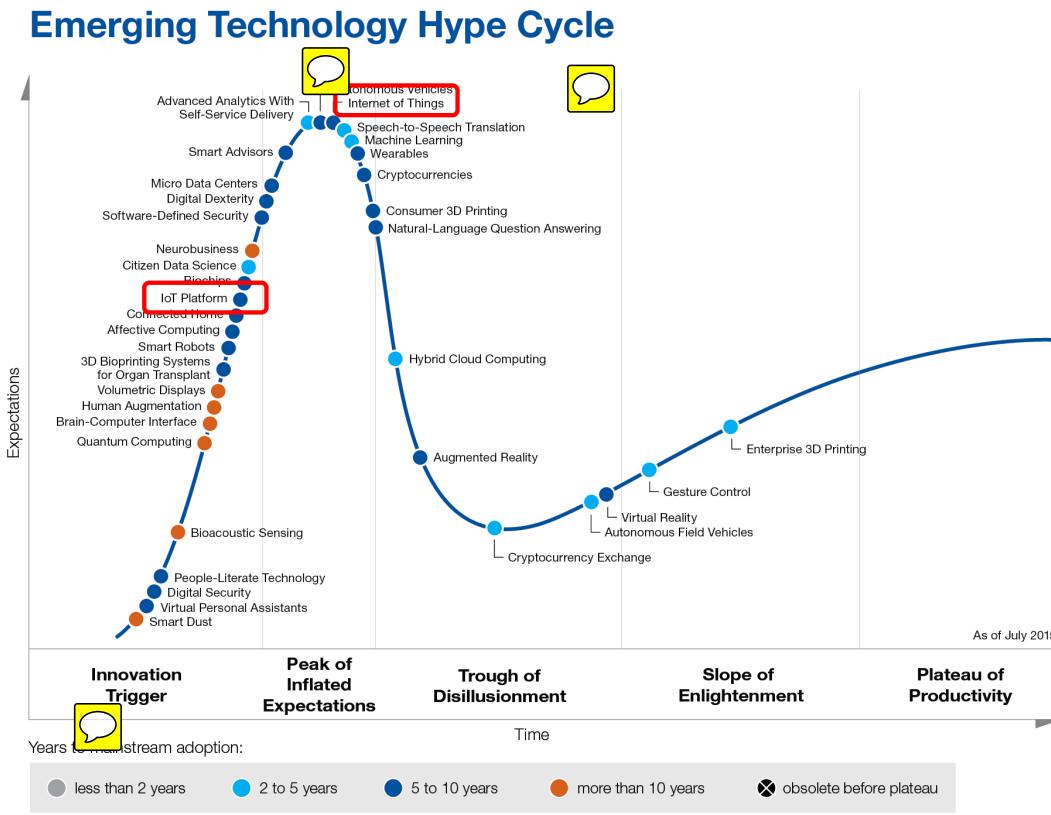


## Outline

- ▶ Traffic Control in the city: Efficiency
- ▶ Smart Cities
  - ▶ Pedestrian in the city: Safety and Security
  - ▶ On-Going SmartCity Projects
- ▶ Discussion - Group by the cities



# Gartner Hype Cycle and IoT, July 2015



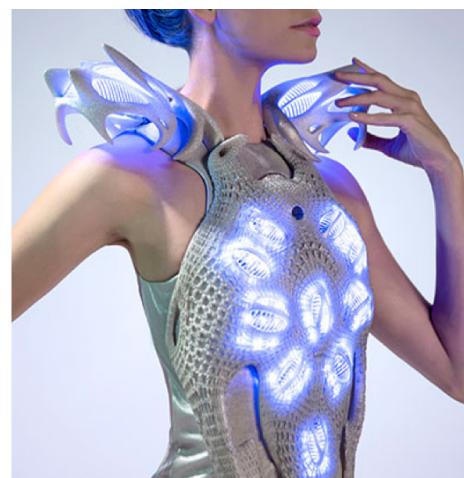
<http://www.gartner.com/newsroom/id/3114217>

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## Smart Applications using IoT

### Making Things Smart

- ▶ Internet of Things (IoT) can be used to build many smart applications
  - Smart Wearable
  - Smart Living
  - Smart Home
  - Smart Building
  - Smart Factory
  - **Smart Transportation**
  - **Smart Cities**



# Traffic Control for Smart City



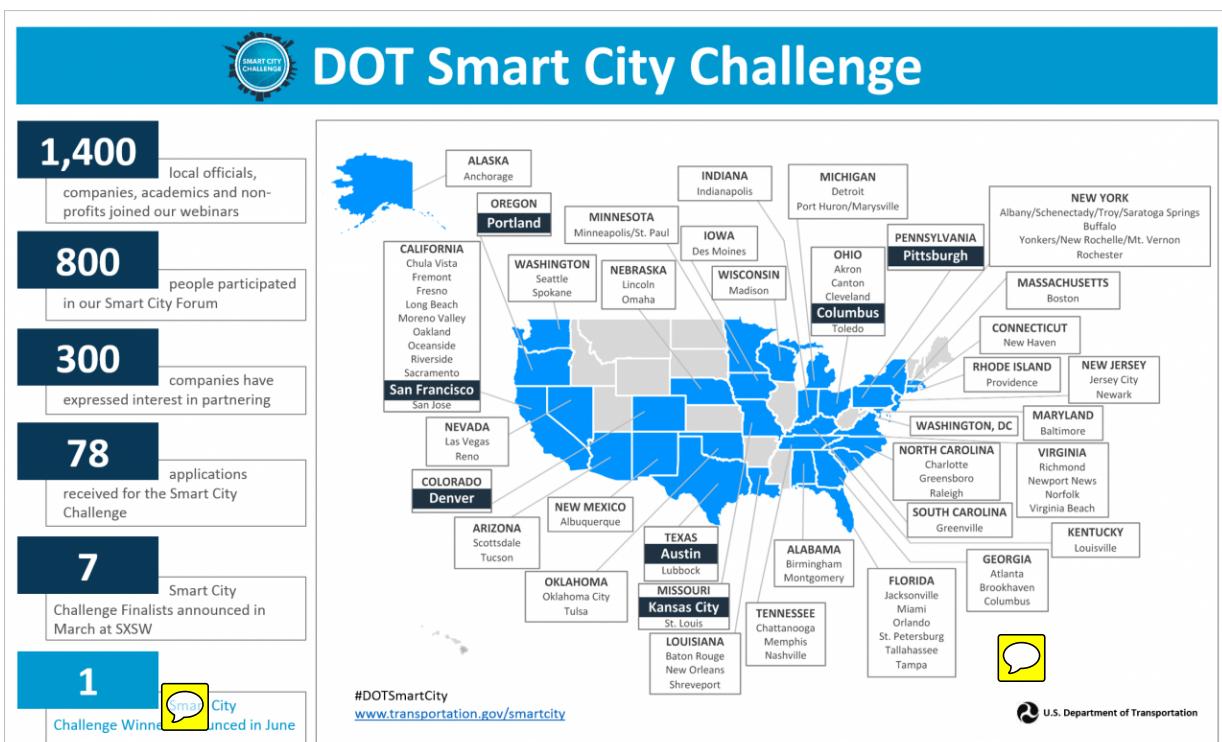
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## Smart City Challenge: US Dept of Transportation

Cities and transportation are major contributors to climate change



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# Winner of SmartCity Proposal (2016)



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Smart City **≠** Smart Cars



*Cities are of the people, by the people, for the people*



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# Intersection without flow control



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## Causes of traffic congestion in the city

- ▶ Congestion is one of major complains in metropolitans. In particular, congestion on intersection.
- ▶ Traffic lights are widely used to control traffic flow.
  - ▶ Unfortunately, *efficiency* is not the purpose of deploying traffic lights.
- ▶ Phased switching process periodically gives non-conflicting flows right to access the intersection.
  - ▶ Delay is part of **setup phase** to clear the intersection, which is estimated based on the travel time for a vehicle in *free flow* condition.
  - ▶ Frequently phase change can reduce average delay for vehicles but setup phase reduces intersection throughput.
  - ▶ One-by-one/First-come-first-serve policy leads to congestion on intersection when the flow is slower than expectation.



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## Is traffic light right for traffic control?



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# Intersection without traffic light



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## Slot-based Intersection (SI) Management

- ▶ Slot-based intersection management can double intersection capacity for twice.
- ▶ Each vehicle approaching the intersection will be assigned a time slot to access the intersection, drives at expected speed, and crosses the intersection at slower speed.
- ▶ Vehicles below to the same flow will be grouped together to access the intersection.
- ▶ The vehicles slow down and speed up to the expected speed before intersection, and do not stop at intersection.

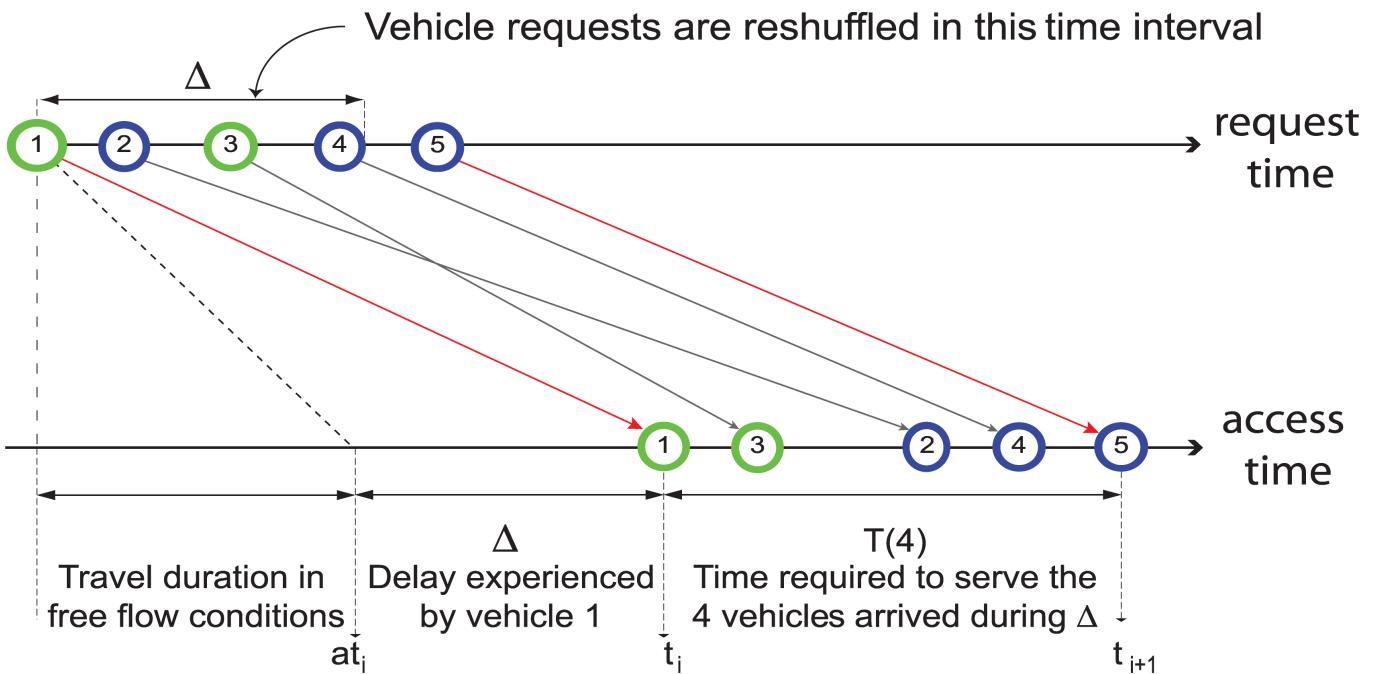
Tachet R, Santi P, Sobolevsky S, Reyes-Castro LI, Frazzoli E, Helbing D, et al. (2016) Revisiting Street Intersections Using Slot-Based Systems. PLoS ONE 11(3): e0149607. doi:10.1371/journal.pone.0149607



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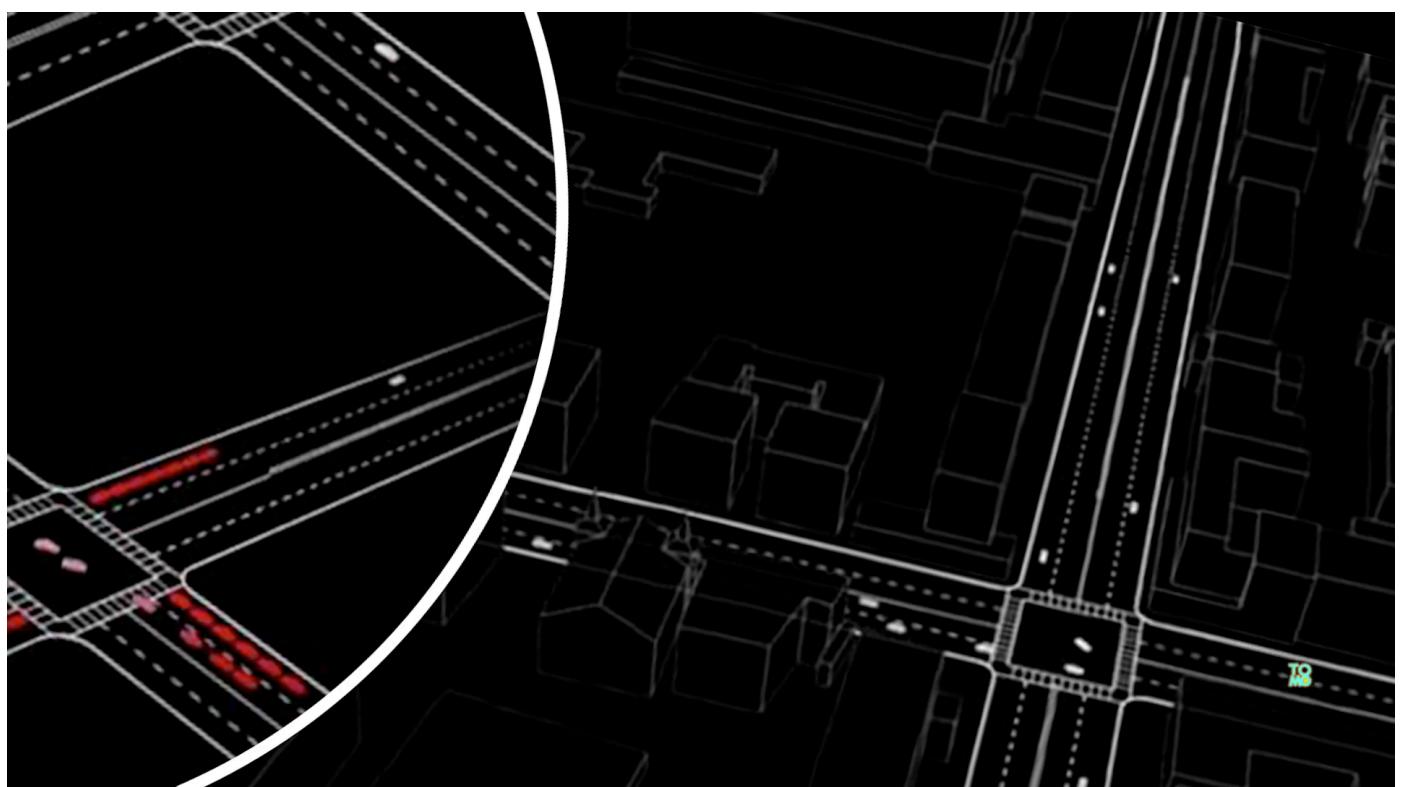
- ▶ The number of vehicles in one group are limited to ensure each vehicle reaches the intersection at the beginning of the assigned time slot.



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# Challenges of Slot-based Intersection Management

- ▶ Vehicles have to make requests to traffic controller and follow the control.
  - ▶ Communication infrastructure
- ▶ Follow the control commands
  - ▶ Driverless cars are more willing to follow the commands.
- ▶ Infrastructure to detect vehicles
- ▶ Exception handling



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## Traffic light vs. No traffic light

沒有紅綠燈 Distributed System

有紅綠燈 Centralized System



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# IoT for Smart City

台灣已經晚了3~5年的發展時間



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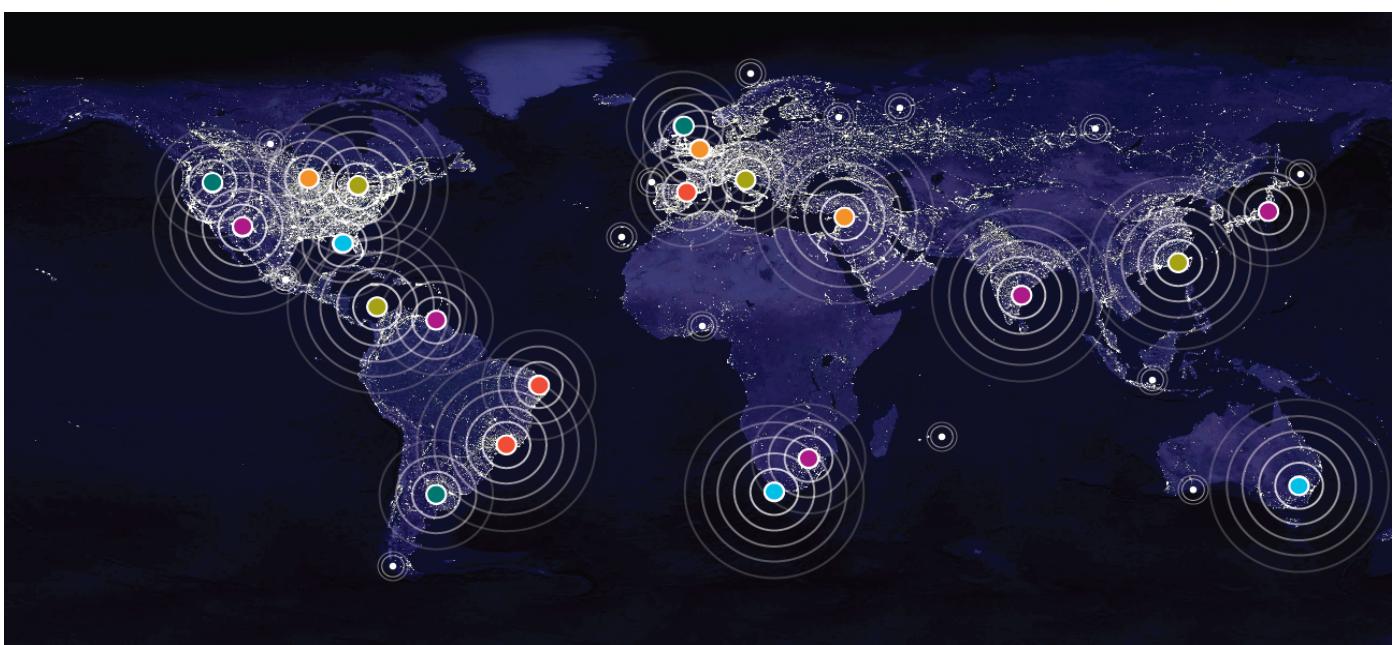


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## A Planet of Cities

人口的集中：人口不斷的往大城市集中(比較多的工作機會，比較好的設施)

In 2007, for the first time in history, the majority of the world's population — 3.3 billion people — lived in cities. By 2050, city dwellers are expected to make up 70% of Earth's total population, or 6.4 billion people.

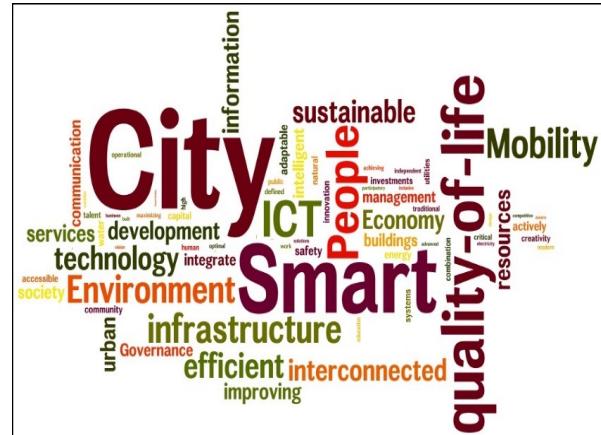


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# Smart Sustainable City: *ITU Definition*

**"A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects."**



**Focus Group on Smart Sustainable Cities (FG SSC)**

October 2015, [itu.int/go/fgssc](http://itu.int/go/fgssc)

\*ITU is the United Nations specialized agency for information and communication technologies



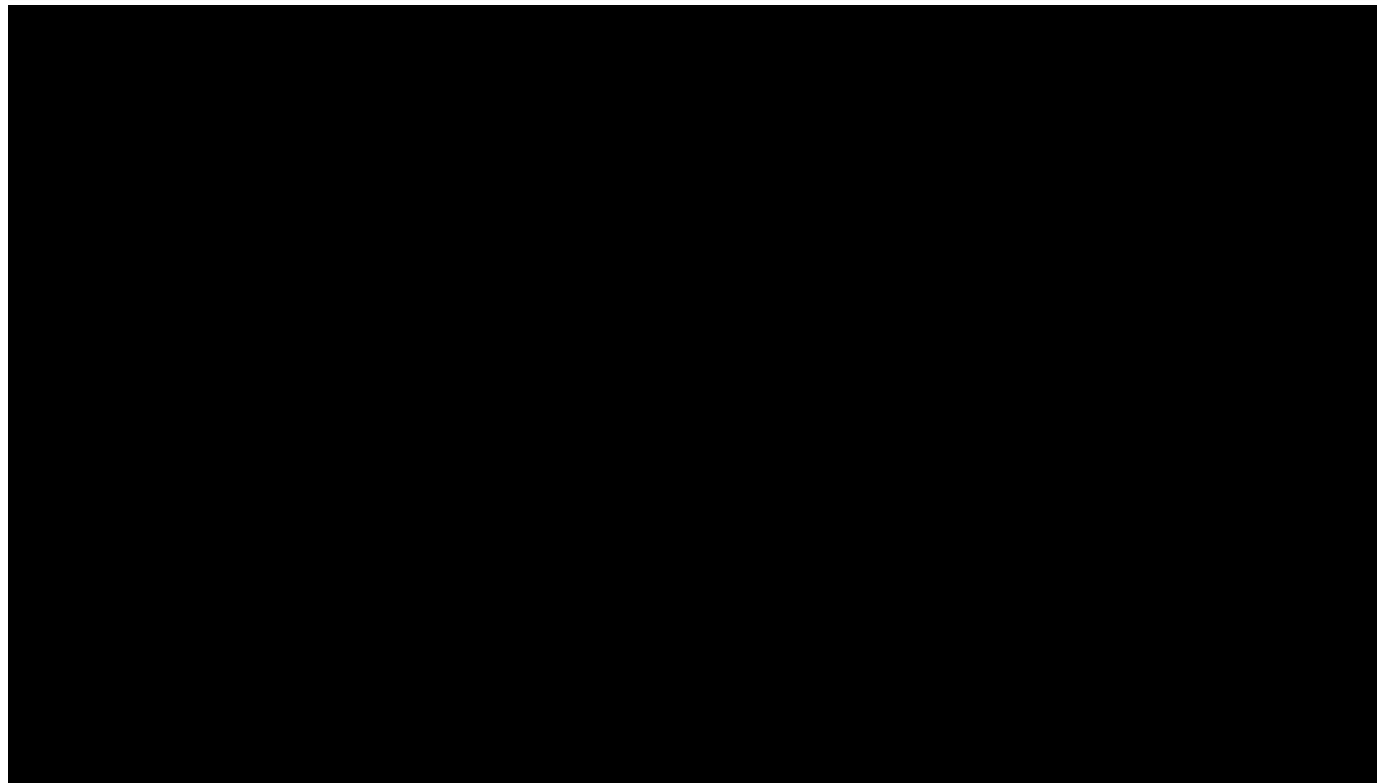
**Smart Cities: Office of Scientific & Technical Information U.S. Department of Energy**

“A city that ***monitors and integrates*** conditions of all of its ***critical infrastructures*** – including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings – can better

- ▶ optimize its resources,
  - ▶ plan its preventive maintenance activities, and 因為會有Down Time(損壞不能用的時間)
  - ▶ monitor security aspects
  - ▶ while maximizing services to its citizens.”



# IBM Smart Ads for Smarter Cities



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## Smart Nation: Singapore

### What are the GLOBAL CHALLENGES?



**Urban Density**  
Two-thirds of the world will live in cities by 2050.<sup>1</sup>



**Ageing Population**  
The world is ageing fast. By 2050, more than 2 billion people will be over 60.<sup>2</sup>

**老年人口增加  
年輕人越來越少**



**Healthcare**  
By 2025, there will be 8 billion people, 800 million of whom will be over 65 with high health needs.<sup>3</sup>



**Mobility**  
People are moving more into congested centres, with urban travel to triple by 2050. Traffic congestion could bring cities to a standstill.<sup>4</sup>



**Energy Sustainability**  
Global demand for energy will rise by up to 37% by 2035.<sup>5</sup>

<https://www.ida.gov.sg>About-Us/Newsroom/Speeches/2016/Opening-Speech-by-Dr-Vivian-Balakrishnan-Minister-for-Foreign-Affairs-and-Minister-In-Charge-of-the-Smart-Nation-Initiative-at-Smart-Nation-Innovfest-UnBound>

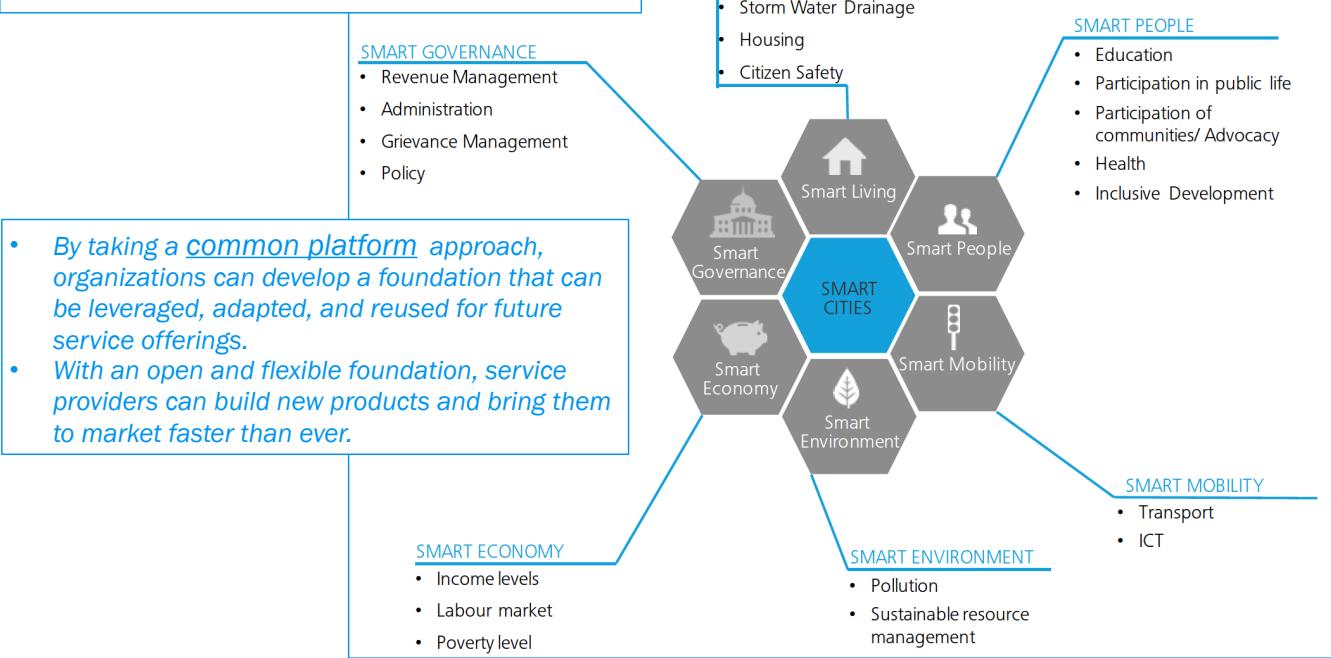


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# Smart Cities: India Smart Cities Challenges

- Smart cities mean different things to different people and areas.
- Every city has its own needs.
- 20 cities selected Jan 2016.



- By taking a *common platform* approach, organizations can develop a foundation that can be leveraged, adapted, and reused for future service offerings.
- With an open and flexible foundation, service providers can build new products and bring them to market faster than ever.

[www.deloitte.com/in](http://www.deloitte.com/in) "100 Smart Cities: Need for Innovation and Integrated Approach" Workshop, Feb. 2015

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## Smart City Services for Pedestrians

The case for PEOPLE without private cars

- ▶ In most big cities outside of US, people rely on mass transportation rather than driving.
  - Many European cities have car-free zones.
- ▶ In fact, more and more big cities encourage/demand residents use mass transportation for daily commute and activities.
  - Beijing, Taipei, Hong Kong, Mexico City, New Delhi, ...
- ▶ Currently, there are many driving information apps (GPS) designed for car drivers.
  - What about the last mile/meters after you (park and) become a pedestrian?



# Big Cities Have Dark Corners ...

不安全的區域

Homeless people is a global issue. So are crimes and disasters.

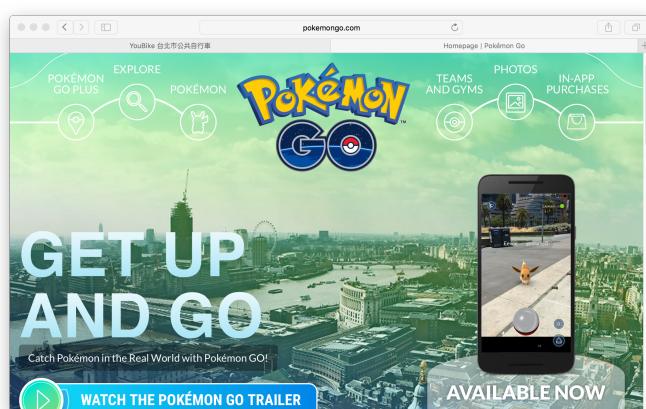
- ▶ Some urban streets are quite dangerous!
- ▶ Big cities have certain streets, events or situations that people may want to avoid (always, or from time to time):
  - Homeless, pickpocket, beggar, gang, prostitute, drunk
  - Crowd, congestion, accident, festival, or sports events
  - Unhealthy air, flood, fallen trees, fires, terrorists
- ▶ Shortest distance or cheapest route may not be the right choice.



## Have You Pokémon Today?

Get Up and Go, but Where?

- ▶ City can be smart and fun!
- ▶ But is it safe?



## Background: Longshan Temple in Taipei

艋舺  
龍山寺



舊台北的文化和古蹟

- ▶ Lungshan Temple is located in Taipei's old Manka (Wanhua) district. It was founded in 1738. It was rebuilt in 1919 and completed in 1924.
- ▶ It was hit by American bombers on May 31, 1945, during World War II. It was again rebuilt after the end of World War II.
- ▶ Lungshan Temple is seen as an emblematic example of Taiwanese classical architecture, with Southern Chinese influences commonly seen in older buildings.



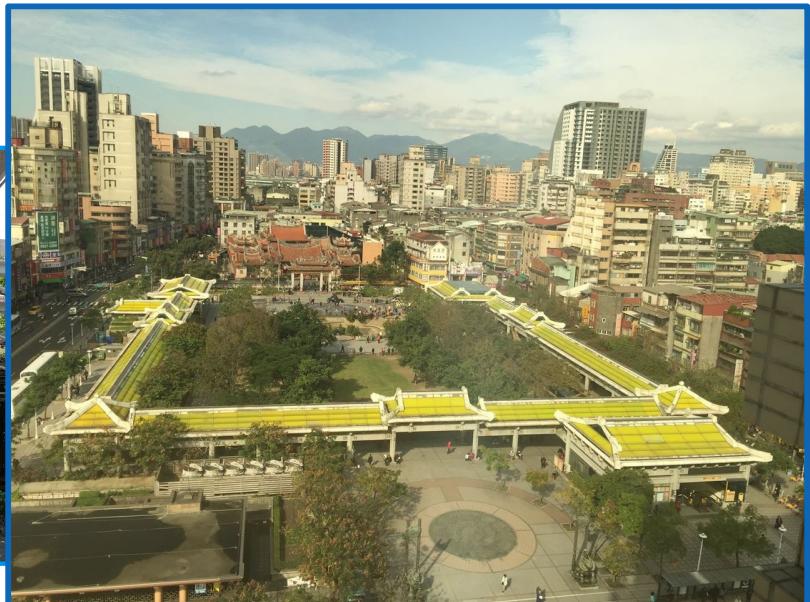
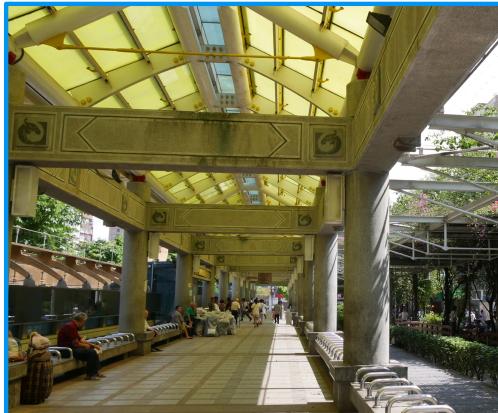
## Lantern Festival in the Longshan Temple

- ▶ It is a tourist attraction for people who want to experience the old Taipei.
- ▶ The area has many small shops, night markets, authentic local food, and traditional lifestyles.



# Longshan Temple and Manka Park

- ▶ There is a small city park in front of the temple, with traditional garden corridors surrounding the park.
- ▶ The park is also on top of a city subway station with heavy pedestrian traffics.



## Manka Park and Its Residents

- ▶ It turns out the park and its open building structure are favorite places for homeless people.
- ▶ Tourists or visitors unfamiliar with the area may walk to the wrong side of the park, or run into unexpected people or undesirable situations.



# Homeless People are Self-Structured

They have their own life styles and self-governed rules

<https://youtu.be/bC9Fu8CJctk?t=33s>



## Needs of Pedestrians

Why are people walking on the street?

1. Walking before/after/between taking private vehicles or mass transportation
  - Want to know: Bus/train schedule, route safety, potential road hazard
2. Walking/Jogging for leisure or exercise
  - Want to know: probability of rain, air quality, temperature, road condition, safety
3. Walking in shopping districts, night markets, and tourist attractions
  - Want to know: direction to right exits, restrooms, help stations, stores with sales, restaurants with good reviews, ...

紐約廁所收錢 : Free Toilet App



# The u-Sense Project: Urban Social Sensing

安全, 交通, 環境  
個人, 社區, 全體

## ▶ Urban sensors on street conditions and situations

- Real-time detection and display of urban conditions, e.g. safety, traffic, unrest, violence, and people
- Using: street sensors, bus sensors, social sensors, government services

## ▶ Apps for avoiding unhealthy or undesirable streets and routes

- Make "block-by-block" walking street information (on public display & Web)
- Personalized route selection app (useful for rush hours or tourists)

## ▶ Public display for emergency/safe routes (for earthquake, flooding, natural disasters, accidents, security events, etc.)

- Safe, efficient or route public display in real time
- Using colors and flashing patterns on street lights, poles and signs



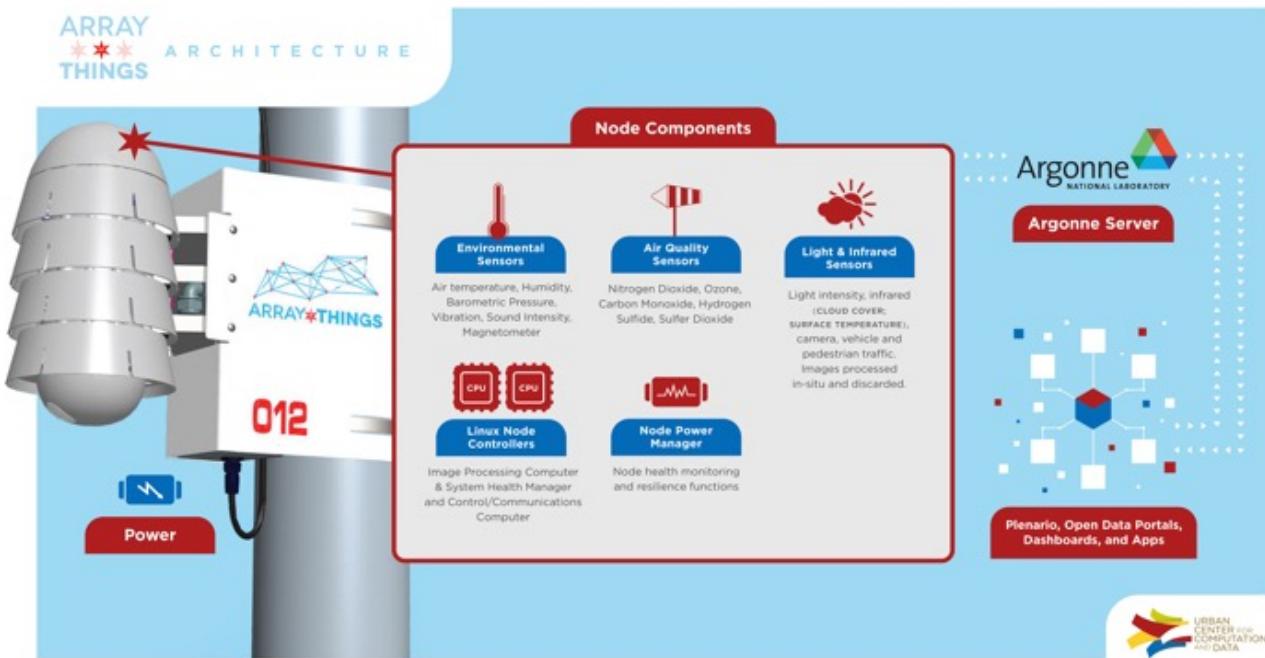
## Making Cities Friendly and Safe for Pedestrians

- ▶ A smart city with “urban sensors” will be very useful to guide people how to move around in the area.
- ▶ Urban sensors can identify specific types of people, events, and situations on city streets to build real-time pedestrian guiding systems.
  - Homeless and drunk people may be detected and traced by street cameras and sensors.
  - Occasional disturbances, fire or natural disasters may also be detected by urban sensors and from social sensing to mark certain areas too dangerous to enter.
- ▶ Combined with historical and social data analytics, algorithms and techniques can be integrated for real time detection of urban events and situations.



# Related Work: Array of Things (AoT) in Chicago

<https://arrayofthings.github.io/>

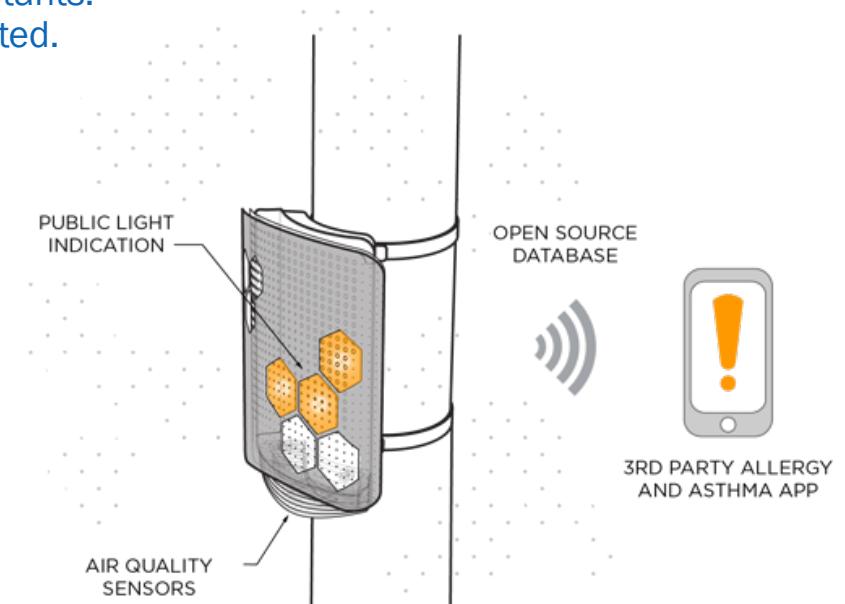


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# Related Work: Array of Things (AoT) Sensing

- \* The nodes will initially measure temperature, barometric pressure, light, vibration, carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone, ambient sound intensity, pedestrian and vehicle traffic, and surface temperature.
- \* Continued research and development will help create sensors to monitor other urban factors of interest such as flooding and standing water, precipitation, wind, and pollutants.
- \* \$500-\$2000/node estimated.



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# Ubike at Univ. Virginia

Gartner

The screenshot shows a web browser window for [ubike.virginia.edu](http://ubike.virginia.edu). At the top, there's a navigation bar with links for 'How it works', 'System Map', 'Rates', 'Mobile App', 'About', 'Safety', and 'Contact'. On the left, there's a logo for 'UBIKE' with a stylized sun icon. Below the logo, the text 'Here is' and 'How it works' is displayed. The main content area features four circular icons numbered 1 through 4, each representing a step in the process: 1. Reserve (Booking a bike), 2. Release (Unlocking Process), 3. Ride (Enjoy your time!), and 4. Return (It's easy!). Each step has a brief description and a small image below it.

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## Copenhagen

- ▶ Copenhagen won the 2014 World Smart Cities award for its “Copenhagen Connecting” plan, which involves using wireless data from cell phones, GPS systems in buses, and sensors in sewers and garbage cans to meet ambitious green initiatives and, “make it easier to be a citizen.”
- ▶ The project promises cyclists and bus passengers a **10 percent reduction in travel time**, and will yield economic benefits of 640 million euros (\$727 million) when completed.
- ▶ The Copenhagen Solutions Lab, the city’s incubator for smart-city initiatives, serves as the governing body for all smart-city projects.



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# InteliLight StreetLight

- ▶ Near-zero street lighting energy cost
- ▶ Security infrastructure
- ▶ Traffic monitoring
- ▶ City sensors
- ▶ Electrical vehicle charges
- ▶ Municipal wireless network



<http://intelilight.eu/technical-area/intelilight-lora-streetlighting-remote-management/>



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## CityPulse: Real-Time IoT Stream Processing and Large-scale Data Analytics

- ▶ The smart city tool is a collection of (for now) 101 future scenarios of how cities can solve existing societal issues.
- ▶ All scenarios have been collected from city stakeholders all over Europe.
- ▶ <http://www.ict-citypulse.eu/page/>
- ▶ <http://www.ict-citypulse.eu/scenarios/>



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# So, What Are the Challenges?

Cost, real time, and reliability

- ▶ Human sensors (homeless or drunk on the ground, sleeping, or in-pain)
- ▶ Normal vs. abnormal traffic and activities (self-learning with time-based model)
- ▶ Routing control display (crowd flow coordination and distribution in all areas)
- ▶ Social sensing and crowd sensing
- ▶ Data quality, data safety, data security

## Fundamental Challenges for Various Areas

- ▶ Distributed Systems: Time, Events and Ordering
- ▶ Real-Time: Predictability, Capacity and Scheduling
- ▶ IoT: Sensibility, Scalability and Flexibility

# IoT: Sensibility, Scalability and Flexibility

- ▶ What information do we need to get the job done?
  - Sensing data modality and hierarchy
- ▶ How much information do we need to make a good decision?
  - When a tree falls in the forest, does it make a sound?
- ▶ Where should we collect the information?
  - Data fidelity and quality are complex to model
- ▶ How often should we collect the sensing data?
  - Situation stability may change dynamically
- ▶ Binding Flexibility: design time, deployment time, run time

## Device flexibility means mix-and-match

- ▶ Connectivity must be standard and tools open source, but applications infinite, said Doug Fisher, VP of Intel's software and services unit.
- ▶ Intel has introduced an upgraded IoT reference architecture which can connect a wider variety of devices, from security cameras to cash registers.
- ▶ Intel must go beyond integration and supporting endless flexibility. Solution providers must meet customer demands for experimentation, and that means any platform must support a wide range of **mix-and-match** functions.

## Discussion: Issues of Interest in Your City or Community

- ▶ What bother you and others most? Parking, watering, electricity, food, education, air quality, etc.
- ▶ Can better coordination resolve the issues? Including
  - ▶ More information
    - ▶ Real-Time information
    - ▶ Historic information
    - ▶ Widely collected information
  - ▶ More intelligent decision





## ICT in Singapore Smart Nation

