STEVE MILES: So we will move right into the first of the technology sessions now, which is focused on the network, the Internet of Things. And our first speaker is Steve Bratt, who is the CEO of the WC3, which is also based here at MIT.

STEVEN BRATT: Thanks very much, Steve. It's going to be difficult to follow that wonderful talk by Sanjay. And I only have about 10 minutes to tell you about a lot of cool things that are going on at W3C right now. And so I'm going to be doing it a very light touch, just hopefully going to tweak your interest enough to come and ask more questions, come and talk to the W3C about some of the work we're doing.

And the title of the talk is RFID, Things on the Web of Data and Services. And as a slight contrast to an idea of an Internet of Things, it's things on the internet. And that's the way I like to get people to think about the use of Web technologies as you go ahead and address the very complex research problems that Sanjay laid out before you.

Oh, and by the way, the talk is also linked. It's on the Web. No surprise. And it's linked from our homepage.

If you don't remember the URI here, go to our home page. There's a public presentations link right from the home page. And you'll find my talk hopefully pretty easily.

So one slide about the W3C itself. How many people here have never heard of the World Wide Web Consortium? Don't be embarrassed if you haven't. So anyway, World Wide Web Consortium was founded by Tim Berners-Lee just 11 years ago now in December in 1994, started here at MIT.

We now have 18 offices around the world. We have about 400 members, corporate, university, organizational. We have also a vision to-- a mission to provide a vision for the development of Web technologies into the future.

And also, we engineer the standards that make the Web work. And I'll tell you more about a couple of those later. But the Web really has changed a lot from the time Tim first invented this thing. And it's really become a really integral part of our fundamental infrastructure.

I thought one of the good questions that was brought up this morning, I think by John, was you need to engineer an infrastructure that's going to last not for a year or two years, but maybe for 100 years. And an interesting question to ask is, is the Web like that? Is the Web the next telephone?

Is the Web technology so pervasive now and so good that it's going to be with us for a long time? And that's going to be an integral question to ask yourselves and whether you want to gamble on using Web technologies as a foundation for your data infrastructure or not. So we'll talk mainly about the Web as it's moving from a Web of documents to a Web of data and services. I'll focus on that.

But there's also a number of other things we're working on at W3C, of moving Web technologies to everything, including phones, and cars, and planes, and other kinds of places, and a Web for everyone. As we expand to a developing world, we're going to be taking a greater and greater advantage of the benefits that the Web has brought the Western world up till now. So one thing I think is clear, to me anyhow, is that the Web really increased the usefulness of the internet for everyone.

The internet had been around for a long time. People used it, academics largely and government and so on. Web technologies, through some very simple concepts that Tim instituted and pulled from many parts of the computer science world, HTTP as a protocol, but more importantly the use of uniform resource identifiers, or URIs, or IRIs, whatever you want to call them, URLs as unique identifiers and as unique identifiers of where something is and a unique identifier to distinguish that item from other things. Very simple concept that's critical for the Web and really critical for you guys, of course.

And then also HTML is a simple way to link things, to link documents to other documents or parts of documents to other documents. That's it, really simple. And just with those simple concepts, we really-- and standardizing these in the global way really revolutionize the way that we can identify and find retrieved documents of all kinds and sorts and around the world.

So if the aim is to put RFID things on the internet, at least I hope the group-- and there are a lot of research problems in this in itself-- will carefully look at the existing and emerging Web technologies before going off and inventing something new. I think that's a logical thing you should do. And I hope that what I tell you today will motivate you more to do that.

So the new work that's going on at W3C in the area of Web services and in the area of the Semantic Web really are going to expand the Web to include more machine understandable resources of a variety of kinds. That's really important. And one thing that it's going to do is it's going to enable you to have greater interoperability amongst the things that you know you want to link together. So it makes sense for you to go off and develop schemas and other kinds of things that make sense in your community. And that'll probably work for the group of people you've brought together at that particular time and in that particular place.

But if the goal is to perhaps be able to enable linking to things you haven't foreseen-- and that's really what made the Web powerful, isn't it? People didn't really appreciate all the things you would be doing with the Web today when Tim first invented it 15 years ago. But I think one of the keys is providing-- using these globally interoperable standards will help you to link between resources you have not yet decided you're going to want to link.

So two areas of emerging standards-- and I'm only going to have time to talk about one today. One is the Semantic Web. And a very simple elevator or bumper sticker is that that's really a Web of data. So it's really providing interoperability at a data level and allow you to better understand, search for, share, reuse, aggregate data on the Web.

And then there's Web services, which probably more of you are familiar with. So I'm not going to spend any time on that. But I've got a lot of extra slides at the end of this presentation really to enable a Web of interoperable programs. So it's basically providing some kind of-- if you want to think about it in a simplistic way, it's APIs to build the access, expose applications that you have, and be able to provide access to those. We won't talk about that much more today.

So in terms of the Semantic Web, there's also-- like everybody's got a stack. And the Semantic Web really starts about where this RDF core red brick is there in the stack. But it's based firmly on the use of URIs.

And that's really important because URIs become the fundamental way to identify a unique identifier for anything in the Semantic Web world, just like for you guys RFID tags or RFID numbers are critical. There's no reason an RFID number can't be made into it a URI. It's really simple.

And then also, there's other kinds of standards that are in the stack which enable you to express relationships between data. And we'll talk about that one later. That's RDF.

Also, a number of other standards here, too. Another key will be OWL. You'll see the OWL thing there. It's a Web Ontology Language to be able to set up a description of some domain of knowledge, maybe a domain related specifically to RFID or specifically to consumer goods or whatever it is, and then also other kinds of standards that are being developed now.

Now, those other ones I've mentioned already are already standards. But there's new ones being developed to be able to do queries, put rules on the Web, logic and trust, security things, and other kinds of activities. And I only have two minutes left.

OK, so RDF, the Resource Description Framework, simplify all the words on this page. Whereas HTML provided an ability to link documents to documents, RDF provides an ability to link data to data. And the links are not just saying, this links, but an explanation of how that one thing relates to another thing. So subject, property, value.

So for instance, I could say that my talk, the subject might be talk has presenter Steve Bratt. And every one of those items itself has a URI. So the talk has a URI, the concept of has a presenter has a URI, and I have a URI. So all those things are not only linked together, but they're on the Web and accessible, as highly accessible as you'd like them to be.

So the simple picture is that this is the current Web. It's all gray and boring, but basically extremely powerful. Being able to link one resource to another, we found how powerful it is.

The Web of the future, we can not only link concepts together but also say how they are linked. So Jane Doe is attending a meeting. It's not just Jane Doe's linked to this meeting. There's a simple relationship.

The linkage is that she is attending it. And perhaps the meeting says she's also the chair. And there's also information about her personal data, information about the location of the meeting and so on. All that information is contained using standards to syntax.

And also, ontology is developed by domain experts. So in this case, it may be an international organization of meetings that sets up an ontology for what meetings are all about. In your field, you can imagine, getting together the diverse kinds of people you want to be able to use RFID, you're never going to get them all to agree on a single ontology for describing everything that's related to RFID. So another idea is to do a more ground up, a bottom up approach to this. We allow communities of people who already have places they meet, more generally likely to agree on things, to come to agreement on their ontologies, and then expose those in RDF, and be able to more easily link them than you can do now.

So I'll show two more pictures, and then I'll have to skip the last couple. The simple enterprise integration facts today is that between things like stock control, and parts, and issue tracking, and human resource management, these organizations, these concepts, and these domains all need to talk to each other. And you still have a lot of big business out there and trying to be able to integrate these very diverse kinds of communities together within even a single enterprise, not to mention across enterprises. And the idea behind using the Semantic Web is you create a bus basically, a bus that would allow you to use, based on the standards in that arrow there, RDF, Resource Description Framework, OWL, HTTP, and other kinds of standards, to be able to access a set of all information and data that are exposed using a common syntax, and then operate on those things with things like the rule standards that are being developed, the query standards that are being developed and so on.

So last slide, there's a number of links on here to some research efforts that are going on now in the Semantic Web. Many of them do apply to some of the domains represented by people in this room. And I encourage you to look through some of these links.

Come talk to me. Come talk to us at the W3C. And we'd be happy to help you get connected with other people who may be able to help you in the research that you're doing. Thank you very much.

[APPLAUSE]

STEVE MILES: So Bernie Hogan is the CTO of EPCglobal.

BERNIE HOGAN: OK, Steve?

GUEST SPEAKER: Presenting.

BERNIE HOGAN: Good morning. I, too, would also like to thank John and Stephen for today, inviting us here today. Chris Adcock, President of EPCglobal, wanted to be here today. But due to scheduling conflicts, he was unable to attend.

But I'd just like to give a little bit different definition of the EPCglobal network. I was here to talk about it. And really, this is what I've learned over four years, what EPCglobal is about. Thank you.

And my view of the world is that EPCglobal is about a network or a community of trading partners that want to share EPC read events in a standardized way to improve their business processes. The technology is important, but it's an enabler. And if I've learned anything over four years-- I was looking back over it in order to prepare this presentation, over the past four years, and I went back into the archives. And those of you that are familiar with Tom Sawyer and Huckleberry Finn, OK, well, Sanjay was Tom Sawyer, and I was Huckleberry Finn.

And I would come up on a regular basis in 2002. And we would sit in Starbucks Coffee shops and drink lots of lattes. And we would draw on napkins. And he was convincing me how much fun he was having painting the fence.

And so I bit into it. And I felt like at right about this time here, that I grabbed hold of a bullet train, because there was such tremendous momentum coming out of the AUTO-ID Center. And we had no idea what was in store for us. Coming from the GS1, and EAN, and UCC, we wanted to look at the next generation of identification. But we just didn't know it was going to be at this scale.

So these are some slides that I pulled that were presented to the AUTO-ID Center Board of Governors. And this was the transition plan from the AUTO-ID Center. There was an entity called AUTO-ID, Inc. at one point in time. Everyone kind of seems to have forgotten today.

And we're going to migrate to this thing called EPCglobal with linkage to AUTO-ID Labs. This was the plan. We didn't deviate too far from the plan.

Phase one, Sanjay's message to me was, we've taken this phase of the research just about as far as we possibly can. We need to get this into the real world. We need to get standards.

We need to get companies utilizing this technology to see what works, what does not work, and where to take the next iteration of research. And only through real implementation, we'll be able to identify and correct the system's issues. So this was the plan.

Now, you have to remember back then, UCC and EAN, we were two separate organizations, not tightly linked. And there was a long history of constant, for lack of a better word, battles between the two organizations, and philosophical issues on how things should be done. So UCC and EAN, the agreement was that UCC would lead the charge and negotiate with MIT on behalf of this thing. But MIT was insistent that this be truly global, not just a US initiative, but also multi-sectoral. They did not want this to go into-- just be buried into retail, be the next generation of the UPC.

So these were some very high challenges for us to reach. And so we worked out the roles and responsibility. I don't know if you remember these slides, Sanjay. But we worked out the roles and responsibilities, who does what.

Well, MIT wanted to continue doing research, development of new technology, publications, and also outreach for government funding and working together on a collaborative way. UCC and EAN, we were going to do what we did best, our core competencies, administration of the systems, commercialization-- key point, OK, we were going to bring us to the commercial world-- manage intellectual property if it is manageable, marketing communications, standards development, and training and education. So this is what we laid out.

And this, I lifted it actually from the contract last night. These were the numbers and the milestones that we were expected to hit, EAN and UCC. And I had a very sinking feeling in my stomach at that point in time because I had to convince my boss at the time that we needed to do this. This was the right thing.

And we were signing on behalf of the US and UCC. And we were supposed to get 20 trading partners up utilizing EPC in 2004. And we were also supposed to make this global and a multi-sectoral approach.

So these were the numbers. And I was probably never more scared in my life when I convinced my boss to sign these numbers. And they looked quite staggering.

So what have we accomplished to date? Well, EAN and UCC is now under one organization. We're now GS1. We work very hard.

We have a common leadership, common approach. It's now GS1. So I'm a member. I work for GS1 US. There's some other people in the room here from GS1 other countries around the world.

And we've also aligned our portfolio of standards and service offerings. We have four primary service offerings today, the bar codes, electronic commerce-- it's EDI and XML-- global data synchronization. And here I am to talk to you about EPCglobal today.

So the mission, to be true to what MIT wanted us to do, is just to take a global leadership role in development and promoting multi-industry, user-driven-- key point, user-driven, because if this is not relevant to the user, it will not have impact. If you've been involved in standards processes before, if you don't get the support of the industry, you will not get the implementation. So we keep on holding back to what the users want, and then we develop the standard. Building standards for the sake of building standards' sake is not interesting.

We wanted to deliver added value to our customers and stakeholders through our activities and drive it through the GS1 member organizations. There are 102 GS1 member organizations around the world today. We want to be the trusted authority on technical standards. We're not a technical development organization. Technology is an enabler, but we want to provide the forum where the technologists can sit at the table and work on standards through our processes, and to effectively manage public policy.

Public policy, what we learn from AUTO-ID Center, is probably as important as anything we do, because if this is not accepted by the consumer, it's not accepted by the legislators, this will not fly. It will not move forward. And we have a lot of activities in that area of public policy.

So where do we stand? You remember the other numbers I put before? It shows the amount of growth around the world and the breakdown by region.

Well, we far exceeded our expectations. And now we have a different challenge. It's community management. How do we manage these communities? But globally, as of January, we have 733 trading partners around the world.

The most unbelievable amount of growth is coming from the Asia region. There's government-funded projects in the Asia region in Hong Kong, Singapore, Japan, and Korea. They're coming on very strong. And people-- not only do they want to build this technology, but they also want to improve their business processing leveraging this technology. So it's quite rewarding to where we are.

You can see in two years where we've come in a very short period of time. And you can see the percentages and the breakdowns by region and the amount of growth around the world. This is very encouraging. And it's a lot of hard work.

But we want to get back to our mission. Initially, what was in the AUTO-ID Center, there was a majority of-- well, a large portion of the companies that were involved in the AUTO-ID Center were solution providers. They were looking for the new, new thing. They were looking for the next opportunity. They wanted to build the marketplace, which is very important and continues to be important.

But if we're going to be relevant to the marketplace, we need the involvement of the end users. And so you can see, as of the latter part of last year, we have 53% of our total membership is end users. A great industry support, some of the companies in the room, Walmart, Target, Albertsons, Department of Defense, Metro, Tesco, so on and so forth. And we're also getting support outside of the traditional retail sectors. So this is coming to true.

Getting back to the multi-sectoral approach, this is a breakdown. This is a US perspective, but it shows across the industry sectors. Not only is it just consumer goods, food and beverage, health care life sciences. There's a great balance across these communities.

And what they're now finding, these communities, they all start as separate groups where they all want to talk about their problems. But they start to cross-pollinate with one another. And they say some of their problems are the same. And there's good interaction.

We have a structure in place and a governance structure. But it really starts with a business problem. The Business Steering Committees, we organize the communities around Business Action Groups. We have a Consumer Packaged Good, Health Care Life Sciences, and we recently launched a Transportation and Logistics.

There's regional adoption programs in Europe and Asia. And now we have some discussion groups in aerospace, food and beverage, automotive, and apparel. So eventually, these will become Business Action Groups as we move forward. So the structure is in place. We have a continuous improvement process to organize things. It's great challenge, but it's a great thing to be involved.

Here's the standards process, where we are to date with the standards and what have been delivered as far as the specifications, what have been ratified by the boards. We have ONS, ALE, or Filtering and Collection, Tag Data Standards. We have several generations of that specification and, of course, Gen2. But the most important part of and the real value of a standard is what occurs in the certification process.

Last September, we announced the certification of Gen2 interoperable products, which tags work with which readers. Or better yet, which ones conform to the specifications. Now as a result of that, you're seeing prices starting to drop significantly, and we're moving forward. So we're building a marketplace for the solution providers. And we're building opportunity for trading partners that give them freedom of choice on which solutions they wish to procure.

We have a governance structure that is balanced and across the sectors. Not only do we have retail. We have transportation and logistics, health care, technology, public sectors. We have regional balance globally from Latin America, Europe, and the Far East. Sanjay serves on the Board of Governors providing linkage back to labs. And we have a couple other sectors that have come on board-- consumer electronics, as well as aerospace. And the Board will expand depending on industry activity.

I want to commend Elgar, and John, and Nick Ferguson up top for the work that they've done in the last years. I mean, if there's any area that we could have improved over the past two years, it was the linkage to the labs. I mean, EPCglobal had challenges, startup issues. The labs they had were-- there was a change in role and how things work.

I think we're on a great course now with the new structure. I commend the work that's been done to date in that arena. We've created better linkage between the labs and the research.

These are some leadership roles that Sanjay serves on the Board of Governors and the Architecture Review Committee. John Williams also serves on the member of the ARC. Elgar serves on the Business Steering Committee.

Also, some of the other research members, Peter and Dan, Peter Cole and Dan Engels, the active members of The Hague. And other members of the research community are participating in this thing, but we need to align this better going forward. It's a great opportunity. And as this academic alliance comes together, we need to extend the outreach.

Looking into the future, well, my list isn't too far from Sanjay's. And we both did this independently. So business justification, return on investment.

There's a lot of trading partners that are still struggling with trying to find the value and return on investment. There are trading partners that get it, and there are trading partners that are still struggling. Huge research opportunity to help them find the way. Business use cases, they need to have clarity to do that.

Information sharing, I think, is one of our biggest challenges, information sharing because there's proprietary solutions. Many of the retailers today have their own proprietary portals. And getting them to embrace an open standard will be a challenge. You have legacy constraints. People have large investments in EDI and other systems.

Lack of trust, getting trading partners to trust. I don't know if this is a research topic. I don't know how to get past the trust issue, but it is probably our biggest challenge right now.

Inertia is another challenge. "We've always done it this way," is what we hear, and getting people past that model. There's also existing revenue models in place in health care, life sciences, and fast-moving consumer goods. People sell information to one another. Well, if you create an open standard to share information over the internet, what happens to the revenue?

We have to deal with it. Nobody wants to talk about that, but it's a reality what we have today. It's somewhat the elephant in the room.

What we need is unbiased research on alternative technologies. I've been approached no less than three times from alternative technology companies and saying, I have the technology that will go past Gen2. But we cannot have a single vendor solution. We need unbiased research to go look at these technologies and come back and help show a way.

Security, you could have put a whole slide on security, encryption, authentication, password management. The list goes on around security. It's such a broad topic. Sensors, active tags.

Intellectual property, how do you deal with it? We're dealing quite a bit with defensive patents today or, use my words, nuisance patents. But we need to work through that.

We're not about companies that truly have an invention that they want to protect. But a lot of the intellectual property issues we deal with are just, in my opinion, frivolous and as well as public policies. And these are all opportunities for research to move forward.

In summary and conclusion, the community, we've moved from hope, to hype, to implementation. There are deployments there. You can read the reports on what's happening.

The community grows stronger every day. It's getting more complex. When you look at the numbers, it's only-- we have over 700. It's quite staggering. How do you organize 1,500 people around the world to develop standards?

These are challenges, but I think we're up to the task. Physics and standards challenges are being overcome. Prices are coming down. The benefits of visibility are starting to be realized.

We need to get more public facts about these business benefits. But the community has moved decisively forward from preparation to implementation. So the companies that are involved, they see the opportunity. And they're off to the race for business benefits. We need to get the research community involved to bring in more people, get this technology to everyone on a global basis. Thank you very much.

[APPLAUSE]

STEVE MILES: And then John Williams, the Director of the AUTO-ID Labs here.

JOHN WILLIAMS: Great. Thanks so much, Steve. This is a little like being in a car race here. I feel I've got about 3 minutes to present 85 slides. No, let me start zipping through these.

Sanjay got me interested in RFID about a year ago. My background is not in RFID. Before this, I built information systems.

So I'm coming to things from the point of view of, how do you build systems that are globally sustainable? And I think there's some very interesting things happening at the moment in the world, certainly in the world of software, that things are changing yet again. We had the internet revolution. Recently, Bill Gates and one of his VPs, Ray Ozzie, sent out a memo-- it was October 30, 2005-- sent out a memo saying, guys, the world has changed again. We've got the internet happening yet again.

They were blindsided. Microsoft were blindsided in the '90s by the internet. Now something else is happening. And it's this world of services. They're very afraid that Google has a totally different business model to providing services.

And I just want to say how Google's model actually impacts RFID, because I think it's interesting when you think about what happens when you know where everything is. And I think that's what's happening with RFID. We have the ability to know where a good portion of the physical things in the world are.

And what happens to business models then? And Sanjay was intimating that, yeah, it's going to change the way we do business. And I'd just like to add to that thought because I think it really is going to happen. It is happening.

My background is software. I'd like to say something about software trends. Security is a major problem.

There was a recent report. It's the fastest-growing area, business area, is fraud. If you want to get into a good area, fraud is a great area at the moment. It's growing at about 1,000% a year.

I was talking to Hao Min. And he was saying that The Hague was recently hacked like yesterday, that adverts were being sent out over the email list. This is a serious trend. The internet was not designed with security in mind. We can see that we're probably going to have to be secure, that we can't allow people to see the drugs in our pocket or that you're walking out of a store with OxyContin or whatever it is.

The other thing I'd like to note is that change, we have to build for change. One thing we've learned about software is we can't expect people to follow a standard rigidly. You can't force people into adopting a standard that's going to stay static. We're going to have standards that are changing. And that's going to be a problem. We have to design for that.

So we've got a system that's global. This was some work we did on incorporating Google Maps so that we could zoom in. We could type in EPC code in and zoom in down through the layers of aerial photographs into a store, onto the shop shelf in the shop. That's possible now. We can integrate information systems that it's distributed across the globe.

Now, I think the interesting thing is that that allows different business models. As I said, Google is a phenomena that we're only just beginning to understand. I don't know if you've heard about AdWords, but it's a $6 billion industry at $0.50 a shot. So what they're doing-- this is one of Google's products-- that what they're trying to do is make anyone can buy and sell anything.

They're matching up search queries with hundreds of thousands of marketers, these people on eBay selling things that they'll match them up. And they do it in a fraction of a second. And they do it with a very different software architecture. They don't use databases. They have everything in memory.

Everything is cached. They have something like 500,000 machines at the moment. Nobody knows exactly how many. But they're not using relational databases. They have a very different approach.

I don't know if you've typed something in and made a mistake in Google. And they suggest what the correction should be. And they don't do it based on dictionaries.

What they do, they do it just based on the fact that somebody else has made that mistake before. They've recorded it, and they've recorded it what you're likely to type in next. So they have a very different kind of set of algorithms to normal.

And Eric Schmidt, who is the CEO of Google, wants to match every single item in the world to a buyer. This sounds very much like RFID to me, that you need to know where are those items, who do they belong to, et cetera. So I think there's going to be a lot of research in integrating services.

The EPC codes are going to be a critical part of that, but then we're going to add other data in. And we're already beginning to see some of the issues that that causes with data coming up through-- we've got through EPCglobal. We've got standards up to about this EPCIS level. So this is dealing with EPC reads.

Now, above that, we've got things like search and discovery, discovery services. We're unsure what those are, and we need to define them. So this whole layer above ONS, above EPCIS, we really need to think seriously about That will involve feeding in other data, matching it with these EPC reads.

So at the moment, we're thinking about, OK, this will be data from the ERP systems. But it may be data from Google Maps, other databases, from government databases for example. So we're trying to build a simulator in the AUTO-ID Labs to understand what this global network is going to be like. We feel that we need to simulate it to get some idea of where the bottlenecks are going to be, what the research that's going to be needed.

We don't know where this data is going to reside. The EPC reads, are they going to be pushed way up beyond EPCIS? Are they going to reside below the EPCIS layer? It's unclear how much data is going to be flowing or where it's going to be. So at the moment, we're defining this architecture.

A lot of the standards for the middleware-- and when I talk about middleware, I'm talking about middleware, the TCP/IP and above level, not the middleware between the reader and the tag. And I think we're already beginning to see there's some confusion about the use of words, of semantics, things like discovery. For us in the Web service world, discovery mechanisms means something different to discovery, I think, in the EPC context. So we're going to need to sort out some of these dictionaries.

So some of the issues that I think are important, one of the most important is security, for sure, that we've got to figure out how to secure these systems. And it's not so much a-- it's a technical problem, but it's at all layers. You can't just secure the tag to the reader, that at some level, security is about risk management, that you can provide a very, very secure system, but it means that you're not connected to the outside world. This is what the National Labs do. They just disconnect themselves from the internet.

If you're connected to the internet, you're going to have to do some kind of risk management. And that means that you have to know who's taking what responsibility. And we don't have that defined at the moment. Brian has been doing a lot of research in how the legal issues are going to be resolved with RFID, of ownership and how that's transferred.

So the security issue, I feel, needs to be addressed. It's a systems problem and that we have to view it that way. We're going to need to understand the business drivers, the software, and the hardware.

Scalability and robustness, as I say, Google are building global systems. And to do that, you have to look at how you scale. You have to scale.

There's this order n. As n increases, you better not be n squared or analog n. It's not going to work.

Caching is going to be a real issue, that we were talking to people in warehouse management. And they were saying that they need response times of way under a second. So that means you can't go out to the internet to get something.

They're down to like one hundredth of a second, that they've got conveyor belts running. They need to know what this item is, how big is it, what's it made of, et cetera. And you need that immediately. So you're going to have to cache things.

Caching, I don't know if you ever tried to do kind of delete what's cached in your computer or in your browser. It's difficult. Shooting down caches is difficult.

You've got multiple levels of caching. And it's not easy to keep that consistent. And so the kinds of systems that we're going to be looking at, I think, are not going to be the traditional database systems. We're going to have to be thinking of these new kinds of architectures.

And lastly, I'd just like to mention Steve's issue, not Steve's issue, but semantics and the idea of Semantic Web. It's a real problem understanding schema, that it sounds like an easy issue, but I give you a schema. EPCglobal, say, publishes a schema.

Now, what happens is I get that schema. I say, yeah, I understand it. I understand what shipping date is. I'm going to start programming things.

And then it turns out that different companies have a different understanding of what shipping date means. Maybe it means when it's actually out of the dock door. Maybe it's not. Maybe it's just ready to be shipped.

So these are real issues as to, how do you understand the semantics of the information that we're passing around? I think I'll finish there. That's a good place to finish.

[APPLAUSE]

STEVE MILES: So maybe five minutes of questions for the panel. This is a quite unusual opportunity to have this range of experience. Any questions for our panelists on the network and EPC network? Oh, actually, if you would come down the microphone, please, to ask any questions. [INAUDIBLE]

AUDIENCE: I have a question. Actually, with this audience it's, I think, a very apt question. And I don't think I'd get this answer from anyone else. So how do we solve the schema problem? I mean, I think the Semantic Web actually I think is just very exciting on that front. But do you think eventually it's going to go away? Now, is it going to converge? Is that going to basically reduce the scale of the problem?

JOHN WILLIAMS: Steve.

STEVEN BRATT: This microphone work? Yeah, it does. Well, that's a good question because XML schema is really embedded in a lot of the business world already and has been relatively successful. But most of the companies find it very difficult to deal with, for the very reasons that John mentioned is that the understanding what the elements mean in a schema are not easily transparent. And so the Semantic Web is trying to address that problem by making sure that there's a much richer definition of everything also on the Web.

So everything that's on the Web, there's also definitions of what it means. What units do you use? How do you define exactly what you mean by ship date? Those are hard problems, too.

But the idea behind the Semantic Web is that you give people better tools for more richly expressing the meaning of everything that they want to put on the Web. So whether that will solve the problem, I don't know. It's a lot of complicated problems including research problems involved. But that's what the aim of the Semantic Web is.

JOHN WILLIAMS: Yeah. I mean, I think to some extent, it's a human problem, that we as humans think we understand what a term means. And it depends. But we use something like Web services. It's pretty fuzzy as to what exactly that means, what it includes, and what it doesn't include.

Now, as humans, we can get away with that fuzziness. I'll ask Steve, so did you really mean this or not? Now, the problem with computers is that they're automatically making decisions for us that we may not like. And we have no-- or we may not understand that the error has been made. That's the problem with the machine.

And at the moment, what we do is we sit down in committees and agree on a precise definition of the term, that, say, in security, a security token has a very precise definition. And you better be aware of that committee and exactly what that definition is and not assume that you know the meaning. But I think it's a real issue.

I think change is an issue when schemas change. And they undoubtedly will change. I think we have to think seriously about how we handle those changes.

STEVEN BRATT: Versioning.

JOHN WILLIAMS: Yeah, versioning.

BERNIE HOGAN: I think John and Steve both touched on it. One of the other challenges is that the association of information, it's going to be different. John kind of alluded to it in his presentation about Google, but how you associate data, because as Sanjay mentioned, you eliminate the line of sight. And so you have all this information coming in today.

So you may have a carton that's associated with a pallet in one instance. And then a few minutes later, it's disassociated. How you manage that and the systems and the solutions out there, it's going to be a huge challenge going forward.

AUDIENCE: My question is related to what Bernie said, information sharing. Maybe this is a slightly different view from using immediately Google or putting-- translating RFID or EPC tag into URI. Basically, the way I look at it is RFID tag itself is just one piece of information. Here what matters is a holistic view of where things are, right, whereas the Google is not a holistic view. You type a word. It shows you a list of things that you, the human searcher, will need to integrate them, OK?

And then also, in this holistic view that RFID is supposed to present, each part of it is owned and obtained by different companies. And most of the companies don't want to share those information. So they are caught in the middle.

They know if they share information, there's going to be great benefit. On the other hand, no one wants to share, give total control of the actual information captured by their readers. So I'd just like to hear your comments on that. Thank you.

BERNIE HOGAN: But there's another--

STEVEN BRATT: [INAUDIBLE]

BERNIE HOGAN: There's another dimension to that. What we're experiencing with the communities that are involved with EPCglobal is migrating from a push model. If you look at EDI today, it's pretty much a push model. I'll send you all that information.

And getting people to go to a pull model, so I can query for the information on demand, that really touches on the trust issue and the security issue. Not only do I trust you as a trading partner and a business partner. And it's going to take a while to get people past that, businesses past that issue. And it's not just a technical issue. There's a business process issue involved with that.

JOHN WILLIAMS: Yeah. I think when-- there has to be some advantage to you sharing your information. I mean, the example with Google is, for example, they provide Gmail where they give you two gigabytes of storage. In exchange, they're watching your email. They're running algorithms on your email.

Now, they're going to start offering data storage in a big way because they want to just see what you're doing. As I say, Eric Schmidt's goal is to know where everything is. He'll offer free storage in exchange for just taking some of that information and processing it. So I think it's these different business models that are the fascinating thing, that you can give away something for free because you're getting value from the statistics that you're running on that data.

AUDIENCE: One comment. Here the trust is not about individual users, which can be easily bought. I can be bought by [INAUDIBLE]. But if it's a company, it's a very different story. That's what I'm trying to suggest.

JOHN WILLIAMS: Right, but I think there has to be some demonstrable benefit. And I think there will be. So the ROIs need to be explicated.

AUDIENCE: All right. Hello. My name is Kevin Fu from UMass Amherst. And I have a question about where the Internet of Things, what role it may play in the next generation internet.

So David Clark here of MIT is talking that the internet is broke broken, that we need to design it from the ground up and start over. So could you tell us what you think is the best place for the Internet of Things to play, what's its best role in the next generation internet, in two seconds?

STEVEN BRATT: I'd say just quickly, I mean, it strikes me again that I like to think of things on the internet, whether it's this generation of internet or the next. And that clearly, compared to the first generation of the internet or the Web generation of the internet, things are going to be-- there'll be a lot more things that are available through whatever means, whether it's the Semantic Web or some other technologies, on the future internet. And so I guess you'd need to be able to design for that.

Now, of course, moving to IPv6 was one example of being able to greatly increase the number of possible IP addresses so that everything, every grain of sand in the world or whatever could have one. But there's a number of other probably design principles that Dave Clark has, I'm sure, thought about more than I have that certainly would need to be taken into account. Just the sheer volume and the security, again, associated with what those kinds of huge volumes of things are I would think would be important.

AUDIENCE: Hi. My name is Ying Li. I'm also from UMass Amherst. So I have two questions. The first was technical. So in the software stack that at the bottom has this device data and then filter, transform, and data that's published, where does XML come into play? Is there any benefit of pushing XML down to lower layers of the software processing environment?

BERNIE HOGAN: In the EPCglobal stack-- I'm not sure stack is the right word these days-- but it allows for an XML binding. There's not a significant demand for that at this point in time because it's pretty low level. And you could express it in different ways, although some companies have the preference. And the standard allows for that option.

Where the XML places is as-- I think it was in Sanjay's presentation-- EPCIS data that's stored at the repository. So the EPCIS standard allows for a way to store information and retrieve information. The opportunity in the information sharing and the-- that will be expressed in XML. How that's done, it's still very early in the process to describe how that's going to be done and how information is going to be associated.

AUDIENCE: Oh, so you think it's rather a representation for storage?

BERNIE HOGAN: Yes, that is the thinking today. Yes.

AUDIENCE: OK.

BERNIE HOGAN: [INAUDIBLE]

AUDIENCE: All right. So the other question is, so when you talk about the Internet of Things through Web technology, is RFID data management, does it represent any new challenges? Or is it just an application of the current Web services in Semantic Web technology? Does it represent anything fundamentally new?

JOHN WILLIAMS: Well, yeah, it's not there yet. I mean, we don't know how to do this, to build a global network. I think Sanjay was pointing out that we've got all these challenges of, how do you control costs? How do you make the chips cheap enough?

How do you get enough data? How do you get reliable data? How do you inference from incomplete data? We don't know how to do those things.

AUDIENCE: I see.

JOHN WILLIAMS: And, yeah, the algorithms aren't there, that--

AUDIENCE: OK. So it has certain characteristics of data uncertainty, security issues involved. So they do present some new challenges beyond other applications. OK, that's a good answer. Thank you.

JOHN WILLIAMS: I don't know how to do it.

AUDIENCE: Yes, hello. Good morning. My name is Harold Boeck. I'm with the University of Sherbrooke and also the Écol Polytechnique. I probably believe I'm the only marketing professor that works in an RFID lab.

[APPLAUSE]

Thank you. And during your presentation, you talked about the research opportunities in terms of business justification and ROIs. And this is specifically what I'm interested in. And you mentioned that certain companies get the ROI, whereas other companies are still looking for it. What do you believe is the reason that the companies who have not found the ROI are not finding it?

BERNIE HOGAN: I'm going to be dangerous here. I think you will notice a relationship between the companies that get it and their success. If you look at the companies that are lead-- these are leadership companies, that they get it. They've applied the resources. Some of the companies that are involved have been involved with the AUTO-ID Center since 1999 and 2000.

It's no different than other standards if you look at the companies that led the way for UPC codes for in the early days. UPC was the standard for 10 years before it took off. But there were companies who were involved working the standard, and deploying it, and discovering it.

Some of the other companies are further along in the curve. I think there's a community in the middle that's not sure. And then you'll have the industry laggards, as we say. The point I was trying to make is that we need to focus from a communication standpoint on the companies in the middle to help tip them over. No different than anything else like the World Wide Web, or email, or any other technology, we need a tipping point to tip them over to get it.

To John's point, there has to be a compelling business opportunity that will just get these companies past the trust issue, past the security issue. And that's going to happen. And I think it's really in the marketing area. It's a messaging area. The technology is-- to me, is-- I think we've solved some of these problems many, many times over. But it's a messaging-- and look at some of the work that-- MIT is doing it with their the business cases and University of Arkansas with Walmart and those type things.

STEVE MILES: So actually, if I could interrupt here because we're eating into our break time. And tomorrow we have a session on supply chain that is very much aimed at asking those very types of questions. So I'd like to thank our panelists very much.

[APPLAUSE]