FUTURe city – Seminar series 2017 2018

Big Data Analytics For Connected Vehicles And Smart Cities

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Bob McQueen & Associates

Instructional Objectives

1. Define a smart city
2. Identify importance of transportation in a smart city
3. Define the role of connected and autonomous vehicles in the smart city
4. Define Big Data
5. Define big data analytics and relevance to transportation
6. Explain the value of Use Cases
7. Discuss Smart Data Management
8. Define an effective approach to Smart Data Management
9. Discuss a planning approach to smart cities
10. Define a benefit and cost approach

Topics

- What is a smart city?
- The importance of transportation in a smart city
- What is Big data?
- What are big data analytics?
- The value of big data analytics in transportation
- Getting what you want from big data analytics: Use Cases
- Smart Data Management and how to get there
- Planning approach to smart cities
- Benefit and cost approach
- Summary of instructional objectives

What is a Smart City?

- Wider than transportation
- Disproportionate importance of transportation
- A range of transportation services
- Connectivity
- Alignment between modes
- Optimization of transportation services
- Matching supply and demand through variations over time
- Monitoring, managing, and learning

What is a Smart City?

- Energy
- Smart Buildings
- Smart healthcare
- Smart education
- Smart retail
- Utilities
- Manufacturing
- Urban Agriculture
- Transportation

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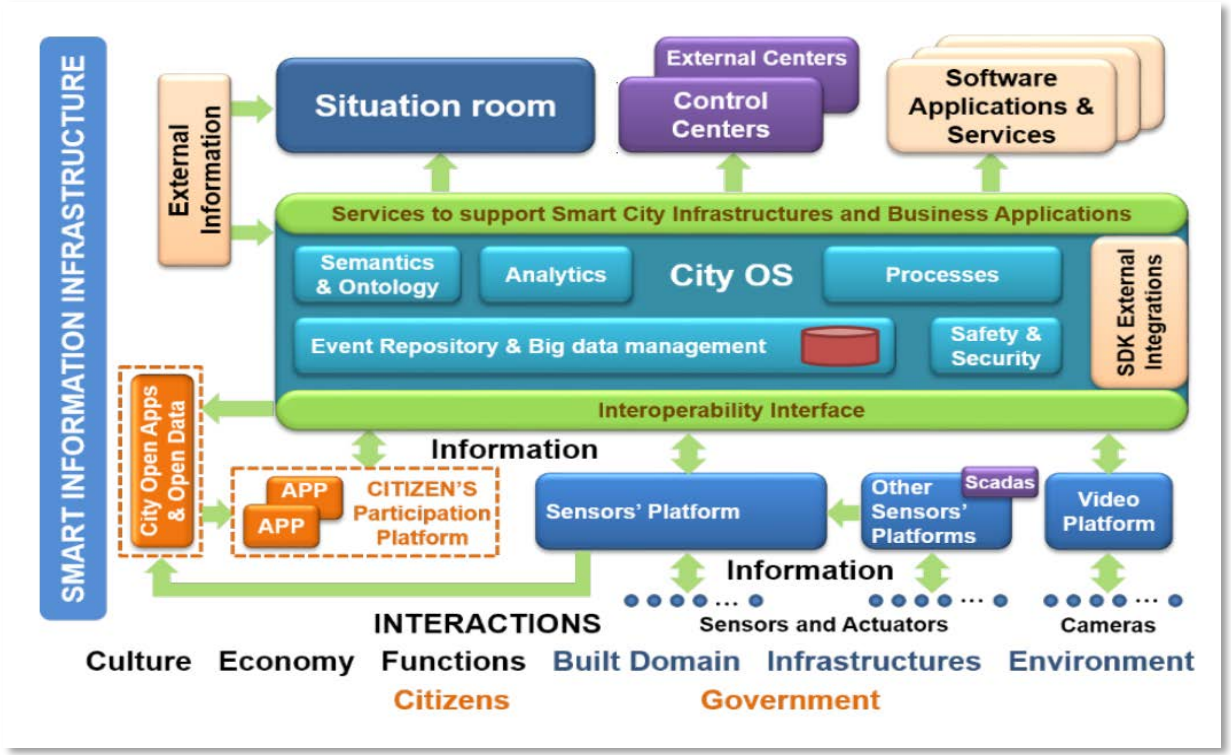
Importance of Transportation in Smart Cities

- Energy: 28% of US energy used for transportation
- Smart Buildings to live and work: accessibility
- Smart healthcare : accessibility
- Smart education : accessibility
- Smart retail : accessibility
- Manufacturing: : accessibility
- Utilities: EV charging, sensor sharing
- Urban Agriculture: farm to table chain
- Transportation: mobility, accessibility, safety, efficiency, user experience



_CPA-I_001-v2_Anatomy City Anatomy: A Framework to support City Governance, Evaluation and Transformation Developed by Task Team - ancha 6 November 2015 http://www.cptf.cityprotocol.org/CPAI/CPA-I_001-v2_Anatomy.pdf

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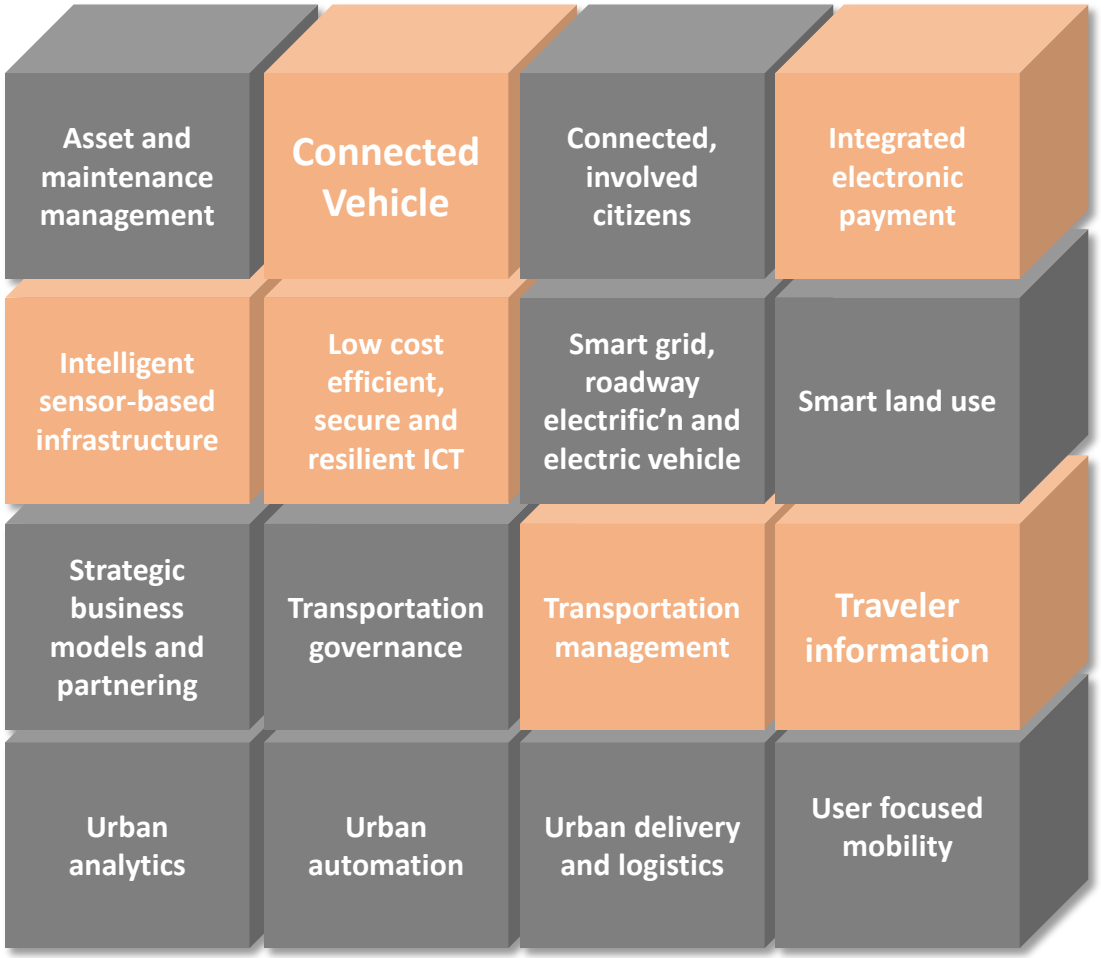
Importance of Transportation in Smart Cities



- Smart:
  - Connected and autonomous vehicles
  - Fee payment
  - Sensors
    - Infrastructure
    - Probes
  - Communications
    - Fiber
    - Wireless V to X
  - Transportation management
    - Traffic signals
    - Freeway
    - Transit
    - Freight
    - non-motorized
  - Traveler information

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Transportation as a Single System

- What is a system?
  - It has clarity of purpose
  - It is connected together
  - We can find out its status at any given time
  - It can adapt to changes in the environment

- "Single system" also includes alignment between planning, design, project delivery, operations, and maintenance

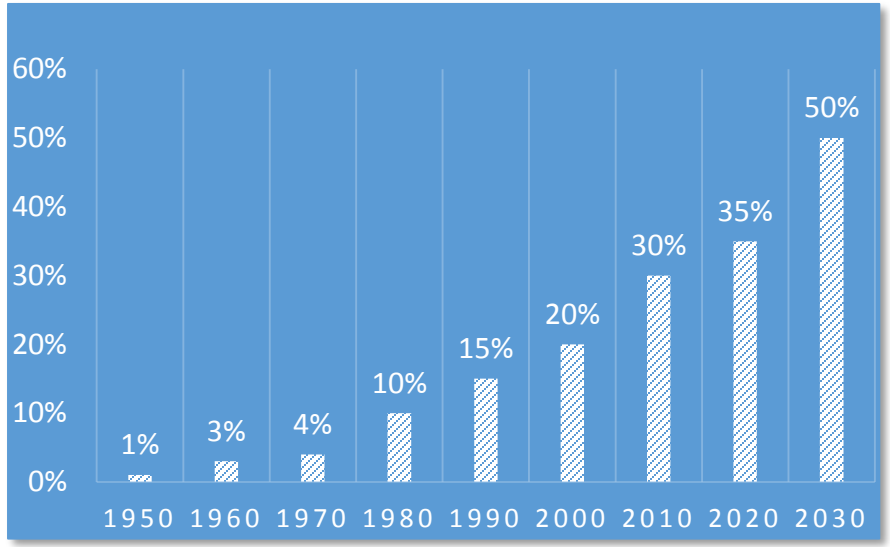
Paraphrased from the speech by Samuel J. Palmisano, Intelligent Transportation Society of America, 2010 Annual Meeting & Conference, Houston, Texas, May 5, 2010

Connected and Autonomous Vehicles

- The Internet of Things
- Cities will roll out more autonomous vehicles over the next five years, including First mile last mile shuttles
- Electric vehicles will outnumber gas powered cars in the next 15 years
- Crowdsourced ride-sharing services will go global (Mobility as a Service)
- Vehicles will connect to transportation systems, Ford says it will equip 20 million cars with built-in modems over five years
- City managers will have new operating systems to manage transportation, data will be integrated from multiple endpoints.

Automobile Electronics and Information Technology

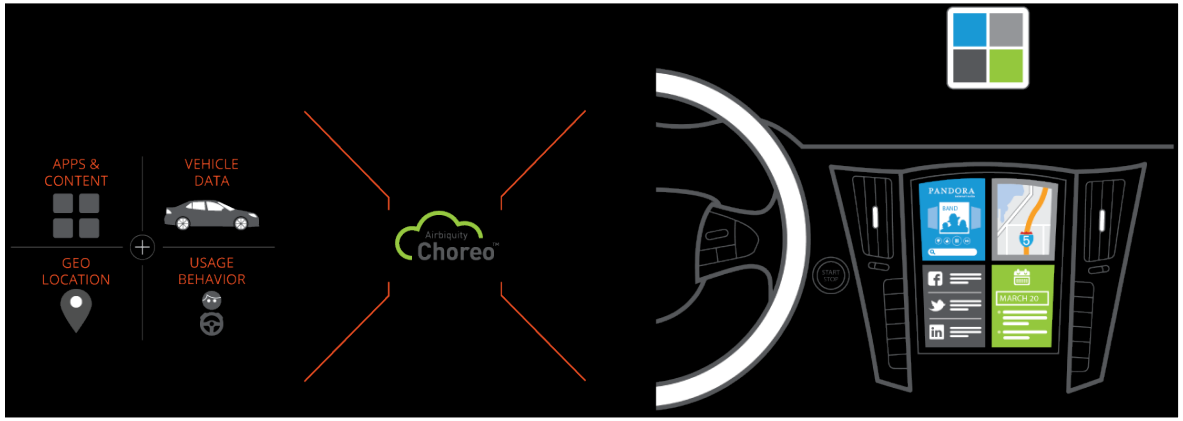
- Today: 30 to 35% of car costs is comprised of automotive electronics
- 2030: this will grow to 50%



Automotive electronics	Description
Active safety	Avoid and mitigate the effects of a crash
Chassis electronics	Monitor and manage the chassis
Driver assistance	Decision support for the driver
Engine electronics	Monitor and manage engine operation
Entertainment systems	In car entertainment systems such as radio and digital music players
Passenger comfort	The air conditioning, heated seats and other applications to increase passenger comfort
Transmission electronics	Monitor and manage the operation of the transmission between the engine and the wheels

Connected Vehicles

Wide-area wireless



Dedicated Short Range Communications (DSRC)

- Two different approaches
  - 5G and beyond
    - Wide area or link focus
  - DSRC
    - Intersection focus

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Connected Vehicle Services for a Smart City

DSRC

V2I Safety
Red Light Violation Warning
Curve Speed Warning
Stop Sign Gap Assist
Spot Weather Impact Warning
Reduced Speed/Work Zone Warning
Pedestrian in Signalized Crosswalk Warning (Transit)

V2V Safety
Emergency Electronic Brake Lights (EEBL)
Forward Collision Warning (FCW)
Intersection Movement Assist (IMA)
Left Turn Assist (LTA)
Blind Spot/Lane Change Warning (BSW/LCW)
Do Not Pass Warning (DNPW)
Vehicle Turning Right in Front of Bus Warning (Transit)

Agency Data
Probe-based Pavement Maintenance
Probe-enabled Traffic Monitoring
Vehicle Classification-based Traffic Studies
CV-enabled Turning Movement & Intersection Analysis
CV-enabled Origin-Destination Studies
Work Zone Traveler Information

Environment
Eco-Approach and Departure at Signalized Intersections
Eco-Traffic Signal Timing
Eco-Traffic Signal Priority
Connected Eco-Driving
Wireless Inductive/Resonance Charging
Eco-Lanes Management
Eco-Speed Harmonization
Eco-Cooperative Adaptive Cruise Control
Eco-Traveler Information
Eco-Ramp Metering
Low Emissions Zone Management
AFV Charging / Fueling Information
Eco-Smart Parking
Dynamic Eco-Routing (light vehicle, transit, freight)
Eco-ICM Decision Support System

Road Weather
Motorist Advisories and Warnings (MAW)
Enhanced MDSS
Vehicle Data Translator (VDT)
Weather Response Traffic Information (WxTINFO)

Mobility
Advanced Traveler Information System
Intelligent Traffic Signal System (I-SIG)
Signal Priority (transit, freight)
Mobile Accessible Pedestrian Signal System (PED-SIG)
Emergency Vehicle Preemption (PREEMPT)
Dynamic Speed Harmonization (SPD-HARM)
Queue Warning (Q-WARN)
Cooperative Adaptive Cruise Control (CACC)
Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)
Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)
Emergency Communications and Evacuation (EVAC)
Connection Protection (T-CONNECT)
Dynamic Transit Operations (T-DISP)
Dynamic Ridesharing (D-RIDE)
Freight-Specific Dynamic Travel Planning and Performance
Drayage Optimization

Smart Roadside
Wireless Inspection
Smart Truck Parking

Wide-area wireless

On-the-road diagnostics

A leading heavy-truck maker wanted its transportation and logistics customers to experience zero downtime.

Its pilot project has proven successful at predicting component failures up to 30 days in advance.

What's more, once its engineers had access to the telematics data, they had a revelation. They found three areas they could improve significantly:

On-road diagnosis
- Reduced warranty cost 50 percent per repair.
- Reduced diagnostic time 70 percent per repair.
- Increased customer uptime by 10 percent per repair.

Campaign reduction
- Reduced disruption of customer operations by 25 percent.
- Reduced warranty cost of the software update by 25 percent.

Predictive maintenance
- Address critical repairs before failure occurs.
- Increased uptime by 30 percent.
- Accelerated root-cause analysis by 25 percent.

Watch the video.

Location-based services: what's analytics' role?

Most of us are familiar with graphs and reports that show trends, ratios and rankings, such as line charts, pie charts and Pareto charts. While this information is useful in telling us **what** happened, it falls short of telling us **why** it happened. And if you don't know why something happened, you haven't a clue of what might happen next. So you are left to use intuition, deductive reasoning and past experiences - aka your gut - to make decisions about the future.

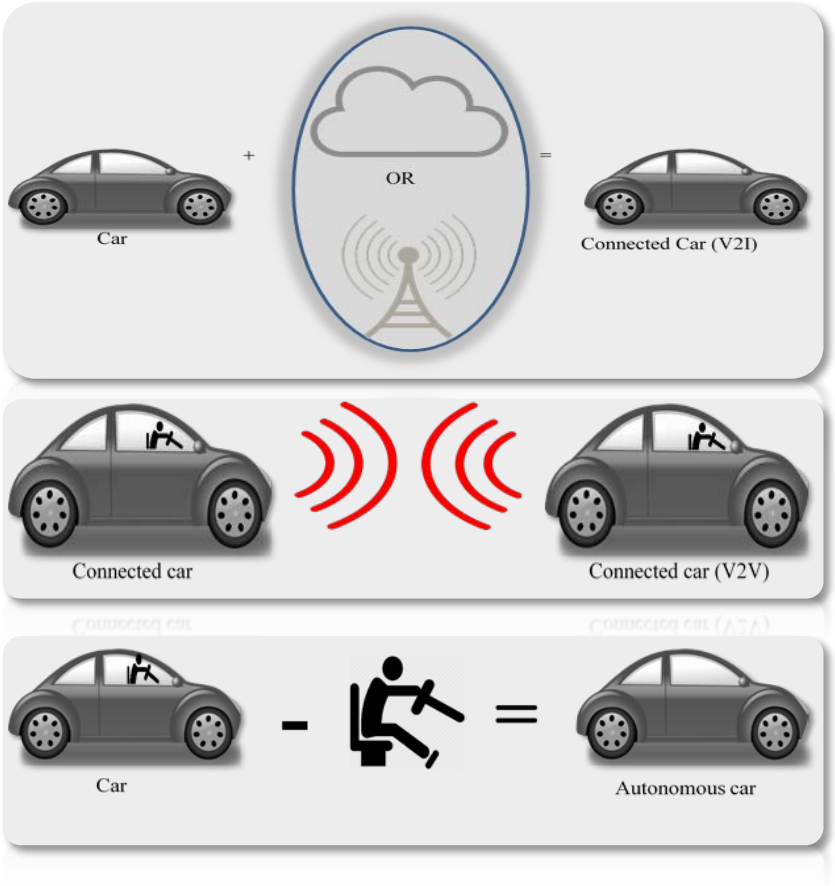
Analytics will bridge that gap. It reveals correlations and causations. It uses sophisticated math and statistics to accurately forecast and predict what is most likely to happen. And it allows you to interject your domain knowledge to assess unprecedented what-if scenarios.

In short, analytics lets you visualize location data to provide insights that improve all aspects of your business.

https://www.sas.com/content/dam/SAS/en_us/doc/whitepaper1/connected-vehicle-107832.pdf

Connected versus Autonomous Vehicles

- Connected: two-way communications from vehicle to infrastructure and vehicle to vehicle
- Autonomous: driverless operation
- An Autonomous Vehicle is one that is capable of operation without a driver
  - First mile, last mile shuttles
  - Cars
  - Trucks
  - Buses



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Autonomous Shuttle

- Easymile shuttle
- 12 person capacity
- Used as driverless bus in Taipei August 2017
- Being deployed in California at GoMentum Station
- Demo in Jacksonville

Autonomous Trucks

- Intertraffic 2016
- European truck platooning challenge
- Rotterdam, Frankfurt and Vienna
- Two or more trucks traveling in convoy in close proximity
- Also Otto self driving trucks on Interstates in the USA (owned by Uber)

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Big Data Aspects

- 2013 Ford Fusion Energi Hybrid
  - 145 actuators
  - 4716 signals
  - 74 sensors
  - More than 70 onboard computers
  - 25 GB of data per hour
  - 2 ZB of data every year nationally
- Tidal wave of data
- Will we get access to it?
- Do we need it all?

What is Big Data?

- Type
- Volume
- Velocity
- Variety
- Variability
- Complexity
- Veracity

New

Analytics: graph and path analytics, and analytics on **new, non-relational data types** (coupled with existing relational data)

Tools: uncover insights from data such as text in accident reports, or patterns in visuals, to quickly ***find the signal in the noise***

Economics: retain, do not throw away signal timings, speed, flow and occupancy data, by ***leveraging "hot and cold data"*** storage

Architecture: hybrid ecosystem that allows both old and new tools and enables rapid ***discovery analytics on new data***

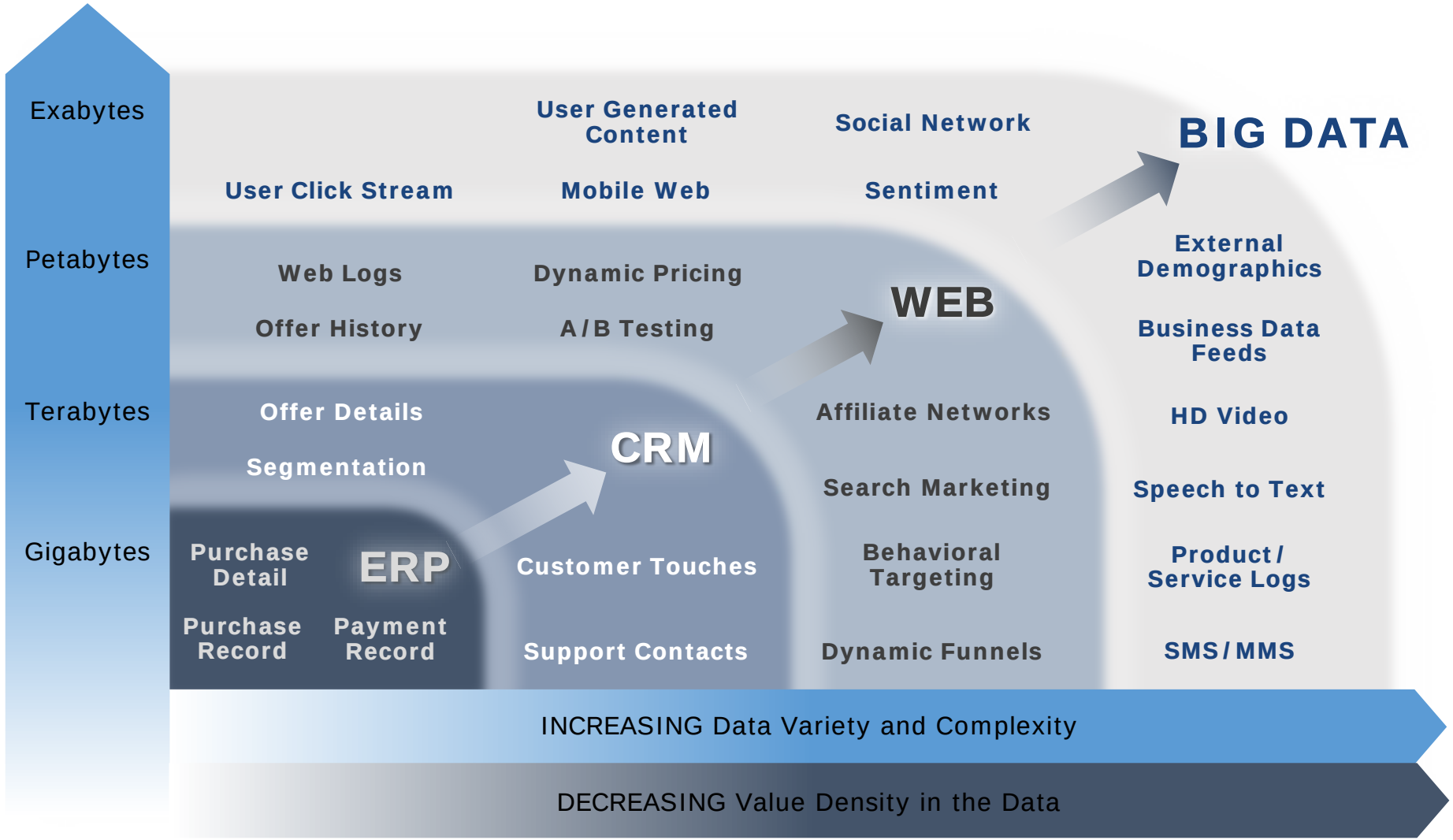
Not New

Most big data use cases are variations on:

- **Safety,**
- **Efficiency**
- **User experience**

…questions that public service agencies have been addressing for years

Evolution



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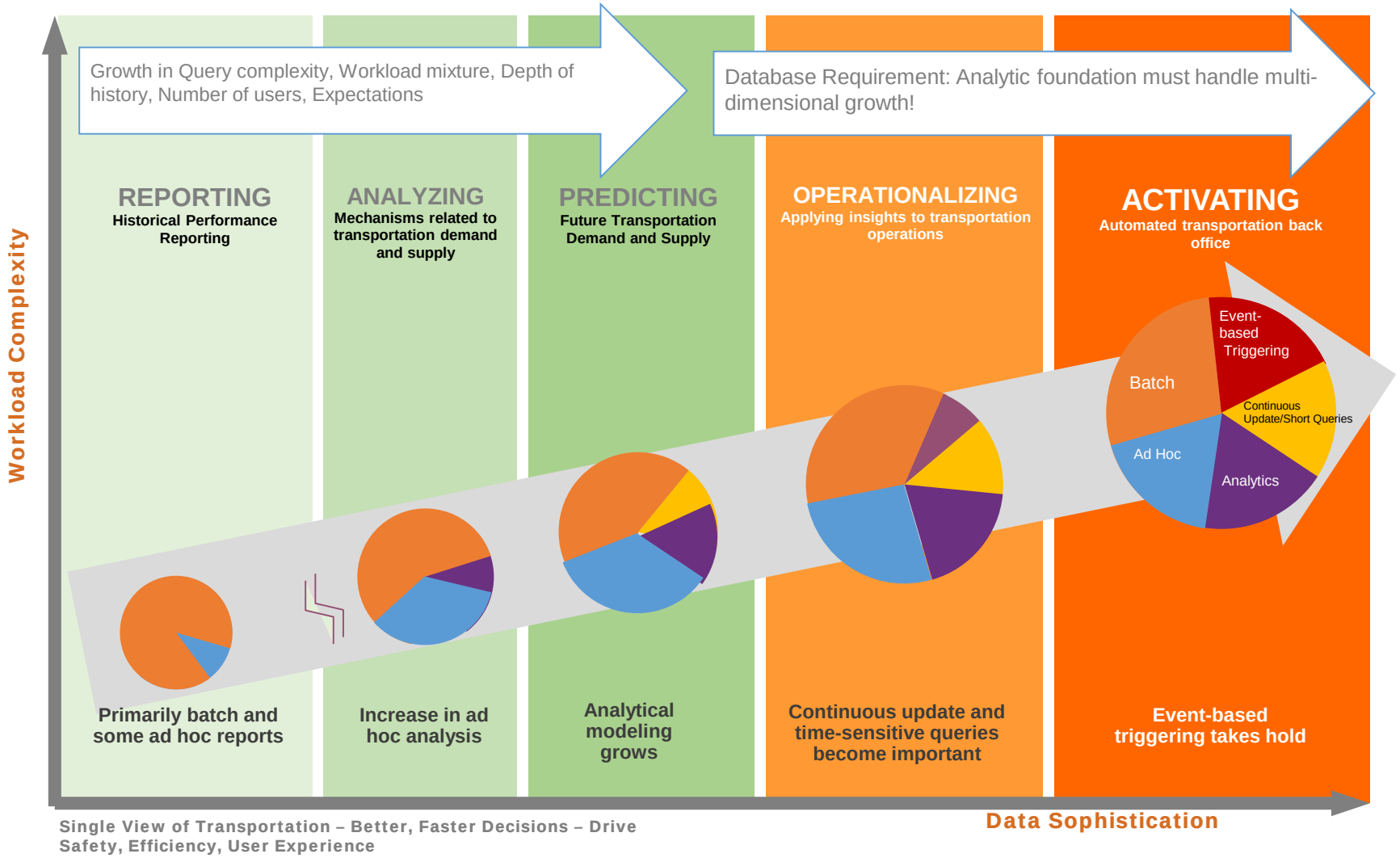
Towards Automation



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What are Big Data Analytics?

Services	Analytics
Asset and maintenance management	Asset performance index, asset maintenance standards compliance measure, optimal intervention point analytic
Connected vehicle	Lane changes per mile, steering angle compared to road geometry, brake applications per mile, driving turbulence index, minutes per trip, trip time reliability index, no of stops per trip
Connected, involved citizens	Citizens awareness levels index, citizens satisfaction levels
Integrated electronic payment	Transit revenue per passenger, transit seat utilization, toll revenue per vehicle and per trip, premium customer identification index, parking revenue per slot, payment system revenue achieved compared to forecast and addressable market
Intelligent sensor-based infrastructure	Data quality index, transportation conditions index, trip time variability index
Low cost efficient, secure and resilient ICT	Network load compared to capacity index, network latency, cost of data transfer, network security index
Smart grid, roadway electrification and electric vehicle	Electric vehicle charging points per mile, electric vehicle charging points per head of population, number of electric vehicles as a percentage of the total fleet, electric vehicle miles per day, electric vehicle miles per trip, electric vehicle miles between charges
Smart land-use	Observed trip generation rates for different land uses, observed actual trips between zones, land value transportation index, zone accessibility index
Strategic business models and partnering	Percentage of private sector investment, number of partnerships, improvement in service delivery for each private sector dollar invested
Transportation governance	Transportation efficiency for each dollar spent, supply and demand matching index, transportation agency coordination index, partnership cost-saving index, cost of data storage and manipulation compared to services provided
Transportation management	Mobility index, citywide job accessibility index, citywide transportation efficiency index, reliability index, end-to-end time including modal interchanges index
Traveler information	Traveler satisfaction index, decision quality information index, behavior change index
Urban analytics	Number of analytics in use, value of services managed by analytics, money saved through efficiencies gained by analytics
Urban automation	Percentage of automated vehicles within the entire citywide fleet, percentage of automated vehicles in use by city agencies and private fleets, proportion of deliveries made by automated vehicles, proportion of passengers carried by automated transit
Urban delivery and logistics	Average cost of urban delivery, average time for end-to-end delivery, freight and logistics user satisfaction index, freight management satisfaction index
User focused mobility	Citywide mobility index, user satisfaction index, transportation service delivery reliability index

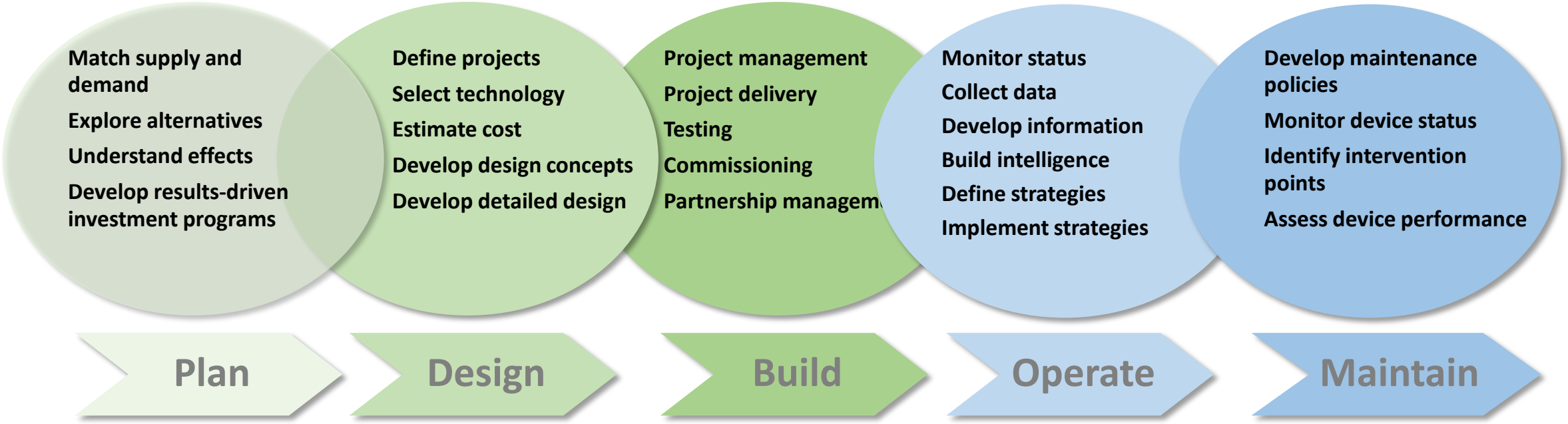
Getting What You Want From Big Data Analytics

- Difference between reporting and analytics
- The importance of Use Cases
- Getting started, developing a roadmap, Defining the future vision
- Building bridges
  - Between data science and transportation
  - Between departments
  - Between agencies and partners
- Using data as the “glue”
- Defining needs, issues, problems and objectives
- Reporting
  - Questions predefined
  - Focus on “knowing”
- Analytics
  - Different questions can be defined
  - Focus is on improving organizational performance by analytics applied to management

- Reporting makes you a well informed spectator
- The right analytics can make you the coach with the ability to change the performance of the team

Focus on Operations for this Lecture

- Opportunities and challenges
- Illustrating the value of analytics in operations through Use Cases



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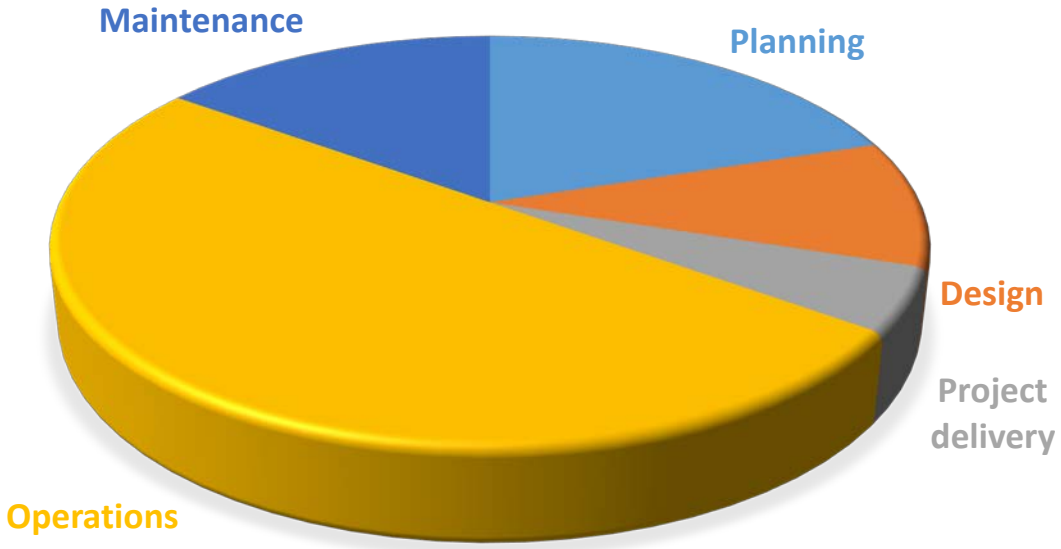
Why focus on operations?

- Operations as a significant data generator
  - SANDAG
    - 1 TB per day
    - Assumed 200 days per year operation
    - 200 TB per annum
  - Connected vehicle
    - 2 ZB per annum
- The impact of operations on safety, efficiency, and user experience
- Coordination of planning, design, project delivery, operations, and maintenance to deliver quality services



	Proportion of the data originating
Planning	20%
Design	10%
Project delivery	5%
Operations	50%
Maintenance	15%
Total	100%

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Operations Challenges

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Operations Use Case Examples

Transportation Operations Use Case Catalog Version 1					
1	Traffic anomaly detection and communications	2	Towing and recovery management	3	Results driven investment
4	Asset management	5	Transportation network management	6	Transportation systems management and operation impact analysis
7	Developer fee management	8	Regionwide safety analysis	9	Regionwide speed in bottleneck analysis
10	Mobility as a service	11	Connected citizens and travelers	12	Project tracking and coordination

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1. Traffic anomaly detection and communications

References
Owner: Bob McQueen

Objective / Problem Statement

- Bring data from multiple sources to a central data lake
- Conduct advanced analytics on the combined data source to detect anomalies
- Support the effective and efficient communication of anomalies to the appropriate parties

Business Benefits

- Increase safety
- Increase efficiency
- Enhanced user experience

Success Criteria

- Reduction in accidents and fatalities
- Faster response times
- Greater understanding of accident mechanisms

Source Data

- Traffic flow
- Wrong way driver detectors
- Traffic speeds

Expected Outcome of Analysis

- Reduction in accidents and fatalities
- Development of a better understanding of causal factors

Challenges

- Speed of processing and communications
- Combining relevant data
- Taking appropriate action based on new insight and understanding

Analytic Techniques

- Speed variability
- Traffic turbulence
- Wrong Way detection
- Recurring congestion identification
- Nonrecurring congestion identification

2. Towing and recovery management

References
Owner: Bob McQueen

Objective / Problem Statement

- Improve the efficiency of towing and recovery
- Optimize the investment in towing and recovery operations
- Ensure consistent policy across the entire region

Business Benefits

- Reduce congestion
- Improved safety
- Enhanced user experience

Success Criteria

- Reduction in towing and recovery time
- Reduction of variability in towing and recovery time across the region
- Higher level of user satisfaction
- Optimized investment in towing and recovery capital and operations investments

Source Data

- AVL data for towing and recovery vehicles
- Incident logs
- Courtesy patrol logs
- Traffic speeds
- Traffic flows
- Capital and operating cost of towing and recovery

Expected Outcome of Analysis

- Shorter towing and recovery times
- Less variability in towing and recovery times across the region
- Optimized investments in towing and recovery capital and operations

Challenges

- Access to relevant data
- Combining relevant data
- Defining appropriate analytics
- Using and communicating appropriate analytics

Analytic Techniques

- Towing and recovery time analysis
- Towing and recovery time variability analysis
- Unit cost analysis for towing and recovery capital and operating costs

3. Results driven investment

References
Owner: Bob McQueen

Objective / Problem Statement

- Improve expected versus actual benefits by measuring investment effectiveness.
- Investment requirements often exceed available funding, so there is need to balance funding between physical infrastructure (e.g. asphalt) and programs in intelligent transportation systems that better use available capacity

Business Benefits

- Ability to do before vs. after investment analyses
- Isolating the effects of investments

Success Criteria

- Better targeting of funding
- Greater understanding of the effects of investments
- Better matching of investment to problem areas

Source Data

- Project costs
- Program costs
- Project effects
- Program effects

Expected Outcome of Analysis

- Better prioritization process, through analytics that define specific effects of a range of investments including intelligent transportation systems
- Adoption of a results driven approach, with focus on optimization of investments
- Understand impact of transportation investments from a detailed understanding of effects

Challenges

- Merging work program and other investment program data with transportation condition data
- Developing and agreeing suitable analytics to guide the investment program

Analytic Techniques

- Unit cost per unit affect

4. Asset Management

References
Owner: Bob McQueen

Objective / Problem Statement

- Ensure that assets are managed as well as possible including the definition of optimal intervention points and the application of citywide standards for maintenance

Business Benefits

- Better cost vs. performance results for asset and maintenance management
- More consistent and appropriate levels of maintenance
- Better understanding of relevant intervention points and replacement cycles

Success Criteria

- Reduced cost of maintenance
- Higher level of maintenance
- More consistent level of maintenance
- Better understanding of the lifecycle for assets

Source Data

- Inventory of assets
- Asset performance data
- Asset maintenance standards
- Historical expenditure on asset maintenance

Expected Outcome of Analysis

- Accurate MTBF calculations
- Separation of routine from non-routine maintenance patterns
- Ability to include sensor data into analyses of historical and predictive maintenance
- Ability to optimize intervention points based on data and life extension programs
- More consistent application of maintenance standards that are appropriate to each device

Challenges

- Using data to define appropriate maintenance policy based on asset performance
- Obtaining an accurate inventory of current devices
- Integrating results into current process

Analytic Techniques

- Mean time between failures
- Routine vs. non-routine maintenance
- Asset performance index
- Optimal intervention points

5. Transportation Network Management

References
Owner: Bob McQueen

Objective / Problem Statement

- Optimize transportation performance management, use of observed data and scientific techniques, development of new tools to make transportation performance management better. End goal is to improve safety, increased efficiency and provide an enhanced traveler experience

Business Benefits

- Better transportation performance management, increased safety, improved efficiency and enhanced traveler experience
- Better compliance with government regulations and expectations on performance
- Ability to measure the effectiveness of performance management strategies

Success Criteria

- Better transportation performance management
- More insight and understanding of prevailing transportation conditions
- Development of predictions for future transportation conditions

Source Data

- Private sector detail data on speeds, volumes, etc
- U.S. Census data
- Transit agency data
- Local department of transportation data
- County data, city data

Expected Outcome of Analysis

- Use of observed data and data science to evaluate transportation performance
- Identify capacity improvement opportunities
- Reduced transportation service delivery costs

Challenges

- Coordinating performance management across modes
- Bringing data together from multiple sources
- Validating and verifying the data
- Agreeing the coordinated list of analytics to be used across all modes

Analytic Techniques

- Transportation performance Index
- Travel time variability
- Travel value proposition
- Regional congestion index
- Overall cost of travel
- Accessibility index

6. TSM&O impact analysis

References
Owner: Bob McQueen

Objective / Problem Statement

- Quantify the safety effects of transportation systems management and operations
- Quantify the efficiency effects of transportation systems management and operations
- Quantified the user experience effects of transportation systems management and operations

Business Benefits

- Providing justification for investment in transportation systems management and operations equipment and staff resources
- Improved transportation systems management operations
- Increase safety
- Increase efficiency
- Enhanced user experience

Success Criteria

- Clearly defined estimates of the effects of transportation system management and operations

Source Data

- Investments in transportation systems management and operations equipment and staff
- Accident data
- Operations efficiency data
- User satisfaction data

Expected Outcome of Analysis

- Appropriate investments in transportation systems management and operations
- Improved efficiency of transportation systems management and operations
- Better service quality for transportation

Challenges

- Access to data
- Combining the data
- Keeping the data up-to-date
- Isolating the effects of transportation systems management and operations from other factors

Analytic Techniques

- TSM&O safety index
- TSM&O efficiency index
- TSM&O user experience index

7. Developer fee management

References
Owner: Bob McQueen

Objective / Problem Statement

- Manage the developer fee process from end to end
- Improve the efficiency of the developer fee process

Business Benefits

- Increasing cash flow
- Increasing revenue
- More efficient distribution of developer fees
- More accurate attribution of developer fees

Success Criteria

- Improve cash flow
- Increased revenue

Source Data

- Development data
- Fee data
- Develop a database
- Financial data

Expected Outcome of Analysis

- Accelerating the delivery of developer fees
- Improving compliance with respect to developer fees
- Better management of the end-to-end process
- improved cash flow
- increased revenue

Challenges

- Identifying the data sources
- Bringing the data together
- Developing a process map
- Identifying performance measures
- Building the system

Analytic Techniques

- Percentage compliance
- Number of days from request to delivery of fee
- Fee revenue

8. Regionwide safety analysis

References
Owner: Bob McQueen

Objective / Problem Statement

- Understand the behaviors, infrastructure and environmental factors, and vehicle, context and other causes of safety issues
- Identify investments that directly or indirectly increase safety and prioritize by likely value

Business Benefits

- Reduced numbers of accidents and associated societal costs, including congestion costs
- Ability to separate the contribution of the various variables to safety issues (either accidents or even near-misses). Highway safety depends on design, traffic mix, congestion levels and many other contributing variables, including weather

Success Criteria

- Reduced highway accidents, better understanding of highway accident causes, improvement in the use of enforcement data

Source Data

- Rich data are available on incidents/accidents on highways, from traffic management centers and law enforcement but it resides in multiple silos and significant content is in text format
- Big data elements such as traffic conditions (from sensors on speed, flow and lane occupancy), traffic signal, weather and other data, provide significant detail on context

Expected Outcome of Analysis

- Identifying classes of similar accidents and contributing factors
- Quantifying frequency by accident type allows prioritization by impact, striving to higher safety
- Better understanding accident causes and the effects of remedial measures

Challenges

- Developing a methodology for multiple factor crash analysis
- Verifying the quality of law enforcement data
- Ensuring that data has same time base and Geo locational referencing base

Analytic Techniques

- Classes of accidents/patterns discerned
- Geospatial patterns by using geospatial kernel smoothing & other spatial techniques
- Sequences of events leading to accidents/ incidents can be found by pathing analysis

9. Regionwide speed and bottleneck analysis

References
Owner: Bob McQueen

Objective / Problem Statement

- Reduce delays due congestion and improve travel time reliability
- Improve traffic flow on arterials and suburban streets, through investments in smart traffic signals and improvement of algorithms for coordination of signals

Business Benefits

- New analytics that can help identify patterns of speed variability, bottlenecks, etc. that can be used in amelioration planning.

Success Criteria

- More scientific approach to traffic engineering of freeways
- Better matching of investment plans to needs
- More insight and understanding into prevailing in future traffic conditions

Source Data

- Public sector sensor/video capture of vehicle speed, flow and lane occupancy data and private sector sources of similar data
- Public sector events data, e.g. accidents, planned closures
- Reference data on roadways, lane configurations, signals
- Range of external data sources, weather, origin& destination

Expected Outcome of Analysis

- More efficient transportation, safer, with better user experience in travel time reliability and with calmer traffic flows
- Better understanding of speed variability patterns, more detailed than previously detectable
- More precise prioritization of capacity improvements
- Analytics techniques to understand speed variability on roads, identify and characterize bottlenecks and apply scientific traffic engineering techniques

Challenges

- Integrating private sector speed data with public sector traffic flow and other data
- Establishing a suitable agreement with the private sector data provider

Analytic Techniques

- Presence of bottlenecks and their extent in time and length
- Speed variability patterns near bottlenecks, at back of queue
- Analytics on recurring versus nonrecurring congestion

10. Mobility As A Service

References
Owner: Bob McQueen

Objective / Problem Statement

- Create a means to deliver information on the multi-modal services that are available, inclusive of cost, time, reliability

Business Benefits

- Greater end-user awareness of mobility choices and the various cost, time, reliability components
- More flexible choices for mobility within an urban area including information on available options for mobility from both the public and private sectors

Success Criteria

- More choices for travelers in the city
- Better accessibility
- Higher efficiency
- Better value proposition for all travelers

Source Data

- Origin and destination data
- Transportation service option data including availability, cost and reliability

Expected Outcome of Analysis

- Understanding of transportation service cost comparisons
- Analytics on cost versus user experience

Challenges

- Establishing suitable smart phone apps
- Establishing partnerships with mobility as a service providers
- Establishing data sharing agreements
- Obtaining agreement on the parameters to be used

Analytic Techniques

- Establishment of a mobility as a service portfolio
- Network models of multi-modal mobility
- Comparison of multi-modal trip time/cost/variability to single mode

11. Connected, Citizens & Visitors

References
Owner: Bob McQueen

Objective / Problem Statement

- To support a two way dialogue between transportation service providers and citizens/visitors. To enable citizens to provide crowd source data and feedback concerning perception of quality and satisfaction levels

Business Benefits

- Better informed citizens and enhanced abilities for citizens to provide data and opinions on transportation service delivery

- Success Criteria
- Higher satisfaction levels among citizens and visitors
- Higher level of connectivity between citizens, visitors and transportation service providers
- Better understanding of prevailing transportation conditions
- Better understanding of citizen sentiment

- Source Data
- Cell phone location data
- Citizen perception data
- Crowd sourced sentiment and perception
- Transportation performance data

- Expected Outcome of Analysis
- Better traveler information to citizens
- Ability to utilize crowd source data from citizens
- Understanding of citizen sentiment based on integration with cell phone location data

- Challenges
- Suitable data collection app that can also enable user perception feedback
- Determining privacy policy
- Defining data sharing agreements
- Isolating transportation and location specific sentiments from general sentiment data

- Analytic Techniques
- Citizen satisfaction index
- Integrating user perception and crowd sourced data with transportation performance data
- Incident detection

12. Project tracking and coordination

References
Owner: Bob McQueen

Objective / Problem Statement

- Coordinate project delivery across geographic regions
- Minimize conflict between projects
- Maximize synergy between projects

Business Benefits

- Reduce project cost
- Reduce project risk
- Reduce congestion and delay

Success Criteria

- Reduction in project cost
- Reduction in project risk
- Maximizing synergy between projects

Source Data

- Project location
- Project type
- Resources involved
- Project cost
- Project risk

Expected Outcome of Analysis

- Better coordination between projects
- Avoidance of additional risk
- Optimizing project delivery

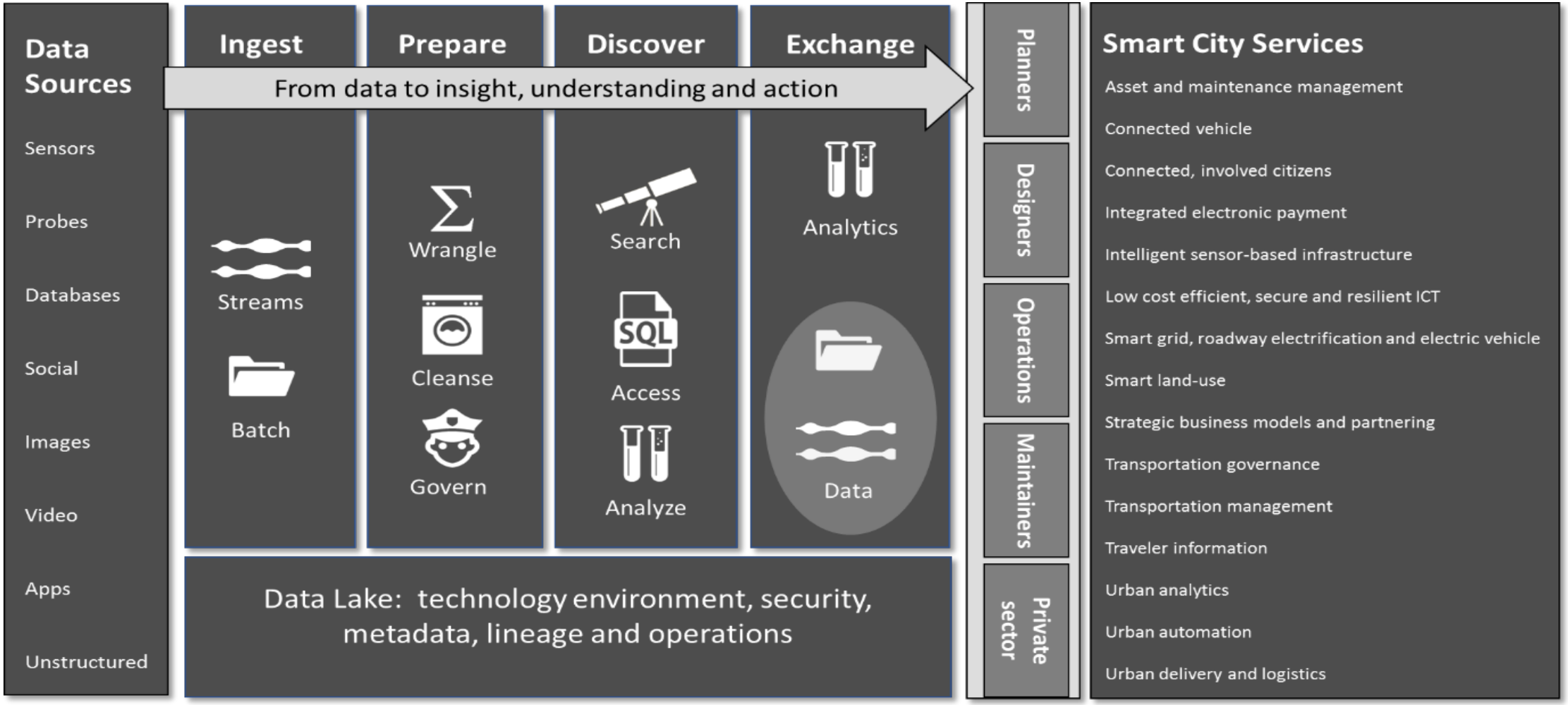
Challenges

- Obtaining data
- Combining data
- Developing suitable performance measures and analytics

Analytic Techniques

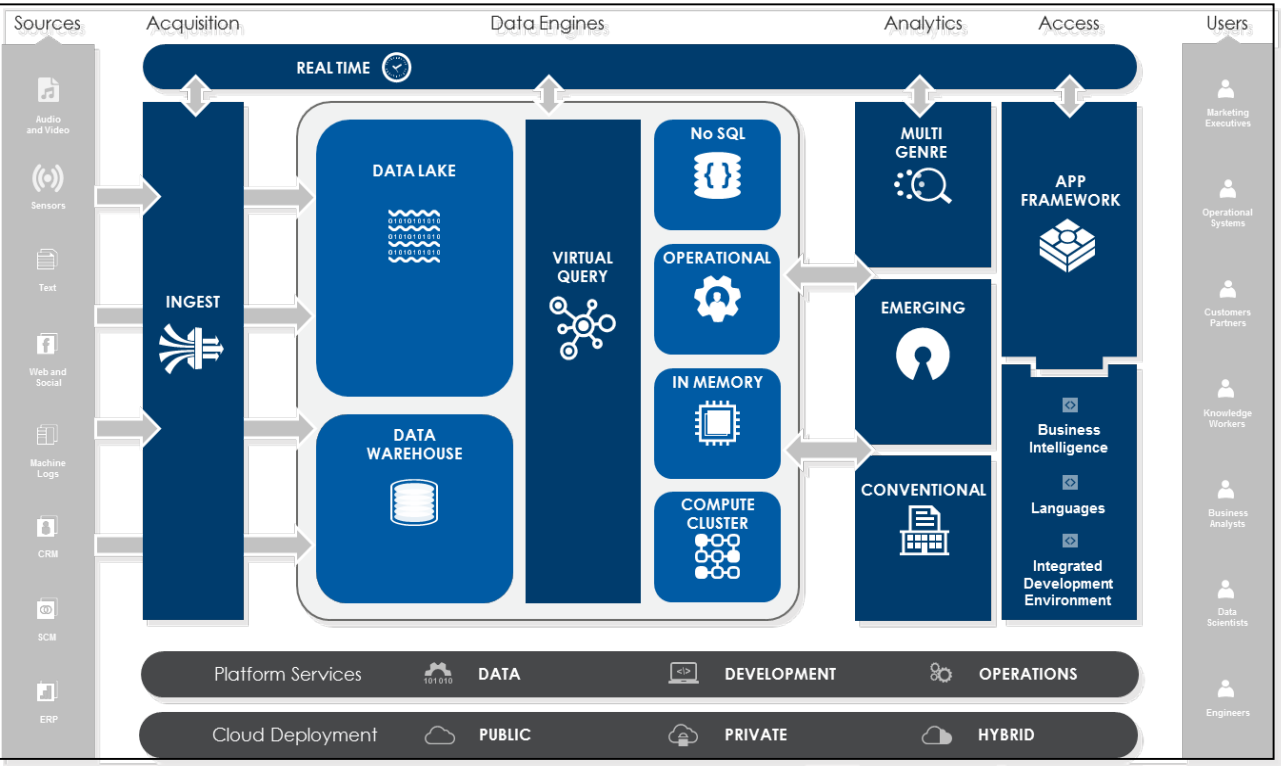
- Project cost index
- Project risk index
- Project synergy index

Smart Data Management

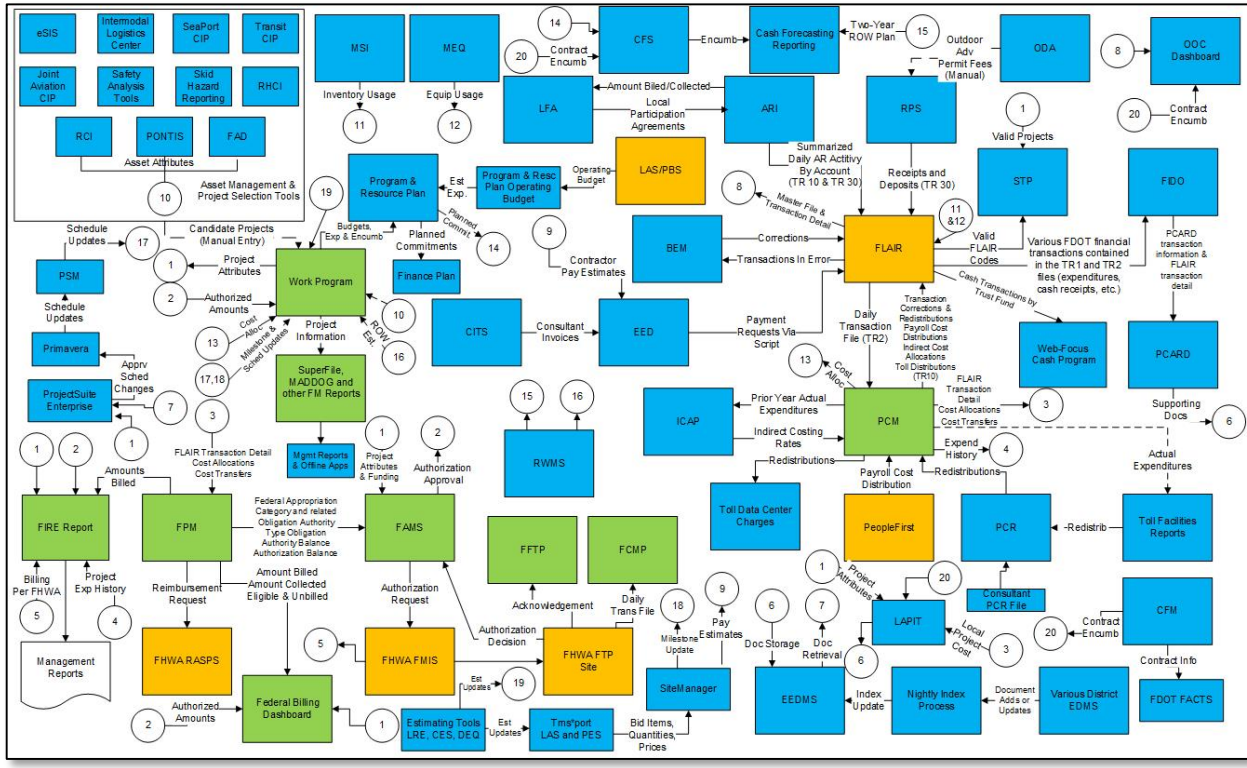


Coherent Data Acquisition, Central Data and Analytics

Smart Data Management



Not So Smart Data Management



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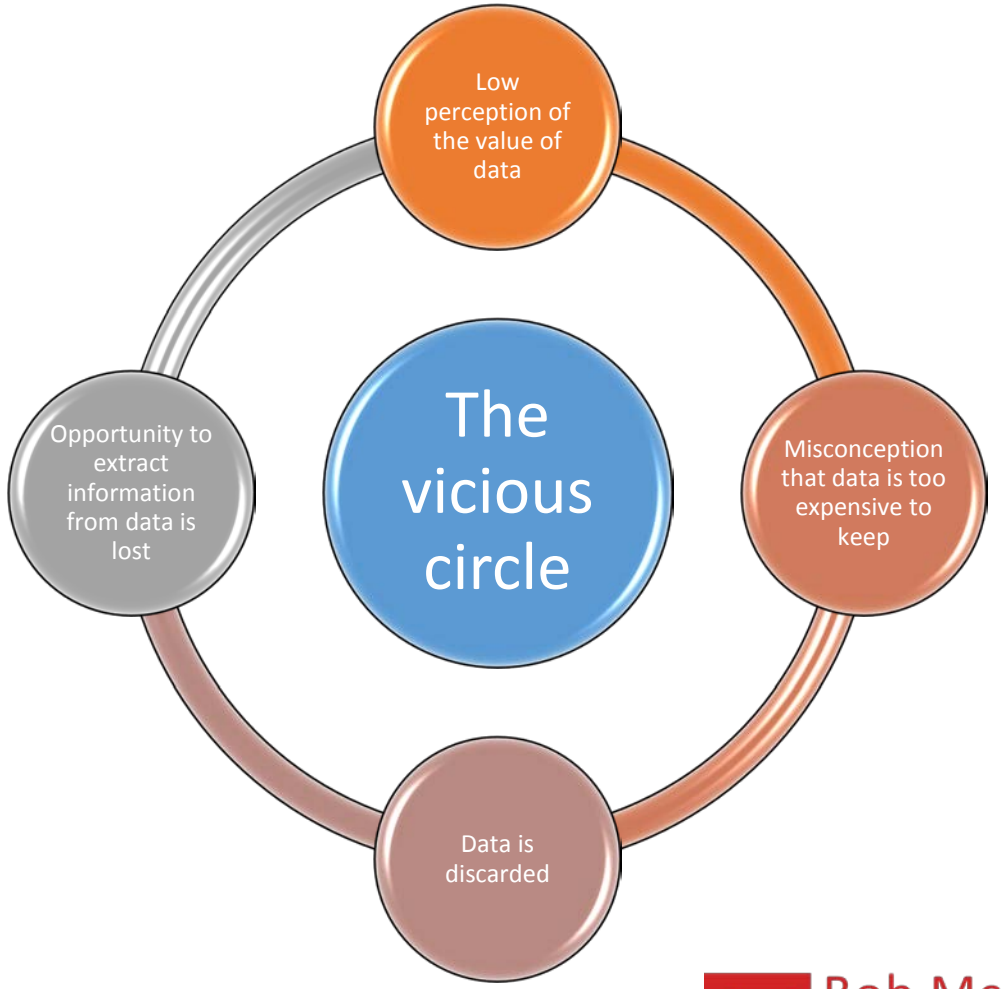
Smart Data Management Challenge

- Data, as a raw material, is perceived to be of little or no value
- This distorts benefit cost calculations with respect to data retention and management
- Consequently data is discarded
- The opportunity to convert data to information to insight to action is missed
- The misconception of little or no value of data is reinforced



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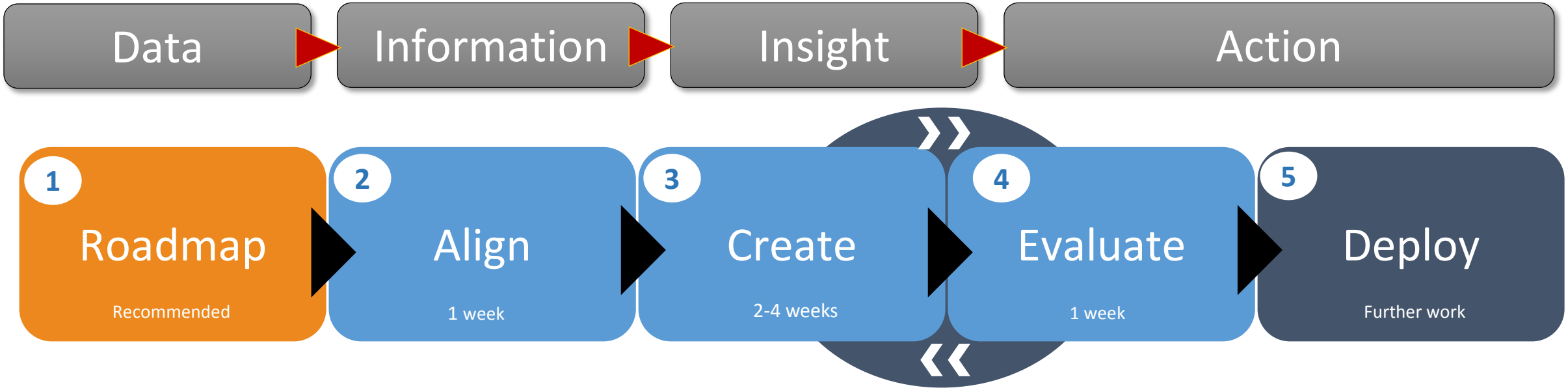
Practical Approach to Smart Data Management



Align	Create	Evaluate
• Document use case detail • Data confirmation • Assign Insight Pod team • Assign Data Pod team • Business client role defined	• Load & prep data • Develop analytics & models • Develop early insights • Iteration phases with business • Finalize insights	• Final recommendations • Document ROI • Deployment plan • Report write up • Executive Presentation
Deliverable	**Deliverable**	**Deliverable**
• Scope Document • Project Plan	• Analysis, Models & Code • Insight Report & Findings	• Report & Presentation

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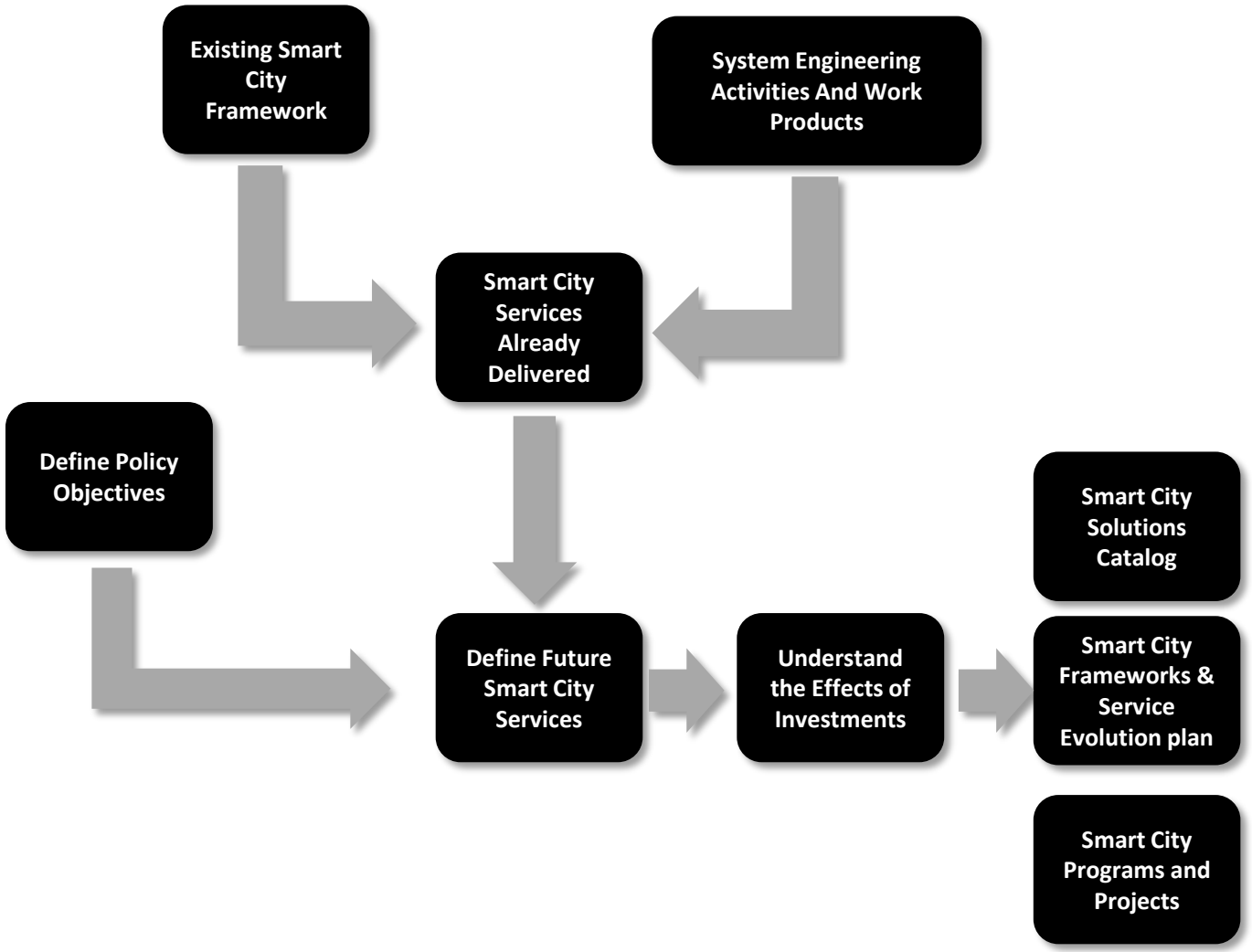
Planning a Smart City



- Departure points
- Roadmap
- Future vision
- Preservation of legacy investment
- Coordination of future investments
- Possible departure points:
  - Integrated payment systems
  - Connected citizens and visitors
  - Transportation management

Evaluating the Effects of Investments

Benefits summary	Annual lifecycle benefits	Lifecycle cost	Benefit cost ratio
Asset and maintenance management	$518,357	$5,183,571	0.1
Connected vehicle	$670,460,315	$145,547,227	4.6
Connected, involved citizens	$86,125,000	$12,964,286	6.6
Integrated electronic payment	$430,625,000	$36,332,842	11.9
Smart grid, roadway electrification and electric vehicle	$4,383,242,730	$144,597,981	30.3
Smart land use	$114,790,926	$14,360,686	8.0
Transportation management	$354,309,126	$13,913,643	25.5
Traveler information	$86,125,000	$16,314,286	5.3
Urban automation	$4,025,301,631	$268,600,049	15.0
Urban delivery and logistics	$287,477,315	$15,380,667	18.7
User focused mobility	$502,289,815	$55,428,571	9.1
Direct benefit services total	$10,941,265,216	$728,623,810	15.0
Intelligent sensor- based infrastructure		$34,557,143	
Low cost efficient, secure and resilient ICT		$59,000,000	
Urban analytics		$4,380,000	
Strategic business models and partnering		$2,347,210	
Transportation governance		$2,347,210	
Indirect benefit enabler services		$102,631,562	
Grand totals	$10,941,265,216	$831,255,372	13.2

Planning factors

- Cost benefit
- Legacy investment
- Policy priorities
- Service evolution over time, space and service quality

Review Instructional Objectives

1. Define a smart city
2. Identify importance of transportation in a smart city
3. Define the role of connected and autonomous vehicles in the smart city
4. Define Big Data
5. Define big data analytics and relevance to transportation
6. Explain the value of Use Cases
7. Discuss Smart Data Management
8. Define an effective approach to Smart Data Management
9. Discuss a planning approach to smart cities
10. Define a benefit and cost approach

Thank you for your Time and Attention

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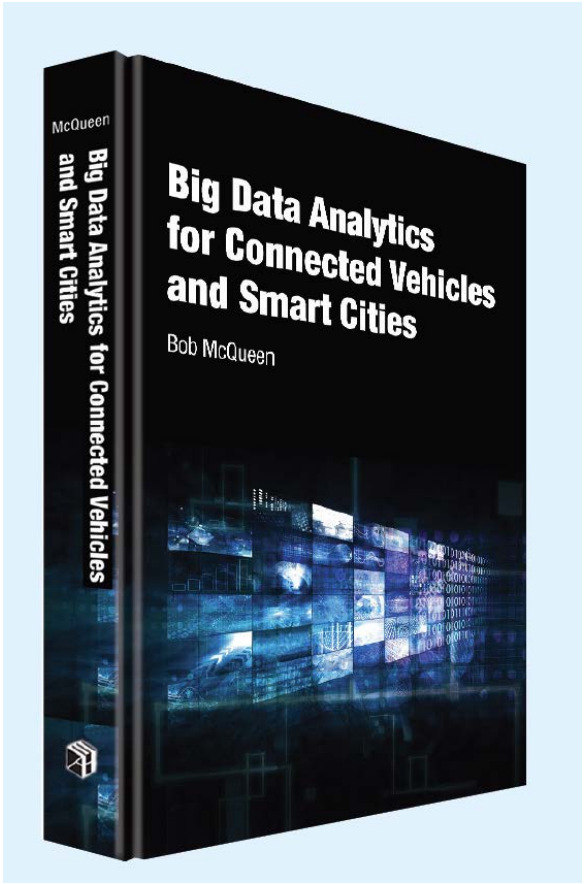
- Latest book:

  Big data Analytics for Connected Vehicles and Smart Cities

  Artech House, published August 31, 2017



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