligned its own nFAPI (network function API) interface with Split 6. The two organizations are increasingly cooperating to ensure they work on platforms that can support both these options, to drive more scale into chips and equipment, and to support MNOs such as Rakuten Mobile, which want to deploy networks with multiple split options for different scenarios.

Some operators are taking the view that Option 6 is the strongest choice for affordable small cell deployments in lower capacity scenarios, especially indoors; while Option 7.2 will be superior for high capacity and ultra-reliable requirements, because it has strong support for multi-point transmission.

A common concern was that there are still too many options and that MNOs either do not know which to prioritize, or each will want a different combination – leading to fragmentation and lack of scale, with consequent risks for pricing and time to market. Some operators, like BT, are already driving the market towards a common platform that could support all split options in software, to avoid the need to choose just one and to future-proof early deployments. In all cases, cost and availability of transport will be considerations.

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Cohere's radio software claims to improve ecnonomics of open vRAN

Deutsche Telekom has been exploring one way to address the higher costs of general purpose processors (GPP), compared to dedicated ASIC chips, in a high performance RAN (see lead article).

Although the ability to run RAN functions as software on COTS hardware is central to the vision of a fully open, virtualized network, it does run up against the high cost of the chips – processors and accelerators – needed to support the very demanding tasks involved in running a RAN, especially those related to low latency and constant updating.

While acknowledging the issue, Alex Choi, SVP of strategy and technology innovation at DT, said one solution is to offset the high cost of the processors by using the hardware far more efficiently. The German operator has worked with Intel, VMware, Mavenir and Cohere Technologies – known for its development of an alternative to 3GPP's OFDM implementation for 5G – on such a solution.

The resulting system, based on Intel's FlexRAN architecture, completely separates the radio resource management (RRM) from the underlying hardware and runs it as a discrete application on top of the VMware virtualization platform. The efficiencies were increased by implementing an advanced RRM algorithm from Cohere. The result, said Choi, was that "in total the overall cost can be lower than in the case of using a traditional platform" because of the improvement in radio performance. Choi said throughput doubled on the test network, leading to a reduction in total costs.

Its next step is to open up the platform and invite others to develop RRM software so that this approach can become more mainstream and competitive.

Welcome return for Cohere:

For now, though, this is a welcome endorsement for Cohere. The company had high hopes of getting its OTFS (orthogonal time frequency and space) air interface technology into 5G standards when it was supported by AT&T, China Mobile, Deutsche Telekom, Telefónica and Telstra as an alternative air interface to OFDMA (OFTS actually sits on top of OFDM, ensuring backwards compatibility, but claims to be more reliable). In the end, the 3GPP RAN 1

group played it safe and stuck with extensions of OFDMA, which led Cohere VP Anton Monk to describe Release 15 as "LTE with Massive MIMO and beamforming — nothing really new except for including Huawei's polar codes in the control channel and using LDPC (low density parity check) everywhere else".

Having failed at the 3GPP, Cohere focused on building equipment that incorporated OTFS, particularly for fixed wireless access (which has the advantage of not requiring standardized devices like mobile cellular). Its technology has been trialled by Telefónica, Telstra, Altice, Sprint, DT and Charter but made little commercial headway. The approach changed a year ago when Ray Dolan, a veteran of Sonus, Flarion (later acquired by Qualcomm) and others took over as CEO.

Under Dolan's watch, Cohere has refocused on software development and on exerting its influence over O-RAN rather than the more cliquey 3GPP. He has also been joined by his head of marketing at Flarion, Ronny Haraldsvik.

The OTFS technology - complete with Cohere's own Delay Doppler-based channel detection, estimation and prediction technology for beamforming – is now available as a software module that can be integrated into existing RANs or placed in an x86-based server and connected via interfaces such as O-RAN. In a vRAN architecture, the code can run as an application on the RAN Intelligent Controller (RIC), which is becoming an important 5G element because of its near-real time performance for low latency environments.

"Currently, 5G offers only about 20% more capacity than 4G," Dolan told LightReading. "But the radio is not where the magic is – that's in the beamforming and you can't do that efficiently with TDD [time division duplex] because currently it's all done by the likes of Ericsson, Huawei, Nokia and Samsung at the cell site. Cohere's technology can be deployed in the cloud and enables the spatial replication of radio. We believe we can double network capacity initially – significantly more as more antennas are added."

Also working with VMware to refine a cloud-based RAN offering is Mavenir, which has announced the integration of its 5G cloud-native network functions (CNFs) with VMware's container-ready Telco Cloud, running on Dell's 5G edge computing nodes. Pre-integration and testing on Dell and VMware infrastructure will help accelerate deployment and reduce barriers to 5G roll-out, said Mavenir.

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> *Ray Dolan, Cohere*"

For instance, it will offer integration of open source container-as-a-service (CaaS) and platform-as-a-service (PaaS) with Mavenir's microservices-based 4G/5G packet core and vRAN network functions, and VMware's Telco Cloud infrastructure. This will allow MNOs or enterprises to deploy telco workloads on private or hybrid cloud environments by extending on-premises VMware environments to the AWS public cloud.

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The two main groups driving open RAN come closer together

The two main organizations working on open RAN specifications, Telecom Infra Project (TIP) and the O-RAN Alliance, have addressed a major perceived barrier to a common RAN platform by announcing a liaison agreement to ensure their efforts are aligned.

Although the two groups have very different starting points, and their work is largely complementary, there has been a widespread perception that they were in competition to provide specs for some key elements of an open network, such as a common fronthaul interface or a distributed cell site gateway (DCSG). The fact they each had different initiatives for such elements, and different operators appeared to be the main drivers (AT&T in O-RAN, for example, and Vodafone or Telefónica in TIP), fuelled the idea that they were in danger of splitting the nascent movement in two.

New level of collaboration for TIP and O-RAN:

Now, the groups have announced a "new level of collaboration" – this stops well short of merger or full convergence, but should make it far clearer to the industry where each organization is focused, and how their efforts will align and, where necessary, work together. For instance, both O-RAN and TIP will test new 5G solutions in a Deutsche Telekom lab in Berlin this year.

This will represent the first common location for an O-RAN Open Test and Integration Center (OTIC) and a TIP Community Lab and it will focus, according to TIP, on "interop validation of O-RAN compliant RU/DU solutions leading to an upcoming Open FronthaUl (RU/DU) TIP Plugfest, as well as supporting Open Optical Packet Transport (OOPT) technology trials".

TIP's executive director, Attilio Zani, said: "Our hope, longer term, is that this forms the ability to accelerate the solutions that are in the marketplace and drives greater adoption of open RAN technologies across the world."

Alex Jinsung Choi, COO of the O-RAN Alliance and SVP of strategy and technology innovation at DT, said in a statement: "Alignment on O-RAN interoperability efforts will help the industry to speed up the delivery of commercial open RAN solutions. The establishment of the first joint O-RAN Open Test and Integration Center (OTIC) with the TIP Community Lab in Berlin is a concrete step to facilitate this multi-community approach."

> "Our hope, longer term, is that this forms the ability to accelerate the solutions that are in the marketplace and drives greater adoption of open RAN technologies across the world
> *Attilio Zani, TIP*"

Under the liaison agreement, TIP and O-RAN can share information and specs, and conduct joint testing and integration. The TIP OpenRAN 5G NR project group will release its base station platform requirements document this year with normative references to the O-RAN specifications.

TIP provides welcome clarification of alliances' roles:

However, TIP does remain neutral in its specs and works with other open groups and even formal standards bodies. For instance, it has a close alliance with the Open Networking Foundation (ONF), which houses the CORD (central office re-architected as a datacentre) projects, among others.

"We're agnostic when it comes to the technologies that we incorporate in our project groups so when it comes to looking for a specification to create a product in the OpenRAN space we'll look around to see if there's something pre-existing," Zani said last year. "We are not at all defensive with anyone else. We're not looking to own a space in any way so we're open to working with 3GPP, ETSI, and other organizations to take a specification, work it through a set of requirements, and define a solution."

However, such an agnostic approach can also appear to be confused. Back in 2018, Axel Clauberg, who was (until recently) chair of TIP and a senior executive in DT, called for greater collaboration between different initiatives, but also for greater clarity of purpose.

He showed how OpenRAN and ORAN could complement one another, highlighting that Telefónica and Vodafone, as well as being leaders of the TIP OpenRAN project, also planned to base their

work on the ORAN specs – this was subsequently clear in the requirements of the RFQ (request for quotes) which Vodafone issued for open RAN technology across its European site footprint.

Clauberg explained the difference between the groups, saying that TIP "has not done any specs from the ground up. They have not built architecture but are looking at how the architecture specified by the O-RAN Alliance could be built and deployed in a commercial way. In this area, TIP would do solutions integration and prove it is possible to build such an open RAN in real life."

Last week, Dan Rabinovitsj, VP of Facebook Connectivity, enlarged on the complementary theme, saying that TIP is more focused on plugfests and system level issues than writing new specs. "We're interested in how do you take disaggregated RAN transport and core elements and be able to swap between them and still come out with the same outcome for mobile operators?" he said in an interview. "We're much more focused on how do we get the whole industry to collaborate on making stuff actually work in the real world when you have to plug it together."

Now, operators which have been prominent in O-RAN development and trials, like Rakuten, are starting to join TIP too, though TIP's new chairman comes from a bedrock supporter, Vodafone. Santiago Tenorio, Vodafone Group's head of network strategy and architecture, will replace Clauberg, who stepped down when he left DT for Amazon Web Services at the start of this year.

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DT and Vodafone lead development of TIP's open remote radio unit

One of the key announcements which Telecom Infra Project (TIP) would have made at Mobile World Congress was of a common remote radio unit (RRU) which would connect via the O-RAN fronthaul interface, opening the way to multivendor RANs.

One of the first and most urgent activities for groups pursuing open RAN architectures was the fronthaul interface between the radio unit and the digital portion of a virtualized network, whether central or distributed. The urgency came because the industry already had an agreed fronthaul interface, CPRI, but it was implemented in a proprietary way by each vendor, so that it was very difficult to mix and match radios and baseband units from different suppliers. That, in turn, threatened to compromise the economics

of a disaggregated, virtualized RAN by ensuring this new architecture remained single-vendor, and not susceptible to competition.

With the Ethernet-based successor to CPRI, eCPRI, also disappointing in terms of full openness, there has been significant operator support for the open RAN fronthaul work done by TIP and the O-RAN Alliance. Now, TIP's Evenstar programme aims to establish open specifications and reference designs for some of the units that those interfaces will connect, starting with the RRU.

The companies involved in developing the RRU platform include:

- two operators and leading lights in TIP, Deutsche Telekom and Vodafone
- the Connectivity division of Facebook, the original initiator of TIP
- two vRAN vendors and high profile TIP/O-RAN supporters, Mavenir and Parallel Wireless
- two radio specialists, MTI Mobile and AceAxis.

> "Though Telefónica is in the background on this particular development, we are communicating our requirements while we focus on other areas. The RRU will be important and this is something we expect to adopt
> *David del Val Torre, Telefónica*"

Indeed, AceAxis is a reminder of how long a journey it has been to disaggregate the RAN. As AxisNT (before it was acquired by Korea's Ace), it was early to spot the opportunity provided by the trend to separate the radio unit from the baseband, placing them at the top and bottom of the tower respectively and connected by fiber. It became a supplier of third party radio heads which could, in theory at least, be procured separately from the basebands, though in reality, the fronthaul issue meant that most sales were to OEMs for end-to-end networks.

Vodafone's Santiago Tenorio, the new chair of TIP, said the RRU would be a "killer radio" because it is so important to operators. It will be available in mid-2020 as part of the Evenstar programme, which will later extend to other architectural elements such as distributed units (DUs).

Attilio Zani, TIP's executive director, said Evenstar was "important because it meets the stated aims of what we're trying to achieve – to reduce cost and increase flexibility. That's very central to our mission statement."

The initial RRU will be for the 1.8 GHz band with a target price point of $1,000 per unit. "This is one variant, the one that's in demand now, but we expect there to be more. We need to test the demand first and will listen to a broad set of operators," Zani added.

The first specs cover 2x20W RRUs for B3, B20 and B7 and 2x40W RRUs for B5, B28 and B71. In future more SKUs will be added, including FDD B3 (4T4R 4X40W) and B28 2T4R 2x80W. The RRH will support the architectural split known as Option 7.2 (see separate item).

"With Project Evenstar, Facebook Connectivity is collaborating with Mavenir and other ecosystem organizations to support building RAN hardware components for 4G and 5G networks," said Dan Rabinovitsj, VP for Facebook Connectivity. "A healthy ecosystem of OpenRAN vendors plays an important role in emerging deployments for 4G and 5G networks based on open architectures addressing various deployment scenarios and use cases."

Commscope and JMA bring O-RAN interfaces to small cells:

Small cell vendors have often plugged away at improving the business case for bringing cellular connectivity to places that make limited commercial sense for MNOs – such as indoor and industrial environments. Now they hope that shared spectrum schemes such as the USA's CBRS, and open architectures, will improve the economics of these networks sufficiently to drive significant scale in the 5G era.

For instance, Commscope has upgraded its disaggregated indoor small cell platform, OneCell, to support open vRAN platforms and O-RAN interfaces.

Based on technology it acquired from small cell start-up Airvana, OneCell will now support O-RAN-compliant fronthaul links between the virtualized baseband controller and the radio units, and will work in midband or millimeter wave spectrum. Also, the cells can be managed within an ONAP (Open Network Automation Protocol) environment.

Another US-based RAN vendor, JMA Wireless, said it had been testing its O-RAN compliant baseband with its CellHub radio units in CBRS spectrum in 3.5 GHz, using test equipment from Keysight. This had achieved 800Mbps throughput to a single user, or support for 5,000 simultaneous users, in an indoor environment with one licensed band and four aggregated CBRS bands.

The tests were conducted using 100 MHz of cellular spectrum - that single licensed band and 4 aggregated CBRS bands in a 256 QAM, and a 2x2 MIMO configuration. CellHub can be deployed in a 4x4 MIMO configuration.

JMA told TMN that performance was similar with or without the licensed band. "We support and expect to see both scenarios. We fully expect enterprises to take advantage of CBRS-only systems. With 150MHz available in CBRS (assuming access to the full band), the noted speeds are easily supported. CellHubs support 1.6Gbps with the ideal configuration (high order carrier aggregation + 4x4 MIMO). With devices available today, we achieved the 800Mbps noted."

Other operators, outside the core development group, also offered support, including the Middle Eastern group Zain. And David del Val Latorre, Telefónica's CEO of R&D and a TIP board director, told LightReading: "Even though Telefónica is in the background on this particular development, we are communicating our requirements while we focus on other areas. The RRU will be important and this is something we expect to adopt, but at the moment Telefónica's focus and efforts are on the transport elements of the network and on achieving full automation of disaggregated networks with CI/CD processes. There are many projects underway in TIP and we can't be involved in all of them."

TIP also announced another for its growing list of project groups, this one focused on the open core network. This will aim to bring together requirements and specs for “a cloud-native and converged core, running on standardized software and hardware infrastructure, and supporting 4G, 5G and WiFi access technologies for deployments in licensed, unlicensed or shared spectrum, and in private networks,” according to TIP.

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