The role of Analytics in Smart Cities and Intelligent Transportation

April 25, 2017

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Teradata Portfolio

Business Solutions

Analytic Solutions

Analytics Business Consulting

Business Value Framework

Data Science

Technology Solutions

Public Cloud, Private Cloud, Managed Cloud, Hybrid Cloud, On-Premises

Teradata Database, Aster Analytics, Hadoop

Teradata QueryGrid, Presto, Listener, Unity, AppCenter

Architecture Expertise

Strategy and Roadmaps

Design and Implementation

Ecosystem Architecture

Managed Services

Teradata at a glance

- 35+ years of innovation and leadership
- ~1,400 + Customers in 77 Countries
- ~10,000 Employees including ~5,000 Consultants
- Market Cap: US $4 Billion+
- 130+ technology partners
- World's Most Ethical Companies – Ethisphere Institute
- Fortune: Top 10 US Software Company
- Gartner Magic Quadrant™ for Data Management Solutions for Analytics
- The Forrester Wave™: Big Data Hadoop-Optimized Systems In-Memory Database Platforms

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Teradata's Analytic Solutions

Leveraging Analytic IP for High Impact Business Outcomes

Innovation Analytics

- Rapid Analytic Consulting Engagement
- Business Value Framework
- Opportunity Identification

Proven Analytics

- Communications Compliance
- Analytics of Things
- Customer Satisfaction Index
- Anti-Fraud Analytics
- Digital / eCommerce Analytics
- Machine Learning & Deep Learning

Packaged Analytics

- Marketing Attribution
- Predictive Early Warning
- Analytic Calculator

Analytic Applications

- Customer Interaction Manager
- Real-Time Interaction Manager
- Demand Chain Management
- Teradata Analytics for SAP
- Master Data Management

Analytic Solutions

- Customer Journey
- Finance Foundation
- Industrial Intelligence

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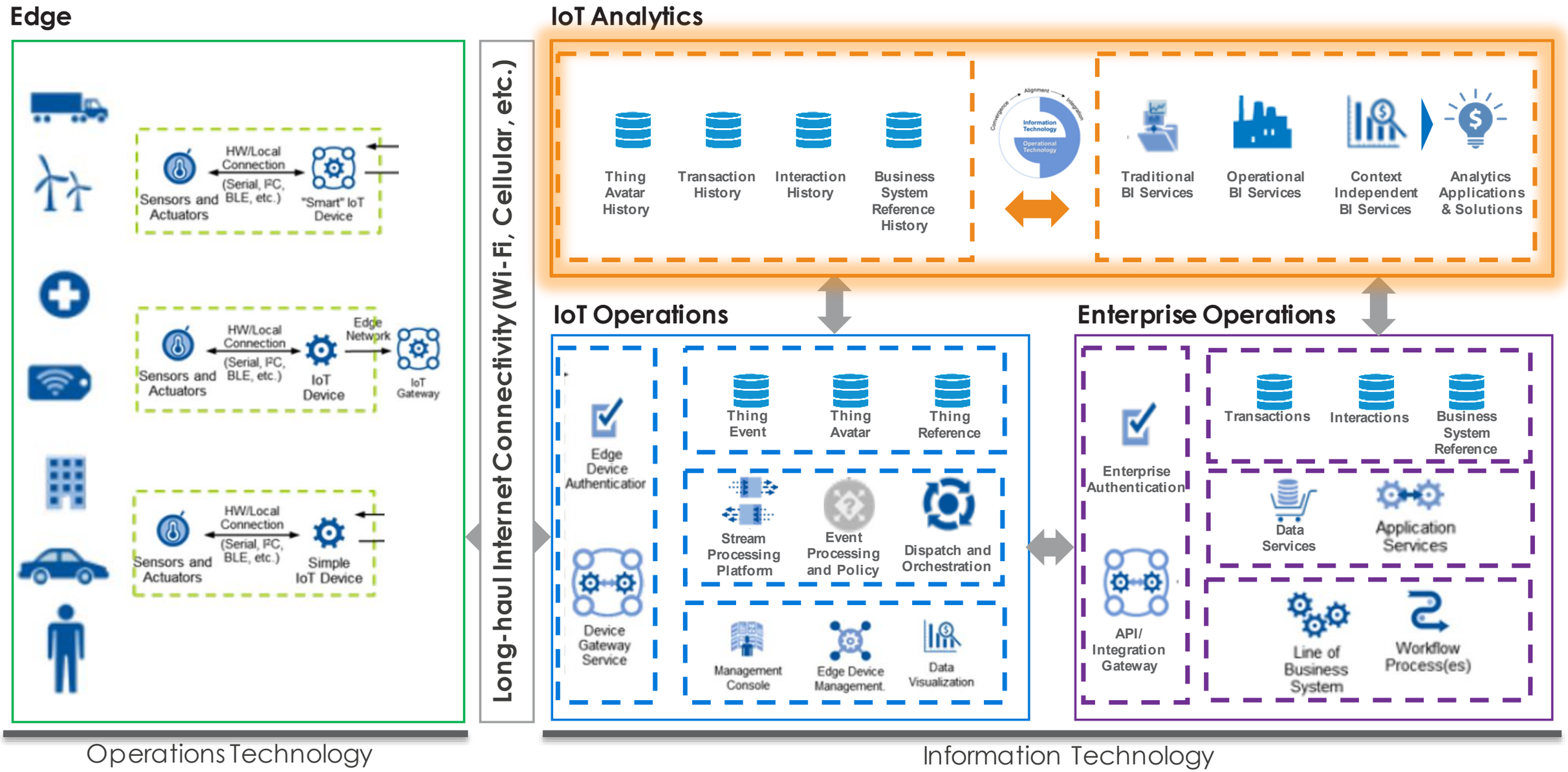
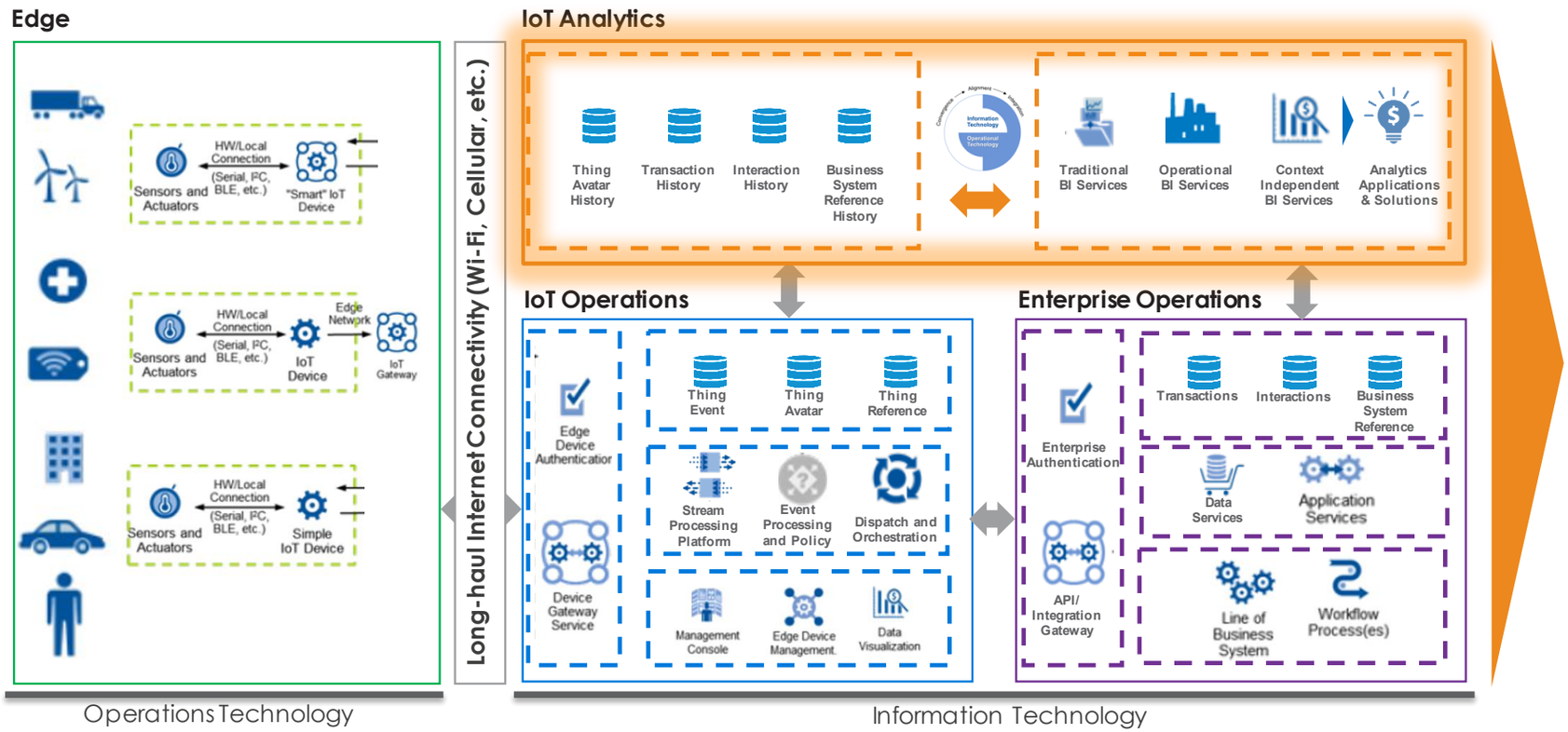
The Value for IoT can only be achieved through analytics



What is required to enable Analytics, through this IoT Architecture?



- Data level harmonization
- Modular, yet flexible
- Distinct Edge, Analytics, Operations functions

From "Logical Architecture for an IoT Solution" and "Assessing Integration Architecture for Internet of Things Solutions" Gartner Group: / Published March 2016

Teradata is in the **Analytics of Things** space

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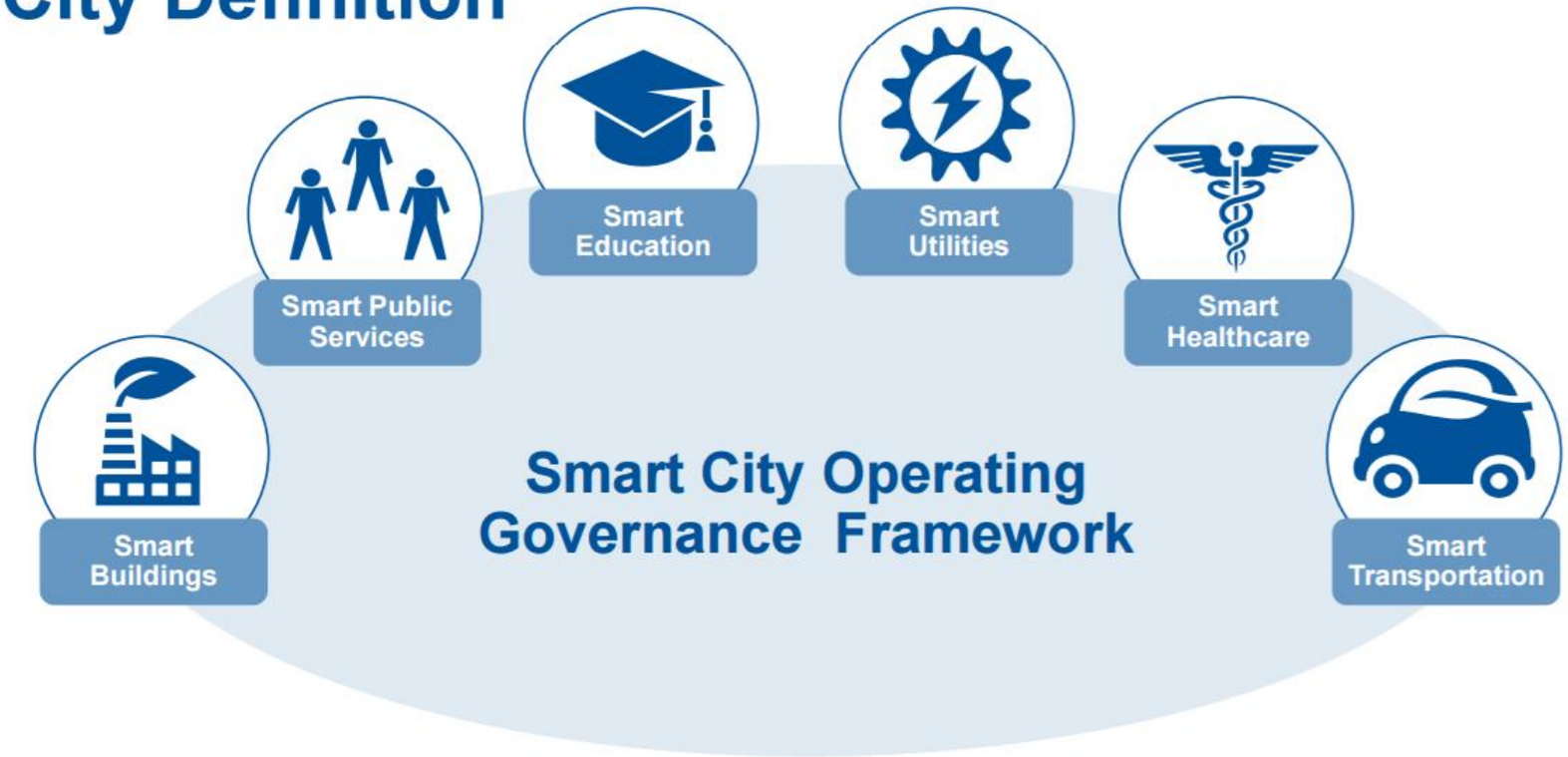
IoT and the Smart City

Smart City Definition



A Smart city is an urbanized area where **multiple public and private sector entities** cooperate to achieve sustainable outcomes through the analysis of **contextual real-time** information shared between multiple domains, especially sector-specific, and operational technology systems.

Gartner®

Internet of Things: the Foundation of the Digital Business, 2016

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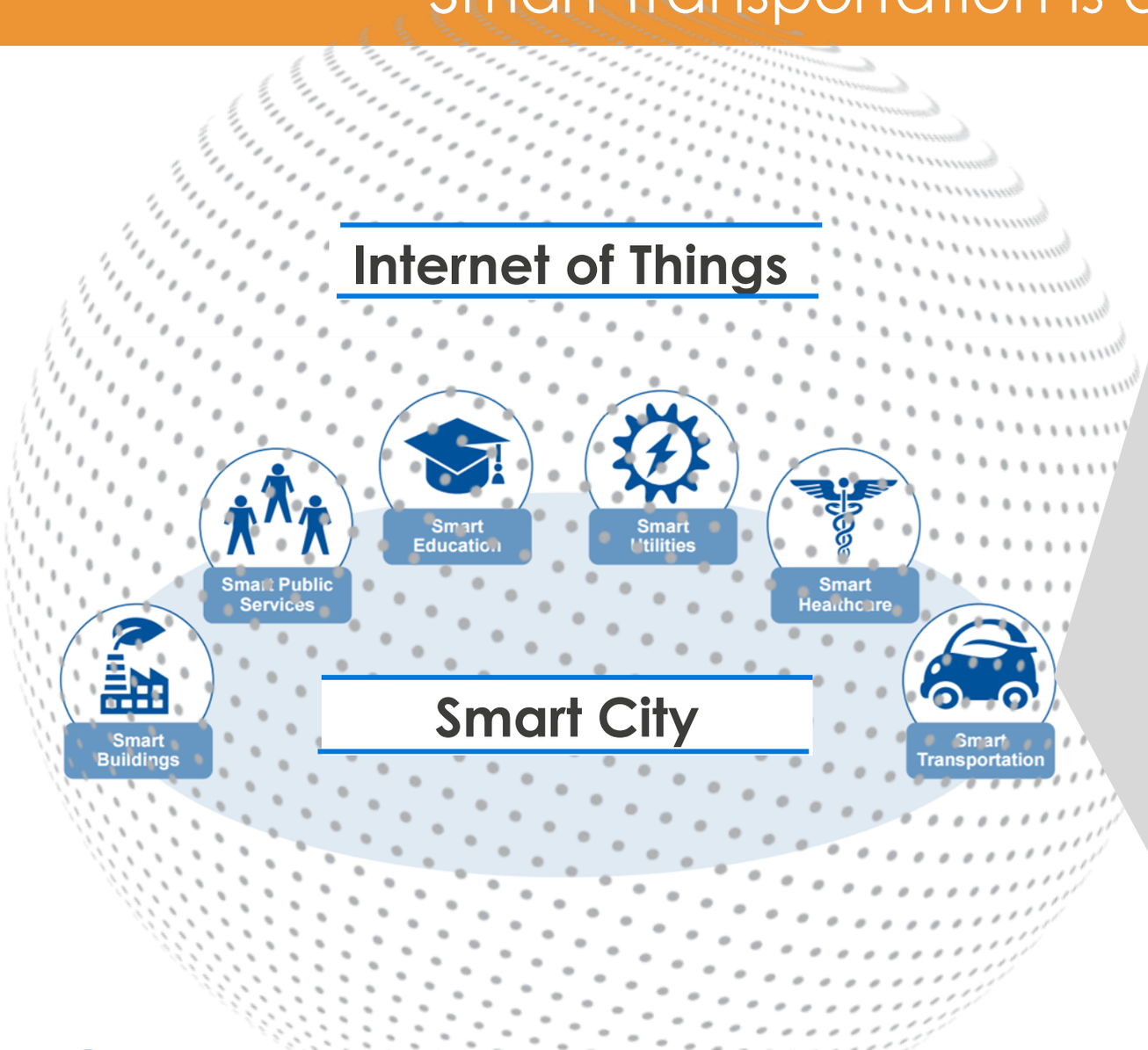
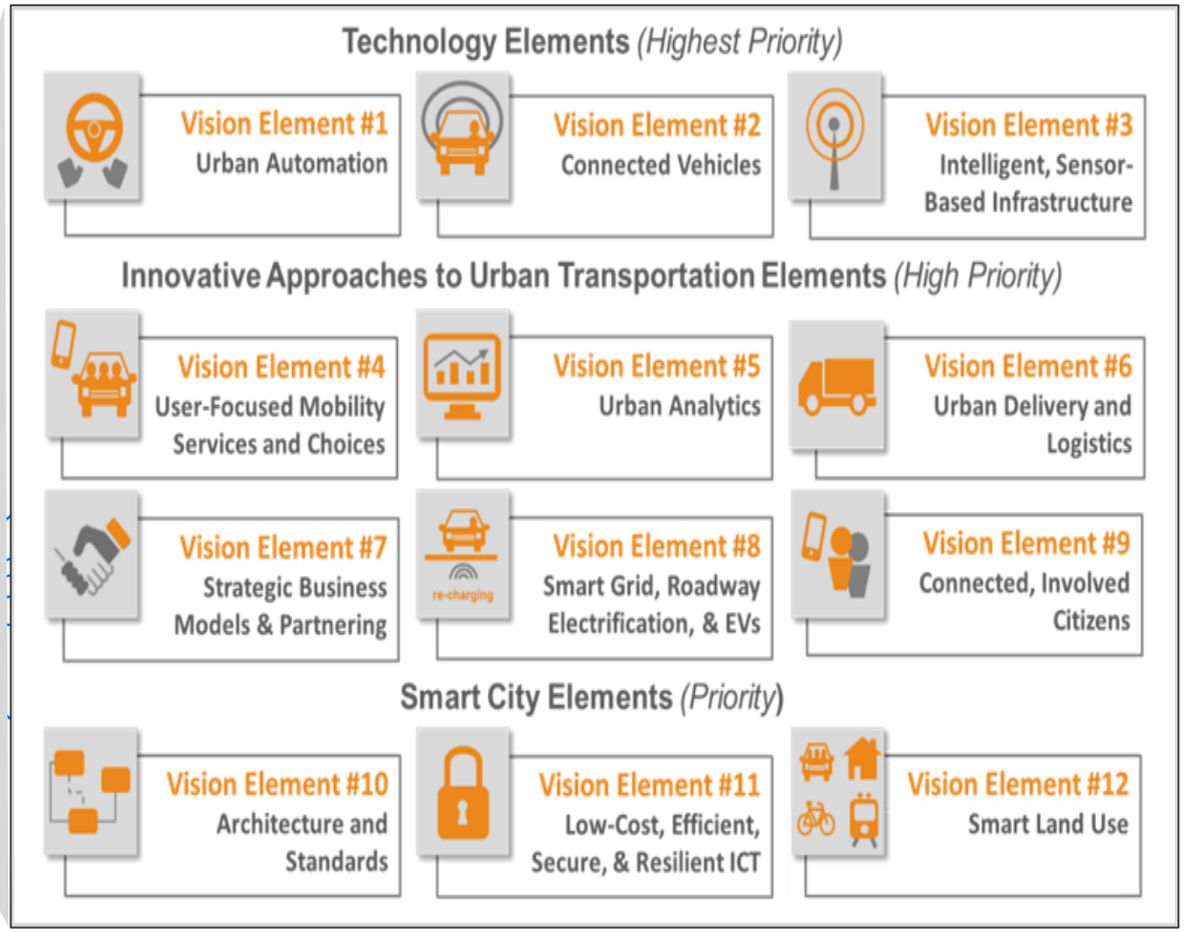
IoT and the Smart City

Smart Transportation is a primary focus for USA





Gartner *Internet of Things: the Foundation of the Digital Business, 2016*

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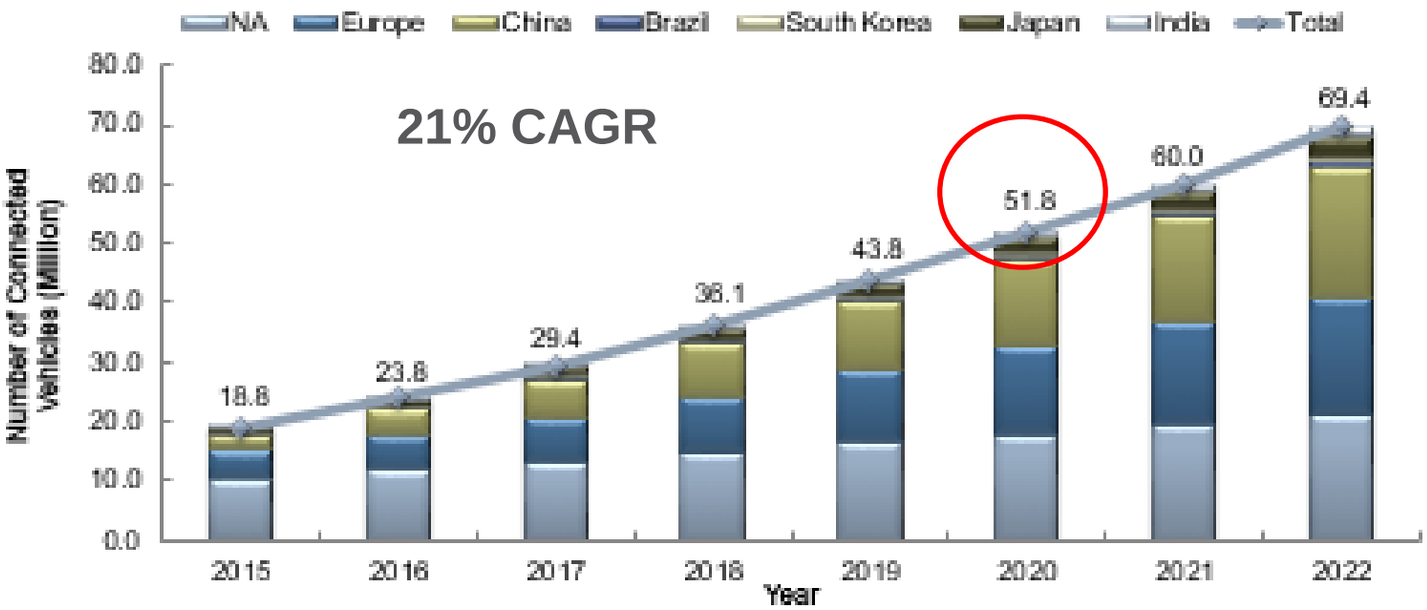
New, Disruptive Business Models and Regulations

Market Forces

- **Biz & User Models Changing:** Rise of ride & car sharing economy - Uber, Didi, Lyft, CAR2GO, Maven …
- **Competition:** EVs & next gen car architecture, billion dollar Chinese car startups
- **Regulations:** New NHTSA Automated Vehicle policy, proposed cybersecurity guidelines
- **Profitability:** OEMs have ongoing low operating margin: ~4-9% range
- **Growth Opportunities:** Connected Vehicles, Auto IOT, monetization of car data, mobility services, towards Highly Automated Vehicles

Global Connected Cars Forecast* 2015–2022



- **~52 M Connected Vehicle sales 2020**
- **2015, global vehicles sales 80M+, trillion dollar market**

*Source: Frost & Sullivan

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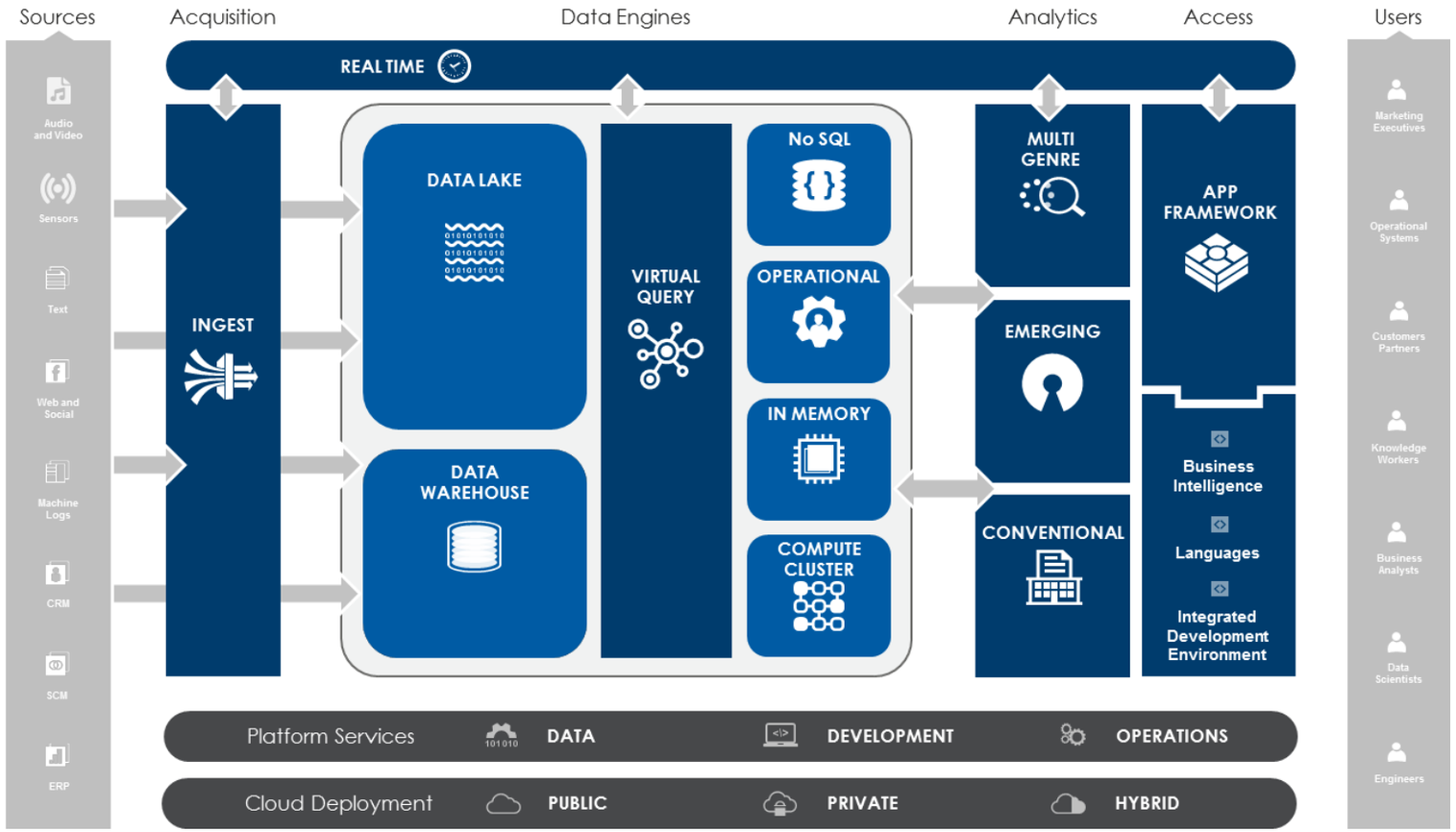
Reference Architecture for a Smart City Analytics Platform – Applied to any IoT domain

- Provide an **integrated software platform** to easily and rapidly build, deploy, manage, and operate data centric solutions across an ecosystem of data platforms
- Allow organization to leverage data platforms in a mixture of **on-premises and cloud** environments
- Provide **APIs and services** to easily integrate into a organization's existing data ecosystem
- Embrace, integrate and leverage **proven open source** software technologies
- Allow **choice** in implementing parts or components of the platform based on their use cases and needs



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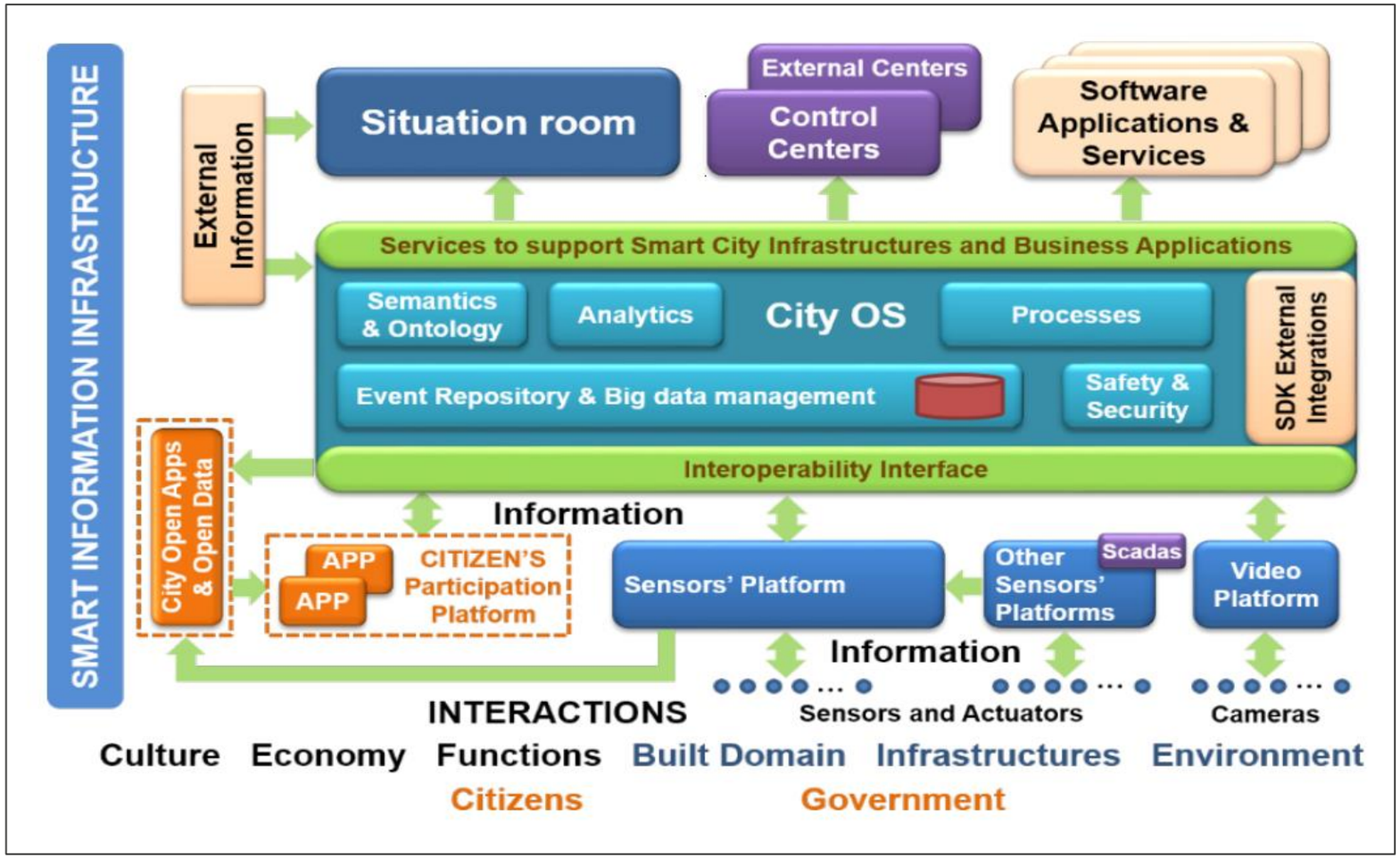
Data and analytics is the glue that holds the smart city elements together

Barcelona's smart city architecture

- Big data and analytics as central core
- Data sharing
- Analytics sharing

_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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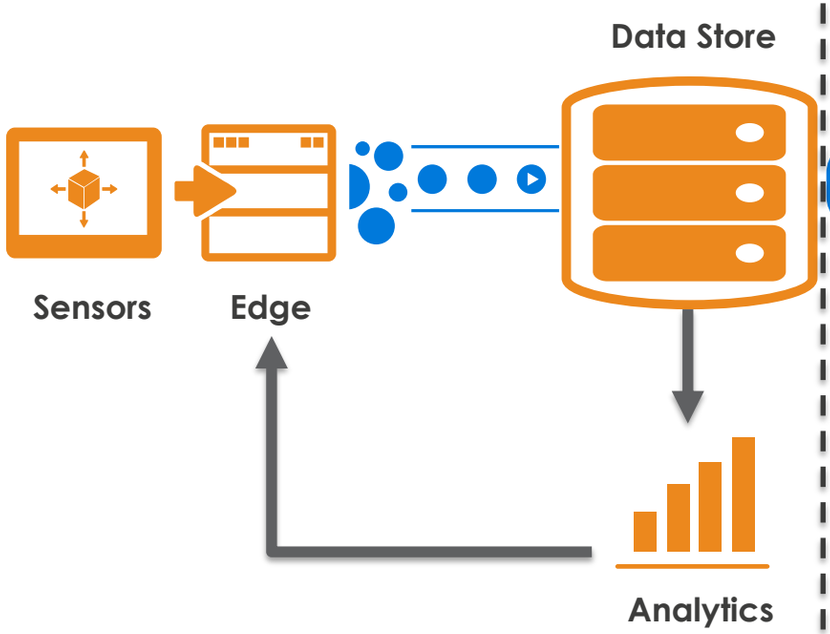
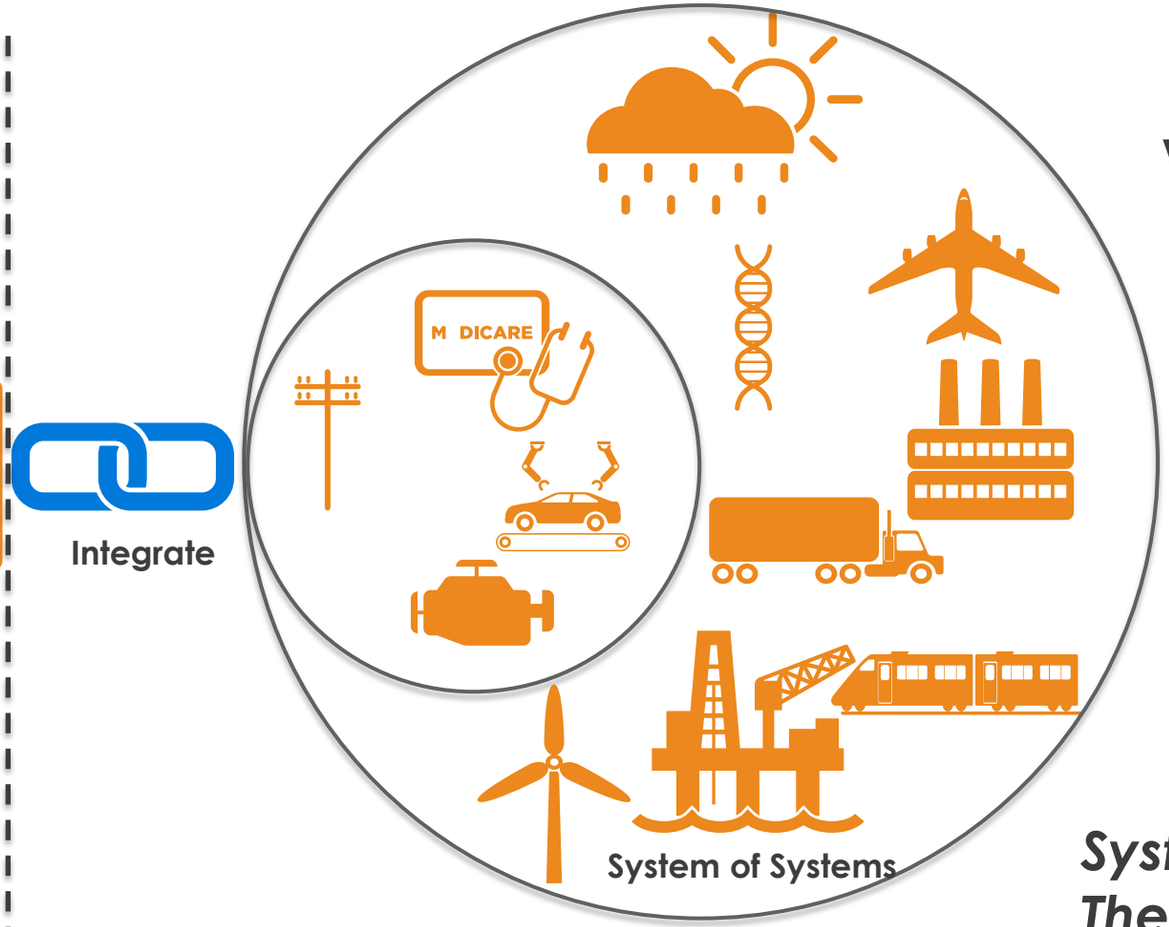
Too much focus is on the THINGS, not the ANALYTICS

INVESTMENT FOCUS





VALUE FOCUS

Systems Science or Theory

ACTING **THINKING** **OPTIMIZING**

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Infrastructure and data re-use yield more insight and value

Transportation "data silos" example

Transit Operations

- Trip patterns: boarding and alighting
- Route utilization
- Bus capacity versus demand

Parking Management

- Number of spaces, location
- Percentage utilization
- Revenue per space

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Infrastructure and data re-use yield more insight and value

Data re-use begins

Transit Operations + Parking Management

- What transit usage and parking utilization is correlation?
- Which transit routes (O&D) are most correlated with parking demand?

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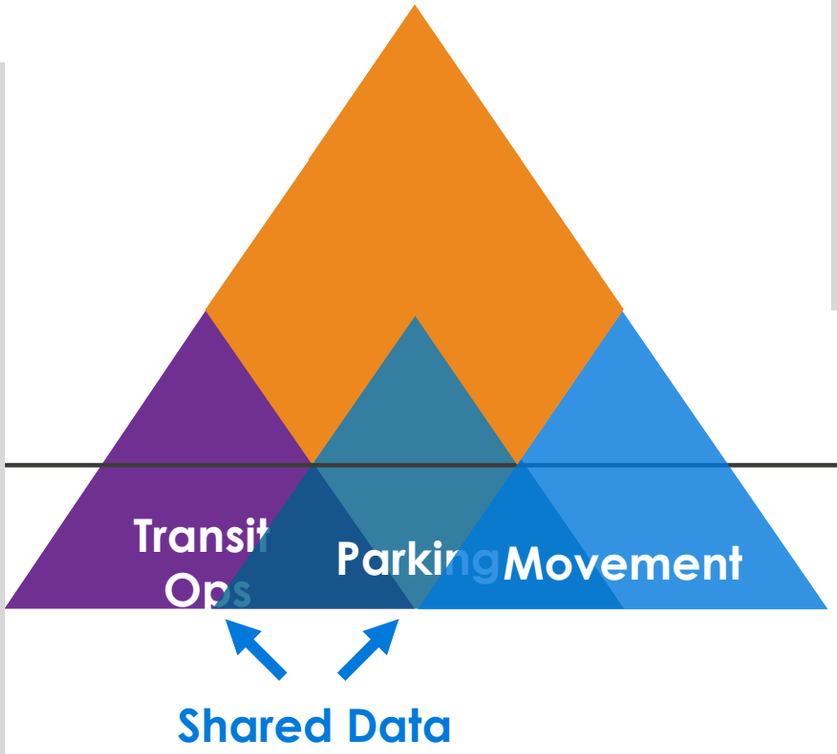
Infrastructure and data re-use yield more insight and value

Addition of new data for reuse:
= Integrated Movement Analytics

- Original origin, ultimate destination data for travelers
- Routes and modes utilized
- Trip times and trip time reliability
- Transit and parking use new data to assess demand for travel and optimize services and supply
- Both identify correlations between services and demand: boardings and parking demand



Shared Parking / Transit Ops / Movement data

- What is the real origin / real destination for transit travelers?
- What is the travel time/reliability for end-end trips, for those taking car/ parking/transit vs. car only?
- How could you adjust parking availability/pricing/transit routes accordingly?

Business Value

Development Cost

Note:

The advent of the self driving car could have a significant impact on the demand for parking

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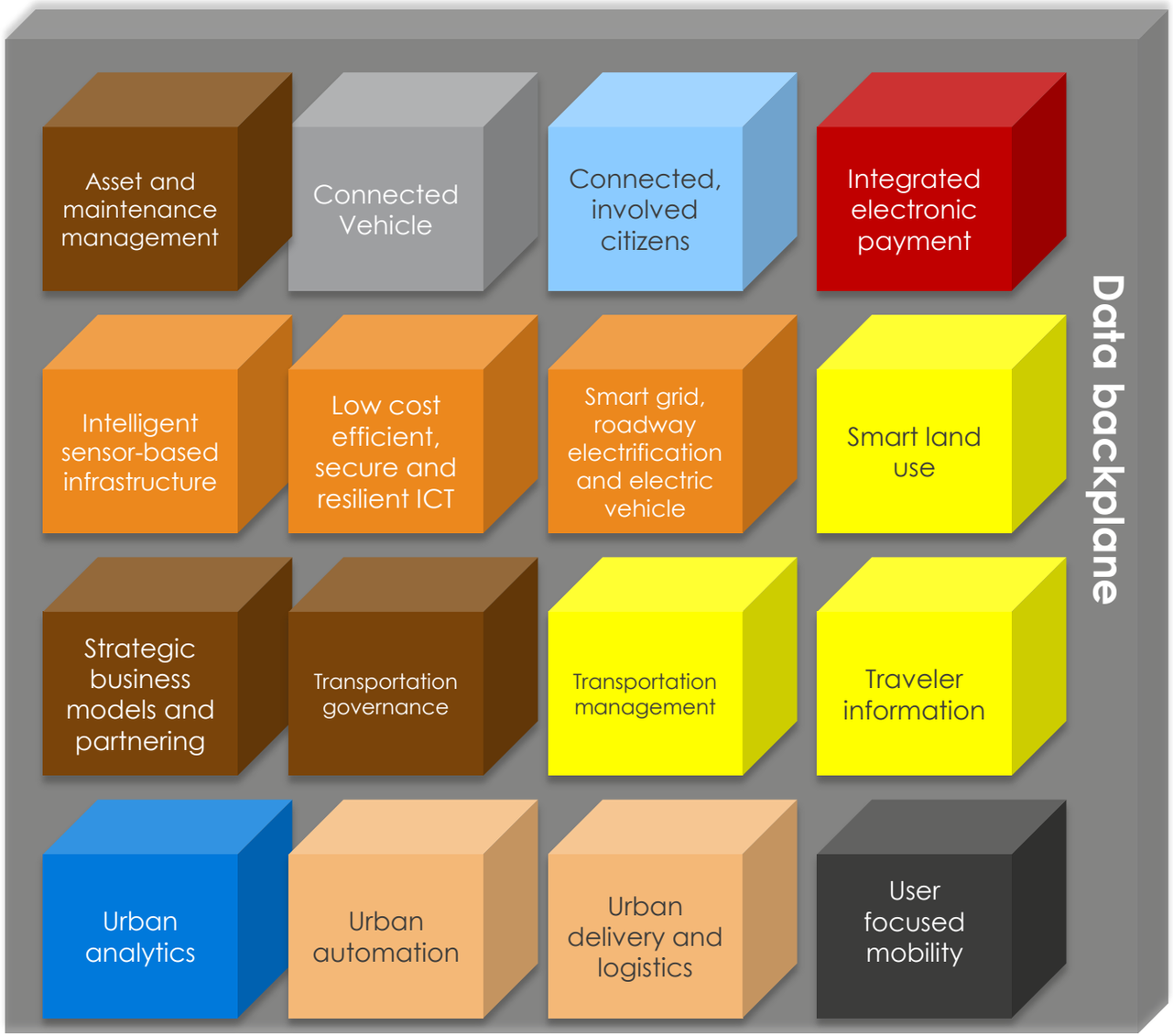
Optimization within and across systems



Semantic data model underpinning connections between solutions

- Data required
- Data sources
- Data flows
- Each block is optimized
- Connection between blocks are defined for interoperability and optimized

Data is the connective tissue for analytics

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How **Planning** aligns with **Action** in Analytics of Things

Modeling / Analytics	…answers Business Questions	…enables Data-Driven Actions
What is the real origin / real destination for transit travelers?	Do we have the right resources allocated to needs of different origins and/or destinations?	Make adjustments to bus routes and/or schedules
What is the travel time/reliability for end-end trips, for those taking car/ parking/transit vs. car only	What is the impact of the following items in affecting transit modal share choice? • Can we improve parking availability? • Can we impact transit travel time problem (what if you miss your desired train?) • Can we solve a first mile problem (reliability issues in drive time to parking lot)?	Take action on highest impact obstacles to modal share (e.g. adjustments to transit pickup and drop-off locations; improve first mile access solutions)
What is the cost, in time and money, (and possibly other intangible factors) of car vs transit?	How could I create a multi-modal park/transit pricing model that would compete with car?	One stop payment system that combines parking and transit use with incentives for regular usage
How could you adjust parking availability/pricing/ transit routes/schedules to keep growing transit modal share?	What should be continuously monitored for short term tuning to achieve improved transit share outcomes?	Real time parking assignment / availability, and/or real time added transit frequency based on demand/crowding, etc.

Projects and examples

Relevant Use Cases

Public Safety
Integrated data for police and law enforcement

Highway Safety
Root causes of vehicle related safety issues

Pedestrian Safety Root causes of safety issues involving pedestrians

Connected vehicle
Vehicle-to-vehicle & to infrastructure connectivity benefits

Performance Management
Metrics, understand patterns & outcomes

Asset Management & Maintenance
State of Good Repair and Cost vs Quality

Scientific, Results-Driven Investment
Analytically informed, network level decision-making

P3 Concessionnaire
Return on Toll roads Investments & performance mgmt

Parking
Demand, revenue management and fee optimization

Transportation Effectiveness
Planning, design, delivery & operations

O&D Demand
Traffic volumes and timings; trip patterns & demographics

Evacuation/Special Events Planning
Single & multi-modal trip timings; route event info.

User Experience
O&D reliability, modal choice impacts & sentiments

Public Transit Management
Service effectiveness, last mile connectivity

Toll Roads & Customer Mgmt
Demand trade-offs on time & reliability vs toll costs

Integrated Corridor Management
Performance by mode; land-use impacts

Freight Plng & Ops
Network viability and access to trade markets

Citizen Sentiments
Aggregation of internal & external data

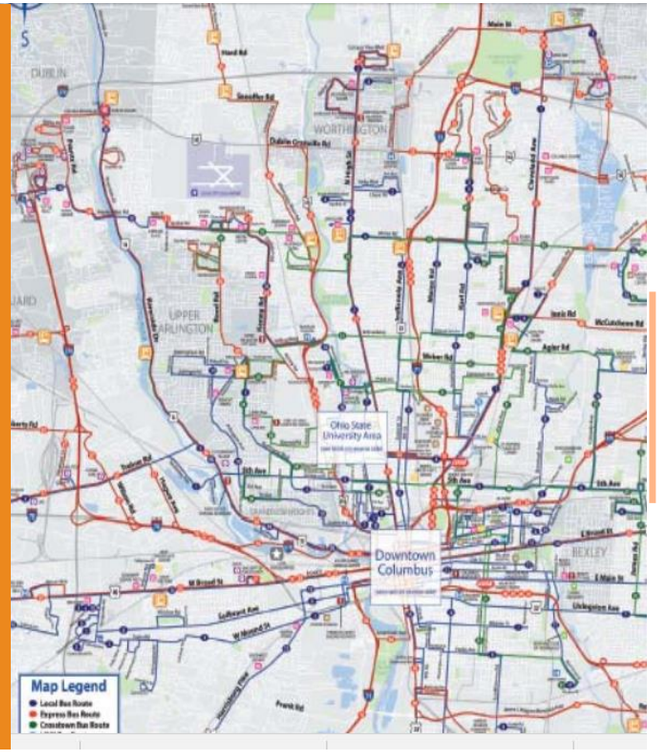
Speed Variability
Statewide, by minute, by road segment speed variability analysis

Bottleneck Analytics
Defining & measuring impact/presence of bottlenecks

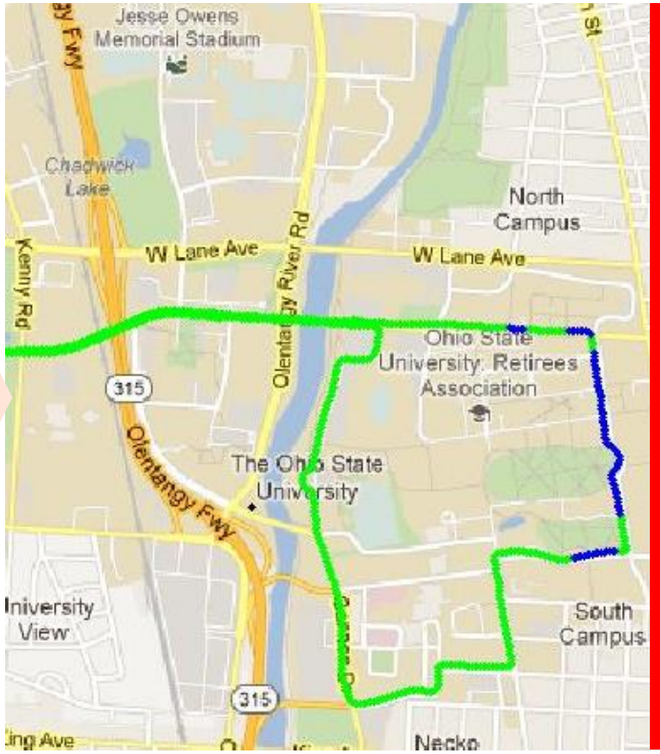
Example: Columbus and Ohio State University

Central Ohio Transit (COTA):

- 15m rides annually
- 234 buses
- 4,214 stops
- 1,310 transfer stops
- 380 bus shelters
- 24 park & rides
- > 1m info calls
- 67 routes; % traffic:
  - 87% on 19 Local Routes
  - 4% on 40 Express Routes
  - 9% on 8 Crosstown Routes



OSU Transportation & Traffic Mgmt:



- 5m rides annually
- 30 buses
- 30 route miles
- 21,000 paratransit rides
- 696 rentals
- 285 vehicles on alternative fuels
- 84,000 vehicles controlled daily
- 894 mtce svcs
- 115 shared bikes @ 17 bike stns

OSU campus is microcosm of a larger city - an ideal test-bed to demonstrate, visualize, experiment and learn on relevant use cases

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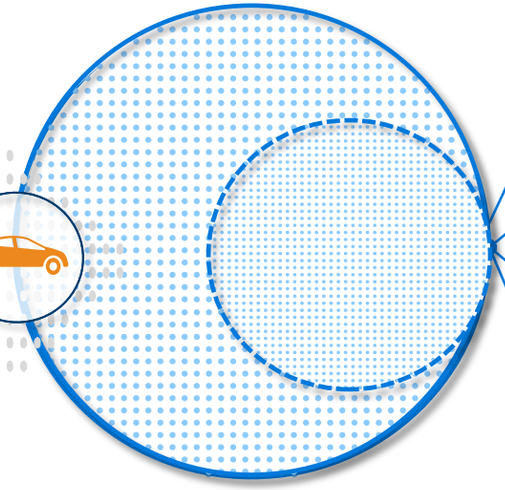
Demonstration Project: Transportation demand and movement analytics

Heterogeneous SOURCES

- CCTN
- EV Infrastructure
- Smart Columbus project results
- **People movement & trips**
- **Mobility network & modal performance**
- Columbus demographics & Human Services
- Deployment zones reference data
- User generated content (apps)



Huge Data Volume

Capture-refine-archive

Data virtualization

Analytic & Exchange USES

Research, deep queries

- How to "break through" on safety improvement,
- Impact of autonomous and EV on electric grid

Urban analytics, rich in demographics/context

- Citizen & visitor trip O&D, mode choice/purposes
- Neighborhood access to jobs/services challenges

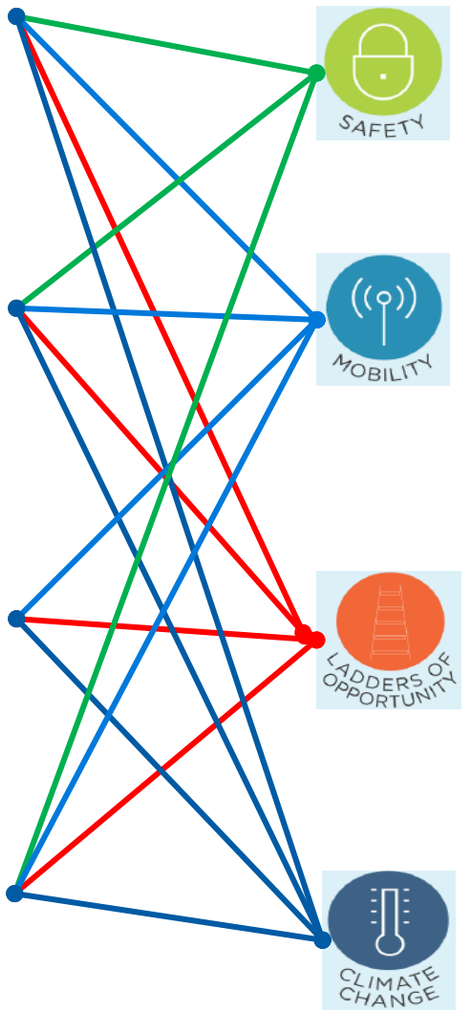
Smart Columbus project evaluations

- Effect of transit hubs & travel time improvements
- Freight flows and logistics improvements

"Smart App" development

- Payment cards & kiosks
- Travel time & traffic data
- Parking &event management

OUTCOMES



The vision of a Sentient City

- Multi-domain system of systems
- Connected, integrated data
- “Data Listening” across all “things
- Shared analytics platform
- Data science and analytics
- Capability to optimize across and within domains
- Coordinated sense and response


THANK YOU
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