Enterprise Systems Architecture (ESA): looking at complex cases

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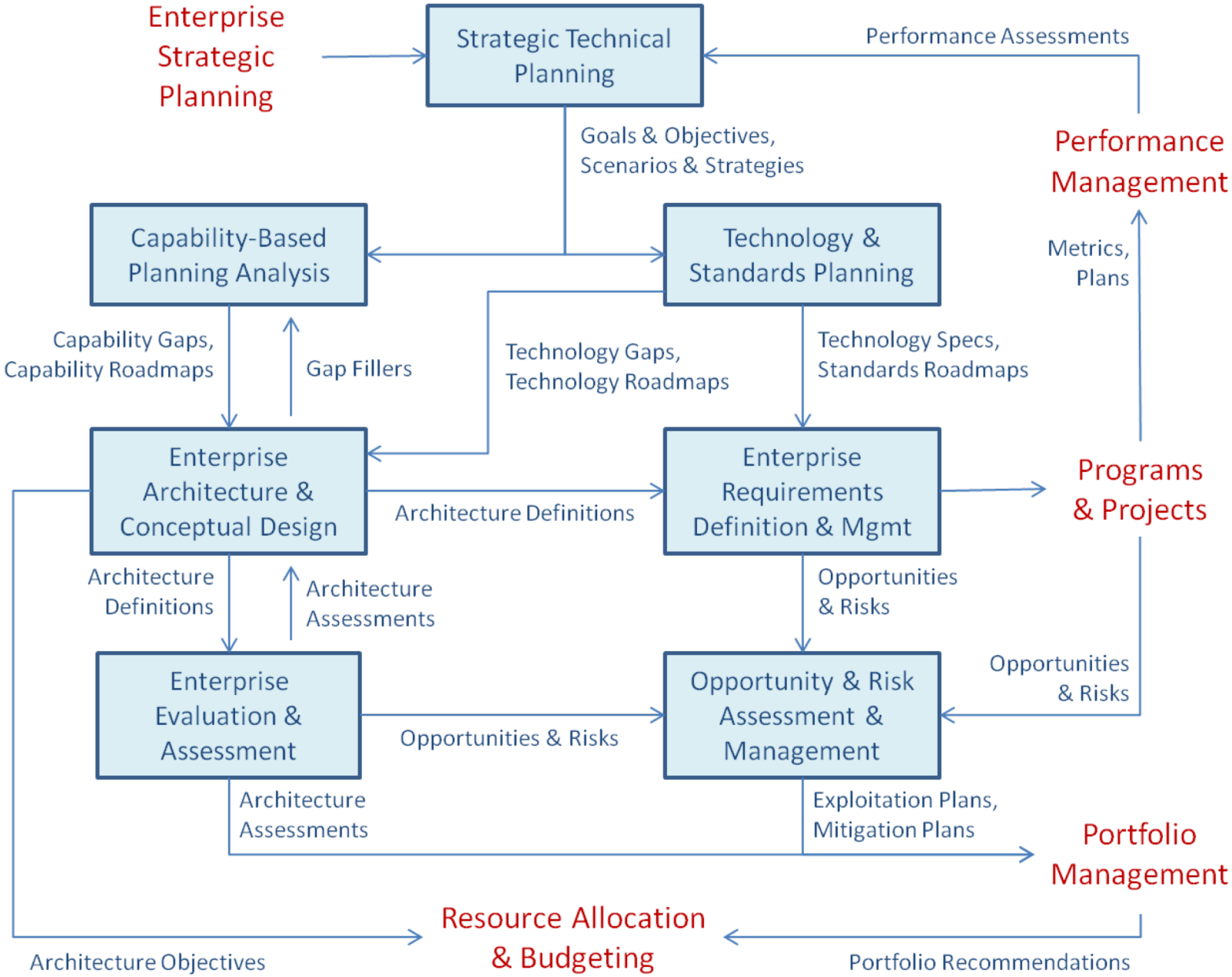
ESE and complex inter-organizational interactions

- “The term enterprise has been defined as follows:
  1. One or more organizations sharing a definite mission, goals, and objectives to offer an output such as a product or service. (ISO 2000);
  2. An organization (or cross organizational entity) supporting a defined business scope and mission that includes **interdependent resources (people, organizations and technologies) that must coordinate their functions and share information in support of a common mission (or set of related missions**). (CIO Council 1999);
  3. […]”

  http://www.sebokwiki.org/wiki/Enterprise_Systems_Engineering

System architecture and system requirements

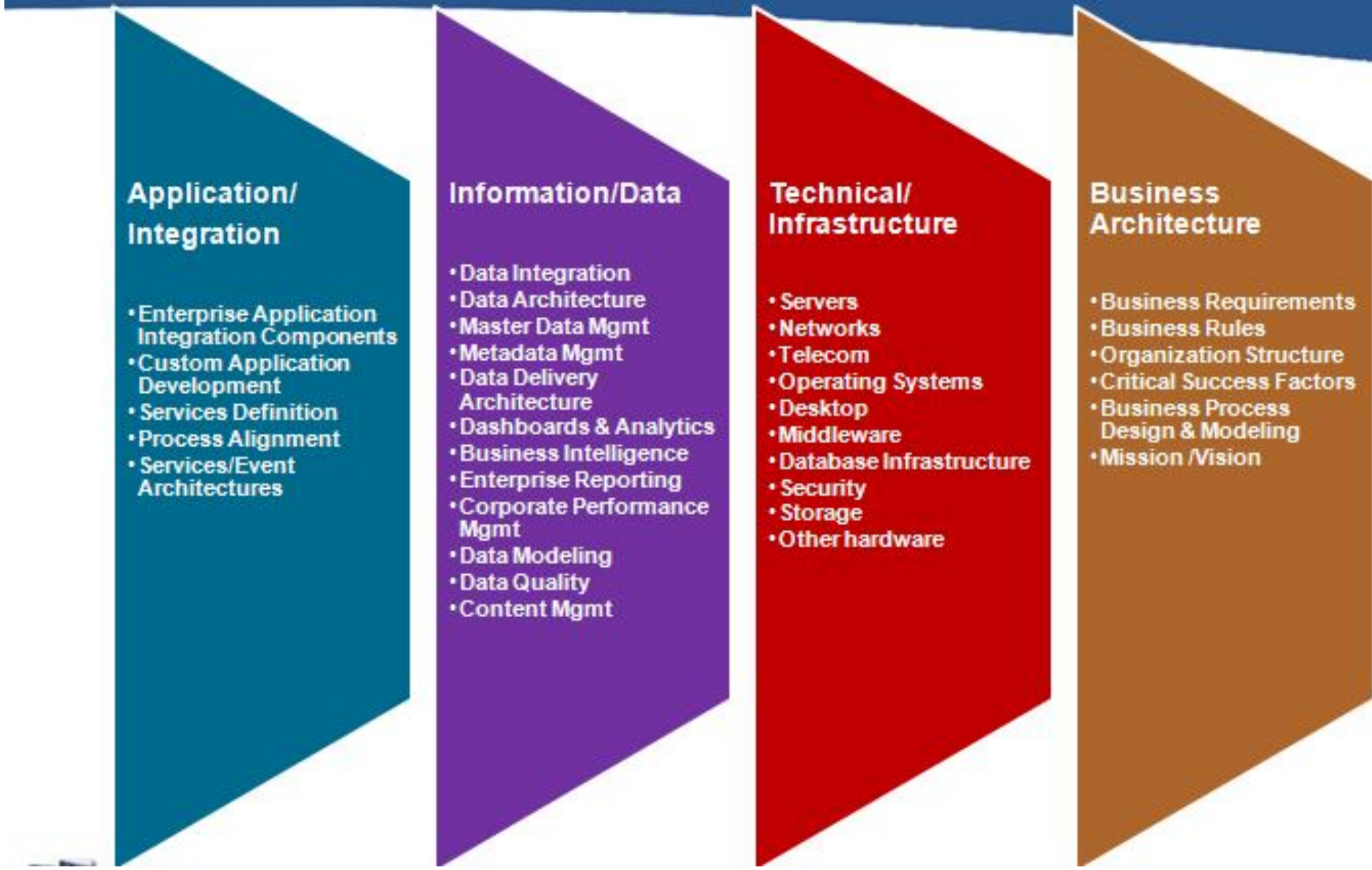
- SEBoK: “The solution architecture has features, properties, and characteristics satisfying, as far as possible, the problem or opportunity expressed by a set of **system requirements** (traceable to mission/business and stakeholder requirements) and life cycle concepts (e.g., operational, support) and are **implementable through technologies** (e.g., mechanics, electronics, hydraulics, software, services, procedures, human activity). ”
- System requirements are all of the requirements at the system level that describe the functions which **the system as a whole should fulfill** to satisfy the stakeholder needs and requirements, and is expressed in an appropriate combination of textual statements, views, and non-functional requirements; the latter expressing the levels of **safety, security, reliability**, etc., that will be necessary.


Enterprise Strategic Planning
Strategic Technical Planning
Performance Assessments
Goals & Objectives, Scenarios & Strategies
Performance Management
Capability-Based Planning Analysis
Technology & Standards Planning
Metrics, Plans
Capability Gaps, Capability Roadmaps
Gap Fillers
Technology Gaps, Technology Roadmaps
Technology Specs, Standards Roadmaps
Enterprise Architecture & Conceptual Design
Enterprise Requirements Definition & Mgmt
Programs & Projects
Architecture Definitions
Architecture Definitions
Architecture Assessments
Opportunities & Risks
Enterprise Evaluation & Assessment
Opportunity & Risk Assessment & Management
Opportunities & Risks
Opportunities & Risks
Architecture Assessments
Exploitation Plans, Mitigation Plans
Portfolio Management
Resource Allocation & Budgeting
Architecture Objectives
Portfolio Recommendations

Objectives

- Understand ES architecture concerns for complex scenarios:
  - Data Lakes
  - Internet of Things (IoT) or Industry 4.0 (i.e. Industrial IoT)
  - Blockchain/distributed ledger applications
- Relate them to concrete pieces of (current) technology.

EA Domains and Sub Domains

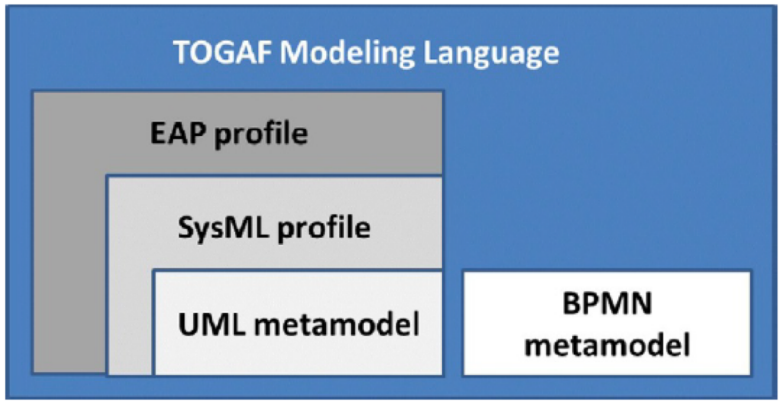


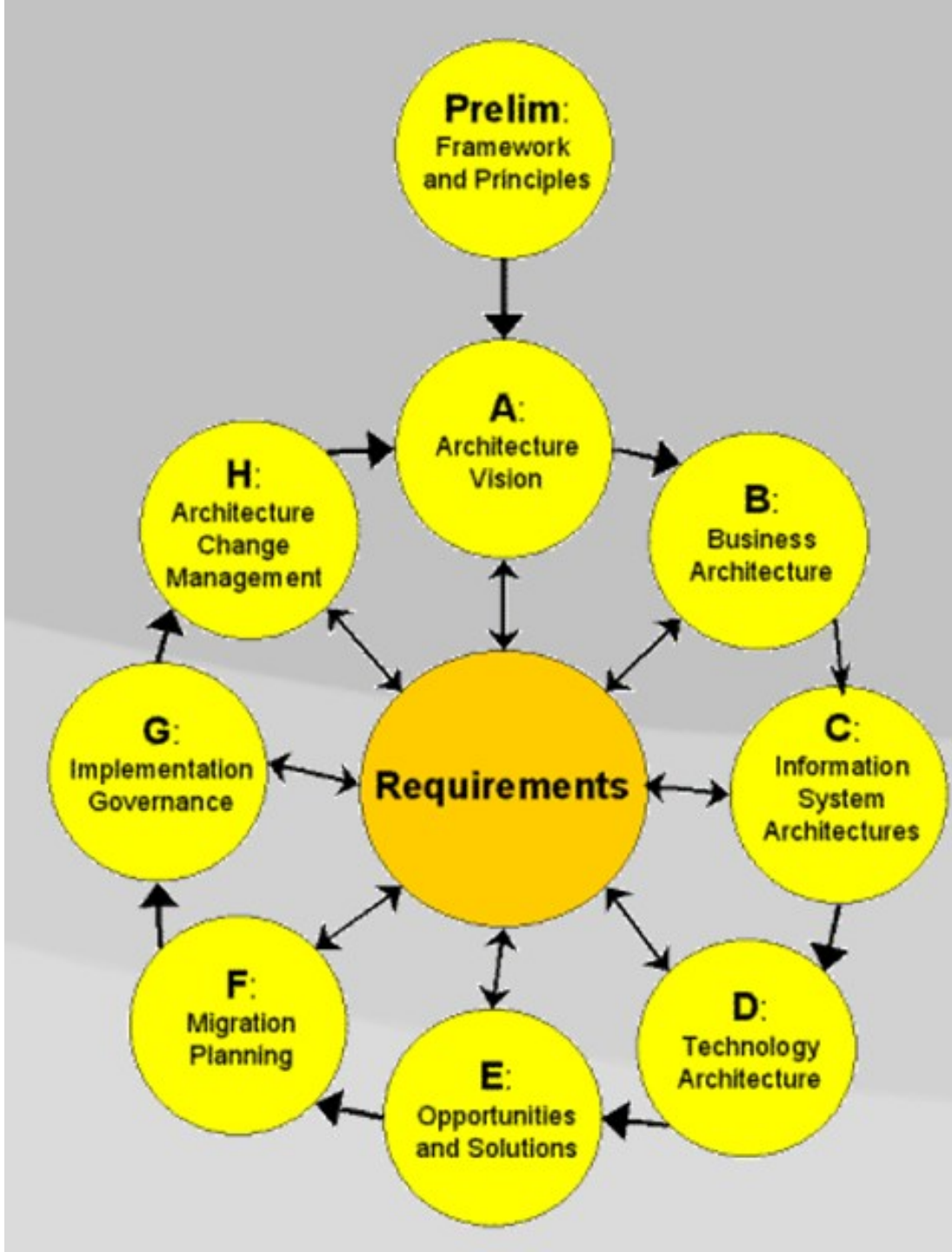
Enterprise-developed Frameworks	• The Open Group Architecture Framework (TOGAFTM) • Generalised Enterprise Reference Architecture and Methodology (GERAM) • Reference Model of Open Distributed Processing (RM-ODP) • Guide to the Enterprise Architecture Body of Knowledge (EABOK)
Commercial Frameworks	• Integrated Architecture Framework (IAF) • Zachman Framework • Architecture of Integrated Information Systems (ARIS) • OBASHI Business & IT methodology and framework (OBASHI)
Defence Industry Frameworks	• Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) • Department of Defence Architecture Framework (DoDAF) and Technical Reference Model (TRM) • NATO Architecture Framework (NATO) • Technical Architecture Framework for Information Management (TAFIM) • Joint Technical Architecture (JTA) • UK Ministry of Defence Architecture Framework (MODAF) • Department of National Defence and the Canadian Forces Architecture Framework (DNDAF) • France DGA Architecture Framework (AGATE) • International Defence Enterprise Architecture Specification (IDEAS)
Government Frameworks	• Federal Enterprise Architecture Framework (FEAF) • Government Enterprise Architecture (GEA) • Treasury Enterprise Architecture Framework (TEAF) • European Interoperability Framework (EIF) • NIST Enterprise Architecture (NIST) • Treasury Information System Architecture Framework (TISAF) • Standards and Architectures for eGovernment Applications (SAGA)
Other Frameworks	• Extended Enterprise Architecture Framework (E2AF) • Spewak's Enterprise Architecture Planning (EAP)

Example: TOGAF

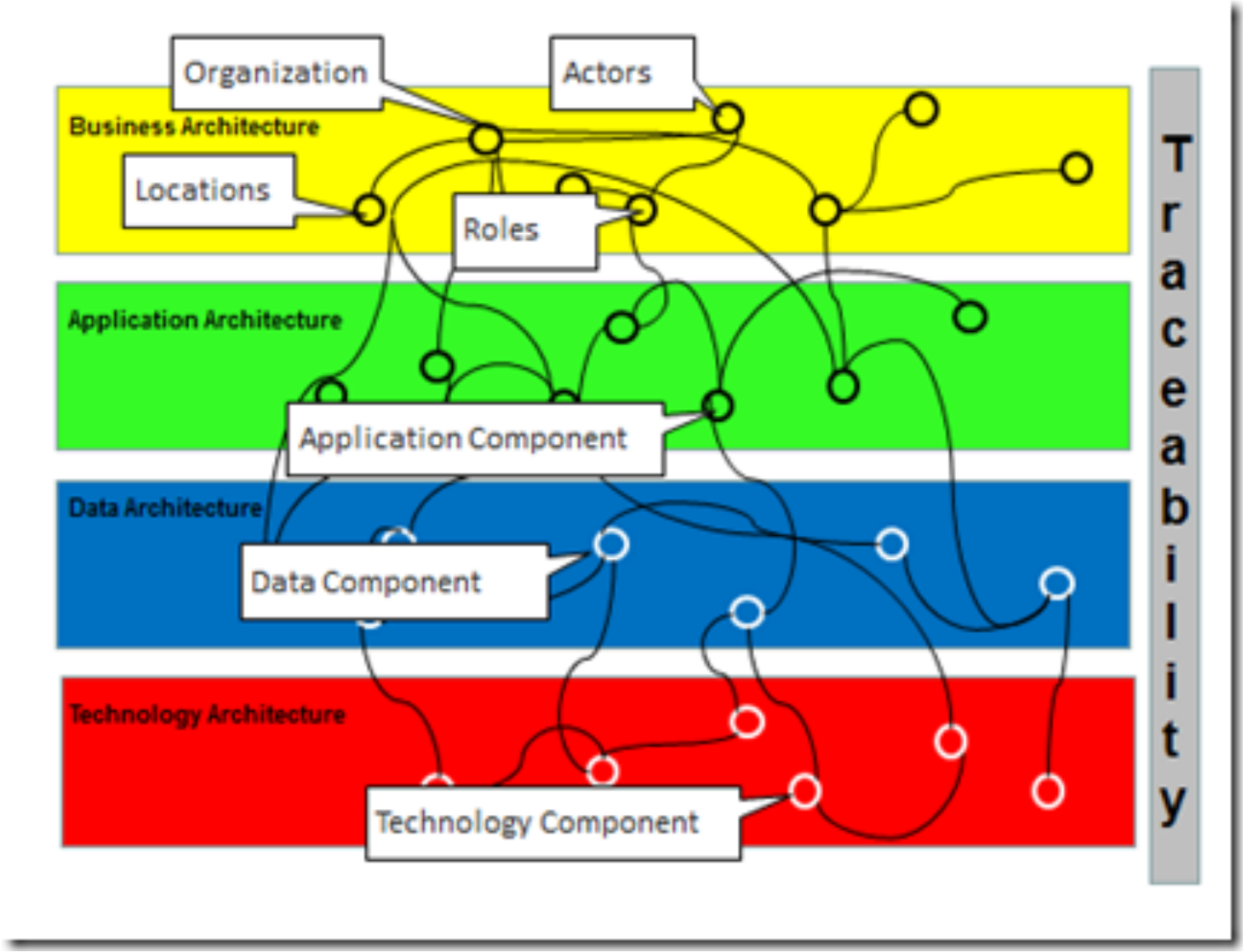
- Jason Bloomberg argues that "for many organizations, TOGAF has gained traction simply because it's better than doing nothing"

- "Enterprise Architecture: Don't Be a Fool with a Tool", Jason Bloomberg, visited 19 May 2016



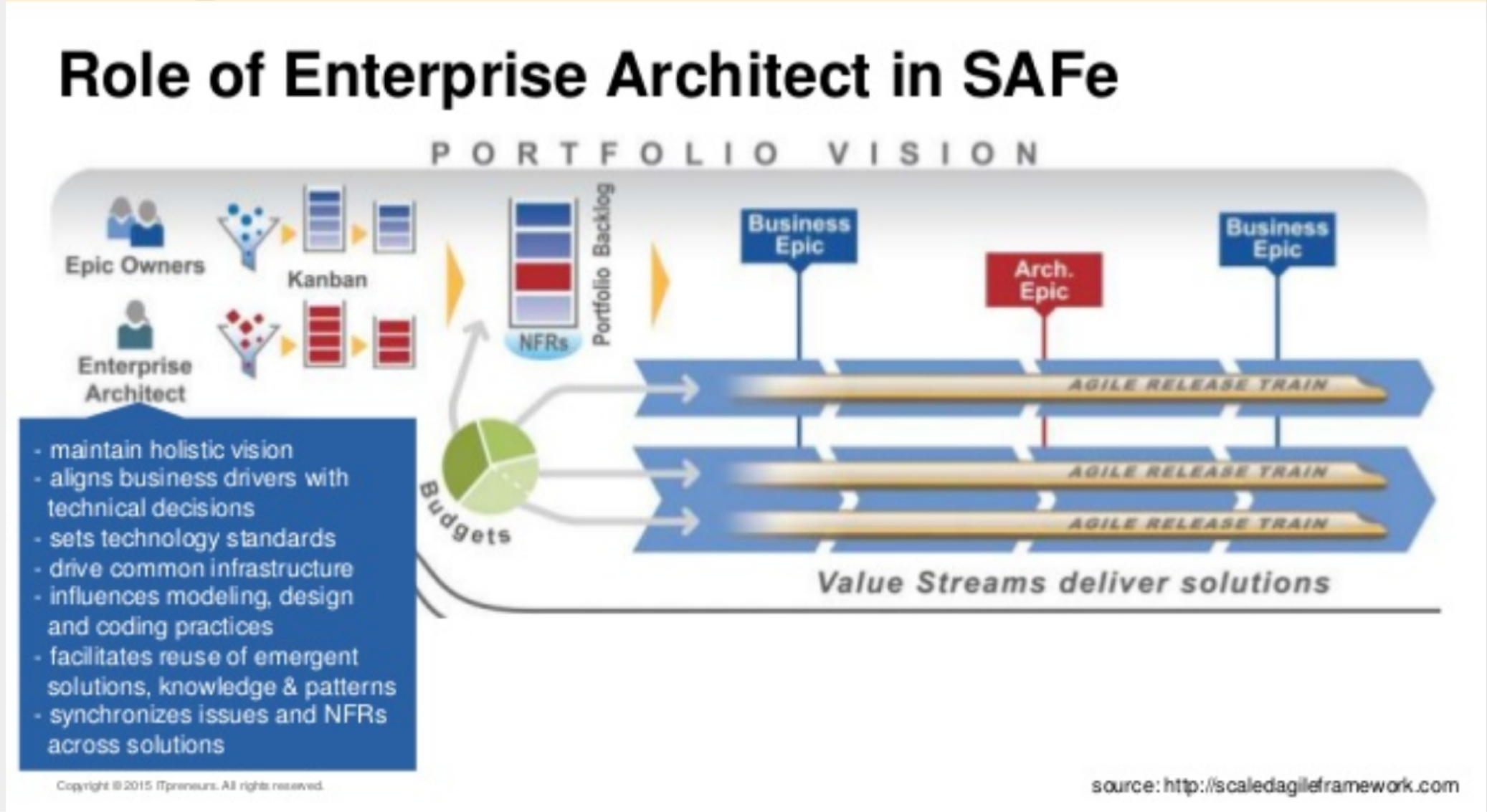


Architecture and traceability



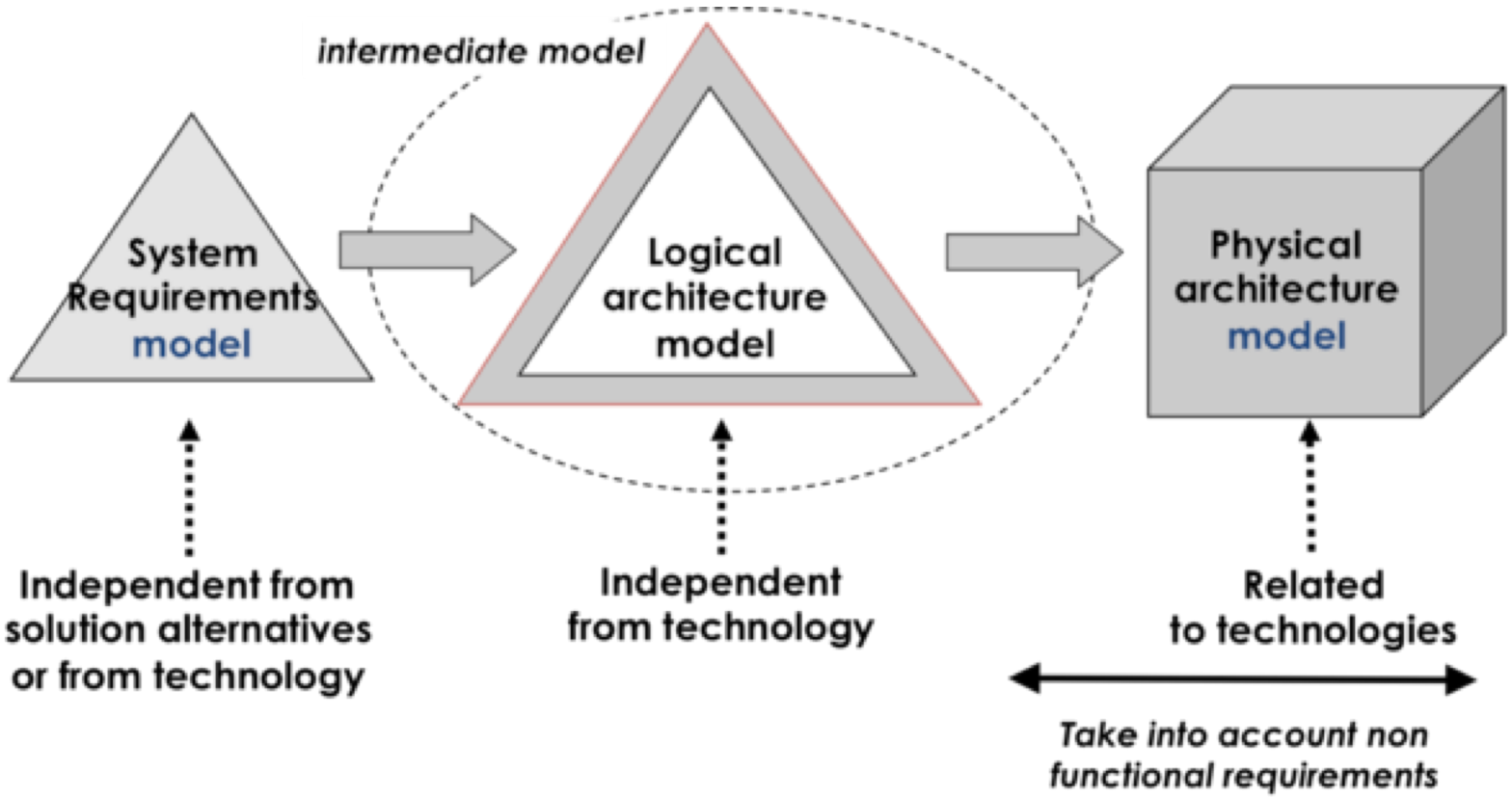

Change
IT Strategy
Business Strategy
Double-click
to open here
Business Operation
IT Infrastructure

Time for agile?



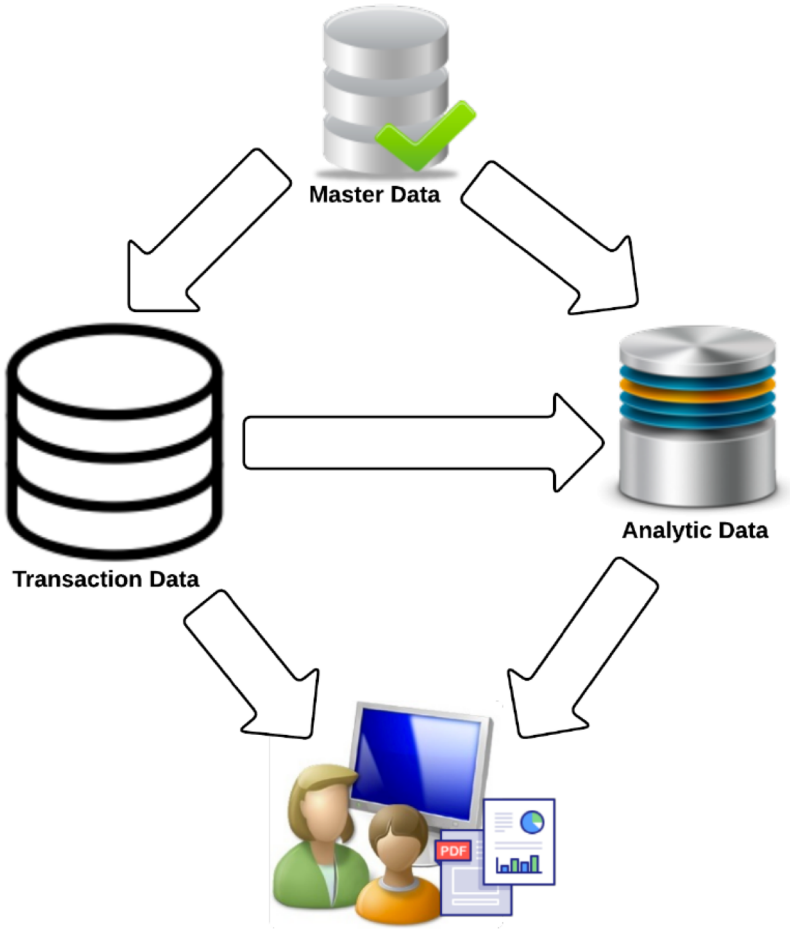
- https://www.slideshare.net/dannygreefhorst/agile-togaf-and-enterprise-architecture-will-they-blend

Systems architecture



Enterprise data categories

- Master data: main data entities.
- Transaction data.
- Analytic data.



What is Master Data Management (MDM)?

Figure 1. Magic Quadrant for Master Data Management Solutions

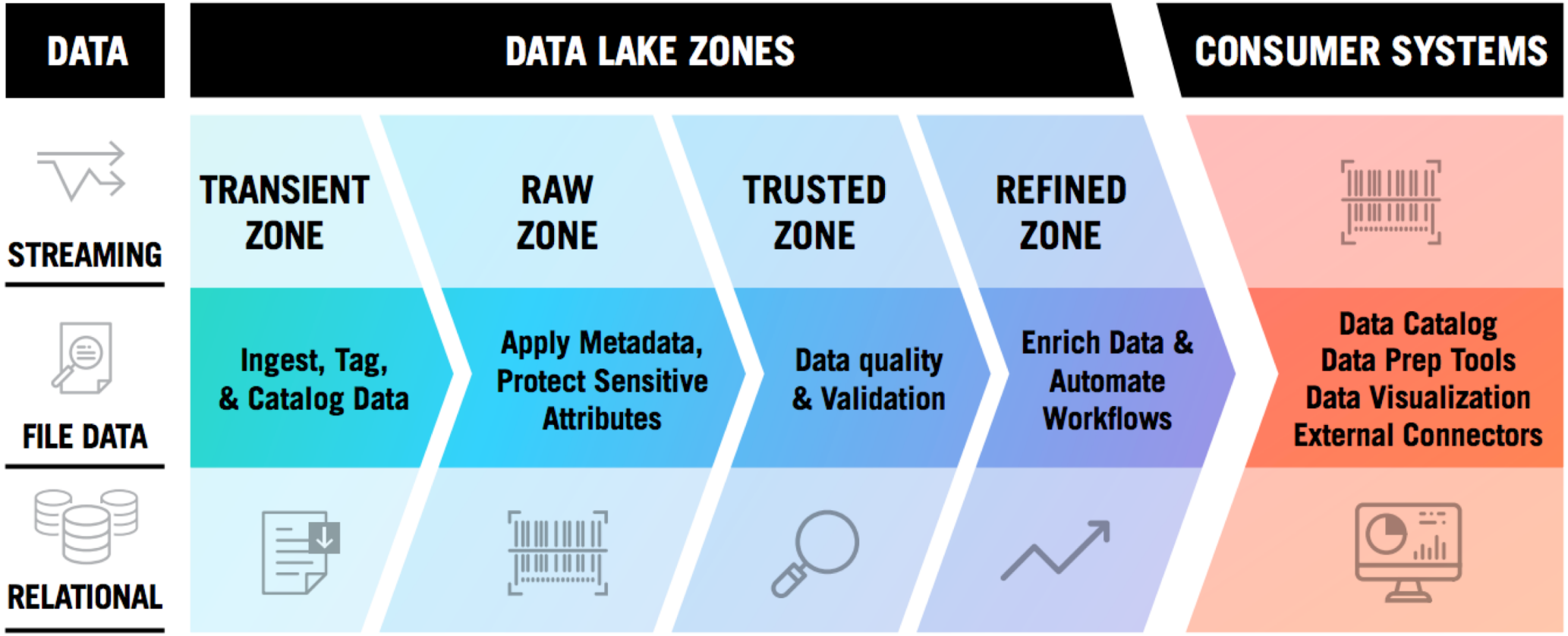
Source: Gartner (October 2017)

"MDM delivers business value straight to your bottom line by providing a trusted, relevant and accurate view of your business-critical master data across your applications and analytics. "

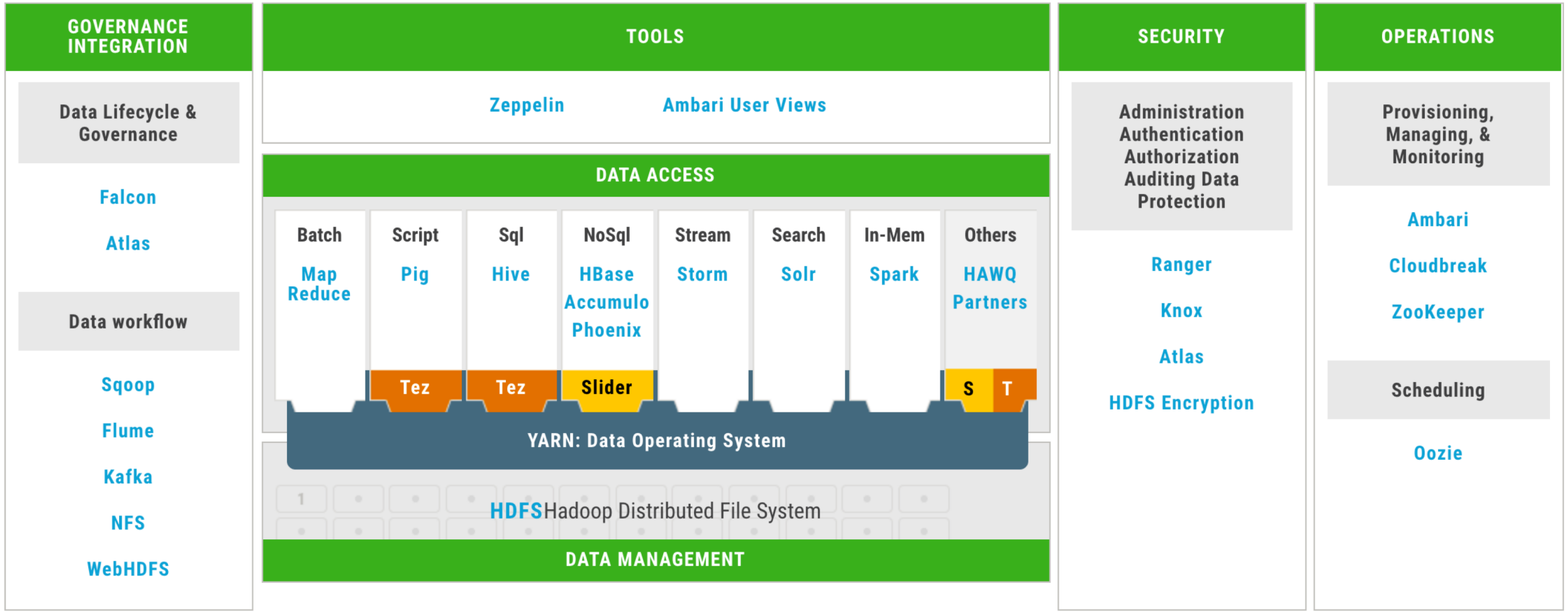
Requirements for data

- Data governance and traceability
- Applying ML, analytics, BI
- Information traceability and consistency
- Centralized management for quicker adaptation

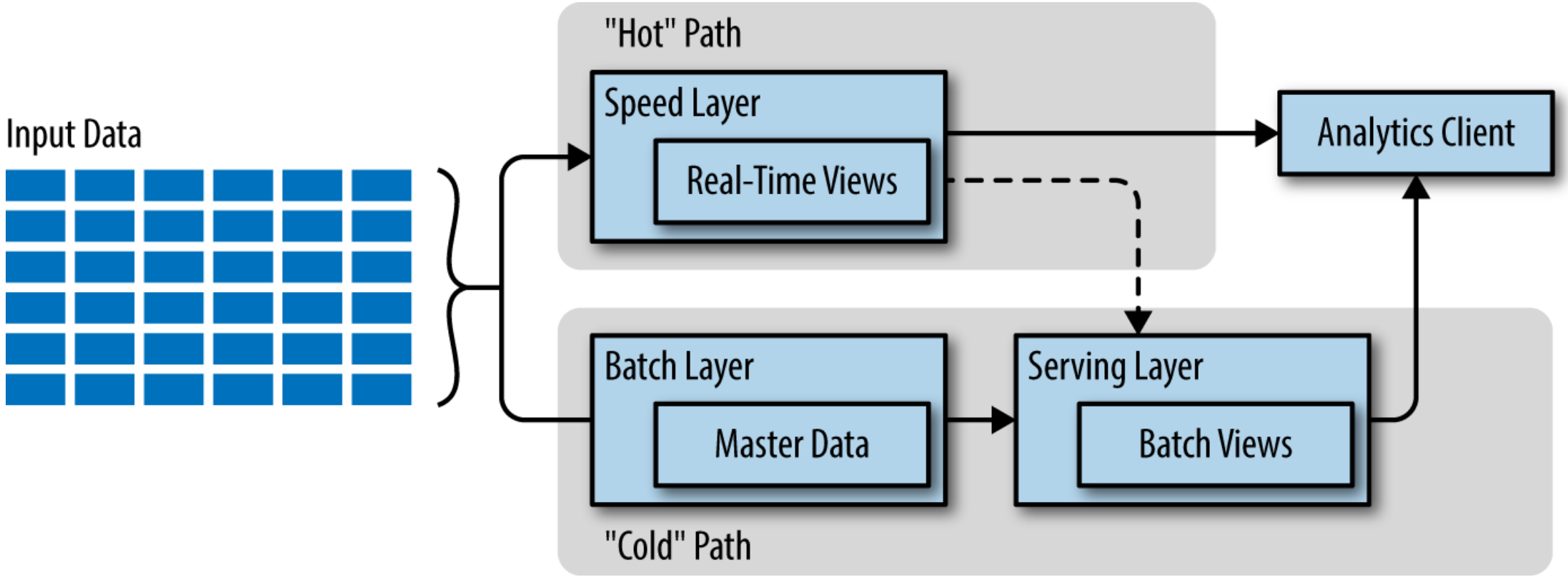
Logical view of a Data Lake



Physical architecture (Hortonworks)



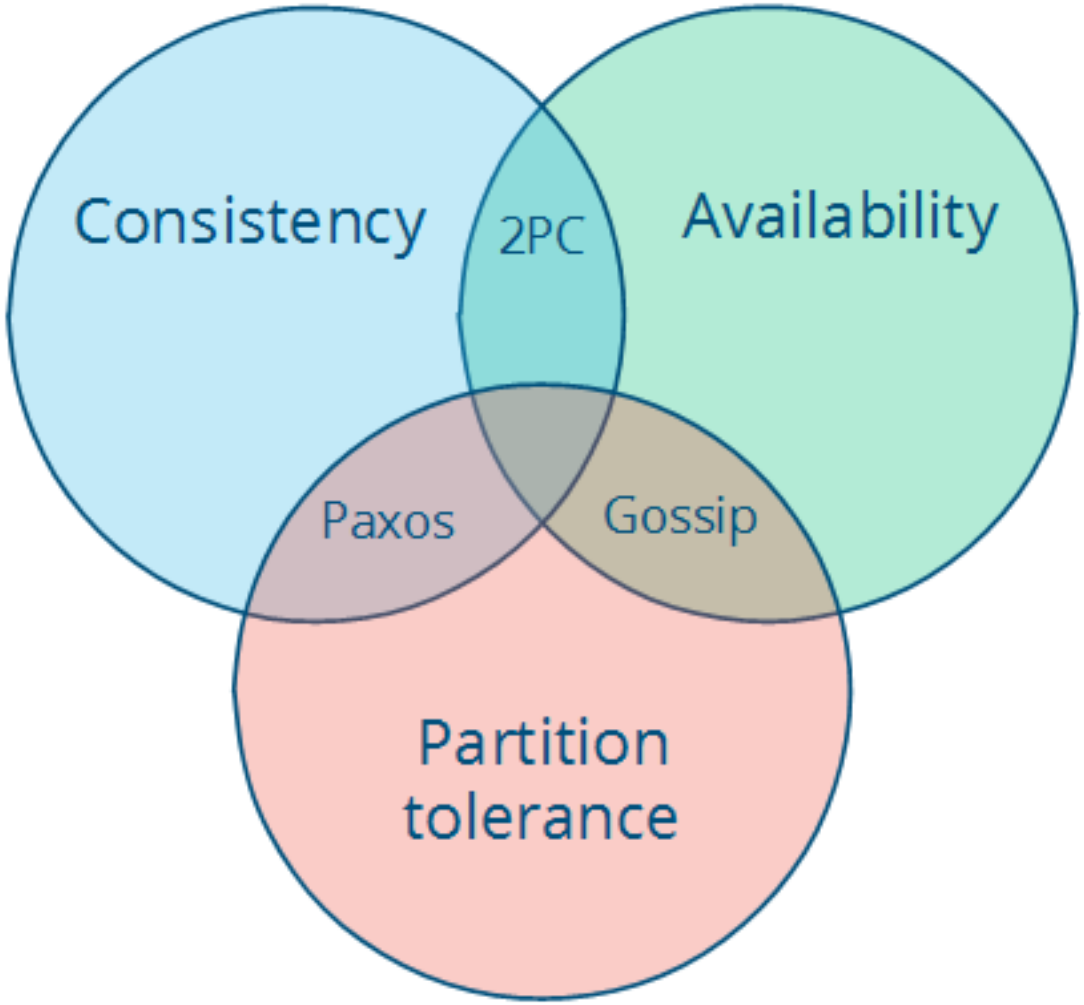
Lambda architecture (processing part of a Data Lake)



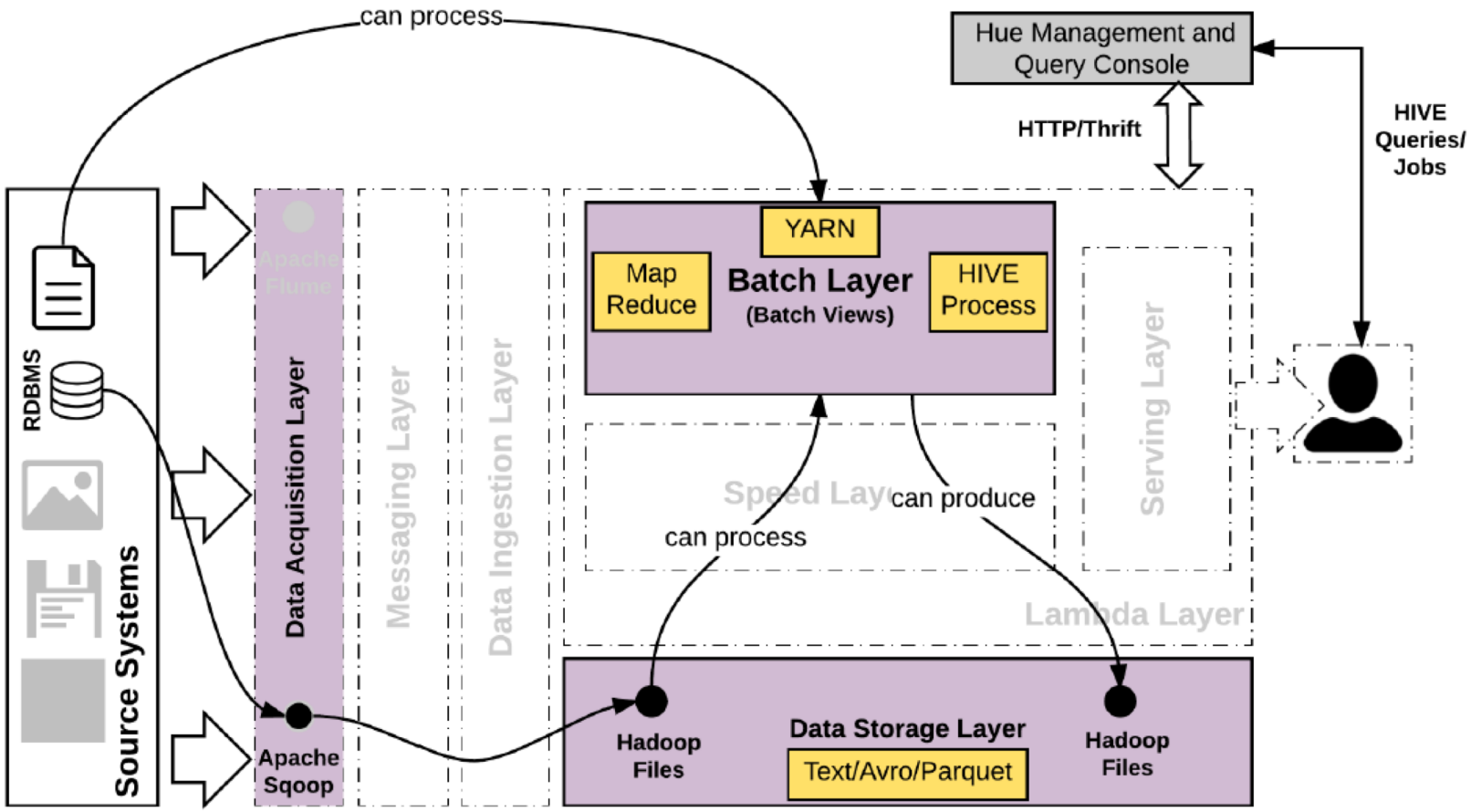
Principles of lambda architecture

- Fault-tolerance
- Immutable data.
- Recomputation from raw data.

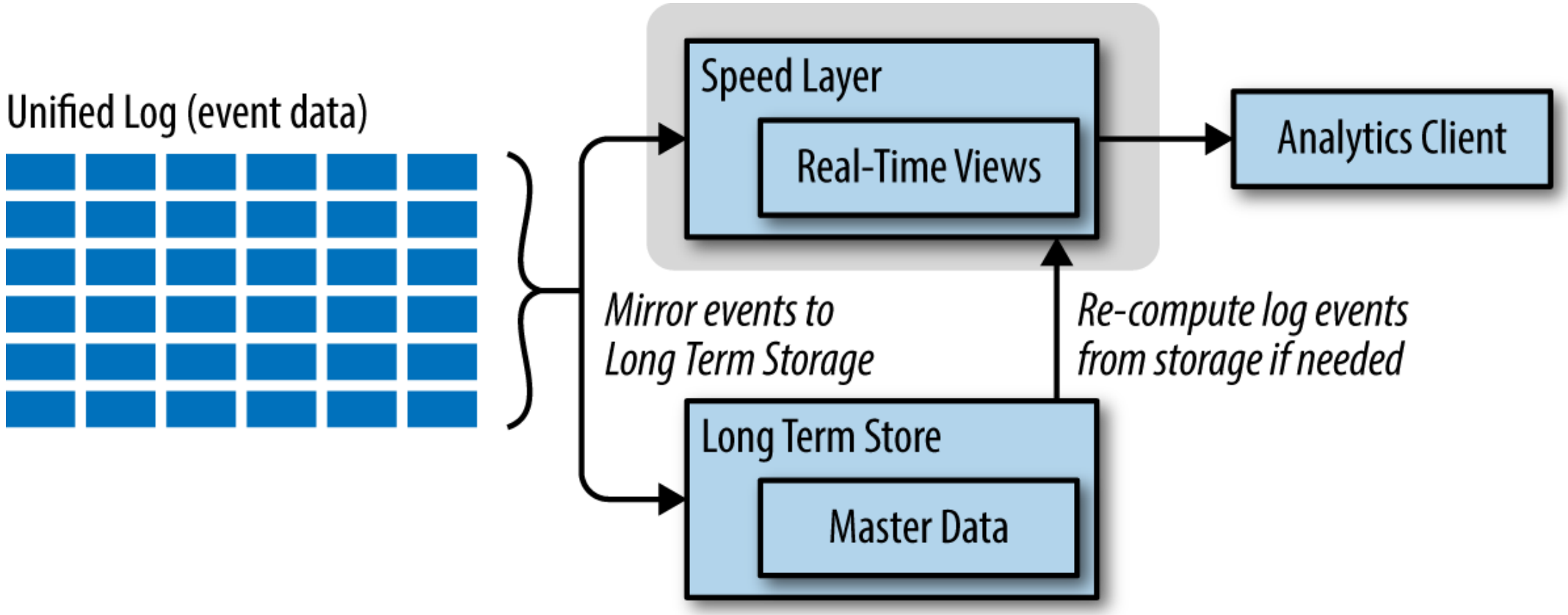
- Usually availability is chosen against consistency.



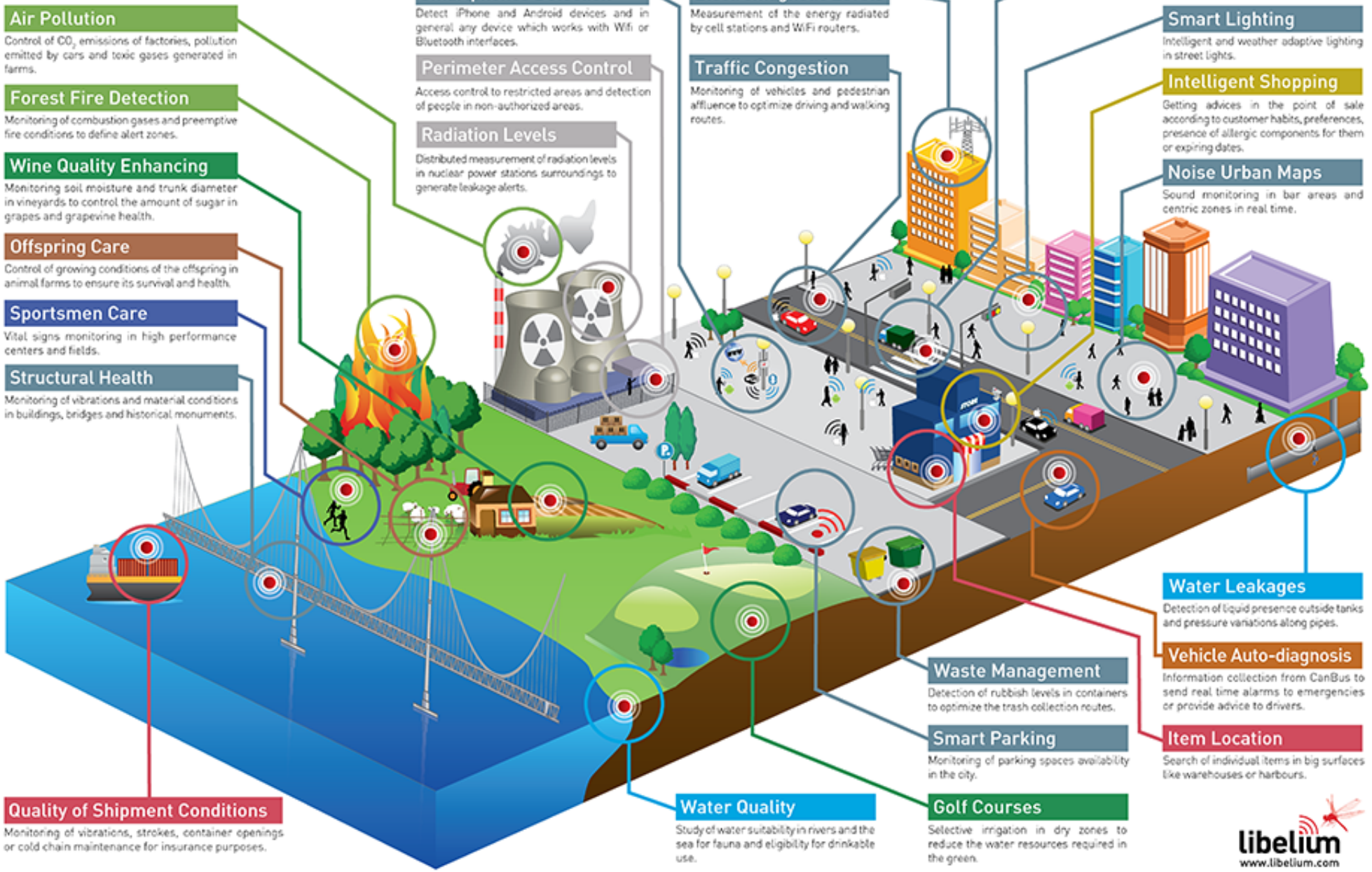
Physical versus logical



Kappa architecture



Libelium Smart World



Air Pollution
Control of CO_2 emissions of factories, pollution emitted by cars and toxic gases generated in farms.

Forest Fire Detection
Monitoring of combustion gases and preemptive fire conditions to define alert zones.

Wine Quality Enhancing
Monitoring soil moisture and trunk diameter in vineyards to control the amount of sugar in grapes and grapevine health.

Offspring Care
Control of growing conditions of the offspring in animal farms to ensure its survival and health.

Sportsmen Care
Vital signs monitoring in high performance centers and fields.

Structural Health
Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.

Quality of Shipment Conditions
Monitoring of vibrations, strokes, container openings or cold chain maintenance for insurance purposes.

Smartphones Detection
Detect iPhone and Android devices and in general any device which works with Wifi or Bluetooth interfaces.

Perimeter Access Control
Access control to restricted areas and detection of people in non-authorized areas.

Radiation Levels
Distributed measurement of radiation levels in nuclear power stations surroundings to generate leakage alerts.

Electromagnetic Levels
Measurement of the energy radiated by cell stations and WiFi routers.

Traffic Congestion
Monitoring of vehicles and pedestrian affluence to optimize driving and walking routes.

Water Quality
Study of water suitability in rivers and the sea for fauna and eligibility for drinkable use.

Waste Management
Detection of rubbish levels in containers to optimize the trash collection routes.

Smart Parking
Monitoring of parking spaces availability in the city.

Golf Courses
Selective irrigation in dry zones to reduce the water resources required in the green.

Smart Roads
Warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

Smart Lighting
Intelligent and weather adaptive lighting in street lights.

Intelligent Shopping
Getting advices in the point of sale according to customer habits, preferences, presence of allergic components for them or expiring dates.

Noise Urban Maps
Sound monitoring in bar areas and centric zones in real time.

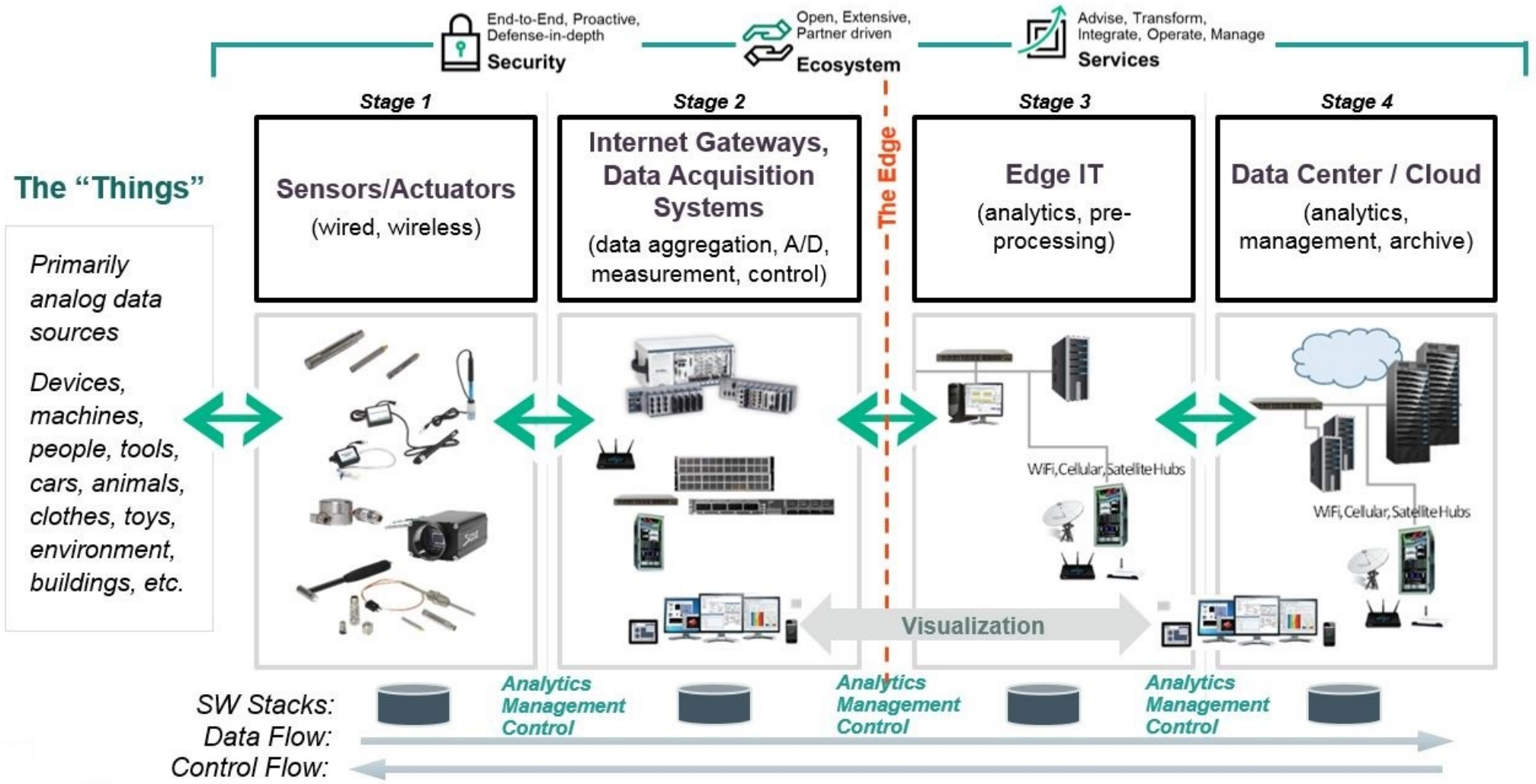
Water Leakages
Detection of liquid presence outside tanks and pressure variations along pipes.

Vehicle Auto-diagnosis
Information collection from CanBus to send real time alarms to emergencies or provide advice to drivers.

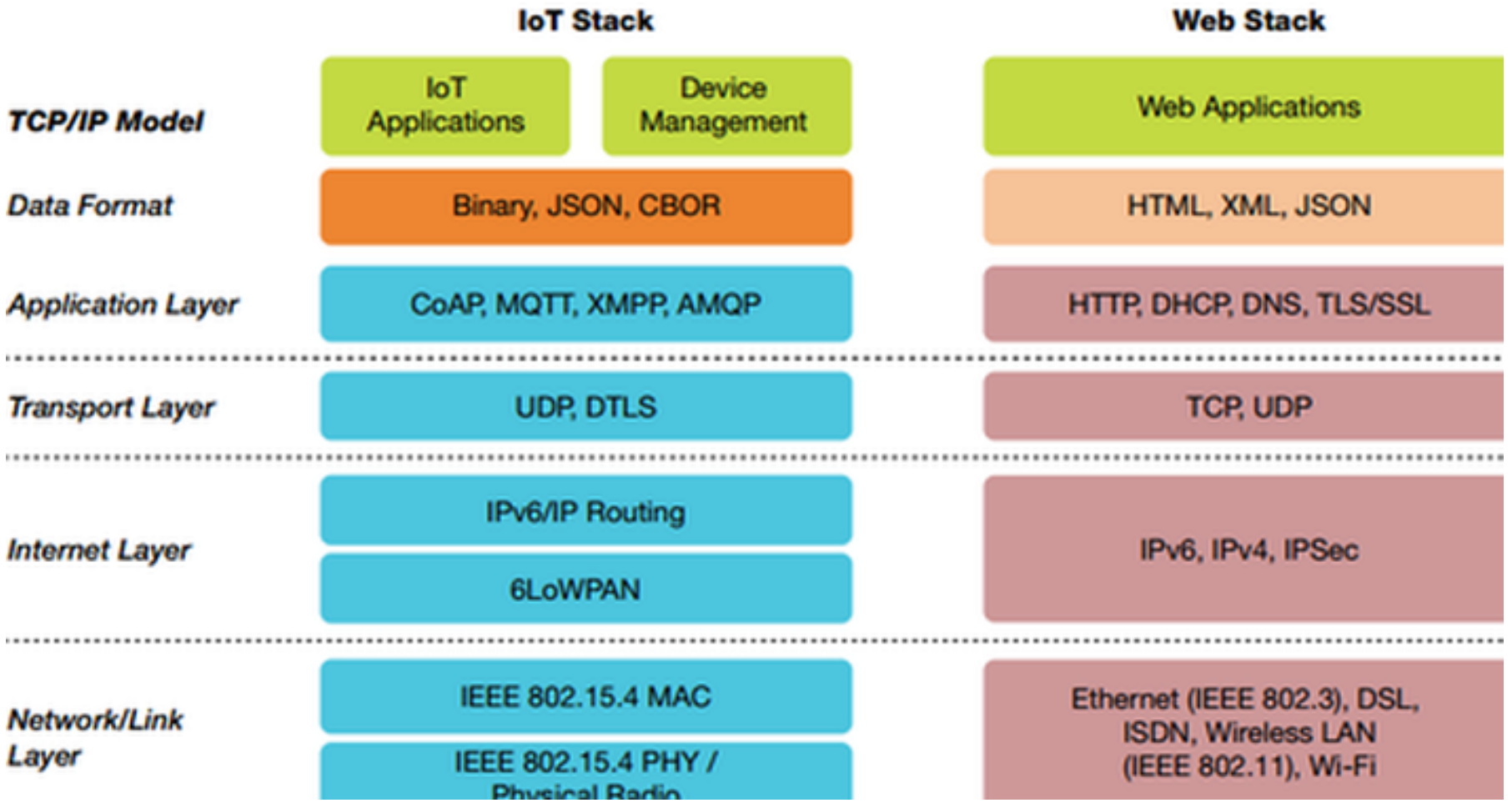
Item Location
Search of individual items in big surfaces like warehouses or harbours.

libelium
www.libelium.com

The 4 Stage IoT Solutions Architecture



IoT and protocol stacks



	ZigBee	Sub-GHz	Wi-Fi	Bluetooth
Physical Layer Standard	802.15.4	Proprietary / 802.15.4g	802.11	802.15.1
Application Focus	Monitoring & control	Monitoring & control	Web, email, video	Cable replacement
Battery Life (days)	100 – 1,000+	1,000+	0.5 - 5	1 - 7
Network Size	100s to 1,000s	10s to 100s	32	7
Bandwidth (Kbits/s)	20 - 250	0.5 – 1,000	11,000+	720
Range (meters)	1 – 100+	1 – 7,000+	1 – 30+	1 – 10+
Network Architecture	Mesh	Point-to-point, star	Star	Star
Optimized For	Reliability, low power, low cost, scalability	Long range, low power, low cost	Speed	Low cost, convenience
Silicon Labs Products	**Ember® ZigBee® EM35x Series**	**EZRadio®, EZRadioPRO®, Si10xx wireless MCUs**	N/A	N/A

Specific IoT patterns

5.4 Device Wakeup Trigger

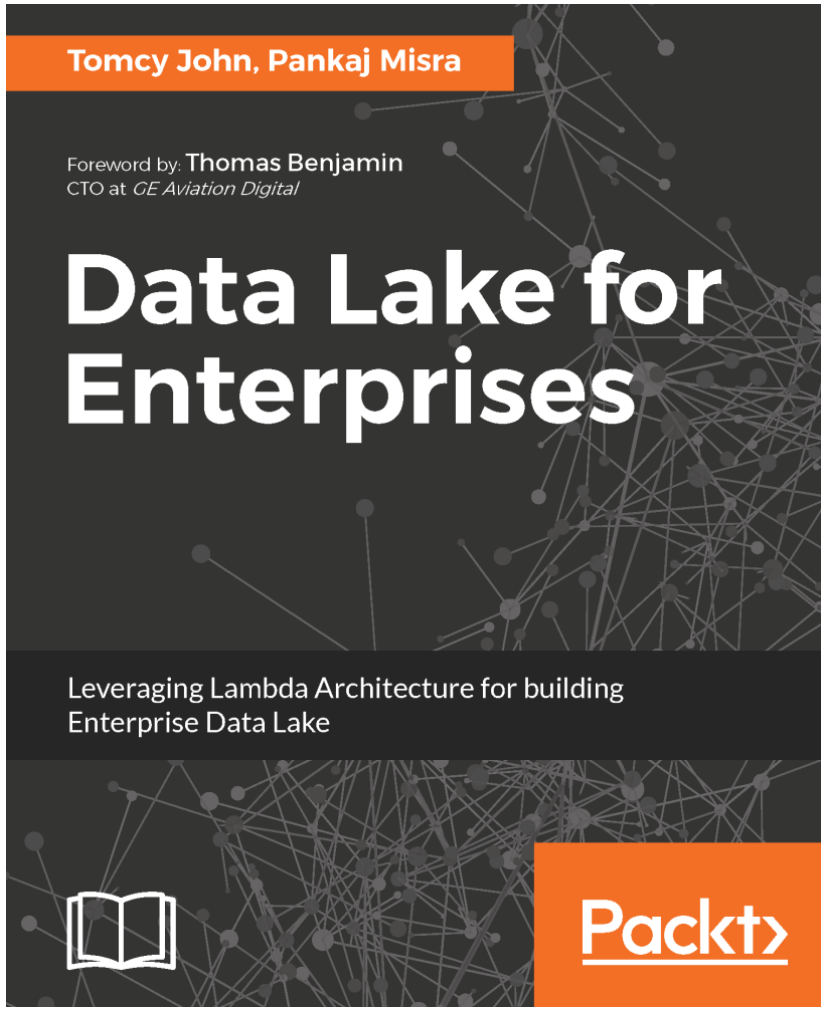
Aliases: Update Trigger, Device Triggering

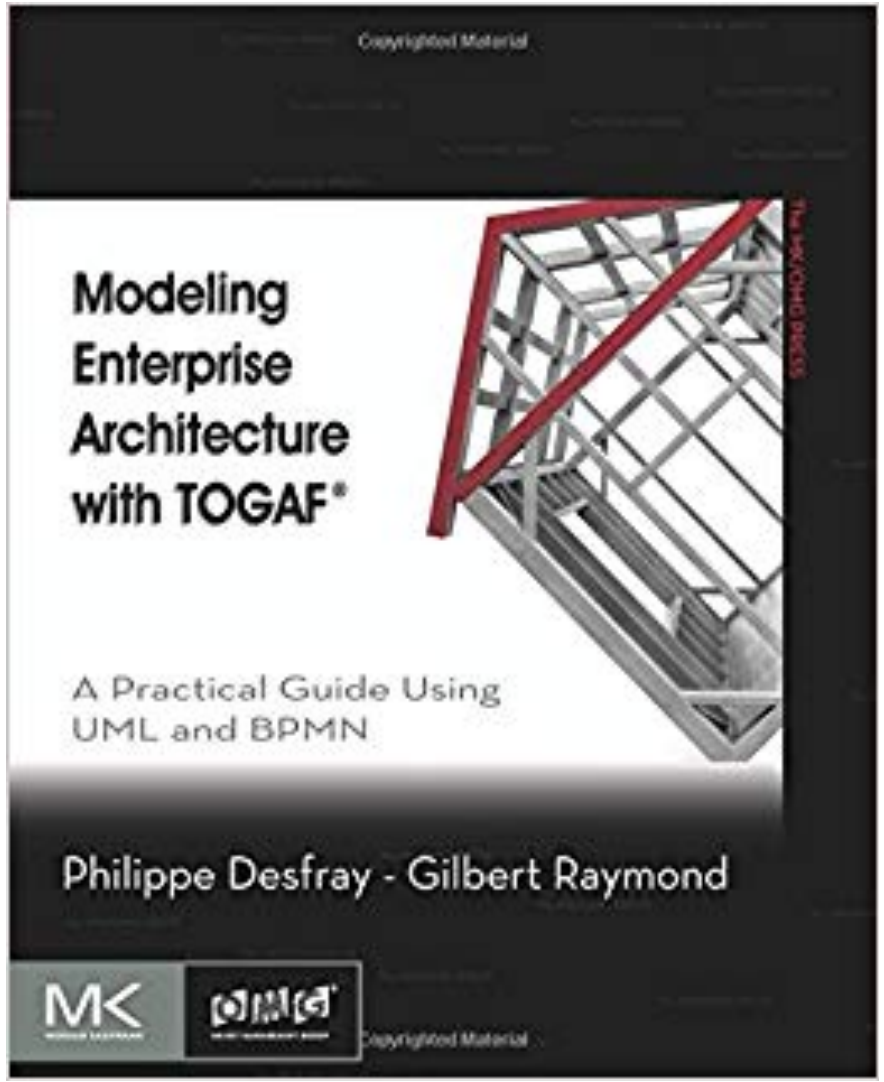
Context: You have a *Constrained Device* or *Semi-Constrained Device* that is *Lifetime Energy-Limited* or *Period Energy-Limited* and operates in a *Low-Power* or *Normally-Off* mode. You have a backend server where the device is registered, i.e. its identity and other metadata is known to the server. From time to time you have a situation where you want to immediately contact the sleeping device. For example, this could be the case if a critical security fix has to be applied, if you need current sensor values or send commands for one-off time critical situations, or if the device has been lost or stolen and you want to use REMOTE LOCK AND WIPE immediately.

Problem: Some devices might go into a sleep mode to conserve energy and only wake up from time to time to reconnect to the network. During sleep, they are not reachable on their regular communication channels. In some instances, other components might have to contact sleeping device immediately.

- http://www.iaas.uni-stuttgart.de/RUS-data/INPROC-2016-46%20-%20Internet%20of%20Things%20Patterns.pdf

References


Tomcy John, Pankaj Misra
Foreword by: Thomas Benjamin
CTO at GE Aviation Digital
Data Lake for Enterprises
Leveraging Lambda Architecture for building Enterprise Data Lake
Packt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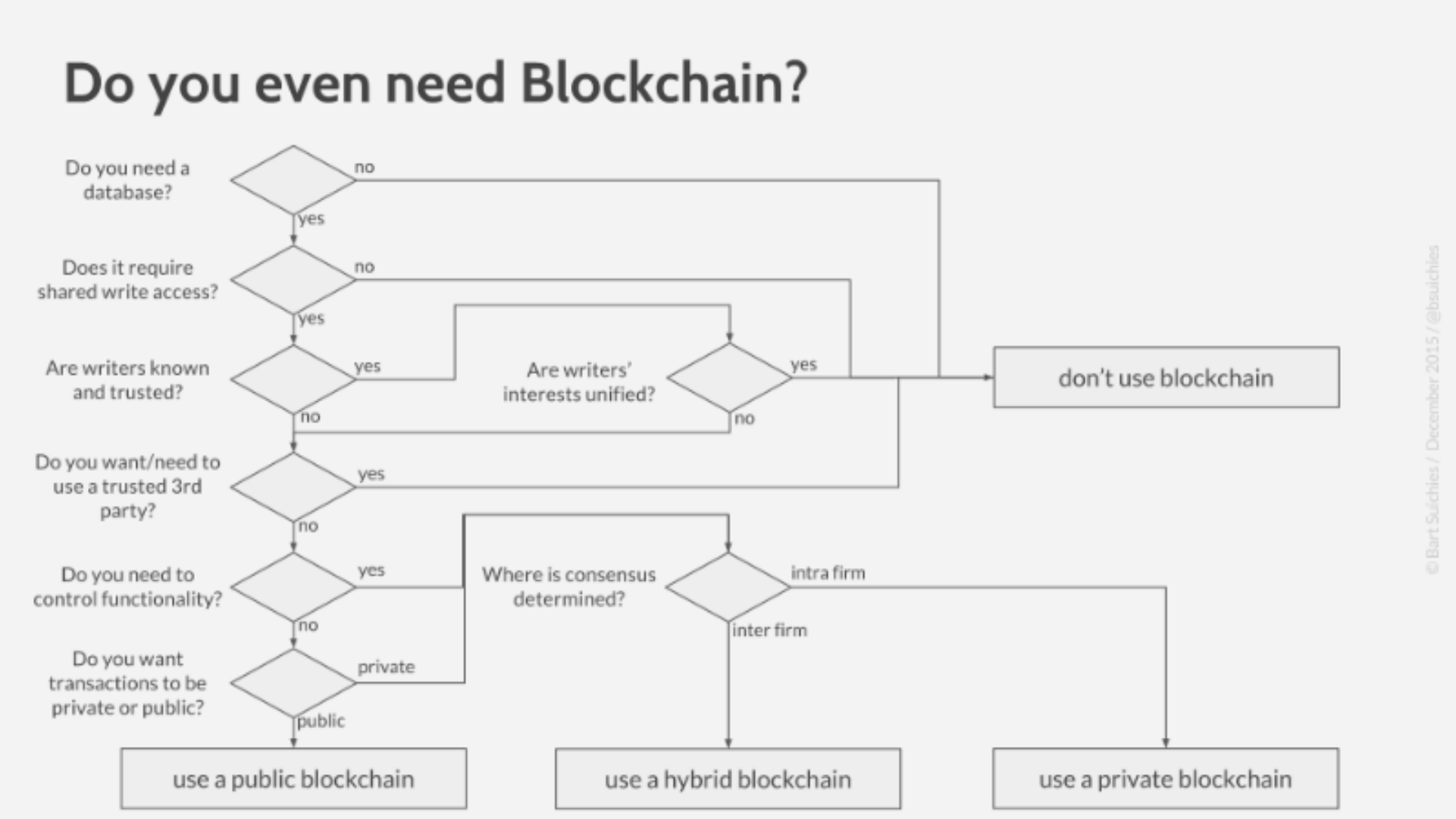
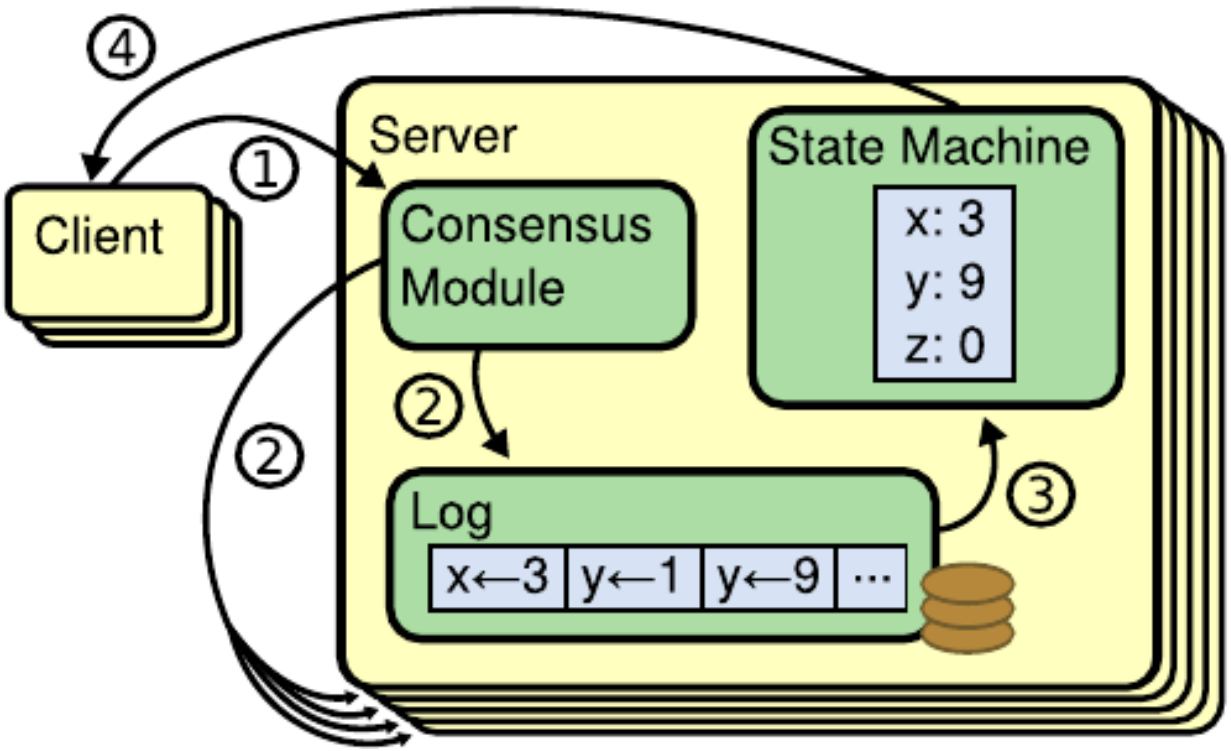
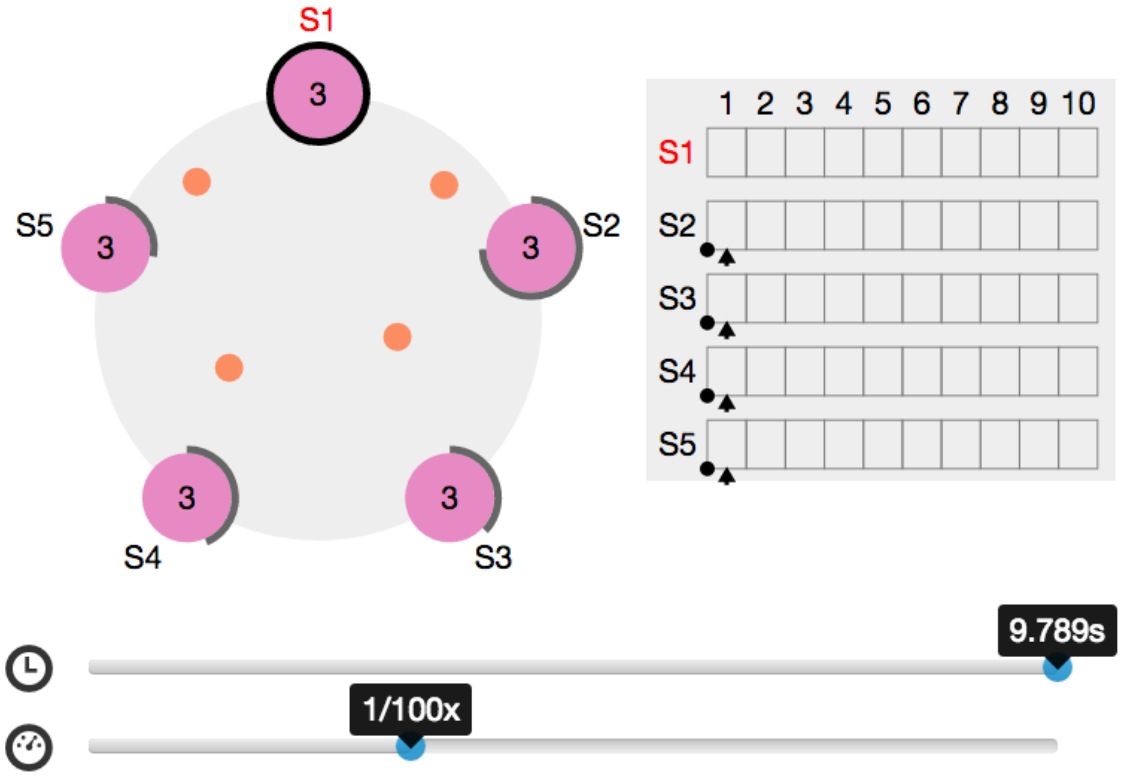
Introducing new requirements



Understanding consensus: RAFT

- http://thesecretlivesofdata.com/raft/



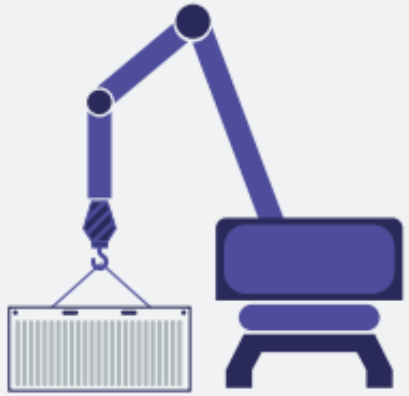


Business networks with limited trust

Blockchain—a shared, distributed ledger—can trace the container's path through the supply chain with exceptional transparency and security.

The flower grower readies the product for international shipment. Shipment information is added to the blockchain.

As the container awaits transfer to port, officials submit approvals electronically. Blockchain confirms the transaction and executes a smart contract, releasing the shipment.



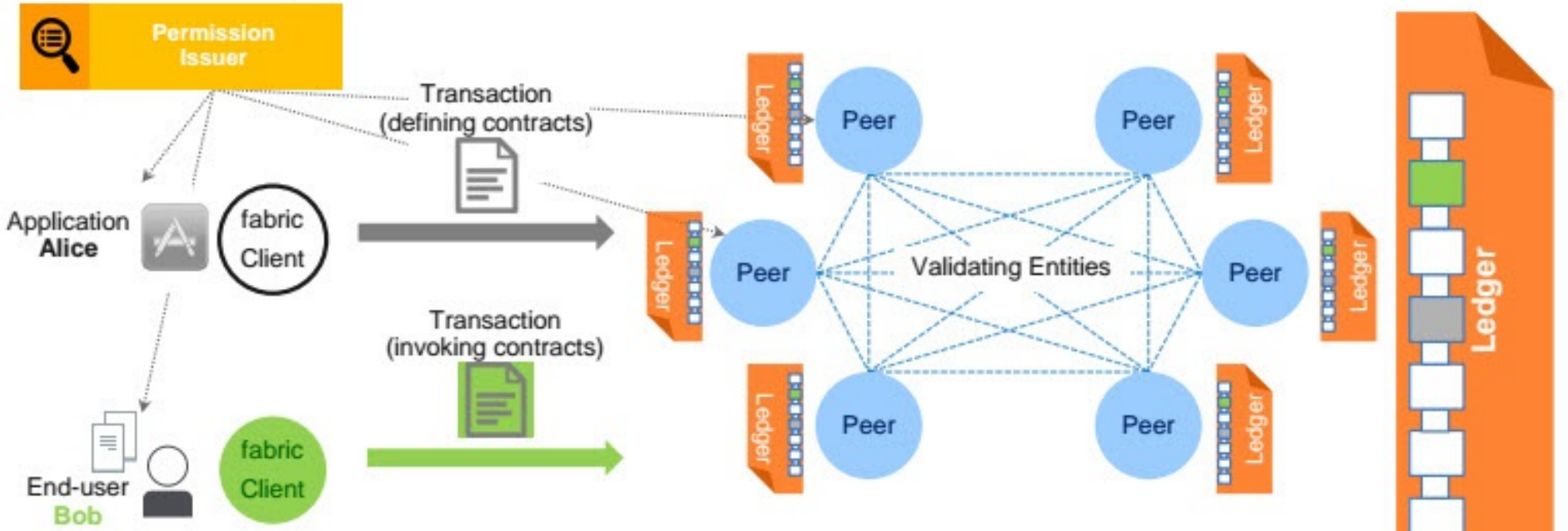
The container is loaded onto the ship.

All parties have end-to-end visibility of the container's progress through the supply chain.

The container arrives at the destination port and clears customs.

Retailer receives the flowers on time and signs electronically. Information is relayed back to the blockchain.

Hyperledger-fabric model



- **Permissioned** system; strong **identity management**
- Distinct roles of **users**, and **validators**
- Users **deploy** new pieces of code (chaincodes) and **invoke** them through **deploy** & **invoke** transactions
- Validators evaluate the effect of a transaction and reach consensus over the new version of the **ledger**
- **Ledger** = total order of transactions + hash (global state)
- **Pluggable consensus** protocol, currently PBFT & Sieve