DIGITAL FACTORY SOLUTIONS: INDUSTRIAL 5G

enterprise iot insights

APRIL 2021

INDUSTRIAL 5G SLAs

– industrial 5G network performance, and the new turf war over the supply and management of 5G in Industry 4.0

by James Blackman
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EXFO VOLTDB

Fire in the hole!

Answers to questions about industrial 5G SLAs – what they contain, who writes them – will light a big-bang charge to remake telecoms

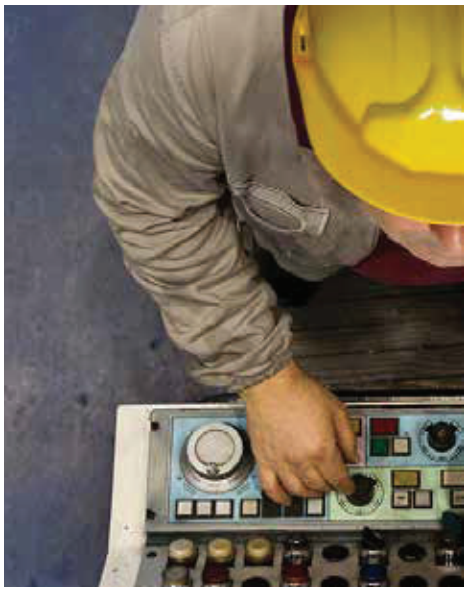
The question about the kinds of service level agreements (SLAs) that will go to support industrial 5G is a powder keg – for industry and for telecoms. Because it asks almost-impossible questions about both the content and ownership of the fundamental networking apparatus being positioned to power Industry 4.0. These twin narratives, hard to disentangle, are alternatively highly speculative and intensely emotive. Because so much is new, so much is promised, and so much is at stake.

Why so much? Before we set the fuse, and survey the wreckage, we should momentarily consider the dimensions of the bomb, itself – and its explosive potential. ABI Research has the projection: the combined value of private LTE and 5G market will be around $65 billion in 2030 (with about $37 billion going on 5G), from a couple of of billion dollars today. Industrial manufacturing, which this report focuses on, will spend biggest in the period, with a little under a quarter (around $15 billion) of the spend. Anecdotally, to pin the spend to network management SLAs, test and measurement company EXFO has done the sums on the back of an envelope to suggest 50 percent of all 5G revenues – including common-or-garden smartphone subscriptions – will be subject to SLAs as soon as 2025 (see pags 10-12).

But the ABI forecast goes into the long-term, too, covering the tail-end of 4G-LTE, the rise of 5G-NR, and probably the emergence of an entirely new (6G) generation of cellular. It describes a seismic shift in the core sales and investment strategy for network building in the cellular market. Spending on private and shared enterprise networks will surpass spending on public cellular networks in about 15 years. The balance tilts decisively towards enterprises in about 2036.

The question about SLAs is difficult because the kind of URLLC use cases 5G is supposed to prop-up after 2022/3 are hard to discern, as yet. The job to construct a matrix in three dimensions to tally unknowable use cases against unknowable networking KPIs, against an unknowable Industry 4.0 market, is an almost futile one, at this stage.

2036
– when the balance shifts between public and private 5G revenues



Shop floor – simplified 5G for non telco-specialists

Which means this 5G bomb is a big one, with the kind of big-bang charge to remake the telecoms world completely. The stakes, then, could not be higher. Old familiars in the carrier community, the same as the young guns in the vanguard, must make camp in a new lanscape. The difference is that they have always had the place to themselves; for the first time in five generations of mobile technology, they are strangers, here, like everyone else, with competition on all sides. So, *bang*...

PERFORMANCE METRICS

But let's deal with that first question first; about the content of these industrial 5G SLAs. In terms of performance, the industry knows, on paper, what the technology offers and what the applications require (see page 4). But as the Lufthansa Technik case study makes clear (page 28-30), these are industry measures – useful, but highly subjective, and effectively worth the paper they are written on. But the real problem is that so little is known. For all the fanfare, very little in the way of factory operations is running on 5G.

But for some minor proofs-of-concept in ringfenced production lines, away from the real business of actually making things, there just *ain't* that much happening. This is

partly because there are hardly any industrial 5G devices available. Lufthansa Technik, one of the few companies really rolling with this stuff (pages 28-32), has only just taken receipt of its first proper 5G unit, to attach to its twin private 5G setups in Hamburg.

Siemens has released 'the first' industrial 5G router, it reckons (see page 20-21); so has Minnesota-based IoT module maker MultiTech, it turns out. Either way, the total supply amounts to a handful of devices, at most. There is a whole discussion about who blinks first over the supply and demand of industrial 5G chips, between the likes of Qualcomm and Bosch, say – and that, in the end, neither will budge until the delayed standards-releases for 5G-proper come into view.

A study from ARC Advisory Group, from January, said that will not happen until the end of 2022, at the earliest, when Release 16 devices flood-in. So despite all the press releases about private 5G deployments, there is a lot of thumb-twiddling in the Industry 4.0 ranks. Just about everything is on LTE. Ask Athonet or Quortus or Druid Software, or any of the new-breed private network specialists; LTE is where the business is being done.

Ask Nokia, as well; visitors to its factory in Oulu, in Northern Finland, say the word on the shop floor is LTE is animating its production lines. 5G? Nokia's factory engineers shrug a bit, the story goes. Nokia's marketing team, in the *Enterprise IoT Insights* podcast on private wireless, says the same: 5G will come, and will matter, but 80 percent (or something) of industrial use cases can be served with LTE. "Industrial 5G is something to think about later," says Appledore Research (pages 7-9). And it suggests that, even then, high-end 5G applications, requiring more stretching SLAs, will be "very niche".

JUST COVERAGE

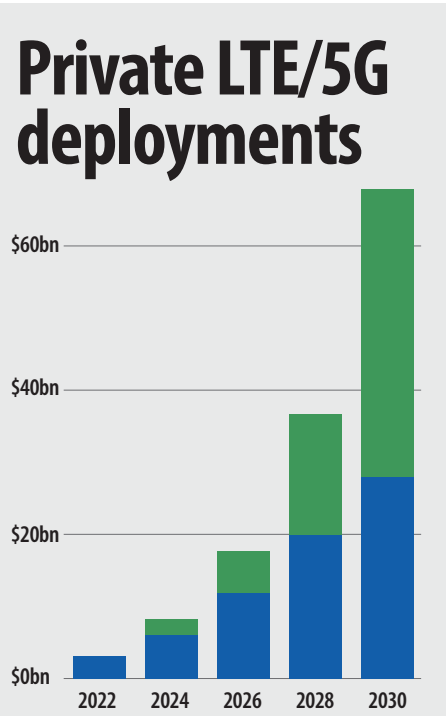
Which returns us to the question about what, exactly, to write down in a contract, really, when the technology is being used to either replace misfiring Wi-Fi networks or to play in the industrial IoT sandbox – or, tentatively, to run non-critical manufacturing processes? Because no one is betting their factory on cellular, yet. No manufacturing company is putting SLAs against 5G performance, yet – until the systems are tested and proven, and humming like a turbojet (to borrow a line).

And, going backwards, nothing is humming because there is nothing to connect, in any volume, and in any serious industrial garb. Because 5G has not yet been fully developed and standardised.

But more than this, the question about SLAs is difficult because the kind of ultra-reliable low-latency (URLLC) use cases 5G is supposed to prop-up after 2022/3 are hard to discern, as yet. The job to construct a matrix in three dimensions to tally unknowable use cases against unknowable networking KPIs, against an unknowable Industry 4.0 market (even manufacturing is hard to pin down), is an almost futile one, at this stage.

What about SLAs for LTE? Back to Nokia; the Finnish vendor has been selling 'critical'-grade wireless networks "for years"; at last count, it claimed 260 customers for some combination of its various private LTE and 5G wares. The message is that private LTE

AGVs – automated guided vehicles are being upgraded to 5G from Wi-Fi (Image: BMW / Cover image: Siemens)



Growth – the value-percentage of private 5G deployments will outrun private LTE deployments in 2029, according to ABI Research.

over-delivers, effectively. "Network capacity and performance in those cases is plentiful – and so the enterprise does not worry too much about putting specific KPIs or SLAs in place," says Stephane Dauble, the company's own Mr Private Wireless (see page 14).

LTE is not burdened with the same weight of expectation, it seems. It works like a balm for most of today's factory headaches and not in the anticipated style of 5G as a kind of industrialised version of *Weird Science* – where a dream factory is magicked-up on a computer. The point is, maybe just, that SLAs for edge-based LTE networks are not that hard to write, or might not be that much in demand. It works well, and is appreciated where it is set to work. So why worry?

Which is not to dismiss the value of LTE to support critical communications, of course. "Just solving the challenge of connectivity is incredibly powerful," says Accenture (pages 22-26), talking about grid modernisation for cirical power networks in the US. "Because you can't daisy-chain a mesh network to go for tens of thousands of miles." But the dilemma remains; private LTE might be "transformative" for certain operations, and backed to the hilt with expensive redundancy, but performance metrics remain familiar, i linked to straight connectivity and coverage. Where are all the SLAs about real-time operations? What happens if the network goes pop?

NETWORK MANAGEMENT

The other (tied) question in all of this – as 5G technology develops and 5G use cases emerge, and as network providers figure out what to deliver in terms of performance (and what to guarantee) – is about who manages the network itself. *Of course it is; what else are we talking about, here?* This is, arguably, the defining narrative for the troubled carrier community in the 5G era – alongside parallel tragi-comedies about commoditized hardware, open source software, and the lengthening shadow of hyper-scalers.

There are plenty on the quiet fringes of the telco sphere – right in the middle of the private networking bubble, right in the middle of this report – that reckon mobile operators are done for, effectively. Indeed, much of the rest of this document reads like a manifesto for a kind of new model army to reorder the telecoms sector and rule the Industry 4.0 market. (See the interviews, already highlighted, with Appledore Research, Accenture, and Siemens.)

Traditional mobile operators have two things going for them, the argument goes: spectrum and networking know-how. The liberalisation of spectrum for 'vertical' pursuits in leading industrial markets – started in the US with the long process of CBRS re-farming; driven-through in Germany, in a heartbeat, with the 3.7-3.8 GHz carve-up; copied one way or another in the UK and Japan, notably – has robbed them of their monopoly on airtime. Meanwhile, the move to shrink and simplify mobile networks in software has, arguably, dumbed-down the

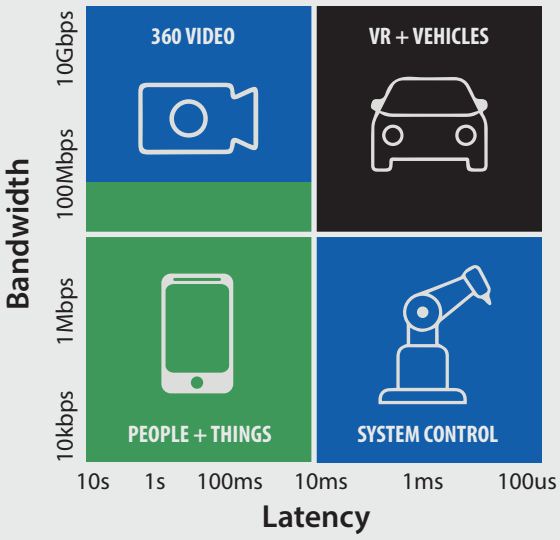
Industrial networking requirements

USE CASE		AVAILABILITY	CYCLE TIME (milliseconds)	PAYLOAD (bytes)	# OF DEVICES	SERVICE AREA (metres)
Motion control	Printing machines	>6x9s	<2	20	>100	100
	Machine tools	>6x9s	<0.5	50	~20	3
	Packaging machines	>6x9s	<1	40	~50	3
Mobile robots	Cooperative motion control	>6x9s	1	40-250	100	<1,000²
	Video-operated remote control	>6x9s	10-100	15-150	100	<1,000²
Mobile control panels with safety functions	Assembly robots / milling machines	>6x9s	4-8	40-250	4	10
	Mobile cranes	>6x9s	12	40-250	2	50
Process monitoring		>4x9s	<50	variable	10,000 devices per km²	

Latency and bandwidth mapped against industrial use cases

"For 1ms latency, LTE won't get you there. It will get to 10ms, but not much lower. But, then, 10ms will serve 85-90 per cent of use cases"

Manish Gulyani, Vice President, Enterprise Marketing, Nokia



Source: Nokia

LEVERAGING 5G CONNECTIVITY FOR SMART MANUFACTURING

- Engage with leading experts in our interactive workshops focusing on AR, VR, robotics and digital twins
- Gain the manufacturers perspective on the future of smart manufacturing through a variety of sessions
- Identify potential partners to build future 5G networks and vendors to support the rollout of projects
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whole networking discipline.

Suddenly, anyone can license airtime and manage a network. Suddenly, anyone can be a mobile operator. And anyway; who says Deutsche Telekom or Vodafone, or any other of the old dogs of telecoms can manage such a diverse customer base anyway? Running one national network, one way, for millions of customers, is very different from running a million networks, millions of different ways, for millions of customers. Is it not easier for each customer to run its own network, or networks, for its own idiosyncratic ends?

Well, yes and no. It's too simplistic – and neat, in this remade industrial landcsape – to say that; such a deathly outlook is a symptom of an early-adopter market, where the freakish tier-one ('tier-zero'?) manufacturing brands are going about like a band of war-painted Schwarzeneggers with digital grenades to light a fire under the whole Industry 4.0 picture, while a whole army of extras plays in the smoke.

But as the smoke clears (by pages 34-38), we will see the cast of characters is only multiplying; the old faces are not exiting, or being replaced, necessarily. There is a whole sell-build-run process that needs to be worked through, for every-sized enterprise in every-sided industry, which will find roles for every kind of supplier, including traditional operators. It is like what the DIY low-power end of the market says about IoT as a team sport. It sounds naive, but it also seems likely everyone, new and old, will play a role – it is just some will just play more of a role.

FOR ALL AND NONE

For Vodafone, which speaks for everyone and no one else in the operator market, the value carriers can bring in the Industry 4.0 market is with network management. Its message is that service providers, of whatever stripe, will be required to offer second- and third-line support for industrial-grade private 5G networks. In most cases, enterprises themselves will take charge of first-line operations. This much is clear; everyone here agrees.

Automotive – among the prime markets to engage industrial 5G for key production line operations (Image: 123rf)

Vendors sell, integrators build, operators run... The picture has changed. The idea anyone can be a network operator, with box-fresh private cellular is simplistic; the notion the old dogs of telecoms will be left out of pocket with industrial 5G is exaggerated.

But Vodafone implies this support will not, likely, come from network vendors or system integrators, which get bundled into the Industry 4.0 mix for 5G 'service provision'. Nor will it come from mobile operators, necessarily. As mentioned, it is talking for everyone in telecoms, and also for no one but itself. But arguments about cultural differences between the two sides are hokum, it suggests. It has no interest to run the factory; just to offer support to run the 5G network, as a "performant" utility, and guarantee ultra-reliable design and "faultless resolution".

Telecoms is telecoms, after all, it says. Vendors sell, integrators build, operators run. For Vodafone, the difference with 5G is the run-phase will be shared with enterprises, which will be equipped to provision 5G networks according to operational requirements, and to run at least some diagnostics, as well. The extent of their run-remit, and of Vodafone's in support, will depend on their size, invariably, and capacity to recruit 5G expertise.

But the picture has changed, by the end of this magazine. The idea anyone can be a network operator, suddenly, with box-fresh private cellular is simplistic (of course); the notion the old dogs of telecoms will be left out of pocket with industrial 5G is exaggerated (of course). System integrators can't do it and network vendors won't do it, according to this late counter-narrative. Maybe, maybe not; it depends who you believe.

More significantly, the sell-build-run narrative is reversed – and subsumed by a new consultancy-phase, as a compulsory preamble to every other stage in the process. It is discussed by Accenture and Lufthansa Industry Solutions in these pages as well. Which is where the real battle is, of course, and the real story – where system integrators and network vendors are already jostling for position. As the interviews in this document – which are too good to be stitched into a single narrative – foretell.

What else is there to say? *Bang*; there's the tangled fuse, and the wreckage and the mess. Time to hand over to the experts.

THE MARKET ANALYST | APPLEDORE RESEARCH

What do enterprises really think of 5G? Frankly, we hear, *they don't give a damn*

It is just another networking technology, after all; Appledore Research tells of the trouble with the telco sector's 'god complex'

About that headline; the message is enterprises do not care about 5G, just for the sake of it – just because it is 5G. It is not a special case, with a special place in their already-tangled networking estates. It is just another tool, after all – not even '*another G*', as the fiercest telco-obsessed critics have it. It speaks of the telecom's sector's god-complex, as if there is some messianic industrial power inside this new technology. The notion 5G should be gifted by the old dogs of telecoms for industrial change is anathema to enterprises, the story goes.

So says market advisory firm Appledore Research, taking a hard line on the task for traditional telecoms to crack the Industry 4.0 market, and get anywhere near the service-level agreements (SLAs) that will go to underpin it. What do they think of mobile operators? *Oh, to be a fly on the wall*. As it goes, Francis Haysom, principal analyst at the company, retells a story about a faceoff between the sides in an anonymous meeting room, where the telco set, represented by a vendor and an operator, sit mob-handed across the table from a "major" manufacturer.

"The message to them was, 'We don't really like you, Mr Vendor, because we don't think you understand us. And, as for you, Mr Operator, we don't even know what you are doing here." But hold up; let us rewind. Because the operator community is not out of the game, yet, according to Haysom. In another refreshingly frank conversation (see also, pages 16-19 and 28-32, and elsewhere), he suggests the best of them – Vodafone and Deutsche Telekom, plus some others perhaps – can carve a role as 'master builders', in a few specialist industries in a few regional markets.

Haysom – enterprises want Wi-Fi-style 5G networks

But the SLAs they write will not be about "green lights" on industrial 5G componentry; they will be about managing disaster recovery in wider-reaching enterprise systems, which go horizontally across the shop floor and vertically into the cloud. Instead of networking knowhow, the opportunity for mobile operators is to bring their scale to bear on this discipline and push support costs down, as critical workloads are put online locally in edge networks. Which means, the logic goes, centralising their support functions, rather than dispersing them into regional enterprise NOCs, or into customers' premises, as Vodafone hints at (see pages 34-38). That is the gist of the conversation, laid out below, in full. Haysom is joined by Robert Curran, consulting analyst at the firm, in equally forthright mood.

So much with 5G is riding on enterprises, and yet the narrative around 'vertical' spectrum and easy 5G edge networks says anyone can be a mobile operator. So where does that leave mobile operators?

Haysom: "You have to look at what enterprises want, which is for these 5G systems to look and behave like Wi-Fi networks, even if they do all this clever stuff, as well. They want private 5G to be operated by their own network teams on site, which are already running these other factory networks. Be-

cause 5G is just another access technology that plugs into the enterprise network.

"Think about what Juniper is doing with [AI networking startup] Mist (acquired in 2019 for $405 million) and AI-driven wireless LAN [local-area network] systems; that is the way it is going – so the whole management headache is removed. Enterprises want the same with cellular. They don't want a NOC; they want a self-optimizing access technology that works out-of-the-box, which they can run and manage on their own.

"So it is not about 5G, as such. And for mobile operators, the challenge is whether they can be better (or cheaper) managers of these networks. Like with BT, for example; its global services business will run the NHS network. Not because BT is the best ethernet provider, but because it manages the network at a lower cost than someone else. The opportunity for telcos is not to build a NOC to run these networks, but to use an existing NOC to share the cost of running them – to make it cheaper to run."

But the NHS has a vast tech estate. Is it the same for a 5G network running in a single factory, or even in a network of factories? Can the carriers scale a managed service down for such a varied customer base?

Haysom: "If it is literally compressed into a box on site, then it is not about the management of that single box. It is about managing everything else as well – the ethernet and Wi-Fi, and whatever else. It is about guaranteeing quality-of-service across the entire infrastructure, at a lower cost than if the enterprise ran it alone. There is an option, of course, for enterprises to reduce costs further by using the public network, instead of going private for everything – by using the carrier's edge (MEC) capabilities.

"It all comes down to cost. The big benefit of the public cloud is that it is cheaper – you can pull IT people out of the supermarket, for example. The last thing an operator wants to do is put a person on site, and they don't want to build an enterprise NOC, either. Not because a NOC is not needed, but because the enterprise doesn't want to pay for it. What they want is a cheaper way than having their own staff running the network."

Networking – manufacturing companies already engage a variety of technologies; 5G, just another, is hardly special

> "It is an open question about where operators will play. But it has to be in that slightly old fashioned systems integration role. Because enterprises see the network as theirs; it is not a special case just because it is cellular"
>
> ***Francis Haysom, principal analyst, Appledore Research***

What is the most compatible business model for private 5G management – to get to a position to write the SLAs against network performance? Is this where the local system integrator enters the scene?

Curran: "Yes. The likes of Cisco, Juniper, Microsoft sell through a vast network of resellers. These national and regional firms have a lot of trust. And these companies are more likely to run some on-site functions for four or five local companies – like schools, or whatever. That is the most compatible model. Because it is localised. The whole premise for (national) mobile operators is their economy of scale, which does not amount to much in this market.

"And even between those, you have T-Systems and IBM, and all of the rest of them – which used to be called 'system integrators'. I don't know what they're called now. But they will do the outsourcing. And then you have Infosys and Tech Mahindra, another level up. So with a SME, you are still multiple layers away from a mobile operator taking on the management of a private network. I just don't see that happening."

Okay. So, it feels a bit like we are flogging a dead horse; what is left for them, exactly? Just the Industry 4.0 mega deals?

Haysom: "For mobile operators to be really relevant in this, they need to see themselves as network resellers and not as communication service providers. They have to see themselves as a network management integrator. And therein lies the challenge, like we said. The telco model doesn't scale

down very well. The question is whether telcos will compete with some of their old partners. Because they are used to providing connectivity for IBM to run a global network for Ford, you know? There is going to be more competition, now. IBM can say, 'Actually, we don't need your connectivity; we are directly wired together from our data centres around the world. We don't need AT&T or Verizon, or whoever'.

"So it is an open question about where operators will play. But it has to be in that slightly old fashioned systems integration role. Because enterprises see the network as theirs; it is not a special case just because it is cellular. They don't want anything to do with the public network. We've been on calls where this question has arisen about roaming between public and private networks, and there just isn't much interest. Yes, you can do it, but they want to be separate."

So with simplified 5G networks, separation from public infrastructure, and familiarity with local specialists, it seems like operators are a couple of steps-removed from hands-on network management. Is it about second and third-line support, for them, and how quickly they respond in emergency?

Curran: "Yes; it is about business-to-business SLAs, rather than business-to-network SLAs. There will be availability guarantees, and so on. But that is just a portion of the SLA. It is totally different to a telco talking about coverage in its own network, or whatever. In an enterprise context, it is about how well the telco is supporting the enterprise. If the network is working fine, but the enterprise is not getting the changes it needs, then that is an issue – as opposed to just being happy all the lights are green.

"So, you have three data centres, and one goes down – well, you need to plan for that. And you are reliant on connections to Salesforce and Amazon and so on for your internal applications, or for the face you present to customers. That is not about network performance; you can't measure that by looking at green lights on a network. It is about how the organisation is engaged.

"With 5G, there are certain applications that make 5G different – these kinds of high-bandwidth closed-loop visual inspections that use real time data to change how robots move in the factory, or how paint is being used. All of that's important. But 5G, 6G, 10G? 'We don't care.' Plus, these applications are very niche – you can't make a whole business around those applications. At the same time, of course, we haven't done any of this before, because it hasn't been possible. So maybe it will change."

How do you view their chances at making a go of this? Will all of this private 5G management be hoovered up by Accenture and IBM?

"There are certain applications that make 5G different – these high-bandwidth closed-loop visual inspections to change how robots are moving in the factory. All of that's important. But 5G, 6G, 10G? 'We don't care.' Plus, these applications are very niche – you can't make a whole business around them."

Robert Curran, consulting analyst, Appledore Research

Curran: "I mean, telcos just completely missed IoT – industry events and conferences, where there was lots of innovation, and no mobile operators. It was strange. They are kind of waking up to private networks, but they are pretty late. They won't admit it. And it's only because of the decline in other things, and the flattening-out and dropping-off in revenue. So they have to go somewhere, and here is something that kind of looks familiar, and is worth chasing. Some companies are making a strong play. Vodafone is pretty notable; and probably Deutsche Telekom in Germany, but only in Germany. A few operators will take a lead in a few geographies, and the rest will be out-maneuvered by IBM and Accenture, and local enterprise resellers and integrators."

So some regional, vertical bright spots, then?

Haysom: "Yes. It is going to be regional. There is an opportunity for them as resellers and managers of industrial 5G networks in countries with strong manufacturing – so in Germany, China, Japan. But they can't do all sectors; they need to be experts in industry, and not just in 5G. So it makes sense Vodafone and Deutsche Telekom will make inroads in Germany, probably. But the telcos that see this as a continuation of what they do in the macro network will fail. They will need, almost, to create different companies to supply industry, which won't have much to do with their telco businesses – like BT with its sports and television businesses."

What about Nokia, out of interest? Is it making a fist of things, to be able to go from straight kit supply into managed services? Or will it work via these others, as well?

Haysom: "Nokia is the one that could make the transition. But again, it is not Nokia's regular managed services business [doing this]; its dedicated private networks business [will offer] managed services or system integration. If you compare with Ericsson, I think Nokia has made the right decision; it has recognised private networks is a different market. That is probably the most important decision the company has made."

THE TEST & ASSURANCE COMPANY | EXFO

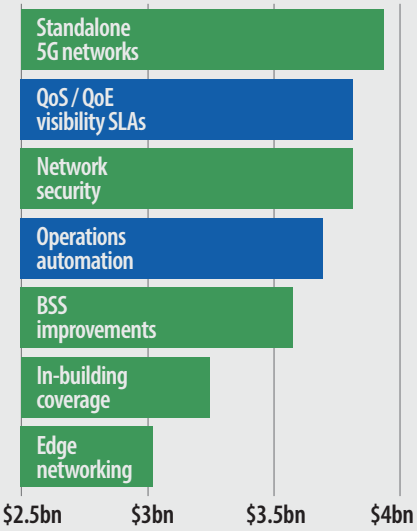
Monitoring is the 'only way' to show enterprises are 'getting what they paid for'

Half of revenue-driving 5G will come with SLAs; test company EXFO is offering 'full-stack' visibility to both 5G operators and enterprises

Perhaps the best statistic about the rush of service-level agreements (SLAs) that will go to support industrial-grade 5G network deployments in the coming years is from Canadian test and measurement company EXFO, combining forecasts for a couple of different sources. Half of all 5G revenues, it says, will be subject to SLAs, compared to practically zero for 4G-LTE deployments today.

That is a direct quote from Guillaume Briand, product line manager at EXFO, speaking on the *Enterprise IoT Insights* webinar session that attends this report. The figure is an extrapolation from a 2020-2025 revenue forecast by analyst firm Omdia that says enterprises will account for 70 percent of 5G revenues in the period, and a GSMA Intelligence survey from 2020 that says 70 percent of new 5G applications will require SLAs for quality of service ("and experience").

The maths (70 percent of 70 percent) says a whole bunch of critical SLA-writing between telecoms and industry will be set down in the coming years. Interestingly, to put the revenue forecast in context, Omdia predicts a $5 billion boom-time for the widening vendor community just from the sale of private cellular to enterprises, topped up by a 'ripple effect' of associated spend on sundry sensing and sense-making (IoT and AI) gadgetry.



The heart of it – test and measurement company EXFO calculates half of all 5G revenues will be subject to SLAs, and that service assurance (above, top, in blue) is the most important 5G revenue enabler after the network itself. The firm is also providing operations automation, which counts high among revenue drivers, as well.

For its part, EXFO is most interested in supplying test, measurement, and assurance tools to the operator community, which is generally going at the Industry 4.0 market with a two-speed offer: with slices of its public networks; and with various 'private' edge networking arrangements, which will commonly use a shared core infrastructure and make use of 'public' spectrum. But there are exceptions, and carriers are increasingly looking to extend their management expertise into private standalone 5G setups, as well.

Either way, and every way, SLAs will go against these networks. "Enterprises and industrial application providers will not buy 5G SLAs without performance guarantees," comments Briand. EXFO, with over 95 percent of service providers on its books, and over 2,000 staff worldwide, reckons it is best positioned to provide service providers with the tools to monitor enterprise customers' 5G networks, and play "referee" between the sides.

PERFECT STORM

A perfect storm is brewing, says Briand, buffeted on one side by the supply of new network infrastructure and automation tools, and rising analytics capabilities, and on the other by demand from industrial markets. "It is evolving quite rapidly, with the global roll-

out of 5G, and with the availability of AI and automation in the networks. And Covid-19 has changed the demand for these technologies, as well, just because all the home-working is putting strain on cellular infrastructure, especially," he says.

"But frankly, with 5G, it is not about subscribers anymore – it is about machines and robots in enterprises. These companies need to be able to rely completely on this new infrastructure. Network providers have to be able to commit themselves to customers with SLAs. The only way they can do this is by monitoring their 5G networks, and only companies like EXFO have the tools for them to measure exactly how these networks are working – to confirm for enterprises they are getting what they paid for."

In theory, EXFO provides the full "multi-vendor, multi-tech" suite for any network owner looking for a best-of-breed 5G network, with test and measurement solutions to kick the tyres before hitting the road, and assurance and correction tools to make sure the engine is ticking over and the ground is being covered. Briand is responsible for EXFO's analytics-based assurance solutions, which provide real-time insights for network and service operations centres.

The step-up from best-effort LTE networks, mostly geared one way for consumers, to deterministic 5G networks, for myriad SLA-bound industrial purposes, goes forwards and upwards, suggests Briand. With industrial 5G, key performance indicators (KPIs) are multiplied in both volume and magnitude, and monitoring tools are extended across domains at the same time. "Tolerance is less [forgiving] and more varied with machines," he says.

"For service providers, wireline connectivity requires SLAs to guarantee availability, bandwidth, latency, performance, quality of experience – all of these KPIs, which we all know. But 5G will be different, and the SLAs will not be so simple. Enterprises will require complete transparency into 5G network and edge compute performance, to get information about mobility, and information per-user and per-device, in real time. Beyond this, this information should be accessible in real time [to other systems] through other APIs."

>70%
– of 5G revenue will come from enterprises
–Omdia

>70%
– of enterprise 5G revenue will be subject to SLAs
– GSMA

STEP CHANGE

The difference with consumer-grade networks, covering most management functions on LTE, is that coverage is the king metric, as a rule; applications may put different strains on the network, but the only headache until now, simplistically, has been whether a video stream drops out on the commute home. With industrial-grade 5G, the range of performance parameters appears to be never-ending, potentially – with a stretch-total arguably equivalent to the number of applications in all of the enterprises, in the world.

"It's the classic case that one size doesn't fit all. SLAs have to be individually defined in each enterprise and dynamically fixed and adapted for different classes of machines. Industrial 5G networks should be anticipated. Because it is not just about ensuring massive throughput, but about allocating for each use case – just like the network demands are different for messaging and video streaming on smartphones," comments Briand.

"Industrial applications make different demands for latency and throughput, and other measures. But the stakes are higher. Imagine you have a factory full of robots, and the connection goes down, and you're forced to send staff onto the floor to heal the network and reconnect the robots. That's a big issue for an enterprise."

Network slicing, whether of public airwaves in hybrid 5G networks or privately-licensed spectrum in standalone edge setups, will allow performance specifications to be allocated either to certain 'verticals' or to certain use cases. "There will be slices for gaming or for transportation, and of course for industry. A factory owner or plant manager will be able to put robots and machines on 5G slices. This functionality will be critical for industry, and will provide a means to ensure latency is low and reliability is high."

It will be critical for network operators, as well, which imagine themselves surging out of a kind of enforced convalescence, after fail-

ing to capitalise on generation-after-generation of cellular technology, offering increasing consumer benefits for the same returns. "The ambition for operators is to monetise this dynamic quality-of-service."

Briand explains: "Some enterprises will pay a premium to get higher quality, lower latency, higher reliability – to connect their critical machinery. Others just want to store inventory on site, at the edge, and don't need an ultra-reliable network; just a geolocation function to know where things are. You look at the warehousing, say, which wants to connect both the parcels and the robots carrying them – they only need the premium slice for the robots, so don't collapse or collide."

DATA ANALYTICS

But the major challenge to underwrite 5G management is a straight data processing problem, about the volume and velocity of the discipline. Managing the great flood from 5G-connected industrial sensors is labour-intensive and time-pressured. Network assurance tools are required to cleanse and sanctify data streams so they are channelled back into the enterprise to bring new life. There can be no slow-down, says Briand, to pick-out and strike-out networking anomalies, even with such heavy workloads.

He explains: "It is critical that the big data analytics running the AI-driven string processing, required to handle the volume of data that will come with 5G, is not delayed." All this AI donkey-work must function for both network managers, as well, he says again, so the enterprise customer and the service provider can collaborate on any alarms raised in the system. "It has to provide full-stack visibility at the same time to identify where the fault originates."

EXFO's Nova-branded family of 'network intelligence' solutions collects and shares 5G events, and maps them to the network topology, jettisoning redundant network data to keep only the 'good bits'. "This information will be essential for operators, not just for SLA reporting, but also to enable the network automation and orchestration to create dynamic 5G services," comments Briand.

"The enterprise will be able to specify their own requirements. They will have access to [network functions] on applications and platforms. Network operators are not just running a pipe, anymore, linking machines together, and to applications on top. Their role will also be to provide the right access at the right time, with the right quality – not with more and not with less; but what the customer specifies for the use case."

He returns, again, to the back-end analytics, to enable this combination of slice provisioning and assurance. "We are not collecting and processing all the events, just the ones we need. And with all this enhanced data, SLA performance can be monitored, and anomalies can be detected and predicted, and the constant impact can be assessed – and issues can be identified before they occur. But the point is it is not just about collecting the data, but understanding what to do with it, and how to extract value from it."

FULL VISIBILITY

The point about "full-stack visibility" is an important one. As the rest of this report makes clear, enterprises want control of their systems, to a greater or lesser degree; the role of operators in this is not yet defined, and they face competition from a familiar stable of specialist system integrators, which have served enterprises with most other aspects of their bespoke networking estates.

Briand says industrial 5G management is a collaborative endeavour, to an extent; carriers must be able to share network performance dashboards with enterprises, whether they have been engaged in the discipline to provide first, second, or third line support. The software will need to dovetail, as well, with fault management and performance management systems, and other service inventories. "Because, tomorrow, you won't call the customer care when issues arise in the network; you will access a self-care application."

He explains: "Enterprise customers are not just paying for connectivity; they want visibility into their compute performance and availability. The challenge comes from the fact many of these services will run in encrypted slices – and that kind of full-stack visibility is something most traditional networks are blind to. And critical services and closed-loop industrial applications also come with legal and human safety consequences, which mandate precise actionable insights within milliseconds."

He steps back, and zooms out. Mobile networks have never been so valuable before, he says, because of the value of the cargo they are being asked to carry; but the challenge, at the same time, to keep the burden secure and punctual, has never been so complex. "5G brings a paradox," he begins.

"The telecoms industry has never had so much valuable data before. But to succeed, and to provide these industrial 5G SLAs without storing and processing everything, AI has a key role to play – in real-time pattern recognition and predictive analysis – to analyse the context of issues arising in the network through through a process of correlation, in order to automatically find out the root cause and to generate SLA-based 5G rules."

AI for 5G SLAs

- Anomaly detection
- Operational analytics
- Service quality
- Network automation

"Telecoms has never had so much valuable data. But to succeed, and provide these SLAs without storing and processing everything, AI has a key role to play"

Guillaume Briand, product line manager, EXFO

THE NETWORK VENDOR | NOKIA

‘These are exciting times’ – slicing comes of age in both public and private networks

Nokia is outrunning the standards process with network slicing for LTE and 5G – in time for the rush of network performance SLAs

Network slicing across the radio, transport, and core networks is coming to both private LTE and private 5G setups, Nokia says. The Finnsh vendor is trialling its new slicing functionality with a trio of mobile operators, including A1 in Austria and Telia in Sweden, in their public macro networks, to provide slices for enterprises in the rail, shipping, aviation, and oil and gas sectors. Nokia claims a number of non-public references, alongside.

The functionality will be offered with Nokia’s private LTE and 5G solutions in due course, following an initial launch with operator customers in the summer. Mika Uusitalo, head of new technologies and innovations at Nokia, says: “We are living in very exciting times, as we speak. We are talking about it mostly in relation to the wide-area LTE and 5G network, but it is merging step by step into private environments, as well.”

Nokia’s solution, in testing since September and announced in February, supports connectivity from 4G and 5G devices over a sliced network to applications running in private and public clouds. It enables operators – followed by enterprises with their own installations – to slice single mobile networks into multiple virtual networks for dedicated applications. It is being readied ahead of 3GPP-specified slicing in the core network, which will be available some time after 2022.

5G-ready – Nokia, mainlining LTE in its own factories, is also offering pre-standard slicing in public and private networks

The new functionality can be deployed via a software upgrade to LTE and 5G non-standalone (NSA) networks, and subsequently to 5G standalone (SA) networks. “Traffic is isolated from internet traffic end-to-end,” explains Uusitalo. The new functionality affords a mechanism, as well, to demonstrate enterprises “are getting what they paid for”, he adds – bringing to the conversation around to industrial 5G service-level agreements (SLAs), and echoing (word-for-word) EXFO’s sentiments on pages 10-12.

"It means you can isolate data traffic from a group of devices in the radio, and map to their own transport path, also isolated, and into the edge cloud. And then associate certain capabilities with the slice, like performance, quality, any security capabilities. Operators can create, delete, and modify slices fast – in a minute – and verify the slice, to provide reporting and monitoring SLAs."

It is a work-in-progress, to an extent; the basic functionality exists, already, including allocation of radio resources and radio-scheduling for the quality-of-service prioritisation of sliced traffic, alongside other scheduling for internet traffic. "The foundation is there; not all the bells and whistles, or full blown automation, but the basics are there to isolate and separate internet and business-critical traffic," says Uusitalo.

The radio mechanism goes across the air interface and the transport interface inside the base station. The slice prioritisation in the radio is "mapped" into the transport network, and routed into the core network function in the edge cloud. "We are tying together parts of the functionality in order to create the slice." The network manager has a dashboard interface to create slices with relevant radio and transport parameters.

The deployment with A1 in Austria is being used by rail company Österreichische BB (ÖBB) and as part of a "campus area slice-testing" with Siemens. ÖBB wants a slice of the network to "track and control trains". But customers and use cases are multiplying, and slices are being used for "pragmatic" ends (an echo, this time, from the Accenture interview, on pages 22-26). "We have airports and seaports," he says, but references a range of cases, with a range of SLAs, such as for traffic management, gas stations, and even for corporate conferencing systems.

Dauble – three and four-layer network redundancy for critical operations

Performance is 'a piece of cake', and reliability comes down to budget

As left, private wireless networks have been over-delivering in the Industry 4.0 space, so far. But this will change, as industrial 5G applications become more varied and industrial 5G networks become more complex. Stephane Dauble, head of marketing for enterprise solutions at Nokia, explains how Nokia is handline critical networks already.

Talk about Nokia's experience with network performance in critical networks, and state of private LTE/5G SLAs today.

"We've been running critical operations on private networks for a long time, and capacity and performance in those cases is plentiful – so enterprises do not worry too much about KPIs or SLAs. It starts with good radio design – that's the key. You can't beat the laws of physics. Coverage equals performance, basically; the better the design, the better the coverage, the better the performance.

"With technology that can handle 120,000 in a stadium, performance in an industrial site for hundreds or thousands of devices is a piece of cake. Enterprises tend to run the network quite happily as it is given to them; even networks for critical operations are mostly sold for a few dedicated applications. As more are added, those parameters will be more important. But [the question of SLAs] is something we've not seen in the first few years. We are only just starting to see those requirements.

"And with more complex radio parameters, and more optimisation, you need to have a network that works together, and not as a collection of different boxes. That is starting to come. So the enterprise team was really happy when Nokia introduced pre-5G slicing – because it means we don't have to wait for the 5G standard."

Are these new requests for performance SLAs on LTE or 5G networks?

"LTE. But we know the requirements before we deploy. We don't just plug in, and it works. There is a whole discussion to get an understanding of the application and reskilling requirements. When a port or a mine tells us it wants critical voice, or autonomous trucks, or an AGV in a factory, those applications require certain latency and certain reliability. We know those things, because we have built that knowledge over the six or seven years."

What does 'ultra reliability' look like in these critical networks?

"It depends on the sector. We differentiate business critical, mission critical, and life critical. But clearly, the requirements in a warehouse are not the same as in a nuclear power station. We are working with a petrochemical plant that wants to go to five-nines with a double-layer network – two systems in two frequencies.

"For another customer, we established three levels of reliability in the core network – so we had to build a dual-core network in one venue, in different rooms, and then a third-level core network in an [adjacent venue] in case the main [venue goes offline]. And I think we had a fourth level of redundancy, as well, using the core network of the operator. So that is the kind of thing we can do in terms of availability and reliability. It just comes down to the use case and the budget."

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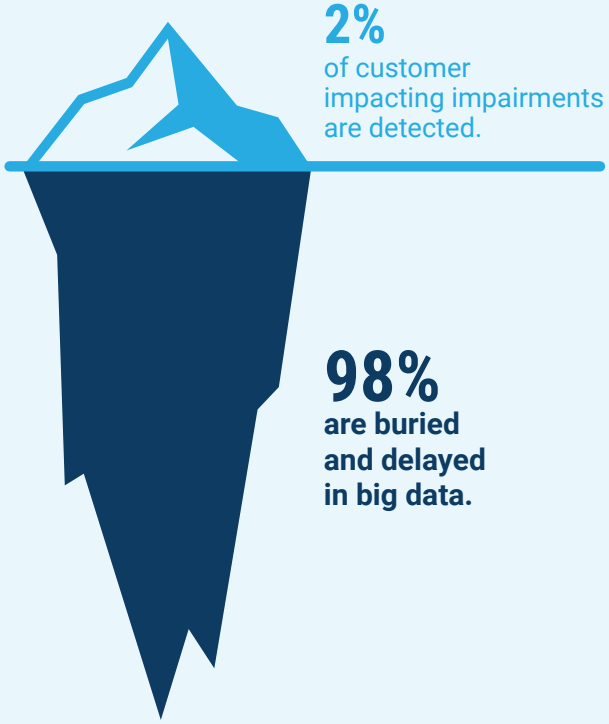

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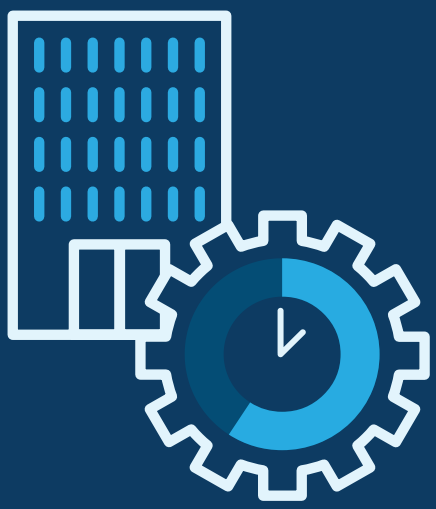

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THE AUTOMATION SPECIALIST | SIEMENS

The mission to package 5G for 'blue collar' Industry 4.0

Industrial specialists are best to develop plug-and-play 5G from scratch, says Siemens; time and custom are on its side, it reckons

Siemens is looking to provide an entire 5G 'system' for private cellular networks in industry, covering the radio network, core network, and end-devices. Industrial specialists, and not telecoms operators, are best to "take care of" the new 5G requirements from the Industry 4.0 movement, it says. But the Munich-based firm is playing the long game; its full-stack 5G solution will not be available until 2022, and it is yet to decide on the kind of network management support to bundle into its offer.

Sander Rotmensen, director industrial wireless communication for the firm's digital industries business, compares Siemens' approach with 5G with its long-time provision of networking technologies and devices for industrial sectors. "The difference with 5G is we want to provide the full system, from the core network down to the user equipment, including the RAN as wel. We want to bring all of that to our customers."

He explains: "Enterprises don't want to look at different bits and bytes to create a solution; they don't want to set up a network, and then a PLC, and then figure out which vendor to use for I/O. It all needs to be integrated in an ecosystem of things that evolve around, and with, each other. We will develop the full ecosystem ourselves – everything will be from Siemens. We believe 5G for industry is something we need to take care of."

As well as a newly-announced industrial 5G router (SCALANCE MUM856-1) and an open VPN platform manager (SINEMA Remote Connect), the firm is pulling back the covers on a prototype of its new 5G system at this year's Hannover Messe. Siemens has deployed in Hall 9 at the Hanover fairground, and is making the system available to enterprises to rent, during or between trade shows, to run the rule over 5G.

"Your factory is online 365/24/7 – so what happens when the network goes down? On Christmas Eve? That is why it needs to be managed locally. That is what will determine whether 5G is successful. in industry."

Sander Rotmensen, director industrial wireless communication, Siemens Digital Industries

In parallel, Siemens is fitting-out its own factories with 5G networks in the 3.7-3.8 GHz 'vertical' spectrum band in Germany. Private spectrum licences are available for the "price of smartphone contracts", it reckons. The company is pursuing the same in every market in which it operates, with private or shared spectrum, as it is available. It is closely engaged in the 3GPP standardisation process for industrial-grade 5G, as well.

INDUSTRIAL-GRADE

Rotmensen notes the difference between existing 5G networks, geared towards consumers with go-faster mobile broadband (eMBB), and future incarnations, which promise support for 'ultra-reliable low-latency' (URLLC), and 'massive machine-type' (mMTC) communications. "5G networks are focused on consumers with cell phones using as much data as possible. That is what 5G is today, really. All the other promises are buried inside future releases – in Release 17 and 18, and part of Release 16, as well. These start to serve industrial requirements."

He suggests Siemens' longer-term sched-

uling is good, in this regard. "I don't really see 5G in a private network taking off on the shop floor prior to Release 16 end-devices coming available." A study from ARC Advisory Group, from January, says Release 16 end-devices will be available at the end of 2022, at the earliest. "It gives a sense of the timing," says Rotmensen. It also explains the company's relaxed mood on the subject of network metrics (KPIs) and management terms (SLAs). "We're still working those out; we're still talking about a prototype."

But Siemens has an ready-installed customer base that will only look seriously at private 5G after 2022, Rotmensen implies. "The industrial sector is in an R&D phase with 5G, and we are developing our solution – which will fit perfectly for industrial use cases, for both our customers and our own factories."

He explains: "The question is: who will bring industrial 5G to market? And for us, companies like ours, which are focused on industry and know what industrial users need [are best placed] to create a full system from scratch. We can already learn from our own factories. With that knowledge and experience, we can create an industrial 5G solution, to give Industry 4.0 a boost."

He echoes comments from others in these pages, that the telecoms market has a god complex, with 5G presented like the messiah-tech for Industry 4.0. "It is just a building block; I can't make anything work just with 5G. Connecting the machine does not make the machine work. It is about how everything plays together. There is a different perspective [in industry] – and we [only] focus on the technology when the technology is ready."

Siemens will offer 5G slicing, bringing assurance functionality, and splicing to run into public networks. The broader package is not fleshed-out. The system can be "run in the way [enterprises] like," says Rotmensen – "with the end-devices they like, as well". He says: "It will be an open system, of course." How it plays with existing installations and network preferences is unclear.

The kind of network management that is bundled with the solution is also undefined, beyond small-print after-sales support. "You get standard support, the same as with any products. But you are asking about managing the network, itself. And that is the kind of thing we are still talking about, at the moment. You need to stay tuned on that."

Router – Siemens' industrial 5G router, affixed to the post in the background, is among first of its kind (Image: Siemens)

EASILY WORKABLE

But Siemens expects industrialists to take first-line network management into their own hands, at least. It is building the system to be easily workable by operational technology (OT) specialists, on the shop floor of factories and industrial plants.

Rotmensen says: "Customers ask about latency and reliability, and whether they can run the network like their Wi-Fi networks– or whether they will need third parties. Which is what we are trying to overcome – by developing an industrial 5G solution which is designed for 'blue collar' workers. So if something happens in the network, it does not require knowledge about the whole network to put it right. That is a big factor, we think, to make 5G successful in industry, and one of the things we can really help with."

Is that how Siemens will differentiate its 5G offer, as an easier system than from rival suppliers? "I haven't seen anyone else doing it. But 5G is so big, and you you need to focus on what matters – and leave the rest of it. It has to be a solution that you or I could set up. Because your factory is online 365/24/7 – so, what happens when the network goes down? On Christmas Eve? That is why it needs to be managed locally. That is the thing that will determine whether 5G is successful."

And what of the traditional telecoms set? As with other industrial service providers, starting to play both sides of the line with private 5G, Siemens says operators will remain part of the Industry 4.0 puzzle for outdoor 5G, and possibly not much else. "There is enough room in the market for everyone. But I really think, in the end, most industrial customers will want to manage the network, and control the network."

THE PROFESSIONAL SERVICES PROVIDER | ACCENTURE

5G takes 'different muscles' – how to serve industry with telecoms (and *vice versa*)

Accenture, cited by many as a 'king maker' between customer and supplier, maps the emerging landscape for private industrial 5G

Accenture, a multinational professional services company with over 500,000 staff, is repeatedly cited in conversation as a primary candidate for the supply and management of industrial 5G networks, alongside the likes of IBM, CapGemini, Infosys, TechMahindra, and others. But it is presented as both a potential rival and companion for the traditional operator community in service of the Industry 4.0 dream. This is a fine balance for Accenture, as the below interview explains; the firm is positioned as a kind of *eminence grise* in the Industry 4.0 game, incorporating industrial 5G as a key tactic.

The firm advises on digital change in just about every industrial discipline, including in telecoms, and takes charge at the same time of the new telecoms supply into them. But, as its recent deal with US carrier AT&T and US oil company Phillips 66, it can also play as king-maker for the operator set. Here, we talk with Jefferson Wang, the company's global 5G strategy lead, about the shifting dynamic with industry/telecoms crossover, and the partnership roles and networking contracts that will underpin it.

Explain Accenture's position with private LTE / 5G. Because the company advises on all kinds digital transformation, including in telecoms, and yet LTE / 5G are part of the new tech bundle being offered to drive this change. How does Accenture walk the line?

"So, yes, it takes a bit of thought to answer this. We work with the entire value chain. We have an entire industry group focused on communications, media, and technology (CMT), which includes helping mobile operators, including with the provision of private networks to enterprises. Because operators have a strong position on spectrum, and in the 3GPP standards process, but [they have a challenge to] break-in with these enterprises. That is one of the questions we have been helping with – how do they go from selling SIM cards at scale to helping these industrial companies.

"[At the same time] three quarters of our revenue comes from outside of the CMT business – from directly helping these industries to digitally transform. Take a manufacturing company, an oil and gas company, an energy company – we are always working with them anyway, with their back office and their cost reduction, and with their digital supply chain. So we are helping them with digital transformation, including how connectivity plays in that storyline.

"So there are two parts to the value chain which meet in the middle. One is about the

> "[It is down to] the support systems behind the SLAs to make sure it is all buttoned-up, so any issues are resolved as quickly and securely as possible. There are lots of parts to the value chain, and pros and cons with each."
>
> ***Jefferson Wang, global 5G strategy lead, Accenture***

Bella Chase – private LTE/5G cases are about connectivity

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business case, which leads to predictive maintenance in manufacturing, for example. There, the discussion is about reduction, or growth, or safety. Which is traditional professional services consulting. [The other is about] the decomposition of those use cases, about the technologies required to make them happen – which gets into private cellular, and everything else. And we have always done that as well. [The difference now is] we cross-over with operators and vendors in the CMT space, if you will. That's where the intersection happens."

So, there remain challenges for operators, then, but opportunities as well. How are they doing with this, generally? How are they making the transition, to serve the industrial space with more entangled OT-enabling systems? What is your assessment of that?

"They have an opportunity with private 5G networks and 5G slicing, even if slicing comes later, to grow-beyond [traditional mobile services]. Because 5G was built from the ground up for many-to-many [connectivity], where it used to be about one-to-many before. But this [discipline] around how to personalise a network for Company X requires different muscles, which the operator community is still developing. They have always sold devices on network plans to individuals, and the deals were just multiplied for enterprises – how many SIM cards, how much data, and a rather straightforward transaction.

"But this is different. Because the manufacturer comes with a particular problem, around safety and security, and whatever processes. The service provider has to map the problem to the equipment in its toolbag, to be able to provide a solution each time. So the manufacturer has a problem with predictive maintenance on the plant, say, where the machines break down when they hit a certain vibration level, and the operator responds with a low-band LTE network that gets connectivity to the places Wi-Fi didn't.

"But, then, the operator is faced with a problem with the sensors, where the wrong ones spark and cause an explosion. So it needs to partner on devices, to build the right sensor, and it needs to partner for the application to bring the data together, and figure out the tolerances and and benchmarks. Which is where a system integrator comes in – to build the solution. It doesn't mean an operator can't develop those skills; it just means for the sake of speed, partners will be recruited to fill certain roles. The value chain will take shape over time."

Wang – walking the line between digital change for industrial customers and digital change for telecoms customers

So who will manage the network in most cases – the enterprise, the operator, the system integrator, or a professional services company like Accenture? Clearly, this is a horses-for-courses kind of a question, but how should we rationalise the management side of industrial 5G?

"Yes, there are a lot of options; it depends on the industry and the use case. A network operator is a good one, clearly, because it knows about running a network, and about spectrum; equipment providers are starting to offer help, as well [to carriers to manage networks]; and Accenture, in certain instances, has helped manage the network, or parts of it, like running the NOC, or helping with issue resolution and ticket triage.

"[It comes down to] figuring out the support systems behind the SLAs to make sure it is all buttoned-up, so any issues are

resolved as quickly and securely as possible. There are lots of parts to the value chain, and pros and cons against each – going with an operator versus going with a vendor or a system integrator. Some will be more expensive, just because they have experience and robust tools; some may focus on other parts of the value chain.

"It depends on what you're trying to accomplish. Because I'll tell you what; some of these private networks don't need the most advanced operations. If you look at the use cases, they aren't necessarily the gold-plated operations [you read about]. There is a job to make sure the network is secure and reliable, but you don't always need the bells and whistles on top.

"Just for example, the private network for Phillips 66 was about getting connectivity to go through the refinery campus. Because there was a lot of metal. [The use case was] enterprise mobility, for starters, around form-filling and workflow – which brings more productivity. And from a network management point of view, the site went from hundreds of Wi-Fi access points to a couple of radios, which is a simplification."

Indeed, presumably the narrative here – with open RAN and self optimising networks, and simplified core networks running a handful of use cases – is the discipline of network management gets simpler? To the point it becomes like managing an enterprise Wi-Fi network, which has been managed mostly in-house? So do enterprises even need a third party for more than emergency issue resolution?

"Yes, that's the way to think about it. But you have to be monitoring, right, because the whole point of an industrial-grade private network, compared to best-effort Wi-Fi, is it is more reliable, and available, and secure. And managing a consumer-grade network for hundreds of millions of people is different to managing a fixed-perimeter network [with lower density and higher variability].

Phillips 66 – and the SI + MNO model for private 5G

Mobile network operartor (MNO) AT&T and system integrator (SI) Accenture have combined on private LTE/5G for US oil company Phillips 66. The pair are developing a bespoke in-setup for low-latency refinery automation and analytics, which used AT&T's public network and multi-access edge compute (MEC) infrastructure.

Phillips 66 invited Accenture to address "cellular performance gaps" with its existing public network near one of its refineries in Belle Chasse, Louisiana. Accenture brought in AT&T to provide local spectrum for a proof-of-concept to afford "increased mobile connectivity" for Phillips 66's digital transformation initiatives. The proof uses licensed spectrum from AT&T, plus various MEC components to enable low-latency local compute functions. Accenture says: "Teams were able to bring dedicated private cellular infrastructure onsite and record speed improvements at the refinery. In addition, the cellular reference signals showed the potential for improvement in signal strength at selected process units."

"A mining company is looking for communications above and below ground, which requires different networks – which are both different to a utility company, say, which wants a field-area network for grid modernisation – which is geared for linear transmission, going tens of thousands of miles. That's a different level of monitoring. And both those cases are totally different to consumer networks.

"Although we are working to simplify private networks in terms of their architecture, their reliability and security [is critical / complex]. That is the differentiator. So it does require operations, monitoring, issue resolution. But it is very different by industry, network, and use case."

Talk about the need for the supply-side to collaborate in the Industry 4.0 market – on the grounds the technology is nascent, but also fragmented, and the applications are still novel, and the use cases are so varied.

"Yes, absolutely. We used to solve all of this with mesh networks, using unlicensed spectrum. It has evolved, and now you have private networks and edge compute, and the chance to have full control. But a private network and edge compute with a local core is expensive. If you install a hybrid network, you might have less control, but it is easier to get started. It comes down to the use cases – the local traffic breakout, worker safety, worker location.

"Then there are decisions to make, about whether to use mesh or Wi-Fi [instead], and how much you want to architect with this new [private cellular] option – whether to put a full core on-prem, or build a hybrid setup, or leverage the carriers' capabilities. It requires a clear strategy and business case, and partnerships [to make it happen]. Because the system integration, to orchestrate all of this together, is a job in itself."

What about the sense that, as it stands, most of this stuff is on LTE still, and it is only doing what Wi-Fi can't do? That the big dream of Industry 4.0, with URLLC-style 5G, is a while off, yet? Is that fair? Or would you suggest that critical comms are running on LTE,

already, with SLAs around network performance and availability?

"Private 4G is incredibly powerful, already. It depends, again, on the industry and the use case. But look at field-area networks for utilities, and how many hundreds of thousands of miles are being connected and monitored [with LTE]. You know, Texas in the US has its own grid, right? There is an east grid and west grid in the US, and somehow Texas got its own. And there is snow and real cold, and big issues for the grid there. We have seen that, recently, right?

"You can't solve any of that with Wi-Fi. By the time you've meshed it out, it is just not an effective solution. We don't think about these things; we think about latency, which can be 10-times lower with 5G – which makes 4G uninteresting for some industries. But for others, 4G by itself is game-changing. Because you can't daisy-chain a mesh network to go for tens of thousands of miles, and solve it all without a number of hops.

"You can do your best, but 4G really changes things, just for modernisation of the energy grid – where you draw coverage in lines, and not in circles, and go for thousands of miles. So 4G is transformative in itself. Upgrade to 5G, and your core network does slicing and low latency, and your radio and transport allow more devices per square kilometre – getting to that million figure. At that point, you add new use cases, and define different SLAs."

What kinds of SLAs are going into those LTE networks for critical comms, and what kinds of SLAs will go against future URLLC networks? It is, of course, an impossible question, because it depends on use cases. But, again, how should we rationalise this?

"I don't think the way to think about this is to define specific SLAs, just because it changes by case, by industry, by company. I mean, how much was Southern California Edison planning to spend [on insulated power lines] to reduce exposure to wildfires? $582 million? [Instead, it has decided to install and connect] cameras to monitor the power lines, so it knows where to remove vegetation to stop the fire risk.

Wildfires – Southern California Edison has gone with private LTE to guard against outages

> "There are deployment SLAs, and there are more creative models – around the upside of a bonus if the downtime percentage meets the target, versus the penalty for missing it. Those value based deals are coming up"
>
> ***Jefferson Wang, global 5G strategy lead, Accenture***

"So the SLA is not just about running at five-nines, which is important, but about the value of the use case – which is something, in the case of monitoring vegetation, that Wi-Fi couldn't support. Private LTE gets you the connectivity, and then you build new use cases on top of it – like for vegetation management with cameras or dones. There are core network SLAs to think about, always, but it is when you get to the use-case SLA that the real value is created."

Is it wrong to think network management SLAs will be linked to network performance? That performance is written about the technology into the design and procurement contracts, and that the SLAs about managed services and support are just about how quickly you pick up the phone?

"There's a lot being written [in contracts] around automation in the network; that is an absolute given at this point. But, again, it goes case-by-case, and company-by company. It is often about how creative the company wants to be – so SLAs about a percentage-less downtime on equipment. There are SLAs on deployment, like you mentioned; and then there are these more creative models around the upside of a bonus if the downtime percentage meets the target, versus the penalty for missing it. Those value based deals are coming up."

That seems like an IoT way of thinking, about how to calculate these softer returns – which it has taken a long time for the traditional IoT market to come to. Just expand on how much that trend is in evidence now.

"There will be a natural evolution where both sides become more creative about this. As enterprises look for more ways of value-exchange, and even demand ways of value-exchange, and as the deals become larger and more complex, so the creativity will increase to make the economics work – between the whole community of operators, vendors, and system integrators in support."

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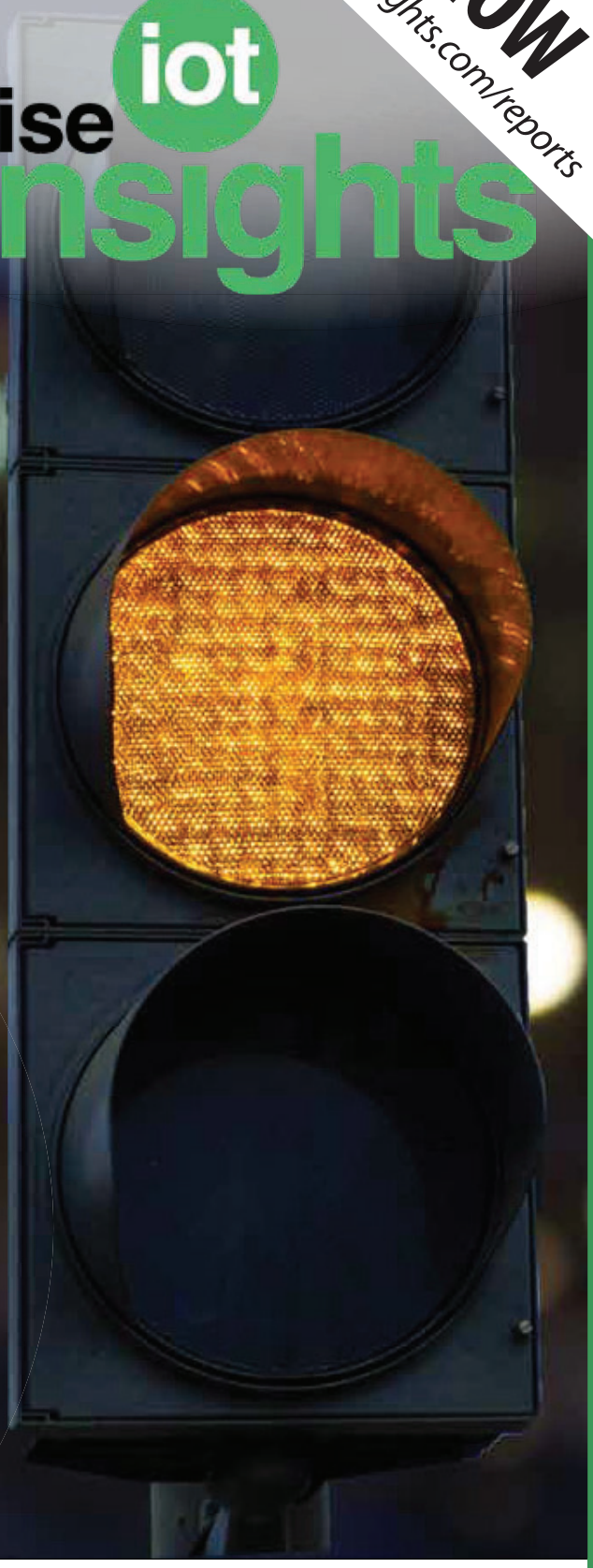
The trouble with SMART CITIES – where are cities with IoT, 5G and AI, and where are all the 'lessons learned'?



by Juan Pedro Tomas
Editor, Enterprise IoT Insights

CHATSWORTH PRODUCTS
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THE ENTERPRISE CUSTOMER | LUFTHANSA TECHNIK

Latency, speed, propagation – the real story of private 5G

A blow-by-blow account of Europe's leading private 5G network, from delivery in the back of a Ford Fiesta to 'business critical' usage

Lufthansa Technik, the aircraft services division of German airline Lufthansa, has more private networks "under one roof" than anyone else "in the world". That was how the firm was introduced at a recent private LTE / 5G event organised by Athonet. In fact, the two setups are in two aircraft hangars at a single site in Hamburg, under two roofs; but the hangars are close enough, on an 750,000 square-metre campus, and the point carries.

These deployments caught the sector's imagination a year ago (they went live on January 30, 2020) on the grounds Lufthansa Technik was quick-off-the-mark with 'vertical' spectrum, and first-off-the-mark (outside Asia) with standalone (SA) industrial 5G. As a twin-set, they were organised differently, too: one with an operator (Vodafone), and the other without (just Nokia, as supplier).

Which captured the intrigue in the market about the role of telcos in Industry 4.0. The approach also seemed to bring the perceived Nokia-vs-Ericsson channel gamble on private cellular into relief, about whether to stick with old carrier *compadres*, or twist on direct sales. It was notable, too, because Lufthansa Technik was breaking new ground, having scoured the market for practical examples of industrial 5G, and come-up empty-handed.

Even the late-2019 vintage, variously deployed, had been *bigged-up* or made-up, and flattered-to-deceive. "All the [private 5G] networks we'd seen were 4G campus networks or 5G showcases. It was disappointing; we wanted 5G to solve our problems." So here the company was, a year ago, having taken Industry 4.0 into its hands: with dual 5G networks of its own, geared for proper usage, and the whole market watching.

Private – 5G appear as 'LH-Technik' on devices; with 5G cell in background (Image: Lufthansa Technik AG/ Jan Brandes)

A year later, and the verdict is in: the results have been great. More than this, 5G has helped Lufthansa Technik stay on track during the Covid-19 pandemic. "5G kept my business alive – that is the business case [for private 5G]," reflects Claudius Noack, IT consultant at Lufthansa Industry Solutions, another unit in Lufthansa, which has managed the 5G project internally, and is offering the same elsewhere (see pages 31-32).

Some perspective: Noack is speaking, here, about a single line of business in a single business unit, rather than about the business overall. (Lufthansa Technik is careful not to overstate the impact of nascent technology, when the airline sector, at large, has been so hampered by the pandemic.) Still the sense is clear: the firm got lucky on its timing last January, to install two private 5G networks just as the planet went into lockdown.

TWIN DEPLOYMENTS

Noack's commentary on the two setups, using the 3.7-3.8 GHz band in Germany, is illuminating, and is arguably the best explanation of contemporary industrial demands on 5G networks. The two use cases – uploading and downloading HD and 3D streams, for remote collaboration on engine maintenance and cabin overhauls, respectively – made different demands of the technology, but the

technology came through in both cases.

The king metric for industrial 5G, as presented by the telecoms market, is latency. According to the Hamburg tests, 5G performs less well than advertised, never hitting the 1ms benchmark the market has promised; but latency of 7ms in one hangar and 16ms in the other is quite good enough for Lufthansa Technik. "We achieved 7ms in an SA network, which is not 1ms – but a lot better than Wi-Fi, I can tell you," says Noack.

The Nokia setup in Hamburg, geared for live video uploads to support remote collaboration on engine maintenance, required stable latency below 100ms. Noack comments: "The first call to the customer, and they said, 'We've never had such a stable, crystal-clear feed, before'. We thought we might use a big 5G use case like this for 50 percent of inspections. But we installed it in January, Covid-19 came to Hamburg in March, and we were suddenly doing all inspections remotely."

Anecdotally, the problem with Wi-Fi is the connection drops between access points, he says. "Which is why the video stream falters – and why the AGV (automated guided vehicle), say, comes to a halt." What about Wi-Fi 6? The team has not seen anything in practical terms yet to suggest it will suffice, he says.

But other measures must be considered, too. It is worth noting that, where 5G helped the company's maintenance work after Covid-19 suspended air travel, the parallel Vodafone network was closed down and signed-off as a ("successful") proof-of-concept, as the Lufthansa group curtailed non-critical workloads. But either way, both projects define key performance indicators (KPI) for key industrial applications.

Besides latency, the key measure for collaborative long-haul video streaming, as facilitated on the Nokia network, is the transmission speed. Besides latency and speed, the key measure for localised AR workloads in aircraft fuselages, as shown in the temporary Vodafone setup, is signal degradation through aluminum alloy and carbon fibre. The key to these metrics, in each case is the contrasting nature of the deployments.

Both are 5G SA networks, both use privately-licensed spectrum, and both focus on industrial applications. But that is where the similarities end. The Nokia network employs two indoor 5G small cells; the Vodafone network, a kilometre away and out of range, used a single outdoor macro cell, fixed to the inside of the hangar. Noack has a good anecdote about taking delivery of the hardware: the team struggled to find a room to hold the Vodafone gear, whereas the Nokia kit arrived in the back of a Ford Fiesta.

Case #1 – 'table inspections', streaming video of engine checks to customers (Image: Lufthansa Technik AG/ Jan Brandes)

"The customer said, 'We've never had such a stable, crystal-clear feed'. We thought we might use a big 5G use case like this for 50 percent of inspections. But we installed it, Covid-19 came to Hamburg, and we were suddenly doing everything remotely"

Claudius Noack, IT consultant, Lufthansa Industry Solutions

7ms

– latency on Nokia 5G SA network in Hamburg (vs 1ms, as prescribed in the 5G spec)

He is quick to point out this was late-2019, when the deliveries turned up, and that the unnamed vendor in the Vodafone setup has since shrunk its radio solution – and that Vodafone, for the record, is doing just fine with private 5G. But he makes the point, also, that Lufthansa Technik got a big-scale solution for a small-scale problem in the Vodafone deal – "a 5G core for a million end devices, when we're using 10, and might use 1,000 in the future" – and leaves it hanging as a cautionary tale about shopping around smaller providers, as well. "The big players might not always be right for your campus."

NETWORK METRICS

But what about the test results? Data rates across the two antennas in the Nokia network are good, it seems. Noack's team has recorded a stable download rate of 500 Mbps, with highs of upwards of 600 Mbps, and even 235 Mbps down in the corners. It is not 10 Gbps as the market has promised but, rather like with 5G latency, the reality gnaws, rather than bites, and it is

probably good enough.

Except this is not the measure that matters for 'table inspections', either, where high-definition video of engine parts is being sent to far-away customers for consultation. The upload speed is what counts, and mobile networks are typically configured 5:1 for download/upload speeds. "It is tough to get high numbers on the uplink," says Noack. So does private 5G deliver? It sure does, it seems.

Noack's colleague, Maik Voigt, who led the project on behalf of Lufthansa Technik, explains: "We thought we'd need 4×25 Mbps; we measured with multiple devices – and those numbers are not very high [on paper], but they were incredibly high for us, and really solved our problems. Because now we had a stable 100 Mbps upload stream with 5G."

Team – Voigt (left) and Noack, from Lufthansa's air services and IT units (Image: Lufthansa Technik AG/ Jan Brandes)

INCREDIBLE NUMBERS

What about the second case, with Vodafone? The results are interesting, again, because they break new ground. "When we started no one knew how well we could go through the hulls of aircraft. No one. Not Nokia, not Ericsson, not Huawei, not anyone." Not anymore, not now; Lufthansa Technik knows exactly how 5G degrades through aluminium alloy, and whether it can stand-up reliable two-way comms between cabin 'techs' and edge servers. The answer is: of course, it can.

The challenge with the AR system is to move the 3D overlays with the technicians in near 'real-time', as they make their way through the fuselage to guide them precisely on how to fit cabling and cabin furniture ("even showers"), and to reflect design-changes back to the server. The crew used beamforming to direct the stream via the antenna at the tablets in the hands of the technicians, and the transfer hit 1.2 Gbps outside the hull and 800 Mbps inside the hull.

Noack says: "They are incredible numbers. We'd never achieve the same with Wi-Fi. It was like, 'Okay, a 32 percent loss in the hull; that's it – 32 percent. But it was funny; we turned the lights off inside the aircraft for one measurement, and the rates went up to 1 Gbps – because these old fluorescent light tubes, with a magnetic ballast, were interfering with the network. Which is important to know – that [other] equipment disturbs your network."

> "We needed 4×25 Mbps; those numbers are not very high [on paper], but they were incredibly high for us, and really solved our problems. Because now we had a stable 100 Mbps upload stream with 5G"
>
> ***Maik Voigt, IT project manager, Lufthansa Technik***

1.2 Gbps – *download speeds in the hangar; versus 800Mbps / 1Gbps inside*

Emboldened, the team measured everywhere, inside and outside of the hangar. "We reached 900 Mbps over here, 700 Mbps over there. We still had 300 Mbps in te next-door hangar. We went outside; 600 Mbps over here, dropping very low over there – but that is like 350 metres away, and we still had coverage." By comparison, public LTE in the airport provides 128 Mbps, and is capped locally at 150 Mbps – no good for cabin-based AR, requiring 300 Mbps. What of Wi-Fi? Lufthansa Technik is running Wi-Fi 5, which stalls when roaming between access points, as discussed. He says: "It's a big hangar – Wi-Fi 6 would cost a lot of money; we have it covered with one 5G antenna."

The crew ran other tests, including with lower power from the base station. Download speeds went up, to a point, as output power went down. "The best result was at 56 percent power, not at 100 percent." Conversely, the coverage area goes down with the power. "At 100 percent power, you still have a wide area, like 500 metres; at 50 percent, you can still be far away, but the rate starts to drop. You can't go as far with lower power, but you might be able to edge the speed higher."

But Lufthansa Technik does not want to be attached to the telecoms sector's grandstanding in the industrial space. Its networks are real, and their impacts are tangible, albeit marginal, for now. At the coal face, the company is not much interested in the great promise of industrial 5G, nor the grand talk of industrial revolution. Noack's team is down in the weeds, trying to solve real business challenges. And 5G – privately deployed, carefully considered – can help with these.

THE SYSTEM INTEGRATOR | LUFTHANSA INDUSTRY SOLUTIONS

'We set the KPIs in the design, and write them in the RFPs – there are no SLAs to speak of'

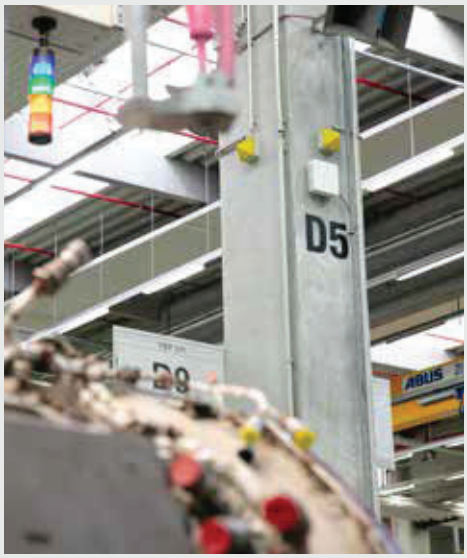
The Lufthansa Technik case study (left) is not the only one; increasing numbers of enterprises are putting private 5G to work. But it was one of the first industrial 5G networks in Europe, and it remains a seminal example of the practical application of cellular in Industry 4.0. Its clarity comes partly just from the fact the two key parties in the project are able to speak about it – because they are part of the same group. They are not sworn to secrecy, like most paranoid 5G experimenters.

Lufthansa Industry Solutions, the second of the two parties, has been engaged variously with the rest of industry, as well, offering a 5G consultancy and design service for digitally-minded enterprises of all stripes – though mostly in Germany, and mostly in automotive, logistics, and healthcare. The firm has around 2,100 staff; last year, 40 percent of its revenues came from inside the Lufthansa group. The rest, the lion's share, came from selling digital change to others. Here, Claudius Noack, with Lufthansa Industry Solutions, talks about how roles and responsibilities are being divvied up in the wider market.

Explain the position of Lufthansa Industry Solutions within the group, and its strategy outside – and something of how 5G fits in.

"Our DNA is in the exchange of knowledge and tech between industries and sectors – such as from the aviation industry to other fields like logistics and automotive, and *vice versa*. Which is what we've done with 5G. But there is no one-size-fits-all system. Which is why we are offering consultation about deploying and designing 5G for industries, with their requirements in mind.

"It requires a broader view – you have to check if 5G is the right fit. There are use cases that work well with Wi-Fi, or with fibre... You need to know about the different setups, which is something the vendors and carriers don't right now. They need more practical experience. They know how to build networks for millions of devices, and they are trying to scale-down for industry. But most industries don't just need scaled-down versions. Which is where we come into play – to [help] design industrial networks. It might be different in a few of years. But for now, you need a partner with experience."



Radio – on D5 (Image: Lufthansa Technik AG/ Jan Brandes)

Which industrial sectors are most interested in industrial 5G right now?

"The automotive sector is very interested; the same with logistics. There is a growing appetite within the pharmaceutical industry, to keep up with processes – especially since the pandemic. Those companies have the money right now, and they know they need to do something – to be better connected. They want their production sites to be automated, to switch production more easily.

"I was on one project where the customer was changing production every three months, and reorganising their whole setup every time – physically changing things from left to right. So having everything on 5G has helped a lot. Flexibility is usually the thing. You read about 5G robots, and sub-millisecond latencies, but we haven't seen much demand. Right now, the demand is for [reliable] connectivity and coverage."

Talk a little more about the use cases, and how this technology is being deployed.

"Right now, the big thing is just that you can create your own standalone network. Before, you needed a carrier, and it was always a public network; yes, you could get some indoor antennas, but it wasn't your network. That is the biggest change. Yes, there is more bandwidth, and there are cases where you need that – such as if you're streaming CAD data. But that's not the case, mainly. And yes, you get lower latency, which gets talked about all the time, but all of our projects so far would be fine with LTE.

"Latency on public LTE is 40ms; we get to

15ms on non-standalone 5G, and 7ms on standalone 5G – with no spikes. But we have never needed latency of 1ms, and not even 5ms. The only reason we don't use LTE – because it would be much cheaper to go with public LTE – is that we need to go indoors, and once you enter a production facility that 40ms latency goes up to 100ms and that 100Mbps downlink goes down to 10Mbps."

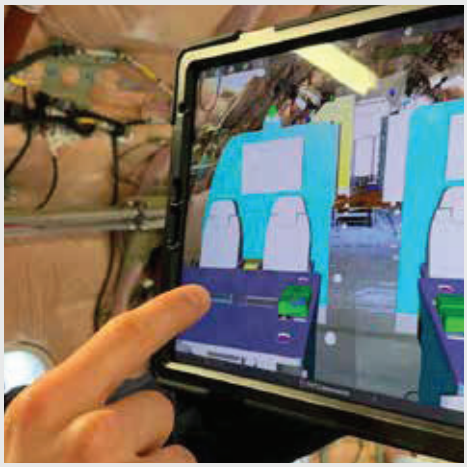
What about demand for hybrid networks, crossing into public 5G?

"So far, our projects have been one or the other. We have done projects with big telcos, for outdoor 5G. The others have required edge compute setups, where you don't want data floating around the internet, and where 5G has been used for the last-metre to and from the edge computers, usually for AI image processing for quality checks. But there is a different setup for each use case. Right now, the systems are designed to deliver for one or two use cases, and not more. We are not at a stage where we need to slice the network for different things – a slice for edge computing and another for calls and video, or other stuff. That will come, but it will take two years."

Talk about the kinds of KPIs these use cases require, and how they are being written into SLAs – and who will write them?

"For all our cases, but especially the one with Lufthansa Technik, which is business critical and which I can talk about, we have had zero minutes unwanted downtime. Yes, we did some updating, so it was down for a minute or so. But zero minutes in over a year. But the question about who manages the network is fair. Because right now our own people are managing these networks. We get called when there is an issue. And given the projected growth, additional support could be required to manage these requests.

"In the end, these industries will likely do it themselves. That is our approach – to enable companies to be autonomous. What happens is we set the KPIs around the use cases in the design phase, and write them into the RFPs that go out for the build phase, so they ares guaranteed in the contract.



Case #2 – AR refits (Lufthansa Technik AG/ Jan Brandes)

"We have had zero minutes of unwanted downtime in over a year... But the question about who manages the network is fair. Because right now our own people are managing these networks [which we don't want to do in the long term]"

Claudius Noack, IT consultant, Lufthansa Industry Solutions

But then the network is set up, and there is no SLA to speak of. That has been the case so far, in 12 months of doing this. Even the vendors are struggling with the question of SLAs, and who will manage the networks in the long term. They know they need to find a solution. [But] the systems are not complex enough yet. We are not talking about ultra low-latency, or even big bandwidth; just about connectivity – which is how 5G is helping right now."

So Lufthansa Industry Solutions doesn't wish to manage – just to consult and design?

"Yes. The first step is use-case identification; the second is technology matching; the third, the most important right now, is finding the right supplier. After that, the fourth step is around legal support and applying for frequencies, which is not that complicated, and the final step is deployment, which basically involves talking to electricians. It is basically project management, but you need to know the tech, and what it's for. Those are the things. After it is deployed, we go to the next project."

Do you expect companies like Accenture and IBM to handle the management? Or can you see vendors and operators being involved?

"Yes; like if IBM, which is doing a lot of networks, had a 5G department. Right now, it takes a lot of effort to carve out these capabilities from operators, and a lot of coordination with [vendors]. Nokia and Ericsson have these cloud systems, which can help, because customers sometimes want to connect from anywhere. But we usually ask those providers to create a cloud platform on site... The smaller the company gets, the more likely they will want a third-party service provider to manage the network. When you talk to the big ones, like Lufthansa, they will manage their own networks by themselves. If they can find the right people."

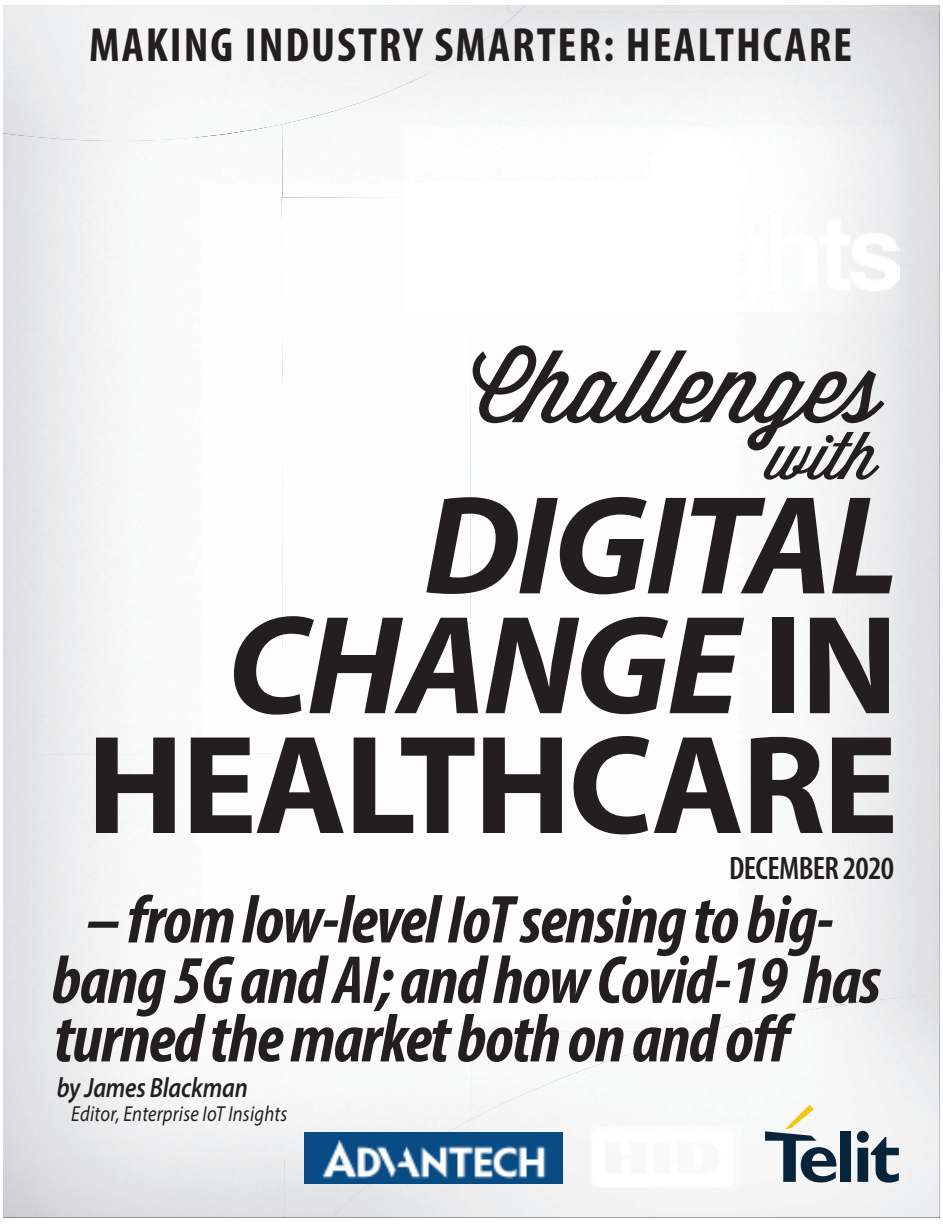
What demand are you seeing for ultra-reliability, as prescribed in the 5G standard?

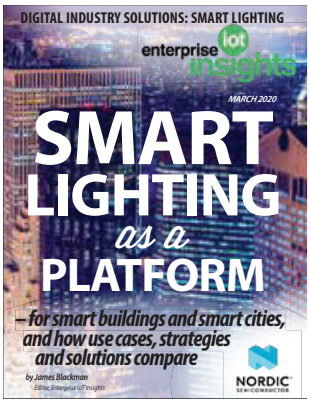
"Everyone asks about reliability, but when you explain redundancy costs money, they hold back, and go with the simple version, just to try it out. The other thing with 5G redundancy is you need space – and lots of it, for all the server racks. Customers don't have lots of space. And I have not yet found a project yet where it is 24/7 business-critical; where they have said, 'If this is offline for even a minute, the business will go bankrupt'. Usually they just want to add 5G to their normal setup, and switch from Wi-Fi."

Should carriers focus on public networks and industrial crossover into their domain?

"Yes, because most industrial 5G use cases are for indoor connectivity, which doesn't need a carrier. There will be plenty of use cases that require outdoor coverage, and roaming between, and cases where enterprises want a slice for normal things, like calls and conferences. So they will get a share of the industrial market, for sure."

enterprise iot insights





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THE NETWORK OPERATOR | VODAFONE

Set the controls for the heart of the 5G 'run' – the operator model for industrial 5G

Private 5G divides as a 'sell-build-run' process; Vodafone will handle the last of these, it says, plus key consultancy. Here is how

After the criticism aimed at carriers in the preceding pages, and as we have shifted interview-by-interview across the private 5G stack, we arrive with UK-based Vodafone. That is to say, we arrive not with an enterprise, as a stricter narrative supply-chain logic would conclude, but with an operator – and with, arguably, the most accomplished enterprise-facing operator of them all. And we are here, with Vodafone finally, because this story is as much about the fate of the old telecoms sector, as it is about the new private cellular market, and about what enterprises want from industrial 5G.

The message from Vodafone, printed here in full, works as a riposte to the doom merchants calling time on carriers, as beleagured and entitled, in entangled OT markets. Indeed, it reads like a defence and manifesto for the whole operator set. But elsewhere, Vodafone confirms what other protagonists in these pages state; that enterprises want charge of industrial 5G networks, but that they need a consultancy-wrap as well, around infrastructure design, stakeholder management, and in-life service.

On one hand, Vodafone's argument that, in the final analysis, this remains a telecoms discipline, best handled by telecoms experts, should not be so easily dismissed. On the other, Vodafone insists it is not typical among mobile operators, on the grounds it serves enterprises already, it 'gets' IT/OT crossover in IoT, and it has its own factories as well. So Vodafone does not speak for everyone, perhaps. And yet, the below interview, with Phil Skipper, the company's group head of IoT business development, is as close as we will come to understanding how the operator community will finally crack Industry 4.0.

"It is wrong to think a telco would have any involvement in private 5G from an OT perspective. We're not interested in what's flowing across the network. We are only interested in making sure the network is available."

Phil Skipper, group head of IoT business development, Vodafone

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How does a network provider guarantee the private network in a factory will not go 'pop', and the production line attached to it will not go down? How is that negotiated between the enterprise and the service provider? How will it be defined in SLAs?

"You have to look at the network infrastructure suddenly as part of an OT platform. As soon as you get your head around the fact you're moving from IT to OT, [the negotiation] moves from how you sell and build to how you run [a network]. The question is how that run-process works. Especially with private networks, you cross between what the telco provides and what the enterprise owns. Manufacturing companies have maintenance teams for when things go wrong, and this hybrid model will gain traction – where relevant skills exist in-house, as well.

"With that, the whole concept of SLAs changes. It becomes about faultless resolution. I don't think any customer assumes 100 percent reliability. What they want to know is that, if it doesn't work, they have a pathway to a faultless resolution – in the shortest time. Which is where you have this more interesting relationship between the factory owner and the network supplier."

Presumably, where Vodafone provides additional support, it does not intend to put somebody on site? Presumably you are running remotely, and can tap into that network to run fault diagnosis? Just talk through the mechanics of that.

"We offer mobile private networks as a managed service, and we will monitor the performance of that infrastructure. One of the things you will see is greater granularity of what is actually viewed. Within the factory, you may go between licensed and unlicensed spectrum. These networks will include a bit of Wi-Fi, a bit of Bluetooth, and some LTE and 5G as well. We will monitor this infrastructure to understand where the core network services are becoming less 'performant', and to make adjustments to avoid problems in the first place."

Is that done from a conventional network operations centre (NOC), from where you also monitor the national network?

"It depends how the network is set up. We have access to everything in a national network, clearly. As a managed service, we would need access to the private network, as well. Even a private network will have interconnect points with the public network. But the network will be optimised for different things, around performance and flexibility, and not the kind of availability or bandwidth [metrics] you find in the public network. It will different monitoring.

"This is where the SLA question becomes quite interesting. Because if you are working in the open space, you basically want many customers to connect in the same way and receive the same quality of service. The axis that varies most is density. When you get into a factory setup, the density is fairly constant – because you have a fixed number of machines. Instead, you have to monitor performance for things like virtual reality and machine control, and so on. The second thing is redundancy at hardware level, to ensure fallback n from the start. The piece in the middle is about how to put feet on the ground if something needs to change."

Connectivity – current private LTE/5G is mostly for connectivity and coverage; future 5G slices will afford a similar channel

But paranoid manufacturers, for example, do not want to interface with the public network at all. Does that preclude you from running remote diagnostics?

"No. Monitoring the network is different to accessing the data on the network. It's sort of like health records – they're protected, but you don't want to stop doctors from looking at them. It will be the same thing. To maintain a network, you're only interested in the flow of data, and not the data itself. So nothing will escape. But, like we said, the network is an asset, so it has to be maintained – and [cellular] will replace existing cable and Wi-Fi systems, which are being actively managed today."

So should we disabuse ourselves, then, of this idea which gets talked about, around whether enterprises will even allow carriers near the controls? Is the term 'network operator' just more fluid in this environment? Because you are not really operating the network anymore; the enterprise is doing that, in the main part. Is that what we are looking at?

"I think 'network operator' is a good name for it, actually. Because we keep the network running, and make sure this magic radio-airwave stuff is working. Which is quite different from the use cases going over the top. We are not operating the factory. We are only providing a piece of infrastructure to help to run it. We are more like the electric network, or the gas network, or the sewage network – all of which are operated by third parties, and help the factory to work. It is wrong to think a telco would have any involvement in LTE or 5G from the OT perspective. We are not interested in what's flowing across the network. We are only interested in making sure the network is available."

The market says that, in the end, this becomes – in a single site, with a simple core – not that complicated, like a Wi-Fi network. Is that what happens? And therefore, is

it a hands-off thing, where the network planning is key? And perhaps the key SLAs are about planning and deployment, rather than performance?

"If you look at the traditional sell-build-run model, there are different SLAs for different bits. For the build-phase, it comes down to how long it takes to get to a working system, with traditional project based SLAs attached. It gets more interesting with the run-phase, because that is where you define this faultless resolution. Because you can't afford the old finger-pointing.

"And, yes, there is this idea of a network-in-a-box, in its simplest form, where you can go in there and connect up, and *dah-dah*. But even with that, there will be a lot of bespoke configuration, and resilience and redundancy to build in. Plus, the enterprise will have devices connecting and disconnecting, and being swapped-out. So all of that needs to be handled – and it has to be handled from the point of view of both the network infrastructure and the business running on top. If a file from one machine does not arrive in the manufacturing execution system (MES), the line of questioning goes: was the network running, was the file generated, was the file lost in the system? So your ability to fault-find is the real key to success for these private networks. "

Does that involve more than the enterprise and the carrier? Does that involve a system integrator, as well?

"It will be the guys running the factory, in most cases. If you have a faulty PTT radio on site, for example, you check-in with maintenance and get a replacement. That's how it works. And if you press the button and it still doesn't work, you run the diagnostics of the network, and work through and find out it is because a transponder over here, or whatever. So the diagnostics process is pretty established, already. The difference now, with LTE and 5G, is these technologies are unfamiliar. That is the key balance to strike, to get the shop floor up-to-speed, so the network operations team and the boots-on-the-ground team are on the same page."

A million private 5G networks by 2030 – in Europe

Private LTE and 5G for industry appears to be rolling faster than anyone expected. "A million private networks by the end of the decade? It is possible. In Europe alone." So says Marc Sauter, head of private networks for Vodafone's business division, speaking at a recent private LTE/5G event organised by Athonet. Most interest is from manufacturing, logistics, utilities, oil and gas, and healthcare.

It was the same line, almost, in June 2019; this time from Athonet, itself, speaking at MulteFire-sponsored panel at Hannover Messe, chaired by *Enterprise IoT Insights*. Except the figure, then, was about the US market for private networks, and the big carriers were on the sidelines still. "Boom-time beckons," ran the article. Go back another six months, before the 2019 Hannover meet, and Nokia was counting-out its industrial targets: "10 million factories, three million warehouses, 50,000 mines," it said.

But Athonet and Nokia have been on the mark for years. The excitement from Vodafone, arguably the leading carrier in the enterprise space, is new. Private cellular is the only way to spring the kind of digital pyrotechnics that will light the way to slicker industrial operations, implies Sauter. "Mobile private networks are closely linked to IoT; the same use cases apply."

He says: "The 'fourth industrial revolution' is all around. Covid-19 will accelerate that. Private 5G will enable all of that – [to connect] robots and machines in manufacturing, AGVs and cranes in warehouses and ports, and [similar in] energy utilities, and oil and gas."

How does that change larger and smaller manufacturers? What is the difference in Vodafone's approach?

"We will offer the same type of service. The difference is the SME, most likely, does not have capacity to create a department of network specialists. It will want that full end-to-end service. But those implementations will be quite small, typically, and self-contained. When you go to a large car plant, by contrast, there may be multiple cells, and the car maker will probably choose to invest more in its own networking capabilities.

"The other thing is these networks seldom go down entirely. What happens is you might lose Building 17, or data traffic from a particular machine. So even though we can diagnose an issue in the network, you still need someone on the ground. Which means this idea about going from working to not-working is somewhat wrong; what you tend to find is you go from 100-percent of everything to 100-percent of most things."

Is this idea of 'five-nines', or seven or eight-nines, reliability written into the technology or into the network management SLA?

"With national roaming, we can bounce to a second network if one goes down. Theoretically, if both are 51 percent reliable, then you probably won't have a problem. Because you bounce from one [to the other]. That's where you also need fallback comms for critical bits of machinery, and so on.

"But if you really want the ultimate, then you need to think about what you want to connect, how you want to connect, and how to support all of that – so devices, network, support. If you consider only one of those three things, then you end up being limited by your 99.999-whatever percent. If you target two out of the three, you make a significant improvement; if you target all of them, then that is how you do it.

"If you look at systems with ultra-high reliability and quality, they normally tackle it on those three axes – on a base-layer of infrastructure reliability, and then on redundancy, and then on resilience. Once you have that three-dimensional space – and aircraft are a fantastic example of this

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– then you can start to get that reliability up. By putting all three together – by deploying really reliable kit, by backing it up, and by establishing ways to work around it – you start to build [that ultra-reliability]."

But presumably that is not in the managed services contract, but in the deployment contract and the sale – in the sell and build phases, rather than the run phase?
"Yes. But as part of the managed service, there is an opportunity to talk to customers about what they want from their OT systems. And most want 100 percent reliability. So you go backwards from there, and say, 'Well, you can't get 100 percent, so the thing to do is to reduce exposure'. And, together, you start to look at what can be done at the device level, operational level, and technology level in order to get you there."

Just going back to the question of remote diagnostics, will Vodafone set up an regional enterprise NOC in industrial heartlands?
"We [are managing] mission critical [network] services today, already. And in some cases we even have people working on site. But I think the model will be different. For us, we are going to need a NOC. And there is a good parallel for this in what we do with stolen vehicle tracking, where we have 52 secure operating centres across the world, already, to pick up stolen vehicles. But it is a good question: whether to have a dedicated enterprise NOC for mobile private networks? I don't know. But you can imagine we will have something like that."

Back, as well, to this idea of simplified 5G: do you get to the stage where enterprises don't need a service provider? Because it is all off-the-shelf, intuitive, and automated? Why does anyone need an operator?
"But mobile networks are not static. They continually change as devices are added and updated, and more routing paths are designed, and as the network interacts with the public network. Enterprises that are massively invested in their own capabilities may well take on more of that service, and SMEs may just want the capability to buy more of those services. It becomes like horses for courses, as to the level of engagement each customer needs and desires."

What about this idea that managing one network is different to managing many networks? That it requires vertical knowhow? Is that fair, or would you say it is a mobile network at the end of the day, and you know about that better than anyone else?
"Yes; that is the point. System integrators handle the build, which [covers] a distinct period of time. We are talking about an operational asset that might last for 10-15 years. So you need somebody that does networks as a business, which is what we do. So the network operator is well placed to maintain these networks going forward."

So the system integrator would not typically be engaged in the network management?
"No. They fill in the middle, between a big consultancy and a network operator, if we put it in simple terms. But the underlying network is a core management issue. And this ecosystem will develop in support of it, because you need to very rapidly decompose that value chain when there is a problem, and decide where the issue is."

There are plenty (in these pages) who say carriers talk about 'enterprise 5G' like it's a telco service, and not an enterprise service. Presumably carriers might respond that they are used to talking about it one way, and enterprises might want to talk about it another way, but that the discussion is about the same thing in the end?
"Yes, that is the point for us. We want to talk about the run-phase, and the in-life service. If you're just selling networks, you talk about technology and hardware and all the rest of it. But if you're going to sell a managed service, you need to understand what the run is. And private networks, in particular, are seen as a hardware thing. We look at it as a managed service. Because for the customer, the most critical thing is the factory keeps running. And so when we talk about the run, we are very aligned – and, of course, if you know what's required for the run, then you are in the lovely position, as well, to know what to build and what to sell.

"But Vodafone is something of an exception, because we combine two things: a very strong enterprise mindset, and a very clear IoT capability. So we do talk the languag. We aren't just talking about the ins-and-outs of 3GPP standards; we are talking about manufacturing execution, real-time performance, quality-of-service, how to put AGVs on the shop floor, and all those types of things."

THE SOFTWARE PROVIDER | VOLTDB

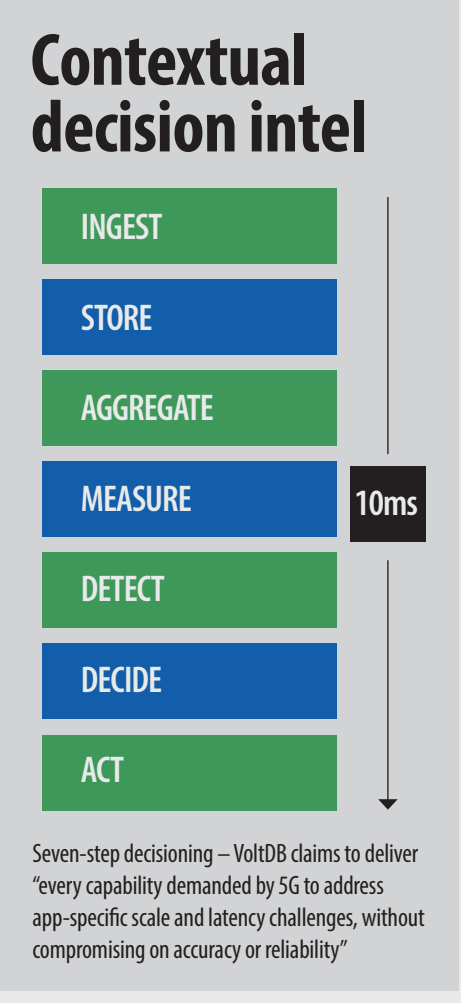
‘What is the point of ultra low-latency 5G if it slows down in the middle?’

Network performance is not just about 5G at the egde, but about what goes on behind the scenes; VoltdDB brings a new angle

It is like that old C. S. Lewis quote, that ‘integrity is doing the right thing even when no one is watching’. If the success of industrial 5G comes down to the speed and reliability of data across the network, the integrity of the data is also about what goes on behind the scenes, in the obscure recesses of back-office business support systems (BSS). Because this is where the battle to deliver ultra-reliable low-latency comms (URLLC) and intelligence is won and lost. So says US software company VoltDB, offering an in-memory NewSQL database to help 5G operators stay sharp.

“All this investment in infrastructure is going to be moot if you’re using old software to provide the service,” comments Dheerah Remella, chief product officer at the Massachusetts firm. “Half a millisecond is half a millisecond, but what’s happening between those two half-milliseconds? If there’s a whole second in there, then you’ve undermined the whole URLLC premise. That’s the value we bring to the table.”

VoltDB has been offering an ACID-compliant relational database system, using ‘shared-nothing’ architecture, since 2010. It reckons 5G has “changed the game” for telcos; a new way of managing data, is needed, it says, for “businesses to survive and thrive in the age of 5G, IoT, and whatever comes next”. A typical 5G setup requires multiple technologies (see left) to come together to solve one problem: real-time intelligence (“ultra-reliable low-latency decisioning, or ‘URLLD’, as we call it). Remella comments: “Because data is useless if you can’t use it for intelligent decisions – to drive action. It is just baggage, otherwise.”



Seven-step decisioning – VoltDB claims to deliver “every capability demanded by 5G to address app-specific scale and latency challenges, without compromising on accuracy or reliability”

Why do carriers need another in-memory database?

“A lot of NoSQL databases came up when internet-scale operations started, and scale became a problem. And they threw out everything that traditional databases had established – which is consistency of data, correctness of decisions, resiliency and immediacy. All of that went out the window. We are bringing all the goodness back into internet-scale operations. We are bringing together the ability to scale and the ability to be immediately correct. Because if you are taking actions based on data that is only nearly correct, at scale, then it is not good enough – certainly for the Industry 4.0 market.”

Talk about this 10-millisecond latency metric – where it comes from, what it means?

“Yes, so VoltDB brings together a set of

capabilities that are necessary to complete this value-extraction, in the first 10 milliseconds of any network event, lifecycle event, subscriber event – whatever. Ten milliseconds is not a statistical measure, but one customers tend to use as a yardstick for making decisions from event genesis – the time to decide on the best corresponding action. That's where they make a difference.

"For example, Mahindra Comviva, selling software to operators to monetise the network, has a total budget of 250 milliseconds from the point an subscriber presses on a call to the point a next-best offer is made. Which requires VoltDB to make a decision in the first four-to-seven milliseconds – whether it is about any kind of fraud, or intrusion prevention, or DDoS detection. All of those things require a decision in under 10 milliseconds."

Talk about some of the standard use cases.
"We offer the foundational platform in OEM products. Openet and HPE have charging and policy, for example, which is our bread and butter. There are areas like monetisation and revenue leakage prevention, or revenue insurance. In all these cases, the accuracy of decisions and the correctness of data is mandatory. And those things are compromised with other database technologies. Ours is becoming the standard platform for charging and policy in the BSS space. And although we could be considered a horizontal platform, we are focused on 5G, and the 5G-enabled world."

How does that BSS-capability transfer into Industry 4.0? How will carriers, via OEMs, make use of your database in this market?
"The last three operators that purchased solutions running our software have all done so to manage industrial IoT – two in Europe and one in the US. I can't reveal names, but the thing with Industry 4.0 is you can't have any downtime. It is not permissive, like in the consumer market, where a subscriber can just retry the connection. If you can't connect in a mission critical environment, it becomes inoperable. There is massive revenue leakage. We see ourselves as an active digital-twin hub, collecting and combining incoming data, machine-learned intelligence, to enable active digital twins and drive actions – to create a closed feedback loop of telemetry."

Talk about how your database plays with network data and enterprise data?
"It brings IT and OT together. You have to bring network data and enterprise together to assure quality-of-service. Which is exactly where we play. Because [our product allows carriers] to unify multiple streams of data to create a complete picture, which is required with network slicing and Industry 4.0 – where service quality and assurance is monitored and optimised based on policies per slice, or per customer, or per use case or application. Release 16 [of the 5G standard in 3GPP] has made a ton of enhancements to policies to address Industry 4.0. These charging and policy systems are moving closer to the things they are managing – subscribers in a nationwide deployment or devices in a concentrated industrial IoT deployment."

Just put these two key elements – policy and charging – into context, in Industry 4.0, as the network and compute functions move to the mobile edge and the enterprise edge.
"Yes, so the first is about doing the work, and ensuring the quality-of-service – that is where policy comes into play. The second thing is that operators are not charities. They need to monetise what they're offering. Which is where charging becomes essential.

"Seven or eight years ago (when VoltDB was still new in the market), operators were actually losing money because they couldn't track charging in real-time. Now, with Industry 4.0, the density and velocity of data is going up all the time. You can't have centralised charging that requires periodic sync-up. All of this computation and management needs to happen very fast. And we are moving closer and closer to the edge.

"None of these three [new operator] contracts are centralised deployments – all are MEC deployments, which is where resiliency becomes super important. Because you cannot have a single edge data centre serving a single setup, [and yet] you need a resiliency

Daimler – car maker has engaged Telefónica to manage the build of its 5G network, but not its operation (Image: Daimler)

model for cross-data centre replication and highly-available data infrastructure. So it's not just about moving to the edge, but also enhancing the reliability and resiliency of these platforms at the edge. That's the trend we are seeing in general."

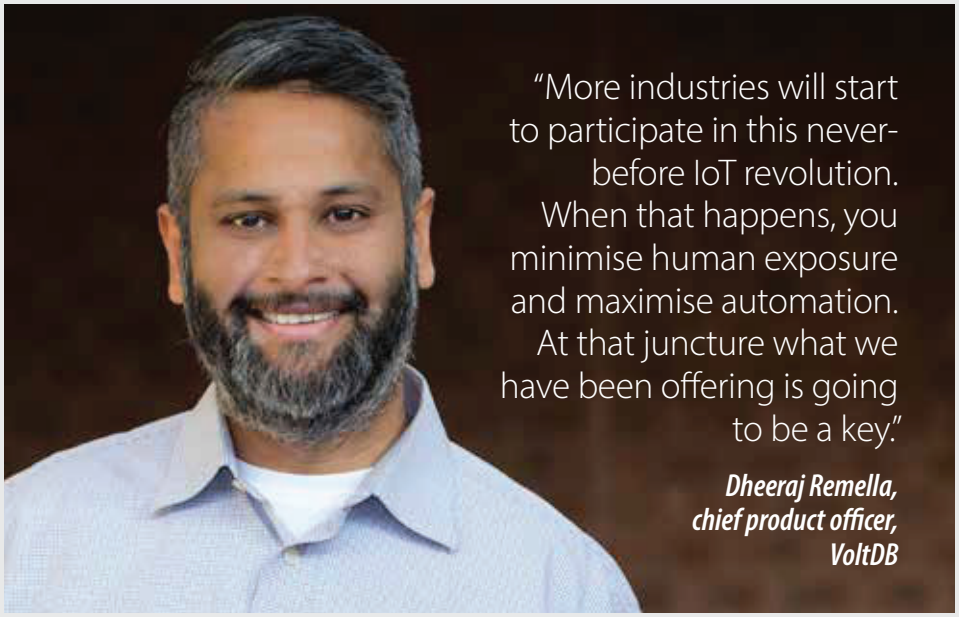
Let's bring the conversation around to 5G SLAs, which is the point of the piece. What is VoltDB doing to help network operators with these performance guarantees?

"Operators need to monetise their 5G investments, and monetisation comes in two flavours – how to make money, and how not to lose money. When you consider the volume and velocity of data being generated as things go live in standalone 5G environments, you need to know what the data is telling you and make intelligent decisions in response to it. That is coming up in charging first, and policy now.

"By protecting network resources, operators can handle fraud prevention and intrusion prevention. They need to operationalise intelligence on all the new data coming into the network – whether to present the best offer, or to reject a connection request in a DDoS attack, or just to ensure the charging is correct. And charging is not just bean counting; the value of charging comes with enabling operators to define and deliver new products with high agility. When charging is done right, those launches will be accelerated – going from several months to days or weeks. "

Are enterprises, which will in many cases run these private 5G networks themselves, mindful of these aspects of network management? Or does this remain a telco-discipline , really for carriers?

"The awareness trickles down. It is already there in the OEM space. Awareness of the need for low-latency decisioning is increasing within the carrier space. And enterprises, yes, they have these needs, as well. As a business, we will focus on the telecoms space, at least for 202. Enterprises are still trying to figure out how to put together a variety of open source technologies, and just to skim by. Until they actually see there is a genuine difference in moving to immediately consistent, ultra-reliable, resilient decision-making, we don't want to waste time there."



Does your proposition have a bearing beyond network management? Does it roll-over into sweating the production line and industrial assets, and getting operational data coming from those machines?

"Yes, we see that. But industry participants need to move beyond SCADA to systems that are more intelligent than just data collection. That is a transition that needs to take place, and the sense of urgency will develop once the latency promises of standalone 5G get delivered. Today, we are looking at charging, policy, real-time mediation for rating and billing, customer management, and revenue assurance. And those things will enable digital twins, industrial automation, process automation.

"More industries will start to participate in this never-before IoT revolution. When that happens, you are minimising human exposure and maximising automation. At that juncture what we have been offering in these five spaces is going to be a key. So we see ourselves as highly relevant in Industry 4.0 – but Industry 4.0 is waiting on 5G SA to come to fruition."

Does it impact how you approach the Industry 4.0 market, as hardware opens up, complexity is stripped out, and enterprises manage these networks themselves?

"Maybe, maybe not. But even the most advanced of these implementations – in Germany, by Lufthansa [Technik] and Daimler – have not required the enterprise to build software components themselves. All they have wanted is the spectrum, to be independent from the public network.

But they are still engaging with operators. Lufthansa Technik worked with Vodafone on one of its installations. Daimler used Telefónica in Germany as a system integrator to implement everything, and then move on – so no more Telefónica. All these operators did was set up infrastructure, feed them with software vendors, and then leave the picture.

"So I don't see the operators or integrators, depending on who the enterprise engages with, taken out of the picture. Because Daimler is not in the business of building and maintaining networks. It is in the business of using then to optimise its manufacturing processes.

"So enterprises will still engage with the regular players in a consultative mode, rather than in a subscription model so to speak."

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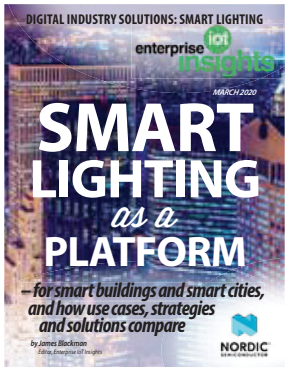

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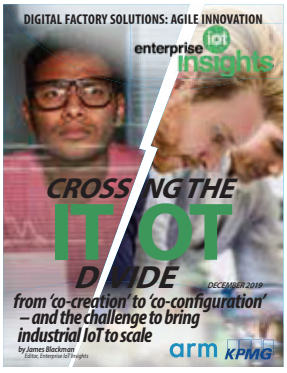

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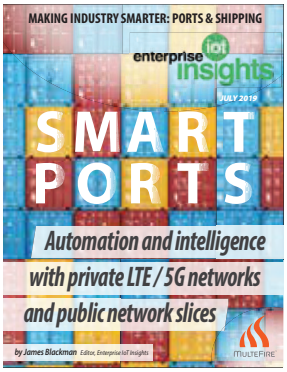

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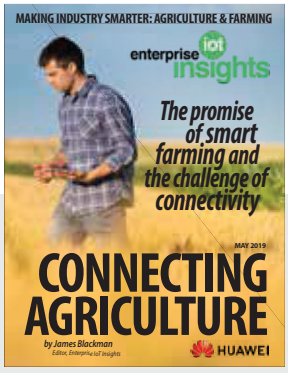

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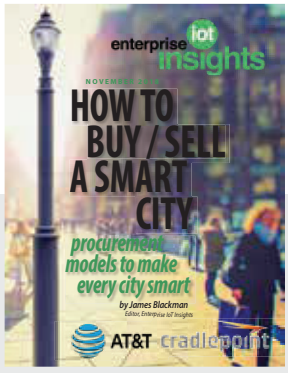

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JULY 2021

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Talking About (Industrial) Revolution (New Series): Conversations with industry about IoT in... Intelligent Transport Systems (ITS)

OCTOBER 2021

Enterprise IoT Insights |
Digital Industry Solutions | Cellular LPWAN | NB-IoT - what has gone wrong, and when will it go right

Enterprise IoT Insights |
Talking About (Industrial) Revolution (New Series): Conversations with industry about IoT in... commercial real estate (CRE)

Enterprise IoT Insights |
Digital Industry Solutions | UWB - why it works for IoT (and why, when Apple talks, everyone listens)