



esri China
HONG KONG



Big Data and Smart City

Dr. Winnie Tang

Chairman and Founder, Esri China (HK)

Agenda

- Smart City: Overview
- Big Data in Smart City
- Big Data Analytics
- Geospatial Big Data Applications and Privacy

Smart City: Overview

Our World Is Increasingly Challenged

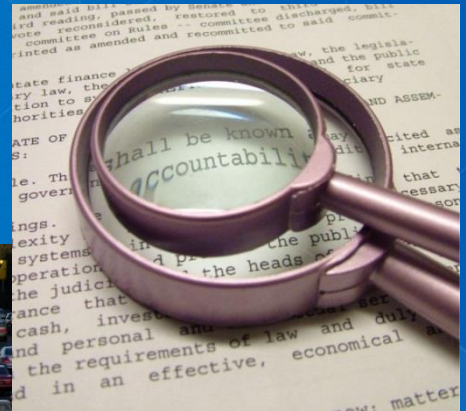
The Evidence Is Clear . . .

We Need to Be Smarter
We Need to Understand
. . . And Act Together



The Challenges That Cities Are Facing

- By 2050, 2/3 of the earth's population (6.4 billion) will live in cities
- Aging population leads to decreasing productivity
- Resource strain of energy, housing, transportation, jobs, public services, etc.
- Citizens demand higher transparency of Government



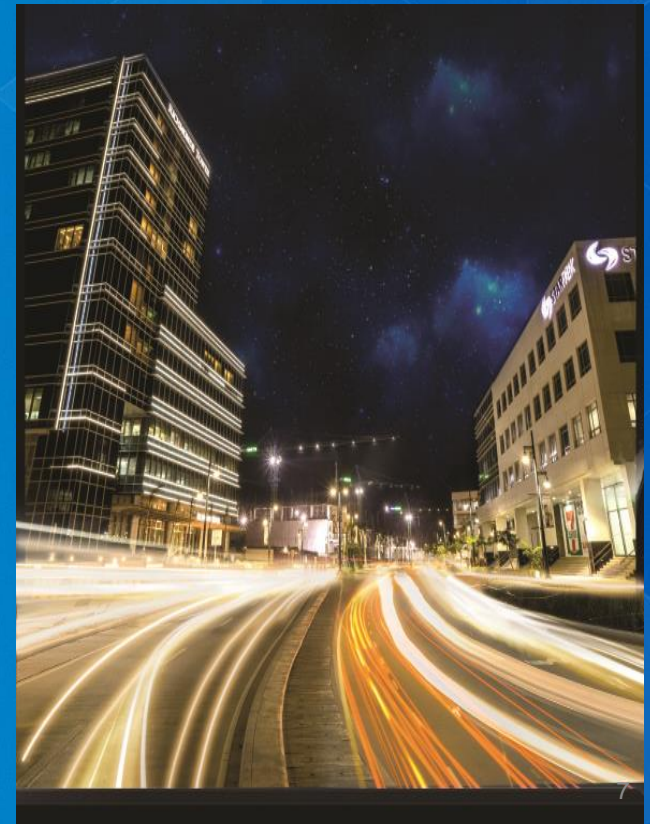
The Challenges of Hong Kong

- About 326,000 private housing units aged 70 or above by 2046, ~300 times of those in 2015
- 1/3 population would be aged 65 or above by 2040
- Overall labor force participation rates projected to decline from 59.3% in 2014 to 48.6% in 2064

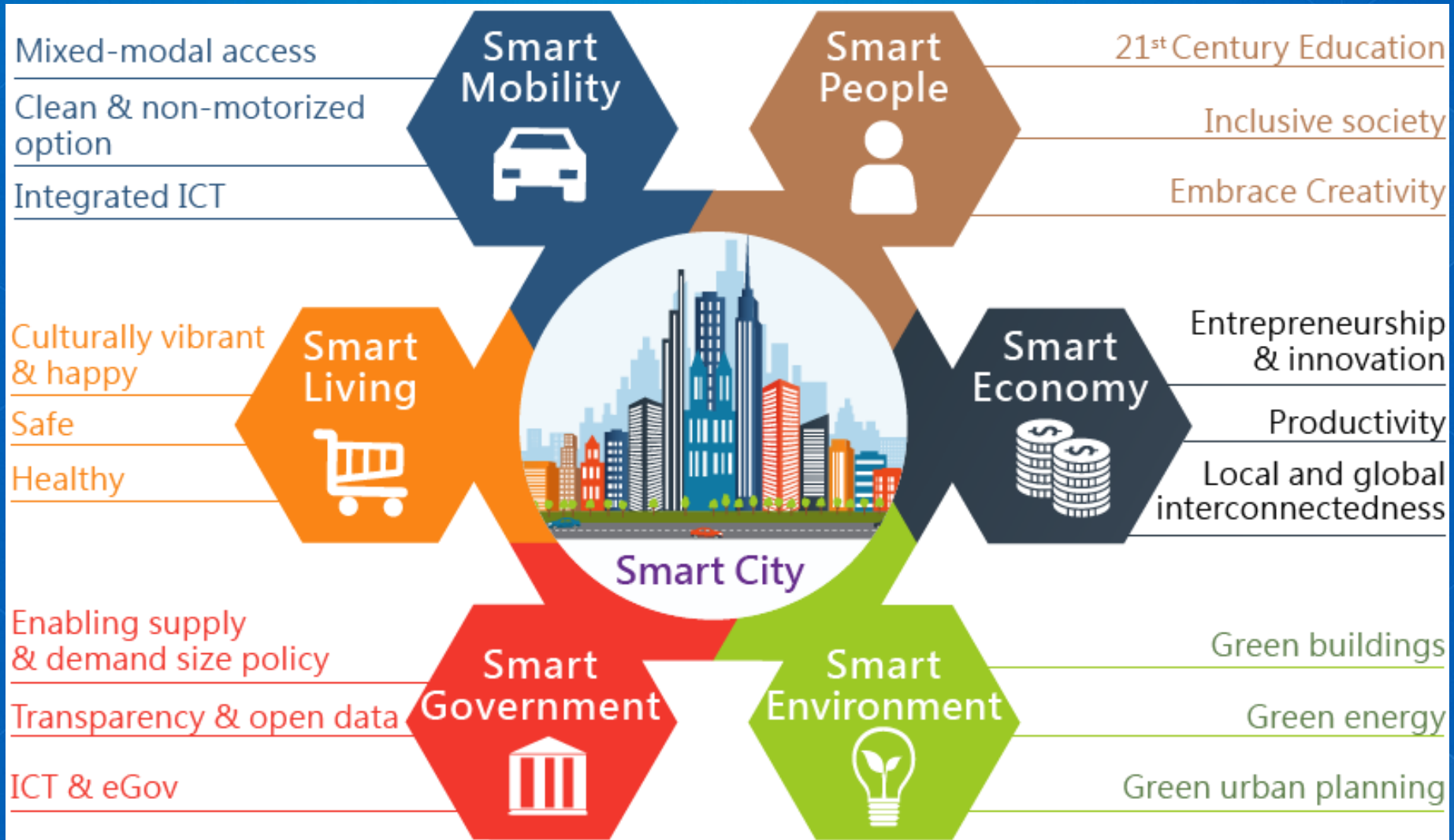


Smart City

- Ultimate Goals:
 - To enhance quality of life of citizens
 - To foster knowledge economy
 - To create a vibrant eco-system

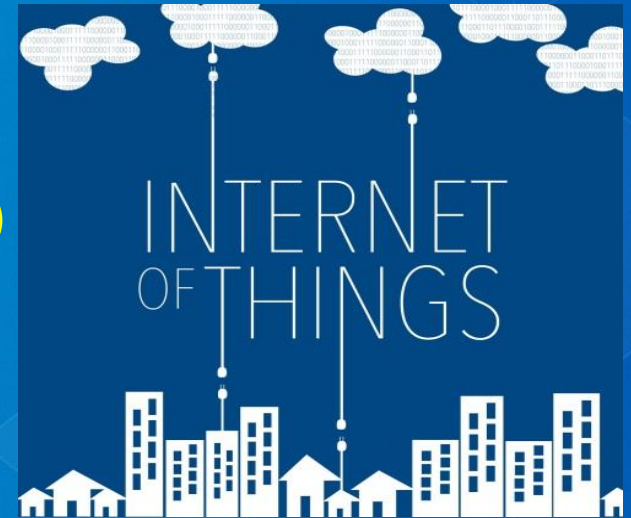


Smart City Components



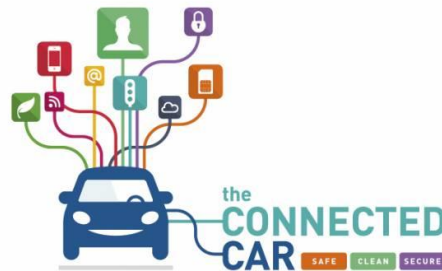
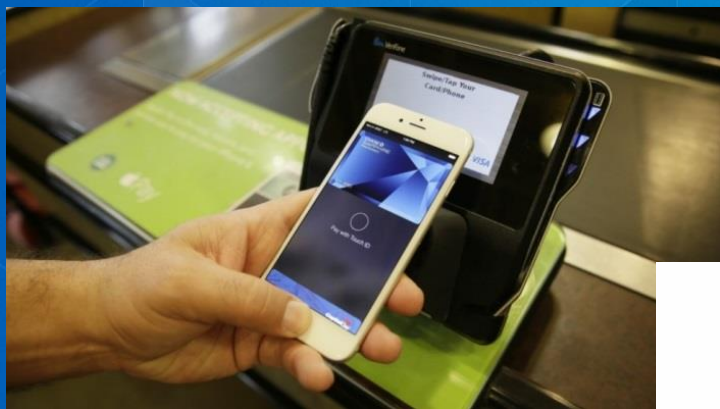
Key Technology Drivers of Smart City

- Big Data
- Cloud Computing
- Geographic Information System (GIS)
- Green Technologies
- Internet of Things (IoT)
- Mobile Technologies



Examples of Smart City Applications

- Smart Living: eHealth
- Smart Economy: Fintech
- Smart Mobility: Connected Cars
- Smart Environment: Green Building



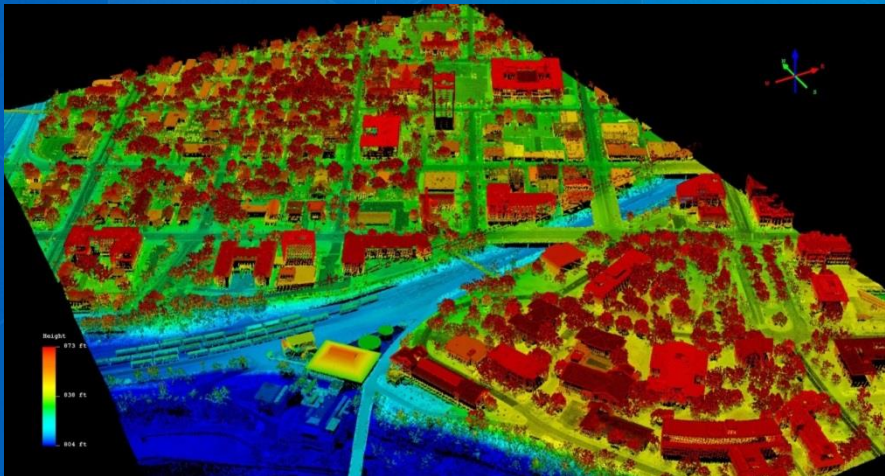
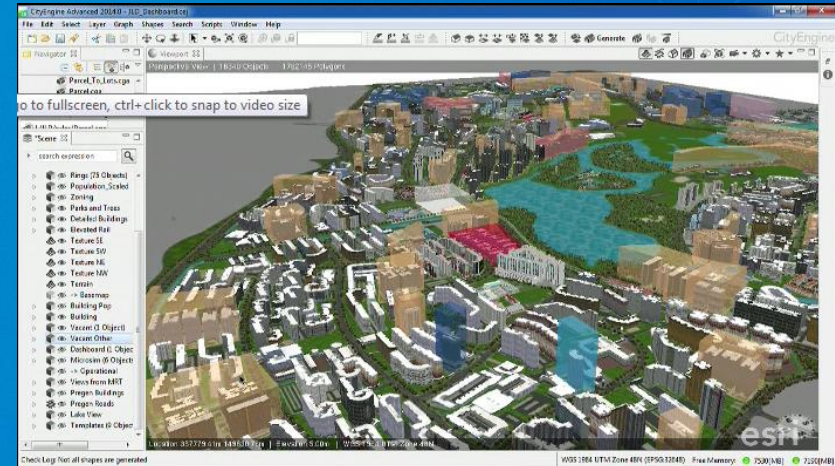
Worldwide Smart Cities Examples

- New York: LinkNYC Wi-Fi Station
- Singapore: Smart Parking Signage
- Barcelona: Smart Bus Network



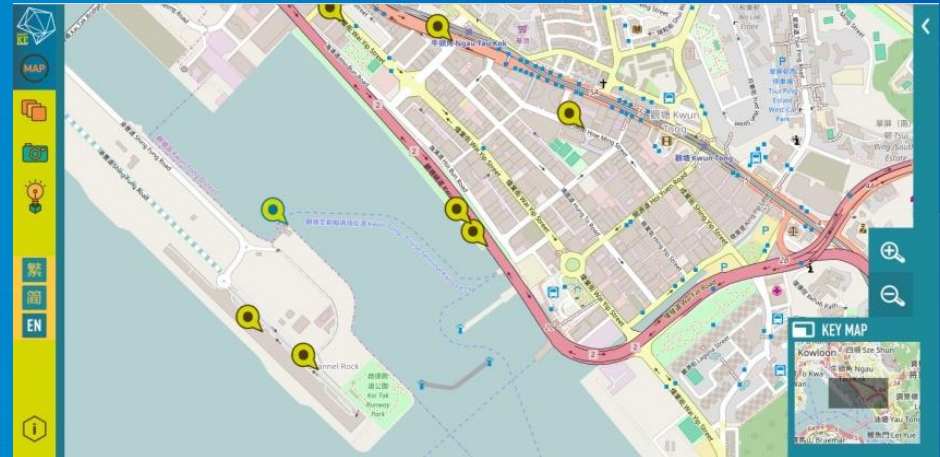
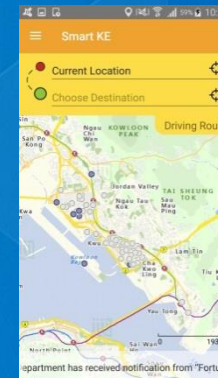
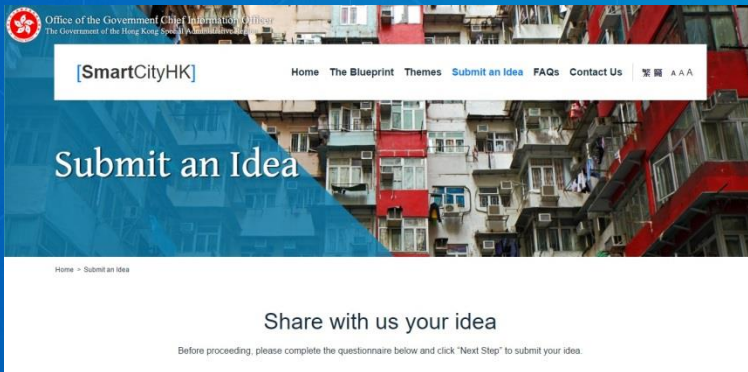
Worldwide Smart Cities Examples

- San Francisco: Crime Map
- Minneapolis: Find My Solar Suitability
- Singapore: Smart Urban Planning of Jurong Lake District



Hong Kong as a Smart City

- Smart City @ Kowloon East (EKEO)
- HKSAR Smart City Blueprint (OGCIO)
- Hong Kong 2030+ (Development Bureau)



Smart City Consortium



- Smart City Consortium (SCC) is formed by a group of professionals from different corporations and organizations to provide opinions and suggestions to the Government for formulating related policies and standards in the development of Hong Kong as a world-class smart city. We encourage worldwide collaboration with different stakeholders to create the right ecosystem which fosters innovation and sustainable economic growth for Hong Kong.

Vision of Smart City Consortium



- To build Hong Kong as the world's leading Smart City to foster knowledge-based economy, enhance the quality of life and to create a vibrant ecosystem leveraging relevant Information and Communication Technologies and adopting effective resources management.

Works of Smart City Consortium

- Organized and participated in over 60 events
- 13 MoU with other Smart City organizations signed
- Views and opinions on smart city blueprint for Hong Kong submitted



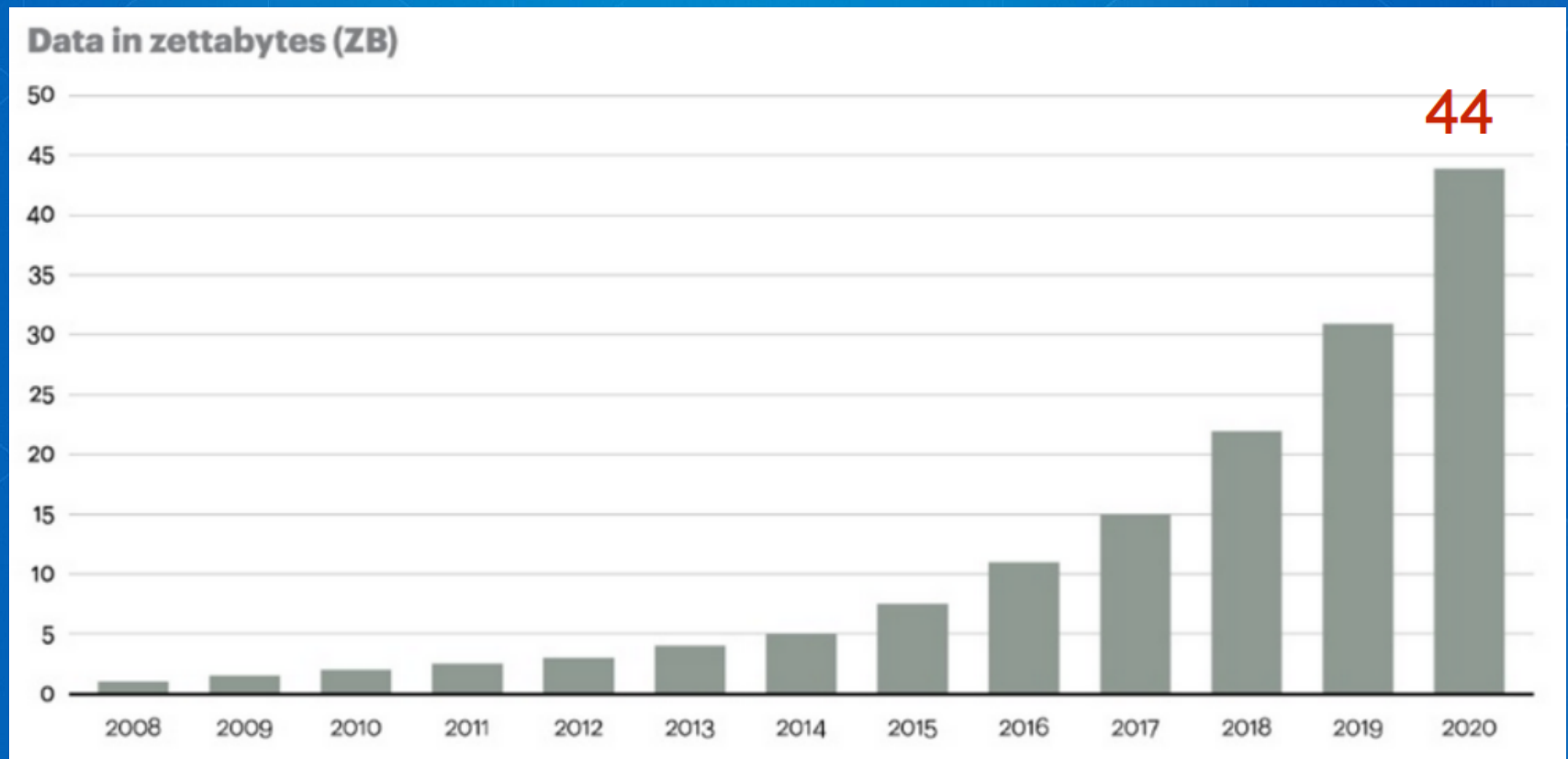
Big Data in Smart City

Worldwide Data in 60 Seconds...



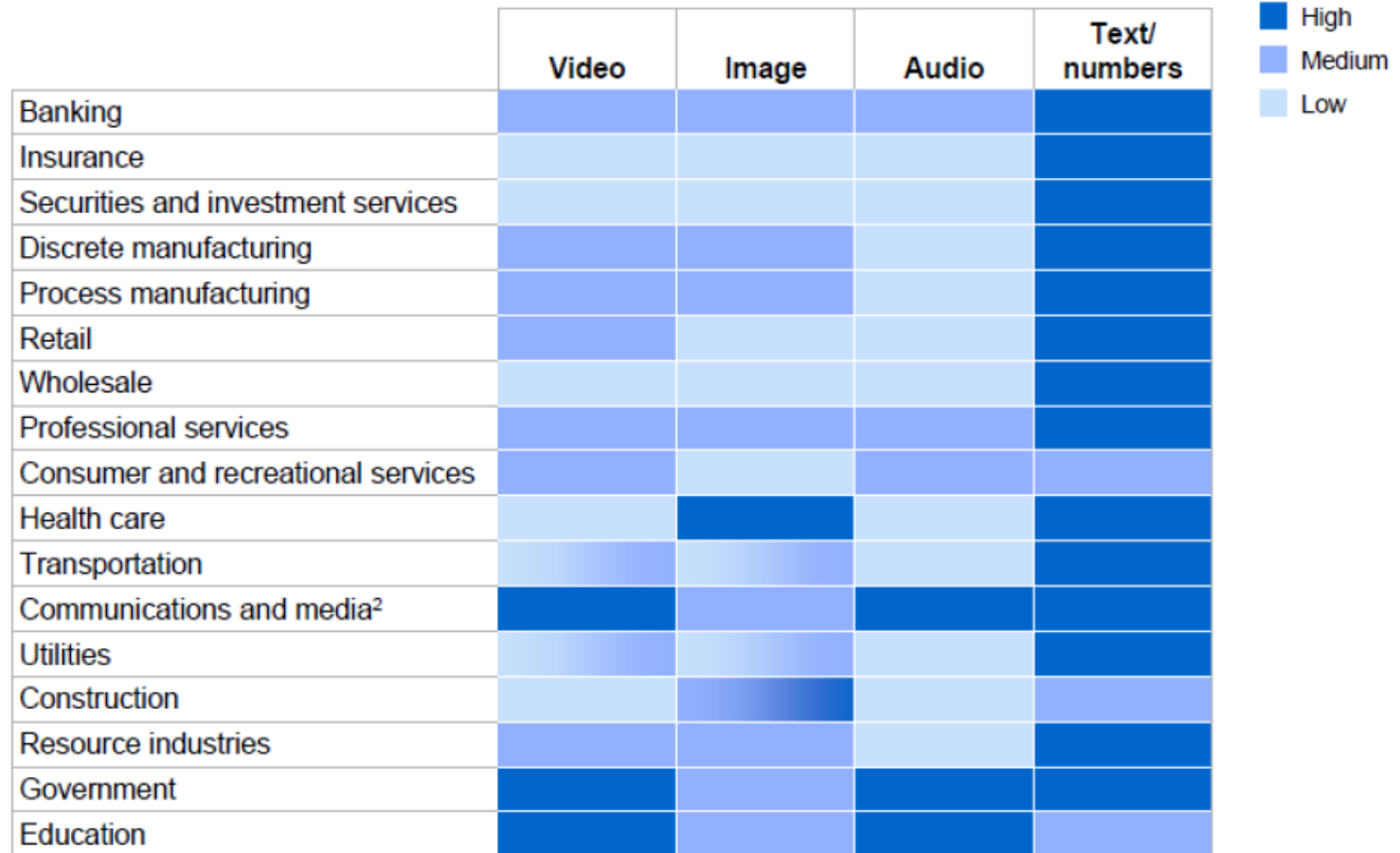
Data Growth

- Data is growing at 40% annually, reaching nearly 44ZB by 2020
- Exponential growth of data requires new methods of collecting, storing and processing



The Type of Data in Various Sectors

The type of data generated and stored varies by sector¹



¹ We compiled this heat map using units of data (in files or minutes of video) rather than bytes.

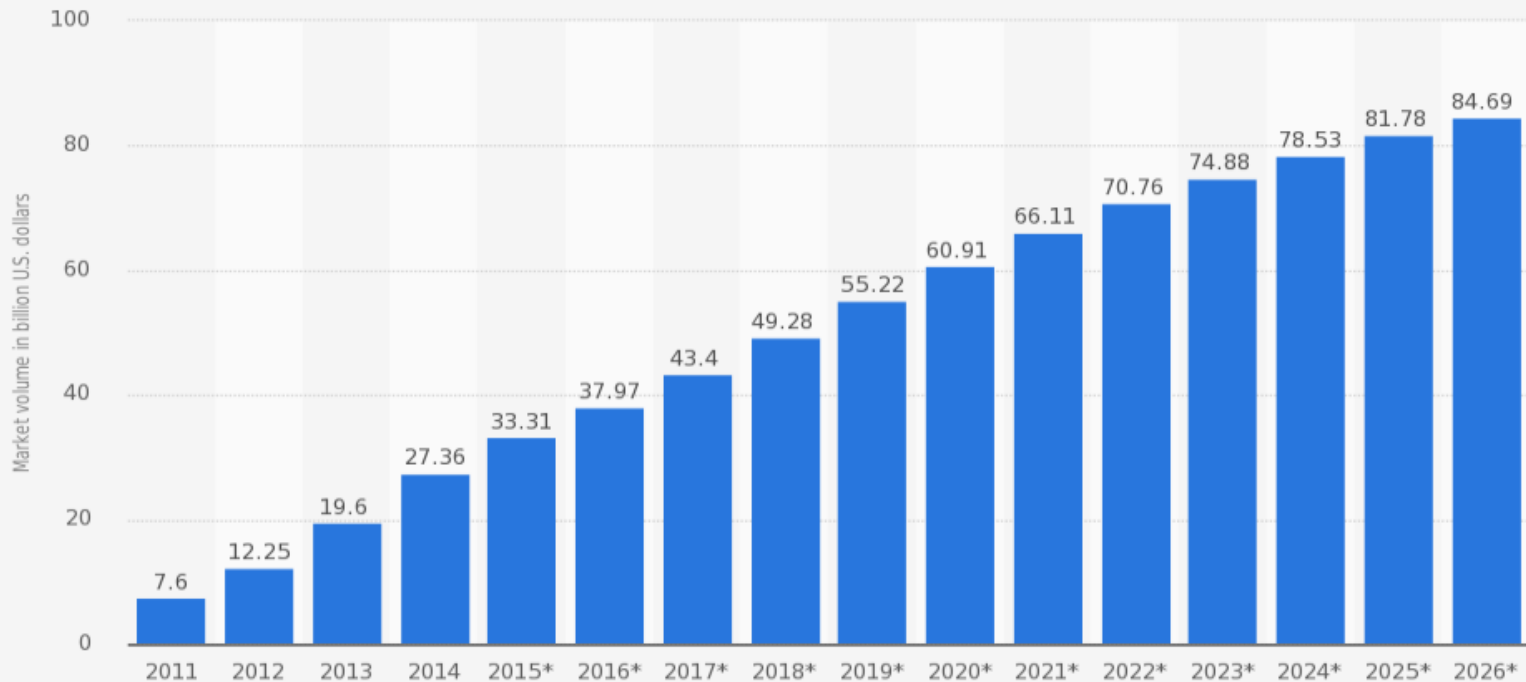
² Video and audio are high in some subsectors.

SOURCE: McKinsey Global Institute analysis

Big Data Market (\$US Billions)

- Forecasted market size US\$43.4 billion in 2017, to reach US\$84.69 billion by 2026

Big data market size revenue forecast worldwide from 2011 to 2026 (in billion U.S. dollars)

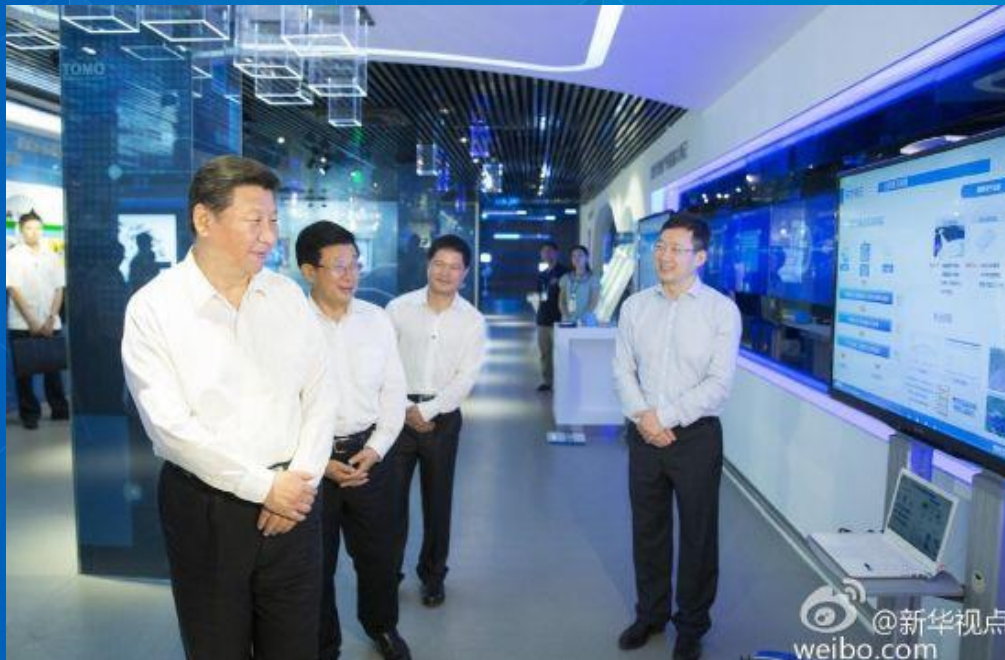


Source:
Wikibon
© Statista 2016

Additional Information:
Worldwide

China to Build National Big Data Center

- President Xi (Nov 2016):
 - The central government will establish a Big Data center at national level, so as to promote the convergence of technology, business and data, and provide coordinated public services based on data sharing across government departments at various levels



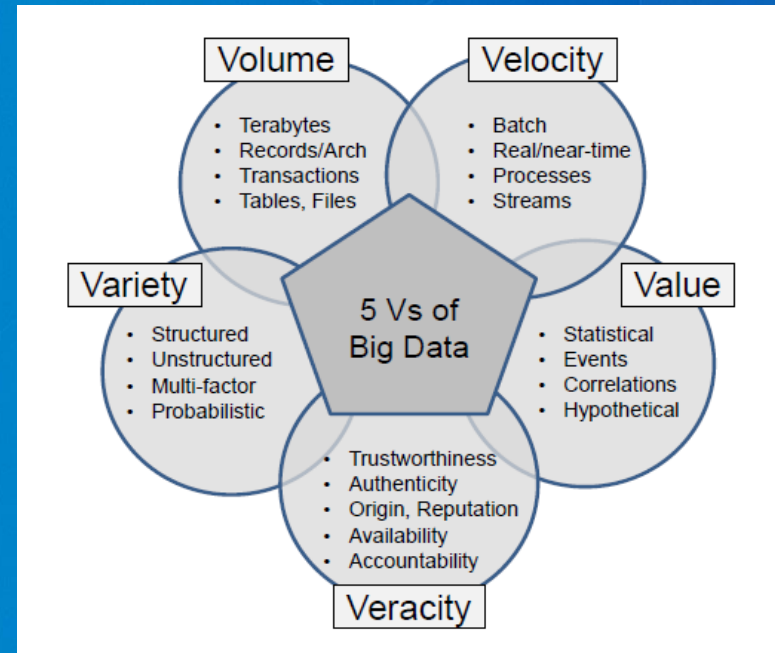
Big Data: Definition

- *// Big data is a term for data sets that are so large or complex that traditional data processing application software is inadequate to deal with them. Challenges include capture, storage, analysis, data curation, search, sharing, transfer, visualization, querying, updating and information privacy. // (Wikipedia)*



Characteristics of Big Data

- 5 Vs
 - Volume
 - The vast amounts of data generated every second
 - Variety
 - The different types of data can now be used
 - Velocity
 - The speed at which new data is generated and the speed at which data moves around
 - Veracity
 - The messiness or trustworthiness of the data
 - Value
 - Having access to big data is no good unless we can turn it into value



How Big Data is Different

Traditional Data

- Large scale
- Highly centralized
- Structured
 - Files
 - Records
 - Databases
- Sequential
- Indexed
- **Processing transactions**

Big Data

- Massive scale
- Highly distributed
- Unstructured
 - Emails
 - Audio/Video
 - Documents
 - Spreadsheets
 - Log files
 - Sensor data
 - Geo-spatial data
 - Books
 - Journals
 - Blogs
 - Text messages
 - Chat sessions
 - Search data
- Random
- **Looking for patterns and relationships**

Major Sources of Big Data

- IoT and Sensors Networks
- Smartphone Apps
- Social Media

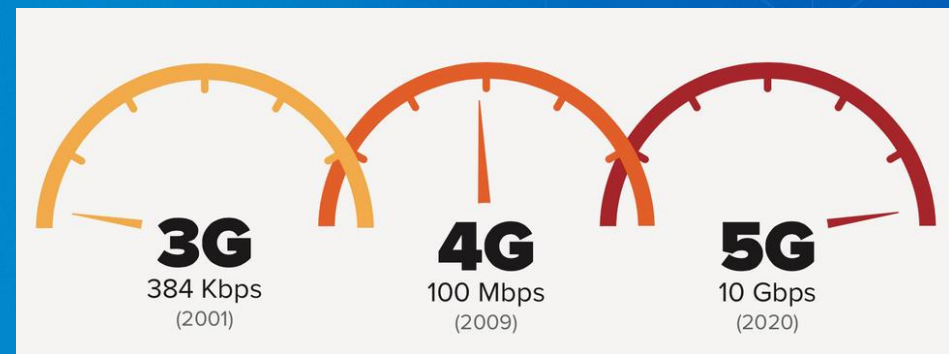


5G – More Data from Billions of Devices

- The fifth generation of cellular networking
- Early products available as soon as in 2018
- Dramatically increase:
 - Speed of data transfer
 - Response time
 - Capacity for billions of devices to be connected



1G	2G	3G	4G	5G
1981	1992	2001	2010	2020(?)
2 Kbps	64 Kbps	2 Mbps	100 Mbps	10 Gbps
Basic voice service using analog protocols	Designed primarily for voice using the digital standards (GSM/CDMA)	First mobile broadband utilizing IP protocols (WCDMA / CDMA2000)	True mobile broadband on a unified standard (LTE)	'Tactile Internet' with service-aware devices and fiber-like speeds
				?



Water Intelligent Network

- Being implemented progressively by Water Supplies Department (WSD)
- Continuous monitoring of water mains over the territory by installing sensors in the underground water supply network
- Determination of the most effective network management measures:
 - Active Leakage Detection & Control
 - Pressure Management
 - Quality & Speedy Repair
 - Re-provisioning of Water Mains



Big Data from Smartphone Apps

- Sensors within Smartphone are connected to Internet via the phone's data connection



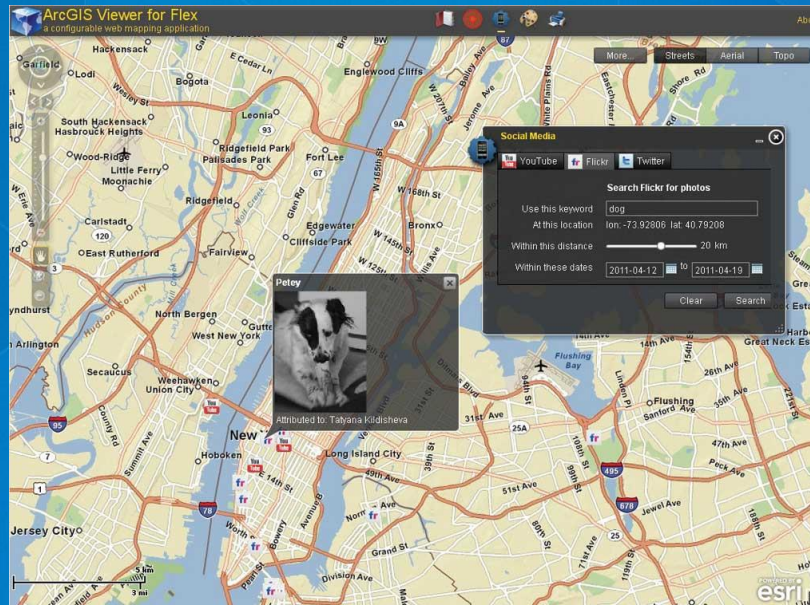
Big Data from Social Media

- Unstructured
- Texts, Check-ins, Hashtags, Voices, Pictures, Videos, etc.



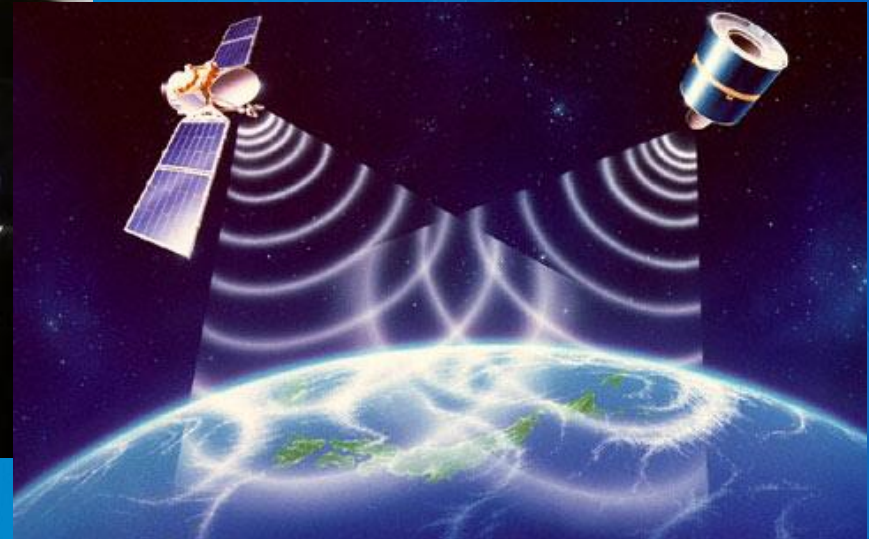
Get Geographic Insights from Social Media

- Putting social media data on a map helps users track a dynamic situation.
 - Retailers display data feeds on maps to monitor and protect their brands
 - Banks use geographic analysis to detect fraud
 - Governments worldwide can gauge public sentiment in real time during significant events, such as elections and uprisings.



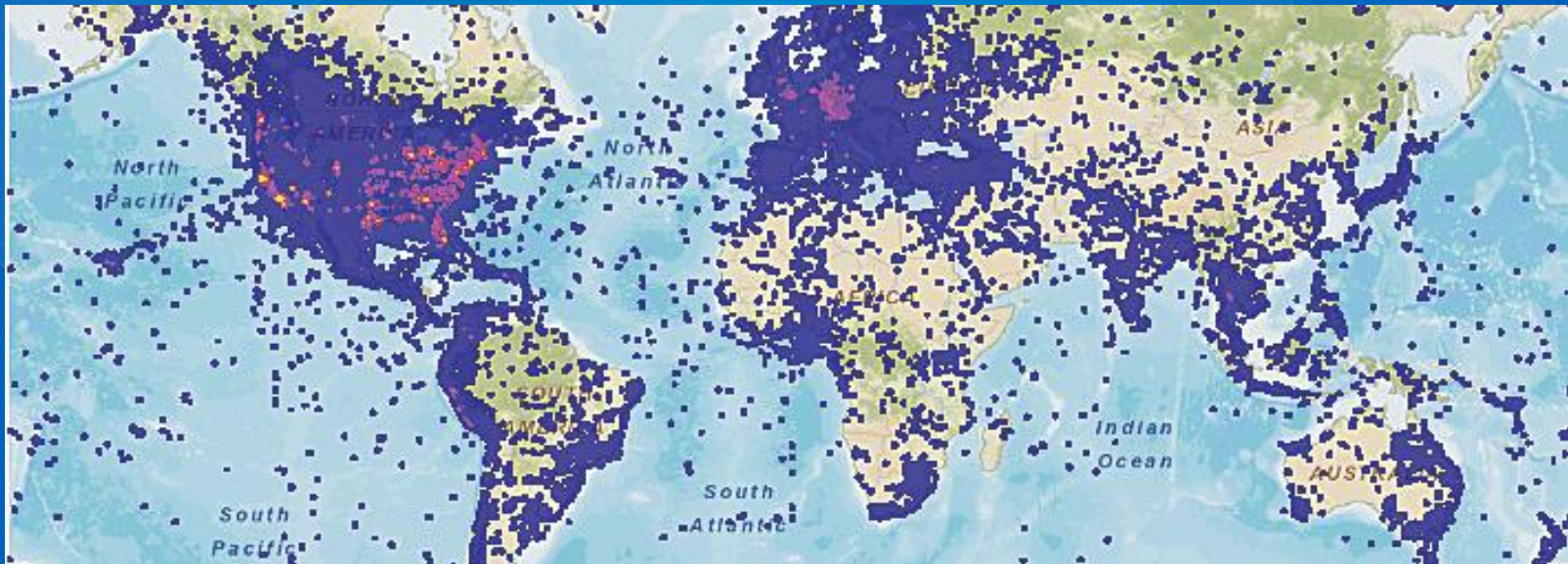
Big Data and Location

- All IoT sensors have locations
- The most common IoT sensors in Smartphones – GPS receiver
- All posts, photos and messages are tagged with phone or IP locations in social media



Geospatial Big Data

- “80% of data is spatial”
- Smart City services rely heavily on Geospatial Technologies
- For many big datasets, location is a crucial component to truly understand underlying patterns and trends
- Without location, datasets are less valuable, or in extreme circumstances - meaningless



Big Data Analytics

Why Big Data?

- Explore trends and patterns hidden in big data
- Model the phenomena leading to big data
- Predict what will happen in where and at when?
- Require Big Data Analytics
 - Turn big data into big understanding, insight and wisdom

DATA

Enabling Technologies for Big Data Analytics

- Grid Computing

Microsoft Azure

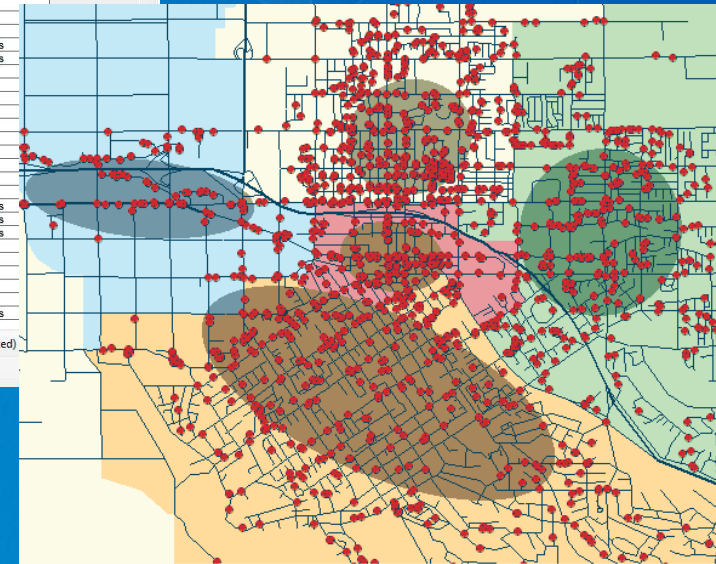
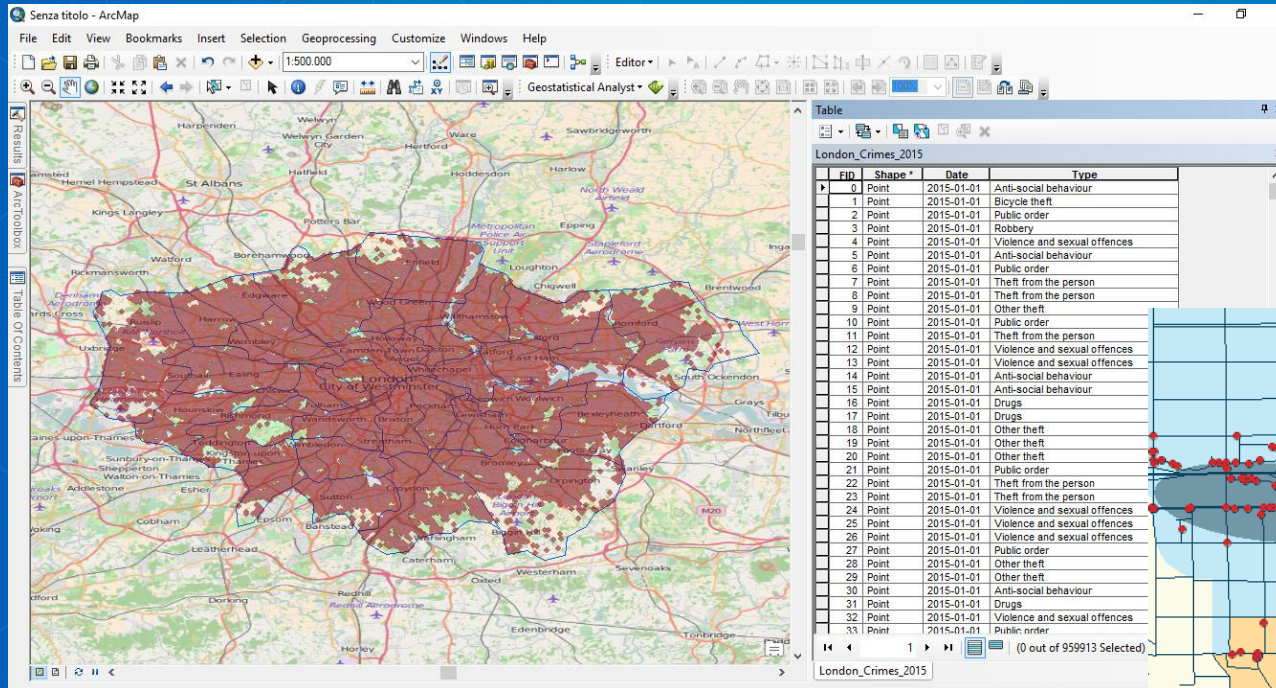


- Parallel Processing



Geospatial Big Data Analytics

- Requires new science of Spatial Statistics
- GIS as a tool for spatial statistical analysis



Big Data Analytics

Traditional Analytics (BI)

vs

Big Data Analytics

Focus on

- Descriptive analytics
- Diagnosis analytics

- **Predictive analytics**
- **Data Science**

Data Sets

- Limited data sets
- Cleansed data
- Simple models

- Large scale data sets
- More types of data
- Raw data
- Complex data models

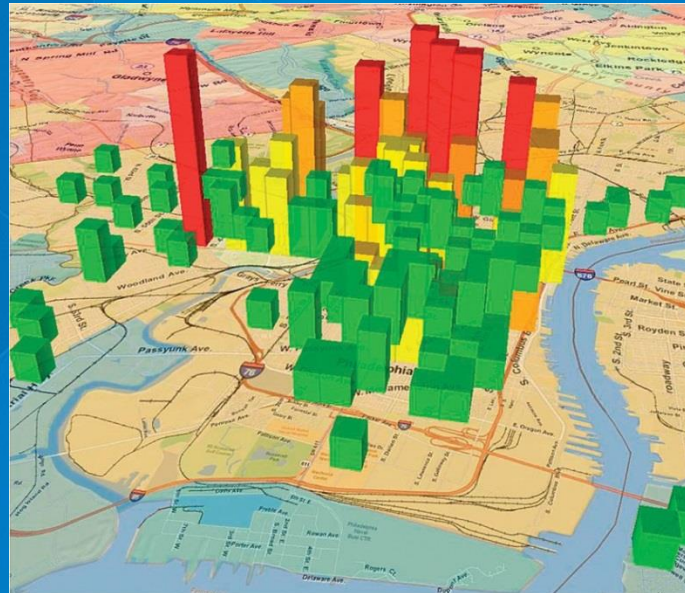
Supports

Causation: what happened, and why?

Correlation: new insight
More accurate answers

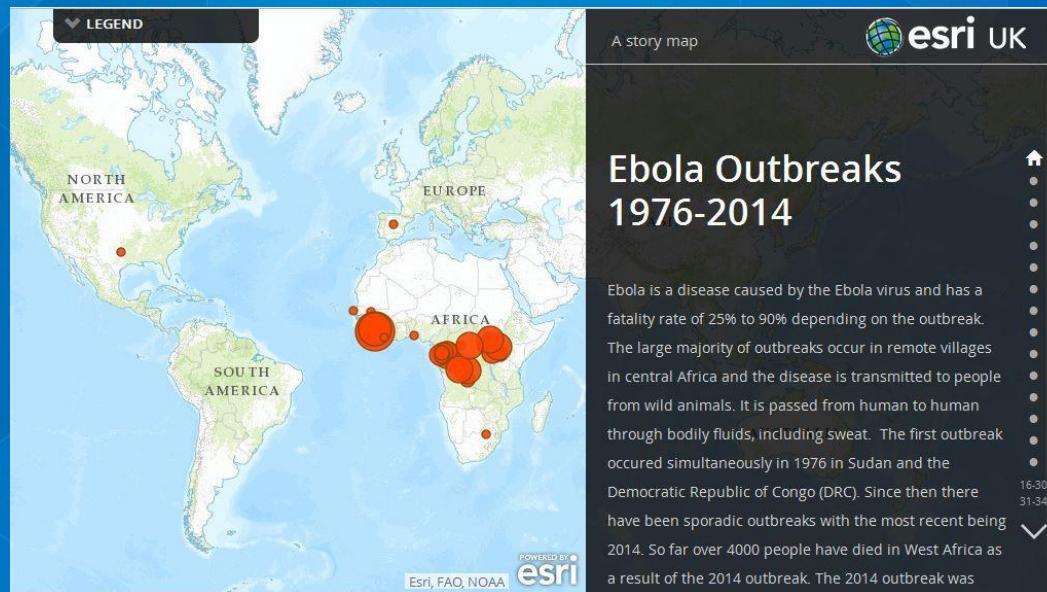
Explore Geographic Patterns

- Use maps to see the story behind Big Data
 - Retailers can see where promotions are most effective and where the competition is.
 - Banks can get an explanation of why loans are defaulting and where there is an underserved market.
 - Climate-change scientists can see the impact of shifting weather patterns.



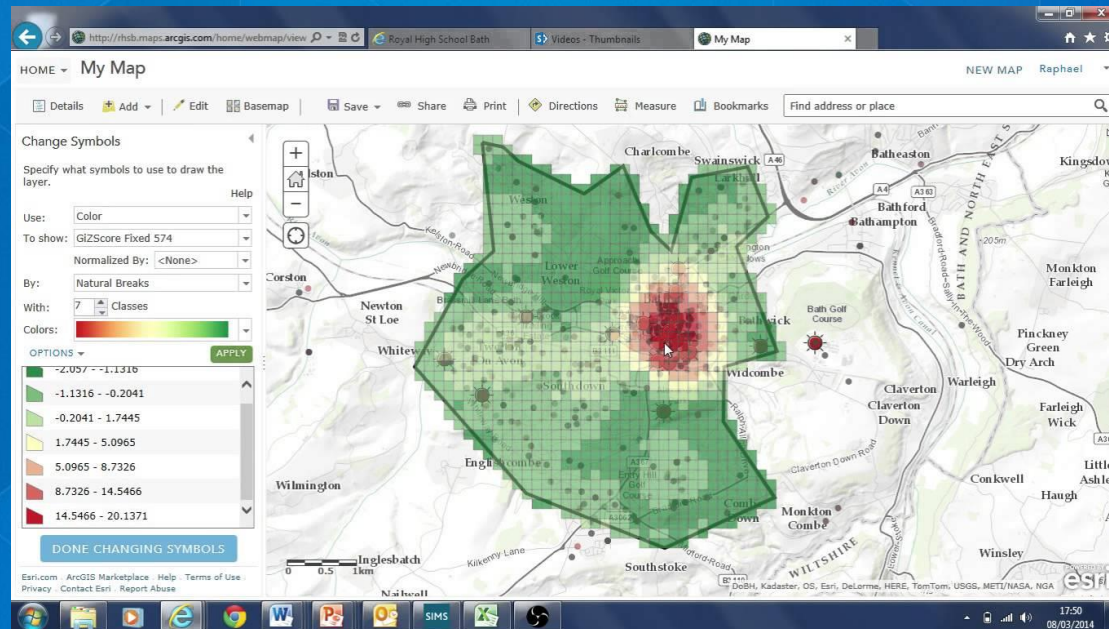
Find Spatial Relationships

- Seeing spatially enabled big data on a map allows users to answer questions and ask new ones
 - Where are disease outbreaks occurring?
 - Where is insurance risk greatest given recently updated population shifts?
- Geographic thinking adds a new dimension to big data problem solving and helps users make sense of big data



Perform Predictive Modeling

- Predictive modeling using spatially enabled big data helps users develop strategies from if/then scenarios
 - Governments can use it to design disaster response plans
 - Natural resource managers can analyze recovery of wetlands after a disaster
 - Health service organizations can identify the spread of disease and ways to contain it



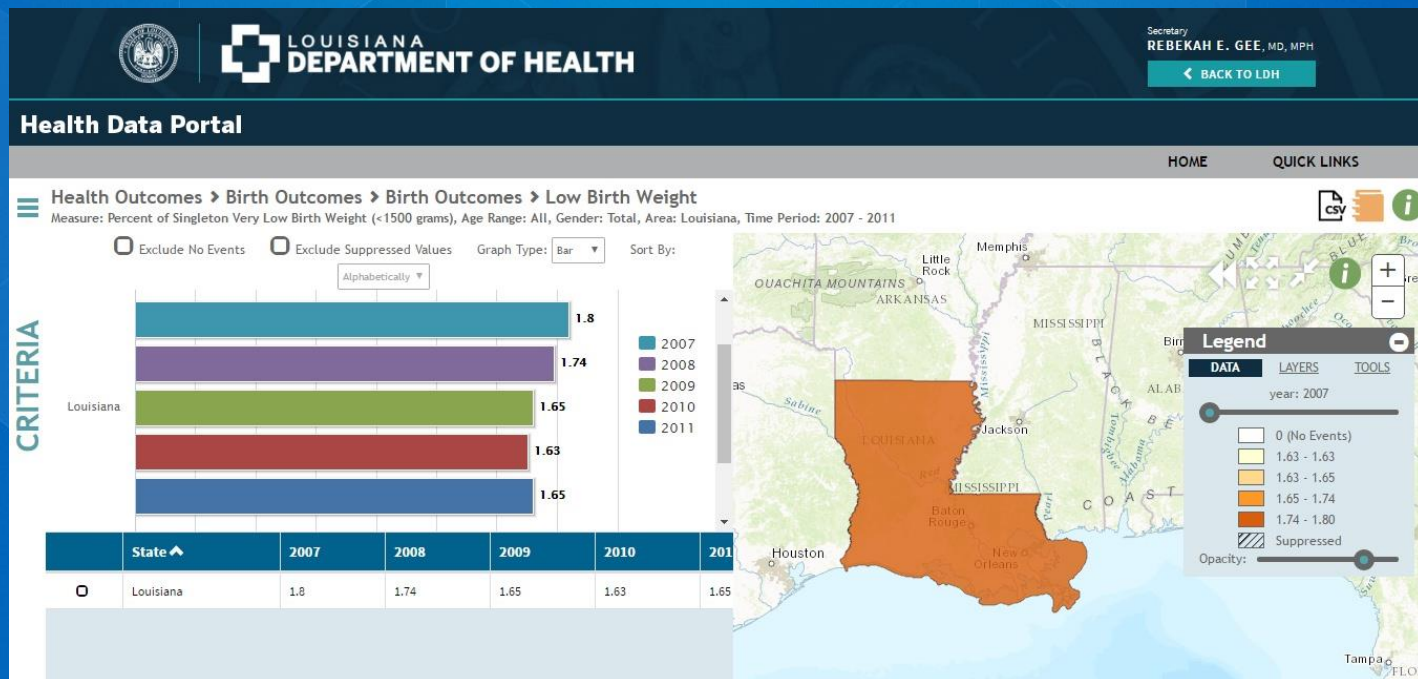
Predicting Crime

- Rutgers University's School of Criminal Justice: Risk Terrain Modeling
 - Examined how the environment affects illegal activity
 - Analyzed maps displaying spatial relationships between shooting incidents and nearby cluster of bars, clubs, liquor stores and fast food restaurants
 - Compared the migration paths of shooting incidents between 2 years
 - Conclusion 1: The presence of above businesses caused higher crime rates
 - Conclusion 2: Criminals shift illegal activities from one high-risk area to another over time



Improving Patient Care

- Louisiana Department of Health and Hospitals
 - To map epidemiological issues such as babies with low birth weights
 - Correlations between low birth weight rates and crime-riddled neighborhoods were discovered
 - Preventative healthcare measures can be introduced to reduce high-risk births, thereby cutting healthcare costs



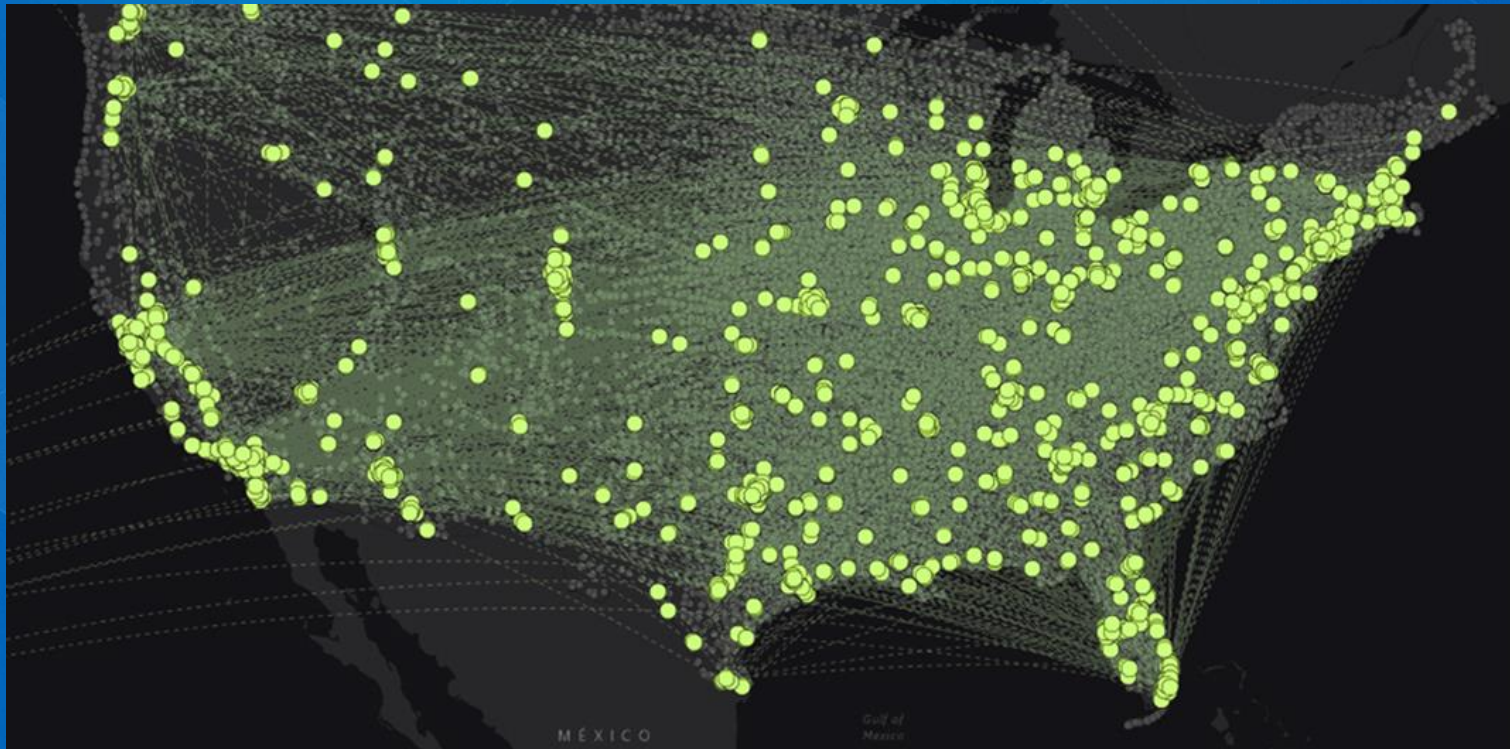
Optimizing Banking Network

- Bank of America
 - Uses GIS to track every single transaction by customer, location, time and channel
 - Stores the information for 60 months of history (more than 20 TB of data)
 - An optimum plan of opening and closing branches and ATMs was drafted by combining capacity of each branch and ATM, cost and revenues of each facility location
 - Reduced its annual expenses by US\$800 million while losing very few customers



Anti-Money Laundering

- To detect and discover fraud and suspected money laundering activities from billion numbers of transaction records daily by tracking and analyzing the flow of money from different locations at different periods of time using Geospatial Analytics



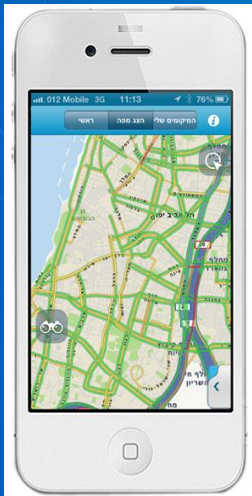
Geospatial Big Data Applications and Privacy

Big Data Applications and Privacy Issues

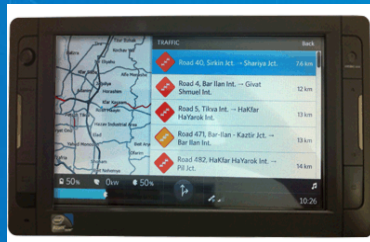
- Most Big Data involves personal data especially that from Smartphones and Social Media
- Big Data Applications and Privacy are not mutually exclusive
- Privacy issues caused by technologies can be solved by technologies
- Just like balancing economic development with environmental conservation results in Sustainable Development, we can facilitate the technological & economic development brought by Big Data Applications while ensuring proper protection of privacy

Real Time Traffic Information

- To compute traffic speed GPS locations of Smartphones and base stations signals
- Data captured will be used for 24/7 speed and event data, location of each traffic congestion, traffic load level, Estimated Time of Arrival (ETA), etc.
- All personally identifiable information from mobility data is removed and Privacy is secure at all times, safeguarded at every human touch point



Mobile Navigation



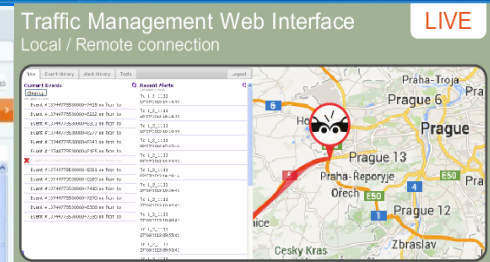
In-car infotainment



Media



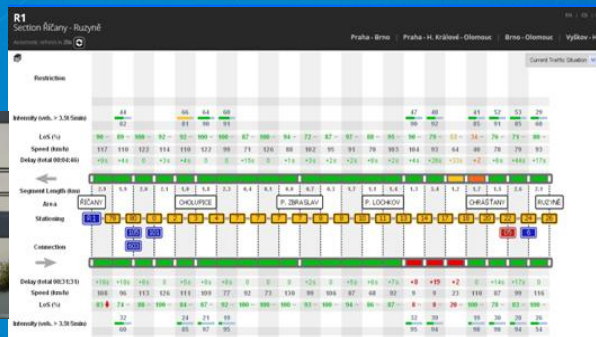
Websites



Traffic Control Centers



PND Navigation



Highway Authority



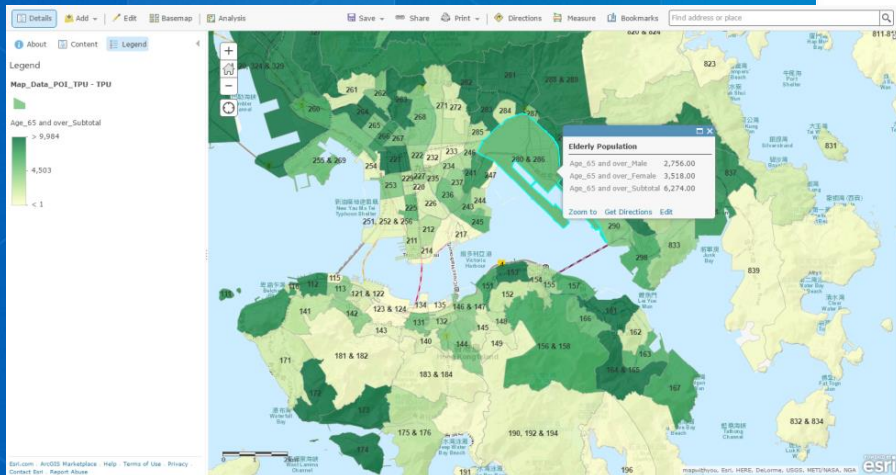
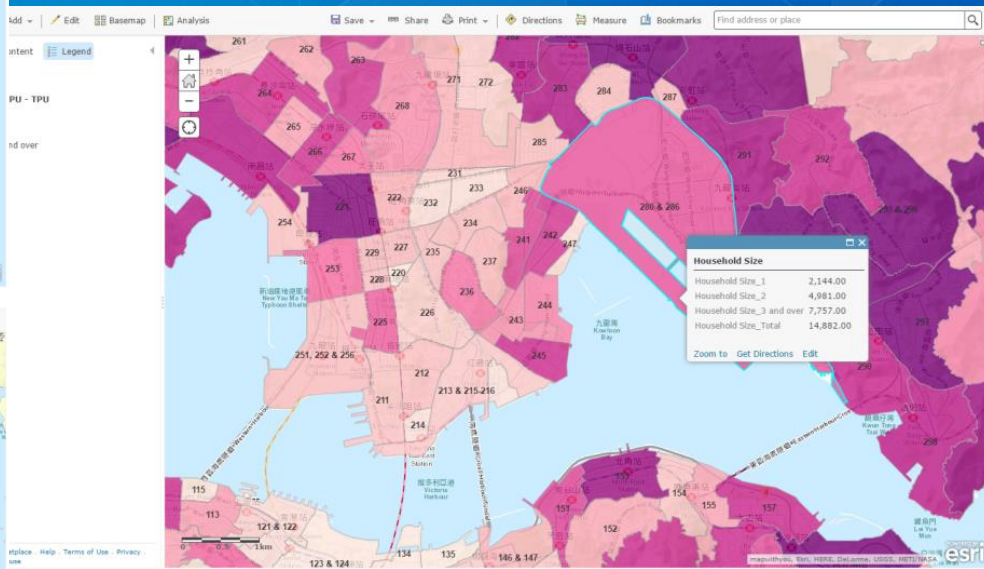
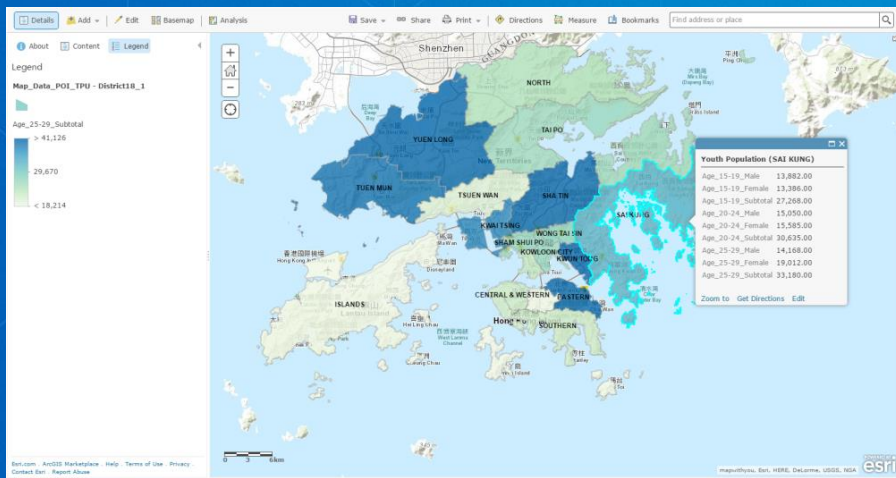
Mobile Mapping System

- To acquire road inventory data
- 3D Geo-Referenced images of roads will be captured
- Images of individuals faces and car plates number will be masked



Resolution of Census Data

- To strike a balance between the usefulness of Big Data and the right of individuals to privacy



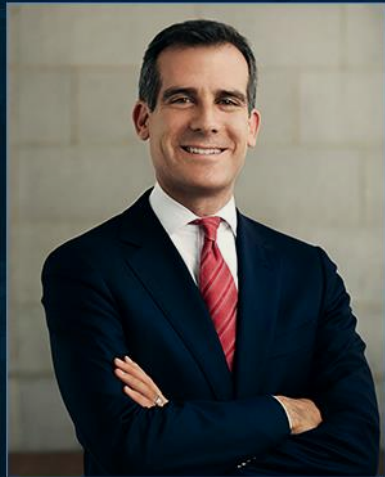
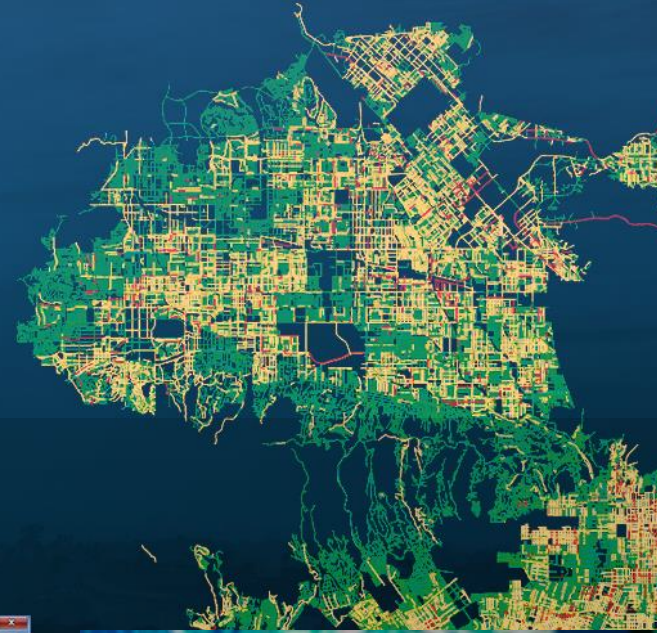
Chief Data Officer (CDO)

- International Society of CDO:
 - CDO is a senior executive who bears responsibilities of creating data governance policies and using Big Data strategically to identify new business opportunities and reduce operating costs
 - CDO must ensure that users have easy access to relevant data and reporting tools, and be able to trust in the data's quality
- Gartner:
 - 50% of all companies in regulated industries will have a CDO this year

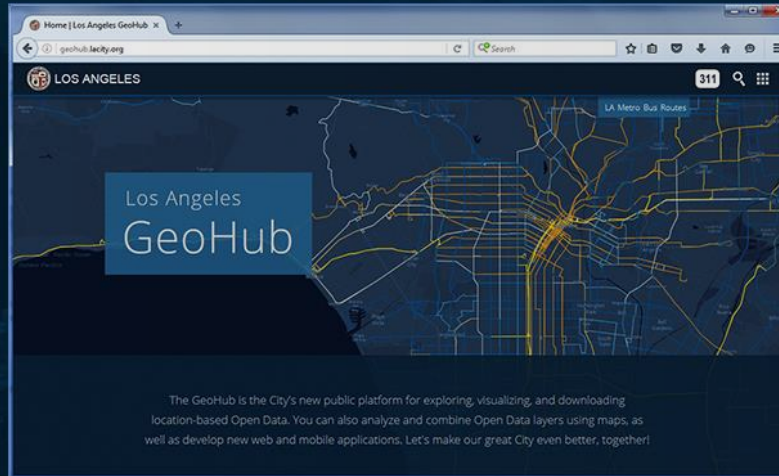


City of Los Angeles

GeoHub

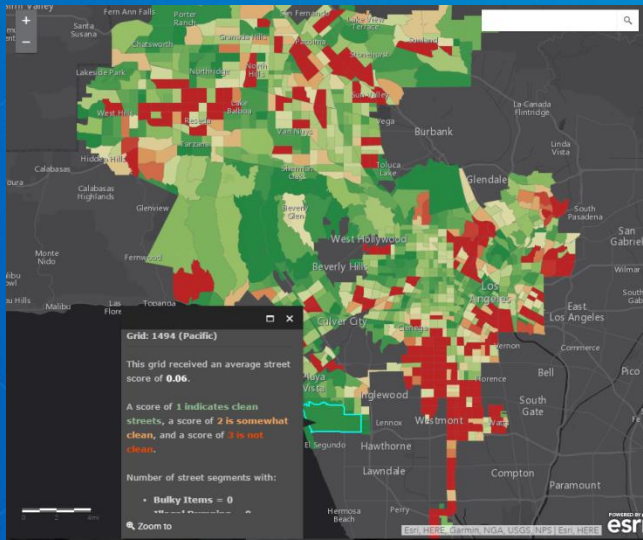


Eric Garcetti
Mayor



Lilian Coral
Chief Data Officer

Story Maps and Apps Based on GeoHub



Clean Streets Index
(Archive - released April 2016)

Understanding the City

Of the 39,915 road segments, 61% were rated **clean**, 35% were rated **somewhat clean**, while streets rated **unclean** made up 4% of total street segments.

This data has been aggregated into operational grids which helps the Bureau of Sanitation strategically deploy resources such as a new

LA Clean Streets Index

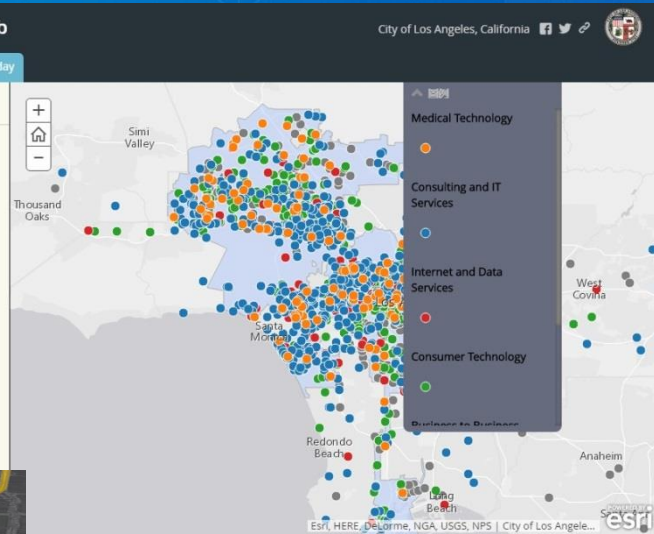
Los Angeles, California. World-Class Tech Hub

Welcome to LA Tech Industry | A History of Tech | The Tech Industry Today

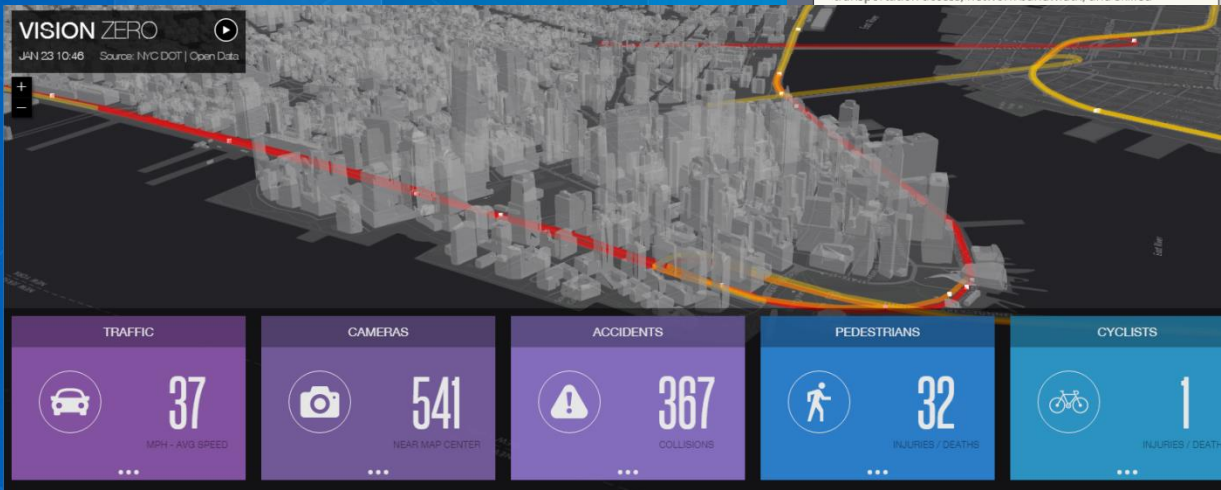
Tech Industry 2015

Tech in LA Today!

Whether you decide to wear your Oculus Rift to the office or steam Hulu videos to your phone while riding the Metrorail, LA is second to none when it comes to cutting edge businesses. LA's promise lies in the diversity of tech companies and industries in and around Los Angeles. This variety makes the city ripe for synergies between IT services companies, Data analytics firms, the Motion Picture industry, and Video game designers. Our tech economy has consolidated around key areas like: the *Wilshire Corridor*, as well as *Silicon Beach* and in *Downtown Los Angeles*. These business intensive regions of the City provide the transportation access, network bandwidth, and skilled



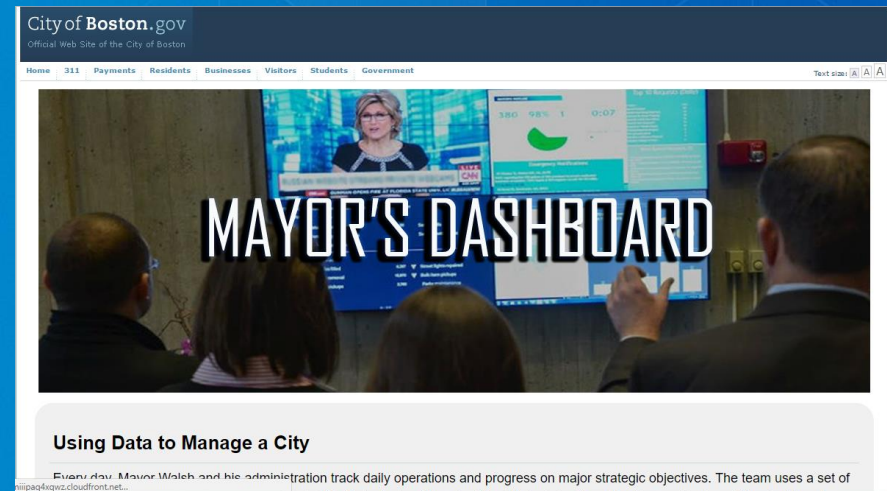
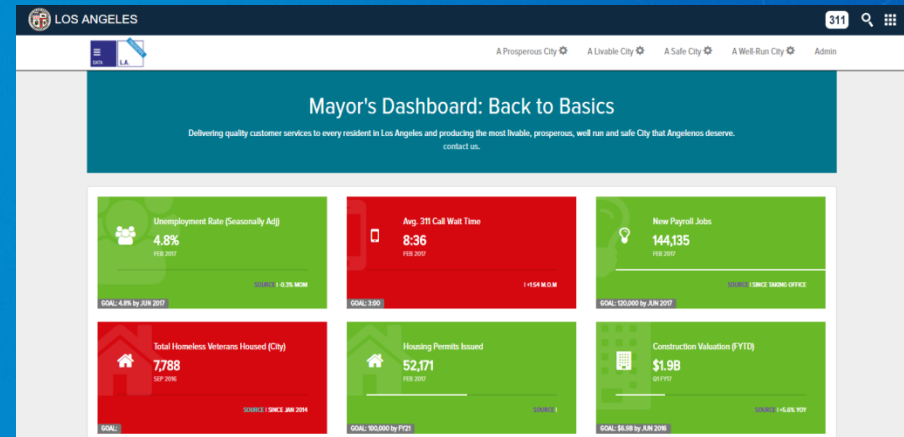
Tech Industry of LA



Vision Zero LA

Mayor's Dashboard

- To display a range of daily statistics covering areas such as public safety, city services, human services and economic development
- Let both the Mayor and the public to track daily operations and progress on major strategic objectives
- Data from various Open Data sources including GeoHub



Good Practices for Organizations

- To attain industry certifications
- Get advices from responsible authorities including Privacy Commissioner for Personal Data
- Employ consultants to conduct a Privacy Impact Assessment (PIA) or a Privacy Audit to assess the privacy risks involved and adopt measures to safeguard personal data when engaging in Big Data analytics or personal data sharing



A screenshot of the Privacy Commissioner for Personal Data (PCPD) website. The header is orange and contains the PCPD logo, the number '20' (likely celebrating 20 years), the website URL 'PCPD.org.hk', and the text '香港個人資料私隱專員公署' and 'Privacy Commissioner for Personal Data, Hong Kong'. Below the header is a navigation bar with a search box and a 'A Quick Guide' button. The main content area features a large illustration of a man holding a padlock, with various icons representing privacy and data protection. Below the illustration is a video player for 'IifanView'. On the right side, there is a '最新消息' (Latest News) section with several news items, and a '個人' (Individual) and '機構' (Organization) section with links to various resources.

Privacy and Security Compliance of Esri's Products

Esri Corporate Compliance

- ISO 27001
 - Esri's Corporate Security Charter
- Privacy Assurance
 - US EU/Swiss SafeHarbor self-certified
 - TRUSTed cloud certified



Privacy & Compliance

Summary Across ArcGIS Online



Conclusion

- Big Data in Smart City can be visualized from a Geospatial perspective that reveal patterns, trends, and relationships
- GIS can pull Big Data all together to help focus Smart City citizens' decision making
- GIS can help to analyze Big Data
 - To solve problems easier by visualization through maps
 - Geospatial analysis can improve the accuracy of Big Data analytics
- Big Data Applications can be developed and implemented by striking a proper balance between economic & societal benefits and the right of individuals



esri China
HONG KONG



Thank You

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