Cloud Computing –
A NIST Perspective and Beyond

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Advanced Network Technologies Division

January 6, 2016
MAGIC Meeting
NITRD
Arlington, VA

In the Beginning

- Cost & Efficiency drivers - US IT Budget ~ $80B/year:
- Federal Cloud Computing Strategy (*Cloud First*)
  - NIST, GSA, DHS
- NIST's Goal – To accelerate the federal government's adoption of cloud computing
  - *Build a USG Cloud Computing Technology Roadmap*
  - *Lead efforts to develop standards and guidelines*
- Starting Material – NIST Definition of Cloud Computing (SP 800-145)
- Develop a Reference Architecture for Cloud Computing

Determine the "What" of Cloud Computing, not the "How"

NIST Cloud Computing Program

NIST Definition of Cloud Computing

"Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." - **NIST SP 800-145**

3 Service Models
- ➢ Software as a Service   (SaaS)
- ➢ Platform as a Service   (PaaS)
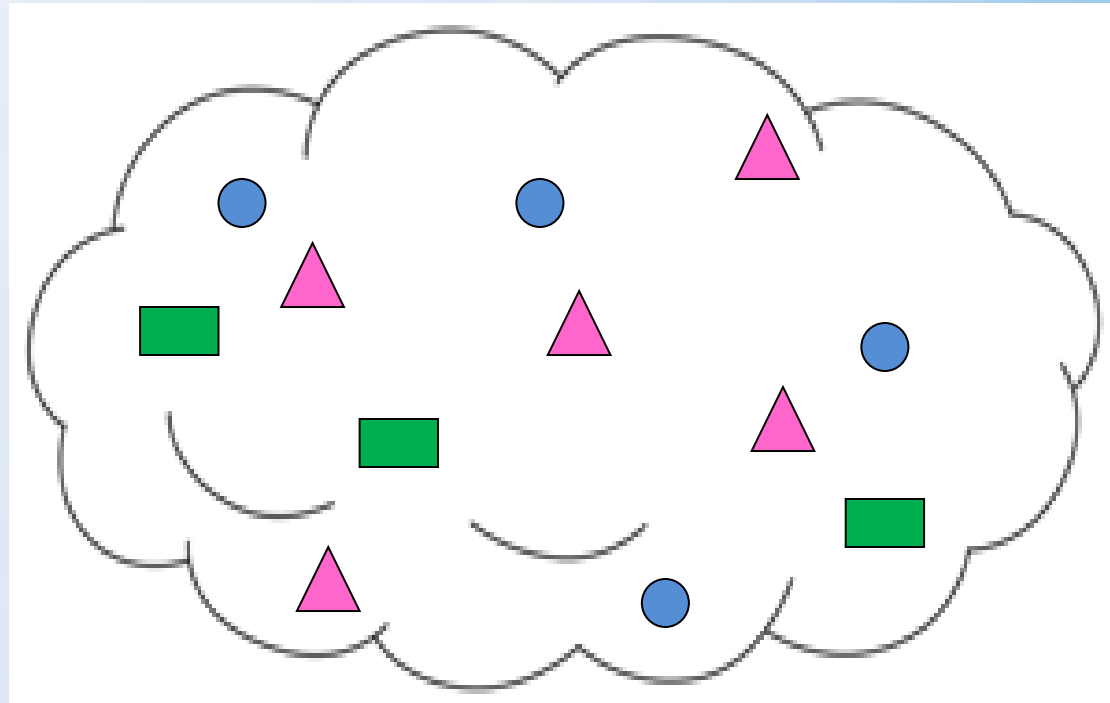- ➢ Infrastructure as a Service   (IaaS)

4 Deployment models
- ➢ Public, Private, Community, Hybrid

5 Essential Characteristics
- ➢ On demand self-service
- ➢ Broad network access
- ➢ Resource Pooling
- ➢ Rapid Elasticity
- ➢ Measured Service

NIST **Cloud Computing Program**

Building a Roadmap (and more)

- Organize & collaborate with industry, academia, govt agencies and host several Public Working Groups
  - RefArch & Taxonomy, Security, Standards, SAJACC, BUC
- 2 Volume Roadmap, NIST SP 500-293 (pub. 10/2014)
  - *Vol I contains 10 Requirements & Priority Action Plans*
  - *Vol II contains the technical output from the PWGs*
- Also published…
  - *Standards Inventory (NIST SP 500-291)*
  - *Reference Architecture & Taxonomy (NIST SP 500-292)*
  - *Security Reference Architecture (draft NIST SP 500-299)*

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USG Cloud Computing Technology Roadmap Requirements (NIST SP 500-293)

1. International voluntary consensus-based standards

2. Solutions for High-priority Security Requirements, technically de-coupled from organizational policy decisions

3. Technical specifications to enable development of consistent, high-quality Service-Level Agreements

4. Clearly and consistently categorized cloud services

5. Frameworks to support seamless implementation of federated community cloud environments

6. Updated Organization Policy that reflects the Cloud Computing Business and Technology model

7. Defined unique government regulatory requirements and solutions

8. Collaborative parallel strategic "future cloud" development initiatives

9. Defined and implemented reliability design goals

10. Defined and implemented cloud service metrics

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NIST Cloud Computing Reference Architecture Actors and their Roles
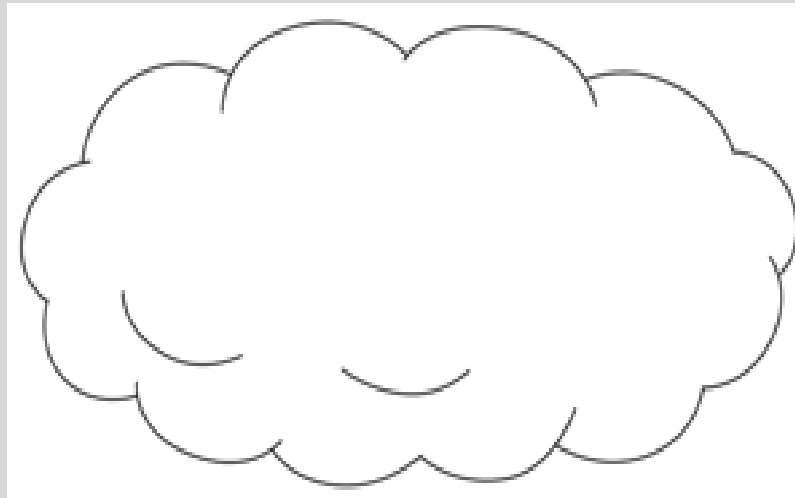
Cloud Consumer
Person or organization that maintains a business relationship with, and uses service from *Cloud Providers*.

Cloud Auditor
A party that can conduct independent assessment of cloud services, information system operations, performance and security of the cloud implementation.

Cloud Provider

Person, organization or entity responsible for making a service available to *Cloud Consumers*.

Cloud Broker
An entity that manages the use, performance and delivery of cloud services, and negotiates relationships between *Cloud Providers* and *Cloud Consumers.*
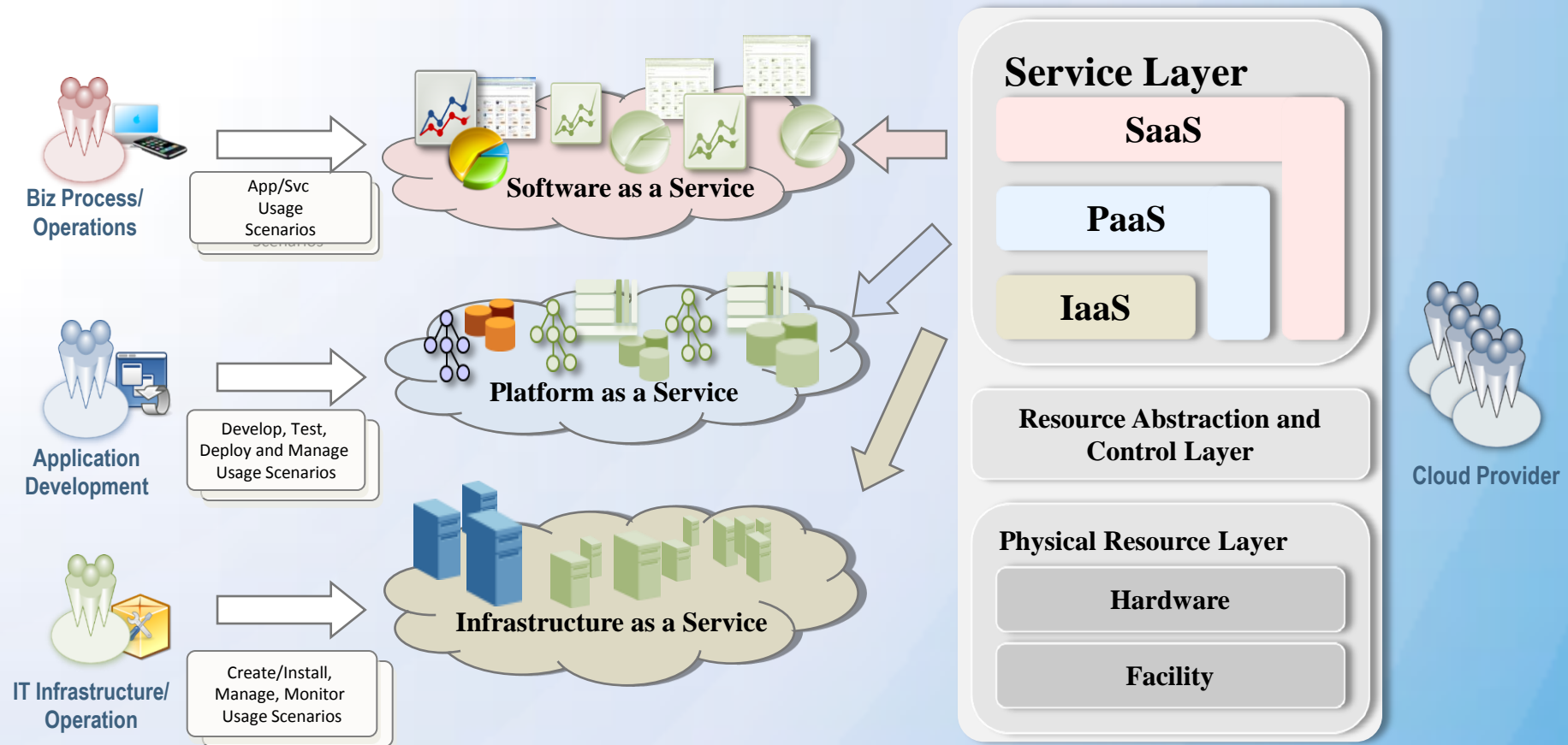
Cloud Carrier
The intermediary that provides connectivity and transport of cloud services from *Cloud Providers* to *Cloud Consumers*.
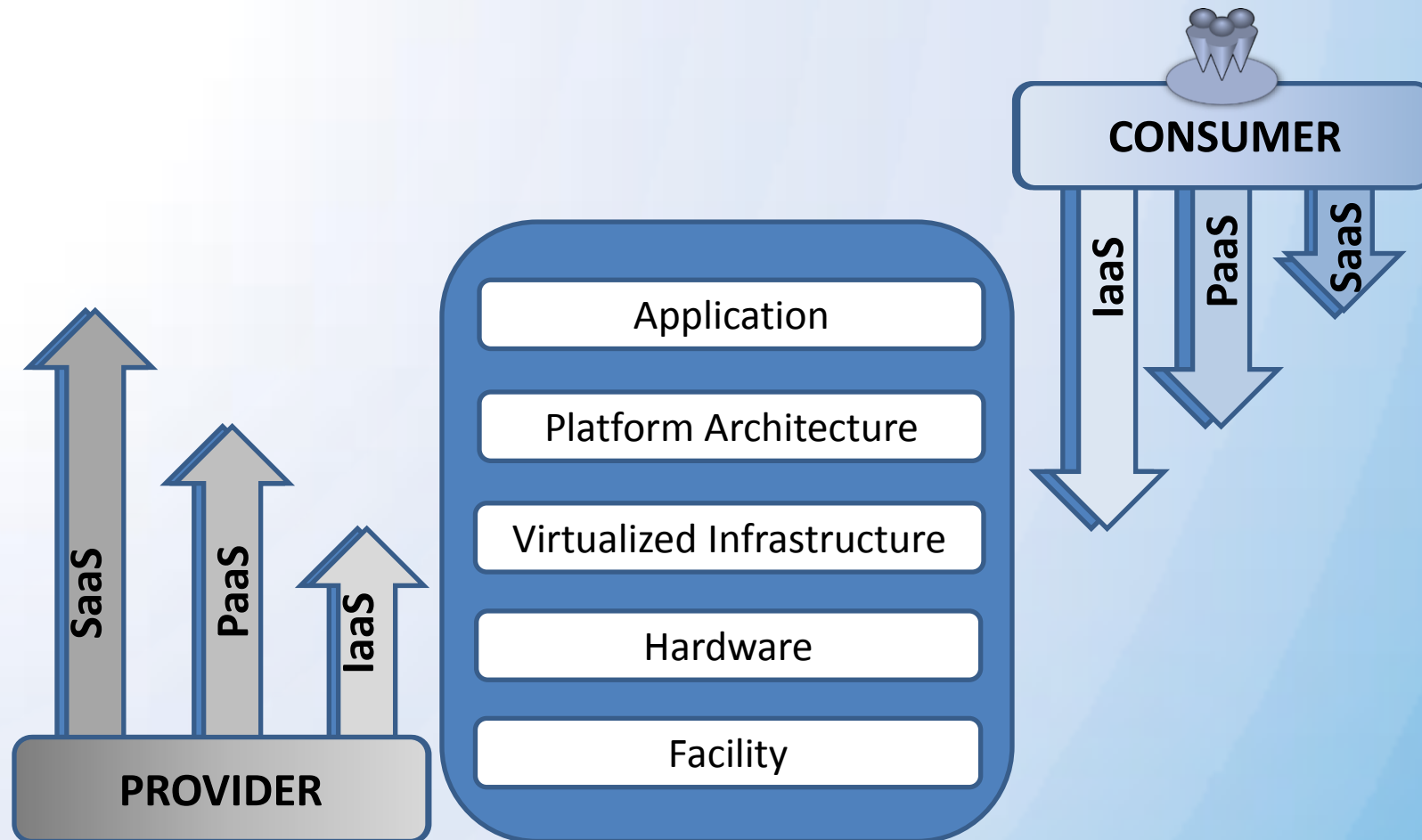
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NIST CCRA (NIST SP 500-292)

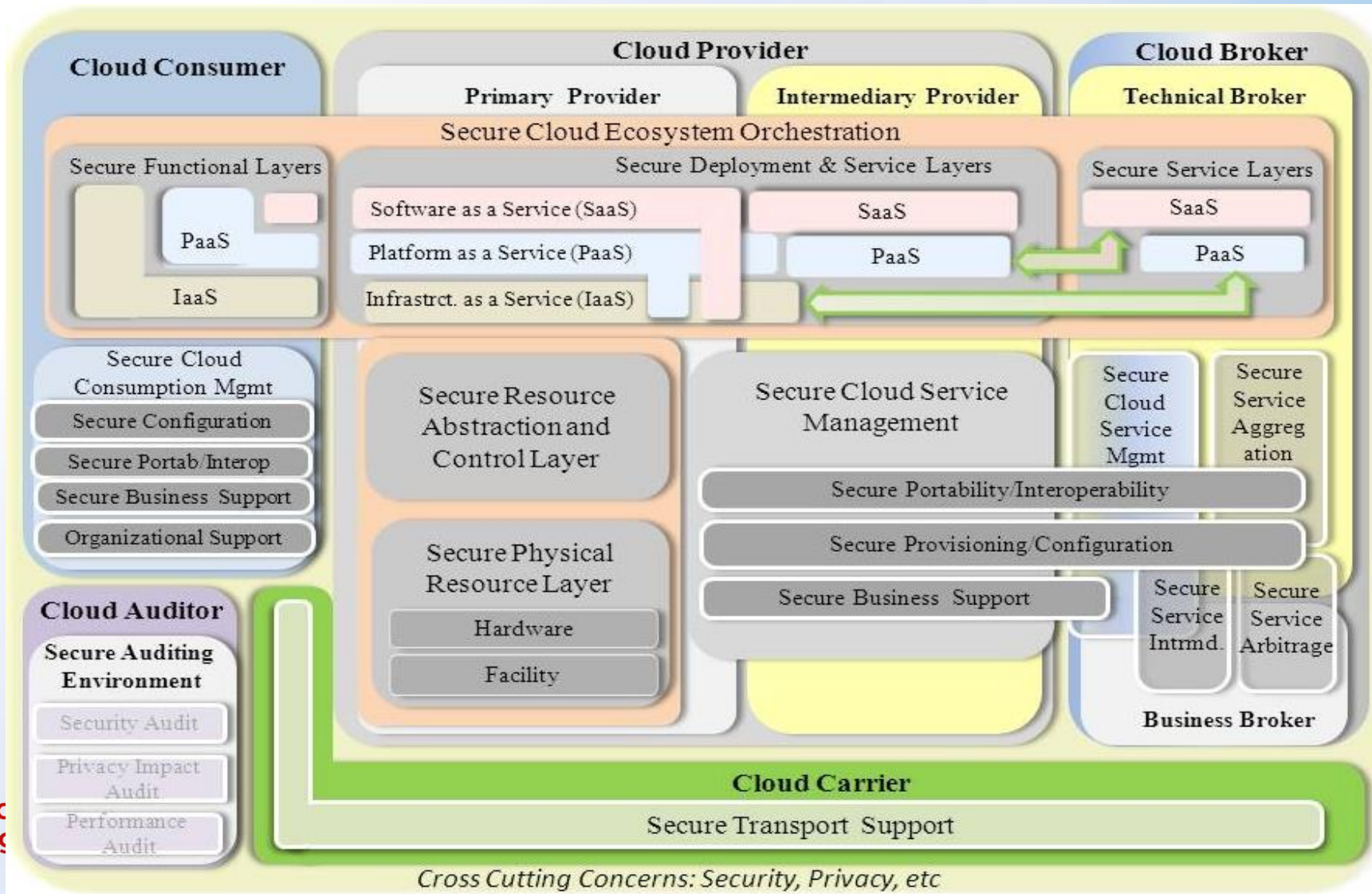*Everyone has some responsibility in managing S&P*
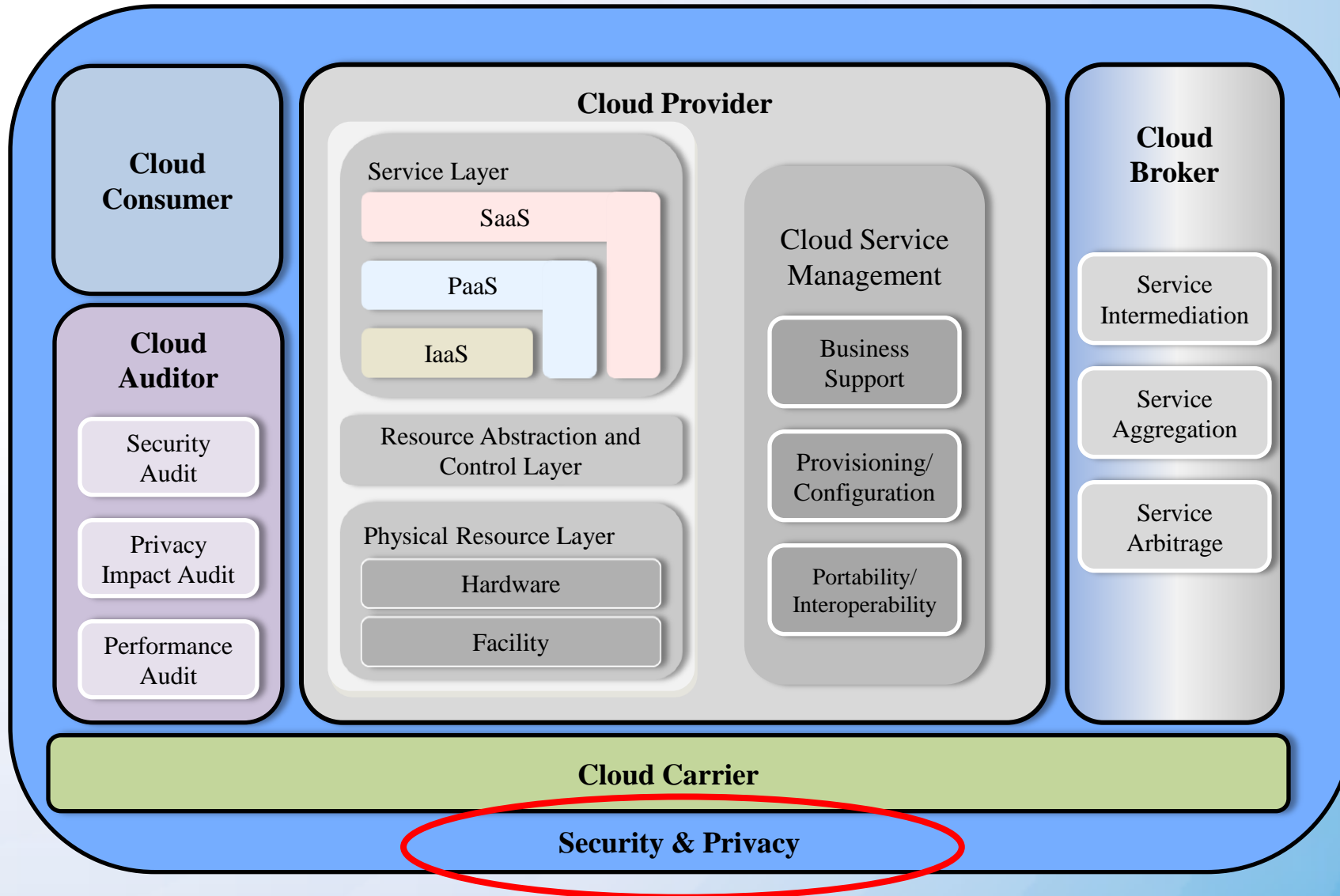
Each Service Layer fulfills a different business need with different security considerations.

Security Conservation Principle

NIST SP 500-299:
Cloud Security Reference Architecture

Present

- At NIST
  - Work on Cloud Metrics (NIST SP 500-307 - **draft**)
  - Cloud Accessibility (NIST SP 500-317 - **draft**)
  - Advanced Actor Analysis (Broker, Carrier, Auditor)
  - Description of Cloud Services
  - Develop Service Level Agreement taxonomy
  - Interoperability & Portability
  - Security
  - Continue Strong Outreach – Workshop #9 September 13-15, 2016

- Standard Development Organizations
  - ISO-IEC/JTC1 Vocabulary & RA (17788, 17789); SLAs - 4 part (19086); Interop/Portability (19941); Data & Data Flow (19944)

Cloud Procurement Problem Statement

Be able to procure cloud services in a secure, reliable, repeatable, and measureable manner which reflect the business & technical requirements of an organization.

Future Vision

*The convenience of **reliable**, **trusted** and **measureable** cloud services become a foundational element of the global economy.*

NIST Cloud Computing Program
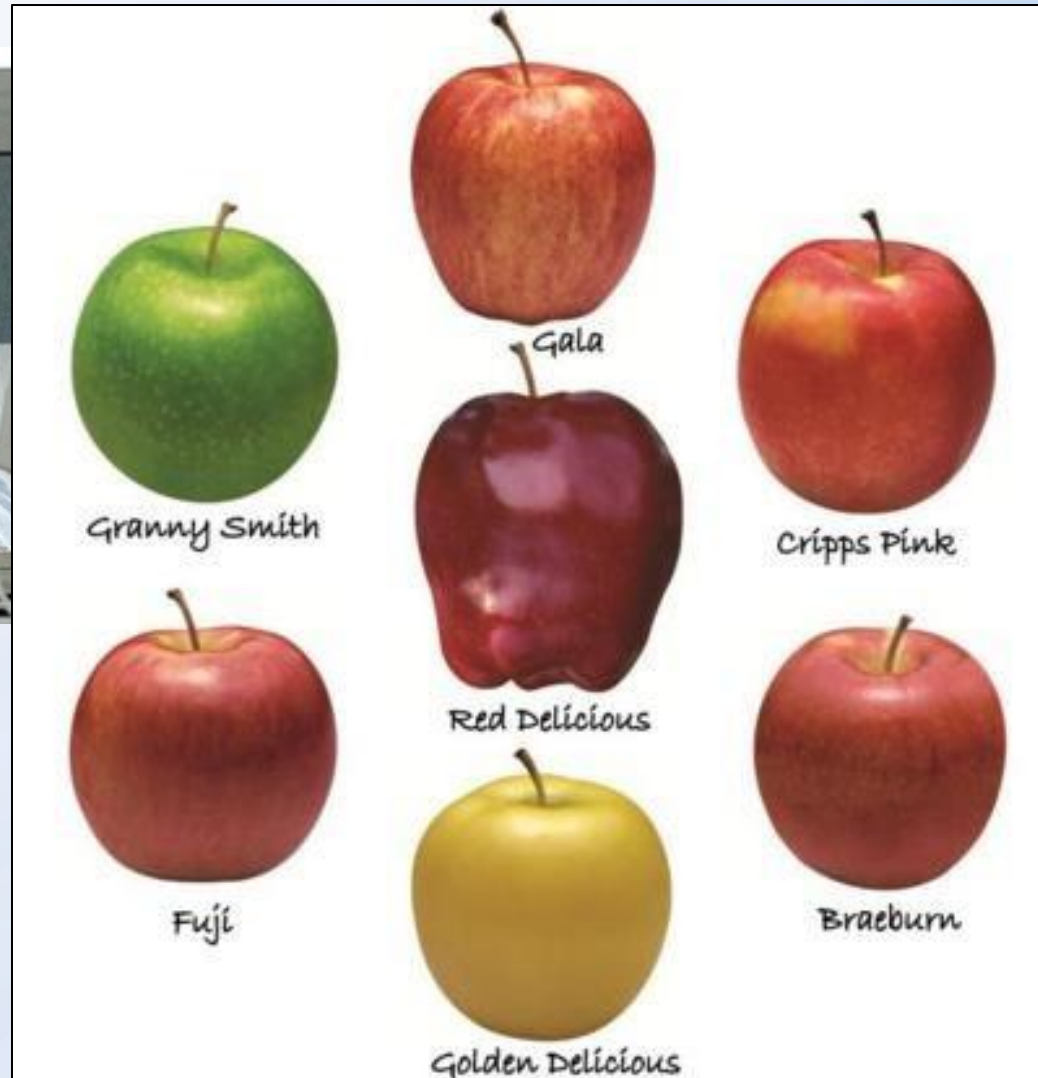
Pete's Journey to Cloud

1. To know the business & technical requirements of his organization.

2. To understand landscape of cloud computing, cloud services and service level agreements (SLAs).

Apples to Apples

5 Essential Characteristics

➢ On demand self-service
➢ Broad network access
➢ Resource Pooling
➢ Rapid Elasticity
➢ Measured Service

Gala

Granny Smith

Cripps Pink

Red Delicious

Fuji

Braeburn

Golden Delicious

NIST **Cloud** **Computing** **Program**

Cloud Service Level Agreements (SLAs)

- **Cloud Service Level Agreement**: A document stating the technical performance promises made by the cloud provider, how disputes are to be discovered and handled, and any remedies for performance failures. *Differs from Master Service Agreement (MSA).*

- No standard cloud computing contracts exist.

- Little agreement with respect to:
  - which elements should appear within a SLA
  - which metrics to use
  - how terms are defined

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Contents of an SLA
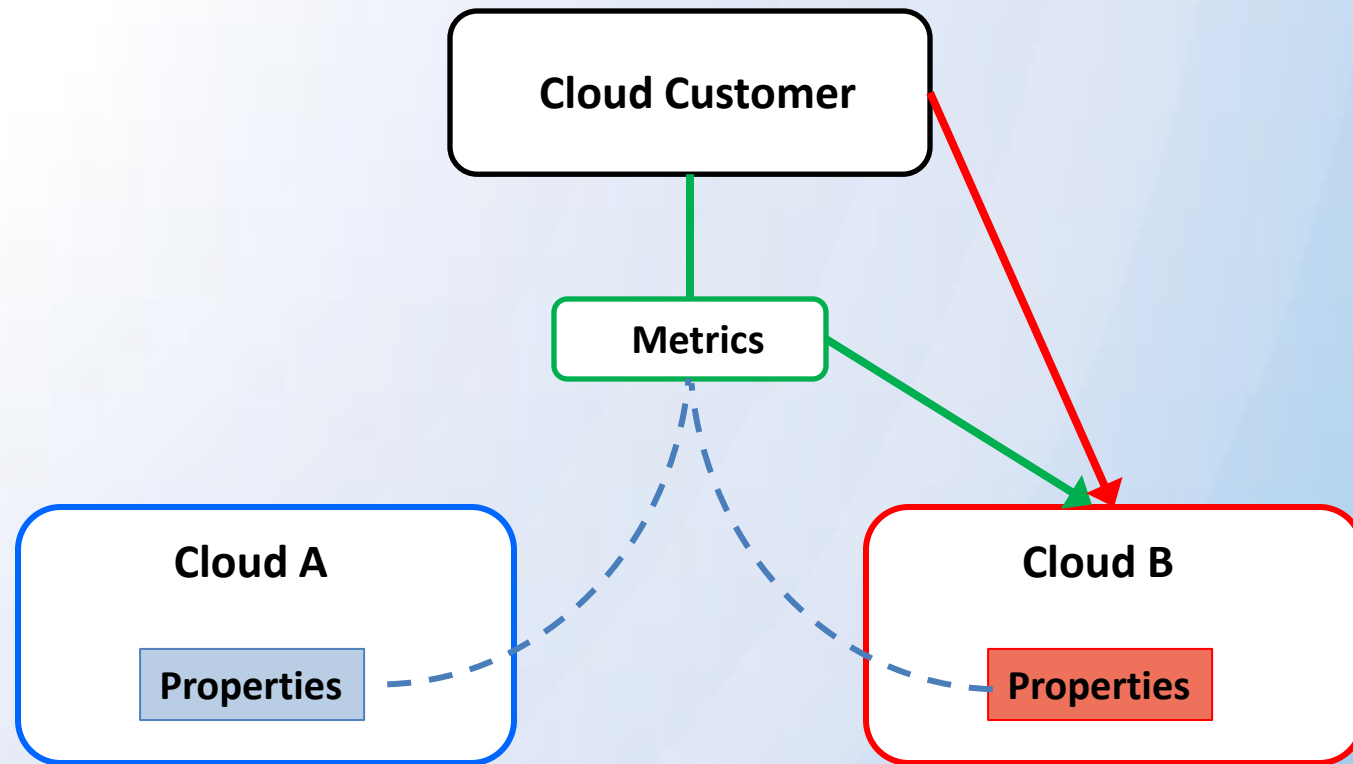
Business Level Objectives

- Roles & Responsibilities
- Requirements
- Operational Policies
- Continuity
- Limitations
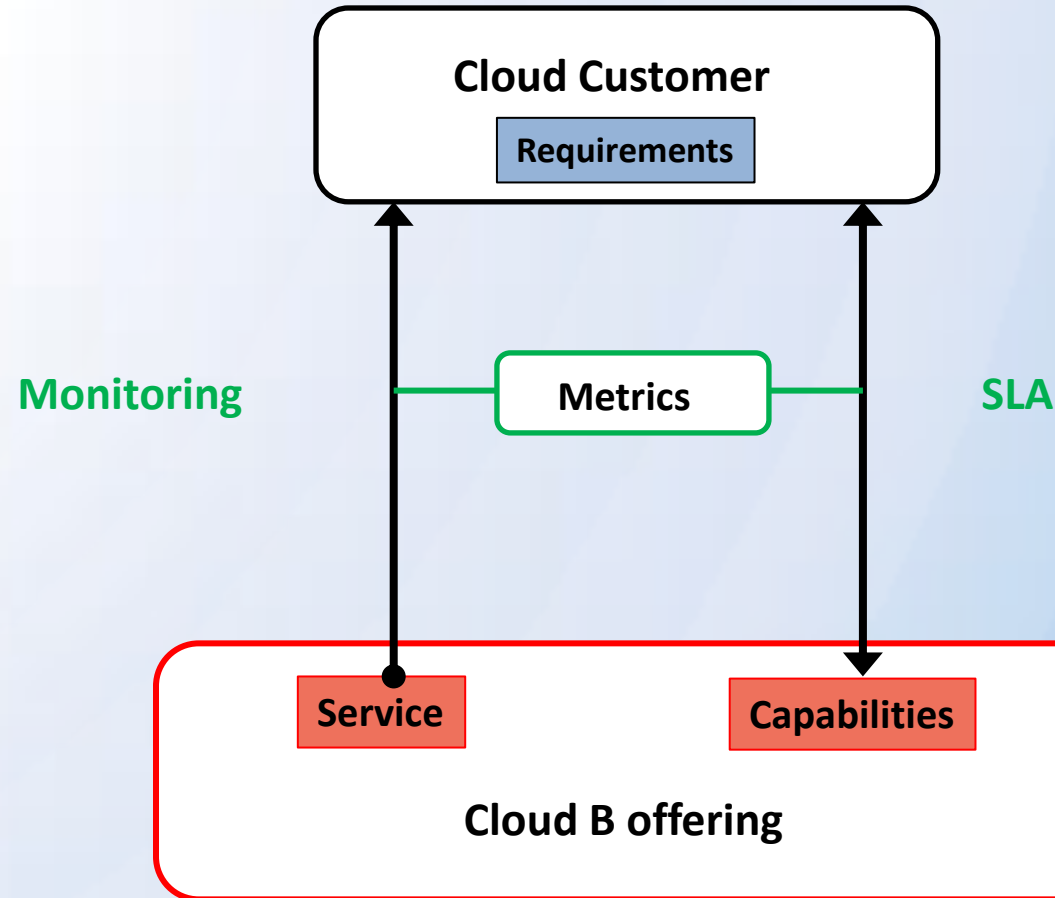- Financial
- Glossary of Terms

Service Level Objectives

- Resources
- Performance Indicators
- Service Deployment
- Service Management
- Description
- Security
- Privacy

SLAs & Metrics
Selecting & Decision Making

SLAs & Metrics - Monitoring Services

SLA Performance Metric - *Service Availability*

- An Availability Metric could be based on different definitions for *measures*:

- Most commonly, availability is evaluated based on the percentage of "uptime" (available state) of a resource, over some period of time.

- **service_uptime_percentage:** the percentage of qualified service availability time over the observation time, as defined by the *expression*:
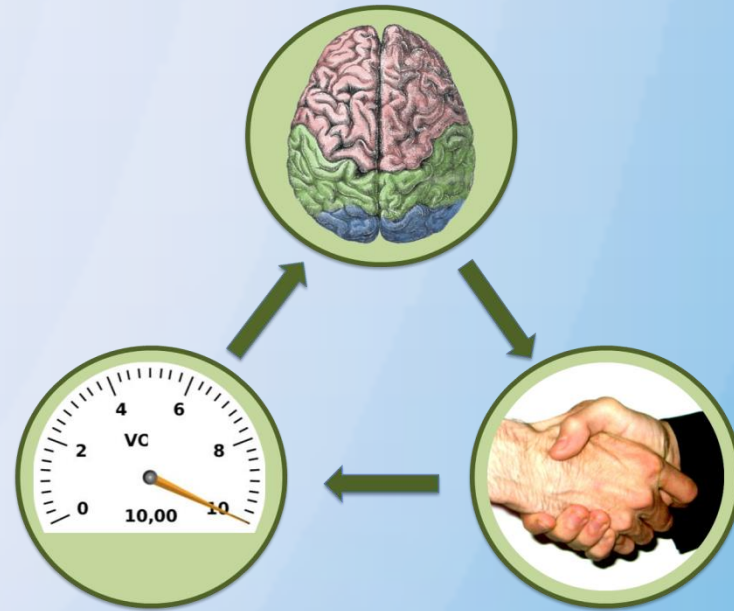
$$service\ uptime\ \% = \frac{qualified\_uptime\_total}{observation\_time\_total} * 100$$

(NIST SP 500-307)

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Three parts to the process

Decide - lay out the requirements for the service

Agree - the **MSA/SLA** is the agreement connecting customer and provider

Measure - are the SLA objectives met ?

Contacts

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NIST ITL Cloud Computing Home Page   **http://www.nist.gov/itl/cloud**

NIST Cloud Metrics Collaboration Site (Twiki)
       http://collaborate.nist.gov/twiki-cloud-computing /bin/view/CloudComputing/RATax_CloudMetrics

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SAVE THE DATE
Cloud Computing Forum & Workshop #9   September 13-15, 2016

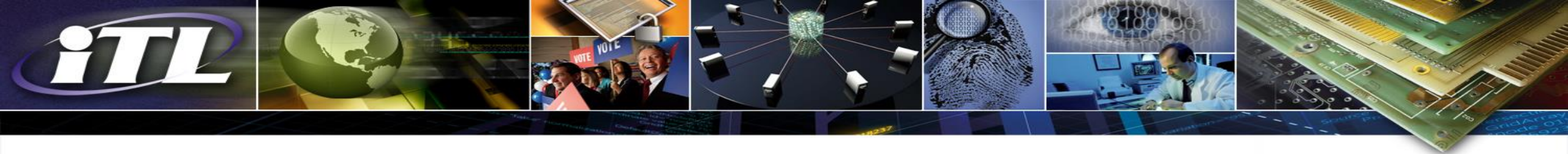# NIST Big Data Standardization Activities

Wo Chang, NIST

Digital Data Advisor

NIST Big Data Public Working Group, Co-Chair

ISO/IEC JTC 1/WG 9 Working Group on Big Data, Convenor

wchang@nist.gov

January 6, 2016

# Background: NIST Big Data PWG Charter and Deliverables

Charter

The focus of the (NBD-PWG) is to form a community of interest from industry, academia, and government, with the goal of developing a consensus definitions taxonomies secure reference architectures, *and* technology roadmap. *The aim is to create vendor-neutral, technology and infrastructure agnostic deliverables to enable big data stakeholders to pick-and-choose best analytics tools for their processing and visualization requirements on the most suitable computing platforms and clusters while allowing value-added from big data service providers and flow of data between the stakeholders in a cohesive and secure manner.*

Launch Date: June 26, 2013

Deliverables:

1. *Big Data Definitions*
2. *Bid Data Taxonomies*
3. *Big Data Use Cases & Requirements*
4. *Big Data Security & Privacy Requirements*
5. *Architectures Survey*
6. *Big Data Reference Architecture*
7. *Big Data Security & Privacy Architecture*
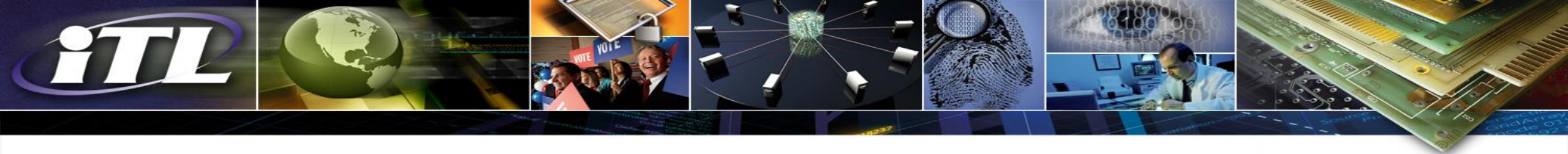8. *Big Data Standards Roadmap*

URL: http://bigdatawg.nist.gov
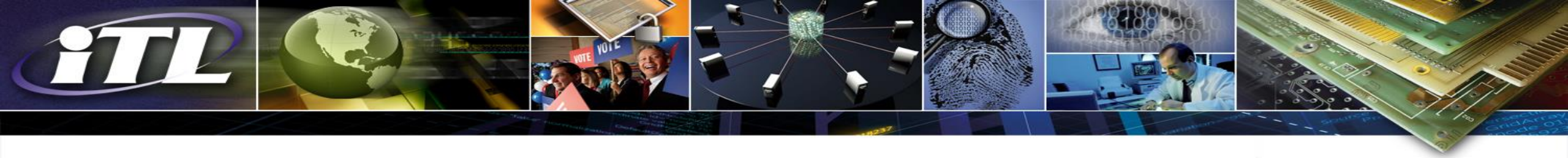
NIST Big Data Standardization Activities

Approaches

- NIST Big Data Public Working Group (NBD-PWG)

- ISO/IEC JTC 1/WG 9 Working Group on Big Data

- ISO/IEC JTC 1/SC 32/WG 11 – MPEG

- ISO/TC 69 – Applications of Statistical Methods

- ISO/TC 204 -- Intelligent Transportation

NIST Big Data Standardization Activities

NIST Big Data Public Working Group (NBD-PWG)

5 Subgroups (June 2013 – continue):

1. Definitions & Taxonomies
2. UC & Requirements
3. Security & Privacy
4. Reference Architecture
5. Standards Roadmap

V1 (high-level RA components and descriptions)
Big Data Interoperability Framework:
Released on September 16, 2015:

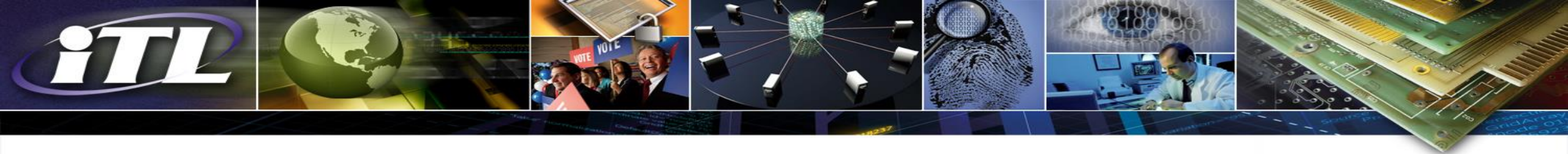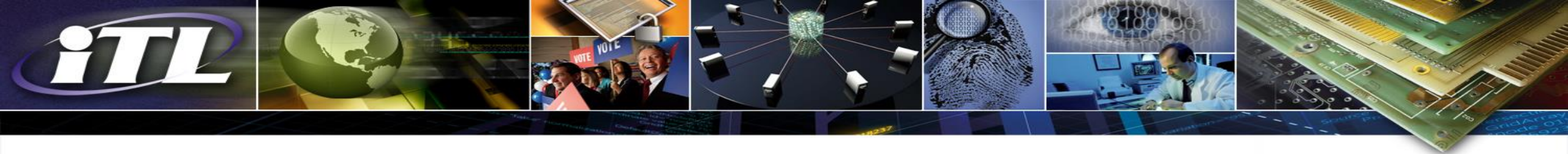|		
NIST SP1500-1: Definitions	**NIST SP1500-2: Taxonomies**	**NIST SP1500-3: Use Cases & Requirements**
NIST SP1500-4: Security & Privacy	**NIST SP1500-5: Architecture Survey – White Paper**	**NIST SP1500-6: Reference Architecture**
	NIST SP1500-7: Standards Roadmap	

NIST Big Data Standardization Activities

NIST Big Data Public Working Group (NBD-PWG)

Vendors Big Data architectures

NIST Big Data Standardization Activities, Wo Chang, Jan. 6, 2016
CODATA Big Data Workshop, Wo Chang, NIST/ITL, June 9, 2014
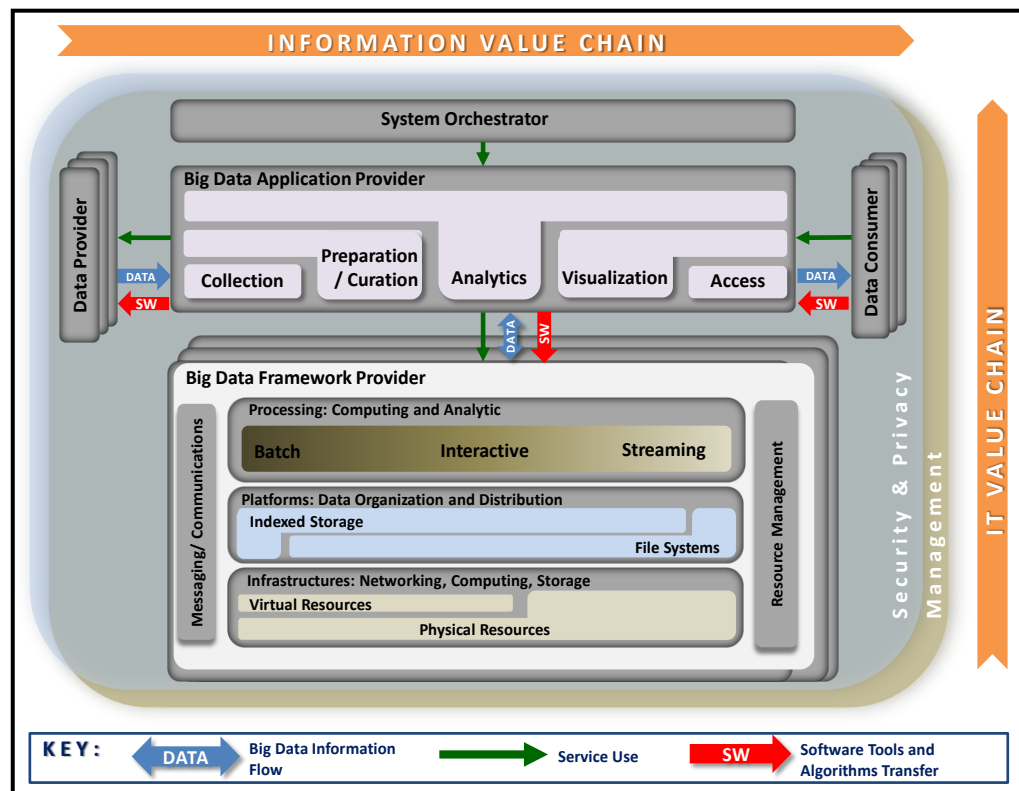
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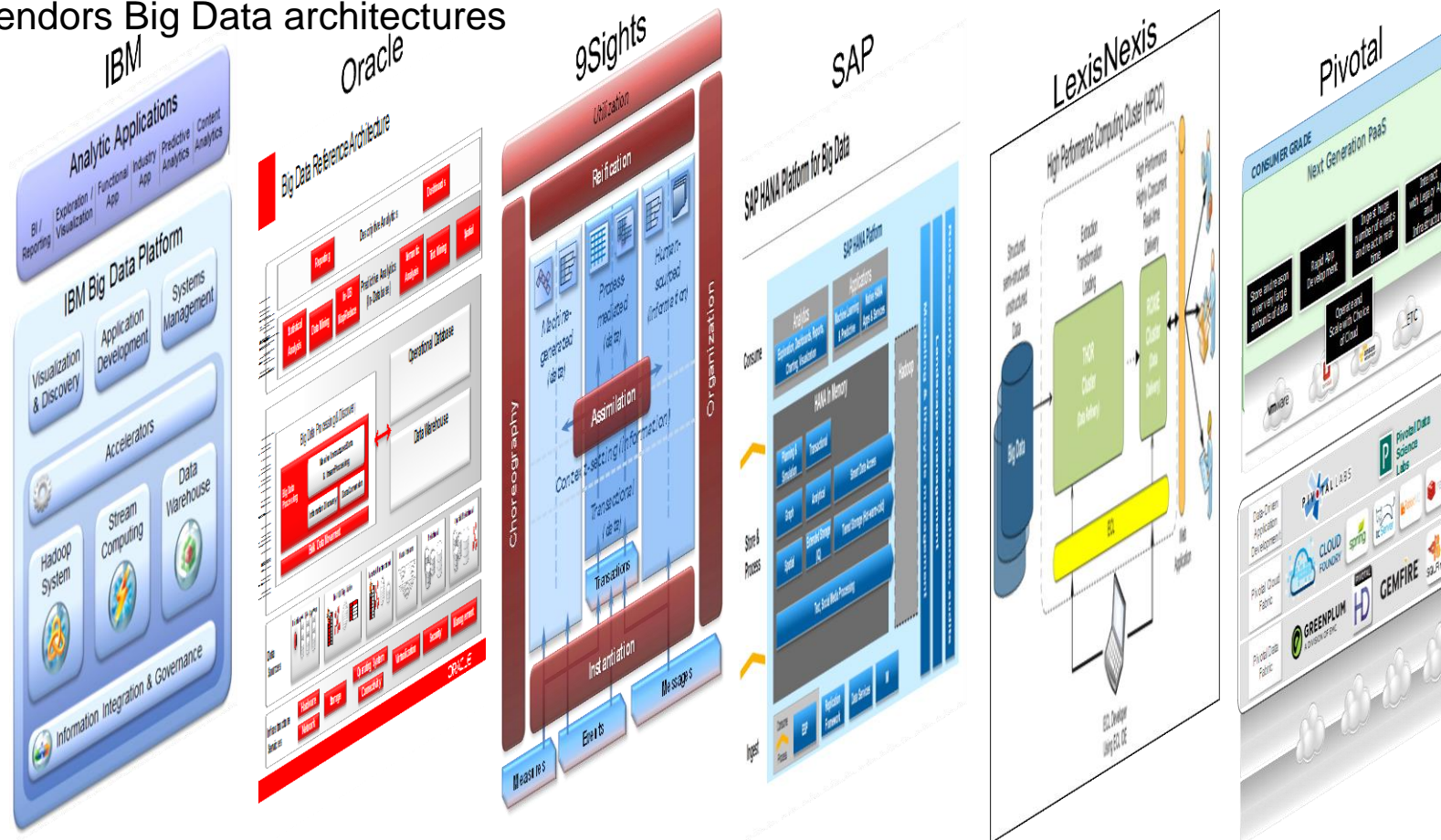
NIST Big Data Standardization Activities

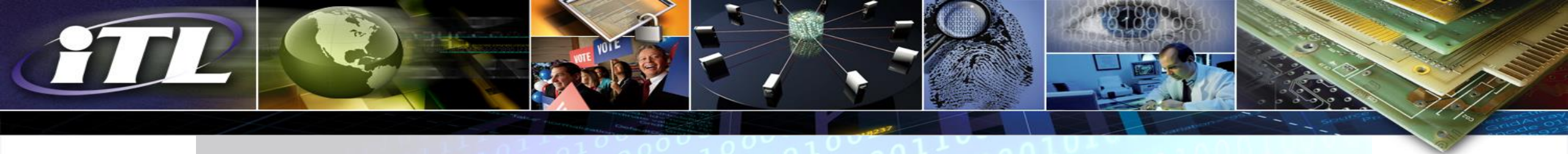## NIST Big Data Public Working Group (NBD-PWG)

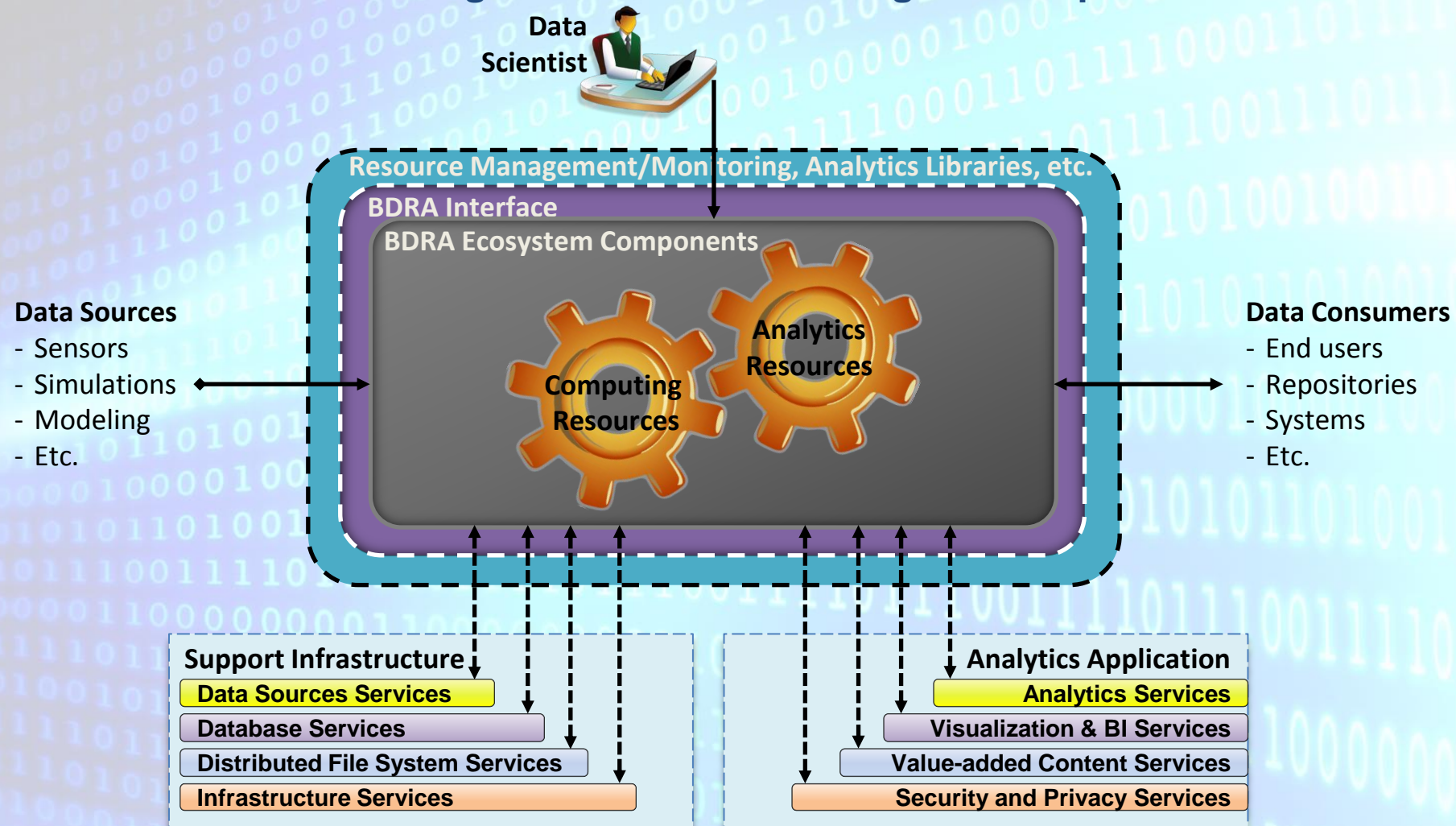V2 focuses on interface between NBD-RA components through use cases by:

- Analyze activities diagrams

- Analyze functional diagrams

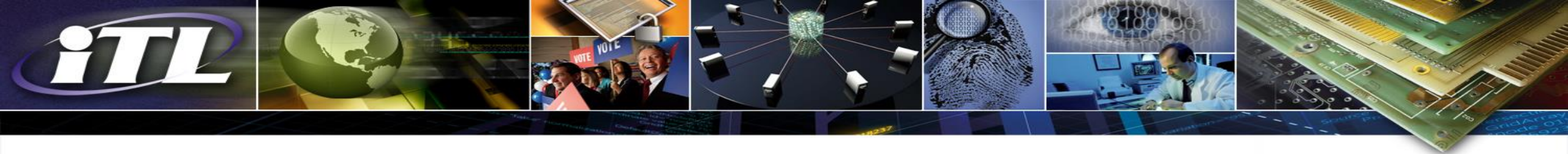- Apply DevOps small scale implementations

Goals:

- Aggregate low-level interactions into high-level general interfaces

- Produce set of white papers to demo how NBD-RA can be used

- Produce preliminary interface by summer 2016

NIST Big Data Ref. Arch. – A Big Roadmap

Data Scientist

Resource Management/Monitoring, Analytics Libraries, etc.

BDRA Interface

BDRA Ecosystem Components

Analytics Resources

Computing Resources

Data Sources
- Sensors
- Simulations
- Modeling
- Etc.

Data Consumers
- End users
- Repositories
- Systems
- Etc.

Support Infrastructure
- Data Sources Services
- Database Services
- Distributed File System Services
- Infrastructure Services

Analytics Application
- Analytics Services
- Visualization & BI Services
- Value-added Content Services
- Security and Privacy Services

NIST Big Data Standardization Activities

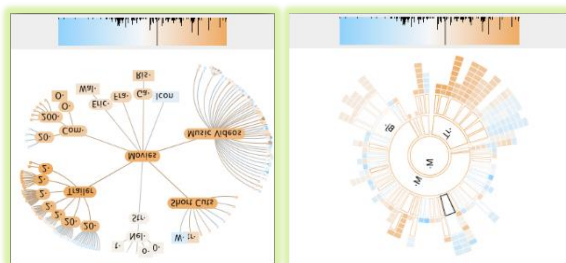**NIST Big Data Public Working Group (NBD-PWG)**

Selection of use cases: (a) available of datasets and (b) available of analytics codes
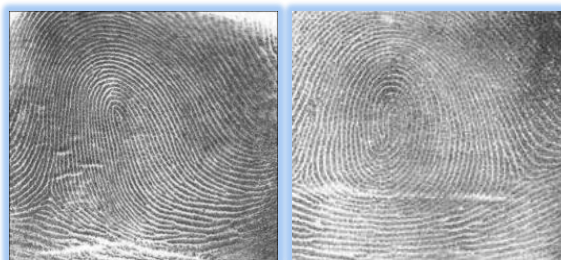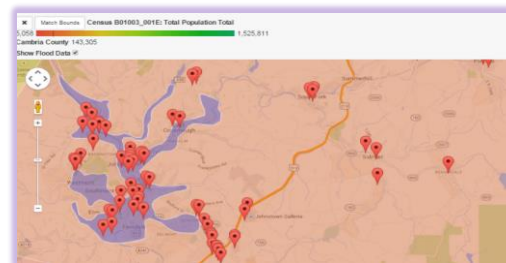

Fingerprints Matching   **Human and Face Detection from Video**

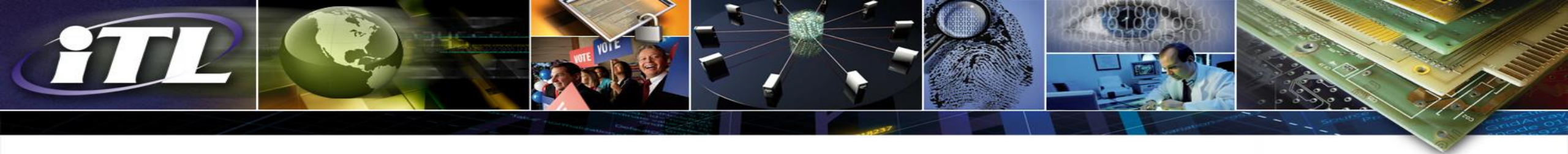**Twitter Feeds**   **Spatial Big Data/GIS**   **Healthcare Payment Fraud**

- Data warehousing
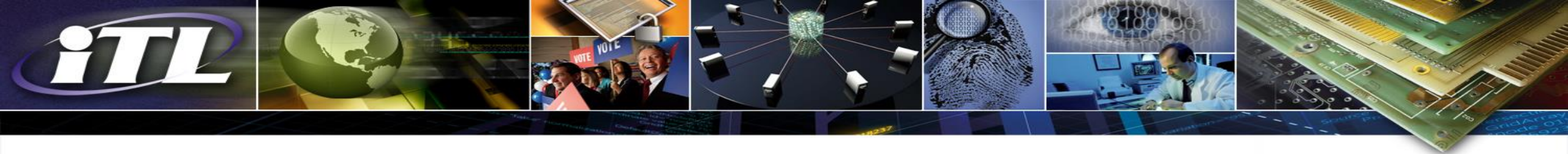- Global Cities
- Earth Science
- Life Science
- IoT
- *Others…*

NIST Big Data Standardization Activities

ISO/IEC JTC 1/WG 9 Working Group on Big Data

- 130+ from 21 NBs: Australia, Austria, Brazil, Canada, China, Finland, France, Germany, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, Norway, Russian Federation, Spain, Singapore, Sweden, UK, US

- Current Projects

  - **ISO/IEC 20546 Information technology – Big data – Overview and vocabulary**

  - **ISO/IEC 20547 Information Technology – Big data Reference architecture (5 Parts)**
    - Part 1: (TR) Framework and Application Process
    - Part 2: (TR) Use Cases and Derived Requirements
    - Part 3: (IS) Reference Architecture
    - Part 4: (IS) Security and Privacy Fabric
    - Part 5: (TR) Standards Roadmap

- ISO/IEC Liaisons: SC 6/WG 7, SC 27, SC 29, SC 32, SC 36, SC 38, SC 39, ISO/TC 69, ISO/TC 204, ITU-T SG13

NIST Big Data Standardization Activities

Explore collaboration by working with industry, academic and governments to harmonize analytic ecosystems

- NIST Global City Teams Challenges
- NIST Cyber-Physical Systems PWG
- IEEE Internet of Things (IoT)
- ISO STANDARDS SCs/WGs
- JTC 1/WG10 Working Group On Internet of Things (IoT)
- JTC 1/SC38 Cloud Computing and Distributed Platforms
- NIST Cloud PWG
- NIST PUBLIC WORKING GROUPS
- JTC 1/SC32 Data Management and Interchange
- NIST Big Data PWG
- JTC 1/WG9 Working Group On Big Data
- JTC 1/SC27 Security and Privacy