Sue Nelson
Hello, I'm Sue Nelson and welcome to the Create the Future podcast, brought to you by the Queen Elizabeth Prize for Engineering. Celebrating engineering visionaries and inspiring creative minds.
[Music]
Mischa Dohler could easily be called a polymath. He's an engineer, a composer, speaks six languages plays the piano, has five albums on Spotify, and is the Chair Professor of Wireless Communications at King's College London Centre for Telecommunications Research in their department of engineering, the first to build a fully functioning 5G system for the UK. He's also worked for France Telecom, co-founded Worldsensing Europe's largest Internet of Things company, is editor in chief of two journals, and is on the advisory board of the UK is communications regulator Ofcom. Mischa has a degree in telecommunications from Dresden University of Technology, and from King's College London, both a masters and a PhD in telecommunications, so I thought it best to start with 5G and get him to explain what the key difference is between this and 4G, which for a lot of people is already pretty good.

Mischa Dohler
Yeah, people always wonder why do we need a new generation. And it turns out that in telecoms, we're quite lucky, actually. And that the key performance indicators of performance in general to the consumer improve by one or two orders of magnitude. So, let's look at the data rates. If we look how, you know, the data rate has improved from 3G to 4G to 5G, we see that actually you know, it's always been multiplied by 10. So if you do have a 5G phone with you today, you can have an average data rate of about 100 megabits per second. And on a good day, or on a good night, when nobody else is using the system is about one gigabit per second right, then 4G, it's a 10th of that. The same happens with the latency. So that's something which we haven't really paid attention to in 4G, but became really important in 5G in that the delay it takes when you click on your mobile phone and load a website, that latency, with 4G was about, you know, anything between 60 and 100 milliseconds, in 5G, this is now down to 10 milliseconds and sometimes to one millisecond, then you may wonder, why do we need such a low latency? Well, it turns out, there are some very attractive 5G applications which need exactly that.

Sue Nelson
Gosh, when you're talking about milliseconds, blows the mind really, but can people really tell the difference?

Mischa Dohler
You know, consciously we cannot, of course, we cannot really measure that. But subconsciously, interestingly, we can, as a human, as a human being, we're good for millions of years, towards a 10-millisecond interaction, it's actually exactly the time it takes for the, you know, the optical signal into my eye, and then the signal being principle transported to my brain is being processed. So every time I get my optical visuals within 10 milliseconds, I know I am with somebody, you know, I get this feeling of immediacy of this, you know, full immersion. And with that comes, of course, all these emotions we get when we meet people, right? So you realise, of course, that, you know, meeting somebody in person is very different to meeting somebody over Zoom. And that's exactly because of these 10 milliseconds. And, you know, having 5G now around the corner, allows us for the very first time and you know, in tech history, to actually recreate these type of emotions, when people meet, while actually not being in the very same physical place. So yes, these 10 milliseconds or one millisecond really matter to humans.

Sue Nelson
It's interesting, you use the word emotion there, because I've seen that you've spoken about wanting to give technology a soul?

Mischa Dohler
Yes, I just realised that we as engineers, we are really good in building boxes and writing millions of lines of code and often people that don't understand why are we doing that? And that you go to these tech shows, you know, all these boxes are being shown off and I you know, when we started designing 5G, I realised that actually what we need to do is to really reach out to the demand side to people who will be using that. With were 5G, I figured, you know, we don't want to, we don't want to do this. We don't want to end up in 2020 when the tech comes out, and then suddenly everybody's asking, why do we need this? Right? So as early as 2014/15, we started a King's, we started to reach out, you know, to theatres, to people, to doctors, to transport companies, just ask them a simple question. You know, if you had a piece of technology, it's called 5G coming out in 2020, what would you do and, of course, everybody was rejecting me initially, because they just thought it's just, you know, it's just a piece of tech they're using every day, but over time we were very persistent. Over time, we kind of came together did very, very interesting co-creation workshops, over time, you know, we realised my engineers realised that there's more to tech in the people using it, I realised, you know, there's more than just an ethernet cable, which happens to be invisible. So that's why I call it giving technology a soul. Because when you start co-creating a lot of really interesting things come out.

Sue Nelson
And let's go to the less emotional side of it, although I'm sure designing something like 5G is filled with emotions in terms of pride and what have you. But what did building that system actually involve?

Mischa Dohler
A lot of revolution has actually happened with 5G. So probably the biggest, you know, tech revolution with 5G is really that we transited from a system, which was very much, you know, hardware based and box driven to one which was completely software driven. And, you know, having a software driven system is actually really a revolution in telecoms, using a computer every day and you know, that transition in the computing industry happened a few decades back. And if you look at you know, I'm sitting right now in front of a Dell computer which has been, you know, manufactured by Dell, my operating system is Microsoft, and I'm using a Chrome browser, right, we have completely decoupled essentially, hardware, middleware, and software. Now in the telco industry, that was not the case until, you know, until 5G came along. And we believe that decoupling that hardware, the middleware in the software, which will run 5G really will accelerate innovation, because everybody now can essentially work at much quicker cycles. So this is really one of the very, very big revolutions, which is happening in 5G. And then there are loads of smaller, you know, a tech revolution, we're using frequencies, much higher frequencies in the gigahertz range, which nobody dared to use before, we're didn't even know it would work. And, and it turns out, it does work. And we are using that today. So, a lot of small components, innovations, you know, a lot of really interesting stuff. But for me the big change is that changing operating philosophy, from hardware, to a fairly open software driven and federated telco ecosystem.

Sue Nelson
Now, I mentioned in the introduction, that you play the piano, you're a composer. So, it's quite interesting that your passions combined, when you worked on the world's first interactive 5G. music concert, explain how that concept worked then. Where were you?

Mischa Dohler
Okay, so yes, we did, essentially the world's first 5G piano concert, it was. You know, I was in Berlin, I was playing under the Brandenburger Tor. And daughter Noa, she was in the Guildhall in London. And we thought, you know, there, let's do this in the Guildhall, because it is the UK is oldest entertainment venue. So the Romans brought that about 2000 years ago, you know, into the UK. And we thought, you know, let's combine this very historic entertainment venue with this very modern technology called 5G. So my daughter was singing there, I

was in Berlin. And yes, we could have done this over a Zoom or Skype call, but the latency would have been in the order of 150-200 milliseconds, we could have also used, you know, a very specialised cable to connect both venues and bring down the latency to something like 10 milliseconds there, but it would have been very expensive, or the novelty the pioneering contribution of this concept was really to use what will eventually become a commodity technology called 5G, everybody can use it, any musicians, anybody who wants to use it, and connect themselves, you know, within 10-20 millisecond reach to any point in the world and that's what we wanted to show, you know, two continents two countries apart, you know, linked on a very emotional link. You know, this is a father, daughter link here, and to be honest with the you, you know, I struggled not to cry during my actual performance because it felt like Noa was with me. Noa was standing beside me with me in Berlin. So it was a wonderful moment.

Sue Nelson
And she's quite young, isn't she?

Mischa Dohler
Well, you know, we did. Yes, she's 14, and back then she was 12. But yeah, she loves singing, she sings in the Royal Opera House, she sang with Madonna as well, when she released her new album Madame X. So she just loves to be on stage. But she was nervous, we were all nervous we didn't even know if it would work. But it turned out to work really well.

Sue Nelson
And what is it about the area of telecommunications that you enjoy as an engineer? Is it the coding side? Is it the technical side? Is it the, combining it with the arts and music?

Mischa Dohler
It comes in waves, you know, it comes in waves, and because we have a bit of time designing these generations, initially, it is a use case exploration, which is what we did in 2015 and 14 with 5G. But then, you know, it becomes a hands on very quickly, because we need to design the architecture, meaning, you know, we are kind of building the building blocks of the of the entire system, and is extremely, extremely complicated. You know, the fact that you can buy a phone in the UK with a SIM card in Spain, and operating system made in the US, and you're actually in South America calling your friend in Australia is because we make it happen, but it's really complicated in the back. So, you know, building, the design of that is one thing, then we need to prototype. So there needs to be a lab where we can build it, then we start standardising this, so we contribute to standards. Then we build policies around this to make sure there's an uptake of the technology and then we really start you know, kind of embedding it into, let's say theatres, we start using the technology, then there's often a lot of press and media and then we start from zero again with the next generation, right? So, we go in these cycles, which is actually quite exciting.

Sue Nelson
You worked at Orange France Telecom. That was a couple of years after your PhD. What did you do in between that led up to that position as senior researcher?

Mischa Dohler
Yeah, so I was actually an academic at King's, so I was a lecturer in Kings College, so I finished my PhD, you know, I got the lecturer position, and my wife got a fantastic offer in the particle accelerator in France. You know, we lived apart for one year, and I said, you know, “I just don't want to do it”. And I left my King's position and moved to France and got that position at France Telecom, which was really brilliant, because we started to work on exciting topics, which, you know, 10 years later turned out to be a really big thing. We for instance, co-

founded the standards group on end to end, machine to machine, which is underpinning now all the IoT connectivity in the world. So, you know, back then you would know, we're doing many of these activities every day. And you know, some of them turn really big. So that's really my big thing I did at France Telecom.

Sue Nelson
And is this sort of part and parcel of a career in engineering that you can work on specific research, and some of it will go on to transform the world and others won't necessarily, you know, have that big of an impact?

Mischa Dohler
Yeah, it's exactly this right. And that makes it almost as exciting and it's, you know, research is really about opening doors and trying to understand there's something new, something exciting, something viable behind that door. And whilst you open it, you often open up many more doors and you know, so as an engineer, I think we learn really to keep things very tangible. And that's what I like about engineering, you know, I think if I look at my mathematics, friends, or physics friends, they can spend, you know, decades on string theory. You know, it's just not possible that we spend decades on 2G or 3G, because the, the field just really moves on very quickly. So, I think that tangible aspect, you know, building impact usage, you know, transformation is a really what excites me, but there's a bit of trial and error, really, and a lot of things we did back then, you know, haven't led to anything, but you just don't know, right? Somebody may read our research we did 10 years back maybe in 20 years' time and their sparks and your idea, you know, that connectivity in the research community is quite fascinating.

Sue Nelson
Was that period of time at Orange France then what sort of got you interested in becoming an entrepreneur and investing in start-ups and small companies yourself?

Mischa Dohler
So it definitely triggered that. The inspiration though to do it came from my father, I have to say, you know, my father really is a very inspirational figure. He was a professor in informatics, in physics in Germany, right, you know, the city where I grew up. He built, at the age of 65, he solved an open problem that the optics community had for 300 years. And he built a whole company empire around this on how to make spherical lenses much cheaper, how to produce them at scale really cheaply at a high quality. And it's then a market leader, it's a million-dollar company, I thought, you know, if my dad can do this at the age of 65, I should be able to do that the age, I can't remember all that was maybe, you know, 30 back then. And that was really the kind of the inspiration bring both together, right. So, I had something to do, which came out of France Telecom, you know, triggered by the actual inspiration of my dad, this is how my first company really came about.

Sue Nelson
Gosh, that's incredible. That's some inspirational figure, though, isn't it to have a father that does that. I was surprised to see that as a entrepreneur advisor, a technology advisor for start-ups, that the House of Lords came among that?

Mischa Dohler
Yeah, look, I mean look, it was less about teaching them about entrepreneurship, but more about, you know, teach them about being more entrepreneurial, you know what I mean, so a little bit more dynamic, engaging stakeholder engagement, tell them what are the latest technologies? What could be done, what can only IoT do? What could 5G do? What are the opportunities and threats of cybersecurity? So, that type of stuff, and I'm you know, I find it quite fascinating. But, you know, I lived in six, seven countries, I don't know, it's actually really the UK, you know, House of Lords House of Parliament actually both sides, as you know, as well as the various

ministries has been really interested in tech, really interested in reaching out, there's a very close connection between innovators. The you know, people who really move the field, and those who write the policy. So, I think it's, that's really an amazing thing about the United Kingdom.

Sue Nelson
And this sort of communication in terms of what you do. I've seen some of your YouTube videos, you're very enthusiastic, very effective at communications, you obviously see that part, and dealing with the media as well as an important part of being an engineer?

Mischa Dohler
Yes, we need more training of that, you know, I always say that, in fact, I see this at Kings as well. And that's why we implemented a totally new set of courses, and I'm teaching myself an entrepreneurship and leadership course. Because whilst you know, traditionally, we're very good in building you know, and upskilling people to become the most fantastic engineers, they really know all about bits and bytes and soldiering and components and building blocks, right what we talked about before, but they're not so good in communicating this. I'm not even talking about the media, I'm talking about their own about their boss about, you know, the people they work with, so I think engineering really needs more of that, we need to teach more soft skills. It's not about hard skills, more soft skills, leadership, management, entrepreneurship, being entrepreneurial, what I alluded to before. It's particularly important in engineering because you cannot think of anything in engineering, which is done by a single engineer, we are by definition, a collaborative kind of cohort, we have to work together and all the big challenges of the 21st century are really, you know, mechanical engineering, electrical, electronic engineering, chemical engineering, you know, material science, all together.

Sue Nelson
I'm going to refer back now to a word that you used earlier, to see how important it has been in your career, even though there doesn't seem to be that much of it. And that word is rejection. You said that, you know, you have various ideas been rejected? How important is that rejection for an engineer?

Mischa Dohler
Yeah, it's rejection and failure. Okay, it's rejection and failure. And it is important, it makes us stronger, it's always painful. And you know, people say you have to pass through this phase. So, you understand, really, what are the boundaries, what's doable, where do you need to push against, but it is painful, okay. So, it's really not an easy process. You know, I have failed on a lot of things, I've tried a lot of things, I've tried to introduce new things. And there was either a problem, I failed with funding, or I failed with, you know, kind of creating the impact I wanted to create, but it only made me understand on really, how to operate, you know, how society works. And I also started to recognise that, you know, you really need everybody, there aren't just three or four people really moving the field, you need everybody to move it and, and that kind of allowed me also to build what I call the streamlined impact pipeline, in fact, I'd explained it earlier. So, you would start with an idea you try to get funding, you would then, you know, start designing it, you start prototyping that, engage with industry, standardise it, build a policy work around this, and then bring it out, make a company around it, you know, build a product, you know, get media attention. So really understanding that impact pipeline, I think it has come about because, you know, I was rejected on a lot of ideas. I failed on a lot of things I would have loved to make happen. So here we are, it's just part of the process. And since we engineers do a lot of trial and error, you know, it's just part of our portfolio.

Sue Nelson

And what about the future then, you mentioned, you've already referred to 6G, you mentioned how Internet of Things took a lot longer than you expected to come together. Do you still see the Internet of Things and 6G as something that's going to happen fairly soon or is it still always feeling just slightly out of reach?

Mischa Dohler
Yes, interesting, the Internet of Things, so the ability to connect, you know, sensors and actuators in the billions and trillions around the world is a slow revolution happening in the back. We can now use 4G systems 5G systems in the future 6G systems to connect it. The problem is not the connectivity, the problem with the IoT was always a demand side, but it's picking up now. And I always like, you know, I like to liken the demand side to a good bottle of wine, right. So, when, when you want to enjoy your wine, you typically open it and then you have to wait no matter what happens. And you know, no matter how good or bad, there's nothing you can do. The wine takes time to do really oxygenate so you can consume this perfect glass of wine. And the same with the demand side, industry, so you, you know, we produce a lot of tech, and then we just need to wait, we shouldn't lose really patience here. For the future. We work now on other things, you know, I work on the Internet of Skills, which I believe will be the next generation internet after the Internet of Things. So, the ability to connect a skillset so you can conduct skills through the internet, you know, without actually needing to move, we can transmit audio and video today, read emails, but you know, I can't touch, I can't move a box, I can't repair an engine through the internet. And imagine you could do that in five to six years' time and we needed 5G for that and probably constituents of 6G, but we're really working on this, I always see these generations as an enabler for the bigger picture. For me, the big picture now is that Internet of Skills,

Sue Nelson
And you've already given some useful advice already, for younger people who are considering a career and perhaps hadn't thought about telecommunications, what would your advice be for them?

Mischa Dohler
So, telecoms in the 21st century, I think it will really be a cornerstone of so many things, connectivity, digital, you know, the fabric of society all together. So, I think it's a career really worth pursuing. But it's unfortunately not only anymore just doing you know, telecoms, where I'm currently looking, I can tell you that I'm currently looking for students who are brilliant in computer science and artificial intelligence. In the future I'll be looking for students who know about quantum and quantum programming. So, therefore, if you upskill, you know, in technologies which are emerging at the moment, such as quantum including quantum security, you know, the quantum networking capabilities, quantum programming, anything related to artificial intelligence, you know, but the core domains such as convolutional neural networks, but also more advanced ones, such as neuromorphic computing, or distributed artificial intelligence, as well as, you know, other domains, combining for instance, quantum and AI, as well as cybersecurity as a field in general. So, these are huge enablers, which allow us to build these next generation systems and really make them, you know, usable for society. So, that would be my recommendation. My other one would be, you know, keep it real, try to be hands on, don't only learn from stuff. I always say, you know, for every big data there needs to be a big action, right? So, for every hour you spend behind the screen, or you know, in the classroom learning something, you should be spending an hour building, as well, right. For every hour playing a game, you should create a game, so you know, this really what moves us as engineers as society. So that would be my advice to the youngsters of today.

Sue Nelson
I love the thought then that phrase, let's upscale and keep it real. Mischa Dohler thank you very much for joining me on the Create the Future podcast.

Mischa Dohler

My pleasure. Thank you.

Sue Nelson
Find out more about the Queen Elizabeth Prize for Engineering by following @qeprize on Twitter and Instagram or visit qeprize.org. Thanks for listening and join me again next time.