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>> The session, it will be moderated by Stephen Ibaraki.

I'll give you a minute to pack in case you would need to leave. I think the panelists can come forward to the podium here. Come on up to the second row.

Stephen Ibaraki is a social entrepreneur and futurist and writer. He has more than 100 executive roles, lifetime April achievements awards and recognitions and his focus is currently on donating time -- am I still on? Yeah? Still donating time and resources to Startups and non-profit organizations in advancing innovation, research, science and Entrepreneurship and he is a supporter of the ITU which empowers all of the U.N. in Sustainable Development Goals.

We're switching the system now. Please listen on your headphones.

Actually maybe we could -- perhaps maybe for your introduction, Stephen Ibaraki, maybe -- can we keep the PA system just for the next 10 minutes or so for the introduction which he'll make and then we'll go back to the headphone system. Is that okay?

Then people will see that there is action.

>> STEPHEN IBARAKI: Okay. We're going to start the session on Artificial Intelligence and we have the benefit of some of the world reknowned keynotes that will be coming up. I'll start now, Your Excellencies, WTSA partners, honored Delegates, thank you. It is a pleasure to be here.

I want to welcome everyone. I'm Stephen Ibaraki, the moderator of this 60th anniversary special session on Artificial Intelligence.

I want to emphasize, express my sincere thanks to the sponsors of this 60th anniversary celebrations for making this talk possible. Namely the United Arab Emirates as gold sponsor, South Korea as silver sponsor and the bronze sponsor and they sponsored the VIP lunch, the gala reception upcoming and the coffee breaks. A really fine contribution today.

We have our notable session keynotes. I will begin with setting the context of the session and we'll begin with backgrounds and we'll have the keynotes speak and then we'll have an interactive dialogue to have the ability to take questions from the audience here.

First of all, let me begin by setting the context.

There is a prediction that the next breakthrough through a master AI algorithm will be producing a company worth 10 Microsofts, that's more than $4 trillion in market capitalization.

From mobile we have AI first as the current enterprise, in fact, China has a start up fund of over a billion and many have a key focus on robotics and AI. The world economic forum has identified artificial intelligence or AI as one of the top six trends shaping our society. The cycle for emerging technologies has the perceptible smart aid as a top three trend, all major technologies vendors are deploying, easily used AI software tools or specialty hardware.

There is also a proliferation of open source AI including the 1 billion funded open AI framework.

At a trade organization consisting of 10 top CEOs, financial services, and who manage more assets in 91.7 trillion than the annual global economy is holding their ideas festival in January, 2017 where AI is a major theme and its implications to financial inclusion and the future workforce.

Data volumes are growing by 2020, doubling every year in the future and that's 50 times greater than in 2010 and since 2015 there is more data created by the billions of Internet of Things, mobile devices and the Internet than in the entire history of humanity. Only AI has the power to analyze the data to solve grand challenges and problems guiding our future. This underpins the worth of two M.I.T. professors who believe we're in a second machine age with dramatic economic growth driven by smart machines, artificial intelligence, network communication and the digitalization of just about everything.

The evidence is here, we're in driverless cars, drones, understanding environments, the holo lens augmented reality, kind language translations, computers writing reviews, resumes, creating essays, music, poetry and classical art. The fourth industrial Resolution and is a -- (audio issue). With natural language processing at average human levels. This was forecasted by Martin ford in writing culminating in the *New York Times* best seller "financial times Mackenzie book of the year raise of the robots. It was noted we have to be careful about artificial intelligence, it is perhaps the biggest threat.

What is AI? It is our weariness of the concept and unintended consequences obstructing our view of the great benefits it can bring to humanity.

Is AI creating a digital quake where 80% of companies and jobs will need to change? What are the implications to society, economic development and the path to prosperity? Could technical standards for artificial intelligence help us to achieve the Sustainable Development Goals? It is an unprecedented era of AI driven hyper time compression in the emergents of new disruptive innovations measured in days and weeks rather than years.

Extreme convergence of multiple domains, physical, biological, there are overlapping over amplification ever value.

Accelerating automation triggered by smart sensors in the Internet of Things and universal connectivity linked by a digital AI mesh through the rapid deployment of machine learning. The future will see large part of our lives influenced by the AI of everything. The global AI mesh spawning additional quake driving the knowledge of everything and an inflection point for human kind and the SDGs for a Sustainable Development Goals.

The evidence is everywhere around us with Singapore launching their first soft driving taxis in September, big AI is being used tore Startups, deep knowledge ventures, they have an AI with equal vote with board members and make investment decisions.

GE is betting their survival in transforming to a software company with AI embedded everywhere. VIDO has a medical voice translation, a virtual robot ask a doctor which knows 520 different diseases and will give diagnosis with odds and links to nearby specialists.

They also have their stock master which analyzes new news and markets to predict changes and there is even controversy where AI picks up human biases of racism and sexism.

The millennial development goals were released and think did not anticipate the impact of technology, Internet, Broadband, wi-fi, smart phones, tablets, Cloud computing, big data and analytics, social media, social networks, cybersecurity challenges and artificial intelligence through machine learning and a deep learning. We missed so much in 2000 in changes accelerating. What will we miss in the future? Just three years ago how many of you would have predicted a trapbot would have to be shut down twice because of inflammatory comments or a machine Alpha go would beat the champion go player, an event predicted to happen in 2025 and not 2016.

AI innovation will be central to the achievement of the United Nations 17 Sustainable Development Goals, SDGs, by capitalizing on the unprecedented quantities of data now being generated on sentiment behavior, human health, commerce, communications, migration, much more.

As an example, tracking property and developing offers slow, manual and at times dangerous data collection. However, using satellite imagery and the machine-learning technique there is an alternative, mapping poverty from space supporting SDG1. Machine learning, will help with remote medical care with effective exploitation of limited medical expertise and transportation resources, supporting SDG3.

Methods to develop within the AI community will help to unearth influences within the large scale development programs helping us to build a better understanding of how we may design more effective educational systems. This maps the SDG4.

Ideas and tools created at the intersection of AI and electronic commerce will uncomp new ways to enhance economic concepts such as micro finance and micro work and this supports SDG8.

AI will also serve as a key resource in curving greenhouse gas emissions and urban environments. And supporting the smart cities, this links to SDGs 11 and 13.

You global partnerships, SDG17 will offer crucial support to the pursuit of all of these goals.

Cooperation amongst the U.N. family between ITU and WHO and health, if labor and automation, UNESCO, education, FAO and agriculture, as well as other stakeholders will be critical to leverage AI in delivering effective services for the benefit of all nations. Every sector will be effected by the raze of AI, including ITU-T, standardization work.

As a result, in addition to this session, a series of talks on AI such as today will be held at ITU Telecom World and ITU-T conference in Bangkok, Thailand.

ITU recently signed a partnership with IBM Watson, a 5 million-dollar prize that aims to accelerate the adoption of AI, technologies from diverse and open sources and spark had creative, innovative, both demonstrations of technologies with the potential to become truly scalable and capable ever solving some of the most pressing challenges to our societies and economies.

A draft report by the European parliament discusses the creation of a specific legal status for AI enabled robots.

According to the draft report the most sophisticated autonomous robots could be assigned the status of electronic persons withs specific rights and obligations, including the responsibility for making amends for any damage that they may cause.

Robots have potential and we see evidence of this in the government's discussions around how we can go about taxing robot earnings. Should robots ever become self aware, the report suggests that the robots would need to apply the moral code outlined by the laws of robotics deviced by a science fiction writer.

The development and adoption of relevant international standards can help us to realize the benefits of AI advances on the global scale, perhaps. Perhaps assisting us in the pursuit of the U.N. Sustainable Development Goals. Perhaps we can capitalize on the work of those who are working on a code of conduct for AI or the British standards institute to the ethical design of robots and systems and collaborate with the Stanford project, the 100 year study that came out with a report with concerns on regulation and in September Google, Microsoft, IBM, Facebook and amazon announced the partnership on AI to benefit people and society to work on best practices on AI. In October the U.S. Whitehouse released two reports on AI preparing for the future intelligence and national artificial intelligence research and development strategic plan. You can see the implications and being informed of this impending revolution that's occurring today and will continue for the future.

This completes my context and presentation. I want to point out some resources. The association for computing (audio issue).

Also my presentation, there is an additional 30 slides, if you decide to download them.

I would now like to take this time to introduce our next speaker. Professor, he's the worldwide business development leader in IBM master inventser of the IBM Watson group. His experience spans multiple industries and he's a recognized innovator globally for the substantial contributions that he's making with the Watson team, including being one of the founding elements of that Watson team.

The floor is yours.

>> NEIL SAHOTA: Thank you, Stephen.

[Applause].

>> I'm honored to be here. Thank you for taking some time.

I'm here to talk a bit about how artificial intelligence is transforming our world and what we can do to actually help -- use that to help ourselves. Stephen has done a great job of introducing me. I should probably hire him as a PR guy actually.

I will say this, right, we're here in the 60th anniversary and if you were to think back 60 years ago we used to imagine a world where we could actually talk to computers. We would have a conversation with them or as a robot. Today in imaginations, it really is innovation. This actually now exists thanks to the work made in artificial intelligence. What is artificial intelligence? We at IBM think it is an ability to mimic human thinking and we have three key features of this. The first is the ability to learn and build knowledge. This is really the machine learning component. The machine starts with some core set of information and actually builds on that through its experience and trying to do things.

Second, the ability to actually understand natural language. I can't underscore how difficult that is for a machine. For us, it is really easy because we understand context, we understand slang, we understand jargon, machines don't. If I were to say I'm feeling blue because it is raining cats and dogs, most people would understand what I'm saying. The machine will be thinking neil is now the color of blue because dogs and cats are falling from the sky? That doesn't make any sense.

The breakthrough was a key process for artificial intelligence. Lastly, the ability to actually interact with machines as if they were human beings. Rather than worry about the right to keywords, do I have the right things going in, I can actually have a conversation with machine.

If I were typing to a Google searching engine, showing restaurants near me but not pizza, you will get a lot of pizza places, it is a keyword. If you ask an artificial intelligence system like Watson that, it will show you places near you but not pizza restaurants and because it knows you, it may actually float to the top, restaurants, you may be more interested in, for example, if you like sushi, those may appear at the top of the list.

Just to give you a flare of what this is like, we'll show you a video about what's going on today.

>> You probably keep hearing that artificial intelligence is the future. It is actually here. It is here now. The robots a good example of that. Robots are rolled out to financial institutions, hotel chains, they are rolling out the

concierges, and that's happening today. What I have noticed, we give Watson a sense of humor, because it makes the interactions that much more natural for people. That's happening now with artificial intelligence.

Thank you.

We have a unique opportunity today in terms of transformation. You may look at something like the iPhone and it is only 9 years old. You think about the ecosystem of apps and how it changed our liveness and how it has changed how we do PSW and we interact with people. It is the same thing happening with wave right now, there is a whole ecosystem being built that will bring a whole new set of products and services. I can't predict what will happen ten years from now with that. No one can predict what would happen with the iPhone. I can say this, ten years from now I'm confident that almost every service out there will have some component of artificial intelligence to it.

One example is to take a look at healthcare. Medical information doubles about every five years. 81% ever physicians report that they have less than 5 hours just to read up on the latest clinical journals, the findings, treatments, things that are going on. If you look at some of the things going on out there, 20% of diagnosis are estimated to be inaccurate or incomplete. 1.5 million errors just in the way that medications are prescribed in hospitals every year. As people unfortunately die from preventible medical errors, that's a tough thing.

If you think about so many data points, things that are happening so fast, especially high pressure situations like the emergencyroom. How do we deal with that? Think if you have your own artificial intelligence solution there, you ever the doctors and nurses, someone comes in and they start to complain about the symptoms, so the doctor, they ask questions versus taking tests, trying to figure out what's going on, in the background you have a artificial intelligence solution listening in saying these are the symptoms that I'm seeing and trying to figure out what the person may have.

Take it a step further. You may limit it to the top 5 and the artificial intelligence assistant is going in, okay, what symptoms is this person not showing? How is that impacted by the potential diagnosis here? There is other information that could pull the family medical history from the doctor, nurse, see what that may lead to. I could pull the patient's history, how does that influence the diagnosis? I can pull in any type of medications the person is taking. I can pull information from any kind of tests that are -- to come up with what I think is my most likely diagnosis on the fly to support doctors and nurses.

That's a simple example of what can be done with AI. A background assistant like that.

When it comes down to using artificial intelligence, it is really about coming up with the best answer Recommendation for that given situation. If you think about what we do today, we try to micro segment things, healthcare, advertising, education, we put people into these polls and there is a large poll. With AI we can drill down to the individualized level and give the best treatment, medication, best educational path forward for that particular person based on their unique needs.

Why do we really need AI? You may ask that question.

We're dealing with a new class of problems. They're very ambiguous and very uncertain and we can't fully define them ourselves. There are two key things to keep in mind here. One, we're now working with interactions over requirements. As you saw in the video, there is no way to test a system like that. You can't anticipate every possible question.

How do you test interactions? The other thing becomes, now we shift our focus from the right answer to what's actually the best answer given the situation given the people involved. The only way to do that is having the processing power of the subject matter expert like an AI assistant.

Some common ones, IBM Watson, Stephen talked of talked about deep minds, Amazon echo, Alexis it is called sometimes, there are a lot of things out there.

What we're seeing, we're using them in unique ways we never thought of before. How many of you would have thought you would use artificial intelligence to come up with unique recipes, to come up with unique ingredient combinations that no human being ever thought of before. How about having athletes such as using AI to train, to train based on body type, injury, history, upcoming match and not just train but to prepare for individual matches.

How about an AI solution that could identify puppies, identify which one would make great seeing eye dogs and train them as seeing eye dogs. How about AI solution that will watch a movie, after watching that movie figure out what scenes to put together that would invoke strong emotional responses for a movie trailer so that people actually go see that movie? All of these things are happening today using AI.

A key thing we have done with IBM Watson, project Lucy. We have a strong sense of give back and we're trying to emphasize the Africa infrastructure and we're leveraging Watson to help provide Medicare services. There is if I remember correctly one doctor for every 2,000 people in Africa. After we enable people to do more treatment, how do we get people the information they need in case something happens, we're also using Watson to help farmers. Helping improve crop yields, how to figure outweighs to irrigate, transport water and leverage renewable energy. There is very humanitarian needs for AI.

You may be asking this sounds great but where are we at today, we have an ecosystem of 1,000 companies, 600 are in market with products powered by an AI solution like IPB Watson and they span the gambit, in media entertain, talent management, education, they are everywhere. One of my big points is that I'm limited in the fluency of the languages I know, I travel the world. You know, I use a solution lining lingulo, a realtime voice to voice universal translator translating up to 47 languages for me and I found it invaluable. I couldn't do that without an AI background right there. Hopefully I'm inspiring some thoughts here. You may be thinking, well, what about standards? This is a new technology, what do we do? We're talking about some real hard problems with EI, climate change, population growth, human development in general. There is an increased level of personization with AI, security, privacy. Common tools and platforms? What about real ethics. This is a discussion that's going on at least among industry and among ITU, what do we do here? One of the first steps we have taken is this partnership for AI to benefit people in society. We really focus on trying to advance the public understanding of AI and trying to help people formulate best practices on how to use AI and the founding members of the group are IBM, deep mind/Google, Amazon, Google, Microsoft, and we're building this organization out now and doing building and looking for people that have this type of experience that want to contribute in academia, non-profits and people that are specialists in ethics, policy, we recognize this is needed, this is such a game changer in our lives that we need to establish good policy, good practices.

You may hopefully ask yourself what could you do with artificial intelligence, a lot of people think about what they have already. I think the best way to think about it is think about the pain point in your life you have not been able to solve, think about the thing you wanted to do but could never do. Could artificial intelligence actually help you do that now?

With that, hopefully I have inspired question questions and we'll take questions in the panel session.

For now, thank you for the time and I hope this was useful.

>> STEPHEN IBARAKI: Thank you, Neil, for that inspiring, very thoughtful presentation on the capability of artificial intelligence. I would like to introduce the next session keynote, that's professor mike Hinchey, director of the Irish software engineering research Centre and a past director of NASA and holds a variety of Patents and quite a notable innovator

throughout his long career. Thank you.

>> Mike Hinchey: Thank you, everybody.

I would like to begin with a little confession.

I have to admit that I'm a software guy and I'm a software guy because I believe software is one of the great inventions of our time. In less than 70 years it has managed to completely transform all our lives and a lot of that is even in the last decade or two as we have implemented ideas and findings from artificial intelligence to make our software more smart.

Basically we use hundreds of thousands and millions of lines of code every day and just getting around, even the humble bicycle nowadays is software driven in many cities with bikes that are for rent, all done using software.

I have a colleague who is determined to get rid of traffic lights by having smart routing of traffic in cities, particularly when there is an accident or a burst water main or something like that. It is a great idea. The idea of living without traffic and traffic lights would be so great.

Of course, there's the grand challenges many of which I have been working on and many other people here have been too, but one such as going into space, space exploration and this particular device was to be the machine to take us to Mars, that's been put on the back burner somewhat but it will happen Someday, just when exactly we're not sure.

We use it for manufacturing, we use software for heating, fuel, and of course don't need to tell you it, it we use it so much in telecommunications and how important it is there.

We have it in our pockets. We have used it for transferring money, sometimes legally, sometimes efficiently, sometimes not.

When it goes wrong, we have problems. We can also use it to help solve some of the problems and to prevent some of the problems. Essentially we're getting to a situation where we have what we now call a cyber physical social system, we cannot only envisage but see a connected world where we have the super highways, medical records are available to doctors instantly and everything is connected together. The cyber aspect is enabled by smart software, the physical aspect, of course, the physical world, but there is a social aspect in that we're involving people who are providing information about themselves, even down to their medical information in social media and online.

I have been working for the last 15 years or so on what we call swarm technologies. The idea is to take inspiration from swarms that we see in the real world. Bees and also flocks of birds, we don't copy them, mimic them but we're inspired by them. This is used in a number of areas.

It is claimed that in drug discovery it has brought down some of the application of drugs from 17 years to actually find it down to a 4-year lead time which is significant, it means that we're bringing new drugs out to the market much more quickly.

It is used a lot in communications down to things like video on demand where you can use a swarm-based process for sending data around that is much more efficient than effective. We use swarms in environmental monitoring, particularly the oceans and the rivers and, of course, using it for exploration and that's in the context that I have been working with.

Using in space exploration a swarm of spacecraft, it gives us the ability to use solar power more and so this reduces the amount of energy we need to use and we're able to send things to places that are far more complicated and complex. We're able to do things that we wouldn't be able to do with something large and clumsy and gives us greater accuracy and flexibility and essentially gives us an ability to recover from a small incident where we don't lose the entire spacecraft because we have one small failure.

The idea is to use a swarm and by a swarm I mean anything above three. From three spacecraft to 1,000 spacecraft to do various types of exploration. One is to go to the lunar surface to explore the moon again. We haven't been there for a long time. To explore the rings of saturn, to understand what their composed of. With the idea of going -- to put a human being on an astroid to explore that and to understand better the origins of our universe.

We have been working on a number of scenarios for how this might actually happen.

We have these -- this is a video but it won't play on this device I'm afraid.

This is a robot that can shrink and enlarge itself so it can climb over obstacles, climb over craters for example, and it is very, very effective.

This is actually -- closer up, this particular one shrinks down to be a 30-centimeter queue and expand out to be 2-meters tall and it can climb the outside of the five-story building. Each block of the device is a computer and it transfers control as it falls over and moves by falling over.

The idea, it is to take something like these and to send a large number of them into a large spacecraft out to L1, the earth-moon point, a point in space where there is no gravity on a body that small enough and to launch 1,000 small spacecraft into the astroid belt carried solely by gravity. This he take between 2, 3 years to get out to the astroid belt but there is no power needed to send them out there. When they get there, they form sub swarms, they get into groups of roughly ten space graft that have different types of instruments for collecting data about the astroids they're interested in and using smart techniques and AI techniques can identify which of these astroids is of interest, swarm around them, collect data about them, send that data back to earth.

This has to be an absolutely smart mission because the round TRIP delay between earth and the astroid belt is 40 minutes. Even if we could identify a problem, even if we could send the signal back to earth looking for help, even if earth could actually solve the problem straightaway it would take 40 minutes before the signal was sent back. That's completely impossible.

The problem in this environment is collisions with, of course, the astroids themselves and collision between the spacecraft and the problem of solar storms so the sun is a star and like every star, it has star dust which sounds romantic but basically it is space junk that's ejected. This and the radiation from the sun could damage some of these devices so we have to be able to put them in a safe mode which is typically a sleep mode when necessary.

We have been working on how do we deal with building this type of a system. We have been looking at approaches based on formal methods which are known to many people here, of course, and they are basically mathematical language for specifying what the system will do.

The problem is no single language would be sufficient to express what we need, what we really need are multiple languages working together to be useful.

We have been working on a specification language called ASSL on allowing us to not only specify what the system will do but the ranges within what we want to be constrained. The system could make decisions and make changes and alter its behavior but we have a constraint on how much we let it change. We don't want it to do crazy things or going too far away.

We're using ideas called automatic computing, that was given to it originally by the NSF and later by IBM in fact and they have built quite an industry around this. The idea is to take inspiration from the human nervous system, the sympathetic nervous system that's concerned with the short-term fight and flight, something sudden, unexpected and then it is concerned with the long-term health of the body. The rest and dijest it is called.

We build up this environment with these managers, and you see the of box, this is the manager that is taking care of the specific component which is marked MC. What we can do, we can build in the concept of the heartbeat which is done in an embedded system and augmented with a pulse beat that has signaled that the system is operational but also healthy. We put the components in sleep mode when they're in danger or when they may cause problems because of their interactions with other systems. We can create an option to bring it back when we have solved the problem or when it is going to be useful to us again.

We can combine all of these into what we call a license or a signal where we can negotiate between the components that they will coordinate and work together and that helps us to identify rouge agents in the system.

We have also been using the concept of a feature model from software lines to enable us to apply these different systems in different environments but using primarily the same core software so that that core software doesn't change and then we have aspects to deal with separately. For example here you see the self-protection component can be changed and protecting it from a solar storm is different from protecting from the rings in saturn, around saturn.

You we have been working on how you may automate our code generation. These systems we want them to be smart. We essentially want the software to be able to change itself so that it needs to be able to write itself. We want to take the requirements that we have expressed for the system and if we can generate models of that, then we can take existing code generation tools and generate code from these models, we can we verse that relatively easily and there is a number of tools already in existence that do that. From the models, we can determine what the actual behavior of the system is going to be by looking at mathematical laws of currency, looking at what the system does and we can reverse this and it gives us a full round TRIP development process.

We have built an approach to this pretype approach to this to enable us to capture the requirements in various notations and then to generate a mathematical model of that so that the system can indeed go and make new code for itself and it can produce parts of the system as new implementations.

A little warning, I found this in an art gallery in London last week or the week before last. It says do not trust robots. We have, of course of, we have to be concerned about how much trust we put into any of these types of devices. A couple of open questions, how do we decide to allow a system to make decisions about how it changes itself? How do we trust it? Do we allow it to do that? If we allow it to change, how do we preserve the safety, integrity of that system?

What degree of trust can we put in the system in that -- allowing itself to do self-adaptation. The problem is, we can't test these kinds of systems if we want to allow for a system that learns as it progresses, it will produce new behavior we did not expect. A lot of this is very, very good. That's one of the advantages of the swarm-based approach. We get -- we get the behavior that evolves that we did not necessarily expect. Things like Watson, learn things we didn't expect it to learn. These are useful things. The danger is, in we put too much trust in the system and we allow it to change itself dramatically, we put ourselves in an awkward situation. What we need to be able to do is express the range of adaptation that we will allow but not the specific adaptation because then we would end up having something that's just programmed. We need to be able to specify the range that it would go to and allow it to make the changes.

If we can specify that carefully, mathematically we can demonstrate that the system meets the constraints and lives within the boundaries we set for it. Otherwise we would have issues.

>> STEPHEN IBARAKI: Thank you for sharing your experience.The next keynote speaker is Dr. Thomas Wi e.g. and, professor of the technical universities of Berlin, executive directser of the Fraunhofer Heinrich institute, he was named as one of the world's most influential scientific minds as one of the most cited researchers in his field and, of course, he received the 150 award for his contributions to really the progress of standards in technology.

Thank you.

>> Thomas Wiegand: Thank you for the kind introduction.

Let me start with talking a bit about the research institution for communications. We have been founded in 1928 and we worked with what we call digital infrastructure, in Germany we have a big revolution. We talk about the digital transformation of our industry, the medical systems, et cetera, we do research for video, wireless technologies. Every second bit on the Internet touches one of our video or photo technologies and we were the first to have one 1 gig per second transmission in the world in the 80s for example and we were delighted to work with the ITU, in the ITU as part of the H.264, H.2765 standardization. This is a research institute for communications. Why machinery, what is the interaction? Because the title of my talk is convergence of communications and machine learning.

In the last years we have started to bring machine learning in communications because we understood that a lot of the problems that we're tackling when we build our communication systems are big data problems. Problems, learning statistical behavior of what we do.

My talk will now be about machine learning and video coding. Machine and telecommunications and a last thing I want to talk about, it is how can we explain the decisions that have been made by machine learning?

Let's start with the first part.

If you look at the communicationsystem, you have been aware of this here, I'll now talk about this part, so we have transmission of a video signal to a video receiver and it is one of the big success stories of the ITU. We have about 13 years ago, we have finalized H.264 and every second on the Internet, probably more, it is difficult to measure, but it is in H.264, three years ago we fine liesed H.265 and it is about at the end of the year a billion devices and we are planning H.266 in 2018 we'll kick that off. In these standards, as you know, for compression, the decoder is specified and in transmission the transmitter is specified. Here the decoder is specified. We basically build encoders, we've built a software encoder for H.265 and we're successfully selling it for broadcast for example and so we are building on top of an improvement of compression capability.

Here you see the improvements H.264 and H.262, which was the standard made 23 years ago, 50%, and we have again the H.265 and 264, 50%, we'll aim for 266 to be also 50%. These scales are only achieved with a realtime effective encoder.

This is where machine learning comes in. We use machinery actually to create a video encoding algorithm. If you look at the specification sizes for these standards it is stunning.

H261, the very first standards, not the first, but the second, but the first one from the H.26 series, it was 25 pages. H.264 was 260 pages when it went up to 600 pages. H.265 was 500 when delivered. These things are extremely complicated and the encoder is complicated. We have basically used the standards and video signals and trained a video encoder, we made it part of a learning algorithm which itself created an encoder algorithm. The encoder algorithm was aimed for realtime video encoding to be put in a product and we did that and we went live with it and we're transmitting the champion league in Germany with this encoder in H.264.

Here you see this -- we started by training here. We reached here and we saved 40%, we had the 40% speed-up there.

We used machine learning in video -- in compressed analysis, a lot of video data is now compressed and compressed databases and we also use it there and we are converging the compression method and the machine learning method so that at the end, for instance, both goals are achieved. Low bit rate for good quality on one hand and the ability to extract features from compressed video signals on the other hand.

The second thing I wanted to talk to you about, machine learning and data communication.

It is another department that we have at the institute, that's why I can talk to you about some stuff we did there.

This is the second part of our transmission system here.

We have in Berlin created a test bed for 5G networks and I invite you to come over and visit us. 5G has an extremely tough requirement that are really difficult for every inning near. You want 1,000 times through put, you have 100 times and 10 times battery life and a millisecond latency, hopefully not everything at the same time but it is really tough.

How can you realize such a system? We want to use it, of course, for enhancing traditional data transmission to cellphones, et cetera, but also for car to car communication and in order to allow for instance cars driving next to each other and to increase safety and security in the street and also for the industry automation of connecting robots and machines over an industrial Internet that we're currently working on as well.

How can you build a system with 1,000 times requirement? One of the biggest problem that you have there, if we use about 5% of our electrical energy for communications and computing, if we have -- if we keep the amount of energy per bits and we have 1,000 times more speed then we have 5,000% energy and that's not possible. We have to find energy efficient ways of transmitting data over the air and part over the air is the one part of most energy consuming so the first thing you have to do is you have to avoid as much transmission over the air as possible.

The second thing, you have to get away from the sectors where you transmit the data into big sectors so that lots of receivers receive the signal which is actually targeted for just one receiver.

The problem with the sectors, many fold folds, not only are you emitting it into big space and you have to have the energy in the air and the pollution, but you also -- all of the other receivers have to cancel out the interference with the others.

A way of doing this, you have the antennas, you have the big antennas on the houses, street lamps, et cetera and you use actually a wave form to produce the antenna cords that direct the transmission to the user. You have less energy in the air and you actually avoid that interference because the likelihood that somebody is in your beam that is not receiving your message is actually very low.

How can you realize this in a actually scenario with the 1,000 time requirement. Part of my picture is taken out for the CC. I'll try to explain it.

Want you're in the black car there, you want to get data. You get this through this wireless fiber antenna.

You move on. You need to be localized. These beams are directing you. They need to be localized.

You drive around the corner, there is a big yellow bus there. It has to switch over to this other one. You have to figure out where you're going from machine learning. You have to have a localization there.

There is more to it. There is this thing you drive into this neighborhood when you begin to drive into the neighborhood and then you are the one receiving cyber physical services when you drive into the neighborhood.

The DSL boxes, the routers there, they have learned about the neighborhood, they have learned about the routing. They could even learn about your behavior and auto mize things for you. You have to convey the machine learning algorithms to basically convey the learning from the DSL box and you have to net the knowledge about the percent of the participants and move around. Last thing, which is as important as the other ones, the safety security and trust, if this car drives, you could create a virtual child that runs in front of the car and the car breaks and it causes something to happen and maybe this is just really a virtual child. If our networks are attacked by machine learning supported viruses we have to build Ned work antivirus systems and they benefit from machinery, they have to learn about the attacks. This is in network system here with lots of sensors and you have to have basically an operating system, it has to update itself. You drive into the -- you receive cyber physical services, you want to be sure that it is safe to drive in there misguided and all of that is done through machine learning.

You see, basically 5G, 1,000 times through puts, 1 millisecond latency, things that are tightly coupled with machine learning. Communication, machine learning, they're converging ASGN we speak and this is our research that we're doing.

One of the things that we have been putting forward in an ITU tech watch report is the Internet where we say that we want to bring the latency down in our communication to a millisecond allowing us robots, other things. This is an example I came up with to bring everything together. Collaborative driving. You have the cars, cameras, all that show the traffic transmitted in realtime and you're learning about the dangerous situation through the machine learning algorithm and if there is a deer running into -- on to the streets, the car in the back, they know, they brake for example and we can increase the safety.

This is just as glimpse of what we do. This is just something to illustrate how machine learning and communication is converging.

We have lots of other subjects. One is cognitive radio management. Develop awareness through recognition and realtime machinal learning so that we can get rid of network uncertainties. Self management loops in sensor networks in order to allow optimization, increased reliability and network loads and also last but not least, counterfeit malicious behavior if you have a virus in the sensor network which is something that we will see what to do about it and how to combat it.

>> Last thing. You heard a lot about machine learning and how nice it is and how much it helps to do things and how important it is for telecommunications. You are in a self-driving car and suddenly it decides to go off and drive into a house and why did it do that? Because it did it because a machine learning algorithm told it to do so. Why did the machine learning algorithm make that decision? There is something to that.

The big question, we have lots of data. We do machine learning and we have automatic annotation, to make a decision, cancer, no cancer. Drive left, drive right. Brake, accelerate, shut -- Rundown the nuclear power plant.

A lot of questions that machines will be deciding but we need it o know why.

Can we trust this machine? I won't trust that machine. Can we trust our machine learning? What we have done, we have reverted a deep learn network which consists of the layers and you have the notes and they're normally the functions and you cannot change the output value.

We invert that value and come up with a heat map in the picture that gives you it's reason why the classification turned out to be that way.

Here is an example.

You have a picture of a shark. Below, the map. Basically the classifier is saying it is a shark because of the fin map.

Another example, this is a decompetition only giving you a reason of -- decomposition, telling you why something is like it but also why it is not. What speaks for and against classification as a three, we try to classify the traditional things from zero to nine and we give it the numbers from zero to nine and basically you see the red dots and the three there. Those are the reasons why that there is a 3 for the two red dots, they're by one another, there is nothing, and for the other red do the, there is nothing. It makes it 3.

On the right-hand side, what makes it -- what makes this not a 9, it is the missing line there, it makes it not a 9. This is an illustration but it works on every input. We tried it with computer viruses and work with it with medical diagnosis and we try to identify sepsis types with that, et cetera, et cetera.

Let me summarize, machine learning and communication are converging. It is happening in video compression. It is happening in data communication, 5G, hybrid, low latencies and centers are not possible without machine learning and good uses, these machines are actually very specific, they solve very specific problems. That's a good thing.

We need the specific problems to resolve and we have heard many arguments before and we can actually with the decomposition explain the results of the machine learning and that is a new thing coming with the right to explain if a person is denied credit card, for example, and a machine makes that decision, you have the right to explain why that was caused.

We can convey this right to explain to all sorts of questions that machine learning algorithms answer.

Thank you very much.

>> STEPHEN IBARAKI: Thank you for your insightful presentation on sort of the building of machine learning with video communications and network management. Machines and communications are converging, a very thoughtful presentation. Thank you for that.

We're now in the session or the section of this AI session on taking questions from the audience. If you can press your button if you're interested in queuing up for a question from the audience. While we're waiting for that, I'll pose maybe a general question to our panelists here. I think, Thomas, you somewhat answered this, it is to everybody, researchers are surprised how well the AI algorithms work and they don't understand why. If you can comment and go from Thomas to Neil and to Mike.

>> Thomas WIEGAND: I think that the subject has a danger of being overhyped and I think we should refrain it.

At the end it is not stuff that we know from the past. Classifications to be derived, the mathematics that we know about it, it is actually -- the only thing that's really complaininged is the huge amount of data and the processing power that we're given and now we're achieving the big results and we're solving this very, very specific problems and we need them, we need to use this technique to solve the problems in order to solve the real big problems which are I think related to energy and climate change. I believe that by on the -- if you leave this topic to the very specific problem solving areas you will see in the next year's very, very promising results to continue to come up. It is actually -- we're further understanding why things are the way they are, why these algorithms come up with these results. It is becoming an integral part of how we design telecommunication systems.

>> STEPHEN IBARAKI: Neil, you want to take a stab at that

question as well?

>> Neil SAHOTA: We're surprised by the approach to try to train the AI solution. When we have to do that, we liken it to any time you ask IBM Watson to do something new it is like teaching a 5-year-old child. It forces us to think about the basics, what are the foundational truths to help make decisions. I think by actually -- we going through that process, for us, it tends to be natural when we think about it, it we think it is going to be hard for the machine but it is actually a lot easier and the fact that the machines can learn quickly and can absorb a lot of data, their ability to grow and learn is actually faster. There is the point of the 10,000 dollar rule to be an expert, with this solution, it may not be 10,000, it may be be 1,000, 500, depending on the situation. That's why they're learning faster than expected.

>> STEPHEN IBARAKI: Thank you.

Mike, you want to take a final stab?

>> Mike HINCHEY: The situation you refer to is related to the talk on emergents, we know about it in biology, economics, other behaviors emerge if you allow a range of behaviors to be possible rather than specifying an exact behavior. A lot of things that we're classifying as artificial intelligence don't need much intelligence but they need processing power. That's an issue as well.

>> STEPHEN IBARAKI: Thank you.

We have some questions from the Delegates here.

The Delegate from Swaziland.

>> SWAZILAND: I listen to the interesting presentations. I do realize that AI can be useful in many aspects.

However, we know that this world of IT has lots of tiers or attacks. I'm wondering if you have, for instance, in this driverless cars and also the machines, the development, it is moving very fast and into many different areas. What are we going to do Someday when there's been a successful attack, a major attack corrupting the diverless vehicles in their reports.

>> STEPHEN IBARAKI: Panelists, who wants to take a stab at that?

>> Thomas WIEGAND: If you were going to make a malicious virus you want it to be as adaptable as possible, the virus wants to survive and do as much damage if it is designed by some malicious intent.

I think the best way to basically combat the virus is antibodies and the antibodies should be designed in the same professional way using machine learning algorithms. If I design a vie advice, I would give it a learning algorithm to adapt itself to be as horrifying as possible.

>> STEPHEN IBARAKI: Mike, Neil, you want to comment?

>> I don't know if I have the solution but there are a lot of people looking at this area of security and privacy and in particular making this adaptive so that as Thomas pointed out it can learn and adapt to new situations as they arise and new techniques are developed by these sort of people.

I won't claim to have a simple solution just yet though.

>> STEPHEN IBARAKI: Go ahead. Neil sahota: With IBM Watson we sent it to cybersecurity school to understand the threats and then trying to actually predict what potential threats may be, what malicious attacks may happen and try to compensate or even try to prevent them.

I don't think this is any good answer there. In the long run if someone wants to attack they can be creative about it. It has to be a combination of proactive and reactive. We can leverage machine learning AI components for that.

I don't think we'll come up with a perfect solution.

>> STEPHEN IBARAKI: Thank you.

The next question from the Delegate from Egypt.

>> EGYPT: Thank you.

I also work for the government.

I would like to thank the panelist for their very interesting presentations, really mind provocative.

Basically I want to share with you a potentially challenge in standardizing AI technologies.

This is from my own perspective: One potential challenge in standardizing these types of technologies is the presence of many partially similar or perhaps slightly overlapping concepts of technologies in academia or the industry. For example we keep hearing about artificial intelligence, cognitive use, big data analytics, social analytics, evasive computing, et cetera, et cetera, and in my view every single technology that I have just pointed out touches upon a specific aspect related to intelligence. On the other side we rarely see any efforts to trying to link these particular concepts with these particular technologies with the actually cognitive sciences and the cognitive new sciences which basically sets the framework -- the event of the framework of how or what we mean by intelligence and how our minds work and how our brains functions.

I wonder if you have -- otherwise every couple of years we could have potentially new concepts emerging, tackling a particular angle.

Thank you.

>> STEPHEN IBARAKI: Neil, you want to try a response?

>> Neil Sahota: It is a concern about the broad industry. We work with cognitive scientists and work with these people. Watson is nodded an easy on algorithm or in search trees and actual -- it thinks like a human being. If you can it a querry,

it does what a human being does, it generates hypothesis and takes from his own set of knowledge and experience to try to approve or disapprove the hypothesis and comes up with a scoring saying this is the most answer that I'm confident in and it can explain why.

A lot of the other AI types of solutions, machine-learned solutions leverage deep analytics and algorithms, we think we have gone down a different path here. We're lucky enough we have put a lot of Patents around it, we have an advantage there. You're right. That's why you see the focus now in industry particularly on trying to understand can we create a competing system that actually mimics how the synopsis of the brain does and there is real value in that but we don't even fully understand how the brain works yet. It is tough to say what that will yield.

>> I'm sure this touches mike and Thomas, your responses?

>> I'm slow to use the word intelligence. I don't think we understand what intelligence is, as neil says, we have a long way to go in understanding the brain.

I would point out in most areas that we have been successful, think of flight, for example, we were successful by not trying to mimic nature, not trying to do what birds do. We were able to do it by different means. I don't think we need to go down the path of understanding exactly how the human brain works.

We can still get inspiration from that and get some good ideas from a partial understanding, although I don't is something that would be Grade Graduation it to understand more how it does work.

>> Standard, it is a technical thing. You want to solve a problem, you start completely open when it comes to how to solve the problem.

If you do it right, you bring all of the experts together and for instance the video compression last week, we had a meeting with 300 participants. We bring everybody together and have an openness to how to solve a problem that's set up by requirements. At the end, a very specific technical solution is being standardized that actually solves that specific problem. If you pose it too generic, of course, it is complex, unsolvable. If you pose a specific problem you can actually take a stab at solving it.

For example, if you want to compress a network to make its transmission easier, you can actually set out a way of doing it instead of this task and come up with a standard at the end that does that.

You this is what the ITU is great at. This is the type of problems that the ITU can actually solve and other subjects are more big picture things that are surrounding this. When it comes to doing it, be specific, be open at the beginning and come up with something specific at the end.

>> STEPHEN IBARAKI: Thank you.

We'll take one more question. This is the delegate from Malaysia.

>> MALAYSIA: Thank you, Chair.

An interesting topic that we have discussed on AI.

I have a few things I would like to discuss with experts.

Number one, it all depends on power, if robotics, whatever we design, you know, how AI can resolve the issue of power.

The next question, with regards to computing and IoT and IoT, how does AI relate to these things that we have discussed yesterday and today.

Thank you.

>> STEPHEN IBARAKI: Thank you.

Mike, perhaps you can lead that off followed by Thomas and then Neil.

>> I'm confused if we're talking about solving power issues through AI or whether we want to envisage AI systems that use less power.

Power is obviously in space exploration, it is a big issue, we have had all sorts of problems with batteries and battery memory losses, it is a big issue.

We have been looking at small-scale devices that would be pulled by gravity so they need very little power and what they have, they can charge using solar power. I don't know if that's the question you were asking or if you're asking more how can we solve the world's energy problems. That I think is something that will take a lot more than a few minutes to answer.

>> STEPHEN IBARAKI: Thomas.

>> Thomas WIEGAND: In many fields progress is made through more intense energy consumption. That will be aen issue. A lot of engineering problems solved through by using more energy to throw at the same problem.

We have to breakthrough this cycle by coming up with completely new methods.

I could imagine that machine learning actually offers these methods. Mathematically speaking, lots of engineering problems, mapping in space, humans don't understand it, the machines can't understand it.

It can help us to come up with solutions that are actually breaking through that a human wouldn't have come up with.

The relationship to quantum computing and IoT, it is -- there are relationships. IoT benefits from it. I pointed out that sensor networks and -- that's something that can benefit from machinery, for instance, the sensor, it is only sensing when the algorithm tells it to listen, now it should sense the data for example.

Quantum computing is too premature to be -- yeah -- to really see the relationship -- let's put it that way. We have the quantum computer that works and then we figure out the relationship.

>> STEPHEN IBARAKI: Neil.

>> NEIL SAHOTA: It is an interesting challenge. We're generatalling data for machines, not necessarily for humans to consume. I have seen studies about 7 years from 50 to 100 billion IoT sensors that are just out there. The question is how can you process all of this information, how do make machines smart enough to know, right, if I like one type of lighting, and, you know, another person likes another type of lighting how do you adjust the lights based on who is in the room?

The other thing, you look at it by 2020, 90% of all data generated will be video or image. We don't have the green power to process that anymore.

That's why there is a push for quantum computing.

We're now generating data that we can't actually consume. It is not because the systems are not smart enough but we don't have the computing power to do it. It is the chicken and the egg as we call it. We invested a lot of focus in the last 2, 3 decades on the software side. The hardware side now, trying to catch up, just on the data alone that we're generating. You will see a big push in trying to meet this demand.

>> STEPHEN IBARAKI: I'm going to ask each of the panelists now starting with Neil and then Thomas and Mike to give a 30-second closing comment.

>> NEIL SAHOTA: Thanks to you and the opportunity to speak here, to our hosts.

We always talk about what's the future going to hold, I think we're at a point now with artificial intelligence to talk about what to do today.

I think hopefully we have enough flavor for some of the things that are going on. This really is a transfer in the technology out there. I think the real questions become what can we try to do today. What are those pain points, the opportunities we can try to capture and I think we use artificial intelligence. This is not simple computalling that we're used to, not just simple programs or requirements or calculations. We're now talking about technology that can provide insights and answer questions we don't know the answers to. What can we do with it. That's what we need to think about.

>> Thomas WIEGAND: Telecommunication without computing is

impossible. We do compression, we do all sorts of data processing tasks where we transmit data.

Machine learning, it is a new processing kid on the block that we need to bring into our work. It is proven to be a successful tool in engineering and we need to find ways for the future to incorporate it into the world of telecommunication so that we will in the future have faster, more secure, lower latency communication systems that are also more energy efficient, everything at the same time.

>> AI had a false start back in the 50s by people claiming that it would do things that it never could do, especially with the technology that was available at the time.

Let's try to make great use of the advances we have made in recent years and to apply it appropriately to advance the world for all of us.

Thank you very much for the opportunity to come and meet with you today.

>> STEPHEN IBARAKI: You know, we have a final announcement, then we'll close the session today.

I want to give the floor now to the deputy director.

>> Deputy Director: Thank you.

Thank you to the panelists and to our sponsors that made this session possible. Given the impact that AI is going to have on our lives, also on telecommunications and ICTs, we're going to organize and host an event together in partnership with AI experts and the topic, it is AI for social good. That's going to be a three-day event, second week of July, 2017 in partnership.

>> STEPHEN IBARAKI: Thank you here. Thank you, Excellencies, to the partners, our honored Delegates, thank you for taking the time to attend this session today and ask thoughtful questions to our panelists here who are really quite notable in their own right. That's Professor Wiegand, Professor Hinchey and Professor Sahota. And thank you to the sponsors for making it possible today. A round of a applause for a special keynotes that took the time to come in today.

Thank you.