Big Data and Analytics: Transportation Implications

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February 22, 2019

Topics

- Transportation
- Big Data
- Analytics
- Data as the “glue”
- Smart data management

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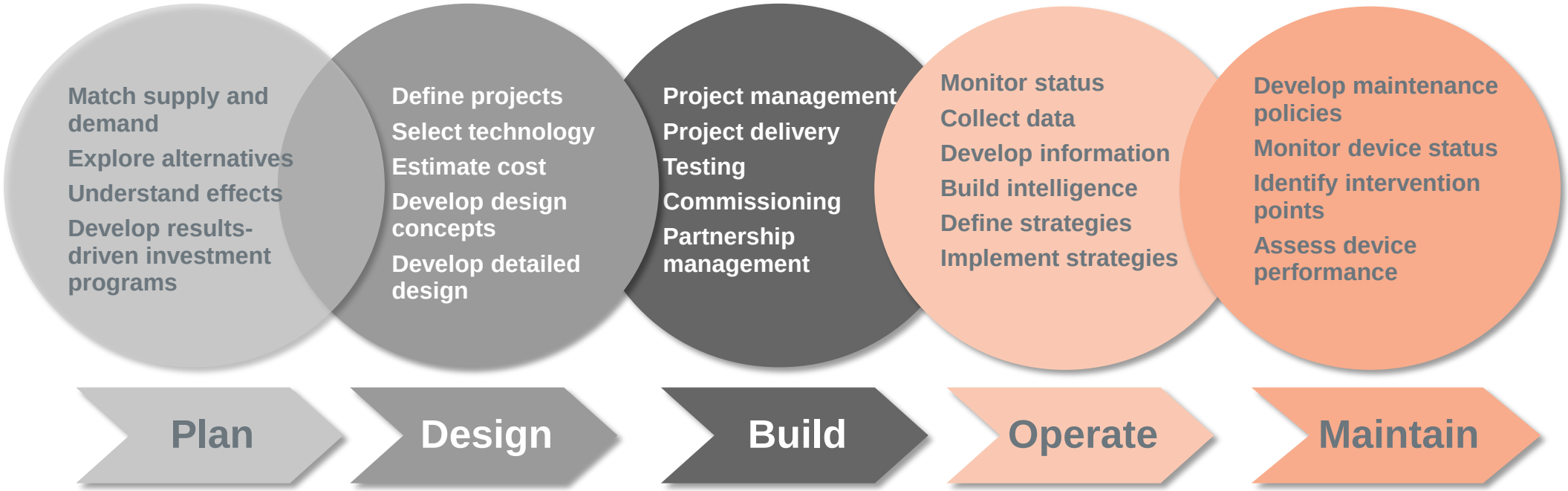
1. Transportation Spectrum of Actions



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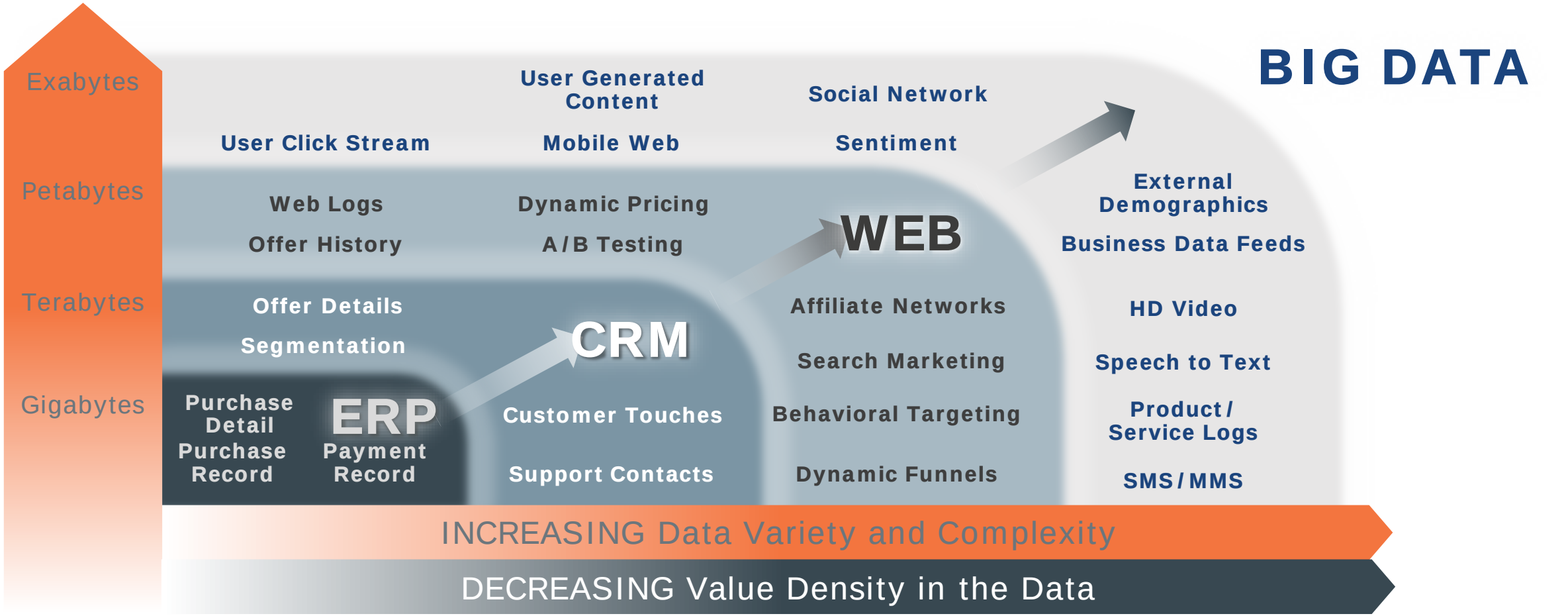
2. Big data



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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**
- **Environmental**

…questions that public service agencies have been addressing for years

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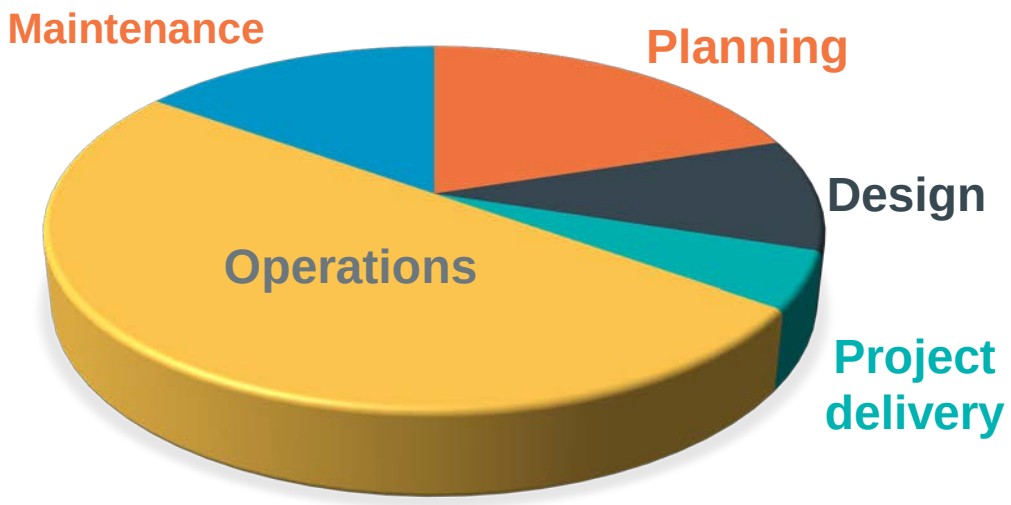
How big is big data?

- 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?

Big data in transportation

- Operations as a significant data generator
  - SANDAG
    - 1 TB per day
  - Connected vehicle
    - 2 ZB per annum

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



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3. Data Analytics gives business greater insight than ordinarily available in **traditional business intelligence (BI)…** techniques include machine learning, data mining, predictive analytics, location analytics, big data analytics, advanced visualization

Service	Analytics Example
Asset and maintenance management	Asset performance index, asset maintenance standards compliance measure, optimal intervention point analytic
	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 vehicle 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 satisfaction index, decision quality information index,

4. Data as glue for transportation

- 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

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

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	How smart data management supports a total system approach	Purpose	Connect	Status	Adapt
1	Avoiding the scramble to provide an answer on time and at the lowest cost	✓	✓	✓	
2	Justifying investments and other decisions by quantifying the results	✓	✓	✓	
3	Understanding your customer in sufficient detail to meet and anticipate their needs	✓	✓	✓	✓
4	Obtaining the maximum value from your data collection , acquisition, and data management efforts	✓	✓		✓
5	Being able to detect trends, patterns, threats and opportunities	✓	✓	✓	✓
6	Demonstrating superior management that maximizes synergy and minimizes conflict	✓	✓	✓	
7	Aligning the entire organization to a results driven focus	✓	✓	✓	✓
8	Delivering appropriate responses the trends patterns threats and opportunities	✓	✓	✓	✓
9	Aligning with regional transportation partners	✓	✓	✓	
10	Defining the ideal and identifying departures from it	✓			

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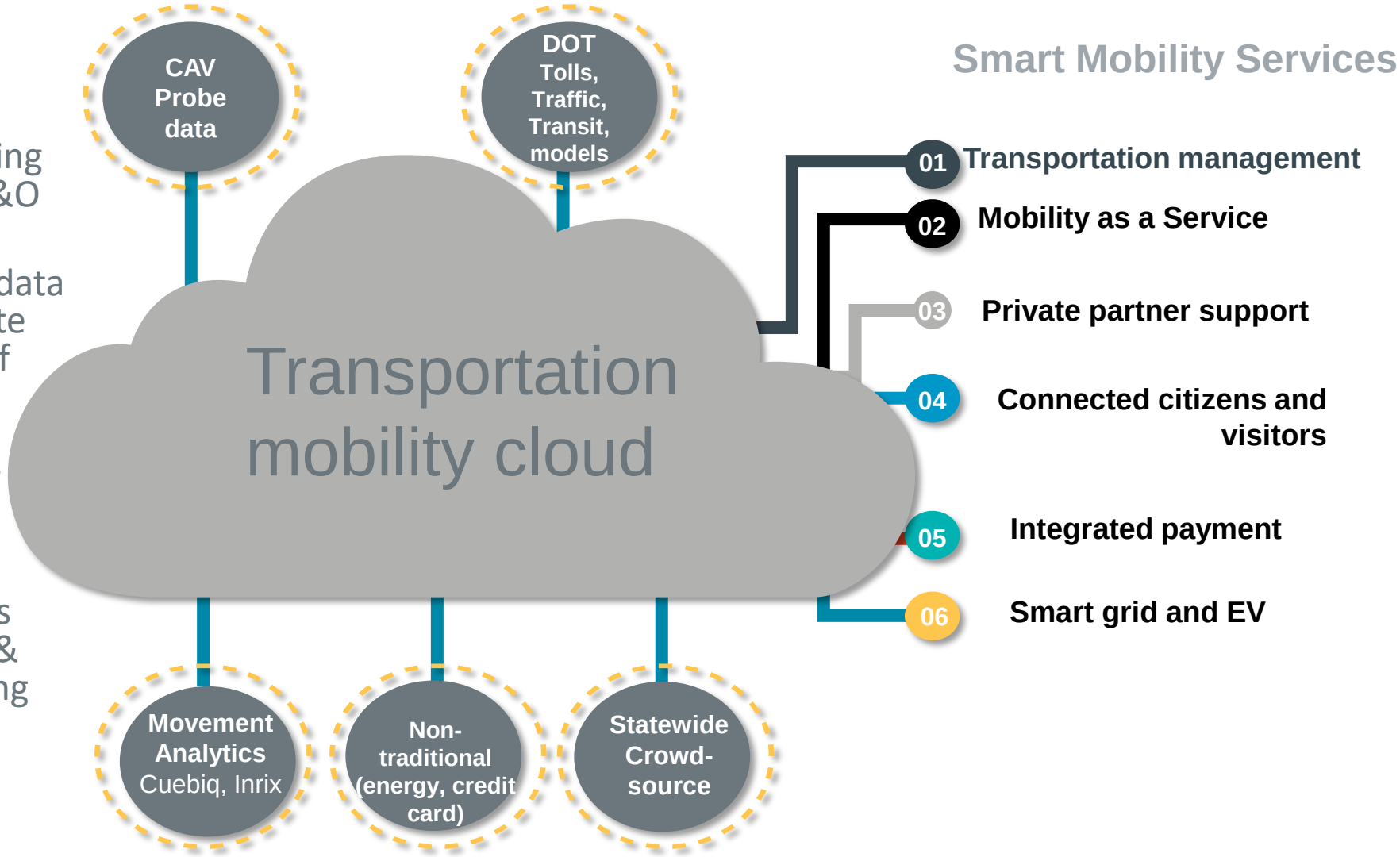
5. Smart Data Management

- Crucial tool in answering questions facing TSM&O
- Organized/accessible data will springboard private sector development of tools and services
- Data will be the “fuel” innovation
- Technology companies will apply knowledge & experience in managing smart city data



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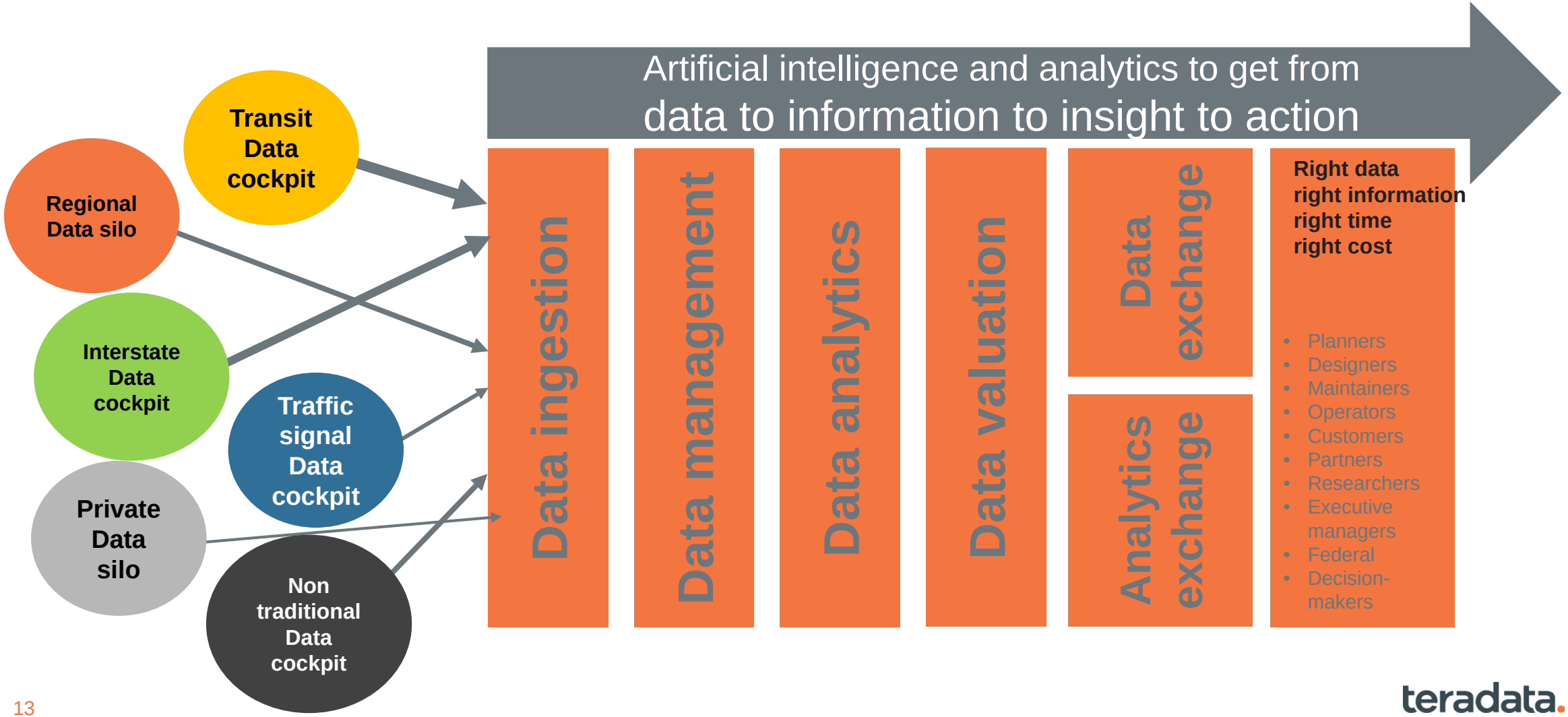
Smart data management



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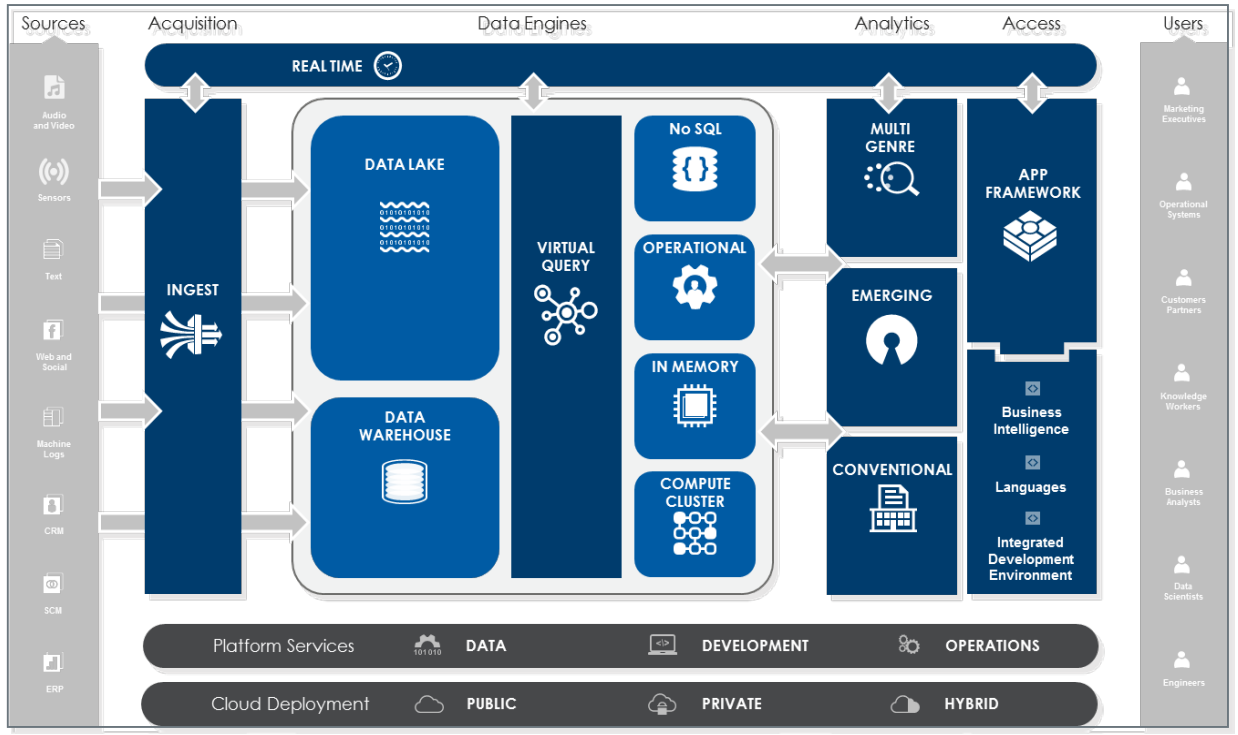
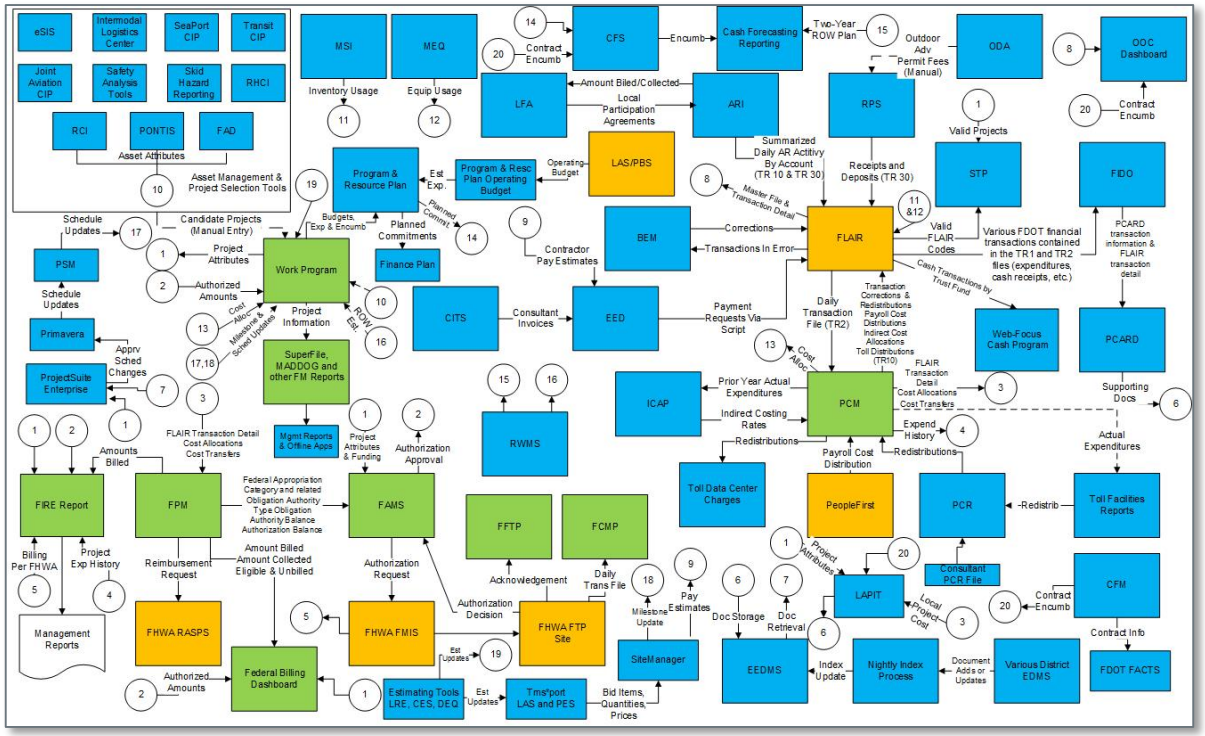
Smart Data Management



Not So Smart Data Management



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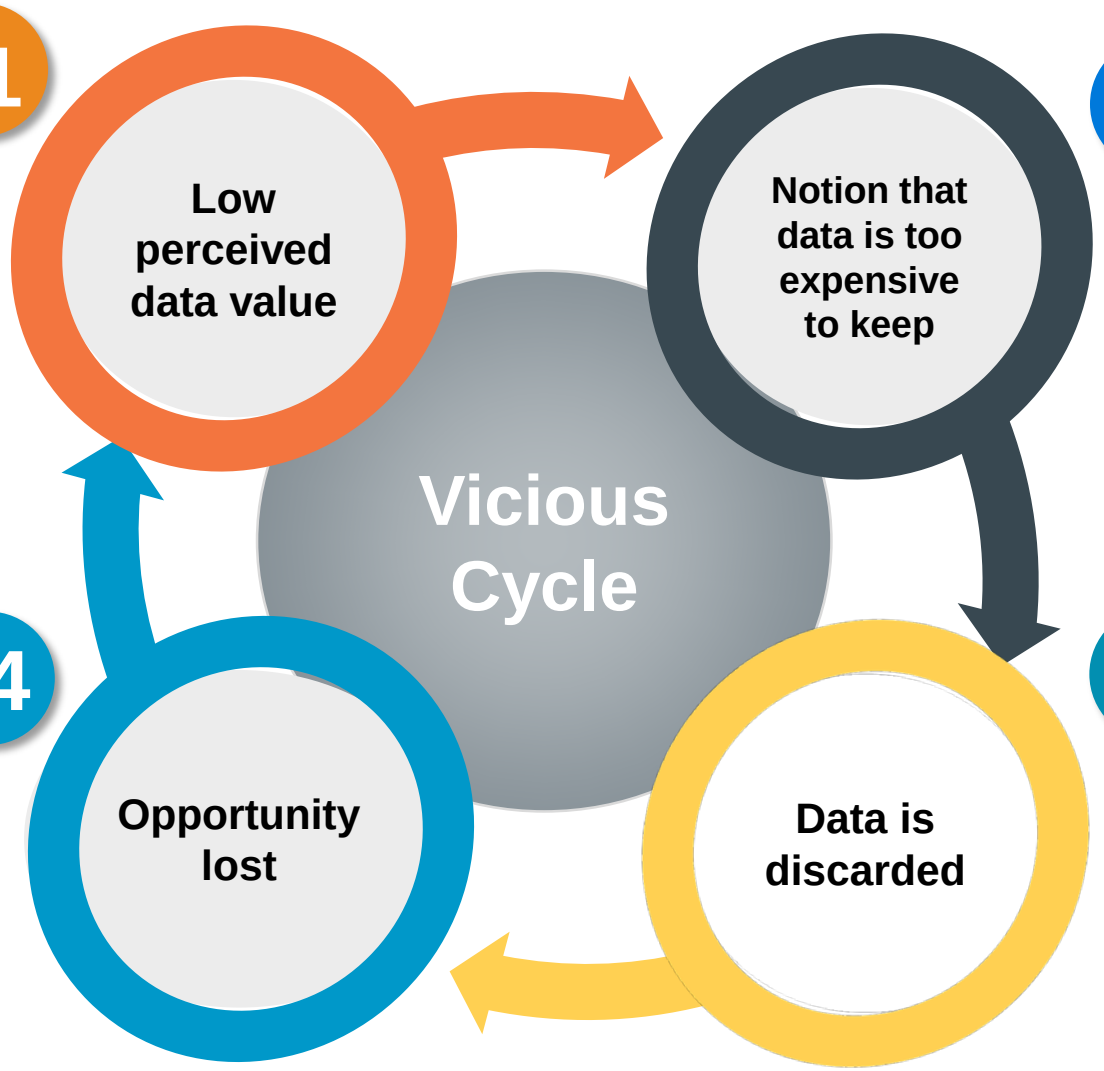
Need for an Early Winner



Data, as a raw material, is perceived to be of little or no value.

Benefit cost calculations with respect to data retention and management are distorted

The opportunity to convert data to information to insight to action is lost, no value is created or understood

Data is discarded because of incorrect assumptions on the value of data and the cost of data retention and management will what

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Getting What You Want from Data

- 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, but the right analytics can make you the coach with the ability to change the performance of the team

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TSM&O Use Cases

Transportation Operations Use Cases					
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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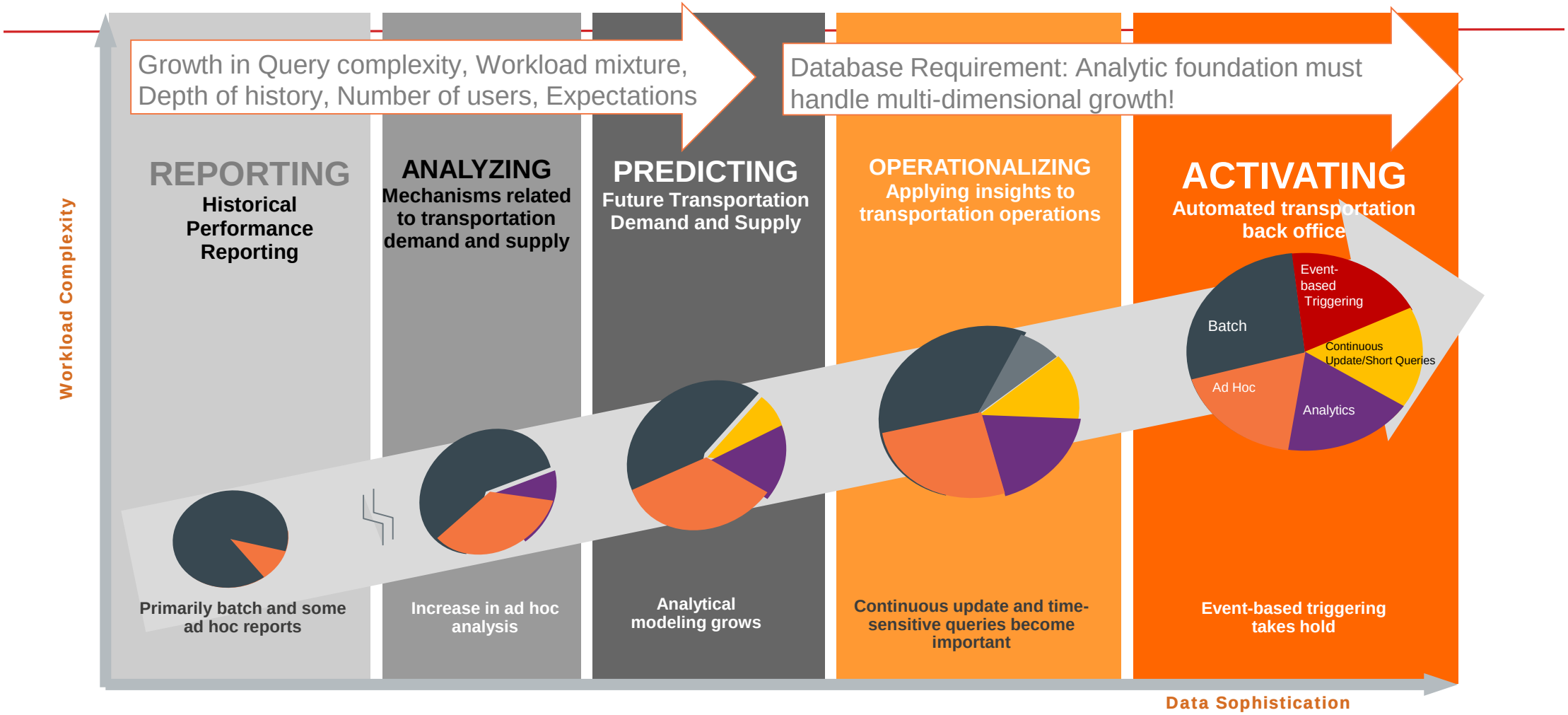
Towards Automation



Single View of Transportation – Better, Faster Decisions – Drive Safety, Efficiency, User Experience

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Thank you.

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