

# PRIVATE 5G *for* IOT

JULY 2023

*– plotting  
timelines,  
defining  
applications  
and making  
bets*

by James Blackman  
Editor, RCR Wireless



**syniverse®**



(Images: Volkswagen; Hannover Messe)

## FOREWORD

**T**he truth about private 5G, certainly so far as IoT and Industry 4.0 goes, can be found somewhere between the desperate excitement of MWC and the distracted indifference of Hannover Messe. And of these twin events, which bookend the spring season and dictate the rest of the industrial tech calendar, the mood in the industrial IoT user market in 2023 invariably lies closer to the *gleichgültigkeit* (we had to look that up!) of the big German fair – if only because it takes a vertical focus, instead of just a horizontal one, and so the crosshairs more easily align.

Take Volkswagen, the biggest car maker in the world, and surely the ultimate bellwether for this stuff; the Wolfsburg firm told Hannover Messe in April about its feelings and findings, and suggested 5G is just an-



other waypoint on the Industry 4.0 road – and a long way off, still. (But what else did we expect, *as this article will conclude?*) Flanked on a panel by Airbus, Bosch, Siemens, plus some others, Klaus Dieter-Tuchs, head of industrial networking planning at the firm, puts the spring-time MWC hullabaloo about private 5G into some kind of perspective.

“We see 5G as just another technology to access the central IT network. For us, [it] is a small part of a complete network,” he says, before listing all the problems with private 5G, as presented to the industrial IoT market today. It was in line with the message from the rest of the show: that private 5G is not a 2023 story, and maybe not even a 2024 one. It will take until 2024/25 to gain any kind of real purchase with the industrial set, to deliver digital change for certain brownfield use cases.

Volkswagen remains very much in test-mode with private 5G-for-IoT, like many enterprises in Germany – which, as the original home of *Industrie 4.0*, might also be considered to be a geographic bellwether for hard-nosed industrial-grade 5G. The company has four different test networks with four different car marques; with Audi in Ingolstadt, Porsche in Leipzig, Volkswagen in Wolfsburg, and Skoda somewhere in the Czech Republic. Each one is from a different network vendor – which says, as much as anything, that enterprises are still weighing the odds and hedging their bets.

“We are trying different vendors to gain experience for live production networks. But we have no live networks, as yet – and we can’t say [exactly] when we will have them,” Dieter-Tuchs suggests, a little vaguely, that Volkswagen will have commercially-active networks “in the next months,” but also raises agitated concerns about user equipment, device authorisation, and network integration (discussed variously in parts two and three). *The point is only to mark the calendar*: in mid-2023, private 5G for IoT is a research project, largely – at least where the two disciplines cross in industrial climes.

This is reinforced by the experiences of

Airbus and Siemens, speaking on the panel as well, and in conversation separately with *RCR Wireless*. Airbus is further along with live deployments. It has 11 networks at 11 sites, all of them deployed for IoT exercises of one kind or another. But it is expanding beyond its core manufacturing bases in France and Germany, to also deploy in Canada, China, Spain, the UK, and the US. And it is doing so with a cookie-cutter blueprint – based on the principle that what works once works every time (counter to the generalist supplier narrative that every plant is different).

Architecturally, it is fairly straightforward, declares Hakim Achouri, 5G and IoT expert for digital aviation at the firm. It takes some radio planning, but not much; two-weeks, from start to finish, with an 80/20 rule for applications on top, as well. “If we need to roll out a new site, we know exactly [what to do] – we have a template, already. We go there, do some radio studies, and it is deployed. It takes a few weeks. With regards to use cases, 80 percent of our sites use the same digital tools... We still have specifics [at each site] that require closer vertical integration. But really, that is the fun part.”

The key message, from Achouri, speaking at *RCR Wireless’* flagship industrial 5G-IoT event, 5G Manufacturing Forum, at the end of last year (2022), is to be bold. Because enterprises know their business best, and because late-LTE and early-5G is good to be going on with. Which makes 5G-for-IoT sound like a *no-brainer*. But Airbus also acknowledges in Hanover, some months later, that it is still kicking the tires, essentially; the hard-ROI of signal coverage and predictability is plain (see part two), it says, but decisions about network management and rollout strategy are still to be made.

“We don’t know yet. At the moment, we are doing it all ourselves. But to scale worldwide, we will probably outsource the service. And it will take some years to deploy everything in all plants,” comments Jirka Klaue, from the firm’s IT department. In the end, Volkswagen and Airbus, both perceived as Industry 4.0 flag-bearers, are at opposite ends of the initial 5G-IoT adop-

tion curve: one is stuck in an experimentation rut, effectively, and the other is in some kind of commercialisation groove. But both of them still have searching questions about 5G-for-IoT; neither have gone all-in.

“If we need to roll out a new site, we know exactly [what to do] – we have a template, already. We go there, do some radio studies, and it is deployed. It takes a few weeks. With regards to use cases, 80 percent of our sites use the same digital tools... We still have specifics [at each site] that require closer vertical integration. But really, that is the fun part.”

**Hakim Achouri,**  
**5G and IoT Expert, Digital Aviation,**  
**Airbus**

Munich-based Siemens, one of the rarefied breed interested in both selling and employing 5G-IoT systems, has only just launched its own home-grown solution, and only just in its home market – for use in the local 3.7-3.8 GHz band, reserved for enterprises to run private 5G networks. It has plans – clear, but also vague – to sell outside Germany, too, starting in Brazil, where the same vertical spectrum has been allocated. It says it will follow in other markets in line with demand, raising bandwidth capabilities to meet the 3.8-4.2 GHz band, around which most of Europe is congregating.

There is an argument – put, typically, by traditional telco-native 5G vendors – to say that Siemens is late-to-market. But like Volkswagen and Airbus, and most of the

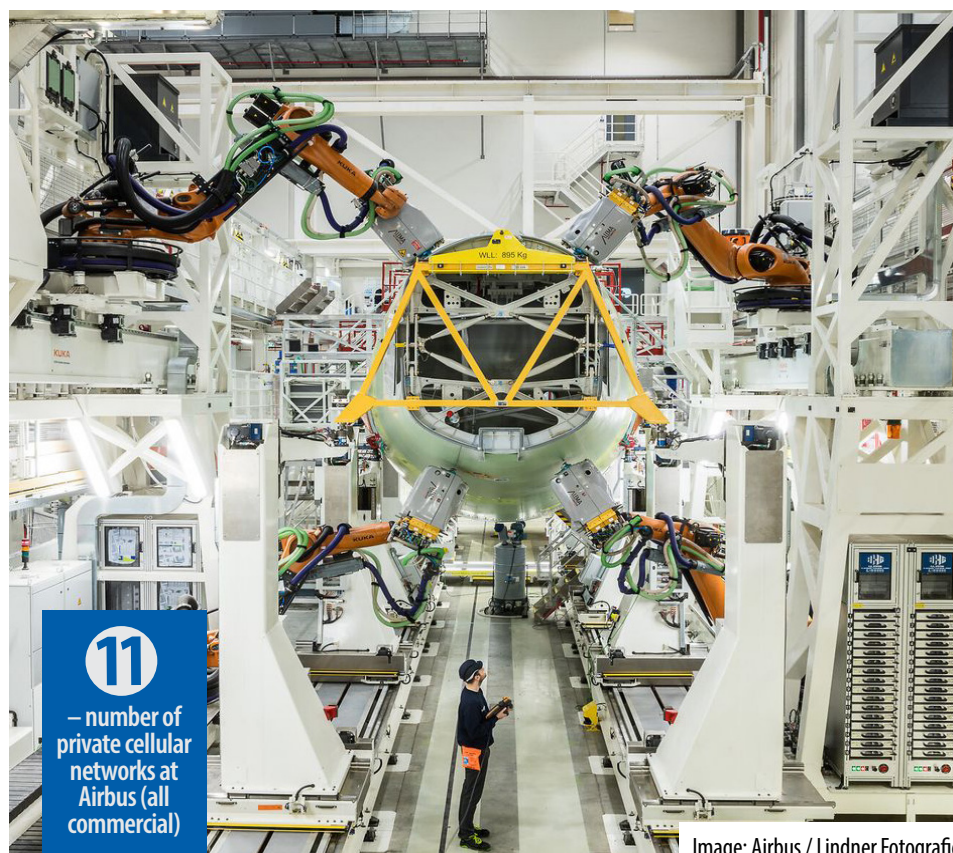


Image: Airbus / Lindner Fotografie

rest of Hannover Messe, Siemens regards 5G as a nascent technology with a lot to prove – at least for difficult IoT workloads. “Challenges persist”, it says; its features and capabilities, as set out in the 3GPP release schedule, make for a developing feast, which is only generally served-up in courses on commercial plates after three years in a sticky ecosystem marinade.

“Why should I have to defend that, actually?” shoots back Sander Rotmensen, Siemens’ one-time *Mister 5G*, responding to this tardiness charge, during a conversation in a back-room in Hanover (just prior to taking charge of the German firm’s new Industry 4.0 cybersecurity unit). His company is not late-to-market, he says. Its strategy has been deliberate, from the start; its timing is right. It has kept to its word, he says, by preparing a self-made cellular system for a summer debut, just as industrial users get serious about private 5G.

Because the 5G narrative only really joins this IoT tale on the shop floor from now, properly knitting-into it through 2024/25 and beyond; everything that has gone before is a scribble and a draft. Rotmensen says: “You heard Volkswagen, on stage with me; it said, three years before it gets mainstream in its factories. Airbus said the same: three years. Everyone thinks it will be mainstream three years from now. So why do something quicker, just to be early? Demand is [just starting to] grow; early adopters are [just starting to] invest... So tell me, why exactly are we late?”

There is lots still to do behind the scenes, the message goes.

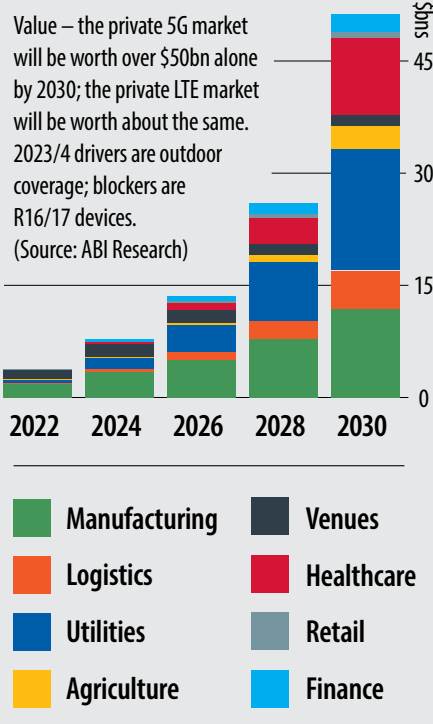
## 1 | PLOTTING TIMELINES

As discussed, and as per the headline description, this article is in three parts, loosely; except that the last part, about ‘making bets’, will focus on only a couple of a gambles, and the whole rest of it will be scattered with minor wagers. But we start with ‘plot-



Klaue (right) – Airbus’ IT chief, speaking at Hannover Messe, flanked by Klaus Dieter-Tuchs from Volkswagen (far left), Andreas Mueller from Bosch / 5G-ACIA (second left) and Sander Rotmensen from Siemens (second right).

## Private 5G – market value



ting timelines’, leading from the preface discussion, and hand directly to Leo Gergs, principal analyst at market advisory firm ABI Research. “The market is in a transition phase – going from trials and proofs to real commercial deployments,” he says, splitting the difference between Volkswagen and Airbus.

Gergs provides a state-of-the-market address about how private 5G sales will develop in the period to 2030 – to the tune of \$50 billion (see left), eventually, and significantly more (“roughly twice as much”) if private LTE revenues are counted on top. “By 2030/31, we will reach a turning point, where private 5G takes over from 4G as the dominant cellular-based enterprise networking technology,” he comments.

So there is our first definitive calendar-marker, stretched even further, from the mouth of an independent market analyst: private cellular will be an LTE market (by volume) for another five years at least. Place your bets; because, very clearly, the road for private 5G, as a springboard for industrial IoT, is a long and winding one, as yet.

At the same time, of course, the incline is rapidly steepening, in order to get to that

LTE/5G changeover point. The question goes to Jagadeesh Dantuluri, senior director for private networks at test and measurement company Keysight Technologies, also acting chairman for one of the 5G-ACIA working groups dealing with IT/OT crossover in industrial 5G systems. *Does that \$50 billion / 2030 statistic tell us how far private LTE has come, or how far private 5G has to go?*

He responds: "Most deployments, today, are on LTE; but 5G is growing much faster. So there is a flipping point sometime next year where most new networks will be on 5G rather than on LTE." Which is another diary date for us (and another roll of the dice), which is even closer than the three-year timeframe spelled out by Volkswagen and Siemens in the intro: that from "sometime" next year (2024), 5G starts to loom-larger in the LTE rearview.

"[The industrial sector turns on] a 10-year lifecycle," explains Dantuluri. "[It doesn't] want to go with 5G [yet] because the cost of 5G devices is too high. LTE performance is good enough for their use cases [now]. But... [Release 16] devices and networks are coming pretty fast, [and] their central theme is this whole industrial IoT movement... Eventually, LTE will not be sufficient... By 2030, maybe a little earlier, 5G [will be] as seamless as Wi-Fi, the cost [will have] decreased, and then we will see what is possible."

## GROUNDWORK AND GUESSWORK

Until then, it is a case of groundwork, guesswork, and gambles. As a measure of progress in the market, German regulator BNetzA told a panel session at *RCR Live* in London in late April that it has issued 312 local (enterprise) licences for private networks in the 3.7-3.8 GHz band; its UK counterpart Ofcom said at the same event it has issued "just around 800-900 [network] licences" at 3.8-4.2 GHz. But most of these, certainly in Germany, are being used in proof-of-concepts. So says the Volkswagen experience, as discussed at the start; so says Siemens, still reeling from its late-ness-charge.

GSA, taking its cues from a select band of

## Private 5G – addressable market

Value – the private 5G market will be worth \$50bn alone by 2030; the private LTE market will be worth about the same. 2023/4 drivers are outdoor coverage; blockers are R16/17 devices. (Source: ABI Research)

| INDUSTRY                   | SITES  |
|----------------------------|--------|
| Industrial / manufacturing | 10.71m |
| Warehouses (logistics)     | 3.3m   |
| Hospitals / labs           | 263k   |
| Utilities (water)          | 140k   |
| Mining                     | 54k    |
| Transport venues / ports   | 50k    |
| Power generation           | 47.6k  |
| Military bases             | 10k    |
| Oil and gas                | 8k     |
| TOTAL                      | 14.58m |

"Why should I have to defend that? You heard Volkswagen, on stage with me; it said, three years before it gets mainstream in its factories. Airbus said the same: three years. Everyone thinks it will be mainstream three years from now. So why do something quicker, just to be early?"

**Sander Rotmensen, (former) Head of Product Management for Industrial Wireless, Siemens**

suppliers, says at least 1,148 organisations in 74 countries had deployed private LTE and 5G networks by the end of March (Q1 2023), up from 1,077 at the end of 2022. Which means 71 new enterprises in three months – at a rate of a little over 23 per month, on average. But however it is counted, the current run-rate is nowhere near the seminal blue-sky figure first presented by Nokia five years ago: that the total addressable market stretches to over 14.5 million enterprise venues, including 10.7 million industrial / manufacturing sites (see left).

Rotmensen at Siemens, hawking a box-fresh new Release-15 system, remarks: "The majority [of licences in Germany] are pilots. We're only really now starting to see the wheels hit the road with private 5G. So the timing is exactly right. We waited for the right technology to be available to offer something which is capable of supporting small and medium enterprises, as well as large ones. Combined with the fact it is industrialised, tailored for OT, I think we have a rough diamond here."

But while this industrialised 5G-future is around the corner, it is also somewhat out-of-sight; meanwhile and still, even if just for another 12 months, LTE is tearing up the road, with clearer navigation and a cheerier payload. Gergs at ABI Research suggests the big promise of private 5G was a scam – at least until now, at least for paying enterprise customers, looking at it as a networking foundation for higher-fidelity IoT.

Release-16 systems will deliver (some of) the industrial-grade networking pyrotechnics written into 3GPP's ultra-reliable low-latency (URLLC) and massive machine-type (mMTC) development streams. But as yet, and as discussed, there just *ain't* much in the way of Release 16 chips and hardly anything in the way of Release 16 devices to attach to Release 16 networks. "The key bottleneck continues to be Release 16 and 17 industrial-grade chipsets and devices," comments Gergs.

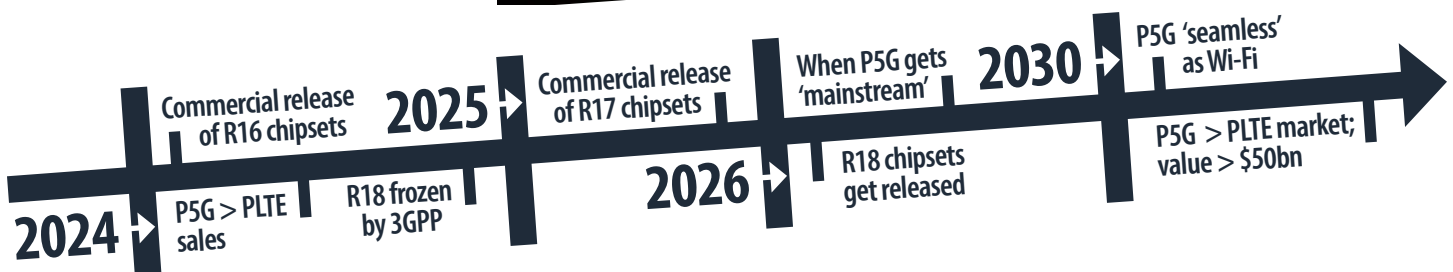
"They are beginning to emerge... We already have 16-capable chipsets for consumer devices, mainly from Qualcomm. But we are not there yet with industrial versions

## FEATURE REPORT

with enterprise features. Towards the end of last year, the talk was that these would start to be available in Q4 2023, reaching scale in the first quarter of 2024."

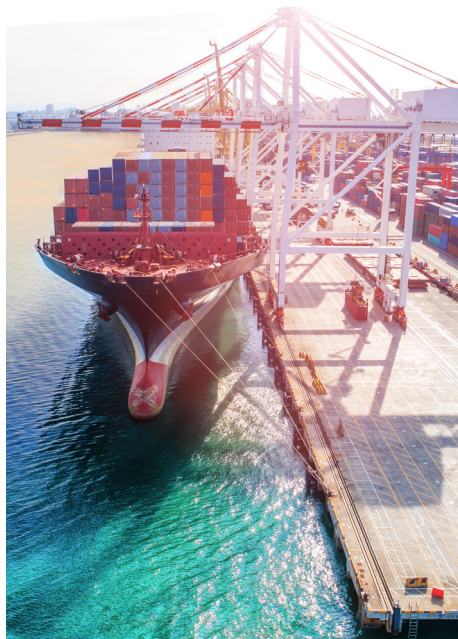
So, there; we have another staging post (and another couple of bets to make): realistically, industrial-grade Release 16 IoT units will become available at the start of 2024; their Release 17 equivalents, to push the industrial IoT journey further along, will make their way into the market at the end of 2024 or start of 2025, about 12 months later – presumably for initial sampling, and not a full-blown commercial rush of new-fangled IoT hardware.

Gergs explains: "We're pretty much there with Release 17, which standardises a lot of the important features of RedCap, for example, and was frozen in March last year. A typical cycle would see chipsets follow 18 months after. But we've seen with Covid-19, and with chip firms more focused on



consumer features, that this does not necessarily hold. So I would put it at two years – as the offset, not a delay." Which is how we arrive at a late-2024/early-2025 date for higher-fidelity 5G-for-IoT.

In the meantime – for the next 12 months, at least; *you can bet your bottom dollar* that – the trade will mostly be in enhanced mobile broadband (eMBB) systems, even if they are dressed up as go-faster LTE on Release 15-level 5G. Gergs references time-sensitive networking (TSN) as the other big IoT promise that cellular is yet to deliver. "The original value proposition was around URLLC, TSN, mMTC – all of which will enable OT systems and data. But we have seen a shift, as the market grapples with the Release 15 [realities] of private 5G,



and what can be done with eMBB"

### ITERATIVE AND EXPENSIVE

While 5G struggles to meet its various commitments, to support more advanced IoT use-cases, everything else comes down to money. The question is: why buy an expensive 5G network when you can do the same work with a cheaper LTE version? In some cases the question is redundant, just because the business case for 5G, over LTE or Wi-Fi, holds up pretty well. An example – raised repeatedly, and discussed in the next section – is to connect large-scale outdoor environments.

For Industry 4.0, these invariably encompass utility networks, port areas, and other industrial campuses. The logic works just because the 5G-cell signal / capacity calculation is better. Gergs says: "The market

is mainly driven by enterprises with large outdoor areas where private cellular is just a much more efficient way to provide coverage – over a wider area with less infrastructure, compared to Wi-Fi. In the end, it is a very straightforward numbers game. You can substitute a larger number of Wi-Fi access points for a smaller number of 4G or 5G small cells – maybe a 10th of the number.”

The bigger the area, the better the return – which perhaps explains why Airbus, often in wide-open aircraft venues, is finding 5G an easier proposition than Volkswagen, say. “The first and most important point is the coverage,” comments Klaue at Airbus. The Airbus manufacturing plant at Hamburg-Finkenwerder airport covers an area of 3.6 square-kilometres. It is already covered (badly, presumably) by 2,700 Wi-Fi access points; on paper, it can be covered rather better with just 60-odd cellular antennas.

But actually, Klaue means coverage in terms of both distance and penetration; cellular solves difficult signalling issues in complex indoor environments, too – in and out of aircraft, too. Airbus will get away with 20 outdoor antennas and 40 indoor small cells, he says, all pegged to the German 3.7-3.8 GHz band. He says: “Cost is a point we are not sure on yet, but we think we will save money with private networks.”

But it is a fine calculation, clearly. Many mMTC cases are already served by a mish-mash of much cheaper non-cellular BLE, Wi-Fi, and LoRaWAN technologies. Which is why the telecoms market so desperately needs reduced-capability (RedCap) 5G, detailed in Release 17, to come quickly, reckons Gergs. “5G has to compete with a lot of IoT tech, mainly on price. As an umbrella solution for lots of different use cases, 5G is not there yet for IoT for mobility and positioning, for example – linked with this bottleneck in the release schedule. Which is why all hopes are pinned on RedCap, which fits somewhere between traditional 5G and current LTE-based LPWA tech like NB-IoT and LTE-M.”

This talk of a stripped-back version of



“The market is driven by enterprises with large outdoor areas ... In the end, it is a straightforward numbers game. You can substitute a larger number of Wi-Fi access points for a smaller number of 4G or 5G small cells – maybe a 10th of the number.”

**Leo Gergs, Principal Analyst,  
ABI Research**



industrial-grade 5G, which blurs the lines between existing 5G-based eMBB and LTE-based LPWA networking technologies, is a good point to pause, to look more closely at the types of IoT applications that are sprung by private cellular systems.

## 2 | DEFINING APPLICATIONS

So, where and how is private 5G to be used for IoT? We have discussed some of this already – or, at least, we have referenced how private networks are being bankrolled, mostly on outdoor LTE and 5G. LTE is important; it is the gateway system for cellular-based enterprise applications, and will, in time, in many cases, give way to 5G upgrades, affording a range of new IoT applications. So while the focus of this report is 5G-based private cellular, it is worth first looking at how LTE is making inroads.

Kathiravan Kandasamy, vice president of product management at Syniverse, a carrier services company that has reinvented itself as virtual operator (MVNO) for global IoT connectivity, acknowledges this loose 5G timetable, for when LTE is outpaced for sales in 2024/25; but he says LTE suffices in most scenarios anyway. “I don’t discount that [some] use cases will require close-to-the-edge latency, and network slicing and so forth,” he says.

“But most use cases, whatever the circumstances, are served with a private LTE solution. And we talk with enterprises, and ask them: ‘Do you really want to invest so much in 5G? What is the driver for it, really?’ Because we have not actually encountered a use case where the workload is so intensive or the latency is so acute that you need 5G – or where it is complex enough that you need some sort of slicing. We just aren’t there yet.”

He continues: “Really, in the past 12 months, and maybe even in the next 12 months, the task has been to educate enterprises about the art-of-the-possible with private networks – whether that is about

high bandwidth, low latency, high security, high density, precise slicing, secure roaming; all of those things are still being played-out. Because today, the question is whether you really need a 5G core – when a run-of-the-mill 4G-LTE core can do what you need.”

But, *hang on*; is there a danger not-to-say to an enterprise it is future-proofed against this art-of-the-possible with a 5G core? “No, I get it,” responds Kandasamy. “And don’t get me wrong, I want to sell a 5G core. But there is a question, still, at this stage, about whether it is worth it.” Indeed – as discussed, and as of-course – money is the definitive factor for any kind of business investment. Even the case for 5G to cover large outdoor spaces looks a little shaky.

Kandasamy, actually selling a “secure” cloud-based MVNO core attached to public-network RAN infrastructure (rather than an all-edge on-prem network system) for national and international mobility cases, says that LTE will deliver equivalent wide-area coverage, if not for an equivalent density of devices. “One of the areas [we are] getting a lot of traction is with power utilities and energy companies,” he explains, referencing the same verticals Gergs suggested previously as ideal homes for private 5G.

He says that 5G has been found out, to an extent, as enterprises have started to look more seriously at the practicalities of private networking. “Eighteen months or two years ago, we were all under the impression that private networks would be driven largely by IoT devices. But the devices on private networks are more or less split evenly between IoT devices and consumer devices – like smartphones, tablets, laptops. Which shows, quite unpredictably, that a lot of these private network use cases have a consumer behind them – a person, and not just a device.”

This is an important point, which brings the whole of the first section of this article into new relief. How much of this market is really just for phones and laptops, rather than sensors and machines? Certainly, much of it newly-exists in academic campuses and public spaces, rather than just in

## The difference between IoT for Industry, and...



Peripheral – 5G-based IoT4I, unlike IIoT, exists as part of production, but also separately of it; IoT cases like tracking and monitoring (top) count as IoT4I in industry; so too do cases like AGVs and AR (bottom). (Images: 123rf, AQ Mesh, Nokia, Lufthansa Technik)

factories and plants – and straight consumer-oriented MBB/eMBB, whether on LTE or 5G, is a draw in factories and plants, also, just as some light-touch IoT is being deployed in so-called ‘carpeted verticals’. *But actually, we don’t care; the remit of this article is about IoT.*

So rather, the question should be: have we been too focused on private 5G in Industry 4.0? Or rather: is our definition of IoT too narrow? *Because* there is a crucial distinction to make between how IoT sensors are deployed in industrial processes, in the task of making or moving things, for example, and how they are used to bring environmental context to core business processes. This is the difference between ‘industrial IoT’ (IIoT) and ‘IoT for industry’ (which might be usefully/awkwardly acronymized as ‘IoT4I’).

### ROLE OF IOT IN INDUSTRY

Most of this article, so far, has discussed hardcore IIoT for hard-nosed Industry 4.0 – as practised and preached by Siemens and Volkswagen *et al.* These terms (IIoT and IoT4I) are used interchangeably, but they describe fundamentally different applications in the Industry 4.0 space – which, on paper, employ different wireless technologies to deliver them. For that, one might read high-power industrial LTE and 5G in critical IIoT-end operations and straighter low-power wide-area (LPWA) IoT standards like LoRaWAN, Sigfox, and utility-focused WiSUN at the IoT4I end.

The former (IIoT) is about volume, variety, velocity in big data, which (possibly, eventually) only 5G-IoT will deliver; the latter (IoT4I) is for more discrete IoT monitoring in industrial venues, and is well served also by a bunch of shorter-range indoor tech like BLE and Wi-Fi, plus of course cellular-based wide-area (LPWA) systems running on 2G and 4G, as well as 5G-RedCap. Mobility use cases, mostly for sensor-based IoT asset tracking, but also for orchestrating high-bandwidth mobile robots (AGVs, AMRs, and suchlike), are an adjunct of the latter IoT4I category, actually; they are not integrated process-bound IIoT functions.

So too are industrial ODM applications, to provide machine monitoring as-a-service (as offered by machine makers to drive new revenues); so too, in fact, are the kinds of trendy remote AR assistance tools that are currently bringing new value to industrial workforces. Some of these IoT4I cases are propped up by public cellular infrastructure; many others are bankrolling new private LTE and 5G installations. In the case of Airbus, most busily rolling out private 5G infrastructure, the revelation has been to reliably and predictably connect an assortment of handsets, headsets, tablets, and robots.

Klaue, in the firm's IT department, lists the initial use cases Airbus is looking to enable, or to migrate from Wi-Fi: basic connectivity for sundry mobile devices to link to the manufacturing execution system (MES) on site; augmented and virtual reality (AR and VR) applications, notably for remote support, assistance, and inspection; plus for some robots, and commonly for "moving platforms" to transport aircraft parts, and classically for automated guided vehicles (AGVs). All of them are IoT4I applications. These are not really IIoT applications, which hinge completely on next-gen 5G.

They are in the IoT4I camp, and are decently served either by common LTE technologies, and even better by existing (Release 15) 5G systems – so long as devices are available. In the end, the reality is this: IoT4I covers a broader set of enterprise applications, many of which are already-familiar in the LPWA networking space, and many of which are gaining traction with new private LTE/5G networks; and IIoT, geared for industrial production and processes, and held up as the ultimate incarnation of Industry 4.0, is a gnarly mess of an ecosystem-play which will take years (2030/31) of tech and teamwork to come off.

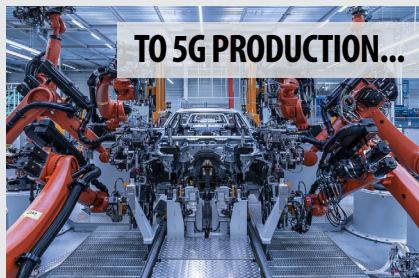
Indeed, IIoT is, quite literally, a *cluster-f\*ck*, suggests Bernd Gross, chief technology officer at Germany-based Software AG, in charge of the firm's IoT and analytics business, which supplies data management tools to a bunch of industrial machine makers. These include the likes of Dürr, DMG

## ... Industrial IoT (IoT4I vs IIoT)

### FROM 5G-CONTROLLERS...



### TO 5G PRODUCTION...



### TO 5G-FLOORS & WALLS (?)...



### TO LIGHTS-OUT FACTORIES?



Control – 5G-based IIoT, unlike IoT4I, is knitted into critical production systems, notably in PLCs (top; c/o Siemens), to bring high-fidelity orchestration to Industry 4.0 (second top; c/o BMW); ultimately the vision in greenfield sites is for fold-up/down production islands, connected even with 5G-floors and walls (c/o Bosch) and 'lights-out' manufacturing (c/o VW).

MORI, and Zeiss, as well as makers of things like wind turbines (Nordex and Enercon) and medical equipment (Boston Scientific and Eppendorf), plus IoT providers of various stripes, such as AWS, Deutsche Telekom, Microsoft, SAP, Siemens, and others. He knows the trouble with IIoT very well.

"It is much tougher; it requires a lot of manual consultancy and professional services work," he says. The slight problem with the Software AG analysis is it reverses the IIoT definition; for internal purposes, the German firm groups all these industrial machine makers, selling connected-equipment monitoring as-a-service, under the IIoT banner, even though their machine data is not being made available directly to production lines. "We define IIoT as wind turbines and elevators, and things like that. We don't think about it as the factory floor, as such, even if some of these machines are being used on the factory floor. Which is how others think of Industry 4.0 (and IIoT)," he explains.

"For that factory-floor case, you have to look across all the machines, to entire production lines, which are multi-vendor. And for that, you need a different skill set... It is impossible for anyone to do all of that alone. Our strategy is to go with system-integrator partners, to use our technology for energy management, performance management, workflow management, and so on. There is a lot of investment in that area, but for us, as a product company, it is a partnership play. Whereas [IoT4I, according to our definition] with equipment makers is our turf, where we are growing fastest."

## ISLANDS IN THE STREAM

The blurred definitions complicate matters; but the meaning is the same. Which of these two IoT disciplines will be bigger, more important, more transformative? We will come back to this in the next section; the point, now, is that plain-old IoT cases, of all different kinds – rather than complex IIoT cases – are driving this enterprise 5G tale. (Volkswagen's hangups are mostly to reverse-fit 5G into this parallel IIoT narrative.) Kandasamy's earlier point about the

popular short-term consumption of private cellular, for inter-enterprise roaming with smartphones and sensors, is a good one.

It also brings into view the role of traditional public infrastructure to stitch together and annex parochial 'island' networks running in enterprise premises. Most of the use cases for this hybrid public/private network crossover have one thing in common: mobility. Somehow unpredictably, but perfectly logically, it puts big telcos at the heart of the matter. Except, maybe it doesn't. The likes of Syniverse – piggybacking on national carriers in each market, in hundreds of markets – can offer near-global mobility for IoT devices to roam in and out of private and public networks.

And they can do it with a single multi-IM-SI embedded SIM (eSIM; eUICC), which enables IoT vendors to provision devices at the point-of-sale. So why choose a national telco for international IoT? That's their argument. Syniverse also has a patented mechanic, it says, to prioritise private networks when in-range of the enterprise (in-bound roaming is complex), and a promise of enterprise-grade security when the SIM attaches to a macro network. "In a private network, you have all of these IoT devices, and all these consumer devices, as well. But not all of them are stationary," explains Kandasamy.

"Lots move about, including off-site. A private network is not enough... Some of the easy use cases are in transportation and logistics – like a truck or a package, covered in the distribution centre by a private network, and attached to a carrier network when it leaves the site; which then rejoins a private network at its destination. We are seeing increased demand for that kind of mobility."

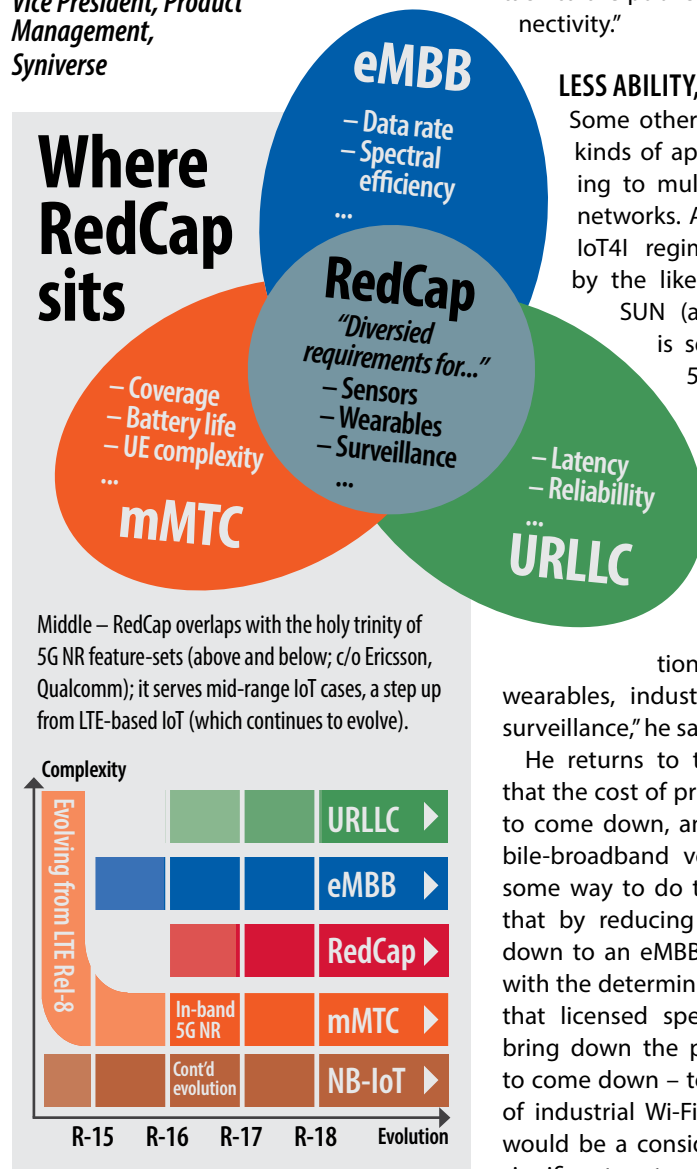
But Kandasamy also suggests a global IoT roaming SIM, providing fallback to a macro network in case of outages or failures, affords the kind of comms redundancy ('ultra-reliability'; effectively) that is, typically, offered as a feature of incoming industrial-grade 5G-IoT (URLLC) networks. In truth, it is not the same (redundancy versus reliability), but the value of public-network

"The assumption is private/public interoperability is for mobility, and the private network is built with five-nines availability; but one of the advantages is that if that private network goes down, the devices automatically attach to the public network."

**Kathiravan Kandasamy,**  
**Vice President, Product**  
**Management,**  
**Syniverse**

failover is proving to be "critical" for certain verticals to load sensitive operational data onto private networks.

"It is a redundancy play [not a mobility play]," he says. "The assumption is private/public network interoperability is for mobility, and that the private network is built already with five-nines (99.999 percent) availability; but one of the advantages – for airports and utilities, for example – with overlapping macro coverage is that if that private network goes down, for whatever reason, all of the devices automatically attach to the public network and retain connectivity."



### LESS ABILITY, MORE POTENTIAL

Some other quick points about the kinds of applications that are starting to multiply on private cellular networks. As discussed, this private IoT4I regime, already well-served by the likes of LoRaWAN and Wi-SUN (and BLE, Zigbee, Wi-Fi), is squarely in the sights of 5G RedCap, along with a bunch of other higher-bandwidth machine applications – according to the 3GPP master plan, at least. Gergs at ABI Research outlines likely RedCap-for-IoT applications: "We're talking about wearables, industrial sensors, and video surveillance," he says.

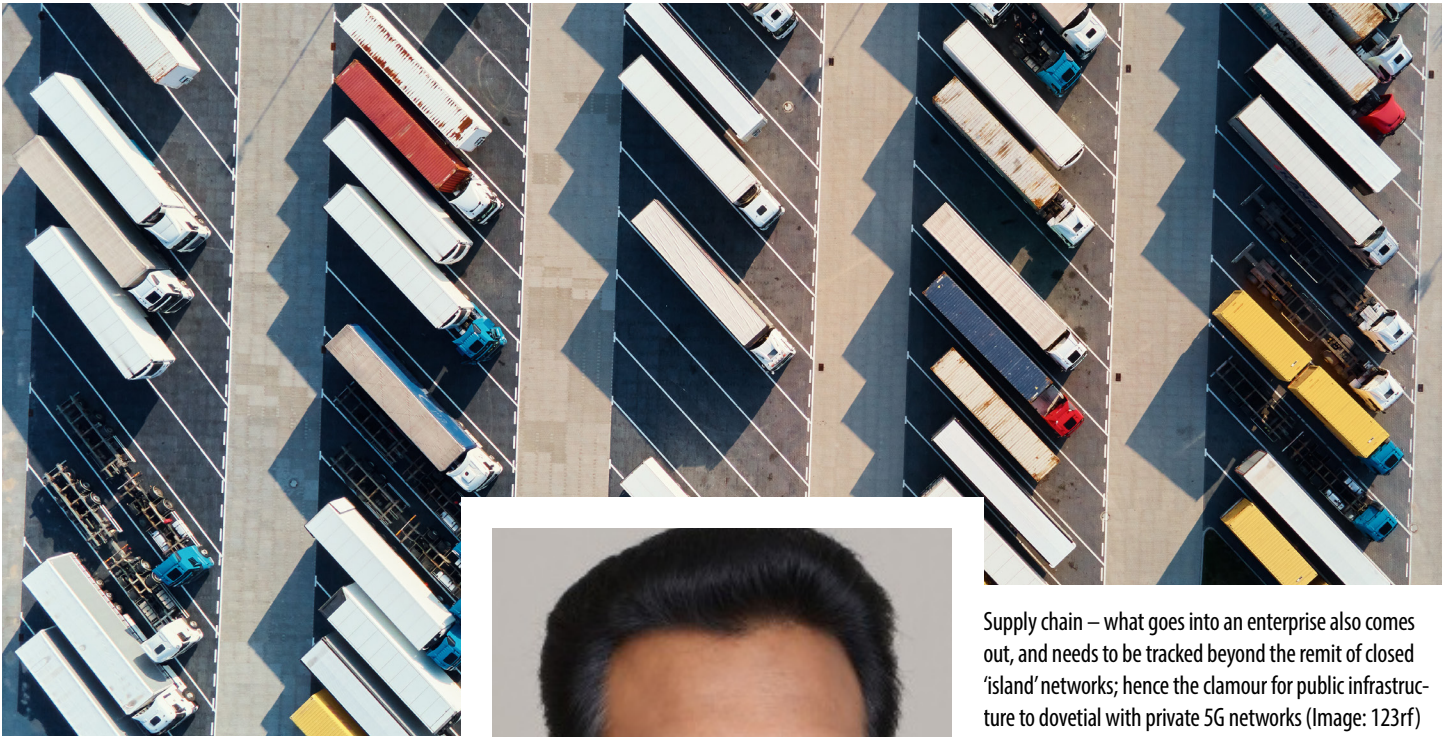
He returns to the note about pricing; that the cost of private 5G networks needs to come down, and that a cut-down mobile-broadband version of them will go some way to do that. "The expectation is that by reducing the capabilities of 5G, down to an eMBB technology, essentially, with the deterministic networking features that licensed spectrum brings, will also bring down the price. And the price has to come down – to at least twice the price of industrial Wi-Fi at the moment. Which would be a considerable reduction, but a significant cost centre still," he says.

**syniverse®**

# Private Networks don't have to be Islands

Syniverse's Private Wireless Network solution allows mobile devices to roam seamlessly between private and public networks extending a private network's reach both regionally and internationally.





"A lot has to be done on that front," he adds. Gergs goes on to ask (out-loud) how urgently industrial (IIoT) cellular, even if it is priced like industrial Wi-Fi, is actually required – if the kinds of cellular-based (IoT) mobility cases Kandasamy references are also removed from the equation. "There is a question about whether enterprises will switch if they don't need mobility, and if Wi-Fi works fine. I think they won't, and I think it is something the telco industry has come to terms with; it has moved away from this idea of a quote/unquote 'panacea' where 5G replaces everything."

Which begs the question: what is private 5G good for, actually, if mobility is provided by public infrastructure, and enterprises will not move away from Wi-Fi *et al* just for the sake of it. We know the answer, of course, although the counter-response remains that LTE will sometimes suffice: that whether it is initially deployed as an LTE or a 5G system, private cellular is providing valuable in-house mobility for automated guided vehicles (AGVs) and autonomous mobile robots (AMRs), and suchlike, with better bandwidth and cell-handover than



"Torque machines are being connected to 5G. But they are simple swap-outs... [and] quite different to connecting PLCs, which control millions of dollars of production. If you subdivide Industry 4.0, 5G is only being used for less-critical cases. It will take time to trust 5G with critical apps."

**Jagadeesh Dantuluri, Senior Director for Private Networks, Keysight Technologies**

Supply chain – what goes into an enterprise also comes out, and needs to be tracked beyond the remit of closed 'island' networks; hence the clamour for public infrastructure to dovetail with private 5G networks (Image: 123rf)

Wi-Fi affords.

This is a well-understood private 5G-for-IoT use case, but it remains an IIoT discipline; others blur the MBB boundary, but are no less potent. Notably, as discussed, private LTE/5G is providing the kind of remote coverage, predictable latency, and decent (upload) bandwidth to support certain modish new collaboration tools such as industrial AR for knowledge transfer and remote assistance, where video streams can be shared and annotated to train staff in the office and guide workers at the coal-face.

Clearly, however, there is a two-speed IIoT market developing with private networks, between sensor-based IIoT applications in (white- and blue-collar) enterprise venues, and complex IIoT systems in collaborative Industry 4.0 systems; the last of these is moving more slowly, but may yet come to define digital change in the 5G era. Dantuluri at Keysight Technologies has a sensible view of it. "If you sub-divide the use cases in Industry 4.0, there are some basic ones," he says.

"Things like screwdrivers, and other kinds

# What is 5G RedCap, and what will it mean for cellular IoT?

**R**elease 17 of the 5G New Radio (NR) standard, frozen in June last year (2022), fixes a problem for cellular-based sensor comms with the emergence of a cut-down version of 5G for massive-scale IoT deployments, called reduced-capability 5G (5G RedCap), which promises simpler hardware and cheaper costs. It presents a commercial pathway in 2024 for LTE-based massive machine-type comms (mMTC) to migrate onto single 5G-based networks.

Provisionally, RedCap sits between mMTC and enhanced mobile broadband (eMBB) in the 5G NR power hierarchy. To add context; it sits two rungs below ultra-reliable low-latency (URLLC) 5G, which affords the headiest view of IoT comms in this 3GPP ladder – more commonly presented as three points in a 5G NR family triangle. Until now, the thing about these three specification-types, which RedCap seeks to put right, is that only two are 5G-native. The twin low-power wide-area (LPWA) technologies underpinning mMTC are LTE-based, albeit compatible with 5G NR radios.

And only these technologies, ultra low-power NB-IoT and 2G/3G-like LTE-M, offer support for stripped-back, dirt-cheap, long-life, mega-scale IoT. So, as it stands, and going forward, cellular IoT needs LTE to make a fist of traditional IoT, at all – and it has a fight on its hands with well-entrenched non-cellular standards like LoRaWAN in unlicensed bands. But RedCap promises to fix that – somewhere down the line (as always with cellular!) in 2024.

RedCap is designed, effectively, to



“The price gap between 4G and 5G modules is one of the essential factors – if not the most crucial one – that will limit 5G adoption in IoT... Without RedCap, 5G is missing a key technology piece for IoT.”

*Omdia*

make this 5G NR family-tech triangle into a venn diagram (see image, page 10), where it overlaps with the other three operating scenarios. In terms of capabilities, it is supposed to plug a hole. Network vendor Ericsson comments: “RedCap is positioned to address use cases that are today not best served using eMBB, URLLC, or LPWA (LTE-based mMTC) solutions.”

It is positioned “lower segment than eMBB... but higher than LPWA,” it writes. Huawei says the same (word-for-word, perhaps lifting from the same 3GPP messaging). Elsewhere, Qualcomm slots RedCap in between (see image below) mission-critical IoT, currently served by consumer-like NR-based eMBB and shortly served by developing URLLC provisions, and massive-scale IoT, served by non-NR NB-IoT or LTE-M (or non-cellular LPWA tech like LoRaWAN).

Analyst house Omdia calls RedCap the “big missing piece of the 5G IoT puzzle”. But operationally, it is closest to LTE-M, described as “the most popular and widely used cellular IoT standard” by Omdia – and therefore to 2G/3G, still being used for legacy cellular M2M devices. Certainly, many of the use cases sound the same: the standard 3GPP line is about industrial sensing, video surveillance, and wearable technology.

Omdia says LTE-M-level pricing for NR-based IoT gadgetry, to serve similar mid-level IoT use cases, is just the ticket for the cellular industry to make a sustained go of massive-scale sensor networks. It notes a 10-time (1,000 percent) delta between LTE-M and eMBB module costs, as it stands, going from \$30 to \$300 per unit, respectively; there is no NR-provision, until now, for such “mid-speed (IoT) applications”, it says.

It writes: “The price gap between 4G and 5G modules is one of the essential factors – if not the most crucial factor – that will continue to limit 5G adoption in IoT applications... Without RedCap, 5G NR is missing a key technology piece for IoT.” ●

of industrial torque machines, are increasingly being connected to 5G. But those are simple swap-outs of the connectivity module, from Wi-Fi to 5G. The other big IoT use cases are to connect AGVs and HMIs (human-machine interfaces; the graphical displays that allow operators to interact with machines and controllers). Those things are being rapidly connected to 5G, wherever private 5G is deployed."

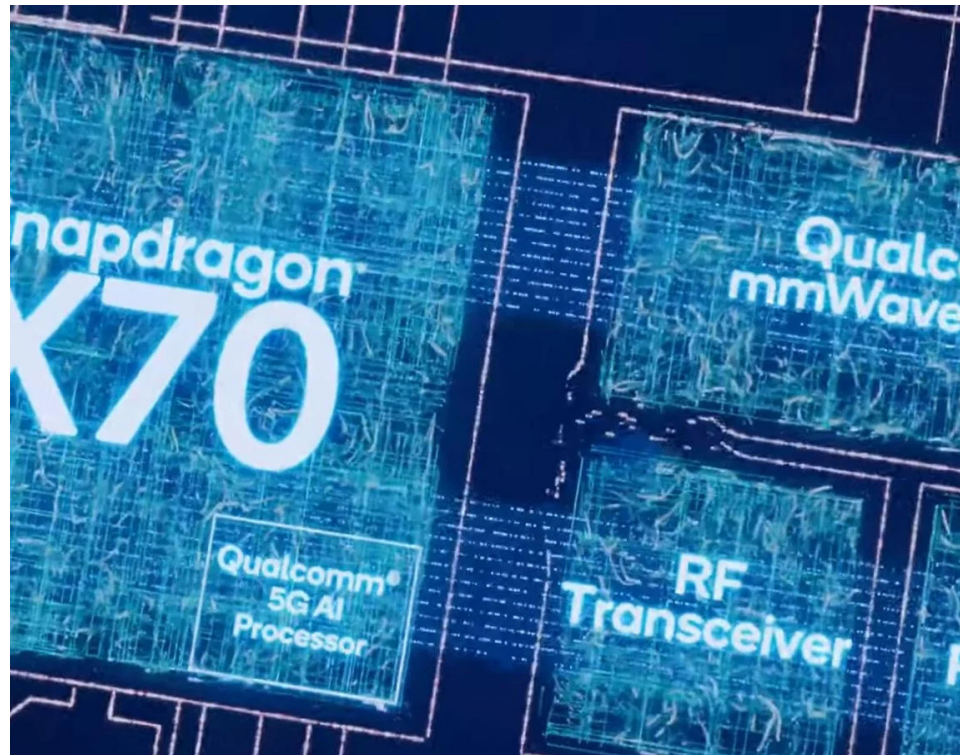
He goes on: "But these are all quite different to connecting a PLC (programmable logic controller; the industrial computer running a manufacturing process) to a 5G network. Which is a critical application, controlling multi-millions of dollars of production. So yes, if you subdivide Industry 4.0 into less-critical and more-critical use cases, then right now 5G is only being used to connect less-critical use cases. It will take some time for enterprises to trust 5G with these more critical applications."

Indeed, as per the last section, it will likely take until the late-2020s, into 2030.

### 3 | MAKING BETS

**A**nd so we come, on our winding journey, to finally place some bets. This is the hardest part to write, just because the wheel is spinning so fast, and all the colours are different; there are so many bets to place. To keep this simple, we will consider only a few of the big themes: importantly, how private 5G will play with Wi-Fi in enterprises, as a network for IoT-connected sensors and solutions, and, as a spin-off, how much it will integrate with Wi-Fi; also, who the likely winners and losers in the supply of private 5G-IoT systems will be; and, finally, whether all the hype and bluster is even justified.

We should deal immediately with this some-time myth that 5G will replace Wi-Fi, as a one-tech salve to remedy sundry IoT networking headaches. All bets are now off; this will not happen – concludes everyone. The notion, pedalled in the early days of 5G, has been rejected as empty postur-



Chipsets – as always, the availability of 5G solutions comes down to the availability of 5G chipsets from the likes of Qualcomm – which has been slow with (or slow to see demand for) industrial-grade versions of Release 15/16 hardware.

ing by the telecoms community. "Will 5G replace Wi-Fi? Nobody expects that, at all," responds Dantuluri at Keysight. "Because Wi-Fi has unique characteristics of its own – it is easy to onboard, and the price points are very low; plus it has its own use cases, connecting to laptops, or HMIs in some cases."

The flipside, of course, and as discussed in this article, is that 5G has its own unique characteristics, too – which will elevate it above Wi-Fi in certain important IoT use cases. "One of the biggest disadvantages of Wi-Fi is interference. And also latency and reliability. Which are all advantages that cellular can provide. So 5G will be preferred for specific use cases. There is no doubt about that... It will dominate in greenfield, and complement in brownfield, but it will always come down to the use case," he adds.

5G-ACIA, the industrial group pitching 5G as the elite IIoT networking option for Industry 4.0, draws the same distinctions, albeit with more punch. A spokesperson

comments: "Wi-Fi is a consumer product that has been modified for industry. The Wi-Fi sector has put in a lot of effort, and Wi-Fi is common in all factories. But it has limitations... Whereas 5G was developed from the start with all these promises [for industry] – about spectrum capabilities, ultra reliability, low latency, and so on. We didn't want the same mistakes with 5G, so we sought to shape it in the standardisation process."

"Which is what 5G-ACIA has been doing for five years. But the job is not done. There is work to validate and modify the standard, and to bring it into chips – and chips to components, components to machines, and machines to assembly lines; and then into the whole factory environment. The ecosystem is there, but the technology is not really fully available. We are at the mid-way point, somewhere. Industrial devices are now needed, and they are coming step-by-step."

It is a definitive summary about the work that has gone in, and the work to be done,

as described in parts one and two. And it would work as the last word on the matter, so far as this report goes – at least in consideration of the 5G-for-IIoT discipline. *Trust in the process, as the cliché goes*; but where does this process lead, finally, and where does it leave Wi-Fi? If anyone is going to put the boot in, then 5G-ACIA, as per its remit, has the steel-toed 5G kickers for the job. “Industrial 5G is for any sector that requires reliable and deterministic communications,” comes the response. “We think 5G [will be] like electricity or water; no one asks whether you want access to electricity or water.”

In the end, it is the same conclusion as Dantuluri’s, as well: that 5G will be a crucial complement and not a rowdy replacement for Wi-Fi in enterprise venues. *So, if they are complimentary in brownfield sites, is 5G dominant in greenfield venues, as busily erected for near-shoring?* “That is the billion-dollar question. 5G will be the standard technology in the future. So you have 230 volts, 50 hertz – as the standard. [And then you have 5G.] Some applications will use other technologies, like Wi-Fi... These others will not be fully replaced, but the key one will be industrial 5G – with dedicated spectrum.”

As an aside, the point about spectrum, annexed in many markets for exclusive enterprise usage, should not be skipped over. Rotmensen at Siemens responds to a question about 5G’s distinguishing marks. *So is the business case mostly about reliable coverage, mostly for mobility – as the start-point for a sales discussion, at least?* “Yes. Plus the private spectrum,” he responds. “That is the unique part, right? It is the first technology ever to give industry private spectrum. And that is the key driver behind the reliability case because there’s no sudden interference – because you know exactly who is using your spectrum.”

But, despite the prevailing wind in regulatory markets, relatively few countries have released dedicated enterprise spectrum. Siemens, with a considerable Wi-Fi base already and a developing Wi-Fi 6/7 portfolio to be going on with, remains completely invested in Wi-Fi, and expects its customers



“There will be a mix of [5G and Wi-Fi] on the shop floor... They will go hand-in-hand. Some might think they will tackle everything with a single technology, but they are wrong. In the end, they might tackle everything with a single network, with all these solutions integrated into one, but not with a single technology.”

**Sander Rotmensen, (former)  
Head of Product Management for  
Industrial Wireless, Siemens**

to be so as well. “For us, this (Wi-Fi story) is still full-on. And it will stay full-on, because if we just look around the globe, we have around 190 countries we can serve and we only have private spectrum in 15, or so. So we need something for those 175 other countries as well” remarks Rotmensen.

He adds: “There will always be a mixture of both technologies on the shop floor... They will always go hand-in-hand. Some end-users might think they will tackle everything with a single technology, but they are wrong. In the end, you might tack-

le everything with a single network, where all these solutions are integrated into one, but not with a single technology.”

So there’s a bet: that 5G will not replace Wi-Fi; not completely, not in brownfield sites, and not in the short or medium term. Instead, whether for IoT sensing or IIoT optimisation, it will bring better performance in some existing use cases, but mostly enable brand new applications.

## COEXISTENCE AND INTEGRATION

But let’s pick up the subtler (related) point about Wi-Fi coexistence, and how 5G and Wi-Fi are growing closer together at an operational level. We should return to Volkswagen, which kicked off this whole debate. Dieter-Tuchs, in charge of network planning at the German car maker, told Hannover Messe that a prerequisite for his team is to ensure 5G integrates with existing networks in its plants – into a single IT-led management platform from which to control all local connectivity, devices, applications, and data. The challenge for the telco market is to extricate the central management system from “inside the 5G network” and place it instead in the internal network IT system.

3GPP has a non-3GPP (non-cellular) interworking function (N3IWF) to enable Wi-Fi to run over 5G core networks, plus with N2 (control plane) and N3 (user plane) interfaces in 5G radio networks. But it remains a (Release 18) work-in-progress, like so much of hard-core 5G-IIoT. 5G-ACIA explains: “OT/IT integration is a key pain point. Nobody wants two manufacturing systems. They want one, driven by IT... The work has been done with this exposure interface. But it is within the scope of Release 18 to bring it into products. Which is the challenge; all these requirements are being met, but it just takes time.”

But the Volkswagen demand, a red line apparently for the whole Industry 4.0 movement, goes further. Its challenge for telecoms is to, somehow, shift industrial cellular away from a SIM-based device authorisation model to a certificate-based access model, in line with Wi-Fi and other

LAN technologies. Dieter-Tuchs says: “The advantage of certificates is you have a completely electronic [and] automated distribution process for adding those certificates to end devices. [Most] 5G end devices have SIM cards, which [require] a manual and complex [authorisation] process by comparison.”

Even embedded SIMs (eSIMs), useful for global distribution and authorisation, as the Syniverse proposition attests, require the involvement of the original device maker. “[It] is still more complicated than the certification process... We would like to see 5G end devices use [certificate-based] authentication mechanisms.” These are big asks (big bets), which are either in-the-works or, according to some telecoms parties, off-the table – at least as a short-term gamble. Just because ditching a SIM-based authentication system sounds like a major fundamental change.

Kandasamy at Syniverse responds: “It is, and it goes to the question: do we still need a 10 digit phone number? I think we are still way off that, today. We are not there yet.” He notes the work by 3GPP, as well as the Wireless Broadband Alliance (WBA), to simplify device authentication – or, actually, to “use cellular authentication for both” – and also the inexorable eSIM/iSIM trend away from rigid physical SIM authentication. But he observes the legal requirements for IMSI-based user identification in the SIM profile, and the feature benefits that can be enabled with it.

He says: “A lot of the feature-functions we have built are based on the IMSI. Because we know which IMSI the device is using, which is how we actually apply that control. And IMSI is unique.” *So is the argument that cellular cannot be simplified to Wi-Fi levels? That it is more complex, necessarily, and by nature – and won’t be box-shifted like Wi-Fi into IT operations anytime soon?* “Yes. I believe so; in the near term, absolutely. It is not going to change even with 5G.” So as discussed, then: Wi-Fi integration is a sure-thing; Wi-Fi authentication, meanwhile, is a more speculative play. But both are long-term bets.

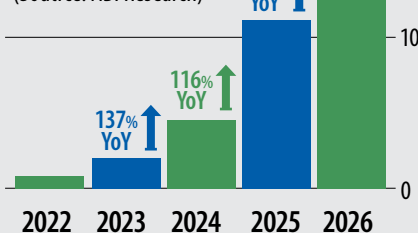


IT / OT – but who makes the decision on 5G-IoT, who pays, and who manages the total solution? (Image: 123rf)

## Total 5G-IoT connections

Connections – the number of 5G-based IoT connections will surge by over 200% between 2025 and 2026; the key is the introduction of RedCap, to reduce 5G costs, and make 5G suitable for an array of tracing and monitoring cases that have been traditionally served by non-cellular LPWAN technologies.

(Source: ABI Research)



## HOW MASSIVE, IOT?

Finally, *with no time left*, some quick bets on who will win the supply-side face-off, and just how big and important 5G will really be for enterprises. Let’s approach these as a single accumulator gamble, and start and end with the question about the market’s potential, and fill in the middle with something about the likely fortunes for the various runners and riders. A new report from analyst group SNS Telecom & IT, based out of Dubai, says global spending on private LTE and 5G network infrastructure for vertical industries will grow at a compound annual rate (CAGR) of about 18 percent between 2023 and 2026.

By the end of the period, it will account for more than \$6.4 billion; quite how this squares with the apparently-equivalent forecast from ABI Research, quoted towards the start of this article, is unclear. ABI puts the 2030 (‘market value’) total at \$50 billion – just for 5G (and \$100 billion for 5G and LTE); its 2026 forecast is somewhere approaching £15 billion, and presumably more-than-double if LTE’s monster-share is counted, as well (see page 4). *Statistics, hey? What do we have, and who do we trust?* No matter; both forecasts predict awesome spiralling growth; in particular, the

longer ABI forecast says that something seismic happens in the 2025-2028 period.

Two data points: firstly, ABI's calculation about the private-5G market's total value (page 4) predicts almost-double growth between 2028 and 2030, going from somewhere north of \$25 billion to past \$50 billion (growth of around 100 percent); secondly, it calculates the total number of IoT connections on private 5G networks will triple in 2025/26 (growth of over 200 percent), from somewhere north of 10 million in 2025 to closer 35 million in 2026. The SNS forecast says as much as 40 percent (\$2.8 billion) of its total forecast-investment (\$6.4 billion) in private cellular gear in 2026 will be directed towards standalone private 5G networks for Industry 4.0.

These numbers suggest a major mid-term tipping point. SNS calls it "unprecedented" growth, and says most of the Industry 4.0 spend will go to automate discrete and process manufacturing industries, and this whole digital / industrial revolution will "transform private LTE and 5G networks into an almost parallel equipment ecosystem to public mobile operator infrastructure in terms of market size by the late 2020s". This is what the seminal Nokia forecast from 2019, quoted at the start, said, also: that the total market for private LTE and 5G cells is potentially twice as large in straight volume terms as the existing carrier market for macro base stations.

So yeah, even if noisy commentators talk about the market dragging its feet, it is still only going in one direction, and its feet will grow jet-heeled in time. *All the analysis says so; it looks like a sure thing.* It is just that the whole sector is still learning to walk. This is Siemens' defence, effectively, against its charge of lateness. And it was perfectly relaxed in Hanover, in April, defending its 2023/24 strategy with private 5G; almost like it will dictate the pace in the IIoT market anyway. *Siemens is a bit like Paulie from Goodfellas, we suggest to ABI Research – insofar as 'Paulie might have moved slow, but only because Paulie didn't have to move for anybody.'*

*It thinks the OT crowd will wait, we suggest – and does not want anything urgently, or pre-*

*maturely, or until 5G is really ready for industry?* Gergs at ABI responds: "Siemens has always been rcareful with its messaging – mainly because it doesn't need 5G. It will supply whatever, right? It has a presence on just about every factory floor, already – providing some form of connectivity. And the other reason for its caution is it wanted to wait until it had something – [which works] to a satisfactorily high standard [for industry]. It didn't want [the market, its own agenda] to be driven by anyone else; it wanted to come out with a bang. Very few players can dictate the pace [of Industry 4.0], and Siemens is one of them. So, yeah, it has that power."

### IOT POWER-PLAY

*Who else has the power, and, indeed, who has the most power? Now, there's a gamble.* Siemens sounds confident, as one would expect of an Industry 4.0 *goodfella*. It has been around for 150 years, and paid its dues through the end of the first industrial revolution, let alone the fourth one. But Nokia – most notably, as market leader (by longevity, numbers, experience), and with various integrator partners – is also selling hard-nosed



Volkswagen – all the focus, but only a piece of the action

5G-for-IIoT in industrial plants, as well as in ports and warehousing, and certain lighter-touch IoT-oriented enterprise sectors.

Rotmensen responds, referencing his firm's steady flow of industrial WLAN into enterprises: "Let me ask the question back to you: who do you call if you want connectivity on the shop floor? Who do you call first? Siemens, right? You have Siemens PLCs and SCADA systems; so, who are you going to call?" *What about the carpeted office block and the big Bundesliga stadium?* Because we are talking about the entire global economy; we've all seen the analysts' vertical-forecasts (see page 5). Is Siemens focused only on IIoT? "If we can entertain those industries as well, then we will be happy to, definitely," he says.

But, in the end, Siemens' soft-launch in Germany is for a captive OT crowd. Its channel strategy is the same as Nokia's, and everyone else's, insofar as it will go with any serious-looking reseller operation. "It doesn't really matter who deploys it, right? We will work with operators and integrators. If you just look at Germany, all the system integrators have 5G offerings now. It's a smart thing to do, and it would be great if they choose a technology that was developed specifically for the OT market."

But is this an OT decision, actually? Or are investments in private 5G systems really made by IT? Rotmensen says it depends on "the customer and the structure". The impulse is all-IT; the caution is all-OT. The money comes from IT; the buck stops with OT. The management is by IT; the usage is by OT. *Maybe?* Rotmensen comments: "The CXOs want to do something with 5G now, just to get their toes in the water. Moving forward, it will be a joint IT/OT approach. There's not a clear decision path except that it's a strategic decision by management."

Of course, we are talking here very clearly about the power struggle in the supply of private 5G-for-IIoT systems, and less about the IoT4I angle. But it is where the supplier ecosystem is most tangled, and the jeopardy is most acute for 5G vendors. Again, the 2023 version of Hannover Messe was informative. There was no Deutsche Telekom, no Vodafone, no Orange; not that we saw. Telefónica

was there, somewhere, set apart from the telcoms crowd in hall 14; and Verizon Business and Elisa, notably, had decent showings – across from the so-called 5G Arena, bunched in with the likes of Nokia, Ericsson, Dell, and HPE.

But nothing from Deutsche Telekom, the king of the ‘campus network’. It was a conspicuous miss, and a difficult one to square with the telco bluster about industrial 5G at MWC the month before. But AWS was there, as was Microsoft and Google Cloud – and their booths were rammed, with partners and visitors. And the buzziness of their made their hosts out like the “king-makers” in the vendor game. Indeed, if you want a grim omen about the power struggle for tech-cos in Industry 4.0, then Siemens’ platinum sponsorship of the AWS booth was as stark as the Deutsche Telekom no-show.

Except that Siemens, as is right and proper, stole the floor-show with a booth that was so big and so busy that it made your head spin. Even so, the rise of the cloud operators in the broad IoT space, combining both low-brow IoT4I and high-concept IIoT, is impossible to ignore. AWS posted revenue of \$76.5 billion over four quarters last year (Q4 2021 through Q3 2022), with growth at 34 percent in the period; if it repeats the same trick in the 12 months to the end of September, it will have an annual turnover of more than \$100 billion. “Every second server on this planet is going into a data centre owned by a hyperscaler,” remarks Gross at Software AG. “Every second server. It’s enormous.”

Software AG appears on both the AWS and Microsoft stands in Hanover; the hyperscalers aren’t just the “kingmakers” for the wider Industry 4.0 movement, he says; they are the “gatekeepers” to it. “Because their relationships with enterprises have grown so massive; so much of the work flows through them. You have large hyperscalers with a hundred million accounts now; they have captured a lot of the IT budget... People have not realised what has happened over the years. They are in every boardroom. They can say, ‘I want to speak to the CEO of industry-company X’, and they’ll have an appointment within a week”



“You have large hyperscalers with a hundred million accounts now; they have captured a lot of the IT budget... People have not realised what has happened over the years. They are in every boardroom. They can say, ‘I want to speak to the CEO of industry-company X’, and they’ll have an appointment within a week”

**Bernd Gross,  
Chief Technology Officer,  
Software AG**

But actually, as well: Industry 4.0 (or industrial 5G, or IIoT, or *whatever we call it*) is not a straight dog fight. There is a difference, which the cloud community understands. It is business, alright, but it is business of a highly-speculative kind, and on an entirely-massive scale. Which requires suppliers to go searching together, mob-handed, and not always with clearly defined roles or prospects. What is clear – when Gross calls them ‘gatekeepers’ and ‘kingmakers’, and when their stands overflow with partners at trade fairs – is that the likes of AWS and Microsoft

are driving the train into the Industry 4.0 hills.

The thing is; the likes of Software AG sound content (or contentedly resigned) to ride-along, and AWS comes across like a benevolent chief. *Ah, it is easy to be benevolent when you’re top-dog, of course*; except there is none in business. AWS just wants the best team to bring the workloads – to help it pull the gold out of the ground. “Yes, we do have access to a lot of customers, right? Just purely because we are helping a lot of customers with their IT concerns,” responds Michael MacKenzie, general manager of industrial IoT and edge (solutions) at AWS, speaking over coffee at Hannover Messe in April.

“But we have a really broad and deep set of partners. Take Siemens, for example; it is a phenomenal partner. It brings a ton of value when we talk to a customer... Together, we have this really deep and broad story, where, you know, I’m being paged at two in the morning to make sure its systems are up-and-running at all times. It is providing this deep set of services and value to customers, and it has been doing that for 150 years. So between the two of us, we’re able to really hit the customer-need. And that’s what helps to earn trust, and to think about how to serve customers in the best way.”

But, still, it is a tough call to place bets. Industrial IoT is a complex and multi-sided endeavour, and industrial 5G is not ready yet. More generally, the SNS report, quoted above, says traditional mobile operators are squarely in the frame, alongside a new breed of “private network operator”. It notes the value of their broader licence holdings, either as a roaming extension to or local reinforcement of private enterprise networks. SNS says: “[With] extensive licensed spectrum holdings, infrastructure assets and cellular expertise, national operators have retained a strong foothold in the market... [They] are actively involved in diverse projects... [from] industrial environments to nationwide public safety networks.”

It hints at the sheer breadth of this 5G-for-IoT glory trail, followed so excitedly by a wild caravan of adventures.

## AFTERWORD

Two points to conclude: 5G covers more ground than we know, and 5G does not go as far as we think. In other words, a neat and easy discussion about its likely timelines, applications, and successes is impossible. The above section, as much of this report, focuses on an industrialised version of 5G, but 5G will find purchase across a great swathe of economic disciplines (as the various analyst graphics show). Kandasamy at Syniverse says the market is too-obsessed with a future where the kings of industry, like Volkswagen, animate their production lines using Release 18-level URLLC 5G networks.

*Is that the point? That the wider enterprise market does not care about any of that? That this kind of Volkswagen ideal is a drop in the ocean?* “I believe so, yes,” he responds. *And your argument, at Syniverse, is that, actually, the future of private networks is not private networks – but a global network of networks with shared core infrastructure?* “The future is going to be hybrid, absolutely.” Part of the trouble with this vision of 5G-for-IIoT is that it is so intoxicating; the mobile industry has got high on its own Kool-Aid, and painted multi-sided industrial change in primary colours.

And there is disillusionment in the market that it has not happened any faster. Gergs rejoins: “The problem was not all of this was communicated to implementers. *Is that the fault of the telecoms community?*” “Yes,” he responds. *It’s not the fault of all the industrialists that jumped on board; it’s down to the 3GPP-crowd, or at least the network of industry marketing departments attached to them?* “Yes, and the telecoms industry realises that now. It says as much; that it has over-promised and under-delivered, and that it needs now to get this right before it can go any further.”

*Right, so what about this end-goal, this goldmine; this dream of industrial revolution? When does the market deliver high-end industrial automation and lights-out factories? Does that take a decade? Does it take forever?* “A decade, at least,” says Gergs. “We are still talking about basic automation; connectivity as a ‘data pipe’ for existing solutions. In the end, the role of connectivity will be much less

disruptive [than anticipated]. It is like these old sci-fi movies that predicted the future, which overestimated the short-term impact and underestimated the subtler long-term impact. The impact of industrial connectivity will be much less spectacular, on its own, but will also be more widespread and far-reaching than we thought.”

And like AWS says, and like the 5G community says behind closed doors: 5G is “just another tool in the box”, even if it is novel and useful. In the end, industrial change takes a whole bunch of technology, plus a shed-load of money and a truckload of faith; 5G alone will get you nowhere. Ishwar Parulkar, chief technologist for edge and telecoms at AWS, comments: “In the last decade, the value has moved above the connectivity layer to the services on top – the devices and applications that run on top of the networks. That is where the value is.”

*But what did we expect?* Whenever market watchers (shareholders, vendors, analysts, *journalists*) are disappointed with the 5G story, it is because of this gnarly ecosystem mess into which industrial 5G is being birthed. *Is the progress, so far, not completely rational? Is the private 5G market not, actually, ticking-along as expected, perhaps even quite*

*well – like most industrial innovations?* Our well-positioned 5G-ACIA spokesperson reasons: “Yes. And we have had huge successes already – most impressively that so many different industries have experimented with it, and demonstrated its benefits.”

He adds: “That’s the good part of the story; the bad part is there is still a lot of work to succeed in complex industrial environments. The ecosystem has to establish itself, and then follow with products and services – and then it’s a complete story. That’s the challenge. It just takes time. But yes, nobody really expected any different. Factories are long-term investments, and 5G is a new technology, which has to prove itself. That’s just where we are at the moment.

“But by the end of this year, or the start of next, the market will really lift up – based on these proofs by the early adopters. Then the others will follow. But no, this is not new; it is a normal trend – where early adopters play with the technology, and make it ready for industry, and then the whole market follows. So the bottleneck... will be resolved. Many automation companies are working on 5G components and products. But those products have to be reliable and certified. So there is just a lot of work to do.” ●



# 'The future is hybrid' – Syniverse on inter-connecting private 5G

*Carrier services company Syniverse sets out its stall on private 5G – as a market that will be massive, but not as commonly perceived*

**S**o, is the correct way to look at this, then, that the private 5G market, when it talks about private 5G, is obsessed with a future where Volkswagen is animating its production lines using Release 18-level URLLC 5G networks? But that the wider enterprise market does not care about any of that? That this VW ideal is a drop in the ocean? "I believe so, yes," he future of private networks is not just private networks – but a global network of radio networks (public and private) with shared core infrastructure or with the ability to interoperate with each other. "The future is going to be hybrid networks, absolutely."

Some interviews are better than others; this is a snapshot, with truncated answers, of a conversation with Kathiravan Kandasamy, vice president of product management at US-based carrier services company Syniverse. The Syniverse proposition in the private networks market is not new; lots of self-styled IoT MVNOs, working in the same way, are promising private-to-public network roaming, mostly for mobility use cases in the supply chain. But Kandasamy's offer sounds bigger, and more ambitious, and his answers about the wider market are candid.

The Syniverse vision – which rivals what the likes of BICS, Telit, Eseye, and Twilio are doing with cellular IoT roaming – gets lost, arguably, in the noisy narrative around straight all-edge private 5G, being offered by big-brand equipment vendors and up-start network providers, in combination with system integrators and cloud providers. But its horizon is wider, also showing

the (crucial but uncertain) place of national operators in sharper relief – to the point traditional Industry 4.0 looks like a niche pursuit. It is worth a read; all the answers below are from Kandasamy.

## **Explain Syniverse's role in the ecosystem, and its role in the private networks space.**

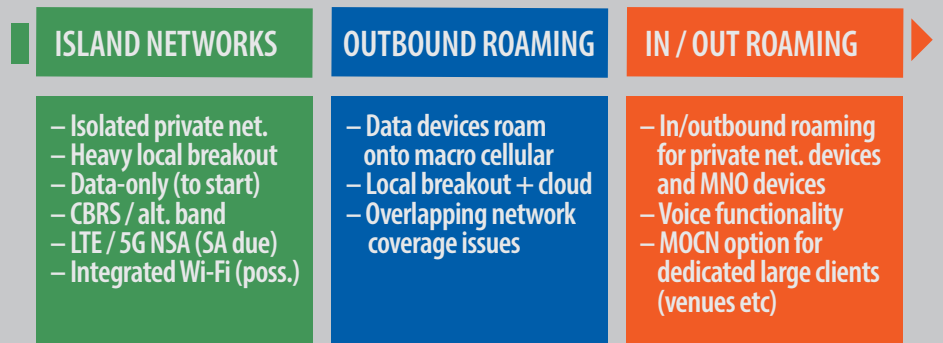
"The carriers use Syniverse as a third-party hub whenever they need to transact – for signalling or data clearing, or whatever. So a lot of it is [about] IP exchange (IPX) services, which is like a private network for MNOs to connect and transact... We are almost like an MVNE; an aggregator. We package connectivity with SIM management, and

with policy and security, for smaller regional carriers, as well as enterprises and resellers.

"We provide a lot of services to companies in Asia Pacific; manufacturing in China and shipping globally – doing logistics, transportation, connected vehicles. They need connectivity when they ship these devices, and Syniverse is the one-throat-to-choke – so they don't have to work with multiple operators, region by region, or country by country. One Syniverse SIM provides access everywhere. And we do eSIM as well, allowing for all types of API support – so all these transactions can be done in software.

"There is no physical exchange of IMSI profiles, meaning customers can order,

## **Mobility, and the evolution of private 5G use cases**



Source: Syniverse

provision, block, suspend, and apply data through our portal or APIs. We are extending carrier features to enterprises.”

***And the private networks piece...***

“Yes, so our focus is to enable those use cases where devices leave the private network and latch onto a macro network. The other angle is to keep these IoT devices secure, and still have that management policy on top. And then, on top, we give enterprises the chance of redundancy. We are working with some utility companies with private networks, for example, which want a fallback to a public network if, for whatever reason, their private network fails – which is what our SIM does.

“We don’t do devices. We don’t do radios, or access points. We do have our own hosted core, so we can provide cloud-hosted core services, but a lot of the enterprises today want on-prem deployments. We provide interoperability between their private network and the public network – for mobility use cases. We rarely go direct to enterprises. We work with system integrators because they tend to be the boots-on-the-ground in the private networks space. And we provide them with the SIM connectivity, a hosted cloud service if required, and all the SIM management. And we work more or less the same way with carriers, as well – to route traffic onto their macro networks.”

***Does the enterprise have control over where you route traffic, according to the service level agreements their use cases demand?***

“Yes. Syniverse aggregates all of that [roaming onto the public network] – so the enterprise only has to deal with Syniverse, which provides access into all of these other networks. So when your devices leave your network, they automatically get access to any of these others, and we can apply policies for whitelisting and blacklisting, and which network to access depending on signal strength or cost, and so on.

“There are so many ways to connect to this network and not to this one, for example, or to only cap data usage; there are so many parameters. But the most important



“Private to public is easy – because the signal fades and the device rescans. The other way is more complex. Most private networks overlap with macro coverage, so the device holds the last active profile. If it’s a UE, you can do the reconnection manually; but if it’s an IoT device, you can’t.”

***Kathiravan Kandasamy,  
Vice President, Product Management,  
Syniverse***

point is that, if you have a hundred private networks, you don’t want to have to strike access deals for every device for every site for every carrier – you just want to connect to Syniverse, which does all that for you.”

***Talk about the primary verticals and use cases for private/public IoT roaming.***

“It started with transportation and logistics – like airports, rail yards, shipping ports – and it has moved into education, into university campuses; and in the past six months, utilities have become very hot. When private networks started, we thought it would be

billions and billions of IoT devices, but really in the past two years, it has been consumer smartphones and laptops that have primarily been driving private network growth. And we also see increased awareness and education for enterprises that their devices can still work when they leave the private network.” However, growth of IoT devices is expected to outnumber consumer based devices in private network deployments”.

***Give a couple of scenarios of IoT devices...***

“The use case for the private network is always about these more advanced use cases they want, or just as a replacement for Wi-Fi. But within that context, there’s always a subset of use cases that require mobility. Not every device on a private network needs to travel or roam; a lot of them will be stationary. But, as we have found as well, in critical industries like the utility space, there is great value that devices can latch onto a macro network in the event a private network fails.”

***Short term, what are you most excited by?***

“There are two things. The first is that, when a device leaves an enterprise, at some point, because of the radio signal, it will detach from the private network and scan and attach to a macro network. That transition is easy; the other way around is much harder – for a device to detach from the macro network and roam back onto a private network.

“We have developed some intellectual property, called Automated Network Reselection, so the device recognises it is in range of a private network and detaches from the macro and attaches back to the private network. And this is getting a lot of traction – because if the device is continuously attached to the macro network, you are actually paying a carrier money.

“Most private networks are built where there is overlapping macro coverage. So the device is always going to hold onto the last active profile. If it’s a UE, you can manually do the network reconnection; but if it’s an IoT device, that is not going to happen. Just because it doesn’t have a screen.”

**And what is the second thing?**

"So the second part is that we think private networks will need a simplified way to connect into carriers. So we are also developing what we are today loosely calling, Private Network Hub, where we can allow private networks to connect to carriers more easily – with Syniverse – instead of approaching every one of them separately. If you want existing mobile network subscribers to be able to roam onto your private network, you still need some sort of agreement with those carriers. We want to be the hub in the middle. We want to organise all of these agreements with carriers, to allow all of their subscribers to roam onto your private network – almost like a neutral host model."

**You mentioned earlier about the security of this private/public network roaming solution; just explain that.**

"Private networks were initially built-out because companies wanted to keep everything within their control. So these island private networks emerged. But today, because of the applications for most of these use cases reside in the cloud, such as when there are five factories running off the same cloud. You want the best private network from a security perspective, but some data has to leave the private network – because everyone is hosting applications with cloud service providers. That is what we are addressing – with private UE IP pools, private APNs, everything. It's an SD-WAN construct. We can route your traffic without ever touching the public internet. So there are a lot of things we can do to keep your data private even while it leaves your private network."

**You mentioned also that, in your experience with customers, that the private networks market, while presented initially as an all-edge setup for machine comms, has morphed more strongly into one for office campuses and the like, where the use cases are driven by basic consumer connectivity for smartphones and tablets. Just say a little more on that.**

"Most use cases, whatever the circumstances, can be met with a private LTE solution. And

## Mobility apps



Source: Syniverse

we ask them: 'Do you really want to invest so much in 5G? What is the driver, really, to go to 5G?' And we have not encountered a use case where the workload is so intensive or the latency so acute that you need 5G – or where it is complex enough that you need some sort of slicing. We just aren't there yet. In the past 12 months, and maybe even in the next 12 months, the task has been to educate enterprises about the art-of-the-possible with private networks – whether that is about high bandwidth, low latency, high security, high density, precise slicing, secure roaming; all of those things are still being played-out. Because today, the question is whether you really need a 5G core – when a run-of-the-mill 4G core can do what you need."

**How does this market develop? Would you say this ideal – about enterprise-sited, enterprise-owned, enterprise-managed high-fidelity private 5G networks is a pipedream?**

"I would say that, at the moment, most enterprises want to get their hands on 5G, and build their own RAN, and manage it all themselves; but that this will fizzle out

over time. It will end up becoming more commonly a hosted and managed service – meaning they will use someone's core, and someone else will run the RAN and core. Because it is not their core competency. And because, in the end, the cost will be less with hosted solutions, which are multi-tenant.

"The vendor providing the solution will make it carrier-grade, fully-robust, with 100-percent redundancy and five-nines reliability, and so on; just at a fraction of the cost, because it is a hosted solution. It could be in a public, private, or hybrid network; it doesn't matter. Like I said, we have so much security control today that if you don't want anything to go onto the internet, then we can do it. Not a problem."

**So is the correct way to look at this that the market at the moment, when it talks about this stuff, is obsessed with a future where Volkswagen is animating its production lines using Release 18-level 5G networks? But that the vast majority of the wider industrial market does not care about all of that?**

"I believe so, yes. It is not just industrial markets. We are banking on 50 or 60 billion IoT devices; every device is going to be connected, right? So when every device is connected, there will be a serious need to apply and manage policy and security on top of all of this. You can't run everything on islands. Because it just defeats the purpose of ubiquitous connectivity. It breaks the model, right? So it will be that hybrid model, in the end – with this level of security for these types of use cases, and with pervasiveness for devices to be here and there, and anywhere. We are even thinking about interoperability between private networks. Because it's going to happen."

**So the future of private networks is not private; it is a network of networks with shared core infrastructure?**

"The future is going to be hybrid networks, absolutely. We are also following the WBA with Wi-Fi 7, and where that goes; and from a performance perspective, the gap with 5G is closing, right?"

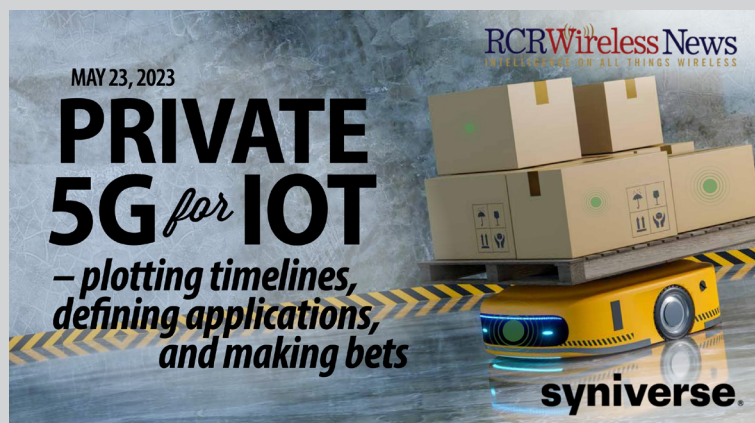
## ABOUT THE SPONSOR

# syniverse®

Syniverse helps enterprises and Mobile Network Operators successfully implement and manage private wireless networks, reliably interconnecting the world's mobile ecosystem, and leveraging the industry's only fully integrated product line.

## Check out the latest webinar...

*... with panellists  
from...*



### PRIVATE 5G FOR IOT | panel

RCR Wireless News  
PRELIEUED BY ALL THINGS WIRELESS



**James Blackman**  
global editor  
in chief

ABiresearch.  
THE TECH INTELLIGENCE EXPERTS



**Leo Gergs**  
principal analyst, 5G  
markets & enterprise 5G

KEYSIGHT



**Jagadeesh Dantuluri**  
general manager, private  
& dedicated networks

syniverse.



**Kathiravan Kandasamy**  
vice president,  
product management

RCR

*In case you missed it...  
check out the companion  
webinar to this report,  
from RCR Wireless, in  
partnership with sponsor  
Syniverse – on private 5G  
for IoT (plotting timelines,  
defining applications and  
making bets).*

- Guaranteed Leads
- Thought Leadership
- Incremental Content
- Marketing Opportunities

Sponsor an *RCR Wireless* multi-platform, editorial program and receive the following benefits:

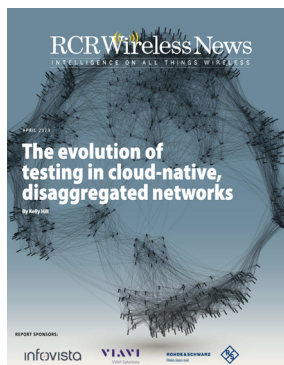
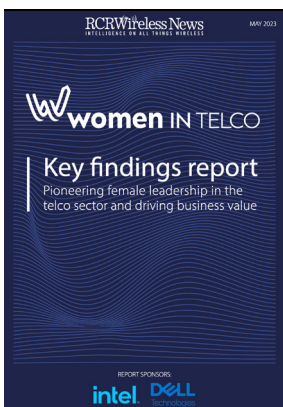
**EDITORIAL WEBINAR** – sponsorship includes 250 guaranteed leads, participation as sponsored guest, and recognition as sponsor in all promotional materials. Sponsors will receive webinar registration and attendee list, responses to pre / post surveys, responses to polls gathered during webinar.

**EDITORIAL REPORT** – in addition to recognition as sponsor in program promotion, sponsorship includes 250 guaranteed leads, distinct from webinar leads, one-page ad spread or advertorial in feature report, and responses to lead capture survey questions.

For information contact: [sales@rcrwireless.com](mailto:sales@rcrwireless.com)

## FAST FACTS ABOUT THE RCR WIRELESS NEWS DIGITAL NETWORK

- 382,000 monthly page views
- 170,000 unique monthly visitors to websites
- 50,000+ opt in newsletter subscribers
- 220,526 monthly video minutes
- 45,000 leads generated annually
- Industry leading demand generation programs and results



## 2023 EDITORIAL CALENDAR

### JULY 2023

#### PIM interference and hunting

Passive intermodulation interference hasn't gone away in 5G networks—if anything, it has gotten trickier to find. Get caught up on current PIM interference issues, challenges and tools for internal and external PIM hunting in 4G/5G networks in this report from RCR Wireless News.

#### AI on the edge – when everything is connected to the cloud

AI is having a major moment. As operators rethink business strategies, with an eye on distributing compute to the reside alongside high-value, latency-sensitive applications, what's the outlook for AI in this domain. The march to network automation to reduce opex and generate new revenues comes with complexity that can't be managed by humans, and a need for responsiveness that can only come from AI.

#### Open RAN reality check – is a multi-vendor plug-and-play RAN really attainable?

Part of the vision of Open RAN has been creating specifications and ecosystem alignment resulting in plug-and-play radio systems. However, the reality today, and the near-term outlook, show this isn't the case; system integration is and will be a key driver of Open RAN deployments. This report examines where we are, the reality of the plug-and-play vision, and how the industry is collaborating to address this aspect of the Open RAN vision.

### AUGUST 2023

#### Beyond mid-band offload, when will mmWave 5G have its breakout?

mmWave is a double-edged sword. On the one hand, it offers additional capacity and blazing fast speeds. On the other, it suffers from signal occlusion and propagation challenges. Currently, this frequency is often used to offload traffic from the further-reaching mid-band spectrum, but this report looks at the unique benefits of 5G mmWave and where this frequency might most shine.

### SEPTEMBER 2023

#### Test, measure, monitor, learn—how operators can make sense of data in a new era of observability

There is a dizzying array of data available to telecom operators on the status, performance and health of their networks; at various speeds and levels of granularity; focused on end-user-experience, or peak network capability. How do you make the best use of that data and translate it into actionable intelligence to validate, assure and optimize network operations?

### SEPTEMBER 19 | OPEN RAN GLOBAL FORUM

#### The new neutral host networks -- how private 5G will change how neutral host networks are designed, sold and operated

The neutral host model is about to change with the increasing availability of private and shared spectrum, including CBRS spectrum in the US, and other 'enterprise' bands globally. This report will look at the implications of private and shared spectrum on the neutral host model, and how it will simplify the design of neutral host networks, and expand the range of potential venues and operators for them.