

# Big Data Management

Master in Innovation and Research in Informatics & Erasmus  
Mundus BDMA

# Introduction to Big Data

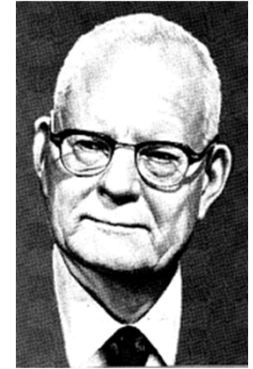
# Knowledge Objectives

1. Recognise the relevance of data driven decision making
2. Identify the three high level categories of analytical tools
3. Identify the two main sources of Big Data
4. Give a definition of Big Data
5. Compare traditional data warehousing against Big Data management
6. Distinguish descriptive, predictive and prescriptive analytics
7. Explain the novelty of Cloud Computing
8. Justify the benefits of Cloud Computing
9. Explain the link between Big Data and Cloud Computing
10. Distinguish the main four service levels in Cloud Computing

# Data driven decision making

# The relevance of data

- “Without data you are just another person with an opinion.”
  - William Edwards Deming (American engineer, statistician, professor and consultant)
- “It is a capital mistake to theorize before one has data.”
  - Sherlock Holmes (A Study in Scarlet)



# We live in a data-driven society

Collect, store, combine and analyze any relevant data to gain competitive advantage

- Decision making
  - *To identify and choose alternatives based on values, preferences and beliefs of the decision-maker ... every decision-making process produces a final choice.* Wikipedia
- 90% of the world's data has been generated in the last two years
  - Data-driven decision making Marr

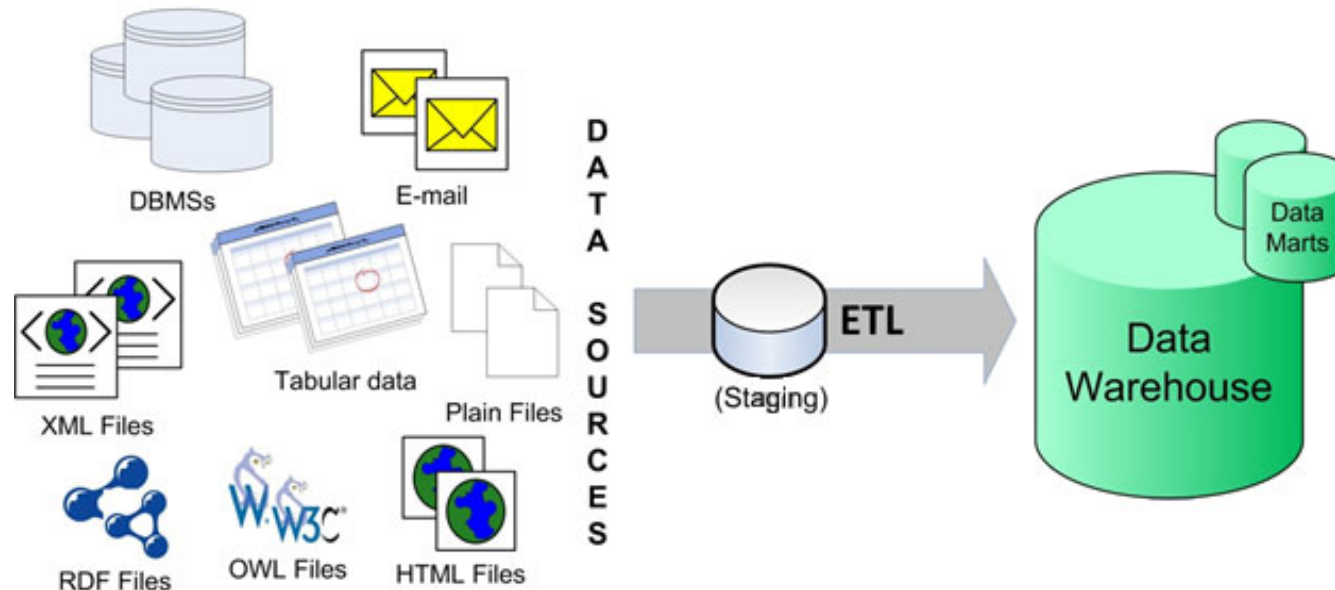
# Data as the New Cornerstone

- We have witnessed the bloom of a new business model based on data analytics: Data is not a passive but an active asset
  - «Data is the new oil!» - Clive Humby, 2006
  - «No! Data is the new soil» - David McCandless, 2010
- Confluence of three major socio-economic and technological trends makes data-driven innovation a new phenomenon today:
  - The **exponential growth** in data generated and collected,
  - the **widespread** use of **data analytics** including start-ups and small and medium enterprises (SMEs), and
  - the emergence of a **paradigm shift** in knowledge
- Organizations must adapt **infrastructures** to leverage the data deluge (Digital data doubling every 18 months (IDC))

International Data Corp.'s (IDC)

# Business Intelligence: Data Management

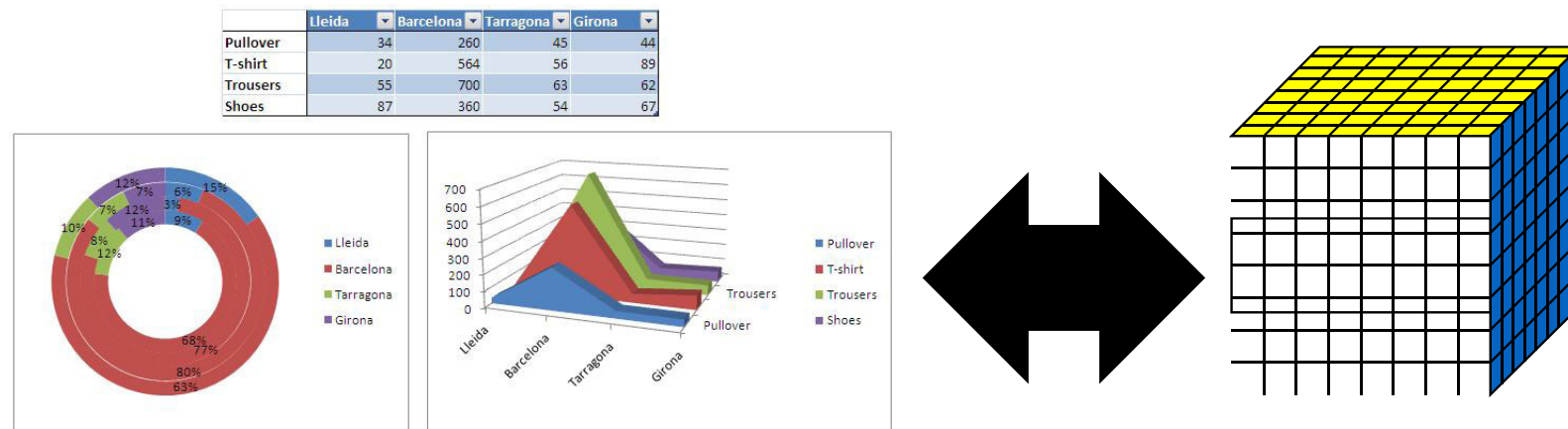
- Well-established de facto standards:
  - **Architecture**: Corporate Information Factory
  - **Data Modeling**: Multidimensional model





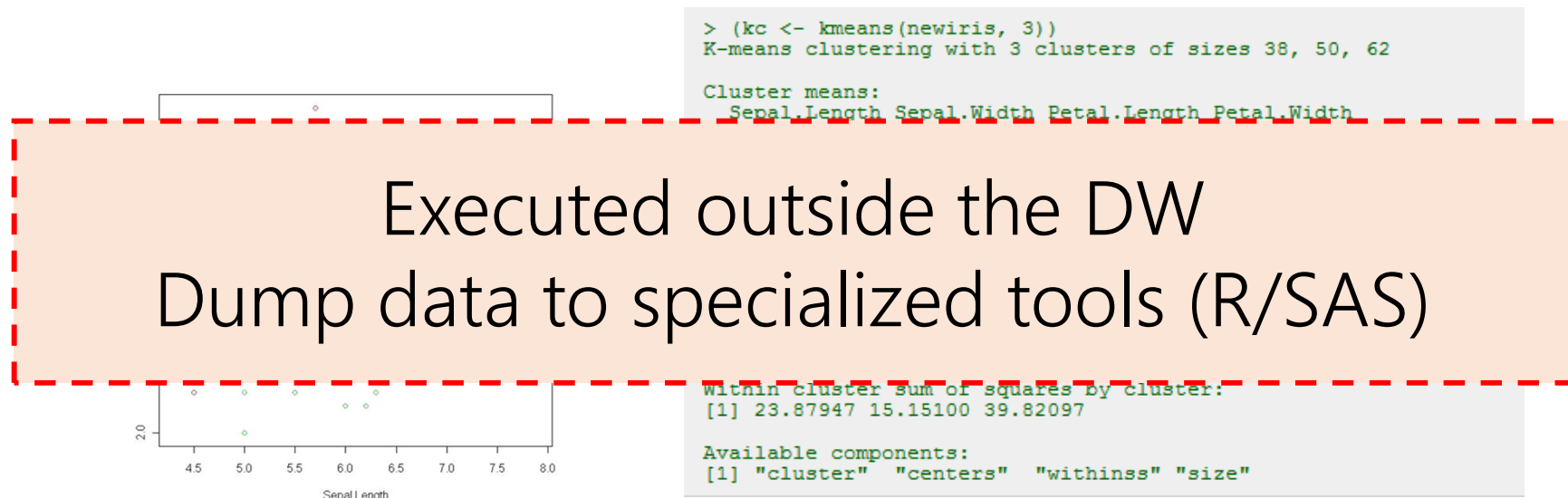
# Business Intelligence: Analytics

- Three different levels of detail
  - Querying & Reporting: Static report generation
  - OLAP: Dynamic navigation of data
  - Data Mining and Machine Learning: Inference of hidden patterns or trends

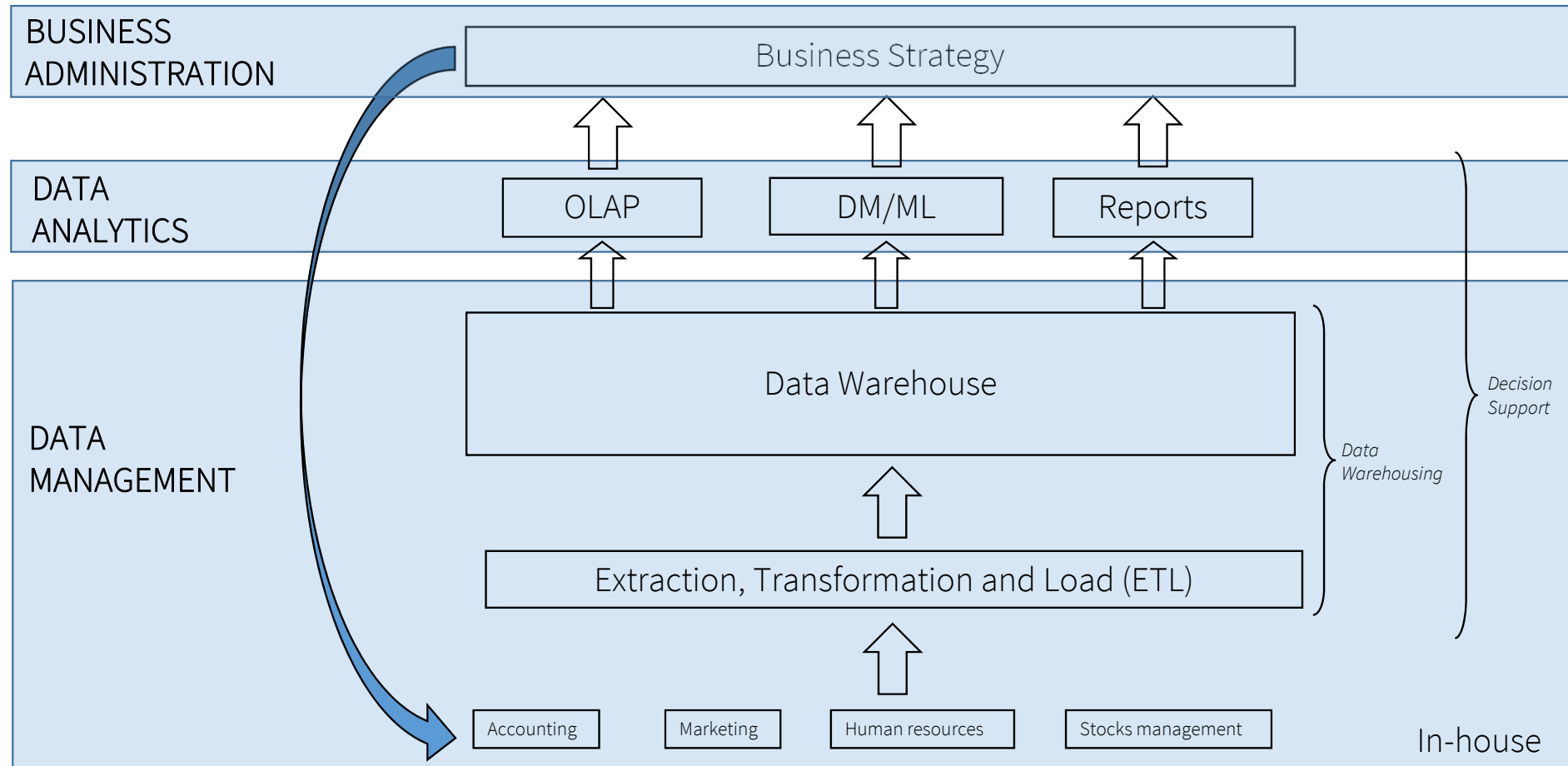


# Business Intelligence: Analytics

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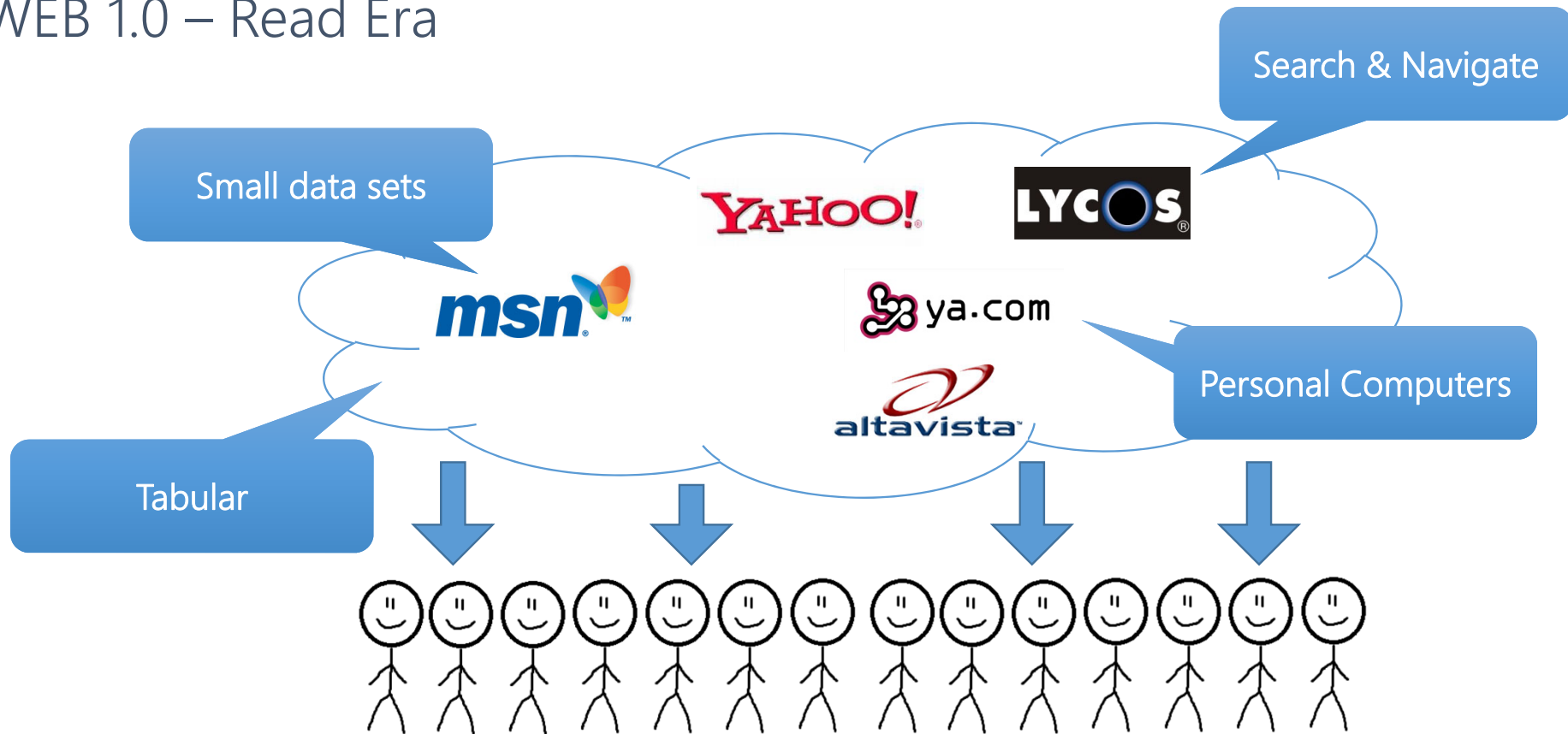
# The Business Intelligence (BI) lifecycle



# Big Data

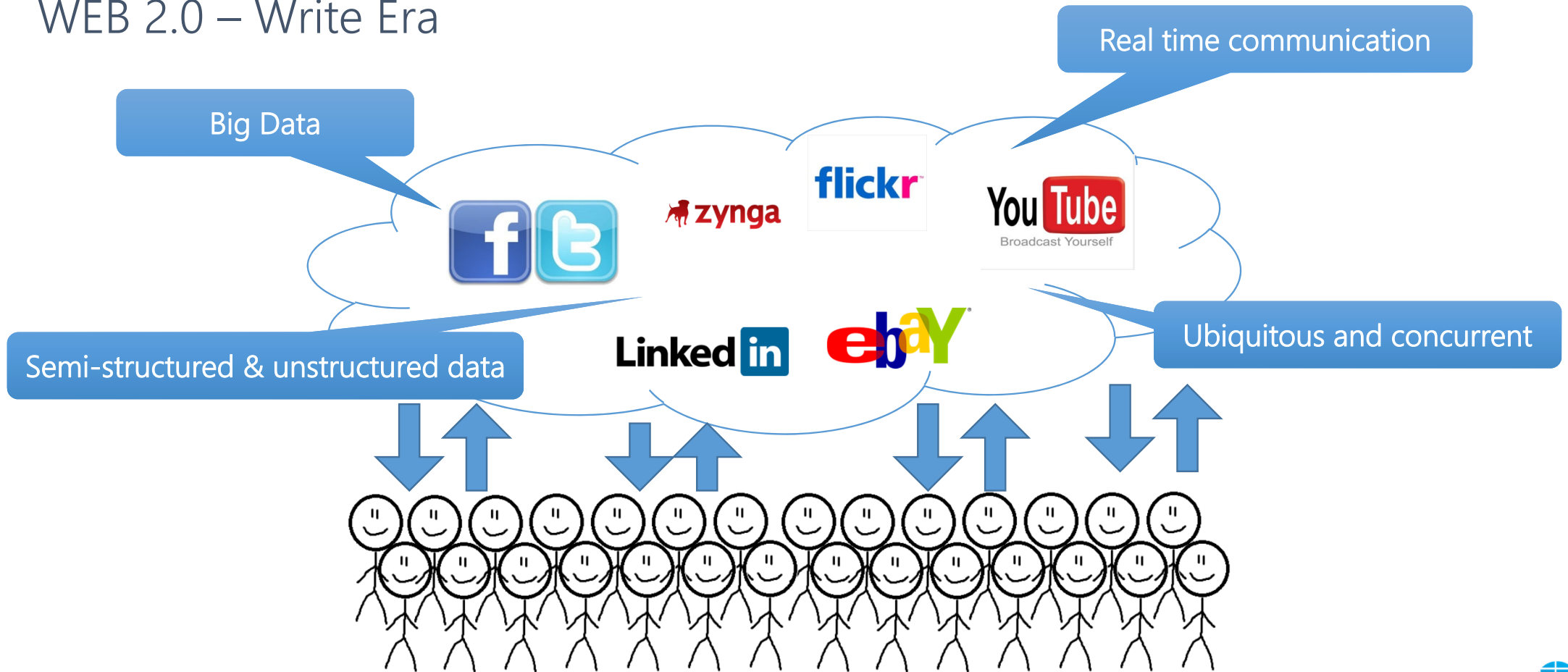
# The end of an architectural era

## WEB 1.0 – Read Era

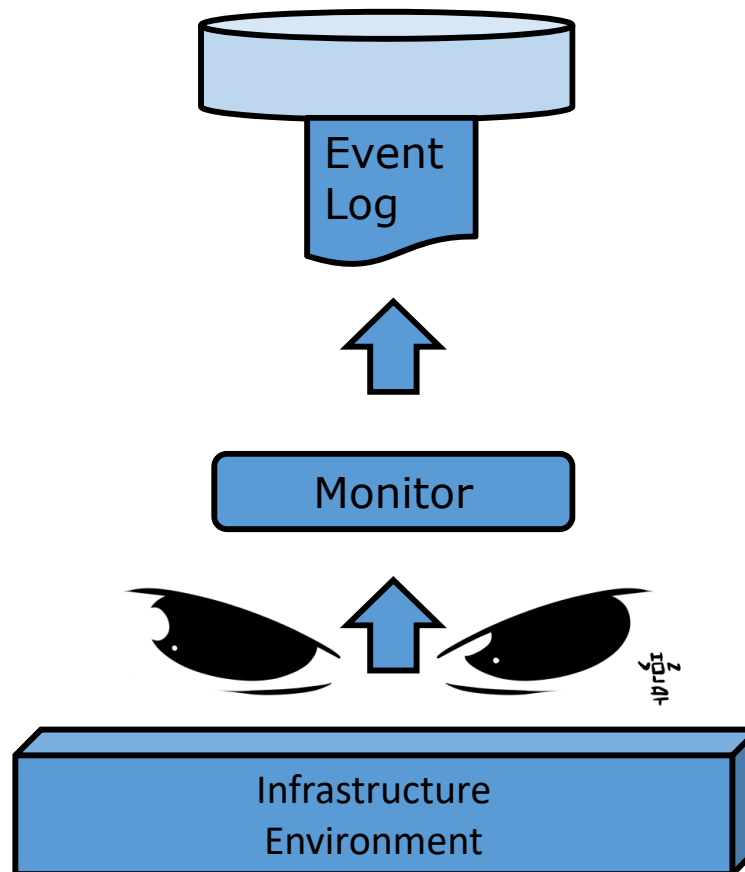


# The end of an architectural era

## WEB 2.0 – Write Era



# Monitoring the infrastructure



# New challenges for data management

# VOLUME

Value =  $f(V_1, V_2, V_3, V_4, V_5)$

Value

Variability

Variety

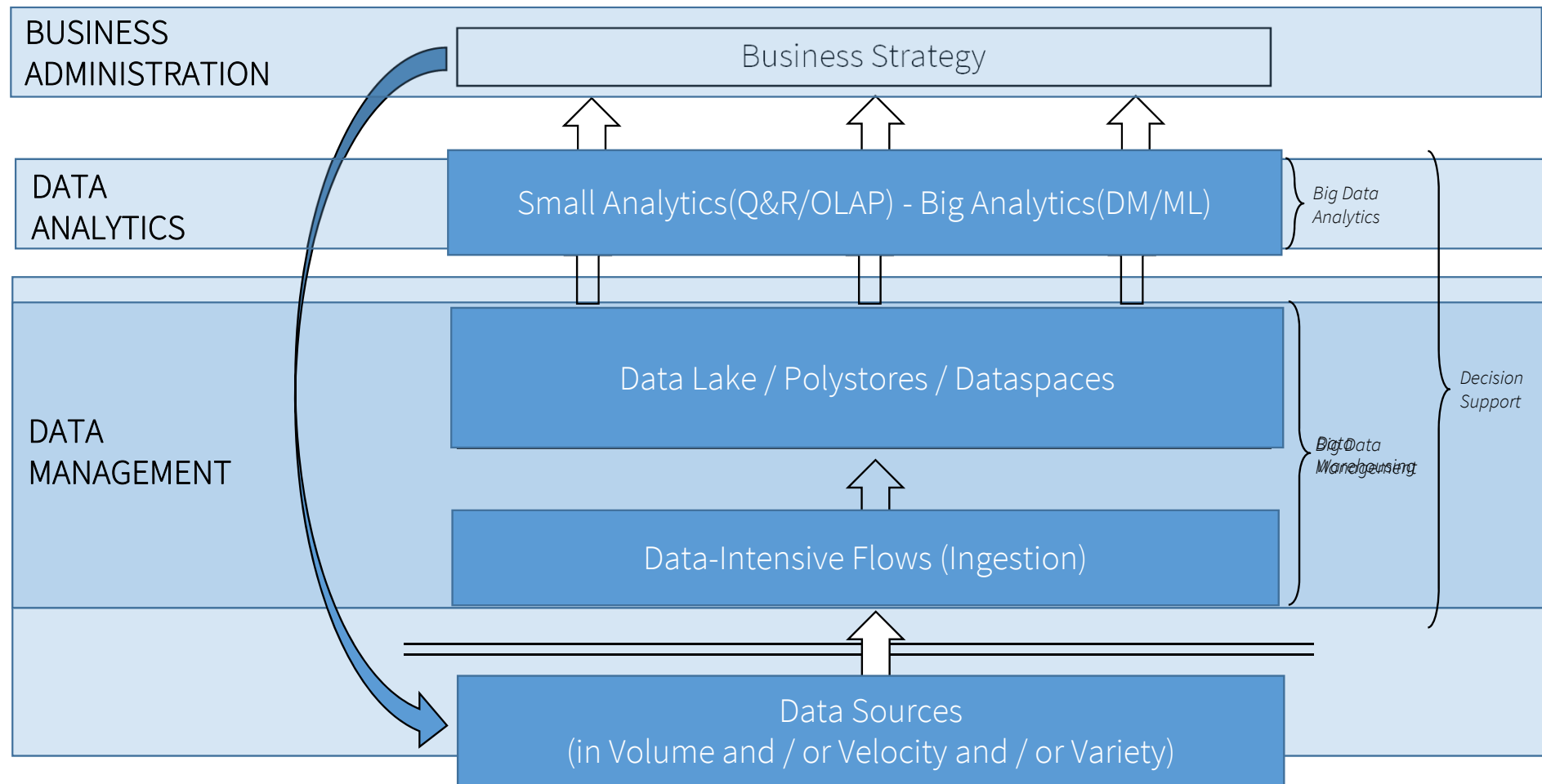


# Big Data facets

- The Original
- as Technology
- as Data Distinctions
- as Signals
- as Opportunity
- as Metaphor
- as New Term for Old Stuff

Timo Elliott

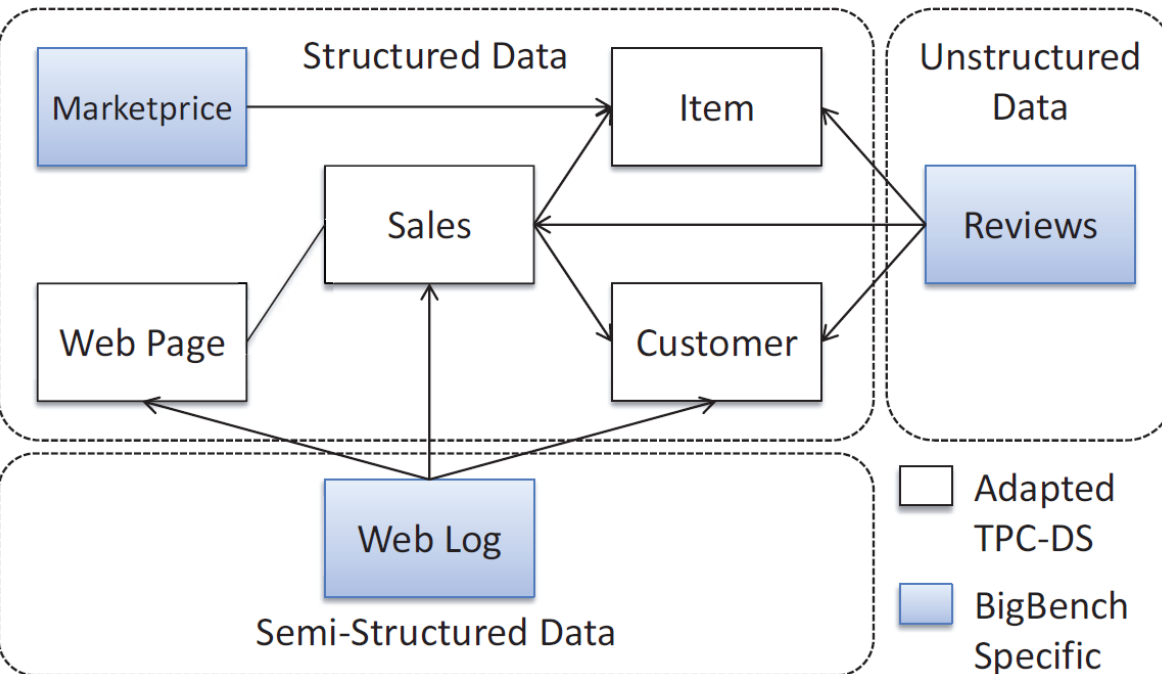
# The Big Data Lifecycle



# Big Data related areas

- Volume and Velocity
  - Distributed processing
  - Parallelism
  - Declarative querying
  - Query optimization
- Variety and Variability
  - Information retrieval
  - Web and text mining
  - Schema evolution
  - Data integration
- Veracity/Validity
  - Data quality
  - Uncertainty
  - Statistical reasoning
  - Data lineage and provenance
- Value
  - Analytics (ML)
  - Biology, Linguistics, Engineering

# Big Bench



Query processing type	Total	Percentage(%)
Declarative	10	33.3
Procedural	7	23.3
Mix of Declarative and Procedural	13	43.3

Data sources	Total	Percentage(%)
Structured	18	60.0
Semi-structured	7	23.3
Un-structured	5	16.7

Analytic techniques	Total	Percentage(%)
Statistics analysis	6	20.0
Data mining	17	56.7
Reporting	8	26.7

# Types of Big Data analyzed in industry

	Manufacturing and Natural Resources	Media/ Communications	Services	Government	Education	Retail	Banking	Insurance	Healthcare	Transportation	Utilities
Transactions	73%	62%	67%	67%	54%	93%	83%	81%	75%	79%	80%
Log data	44%	57%	58%	59%	54%	40%	66%	61%	33%	71%	60%
Machine or sensor data	53%	38%	35%	33%	31%	27%	27%	48%	42%	50%	40%
Emails /documents	27%	43%	43%	41%	46%	27%	34%	39%	17%	29%	20%
Social media data	32%	52%	39%	26%	54%	73%	27%	13%	-	50%	-
Free-form text	17%	24%	28%	30%	31%	20%	34%	35%	67%	21%	40%
Geospatial data	27%	14%	19%	19%	38%	27%	27%	26%	8%	29%	40%
Images	19%	24%	17%	11%	38%	13%	5%	16%	25%	7%	-
Video	8%	29%	12%	7%	31%	13%	-	6%	8%	7%	-
Audio	10%	19%	8%	4%	8%	-	-	6%	-	-	-
Other	8%	14%	13%	15%	8%	7%	10%	16%	42%	14%	-
n =	59	21*	127	27*	13*	15*	41	31	12*	14*	5*

Note: Highlighted cells indicate the top three data types by industry.  
Multiple responses allowed

Source: Gartner (September 2013)

# An orthogonal classification: kinds of data analytics

- **Descriptive**: Deterministically compute summarizations
  - Count, sum, average, min, max, etc.
  - Typical OLAP operations
- **Predictive**: Probabilistic by nature, try to forecast what may happen according to what have happened
  - Linear and non-linear regression,
  - Classification,
  - Clustering,
  - Association rules, etc.
- **Prescriptive**: Given the prediction(s) of a (several) model(s), understand why something is happening and undertake automatic action(s)
  - Examples:
    - Stock market (buy/sell shares)
    - Set Price (automatically increase/decrease)

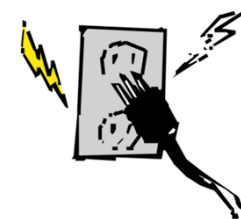
# Cloud Computing

Providing access to infrastructure

# Analogy: Electricity as a Utility



Own production



Pay-per-use



# Computation as a Utility



**Private Data Centre**  
*("Own production")*



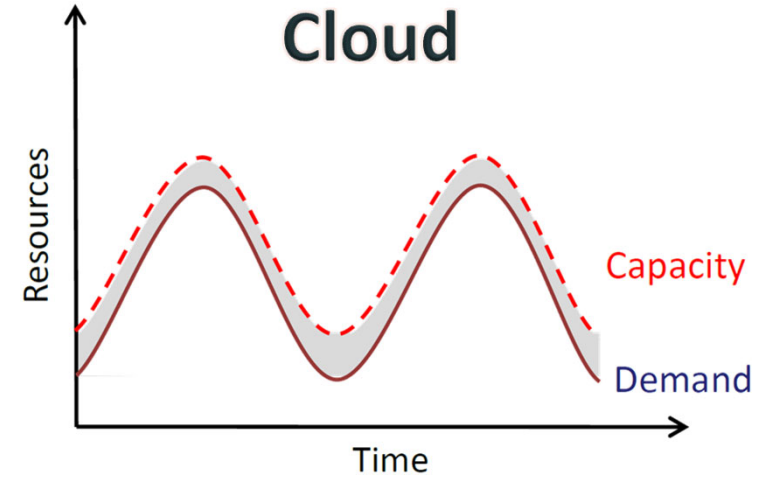
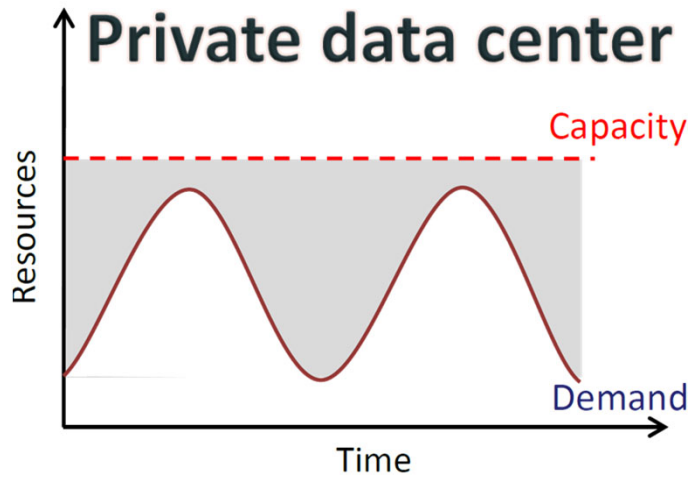
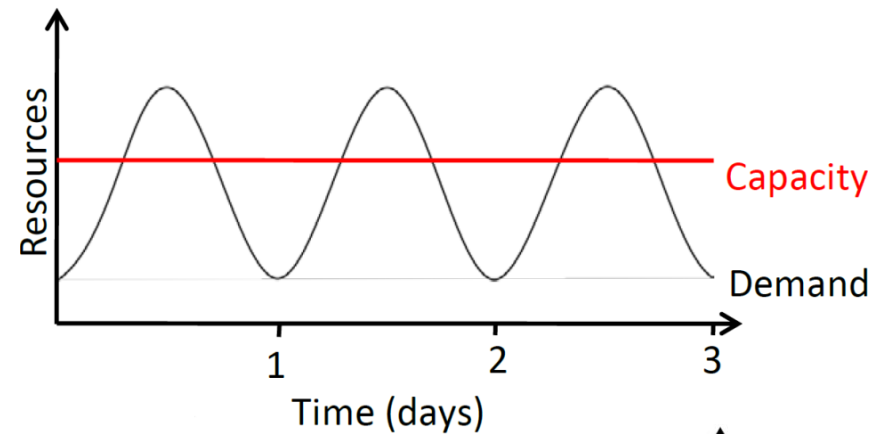
**Public/Private Cloud**  
*(Pay-per-use)*

# Cloud Computing definition

“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 (National Institute of Standards and Technology)

# Undercapacity Risk



# Novelty of cloud computing

- Elimination of up-front commitment
- Illusion of infinite resources
- Pay-per-use (elasticity)
  - Cost is 5-7 times cheaper than in-house computing
- Service Level Agreements
  - E.g.,  $\text{Availability} = \text{uptime} / (\text{uptime} + \text{downtime})$ 
    - Measured in terms of nines (99.99...9%)

# Benefits of cloud computing

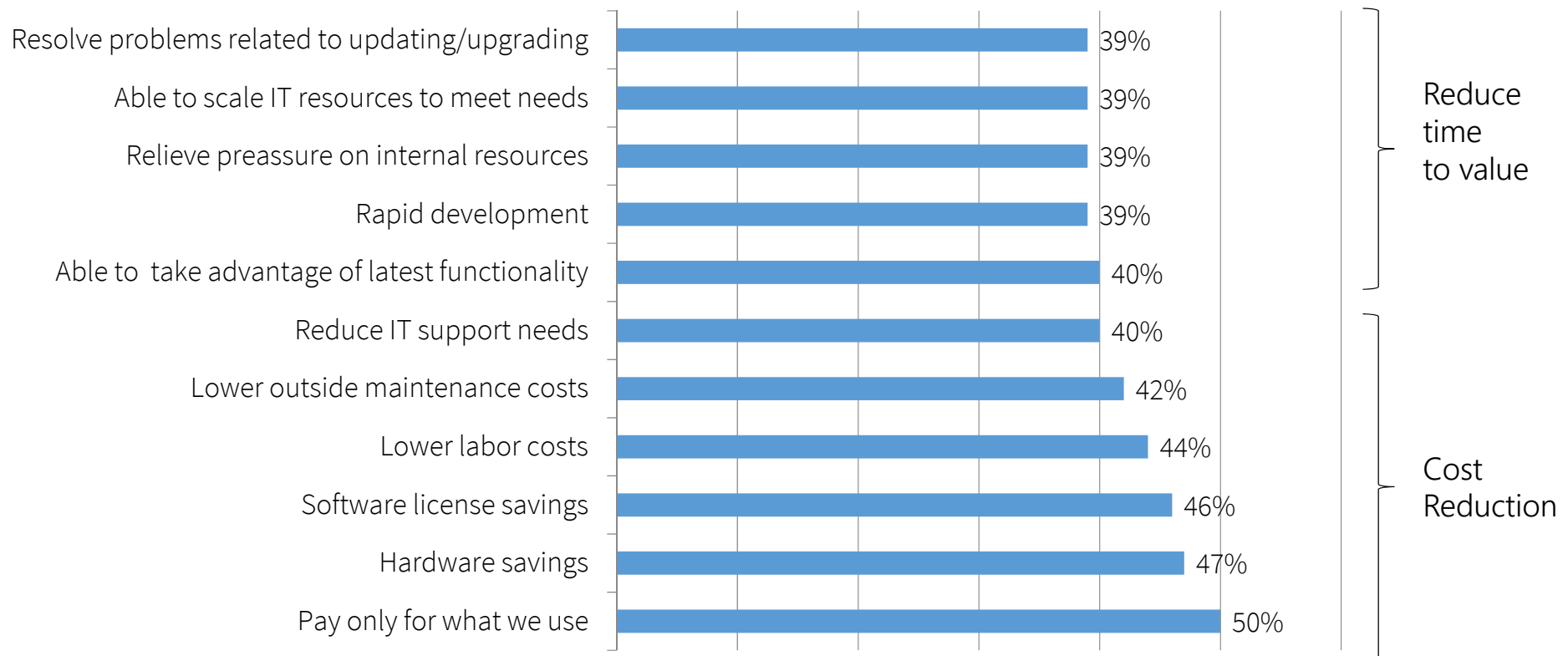
- Reduce costs
  - Economy of scale in software development
  - Energetic efficiency
- Agility
- Flexibility
- Easier management
- Superior safety
- Better upgradeability
- More business



Big Data

# Benefits of cloud computing

## Benefits for deploying in a cloud environment

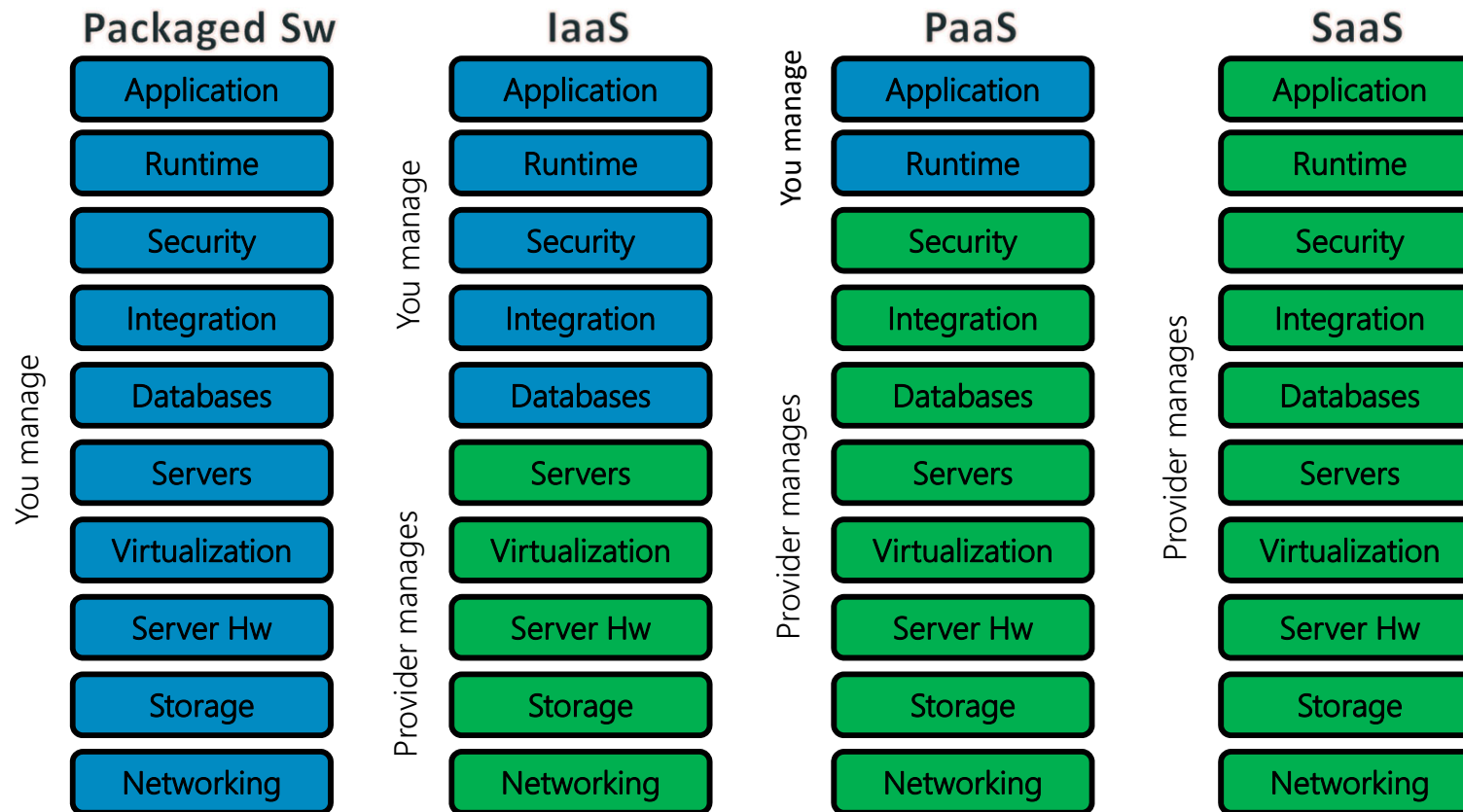


IBM global survey of IT and line-of-business decision makers 2012

# Levels of Service

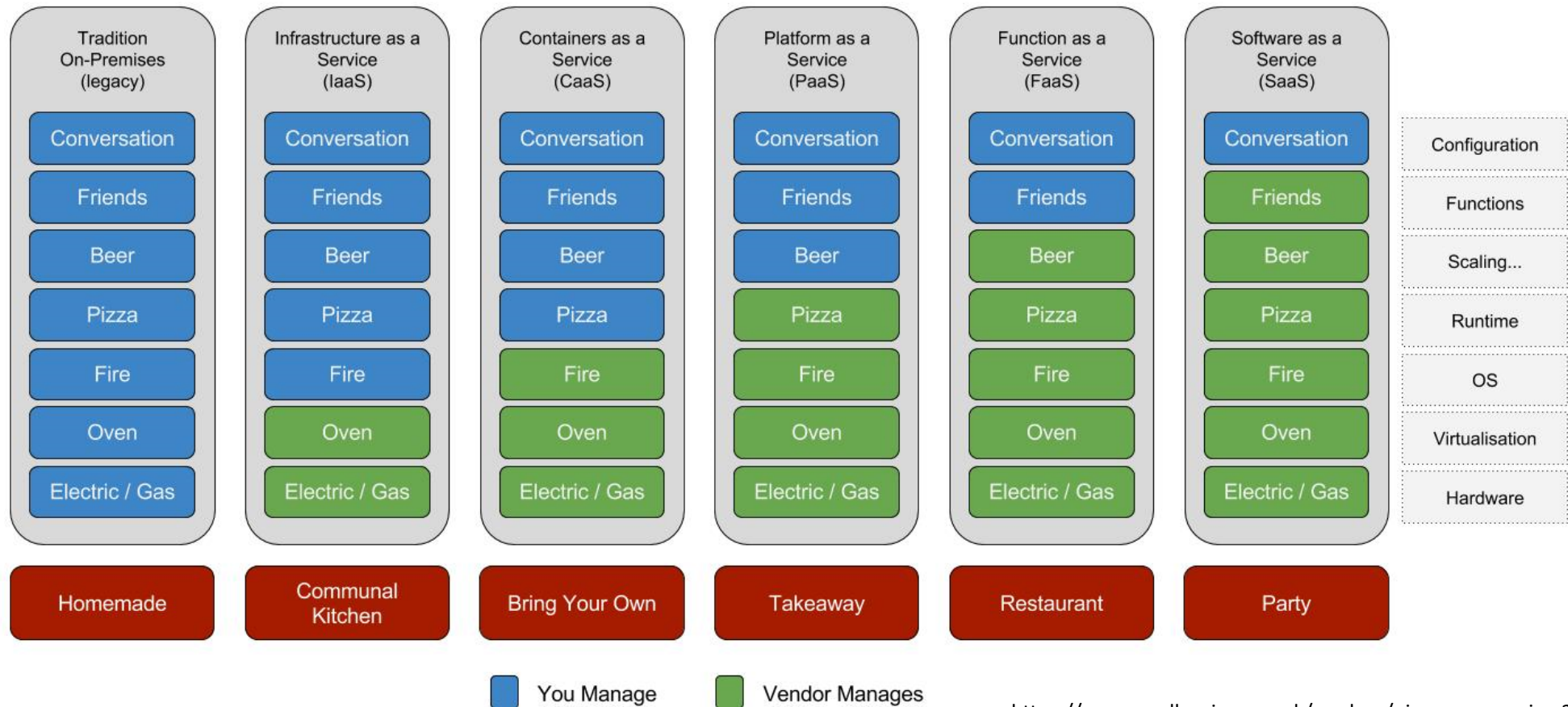
- The company outsources some responsibility to the service provider
  - Infrastructure as a Service (IaaS)
    - You get a server to connect through remote connection protocols (e.g., VPN, SSH, FTP)
    - Typically it covers the hardware (e.g., computers, network, virtualization)
  - Platform as a Service (PaaS)
    - You get software modules needed to run applications (e.g., databases, web servers, security)
  - Software as a Service (SaaS)
    - Software is there ready to be used (e.g., Google Docs, Dropbox)
  - Business as a Service (BaaS)
    - A whole business process is outsourced (e.g., Paypal, Amadeus)
- Levels are incremental: SaaS implies PaaS, and PaaS implies IaaS

# Share of responsibility





# Pizza as a Service



# Service providers

- Some of the strongest players in the market
  - Amazon Web Services (AWS)
  - Google Cloud
  - Microsoft Azure
  - IBM Cloud
  - Rackspace
  - Digital Ocean

# Closing

# Summary

- Big Data definition
  - From a data management perspective
  - From a data analysis perspective
- Cloud computing needs and contribution

# References

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