Intel IDF – 3.7.06 Maloney Keynote Presentations

[Music]

[Video plays]

Female Voice: Ladies and gentlemen, please welcome Sean Maloney.

[Applause]

Sean Maloney: Well welcome back after your lunch. For those of us in this room, that is what I'd call a good news video, because almost everybody in this room in one way or another makes their living off the Internet. You're either designing products that end up using the Internet, hardware or software, or maybe you write articles in newspapers that cover our industry, our technology, and these users.

We could have shot that video almost anywhere in the world, almost any city in the world. We actually shot it about 200 yards from here just a few days ago to hear about the passion that people have for using the Internet. I think it behooves us as an industry to look at the environment of the Internet and to look at what's changed over the last six months since we were together last time, because the way that the Internet changes, changes the way that we do our jobs and the kinds of products that we need to design.

This, of course, is not the Andromeda galaxy. It is a representation of the Internet where the color lines denote domains, countries, and the thickness of the pipes denotes the bandwidth and the infrastructure. The Internet is an enormously complex and changing phenomenon. And so we thought we'd take a different slice of it to see exactly what's

going on, and we sat down and we thought we would take 16 of the top websites in the world, and we would profile them over a period of a day to see the usage patterns on those websites. The websites that we chose are a cross sample of the world of the Internet. This represents a total of something like 55 million people, 60 million people at any time. You're frequently in one of these communities. These communities are global communities in Internet search. They're semilocalized communities with localized Asian or localized European content. They are entertainment and game communities. They are commerce communities, mail – news communities. And they are evolving pretty rapidly.

And over a period of the last six to nine months, a couple of things have happened that are worthy of our attention. The first thing that's happened is there has been a repaid growth in video. Now the Internet overall is on its way to being the largest media, surpassing the other media, and one of the ways that's happening has been through this very, very rapid growth in video. We've talked about video on the Internet for years and years and years, since the middle 1990s. The last three months this has finally really begun to kick in. And I'll show you an example here of some of the things that are happening, which you may see – you're seeing a race to catalogue and archive this video. And this is not like watching a cactus grow. This is like watching a sunflower. The amount of content that's coming on now week on week on week is dramatic. We have Google obviously looking to archive the content. You have Yahoo doing the same thing with the Yahoo search site. We have AOL doing the same thing with the AOL search site. You've got newer sites coming in – U-Tube archiving a whole series

of content. We have Blinkx coming in and archiving, again, massive amounts of news content from all the way around the world.

What's increasingly commonly when you go and look at these new video search engines or new video search technologies also is the amount of personalized content that's coming on there. It's not just sports or video clips. It's people putting up their own clips that come. People who are going into sports stadiums and holding up cameras, people who are shooting video in their home and putting it up. And the impact of this is clearly going to be a rapid growth in Internet traffic. It has a big impact on the infrastructure demands and it has a big impact on the client. Not only the amount of bandwidth you need to reach the client but then the display and storage capabilities of the client.

The personalization phenomenon is also happening in other ways as well. We're seeing new browser-based technologies coming out that are accelerating personalization. RSS clearly has been around a year or so with people personalizing their news streams. You're seeing tagging – people beginning to personalize and archive in a much more granular way, content. Ajax and Mash-ups, much more recently, in the last six months. As people are beginning to use these XML-based technologies to mash together existing infrastructures on the web and come up with totally new, different types of applications.

I'm going to show you a couple of those, and I'm going to start with a very interesting one. This is a mash-up of the FBO web, which is the FAA's – Federal Aviation Authority's – live database of flights in the U.S. Now I didn't know this. Maybe you didn't know it. But the FAA

has a public database recording where planes are in the US at any one time. Difficult to understand the format of it until somebody came along and mashed it with Google Earth. And so you're now looking at a live map of flights across the United States. I'm looking at it here on this beautifully smooth Apple iMac with a Core Duo at 2 gigahertz.

[Laughter.]

And I'm diving in over LAX. And you can see all these flights underway. And if I go down to here, I can tilt it 'round and I can see a three-dimensional representation of all of these aircraft as they're coming into LAX. This is a kind of accidental result of having open databases on the Internet and somebody mashing both of them together. And if you have the appropriate mobile client, you're going to be able to stand in front of the airline desk when they tell you your flight is delayed, and you're going to know more about where it is than the person behind the counter.

[Laughter.]

Another unintended consequence of the magic of the Internet. Now that one's going to be really, really – I tried to access it at SFO recently and I haven't quite figured out how to get onto it when I'm there. Here's another one. Now this is a mash-up of Google Maps and a database called Hot or Not. Now those of you who laugh know what Hot or Not is. Hot or Not is a website where you go put your own picture up and people go vote on whether you're hot, right?

[Laughter.]

I would not put my picture up there under any circumstances, having a fragile ego, but this is a mash-up between Hot or Not and Google Maps, so we can see who's hot around The Moscone Center. It won't include many of the geeks in this room. But, anyway, I can dive in and look up somebody. And there's a picture of someone who considers themselves hot. And I'm not going to go any further with this application.

[Laughter.]

So, anyway, unintended consequences, weird and wonderful things, access to information, personalization, and that passion of the personal, that passion of pioneering has always come around in our industry to a large extent by the desire for things to be personal. Forty years ago, the passion at Stanford University to get away from the horrible mainframe interface led to the creation of the GUI and obviously therein through Xerox Park, the mouse. The passion that led to the Palo Alto Home Brew Computer Club that ultimately gave birth do the Apple Computer and the PC. The passion to link networks that gave birth to TCP/IP and the beginnings of the Internet.

Our belief is that the next phase of the Internet is about the personal and it's about the personal access to it. I think you can make a case that says we are at the beginning of the lift off. We've seen the growth rates in broadband of 30, 40, and 50 percent over the last two years. And yet, I would still make the case that we're at the very beginnings of

this. Why are we at the beginnings of it? Well, to a rough approximation still, nobody has broadband – to a rough approximation. It's still a very small number of people in the world. If you look at the pull of this medium versus the previous medium of TV and so on, we're still a very small penetration rate. Even when you dive into that 250 million people who have broadband, many of them are down at 250 kilobytes or 500 kilobytes. There's a long, long way to go for this – a long way to go in terms of growth opportunities for us and, of course, technical challenges.

The second reason is that the Internet isn't mobile. And mobility gives that extra dimension to technology. When you can take it with you – when it's always with you – that was the vision that Monte Cooper had with the cell phone in 1978. That is why the cell phone has now got a billion and a half people who carry them around all the time. It's because it's with you always. It's personal. That, we feel, is the next phase of the growth of the Internet.

So let me spend a few minutes looking at what the technology initiatives we're trying to drive at Intel over the next year or so are to try to help make that happen in partnership with the work of the folks in this room. I'll break it into three areas. Firstly, small screen devices – phones, smart phones, PDAs – and a blurrier device slightly above that that I'll spend some time talking about…Secondly, what we call the big screen devices which are notebook computers. Notebook computers are going through an astonishing period of growth right now. And then thirdly, the packet-based wireless technologies that are designed for this high-speed personal broadband.

Let's start for a couple of minutes by looking at the small screen and some of Intel's initiatives in the small screen space. Last time I was here in the fall, I talked a little bit about [Hermone], which was our first 3G chip. We said that we expected to go into production on global networks by the end of that year – the end of 2005. We hit that schedule and we did it in a device that was already highly addictive – the Blackberry – and we believe that the power of that product (because it's gone into the new Blackberry) has helped make that device an even more compelling device. We've put a lot of focus into the bandwidth and the performance and we're feeling pretty good about how it panned out.

In the applications processor space, I showed you the [Bulverde] microprocessor that was going into the Palm and Motorola and other phones. I'm delighted to say that we're now in sample on the next generation which is Monahans. I showed you a demonstration last time of the Monahans running something like a gigahertz. We are now moving into sampling on this product and today I can announce three new technologies that will help the Monahans family be better on video and audio.

The first two technologies in video and audio essentially enable you to shut down the microprocessor power consumption when you're in the output phase of the audio or video signal. We're then also enhancing the instruction set with MMX 2. We're also putting hardware acceleration features into it that help enable the acceleration and capture of camera images through the camera.

So all of this in Monahans, we believe, will give us the ability to sustain this improvement in battery power consumption performance and we can push ahead with even better efficiency as Monahan starts to appear in these smart phones and devices.

Let's go back to the Internet for a second and back to our confusing and complex infrastructure. These smart phone devices – even though they are becoming more and more powerful, have a big challenge in delivering the crispest and most authentic web experience. One of the reasons for this is that the Internet itself is always under construction. We know it's always under construction on hardware, but it's also always under construction in software. Every day, if you're a corporate user, you're used to having the latest virus fix and the latest software fix to protect yourself from attack. But if you're a frequent browser user, you're also used to the numbers of times that you have to change your codecs, and update your audio and video codecs. On Internet Explorer, you have an enormous range of [ScriptX] extensions that you can use to enrich the web experience. On Firefox, you have something like 5,000 different plug-ins, with new ones arriving every day. That is the nature of the Internet and the web, and it's what gave birth to these kinds of applications. It's not a static medium; it's a medium where the software is being refreshed on a daily basis. The PC has always had an advantage in being able to adapt to this challenging software.

Let me come over and show you an example. We have three kinds of handheld devices here. On the Elmo, you're seeing two very, very

good devices out accessing one particular common website, which is a music video website. Then, the device I'm pointing out here is a next-generation micro-PC-style device. What you see on the two conventional non-PC devices is the inability to display the content. That's not because the designers of these products are incompetent; it's because the codecs and the software change too regularly for a static device to stay up-to-date. That has always been the advantage of the PC on the Internet. But the problem that the PC has had (even the notebook PC), is that it's too large for you to carry it around with you.

So there is a huge effort underway to shrink down that PC architecture and put it into a smaller and smaller space. That initiative is called the Ultra Mobile PC – that's the most common name for it. Here's an example of one of those devices. You're going to see a tremendous wave of experimentation, in the next year-and-a-half or two years, taking a lesson from the cell phone industry, with new types of form factors, keyboards that swivel out, keyboards that clamshell open, all kinds of different form factors and sizes, as the PC industry races to get this flexible architecture into a smaller and smaller space. You won't have to wait long at all for the announcements of the first ones of those devices.

So that is what I'd call the next step in PC mobility. These devices will be launched by numbers of companies in a relatively short period of time. Collectively, at IDF, we will be putting more and more attention on the ergonomic challenges, the software challenges, the packaging challenges, and the heating challenges, to squeeze these things into smaller and smaller spaces. At Intel, we have a vision of reducing the

power consumption by an order of magnitude, so that we can meet the demands of this kind of market. I think, collectively, that's a great objective for us to have.

So there's a lot going on with small-screen Smartphones and Ultra Mobile PCs. But the big screen devices and the notebooks have also been moving very, very quickly over the last 12 months. As you probably know, notebook sales actually grew much more quickly than cell phone sales over the last twelve months – at something like 40 percent. At Intel we've been focused pretty hard on that, obviously, with Centrino. We kicked off the year in January with the introduction of the latest Centrino, the Core Duo, which we talked about at the last IDF. We've had a very strong reaction to the products that the folks in this room have designed. We're seeing a tremendous surge in demand for those products as they fill out into the retail channel, this month and next month, all the way around the world.

This builds upon the two previous generations of Centrino. [Banias], was the first architecture, then [Dothan], then Core Duo. But we intend to keep the pace up, with the introduction, in the second half of the year, of Merom, which builds upon that [Yonah] architecture, takes it into a newer space, in terms of performance. And overall, during the course of these four generations, we see a 3x increase in performance per watt.

And I'd like to spend a few minutes looking at that architecture and taking you on a tour through the architecture, so we can explain some

of the things we've done in there in order to increase the performance without taking a hit on the power.

What you're seeing up on stage here is a [die plot], a physical representation of Yonah on the right-hand side and Merom on the left-hand side. And I'm going to start by walking you through what's in the Yonah and then look at what's inside Merom.

And I'll start by comparing Yonah to a conventional dual-core architecture. The biggest thing that you'll see when you look at the architectural comparison is the introduction of smart cache technology into Yonah. Essentially what it means is that the two cores inside Yonah can, in an intelligent way, access the same cache. That means you have a far higher likelihood that the data is present inside of the cache than in a conventional architecture. It means you're far less likely to have to go out on the front side BUS, which you do in a conventional architecture. Going out on the front side BUS of course incurs not just a performance hit but also a power hit. The smart dual-core cache is a big deal. It's complex to design, and it gives big payoffs.

But we also took that a stage further by allowing granular power control of the various elements inside of the cache. Cache consumes – memory consumes a lot of power, and having the ability to turn off elements of that cache in an intelligent fashion really helps in terms of power consumption. The power approach also extends up into the logic areas of the chip where, in the dual-core itself, we can turn off micrologic areas inside of the core, micrologic area-by-area, switch

them off when they're not needed, to further reduce power. And at a higher level, we can have complete independent dynamic power control of both cores, or we can take one of the cores right down into a low-sleep state, if we want to, while keeping another one active. So that power management allows us to be very, very flexible in the way that we control the product in order to keep the power consumption down low.

Now heat is also an issue in advanced microprocessor design. So with Yonah we've gone a step further and embedded digital sensors inside the chip. This is actually a real representation of a thermal scan of the device, [we've embedded] it in this PowerPoint image. And this enables us to really push the limits on the [guard bands] of the device. When you know this information about the chip, it makes it far easier for you to design very, very small devices because you're able to get a very granular control over how much heat is being dissipated.

Now all of these things are in Yonah. All of these things are also in Merom. Merom builds upon that. It builds upon it by extending the cache out to a full four megs. We also have a faster cache, obviously 64 bits, with an intelligent memory access system as well, to improve performance. Merom also brings some other, newer features. What we call wide dynamic execution. Basically for those of you that are interested in microprocessor design, that is wider pipes and deeper buffers so we can get more instructions in-flight on a short pipeline. And then at the instruction level itself, we've gone another step further in order to increase the number of instructions that you can execute per clock tick. At these very high frequencies you want more instructions

per clock tick obviously as a high priority. And so by doing fusion, we're enabling that to happen. We're fusing at the micro-ops level, which means you can minimize the number of unnecessary micro-ops that you execute. And then we fuse also, then, at the instruction level where we fuse together x86 instructions so that we can intelligently execute and execute the minimum number of times.

All of these are significant architectural enhancements. I go into the details on this because this architecture will be the foundation of a lot of the mobile computer industry out over the next three to five years.

Okay, so that is a tour through the innards of Yonah and Merom. So when do we see Merom? Well the first time that we'll see it will be in the refresh in the second half of this year. The Napa refresh comes in the second half of this year and we have here three notebooks that have Merom – beautiful notebooks from Dell, Samsung and Sony. These are basically drop-ins to the existing Napa platform so the global OEM community will be able to ramp this technology quickly. After that, we have the next major platform refresh – that's the Santa Rosa refresh. Santa Rosa will be all the goodness of Merom plus Crestline next-generation chip set and also Kedron which is the next generation wireless.

Let me spend a few minutes talking about Santa Rosa. Dramatically better microprocessor performance – the data that we're seeing on Merom is extremely encouraging in terms of performance. Significantly better Gen-4 graphics that are coming in with the chip set – another step forward again in graphics. 802.11N – that is the MIMO

version of Wi-Fi. I'll talk about that in a little bit. Professional level manageability and security – that's the IAMT that is being embedded in here. Media share – which is the Viiv client software embedded in it. And we're also going to be doing some things with NAND technology. You may have seen that since the last IDF, we made an announcement of a significant investment in nonvolatile memory to extend what we're doing from NOR into NAND. We're very interested in the use of NAND in mobile devices in addition to NOR and we're also very interested in the use of NAND in computers in general.

What I'd like to do now is to call up Adam to show us some things that we can do with a combination on NAND technology plus some embedded intelligence.

Adam: Hi Sean, how's it going?

Sean Maloney: Good. You've got the cool black shirt whereas I have the old-fashioned blue one.

Adam: I'm not going to trade you right here on stage. What I have here on stage is the Robson Technology built into this platform. As you see on the sticker down here, it says "Robson." I'm starting these things up from scratch. We're booting them up in parallel. This is our control unit, or non-Robson technology system. It's important we start this thing out in an off-state so we can see the impact of nonvolatile memory on a platform. It's just not about simply pouring flash into a notebook.

Sean Maloney: Basically, what you're seeing here is a rapidly faster boot time as a consequence of using a NAND cache with an intelligent series of algorithms embedded in silicon to speed that up.

Adam: That's right. We have a controller that helps feed all of that up to leverage the speed of that NAND flash. The Robson unit is finished booting – it booted up in half the time. The control unit is actually still working away. It's got a whole bunch of start-up apps to do. There are really only four different start-up apps in this. Imagine what this will do to your IT build corporate notebook.

Sean Maloney: Again, the objective here is that we need to have devices that boot very, very rapidly. The same way you climb off a plane and you immediately get a cell phone signal, we need devices that come into life very fast.

Adam: Exactly.

Sean Maloney: You also get the benefit, when you do that, of power-saving, right?

Adam: We do. I've got a quick application performance scenario and then we'll touch on the power savings. I want to get as much power savings as I can out of this. So what I'm going to do is start up some common office applications in parallel – things like Adobe Acrobat – we know how long that takes to start up. We've also got Excel, PowerPoint and a few other Microsoft applications. You see that the Robson system has finished opening these, running the macros and getting it done in three seconds.

Sean Maloney: That was not zero seconds.

Adam: Right. It was 15 – I hit enter twice. So we're looking at 15 seconds on here. Sorry about that – and three seconds here. So five X performance on application startup and executions. Now back to the power thing you talked about Sean. During this, we also were metering each system and I have the zoom sort of zoomed in on the watts that we consumed during the boot-up and also during the application performance comparison. What you see here is that we used about 2 watts on the Robson system and about 2.7 on the control unit. A watt here or there can go a long way towards…

Sean Maloney: A watt's a big deal when you're in the mobile industry.

Adam: Yes. It gets us a lot closer to the eight-hour battery.

Sean Maloney: Very good. So what you saw here what we call the Robson Technology which we're targeting at the Santa Rosa platform transition to give a much faster boot time and a faster applications response and again, save that power because we need it as we make these devices smaller and smaller and faster.

Now, in the Santa Rosa generation we're also expecting to see continued experimentation with new types and new shapes of PCs. These will be coming out during 2006. You're used to us doing these demonstrations at IDF. This year we've got another series of new concept PCs that we will be handing to the ODM and OEM

community, covering all kinds of different uses. This is sort of a consumer concept PC where you can take it out from that slick little docking station and then you can pull it back like this, you know, lift it up. You can have it in economy class mode for when you're –

[Laughter.]

For when you're – it's tough at Intel. This is the way that you would look at a DVD or some passive entertainment, and then of course more in your work mode like that. And then we have a range of other ones. This one is called a road warrior, where we have been once again experimenting with different ways of having screen but also in this one embedding Wi-Fi and WiMAX and seeing how that gets used. And all of these are products that we'll be working as an industry to see how we can deliver new types, forms, and sizes of notebook computers.

But it's not just about the compute power and the form factor. It's also about the wireless and the wireless experience. And if you listen to the words of those people that were stopped and interviewed on the street, connectivity is really, really, really important to them. When you ask people what is the most important thing in your notebook, almost everywhere in the world now people say improved connectivity. Connectivity is very, very important. We're very happy over the last year-and-a-half that we've continued to make progress in moving ahead with Wi-Fi. The 11N discussions have proceeded well in the last six months and we're moving well towards standardization on 11N. 11N is critical of course because it will enable the speed of 11N with MIMO technology will enable the transition of real high-def video

inside of the home. And high-def video is going to be critical over the next three years for the whole consumer electronics and computer industry.

We've made good progress on that as an industry, a big thank you to those who've been working on that. Inside of Intel, we're also happy to have made good progress as well. I'm delighted today to be able to show you the MIMO 11N demonstration of [Kedron]. Kedron is the next radio product, 11N product coming out of our Wi-Fi teams. It's a highly integrated, leading edge 11N MIMO implementation, and here we're showing it live running full-streaming high-def video. So good progress there and good progress overall for Wi-Fi. And of course the attach rate continues to increase for Wi-Fi in all sections of the industry.

When you get that crisp broadband experience that you get with Wi-Fi, that's when you can really experience the web. But then you get the frustration when you lose the signal. That's why many of you have been working over the last 12 months to continue to push ahead with WiMAX. So let me update you on the progress that we've made collectively over the last 6 to 12 months on WiMAX.

If we go back to 2004 IDF, we said that by 2006, we would need to have a fairly mature range of products covering broadband wireless to the home, consumer access. And indeed we've hit those milestones. Here you can see what are typically second-generation or even third-generation implementations – these are products that are delivering broadband to the home using 16D, which is the initial phase of

WiMAX. The cost of these connections is coming down significantly. The volume is increasing significantly. And as you'll see shortly, this equipment is being installed in pretty much every continent in the world as these WiMAX installations begin to kick in.

We also said that we would see progress on portability. Portability in 2006/2007. Portability in WiMAX is really resting on the shoulders of 16E, which is the next extension on WiMAX in the same way that 11N in Wi-Fi extends from ABG. And 16E, we saw the great news coming out from Korea, the announcement by Korea Telecom of their first 16E implementation, the 16E [SISO] implementation [WiBro]. But we haven't, as yet, seen any demonstrations of 16E here in the United States. So it would be really interesting – ah, just on time.

Craig: Yeah, Sean. Of course!

Sean Maloney: Here's Craig, on a very quiet-sounding scooter.

Craig: Oh, very quiet. What we've brought you today, Sean, is the U.S.'s very first demonstration of mobile WiMAX. On the little electric scooter that I have here, I've integrated a Centrino Napa platform notebook on the back, for using Intel [Core Duo], and our very first Intel WiMAX PC card, giving us a direct connection to the Internet constantly, even mobile, while you're cruising around San Francisco on your new wireless scooter.

Sean Maloney: What kind of speed are you getting?

Craig: We're getting upwards of two megabits for the purpose of this demo. We're seeing that around town.

Sean Maloney: In Korea, back in September or October, we were seeing speeds up to 16 meg. You've set this up for the demo at speeds around two.

Craig: Exactly. We were looking for a lot of range on this demo. We wanted to make sure that you could get down all the way to the wharf. As you can see, we actually have this setup here on our screen, where we have integrated VoIP as well as our blog page. This is stuff we've never seen before, right? A live video blog of you, cruising around San Francisco. [Something] we can bring down constantly on the web. In addition, there's some regular stuff that we can integrate in. Let's just go down to the touch screen, and I can bring up our directions. None of this is local on our bike. We're bringing this straight down the wire, so to speak. As I can see, we have our directions straight down to the wharf, for you to drive down here, downloading a video on Google Earth. I can get all of our traffic directions brought directly down to the bike. In addition, weather's been a little shaky in San Francisco lately, right? So, what do we have for a live streaming webcam from Pier 39? It's a little bit better, but maybe an umbrella would be useful. There's a lot of gear on this thing, right? What do you think?

Sean Maloney: That's a really good demo, but motorbikes or scooters are designed to annoy you with the noise they make. The electric one is far too wimpy.

Craig: Far too wimpy? Just a little bit underpowered, it sounds like you're saying? Well, I'll fix that for you. I knew what you were going to say.

What we have here, actually integrated into our thing, is what we're calling muffler tones. You want to talk about the success of ring tones? Wait until [APAC] gets a hold of this. How are we going to beef up your little scooter here, Sean? We're going to give this guy a little volume. [Motorcycle muffler sounds.] Oh, very Harley-like on this side. Not bad. But, of course it is a scooter, right? Maybe a little bit too aggressive for our ride around town? Just crank this guy down a few notches. [Humorous sounds.]

[Laughter.]

Craig: You get the idea, right?

[Applause.]

Craig: So, Sean, you have a very, very great time cruising around San Francisco. No DVDs and IP TV when you drive, please. But thank you very much.

Sean Maloney: Thank you. That's a really good demo. That sets the bar at wrapping a creative wrapper around a technology demo, I think. What we're showing here, obviously, is 16E continuing to make progress. Part of what Craig said as he went through that was that we said we would have a 16E card for Centrino in '07, and we're actually managing to do that a little bit earlier than we had said. This will be for the second half of this year, for the 2.3 - 2.5 gigahertz band. The 2.3 - 2.5 gigahertz band is a band which is in favor in some of the early WiMAX implementations in Asia.

Now, we want a global standard, and that same desire was behind Wi-Fi. I remember that there were many people outside of the Wi-Fi-supporting community, who said that Wi-Fi would never become a global standard. Many of you worked very hard in the late '90s through 2002, standardizing Wi-Fi globally, and overcoming the legislative and government hurdles, so that we could get global frequency bands for Wi-Fi. We ended up, as you know, with 2.4 and 4.9 through 5.8, which enabled our industry to set the wheels in motion that led to the economies of [scale] and the cost reduction of Wi-Fi which has helped so much over the last three years. Over the last year, we've clearly been doing the same thing on WiMAX. We've been working hard to come up with global standardization around the frequency bands. And considerable progress has been made. We are now at the point where there is a clear coalescing around the 2.3, 2.5, 3.5, and the 5 gigahertz bands. And it looks likely that the planet is going to be able to be covered using those frequency bands. But in order to do that you're going to have to have radio technology that is very agile and capable of supporting those three radio bands. You'll want a radio that is capable of supporting those three radio bands.

So I am delighted today to be able to announce the world's first integrated Wi-Fi/ WiMAX flexible radio capable of operating in the 2.3, 2.4, 3.5, and full Wi-Fi/ WiMAX frequency range in the 5 gigahertz band. It's a very small device, suitable for very high integration. It's a Wi-Fi/ WiMAX radio. As we said before here the objective is that over a period of three years or so these two technologies essentially would merge with an integrated Mac handling

both. This is a very important first step, the radio that's capable of handling both standards in all of those frequency bands. And what we have here on the screen, if we can bring it up, is we have an analyzer showing the full transmission going over – this is going over the 3.3 gigahertz band, end to end, using O4R radio, [both] ends of the band.

Okay, so I'm just about drawing to a close here. And I'd like to summarize with a few points. Those people that we saw at the beginning of the speech are passionate about the Internet; they're passionate about what the technology can do for their lives. People are, to an increasing extent, addicted to it because of the benefits that it brings. Paying attention to how the Internet gets used, how it changes is of incredible importance to all of us. And we have to make sure that we do that and we learn the lessons from our customers in the different ways that they're beginning to use the technology.

I then showed you the three areas that Intel has been focusing on in the mobility space. Firstly in the handheld area increasing performance, increasing integration of audio and video, then shrinking the classic PC and putting it into a smaller and smaller space in the ultra-mobile PC initiatives. And then in the notebook area, a new architectural foundation for the next few years, architected from the floor up for extreme power efficiency and high performance. And then all the other ingredients that go 'round with it, the chipset and the radio and so on. And finally I have, I hope, given you some insight of the effort and energy that we've put in on Wi-Fi is also now translating into WiMAX, and we're beginning to see global progress on that. Global is the keyword. Our growth opportunities on the Internet are absolutely

global, and I'd like to leave you with a view of that global progress on WiMAX and how that's rolling out around the world. Thank you very much.

[Applause.]