UNITED STATES
DEPARTMENT OF TRANSPORTATION

ITS ePrimer
Module 4: ITS Data in Decision Making

ITS Professional Capacity Building Program
ITS Joint Program Office
U.S. Department of Transportation

United States Department of Transportation
Office of the Assistant Secretary for Research and Technology
Intelligent Transportation Systems Joint Program Office

INTELLIGENT TRANSPORTATION SYSTEMS
PROFESSIONAL CAPACITY BUILDING

Instructor

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Transportation Systems

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Learning Objectives

A. **Learn through examples – data-informed decision making.**

B. **Identify sources, content, and differences among ITS and newer data.**

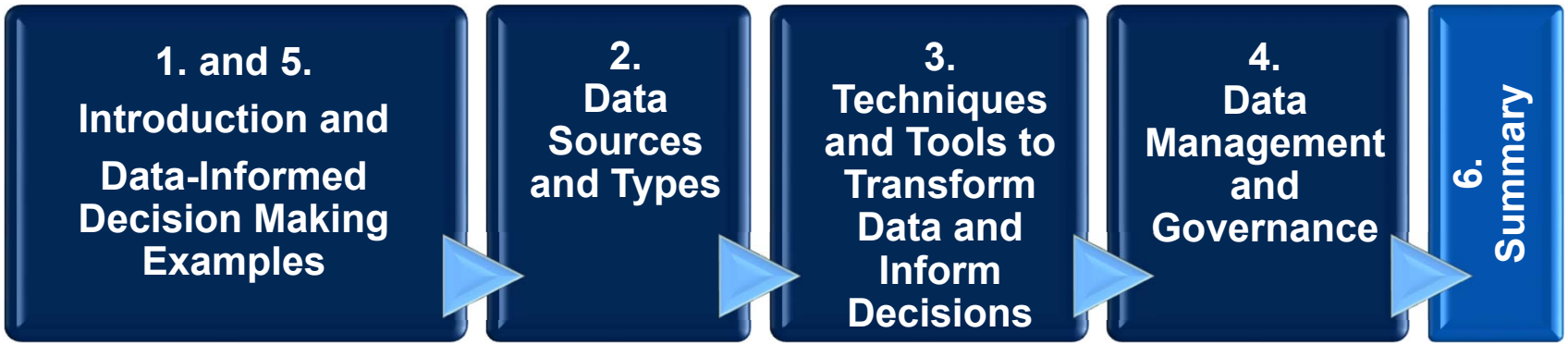
C. **Understand the role of performance management and analytics in bridging the data to decision making divide.**

D. **Recognize the difference between traditional and modern management, and how the latter better supports improved decision making.**

Presentation versus Module Organization

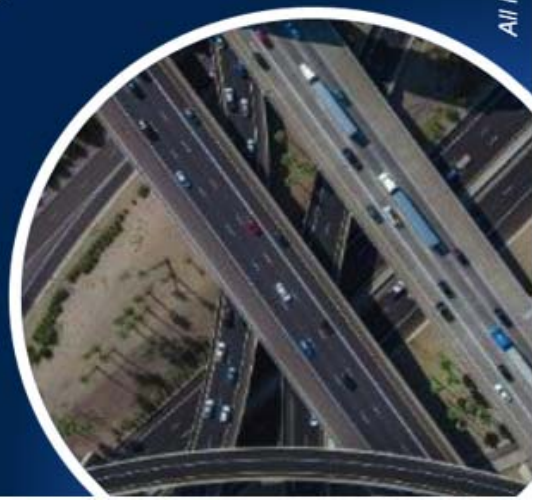
Module 4 Report: ITS Data in Decision Making

This Presentation Begins with Examples



Data-Informed
Decision Making

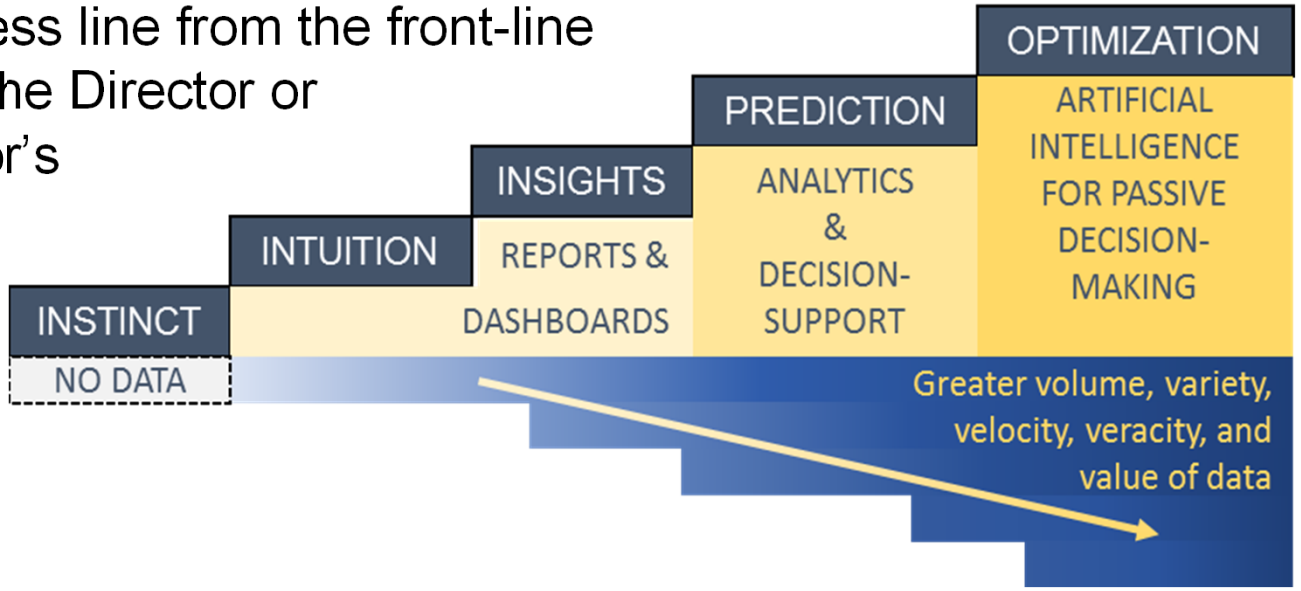
What does it mean?



All images source: Pixabay.com

Why Data-Informed Decision Making?

- Using the right data to make decisions more **quickly, simply, consistently, transparently, proactively, and more optimally** to efficiently deliver on the agency's mission, goals, and objectives.
- Relevant to every level of an organization and every business line from the front-line operator to the Director or Administrator's office.



Source: Shah et al., 2019

Decision Making: Front Line

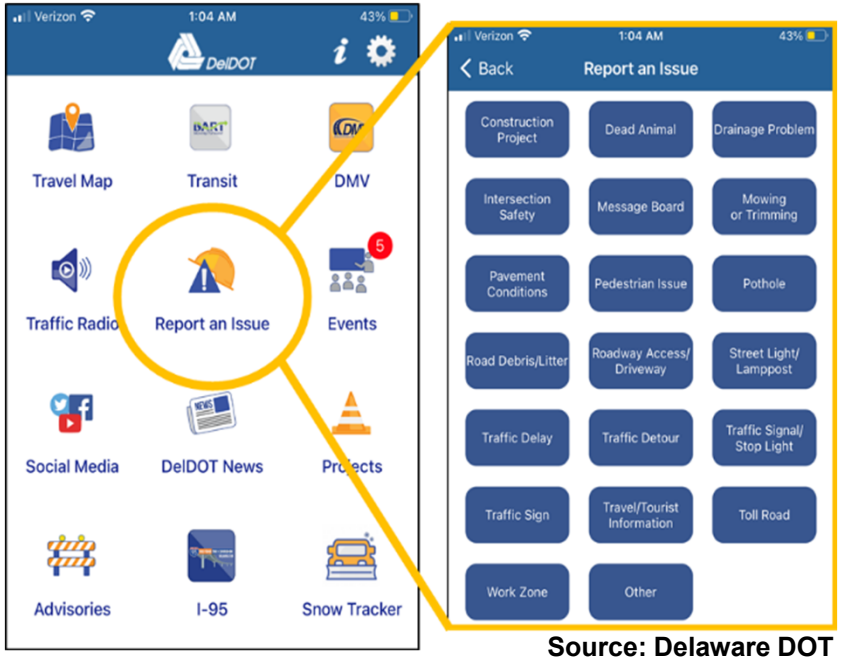
Queue monitoring by off-duty law enforcement officer at a work zone using the Delta Speed tool

-Indiana DOT

Source: Indiana DOT

Better maintenance priorities using crowdsourced data from 511 app and Waze

-Delaware DOT



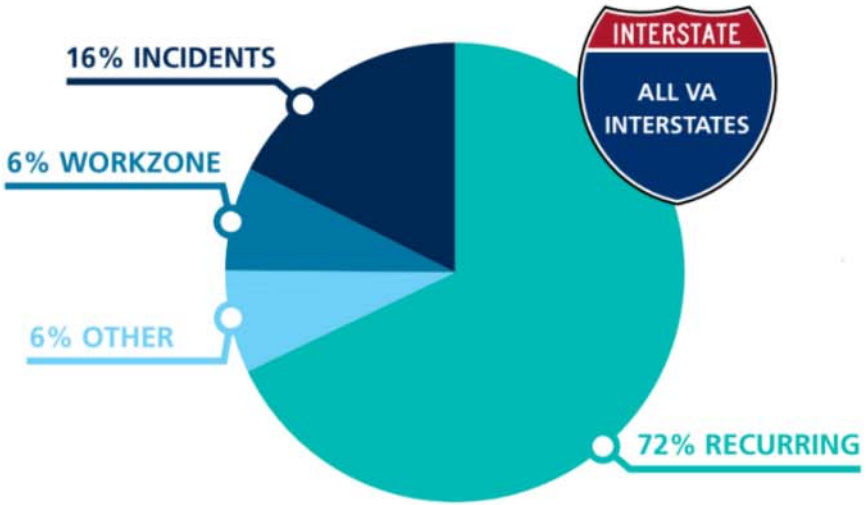
Source: Delaware DOT

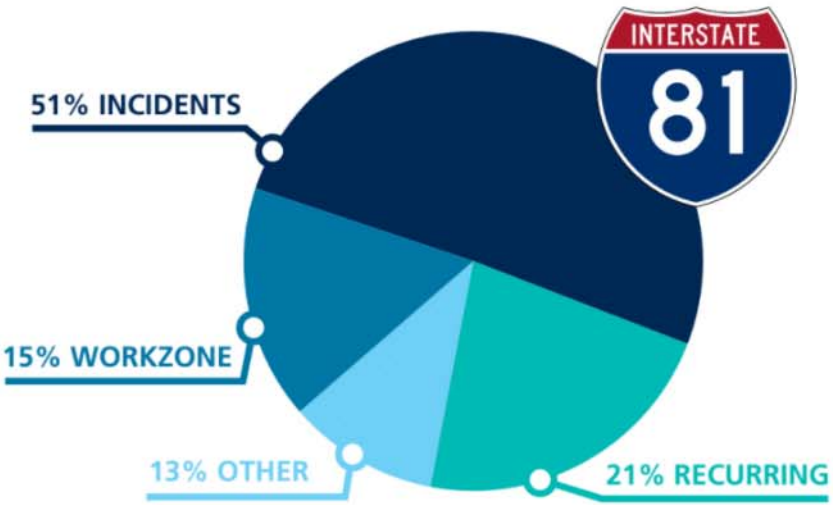
Decision Making: Program/Project Level

VDOT Mission: "Enable easy movement of people and goods"

I-81 Corridor: Highest truck volume and highly unreliable travel times
51% of the delay was caused by incidents

Decision: ***Invest in Traffic Incident Management Program***





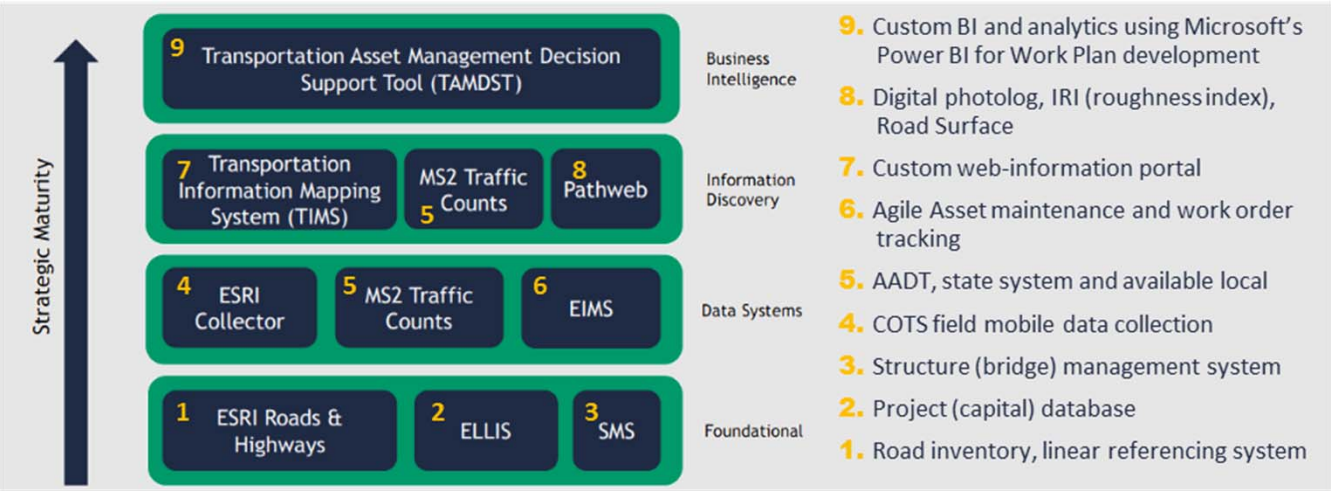
Source: Virginia DOT

Decision Making: Enterprise Level

Ohio DOT strategically redesigned their asset management process in year 2017. Estimated $400M savings over 6 years by:

- Considering lifecycle costs
- Emphasizing pavement preservation treatments
- Collaborative and consistent decision-making procedures

Ohio DOT invested in accessible data and decision support tools.



Source: Ohio DOT

Sources, Types, Differences

Among ITS and Newer Data

Source: Pixabay.com

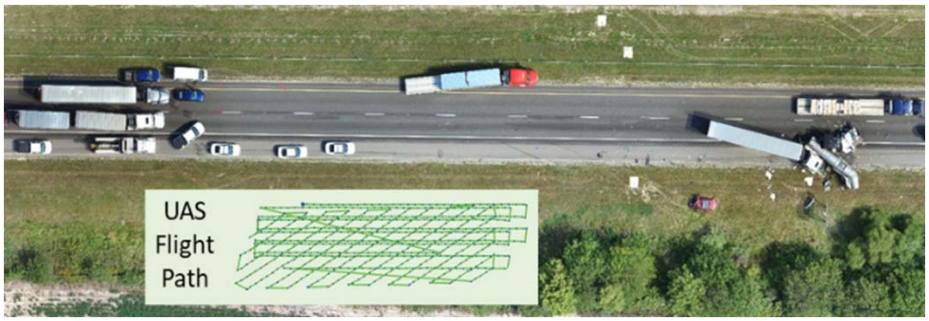
Data is Expanding

- Traditional and newer ITS infrastructure-based data
- Traffic operations data
- Transportation-adjacent data
- **Emerging technology data**
- **Crowdsourced data**

Ownership, cost, management, quality/consistency, structure, sensitivity, timeliness, analytics needs, and other factors at play.

Emerging Technology Data

- The availability of **low-cost communications and sensors** offers new opportunities from the following:
  - Transportation network companies (TNC) and micromobility
  - Connected vehicle, traveler, and infrastructure
  - Internet of everything (IoE)
  - Unmanned aircraft systems
- **These data differ from traditional data** in volume, variety, velocity, management, processing, granularity, security, veracity, and more.
- **Technology is shifting data** from infrequent, small-samples to routine, frequent population reflective data.

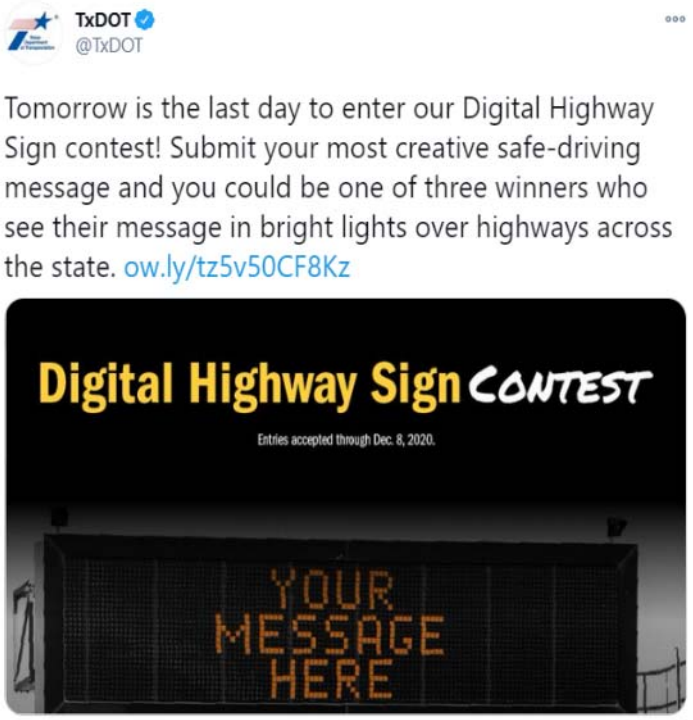


Source: Tippecanoe Sherriff

Crowdsourced Data

"Crowdsourcing is the practice of **addressing a need** or problem by enlisting the services of a **large number of people** via **technologies**."

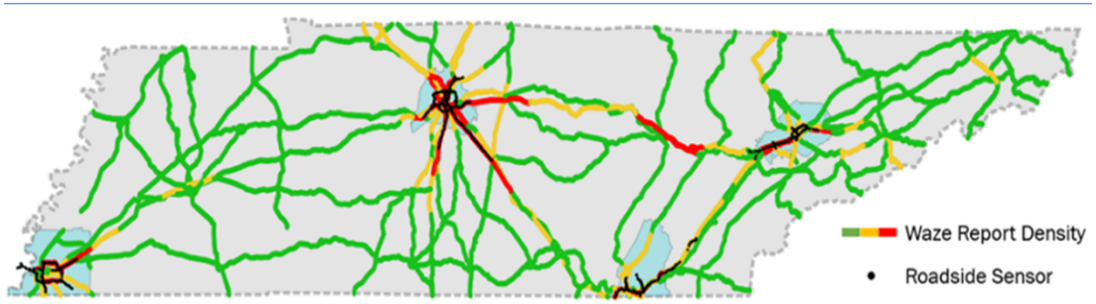
– *FHWA EDC-5 Crowdsourcing Orientation Webinar, Sep 2018*



Source: Texas DOT

Includes data from:

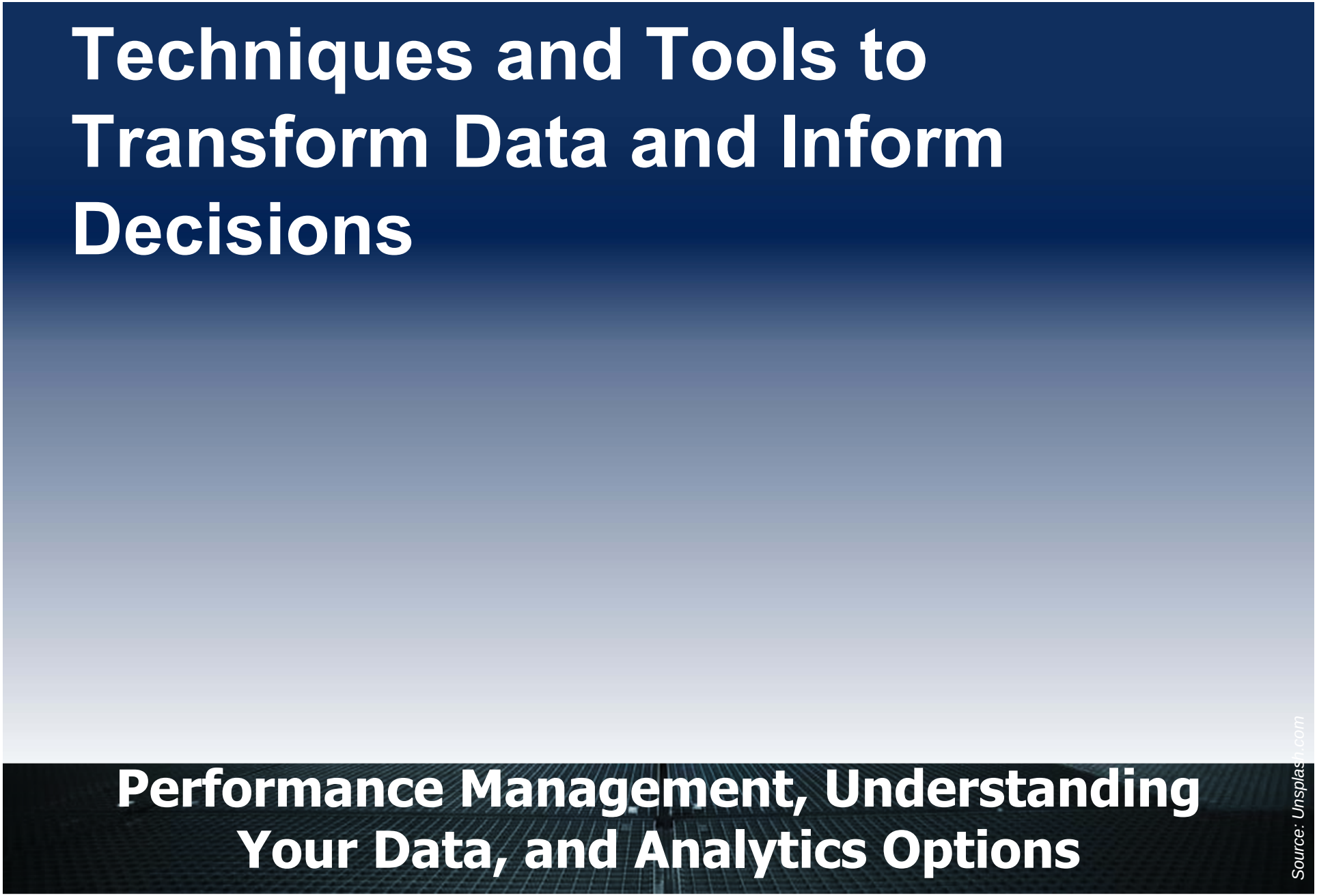
- Vehicle probes
- Mobile apps
- Social media
- Connected vehicle
- Public engagement



Source: Tennessee Department of Transportation

Techniques and Tools to Transform Data and Inform Decisions

Performance Management, Understanding Your Data, and Analytics Options



Source: Unsplash.com

Performance Management

Provides a framework to:

- Set realistic performance goals
- Focus on the most important challenges
- Improve efficiency

The framework should map mission to goals, objectives, performance measures, and targets.

Without this framework, agencies can become overwhelmed with data, complex analytics, and too many performance measures, some even conflicting.

Fundamentals: Understanding Your Data

Data quality is a measure of the degree to which **data meets the purpose of intended use** by systems, processes, and people.

Agencies must remain vigilant across every facet of data quality. Critical facets include:

- Accuracy
- Consistency
- Completeness
- Uniqueness
- Timeliness
- Validity

When organizations deliver reports, dashboard statistics, and decision support without first exploring the data, the resultant information can lead to poor decisions.

"Garbage in Garbage Out" is exacerbated when working with Big Data and "Black Box" analytics.

Traditional v. Real-Time Analytics

Traditional Analytics	Real Time Analytics
Traditional analytics – • Typically, numerical data to infer population characteristics from a sample • Well-defined schema, minimal change in terms of data fields	**Real-time analytics –** • May be numerical, text, geocoded, image, video, or other data • Triggers and metrics for monitoring and notifications to improve decision-making timeliness and efficiency
Common tools – Spreadsheets (Excel), Traditional relational database (Access, Oracle, SQL), some specialized software	**Common tools** – Cost-effective using cloud services such as Apache Kafka, Apache Storm, AWS Kinesis, Google Cloud Dataflow, and Microsoft Azure Stream Analytics
Common techniques for traditional and real-time analytics include **classification or clustering, graph analytics, video/image analysis, and artificial intelligence**. Technique execution has improved with Big Data, new computational strategies, and the power of cloud computing.	

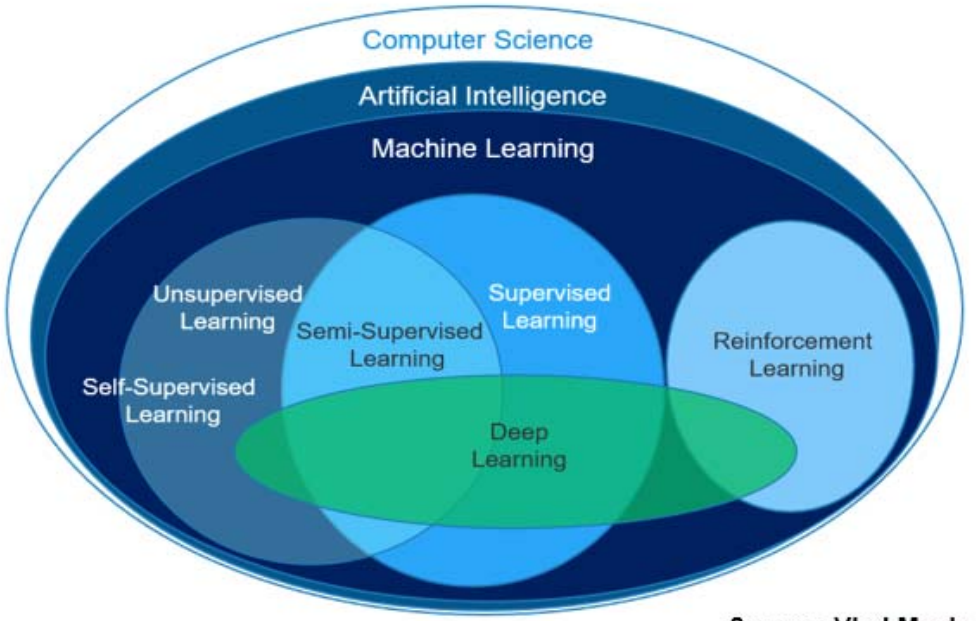
Analytics Trends and Terminology

Trends

- Analytics on the edge
- Democratization of data
- Velocity of obsolescence
- Maturation of AI in a box

Terminology

- Artificial intelligence
- Machine learning
- Role of supervision
- Deep learning



Source: Vlad Mysla

If your data is bad or small, your machine learning tools are likely useless.

Modern Data Governance and Management

Data Governance – Traditional v. Modern

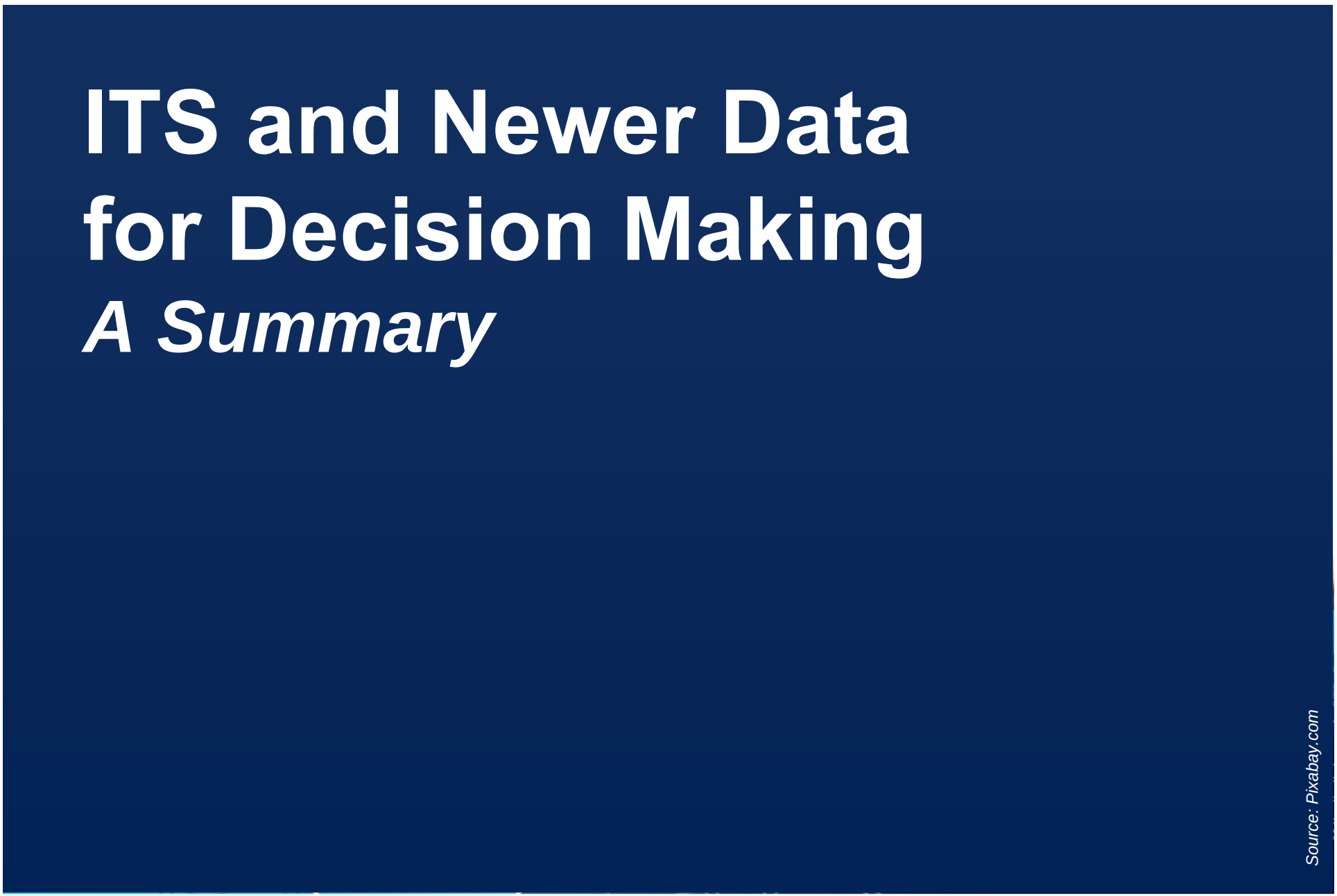
- **Data governance** is the exercise of authority, control, and shared decision making over the management of data assets.
  - **Traditionally,** has been closely associated with managing legal risk, regulatory compliance, and security by IT departments
  - **Modern governance** needs to encompass the entire data supply chain rather than mandate data structures and data tools for business units
- According to the Data Governance Institute, **eight principles are central to successful data governance** and stewardship programs:
  - Integrity
  - Transparency
  - Auditability
  - Accountability
  - Stewardship
  - Checks and Balances
  - Standardization
  - Change Management

Data Management – Traditional v. Modern

- **Data management** is the practice of collecting, keeping, sharing, and using data securely, efficiently, and cost-effectively.
  - Developed last century to support consistent, routine reporting using relational database systems, through fully define requirements
  - **Modern data management is intended to support change** – in data types, access, analytics, software, and processes
  - DAMA, the global non-profit association, identifies eleven knowledge areas in their "Data Management Body of Knowledge:"
    - Metadata
    - Quality
    - Architecture
    - Security
    - Storage and operations
    - Modeling and design
    - Document and content management
    - Integration and operability
    - Reference and master data
    - Warehousing and business intelligence

ITS and Newer Data for Decision Making

A Summary



Source: Pixabay.com

ITS and Newer Data
Opportunity & Challenge

- ITS and newer data can improve operations, investment, planning, and human capital decisions at every level of decision making
- AI applications hold promise for improved decision making, presently in the areas of video and image analytics
- Shifting from manual ad-hoc to real-time analytics offers more immediate value for transportation decision making
- Rely on the guideposts of performance management, and modern data management and governance, to achieve improved decision making and avoid unnecessary or unwise investments in data and analytics

Questions?

1. What types of transportation agency decisions benefit from data?
2. What are some emerging data sources and how do they differ from traditional ITS data?
3. What is the difference between traditional and modern data management?
4. What will help agencies choose high-value relevant data and analytics to improve decision making?

Resources: *Guidance, Research, Case Studies*

- Framework for Managing Data from Emerging Transportation Technologies to Support Decision Making, NCHRP Research Report 952, 2020
- Leveraging Big Data to Improve Traffic Incident Management, NCHRP Research Report 904, 2019
- Management and Use of Data for Transportation Performance Management: Guide for Practitioners. NCHRP Research Report 920, 2019
- Guidebook for Data and Information Systems for Transportation Asset Management, NCHRP Report 956
- Business Intelligence Techniques for Transportation Agency Decision Making, NCHRP 03-128 (Forthcoming)
- Use of Vehicle Probe and Cellular GPS Data by State Departments of Transportation, NCHRP 20-05/Topic 51-06 (Forthcoming)

Resources: *Guidance, Research, Case Studies*

- Transportation Management and Operations Guide, AASHTO
- Transportation Performance Measures Guidebook, FHWA
- Developing and Sustaining a Transportation Systems Management & Operations Mission for Your Organization - A Primer For Program Planning, FHWA
- Transportation Management Centers Streaming Video Sharing and Distribution, FHWA
- GIS in Transportation: Data Governance and Management Case Studies of Selected Transportation Agencies, FHWA
- FHWA Traffic Analysis Tools
- Traffic Monitoring Guide (Updated 2016), FHWA

Resources: *Guidance, Research, Case Studies*

- Automated Traffic Signal Performance Measures, FHWA
- Real-time Incident Detection Using Social Media Data, Pennsylvania DOT
- The Application of Unmanned Aerial Systems In Surface Transportation - Volume II- C: Evaluation of UAS Highway Speed-Sensing Application, Massachusetts DOT
- Utilization of AVL/GPS Technology: Case Studies, Clear Roads Pooled Fund Study
- Video Analytics Towards Vision Zero: Case Study Report, City of Bellevue

Resources – *Webinars, Briefings, and Web Tools*

- **Webinars, Videos, and Briefings**
  - Adventures in Crowdsourcing Webinar Series, FHWA
  - Point Versus Probe Data 2-minute video, Utah DOT
  - Current and Evolving Practices in Asset Management for Highway Agencies, TRB Webinar Slides
  - Optimizing traffic signal performance using connected vehicle data, Wejo
  - Video Analytics Towards Vision Zero, City of Bellevue
- **Transportation Data Analytics - Web Examples**
  - Utah DOT Signal Performance Analysis Interface
  - Indiana DOT and Purdue University Delta Speed Tool

Resources – *Websites*

- FHWA Transportation Performance Management Site
- FHWA Automated Traffic Signal Performance Measures Site
- FHWA EDC-5 Innovation, Unmanned Aerial Systems Site
- FHWA Connected Vehicle Pilot Deployment Site
- AASHTO Core Data Principles, Data Management and Analytics

Thank you & Questions?

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Knowledge Check

How do *emerging data* differ from traditional ITS data?

- ❑ Volume
- ❑ Variety
- ❑ Velocity
- ❑ Veracity
- ❑ Management
- ❑ Processing
- ❑ Granularity
- ❑ Security