Marcus Weldon: '5G will enable a new era of productivity and economic growth'

*In the early aughts, Nokia produced the most coveted mobile phones in the world, before it was disrupted by big tech giants ushering in the age of smartphones. The Finnish multinational corporation no longer produces phones directly, as its core activity has shifted to network equipment. It now aims to lead the market for end-to-end 5G networks. With a PhD in physical chemistry from Harvard and a B.Sc. in computer science and chemistry from King's College, British executive **Marcus Weldon**, Nokia's chief technology officer and Nokia Bell Labs' president, has global responsibility for defining the company's technology strategy. Marcus believes 5G technology will be able to solve the productivity paradox, "the global slowdown in productivity growth despite a rapid acceleration in technology progress", as he and co-authors Sanjay Kamat, Subra Prakash and Iraj Saniee explain in the white paper [Digital networks at the nexus of productivity growth](#). "5G will enable a new era of productivity and economic growth", he told LSE Business Review managing editor **Helena Vieira** on 5 November, during the Web Summit conference in Lisbon.*

I'd like to start from the basics. What exactly makes 5G different from 4G? Is that satellites? Is that the idea of interconnection? What exactly is it?

5G is materially different from 4G, because it's been designed for machines and systems from the ground up, not just for people. Most wireless networks today have been focused on people comms, and you think, well, what's the big difference? Well, people communicate with certain attributes. They need a certain capacity. They need a certain latency. In fact, latency is the big change. When I'm speaking to you, you can recognise a delay of 100 milliseconds. So, if I speak, your brain takes about 100 milliseconds to process it. You hear it as instantaneous if it falls within 100 milliseconds. Outside 100 milliseconds, you think, why is he speaking so slowly? It's that thing on a phone call when you say, 'you still there?' If you don't get an acknowledgement or sound within 100 milliseconds that says the person is still there, your brain starts thinking there's a disconnect. Machines might need one millisecond of latency. That's 100 times faster in latency, which means I have to redesign the network to support that. Just to give you the number, light, which also means electromagnetic radiation, generally can travel about 10,000 kilometres in 100 milliseconds. So that means if we need to build a network that has one millisecond latency for machines, the network and all its equipment and all the cloud processing can only be, say, 50 to 100 kilometres away. So instead of being highly centralised networks, think of big data centres in the middle of the US, you have to massively distribute everything. Computing technologies have to move close to radio technologies. All of that has to change just so machines can now communicate to systems and processes.

"The industrial automation part is the driver this time, not human communications."

What is the big deal about machines? Why do we suddenly care about them? The whole idea of 5G is that we want to digitise our physical systems. The industrial automation part is the driver this time, not human communications. Human comms is what the last two or three generations of wireless have been focused on. But they haven't focused a lot on system comms or industrial machine comms. When you start thinking about automation, robotics, autonomous vehicles — anything where the machine has to move or perform a function that is very precise — then you need this very low latency, and that's the essence of 5G. 5G is also designed to be very reliable. When I talk to you, if the call drops, we're a bit annoyed, but it's not the end of the world, we'll just redial. But obviously, that doesn't apply to an industrial process, which is sort of mission critical, so 5G is both low latency and very reliable. And of course, if I've got all those machines talking, I need more capacity. That's where new spectrum and all that comes in. Those are the attributes of 5G. And that's very different from LTE, which is sort of focused on just people communicating either with each other or with the web. That's the shift.

How do you build the 5G networks physically? Not with satellites?

Not with satellites. Satellites are never the answer for any high capacity or low latency, because in fact, the latency to get up to a satellite is quite long, depending on what type of satellite, whether it's a low earth orbit or geostationary, these distances are quite long. And when you have long distances, you get long latency. The problem with satellites is that they have a large region they serve. Their footprint is normally hundreds of square kilometres. All the capacity of a satellite gets shared over a very large area, so satellites are never the answer. It always has to be terrestrial and close to you. 5G networks will get built by putting radios within 100 metres of everyone. 100 metres, not 100 kilometres. So, it will go very close. You will have to think of them like you think of WiFi access points. You will have 5G access points everywhere, so that we can get very low latency, very high capacity. Satellites will only be used for extremely rural areas where they have value there because I can't get close, I can't run a fibre all the way to every farm. So, satellites will still be used in rural locations, but otherwise 5G is a very terrestrial network with very deep fibre going very close and then radio sort of very close to you,

Is there a danger that 5G will create huge difference between cities, cities that will be highly connected with 5G networks and others without?

All dense urban areas, whether they're cities, towns, whatever, will be heavily 5G-ised, because fibre already goes to those places and fibres can also be found typically throughout those places. I have to just tap into that fibre and deploy a radio and you will be 5G-ready. I think the question always is how you cover rural where the fibre isn't going there. There are actually lots of interesting ideas for that. Using optics to satellites gives me more capacity and I can bounce a signal off a satellite and then serve you on the ground, so I don't have to run a fibre to you. So, there are satellite-related technologies but not for the wireless part, more as an optical relay. And people are looking at that as a way to better serve rural. And frankly, increasingly, people are dragging fibres to farms and rural locations and mines and places like that, because enterprises are worth fibre-ing. And so, if you think of an industrial focus, often people are willing to drag a fibre out to a big industrial complex even if it's remote. And as you pull that fibre, you can serve the homes. So, lots of service providers now have strategies where they dig once and they serve some enterprises, even if they're remote, but at the same time they serve all the surrounding community. So it's not out of the question that even rural areas will be served by fibre because the industrial factor is such a motivator to deploy fibre and 5G technologies that I think it will drive development or deployment of 5G to previously underserved areas, because in those areas there are businesses, farms, a classic case are mines, and energy farms, solar or wind. Those places are willing to pay for fibre to be brought to them so they can be massively connected. The surrounding neighbourhoods get served at the same time. So, I think that's probably how we're all going to be better served in the 5G era.

"The big question for enterprises is, how do you wirelessly enable yourself to be highly productive in the future?"

I read somewhere that as 5G becomes fast and reliable for everyone, we may not need net neutrality anymore. Have you given any thought to that?

Net neutrality was always focused on consumer fairness. In an industrial-driven world, net neutrality won't apply to industries because they know how to negotiate for themselves. I think there is an argument that for this new world of 5G serving industrials, net neutrality doesn't really apply. So, the question is, does it still apply to the consumer part of that network? I would say, in a different way to what you said, I think there'll be enough interest in people building 5G networks because of what they will enable, that there will be many service providers. The concern in net neutrality is that there are just a few providers so perhaps you don't have full market dynamics in operation that allow for competition to drive the process. Remember, net neutrality was always focused on wired more than wireless, because wireless is a very competitive market where everyone overlays each other. So, I would say 5G is a very attractive wireless technology. There will be plenty of service providers who deploy it. And I don't think net neutrality is or should be as much of a concern in a hyper competitive marketplace where there are lots of market dynamics that actually serve consumers' need. I think net neutrality won't be as relevant in that era.

In a recent white paper, you talk about great digital innovation networks. Can you explain what they are?

What we said in that paper is that new digital innovation networks will actually drive up productivity levels. We identified transportation networks that will be largely digitised, which means that all the transportation infrastructure will be under intelligent assistant control — we call it augmented intelligent control. The idea is that rather than traffic lights, it will have pre-set patterns optimised for every time of day, for every circumstance or traffic flow patterns. Flight schedules, train schedules, trucks on roads will all be optimised — how packages are routed to trucks and trucks to destinations. We will also have energy networks, communications networks and manufacturing networks. There will be a new manufacturing paradigm. You can think of that as automated logistics and manufacturing processes. Lastly, we will have healthcare networks. I always describe healthcare like this: once a year I go to a doctor, and I tell them some facts that are only partly true. Because, one, it is based on my perception, which is not reality. Secondly, I probably only tell them what I feel comfortable telling. You don't reveal the extent of everything and you're not even aware of it. And then they, based on some facts you verbally report, try and diagnose you. It's almost magic. A better system would be one in which I'm perpetually instrumented in some way, with a perpetually monitored reference to all people with a similar genomic disposition and family history. Then I get alerts that maybe it's time for some process, procedure or consultation. That would be an idealised healthcare system. It'll be more like a wellness system. You're being monitored for your current state of wellness, not waiting for you to be sick. But again, that requires very high reliable connections and sensors and AI systems that are constantly monitoring and comparing you to everyone who's like you. And then when some action is required, it would be nice if I could tell you "do that". The doctor could actually either diagnose me remotely or even operate remotely. In fact, I could go to a facility where there are some basic robotic arms and they could operate on me remotely. Because of course, it's much more efficient if a doctor can sit in one place and operate on "n" people than having to go to different places, because you've got all the travel time and logistics time. We think this is how our physical world will be optimised. And 5G is the great enabler of that by building technologies that enable all that automation and optimisation. That's how human productivity will increase.

I do worry as a consumer about the privacy side of this. Don't you think we need consumer control?

It's a very good question. So when I mentioned that the cloud will come closer, the computing will come closer so that I get very low latency, very high reliability, that's also the place where privacy is better preserved, because the data needn't ever leave that local environment, which is, I said, within 50 to 100 kilometres. So that's one level at which the data has geographic limits on where it sits. It's within 100 kilometres from you. And then it's a question of what is stored and how it is protected. And I think it's a very good question. You're being monitored and measured. How is that data stored? Is it all stored? Or is it only contextualised and the analysis result gets stored? How is that data protected? Or is it leaking to someone else? And I think we're looking at new security paradigms. For example, you could use blockchain to ensure that no unknown device is able to access that stored data about you because it was not part of the original blockchain. Obviously, your device manufacturer might be allowed to access that data, because they may have to perform some analysis, but no unknown entity, no rogue entity, will be allowed to do that. The EU has done good work on the right to be forgotten, I think it is actually a reasonable request. You should have the right to ask for it to be erased if you're not comfortable with what's stored. I think there has to be some more work on the right to be forgotten or erased once that data are stored somewhere. There has to be absolute data protection in that local storage place. You have to be able to see what data are stored about you. And you have to be able to ask for it to be erased.

"I think the problems we're going to solve with 5G on earth will be similar to the ones we'll need to solve on other planets… "

When do you think most western cities will be using 5G at scale?

We begin to see trial deployments now, which means a few sites, tens of sites, maybe even hundreds of sites. In 2020 that gets bigger. We think it will go mainstream in 2021. But some of these machine technologies I just talked about will only be coming online in 22 and 23. 5G probably faces a ten-year cycle of deployment, maybe even a little bit longer. And each year, new technologies will become available that get deployed on top of the base. But in 2021 it will already be pervasive, meaning that you'll start running into 5G networks. You will see the 5G signal on your phone more often than not, but in 22-23, more machine technologies will be coming online as well.

I imagine this will create winners and losers among companies. How does a company prepare? Processes are going to change, not only the physical infrastructure, right?

It's a good question for companies because one of the things we say to them is that they should build high performance private network infrastructure. We talked about wide area networks, the things that you see as a member of the public that you run into, and you get a 5G signal. But an equal part of 5G is building private network infrastructure dedicated to that enterprise. You can also optimise how they perform their functions within their campus, within their factory. You can use the same technologies in a factory, campus, wind farm, airport or port. That's one thing companies should be preparing for. Right now, they use WiFi mainly for those deployments. But WiFi doesn't have the low enough latency, or the high enough reliability to be mission critical. It's a best effort network or WiFi network. But if I want to become mission critical and wirelessly connect everything, my robots, my people, my senses, my systems, 5G will be deployed inside enterprises. So that's a change, I think, where enterprises have to think about strategies to change their internal network infrastructure to be wireless. That's the big question for them. In the meantime, service providers will be deploying networks outside. And of course, those two connect, meaning when I leave my premise, I jump onto the public network. And then I rejoin my private network when I go back. The big question for enterprises is, how do you wirelessly enable yourself to be highly productive in the future?

And that, according to the white paper we mentioned before, will solve the productivity paradox…

It will. Most businesses have less than 50 per cent of the productivity they could achieve. McKinsey has done a lot of good work looking at net productivity business by business, and it hovers around 50 per cent maximum because they haven't instrumented the physical world, whether it's the route the car takes, the spreading of a pesticide or crop or seeding a farm, the growing of a crop, medical healthcare, etc. The inefficiencies are huge, and they remain because we've had a wired world, which is sort of fixed in its configuration. As we go to 5G we make everything wireless. It will no longer be fixed in its configuration, because AI systems coming online can compute problems that were beyond what you could compute mathematically. We've got clouds that give you access to infinite processing power; we can do that computation. And we've got networks that can connect it all. When all that comes together, productivity should be massively increased, and we will get a new phase of economic growth. That's what the paper claims.

"With 3d printing, you will make things locally… a return to local communities… That could be the answer to the political turmoil…"

How does that have any impact in our quest to conquer space and other planets?

Interstellar 5G networks (laughs). One of the projects we've had was a mission to the moon, which we're no longer involved with. But we were going to put a wireless network on the moon. We wanted to work out how to do wireless communications on other planets or satellite planets. The idea is that in space it is hard, because of a very harsh environment. The nice thing is that the signals propagate a long way, because there's nothing in the way, but it's a very harsh environment. Working out how to build communications networks in space is an interesting problem. If we ever go to Mars, the first thing we want to do is build a communications network, so that the different hubs will be connected. I'm thinking Star Wars: there will be a moisture farm, a growing farm, a wind farm, etc, and all of those will have to be connected. I think the problems we're going to solve with 5G on earth in the next decade will be similar to the ones we'll need to solve on other planets when we get there. Yes, the environments are harsh, radiation levels are high, and equipment gets bombarded, which causes errors and even destroys the component technologies. There's something called radiation hardening that you have to do to components so that they survive high radiation without being compromised.

Any chance 5G will help the earth with its socio-environmental problem?

Imagine I could see everything I needed to see, factually, so that it's not just being reported to me by a human perspective. If I could see the state of every river, the state of every forest and degree of deforestation, the movement of people in images, then I could have perfect knowledge. My hope is that we make perfect decisions when we have perfect knowledge. Right now, we have highly imperfect knowledge of what's going on, right? Particularly in some of the most challenging environments, people don't like to go there, or they're too remote to even get there, until we get to the consequences of our actions. If we could be more completely informed about the current state, think of the climate debate. If, in fact, we could have perfect knowledge of what the current state of our climate is, not based on historical, or just point measurement, but complete knowledge, we would probably all make better decisions about the actions we take. What we have now is a very slow feedback mechanism. When we see plastics in the oceans, we think we should stop using plastic drinking straws. But say it was five years ago, or 10 or 20 years ago, that this plastic problem was created, but we're only aware of the consequences now, 20 years later. So, I think more complete knowledge of what's really happening, where you can see the problem as a consequential effect, say, of the straw that you drop in the trash. I think that fast feedback, where you've got the information, 'do you realise you have just done this', would probably lead you to behave better. I think humans are not very good with slow feedback loops, because it feels too indirect. If we could have direct feedback by having perfect knowledge, I think we'd make better decisions. That's my hope. Instrument everything, give people an interpreting agent that tells you what you've just done. And people would probably behave in a reasonable way. I think people are decent, well intentioned, they're just disconnected from the consequences of their actions.

That is very interesting.

And when something is proximal to me, I feel more connected to it. That's one of the theses we have. You can imagine that additive manufacturing, also called 3d printing, means that you will make things locally. Digital processes and services that are rendered to you locally matter. Factory processes will be local because I can make things locally in a way that I couldn't before. So, it's a return to local communities mattering, and not by nationalism, but by technological enablement and, to some extent, necessity. If I have to be close to get low latency services, I will be closer to you. But now I know who you are, I feel that I have a relationship with you. If I'm making a good for you, I can make that good locally. I don't have to do it offshore, to outsource. I feel more connected to you. Because I made it locally. I'm in your community. I'm making things for you. That could be the answer to the political turmoil. It is not nationalism for the sake of protectionism. But localisation will restore some sort of human level of satisfaction and sense of well-being without having to be nationalistic. Power to local: global thinking, local enablement.

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- *This is part of a series of four interviews during the [Web Summit](#) conference in Lisbon, 5-7 November 2019. The conversation was lightly edited for clarity and brevity.*
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