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This is a raw transcript of the Flagship Urban Solutions session on Smart Cities of the World Cities Summit, held at Marina Bay Sands, Singapore, on 3 July 2012. The panel comprised:

- **Warren FERNANDEZ**– MODERATOR  
*Editor, Straits Times*
  - **Guruduth BANAVAR**  
*VP and Chief Technology Officer, Global Public Sector, IBM Corporation*
  - **Carlo RATTI**  
*Director, MIT SENSEable City Lab*
  - **Yasuyuki SHINTANI**  
*General Manager, Energy Solutions Development Center, Panasonic Corporation*
  - **TAY Hun Kiat**  
*CEO, Sino-Singapore Guangzhou Knowledge City Investment and Development Co., Ltd*
  - **Ronnie TAY**  
*CEO, Infocomm Development Authority, Singapore*
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**Mr Fernandez:** “Good afternoon, everybody and thank you for joining us at this panel discussion on Smart Cities. My name is Warren Fernandez and I’m the editor of the Straits Times and today we have a very interesting topic before us on Smart Cities. I think this term smarter cities is one of the most brilliant marketing catchphrases that the marketing folks have come up. First you have smart phones, then you have smart grids or smart tablets because who wants to use a dumb phone, right? The choice between a smart phone and a dumb phone, not much of a difficulty picking the smart phone. But what exactly does a smart city mean? I’ve often travel around the region and sometimes you know you’re in a city that’s not so smart when you have to go for an hour to get to your first meeting and then travel back in the opposite direction for an hour. That’s not a very smart city or a city which is highly energy intensive and not very sustainable, you know it’s not such a smart city or if you get down to the quality of life issues, cities which have a soul where people enjoy being and want to live. Those are cities which seem to me to be smart. But that’s just my layman understanding of the issue and we have a much more distinguished panel to ask questions on what is a smart city with us today.

Let me introduce them very, very briefly. You have detailed their biodatas in your information pack so I’m not going to go into chapter into their distinguished background because it will take all afternoon. Very briefly, we have with us Mr Tay

Hun Kiat, the CEO of Sino-Singapore Guangzhou Knowledge City. Dr Guruduth Banavar, he was joking to us call him the guru of smart cities. He's from IBM, Vice President and Chief Technology Officer for their global public sector. Then we have Professor Carlo Ratti, director of the MIT SENSEable City Lab, Mr Ronnie Tay, the CEO of Infocomm Development Authority of Singapore and last but not least, Mr Yasuyuki Shintani, general manager of the Energy Solutions Development Centre of Panasonic Corporation. I've asked them to boil down to the essence of what is a smart city. What are the characteristics that make, that distinguish these cities from dumb cities and what are the underlying factors that help create cities and help cities raise their smart quotient. And I've asked each of them to sort of take five minutes to spell out their thoughts, which we can then use as a basis of getting into our discussion. I like this to be a highly interactive smart discussion rather than a series of long speeches and presentations. So we've decided that Mr Tay will start. So let me handle the floor over to Mr Tay."

**Mr Tay:** "Thank you, Warren. Distinguished guests, ladies and gentlemen, from my perspective of my company operating as a master developer, that is my company is Sino-Singapore Guangzhou Knowledge City investment and Development Company, a joint venture between Temasek's Singbridge and also the Guangzhou Development District Government. From an angle of a master developer, smart city should be one that is harnessing technology data with a very strong government support where demand and supply should meet efficiently as well as sustainably to create a city for living, of high standard of living, affordable, reliable as well for enterprises to operate in a conducive environment. Last but not least, a government providing efficient services to residents and enterprises. If you look at China, the next 10 to 15 years, there's going to be 350 million people moving into the city. With a very land constraint and resource constraint urbanised city, it's going to put stress in every city in terms of scales, in terms of the quality of life. We feel that as a smart city, there should be very strong tripartite partnership of government, enterprises and residents to make a city work and towards a smart city development. If you look at Pike research work that was published this year, globally we're going to see probably about \$1.87 billion of investment for the next eight to 10 years into smart cities. And I envisage globally there could well be 40, 50 smart city development in the next 15 years of development.

Now for the smart that we are looking, we should see that the harnessing of technology and data as a main thrust of smart city development. In the case of interconnectivity as well as the integration of systems, sub-systems solution in a city, from my perspective I see in China city there are few areas we can look at. One, in terms of product and services, there's great deal of standardisation required in China's city, for example, electric vehicles or hybrid vehicles. There is no standard now in China for such a big market. I think for standardisation will drive towards a better and more efficient way of deploying our resources in China's city. Number two if you look at research and development areas, I think the academia and researchers should be looking at cities of today's problems for future solutions and just name you a few.

We started a green hospital project with Siemens in Guangzhou Knowledge City. It is precisely we are solving today's problems for tomorrow's solution. We could create the test-bed opportunity to work with corporations and if it works, successfully

implemented, we will roll out in the entire city and we radiate out to other parts of Guangzhou and China so it makes sense for corporations to work on this project and achieve their financial returns for a smart city. The other areas of challenge I think for the China city is the Chinese Government. When we look at inter-connectivity, integrations, I think the government themselves have to have a cultural shift. Today, if you look at most of the cities in China, they are very silo and how to change the culture to share information, share data and even shared system to cooperate, to achieve efficiency for serving the community by the government? And how to streamline the processes, systems at the backend? That entails quite a fair bit of challenge for the government. I would stop here for a short while, allowing other speakers to continue.”

**Mr Fernandez:** “So the two points I picked up is integration of facilities, interconnectivity and also partnership between government, business and citizens. We’re going to move to Professor Carlo Ratti because in our initial discussion we thought that would be a good segue into sensible cities based on your work in the MIT. Please tell us about it.”

**Prof Ratti:** “Thank you, Warren. Good afternoon everybody, it’s a great pleasure to be here and can we have the slides please? I’ll just you show, I’ll just put together a few videos. I mean I try to answer this question about what all this talk about smart cities? As Warren just said, it’s just a big marketing campaign behind but what is substantial and actually what is the hype hidden behind? The first thing, sorry, I’ve just seen our spelling mistake in ‘cities’ here, but change slide, we call it sensible city because we actually like more the idea of a city that is sensible, that is able to sense and actually responds more to citizens because in the end we believe all of this is not about technology; it’s really about us, about citizens. Now in a couple of words, it’s something that happened in another field that’s very similar to what’s happening in smart cities. Take Formula One, 15-20 years ago, actually if you wanted to win a race, you need a good car and a good driver and if they were good enough, you win. Today if you want to win a race, you also need something like this, a system with thousands of sensors onto the car, collecting data information in real time, sending them to those computers and then making decisions in real time. In other words, to these engineers is what we call real time control system. It’s really the basic of every dynamic system; the basic of life is sensing enough. When we meet each other, we sense each other, we shake hands, we collect information, we touch each other, we smile at each other and then we respond to that. So that is the basic of every dynamic system.

The amazing in this is why there is something actually under smart cities and what is happening today, this is the incredible thing that’s happening today is that our cities are starting to behave like that Formula One racing car. They’ve been covered, layered with many, many digital type of information with sensors, with networks. I think the cell phone network didn’t exist 30 years ago and now it’s exploding for data, for voice and all of this is allowing us to understand in many different ways into actually interacting, interface in many different ways, almost as if every atom out there in the physical world will become a sensor in the network. Now having said that in the remaining few minutes, I just want to share with you some projects as an example what we can do today. We can sense things in a different way. In this case, we look at trash. If you take a computer and you know everything about chips, how they move to

become this computer but when you throw it away, you don't know. Sometimes, it ends up like this where it shouldn't. So we decided to put tags onto trash and follow the trash. Here was the first deployment. You can see we started tagging many, many different objects. Can we have the audio please?"

(Music)

And then after tagging them, we started following them. This is 3000 objects, 500 volunteers from Seattle. You see the day of deployment. After a few days, you see the main landfills next to Seattle. You have the things up there but then we're surprised actually, things have been to thousands of kilometres nobody expected this. Sometimes in a clumsy way, see the trace went all the way to Chicago and then down back to California, especially these wastes, cell phones, cartridges, all of these electronic things after more than one month, two months. (14:28) the symphony was for this. But anyway, this is an example of how we can sense things in different way. Here's another example of how this layer of technology can actually change the most basic things in our life like a bicycle. This was based on a question by the Mayor of Copenhagen who came to us asking all of these pervasive, ubiquitous computing how can they change traffic. Traffic in Copenhagen actually means something like this. Copenhagen has a lot of cars a few decades ago, now it has large amount of bicycles. 30 to 50 per cent of all trip everyday is done by bicycle so we came up with this idea.

(Video presentation)

"Welcome to the Copenhagen Wheel, the wheel that turns your ordinary bike into a smart electric hybrid, quickly and easily with no additional batteries or wires. The Copenhagen Wheel allows you to capture the energy dissipated while braking and cycling and save it when you needed boost. Control through your smart phone, the Copenhagen Wheel becomes a natural extension of your everyday life. The Copenhagen Wheel is your personal trainer, sensing your effort level and providing you with real time feedback about your fitness and exercise goals. The Copenhagen Wheel also enhances your experience in the city. It connects you with things the cyclist wants to know - upcoming traffic congestion, road conditions and pollution levels. Just keep your data or show it with your friends and other cyclists through social networks like Facebook. As you ride, you also collect green miles. It's similar to a frequent flyer programme but good for the environment. Elegant, responsive, smart - a new mode of transport for a rapidly changing world. So turn on your bike and turn on the city, the Copenhagen Wheel."

Well here you can see the city, the bicycle in the city with the Mayor of Copenhagen. Just a final thing, so all of this is actually changing our individual behaviour. We can get information, it's changing our (16:32) it's really changing as a response all our biddings (?) in our cities. So we're involved in a few new cities projects all across the world from Latin America to Middle East and Russia and Asia. But I just want to finish with a couple of images how it's changing architecture. With this project, it's building for the world expo in Zaragoza in Spain in 2008 and the mayor came to us asking, the theme of the expo was water, and he said can we use water today in a new way because of technology? So this idea come up of actually pipe as you see here with many valves

opening and closing very fast and creating like a living curtain made of water, something where you can ride, you can show images and it will respond to you when you (17:16). So we're commissioned to design the building of the entrance of the expo.

The whole building is made of water. All the walls are water where you can actually see, you can show images, patterns and all those are windows where your project opens up to let you in. When you're inside actually, all those walls will then move. It can move and expand and shrink based on you have so the café expands if there's more people, if you need space. The roof is also covered in a layer of water and then if there's too much wind actually you can lower the roof to minimise flashing or at the end of the day, you can actually close the building and the whole architecture disappears hopefully without anybody underneath. But here's the building before the opening. You see the building becomes almost like a computer, they response to you. This guy was very puzzled if you look at his face. It was the digital and physical adding projections onto the water at the opening. It was myself trying not to get wet but actually one night when all the sensors stopped working, all the sensors are controlled by computer, the computer crashed so that night we were terrified. We didn't what would happen but that night was actually one of the most fun nights when thousands of kids from Zaragoza, from the city came to the building to play a new game like this. Can you just press for the video? I don't know why it didn't start. Can you just press, play on the video? I don't know why, if you just put the mouse, yeah, if you can just press the arrow, it will start. I don't know why it didn't start automatically. If you go back one, you can just press play on the left, to the left there's a real arrow. Sorry about that. Can we just press the little arrow? Thanks. Click there, all right, can we just click, okay. All right, we'll skip that. That was the last one. I'm sorry; it was very fun actually. People start playing with the building in a radical new way. For me, it was actually the fact that as engineers, as designers we always design things that we think help people we interact with but actually the reality is, especially human reality, always a surprise and that's what we should start with when we design smart cities. Thank you."

**Mr Fernandez:** "The video was a bit too smart for the technology, I think. But I like the image of the city as a Ferrari car and it's reacting to your senses and adapting as you go along. So we have the idea of the city as a knowledge city, a city as a sensing city. Now we come to Guru who is going to talk about city as smart cities, which is the meat of our discussion today."

**Dr Banavar:** "Thank you so much Warren. I want to build on what my colleagues have already started. I absolutely agree that at the end of the day, a smart city must provide better services to citizens and must manage its resources better, whether it's natural resources or man-made resources, it should manage the resources better. I think I want to sort of step back a little bit and think about what is different about cities today compared to let's say 10 years ago or 100 years ago. Cities have existed for thousands of years now and many cities have evolved in a pretty smart way. So what is making cities smarter now? I think there's a fundamental new observation. I think it goes back to the discussion about sensors and data which is that in the last maybe five to 10 years, there's just an explosion of new information that's available about everything around us, starting from the physical infrastructure, the services that we all depend upon, whether it is health or education or any other service within a city and all of the activities that have happened within the city because of the ubiquity of mobile devices

and ubiquity of information captured about everything we do, processes and activities and entertainment.

So the question that I think we should ask now is what can we do with all of these new information that available within cities. Any city that you go to, there's a huge amount of information that's already been collected. So can you do with that information? It's not enough to say that you have a good physical infrastructure in your city anymore. You have to say something about your digital infrastructure. What kind of a digital information do you have to capture and harness the information that is being generated to run your city better, to experience your city better from a citizen's perspective? So I have come to the conclusion that information is this new resource, just like we have land and water and air in all the traditional and buildings and everything else. Information is a new resource that we need to use better and the amount of information that is being generated is huge. I mean, every year we generate something like a zeta bit of information, which is times to the power of 21, and the question is if you are going to use that information better, what kinds of technologies would you need in order to understand that information because you can't just understand that scale of information with the human mind and how can you then make better decisions based on the insights that you get. So for me, fundamentally the idea of smart is to be able to harness the information, understand it and make the rights decisions about it, whether you are citizen making decisions in your everyday life or whether you are a manager or a governor of a city that makes decisions about the resources and services of the city that affects a number of people?

So with that definition, I would like to go to the domains of our life in which information is available and how can we use it. So if you think about transportation, we have information about the volume of traffic, we have information about the state of the lights, we have information that has to do with the patterns of movement. If you think about safety, you have information about incidents that happen within a city, you have information about citizens which also means you have information about criminals, potential criminals and you can use that information in ways that can make policing and safety much better. We have information about the buildings and the infrastructure that can help you manage emergencies better. All of these information are available and you can even think about social services. We have information about who is needy and what kinds of services are going to be the most relevant to them. And if you are a service provider, you want to also make sure that who's eligible for certain kinds of services, whether it's employment services, social services and so forth. So there's a wide variety of information including water and energy and everything that's available to you within every type of endeavour within a city.

Once you have that information, the question is how do you use it to make it, make more efficient use of it and for that you come up with the idea of models. You can build models of your transportation network or your energy grids or of your building use or of your social networks within the city. So all of these are models, which are essentially representations of the real world in the virtual world. Once you have the models, you can start doing very interesting and useful things such as analysing it, predicting what is likely to happen in the future. So for example you can predict when, you not only

now what kind of traffic volumes exist right now, that's real time information, but you can look ahead an hour and see where congestion is likely to occur in the future, or if you're a police department, you can look at one of these models and try to predict what kinds of incidents are likely happen tomorrow at this time or later in the day. So if you have a limited police department, you can deploy them in the right way. Or you can look at demand and supply patterns. I think you mention already about how to manage demands and supply. You can understand the demand for energy, demand for water because you have these complex models and then you can manage the supply resources to match the demand.

So once you have these models and you're able to analyse it and start understanding the behaviours of these systems and then start predicting the outcomes that are possible in the future, you can be a lot smarter about what you do. You can plan ahead, you can optimise the resources that you use and that's where the crucial differences that is possible today that wasn't possible 10 years ago. There's new kind of information technology such stream computing, that looks at fast moving data, high velocity data in very large volumes that you can make sense of because this data becomes invalid very quickly. If you're thinking about the number of RFID tag that are out there and the amount of information that are coming in to tell you the state of the supply chain for example, that information is invalid very, very quickly. So you have to make decisions in a split second about huge amount of information. Now there's new algorithm available for making those kinds of decisions. Similarly, for transportation networks and safety networks and buildings and everything else. So we have in IBM have a programme for smart cities where we develop these advanced models and data management techniques, prediction techniques and also integrating all of these silos of information that's available across the department within a city because once you combined information, you can be even more efficient and even more optimal in the way you manage a city and the way you use the services.

At this point, we have about 2000 projects that we're doing around the world in many different silos and in integration of the silos to form a holistic city, I have several examples. We have a booth downstairs that shows many of these examples but one example I just bring up quickly here is the city of Rio de Janeiro where we have been able to integrate information from 30 different departments within a city starting from transportation to civil defence which is a safety centre, social services and waste management if you will, water, energy and so forth so that there's more unified decision making, coordinated decision making and as a result of that you have better city, better planning and at the end of the day it improves the governance of the city because the city is able to make better decisions and preparations or major events for example or in reaction to major events within the city crisis or disaster and so forth. And so I would like to end with the thought that at the end of the day it's going to provide better s and it's going to support better governance within the city."

**Mr Fernandez:** "Thank you, Guru. I like the idea of it's about better services to citizens because gathering information is a means to the end and in the end is better services for citizens. So I want to come back later to some of the examples that you have of how it's actually playing out in real life which members of the audience might be interested to find out, how it might apply to their own cities. But before we do that ..."

**Prof Ratti:** “If I can say something maybe for the discussion later, just one quick thing but I think we also need to pay attention because in this, there’s also some of the charismatic smart cities. So smart city is not just the innovation, not just about computer so let’s just discuss it further perhaps in the first round of things. But I just want to add this as follow-up before the next.”

**Mr Fernandez:** “Sure, we’ll take it up during the question and answer but I thought we should move to Ronnie Tay, the Infocomm Development Authority CEO in Singapore. Who better to talk about the use of information than Ronnie? So please Ronnie.”

**Mr Tay:** “For smart cities that are many examples of such initiatives, smart cities initiative in the world today. Some of them you can find new cities or some of them in more established cities. But I think many of them have similar goals, goals such as enhancing the liveability of the city or in optimising the scarce resources that are consumed in the city or enabling sustainability, a sustainable development. And this could be achieved through various initiatives such as reducing human and vehicular congestion and offering enriched location-based services to residents and consumers, having smart buildings and smart grids with the idea of conserving the use of scarce resources such water and energy and even space. So while cities may have similar end goals, the approaches that it takes in the implementation of smart cities can be quite different. But I think there are at least three fundamental elements in smart cities. I think one is that ICT or information technology is a common crosscutting enabler, enabling infrastructure that brings together the different urban infrastructures together to enable interconnectedness, to enable intelligence. So therefore ICT, infocomm technology can be the backbone of a city.

Secondly, traditionally cities are organised with their different domains such as transport, water, electricity for example acting quite independently with their independent functions. So in smart cities, there’ll be a need for greater coordination, greater interaction and integration across these different domains. And so therefore there’ll be greater need for more systems-of-systems so that the different sub-systems in one function can operation as part of a larger whole. And thirdly and very importantly too, there is a lot of data to be dealt with because with all the network devices and sense that can create, that can transmit data and communicate data, there are literally trillions of bytes of data being generated. So therefore the management, the analysis of this vast volume of data to recognise the patterns of economic and human activity would be important as part of understanding a smart city. So I think there is great potential to leverage on ICT to meet the goals of a smart city both in transforming the vertical domains such as education, healthcare for consumer services as well as in leveraging ICT as a common infrastructure on the backbone for sensors, for data and for services to be built on top of it. Then that brings together different domains to better control, to better manage and optimise resources.

So there will therefore need to be closer coordination and interaction between the different domains as well as between the different layers of the eco system. But because there is, data is fundamental to all these, I think in the drive towards building smart cities, there’ll be a need to leverage on big data to address what is commonly

known as the 4Vs of data. V for volume because there's a huge volume of both structured as well as unstructured data that's generated by the multitude of sensors and devices. Velocity, because data is being generated literally on a real time basis and we need to incorporate that data for up-to-date analysis. Thirdly, the variety of data because the data will come from a wide array of sensors, of sources as well as formats and the veracity or the accuracy of data because the data is being derived from different sources and even bases. So I think as we build smart cities, we will need to also enable capability development, development in areas of infrastructure, in areas of technology and in the areas of even manpower because you need to have infrastructure with the sensors and the grids. You need to have the technology, such as cloud computing, such as data analytics and you need to have the manpower to be able to manage, to incorporate the use of technology into the different domain areas and to utilise and make sense of the technology. So while there is no sort of common definition of smart cities, I think the key elements are the contributing factors to smart cities. So I think in the end it is really about leveraging the potential and the opportunities of ICTs in the course of building smart cities."

**Mr Fernandez:** "It's clear to all of us that it's about the integration and the processing of that information. I think many of you would have had the experience of travelling to one city to the another and you arrive at the airport and you fill up a form and when you leave the city, they collect the form again and I often wondered what do they do with all these forms. Did they just throw them away or did they have the infrastructure to actually collect that information and process it, put it to some meaningful use, which I think you're alluding to. Hun Kiat started off by talking about partnerships between business, governments and citizens and I think that's a good point to lead on to the Yasuyuki on what businesses can do to help cities become smarter and more efficient."

**Mr Yasuyuki:** "Okay, thank you very much, Warren. So I will talk more about a different angle, from a different angle. I'm talking about the energy solution. Rising population, high economic growth and rapid urbanisation have led to enormous energy demand in Asia. Hence, energy security is high on the agenda of many cities' administrators. A smart city is the one which well conceive energy efficiency strategy. Having a smart city is not only to achieve comparatively lower energy consumption but also to enable people in such cities to improve their quality of life. In addition, there is renewed attention to save and secure energy infrastructure following the great East Japan earthquake. Against this backdrop, Panasonic is focusing on developing a concept of safe and secure and sustainable smart cities which embrace the nature to the full extent as well as produce energy for local use in the cities. We also want to provide consumers with solutions that allow them to achieve a comfortable green lifestyle and enhance the economic merit of their property. Our approach to developing a smart city is to create energy solution where energy strained and energy saving must play their part along with the energy creation. Finally, to implement to energy management solutions that joins ..., homes and buildings together in the network to achieve greater efficiency. In other words, to marry infocomm connectivity with energy efficiency and technology innovations.

As different cities have different needs, we aim to provide a solution utilising a best mix of variety and resources. This can be seen in the project like Tianjin Eco City in China,

Punggol Eco Town project in Singapore and Fujisawa Sustainable Town in Japan. In these efforts, a collaboration between public and private sector also play a key role. In Tianjin Eco City, we collaborate with Hitachi to introduce our home energy management system, commonly known as HEMS, adding to community energy management system that we already developed. It is important that all systems link to energy supply and energy demand must be linked towards industry. Such a thing will promote commercialisation of both systems to more smart cities. In Singapore last year, we partnered with three Singapore Government agencies to start Asia first public housing test-bed of total energy solution in Punggol Eco Town. The project test-bed integrates energy creation, strains and saving solutions into existing public residential building. It also test-beds the integration of home energy management system to smart metres and smart grid that EMA is piloting.

The strategic relationship between infocomm technology and energy efficiency solution is another key focus in smart cities. Panasonic's home energy managing system as mentioned in the project is part of that infocomm technology that will enable house hold to monitor and better manage energy usage by a smart phone application. In addition, a home energy managing system connects the smart meter and smart grid to home appliances allowing a response to enhance efficiency and resilience to the smart power system obviously. The main response is managing the customer's electric consumption in response to the supply conditions. However, developing technology alone is not enough. To achieve smart cities, we need to convince users how these technology will benefit them without compromising their comfort. Thus our test-bed are not only to prove technological concept but also to (14:39) all stakeholders value, including resident's response to the technology. In summary, to achieve the goal of smart cities, we need to pursue the comprehensive integration approach through both infocomm technology and technical innovation of energy efficiency. Best mix of energy solution based on the creation (15:05) saving and management concept and the collaborative effort of all stakeholders can achieve comfort, sustainable and efficiency for the entire city. Thank you very much."

**Mr Fernandez:** "Listening to the five introductory presentations, it seems to me that we can arrive to a sort of common idea of what a smart city is. It's about using information in a smart way, joining the dots, interpreting that information to help develop services which are integrated, interconnected and deliver those services to improve the lives of your citizens for energy efficiency, for more sustainable cities. That seems to me the big picture overriding, the overarching scheme of things. But I think in order to make this discussion interesting and smarter, let's drill down a bit deeper to real-life examples of how this is playing out in cities around the world, what made that happen because that's where you get into the nuts and bolts. So maybe Guru I can ask you, I saw some adverts in my newspaper today for IBM where you had examples of smart cities and applications of some of your work. That would be interesting for the audience to hear as well and that will get you into the discussion that how are you getting into this as well, so please would you? And then I'm going to throw it open to your questions so if you want to start framing your questions, you can either come up to one of the mikes afterwards or you can send me the questions on the system that we have and it will appear on this iPad that I have before me. So Guru, over to you."

**Prof Banavar:** “Okay, thank you, Warren. I am going to try to use examples in a few domains of interest so let’s start with transportation. There’re many good examples but I’m going to pick the examples of the city of Stockholm which implemented a road charging system a few years ago. There was initially some public opposition to it but the government went ahead to do that and eventually they saw many positive results. One positive result they saw was a 20 per cent reduction in congestion incidents in the central business district and that had other secondary and tertiary effects. Secondary effects like the amount of carbon emissions went down by 12 per cent, the number of citizens that move from private transportation to public transportation was something like 40,000. And then there were tertiary effects which were like more people walking in the central business district that increase retail sales in the central business district and there were a number of asthma cases fewer in the city, et cetera, et cetera. So there was lots sort of ripple effects of that decision that the government made and now, there’s a lot of acceptance in the population that this was indeed a solution.

If I were to pick an example in the area of public safety, I just want to mention before I go too far away that close to Singapore in the city of Davao in the Philippines, the mayor, who’s by the way here as part of our discussion, has just made a decision to implement a smarter public safety system which includes video and analytics that can, with the goal of reducing the number of criminal incidents. But that’s just starting off but an example where we already made a significant quantitative difference is the city of Memphis. There are many other cities, including New York City is where I live, but the city of Memphis we have used analytics for helping the police department to deploy their resources, limited number of police officers to right district within the city based upon a prediction of the number of incidents that are likely to occur and that has not only allowed them to use limited resources in a better way but reduce the number of, the most serious types of criminal incidents by about 30 per cent in the few years that we’ve been doing that work.

An example that I want to use in the area of water and energy is the city of Dubuque in Iowa who’s mayor is also here among us today talking about how citizens’ behaviours change when they saw the patterns of usage of water and energy. So there’s a portal which provides information at an individual household level through the use of smart meters and at the level of communities to show the collective use and that according to him has changed the behaviour of 60 to 70 per cent of the people in these communities to be more energy aware or water aware in their daily use. So that’s actually a powerful way of saying, seeing how people can actually make a difference to change their lives based upon new information that they get. I think I’m going to use those three examples.”

**Mr Fernandez:** “Thank you. Those are good examples, I mean. Carlo, you want to jump in on this point about?”

**Prof Ratti:** “Yeah, I’ll just have a couple of comments about, but I think Warren, you’re absolutely right. Smart cities are about, we know much more about the city in real time, we got all these data coming in. It hasn’t been mentioned today but if you take hold the data produced by humanity from the beginning to 2003, that amount of information, now we produced between two days and one day, so this scale of how

much new information that we have. And then smart city is really a lot of these information is generated to cities and we can respond to that and as we respond, we create feedback loops that happens with different time scales. Some of them are in real time. We see a traffic jam and we can change our pattern to go to work, some of them happen in the longer term, can be planning a city. We use this data to better city, how it could develop and so on. So this is really the essence of smart cities. But, there's a big but, the devil is in the details. How you want to do this? In this, you can do two ways. One way is a very open way where this information is made accessible to everybody and then people will create their own feedback loops, then we create many, many ways of empowering citizens and to improve quality of life because of that. I think this is really the way we should all do it in all cities across the world.

If you take it to the extreme, I sometimes argue, one could say a smart city has been or is the city of Cairo where the actually the Arab Spring happened or somebody sees the Arab Spring happens because that's really about using new technology in order to empower people to do new things, like it or not like it, but it's about really data that's being used in order to promote incredible change. The other way and I think we should all be concerned about is the way we simply think that the city is a big computer, that we can put cameras and reduce crime, we can just do road pricing and charge people for what they do. I think that is a very scary prospect. For a number of reasons, and if nothing else, because as our computers that system is going to be not a robust system. Now let me make a quick example here. What we are creating basically is a cyber physical system, what we are talking about in other terms and technical terms is cyber physical system where yes, we are connecting digital information with physical system, in this case the city.

Now we're all familiar with the, if we think about cities just as a computer to optimise, to put cameras, to reduce crime and those types of thing, it's not scary only because of its big brother implications but it's scary just because of the resilience of the system. Now, we know these computers if they are done especially programme in a closed way, sometimes they get viruses, they can crash. Now if your computer crashes it's not a big deal but if a cyber physical system like your Toyota Prius, that's basically computer on wheels, crashes it's a problem. If your virus just changes say the gas pedal in the brakes, then you're in trouble. The same can happen to your city. The same we saw happened in Iran with (inaudible) and will happen with the Iran nuclear programme. But we're going to see much more than that. So that's why I believe the only way and that's only the big fight we all need together fight is really beware of people who thinks just information, there's always information, we can just apply all these wonderful tools, computer science and treat the city as a computer. It's going to be very dangerous. The point is how this information can empower us to have a better quality of life and is a consequence to change our cities."

**Mr Fernandez:** "Paolo, there's a good follow-up question from someone in the floor obviously reacting to what you're saying because it sounds like smart cities are going to be highly capital-intensive, going to be very expensive to set up. It's almost like a Ferrari car but many cities aren't ready to have a Ferrari car. They are still at the level of a Cherry QQ or a Toyota. So how do we get to that point where you have this kind of city that you're talking about?"

**Prof Ratti:** “But actually I don’t think so because again the case of Cairo for instance. If you analysis what happened in Cairo or the Arab Spring, it’s in a way that cycle we were talking about, about increasing information, real time information, localising information that people use, using tools that were developed the past three to five years or 10 years, using Foursquare or Flickr or Twitter or Facebook, but quite recent tools and actually use that information in order to promote incredible change in the scale, in the case of the government governance and so on.

I mean, what we are seeing more and more is actually the smart city, this again a point if you think about smart city in top-down way is a big computer. Yes, it’s capital intensive but if you think the smart city as just as any neighbour, and using technology in a smarter ways, we can all live better and we can all make decisions in a emerging bottom up way, then actually the amazing thing is you find it, as they said, Cairo there’s no investment there but this incredible movement and in many other cities has been developing. So it’s again about this distinguishing that we’re all aware about it’s about top-down versus bottom-up and really this is going to shape how, it’s going to shape our common urban future. So it’s a big debate today. We should all be aware of it and of the difference and so that’s why I think smart cities are an exciting field, it can really revolutionise all what is happening in the urban scale but we need to be very careful.”

**Mr Fernandez:** “Thank, Carlo. I can hear the passion in your voice. Are there questions from the floor? I’m getting a whole bunch of interesting questions, questions from the floor. From this gentlemen, yes, please, just tell us who you are and where ...”

Q: “(inaudible)”

**Mr Fernandez:** “It would help if you could speak into the microphone so people can hear the question. Thank you.”

Q: “Hi, my name is Vijay, been involved for about a decade in large land area based development in India. This is almost coinciding with the dotcom buzz. I’ve been hearing from them almost about a decade, IBM and others, are about to launch what you called the digital utility, the cyber equivalent of the physical infrastructure. I haven’t seen even from your examples one city where you have integrated your own layers from network to hardware to software to apps, all functioning at least in a small village. Is there an example because I don’t think you can or any of us can hope to connect the multiple dots of the silos if we can’t connect our own layers in IT?”

**Mr Fernandez:** “You like to take that question?”

**Prof Banavar:** “You’re right that integrating everything across the board is very difficult to do and maybe not really necessary in its entirety, right? The question I think we need to ask what is the outcome you’re looking for. So for example, if you’re looking for an outcome that requires the response time for an emergency to be reduced by whatever per cent, let’s say 10 per cent, 20 per cent, 30 per cent because it means lives, human lives and it means loss of property if you don’t respond to it quickly, that requires integration across some set of silos which includes a police department, a transportation department, a health department, fire department. So you take the used

case that you are interested in based on the outcomes that you're driving towards and you have to integrate the information required for improving your response. That's the kind of example that you're driving for. I mean, you don't integrate for integration's sake. You integrate because you have an outcome that you're trying to achieve and without that integration, you cannot achieve that outcome."

**Mr Fernandez:** "But is there an example where it has happened? I think that is his question."

**Prof Banavar:** "Let me, I think the case of Rio de Janeiro I brought up earlier has integrated just for emergency response, just to pick that one example, they now have integrated information necessary for emergency response across eight departments and according to them, it is reduced the response time by 30 per cent. So again, start from the outcome, this is not a technology discussion, like somebody said. It's about offering a better service, in this case it's service of emergency management and if you can reduce response time by 30 per cent by integrating those eight departments that happened to be not integrated in the past, I think that is not only worthwhile goal, I think that is something that we should try to replicate as much as possible."

**Mr Fernandez:** "Thank you, Guru. There are a couple of question here, I think, I think let's move on so we get more question from the floor to be fair. I think Ronnie, there are a couple of questions I think directed at you. Firstly, how do we ensure that all these information that's being gathered is used in the service of citizens rather than the corporations or the state, that's one. And the second is what can Singapore do to it an even smarter city?"

**Mr Ronnie Tay:** "I think the end goal of smart cities effort would of course be for the citizens and for enterprises. So therefore I think in structuring various initiatives and bringing different layers together, we have always, could ask what is the outcome we want to achieve. So maybe an example of what we can do in this regard, so for example earlier the question was about bringing the sensors and the data and the service together. So one way that we are looking at is what do you call in positioning information. You go to a shopping mall or a building. So if we are able to bring together the information about the people through let's say their hand phones, through Wi-Fi connectivity, we've done some experiments and pilots in this, so the sensor then would be the hand phones with the Wi-Fi antenna knowing where the individuals are and putting them together. Then being able to do the analytics, putting onto the platform, being able to create the so-called heat maps, meaning to see the flow of people. So I think that's the data and that's the information and how would you make use of that? By knowing the flow of people within the building between the different floors, especially if you have the vertical dimension of information as well, then you would be able to use it for a variety of purposes whether it's to offer location-based services to the individuals or for the mall owner to know which parts of the, which shop units within the floor tend to attract more people and therefore that can affect pricing decisions.

If you're talking about providing amenities like whether it's a snack shop or a transport service at whichever outlet or whichever exit of the mall, you can also better plan. So

that allows you to create insights. So in the end, I think it would be the consumers, the people both patronising the mall as well as the enterprises, the shops within the mall can benefit from this example. So I think it's about and I think you can also leverage on economies of scale if you can bring people together so that you don't have within one mall different entities trying to provide such services. So I think if you are able to structure a platform, a common platform that people can draw out from the same sets of basic data, then sharing from the same sort of layer of analytics and data, and then different entities being able to take whatever it needs to service that it wants to provide, then I think that would be the way I think we can actually implement such smart cities solutions."

**Mr Fernandez:** "I saw a few hands go up. Yes, please."

Q: "Hello, hi, my name is Faye. I'm from MIT and I'm here working at the city for MIT (?) Hello, Professor. So I have, first one, to say thank you for your comments and presentations on this topic. It's been really awesome. I have a kind of multi-pronged question. Firstly, what's the hardware for feeding the basis of a smart city? Not everyone has a smart phone, for example the elderly, so are there other ways that these smart devices can be integrated into our cities possibly by hijacking current or even obsolete infrastructure like telephone booth or something? Thank you."

**Mr Yasuyuki:** "If we look at smart cities, these kinds of smartphones or some sort of RF types kind of things since it's a kind of sensor. But they are affordable kind of radio frequency technology or high city (?) technology, we can connect all of the existing device to the smart network. For example, as I mentioned, we can connect the home appliances and we can connect the homes and buildings as a part of a smart city. And we can connect via smart meter and smart grid, then we can integrate to achieve a very much affordable and better energy efficiency. This is one of the outcomes of the smart technology as from the hardware point of view."

**Mr Fernandez:** "Does anybody else on the panel want to add to that?"

**Mr Tay:** "Just want to add that in China, the major cities, including second and third tier cities, the use of hand phone has been very pervasive and you notice that in fact the habit of Chinese in many of these cities, they use smartphones or ordinary phones for transactions, including ebanking, purchase of tickets and for commercial activities. I think there is a great opportunity for such a media to provide services to the residence and even for the government to pump through these devices for services we provided for. If you look at Belgium, you look at the city of Luxembourg and the common areas are all with Internet access and with mobile phone access we can get to government services, we can do transactions. I think in China, the infrastructure do allow for such an opportunity and the user market is huge. So I encourage you to work more on this smartphone and there's great opportunity in China's city."

**Mr Fernandez:** "Carlo, you wanted to jump in at this point."

**Prof Ratti:** "I mean, just very quickly, I mean it's a great question. So basically we said before, all of us, smart city is all about these data we collect and the question is what

the infrastructure we need to deploy for this data. Now there's a very interesting point that for some of these data we employ new infrastructure. If you think about loop detector more of them, you got more and sensors into street lights in the city so some of these or think about smart energy, smart grid, then we deploy some of these things. But the amazing thing that a lot of the big changes over the past few years actually happened in the opposite way by hacking almost existing infrastructure. Data is produced for other things. Think about all the data that's produced through cell phones. Now in some, each of us but for different reasons, smart city reason we have all become like walking sensors. There is probably like 200 accelerometers in this room. As we speak, there's probably a few hundred cameras on all the devices we have.

So because of that all of these information, all of these is like an infrastructure that are developed for other purposes and can be used for smart cities. So this is quite the beauty of it. There is also the way smart city that's being developed that's democratic in a bottom up, not really by doing big investment on new sensors. Yes, you need also that if you want to do, if you want to look at traffic and a few other things. But it has happened not through this. In one of the most beautiful sources, it's actually today more and more of these user-generated content from Flickr to Facebook to all the online database we all produce can tell us a lot about our environment."

**Mr Fernandez:** "There seems to be a thought that's running through many people's minds based on the number of votes for this question that's come on my iPad. Essentially people are saying we are painting this utopian vision of smart cities and information being gathered. What about the privacy of citizens? Do people really want to have this information about them and process and interpreted and worked upon? Can I throw this question open to members of the panel? How do citizens feel comforted? It's not impinging on their lives. Go ahead, go ahead."

**Prof Banavar:** "Absolutely, I think privacy is a key concern and we have to have all of them mechanisms available for people to protect information about themselves. I believe that the maturation of these kinds of services will ensure in the appropriate societies and political environments that the right safeguards are going to be in place and this technology support for privacy at various levels? The question is what kinds of regulations will make this and what kinds of market forces will make this be adopted faster or slower? There's also another thought I want to put in the picture here which is that I think it's going have to be, I mean I completely agree with the point it has to be open platforms and open data. It's going to allow more engagement and more participation. But at the same time, I think there is going to be certain systems where you will need larger capital outlays and there is going to be certain systems in which you will mostly need citizen participation. So it's a combination of those things that has to come together. It's not one or the other. It has to be a combination and on top of that, there's got to be the right level of open protocols and open APIs if you will for people to leverage and harness the information and the right mechanisms for safeguarding the privacy. That's I think the core."

**Mr Fernandez:** "Ronnie, you want to jump in on privacy?"

**Prof Ratti:** “Sure, I just have a couple of thoughts. On the privacy, I think it’s a very important point. But it’s a point because much beyond smart cities, forget for a moment about cities but think about something else there’s actually one, or the most innocent thing you can think about, taking pictures. Now in the old days, in the analogue days, what will happen is that people will take pictures, the picture will be printed on a piece of paper. People won’t take too many pictures because it was expensive. Then it would end up in the drawer and stay in the drawer for maybe one year, 10 years, 20 years, 100 years and then disappear. So nobody ever thought that taking pictures was really a big invasion of privacy. In the digital world, the world that is, the new world, the new system, actually everybody is like a walking camera. We are taking gazillion pictures everyday. All of these pictures go online, they stay there, they can be tagged. You might know the debate about Facebook acquiring face recognition software so from the picture you know who the person is and so on and because of that something is innocent, like taking a picture, can be a problem.

Some countries like Switzerland, actually banned the Google Street View app because of privacy concerns. So just a simple example that shows you what is happening which is in other words, we are creating, we are digitising a lot of things. And because of that actually if you had access to the databases, the databases are not connected but information is there. So if you have access to the different databases, you can probably build every 10 minutes of my life today – when I woke up, when I call a taxi, when I pay a credit card, I check in for conference, the other day when I checked in at the airport – all of that, you can do that. So we think this have very profound consequences. We are almost building a world where it’s going to be very, very difficult to forget and forget actually is human basics, is human vital mechanism. So it’s a debate we should all have, it’s not about smart cities. It’s about the world in general, what is happening. We tried and have been trying to contribute to this debate, we organise a forum at MIT called Engaging Data where we had people from the Obama Administration, from big companies who produce data, from academics, from privacy advocates, all together to talk about these issues. But I think this is another, one of the big challenges that we should all engage because this will shape our world as it will be tomorrow. And this is not really, this is not really about smart cities, this is much, much more profound. It’s about how we live and how we cope with memory and the things that happen on our planet.”

**Mr Fernandez:** “I think we have time for one last question. Let me take it from this gentlemen who has been waiting very patiently.”

**Q:** “Good afternoon, Stephen Yarwood Lord Mayor of the city of Adelaide, also an urban planner and a futurist. A great segue to my question I note we kind of talk about today and I really wanted to ask a question about tomorrow which lead to Carlo really about convergence. So I think it’s very important that people appreciate that 10 years ago we weren’t anywhere near where we are today and then 10 years from now what pretty much has been talked about in this room will be very old school, the acceleration of technology. So I really appreciate somebody maybe having maybe a quick comment on the notion of convergence but my key question is, is it going to happen and it is going to happen in our lifetime because I think as leaders that is something that we need to understand. We haven’t even got our heads around yet. I personally studied this many

years ago. I called it information ecology, this very sense that humanity is going to stop fighting with nature and actually dancing with nature in a way that we never possibly imagine before. So I'm not sure, that's a big philosophical question but ..."

**Prof Banavar:** "Can you just explain what you mean exactly by convergence?"

**Q:** "Convergence, the whole notion of all of this stuff coming together where human beings interaction with the city is seamless to the nth degree."

**Mr Fernandez:** "So your question is, is it going to happen?"

**Q:** "So because you've cited a transport example or an energy consumption example but Carlo is right. We've all got it already here. We are already prepared to have our entire lives seamlessly connected within the urban form and I'm just wondering if this is reality in our lifetime."

**Mr Fernandez:** "You want to, have an answer for that? Do you see it happening already in your project?"

**Mr Tay:** "I would spell out some challenges that prevent some of these convergence trends that may be happening. I would say that technology is there to integrate, to share information and with this big data. One of the issues that has been raised is the privacy versus if there is an emergency situation, would you like the government to be able to respond in a very effective manner to save lives? I think yes, the answer is yes. But do you want them to go to the other extreme of knowing everyone, what they are doing every hour of the day? No, I think that should be a balance over there. And number two, I think the government operations has been all these years with different legacy or system and operating processes to have an integrated system, to have information made available for one government to operate in the entire city, I think will take some time because of legacy operating systems and the silo in their approach and information means power for many of them. I think thirdly the development of technology, be it social media, print media, digital media, it allows for government to listen, to know what is happening from bottom up.

I think that is important that in the past we rely on facts, print media and today it's a digital information that is made available almost to everyone. I think in our city we not only implemented AGT's safe city software and sensor system for the public safety management of five square kilometre area, with a CCTV sensor system and the government is very conscious about having a safe city at the same time, listening to the ground what is happening. I think a city only as good as a smart city if we have happy citizens working there, living there and playing and learning in the city. So my view is that it's going to be very tough to have full convergence and I think it will take some time and let's look at the political will, the people, what do they need. I think there'll be a balance and the technology can do I'm quite sure. So that is my take for the day."

**Mr Fernandez:** "Thank you. We're kind of running out of time and we'll have to continue the conversation over coffee during the break but the remaining two or three minutes, I'd like to address the question that you posed right at the start. It's about

partnerships, government people business and maybe ask each panellist to say very, very briefly in a statement or two what do you think are the critical factors of that need to apply before cities can get smarter and let start at that end and work our way backwards. Very briefly, two or three factors.”

**Mr Yasuyuki:** “Yeah, the partner, private-public partnership or PPP, public, private and people, this is crucial. And look at energy efficiency, this is a kind of mature solution but again will be coming later. So private-public partnership for PPP, including the people, to review the value proposition for the future and smarter investment, this is kind of the key.”

**Mr Fernandez:** “Ronnie, your take to make it happen.”

**Mr Tay:** “I think there’ll be the people, there’s the technology, there’s the enterprise offering it and I think it depends, I think you require the different pieces to in the end have the objectives being met by the technology and by the model that is being strung together because if there isn’t that balance, then you may not be able to achieve the objectives. So I think it’s a constant case of being able to bring the different parts together such that the outcome from applying the technology, from bringing the different parties together in the structure that we created will be able to meet the outcome that you want that will provide real tangible benefit in the sustainable way for the businesses and for the people.”

**Mr Fernandez:** “Carlo?”

**Prof Ratti:** “What is happening now is quite similar to the beginning of the Internet. We welcome many people also who will be involved in that MIT and that’s why it’s crucial to the beginning and we see a lot of similarities. But it’s a different type of thing. It’s about now connecting all these databases. Actually, the last question I think was very important is about how is it going to connect and again I think there’s two way to see it. There’s some experiment. There are also interesting about connecting things at the top so you got big database trying to merge so all these information about the city can be combined. When you combine information, the power grows exponentially. When you have information from the different data, there are things you can do, can grow in incredible way. But I believe that again the way this will happen and I believe for the last question, it will happen, it will happen soon. But actually again in the kind, by sharing the individual information and all of these fusion will happen in the bottom-up way from the people. In any case, we should fight in order to have it like that because this will give each of us the power to see what we want to share, how we want to share. So it’s similar to the Internet, it’s about connecting computer and sharing information. Here is about a similar thing, about all these information that’s produced in space and how, by people in space, how we bring all of it together. We just need to find the right aggregate in, it’s really happening now.”

**Mr Fernandez:** “Guru, please.”

**Prof Banavar:** “Every one of the successful projects that I have known of have involved a partnership and so I think it’s crucial. It happens because different entities, public

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and private and people, citizens share a common objective at the end of the day and maybe one of them makes a decision but there's got to be stakeholders that bring in let's say investment ideas and capabilities in that ecosystem and everyone of the examples I've mentioned before, I can tell who the public players were, how the citizens were engaged, what the private players were in order to make it successful,"

**Mr Tay:** "This 'tripartiteship' I think government, my take is that we're told about it, budget, set your vision, be prepared to change. The technology is there to create a smart city. Citizens will continue to be in this enjoyable journey of having advanced technology, big data and set a standard of living higher in our cities. And enterprises, well, do more R&D and come up with new ideas, commercialise them and implement in the smart cities to make a better living for all of us. And last but not least, I invite all of you if you have opportunity to come to Guangzhou and visit us in Guangzhou Knowledge City."

**Mr Fernandez:** "A word from the sponsors. I'm going to sum it all up by saying in my view listening to all on this distinguished panel, to get smarter cities, you need smarter consumers, you need smarter voters and I also think smarter newspapers. So on that note, please join me in thanking panel for this very interesting discussion."

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