The Global Technology Outlook

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INTRODUCTION

Well, good morning. I'm going to spend a little bit of time talking about something we call the global technology outlook. And I apologize. I know there are people in the audience that have heard me talk about this before.

This is something that we do in IBM. It's my responsibility that helps us answer some of the questions you've asked Irving this morning. It helps us understand the technology trends and understand:

~ Where is commoditization going to happen?

~ Where do we need to collaborate?

~ Where are there new, emerging opportunities for the IBM Company; and perhaps even

~ What businesses might we not want to be in, and

~ What businesses might we want to be in?

And the technology outlook is our focus on:

~ What's emerging;

~ What's disruptive; and

~ How is that disruption going to potentially commoditize our businesses and our customer's businesses; and

~ What are the new opportunities that emerge?

IBM RESEARCH WORLDWIDE

I apologize. I have to give you a few quick charts on my own organization. It's a worldwide research organization and we're very, very proud of our technological history, national medals of science and technology. It's the organization that invented the single-cell DRAM, the memory in your computer, the disk drive, relational database, the modern parallel computer, RISC architecture, etc., etc., etc.

And as you know, we've been very proud of our patent history. You'll hear more about this from John Kelly tomorrow, twelve years in a row of patent leadership.

U.S. PATENT LEADERSHIP

However, what this conference is all about is patent leadership is nice, but it isn't how you're going to succeed with your company.

I like to brag about the fact that, last year, we licensed our intellectual property for $1.2 billion of bottom-line profit, but whenever I do it and Sam's around, he reminds me we spent $5.5 billion on our R&D, and that's not a great business arrangement if that's all you do with your $5.5 billion of R&D.

COLLABORATIVE INNOVATION

In fact, collaborative innovation, this topic in today's discussion, is all about how you can accelerate the R&D process to create new innovations in the marketplace by working with your customers and partners in various alliances.

So we're very happy – as Don Tapscott mentioned in his talk – we're very happy to give any or all of this away if it can speed up our flow of innovation into the marketplace. If it helps by working in partnership with you and other companies, then we will be glad to give it away if it gets us to the marketplace faster.

EVOLUTION OF ROLE

This is sort of our internal approach, which has happened gradually over time, to basically reach out with the R&D organization; in particular, this is focused on my own organization, the research division, to get us in the marketplace quicker. So we started as a very traditional research organization, centrally funded, focused on the hard problems that our development laboratories were too busy to work on, and we found, I think, over time, that we were great in invention – invented all sorts of great things – but not always great in innovation.

Because innovation requires not only understanding and building perhaps what's new, but having a channel for the rapid flow of that idea or that invention into the marketplace.

And over the course of time, as you can see, lately, we've been working very much more in the marketplace with things like FOAK, which is our first-of-a-kind approach to bring our researchers into contact with our customers by actually having them then build solutions in the marketplace.

And on-demand innovation services: that happens to be a little, well, no so little this year, it's in its third year, where we've actually gotten our researchers to consult together with our business consulting services, and they're going to have helped close about $1.2 billion this year – if I can find some wood to knock on, the year's not closed – of consulting services business because we brought unique technology, unique solutions, and unique skills, together with our consulting services partners, into the marketplace.

But we're not doing either of those things because we want to bring a little money back into research, because I want to have the market pay for my researchers. We're doing it because I want the marketplace insight and the partnerships to bring back into the research division so we can set our technical agenda, so that we can build the technologies that our collaborators and partners tell us are important, not the technologies that our underlying researchers think are important.

So we have a number of programs. We're very proud of it, but we continue to evolve as an organization, and I'll talk a little bit about that evolution when I talk about the technology trends.

KEY IT TRENDS

Now, we've been doing the technology outlook for a number of years and I'm not going to be able to talk about all of the key technology trends. I put some on this chart and I'm going to talk a little more in detail with the ones that are highlighted in white, but I thought I would at least just mention some of them that have bubbled up recently, some of the important things that are changing the information technology landscape that have potentially major impacts on you.

KEY IT TRENDS: TECHNOLOGY AND SYSTEMS

The first is technology and systems and I think, as you all know, a lot of our industry – the information technology industry – has been fueled by the underlying evolution of semiconductor technology. Well, that underlying evolution, about two years, took a right turn. Maybe it was a left turn, but it wasn't straight ahead. And it's going to fundamentally change the way systems are built and how you need to think about the IT infrastructure that supports your organizations and the underlying technology that will be available to you for solving your problems.

KEY IT TRENDS: STOCHASTIC ANALYSIS AND OPTIMIZATION

So I'll talk about that. Stochastic analysis and optimization: well, I think you probably all know that there's been sort of a quiet, underlying revolution in how you can optimize systems that are noisy. And that's what stochastic analysis and optimization all about.

It turns out that there's new mathematics that allows you to do more stochastic optimization to deal with things like the noisy world in suppliers that you don't really know 100% when you're

going to get something, or market fluctuations, or in logistics or scheduling, like crew scheduling, the fact that the weather changes and the planes don't land on time.

So there are lots of hard problems, and there's huge value in focusing on how you can use modern mathematics to do a much better job of optimization than we have in the past.

We found that more traditional optimization, if you apply these more advanced mathematics to real-world problems, you can gain 20-25% in your optimization point, which is real money for how businesses operate.

And in fact, the real reason it's on here is because I want to brag because it was one of the early pieces of work that was going on in a skunkworks in research that now has become the center of business optimization, which is a major practice in our business consulting services, in our consulting services business.

TECHNICAL ACCELERATORS

The next three that I've got in white, I'll get into in detail, but what they are are the underlying accelerators, technical accelerators, for everything that we talked about in this morning's talk with Irving.

So there are technological reasons that Irving alluded to that are flattening the world that are making collaboration fundamentally more important, and they're in those three that are in white.

KEY IT TRENDS: PERVASIVE CONNECTIVITY

Pervasive connectivity: I won't have time to talk about this, but let me just mention the concept. We've had pervasive computing forever. What's changed – and I think you all know this because we're living through it – is that the flow patterns on the Internet have fundamentally changed in the last couple of years.

So initially, the Internet was – to a very large degree – a broadcast medium. So if you were going to use the Internet like, for example, Charles Schwab does, and you have a Web site which your customers use, what do they use it for? Well, I happen to have a Schwab account and I know what I use it for. I go on there and I want to find out how much my stocks are worth, and I go on there every day and I check it out. I'm usually disappointed because I'm not great at picking stocks, but nonetheless, that's what I do.

Now, I know, for me, and in general, for Charles Schwab, it's very unusual that I'll go on that site and make an actual transaction.

So the stuff that I look at is static or nearly static information that can be broadcast out to edge sites on the Internet. And that broadcast allows the network to operate in fundamentally more efficient ways. And companies like Akamai were created to form those cache sites and help network performance.

Well that works because the flow patterns were primarily outward. And what's changed is the flow patterns are now much more peer-to-peer and actually inward.

So we have digital cameras on every other street corner in London measuring license plates to see whether they paid their toll to get in and out of the loop in rush hour, and the proliferation of sensors at the edge of the network is actually changing the flow patterns.

There's more data out coming in. And, of course, if it's out, it's being captured out there. You don't want to send it all back because it's just too much. So you need to do different things at the end of the network, and it isn't just caching anymore.

KEY IT TRENDS: PEOPLE PROXIES

And finally, the last one which I will introduce just briefly is our people proxies. People proxies are a real simple concept. It's the digital persona of an individual in an enterprise.

You all have a person proxy in your companies, and I know for IBM, in my company, they've got information on me everywhere. It's in HR databases, and it's in what I have access to in my Notes databases, and it's in my executive resources and, who knows where it all is?

And it's not managed centrally and it's not particularly useful to the enterprise. And what a person proxy is, is basically the federation of that data, in some semi-holistic way that allows the corporation and other individuals to get value.

So for example, last year, IBM spent 22 cents a share hiring people over here, firing people over there. Now, a lot of these could have gone over there. If we really knew about those individuals in a collective way: where could they work, what skills did they have, how could you really use them?

So a collection of people proxies is a corporate asset that allows you to do human capital management in fundamentally new ways.

KEY IT TRENDS: WRAP-UP

So that's a really fast run-through of some of the key technology trends that we've highlighted. There are many more, but that will at least get us sort of a brief overview.

And now I want to get into a little more detail, very briefly, though, in some of the more significant ones.

TECHNOLOGY AND SYSTEMS

So this is technology. I have to admit that I shamelessly stole this from Kurzweil, and since I believe only about 10% of what he writes, it's very interesting for me to be showing this as my first curve, but this one I believe in. This is, of course, looking backwards so you can't argue with it.

TECHNOLOGY AND SYSTEMS: HOW MUCH TECHNOLOGY CAN YOU BUY FOR $1000?

It's how much technology you can buy for $1000, going back to 1900 when compute technology was done by mechanical things.

And as you can see, this is a semi-log plot. Each one is a factor of a 1000, so in the last 100 years, the technology cost performance has gotten better by 15 orders of magnitude.

Not bad, in fact, there is almost nothing that humankind has done in the last decade that's gotten better by 15 orders of magnitude.

And to keep in the Kurzweil context here, it's probably useful to say well, today, you can get about a few billion operations a second out of your PC, a few, two, three, gigahertz, and that's not bad.
But if you compare it to anything in the animal kingdom, like a brain, it's got less than the brainpower of a lizard, so it's not very smart.

But the fact is, if you stay on this curve – and we believe you will continue to see dramatic increases in the overall cost performance – in the next 20 years, you'll have not a billion, but a million-billion operations per second, and that's, more or less, the brainpower, 10 to the 15^{th}, or a pedaflop, of a human being.

So reasonable estimates for your brain are between 10 to the 14^{th} and 10 to the 16^{th} ops per second, just by looking at the number of neurons and how often they can fire and simple arguments like that.

In the next 20 years, we're going to go through the equivalent of 100 million years of human evolution, from dinosaurs to human beings.

While you can forget about any computer passing an unrestricted turing test, for the experts in the audience, the point here is not that computers will emulate human beings in the next 20 years because they won't, and you can forget AI, the movie, but the amount of performance that's going to be available is staggering.

And the changes that we're going through are nowhere near coming to an end. We are really in the middle of a huge revolution and not anywhere near close to any end of it.

SUPERCOMPUTING ROADMAP: THE BLUE GENE SUPERCOMPUTER

This is the supercomputing end of it. And you can see Blue Gene/P, which we will have sometime later this decade, will be the first machine that's somewhere in the vicinity of the human brain in power.

Blue Gene/L, which we're in the process of completing with Lawrence Livermore, is, I shouldn't be bragging about this stuff, but this is a project which we worked on very hard for five years with the outside community, very much a collaborative project.

And the Blue Gene supercomputer is now five of the top ten supercomputers in the world. And the top one, the Blue Gene/L at Livermore, has about 6X more performance than its nearest competitor.

POWER COMPONENTS: ACTIVE VS. PASSIVE POWER

Okay, now, I want to talk about the underlying technology in the industry just for a minute. Stop bragging and talk about what's really going on.

Now, you may hear more about this from Bernie. Are you going to talk about this, Bernie? So I won't spend a lot of time on it, but the simple fact is that the core of semiconductor technology that goes in the information systems was shrunk so much that when you turn the switch off and, after all, all a transistor is is a switch, when you turn the switch off, the current is still flowing everywhere.
So the passive power, which ought to be zero or at least orders of magnitude smaller than the active power, is actually close to the active power.

And that's lead to a huge power problem in the industry. It's now become basically impossible to build systems the way you would like to because they're totally power-constrained, that is, the power has run amuck.

POWER COMPONENTS: APPLE G5 HEAT SINK

This is an example of a heat sink in a PC. The heat sink is about that big. You slap it down on top of a little chip that's only that big. You put some thermal grease on it. You slap this heat sink down on it. You blow a gale of air through it and that's not enough to cool it.

So what they do is they put another one below it, run a copper wire up to another heat sink, and between the two of them, they can just barely cool this thing, and this is a PC. This is a workstation, an Apple workstation.

The whole form factor is dominated by getting the heat out, sort of like where we were in the old mainframe days, when we used to have water running under the raised floor. Well, we were back in those days again because you just can't get the heat out the way you'd like to.

INTEL 32-BIT PROCESSOR TRENDS

And this is what's happened. This happens to be Intel's roadmap and, you know, the whole Intel business model was, every year, you'd get a higher-frequency PC, and if the frequency went up enough, you felt like you needed a new PC so you could rev the desktop. And if you rev the desktop, then they sold their chips, and if they sell their chips, they do fine.

So Intel's business model is all about convincing you that you need a new desktop.

Except what happened was, while they thought they were going to increase the frequency along the blue line, they got to 2003 and they couldn't do it anymore. It was increasing 35, 40, 40% compound growth rate every year and it just stopped. They got to a processor called Prescott.

They couldn't get the heat out. They couldn't get the frequency up and they started on a whole new line.

Now, you can get about a 3.4 or 3.5 GHz Prescott, about, essentially two years later than they thought and the frequency is less than they thought.

THE SYSTEM PERFORMANCE STACK

They eventually stopped building the Prescott follow-on chips completely because the whole process of how you build a supercomputer or a desktop, the whole ways that you use information technology, build information technology machines out of semiconductor technology has changed dramatically.

Now, this is Intel, but it's the whole industry. So this is not just something that Intel is dealing with. The industry has switched from the left to the right. On the left, you can see the way it used to evolve.

Every year, you could buy a system that had 80% cost performance, compound growth rate, year in, year out. And the way the industry did that is that they had uniprocessors, microprocessors, that every year in and year out, were 50% faster than they were the year before.

This is sort of an average for the industry for the last 10 years. Most of the performance gain came from the blue. Now, what's happened is because of the power crisis, all of that blue stuff shrunk. It's down to now 20% or less, so it's not happening from faster and faster microprocessors.

The overall improvement in systems is going to continue to go up, but it's going to go up in fundamentally new ways, much more small cores, much more embedded technology. It's the kind of technology a lot of you guys in this room use, and it's that sort of pervasive, embedded technology that's going to drive this industry, not the large honking microprocessor that gets bigger and bigger every year.

It's going to be using the silicon transistors in fundamentally new ways, and let me tell you, you better bet this is going to change the business model of the participants because instead of competing on the blue, you've got to compete on, for example, on the red, and that's very different.

That leads to very different businesses and you have to ask yourself, if you're a distributor of other people's technologies, like Dell, what does it mean for your business model if you can't just plug in a faster microprocessor every year? It's an interesting transition.

KEY IT TRENDS: WEB SERVICES COMPLETES THE INTERNET PROTOCOL STACK

Okay, now, Navi, how much time do I have? Okay, well, I'll finish before that because we really need questions.

I want to talk about one more key technology trend and then all of the rest will be implications. And this is the technology trend and it's all about an accelerator for the collaborative ecosystems in innovation that we talked about. And it's that sort of techie statement across the top that's going to fundamentally change the world for all of us.

Web services completes the Internet protocol stack. Now, I'm not going to get into that because I don't have the time, but all it means is that where, in the old days, one IBM computer could talk to an IBM computer based on proprietary standards, now any computer can talk to any computer based on open Web services standards.

The protocol stack basically is how one computer talks to another computer. And so XML and SOAP and a whole bunch of Internet standards are essentially allowing information appliances of all sorts to interact with each other over a set of standards. And it's that that's going to change the world.

Now, why is that gorpy thing going to change the world? Well, that gorpy thing is going to change the world if the easiest way to think about it, and maybe it reflects my age, is to go back and think about the old mainframe. The old mainframe, you know, when I first programmed it, I took my cards in a box and went to the computer center and I got a little piece of the mainframe. I got a little memory. I got a little I/O. I put in my jobs. Hopefully, it worked. Sometimes it didn't. And that's the way it worked.

That was fine until they got powerful. Then when they got powerful, if I wasn't using it, because I had it allocated to me, nobody was using it, so IBM invented the virtual machine and you didn't get a piece of I/O or a piece of the machine. You got a virtual piece of the machine and if you weren't using it, someone else could. And the utilization of the mainframe went way up, from some low tens, 15%, up to 65, 75% – 75, 80% is not unusual today for how one of our mainframes are used in a business. They had 75, 80% utilization.

Now, what's happened, because of the completion of the Internet protocol stack, behind the firewalls in companies, you can now share distributed compute assets. You could put them on a grid. You could share them. You can treat them like a virtual machine and you get a huge increase in productivity of your compute assets, from a typical Linux server, which has 25, 35% utilization in a typical company, up to something similar to the old mainframe, so that's nice.

Of course, nice isn't going to change the world. We're talking about a factor of two or three in the utilization and cost performance, and that's all great.

What's going to change the world is when you have this concept of shared compute assets, of shared function, not behind the firewall on the Intranet, but over the Internet. And here's a classic example. It happens to be an IBM one, but many of your companies are doing the same thing.

WEB SERVICES EXAMPLE: IBM USES A 401K SERVICE PROVIDER

Let's talk about our 401K program in IBM. If you are in IBM, you go onto an IBM Web site and, on that Web site, you can adjust your retirement holdings, your stocks and your bonds, and you can adjust it and you can manage your personal portfolio.

That ability is administered by an external provider to IBM. It's outsourced to a company called Hewitt, and Hewitt gets the stocks and bonds services from their suppliers.

So what happens is – and I'll use the term components or, better, I'll use the term services – are provided to Hewitt in a services-oriented architecture and they're provided in a services-oriented architecture to IBM, aggregated and provided to IBM.

In fact, IBM, in our HR services business, will aggregate the services Hewitt provides, along with some of our own and along with some from other companies, and we'll provide a spectrum of HR services to a customer.

So if you ask whose computer is actually doing the job when the IBM employee goes on the Web site, it's clear. It's all of them, they're all providing services to get a job done, and there are all sorts of things that have to happen to get it done and I won't go into the details. But it's this thing that's changing the world, and I want to talk about how it's changing the world by going back to this discussion of the left side, the old world of innovation, and the right side, the new world of innovation, by talking about the evolution of companies and industries. And this is an example of Ford.

WEB SERVICES EXAMPLE: FORD'S DISTRIBUTED ECOSYSTEM

The Ford Company – like every automotive company in its industry – started, more or less, as a vertically-integrated company. In 1920, Ford planted rubber trees in Brazil so they would have the best tires. It's inconceivable today. And over time, Ford evolved, if you will, the industry evolved and the companies in that industry evolved, as it matured, to something over here on the right, which is Ford gets componentry, based on standards from a distributed ecosystem or a set of suppliers, and they integrate that componentry and actually, sometimes, they don't even do the integration. Carmen and others assemble and integrate it.

Even the modeling doesn't always get done by Ford and Ford becomes the distributor. They become the distributor of componentry, and I'll soon make that equivalent to services, but right now, it's hardware componentry that the industry ecosystem provides, and if they're the best distributor, then they'll succeed.

That's what Dell does in the electronics industry. They don't do any R&D. They integrated componentries – hardware componentry – based on a set of standards and based on an engineering discipline that allows you to integrate pieces of hardware – and again, they don't always even do the integration. It could be assembled in China – and they will succeed or not if they're a world-class distributor of other people's technology.

WEB SERVICES AND THE EXTENDED VALUE NET

The point is that, as companies mature, as industries mature, which is one of the points that Irving was making, you move from vertically-integrated when the industry of the technology is young, into participants in an extended value net.

And it's that extended value net where all of the value comes from, and it's the collaborations within that extended value net which determines the success or failure of the membership of the net.

DECONSTRUCTION INTO EXTENDED VALUE NETS

And competition is not, anymore, the competition between individuals – individual companies within the network – but it's the competition between one value net and another value net, with success being the most successful networks.

Now, you can look at every industry and you could say where are they on this cycle from vertically-integrated to extended. And these are crude charts, but they give you a feeling for where banking is, insurance is, financial markets, etc., etc., and you can pick your own personal industry here and see where you are on the evolution chart.

Now, so the point here is that, while I used the hardware component model, this isn't about hardware and components. It's about all of the elements that make up companies, and they can be business processes, core technology that can be integrated from a set of business processes suppliers, and provide value to you as a company. And the value for participating in these networks is substantial.

Slywotsky, who wrote the book on the profit zones, talks about the collaborative, collaborate-to-compete ratio. And the one of the points he makes, which is probably underlying why we have this conference, is that companies start vertically integrated and they try to do everything.

Now, they get into financial problems, and they realize there's some things they can't do, and they better go partner, and they better offload, and they're not the dominant supplier of X, Y, or Z, and they better get it from the dominant supplier rather than try to do that all themselves.

So there are forced financially to go to a higher collaborate-to-compete ratio, and the point he makes is that often companies wait too long. They wait until they're in a financial crisis and then they say oops, I better not do some things. I better find someone else to help me with that piece of my business and that piece of my business, and there's huge value.

This is, if you will, nothing new, but the point I'm making is that it's being accelerated by Internet standards.

GROWTH IN COMPUTING IS EVIDENCE THAT BUSINESSARE ARE COMPONENTIZING

This whole flattening of the Earth, the ability to do this in collaboration worldwide, to integrate business process and componentry, software pieces from ecosystems, are changing the nature of industry. Again, it happened for Ford and happened to manufacturing industries a long time ago, but it's being accelerated at an incredible rate by the underlying Internet standards, and it's changing, for example, the whole services industry, from massive large-scale outsourcing to outsourcing individual processes or process elements, and there's a huge ecosystem.

THE EMERGING BUSINESS SERVICES ECOSYSTEM

These are the ecosystem of application services providers or, if you will, business processes providers. Remember, those were the guys in the beginning of the dot com bubble everybody invested in.

And then everybody lost their money because the application services providers never really materialized, so you were going to be able to get this piece of your business and that piece of your business, and you were going to be able to integrate it and get it from the ecosystem.

Well, it didn't materialize because, if you've got payroll services over here and ERP services over there, guess what? They didn't integrate. You couldn't use them. But along comes Internet standards and component approaches or component business models, and all of a sudden, these componentries can integrate.

And it's important to understand how much value you get by participating in these networks.

THE EMERGING BUSINESS SERVICES ECOSYSTEM: THE LINUX EXAMPLE

So the Linux example, which we talked about just briefly, is one of my favorites.

To have a world-class operating system – and we know about how much it costs – it costs about a half a billion dollars a year, year in, year out. The ecosystem on Linux is spending about a billion dollars a year. IBM is spending about $100 million a year, $50 million to customize it for our own particular customer needs.

So for $100 million, we get the equivalent of a half a billion-dollar operating system or more. We only spend a small fraction of it and we can take that extra $400 million that we're not spending on the operating system and spend it higher up the value stack where there's more value to be had, and we can build that on top of the Linux world.

So there's huge value and these ecosystems have with them scale economics that you can't get by just going alone, and because you've got a set of customers and suppliers working together, that you get the synergistic effect of working together within that ecosystem.

THE EMERGING BUSINESS SERVICES ECOSYSTEM: WEBSPHERE COMMERCE SUITE

A good example, now, it's not so good for IBM, but I'll tell it to you anyway, and I'll end my talk on this one. A good example is, you know, if you want to be an Internet retailer, you want to go on the Internet and become a retailer.

We've got some great stuff for you in the IBM Company. It's called WebSphere Commerce Suite and it is the best software you can get to go build on top of the Internet and do all of the stuff it takes to become a retailer. It does all of the back ends. It does all of that neat stuff.

Now, who do you think, and it's enterprise, it's coming. It's got all of the IBM Corporation behind it and it's made like the IBM Corporation would make software. Now, who do think are our biggest competitors for WebSphere Commerce Suite?

I've given this question to maybe 20, 25 different audiences and there was only person once who had the right answer who hadn't heard it before, and it wasn't at IBM and had suffered through it.

BIGGEST COMPETITOR FOR WEBSPHERE COMMERCE SUITE IS AMAZON

The biggest competitor for WebSphere Commerce Suite is Amazon. It's not BEA. It's not Microsoft. It's not Oracle. It's not anyone you would think of as the standard competitor. It's Amazon.

Now, why is Amazon a competitor to IBM, who makes this real hardcore stuff? Well, Amazon is a competitor because they say hey; you don't have to do that? We'll provide all that back end as a service. They'll go on your Web site. When they click "Buy", it will come to us and you pay us based on how much you used that service.

Now, why is this such a big deal? In one case, you install the software, the other case you get the software as a service. It's a big deal because of the ecosystem. There are 50,000 developers developing to the Amazon platform, 50,000! Amazon isn't paying for them. They've got the dominant ecosystem, selling to small and medium businesses. It hasn't gotten to the enterprise yet. Maybe it will or maybe it won't, but you can see this disruptive kind of technology coming up from below.

And what's happened here is that you've got all of these associates, little software companies, that are building applications to do things like comparison shopping, and those guys, they've got to build something. They're going to build it to the dominant platform, to the dominant ecosystem.

And so there's tremendous, tremendous value participating in these ecosystems. They can change the nature of competition. I mean, just think, Microsoft has to spend $500 million a year on Windows, minimum, and we get to spend a hundred.

Now, they've got enough money. They're not going away tomorrow, but they're in a business model where they have to spend 5X or more what their competitors are on the same thing, and as Irving succinctly put it, it's a long story, but you know what the end is because if you've got a business model that's that much out of sync with reality or with your competition, you don't last that way very long.

DR. PAUL HORN & NAVI RADJOU: THE GLOBAL TECHONOLOGY OUTLOOK – Q&A

Dr. Horn: I can't comment specifically about Ford (referring to the Ford business model). There are various ways to operate within ecosystems, and it doesn't necessarily mean that you

outsource the whole thing. It means that you've got to find out where the scales are and where the best places to collaborate are, and it doesn't mean that you offload or outsource everything.

So I don't know the specifics of what Ford is thinking today, although we talk with them a lot. They're a big customer of ours and, I'll tell you, they understand this and they aren't going backwards, so I don't know the specifics of what they're insourcing vs. outsourcing.

Q: When you look at, say, the $100 million that you're spending on developing operation systems, and so on, what percentage of it are you spending on doing something that's of real value and what percentage of it are you spending just managing the churn in the environment because it's an uncontrolled environment?

Dr. Horn: There's no hard split. We sort of estimate, for Linux specifically, that about $50 million of it is a unique function that we think is important for our customers. So it may well be that a good piece of the other fifty is spent on making sure that we're operating within the ecosystem.

Certainly, as a major player in that ecosystem, you have to spend money. You have to build the right kinds of partnerships, you have to attend key meetings, and you have to help steer the ecosystem in useful ways. There are a lot of things that you need to do to participate in these ecosystems, but it's a lot less than doing it on your own.

Navi Radjou: There's a cost of coordination involved in managing the ecosystem. I have a question, actually, for Ford, because I read this quote from Sam Palmisano, your CEO, saying that just increasing R&D doesn't automatically translate into more innovation.

Dr. Horn: I know. That really got to me when he said that.

Navi Radjou: I was thinking of you. And then he also said something interesting. Sam, as is often quoted, said that invention, which typically is measured by patents, is not the same as innovation. You always try to differentiate invention and innovation. So in the context of innovation networks or collaborative innovation, what are the kinds of ways to measure success?

Dr. Horn: There's a little talk about this in the discussion with Irving. First of all, you have to ultimately be successful and your parent has to be successful, both short term and long term, and it's important that you don't measure it with a single metric or a single set of metrics.

So what we do in the IBM Company, which is not unusual, and I think it's important to think this way, is to look at traditional businesses and measure them with the standard traditional business metrics. And that means cash flow, profit, revenue, and maybe revenue growth. And then have an understanding of where the emerging businesses are and then measure them differently.

And to a very large degree, being innovative means having a set of new businesses or new partnerships, that are growing rapidly or more rapidly than the marketplace and you measure them with things like revenue growth as opposed to profit. You measure them with participation in the broader markets, market share, not with the traditional business metrics.

So for us, a key thing that we are sort of proud of is that we have a set of emerging businesses which we incubate and they have to grow the overall revenue of the IBM Company at the top line, and that has to be substantial. And that's probably better than anything else that you can do for measuring innovation.

There are a lot of subsidiary measurements you can use, like how many new products you have and what intellectual property content is in the evolution of your existing products. You could do all of that, but in the end, it's the top-line growth of the company that counts.

Navi Radjou: These new businesses you are talking about typically tend to be also relatively collaborative in nature, such as in the case with Linux, for example.

Dr. Horn: Some yes and some no. The interesting thing is that some of the new businesses are early in the evolution cycle, and if they're early in the evolution cycle, you may control the pieces of intellectual property, which you may have gotten from the ecosystem, or they may have come from the fact that I didn't have to spend $500 million on the operating system, I could work on this new stuff, and allowed you to go build now whole new businesses.

So the businesses could be collaborative and come out as a joint thing from the ecosystem or they could be things that the ecosystem enabled you to go look at because they've freed you up from other stuff.

Navi Radjou: They provide the invention but then you take the lead in the transformation, bringing it to market. Unfortunately, we are running a little bit late so I might be able to entertain one more question from the audience and then that's it. There's on in the back.

Q: You started to talk about how your research has changed over time, from basic research to more first-of-a-kind service solutions to customers. That also sounds to me like you have changed your workforce from physicists to software engineers with business development skills. Can you elaborate on how you've handled that and, also, are you still keeping basic research functions or are you only doing these service solutions?

Dr. Horn: We still have a very significant basic research organization, pieces of our organization. We estimated it's about 15% of the overall research division. I don't like to use the word basic, but it's exploratory in areas that we think are going to be important for our business, but could be very long range and very far out.

Our mix has changed. In the early 1990s, we were 85% systems and hardware-related. Now, the overall mix in IBM Research is about 50/50, about 50% software and services and about 50% related to our hardware businesses.

There are cultural changes. There are cultural changes that you have to manage and it's non-trivial. It was non-trivial for us to go through that evolution and we're continuing to grow – now our services-related research – more rapidly than anything we're doing in hardware.

And if you talk about these collaborative ecosystems, I think it's important to understand that what they're all about is getting pieces of a company – business processes – and integrating them. And as I mentioned briefly in my talk, there's no engineering discipline for bringing together business processes and integrating them into a larger business process.

So the equivalent of building a bridge with a set of hardware components, and you know you can model it and that the bridge isn't going to collapse, doesn't exist in this space. And there's very long-range, short-term and long-range research in that space for how you can help companies.

And it involves not just the more traditional forms of IT technology – integrating components and versioning and how you get them to find the things you need with natural language and semantic understanding – it also has a social component, social networks and how you can optimize putting together the pieces of a distributed value network that's going to optimize the functioning of that distributed organization.

And that's very different from the traditional kinds of research we've been doing, but it also can be very long-range. And it's also is a topic that's of great interest to the university community, so it doesn't have to be short-range because it's in software and services. It still can be exploratory.

Navi Radjou: Thanks, Paul. Dr. Paul Horn.

Dr. Horn: Thank you.

Navi Radjou: Thank you very much.

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