

Getting Ready for LTE

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3GPP Long Term Evolution (LTE) is promising to blow 3G out of the water – with speeds as high as 100/50Mbps. Not to mention more services, lower latency, better QoE, simpler architecture and a network optimized for data traffic without the burden of a separate circuit-switched voice channel.

Putting all that power in the users' hands could mean phenomenal uptake on the new technology – is this what we've all been waiting for? But that in itself poses a problem: will the infrastructure support the new demand? More generally are we, the industry and users, ready for LTE?



John Delaney, Research Director-consumer mobile, from IDC

An all-IP network simplifies matters – Ethernet everywhere is a given. But what have the carriers got to offer in terms of backhaul? Will we be laying a lot more fiber, bonding more copper, or does microwave offer a faster, cheaper solution? How well is the industry prepared to handle an explosion in services? Then what about the handsets – is the current smartphone format too limited for tomorrow's applications?

These are complex issues, but we have just the team lined up to address them. John Delaney, Research Director-consumer mobile, from IDC, explained last week at NetEvents EMEA Press Summit, in Barcelona, the significance of LTE and when we can expect to see it on the streets. Then he puts the challenges to the panel, and takes questions from the floor. So, are you ready for LTE?

Panellists: Phil Tilley, European Marketing Co-chair, MEF; Amir Zoufonoun, CEO, Exalt Communications; Natasha Tamaskar, VP Marketing, Genband Inc; David Hill, Vice President, EMEA, Spirent Communications

John Delaney

We're going to be talking a little bit about the public networks now that hopefully will support a lot of what's been talked about earlier today, cloud computing paradigms, video conferencing in terms of the loads on the networks. All of that needs a lot more than what networks can deliver today. And so we're going to look a little bit now at what the next generation of public wireless networks might and, equally importantly, might not be able to do.

Let me briefly introduce my fellow panellists. Natasha Tamaskar from GenBand, Phil Tilley, who is just about to join us, from Alcatel-Lucent and the Metro Ethernet Forum. Next to him Amir Zoufonoun

from Exalt and David Hill from Spirent. I'll leave them to introduce themselves in a little more detail in a moment.

Before we do that, for those of you who are not as familiar as telecoms heads with LTE, a little bit about why it might be important, what LTE promises - promises being an advised word here - what it might and might not deliver. Probably what most people understand about LTE is that it's faster, higher data rate in the access network, depending on who you believe up to perhaps 100 megabits per second. Certainly the initial commercial deployments of LTE are delivering data rates, real data rates in a 20 megabit plus range, which is an order of magnitude better than what you can get on cellular today.

Also higher capacity in the sense that you can cram more bits into each hertz that you're using. That's very important because another thing that we telecoms heads have to live with all the time is the scarcity and uncreatability of electromagnetic spectrum. You can use electromagnetic spectrum better, but you can't create new electromagnetic spectrum. It is the ultimate scarce resource. So anything that lets you use it more efficiently is valuable in its own right.

LTE differs fundamentally from the previous three generations of cellular networks in that it's all IP. It is a data network from end to end. There is no circuit switched voice in LTE. And there's currently a lot of debate, which I guess perhaps Natasha particularly may touch on, as to exactly how you do voice therefore on an LTE network to telecom standard.

It's the first time there's been a realistic prospect of globally interoperable mobile networks. As far the end of 3G was concerned there was always the dichotomy between the CDMA world and the GSM world. Hopefully with LTE that starts to go away, because the major CDMA operators, Verizon Wireless in the US for example, have committed to LTE as their fourth generation standard. So we're moving further in the direction with LTE, at least of a global interoperable network.

Not only does it use spectrum more efficiently, it also uses it more flexibly. So with 3G you have to have your spectrum in 5 megahertz chunks. With LTE you can be a lot more flexible. You can deploy it in that; you can deploy it in larger chunks. You can even deploy it in non-contiguous spectrum. So if you're an operator that owns spectrum in various parts of the waveband, you can start to virtually knit those together. If you have [TBD] holdings that you're not able to use with 3G, you can start to look at using the TDD spectrum, the paired spectrum with LTE. So not only does it let you fundamentally use the spectrum more efficiently, it also lets you use what spectrum you have, the commercial aspect, more efficiently.

We think that LTE is getting real. And there are a couple of commercial networks up and running already. The one in Stockholm is probably the nearest one to where we are now. We think by the end of the year there will be a dozen or so of those. They will be in smallish geographical areas.

In terms of performance we think people will be pleasantly surprised. I mean I've seen some demos from Ericsson on this in a moving van, but I'm trusting Ericsson not to be pulling the wool out of my eyes. But if they're not, then this thing really does perform. The corollary of that is going to be that people are going to be dissatisfied by coverage. If it's only in a small area, it's a bit like the 3G, 2G handover. You had a 3G data card, it was great until you got out into GPRS, and then it sucked.

You're going to have the same thing happening with LTE, I believe, where it's going to perform so well where it's deployed, as soon as you're outside of where it's deployed, you're going to be really dissatisfied. And so there's going to be a lot of pressure on coverage.

But that aside, we believe that the early 2010 deployments are going to be enough for the industry to start to bet on LTE in terms of developing devices and applications. That's going to start to build in scale next year.

Hence our market forecasts. Now this morning we talked about analysts only forecasting markets that do [well]. That was an IT analyst talking. We telecoms analysts are used to talking about flat markets. This one's not quite flat, but it's not growing very much. This is the global spend on mobile access infrastructure. And it's important to note straightaway the big story here is not the move from 3G to 4G on the global network, but the move from 2G to 3G. Somebody else referred to that earlier, that the big migration that's happening at the moment is to 3G. And I think everything else that we talk about needs to be in that kind of context.

Having said that, LTE, what we're here to talk about now, is that little red chunk at the top. And we are going to start seeing some significant investments in developed markets in LTE during the next year and the following year, as that eco system, that commitment to LTE as the next generation, starts to build up.

All of which begs the question that I am shortly going to ask our panellists to address. What's LTE for? We've seen what it can do; why would you want those things? And having identified those things, do you need LTE to do it? Is HSPA good enough. If it is, then you're just adding a software upgrade, or at best a card upgrade to existing base stations. You don't need to buy a new base

station. So operators are starting to think hard now about whether what they want to do with their networks really needs LTE and when it needs LTE.

Whatever else it needs to do, it needs to sustain the two services that generate most of the operators today and for the foreseeable future, namely voice and SMS. How will it do that? Will these still be telecom networks in the sense that most of the revenue comes from telecom services voice and SMS. Or are they actually building data networks for the first time? If they are building data networks, how do they make money out of that? Will an access-only model sustain the investments required? Are these guys going to make enough money as ISPs? How many of these networks will the market support. In the UK we have five mobile networks. Can you really imagine five LTE networks supported by access revenues? These are the big questions that the operators are starting to have to think about.

What do you use it for? Do you use it to deliver those order of magnitude increases in data speed, given that in the fixed world we haven't really seen very much willingness on the part of consumers to pay more for faster speeds? We'll pay the same for a faster speed, sure. But are you going to get 10 euros a month out of me to get twice the data rate? You're not. Is that going to happen in the mobile network too, or are the operators going to think, well what we need to do with this is deploy more capacity, support more usage.

Then you start to think about what you do with the radio access network. If you are doing access only, and it's applications running on top of that, do you want to manage those applications? Are you going to be allowed to manage those applications, or will Net neutrality get in the way of that. So those big questions are what I'm going to ask here to address the remainder of this session.

I'll start, if I may, with Phil at the end there and ask you a simple question. In your view what is LTE for?

Phil Tilley

So I think LTE certainly starts addressing what we expect to see, an increased bandwidth demand. We do see, and expect to see people driving or requiring much more bandwidth than they are today. And I think with LTE, that all-IP -- the challenge we face is with the network going to all-IP and expecting much more, greater data traffic, we need to engineer a network which is all-IP, all data orientated. I think historically we've seen something very similar if we look to TDM voice switching and we started using dial-up modems and that sort of stuff, we broke the network and we had to move to broadband. And we reengineered and transformed fixed networks from data TDM networks to IP broadband networks. Exactly the same thing; we're going to break and we are breaking mobile networks today unless we go to an all-IP, all data architecture.

John Delaney

So LTE is basically about following the traffic pattern?

Phil Tilley

Traffic yes. The emphasis will move from voice to data.

John Delaney

Amir, do you go along with that?

Amir Zoufonoun

Absolutely. Data and video, we're seeing today, and also software as a service and gaming and other applications, we're going to be bombarded by bandwidth intensive applications that current networks cannot support, both from access point of view and also from a backhaul standpoint. They are just severely constrained relative to these new applications.

John Delaney

So there are two ways that an operator can deal with that. They can either handle those applications, or they can decide not to support those applications. Is the latter strategy tenable in your view, Dave?

David Hill

Certainly not, no. I think the interesting challenge is going to be that some of the larger operators may actually not want to invest in LTE. But I think they're going to have to, because certainly some of the smaller operators in those regions will be competitive enough. They'll put in the infrastructure for the

metropolises where there's large volumes of businesses and people who want to use it, and they could take the cherry. So I think they're going to have to support it, yes.

John Delaney

Natasha?

Natasha Tamaskar

If I was to add a little bit of specific examples, I think the reason people will go to LTE is going to be different in different regions. If I look at the North American market, you see the first person or first large company that talked about LTE is Verizon. Now what was Verizon's option if they did not go to LTE, because remember this is not a UMTS GSM based technology. It's all CDMA. No way to support voice and data application when you go to 3G. That's a huge problem. Here you have AT&T supporting voice and data applications on iPhones. How can Verizon support that? So they have to take the next step, and the next step is LTE. Now if they go to LTE, now the next thing for AT&T is clearly there's going to be more capacity going into Verizon. So AT&T will also go towards LTE. But then there are smaller players also like CenturyTel, there are players in the rural markets. And they are trying to deploy LTE because cost per bit is much smaller for them for greenfield applications.

John Delaney

So Verizon was kind of at the sharp end of this and it hits the buffer sooner than most others. The buffers are a bit further away for the 3GPP operators in the sense that HSPA is available. It's an upgraded 3G network; it's an HSPA+. It's starting increasingly to look viable. In terms of what you guys were talking about new applications, video being the most extreme example, which are putting enough strain on the network that you need to reinvest, how far can you go to meet those requirements with HSPA? How far do you get before you really need LTE?

Phil Tilley

Yes. So I think, certainly with the HSPA we can go that much further. Whether that's one year, two years, if you look at the bandwidth and the data rates right now, I think that's potentially two years, three years, something like that. But at the end of the day even the number of subscribers, the amount of data of each subscriber is going to hit the buffers at some point. And that's probably two years out, three years out, something like that, which is really -- if you look to the European buildouts where HSPA is being used extensively right now in Europe, then we'll see that -- I agree with Natasha in the Verizon CDMA approach. It does happen much sooner, and is happening.

Natasha Tamaskar

But to add to what you're just saying, if I look at the UMTS model and what people are trying to offer, it's not just about -- well there is capacity available for the next several years. It's about can the operators deliver that capacity cost effectively for the applications they're trying to roll out. Is it going to be cost effective, or is still cheaper to build a new infrastructure to deliver that.

John Delaney

Amir, we haven't talked very much yet about what lies immediately behind access, I mean the backhaul. It's all very well to be able to support these kind of data rates in the access, but then if you need to take it out to the core, how far are we away from being able to manage that efficiently? Because this is really where most of the operators with their mobile broadband products are getting the crunch now. It's not in the access. The access can handle it. What can't handle it is the backhaul. How are they going to be able to deal with that when LTE makes the avalanche ten times faster?

Amir Zoufonoun

Yes, we're far away from where we need to be; far, far away. The average bandwidth to a cell site is typically; in North America is about 3.5 T1s worth of bandwidth, 5 or 6 megabits per second. Per cell site in Continental Europe is about 3 E1s worth of bandwidth, again about 6 megabits per second. We need to get up to about 100 to 150 megabits per second. So it's a huge, huge difference. Not only that, we also need two orders of magnitude more nodes because of laws of physics. So access technology is going to have to effectively get to the point, from a cost standpoint, to cover a much smaller area so that you can have a lot more nodes. Right now the distances between nodes are typically in the 2,000 to 10,000 meters. Now we're going towards eventually 20 to 100 meters. So

imagine what that means if you just draw a grid and fill it up. It's a huge, huge amount of backhaul at these nodes that's needed. So 100 to 200 megabits per node; two orders of magnitude. So it's two orders times two orders is 10,000 effectively, four orders of magnitude.

John Delaney

So the graph I put up at the start there was talking only about access infrastructure. But actually that, in the light of what you just said Amir, significantly understates the magnitude of the investment that operators are going to have to make to make these networks work.

And what I'm wondering is does the other side of that make sense? Because you're going to have to invest all that kind of money in your network, are you going to benefit in terms of new revenues, if there are any new revenues. If there are any new revenues, do they come to you or do they come to the providers that come in over your head, because we're talking about IP networks here which are flat and services or applications running on the top. Can the operators really be convinced that a) there's money there to justify this investment, and b) if there is money there, that they will get it. Dave.

David Hill

I think that's an interesting question. If you look at the case, as Natasha said, in the US, it's different pressures that actually drove the changes there or are driving the changes. If you go to other countries, maybe they don't have the same pressures, and who's going to pay for it? Who's going to pay for the operators to actually make money? They are long term organizations, that's for sure.

Long term for me is about 12 to 18 months. Long term for an operator, I saw a brief announcement from BT this morning that they're kind of concerned about their pension pot and how much money is still owed for their pension fund. And their recovery plan for the business is 17 years. So they're worried about the recovery plan which is 17 years long. So payback is really rather long term.

I would say there are some other interesting challenges as well. First of all there are no devices yet. At the moment LTE is all about data. And the data side of that, if you take the Stockholm situation, I think 2,500 users. But they're also using 20 megahertz of frequency. I think Verizon have stated they're probably going to use 10 megahertz of frequency. Is it going to be that much better than HSPA? I don't know the answer to that question. And until they actually go around and test it properly, that's going to be an interesting question to ask.

The other thing is these mobile devices; they're now having multiple antennae raised inside them. How much juice is that going to use up? Is the battery technology there to be able to use those devices wherever you have to be? Can you handle the hand off as well? Let's face it, if it's 4G in a small space, every time you move and you want to go further out, you're sitting in your car, is it going to manage the hand off between 4G and 3G, or 4G and 2G and so on. So I think there's a huge number of questions that still need to be asked.

Frankly at Spirent we're pretty agnostic. We're a testing business, so any challenges that are out there are meat and gravy to us. We will test anything. So the more problems there are, the happier I am.

John Delaney

And that is a man with a big smile on his face. There are a lot of problems in store here. Natasha you had something to say. Go ahead.

Natasha Tamaskar

Yes I did want to elaborate on what was just said. And that is that you talked about are operators going to make money on all this. And you looked at the LTE network there was a problem statement about lack of bandwidth. People said okay we're going to do the access network, it's LTE. It just created a bottleneck. The bottleneck now shifted towards the backhaul. So you're looking to solve the backhaul problem too. But at the end of the day all that traffic eventually does end up in the core networks all the time. So now people are looking, operators are looking at the core network and saying, well wait a minute, at the end of the day, all of this huge amount of traffic is making it into SGSN, GGSN, in today's terminology, and PDN gateways and all those large gateways, and do I really need to see all this traffic. Because if I offload some of this traffic, really maybe I have a more cost effective solution. Otherwise I'm deploying tons and tons of infrastructure. So data offload is starting to become another huge issue that operators are looking at just for this reason.

John Delaney

By data offload you essentially mean taking the traffic off the cellular network onto the fixed network.

Natasha Tamaskar

Taking it directly, yes, to the fixed network or the Internet by any other mechanism possible. If it's not destined for you does it really have to go through you?

John Delaney

And if that turns out, and I think you're right, that will turn out to be a significant trend in terms of solving this problem, does that then start to favour operators who have both fixed and mobile property?

Phil Tilley

Yes. I was going to pick up on that point. Absolutely. So here representing Metro Ethernet Forum, MEF, actually what we're seeing with the members is it's a sort of large wholesale Ethernet type offering. So a lot of mobile operators are actually looking to purchase Ethernet wholesale product where obviously the infrastructure backhaul cost is shared across multiple providers. And that way the investment goes, and the wholesale provider is prepared to invest, or can invest to support multiple providers and fixed mobile traffic as well. Because you're not going to want a fixed connection out of every cell site, but at least you're digging the fibre out much deeper towards the cell site. And then it might either be a microwave pop to the cell site or a shorter fibre run. So in the backhaul, yes, convergence.

John Delaney

That's a way of talking about network sharing isn't it? So when we talk about network sharing we mostly talk about access, the radio access network. But that's network consolidation at the back end. It kind of raises another question that I'd like everybody's take on. Let's assume that LTE is the way forward. Let's assume that mobile operators will invest in LTE as the next generation of their networks. How many networks can a market support, given that most markets at the moment have between three and five separate radio access networks in 3G. Is that sustainable? Or how many is sustainable.

Phil Tilley

I don't think anybody knows the answer to that question. But I suspect what we may see is consolidation. So we may see mobile operators using the same infrastructure and delivering different applications over that infrastructure. So maybe it becomes an application play in the end, which I think will be an interesting direction.

John Delaney

Which is intrinsic in IP in any case. Amir, you have a view on this?

Amir Zoufonoun

I think as we're experiencing a shift in this market, it's a huge shift that we're talking about here for the next few years; there will be lots of players. There will be the big companies. There will be smaller, more innovative, nimble companies that will enter the market, tier two, tier three kind of operators, who have specialized services such as Clearwire, for instance, in the US. And then there will be a period of interim consolidation as the market matures. And then final consolidation you end up with three companies. I mean that's just happening in every industry. It's going to be three. So it's --

John Delaney

Amir says three, right.

Amir Zoufonoun

That's my bet. Yes.

David Hill

Perhaps it's three, but certainly the range and the array of packages and applications would just be

vast and I think will actually -- as consumers will actually not understand, not know who is behind, who's actually building the network.

John Delaney

So what we're talking about, underlying all this, is a decoupling of the service provider business from the network operator business, which of course has been done by regulation on the fixed network. What we're talking here about is the market doing it. What consequences does that have for the network companies? How many of them can be sustained in that business scenario? Does it mean, for example, they need to go wholesale, they need to get away from the retail model? Does it affect their business to that extent?

Phil Tilley

What we, I think, have seen and are seeing is actually operationally more than one territory, and scale is quite significant. So I think we've seen quite a significant consolidation in terms of the number of providers. So historically where each country has had its incumbent mobile provider, what we've actually seen is those being absorbed into some global companies. And there's a handful of those really in reality.

John Delaney

So I've already started asking questions that are too hard. Let's see how the floor can do. Any questions for the panel at this point. One at the back there.

Steve Broadhead - Mobile Test Labs

With my Mobile Test Labs hat on there, I just want to add some information to David's point about one of the key problems here is not the network per se but actually the end point, the mobile device. And the two issues you brought up, we did a load of testing of smartphones last year, actually on a Spirent test bed, and every single phone had medium to very major issues handing out between 2G and 3G cells and back again. Add a 4G cell into that and I hate to imagine what the scenario is. And it was clear there's a massive trade off when you're having to put so many radios and hardware into physical small amount of real estate. The other issue is indeed battery life, right. So LTE is going to take up approximately three times as much power as 3G. So if you imagine a typical iPhone or Blackberry the battery life therefore would be approximate to "Hello? Oh the phone's gone dead. Sorry." So that is a massive, massive issue. Do you really want one hour of battery life?

John Delaney

So these are the two issues that killed 3G for a long time. The fact that it didn't do handover, which basically meant your mobile phone wasn't mobile, and the fact that the early 3G phones killed batteries in about half an hour. Can we expect anything better from LTE, or we're back into that scenario again? Dave, probably best to start with you.

David Hill

I don't know. I think it's going to depend very much on battery technology and if there are other ways of keeping a phone charged up other than plugging it into the mains. So maybe there are other technologies around. I know we had a discussion earlier on about that, but --

John Delaney

Amir, would you briefly talk about that?

Amir Zoufonoun

I was just sharing with the folks earlier this morning that I saw a very, very cool technology that a company is working out in California, it's a start up. They've come up with a charger, very, very thin panel, that you slap on the back of the phone or laptop. And it uses, not only visible light spectrum, but also infrared. So at night, using our radiation from our bodies and from the walls, everything else, constantly these devices are being charged up. And their goal is to effectively get you off the mains so you don't need anything. Effectively the phone is self sustaining.

David Hill

So that's going to kill the power companies then.

Amir Zoufonoun

I don't know about that one.

Natasha Tamaskar

So talking on a slightly different subject but related to this, is really we haven't talked about the business case. Yes. And one of the things we look at is that while LTE has been completely data focused and that's where the requirements came in, what we have seen is we have today more than \$800b infrastructure industry, services industry which is focused on voice and SMS. And unless we have a very good solution for the delivery of those two services, we do not see whether data solutions will actually be able to generate and return enough revenues because the rest of the market is where the money is today.

John Delaney

Right, because we talked about traffic as the driver for LTE. And of course when we talk in traffic terms data predominates, but in revenue terms it's the other way around.

Phil Tilley

But I think talking to operators, certainly European ones right now, their focus isn't on voice. There are challenges with voice, voice over IP, because of course if you're going to put voice in in an LTE environment, it's got to be voice over IP. And therefore there are still questions and challenges on the voice quality. So I think what we're seeing is actually operators just focusing on the data part right now. We'll get that operational, understanding that actually we've got a lot of subscribers still on voice on 3G, 2G. And they will stay there for awhile. And therefore the devices -- and again it's linked to some of the battery stuff, will actually use LTE initially as dongles and that sort of environment, which is where a lot of people use a lot of data today that comes on mobile. And then I think one interesting application that we're talking about at Alcatel-Lucent as a company is a connected car. It's a huge mobile demonstration facility so streaming video to your car while driving down the road. So instead of having DVD in there --

John Delaney

You need some seriously good hand off.

Phil Tilley

Good hand off and a nice gentle policeman.

Frank Johnsen - ComputerWorld Norway

Equivalent of Network World. Data offload, I heard you talk a bit about that. Last year I spoke to an operator about what they were going to do. And one of the answers was femtocells. So that everybody else can understand what I'm talking about, that would be a thingy you plug into your broadband connection, which is a small base station for the mobile network. And I said, why would I want to have one of those? And they said, if we can give you one for free and you can call all Europe for free, fixed lines, would you have it? And what happens then is that all your mobile traffic goes to your broadband provider's network. Do you think that's a good idea? Do you think that's sustainable?

Natasha Tamaskar

So GenBand is actually one of the leading providers of infrastructure for femtocells. We're actually involved in two thirds of the worldwide deployments in femto trials, as gateway providers, media gateways as well as security gateways. So we have been working with a lot of operators. And many of the operators initially started talking about femtocells for the reason of coverage. And that's North America -- or it's capacity. But what we are starting to see is now, as they're starting to look at more and more data, this is absolutely one of the ways that they are looking to offload now. It's not just femtocells. It's WiFi enabled handsets as well. So this is about dual mode handsets that can actually do the offload from the device itself.

But they're also looking at is this going to be sufficient or not in the sense that is there enough correlation back to the core network so they can charge for applications. Is there any control. So they're saying that perhaps maybe it's not at the femtocell or the WiFi enabled handsets that you do the offload. But you do it at the edge of the core network where gateway sits. So you have the offload at that point, and from that point on you do not have to send any of the traffic back into the core network. So different models being explored.

David Hill

So it raises another challenge for the operators. As more and more equipment ends up in people's houses, how do they manage service assurance? Can they provide service level agreements? Do they control, do they own that equipment? Is it owned by the householder? If a problem occurs, whose responsibility is it? So I think there's some really big challenges with extending things into the home.

Amir Zoufonoun

There's also a huge backhaul issue here. In fact AT&T, I think one of the estimates is 7% of the users since the iPhone was introduced are using 50% of the bandwidth in the network in areas where people are using it. And now they're realizing they would much rather have people use the WiFi network and any other network and just offload all that traffic because it's getting into their main core business.

Natasha Tamaskar

By the way AT&T also deploys femtocells for offload purposes as well and sees some great value in doing so. I mean, today they're offering as consumer, but we can see in the future going towards enterprise based solutions as well.

John Delaney

I think we have time for one more question. I'm going to go with first come first serve here, I'm afraid.

Annette Stadler - Markt & Technik

What's about the availability of LTE chip sets at the moment? What kind of choice do the vendors have here.

David Hill

I'm not going to answer that because most of them are our customers, so I've got to be very careful.

John Delaney

Anybody else feel up to it.

Phil Tilley

I'm certainly not knowledgeable on that. I know where, in terms of trials, I know we're actively involved with well over 15 LTE trials globally. So in terms of deployment trialling and we're at that level, in terms of chipsets going into devices that's certainly beyond my area of knowledge and understanding.

David Hill

I can tell you we are testing. But I can't -- I'm not prepared to tell you whose we're testing and how far down the line they are.

John Delaney

Okay. And on that tantalizingly cagey note, I'm going to bring it to an end. Please join me in thanking the panellists.