# Business Performance Analytics & Business Intelligence

## Module II

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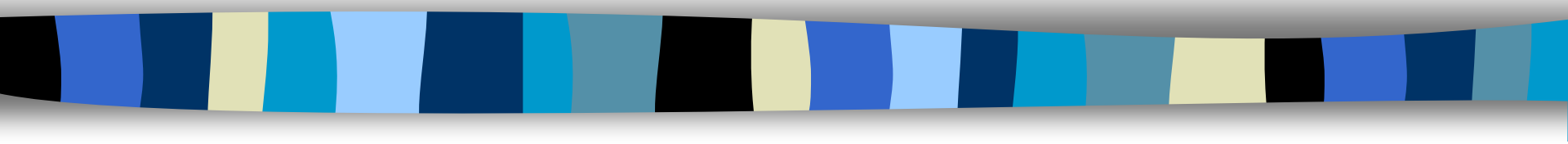
# A Classification of Information Systems

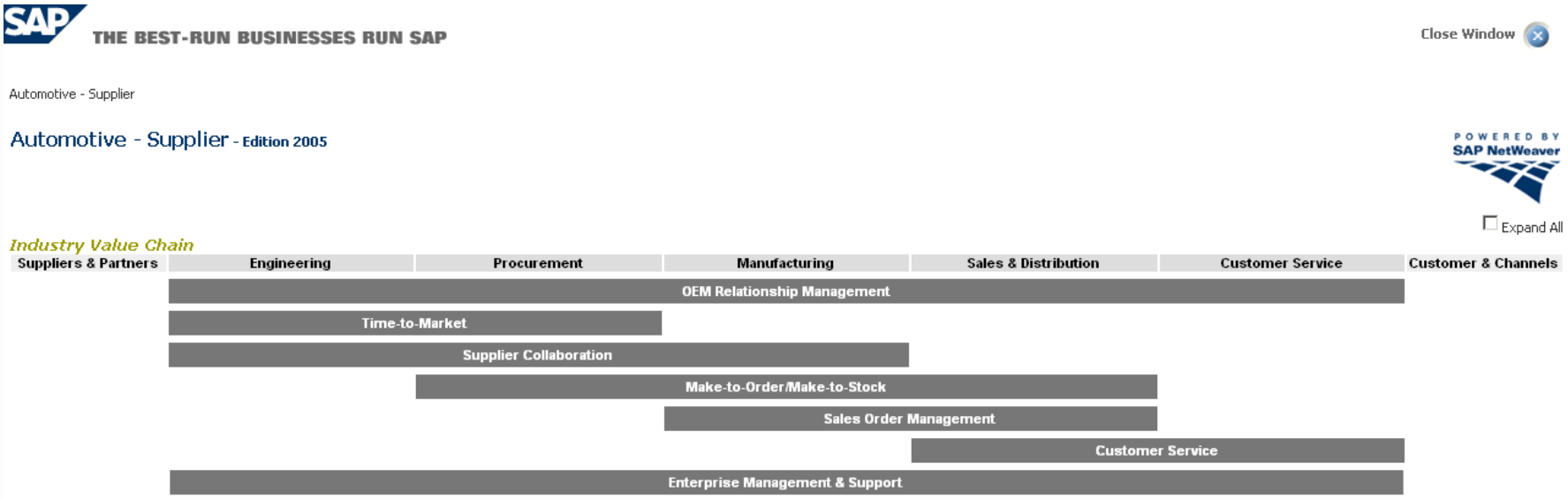


# The Application Portfolio

- The **application portfolio** is a record of existing and future business applications. It may describe the responsible organizations, the costs, and the technologies involved.
- The application portfolio is an **Information System Map**, and breaks it down into modules for cognitive and classification purposes
  - A **module** provides a set of software features that support a phase of a business process, homogeneous in terms of frequency, actor and profile of use cases
  - A module describes an **information need** and therefore indicates the potential use of information technology
- Breaking down IS into modules is also used by software vendors (SAP, Microsoft, ORACLE) to organize their offers
- Modules can be
  - Horizontal: they do not vary according to the company type and the productive sector (e.g. banking, manufacturing, chemical)
  - Vertical: they are used in specific production sectors only

# An example by SAP

- Modules recommended for the automotive producer market (https://solutionportfolio.net.sap/)



# Building the Application Portfolio

- Since each application/module should cover an information need, the application portolio should be strictly related to processes
- The application portfolio can be built by crossing each macro phase of the **Porter's chain value** with the *types of activities* it involves. Each intersection determines a possible module / application.
- Activity types can be roughly classified as:
  - **Planning activities** determine the plans and monitor their progress. The planning activities are distinguished by the time horizon and the level of detail
  - **Execution activities** implement the planned operations, thus producing the desired output.

# Building the Application Portfolio

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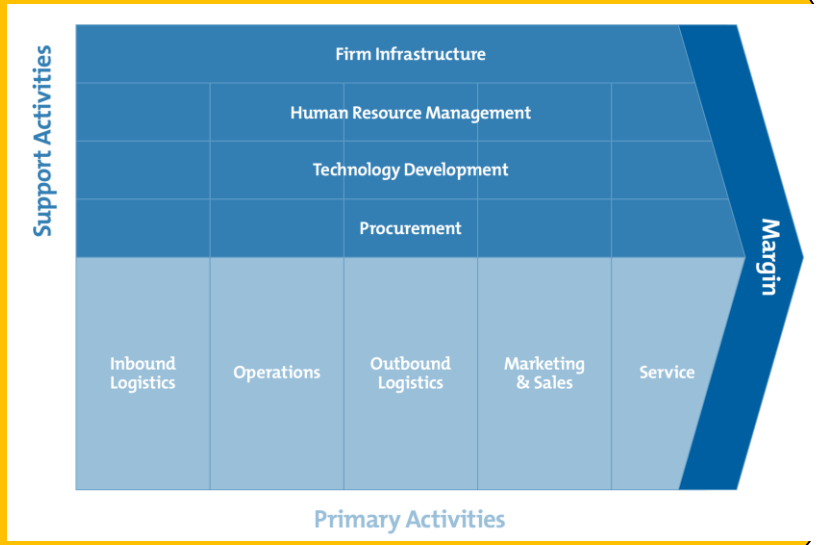
- Activities are roughly classified as:

Describes a chain of activities common to all businesses that transform inputs into outputs. The activities are classified as primary and support activities



# Planning Activity Profiles

| | Goal | Data flow | Critical issues & volumes |
|---|---|---|---|
| **Strategic analysis** | ❑ Market forecast<br>❑ Market & Innovative technology monitoring | ❑ External information<br>❑ Unstructured or absent process | ❑ Ad hoc applications<br>❑ Volumes are limited<br>❑ Unstructured data |
| **Annual planning** | ❑ Sizing of volumes and activities in the medium term<br>❑ Coordination of operations<br>❑ Timing of innovation | ❑ Structured & internal data (high level goals for production/sales/ provisioning)<br>❑ Inter-division data flows | ❑ Optimization models become complex in large and multi-localized companies or when extended supply chains are involved<br>❑ Summary data with limited volumes |
| **Operative planning** | ❑ Define detailed activity programs and control of their progress<br>❑ Coordination of operations<br>a) Resource sharing<br>b) Optimal activity sequence<br>c) Synchronization of operations | ❑ Structured & internal data<br>❑ Inter-division data flows<br>❑ Granularity: Day/Week – Division-Order | ❑ Optimization models<br>❑ Detailed data |

# Execution Activity Profiles

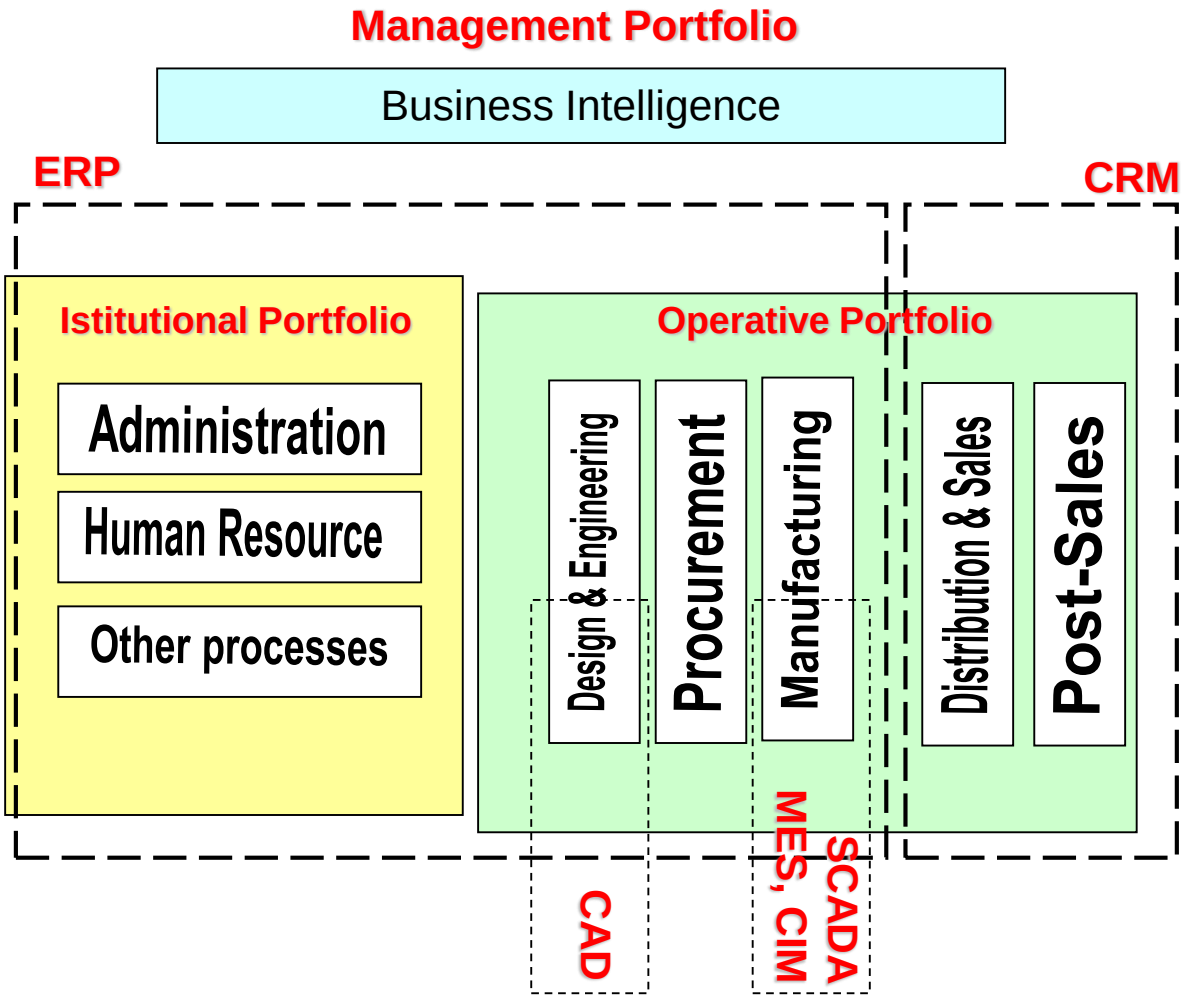
| Execution | Goal | Data Flow | Critical issues & volumes |
|---|---|---|---|
| **Orders** | ❑ Transaction processing<br>❑ Activity & Process Automation | ❑ Inter-division & inter-company data flows<br>❑ Input for operative planning | ❑ Large volume of transactions<br>❑ Database schemata are complex |
| **Materials** | ❑ Event logging<br>❑ Material and stock management | ❑ Intra-division, Inter-division & inter-company data flows<br>❑ Feedback to operative planning<br>❑ Internal (own stock) and external (supplier stock and customer stock) data | ❑ Medium volume of transactions<br>❑ Database schemata are complex |
| **Operations** | ❑ Event logging<br>❑ Operation management | ❑ Intra-division & inter-company data flows<br>❑ Feedback to operative planning | ❑ Large volume of transactions<br>❑ Database schemata are complex<br>❑ Real time constraints (stream of data) |

# Application Portfolio

| | Design & Engineering | Procurement | Manufacturing | Distribution & Sale |
|---|---|---|---|---|
| **Strategic analysis** | ❑ Technological observatory | ❑Supplier analysis | | ❑Market analysis<br>❑Customer and Product Analysis |
| **Annual Planning** | ❑ Innovation planning | ❑ Procurement planning | ❑ Manufacturing planning | ❑ Sales forecast & Sales planning |
| **Operative Planning** | ❑ Innovation planning | ❑ Procurement planning | ❑ Manufactoring planning | ❑ Delivery & Logistic planning |
| **Orders** | ❑ Innovation implementation<br>❑ Product catalog | ❑ Procurement processing<br>❑ Supplier Catalog | ❑ Order scheduling | ❑ Customer catalog<br>❑ Delivery scheduling |
| **Materials** | ❑ Innovation processing | ❑ Reception<br>❑ Waharehouse management<br>❑ Tolling management | ❑ Handling of materials and semi-finished products<br>❑ Product quality control | ❑ Shipping and transport<br>❑ Product Warehouse management |
| **Operations** | ❑ Worksheet definition | ❑ Procurement processing | ❑ Manufcactoring processing | ❑ Delivery processing |

# Application Portfolio

- Information needs are handled by large software families



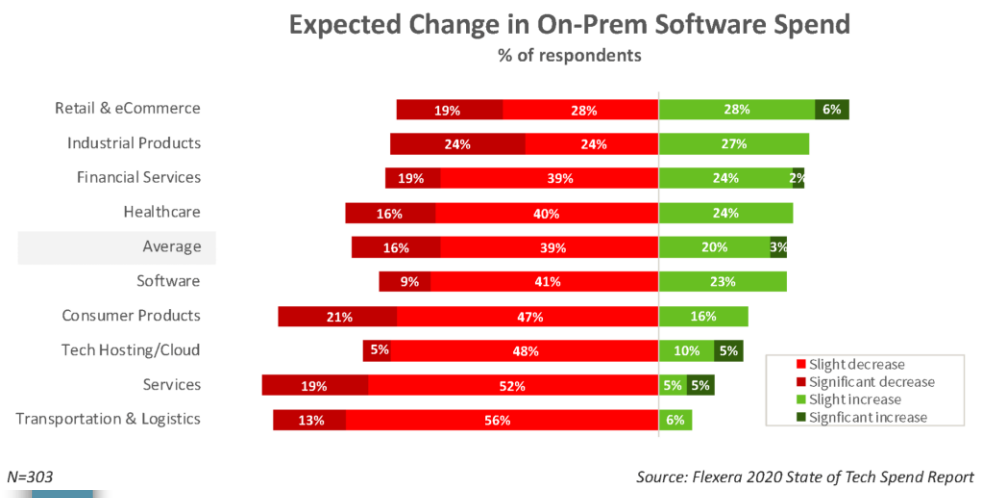
# How to understand modules relevance?

- We define **Information Processing Capacity** – “the appropriateness of an organization with respect to the need to process information imposed on it by its objectives and by the context in which it operates”.

- Module relevance is strictly related to the quantity of data needed in the corresponding part.
  - Information systems become a production technology in the business that “sell” information (e.g. banking, insurance, telecom)
  - Information system become a process technology when the product is a material good (e.g. manufacturing companies)
  - IS budget is proportional to the role of information (it ranges from less than 1% of the revenue in small manifactures, up to 7% in telco)

| Information intensity of the product | Information intensity of the process: Low | Information intensity of the process: High |
|---|---|---|
| High | Publishing companies | Bank & Insurance<br>Telco<br>Public administration |
| Low | Manufacturing companies | Utilities<br>Large retailer |

# IT Spending by Industry in 2020

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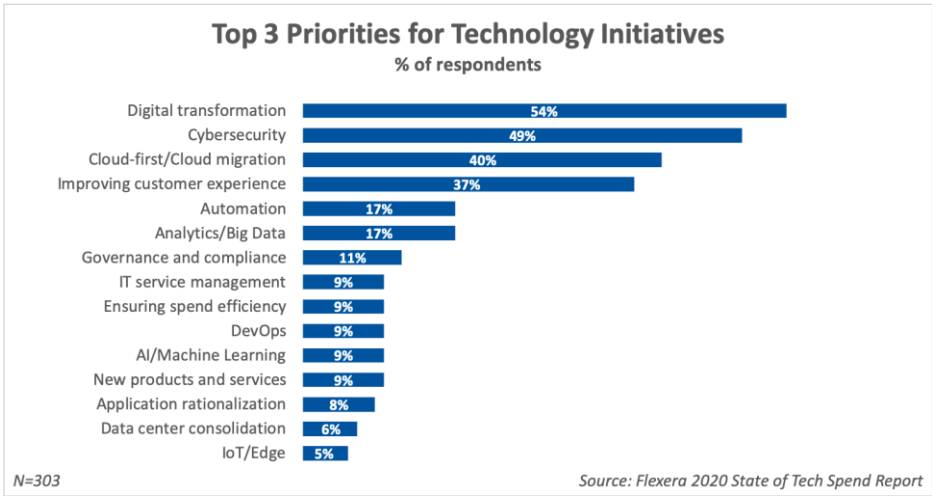
Source: Flexera 2020 State of Tech Spend Report

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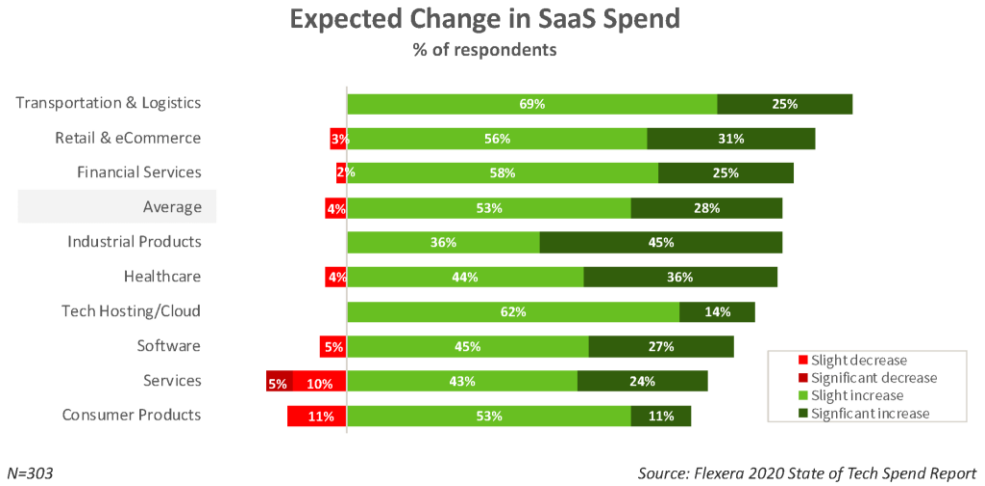


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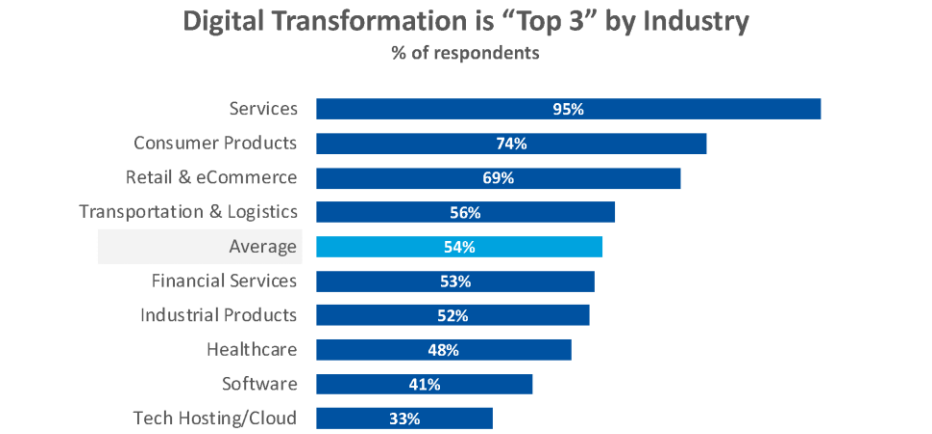


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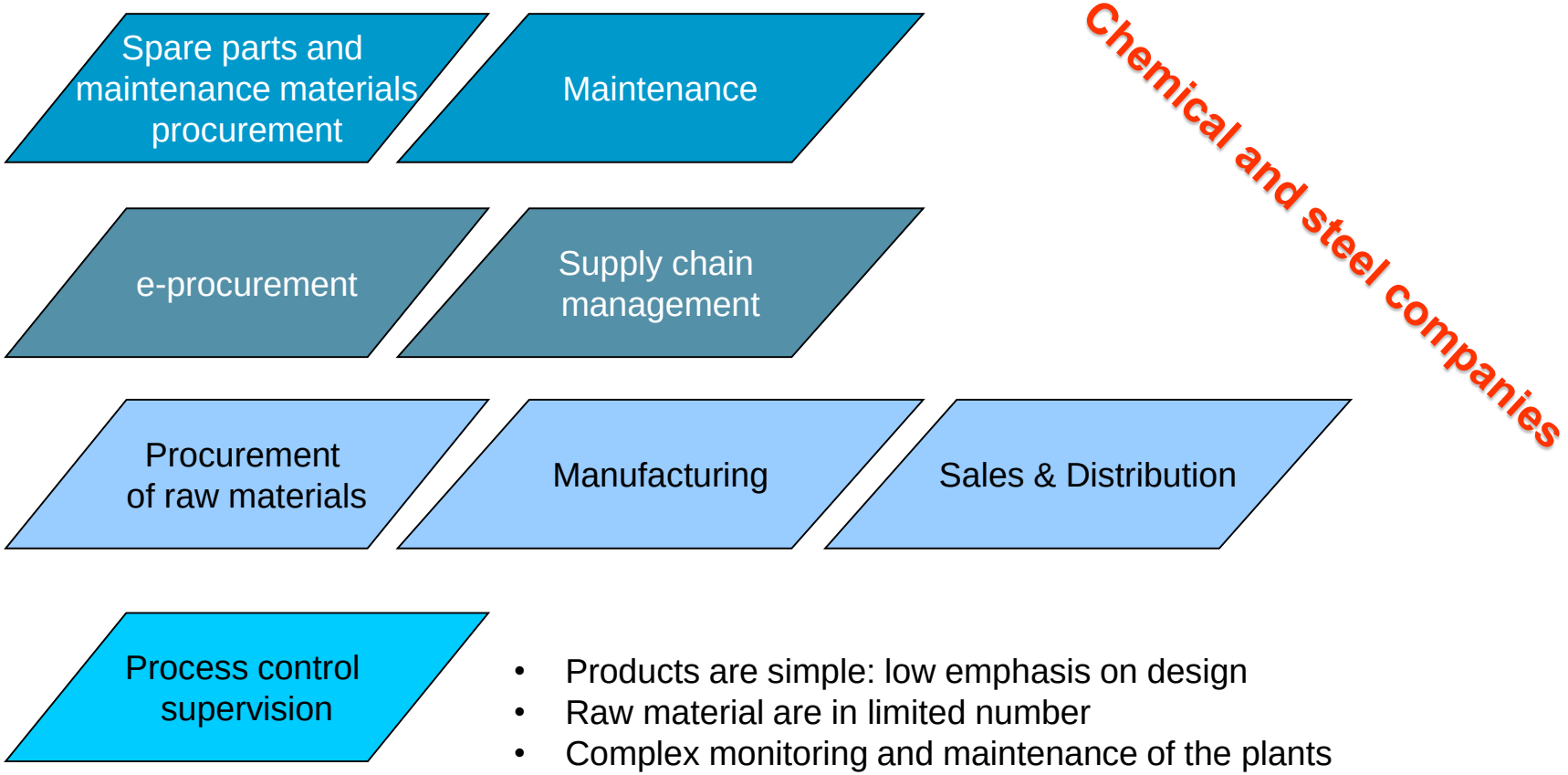
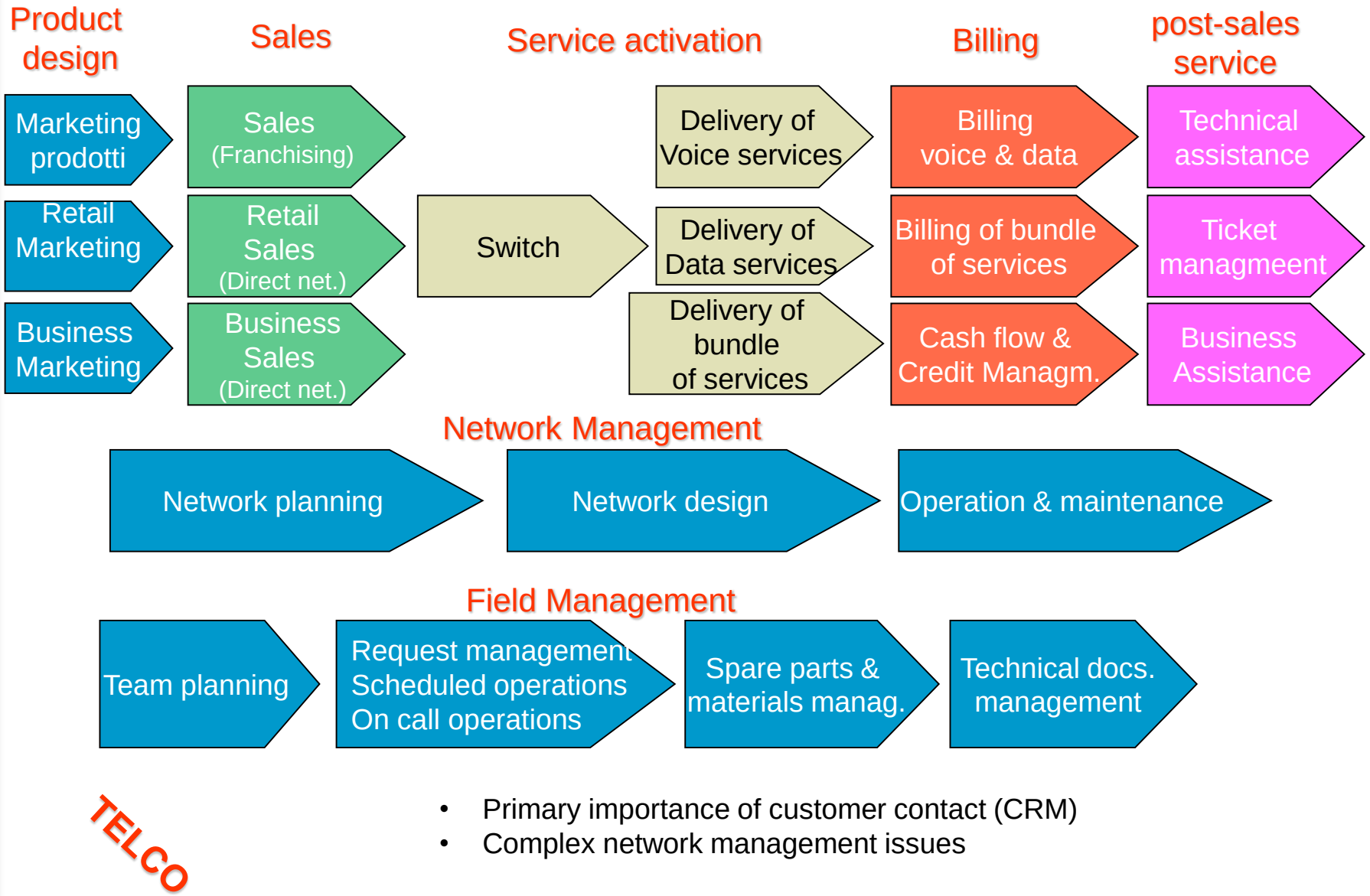
# Application Portfolio by Industry




- Products are simple: low emphasis on design
- Raw material are in limited number
- Complex monitoring and maintenance of the plants
- Considerable investment in plant spare parts (e-procurement)
- Need for coordination in multi-plant companies (supply-chain management)

# Application Portfolio by Industry

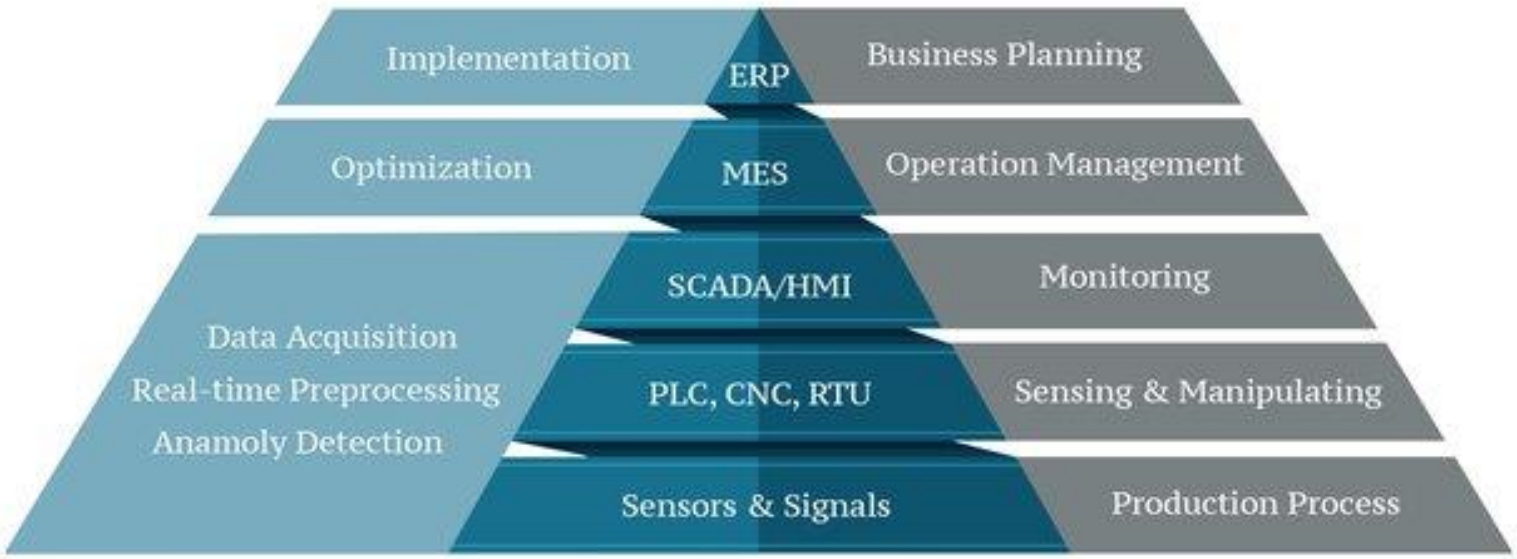



TELCO

- Primary importance of customer contact (CRM)
- Complex network management issues

# Smart Manufactoring (AKA CIM)

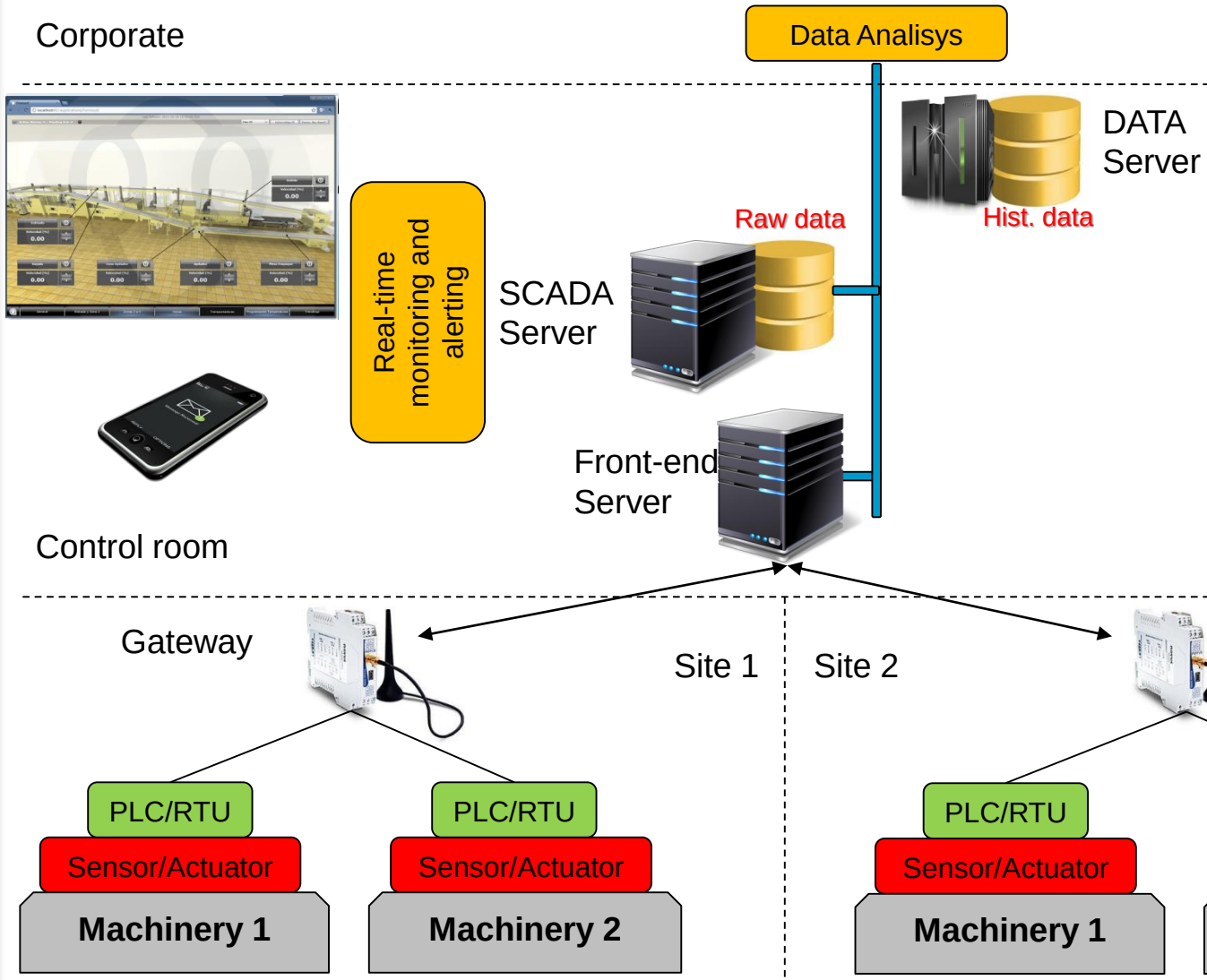
- A multi-level architecture that connects different levels of a production system and is aimed at process optimization and resource management optimization
- SM pros:
  - Stock reduction: through production and planning control
  - Time to market reduction
  - Increase in product quality: analysis and control of the production process
  - Cost reduction due to the greater efficiency of the factory
- SM is organized in a five-level architecture. Each level carries out its own elaborations and is connected with the others.



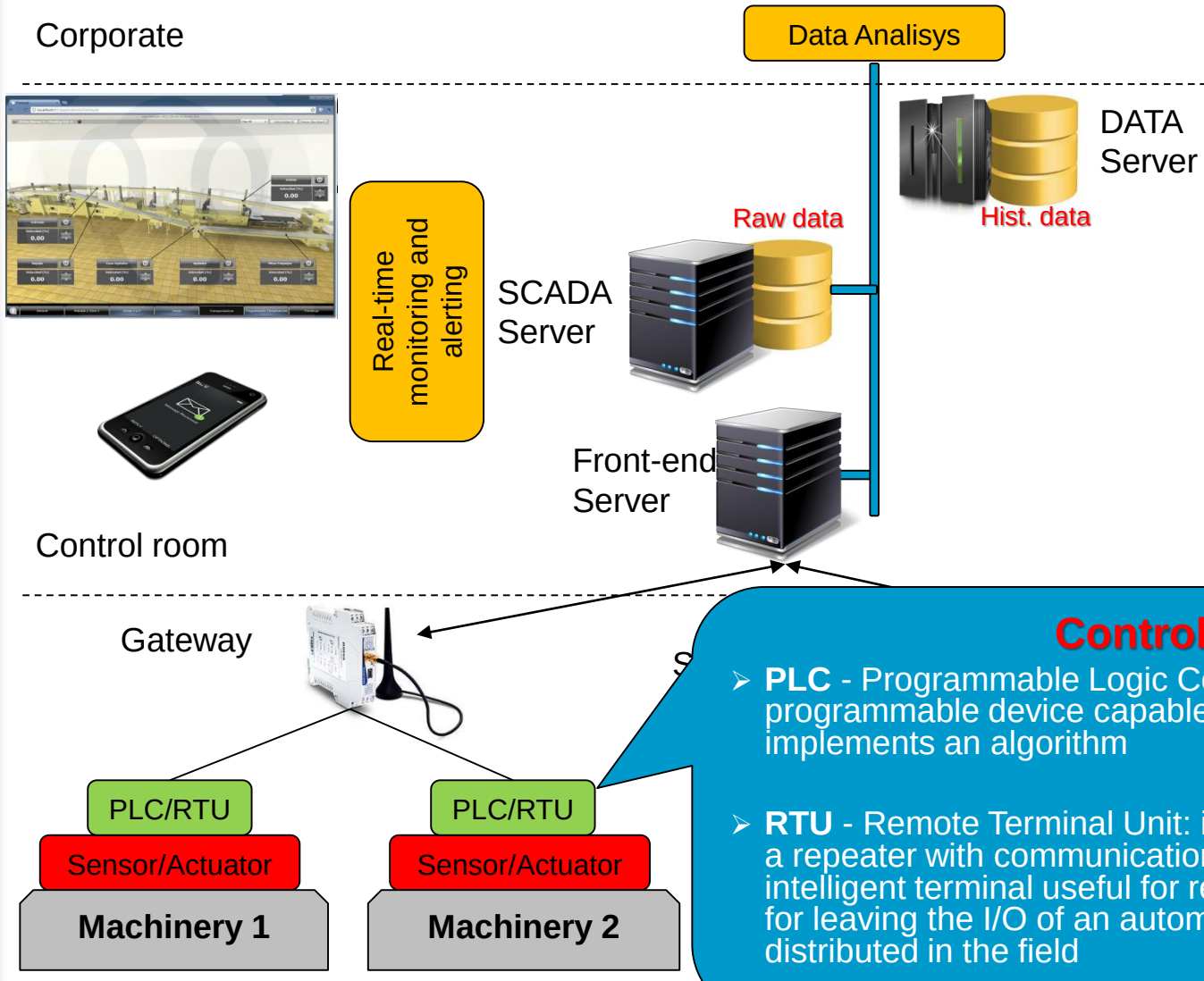
# SCADA system

- The component of a CIM system in charge of controlling industrial systems, acquiring and analyzing the data they produce is called SCADA
- SCADA (**S**upervisory **C**ontrol and **D**ata **A**cquisition) systems are used to monitor and control large industrial plants and mechanical/electronic systems distributed throughout the territory. The main areas of application are:
  - Large industrial plants and complex industrial processes
  - Telecommunications (e.g. Repeaters)
  - Management systems of water, sewage, energy distribution (e.g. HERA)
  - Energy production systems (e.g. photovoltaic and wind power plants)
  - Refineries
  - Transportation (e.g. airports, traffic control, railways)
  - Research centers (e.g. CERN)
- The adoption of a SCADA system saves time and money:
  - Less travel for workers
  - Reduction of staff needs
  - Increase in productivity
  - Greater reactivity with respect to anomalous situations
  - Reduction of management costs
  - Greater reliability of the systems

# SCADA Architecture



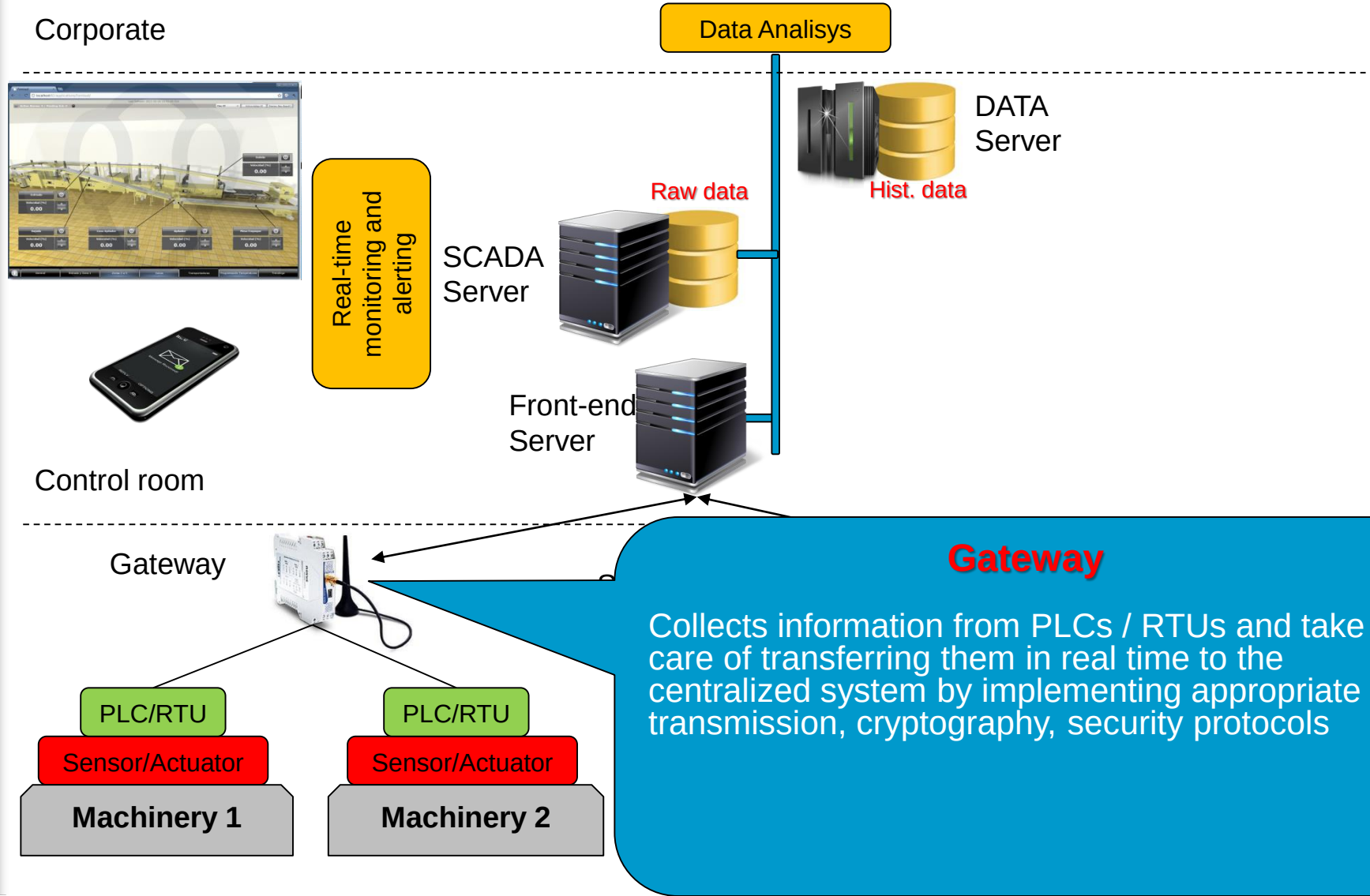
# SCADA Architecture



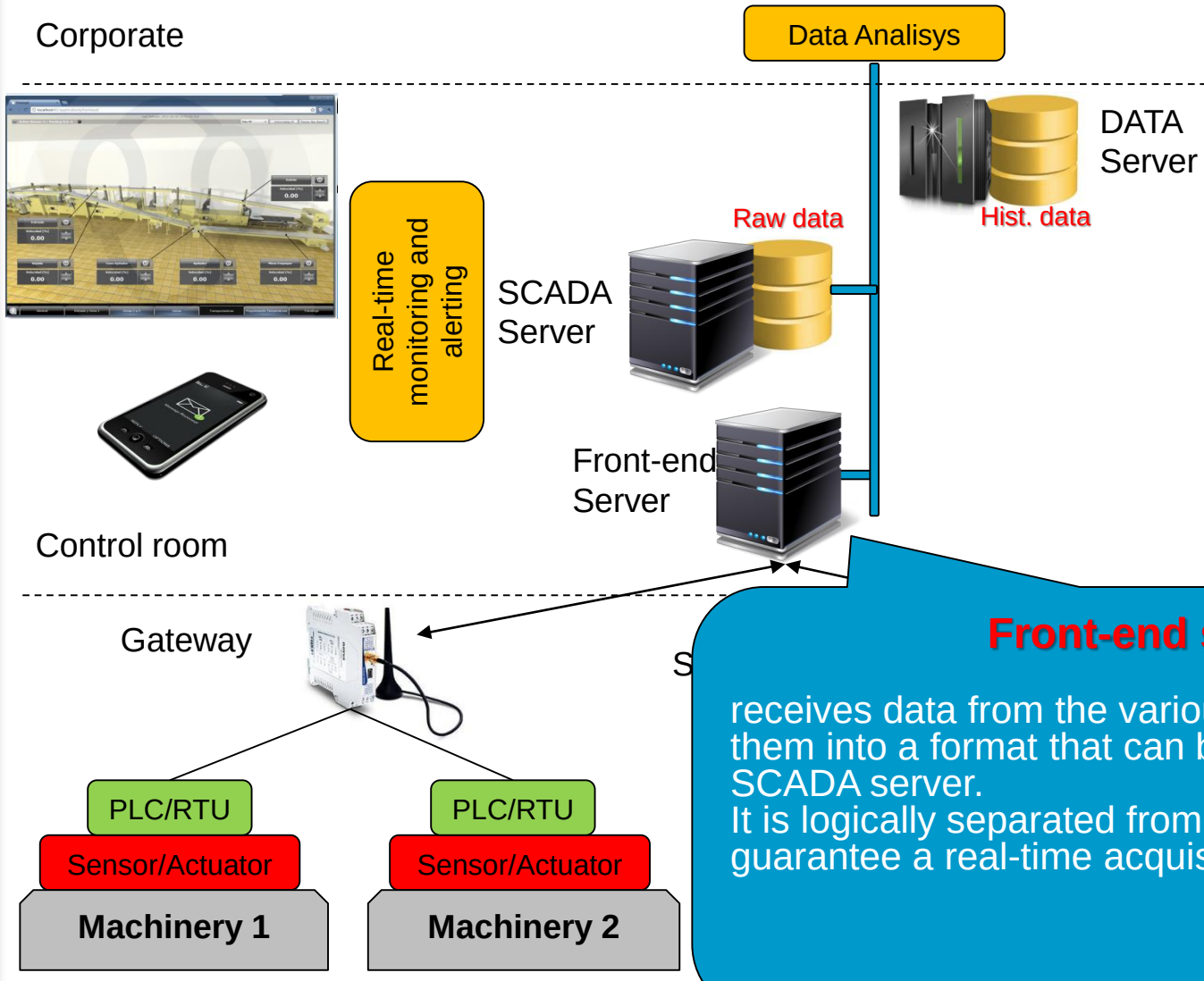

## Controller

- **PLC** - Programmable Logic Controller: it is any programmable device capable of running a code that implements an algorithm
- **RTU** - Remote Terminal Unit: it does not run code. It is a repeater with communication capabilities, an intelligent terminal useful for reducing wiring costs and for leaving the I/O of an automation and control system distributed in the field

# SCADA Architecture



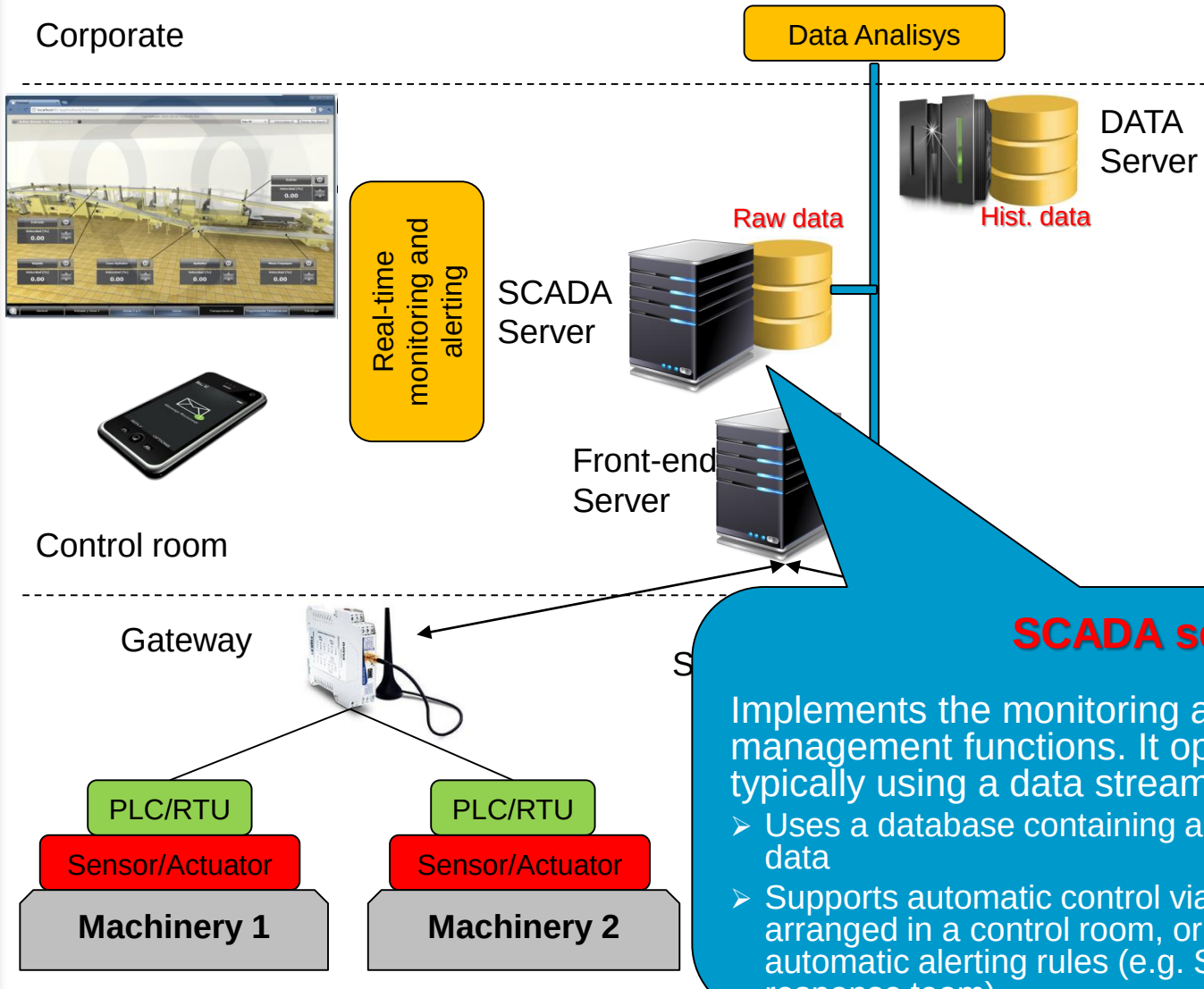
# SCADA Architecture




**Front-end server**

receives data from the various sites and translate them into a format that can be used by the SCADA server.
It is logically separated from the latter to guarantee a real-time acquisition time

# SCADA Architecture

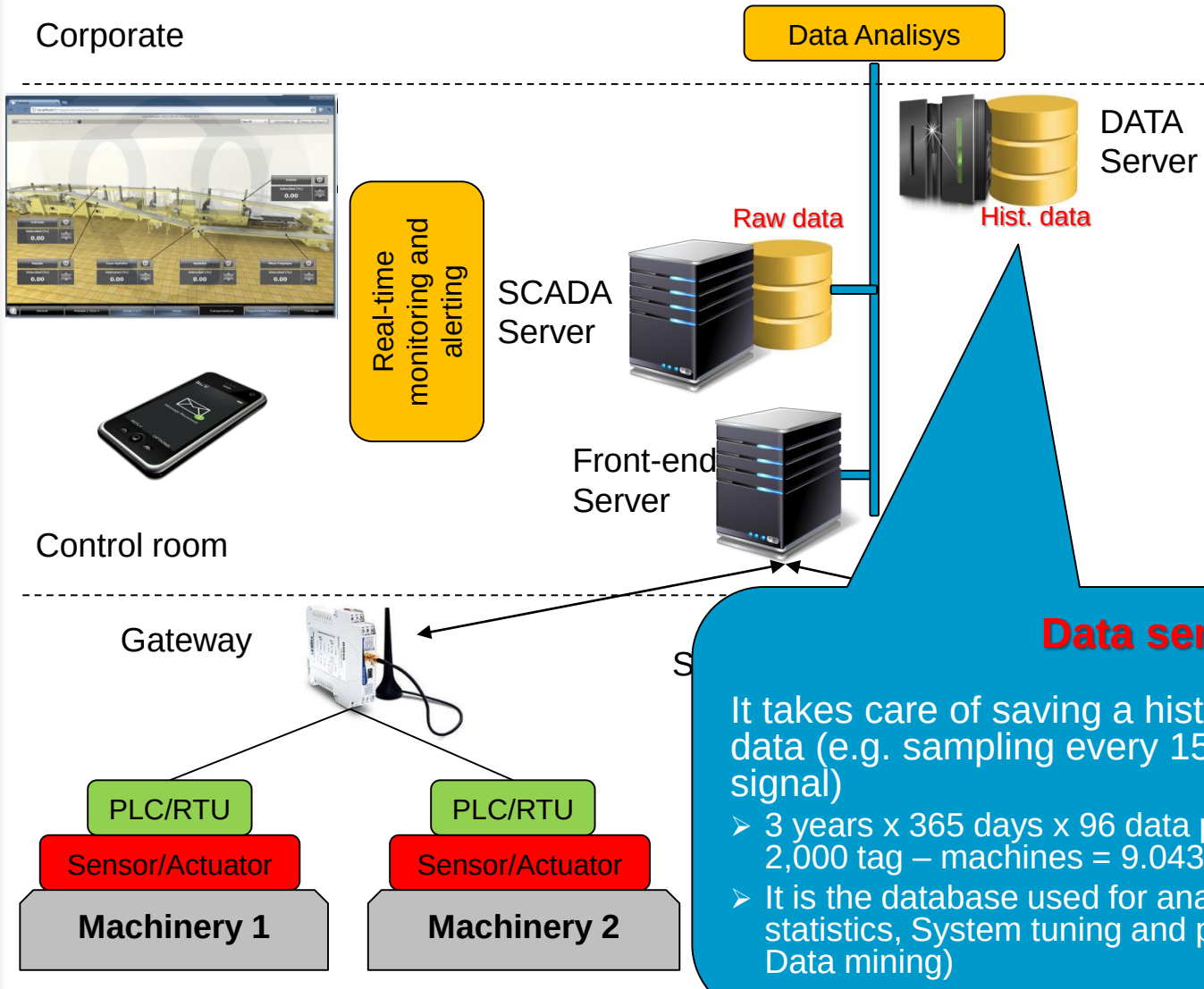



## SCADA server

Implements the monitoring and alarm management functions. It operates in real time typically using a data stream

- Uses a database containing a limited set of detailed data
- Supports automatic control via graphical interfaces arranged in a control room, or it can implement automatic alerting rules (e.g. SMS to the emergency response team)

# SCADA Architecture




## Data server

It takes care of saving a historical version of the data (e.g. sampling every 15 minutes for each signal)

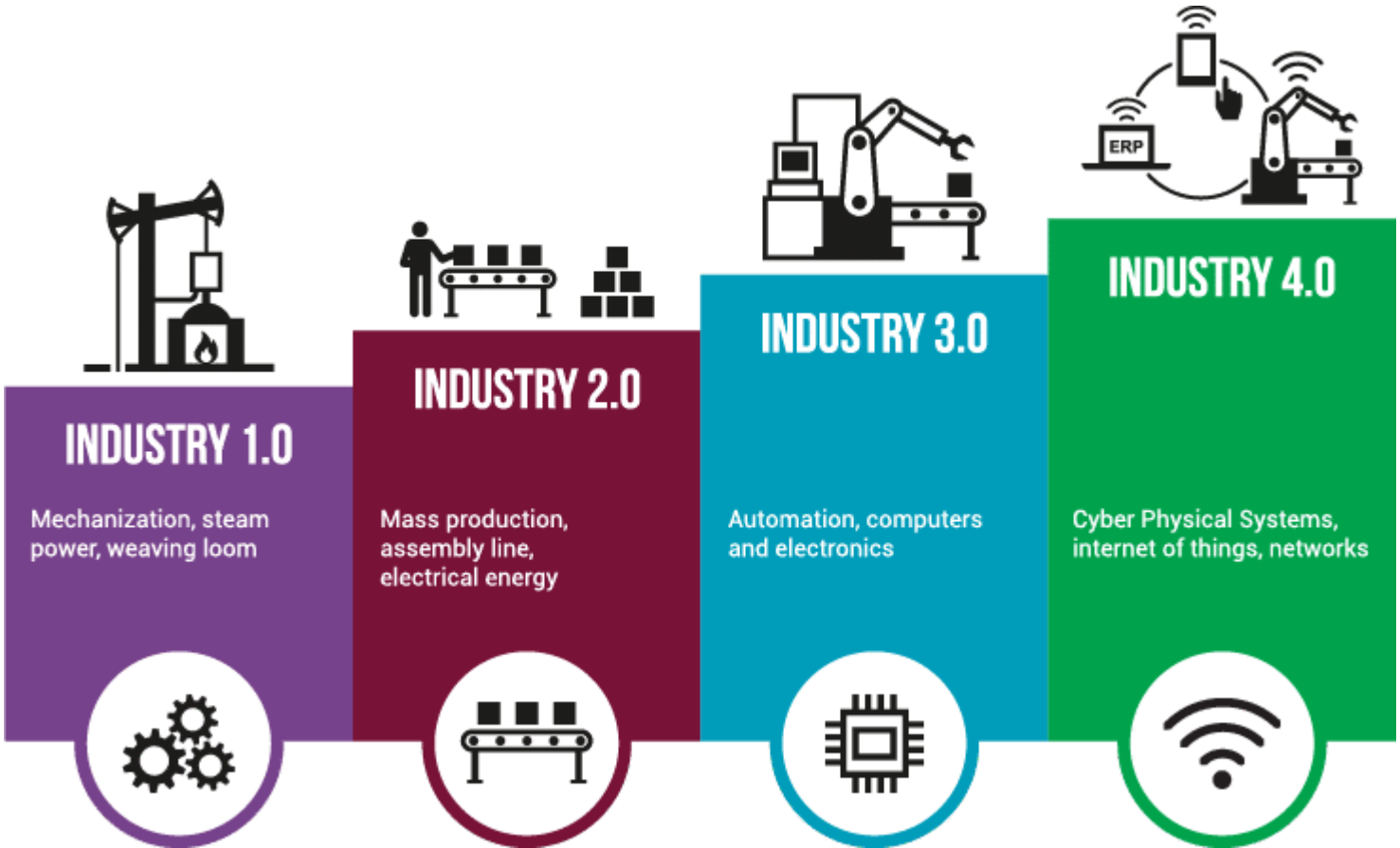
- 3 years x 365 days x 96 data per day x 43 machines x 2,000 tag – machines = 9.043 billion data
- It is the database used for analysis purposes (e.g. statistics, System tuning and performance optimization, Data mining)

# SCADA System Challenges

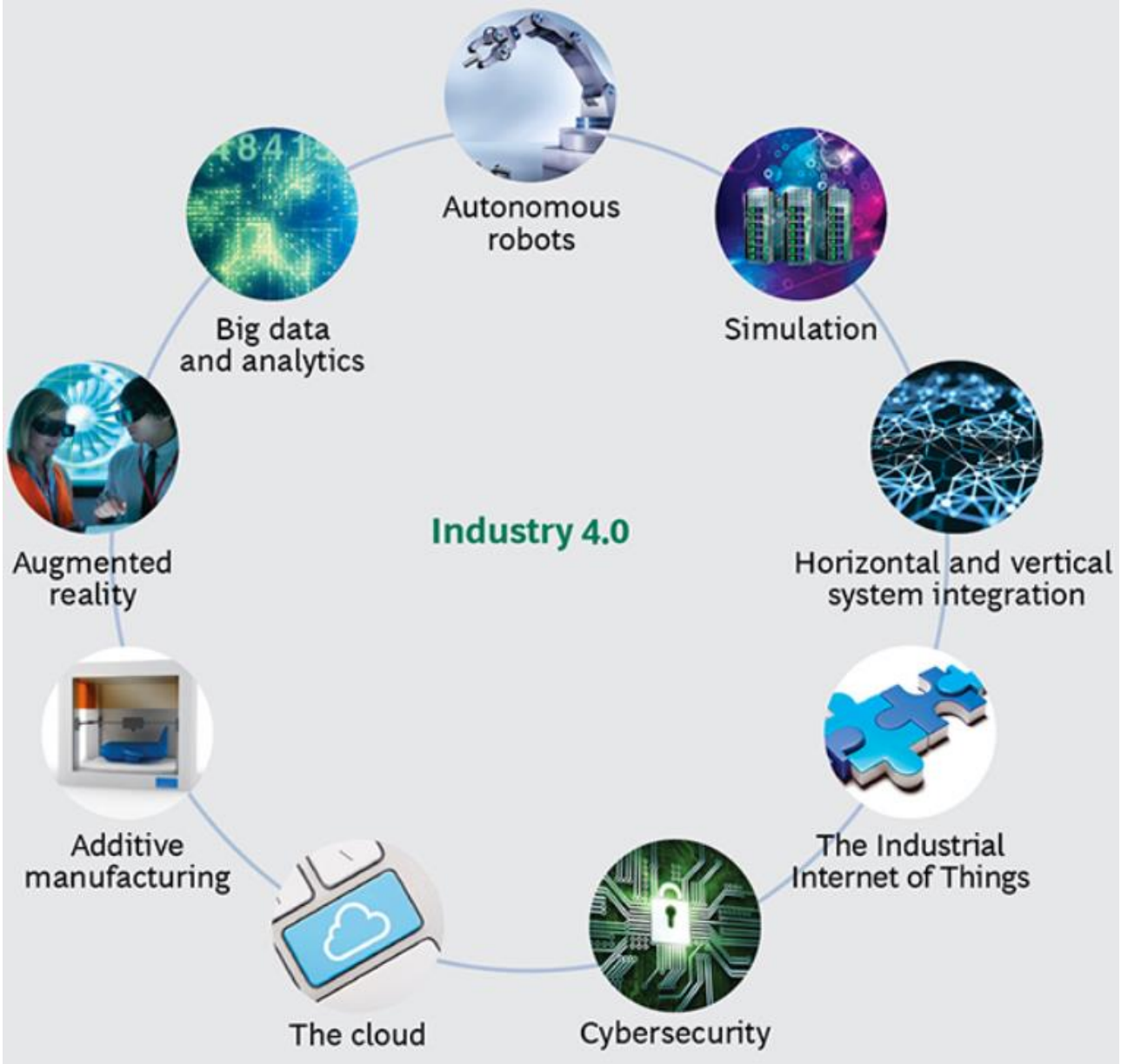
- Scalability: the increase in the number of monitored systems raises the problem of the huge amount of data to be managed (in real time), stored and analyzed
- Data Analysis: while in the past the SCADAs were mainly monitoring systems, nowadays the battle is on their data analysis capabilities
- Security: SCADA systems control critical infrastructures. Many installations rely on technologies that are 5-10 years behind the state of the art of IT
- From SCADA to Industry 4.0: evolves from a funnel that collects data from the edge to a center, to a system where intelligent objects share information and show an intelligent behavior

# Industry 4.0

- The term **Industry 4.0** refers to a trend in industrial automation that integrates ***new technologies*** to improve working conditions and increase the productivity and production quality of the plants.

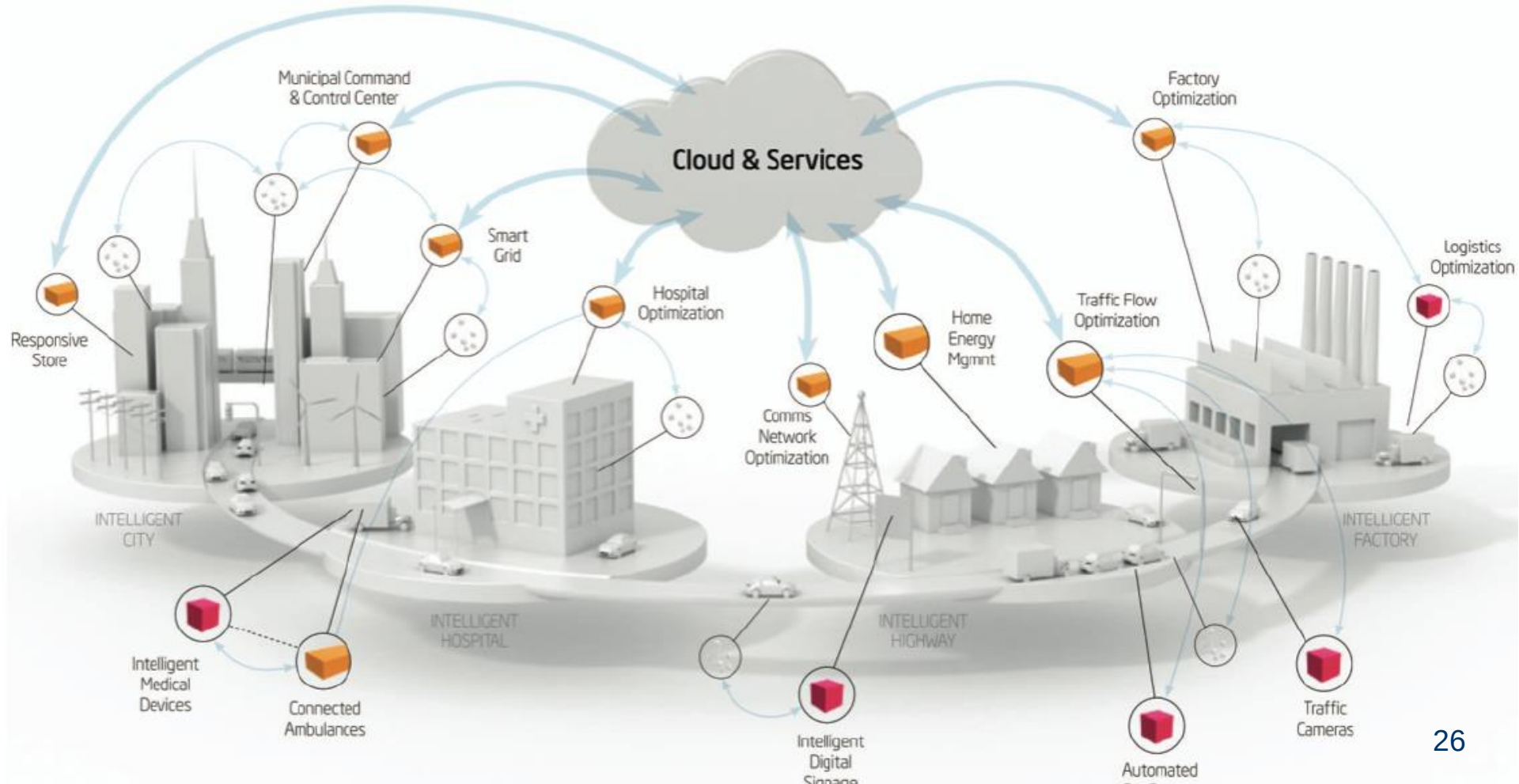


# Involved Technologies



# Internet of Things

- Refers to the digital connections between objects ("things") that make themselves recognizable and acquire intelligence sharing data about themselves and accessing aggregate information from others




Smart Ventilation
Inbound Delivery ID: 145300415
Product Code: 23704B
Location: T023134
Volume Count: 2/20
Condition: OK
Product Code: 54970A
Location: T014425 correct
Real-time inventory count: 36
Condition: temperature OK, humidity OK
Heavy item
Handle with care
Warning: forklift ahead
Belt ID: 00384
Status: gearbox requires
immediate maintenance
Action: appointment scheduled
Warning: hazardous and heavy item
Load center not achieved
Warning: pedestrian
Outbound Delivery Order ID: 477958B
Order Status: complete
Condition: OK
Smart Lighting

# A change of paradigm

- Industry 4.0 & IoT completely changes the way work is organized
  - The Amazon Warehouse Robots

# A change of paradigm

- Industry 4.0 & IoT completely changes the way work is organized
  - The Amazon Warehouse Robots
- In a Warehouse organized for **human-picking** Product Ordering is explict and simple (human understandable)
  1) Products are organized by types
  2) Similar products are co-located

# A change of paradigm

- Industry 4.0 & IoT completely changes the way work is organized
  - The Amazon Warehouse Robots
- In a Warehouse organized for **human-picking** Product Ordering is explict and simple (human understandable)
  1) Products are organized by types
  2) Similar products are co-located
- In a Warehouse organized for **robot-picking** Product Ordering can be very complex (robot understandable)
  1) Robots always know where products are located
  2) Products looks randomly positioned but actually it works so that frequently picked products are close to picking points but are spread around to avoid robot paths overlapping (it avoids crowding)

# MES

- **Manufacturing Execution Systems** - MESs provide overall control and management of the factory floor, receive orders from ERP, gather information from SCADA and provide updated information to ERP

- MES main functionalities are:
  - Resource allocation & Status
  - Operation Scheduling
  - Production Dispatching
  - Labor Management
  - Quality Management
  - Performance Analysis
  - Process Managment
  - Product Traking
  - Maintenance Management

- MES benefits are:
  - Reduces manufactoring cycle time
  - Reduce set up costs
  - Eliminate or reduce data entry time
  - Improved product quality
  - Improves production efficiency
  - Empowers plant operation people

# Overall Equipment Effectiveness

- **OEE** is the primary KPI for measuring the production capacity of a manufacturing company. It is often used in Lean Manufacturing to achieve operational excellence

**Availability** x **Performance** x **Quality**

- **Availability** [0;1]: Percentage of time worked versus time available.
- **Performance** [0;1]: Percentage of parts actually processed compared to the theoretically processable parts. In the planning are calculated the parts that can be processed at optimal regime, any reduction in these performances indicate a decrease in production.
- **Quality** [0;1]: Percentage ratio of conforming parts to total parts produced. In this way, production drops related to rejects or rework are highlighted, affecting the overall inefficiency.

- OEE detailed/automatic computation requires SCADA & MES

# OEE Example

- Planned batch of production: 5.300 pieces.
- Theoretical processing time per piece: 87 secs.
- Working shifts: 3 x 8h working shifts per day, 5 days per week.
- Theoretical working time (100% efficiency):

(5.300pcs x 87secs) / (8h x 3.600pcs) = 16,01 working shifts

- *Machinery set up* (first working shift only)= 90 mins
- *Weekly Machinery start up* (monday only): 35 mins
- *During working shift processing*
  - Manual checks on the machinery state: 24mins overall
  - 12 alarms (safety, fault, pressure check, etc): 24mins overall

- **Availability OEE** =

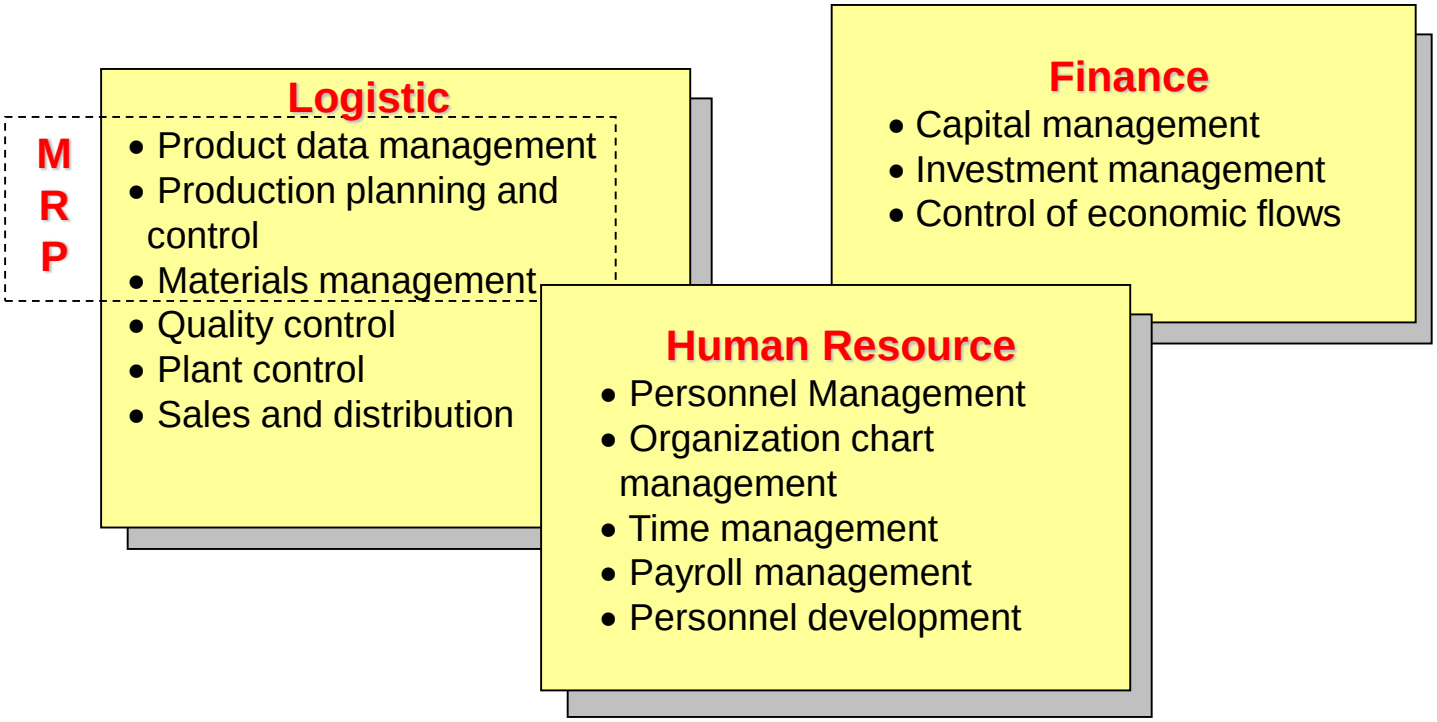
(60mins x 8h-90mins-35mins-24mins-28mins) / (60mins x 8h) = 63%

# OEE Example

| Theoretical machining time per piece | secs | 87 | | | |
|---|---|---|---|---|---|
| | | Shift 1 | Shif 2 | Shift 3 | Day |
| Theoretical working shift duration | mins | 480 | 480 | 480 | 1440 |
| Downtime | mins | 35 | 11 | 20 | 66 |
| Set up | mins | 90 | 0 | 0 | 90 |
| tool replacement | mins | 0 | 27 | 0 | 27 |
| Alarms | mins | 28 | 11 | 85 | 124 |
| Maintenance | mins | 0 | 21 | 0 | 21 |
| Manual checks | mins | 24 | 28 | 31 | 83 |
| Overall lost time | mins | 177 | 98 | 136 | 411 |
| Actual availability | mins | 303 | 382 | 344 | 1029 |
| Availability OEE | | 63% | 80% | 72% | 71% |
| Theoretical worked parts | pcs | 209 | 263 | 237 | 709 |
| Actual worked parts | pcs | 181 | 250 | 225 | 656 |
| Performance OEE | | 87% | 95% | 95% | 93% |
| Scrapped parts | pcs | 4 | 4 | 7 | 15 |
| Reworked parts | pcs | 1 | 1 | 2 | 4 |
| Overall faulty parts | pcs | 5 | 5 | 9 | 19 |
| Quality OEE | | 97% | 98% | 96% | 97% |
| | | | | | |
| Shift OEE | | 53% | 74% | 65% | 64% |

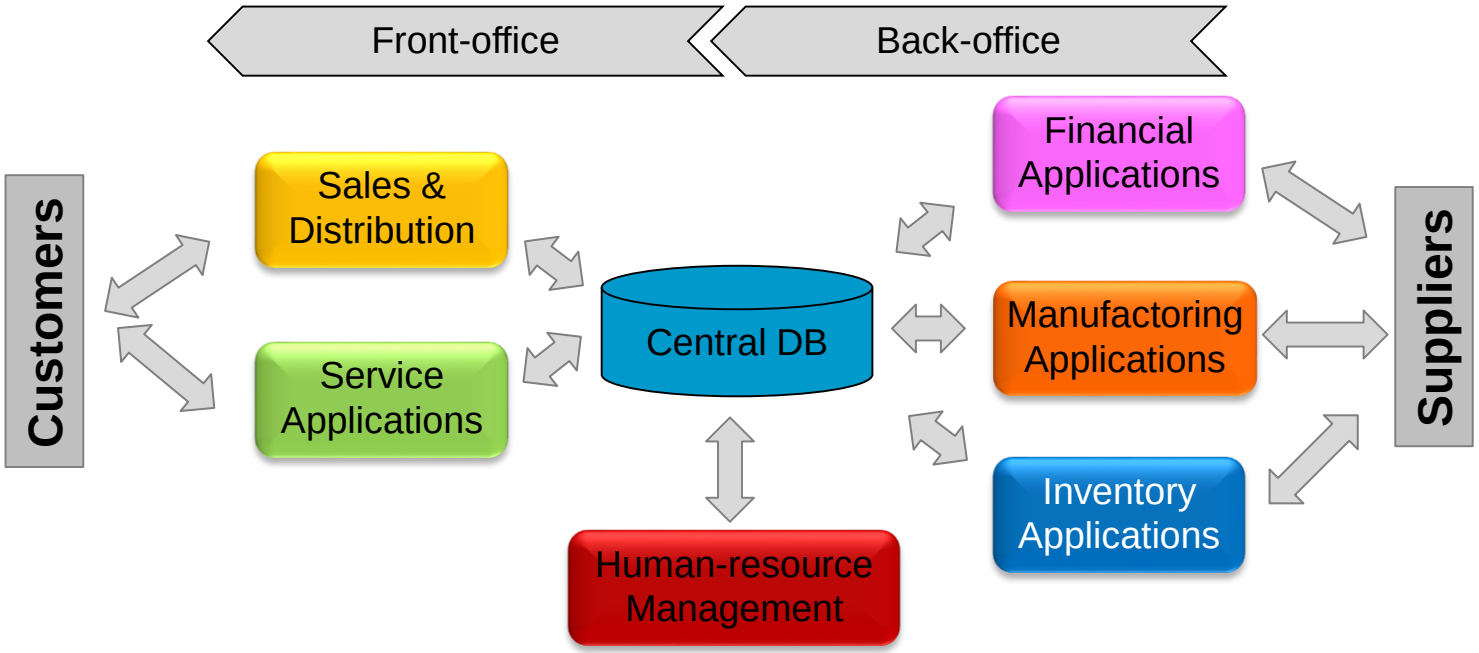
# ERP Systems

- The term ERP (***Enterprise Resource Planning***) was coined in the early 90s by the Gartner Group to indicate a suite of application modules that support the full range of business processes
- ERP includes both horizontal (industry agnostic) and vertical (industry specific) modules



# ERP Systems: Alternative Definitions

- "Enterprise resource planning (ERP) is the integrated management of business processes. ERP is a software that promises the seamless integration of all the information flowing through the company: financial, accounting, human resources, supply chain and customer information"(Davenport,1998).
- "One database, one application and a unified interface across the entire enterprise"(Tadjer,1998).



# Extended ERP Systems

- The previously mentioned modules represent the *core* of the ERPs to which further modules can be added
  - **PLM - Product Lifecycle Management:** to support the management of the technical documentation of the products and the related production processes
  - **SCM - Supply Chain Management:** to support the planning and control of inter-company activities
  - **CRM - Customer Relationship Management:** to support the interaction with the customers
  - **E-procurement:** to create inter-company electronic markets in which the condition framework and the suppliers are defined from the offices purchases, while they are the departments customers to follow the purchases thus reducing costs and times.
- The final benefit of integration is the synchronization of processes through the **circulation of information**.
- The ERP suite reflects a precise conception of the information system that is based on the following distinctive features:
  - **Uniqueness of information**
  - **Functional extension and modularity**
  - **Prescriptiveness**

*Not all the management softwares are ERPs*

# The ERP Paradigm: Information Uniqueness

- All processing shares one and only one value for each piece of information
- Information uniqueness is achieved by using a single shared database that provides the following benefits:
  - **Data synchronization:** allows the synchronization of interdependent processes (e.g. the arrival of a material at the warehouse updates the situation of stocks, orders to suppliers and accounting)
  - **Absence of redundancy:** it is no longer necessary to have complex procedures to update the data present in the different company islands (no more *information silos*)
  - **Traceability of updates:** it is always possible to identify why and who has modified a certain value
  - **Reliability of business information:** coming from a single source, there is no risk that business data is inconsistent and consequently lose credibility (e.g. the total quantity sold recorded in accounting differs from that recorded by the sales division)

# … and when Uniqueness Lacks

- The non-payment of a customer is recorded in the accounting system, but until synchronization of the archives the commercial system will continue to accept orders from the customer
- The stocks of raw materials are stored in the warehouse database, but also on the operative planning database. For every material will exist therefore two inconsistent inventory values
- The sale data of a multinational company are stored in heterogeneous local systems; the consolidation of the data demands every time an ad hoc process and lasts some days

# The ERP Paradigm: Extension & Modularity

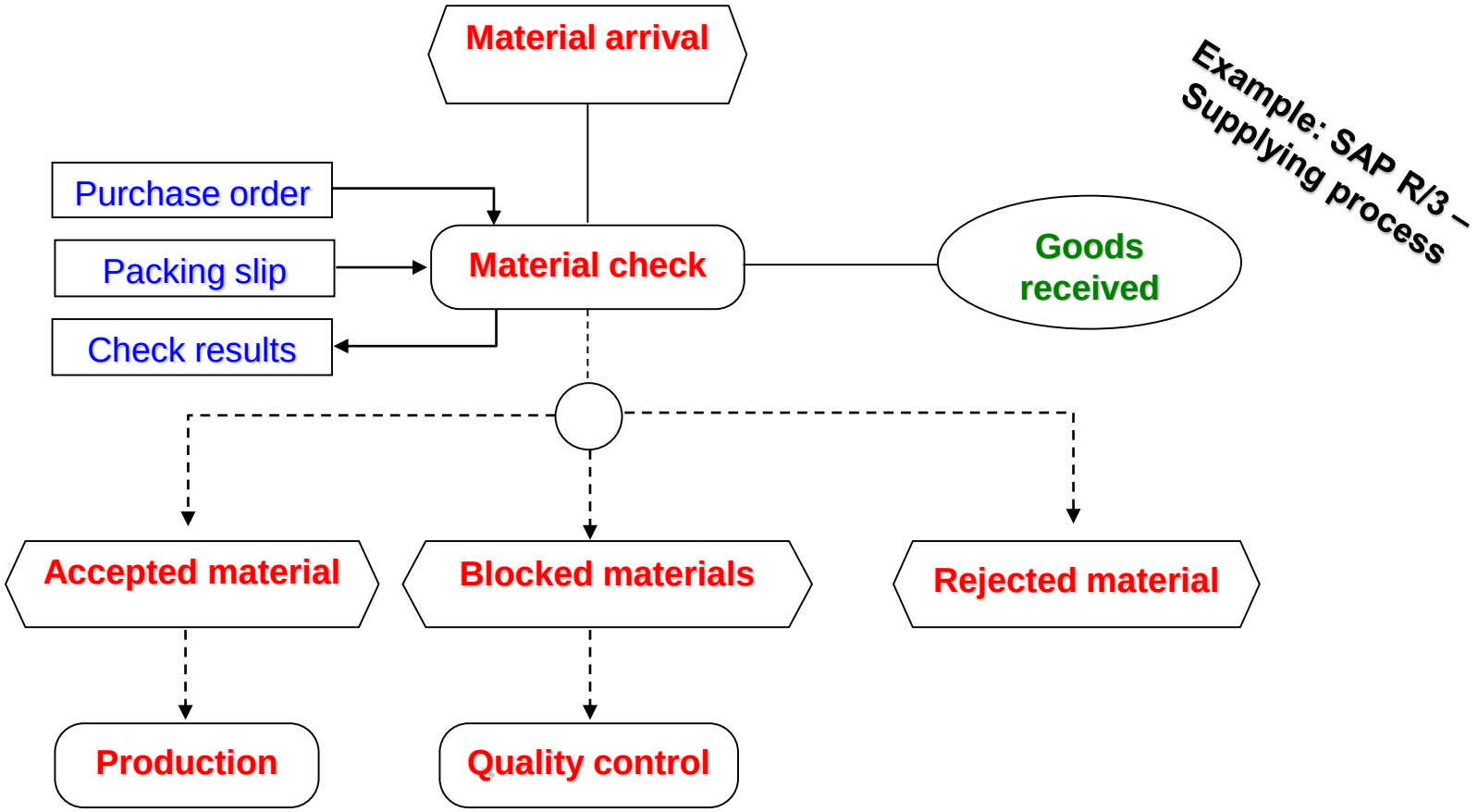
- The *breadth of coverage* of ERP systems enables them to be used as a single solution for DIS

- The modularity of the system allows the company to *choose* (i.e. buy or activate) only the modules of interest typically in an incremental fashion
  - **Incremental:** progressively purchase modules that become necessary, or that were implemented using inadequate legacy systems.
- The adoptable strategies are the following:
  - **One stop shopping:** linearity is preferred, purchasing all modules from a single vendor, possibly in a single installment.
  - **Best of breed:** modules from different vendors are used that best suit the company's needs or are considered the best

- Typically…
  - **Company with niche core functions:** a best-of-breed approach is adopted for the company's core functions (favoring specialization), while a single supplier is adopted for the remaining functions (favoring the cost factor and level of integration)
  - **Company with generic core functions:** a single vendor is adopted to cover all possible functions (giving priority to cost and level of integration), while a best-of-breed approach is adopted for functions not covered

# The ERP Paradigm: Prescriptiveness

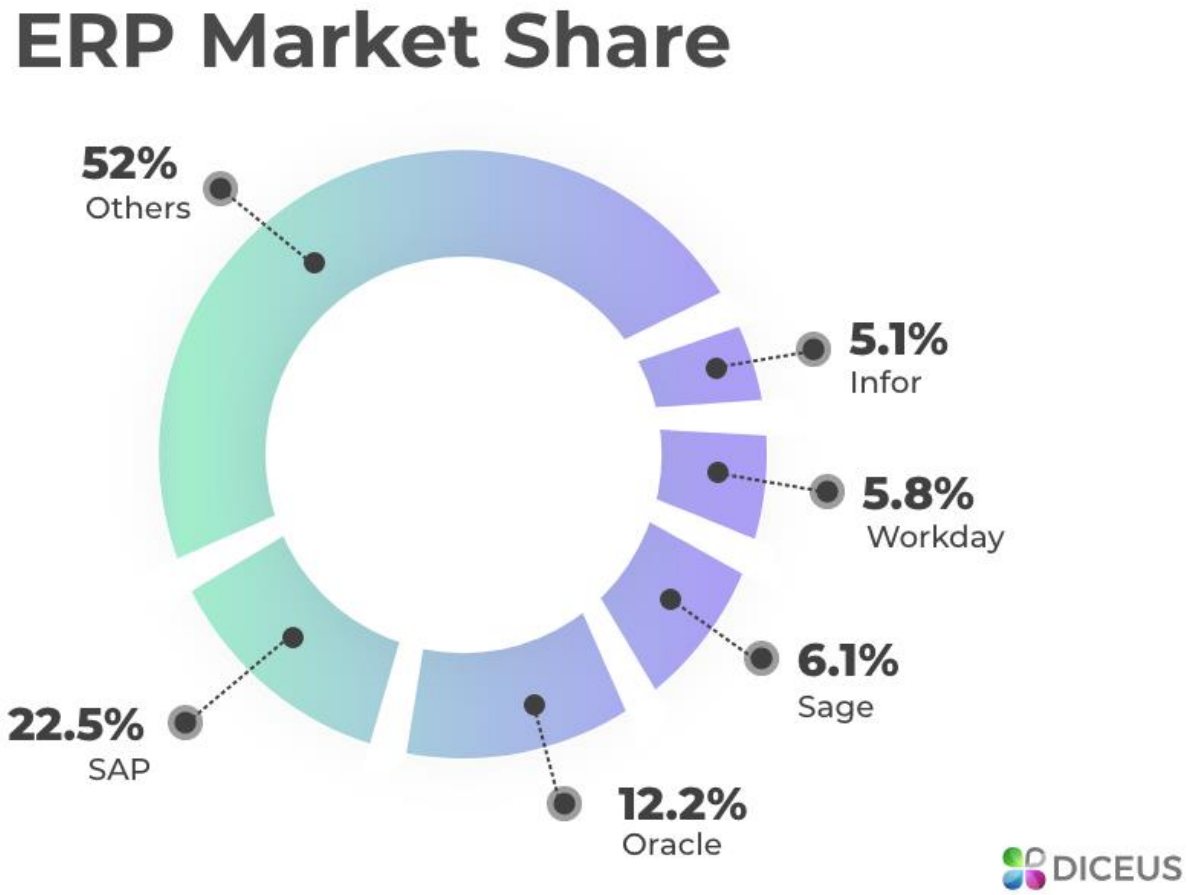
- ERP systems incorporate business logic



# The ERP Paradigm: Prescriptiveness

- It is necessary to make business processes adhere to those defined in the ERP.
- The approach to an ERP project is reversed from that of designing a “tailor made" IS.
- Organizational impact can be high, however
  - ERP processes are based on industry best practices
  - They guarantee the correctness and standardization of operations
  - Promote the rationalization of processes, making the ERP IT project coincide with a BPR project (Business Process Reengineering)

# The ERP Market



# ERP in Small & Medium Enterprise

- ERP market share declines sharply in small and medium-sized companies

- The map of IS modules in small and large business coincides, however:
  - IT budget is limited
  - Business complexity is low
  - Flexibility and speed of action are more important than standardization
- Uniqueness of information and modularity, however, remain strongly positive features of IS, and software vendors are gearing up to provide cost-effective solutions:
  - Simplified modules for industry independent processes
  - Pay-per-use contracts: to reduce costs and to convert Capex (*Capital Expenditure*) to Opex (*Operational Expenditure*)

# CRM Systems

- CRM (**Customer Relationship Management**) stands for the integrated and structured process for customer relationship management. Its purpose is to build personalized long-term relationships, capable of increasing customer satisfaction and, consequently, of increasing the value of the company for the customer and of the customer for the company.

- The customer becomes the central focus of the business strategy.

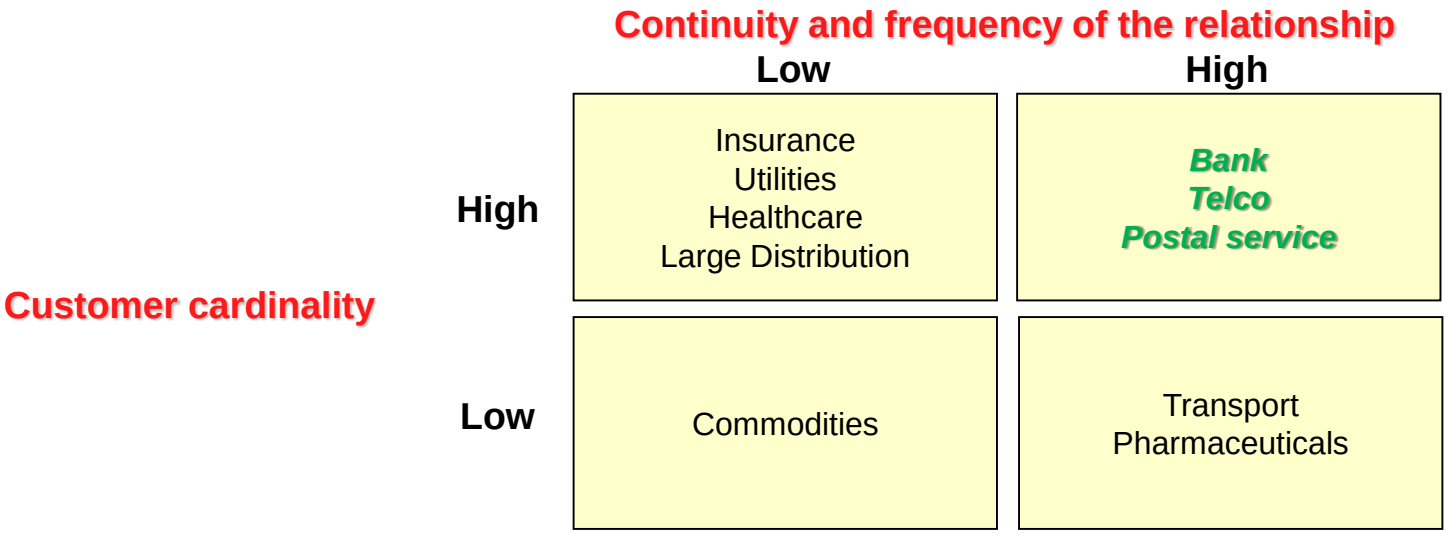
- Telco are the best example of the CRM approach
  - Phone and SIM can be bought via web
  - The customer can tailor her rate by choosing the services most important to her
  - Call centers are active 24 hours a day

- CRM is unfeasible without digitalization

# CRM Systems

- CRM systems are the IS modules that support customer relationships and computerize the flow of activities through which customer requests are served.

- The role of CRM systems varies by business sector and is greatest in companies with **frequent** and **continuous** relationships over time with a **large**, geographically distributed customer base that interacts through various channels

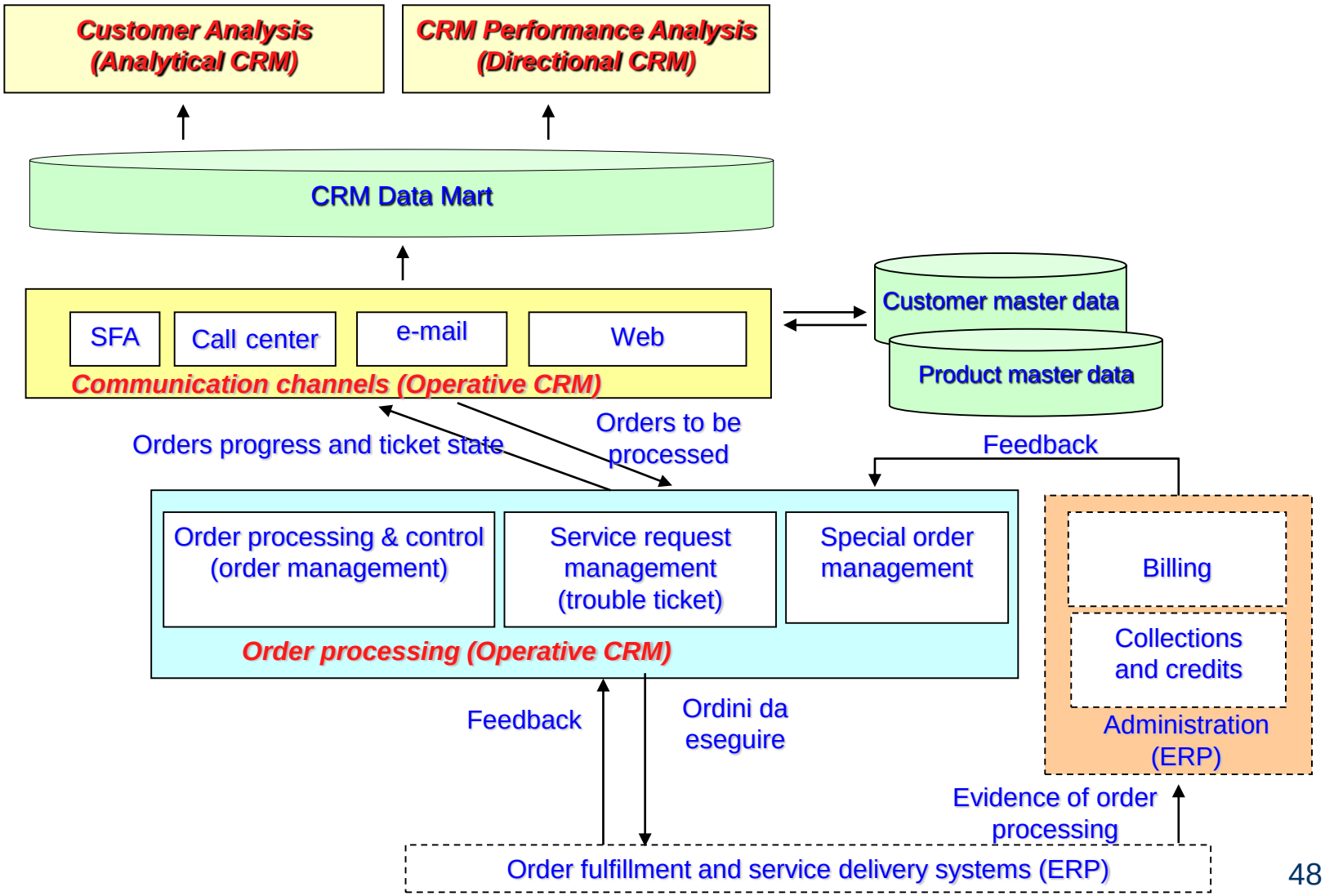


# CRM Systems

- There are three main modules in a CRM system
  - **Operative CRM:** digitalizes the communication channels: Presence – Voice – Web - Mail
  - **Analytical CRM:** digitalizes customer analysis in order to define promotion and contact policies
  - **Directional CRM:** allows management to evaluate the company's performance with respect to the customer and to the CRM

- Analytical CRM supports the sales and marketing department in planning their activities.
  - *What are the top 5 customer clusters based on buying habits?*
  - *What is the profile of the customer who most buys product B?*
- Directional CRM supports management in evaluating the efficiency of marketing and sales. Both are based on summary data stored in the company DW.
  - *What is the conversion rate of outbound markeing via call center?*
  - *How long do different types of tickets stay open?*

# CRM Architecture



# The CRM Paradigm

- The features denoting a CRM system can be summarized as follows:
  - **Multichannel:** the customer chooses the most convenient contact channel each time. The service must be available 24 hours a day.
  - **Completeness and uniqueness of product and customer data:** to make multichanneling possible, customer information must be shared by different contact systems that will use a common database (master data).
  - **Service chains:** requests submitted to front-ends generate a series of complex activities on back-end systems. The efficiency of the CRM system therefore depends on the ability to integrate SI services.

# CRM Channels: Presence

- The customer interacts directly with a company representative.
- CRM supports the salesperson in the cycle of customer identification, contact, negotiation and actual ordering. Since automation is primarily directed at the salesperson we talk about **Sales Force Automation** (**SFA**) applications. These systems originated in the 1980s and have been widely used by sellers of complex products (e.g., medical representatives, financial advisors). Salespeople are provided with a laptop computer that:
  - Allows the salesperson to fine-tune offers to customers
  - Contains fact sheets and product demonstrations
  - Collects orders
  - Collects information on the progress of visits to customers
  - The data and information collected in this way are then transmitted to the company's central system, which provides for their management.

# CRM Channels: Voice & Mail

- The customer interacts via telephone with a network of operators assisted by the CRM system, and automated systems integrated with the telephone equipment (call-center)

- Digital Technology:
  - Allows you to sort calls based on the service required
  - Provides answers and services automatically and in self-service mode
  - Makes call center **multi-location** transparent
  - Supports operators

    *In an after-sales service call center, upon receiving a call, the operator reads the customer's data on the screen and records the request data on a card. This recording automatically generates work orders that are assigned to the teams that will perform the maintenance. The operator can also view the status of the work orders for that customer or his previous requests.*
- Through the mail channel, the customer interacts via email with the company where operators sort the incoming letters. The company can also use automatic mailing systems, making possible marketing campaigns or information services that would otherwise be impossible.

# CRM Channels: Web (& Social)

- The **web** channel is the main CRM channel:
  - 24h self-service sale
  - Single customer personalization
  - Evidence of the order status
  - BOTs for automatic chats
- Web :
  - **Business-to-Customer (B2C):** access points for final users (oriented to sales)
  - **Business-to-Business (B2B):** access points for partner in the supply chain (oriented to sales and collaboration services)

# The CRM Market

## CRM Software Spending by Vendor

**Total Software Revenue Worldwide, 2018 (Millions of U.S. Dollars)**

| Company | 2018 Revenue | 2018 Market Share (%) | 2017 Revenue | 2017 Market Share (%) |
|---|---|---|---|---|
| salesforce | 9,420.5 | 19.5 | 7,648.1 | 18.3 |
| SAP | 4,012.2 | 8.3 | 3,474.4 | 8.3 |
| ORACLE | 2,669.0 | 5.5 | 2,492.9 | 6.0 |
| Adobe | 2,454.8 | 5.1 | 2,017.2 | 4.8 |
| Microsoft | 1,302.0 | 2.7 | 1,132.1 | 2.7 |
| Others | 28,371.7 | 58.8 | 24,962.0 | 59.9 |
| Total | 48,230.2 | 100.0 | 41,726.7 | 100.0 |

Source: Gartner (June 2019)