Smart City, Standardization and its Services

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Various Thoughts on Smart City

Various Thoughts on Smart City : Analyzing

- A smart city means so many [different] things to different people and different (levels of) governments.
- Many different or variations of the Smart City definitions exist.
- In the survey of the definitions, we can identify three main categories that the definitions address.
  - What a city's (government) and its people's (citizens) "*wants*";
  - Where (or which areas of) the city (affairs) to improve in order to satisfy the "*wants*";
  - Technologies to formulate or implement the "How" to fill the *wants*.

Various Thoughts on Smart City : Analyzing

What governments & citizens Want (requirement)	City affairs to Improve by "requirements"	How to Achieve the "requirements"	Technologies to fill the "Wants"
• Enhance quality of life, living, services (community/government), welfare • Reduce resource consumption & wastage • Reduce overall cost • Optimize the efficiency of city operations and services, supporting citizens, and city infrastructures • Make cities more livable, resilient, better able to respond to challenges • IT to facilitate the planning, construction, management and smart services of cities • Smart cities = smart citizens • Better environments – socially and naturally • Sustainable, prosperous and inclusive future of citizens.	• Transportation systems / Traffic • Utilities to citizens (power, water, gas, etc.) • Utilities systems (power plants, water supply networks, gas supply networks, etc.) • Waste management (e.g., water, garbage, etc.) • Environments (e.g., micro dusts, etc) • Law enforcement • Infrastructure systems • Schools • Libraries • Hospitals, etc. • First responders • And many others	• Incorporate ICT • Use electronic data collection (from citizens and systems) • Use IoT & connected devices via networks • City officials directly connect with citizens, communities, and city infrastructures • Integration of physical, digital and human systems • Interconnected information	• Information & Communication Technologies (ICT) • Internet of Things (IoT) • Big Data • Artificial Intelligence (AI)

Use Cases of Smart City

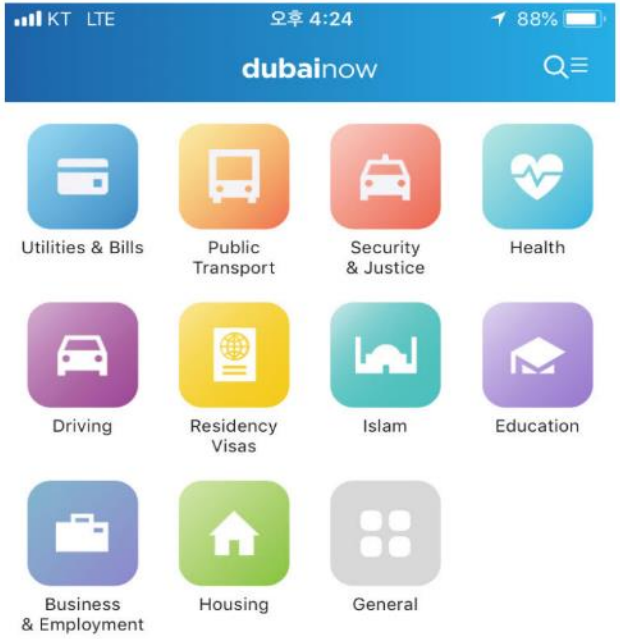
Summary from the CNBC Video

CNBC Smart City (published on 2017-02-08)[3:17] (https://www.youtube.com/watch?v=bANfnYDTzxE)

- How smart is your city?
  - Probably getting smarter every year
  - Governments infusing technology in every aspect/part of the city's operations, including
    - Public transportation
    - IT connectivity
    - Water, power supply, sanitation, solid waste management
    - Urban mobility
    - E-governance
    - Citizen participation
- Singapore (a city state) Case
  - Collect the data in daily living using sensors (e.g. cameras) to monitor:
    - Crowd density
    - Cleanliness of public spaces
    - Exact movement of every locally registered vehicle
  - "*Virtual Singapore*" – the name of the on-line platform
    - In additions to monitoring and tracking of people and entities in Singapore, it also provides emergency services
      . Predict crowd movements in emergency situation (e.g., explosion)
      . Predict how an infectious disease might spread

Summary from the CNBC Video

- Dubai's "Smart Dubai Initiative" Case
  - Launched more than 50 smart services from 22 government entities
  - Use an app called "*Dubai Now*" to:
    - Pay traffic tickets (captured on a public camera and e-mail delivery of the tickets);
    - Pay electric bill;
    - Call a taxi;
    - Track a package you sent;
    - Find the nearest ATM;
    - Renew your vehicle registration;
    - Track the visa status of a relative;
    - Report a violation to the Dubai police.



- Barcelona Case
  - With smart system installation in the city, the city will save a billions of dollars a year in energy cost:
    - Smart street lamps;
    - Smart parking using parking sensors;
    - Garbage sensors.
- Other comments in the video
  - Juniper Research estimates that by 2021, cities will save US$19B by making their city smart
  - To save money, you have to spend money first.
  - The global smart city market is estimated to attract US$15B by 2021 just for software.

Summary from Tech Republic Video

[Tech Republic.com Video on Smart Cities (published on 2018-07-16)[2:21]
(https://www.techrepublic.com/article/smart-cities-the-smart-persons-guide/)](https://www.techrepublic.com/article/smart-cities-the-smart-persons-guide/)

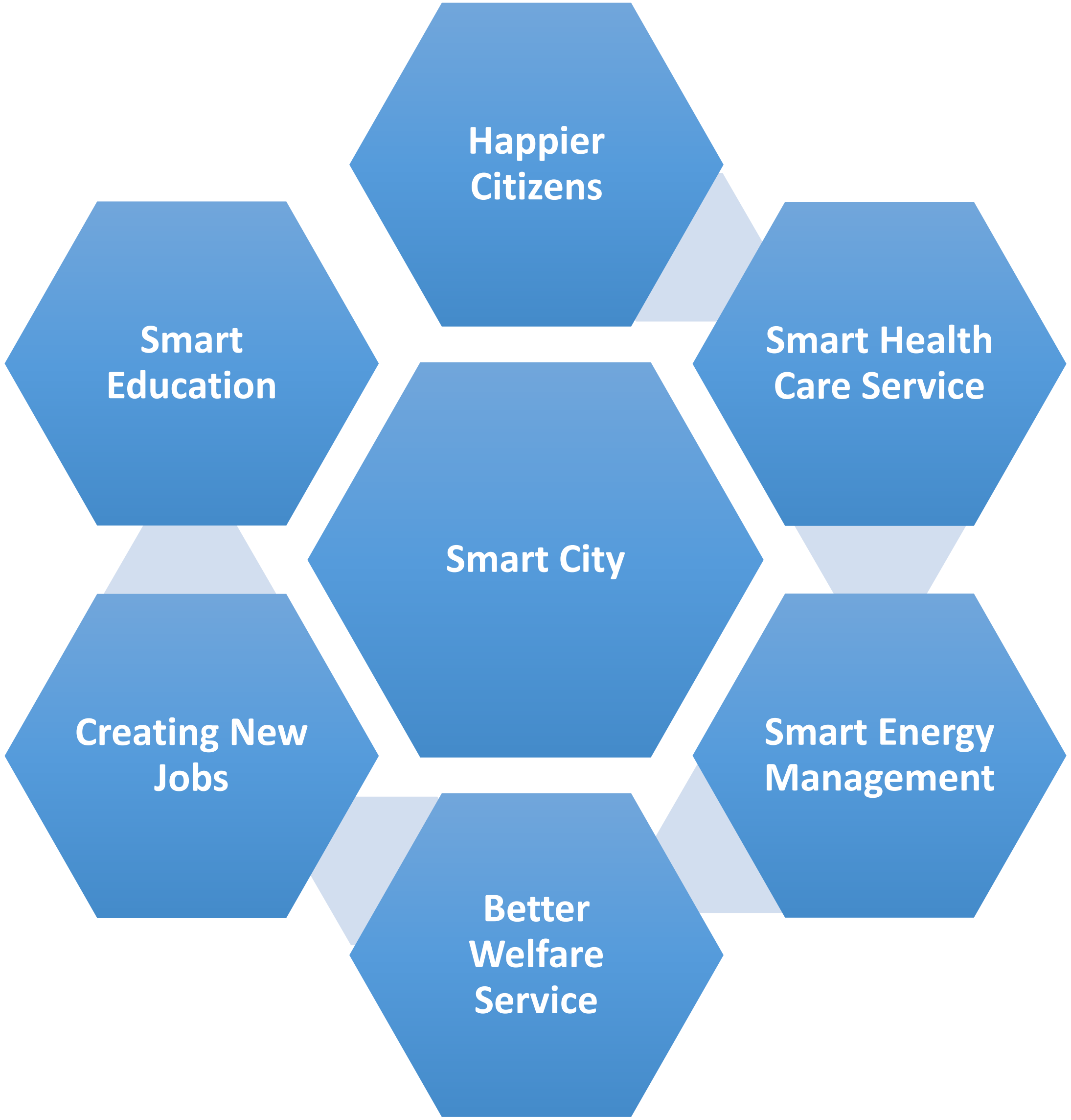
- The world becomes more urban
  - More than 60% of population expected to live in the city by 2050 : Smart cities are the wave of the future (UN)
  - Smart cities are more than a trend, they are the wave of the future
- Smart cities spending has reached US$80B in 2016, expected to grow to US$135B by 2021.
  - Funding typically is from public and private partnerships
- Immediate benefits to citizens/visitors by connecting to government for information/services
  - Using IoT sensors, actuators, and technologies to connect the components across the city, reaching every layer of the city, from air, to the street, to the ground below the street
  - Smart traffic management, smart waste management, air quality sensors
  - Improve public safety, e.g., gun shot detectors
  - Smart LED street lights (energy-efficient LED)
  - Smart city also benefits the environment: water/energy usage and sustainability issues, reduce CO_2 emissions
- Individuals can improve QoL and QoC between citizens and government typically using mobile apps to immediate access to data
- Early adopter cities are:
  - Barcelona, Amsterdam, Copenhagen, Hamburg, Nice; Dubai, Singapore; San Francisco, Chicago, New York, Miami, Kansas City
- Any city of any size can become smart cities because all it requires is the commitment of the city officials and citizen to work together to find solutions to every day issues.

Why do we make Smart City?

Why do we make Smart City: Economic Impacts and Life

- The global smart city market is estimated to attract US$15B by 2021 just for software (CNBC Video)
- Smart cities market will increase significantly over the next five years to be anywhere from over US$400B to over US$1.5T by 2020 (from Deloitte Report, *2014*)
- By 2021, cities will save US$19B by making their city smart (Juniper Research)
- The world becomes more urban
  - More than 60% of population expected to live in the city by 2050
  - Smart cities are more than a trend, they are the wave of the future
- Smart cities spending has reached US$80B in 2016, expected to grow to US$135B by 2021 (Tech Republic Video, 2018)
  - Funding typically is from public and private partnerships
- The forecast is that city authorities across the globe will spend upwards of US$81B on smart city technology this year [2018], and that figure will rise to US$135B by 2021 (IEC Emerging Trends – Smart Cities vulnerabilities Report, August 2018)
- Individuals can improve QoL and QoC between citizens and government typically using mobile apps to immediate access to data

Why do we make Smart City?



Key Drivers for Success of Smart City?

1. A clear vision
2. Public-private partnerships*
3. Integrated organization
4. Efficient smart city platform
5. Strong citizen engagement
6. Technology as an enabler
7. Risk management
8. Social inclusiveness
9. Project upscaling
10. Supportive legal framework

- The *real benefit* of smart cities is not the individual solutions, but the government-led creation of *a holistic system where all solutions work together*.
- *Technology* adoption should not be an end in itself, but should be used to *address the major pain points of the city*, such as mobility, energy, water, public services, and so forth.
- A good smart city *regulatory environment* will provide the protection that start-ups need while being adaptable enough to *allow for the risk-taking and trial-and- error innovation* requires.

* Water Flont in Toronto, Canada : partnership between City and Google

Pros and Cons of Smart City

- Advantages/Benefits
  - Increase efficiency in utilizing public infrastructure
  - Lower costs of goods
  - Potentially, better governance
  - Lower crime
  - Everything has the potential to be automated
  - Growth in economy and productivity
  - Greater communications
- Disadvantages/Drawbacks
  - Very limited privacy
  - Vulnerability in security – More connections mean more vulnerabilities
  - With everything being tracked, there becomes a pretty big concentration of power
  - Limited potential for innovation/creativity
  - Potentially overreliance on electronics/network

Data on this charts are from https://www.quora.com/What-are-the-advantages-and-disadvantages-of-Smart-City, http://nextgenblog.org/smart-cities/, https://www.pandasecurity.com/mediacenter/news/asia-leading-way-pros-cons-future-smart-cities/

Core Technologies for Smart City

Core Technologies for Smart City

- Add smartness to existing infrastructure
- What kind of services citizen are demanding?
- Key components to build a Smart City

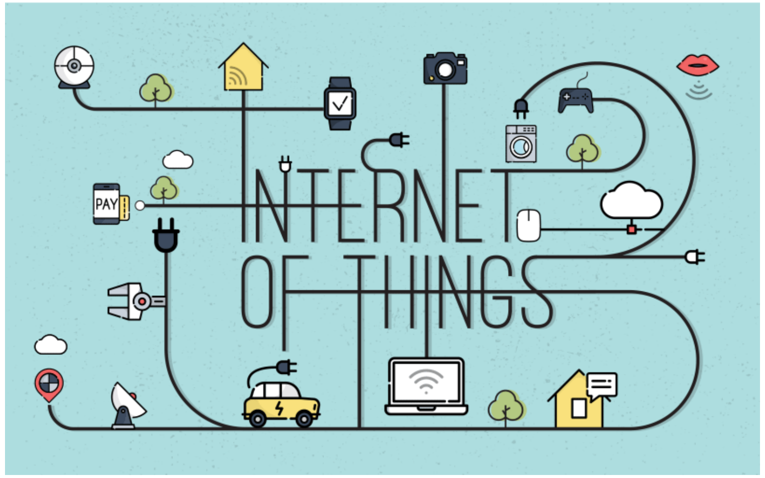


Photo Credit: Satyakam Banerjee/VCCircle

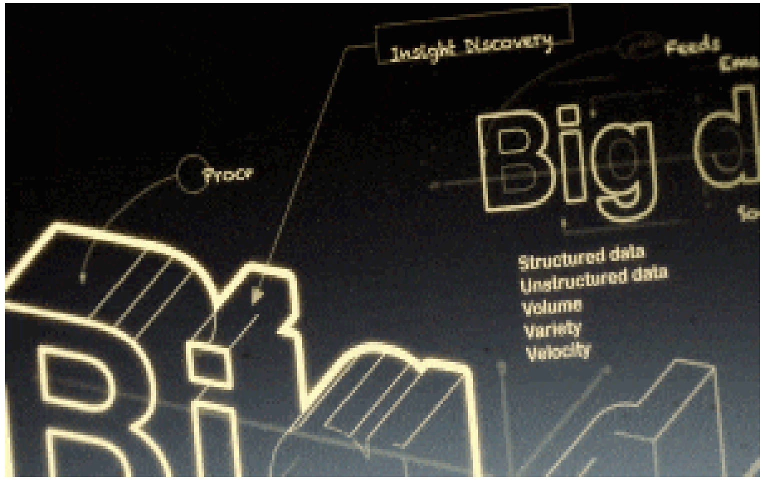


Photo Credit: http://www.mellanox.com/blog/2016/09/where-hpc-meets-big-data/

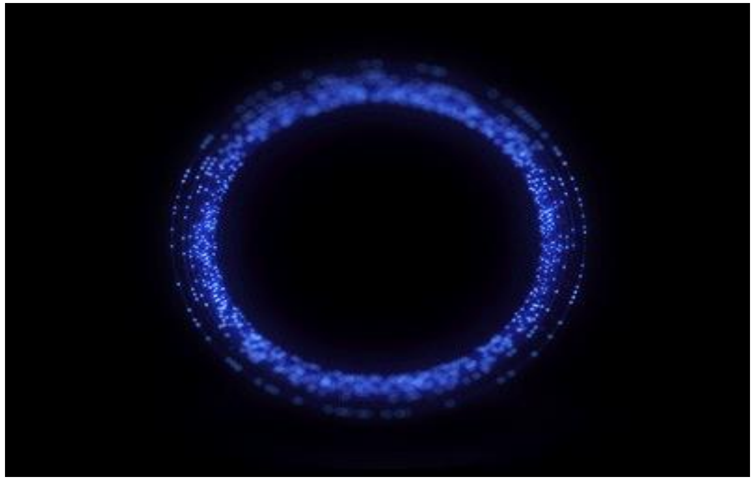


Photo Credit: https://www.pinterest.co.kr/pin/547046685971871360/?lp=true

Internet of Things and Supporting Things

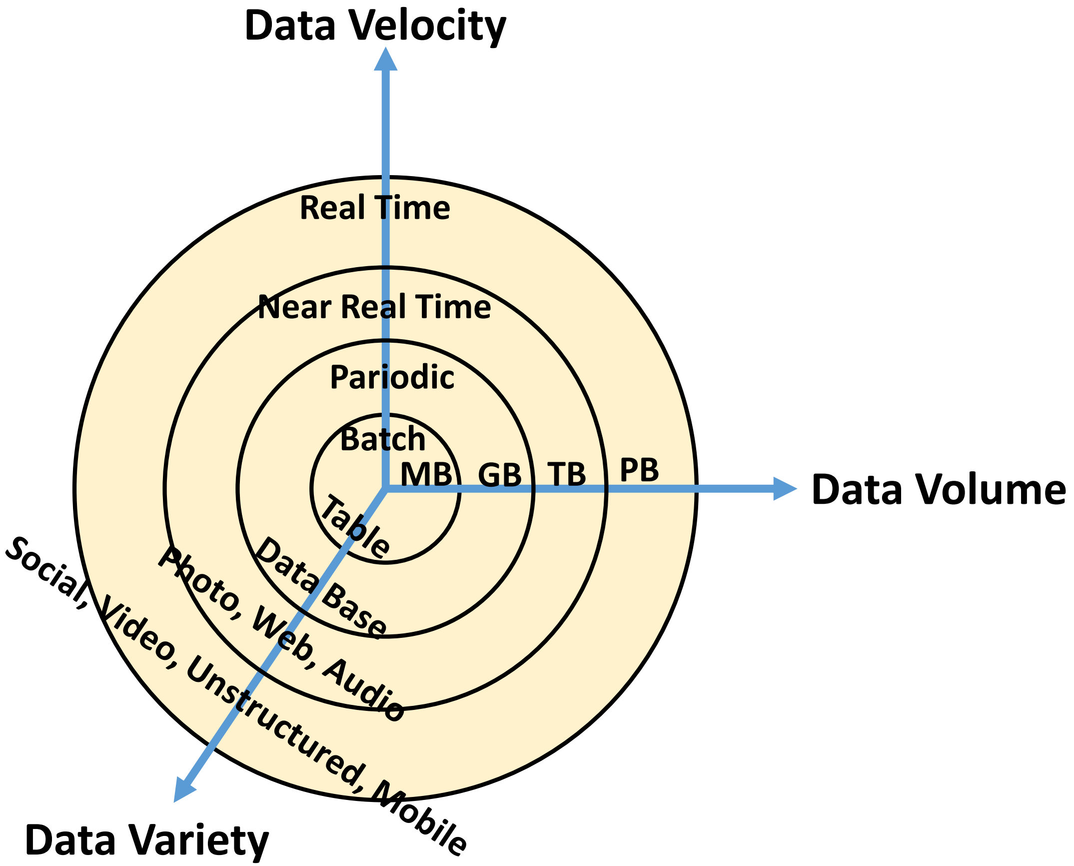
- Sensors for:
  - Transportation congestion detection
  - Water and wastewater monitoring
  - Parking services
  - Bridges and other infrastructures
  - Waste management sensors
  - LED street lights
  - Fire detection
  - Energy monitoring
  - Surveillance (e.g., cameras)
  - Wearable detection (detecting smartphones and wearables on people)
  - Body cameras
  - Others
- Other IoTs
  - Self-driving cars
  - Drones
  - Others
- Other supporting things
  - Solar panels
  - Smart logistics/freight
  - Vehicle fleet communication
  - Broadband infrastructure
  - Other supporting things

3Vs (volume, variety and velocity) are three defining properties or dimensions of big data.

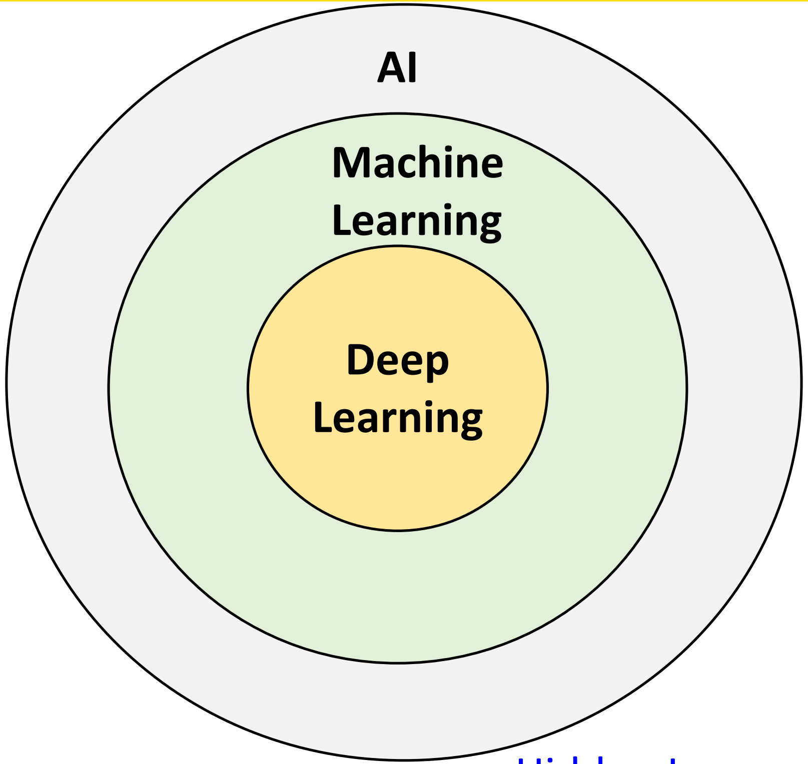
Volume refers to the amount of data

Variety refers to the number of types of data

Velocity refers to the speed of data processing.



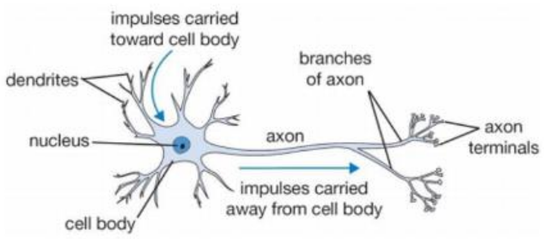
According to the 3Vs model, the challenges of big data management result from the expansion of all three properties, rather than just the volume alone (the sheer amount of data to be managed).

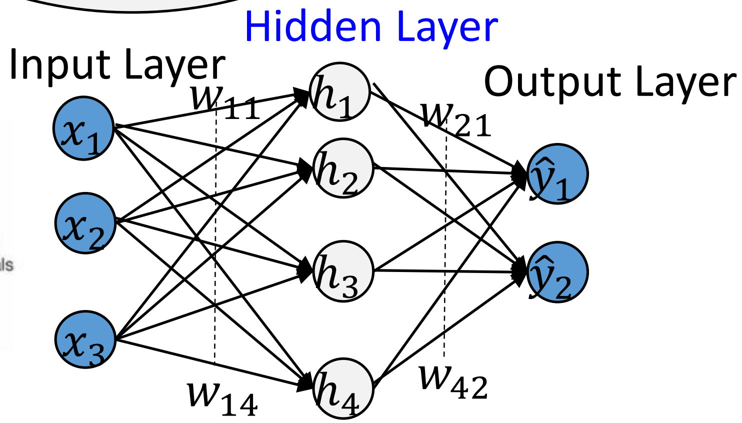


AI : Any technique which enables computers to mimic human behavior.

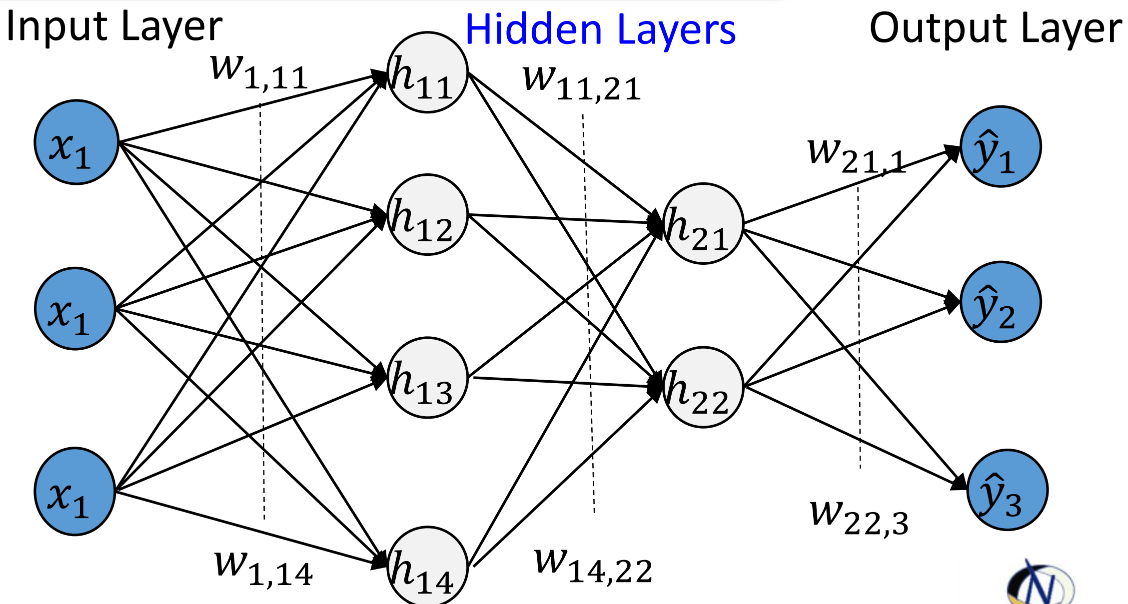
ML : Subset of AI techniques which use statistical methods to enable machines to improve with experiences.

DL : Subset of ML which make the computation of multi-layer neural networks feasible.





Shallow Artificial Neural Network



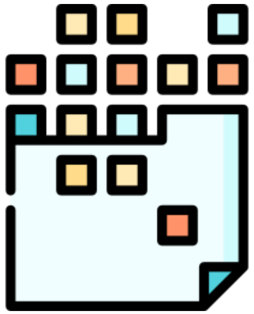
http://www.deeplearningbook.org/contents/intro.html

Deep Artificial Neural Network

Big Data and AI

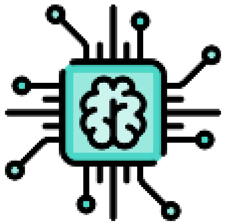
Data Generated → Data Stored → Data Processing → Actionable Insights

← Big Data → ← Artificial Intelligence →



Structured and unstructured (ex. video) data

Data is stored in databases and servers



Process the data using CPU/GPUs and AI algorithms to detect patterns

Predictive signals are generated

Central Processing Unit (CPU)/ Graphics Processing Unit (GPU

Source: https://www.slideshare.net/mrjain/predictive-analytics-big-data-artificial-intelligence

IoT, Big Data + AI Technology in the Smart City

Road Network:
StreetID, DeviceID, EnergyUsage, etc..

Traffic Control:
StreetID, TrafficID, Duration, etc..

Water Management:
Water quality

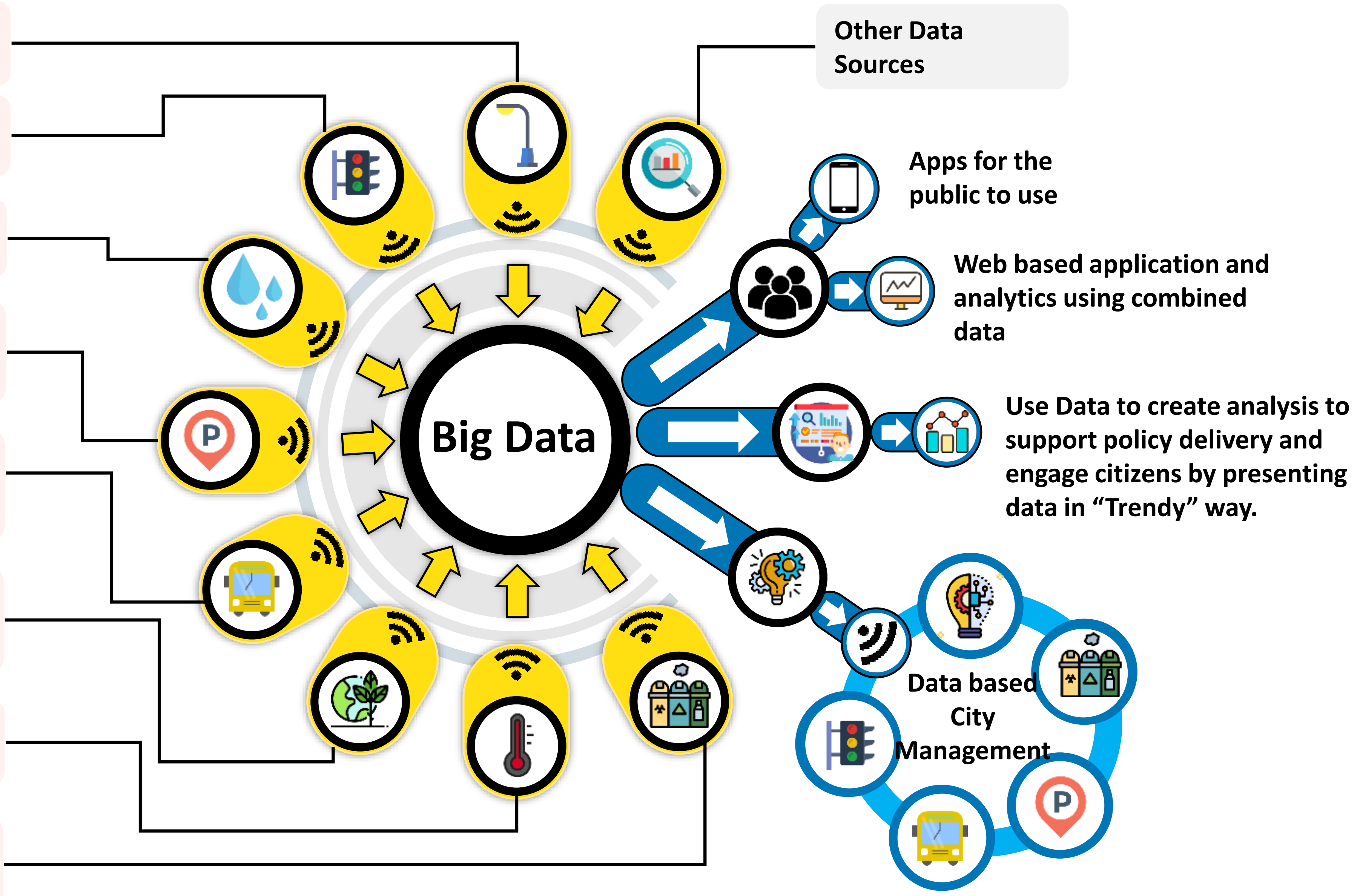
Parking:
StreetID, CarID, Arrival Time, Departure Time, Duration, etc..

Buses:
BusID, GPS, Timestamp, Number of people, etc.

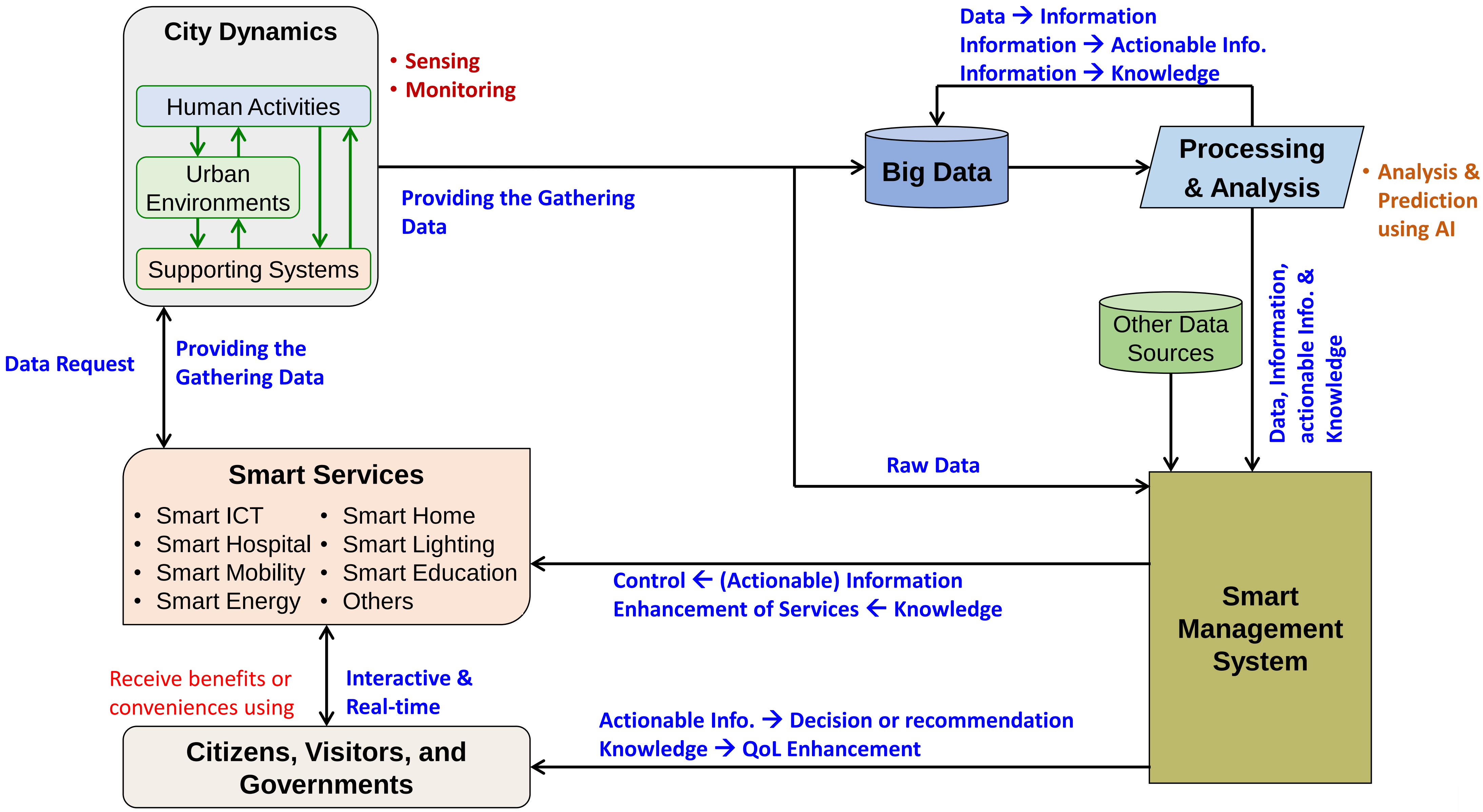
Air Quality:
CO_2, PM 2.5, PM 10, Temperature, Relative Humidity, etc.

Temperature:
Temperature, GPS, Timestamp, etc..

Waste:
StreetID, DeviceID, WasteLevel, etc.



An Architecture for Smart City Operation and Management System



Standard Developing Organizations Working on Smart City Standards

Smart City Standard Developing Organizations (SDOs)

- International Standard Organization (ISO)
  - TC 268 Sustainable cities and communities:
    - ISO 37120 Sustainable development of communities: Indicator for city services and quality of life
    - Used by World Council on City Data (WCCD) to certify cities for city services and QoL.
- International Electrotechnical Committee (IEC)
  - Systems Committee Smart Cities
    - WG 1 Terminology
    - WG 2 Market relationship
    - WG 3 Reference architecture
- International Telecommunications Union (ITU)
  - Study Group 20 on IoT and smart cities and communities (SC&C)
- ISO/IEC Joint Technical Committee 1 (JTC 1)
  - Working Group 11 on Smart cities
- Institute of Electrical & Electronic Engineers (IEEE)
  - P2413.1 Standard for a Reference Architecture for Smart City (RASC)
- CEN-CENELEC & European Telecommunications Standard Institute (ETSI)
- Telecommunications Industry Association (TIA)
  - Project "Smart Buildings: Microcosm of Smart Cities"
- Many national standard bodies also work on the smart cities and related standards:
  - Australia (SA), Canada (SCC), China (SAC), France (AFNOR), Finland (SFS), Germany (DIN), India (BIS), Italy (UNI), Japan (JISC), Korea (CATS), Netherlands (NEN), Singapore (IDA), Sweden (SIS), UK (BSI), USA (ANSI), etc.

Smart City's Key Performance Indicators (KPI)

ISO 37120's 17 Themes (or KPI) for city services and quality of life

1. Economy
2. Education
3. Energy
4. Environment
5. Finance
6. Fire and Emergency Response
7. Governance
8. Health
9. Recreation
10. Safety
11. Shelter
12. Solid Waste
13. Telecommunication and Innovation
14. Transportation
15. Urban Planning
16. Wastewater
17. Water and Sanitation

ITU's Focus Group's KPI Dimension categories on Smart Sustainable Cities

1. **Information and communication technology**
2. **Environmental sustainability**
3. **Productivity**
4. **Quality of life**
5. **Equity and social inclusion**
6. **Physical infrastructure**

Smart Dubai's Main Dimensions

1. **Economy**
2. **Governance**
3. **People**
4. **Living**
5. **Environment**
6. **Mobility**

ISO 37120 has 100 KPI across the 17 themes; ITU FG has 37 KPI across 6 domains

Data on this charts from Patricia McCarney,, "New urban indicators for city services and quality of life," Webinar, November 11, 2014.
Data on this charts from http://www.dataforcities.org/wccd/ ; Data on this charts from "Smart cities… Not just the sum of its part," Monitor Deloitte

IEC Systems Committee (SyC)
Smart Cities:
Systems Approach in Standard Development

- IEC adopted a Systems Approach in its standard development for a large system made of many (sub)systems, e.g., systems of systems (SoS).
- IEC stands for International *Electrotechnical* Committee
  - Definition of Electrotechnical is:
    - The study or science of practical and industrial applications of electricity [a]
    - The technological use of electric power [b]
- Thus, for Smart Cities…

[a] https://www.dictionary.com/browse/electrotechnical;
[b] https://www.thefreedictionary.com/electrotechnical

Welcome to IEC Smart City's Standard Population

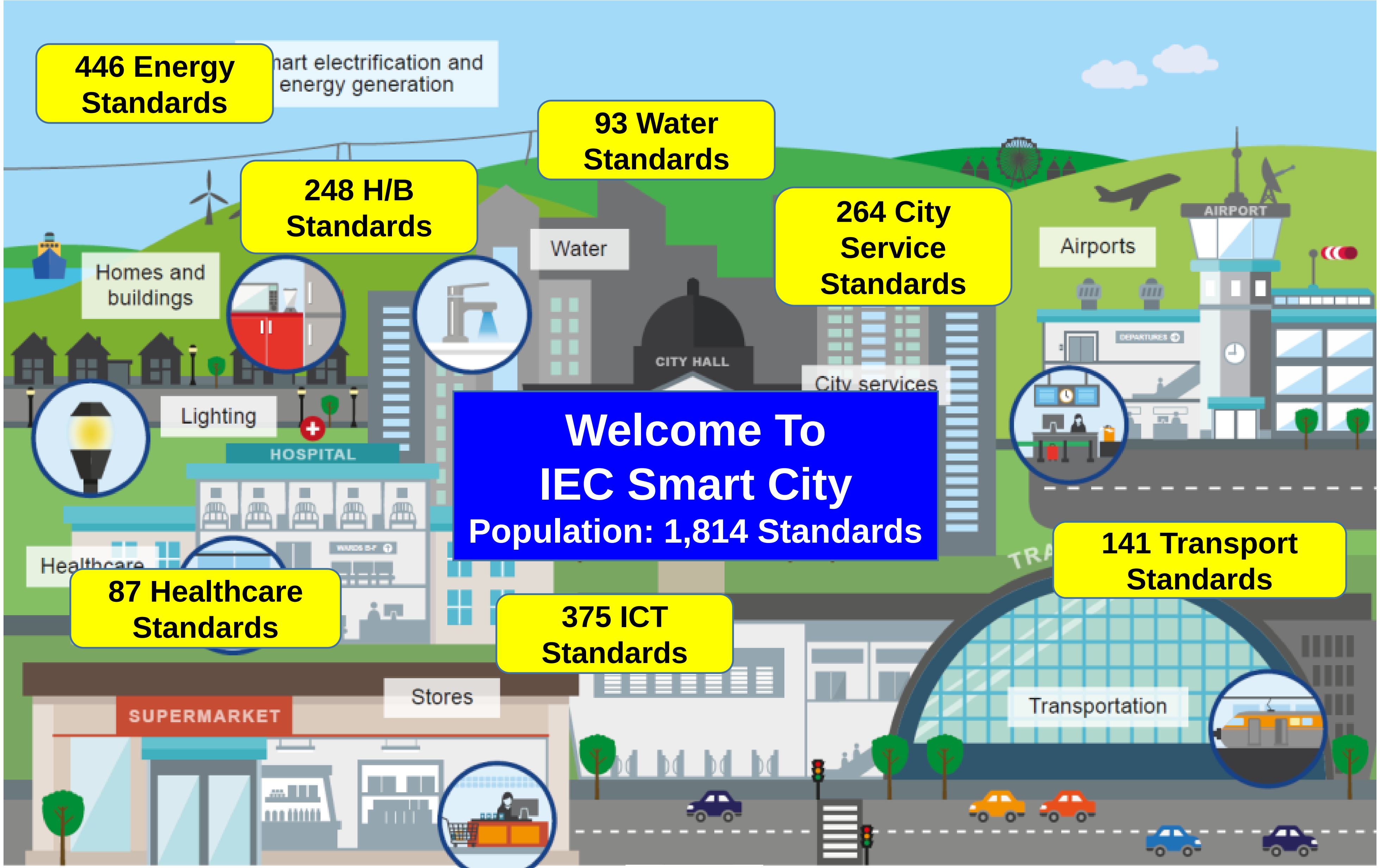


Figure from Ginnaro Ruggiero, "Systems Work at the IEC," a presentation at the IEC Smart Cities Workshop, 10 July 2018, Washington DC. USA.

Systems Work at the IEC

- To deal with complexity and ability to interconnect by:
  - gathering "requirements";
  - applying "systems approach"; and
  - providing "guidance and guidelines" standards
- The current IEC Systems Committees (SyC):
  - SyC Smart Energy
  - SyC Active Assisted Living
  - SyC Smart Cities
  - SyC Smart Manufacturing
- IEC Organization Entities to deal with the "Systems Approach"
  - Systems Resource Group
    - Provide method of work
  - Systems Committees
    - Explore systems domain for standardization
    - Develop systems-level International Standards
    - Develop systems-level System Reference Documents
  - Technical Committees
    - Develop specific technical International Standards
    - Develop specific Technical Reports/Specifications

Complex Systems need a systems approach.

Data/information from Ginnaro Ruggiero, "Systems Work at the IEC," a presentation at the IEC Smart Cities Workshop, 10 July 2018, Washington DC. USA.

Services for Smart City

Smart City and Sharing Economy

- Surplus resources at different geographical locations
- Multiplexing supply and demand to increase efficiency
  - Increase resource utilization
  - Decrease cost
- Examples of resource sharing

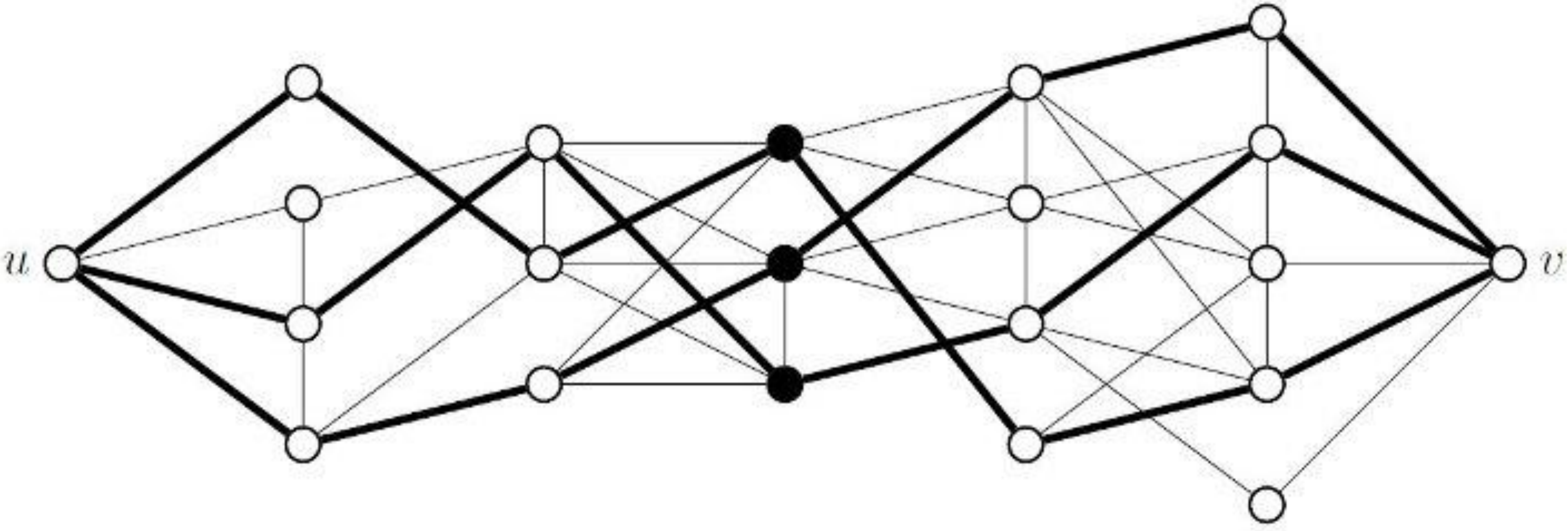
Resource	Concept	First Company/ Country	Founded
Offices	Office sharing	Wework (U.S.A)	2010
Cars	Ride sharing	Uber (U.S.A)	March 2009
Apartment/House	Short-term lodging	Airbnb (U.S.A)	August 2008
Computing/Storage	Cloud Computing	Amazon	2006
Bikes/ Scooters	Dockless bike sharing	Call a Bike (Germany)	2000
Network	MVNO	Europe	1990
Electricity	Feed in Tariff (FiT)	USA/ Germany	1978

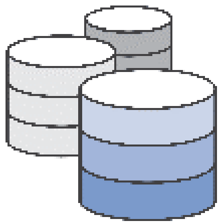
IoT (Internet of Things) and Sharing Economy

- IoT
  - Everything is connected to everything
- Sharing economy (Jeremy Rifkin)
  - Resource pooling and sharing via IoT [1, 2]
- Enablers [1, 2]:
  - Communication Technology
    - Internet, Mobile (Smart) Phones, Cloud Computing
  - Energy Technology
    - Renewables, Energy Storage (Battery), Smart Grid
  - Transportation Technology
    - Autonomous transportation/ logistics

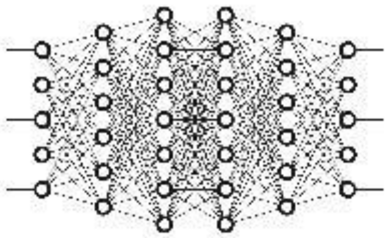
1. *Jeremy Rifkin, "The Zero Marginal Cost Society,"* **ISBN-13:** 978-1137280114 (2014)
2. *Jeremy Rifkin, "The Third Industrial Revolution,"* **ISBN-13:** 978-0230341975 *(2011)*

Distributed Shared Resource Allocation

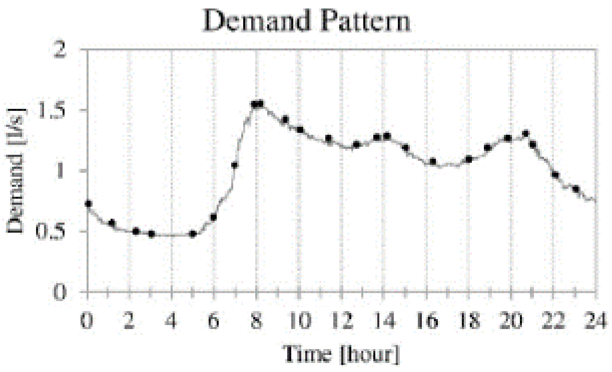




Big Data



AI Technoly



Demand Pattern

Resource Allocation

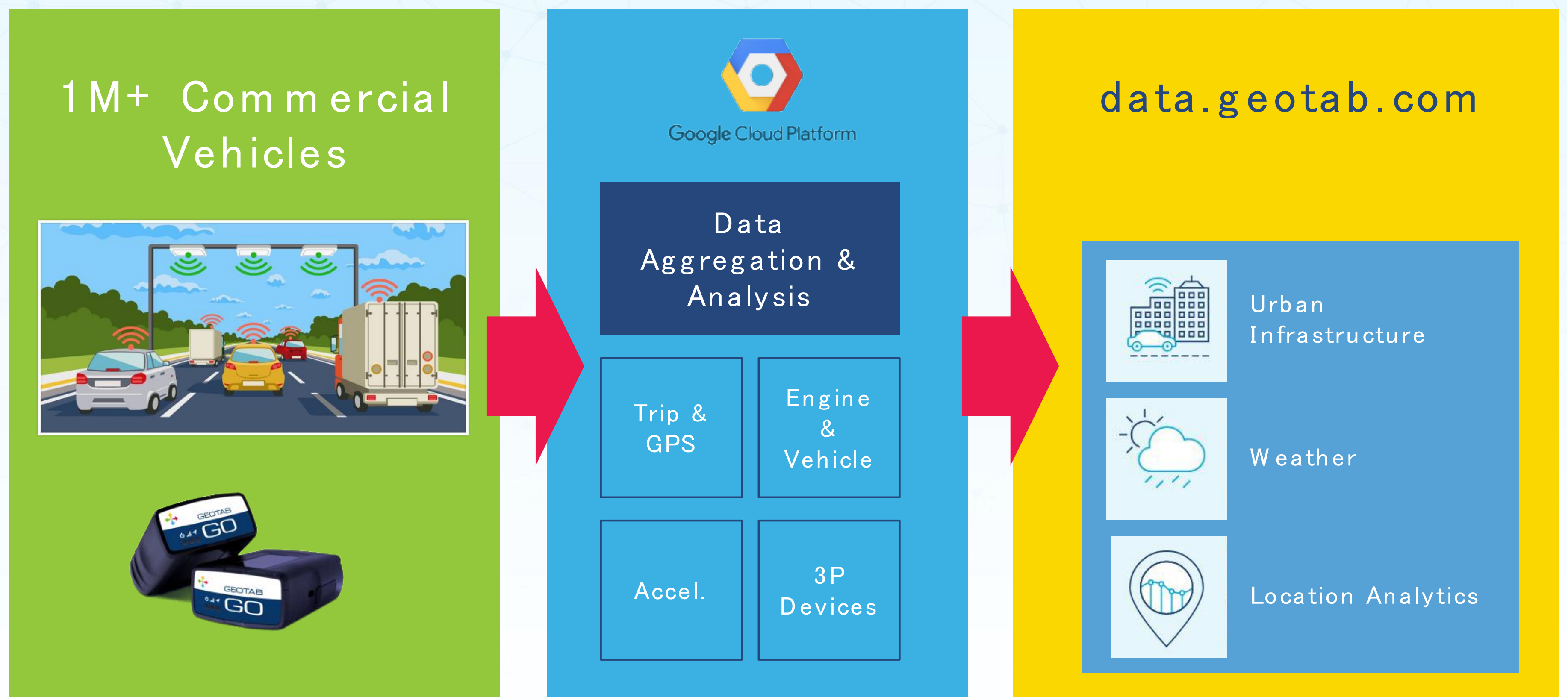
About Geotab – A Vehicle Telematics Provider

- Geotab is a Canadian Company in Toronto, Canada.
- It provides vehicle telematics services worldwide.
- Its motto is "Management by measurement."
- It is the world's second largest telematics provider.
  - Over 26,000 customers and more than 1 million subscriptions.
- Solution scales to fit customer with 1 device up to 80,000 devices, and used in many different ways.
- Geotab provides a open platform for telematics
  - It believes "open platforms" empower Smart Cities.
  - Open Platform is not equal to Open Source.
  - Close Platform stifles Creativity.

Data on this charts are from "Vehicle Data Driving the Smart City," presented by Mike Branch of Geotab, at the IEC Workshop on Smart Cities, 10 July 2018, Washington DC, USA.

Aggregate Data from 1M+ Commercial Vehicles

Dedicated Data Science Team



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Aggregate Data from 1M+ Commercial Vehicles

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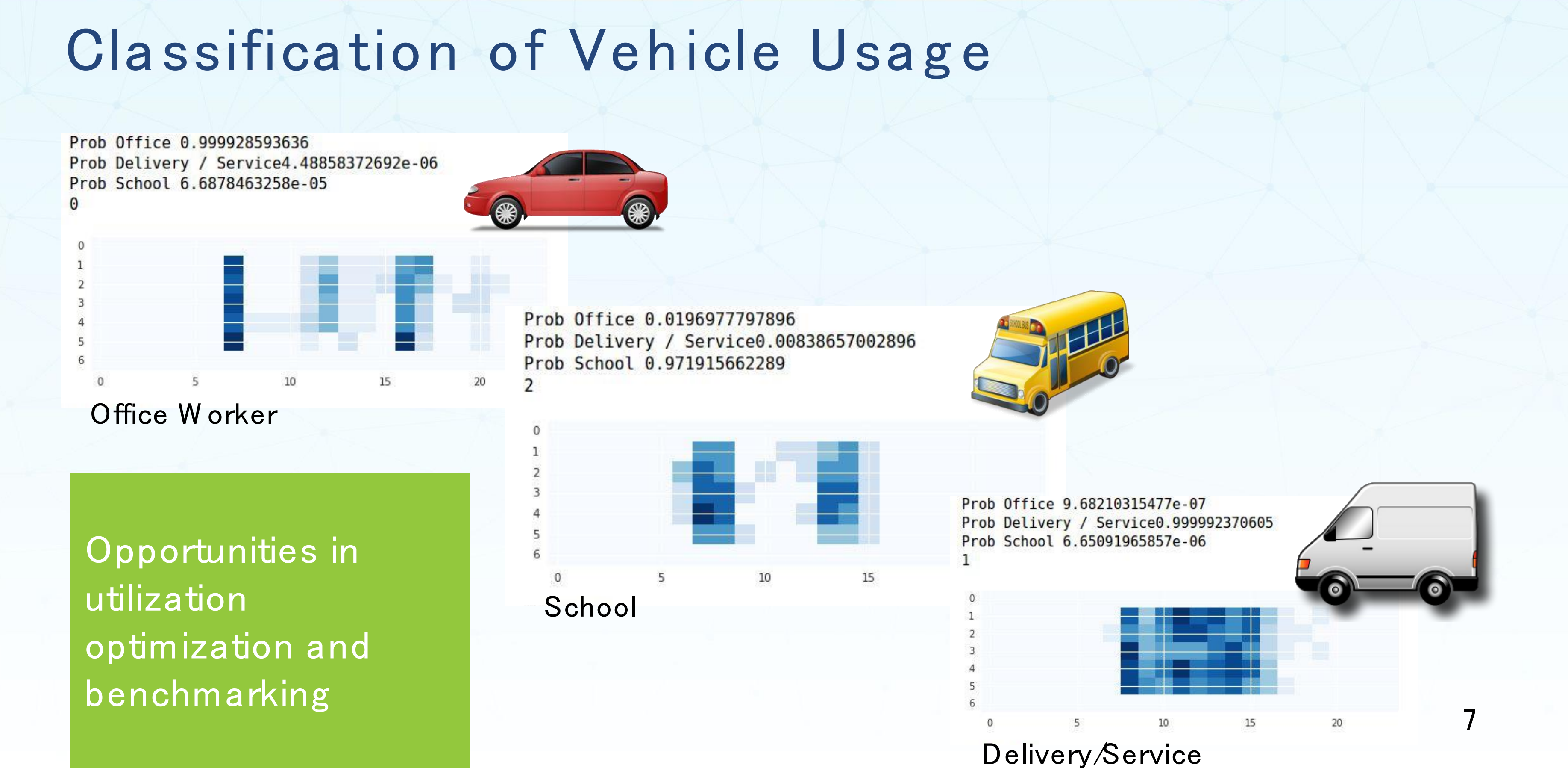
Classification of Vehicle Usage



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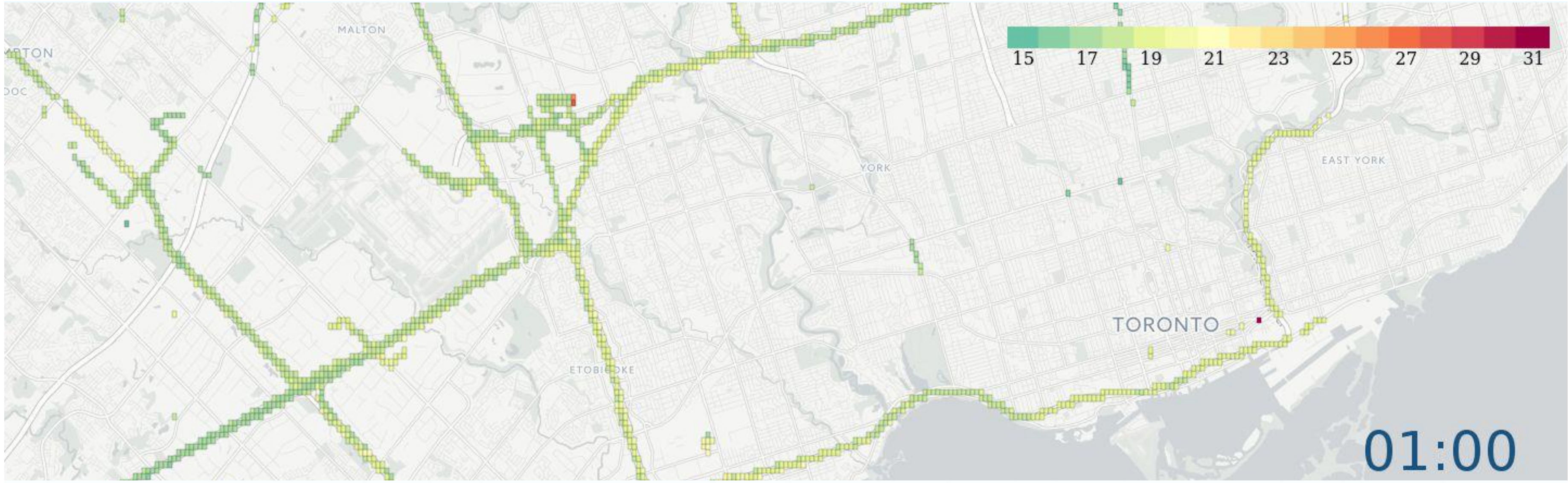
Hyper Local Temperature (Toronto)

Geotab HyperLocalTemp



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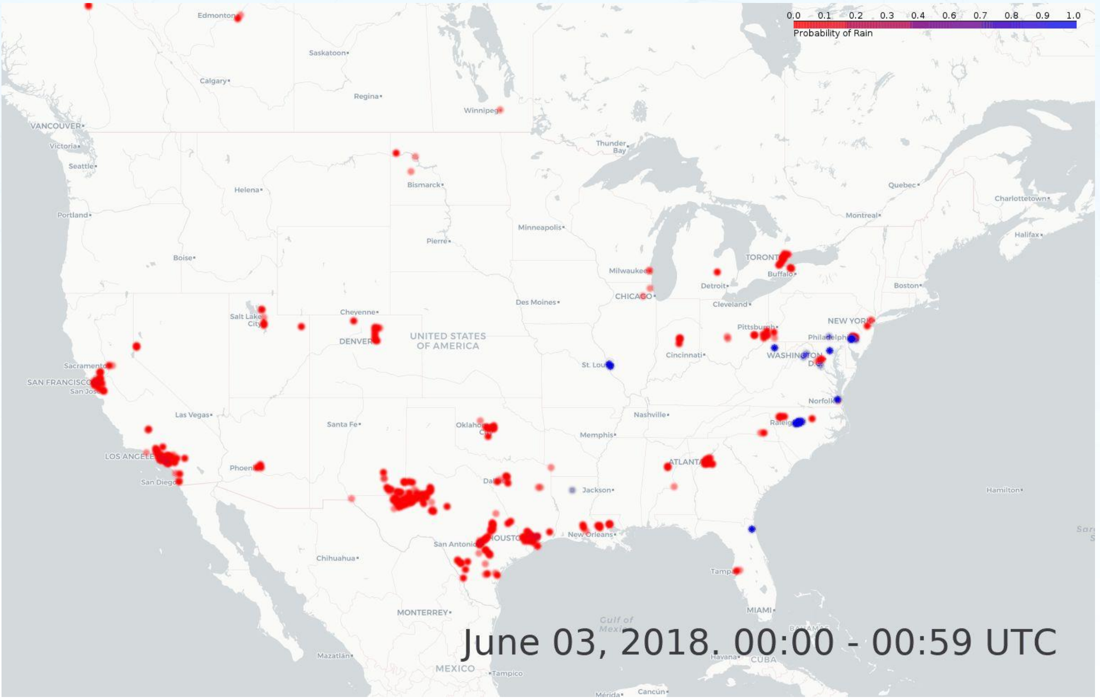
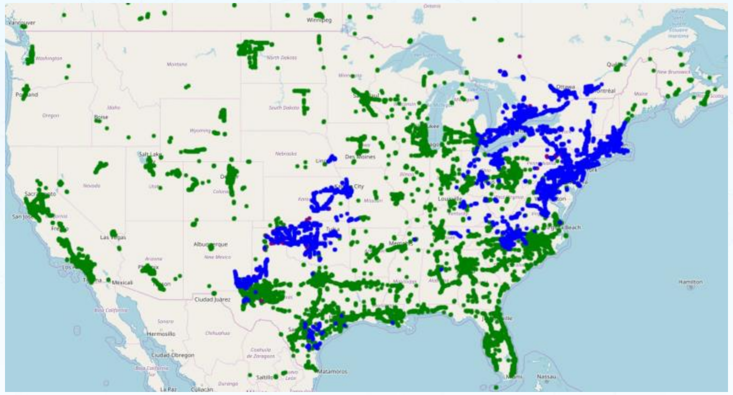
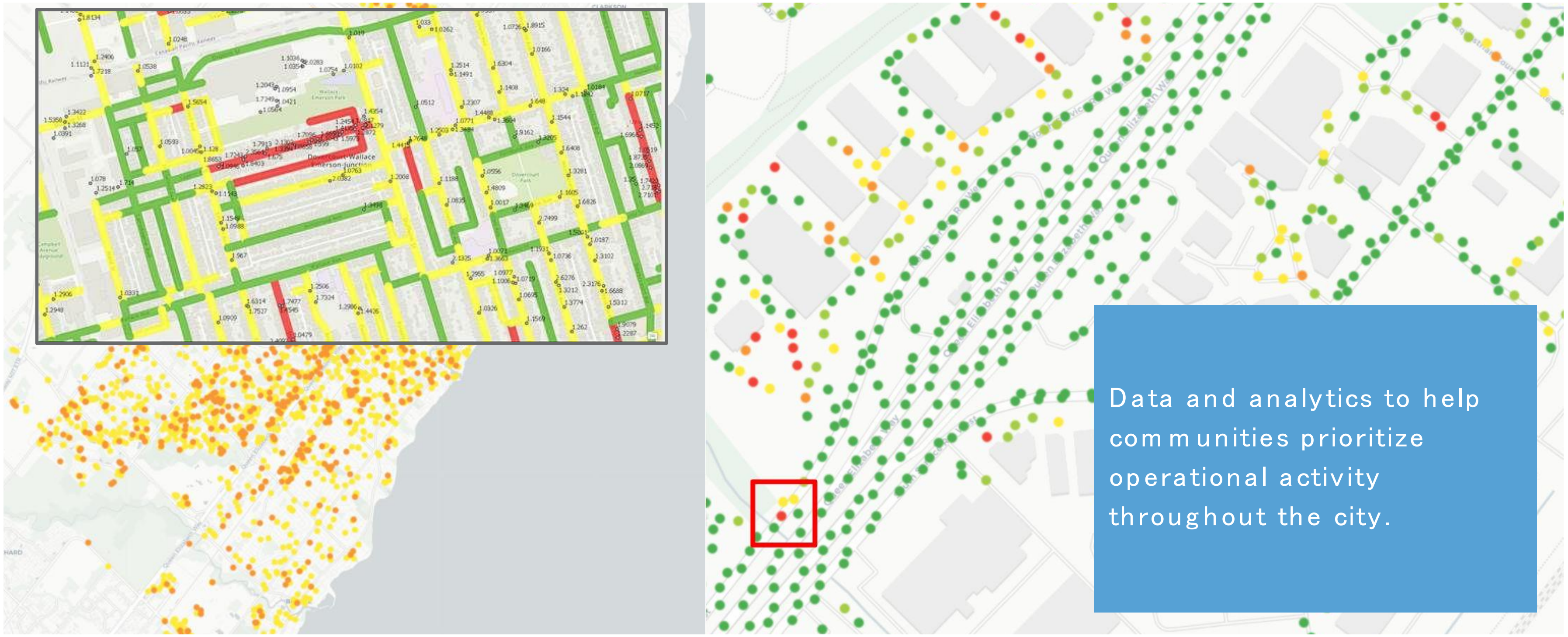
[Geotab HyperLocalPrecipitation]





Road Impediment Detection



Data and analytics to help communities prioritize operational activity throughout the city.

Data on this charts are from “Vehicle Data Driving the Smart City,” presented by Mike Branch of Geotab, at the IEC Workshop on Smart Cities, 10 July 2018, Washington DC, USA.

Cellular Dark Spots

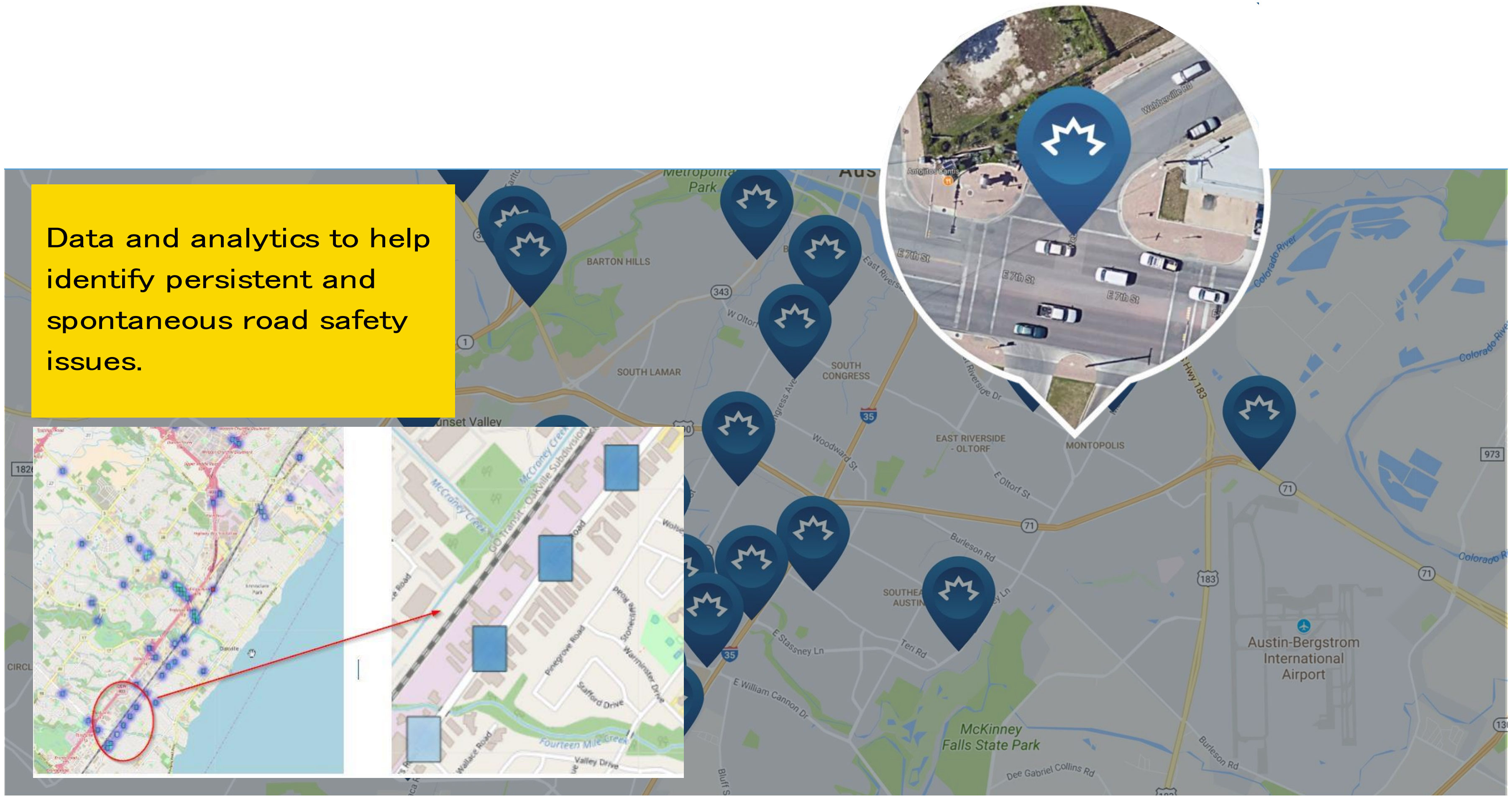
Data on this charts are from “Vehicle Data Driving the Smart City,” presented by Mike Branch of Geotab, at the IEC Workshop on Smart Cities, 10 July 2018, Washington DC, USA.

Search for Parking

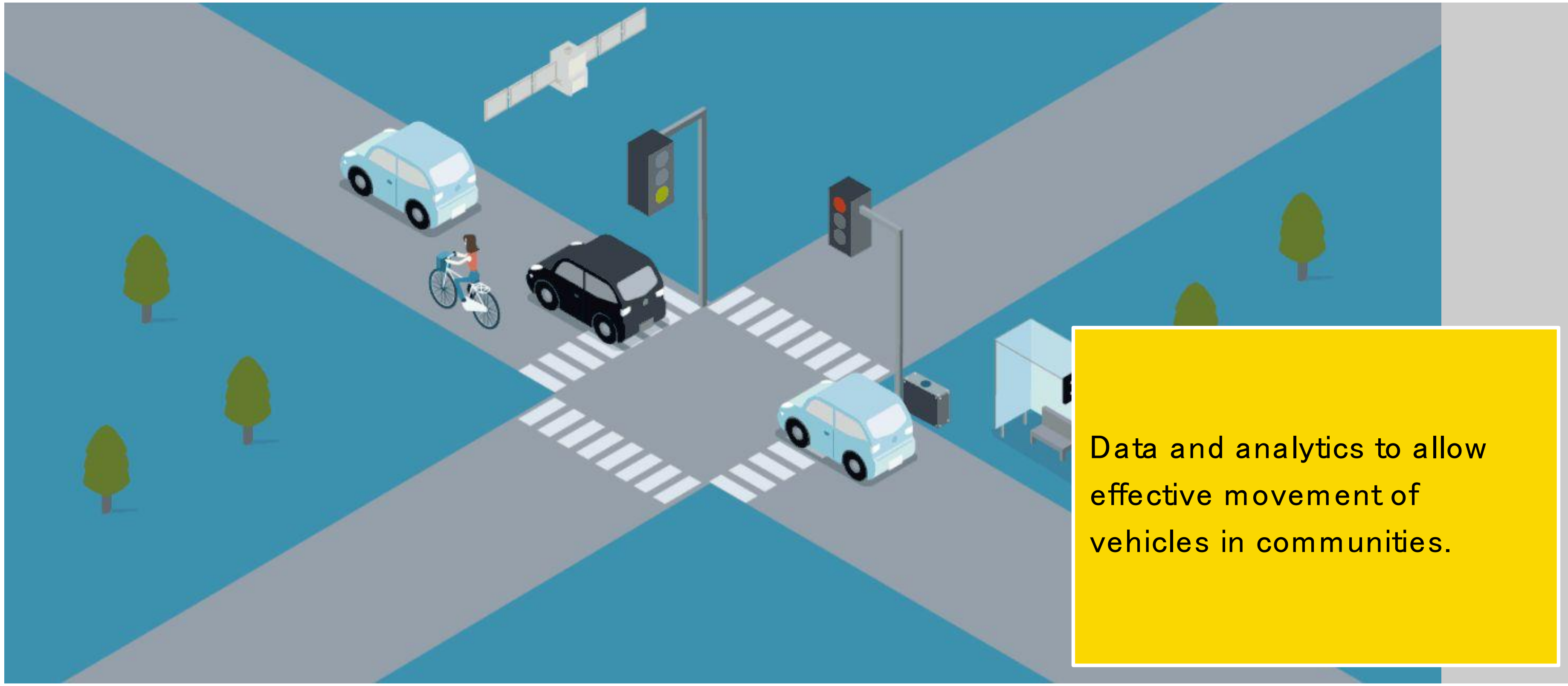
Data on this charts are from “Vehicle Data Driving the Smart City,” presented by Mike Branch of Geotab, at the IEC Workshop on Smart Cities, 10 July 2018, Washington DC, USA.

Hazardous Driving Areas

Data and analytics to help identify persistent and spontaneous road safety issues.



[Geotab Mobility]

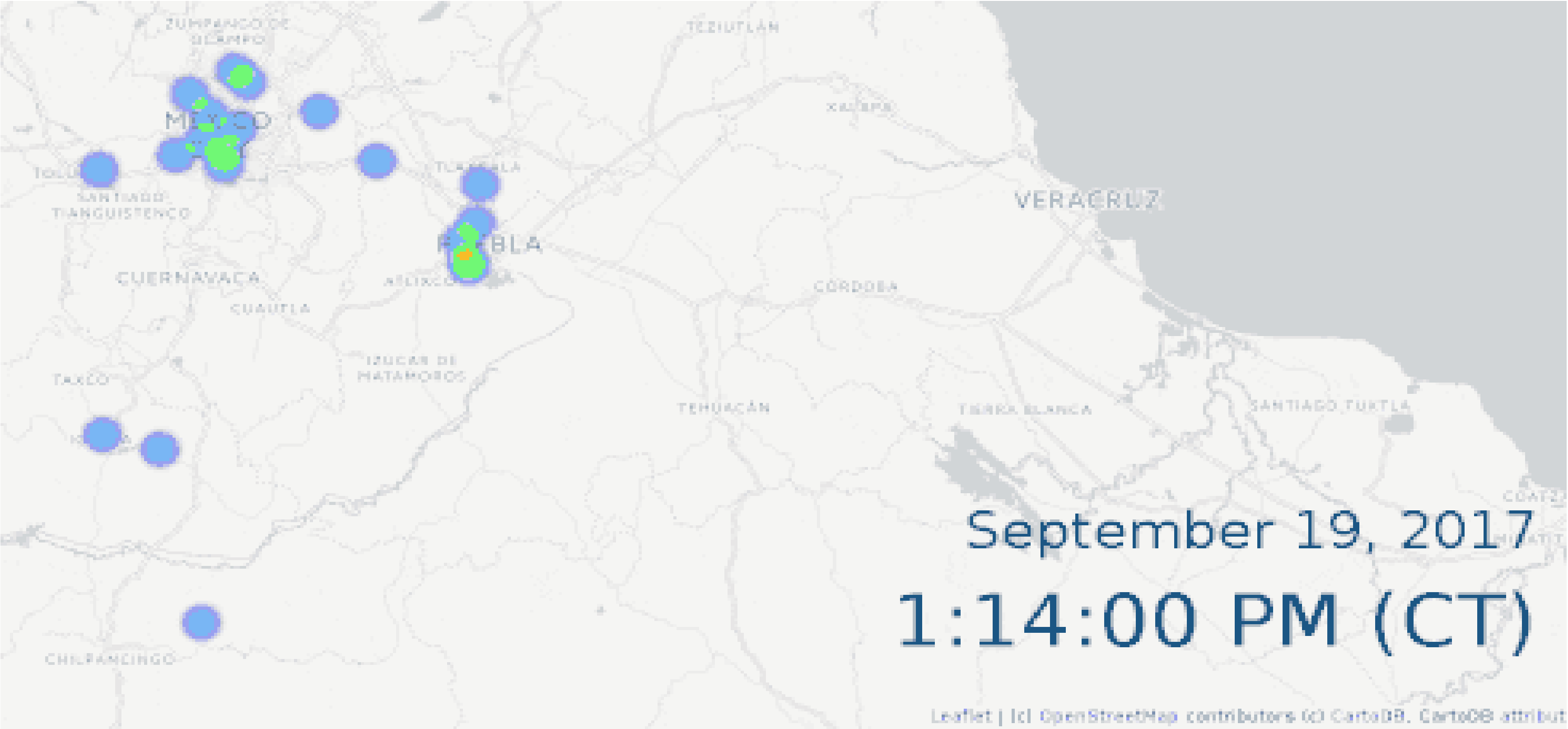


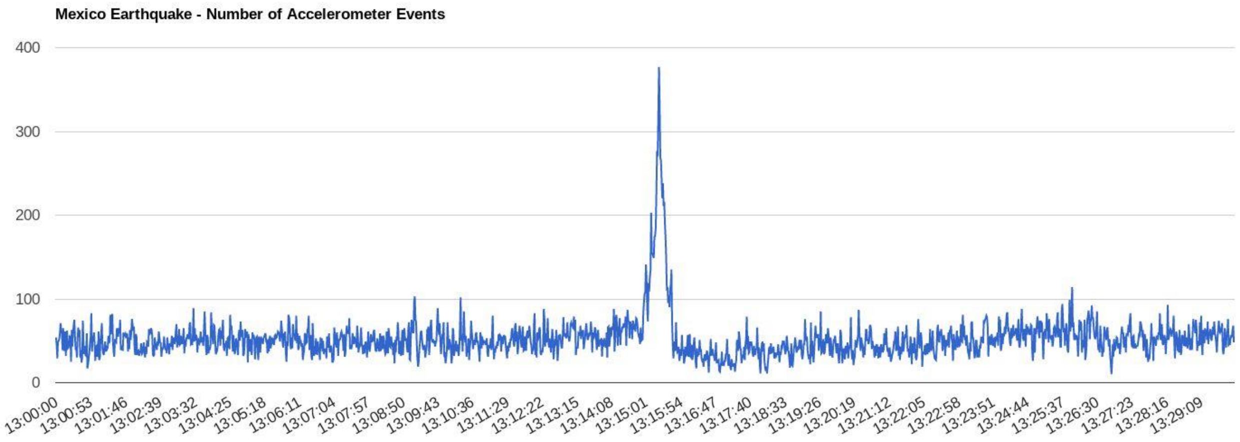
Data and analytics to allow effective movement of vehicles in communities.

Data on this charts are from "Vehicle Data Driving the Smart City," presented by Mike Branch of Geotab, at the IEC Workshop on Smart Cities, 10 July 2018, Washington DC, USA.

Connected Car Detects Mexico Earthquake

Geotab Earthquake





Data on this charts are from “Vehicle Data Driving the Smart City,” presented by Mike Branch of Geotab, at the IEC Workshop on Smart Cities, 10 July 2018, Washington DC, USA.

First and Last Mile Transportation

- First and last mile transportation is largely unaddressed
- Public Transport / Mass Transit
  - Long wait time
  - Insufficient stops
  - Expensive
  - Traffic congestion
- 50%+ of car traffic in US < 3 miles
- 20-30% of the canceled trip on Uber is due to short distance

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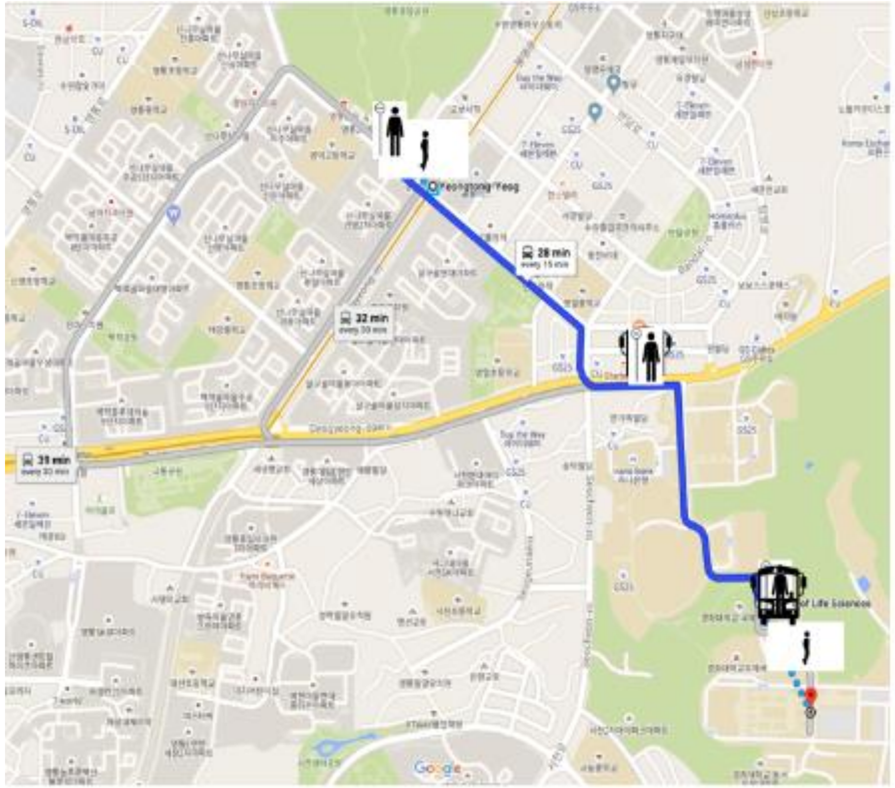
- From Kyung Hee University Global Campus to Yeongtong Station

14 min by bus + 5 min on foot + waiting time at bus stop = 24 min

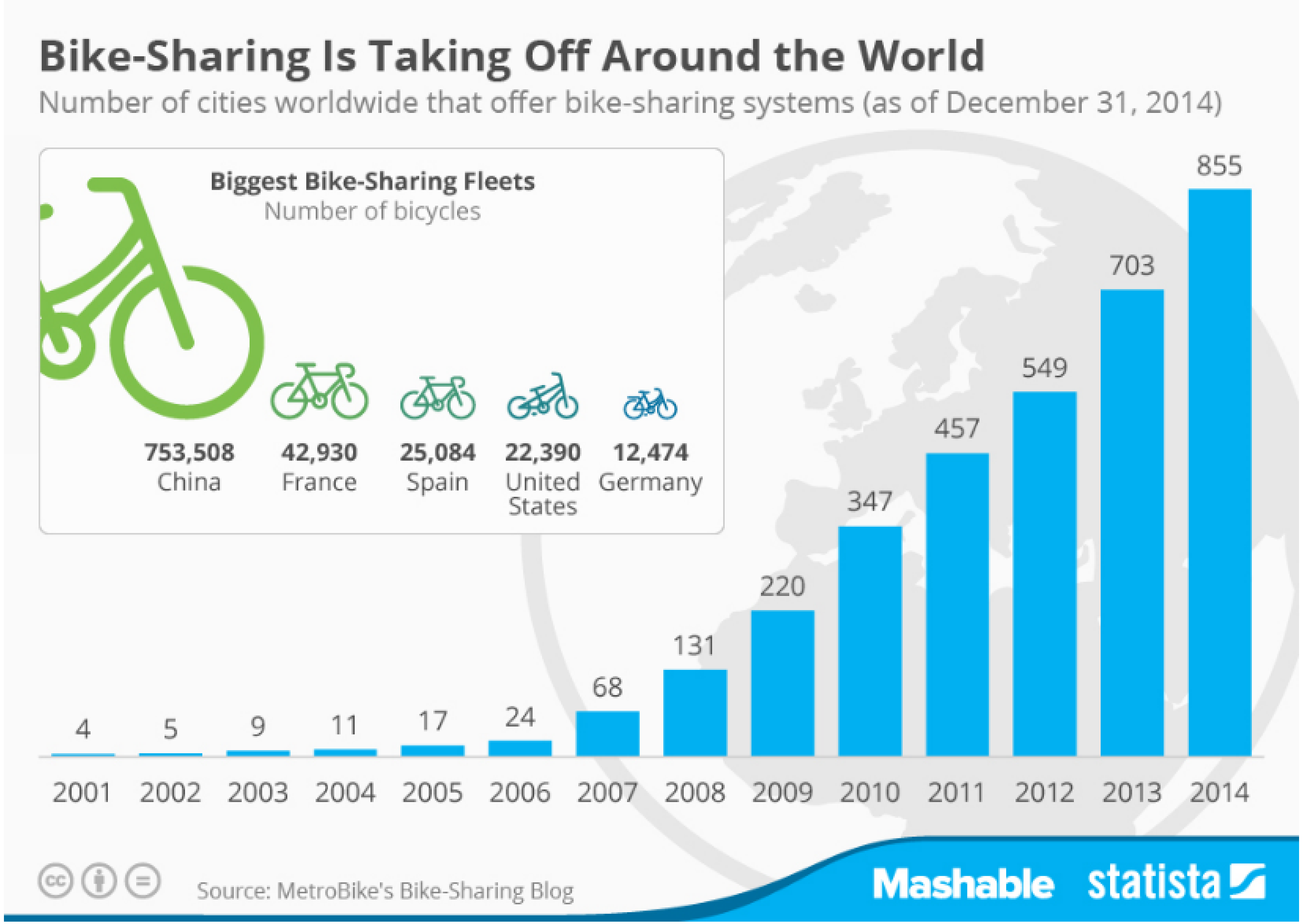


3 Min
4 Min
5 Min
1 Min
9 Min
2 Min
24 Min

8 Min

8 minutes by bike

Bike Sharing in the World

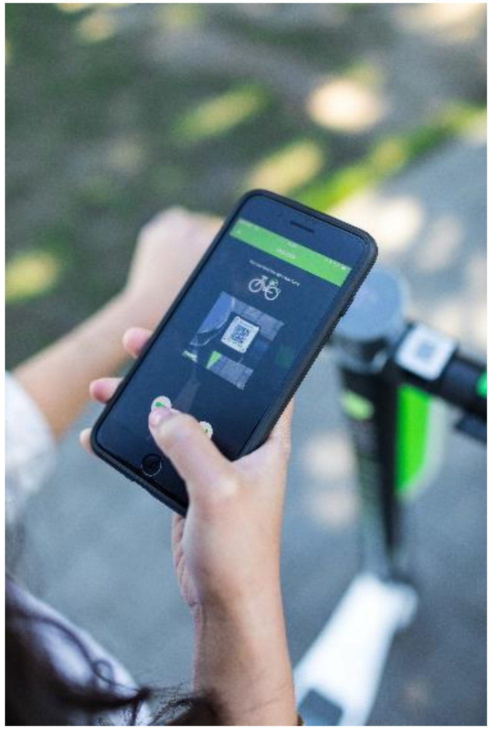


Bike Sharing in Korea

City	Company	Starting Year
Seoul	Seoul Public Bike (Ddareungyi)	2015
Suwon	Mobike (Tencent), Singapore	Dec, 2017
Busan	Ofo (Alibaba), China	Jan, 2018

Data Collection (LimeBike)

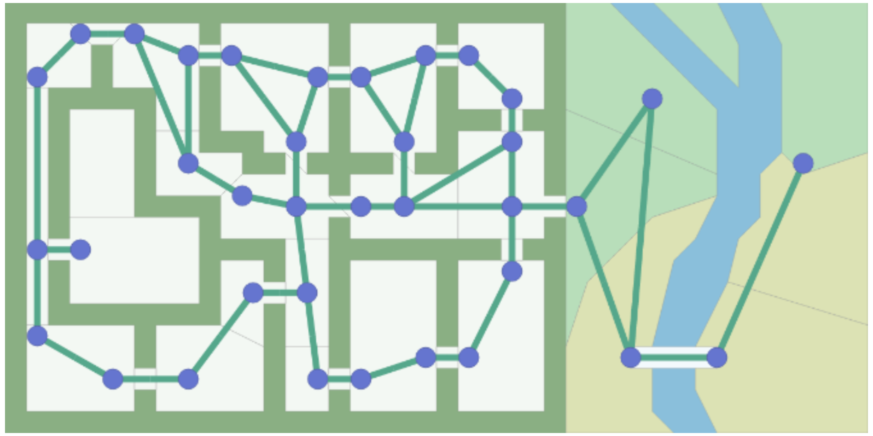
- GPS Data (shared with the City)
- Where the commuters are going
- Better city planning



Source: 50 markets in 10 Months: LimeBike's Impact
url: https://www.youtube.com/watch?v=NmUYH7jdhE8&t=534s

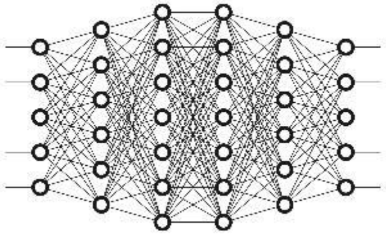
Using Big Data and AI

- Challenges for the Operators
  - Charging bikes and scooters
  - Repositioning bikes and scooters
  - Maintenance
- Problem: balancing Supply & Demand
- Solution: Distributed resource allocation over a graph
- At each node

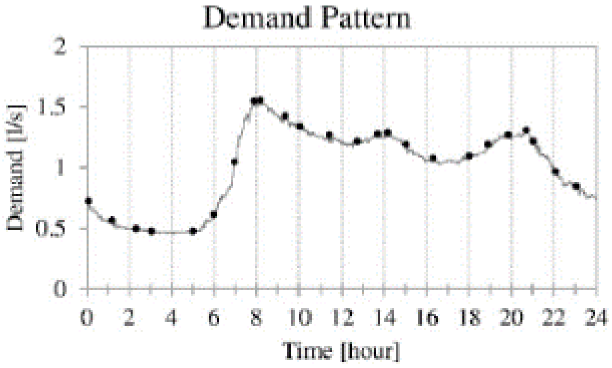


Street Map Converted into a graph

Big Data



Artificial Intelligence

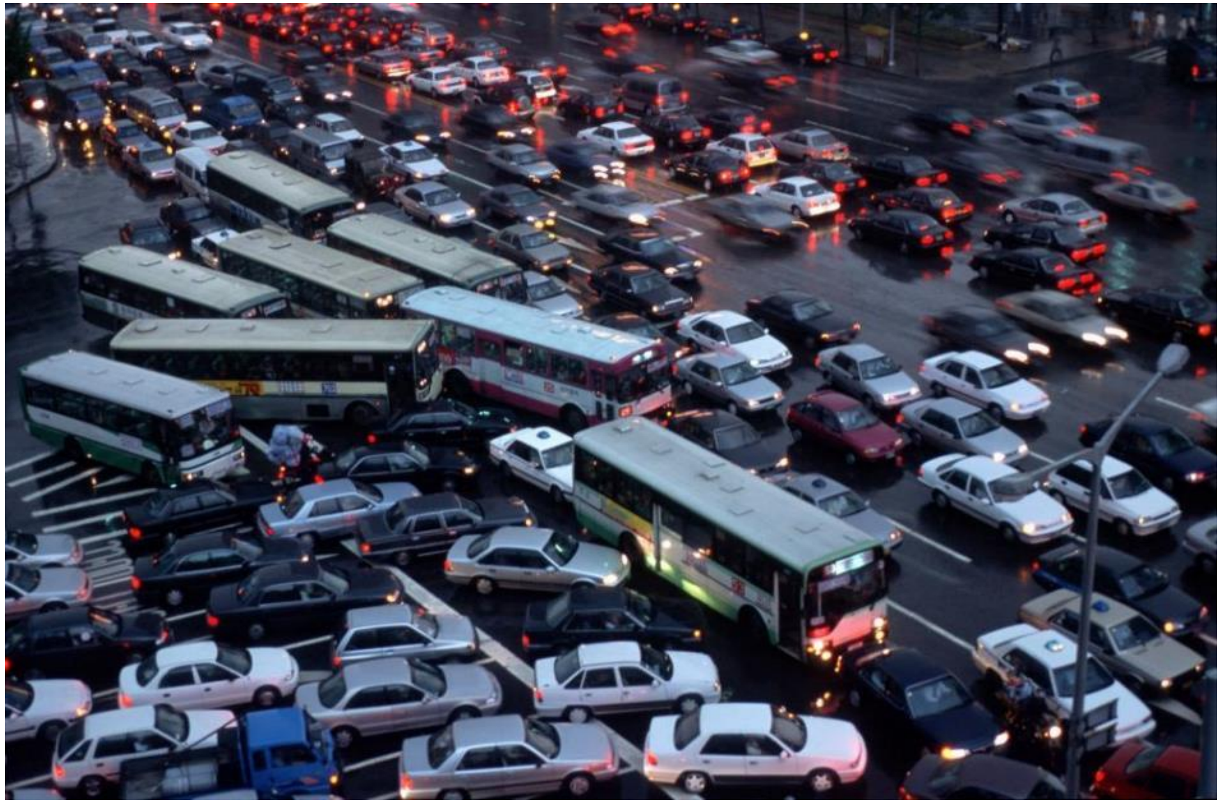


Demand Pattern

Resource Allocation

Innovation Technologies for Smart City

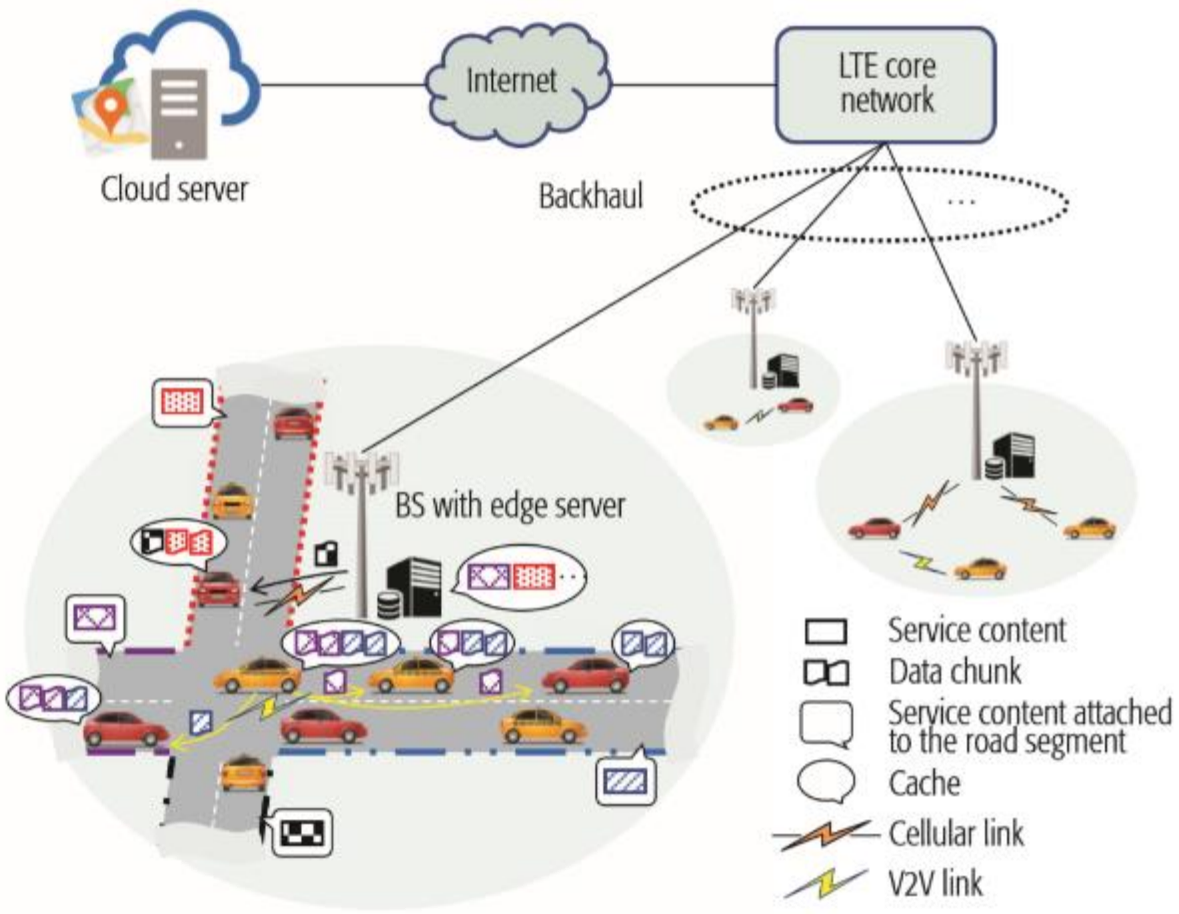
- In city, road congestion determines substantial productivity losses and accidents
- In 2016, 235,532 people were killed, and 6,648,078 people were injured in traffic accidents [1].
- US National Highway Traffic Safety Administration data in 2015 shows that, in Georgia, 94% of car accidents caused by human errors and bad decisions [2]



1. Icebike, "Real time traffic accident statistics," https://www.icebike.org/real-time-traffic-accident-statistics/ ,
2. http://southsideinjuryattorneys.com/lawyer/2016/07/21/Personal-Injury/New-Data-Shows-94-Percent-of-Car-Accidents- Caused-by-Human-Error_bl25860.htm,

Autonomous Car and AI

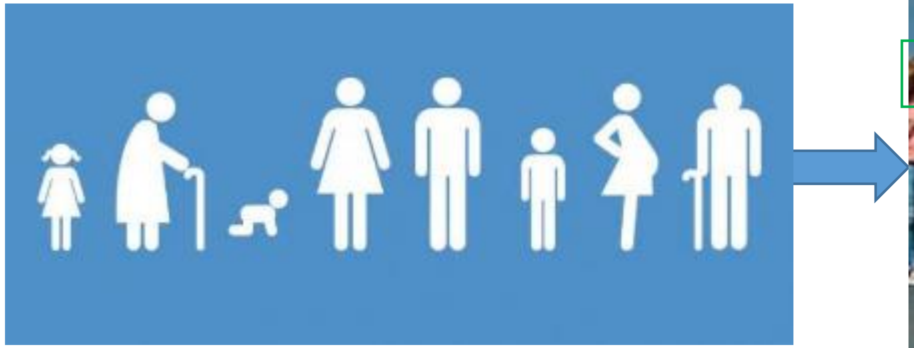
- Relying on cloud computing services can hinder the performance of big data analytics, due to the associated overhead and high delay of car-to-cloud communication
- We need real-time big data analytics at the edge in close proximity to the self-driving cars

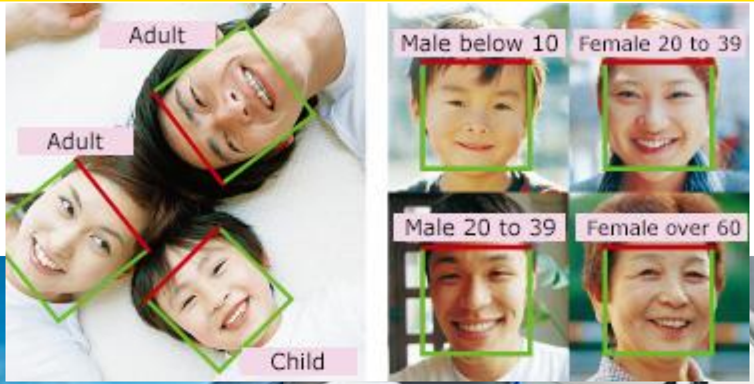


Yuan, Quan, et al. "Toward efficient content delivery for automated driving services: An edge computing solution." IEEE Network 32.1 (2018): 80-86.).

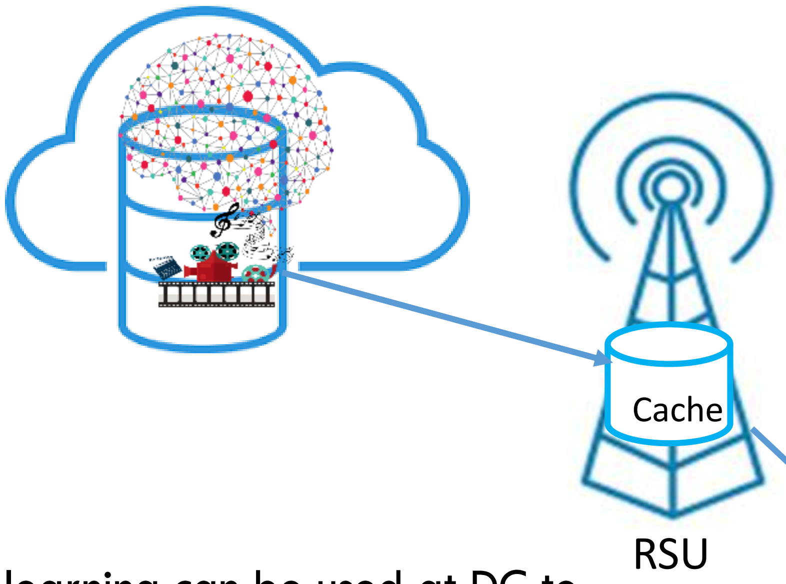
Autonomous Car and AI

- Self-driving cars need to learn and analyze data related to people on board in real-time
- This can help in getting passengers' features and provide them enhanced and customized services such seating arrangements and infotainment





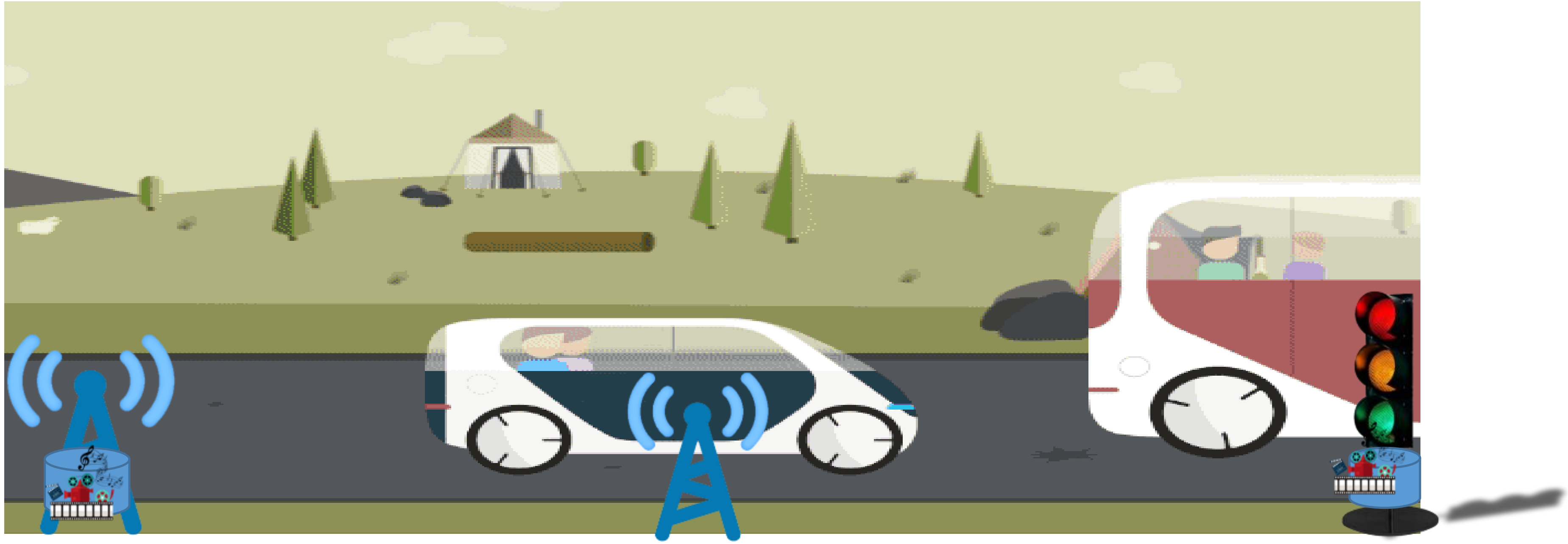
Deep Learning Based Caching in Autonomous Car



- Based on demands, deep learning can be used at DC to predict the entertainment contents need to be cached in the areas of RSUs
- Each RSU downloads and caches the contents that have high probabilities to be requested in its areas
- Based on passengers' features such as age, gender, and emotions, self-driving downloads from RSU the contents that are appropriate to them and cache them

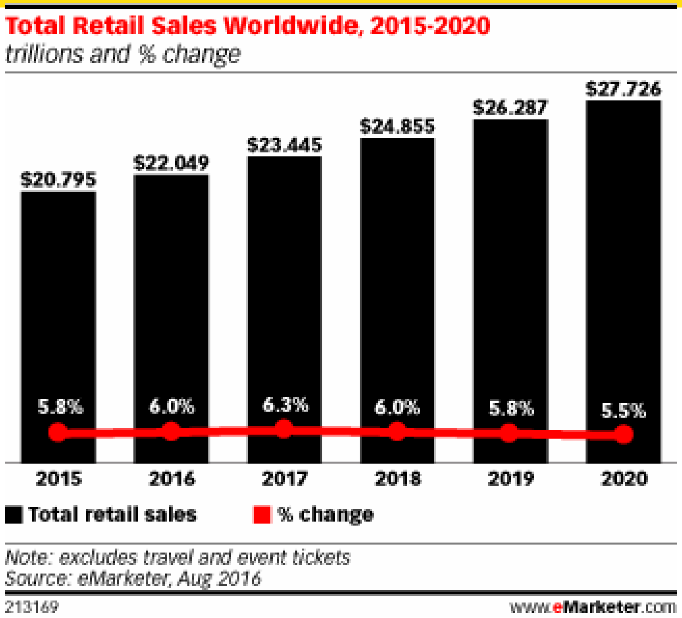
* RSU (Road Side Unit)

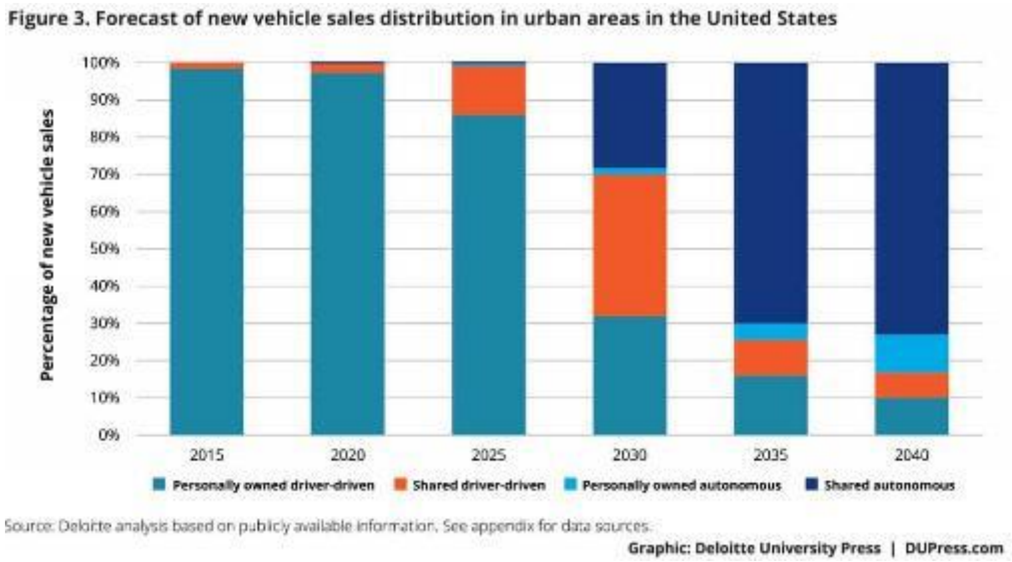
- The speed of autonomous car can be adjusted with considering the position of RSU for the downloadable contents of the infotainment passenger in the car before departure and the service continuity.



RSU : Road Side Unit

Smart Transportation and Delivery Services : Motivations





Customers

Individuals/businesses buying goods through retailers and e-commerce

- **Increased delivery speed:** Drive to decrease time between order placement and order receipt
- **Lower shipping price:** Desire for insight into different price points and "free" shipping options included in a subscription (e.g., Amazon Prime)
- **Flexible destinations:** Push for flexibility on location to pick up a package (home vs. smart locker)
- **Dynamic shipments:** Ability to divert a package mid-shipment
- **Easy returns:** Desire for hassle-free, low-cost returns
- **Simple tracking:** Ability to seamlessly track individual orders throughout the journey

Retailers

Amazon, Target, and Macy's

- **Shifted shipping mix:** Rebalance the shipping portfolio (e.g., third parties vs. in-house)
- **Increased customer insight:** Provide insight into customers through digital touchpoints
- **Enhanced visibility:** Enhance visibility to shipments, both internally and externally sourced
- **Distributed distribution:** Increase the need for distribution centers near urban centers to enhance delivery speed
- **Proliferation of shipping options:** Create need to vary service level (e.g., expedite for key customers, deliver to locker)

Carriers

US Postal Service, FedEx, and XPO Logistics

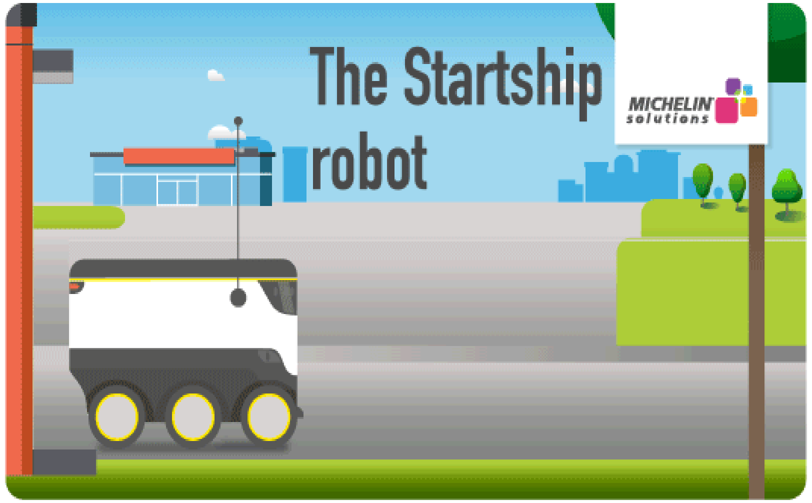
- **Reduced cost:** Reduce the cost structure of each individual delivery
- **Increased accuracy:** Help to manage the network to achieve higher accuracy
- **Analytic insights:** Enable predictive and prescriptive insights from network data
- **Increased utilization:** Increase utilized capacity and throughput
- **Shifted talent base:** Enhance returns on hiring and retaining skilled labor
- **Increased safety:** Minimize accidents and lower insurance costs

Source: Deloitte analysis.

Deloitte University Press | dupress.deloitte.com

Smart Transportation and Delivery Services: various ways

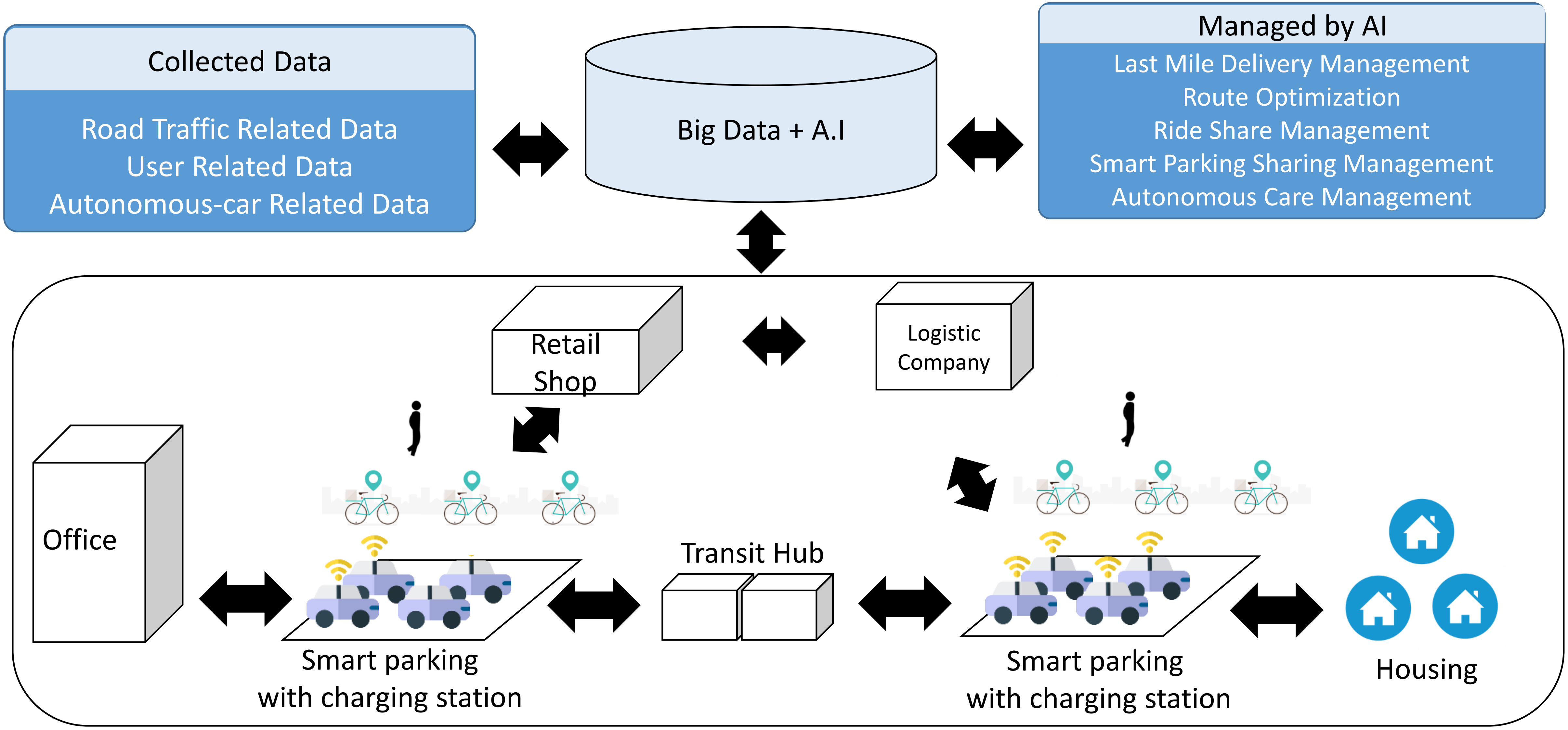
The combination of autonomous transportation and delivery services will play major role in the future of smart city.

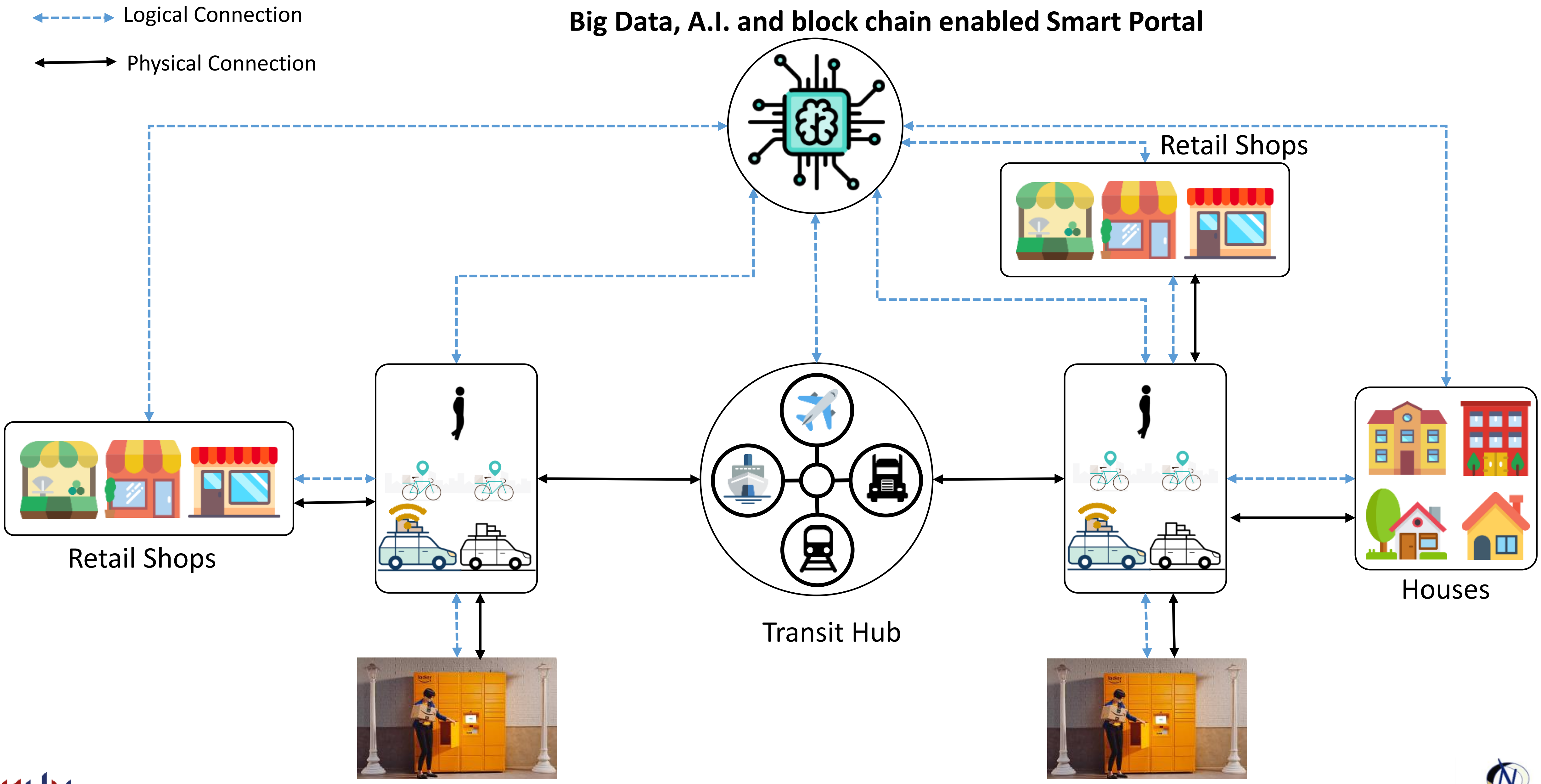


Nuro autonomous vehicle (Source: Kroger)

AUTOLIVERY vehicle (Source: Kroger)

The Future of Connected Transportation Service in Smart City




Logical Connection
Physical Connection
Big Data, A.I. and block chain enabled Smart Portal
Retail Shops
Retail Shops
Transit Hub
Houses

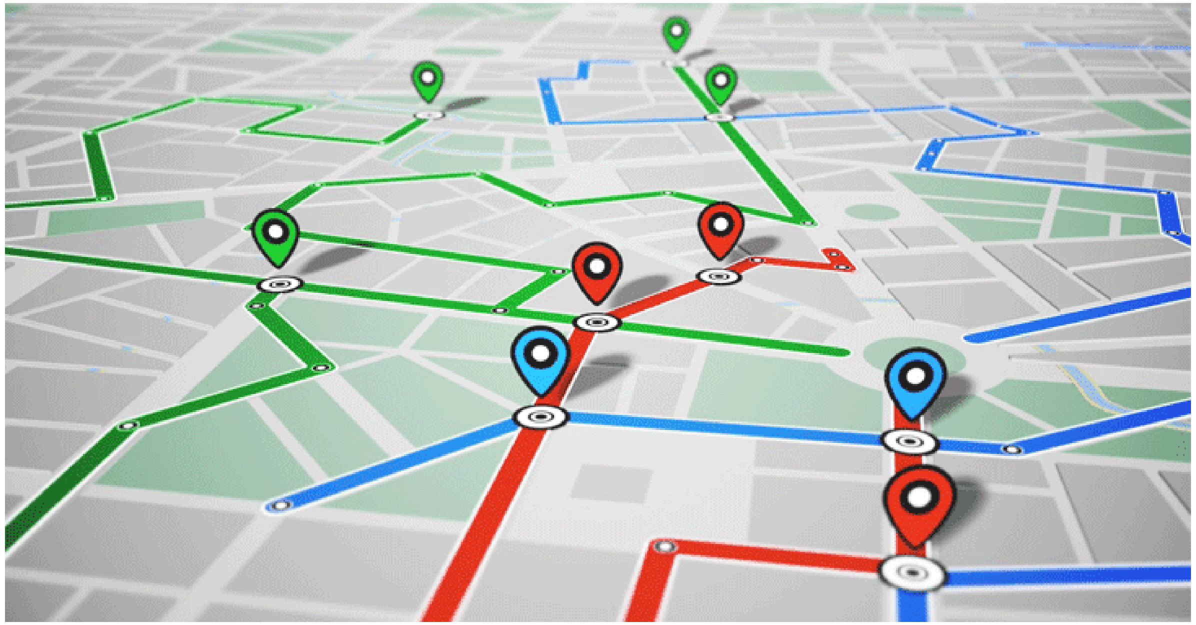
- Crowd-based pickup and delivery
  - Applied to a distribution network, a crowd-based approach may create substantial efficiency enhancements on the last mile.
  - Commuters, taxi drivers, or students can be paid to take over lastmile delivery on the routes that they are traveling anyway.
  - It has potential to cut last-mile delivery costs, especially in rural and sparsely populated areas.
  - The automated control of a huge number of randomly moving delivery resources.
  - Massive real-time information (originating from sensors, external databases, and mobile devices)
  - This requires extensive data processing capabilities, answered by Big Data techniques such as complex event processing and geocorrelation.
  - A real-time data stream is traced in order to assign shipments to available carriers, based on their respective location and destination.
  - Interfaced through a mobile application, crowd affiliates publish their current position and accept pre-selected delivery assignments.

Motivation for Global Optimal Car Navigation

- For every day commutation : 100 minutes (to Company: 48.1Min, to Home: 53Min)
  - In Seoul: 134.7 Min (Ranking No.1 in OECD)
- Intelligent Transportation System (ITS) is used as an important metric to solve the traffic congestion problem especially in Urban population.
- In a study of 471 U.S. urban areas in 2014, the extra energy cost due to the traffic congestion was estimated at $160 billion (3.1 billion gallons of fuel).
- With the development of ITS, car navigation devices are capable of receiving real-time information on the traffic situation.
- Navigators provide vehicles with their navigation paths from the source to the destination with road traffic statistics or real-time traffic conditions.
- Efficient navigation will save time and fuel effectively; hence, research on navigation will continue in the future.

Challenges of Existing Navigation Systems

- A car navigation system combines *GPS technology with a computer communication system to track a driver's progress on a digital map*.



- GPS provides services:
  - shortest or fastest road to your destination
  - amount of fuel needed
  - the expected travel time.

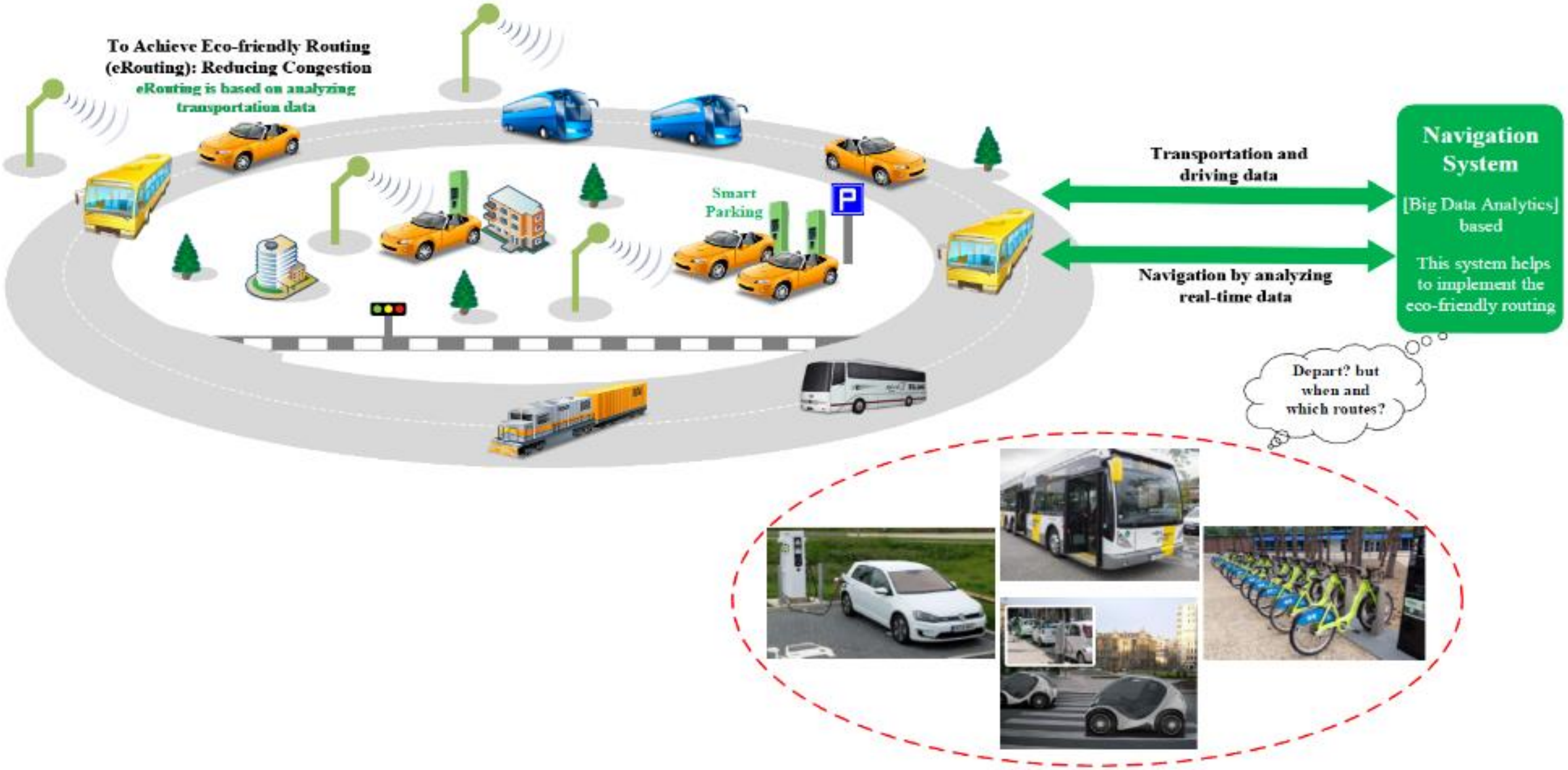
- Due to the trend of wireless access diversity and navigator popularity, a ***natural research question*** is
  - How to design an efficient navigation system by utilizing both real-time traffic conditions and vehicle navigation paths?

Challenges of Existing Navigation Systems

- Typically in traditional navigation systems, when road segments are less congested, navigation systems will construct navigation paths using the light-traffic road segments.
  - TMAP
  - Kakao Driver
  - OneNavi
- In such a case, many vehicles will simultaneously use the light-traffic road segments for their travel paths in a greedy way that results from locally optimal navigation systems .
- As a result, those road segments will soon be congested with high probability.
- This phenomenon happens because the current navigation systems compute time-wise shortest travel paths, based only on the snapshot of road traffic conditions without considering the near-future congestion in currently light-traffic road segments.

Intelligent Transportation System for Smart City

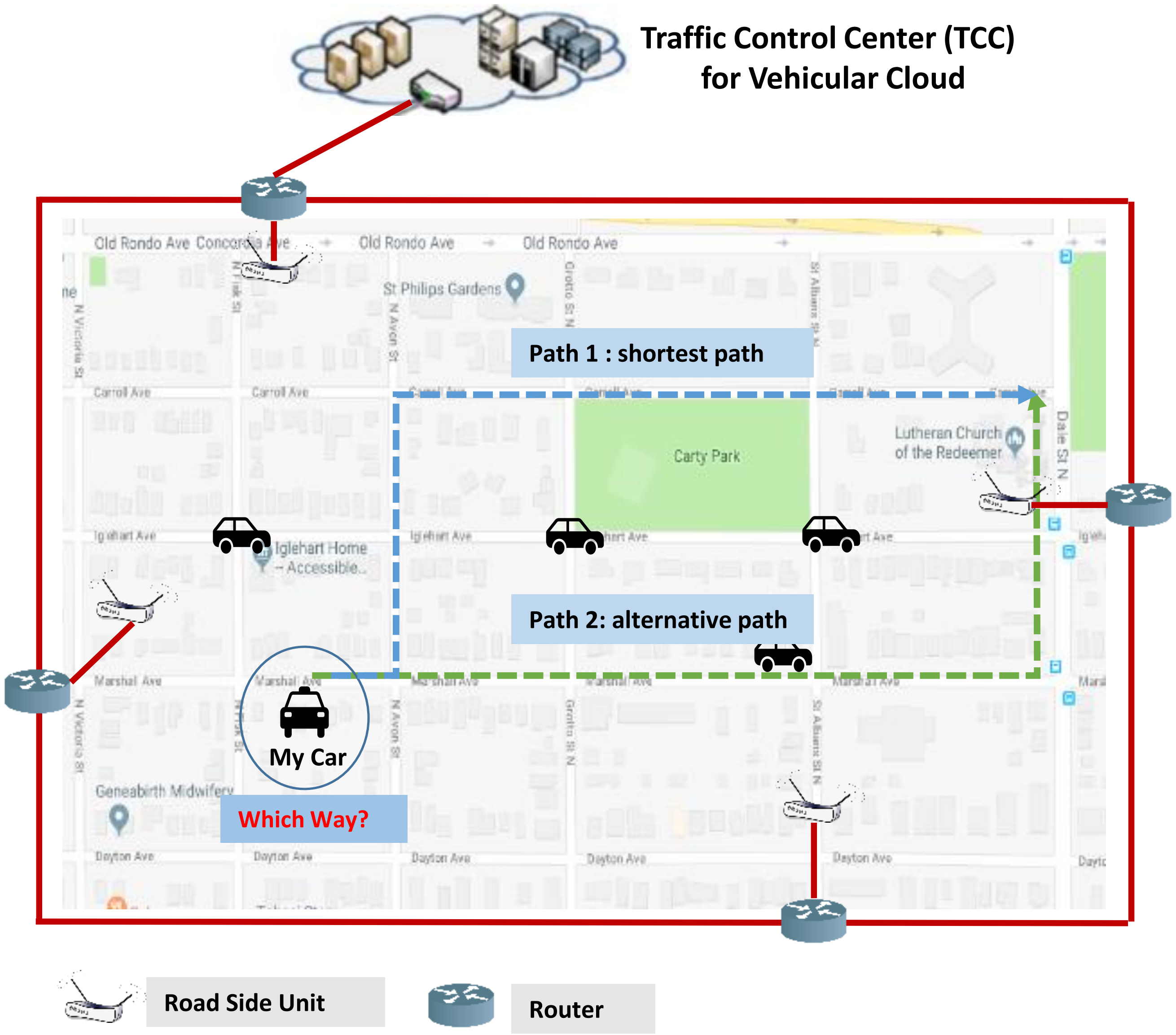
- In smart city, we need intelligent transportation system that requires Big Data analytics for making real time decisions
- The goal of the global optimized navigation system does not include the navigation for segments with high probability of congestion in the near future,



Chen, Yuanfang, et al. "When traffic flow prediction meets wireless big data analytics." *arXiv preprint arXiv:1709.08024*(2017).

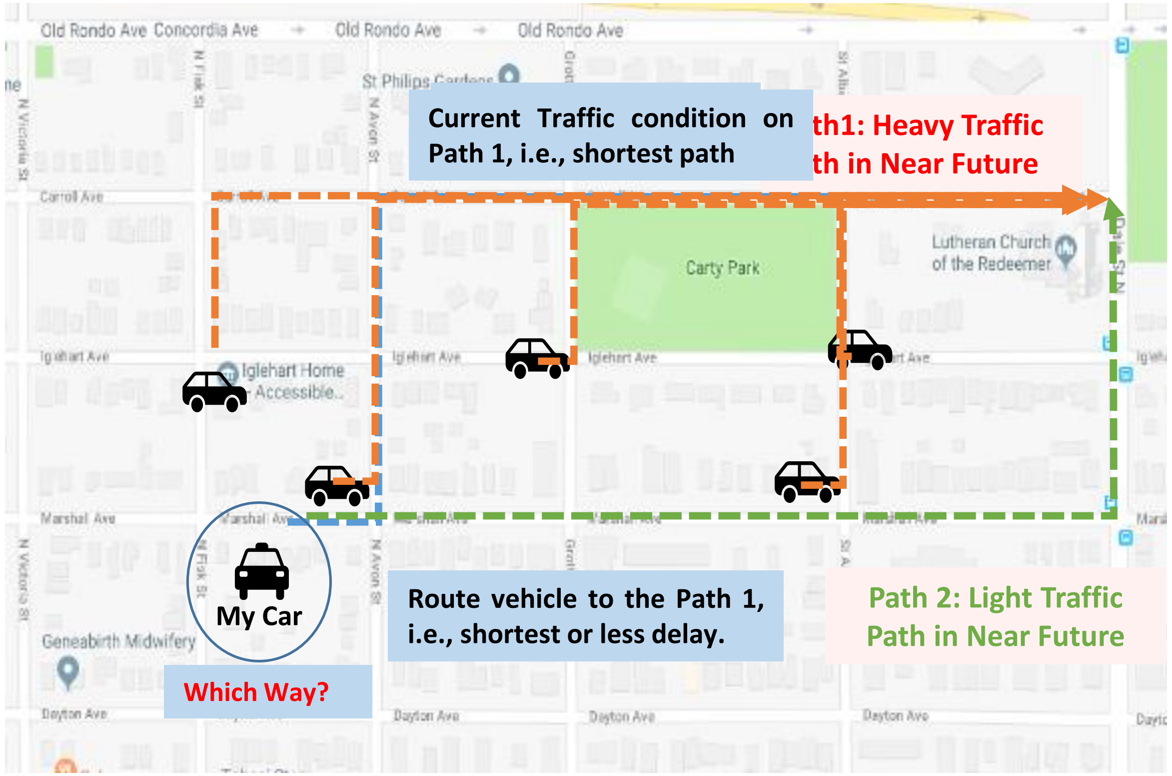
Scenario: Optimal Car navigation Model

- A Traffic Control Centre (TCC) is a road traffic management node for a vehicular cloud system in a target road network.
- The TCC maintains the trajectories and locations of vehicles for location management.
- The TCC has up-to-date vehicular traffic statistics, such as
  - Vehicle arrival rate
  - Current time stamp
  - Average speed per road segment



Scenario: Optimal Car navigation

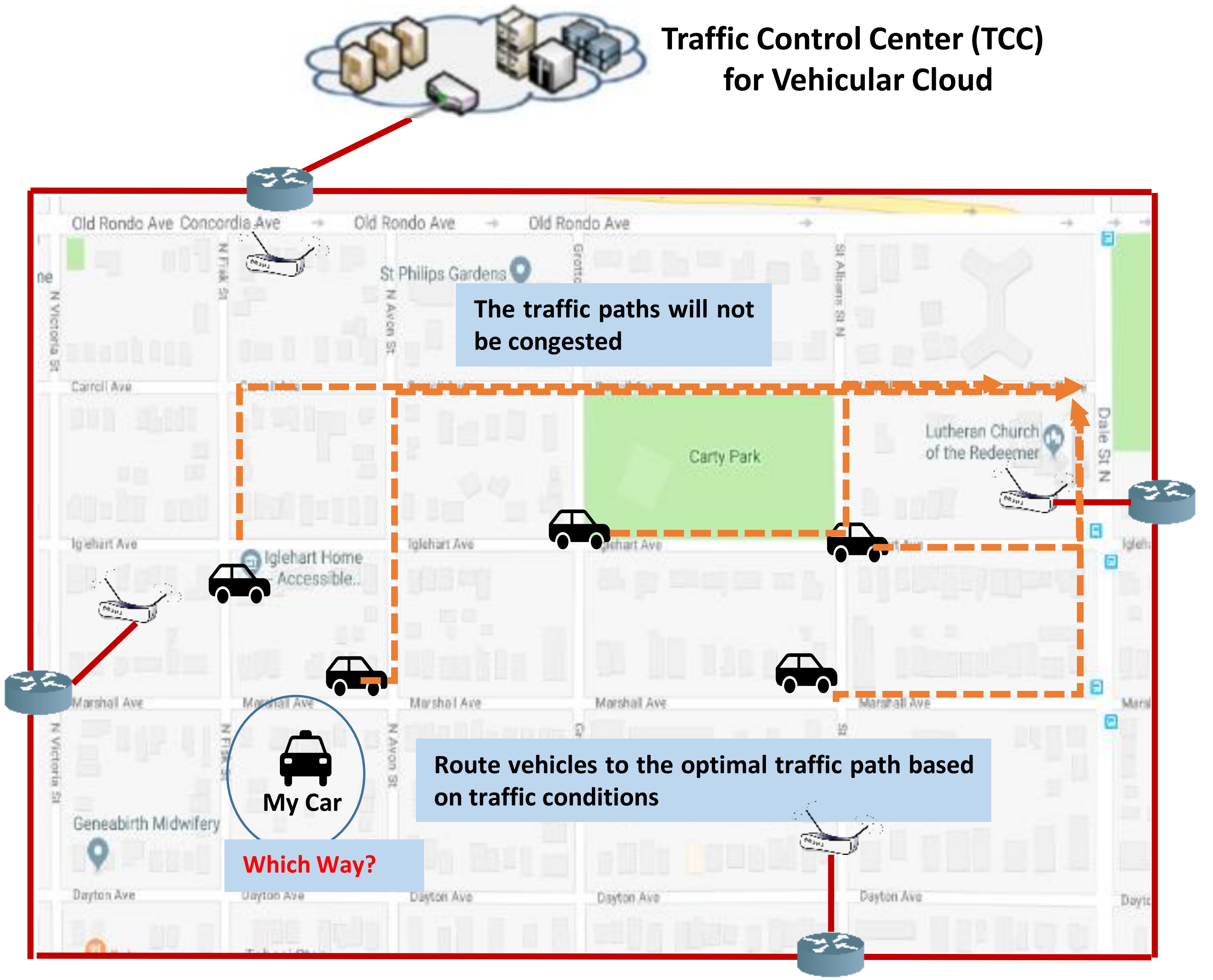
- Local optimization for individual vehicles, which is used by legacy navigators such as Kakao Driver or TMAP will route cars to the upper road which is less congested.
- Result
  - All vehicles can simultaneously reroute their paths toward the alternative path, which is a light-traffic path.
  - The simultaneous rerouting will cause the alternative path to be congested very soon.
- Thus, local optimization causes congestion in a area because it follows a greedy solution.



Local Optimization Approach

Scenario: Optimal Car navigation

- With AI enabled systems, global optimization can be performed.
- We make use of real time analytics from RSU or MEC servers to predict the near future traffic using AI.
- Result
  - Some vehicles reroute to the light-traffic road segments rather than all of the vehicles in the area.
  - Recommendation is provided by TCC to each car based on traffic conditions.
  - This strategy allows the high-traffic road segments to be lighter and all of the road segments to serve the vehicles almost with the same traffic load.
- Thus, an equilibrium can be obtained for all vehicles and a globally optimal solution can be obtained for the service area.



Global optimization Approach

* MEC : Mobile Edge Computing

Parking Lot as a disposable cloud for Smart City

- Huge number of cars are pared especially in parking lots during office hours, specific events and etc.
- Future smart electric vehicles (EVs) that are equipped with resources can support by utilizing their on board capabilities.
- If parked EVs could use their computing, communication, and storage resources, it could also generate revenue by renting out these resources.
- One possible technologies formed by EVs is a disposable cloud computing and storage.
- The formation and use of the cloud by those EVs will generate a myriad of applications and resources that can be virtually made available on the go.

Current parking Lot

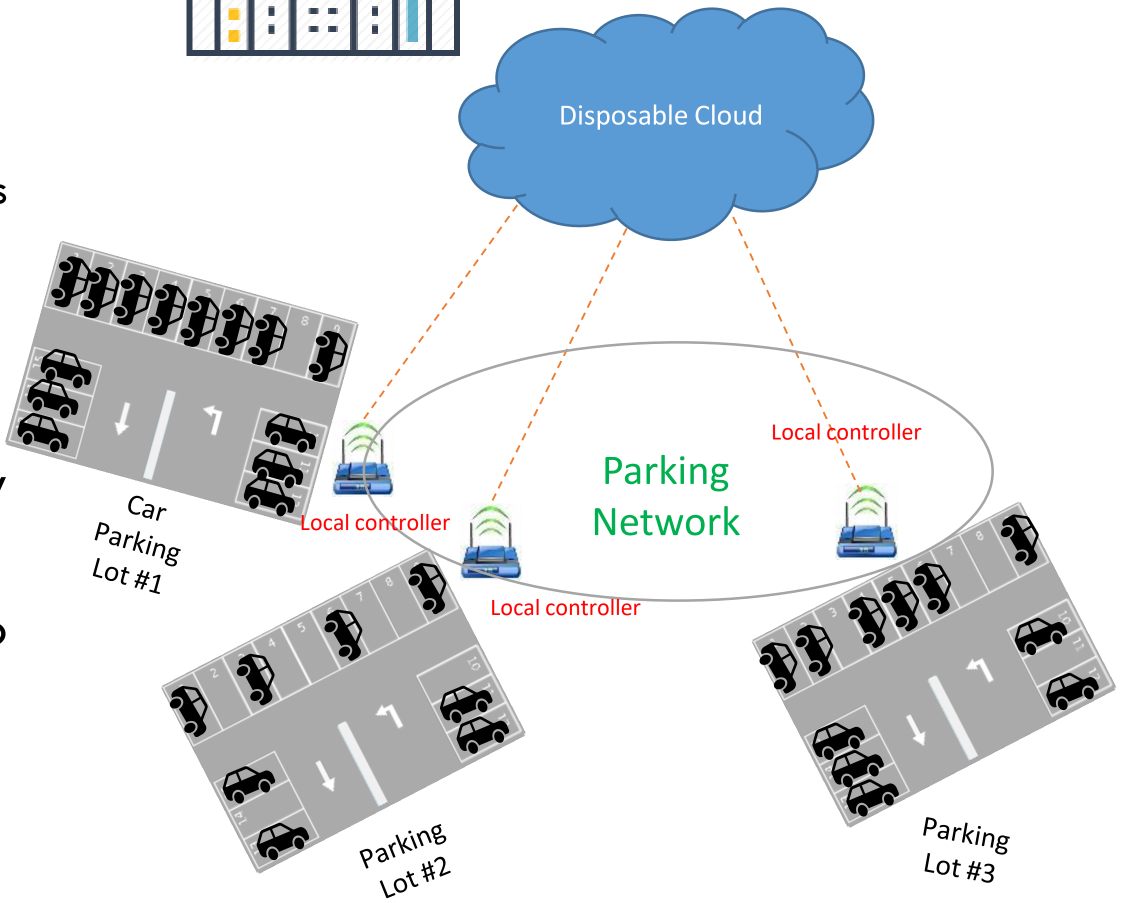
Future parking Lot

Parking Lot as a disposable cloud

- Stationary EVs pool their resources together to form a disposable cloud that can deliver different services.

- Parking lot as a service provider (Business Model):
  - Parking owners can install controllers that can form clusters of parked vehicles.
  - A cluster controller unit on RSU stations will register the on board units of EVs to join the cloud and group them as a part of multiple logical VMs.
  - Data analytics and storage can be provided to nearby customers by these temporary service provider.

- It is very likely that, given the right incentives, the owner of a EV will decide to rent out their on-board capabilities on-demand or on a per-hour or per-day basis, just as owners of large computing or storage facilities find it economically appealing to rent out their excess capacity.



* EV : Electric Vehicle

Conclusions

Conclusions

- A Smart City is for People and the culture they live in.
  - Smart Cities should empower the "People," not the government (i.e., not governing people). It should be "Citizen First."
  - Preserve local culture. With globalization in the 90s and 2000s, many local culture and its beauty were or are being lost in urbanization and commercialization.
- A Smart City should be built on standard-based, open architectures.
  - Interoperability between systems of systems should be built-in.
  - Open competition for business regardless of business sizes.
- A Smart City is systems of systems leveraging and implementing all advanced technologies using the infrastructure.
  - Interoperably integrated IoT systems of systems.
  - It is all about information and knowledge extracted from the massive data (Big Data).
  - You may be surprised what you can find from a massive amount of data until you aggregate, fuse, and analyze it.
- Data and information security and privacy should be an essential part of the Smart City.
  - Individual life can be traced from the personal data.
  - It is not just about your bank account or credit card numbers. It is about "everything about you and your family."
- Finally, a systems approach in developing Smart City standards (especially, the architecture) ensures the systems approach in building Smart City, leading to the success of Smart Cities for the people.
- And as an ending note, moving toward to Smart City is a step forward to Digital Society and Digital Economy.
  - Blockchain or similar technology would be an essential player of the future smart city.
    - Smart contracts, cyber-currency, etc.

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Thank you !

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