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Information Systems

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1. Introduction to Information Systems

BASIC TERMS FROM COMPUTER SCIENCE

Data – information - knowledge

Data indicates about the world (for example, can be obtained by measurement)

Information arises by interpretation of data. Information is data, which is assigned meaning.

If we talk about **knowledge we** mean information embedded in a context and combined with experience. Knowledge is often the most valuable asset companies possess. Knowledge may be, for example technological process, which leads to a unique product. The know-how required in production process of Coca Cola may serve as an example.

Information provides something new to the user, thus it reduces the uncertainty of the world (uncertainty is also referred as „entropy“, information reduces entropy).

The basic unit of information is **bit** („BInary digiT“).

Bit takes values of 0 or 1. Working with bits, we are working in a Binary numeral system. Bit was chosen for historical reasons – it corresponds to two-state logic („true – false“ or „yes – no“) and also it is easily implemented in physics (for example: relay - closed contact – open contact).

Higher unit, often used in computer science is a **byte** (eight bits, eight is a multiple of two, making it easier to transfer between octal and hexadecimal numeral systems) and a **word** (16 bits).

When indicating the size of memory in bytes we are often working with multiples:

Kilo (KB)	thousand
Mega (MB)	million
Giga (GB)	billion
Terra (TB)	trillion
Peta (PB)	quadrillion
Exa (EB)	

SYSTEM

What is a system?

The system is a specifically ordered set of elements and a set of links between them with a dynamic, purposeful behaviour. It is a set of interacting or interdependent components forming an integrated whole.

System is defined by:

- Elements
- Links between elements
- Parameters (evaluation of links and elements)
- Objective function (determine the reasons for the existence of the system)
- Target functions (state that we want to achieve)

The system has its own **structure** and **behaviour**.

Certain structure of the system corresponds to a particular behaviour, but behaviour corresponds to a class of structures that is defined by this behaviour.

The analysis is a definite task, when based on the known structure of the system, behaviour must be determined.

Synthesis is an ambiguous task, when based on the desired behaviour, we are seeking appropriate system structure that would ensure this behaviour.

CLASSIFICATION OF SYSTEMS

In relation to reality:

- Real
- Abstract

Depending on the type of establishment:

- Natural
- Artificial (man-made)

According to the behaviour in time:

- Static (their status does not change with time)
- Dynamic

Depending on the type of system variables:

- Continuous (have a status at each time point)
- Discrete

According to the shape of the static characteristics:

- Linear
- Non-linear

According to the generality:

- Hard (solve a specific, structured problem; mostly technical systems)
- Soft (more general)

The systems may include **feedback** – control of the system is influenced by output value.

INFORMATION SYSTEM

Information system (IS) is a system for collecting, transferring, maintaining, processing and providing information.

Definition:

Information system is any combination of information technology and people's activities that support operations, management and decision making.

Another definition describes the information system as a form of purposeful use of information technology in the socio-economic systems.

What the **information technology** is?

Information technology is any technology involved in processing information.

PARTS OF INFORMATION SYSTEM

- Software (applications, programmes)
- Hardware
- Database
- Human element (Peopleware)
- Organizational structure (Orgware)
- The context of information system (real world)

INFORMATION PROVIDED

- Periodic reports
- „Ad-hoc“ on-line queries

It is important to realize that for businesses and companies the information system acquisition **is not a goal** but **a means to improve the operation of the company (and to increase profits).**

HISTORICAL STAGES IN THE DEVELOPMENT OF INFORMATION SYSTEMS

The era of batch processing of data, without any links to other control components. This era is characterized by the use of **mainframes**, processing batch jobs. Interactivity with users is low. Computers are stored in the computer centres separated from the rest of the company**.**

The era of providing information for management - information systems work by means of indirect control - based on information provided, the managers have better decision.

The era of strategic information systems - information systems produce changes in the style of business or changing business processes. Existence of an information system and knowledge base provides companies a competitive advantage.

The information system serves as a **support** for the management of the companies.

EFFECTIVENESS OF IS

In relation to information systems the term effectiveness is often mentioned.

Effectiveness is the efficiency of funds invested in activities assessed in terms of useful outcome of this activity.

A **balance between cost and benefit** is considered as an optimum.

Evaluating the effectiveness of resources invested in information systems is difficult because:

- Costs are visible (invoices), while the benefits are not
- The effect of IT investments can appear with a delay
- The benefits can be indirect – better management decision using provided information

ACQUIRING INFORMATION SYSTEM

When acquiring information system we can proceed in two ways:

1. Finding maximum value at the specified level of funding
2. We know what the IS / ICT application we need and we are looking to buy it as cheaply as possible

The information system comes into contact with four categories of people with different expectations:

- Owners
- Managers
- Employees
- Customers

The expectations of each group mentioned above somewhat vary.

Owners: IS should bring assets (higher profit).

Managers: IS/IT enables them better management; to achieve desired results with minimal resource consumption (minimal costs).

Employees: IS should create a better working environment for them.

Customers: Thanks to IS they expect a product (service) of high quality with affordable price.

REQUIREMENTS FOR INFORMATION SYSTEM

- Reliability
- Effectiveness (in relation to costs)
- Flexibility (the ability of future development)
- Maintainability
- Security
- Robustness

REQUIREMENTS FOR PROVIDED INFORMATION

The information provided should be:

- Timely
- Relevant (appropriate to the needs)
- Accurate (without errors and without any possibility of misinterpretation)
- Verifiable (the control mechanism)

This means that the information system should not overwhelm the user with plenty of mostly useless information. **Simplicity** and **clarity** is certainly to be preferred wherever possible.

An example of the information system is Internet.

- Is information on the Internet accurate?
- Is information on the Internet relevant?
- How much rubbish and useless information will the search engine produce when searching for a particular term?

CONTROL AND INFORMATION SYSTEMS

The term "control system" and "information system" do not have sharp boundaries. Control system is used for controlling while information system provides information. However, this information is provided to support management, therefore we can talk about indirect control.

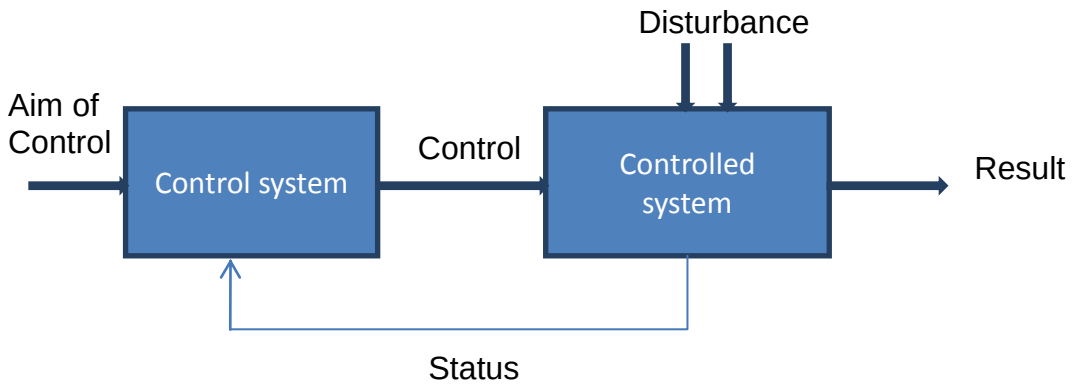
Control level is important when analysing a control system. In principle we can distinguish three levels of control:

- Operational (process) control
- Tactical control
- Strategic control

Operational control deals with control at current time, control of technological processes often in real time control. This is usually about decision-making in a very short time. Automatic control belongs to this category. For operational control the short-time data (current state) is of crucial importance.

Tactical control deals with control of a larger unit of time, usually a shift or a day. It works frequently with the trends, retrospective values and historical data. At this level, the production plan for a shift or the sales plan for a day are put into practice, etc.

Strategic control working with a larger time horizon, at this level we are dealing with strategic plans and long-term decisions. We work here with the data acquired in a larger time horizon, which are often aggregated in some way or pre-processed in some other way. Also, at this level statistical methods of data processing are largely used. Strategic control often contains decisions support systems, business intelligence etc.



Control system that operates with a certain aim (achieving a desired state/condition) drives the controlled system so that the output state is consistent with the desired state. At the same time the controlled system is influenced by disturbance, diverting it from the desired state. Aim of control is to eliminate the effect of disturbance.

If we know the state of the controlled system (e.g. by measurements using sensors), and this information is used in operation, we talk about feedback control systems.

The control operations are regarded as **optimal** when the aims of control in a given situation are achieved in the best possible way. With regard to the above**, Control** is a **goal-driven, purposeful acting of the control system on the controlled system in order to achieve the required target**.

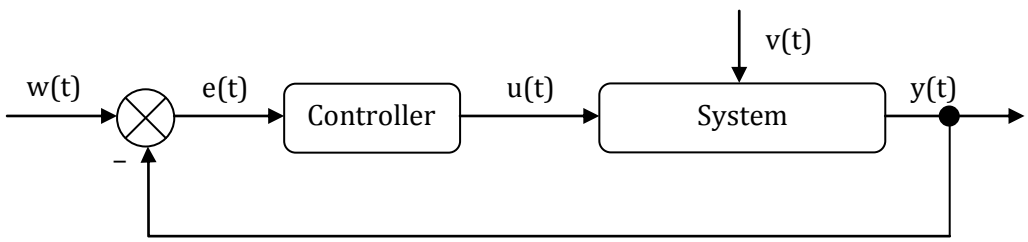
AUTOMATION CONTROL

Under "automatic control" we mean control without participation of humans. Cybernetics (or Control Theory) deals with automatic control (linear and non-linear, stability of systems, discrete control…)

Feedforward control and **regulation** control are specific types of control systems.

In case of **feedforward control** - control efficiencies are not compared with the expected outcome; It is a control with no feedback. It is sometimes called an open control system.

The **regulation control** is based on the automatic balancing of deviations from the set - point by a certain criteria. The regulation uses negative feedback.



At the picture above we can see basic concept of automatic control.

w(t)	required value
e(t)	control deviation
v(t)	disturbance
y(t)	output value
u(t)	control (action) value

Controller could be proportional (P), integral (I), PI or could contain derivative part as PD or PID.

Example:

The required value is the value of temperature in the room. Y(t) is current value of temperature measured by thermometer. If the temperature is lower than required ($w(t) - y(t) > 0$), the controller starts heating. The result of automatic control should be $e(t) = w(t) – y(t) = 0$. At this moment controller stops the heating.

2. Acquiring and Implementation of Information Systems

The Lifecycle of IS

Just like machines or technological lines (which are acquired, operated and subsequently removed), information systems also have the lifecycles. The lifecycle of IS in medium and large enterprises can be divided into several stages:

1. Planning — takes about 1 year
2. Acquiring (purchase or development) — approximately 1 year
3. Implementation
4. Operation and maintenance — 6-8 years
5. Liquidation

Working life of enterprise information systems is usually less than 10 years. This is because the company is changing over time and IT technologies, products and services very quickly becoming obsolete.

Acquiring IS

A key question in the acquiring of an information system is to decide whether to **buy a ready-IS** (delivery solution) or **develop** the information system on its own (if the company has its own IT department). Both have their advantages and disadvantages.

Determining whether it is better to buy or develop a system is highly individual. In general, the more standard the application is, the stronger the case is for buying rather than developing a system.

Another possibility is to use some form of **outsourcing** - IS is provided as a service by provider.

Outsourcing therefore means ensuring the implementation and operation of information system with external suppliers.

There are several types of outsourcing:

- Complete outsourcing (including HW infrastructure)
- Personal outsourcing (delivery of specialized professionals who are physically present at the customer's place but they are employed by suppliers)
- Outsourcing of applications or services (ASP – Application Service Provider, SaaS (Software as a Service), cloud computing etc

Decision whether to go for the acquisition or the development is also influenced by answers to the following questions:

a) Are the business processes adjusting to the IS or does the IS have to exactly fit the existing processes?

b) Who and how will maintain the system?

c) Do we have sufficient resources for development?

Business process reengineering is not a common thing and it is often expected that the information system will adapt to the deeply rooted business practices. But business processes are not always working optimally and it is advisable to do a business process reengineering (BPR) before implementing the information system.

Often underestimated aspect of IS acquisition is the system maintenance during operation of the system.

In the planning stage it often ends with the implementation of IS and its putting into operating. But during operation, the system is still alive and changing, there are a lot of influences (HW or SW obsolescence, new requirements, company development, user's activity, databases overloading, security issues, regular backups etc). If these issues are ignored, the system can fail. If the company does not have sufficient capacity to ensure the IS operation, it is better to use the delivery solution. On the other hand, there is a risk of dependence on suppliers (suppliers going bankrupt, not enough capacity, they lack of experience…).

Economic side of things also plays its part. If this is a standardized software solution offered by a number of IT suppliers who have lots of customers (and they can spread the development costs to a number of licenses sold), it can be expected that the cost of development of IS on its own exceeds the price of commercially offered products. Development of the IS in this case makes sense if the company requires specific features and solutions not possessed by other competitors in business. Motivation here can be obtaining competitive advantage in the form of specific, original solutions.

IS Cost Structure

1. Hardware costs
2. Software costs
3. Implementation costs
4. Maintenance fee (estimated 10-20 % of IS cost)

A common problem when acquiring the IS through company's own development is to keep track of the costs:

a) How to measure laboriousness of IS development?

b) How to measure the quality?

As a good practice it is sensible to specify these metrics in advance (evaluation method).

Delivery Solutions (Purchased IS)

When using delivery solutions (acquiring IS by purchase) the following problems may be encountered:

- Alignment of IS/IT with business objectives
- The need to maintain older systems
- Increased complexity (over supplies in the past)
- The balance between the requirements of the client and project risks
- The trend of reducing budgets for IT
- Deadlines for implementation are often too short
- Lack of project status transparency
- Ineffective communication within the supplier's development team

Specifics of Implementation of IS

As opposed to the implementation scenarios decades ago, when for deployment of IS there was enough time, money and when the functioning of the company was not directly dependent on the success of the deployment, IS implementation nowadays is characterized by some specifics:

- Short development time
- The growing complexity
- Development is hardly controllable
- High skill requirements of developers (there is a constant lack of programmers)

The demands on quality of information systems are constantly growing, because of:

- Companies are more dependent on IT (IS fails can cause stop the production…)
- Failure of IS has serious economic consequences
- User requirements are more accurate
- Increases the emphasis on return of IT investments
- Growing competition from suppliers
- Influence of legislation

IS Implementation

Implementation of IS consists of the following phases:

1. **Initial studies („feasibility study“)**
2. **Global analysis and design**
3. **Detailed analysis ("functional specifications")**
4. **IS development and testing**
5. **Implementation (including training, manuals,…)**
6. **Deployment, trial period and testing**
7. **Operation with warranty service**
8. **Operation –customer service, technical support**

The aim of **initial study** is to assess whether with the money available, and with a given time, it is possible to provide the desired functionality. Thus, generally speaking, whether the project ever pays and whether it is technically feasible.

In **a global analysis**, we try to capture the concept of the project, to create its global architecture. A proposal for technical and software resources is also a part of this phase, as well as technology architecture, software estimation claims, etc.

Detailed analysis is concerned with a specific information system solution, at this stage we perform the analysis working procedures, collected information about required outputs. Data model and **the functional specification** is included (precise description of the functions that the system should be capable of, sometimes this document is developed to the design of each screen user interface).

Development phase follows, with **testing** that is equally important. It is appropriate if the development is controlled in some way, e. g. by using some of the existing methodologies (see the chapter “software engineering”). Underestimating the analytical phase may occur precisely

at this stage and will be characterized by increased work difficulty or even inability to successfully complete the project.

The implementation of IS should include (and unfortunately it is not always the case) the conceptual solution of further operating of information system, its maintenance, development, post-warranty service solutions, etc.

TOTAL COSTS OF ACQUIRING IS

Structure of acquiring costs:

- HW
- SW
- Implementation team salaries
- HW maintenance
- Design and development of SW
- SW maintenance
- Communication services
- Preparation of agendas and reports
- Overhead – material overhead, energy costs salaries of management and administrative staff

The costs have low limit and also saturation stage. Saturation stage means that the increase in spending has not led to improved performance or quality.

TOTAL COST OF OWNERSHIP (TCO)

TCO includes:

1. Investment
2. Technical support
3. Management and administration
4. End-user work

RETURN OF INVESTMENT (ROI)

ROI means return on investment and is calculated as:

ROI = yields / investment * 100 [%]

ROI = 100 %	yields fully cover the investment,
ROI > 100 %	the project makes profit,
ROI < 100 %	the project is in loss.

CONDITIONS NECESARRY FOR SUCCESS IN THE DEVELOPMENT OF SW

- Appropriate development team
- Selecting the right tools
- Purchase or develop decision
- Finding common ground with client
- Solution of maintenance and IS expanse (or changes) in the future

3. IS DEVELOPMENT – SOFTWARE ENGINEERING

PROBLEMS OF SOFTWARE DEVELOPMENT

Development of the first programs was conducted by enthusiasts; programs-were tailor-made. Software development methodology at that time did not exist. Software development was perceived as research.

Goal - what the software will do - was determined by programmer himself on very vague input - others often had no idea what to expect from computers and software. Development wasn't bound by any terms (when the software was ready, it was deployed).

As a result of expanse of information technology and a growing number of projects that did not end successfully (it means - they were not completed on time or were too expensive or not completed at all) the turn of the 1960s and 1970s began to be called/tagged/nicknamed a time of "software crisis".

SOFTWARE CRISIS

- Project costs overrun unbearable
- Unbearable extending of projects
- Low quality of programs
- Low productivity of programmers
- Inefficiency of development
- Uncertainty of results

„Software crisis“ raised the need for using methodologies of software development management (IS). And what do the 'software crisis era' problems look like from today's perspective?

PROBLEMS WITH THE SOFTWARE DEVELOPMENT IN THE PERSPECTIVE OF "SOFTWARE CRISIS"

- Poor communication: the customer deals directly with the programmer, the analysis is not separated from the development
- Approach: Programmers sometimes tend to prove themselves, show their pride, impress others, lack of teamwork
- The lack of a development plan: "We'll do it somehow ", hitting the keyboard right as soon as the project kicks off (Solution: use a software development methodology)
- Low productivity: programmers deal with everything but what is needed. The tendency to write code immediately and churn out as many lines of code as possible.
- Underestimating risk: Issues that could be resolved in the beginning, were ignored. "It will finally be solved", "no problem", "it will go unnoticed".

DIFFERENCES AND SPECIFICS OF SOFTWARE DEVELOPMENT AS COMPARED WITH OTHER BRANCHES

Quality of professionals is a critical success factor.

In most areas the management is the architect of success and the workers at lower levels are regarded disposable and easily replaceable. It doesn't apply for software development - a departure of a key programmer from the team can cause serious complications (or even terminate the project).

The big difference is in productivity. Programming is not just about mastering a programming language, but also about **experience**. Among programmers there are fundamental differences across education, experience and talent.

Professional Staff must Continually Improve and Learn

New technologies arrive about every three years. Continuous training and education is a must. Programmers risk falling behind the latest technology on one hand, and burning themselves out on the other hand.

The Different Ways of Work are Beneficial

Programming is not about the eight-hour working time. Programmers often enjoy work and it is convenient for working hours to flexibly change. A team imbued with passion can achieve significant productivity, as long as the work is not too stressful and periods of increased effort are time-limited.

The most Productive are Small Positively Motivated Teams

A strictly hierarchical system, with work under pressure and threat of not receiving rewards, is not suitable for the software development world. Software development is a creative work. Development Manager should not pursue it by commands, if the team works successfully. When a problem occurs on the other hand, they should step in as soon as possible.

Error is a Legitimate Part of Development Process

Because software development is a creative activity, it can not be scheduled as in building construction.

Even in the best-managed projects, errors occur. But it is necessary to establish procedures to ensure that as many of them as possible are eliminated.

Fast Technological Development Brings new Opportunities

Managers stuck in routines of their leading positions are often unable to predict them. The initiative may come from below. Success in the past does not mean anything.

Does Digital Equipment Corporation (DEC) say anything to you?

In the 80's, along with IBM it was the largest IT company in the world, having more than 50,000 employees, one of the leaders in the mainframe, the company that brought the successful series of mainframe computers such as the PDP, VAX, ALPHA, operating system, RSX and VMS. Currently it is just a small group division of Hewlett Packard.

Most Common Problems in Development

- Delay
- High error rate
- Failure to meet the required performance
- Underperformance
- Complicated user interface
- Difficult maintainability

Causes of Problems

- Underestimating the project and miscalculation (time, costs)
- Poor input
- Insufficient analysis
- Excessive complexity of the project
- Overemphasis on technology (the use of new products without experience)
- Poor quality of program code (error, incomprehensible, slow, poorly annotated)
- Suitable methodologies, processes, technologies
- Insufficient testing
- Poor project management

Introduction to Software Engineering

The subject of software engineering is a methodology for managing software development.

Why do we need these methodologies?

In what is the software development unique compared to other sectors?

Software Engineering

Software engineering is the introduction and application of engineering principles in order to achieve economic production of software.

Approach to the IS Development

From the perspective of authors we can divide approach to information systems development into two areas:

a) Work-down
b) Value-up

Work-Down Approach

Work-down approach to the development of IS is based on the fundamentals of project management. Development and implementation of IS progressing according to the plan (schedule) specified at the beginning of the project, which breaks down into a series of partial

fulfilment of specific tasks (terms). Tasks are gradually implemented, the implementation schedule is continuously monitored.

Work-down approach is suitable for projects with well-known design and low risk (target is clearly defined; the solution has a fixed concept).

The value that information system brings to the customer is clearly defined at the beginning of the project. The big advantage of this approach is to monitor and review the progress of work, the project is controllable according to clearly defined criteria.

Disadvantages

- Changes arising during the project are difficult to integrate
- Ideas and practices that might mean benefit for the customer, but that are not in the original proposal, can not be applied (to meet schedule and budget)
- Insufficient analysis and the uncertainty of resulting solution can cause serious complications
- The customer has a minimal effect on the project
- Quality is defined as meeting specifications (compliance schedule)

VALUE-UP APPROACH

Within value-up approach the development takes place in iteration with the customer. Emphasis is placed on the value of information system for the customer, which can be continuously increased. In value-up approach a plan is also being created, but the procedure according to the schedule is not the main objective. If during the development new factors and processes arise that lead to customer's getting more value, this innovation takes precedence over meeting the schedule at any cost. We may drop parts of software that during the solution phase turned out to be unnecessary or obsolete. The aim is to deliver the well-functioning parts to the customer as soon as possible so that the customer can verify and comment the solutions and ideas and these comments could be incorporated into the development.

Value-up approach has:

- Focus on continuous value creation
- Customer participation in the project
- We expect uncertainty and we are ready for it
- The source of values are individuals - by recognizing increasing creativity
- We encourage the performance by group responsibility for results and team effectiveness
- Quality is defined by benefit to the customer (the term can be shifted if it brings something to the customer)
- Changes and variations are considered to be a natural part of the solution
- It is possible to use creativity of solvers

Of course, even this approach has its drawbacks - difficult controllability of the project, including an evaluation of the progress of work, the threat that the project will not be completed

satisfactorily, etc. This procedure is also unusable for large investment projects, where the investor and the user are different entities.

Recommendation for the Development of IS

One of the important IS success criteria are:

- Ease of use
- Speed of launching into market

It is more convenient to write an application that will be upgradeable in the future than a monolithic system that will include all possible features at the very beginning (including features that nobody ever uses).

Applications written to suit specific requirements, lacking any features of generality, can be difficult to modify in the future.

The tendency to write too general systems often leads to two results - incomprehensible and opaque architecture or systems that, due to a number of adjustable parameters, cause behavior that not even the system creators are able to document.

It is therefore necessary to find a reasonable compromise between generality and specific requirements.

Access to the development is different, if we create a single application that will run for a limited period of time, or try to develop "packaged software" that will work in many companies. In the second case, it is certainly worth to design the entire concept of the system to be the most general and parameterized. In the case of a single determination too much generalization may be a waste of time and resources.

What is a Methodology?

Software development methodology includes all stages of the solution, it should answer the questions: Why? Who? When? What?

Methodology is the set of processes leading to the delivery of functional software.

Classification of Development Methodologies

Significant traditional design and development methodologies:

- Code and Fix
- Stagewise Model
- Waterfall
- Spiral Model
- Other like: RUP, UP, USDP, …

Some agile development methodologies:

- Extreme Programming
- Crystal
- SCRUM
- Aspect Oriented Programming
- Test Driven Development

TRADITIONAL METHODOLOGIES

CODE AND FIX

Implementation -> Delivery -> Bug Fixes

This methodology is the oldest-known methodology in the field of software development, it is listed here only for completeness, and except for small one-off projects, its use is inappropriate.

STAGEWISE MODEL

This model of software development was defined in 1957.

It is based on a strict sequence of phases:

- Definition of the problem
- Analysis
- Specification of requirements
- Design
- Architecture
- Implementation (and testing)
- Operation

This method of software development is based on the following factors: absence of feedback, no phase or requirements are revised, no risk evaluated.

WATERFALL

- 1970 Winston Royce
- Each stage has its exact objective set and accurate documents that must accompany it

- At the end of each stage there is an evaluation and possibly rework or repair
- Ability to return to the previous stage
- Proceed only when the stage is completed and approved (point of no return)

Advantages:

- Simple
- Ideal for management
- It brings discipline in the development

Fig. 3.1 Waterfall Model [http://www.managedmayhem.com/2009/05/06/sashimi-waterfall-software-development-process/]

Disadvantages:

- Delivery of the form of a "big bang"
- Certain rigidities
- In the time between the analysis and deployment requirements can

"If I start to fall, I will not stop before hitting the wall called demonstration"

SPIRAL MODEL

- 1985, Barry Boehm
- Introduces an iterative approach and repeated (consistent) risk analysis

Risks - situations or events that can cause failure of the project objectives.

It is assumed that at the beginning it is difficult or even impossible to specify all functions. Thus it provides only a general framework.

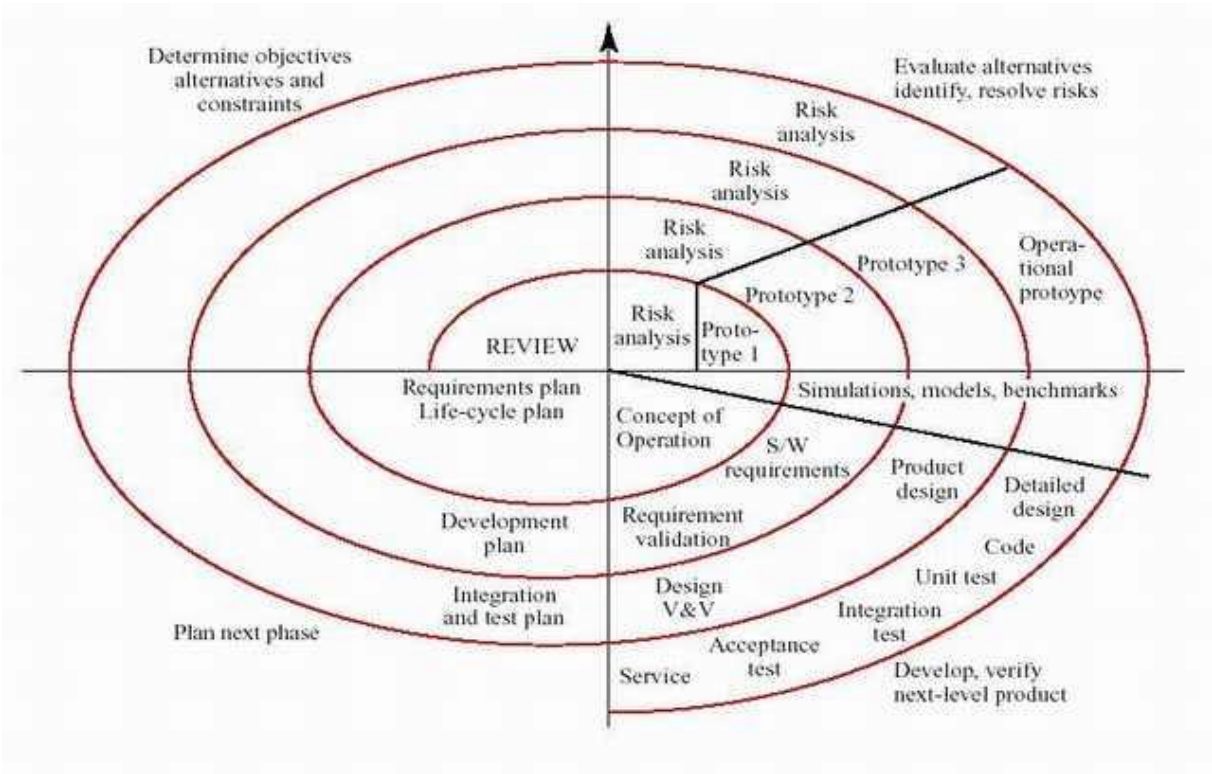


Fig. 3.2 Spiral Model
[Source: http://kep3.com/en/30Services/60SwDevelopment/Articles/DevMethod.html]

Developing part of the application -> demonstration and consultation with the client -> going to the next step.

Development takes place in a spiral, in gradual iterations. Unlike agile methodologies mentioned below the customer only sees the individual results and does not participate in the ongoing development of the software.

Advantages

- Creates an environment for the development of reusable components
- It is comprehensive and well suited for complex projects (the emphasis on planning)
- Early elimination of inappropriate solutions

Disadvantages

- The overall complexity
- Software is not released before the completion of the last cycle
- Changing requirements is possible only after completion of cycle
- For new types of applications (eg, Internet) it is not flexible enough

It is more appropriate for large projects.

RUP – Rational Unified Process

Development takes place in iterations, divided into 4 phases: Initiation, Planning, Execution, Delivery (to the customer or to the next stage of development).

The methodology is robust, sophisticated, suitable for larger projects and larger teams.

Commercial product (formerly Rational, now IBM)

It is based on the use of UML (graphical modeling language used for systems design, is based on the object-oriented approach, using a set of diagrams it models the static and dynamic view of the system)

Key principles:

- Iterative software development (based on the spiral model, continuous detection risk)
- Governance requirements (requirements are changing over time)
- The use of component architecture
- Visual modeling software (in order to understand the system; using UML)
- Ongoing quality assurance and verification (investigating problems after transfer becomes more expensive)
- Change management - keep in mind that changes will (inevitably) come, not managing them leads to chaos

Advantages of RUP:

- The generality and robustness
- Iterative approach - early detection of risks
- Easier change management
- Links with UML notation, documentation
- Manufacturer continually working to improve the methodology
- Existence of complementary tools

Disadvantages of RUP:

- Commercial, it is a paid product
- The size RUP can be harmful in small teams - team spends a lot of time implementing the methodology
- Its use requires a deep study (it also applies to project managers)

Traditional software development methodologies are based on a strict definition of procedures.

Unified Process

UP (Unified Process) is a methodology similar to the RUP, it is a non-commercial version.

Unified Process is driven by requirements and risks. It is iterative and incremental. Each iteration includes all phases of normal development (planning, analysis, design, integration, testing).

Iteration includes:

1. Opening – determinative of feasibility, the establishment of business case, requirements capture, risk identification
2. Development - executable version of architecture, refinement of risks and requirements, the definition of quality, design and resources plan
3. Construction - tuning requirements, implementation
4. Introduction - bug fixes, site preparation for deployment, customization of workplace and software, manuals, tutorials

AGILE METHODOLOGIES OF SOFTWARE DEVELOPMENT

Procedures in previous methodologies, based on thorough analysis and sophisticated design are generally the best.

But…

"Did you take six months to build your website? The competition in the meantime launched two of them ..." Apparently it may seem that the customers' lack of ideas or knowing what they want is an advantage – we deliver "something" to them and they will be satisfied. At the end of the project the customer may say that the result is not what he/she wanted. They want you to complete or redo the project - for the originally agreed price. They expect quality, but they are not willing to wait long. Agile methods attempt to address this contrast establishing a closer connection with the customer's development team.

2004 „MANIFESTO FOR AGILE SOFTWARE DEVELOPMENT“

The only way to verify the correctness of the designed system is to develop it as soon as possible, present it to the customer and use received feedback for system's modifications.

The main idea of agile approach is to pull the customer into / make the customer an active part of the development process.

The traditional approach - requirements are defined at the beginning of the development process and are unchangeable. Resources and time are variable.

Agile approach considers resources and time to be immutable, the functionality is subject to change. At the beginning of the project the longest possible time and cost is determined. During the engagement, the team communicates with the customer and continually reassesses priorities.

Theses of Agile Manifesto

- Accepting and enabling change is more effective than preventing it.
- It is necessary to be prepared for unforeseen events - "the only certainty of the project is change."

Principle of Agile Methods

- Effective customer value
- Changes are an advantage (for the customer they can be a competitive advantage, agile methodology does not address anything that is not currently needed, because in the future it may change)
- Frequent deliveries (very short iteration)
- Key is motivation
- Customers cooperate with the team
- Success of the operation are reviewed for compliance and not according to specifications
- Simplicity is essential
- Trust and communication lead to creativity
- How do we increase efficiency?
- Perfect design and solution (change is not considered proof of its poor quality)
- Sustainable development (overtime and night work solves short term problems but reduces long-term productivity of labor)

Agile Development Team

- Up to 10 memebers:
  - Coach
  - Programmers
    - The Timekeeper
    - Constantly present employee of customer
  - Programmers work in pairs which change
    - The first programmer - invents and writes
    - The second programmer - opposes, checks
- Room for relaxation and meetings
- Emphasis on the use of creativity
- Minimize the documentation (nobody reads), only clear source code
- Overtime does not increase long-term productivity

Agile development reduces the:

- Risks associated inaccurate task definition or the complexity of the system being built
- Risks associated with fluctuations of team members
- Risks associated with the fact that there is no standard documentation
- Risks associated with non-compliance with deadlines and budget overruns.

When is it not appropriate to use agile methodologies?

- Critical systems where it is necessary to strictly follow agreed technology
- Extensive systems that can not decompose
- There are no quality developers
- There is no willingness to negotiate about the destination on the fly (such as a contract, or penalties for non-compliance)

OVERVIEW OF AGILE METHODOLOGIES

- Adaptive Software Development
- Extreme Programming
- Lean Development
- SCRUM
- Crystal
- Test-Driven Development
- Feature Driven Development

SCRUM

- The name comes from rugby - players' formation for the purpose of getting the ball in position
- 1995 Schwaber, Beedle
- Developments in the sequences, short stages, which are called "sprints" (maximum length - a month)
- For each stage the list of tasks - backlog is established
- Tasks are sorted according to priority, designed in collaboration with the customer
- Short daily Scrum Meetings -> determination of specific activities; which items from the last meeting have been completed and what new challenges have arisen; presentation of results to the customer
- These meetings are essential. They determine:

    - Summary of progress to date
    - Demonstration of intermediate results
    - Identification of new tasks
    - Increasing the cohesion of the team
    - Detection of problems in interpersonal relationships
- SCRUM assumes that it is impossible to plan the exact course of development and therefore it doesn't attempt to come up with a plan, accurate planning is substituted by daily tasks

Characteristics of projects according to SCRUM:

a) Flexible delivery subjects (content delivery dictated by the environment. Example: What should be the output of analysis? Sometimes specifications according standards is better, sometimes object model is better, sometimes a prototype delivery...)
b) Flexible schedule - delivery can take place later than expected but the customer must be immediately notified (this is difficult, depending on the level of relations with the customer, the risk that it will be perceived as a problem or manifestation of unprofessionalism)
c) Small teams – ideally team of 3-6 people, more small teams can work on a project
d) Frequent revisions
e) Collaboration - an intensive communication among team members, the team with the customer and investor

Backlog – list of the properties, functions and activities to be implemented (they can be in a form of "User Stories"). Backlog can be modified only by the project manager, other members of the team can only read them.

Risk - strong emphasis on risk analysis. Revision of risk is at the end of each interaction, but also during **daily meetings.**

Sprint - basic development time entity (iteration) with stages: Develop, Wrap (packaging), Review and Adjust, usually maximum of 30 days

LEAN DEVELOPMENT

Originally Toyota - punchline is **the removal of all unnecessary** and minimizing inventory (nothing should be in stock), later transformed into the software

Lean Development rules:

1. Remove everything that is unnecessary
2. Minimize inventory (minimize intermediates)
3. Maximize the flow (= shorten development time)
4. Development is driven by demand (decision making as the latest possible)
5. Workers have the power to decide
6. Main objective is to satisfy customer requirements (now and in the future)
7. Feedback (not to be afraid of changes in the decisions taken)

8. Remove local optimization (continuous optimization of existing solutions does not make sense)
9. Build partnerships with suppliers
10. Set ground for constant improvement

If things don't add value, they are unnecessary.

Lean Development describes six kinds of waste:

1. Overproduction (for redundant software requirements which are later not used)
2. Time lost waiting (tester waiting for the code could have done something else instead)
3. Wasting associated with transport (for software solution lies in the automation of certain processes)
4. Wasting related to processing (management team should aware of who does what and at what stage of the development it is)
5. Inefficient work (for software – existing tools and solutions should be used, developers often do not know about them)
6. Defects in products (there are no error-free programs but actions should be taken to minimize errors)

In any case, developers must understand how they contribute to the ultimate objective of their work and where it goes.

Meeting users' needs - one often does not know what he wants, requirements are constantly changing and they are sometimes seemingly pointless - it is better to work in partnership and closer relationship with the customer force him/her to sign a one hundred-page functional specification right from the start.

Feature Driven Development

Product properties, the properties governing the development of the product play the main role

The methodology originated in 1990's 90th of the 20th century and is based on iterative development, short iterations.

Modeling - development begins by creating a global model of the system - from which overall direction of development should be apparent - the goal is not to bring a complete list of features but to outline what the system will consist of and how it will interact with the environment.

It assumes that the customer is continuously supplied with beta versions of software (at least once every 1-3 weeks). The customer sees that development is ongoing (psychological effect) and also has the ability to influence the development.

Feature - A small outcome (operation) useful from the customer's perspective.

The feature is characterized by:

- Measurability (Is the implemented functionally identical with the functions required by the customer?)
- Intelligibility (We must be able to describe the feature)
- Feasibility (Can we deliver the feature? Will their development not take too long?)

Procedure:

1. At the beginning we create a list of features.
2. Rank according to priority.
3. Above the list there is development - continually changing small teams are in charge of the implementation of specific features.
4. After the implementation phase testing and integration come.

The methodology is suitable for smaller projects.

TEST DRIVEN DEVELOPMENT

The basic idea: Test code must be prepared and completed **before** writing the actual code.

1. Write a new test of the required functions so that it fails
2. Incorporate it into the project (into the complete test kit) and check whether it fails
3. Implement the desired function
4. Re-launching tests, if the test is not successful, we have to fix code
5. If the test passes we will include it in the test set (library)

Testing -> Implementation -> Design

Errors are captured by passing a test case. This methodology is less process-oriented, does not deal with the creation of specifications.

Advantage
Produce quality software with predictable behavior and well-explored.

Disadvantage
Need for strong-arm of the project management (it is uncomfortable for programmers to write tests in the beginning).

4. Architecture of Information Systems

Architecture of Information Systems defines a conceptual framework to design the information system. It provides IS with a certain direction, and it is the appropriate means of communication between the management and designers of IS. Architecture must be instructive, clear and simple.

Information system is a management support tool. You have to know the management target to be able to design it. That sounds like a trivial thing but when it comes to creating a new IS, the management has sometimes a trouble to formulate business objectives. Then the created information system does not meet the expectations and the project implementation can be considered a failure.

IS architecture ensures mutual understanding of three subjects involved in the IS formation:

Investor – IS Developer/Supplier – User

Note:
Investor and the user may or may not be the same person. For large companies, it is common that the investor is the owner or manager of the company who is not going to work with the IS at the end (or will use only some of its functions).

Architecture is one of the tools for **system integration.**

What must the architecture meet in order to satisfy the required IS targets?

- Be consistent with the strategic business objectives
- Respond to the users' needs
- Integration - data, software, hardware,…
- The system should be open and parameterized (the system's ability to accept changes)
- Lead to IS which is transparent and well-understood by the users
- The efficiency and reliability of the data processing (response rate, data protection ...)

Importance of IS Architecture

- Formulation of the overall concept of IS
- Management of IS development
- Solutions relationship with IS suppliers

Architecture during the development, implementation and operation of IS needs to constantly adjust and adapt to changing requirements while preserving the original concept.

Global Architecture

If the subject of IS design is overall view we are talking about the global architecture of IS.

Global architecture **- basic scheme expressing the rough shaping of the future IS** (e.g. method of acquisition, material orientation, relationship to the management level ...)

Partial /Sub-Architecture

Global architecture disintegrates into sub-architecture design - detailed suggestions from different views of a system: application, technology, software, hardware, functional specifications...

Examples of sub-architectures:

Functional analysis, functional specifications – verbal description of the functions of IS

Process architecture - business processes and data flows (e.g., in the form of Data Flow Diagrams – DFD or UML diagrams)

Data architecture – design of databases (ERD or UML diagrams)

Software architecture – selection of operating systems, software components

Architecture of hardware – hardware components, solution of network; it can be centralized or distributed

Technological architecture – description of the technological solution - integration software, hardware with data architecture, definition of the method of processing (batch / interactive / real-time / event-based)

Examples of technological IT architectures:

- Mainframe (server and network of terminals)
- Architecture based on file sharing
- Architecture client – server
- Two-layer architecture (user and data layer)
- Three-layer architecture (layers: presentation, business logic, data)
- MDA – Model Driven Architecture
- SOA – Service Oriented Architecture

SOME OF THE TECHNOLOGICAL ARCHITECTURES

Three-Layer Architecture

Three-layer architecture is a software architecture which is commonly used for web projects.

This architecture has the following layers:

Presentation layer – user interface, graphic design. Within the web projects this is about graphics (HTML, CSS) and method of operation.

Application layer (Business Logic) – creates an environment of application functions. This layer addresses functionality (called business logic). The layer consists of such functionality as PHP or ASP scripts (or stored procedures in database server).

Data layer – provides management of database operations, provides data to application layer, works with the data model and the structures in the database.

The purpose of the three-layer architecture is the separation of individual layers so they are not depended on each other. This way they can be solved by a different specialist.

SOA (Service Oriented Architecture)

SOA defines its architecture as a set of software components cooperating like services of the real world. Monolithic software is thus divided into a set of independent, loosely connected components.

An example of SOA may be some Web 2.0 applications using services such as Google Map etc..

MDA (Model Driven Architecture)

MDA is based on an idea to separate the description of processes in the organization from the application logic and the description of the implementation on the chosen platform. Separation of application logic from changes in technology layer leads to the independence on the technological platform.

MDA provides a general instruction to:

- Specify the system regardless of the platform on which the system is built
- Specify the technological platforms
- Choose a specific platform
- Transform the system according to the chosen platform

MDA is defined by OMG (Object Management Group, http://www.omg.org/, international non-profit organization that defines software standards like MDA, UML, CORBA etc.). A format definition of data interchange is also a part of this specification (for example XMI, the format is based on the use of XML markup language).

Commercial solutions for MDA tools are often based on the use of UML (Unified Modelling Language - standardized general-purpose modelling language in the field of object-oriented software engineering.

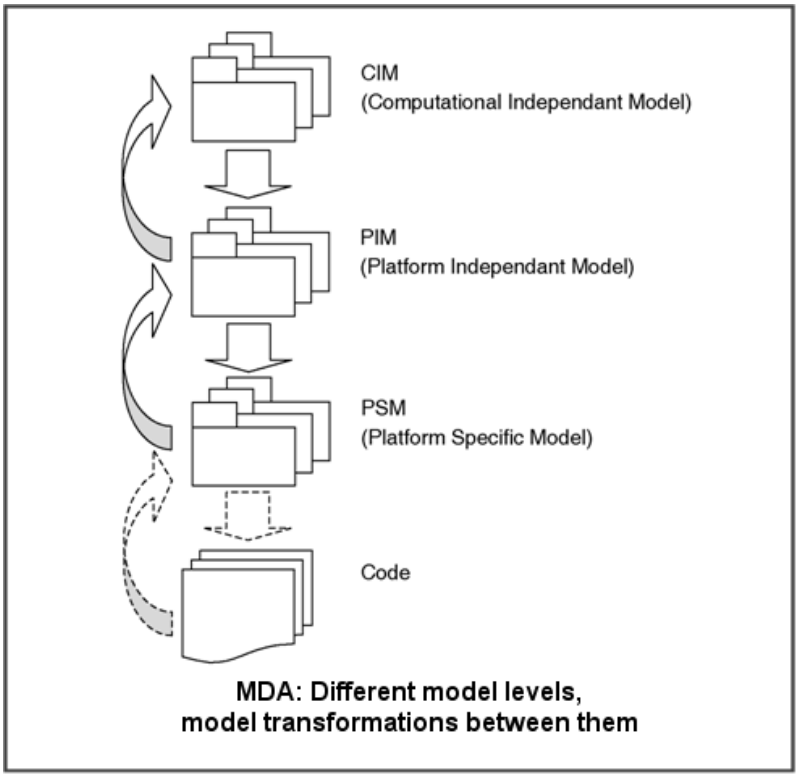


Fig. 4.1 MDA architecture [Source: http://www.modeliosoft.com/en/technologies/mda.html]

ARCHITECTURE OF INFORMATION SYSTEMS ACCORDING TO CONTROL LEVEL

Depending on whether the information system operates at operational, tactical or strategic control levels, systems can be divided into groups.

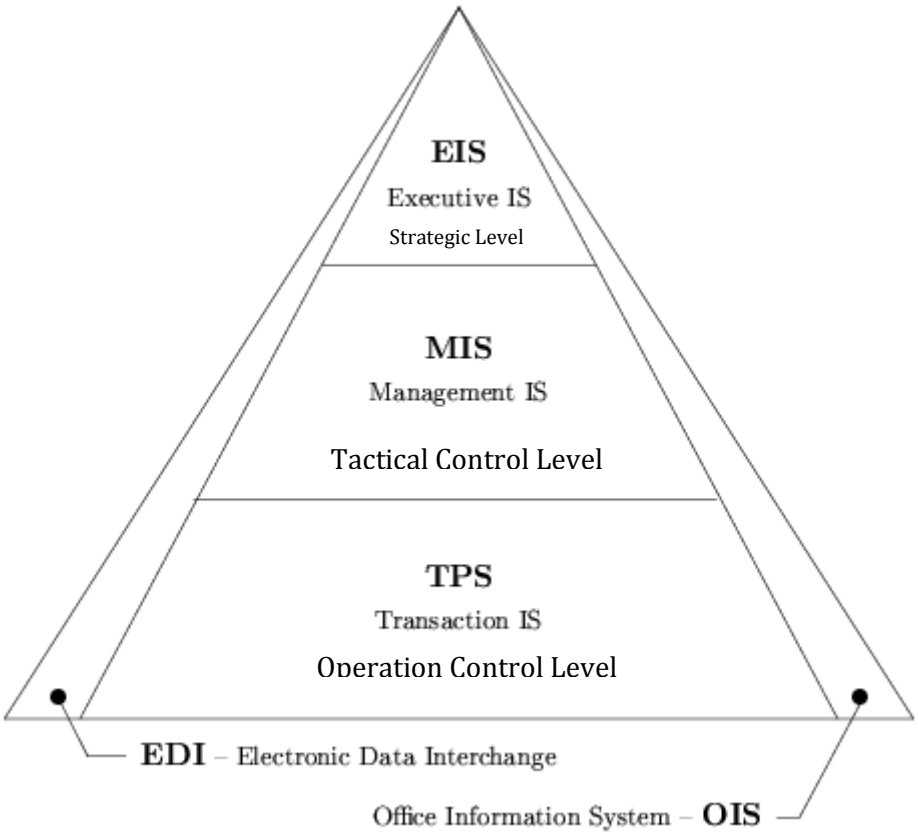


Fig. 4.2 Information systems according to control level

Sub-system **OIS (Office Information System)** is composed of standard office and communications resources to support office work (processing, spreadsheets, Access, mail, ICQ...) and passes through all control levels.

Likewise, **EDI (Electronic Data Interchange)**, which is a de facto standard for electronic data exchange.

TPS Information Systems

Aims of **TPS (Transaction Processing System)** information systems is to support the main activities on the operational control level (based on transaction monitoring - i. e. individual production operations).

It is a set of applications focused on core business activities. In terms of the company focus it is highly specific and its **defined solutions depend on the defined company business**.

TPS systems therefore vary in function and structure, depending on the following:

What character of the business it is (production, sales, transport…?)

If it is a manufacturing company, what type of production it is? (piece work, etc.)

If it's in manufacturing, the TPS system can be based on the so-called CIM conception (Computer Integrated Manufacturing).

The principle of the CIM is the integration of production processes:

- Product processes
- Custom processes

TPS is a successor of the traditional batch processing in mainframe computers (e. g. payroll where acquired data was processed as a batch).

Transaction

Let us remind the term **transaction** which was already mentioned in the „Basics of Computer Science“. Transaction is a sequence of operations (commands) can no longer be broken down and must be done as a whole.

Transaction must meet a condition referred to as ACID:

A	Atomicity
C	Consistency
I	Isolation
D	Durability

By TPS we understand operational information systems to provide basic functions of operation control. They are focused on interactive, batch or automated data acquisition of a production operation. This means that processing of TPS have often transactional character.

OLTP

In the area of database systems, systems based on transaction processing are referred as **OLTP (On-Line Transaction Processing)**.

Note: Other type of database systems, that are mainly designed for analytical purpose, is referred to as **OLAP**. With OLAP we introduce in the chapter „Business Inteligence“.

TPS can contain subcomponents such as:

- CAD – Computer Aided Design
- CAM – Computer Aided Manufacture –automated support for production control
- CAQ – Computer Aided Quality - control of the production process and product quality
- CAP – Computer Aided Planning – automatic of planning
- CIS – Contact with the customer (e.g. meter readings)
- GIS – Maps, spatial data

Fig. 4.3 An example of TPS system – dispatching room [Photo: J. Gottfried]

MANAGEMENT INFORMATION SYSTEMS (MIS)

Information systems **MIS (Management Information System)** deal with management on the Tactical Control Level.

MIS produces fixed, regularly scheduled reports based on data extracted and summarized from the firm's underlying transaction processing systems to middle and operational level managers.

This includes economic, organizational and business aspects and the area of control.

Basic area of MIS systems:

- Business and logistic processes

- Financial accounting processes
- Cross-sectional applications of the whole-enterprise (management, legislation, human resource management, marketing, quality ...)

Characteristic activities within the MIS systems:

- Evidence of processes
- Preparation of economic analysis
- Registration, accounting and analytical works

TPS and MIS systems tell us about the current state of business processes.

INFORMATION SYSTEMS - EIS

EIS (Executive Information System) is a type of management information system intended to facilitate and support the information and decision-making needs of senior executives, at strategic control level.

Data, the EIS system works with are mostly acquired in TPS and MIS systems. The data for the EIS, however, are characterized by high aggregation and are structured. Compared to TPS and MIS, which usually work with immediate status, EIS is working with the data within wider time horizon.

There are software tools, typical for EIS, that we refer to as **„Business Intelligence“ (BI)**. Business intelligence works with a special type of database – data warehouse and use analytical tools, such OLAP or Data Mining. Detailed description of these software tools can be found in the chapter “Business Intelligence”. The main objective of BI is to give managers the tools for the analysis and presentation of business data.

Typical functions of the EIS are:

- Long-term planning
- Economic analysis of overall performance of the company,
- Evaluation of business plans,
- Developing innovative actions,
- Formulation of strategic projects, project management methods,
- Support marketing strategy specification,
- Managerial reporting
- Analysis of the market situation, etc.

The concept of **DSS (Decision Support System)** is often mentioned in connection with the EIS**.** DSS are decision support tasks. They have the ability to perform a variety of data analyses without the need of complicated control mechanisms. They are rather designed for middle management, and are composed of the computer support for decision analysis methods and operating system analysis.

Knowledge base can also be a part of DSS. DSS therefore consists principally of three parts - database, method, and user interface (presentation layer). The output of the DSS is not a decision replacement but providing the user with an analysis of options or a risk analysis.

Some DSS can work as an expert system.

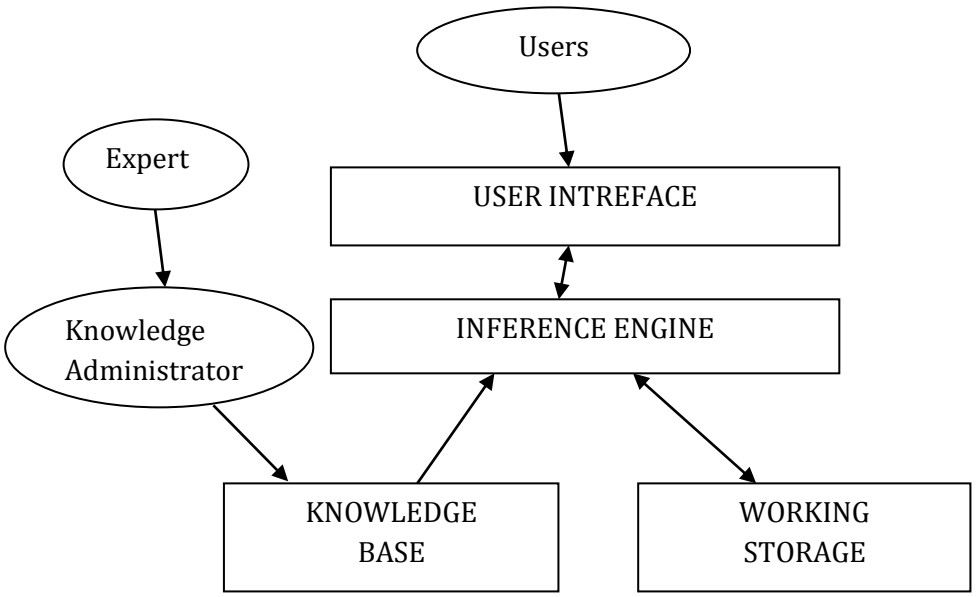


Fig. 4.4 An expert system component

Basic components of the expert system are drawn in the Figure 4.4. The knowledge base is a representation of expert's knowledge. The working storage contains data specific to a solved problem, it's the most dynamic component of the system. Core of the system is the inference engine which derives recommendations from the knowledge base and the working storage. The knowledge is declared in rules. The expert system should have ability to explain the process that it used to provide a recommendation. Knowledge administrator encodes the expert's knowledge in a declarative form ("if-then" rules). The user is a person who consults the system to get advice.

5. Database and Information Systems

Information system works with information and they must be stored somewhere. For this reason, overwhelming majority of information systems also contain database systems (except possibly the real-time systems that deal with real-time control).

The basis for a successful operation of this system is mainly the database.

Database design is a part of the IS architecture in its initial phase (choice of type, design of its structure, mode of operation, the solution efficiency ...)

Types of Database Systems

- **Manual systems** – files/card index
- **Hierarchical database model** – data is stored in a tree; parent-child
- **Network model** – a generalization of hierarchical model with multiple relationships
- **Relational model** (designed by E. F. Codd 1970) – data is stored in tables with a defined relationship, based on the set theory and predicate logic
- **Object-oriented model** (Gemstone, Caché, O2, Versant, …)
- **Object – relations model** (Oracle)
- **„NoSQL" database** (such as CouchDB, MongoDB, Redis, Cassandra; they are used on web projects to solve large chunks of data)

Database Models

Depending on the abstraction level, the database models can be divided into:

- **Conceptual model** – recognition of fundamental data structures and their relationships - design - what will be the content of the system
- **Logical** model – design of relational scheme including integrity solution without specific implementation is independent on physical database system. This level of model is often described using structural analysis (ERD, DFD, STD diagrams) or other (UML…).
- **Physical data model** – implementation in a particular database system

DESIGN OF RELATIONAL DATABASE

Using **structural analysis**, basic components for designing the database model are:

- ERD (Entity Relationship Diagram) – describes database structure and integrity constraints
- DFD (Data Flow Diagram) – gives functional model – describes data flow and functions
- STD (State Diagram) – describes state changes in time
- DD (Data Dictionary)

ERD (Entity Relationship Diagram)

ERD describes in graphical form the structure of the database.

The aim of ERD is to map data stored into the database and analyse their relationship.

Logical structure of a database consists from:

- **Entity** – object where data is stored
- **Attribute** – fundamental element of data that characterizes the entity
- **Relation** – relationship between the entities
- **Cardinality** – type of relationship between entities: 1:1, 1:N, N:1, M:N

Notes

Relationship is the information that the system needs to remember, it can not be inferred.

Note that there is a difference between ERD (designed by Chen) and relational data model (theory by Codd). ERD does not plan physical tables and rows, that's the ERD implementation using RDM (Relational Data Model). That's the difference between the terms “Relationship” and “Relation”.

DFD (Data Flow Diagram)

The aim of DFD is modelling of data or control flows in the information system (in graphical form).

DFD diagrams describe functionality of the system.

DeMarco's notation is the most commonly used diagram within DFD.

DFD consists of the following elements: "process”, "database”, "input/output” and “flow”.

DFD diagrams have hierarchical structure. **Context diagram** is at the highest level – the system is presented as object with links to the neighbourhood. At the other levels of DFD hierarchy there are descriptions of the individual processes and data or control flows.

DFD decomposition to lower levels up to the level of elementary functions:

- There shouldn't be a process that has no entries yet produces data streams
- There shouldn't be a process that consumes data only and has no output

STD (State Transition Diagram)

STD contains a sequence of states in which the system can find itself and under what conditions it may change its state. It models the system's changes over a period of time.

- It is important in terms of understanding the logic of the system
- States are static, change of state is often a consequence of an event.
- It can be shown by state diagram or flowcharts
- It can be hierarchical

DD (Data Dictionary)

A data dictionary is used to describe formalized system data from the user's perspective.

DD works with a **metadata** (data describes user data):

- Metadata are managed by database system
- Read-only access

Metadata can, for example, be stored in a table that contains definitions of user data tables (table column names, their data type, size, etc).

Note: The metadata can be found e. g. in Microsoft Access, when Design Mode is on.

SQL - Structured Query Language

Current relational databases support standards of the SQL programming language which is key for database design and data manipulation.

SQL is a declarative **programming language** whose primary purpose is to enable working with data in a relational database.

Note:

The term "declarative language" means that the programmer declares what he wants to do and not how it should be done.

SQL commands can be divided into two groups:

- **DDL - Data Definition Language** (CREATE, DROP, GRANT)
- **DML - Data Manipulation Language** (SELECT, INSERT, UPDATE, DELETE)

SQL is standardized; there are several SQL standards such as:

  - SQL86
  - SQL89 - included referential integrity
  - SQL92
  - SQL99 – extended with OOP (object oriented programming)

DATABASE NORMALIZATION

The aim of normalization is to achieve ideal database data structure. Data should be stored in the simplest form and without a redundancy (recurrence the same information).

The so-called „normal forms“ of database are:

- 1st Normal Form – record does not contain any recurring item
- 2nd Normal Form – record has only PK (Primary Key, for details see next paragraph “Integrity”) and non-key fields are dependent on the entire PK
- 3rd Normal Form – excludes transitive (delegated) dependence - the table does not include records that are not part of the key (i. e. the content of the columns are simple, indivisible information)
- BCNF (Boyce-Codd Normal Form)

Although there are fourth and fifth Normal Forms, they are not widely used. The most often used one is the 3rd NF.

Bad design of relational model results in:

- Data redundancy

- Inability to convey certain information

Denormalization

• Maximum normalization is not always ideal - too meticulous standardization can reduce the processing speed

• Denormalization - aggregated data values for canned reports lead to faster outputs

INTEGRITY

- **Entity integrity**
  - Realized by **Primary Key** – unique identification of entities (without NULL)
- **Referential integrity**
  - Realized by **Foreign Key** – column value that refers to the value in the column of another table. The foreign key enables links in the relational database.

Referential integrity:

- **Restrictive**
  Parent record cannot be deleted if there is a link to it from a child record.
- **Set null**
  If the parent record is deleted, the child record sets the value of the foreign key to NULL.
- **Cascade**
  If the parent record is deleted, all child records that refer to it are deleted too.

TRANSACTIONS

As mentioned in the "Transaction Processing System" chapter, the basic idea of transactional systems is the transaction - a sequence of operations that need to be done to reach the goal while the database remains consistent.

The transaction is indivisible, must be executed either as a whole or, in the case of failure, it must cancel the results of the transaction and return the system to its original state.

Consistency of the database may be violated e. g. with parallel processing of multiple SQL commands that operate over the same data.

Transaction attributes:

A C I D = Atomicity, Consistence, Isolation, Durability

- Atomicity – transaction is atomic, i. e. indivisible, it is understood as a whole.
- Consistency - the result of the completed transaction must be the data in a consistent state (i. e. it must comply with all integrity and referential constraints)
- Isolation – data changed by transactions are invisible to other users until the transaction is completed
- Durability – result of the transaction must be permanent (the data changed as the result of that transaction have to be physically recorded on a disk, not only in the database engine cache)

The reason for introducing transactions was to troubleshoot multi-user access to databases and to prevent users from mutually overwriting data.

Closing of the transaction is possible by two ways: **COMMIT** (validation) or **ROLLBACK** (cancel the transaction or return the system to the state before the transaction was started).

RELATION BETWEEN THE DATABASE TABLES - CONCLUSION

- The database contains a number of tables
- All tables are not necessarily linked
- Related tables produce "schemes"
- A database can contain several schemes

Note:
In the era of file-based databases such as DBase or FoxPro, a single table corresponded to a single database file.

INDEXES

Indexes are defined on a column or group of columns in the table and are used to accelerate searching and reading data from a table. If data needs to be found in a column that is part of an index, the database engine doesn't need to retrieve the entire table (sequential scan) but only loads the data page according to the information stored in the index, which leads to faster response during the query.

INTERFACES TO ACCESS THE DATA FROM DATABASE SYSTEMS

Data stored in a database system are accessed by the database engine interface. In addition to interfaces provided by database system vendors there are also standardized interfaces. The most common data interfaces used in information systems are:

ODBC	Open Database Connectivity
JDBC	Java Database Connectivity
ADO	ActiveX Data Objects (from Microsoft)

6. Business Intelligence in Information Systems

Data Warehouse

The term data warehouse is a special type of database designed primarily for data analysis in Business Intelligence (software used as a basis for management decisions).

Definition

A data warehouse is a subject-oriented, integrated, time-variant and non-volatile collection of data in support of management's decision making process. It consists of both detailed and summary data.

Bill Inmon, president of Data Systems, „father“ of Data Warehouse

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Where did we get data?

The data stored and processed in transaction systems (OLTP) do not allow for performing high-quality analysis, because analysis based on data stored in relational database is very difficult. For this reason, data from operational databases are transformed into a warehouse where they are stored in a form that is more suitable for analytical processing

The information stored in data warehouses come from operational databases using data pump or ETL (Extraction – Transformation - Loading).

In the extraction phase we pick data from OLTP database. During Transformation phase verification and data cleaning take place (cleaning data means filling up missing values, removing typos, converting into the same format, matching the single classifiers / dimension), data consolidation and aggregation calculation according to the main entities. At "loading" phase data is stored into the data warehouse.

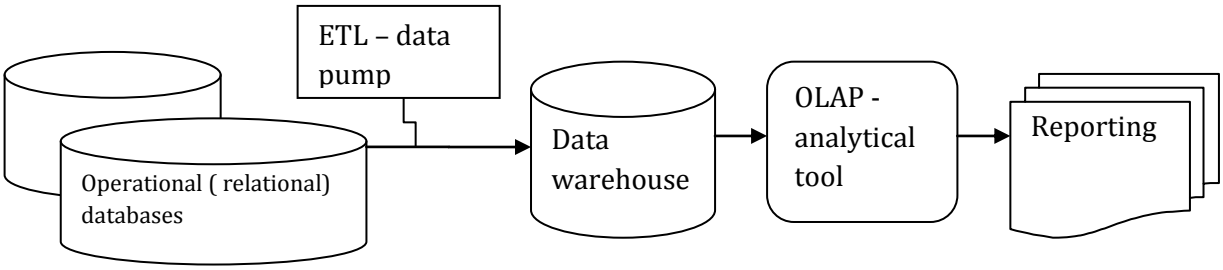


Fig. 6.1 Structure of Business Intelligence Components

Data Pump (ETL) works as a batch job and it is often automated. The process of transforming data from operational databases into the data warehouse can be time consuming.

An example ETL tools may be a Microsoft DTS (Data Transformation Services) included since the MS SQL Server 2000 or Oracle Data Mart Builder.

WHAT IS THE DIFFERENCE BETWEEN RELATIONAL DATABASE AND DATA WAREHOUSE?

In the case of the relational database, there is usually a push for minimizing redundant data storage, which is achieved by normalization and internal linking of each logical functional unit by relations (foreign keys).

In a data warehouse on the other hand, there is an effort to create a structure that is readable for the user (manager, business analyst) at the price of increased demands on memory space. Data arrive to the data warehouse in large chunks and are no longer modified.

While relational databases are designed using ERD (Entity Relational Model), data warehouses are designed using dimensional modeling.

Modeling relational databases:

- Elimination of redundancy (repetition of data)
- Normalization (resulting in lower clarity to humans)
- Optimized for inserting, updating and reading

Modeling data warehouses:

- Optimised for reading, data search and analysis
- Emphasis on clarity for the user
- Denormalization, redundancy
- Expandable - add facts and dimensions without affecting the applications running on them

Data Mart

Analytical BI tools can draw data for analysis either from a data warehouse or **data marts**. A data mart is a subject-designed data warehouse dedicated to providing information for a specific department of the company (e.g. marketing, finance department, etc.).

Sometimes it can be a data warehouse created by amalgamating several data marts that are built on the requirements of individual company departments.

When creating a data warehouse from data marts the so-called **two-tier architecture** is often mentioned (draft Ralph Kimball). It is used particularly in a situation when you need to prioritize a specific department or office and deliver first data warehouse outputs in a relatively short time (within a few months). The data warehouse is then built gradually as data repositories and not only the results but also the financial resources for development are spread over time. Decision-making environment built in this way however does not provide an enterprise-wide information overview. If we look at the schematic representation of architecture, corresponding to the approach, then this may remind us of "spider web" ("spider web“ is a data warehouse architecture based on individual data marts).

In contrast, the concept, which came with Bill Inmon and Claudia Imhoff (including temporary storage, central storage, and data marts), is referred to as **three-tier architecture** of the data warehouse. It is a pure solution, which, however, requires a higher initial cost of the analysis, and a relatively long time to complete execution.

Operational Data Storage

There is often a need to work with consolidated, but most current data with minimal response time - for example, a call centre, where each customer’s data have to display the current profile, the activated or ordered products marketing offers sent within a particular segment. This requires an additional component data warehouse - **Operating Data Store** (ODS).

For the purpose of maximum "operativeness" the operative storage is connected to data sources through EAI tools (Enterprise Application Integration). They allow communication between any two applications in real time without the need for these two applications to directly interconnect. Unlike ETL platforms that handle events in batches at a predetermined time, EAI platforms respond to events immediately.

What is a data warehouse structure?

Data in the data warehouse are divided into the so called schema (logical structure). Each schema corresponds to one functional area analyzed.

Schema contains two types of tables – facts table and dimensional table.

The core of each schema consists of one or several fact tables. They store analyzed data - values that are used for analytical calculations - aggregation, classification, etc.

Fact Table Granularity determines the level of detail in the fact table. The lower the level of granularity, the more detailed are the data designed to perform mathematical operations.

Fact tables are associated with the dimensions. Dimension tables contain lists of values used to categorize and sort data in fact tables (attributes, through which "look" at data). It's actually an itemized list by which the data are analyzed.

"STAR" AND "SNOWFLAKE" SCHEMA

The schema specifies the structure of the data warehouse. According to the method used in connecting the dimensions table to the facts table, we can distinguish a **star** type and a **snowflake** type of schema.

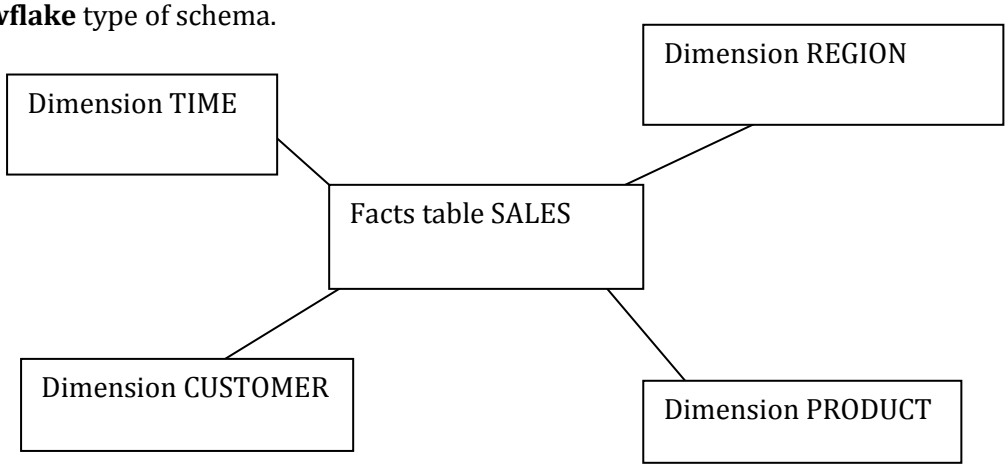


Fig. 6.2 An example "a star" data warehouse schema

This is the easiest way to convert data from a relational database into a multidimensional structure. Graphical representation resembles a star shape, hence the name. Each dimension is represented by just one-dimensional table.

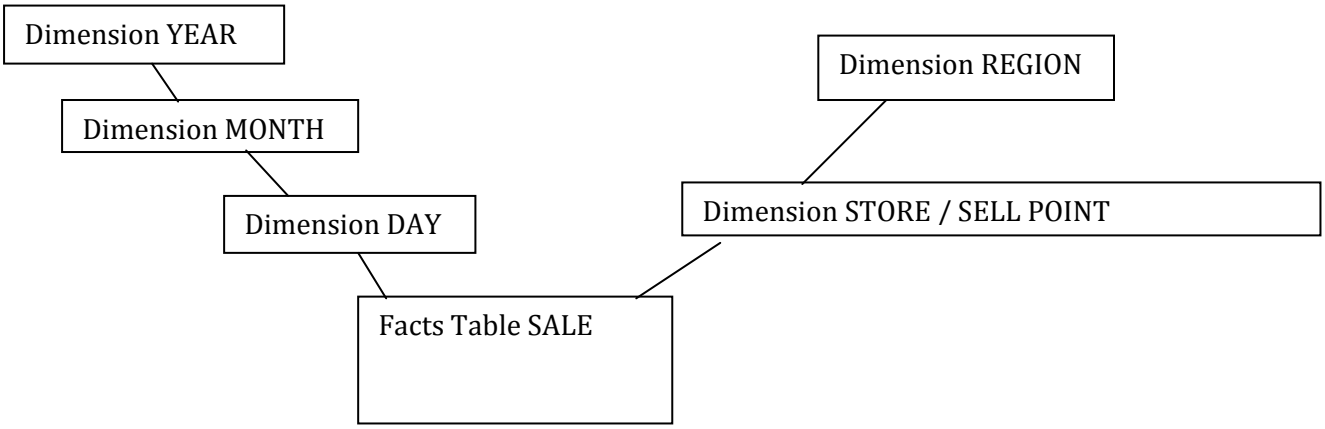


Fig. 6.3 An example of a "snowflake" data warehouse schema

The snowflake schema contains dimension tables that are normalized and have a relational structure. The facts table contains foreign keys to dimension tables.

Creating a star model (where the data are not normalized) can be time-consuming, but provides a high query performance. In the-snowflake schem the dimensional tables are relationally linked - loading data into dimensional table is faster but the query performance on the other hand is lower because it is necessary to connect multiple tables.

Another form of the schema is **constellation**. It is a set of "star" schemas, ie multiple facts tables with shared dimensions.

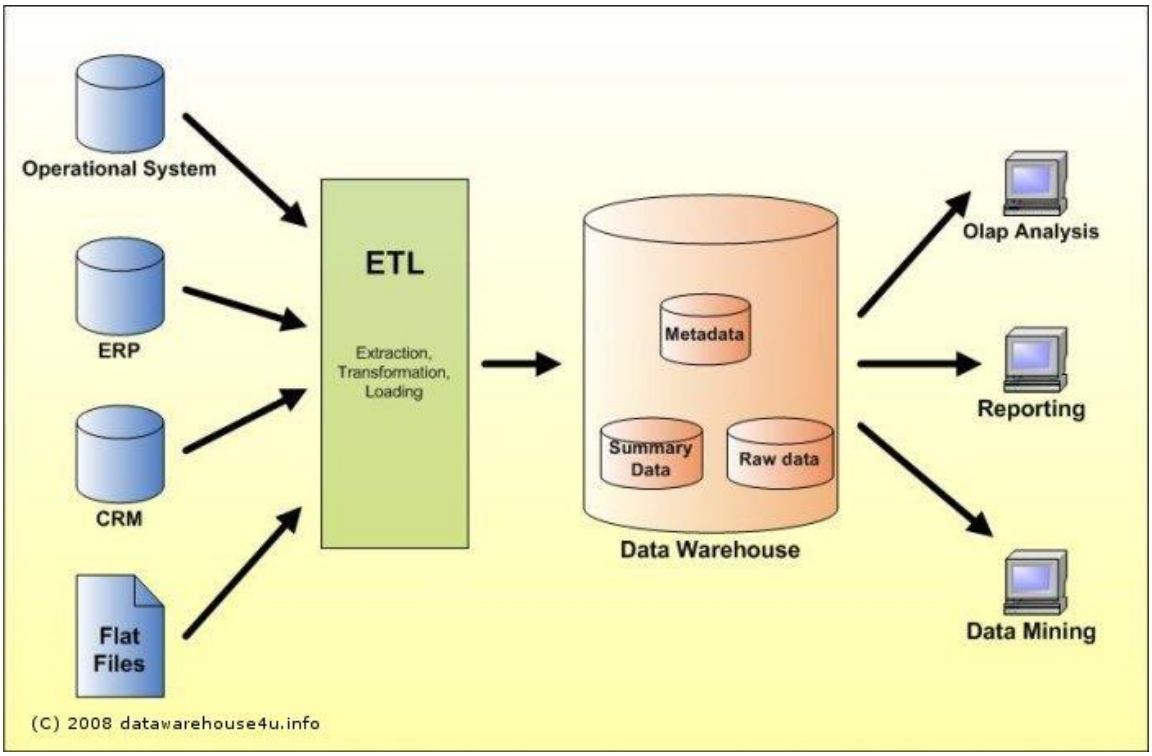


Fig. 6.4 Relationship between OLTP, Data Warehouse and OLAP [Source: datawarehouse4u]

OLAP

The term OLAP (Online Analytical Processing) is Business Intelligence tools for on-line analysis of large volumes of data. The term “OLAP database” is also referred to as a data warehouse. In a broader sense, it is a label for an information system which is based on the use of data warehouse and analytical tools.

Definition

Category of software tools enabling the analysis of data stored in the database.

Edgar Codd

OLAP technology works with the multidimensional data. Unlike the two-dimensional data storage in relational databases (column, row), it works with the data cube (mathematical equivalent of the concept of data cube is matrix).

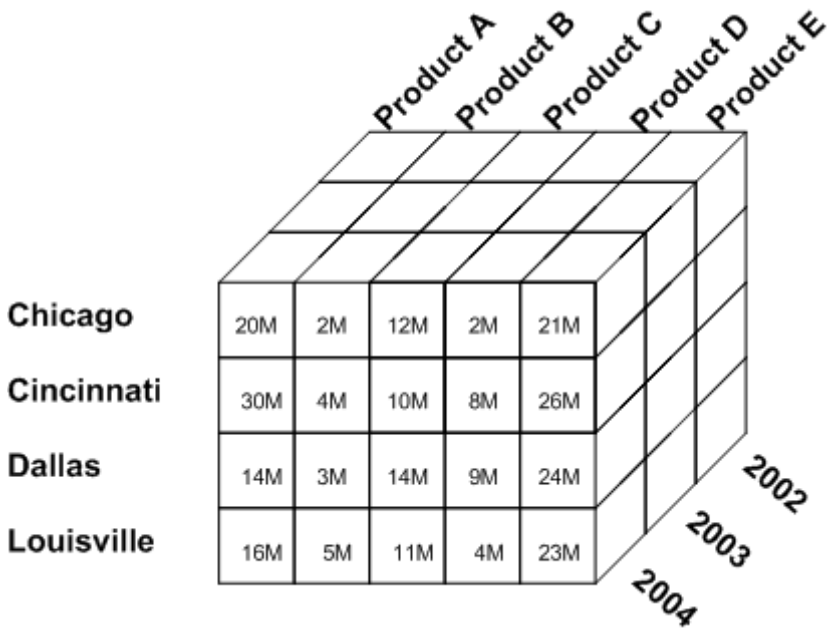


Fig. 6.5 Data cube [Source: http://docs.oracle.com/html/B13915_04/i_olap_chapter.htm]

Note: A data cube can have more than three dimensions, e.g. MS SQL Server allows you to work with cubes up to 64 dimensions.

The procedure for OLAP analysis is as follows:

a. Defining data sources
b. Defining data views
c. The design and dimensions of the data warehouse
d. Proposal for OLAP cube (OLAP cube)
e. Presentation of results (OLAP Access Tools)

ROLAP, MOLAP AND HOLAP

OLAP tools vary, depending on what data analysis is performed.

If OLAP analysis directly uses data stored in a relational database, we talk about relational OLAP - **ROLAP**. OLAP in this case creates a relational database table to store the aggregation. The analysis is challenging due to the need to use standard SQL commands to retrieve data from the relations table structure. Viewing analyzed data is already multidimensional.

ROLAP advantage: Flexibility, there is no need to build a data warehouse.

Disadvantage of ROLAP / ROLAP Disadvantage: Demands on database performance, slower analysis.

If the analysis is performed over a data warehouse where the data are stored in a multidimensional structure, we are talking about multi-dimensional OLAP analysis - MOLAP. Compared to ROLAP, outcomes from the MOLAP analysis are faster because there is no need to use complex SQL queries to read data from relational database. The data in multidimensional structure are stored in a form that is more suitable for analytical processing and they are grouped according to logical meaning. Unlike ROLAP, however, we need to transform data from a relational database into the data warehouse.

MOLAP Advantage: Speed of analysis.

Disadvantage of MOLAP / MOLAP Disadvantage: Disk space requirements, data must be transformed into a data warehouse.

The specific case is a combination of both approaches, called hybrid OLAP - **HOLAP**. The analysis is carried out in a relational database, but the tables with aggregations are stored in multidimensional structures in a data warehouse.

HOLAP advantages: Access to large data together with rapid aggregation

HOLAP Disadvantages: The need to maintain data in two places

A special type of OLAP is a dynamic OLAP called **DOLAP**. In this solution there is a multidimensional cube built in as a virtual RAM memory. It has the basic advantage of unlimited flexibility. The disadvantage is high demands on RAM memory and the need to construct a cube every time.

BASIC OLAP OPERATIONS

Drill-down – allows the user of the selected instance on a certain aggregate level to set lower (finer) level of aggregation. It means navigating towards greater detail within the dimensions hierarchy.

Roll-up – is the opposite of the previous operation. In selected instances, certain aggregate level sets higher aggregation level (less detail in the hierarchy of dimensions).

Pivoting – allows you to "rotate" the cube, i.e. change the angle of viewed data at the level of data warehouse content presentation.

Slicing – permits slicing of the data cube, namely to find a perspective in which one dimension is fixed in a given instance of a certain level of aggregation. In other words, this dimension applies a filter to an instance of the aggregate level of the dimension.

OLAP Definition According to Codd

OLAP is defined according to 12 rules by Codd (1993). It is also possible to define OLAP by five words - ***F***ast ***A***nalysis of ***S***hared ***M***ultidimensional ***I***nformation (FASMI, 1995).

Codd's 12 rules:

1. Multidimensional conceptual view - User-analysts would view an enterprise as being multidimensional in nature - for example, profits could be viewed by region, product, time period, or scenario (such as actual, budget, or forecast). Multi-dimensional data models enable more straightforward and intuitive manipulation of data by users, including "slicing and dicing".
2. Transparency - When OLAP forms part of the users' customary spreadsheet or graphics package, this should be transparent to the user. OLAP should be part of an open systems architecture which can be embedded in any place desired by the user without adversely affecting the functionality of the host tool. The user should not be exposed to the source of the data supplied to the OLAP tool, which may be homogeneous or heterogeneous.
3. Accessibility - The OLAP tool should be capable of applying its own logical structure to access heterogeneous sources of data and perform any conversions necessary to present a coherent view to the user. The tool (and not the user) should be concerned with where the physical data come from.
4. Consistent reporting performance - Performance of the OLAP tool should not suffer significantly as the number of dimensions is increased.
5. Client/server architecture - The server component of OLAP tools should be sufficiently intelligent that the various clients can be attached with minimum effort. The server should be capable of mapping and consolidating data between disparate databases.
6. Generic dimensionality - Every data dimension should be equivalent in its structure and operational capabilities.
7. Dynamic sparse matrix handling - The OLAP server's physical structure should have optimal sparse matrix handling.
8. Multi-user support - OLAP tools must provide concurrent retrieval and update access, integrity and security.
9. Unrestricted cross-dimensional operations - Computational facilities must allow calculation and data manipulation across any number of data dimensions, and must not restrict any relationship between data cells.
10. Intuitive data manipulation - Data manipulation inherent in the consolidation path, such as drilling down or zooming out, should be accomplished via direct action on the analytical model's cells, and not require use of a menu or multiple trips across the user interface.
11. Flexible reporting - Reporting facilities should present information in any way the user wants to view it.
12. Unlimited dimensions and aggregation levels.

MS Excel "Pivot Table" can be used as a simple OLAP tool. Working with OLAP cube is basically same as working with Pivot Table – depending on the selected queries the cube is modified for better and faster data processing.

DATA MINING

Data Mining is the process of finding the unknown information and knowledge in large data volumes. The Data Mining technologies use pattern recognition, statistical and mathematical methods.

Definition

Data Mining is the process of selecting, searching and modeling large amounts of data, used to discover previously unknown relationships between data in order to obtain commercial advantage.

Fayyad

In the literature there is some inconsistency in the use of the terms Data Mining and Knowledge Discovery in Databases (KDD). Some authors use these terms as synonyms. According to the first international conference KDD (Montreal, 1995), Data Mining is part of KDD.

DEFINITION OF KNOWLEDGE DISCOVERY IN DATABASES

Knowledge Discovery In Databases (KDD) is the process of discovering implicit non-trivial, unknown and potentially ahead of applicable knowledge in the data.

Fayyad

DATA MINING METHODS

- Regression methods (linear regression analysis, linear regression analysis, neural networks)
- Classification (discriminant analysis, logistic regression analysis, decision trees, neural networks)
- Segmentation - clustering (cluster analysis, genetic algorithms, neural clustering - Kohonen maps)
- Analysis of the relationship (association algorithm for type inference rules "if X then Y")
- Prediction in time series (Box-Jenkins method, neural networks, autoregressive models, ARIMA)
- Detection of deviations

DATA MINING MODELS

Descriptive model - describes the patterns and relationships found in the data, which may influence decision-making (For example a supermarket sale analysis used as a base for placing goods on the shelves).

Predictive model – allows predicting future values of attributes based on patterns found in the data (For example analysis of customers for whom there is a high probability that they will respond to a sales promotion ...).

Data mining has the following procedure:

a) Selection of a suitable algorithm (model)

b) Phase of learning on existing data + testing

c) The actual analysis and prediction

DATA MINING METHODOLOGY

The aim of the methodology is to provide users with a unified framework for solving various tasks in the field of mining. These methodologies allow you to share and transfer experience~~s~~ from successful projects.

Most common methodologies are: SEMMA (SAS), 5A (SPSS) and CRISP-DM.

CRISP-DM

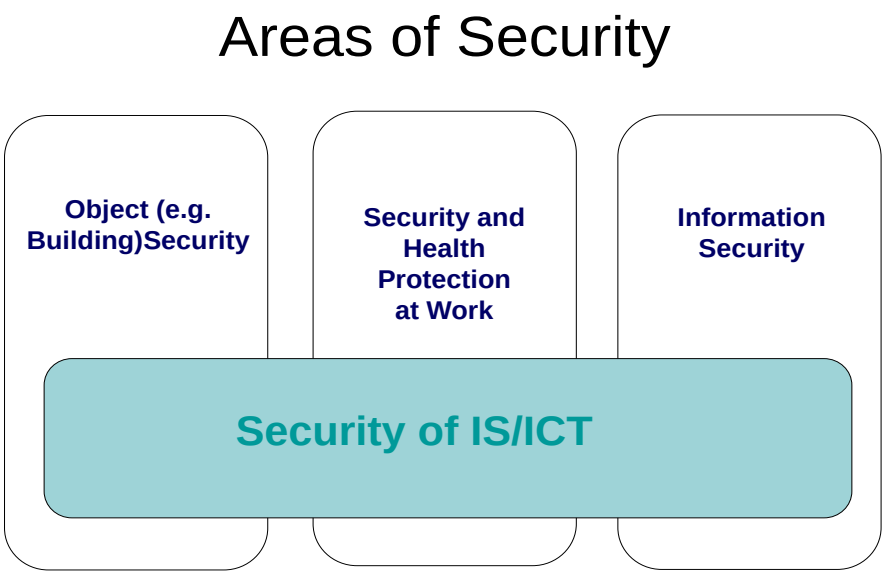
CRISP (CRoss Industry Standard Process for Data Mining) is a comprehensive methodology of knowledge discovery in databases, allows large mining projects to be carried out faster, more efficiently and less expensively through best practices.

Basic stages of the data mining process are:

1. Business understanding
2. Data understanding
3. Data preparation
4. Modeling
5. Evaluation
6. Deployment

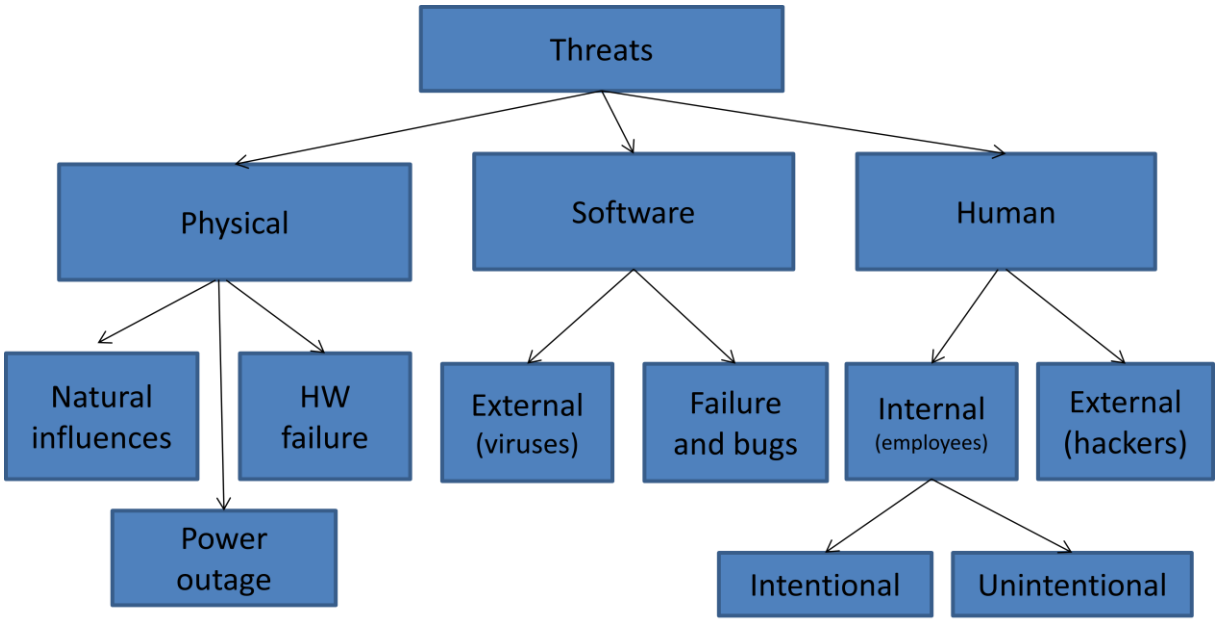
7. INFORMATION SYSTEM SECURITY

The term "security" is a broad concept. In principle, we can divide it into the three areas:



The following text is going to treat security as "Information Security".

The basic division of security threats (Risks Analysis):



RISKS ANALYSIS

- What happens when information is not protected?
- How information security could be violated?
- How likely is it to happen?

What should be protected?

- Technical Resources - against technical defect, theft, ...
- Communication paths - avoid monitoring data to be transferred ...
- Software
- Data – damage, theft

What is an aim of information security?

- Ensuring confidentiality of data
- Ensuring data integrity
- Ensuring data availability

ATTACKER TYPES

- Hacker
  - Beginner -> recognition, self-realization
  - Advanced -> overcome intellectual challenges, the ideal of free access to information ...
- Virus creator - "betrayed idealists", "unappreciated experts" ...
- Insider threat - retaliation against an employer, a sense of injustice, ...
- Information warrior - patriotic themes - destabilization of enemy sources
- Thief - pursuit of profit finance, BC Fishing
- Political activist - fanatic idealist ...

Errors that attackers employ:

- **Programming errors** - occur when some state of programs are unhandled, poor memory allocation calculations, inadequate checking of user input and so on.
- **Design errors** - arising from the erroneous judgment of the program designer. They are often difficult to remove. WiFi networks encryption by WEP is a good example. It is still

widely used on all network cards and WiFi access points, in spite of the fact that soon after its introduction a very simple way of breaking it was published.

- **Configuration errors** - caused by error or ignorance on the side of the user or administrator who configured the program or the device. Many of the devices and programs are set for total ease of use from the manufacturers and these settings can sometimes be hazardous. An example may be a typical access point on WiFi network - where the vast majority come with encryption turned off, so after switching to WiFi networks (and thus to the local network, where the access point is connected) anyone can join.

- **Physical violation** - a large part of the security arrangements can be bypassed if the attacker has physical access to the device or computer. For example, the hard drive may be removed from your computer and its contents read of edited even though the hacker cannot log on to the computer itself.

- **Operator errors** - just accidentally running a malicious program when the user is logged in with administrator privileges may infect your computer, regardless of how good a firewall protects you against Internet attacks

Aims of attackers:

- Theft of data and information
- Identity theft
- Destruction of Data
- Destabilization of system
- Blocking certain sites or resources

DEFENCE MECHANISM

PHYSICAL FAILURE, NATURAL DISASTER THREATS

- **Data backup**

- **Technical support** – UPS, overvoltage protection,…

- **Systems resistant to failures:**

  - **Fault-tolerant System** - a system resistant to failures - failure of the system (electricity, component, network) will not cause significant interruption to the system; solutions through duplication of critical components

  - **Disaster Tolerant System -** a system resistant to disasters - just like Fault-tolerant System it uses duplication but additionally it physically separates the backup system (to a different building, different city…).

- Cloud computing

DEFENCE AGAINST SOFTWARE THREATS

- Firewall, antivirus programs ...
- Networks - VPN (Virtual Private Network) -
- Authentication and access control
- Security policy, business recovery plan, emergency plan (operating instructions for what to do in case of an accident - whom to call)

Authentication = user access verification

Authorization = user rights verification

Firewall is a "security gateway". It is a device or software that separates traffic between two networks (e.g. the company's internal and public internet), and transmits data in one or another direction according to pre-defined rules. In particular, it prevents from unauthorized intrusions into networks and sending data from the network without the knowledge and consent of user.

AUTHENTICATION

• Access via user names and passwords or PIN

- Password expiry
- Limited number of login attempts (password, PIN)
- "Strong" password - the minimum number of characters, required combination of numbers and characters, and avoid the use of known words
- No "blank" password

• User Authentication

- Ownership of an object - a card, bar code, token
- Verification of physiological characteristics - biometrics

• The use of time intervals (automatic logout after a period of inactivity)

Authentication issues:

- Too many passwords to different systems
- Ambiguity of identity (somebody else under identical username in a different system)

BIOMETRICS VERIFICATION

- Fingerprints
- The image of the retina and iris

- Face Detection, palms
- Voice recognition
- Dynamics of signature, typing

Problems of biometric method:

- Difficulty in measuring biometric information
- Verification that the user is alive (LIVENESS Test)
- Dependence of measurement on environment and physical condition of verified person

Errors of biometric systems:

False Rejection Error - authorized user is denied access to the system

False Acceptance Error - unauthorized user is recognized as a legitimate one by biometric device

DATABASES SECURITY

- Protecting database against abuse
- Securing login information
- Securing communication between applications and databases
- Securing queries against „SQL-injection“

Architecture of secure information systems:

- *Trusted Subject Architecture* – Database system and operating system are one entity
- *Woods Hole Architecture* - Users are working with a set of untrusted interfaces for different security levels. They communicate with a trusted interface (front end), which acts as a reference monitor. Database system itself is again untrustworthy.

REQUIREMENTS OF IS SECURITY

Safety requirements for information systems for government is defined by "National Information Security Strategy of the Czech Republic" (www.micr.cz). Generally, it can be formulated as:

- **Confidentiality** - only authorized entities have access to assets, i.e. person, process, or device possessing privileges to carry out activities in the IS / ICT.
- **Availability** - authorized operators can perform an activity at their request and they are not denied access to the activity.
- **Integrity** - assets cannot be changed by unauthorized entity, illegal activities or applying incomplete changes.

System properties affect its security:

- Ensuring of authentication - any action that was run in the system can be traced back and it is possible to determine the originator of such action,
- Non-repudiation - the entity cannot deny his participation in the implementation of an action,
- Maintaining confidence ("reliability") - the real behaviour of the system is consistent with the documented behaviour of the system

SECURITY POLICY

Security policy is a set of principles and rules (documents) to help organizations protect their assets.

Security policy contains:

- A description of the information system
- Objectives Security Policy
- Definition of the sensitivity of the information
- Definition of possible threats
- Principles of personnel policy
- Determination of the backup policy
- Plan for disaster recovery
- Methodology for emergency response

Things are not "safe" and "unsafe", there are just different levels of risk.

Different people accept different levels of risk in different situations.

Security Solutions are a never ending process.

Institutions in the Czech Republic Related to IS Security

• The Office for Personal Data Protection (ÚOOÚ)

• National Security Agency (NBÚ)

• Ministry of Interior – (MV ČR)

• Czech Standards Institute - CNI

• The Office for Standards, Metrology and Testing - ÚNMZ

Legislation Regarding the IS Security

- Act No. 106/1999, On Free Access to Information
- Act No. 101/2000, On the Protection of Personal Data
- Act No. 227/2000, On Electronic Signature (last modified by Act No. 110/2007) And 304/2001 Implementing Decree
- Act No. 365/2000, The Information Systems of Public Administration (last change 81/2006
- Law No. 22/1997, On Technical Requirements for Products
- Czech National Council Act No. 20/1993, The Security of the State Administration in the Field of Standardization, Metrology and Testing.
- Act No. 412/2005, On the Protection of Classified Information and Security Capacity.

TWELVE TIPS FOR CORPORATE DATA PROTECTION (Source: Network Box)

- Select the browser and keep it up to date so that it can properly assess the existing risks.
- To enable the use of only approved browser, on any computer company (whether at work or at home).
- Make sure that users know the meaning of the act if signed by the Internet services.
- If your e-mails or saved data are managed by another provider, you sacrifice some of your privacy rights.
- Be careful about the data you're storing because in some countries it is regulated by legislation (e.g. Germany).
- Disable third-party cookies on business computers.
- Ensure that the security systems are up to date and that you are using multi-layer security approach.

- Validate application in relation to vulnerabilities (e.g. SQL injection).
- Ensure that employees do not use private e-mail for work purposes.
- Ensure that staff regularly cleans the browser history and cleans cache information that is stored on their computer.
- Remind users that they need to regularly change passwords and that the passwords are sufficiently robust. Remind them not to use the "Remember Me" property when logging on to protected sites.
- Be alert. Make sure employees understand the existing security risks, and that they do not become victims of phishing scams.

8. ERP INFORMATION SYSTEMS

ERP (**Enterprise Resource Planning)** is enterprise information system that integrates and automates many processes related to production activities of the enterprise. Typically ERP includes manufacturing, logistics, sales and service, asset management, finance/accounting, customer relationship management etc.

ERP can be defined as information systems through which we are able to deal with the planning and management of key business processes at all levels of the enterprise architecture.

ERP systems are also intended to ensure enreasing efficiency of the key business processes. The key processes can include for example: logistics, manufacturing, order processing, financial analysis along with the economy, maintenance and asset management.

Due to its division according to IS control levels (operational – tactical – strategic), ERP systems can operate at all levels, but the main focus will be more on the level of tactical and strategic management of the company

The main objective of ERP is support business processes and collect data necessary for the successful management of the company.

STAGES OF APROACH IN ERP

Early 90s: effort to optimize the production

- High quality (enforcement on the market)
- Low costs
- Functional structure

End of the 90s: customer satisfaction

- High added value for the customer
- Flexible and rapid fulfilment of the requirements
- Process management

TYPES OF ERP

- Complex ERP (SAP, Karat, K2, …)
- Problem-oriented (VEMA)
- Systems for small and medium businesses

TRENDS IN DEVELOPMENT OF ERP SYSTEMS

Earlier trend in the ERP was to achieve maximum functionality.

But with the expansion of functionality system complexity grows.

The current trend in ERP systems (the so called second generation of ERP) is **integration**. ERP retains only the functions for which it was primarily intended - to support business processes. Other functions are solved by integrating with specialized products (reporting tools, workflow, etc).

MANAGEMENT SUPPORT

This includes tools such as **business intelligence** (BI). The basic task of BI is to monitor, analyze and plan business processes. Analytical tools unlike reporting not only present the business values, but try to answer the question "why it happened" and "what will happen next."

Monitoring the status of enterprise:

- Reports
- Score carding – monitoring key performance indicators - instant view of the state enterprise in the defined indicators, mostly based on a comparison of plan and reality

PLANNING

Making financial and business plans, budgets and investment plans (activities typical for MIS systems). Systems can generate plans based on data from past periods, make their extrapolation from observed trends, simulation variants budgets.

INTEGRATION WITH DMS SYSTEMS

Structured data is stored in the ERP system but part of it is also outside. It's important to integrate it with document management systems (DMS). These systems are responsible for monitoring the flow of documents, archiving, upgrading, etc.

MOBILITY OF STAFF SUPPORT

To ensure greater employee mobility there is a growing need to access the ERP via the web interface, PDA, SmartPhone, etc.

SOLVING THE CRM

There are two possibilities for integration the CRM (Customer Relationship Management) functionality – custom module within ERP or integration with an independent CRM system.

Too complex ERP solution has a problem when deployed in small and medium-sized enterprises, which begins to be interesting segment of the market. Small companies are growing dynamically and it is necessary to make the system evolve according to business development.

EAM

One of the functions of ERP system is also to include the functionality of EAM (Enterprise Asset Management) systems. With Reportage and analysis tools is EAM platform for optimizing enterprise asset performance. Use of an information system in the field of maintenance is still exceptional in the Czech Republic.

ERP – Benefits

- More efficiency and acceleration of economic processes
- Data integration – availability of accurate and consistent data, data sparing
- Reduction of errors
- Savings investments in IT (in the long run)
- Increase in IS security (data security)
- Faster outputs for management (no need to prepare documentation)
- Support for Accounting (with multi-national enterprises - by international standards)
- Increasing competitiveness
- Faster approval of data (e. g. payments)
- Possibility of connecting with systems of customers and suppliers

Weaknesses of ERP

- High costs
- Other costs - maintenance, training, new functions…
- Dependence on suppliers

Instances users don't want to use ERP:

- Poor control of application
- Functionality does not match the needs

From an IT perspective ERP systems are based on the database, i. e. they assume table-oriented structured data.

For unstructured data it is better to use Document Management Systems (DMS) and Document Flow, and these integrate with ERP.

ERP Development Stages

- Strategy of corporate management
- Preliminary study – feasibility study
- Global analysis and design
- Detailed analysis and design – functional specification
- Implementation
- Deployment
- Operation, maintenance, further development

ERP Implementation

Realization of ERP system and its putting into operation is called **implementation.**

Implementation is not only about software installation but also includes a thorough analytical work describing the current practices and proposals for new procedures and solutions.

Implementation is also required to describe the current business processes and define processes to the ERP system so realization/deployment of the processes will be efficient, fast and easy.

Structure of implementation:

1. Business stage
2. Implementation stage
   - Process definition from economic perspective
   - Programming or reengineering of existing code
   - Testing in testing environment
   - Transfer to the production environment

Feasibility Study and Contract

Feasibility study includes for example estimation of person days needed for developing the system –which determines the price. If the implementation in a given time and on given funds is impossible (e.g. competitive pressure among suppliers leads the customer to determine unrealistic requirements) – supplier of ERP must withdraw from the contract.

Preparation of contract - puts emphasis on "legal" aspects. The contract about ERP implementation is necessary to accurately determine content of delivery.

Detailed description of the contract subject including its scope is crucial for smooth execution.

Declaring the expected project management methodology, particularly for change management and acceptance procedures.

No supplier can implement the ERP without interaction with the end-user (customer). It is therefore vital that the definition of synergy is not missed in the contract.

The expectation that the customer gets the newly-acquired, custom-made system from suppliers without his/her end-users' engagement, would be completely wrong.

Realization Stage

Project Management - The priority of project management is to achieve the desired objectives in a specified time, with limited resources and minimum cost.

Critical points of the implementation phase:

1) Change Management
2) Testing
3) Acceptance

There is no such thing as a standard delivery of ERP solutions with ready-made functionality. Change management is always required.

A necessary condition for good change management is the rule of **only one guarantor per customer and area of expertise** who will be entitled to suggest changes for the customer.

It is about agreeing what work will be counted as extra (paid on top of the contract) and what will be included in the project price.

Testing

Testing is very laborious and time consuming activity.

Consistency is critically important for its success.

If the supplier does too little testing, the customer finds many faults and loses confidence.

If the customer does little testing and trusts the suppliers, after the deployment of the system, errors and other than expected functionality can come to the surface.

Acceptance

1) Formal – For billing
2) Real - Actual

Successful project - both acceptances will take place in accordance with each other and at the same time.

To achieve this, **the acceptance tests** must be made available. They define the procedures and criteria ensuring that the implemented system works properly and in accordance with the specifications. Rules for acceptance tests must be ready by the end of the business phase.

Deployment

User expectations of ERP are never met 100%.

Successful implementation means that the customer research team has been trained, initiated into the analysis and involved in the testing -> the customer research team "plays" with supplier

teams and helps persuade users to adopt ERP (despite the problems they might bring: Users have to learn new things, work harder, etc.)

Implementation often causes **changes in business processes**. If this fact isn't taken care of-– it can turn into a time-bomb of failure. Support of customer management is the key factor of implementation success.

In practice, there are usually three systems:

- **Developer system** – used by programmers, after they finish certain components/versions, the code is released for testing.
- **Testing system** – this system contains a copy of real production data. Here we test the code created in the development stage. At agreed intervals (say once a month) the production system data is loaded into the testing framework.
- Testers examine whether the code performs its activities as planned and in accordance with economic processes.
- **Production system** – this is where the life production data is. Changes are applied only after thorough testing. Regular users work on that system.

The process of deploying new software version is called **Release Management.**

DELIVERY MODELS OF ERP

ERP systems can have the following delivery models:

- **On-premise model**. The application is installed on the company's own servers. The company must have internal resources for the operation and maintenance of the ERP system. The upgrades, updates and modifications to the system company participates itself along with the supplier. It is the most common use of the ERP model.
- **On-demand model**. This model is also known as **ASP** (Application Service Provider) or **SaaS** (Software as a Service). The main common feature is that the ERP system is available remotely over the Internet. The updates and upgrades are done by suppliers who run the ERP system on their servers. The safety and reliability of the service might be a bigger concern within this model because the organization does not have direct control over the management of the ERP system.
- **On-appliance model** – another form of SaaS. Customer uses only some modules, and only pays for what he uses.

MASHUP

is not a product, service or technology but a principle: To create new services by integrating the existing ones.

Added value is where it makes the difference. Mashup is integrated through APIs. For example we can create a new web service or page using web services from third parties. (Example is the use of Google Maps within one's own web project).

KEY MANUFACTURERS OF ERP SOLUTIONS

- SAP
- Lawson
- Oracle Applications
- IFS
- Nexedi
- Infor
- ABAS AG
- Microsoft (Dynamics AX, Dynamics NAV)

Microsoft Dynamics NAV

The product is part of Microsoft Dynamics, which helps businesses with accounting and economic planning, managing relationships with customers, suppliers, operational analytics and e-commerce. Microsoft Dynamics NAV 2009 has a new three-tier architecture with a new client-user interface focused on the role (Role Tailored Client - RTC) It was launched in December 2008.

New application functionality is in development for future releases, client for SharePoint (integration platform for presentation layer), the implementation of all components to .NET (and thus support of 64-bit platforms and Unicode support), and others.

There is a document called "Statement of Direction" published by Microsoft for its partners and customers that includes strategy and course of applications up to 2017.

Infor

Composed of acquisitions of a number of companies, making it the third largest provider of enterprise applications (measured by turnover) after SAP and Oracle Corporation. According to various corporate and media sources Infor turnover is $ 2.2 billion today, the tenth largest software company in the Word.

SAP

SAP is acronym of „Systems - Applications - Products in data processing“ (Germany, Waldorf)

SAP R/3 consists on the following modules:

- FI - Financial Accounting
- CO - Controlling
- AM - Asset Management
- PS - Project System
- WF – Workflow
- IS - Industry Solutions
- HR - Human Resources
- PM - Plant Maintenance

- MM - Materials Management
- QM - Quality Management
- PP - Production Planning
- SD - Sales and Distribution

SAP R/3 is a client - server application using three-layer model. Presentation layer or client communicate with the user. The application layer contains business logic and database layer records and stores all the data including transactional and configuration data. Functionality of SAP R / 3 is programmed with its own proprietary language ABAP (Advanced Business Application Programming, since 2003, you can also use Java). ABAP allows you to communicate with databases (using SQL), create graphical user interfaces and middleware for integration with other systems.

MySAP is a set of adaptive solutions to optimize business processes. It consists of the following components: mySAP ™ ERP, mySAP ™ CRM, mySAP ™ SRM, mySAP ™ SCM, mySAP ™ PLM. These solutions are compiled from the application components called „SAP Components“, sectoral components and technical components SAP NetWeawer ™. MySAP ™ ERP solution comprehensively solve the ERP business processes.

Information system for small and medium enterprises (SMB - Small and Medium Business) is available under the name **SAP Business One**.

Open Source ERP

There are a lot of open-source ERP systems such as Compiere, JFire, OFBiz,…

Advantages of open source systems:
- Source code disposition
- The ability to change the use of software according to future needs

Disadvantages of Open Source solutions:

- Instability in time – project can be closed without continuity
- Unclear concept development
- The project can be incomplete – problems with localization, etc.

The strength of commercial solutions is in their focus on analytical and implementation phase. The development of ERP is not only about creating software, but also in the proper understanding of business processes functionality.

http://www.erp5.com/ ERP5 ToLive

http://www.compiere.com/

http://www.bsys.cz/comp_erp.html

ERP Systems Market

- Large Enterprises – multi-national corporations – segment already occupied.
- Medium Enterprises – most interesting segment for key suppliers now
- Small Enterprises (up to 50 employees and 100 mil. CZK) – segment for proprietary products of local software manufacturers

Smaller companies place emphasis on speed and ease of data acquisition at the expense of extent, complexity and quality. The smaller the company, the lower the requirements for retrospective evaluation of data, however, the higher demands for speed and ease of acquisition of input data. This is in contradiction to the initial demand for quality, scope and complexity of data.

Therefore, smaller companies do not prefer complex large solutions with the emphasis on the complexity, quality and high-level analytical information. For small companies, the implementation of such packages can be a problem.

Possible Further Developments in ERP

- Integration MES systems
- Integration of PDM (Product Data Management)
- New technology – SOA, Web 2.0

SOA

SOA (**Service Oriented Architecture)** is an IT designing and developing approach. The key idea here is the orientation on services. SOA is a solution pathway which can deal with challenging tasks associated with the integration of separate applications. Its fundamental attributes focus on-services, with an emphasis on reusability of services and the loose coupling between applications.

Web 2.0

The term "Web 2.0" is an established designation for the phase of the website development in which passive content is replaced with shared, user-created content (examples: Wikipedia, YouTube, social networks like Facebook etc).

9. INFORMATION SYSTEMS – MES

MES (**Manufacture Execution System)** is a company information system that runs manufacturing operations in factories.

MES provides information to optimize manufacturing operations from obtaining orders and ending with the final product. MES provides operational information for the direct control of production processes.

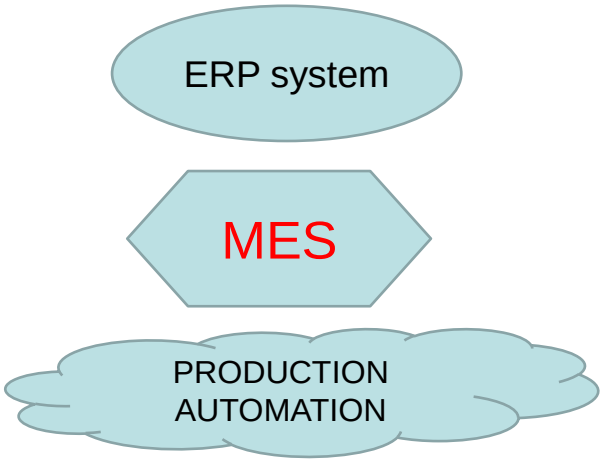
There is international organization of manufacturers of MES systems - **MESA** (http://www.mesa.org/en/). MESA is a global community of manufacturers, producers, industry leaders and solution providers who are focused on improving Operations Management capabilities through the effective application of technology solutions and best practices.

MESA defines standards for MES systems, and also 11 functional areas that fall into this category of information systems.

Definition of MES systems according to MESA:

„Using current and accurate data, MES guides, triggers, and reports on plant activities as events occur. The MES set of functions manages production operations from point of order release into manufacturing to point of product delivery into finished goods. MES provides mission critical information about production activities to others across the organization and supply chain via bi-directional communication."

MES systems bridge the gap between corporate information systems (ERP) and processs automation.



The basic objectives of MES systems are:

- Achieving low costs
- Improving the quality
- More flexible response to customer requests

MES systems deal with the following terms:

QUALITY – PRODUCTIVITY – EFFICIENCY

Deploying MES system in the company should:

- Allow controllability of processes
- Guarantee deadlines of orders
- Optimize production status
- Optimize logistics processes
- Reduce transit time of product manufacturing to a minimum
- Provide tools for rapid response to the immediate situation in production
- Monitore the production quality including its archiving
- Reduce the cost of material handling in production
- Automate administrative activities

PRICING MODELS OF MES SYSTEMS

- User-based – licence according to number of users
- (Usage) Module-based
- Outsourcing – ASP, SaaS, …

According to statistics, the average price of MES systems in the world is from $ 150,000 to $ 300,000, with the return of 6-24 months.

MES systems evolve more slowly than other types of enterprise information systems; this is a relatively conservative area where new technologies take a lot of time to be applied.

Some current trends in MES systems are:

- Using web services,
- Using the OPC (OLE for Process Control; software interface standard that allows Windows programs to communicate with industrial hardware devices)
- Presentation of output using dashboards.

http://www.opcdatahub.com/WhatIsOPC.html

FUNCTION AREA OF MES ACCORDING TO MESA

1. Operation Scheduling
2. Resource Allocation and Status
3. Dispatching Production Unit
4. Documents Control
5. Product Tracking and Genealogy
6. Performance Analysis
7. Labour Management
8. Maintenance Management
9. Process Management
10. Quality Management
11. Data Collection/Acquisition

OPERATIONS SCHEDULING

Implementation of production sequences on the basis of:

- Priorities
- Indication/Symptoms
- Characteristics
- Production regulations

Operating and detailed scheduling recognizes alternative and overlapping parallel operations for the calculations in detail and determines the exact time of equipment loading; it includes changes in formulas for calculations of times specified in the regulations

Resource Allocation and Status

Allocating and monitoring the use of resources:

- Machinery,
- Tools,
- Staff skills,
- Material,
- Other equipment,
- Documentation,
- Other

Dispatching Production Unit

Managing the flow of production in the form of:

- Work,
- Sequences,
- Batch,
- Quantity,
- Determination of work

Production can be changed in real time, based on actual events at the workshop.

Documents Control

Collection of data/records and forms that include:

- Work instructions
- Guides
- Project documentation
- Standard operating procedures
- Parts of programs
- Records of batches
- Notes about engineering changes
- Records of communications
- Plans, recipes and production results

PRODUCT TRACKING AND GENEALOGY
Includes:

- Personnel assigned to work,
- Material components used in production,
- Actual production conditions,
- Alarms,
- Reprocessing and other exceptions related to the product

PERFORMANCE ANALYSIS

- Immediate reporting of production results
- Comparison of immediate results with recent history and expectations
- Prediction estimates of economic output

The results of performance analysis include:

- Appropriateness of resources,
- Measurement
- Depreciation of production units,
- Compliance with the plan
- Comparison with standards

LABOR MANAGEMENT
Includes:

- Reports of time consumption and workers' attendance (rosters),
- Permissions
- Certification of workers,

MAINTENANCE MANAGEMENT

- Ensures efficient equipment and tools used to manufacture
- Includes scheduling periodic and preventive maintenance, as well as responds to immediate problems
- Keeps history of past events or problems to support their diagnosis

PROCESS MANAGEMENT

- Monitoring of production and automatic correction of production
- Decision support for operator providing the corrections
- Improvement of the functions in the production process may also include the management of alarms

QUALITY MANAGEMENT

- Obtaining measurements of production in real time
- Analysis for quality control of the product
- Identifying problems requiring attention
- Recommendation of action to correct the problem
- Identifying undesirable deviations in production

DATA COLLECTION/ACQUISITION

Aim of data collection is:

- Obtaining information about the operations in production/manufacturing
- Parametric data
  - From production facilities
  - From the manufacturing process
- Provide real-time evaluation about status of:
  - Production facilities
  - Manufacturing process
  - The history of the manufacturing process
  - The history of parametric data

The implementation of these functions allows full monitoring of production, management and logistics processes, including **traceability**. Documentation of production processes, and controlled production control solutions, including the so-called "non-conforming products" (= scrap, defective pieces, etc.) with the possibility to trace the cause of their formation is a prerequisite for ensuring the quality certification according **to ISO 9000 standards**.

TECHNOLOGY AND SYSTEMS RELATED TO MES

ADVANCED PLANNING AND SCHEDULING (APS)

Systems for planning the size and the sequence of production batches, their priorities and requirements of raw material; production planning with regard to its capacity.

SUPPLY CHAIN MANAGEMENT (SCM)

Systems for supply chain management and control (supplier - manufacturer - customer). The aim is to improve the ability to respond to user requests.

Some modules of SCM:

- Planning – planning how to deliver high quality product at the lowest possible cost
- Sourcing – relationships with suppliers
- Making – production itself
- Delivering – logistics of products
- Returning – complaints and claims

Components of SCM systems:

  - The product flow - information about the movement of the product to the customer
  - The information flow - records information about the order and its status
  - The finances flow - monitors the status of payments for supplied goods

Software in SCM:

1. Planning applications – order optimization and processing
2. Execution applications – monitoring of the physical state of processing of the order (product, finance).

PRODUCT LIFECYCLE MANAGEMENT (PLM)

Managing product life cycle; underpinning best practice and knowledge gained throughout the product life.

Convergence of CAD, CAM and PDM (Product Data Management; an application that deals with creating, managing and publishing data on the product).

QUALITY MANAGEMENT SYSTEM (QMS)

Quality management system: a group of attitudes, processes and procedures required for planning and execution (production / service) in the core business of the organization.

10. CORPORATE INFORMATION SYSTEMS – CRM

CRM (**Customer Relationship Management)** is corporate information system that deals with customer relationship management.

The predecessor of CRM was Relationship Marketing.

With growing systems, companies also changed the way of looking at profit. While originally the focus was on the product, now the customer who bought it was newly the centre of attention.

What are CRM systems about?

- How to capture information about existing and future customer
- How to capture those customers who make the most profit
- How to create products and services that will satisfy customers and deliver profit
- Finding the best way to communicate with customers (based on analysis of records of previous communication ...)
- Substitutability of the staff at the business, marketing and other departments

AIMS OF CRM SYSTEMS

- Analytical tool - support for planning
- Formulation of the corporate culture
- Assistance in developing corporate strategy
- Recording information about customers, their behaviour, needs, preferences, habits
- Support of marketing and marketing campaigns

Sources of CRM information are: E-mails, telephone conversations, information obtained by direct contact with customers or company information - documents, web, agreements, contracts, orders...

ARCHITECTURE OF CRM

CRM system can consist of several software components, such as:

- Database, data warehouse, BI software, prediction
- Tools for dialogue with the customer
- Tools for adapting the products and services to customers - a layer of communication
- Automation of marketing activities, sales, service activities

In terms of CRM system's functionality it may consist of the following modules:

- Business partners and other contact records
- Business cases and opportunities
- Marketing
- Related information
- Communication
- Planning
- Analysis and evaluation

FACTORS INFLUENCING THE SELECTION OF THE CRM

- What has the subject experienced with CRM?
- How big is the company/corporation?
- How big is the budget?
- Return requirements
- How big is the target audience?
- Is there CRM information system for specific business sectors on the market?
- Which business activities in terms of customer relationship management should be automated?
- How will the CRM bind with other corporate information systems?

CRITERIA FOR SELECTING THE CRM

- Quality of contact information and its management?
- To what extent information is in context?
- How does it deal with documentation work?
- How does the CRM evaluate business cases?
- Is the system transparent?
- Does the CRM support teamwork?

Choice of the CRM system should reflect the market segment in which the company operates as well as the number and type of its customers.

DEPLOYMENT STAGES OF THE CRM SYSTEMS

- **Lowest - no CRM** - the customer initiates business
- **Pre-CRM** - a sales department exists but it's characterized by uncoordinated sales approach
- **0 stage** - **traditional marketing** for the product (4P marketing mix - Product, Price, Promotion, Placement)
- **1st stage** - focus on the customer; **reactive approach** - evaluation of customer satisfaction
- **2nd stage** - **a proactive approach** (use of analytics tools, BI, win-win strategy ...)

TYPES OF CRM

OPERATIVE CRM

- Ensures that the CRM strategy is followed
- Sales and marketing support
- Automation of communication and sales processes
- Thanks to operative CRM, the company delivers on time what the customer ordered, it bills the customer correctly and it knows whether the customer has paid
- Customer database reporting/ Reporting on customer database improvements

Analytical CRM

- Analysis of customer data, analysis of customers behaviour - Data Mining, Web Mining, …
- Unified view on the customer in the timeline context, profitability forecasts
- Finding potential sales channels
- Optimizing the effectiveness of marketing campaigns

Collaborative CRM

- Quick passing of relevant client information to the right company departments

Examples

„When a customer rings a call centre of his/her bank to make a payment order, the call centre staff should already know that yesterday the customer ordered his/her credit card through the bank's website and therefore there's no need to offer it. They should know that a week ago at a branch called 'X' he/she negotiated his/her mortgage, so there is no point in offering a home loan either. And after the payment order has come through, the bank should notice the remaining account balance of CZK 2.70 and realize it might be beneficial for the customer to apply for an overdraft. But because only yesterday the customer was approved a credit card and only a week ago he/she had got a mortgage, it is crucial for the bank to calculate the customer's credit score with minimum delay so that he/she doesn't become one of the bank's late-paying or defaulting customers.

What Is Web Mining?

1. **Structure Mining** - how the customers use the web (what links they click, how they respond to advertisements…)
2. **Content Mining** (=Text Mining) – data collected through search engines
3. **Usage Mining** – data collected from on-line forms or logs (for example: do the customer use more multimedia content or texts?)

The worldwide market for CRM systems reported sales of about $ 8 billion a year. The leading developers of CRM systems are SAP, Oracle, Microsoft, etc.

Links to CRM Sites

- http://www.crmforum.cz/
- http://www.crmportal.cz/

11. CORPORATE INFORMATION SYSTEMS – ECM, EAM AND HRM

ECM

ECM (**Enterprise Content Management)** is a corporate information system that manages the total of the company's documents and other content.

The content is not only in the form of electronic and paper documents but it is the management and administration of all information that the company creates and uses therein.

The main objective is to ensure **the availability of information** and **information security, reducing errors and achieve savings** (increasing speed, accuracy and quality of information processing and **conversion of paper documents into electronic form** (as structured data).

Corporate data can be divided into the following categories:

- **Structured data** – database-stored data with search facilities
- **Unstructured data** – documents, emails, contracts, offers,…
- **Electronic data** - photos, video, audio, web, …

STRUCTURE OF ECM SYSTEMS

1. Capture – technology and tools to obtain electronic documents.
2. Manage – management of access to content.
3. Store – databases and other media to store the documents and related metadata.
4. Preserve –physical security of documents.
5. Delivery - delivery and presentation of the content to users.

DOCUMENT DIGITALIZATION

- Preparation of documents
- Scanning
- Text recognition (via OCR or other software)
- Indexing (the outcome in the form of metadata)
- Verification, validation
- Saving documents

SCANNING

Scanning technologies use CCD (Charge Coupled Device) or CIS (Contact Image Sensor). CIS sensor has a smaller head and works with low voltage, but cannot take transparent sheets (films, slides) and does not reach the quality of high-level CCD.

Raster images are the output of scanning. They are files such as JPG, TIFF, PDF....

To transfer images into text, they must be processed by character recognition software.

CHARACTER RECOGNITION – TECHNOLOGY

- OCR (Optical Character Recognition)
- ICR (Intelligent Character Recognition) - handwriting
- OMR (Optical Mark Reading) - text in form fields
- BCR (Bar Code Reading) –converts bar code into characters

INDEXING

- **Manual** –scanning generates only an ID. The operator must then create indexes.
- **Semi-automatic**
- **Automatic** – the system generates all the indexes automatically

Objective of indexing is to create **metadata** that allows to search for information in huge amount of scanned documents.

ECM COMPONENTS

- Document digitalization - Imaging
- Data Capture
- Document Management System
- Records Management
- Archiving
- Workflow
- Groupware (software for team collaboration)
- Web Content Management
- Knowledge Management
- Digital Asset Management

DMS Systems

DMS (Document Management System) is a part of ECM systems. DMS deals strictly with management of documents. Sometimes the terms ECM and DMS are used as synonyms but DMS has narrower focus, however the ECM also includes parts that are not primarily ~~not~~ concerned with documents.

DMS systems address the creation, modification, approval and use of digital documents.

Purpose of DMS

DMS provides the following information:

- Where and under what name the document is stored
- Who is the author of the document
- How many versions of that document exist
- Access rights to the document
- Full text search in documents
- Record history and activities carried out with the

Note:

The term "Fulltext" means comparing phrases with other words of the document.

Other Technologies Related to ECM Systems

Document Imaging (DI) – documents scanning,

Document Management (DMS)

Web Content Management (WCM)

Digital Asset Management (DAM) – management of multimedia content; it is a specialized area of ECM, which supports multimedia data - photographs, audio or video recordings

Records Management (RM) – management of documents whose contents can not be changed, yet it must be archived due to its validity - such as signed contracts, received invoices, financial statements, it is more or less an electronic archive, which controls the retention and archival period of documents

Team Collaboration (TCM) – used to support decision-making processes.

WORKFLOW MANAGEMENT SYSTEM

The term workflow is used to describe business management, business processes and related documents. Workflow defines, creates and controls the progress of business processes.

Workflow consists of:

- Tasks – activities that must be performed to achieve business goals
- People – carry out the tasks
- Tools – application enabling execution of tasks
- Information

Workflow Management Systems provides automated business processes in companies - it makes commonly performed activities faster and cheaper

GROUPWARE

Groupware is a tool that supports team collaboration in project work.

Groupware addresses:

- Communication
- Data sharing
- Workflow
- Team collaboration

CORPORATE INFORMATION SYSTEMS EAM

EAM (**Enterprise Asset Management)** is corporate information system which deals with the management of company resources. The term resource means primarily capital assets e.g. machinery, technological units, buildings, engine spare parts. The main area of these systems is therefore asset management and the management of its maintenance.

The EAM functions are:

- Monitoring the status of the device
- Maintenance scheduling
- Functions of commercial and logistic system
- Some functions of human resources

Objectives of EAM systems:

- Reduced downtime
- Reducing losses due to equipment malfunction

- Improved organization of maintenance
- Increasing the capacity of the production facilities
- Proactive maintenance

Proactive maintenance - forecast maintenance and service operations according to the actual state of the device. **Technical diagnosis** can for example be a source of information for the proactive maintenance.

Technical diagnostics is concerned with identifying the technical status and fault diagnostics. Uses methods based on e. g. frequency vibration spectrum analysis, measurement frequencies or thermo diagnostics methods.

Common tasks of technical diagnostics:

***Detection* -** detection of presence of disturbances arising

***Location* -** determine defective component or node

***Prediction* –** prognosis of residual life assessment

VIBRODIAGNOSTICS

Vibrodiagnostics deals with the analysis of vibration such as the detection of the following problems:

- Imbalanced rotors
- Misalignment of couplings, bearings and gears
- Mechanical release
- Damage to rolling bearings
- Transmission wear
- Grind
- Hydraulic and aerodynamic problems
- Electrical fault
- Resonance
- Deformation

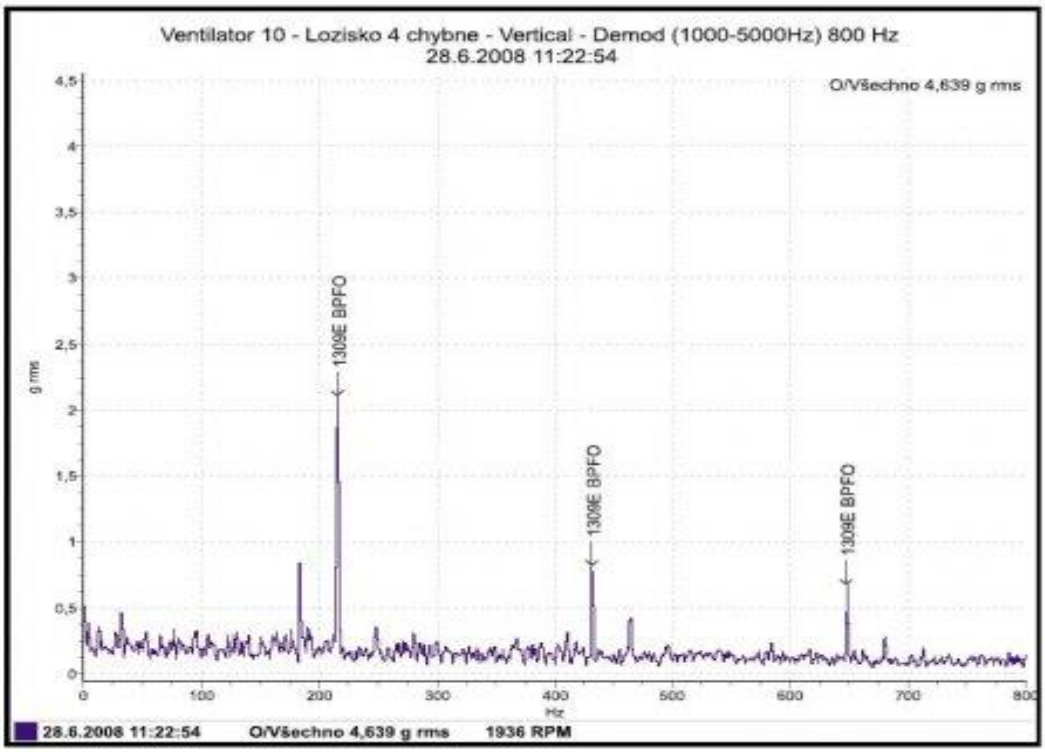


Fig 11.1 Example of analysis: Defective bearing is reflected in the frequency analysis of amplitudes at certain frequencies. [Source: http://www.systemonline.cz/]

Overview of EAM systems (Czech market):

- http://www.systemonline.cz/prehled-informacnich-systemu/eam-systemy/

HRM Corporate Information Systems

HRM (Human Resource Management) is a corporate information systems that deals with tasks and issues of human resources

Tasks addressed by HRM:

- How to find key employees?
    - Internal motivation
    - Knowledge and skills of employees
    - Employees references
    - The employees development plan (after investing in employees we want to keep them)
- Human resources

- How to retain key employees?
- Wages
- Attendance

FUNCTIONS OF HRM

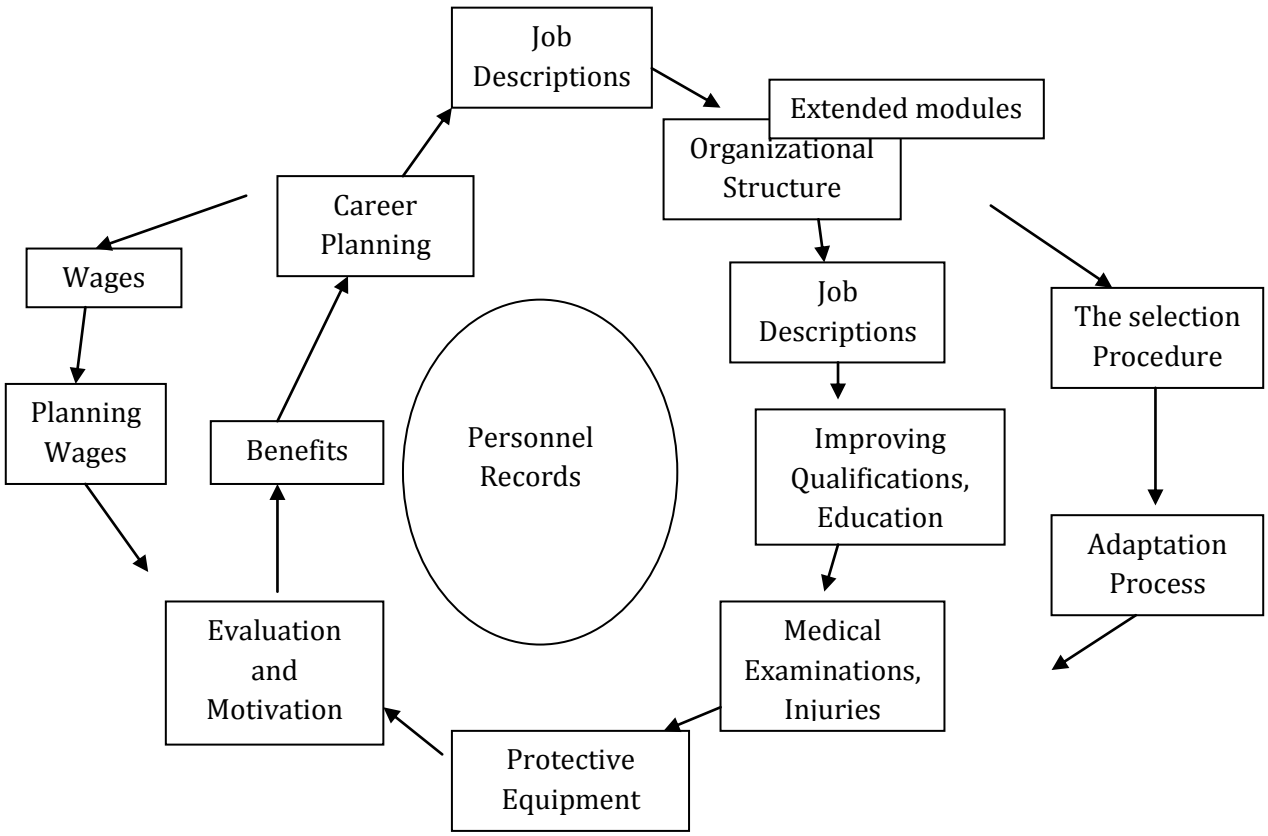


Fig 11.2 Modules in HRM [Source: http://www.systemonline.cz/clanky/personalni-informacni-system-budoucnosti.htm]

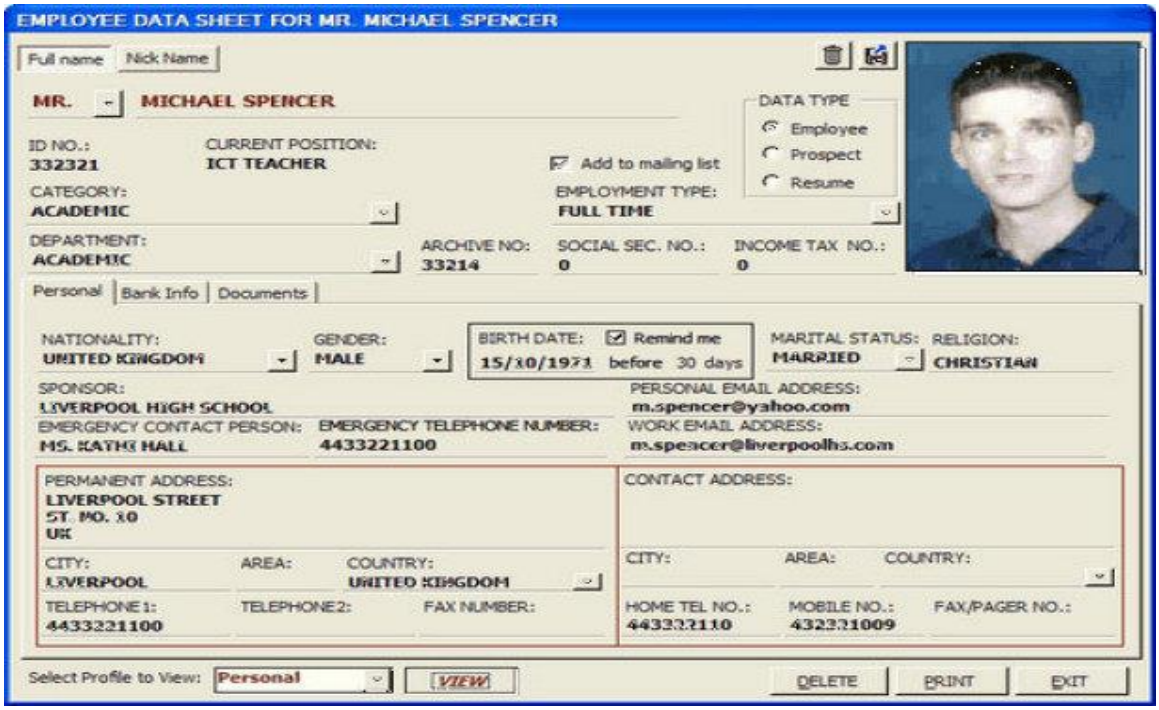


Fig. 11.3 Screenshot taken from HRM

12. WEB INFORMATION SYSTEMS AND GIS SYSTEMS

WEB INFORMATION SYSTEM

Web Information System is a system designed to operate in conditions of Internet / Intranet, i.e. it is accessed by a web browser.

Using a web browser as a tool for working has some specifics. Perhaps the most important difference, especially for the application developers is that applications run in a **non-linear and stateless environment.**

What is the **nonlinearity** of the system?

- Entry into an unexpected point (direct access to specific URL in the middle of application)
- Return in the sequence of operations ("Back" button on your browser)
- Repeat request ("Refresh" button) with repeated sending of the same request to the web server.

The Internet is implemented at the application layer through the **http protocol** which is **stateless** that is - to return control to specific http page, the system doesn‘t remember the previous status of the page. Calling each site bring about isolated series of entries into the operating system. Information is processed in a number of separate steps and for the developer it means ensuring a continuous data transfer during a call to individual pages.

FUNCTIONAL REQUIREMENTS FOR WEB APPLICATIONS

i. The appropriate application architecture
ii. Modularity
iii. Application security
iv. Validation of input parameters
v. User authentication and user management
vi. Sessions and entity (user) authentication
vii. Authorization and access rights
viii. Unified database layer
ix. Logging events and actions
x. Validity of web pages
xi. URL masking
xii. Security (SQL injection, cross site scripting, …)

WEB APPLICATION ARCHITECTURE

Model 1 – the browser accesses a site directly; site handles inputs from the client in the **GET or POST parameters**

Model 2 – uses a „**controller**“ – a layer located between the browser and the processed page/script

When developing web applications libraries are often used. They provide functionality for developing complex web applications - termed **frameworks**. Frameworks allow applications to be divided into logical sections (modules).

Examples of frameworks are: Zend framework, Nette, Smarty…

Auditing and Logging

Auditing – records of changes made in the information system

Logging – monitoring the sequence of work of individual users and their activities

SESSIONS

HTTP is a stateless protocol. The server responds to the client requests without putting them into perspective. For the applications to function properly, a mechanism called “sessions” was introduced (to allow exchange of global application data). After establishing the connection (to web server), a unique session identifier is created (called “session token“). Session token is sent to the client (saved in the form of a "cookie") and is sent to the server with each request.

Note:

For security reasons, developers should use non-persistent cookies, ensuring the session token is no longer available after the browser is closed.

VALIDITY OF WEB PAGES

- Proper use of tagging – effects the location in the search results
- SEO (Search Engine Optimization) - is the process of improving the visibility of a website or a web page in a search engine's results

SECURITY ON THE WEB

SECURITY RISKS

- Bad programming practices
  - E.g. lack of checking the variable inputs, missing initialization of variables
- Incorrect or insufficient analysis
- Web browser weaknesses

APPLICATION OF SECURITY

Recommendation for application security:

- Validation of inputs and outputs
- Safe failure (data consistency after a failure)
- Simple security mechanism
- Use of proven components
- Planning for unexpected events
- User permissions should be as small as possible

Security recommendation for forms

- Enter password only through „password input“ field (text is encoded)
- Data sent only by POST method (to prevent injection of parameters or SQL commands)
- Use SSL communication (Secure Socket Layer, a cryptographic protocol that provides security communication over Internet. Https is built on the SSL protocol)

USER AUTHENTICATION

Authentication handles the system access rights, while authorization takes care of the permissions to perform certain functions.

We can divide methods of authentication into the following groups:

- Based on the knowledge of certain information (password)
- Based on the ownership of certain things (e. g. a smart card)
- Biometric methods

Managing Users and Passwords

- Forgotten password (additional renewals by answering secret questions, sending access information by ~~via~~ e-mail, etc.)
- Password expiry
- Locking the account after multiple unsuccessful logons
- Password strength

Some Technologies and Terms Related to Web Applications

- HTML (Hypertext Mark-up Language) - the basis of applications on the web; It works through a request-response; It is stateless
- CSS (Cascading Style Sheets) – a language used for formatting html pages
- PHP, ASP, NET, JSP, Python, Ruby, CGI, Perl - **server-side scripts**
- JavaScript, Jscript, VBScript, DHTML, ActiveX - **client-side** scripts
- XML (eXtensible Mark-up Language) – a general markup language, e.g. use for data exchange
- AJAX (Asynchronous JavaScript aXML) - a set of technologies that alter the content of web pages without having to reload
- XHTML (eXtensible HTML) - extension of HTML with XML uses
- Flash - a vector graphics program to create interactive animations, presentations, etc., through the use of plug-ins in web browsers to work with graphics, animations, etc.
- Silverlight (or open source implementation called Moonlight) - Microsoft alternative to Flash technology
- SOA (Service Oriented Architecture) - a service-oriented architecture, the application consists of a group of services that communicate with each other.
- RIA (Rich Internet Application) - Internet Application solution, which eliminates the shortcomings of html protocol (based on the model of request-response), using technologies such as AJAX, Flex, OpenLaszlo, etc.
- Web 2.0 - a designation for applications on the Web, where users help create content (eg YouTube, Facebook, ...)
- Mashup – hybrid web application that uses and combines data, or functionality from two or more sources to create new services; a service based on the use of existing services (for example, using the Google Maps application for presenting the position of specific objects in maps used in the application).

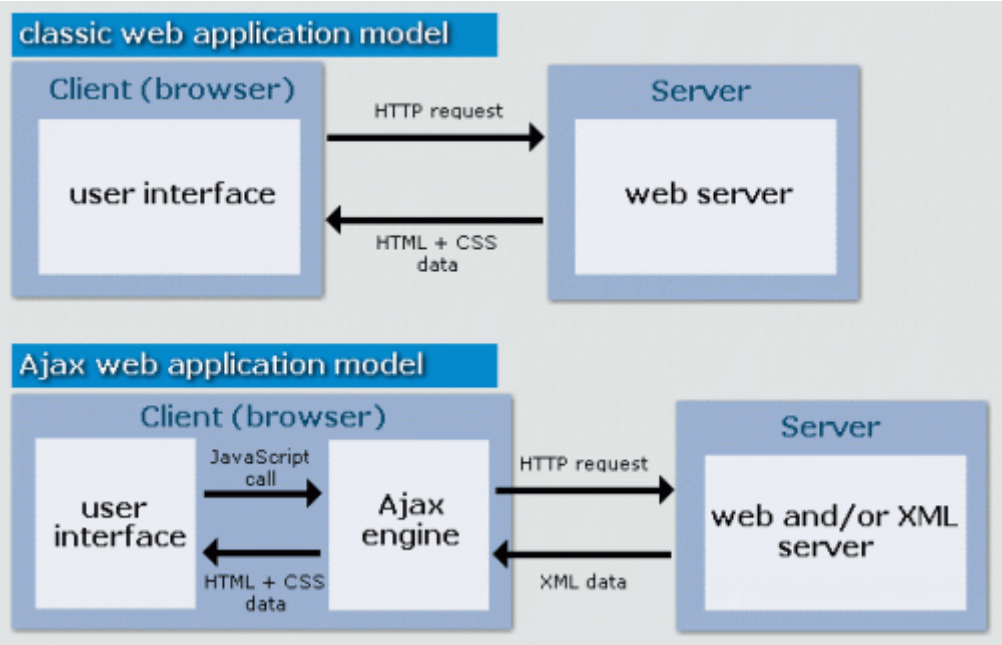


Fig. 12.1 Comparison of a typical application model with an AJAX application [Source: http://interval.cz/clanky/rich-internet-application/]

WEB SERVER

To run an information system, such as the intranet / internet application, a web server is needed to ensure its technical support. In the software sense it is a program that is connected to the network and ensures handling http requests. Server returns a response to client, which initiated the request (usually an HTML document).

Part of the answer is also a status monitor, indicating the stage of the processing request. Code 200 means that the request was successfully discharged; 3xx - Problems with redirection; 4xx – Client errors; 5xx - Internal server errors.

The most commonly used software for web servers is an open source **Apache,** Microsoft **IIS (Internet Information Server)** or Tomcat. A web browser needs to be installed on the client side to display the requested web page**.**

GEOGRAPHIC INFORMATION SYSTEMS - GIS

GIS (*Geographic information System)* is a system designed to capture, store, manipulate, analyse, manage, and present all types of geographical data.

The term GIS can be understood as **a software** to produce maps, as well as **the application** itself or the entire **information system**.

GIS uses data that is associated with spatial orientation (Spatial Data). Spatial data consists of individual spatial objects.

Spatial object contains two types of information:

- Spatial information (shape, location, topology)
- Non-spatial information (attributes specific to each type of object)

GIS works with raster and vector data.

RASTER DATA IN GIS

- Raster map layers are used to model variables, which are defined continuously throughout the model space. An example might be a map layer of altitude map of soil type, vegetation, atmospheric pressure, temperature, etc.
- The space in the raster map layers is divided into many small facets whose dimension is sufficiently small to regard the variable on its surface as constant.

VECTOR DATA IN GIS

- In the vector map data layers, data is stored using points and lines.
- The point is the basic element with a defined position (coordinate) and from geometric point of view it has no dimension. A line is a segment or curve connecting two points
- Basic components: point, line, polygon, surface
- Vector data is organized using different models (spaghetti, hierarchical, topological, ...)

Vector data allows the use of information **layers** (e. g. roads layer, layer objects, such as restaurants, etc.).

Rasterization - the process of converting vector graphics to defined bitmap (bitmap)

Vectorization - derivation of vector data from raster data - raster areas are converted to polygons.

COORDINATE SYSTEM AND PROJECTION

Each map system must use a coordinate system (coordinate system allows positioning of an object in relation to the real world) and projection (earth is a sphere, while the map is an area, uneven surface of a sphere must be converted to a planar view).

In the Czech Republic the most commonly used coordinate system is JTSK.

METHOD OF OBTAINING DATA FOR GIS

- Digitizing of analogue maps
- Digitizing of files and other documents
- Remote sensing of earth - aerial, satellite images
- Photogrammetric evaluation of aerial photographs
- Custom geodetic terrain measurements
- The takeover of existing data

GIS APPLICATION

- Documentation, identification and localization of objects, areas and relations
- Thematic mapping
- -Planning and decision-making support
- Support of business processes
- Spatial analysis and modelling

WORKING PROCEDURE IN GIS

1. Specification of the problem
2. Data acquisition
3. Analysis and management of data
4. Visualization

TYPICAL TASKS DEALT WITH IN GIS

- Location - where is the object located
- Condition - locate the point satisfying a certain condition
- Dissemination - a move after a defined surface
- Structure - the spatial arrangement
- Modelling - addiction, prediction, trend

DATA SOURCES FOR GIS IN THE CZECH REPUBLIC

- ZABAGED database - Czech Office for Surveying, Mapping and Cartography - raster and vector data at a scale of 1:10 000, 3-10 m accuracy:

    - Residences, economic and cultural objects;
    - Public transport routes;
    - Grids and pipelines;
    - Water systems;
    - Territorial units;
    - Vegetation areas;
    - Terrain relief;
    - Survey points.

- Digital model of the territory (DMU 25) - Military Topographic Institute in Dobruška - scale 1:25000, with seven logical layers of data:

    - Waters;
    - Public transport routes;
    - Pipelines, energy and telecommunications routes;
    - Plant and soil cover;
    - Settlements, industrial and other topographic objects;
    - Borders and fences;
    - Terrain relief.

- Land register
- Geofond – bore holes register, registry of hydrogeological and geological profiles
- Czech Geological Survey:

    - Geological map;
    - Utility lines and geological map;
    - Hydrogeological map;
    - Map of mineral deposits;
    - Map of geochemical reactivity of rocks;
    - Map of soil interpretation;
    - Map of soil;
    - Map of the geochemistry of surface waters;
    - Map of geophysical indications and interpretations;
    - Map of geofactors - conflicts of interest;
    - Map of geofactors - significant landscape effects;
    - Map of Protected Areas of the Czech Republic 1:100 000~~th~~

SOFTWARE FOR GIS

AUTOCAD – add-on for landscape modelling:

- Autodesk Land Desktop;
- Autodesk Survey;
- Autodesk Civil Design.

Autocad Map 3D - the add-on used for GIS has following functions:

- Data entry using digitization;
- Import and export of various formats including DGN;
- Creating maps in arbitrarily defined frames;
- Creation of thematic maps based on object and topological queries;
- Creation of point topology, network or polygon (surface);
- Data Analysis, located in overlap, selected area or zone along the route;
- Network analysis;
- Ability to create its own mathematical projection, own ellipsoid

Autocad Civil3D

Archicad

MGE (Modular GIS Enviroment) is an open modular environment for creating GIS from Intergraph Company. MGE supports large number of formats from which to import data. Currently it has a free GeoMedia product, which includes comprehensive GIS solutions from intelligent GIS client, through GIS desktop application, to web application servers. The most important element of the new generation GIS solution is to store both attributes and graphic elements in a spatially oriented data warehouse and the ability to read foreign GIS formats in their native form.

ARCVIEW GIS is a compact system for GIS of ESRI, allowing for the creation, maintenance and processing of GIS. The main advantages according to the manufacturer:

- Intuitive graphical user interface;
- Creating maps using symbols, choice of colours, different types of classification data;
- Support for both simple and complex queries spatial and tabular data;
- Functions for business graphics - drawing different types of graphs;
- Support of communication between applications;
- Client-server architecture;
- Object-oriented system;
- Tools for application development
- Czech environment, the current support for various code pages..

ArcView software allows the spatial data to connect to another relational database. To work with tables ArcView offers a wide range of tools for sorting, queries, selections, statistics, calculations, and editing tables. Databases can be in many different formats, supported by ODBC. It works with a variety of data formats, both raster (TIFF, RLC, BIL, BIP, Erdas, JPEG), and vector (such as DWG, DXF, DGN).

ArcGIS Desktop is a GIS system of ESRI, which is basically a set of sub modules operating over a single data structure over geographic databases. It differs in functionality level - from ArcView, ArcEditor to ArcInfo

It allows all the features of ArcView GIS, and it has advanced features for creating interactive maps, complete query above the map, direct reading of other data formats and, depending on the level, many other features.

13. INFORMATION SYSTEMS IN PRODUCTION

The aim of these systems is to provide quality data according to the recipient's job position (worker, foreman, manager).

Optimizing individual parts of production is not enough (e. g. through technology automation), but it must be optimally managed as a whole. Siemens has introduced a holistic management automation labelled as TIA (Totally Integrated Automation).

Benefits of information systems in production:

- Automation repetitive tasks (processes)
- Removing duplicates agendas and activities
- Secondary effect - elimination of "bogus" work
- Reduced ongoing processing times
- Minimizing downtime
- Evaluation of production
- Link to sales

TYPE OF PRODUCTION SYSTEMS

Activities and tasks contained in the information system of production vary depending on the type of production controlled by the IS. There are three production types:

- **Factory Manufacturing** – managing discrete manufacturing processes - such as machinery manufacturing
- **Process Manufacturing** – continuous production process – such a chemical
- **Batch Manufacturing** – the product is produced in a batch - pharmacy, metallurgy, food industry (e.g. production of wine)

Batch production of works of units, sometimes referred to as a batch.

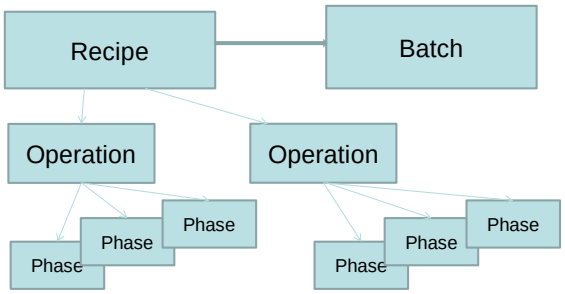


Fig. 13.1 The structure of batch production

Recipe – the necessary information that uniquely defines the manufacturing requirements for a specific product.

Type of recipes:

- General recipe
- Site recipe
- Master recipe
- Control recipe

Operation – function containing at least one stage.

Phase - basic production step, it always belongs to a specific operation.

Information system for batch production usually includes:

- Electronic record of the batch (batch progress)
- Report on the batch

User requirements for IS are characterized by:

- High degree of freedom (flexible adjustment range of products to customer requirements)
- Demand for high quality
- Full documentation of the production.

PRODUCT IDENTIFICATION

- Barcodes
- RFID
- Camera systems

BARCODES

- The code consists of black print stripes (or mosaic)
- Optical Character Recognition by laser light reflection (the light is absorbed by dark lines and reflected off by white spaces)
- Each digit or letter is recorded in the barcode using precisely defined bar widths and spaces.
- Bar code contains 12-15 characters of information
- The barcode must come into visible contact with the reader (optical reading, laser)

Fig. 13.2 Samples of EAN codes (EAN 13, EAN 128, CODE 39)

EAN

- European Article Number
- The most used barcode
- EAN-8 or EAN-13
- First three signs – country code, for example Czech Republic is 859

RFID - Radio Frequency Identification

- Information in the range of up to 96 kilobytes
- Rewritable tags
- High-frequency radio signal without the need for visual contact
- The ability to read multiple tags
- Call events with moving object from / to range RFID reader

RFID tag has an oscillating circuit which receives a signal while it modulates - transmission EPC (Electronic Product Code) - reader decodes the information from the received RF signal and passes on through EPC middleware (middleware task is to reduce the data flow associated with re-treatment). Data can be read and stored by the RFID reader, RFID tag can function also as a sensor.

According to the way they are powered, we distinguish: passive tags, active and semi passive tags.

Note. RFID tags find usage in shops, where the tag protects against theft of goods (active tag passing through the sensing frame generates an alarm).

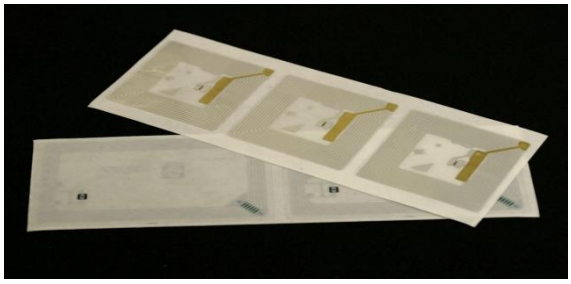


Fig. 13.3 RFID tag and a RFID reader

CONTROL SYSTEMS

The control system is the physical realization of the prescribed control instruction.

Information systems can operate as control systems. It may not be a direct control, but these systems provide information to managers to better manage their decisions. It is referred as an indirect control.

Control systems thus can be classified into the following groups:

- Automatic control – continuous control (P, PI, PD, PID), discontinuous control, fuzzy control,…
- Logic control - PLC
- Distributed direct control - DCS
- Indirect control - information systems provide information on the controlled subject in real time

REAL-TIME CONTROL SYSTEMS

Control systems that operate in real time - they are able to respond to events in a predetermined time (guaranteed response time).

Division of Real Time Systems:

- Soft RT
- Hard RT - deterministic response in the precise time

Hard Real-Time systems must be supported by operating system to ensure deterministic time of response of the system to the event. For these purposes, you can not use the standard kernel of common operating systems that includes a job scheduler and a tasks priority system, which is not user-influenced. As an example, the specific operating systems, which provide hard real-time support, can give Windows RTX (with modification of Windows NT kernel), RTLinux or RTAI (distribution of hard real-time Linux operating system).

STRUCTURE OF AN INFORMATION SYSTEM USED FOR THE CONTROL OF TECHNOLOGICAL PROCESSES

Information system used in the technological process control usually consists of the following components:

- Data collection
- Alarms
- Real-time visualization of technologies (usually SCADA systems)
- Technological modules (calculation of process variables, trends, moving average, etc.),
- Balancing outputs

- Databases – parametric data (e.g. parameters of sensors)
- Historical data
- Kernel of Information System
- Administration software and utilities

Sensors

To be able to monitor and control the technological process, we need to measure its state by sensors.

The sensor can be classified into three groups:

- Analogue
- Binary
- Incremental

Analogue Sensors

Analogue sensors measure analogue (continuous) values. The output from the sensor e. g. a current that A / D converter converts into the byte interpretation of the measured value (that is the value in the range 0-255) is then converted into the physical quantity. Examples of measured analogue values are the temperature, pressure, humidity.

Calibration of analogue sensors - measuring and calculation carried out on a standard (the standard in metrology is a gauge of known properties, used for maintaining or verification of scale or unit of measurement).

Binary Sensors

Sensors that record two logic states (0 and 1). An example might be measuring equipment's state of operation (standing - going), opening of flaps or doors (open - closed).

Boolean value corresponds to certain current or voltage. The most often used are values of 4 mA of current for logical 0 and 20 mA for logical 1. The current value for a logical zero isn't nil (0 mA) deliberately, so that it is possible to distinguish between a logical zero as the measured value and the situation when the sensor is switched off or faulty (in which case the current is zero).

Incremental Sensor

Incremental encoders (also referred to as the counters) are based on counting pulses, where each pulse is generated by increments of the measured value. An example might be measuring the amount of raw material on the production belt, counting litres of liquid going through a pipeline, measuring amounts in a tank. The total weight/volume/amount is so a sum of all pulses multiplied by the value corresponding to the single pulse.

Verification of Value

For further work with measured quantities the verification of the measured values needs to be placed in context.

Example:

For a set of three belts, there cannot be a situation when the first and the last belts measure "stopped" while the middle belt's incremental encoder measures the amount of material passing through the conveyor belt.

Connecting Sensors

Transfer data between two points (sensor and computer) is done through **the transmission channel**, the so called **bus.**

Transmission speed is expressed by Baud Rate [Bd, Baud] - the number of changes per second.

Data transmission:

- Serial (stream of bits)
- Parallel (transfer of bytes)

Rules of communication are defined by **communication protocol.**

The information is transmitted in a time sequence, the transmission has a beginning and an end.

Safety of transmission of information:

- Parity bit (sum of elements modulo 2) - added bit, a simple error detection
- Checksum - to verify that the information is complete and whether the transmission error has occurred
- Cyclic sum (CRC) - hash function to verify transmission
- Communication Handshake - mutual acknowledgment that the data has been received

Interface is a device or software for communication between different devices. In computer science interface allows data transfer between devices.

The most common interfaces

- Parallel - CENTRONICS
- Serial – RS232 (point to point)
- RS422, RS423, RS485
- Network interface

BUS

The bus is designed to ensure the transfer of data and control commands between two or more electronic devices. Data transfer on the bus is governed by established protocol.

FIELD BUS

- SensorBus - the lowest control level to communicate with sensors and actuators in real time (AS-Interface, Profibus DP)
- DeviceBus - a higher level of control, communication with PLC (DeviceNet, LonWorks and Modbus)
- Fieldbus - multimaster network, define all 7 layers of the OSI network standard (Profibus FMS, FIP, P-Net).
- Profibus (Process Field Bus) - RS485 or fiber optic, token ring
- CAN (Controller Area Network) - CAN bus is a serial communication protocol of the BOSCH laboratory

POPULAR AUTOMATION PROTOCOLS

- MODBUS - an open protocol for communication between different devices, www.modbus.org
- HART (Highway Addressable Remote Transducer Protocol) - implementation of Fieldbus, widespread standard protocol that enables two-way digital communication with devices connected by two-wire current loop with an analogue signal transduction current levels of 4-20 mA.
- EthernetIP (Industrial Ethernet) - Rockwell Automation, the network layers of the OSI uses the existing Ethernet

For an overview of field bus, go to http://fieldbus.feld.cvut.cz/

ACTUATORS

Control system can influence the controlled object by actuators.

Binary actuators

- Coil relays, contactors

Analogue

- The output is current or voltage signal - for instance speed control, selsyn, proportional valve, asynchronous or synchronous engines, DC engines, stepper motors

VISUALIZATION OF TECHNOLOGICAL PROCESSES

Special software, called **SCADA/HMI** (Supervisory Control and Data Acquisition / Human Machine Interface) is often used for visualization of technological processes in real time.

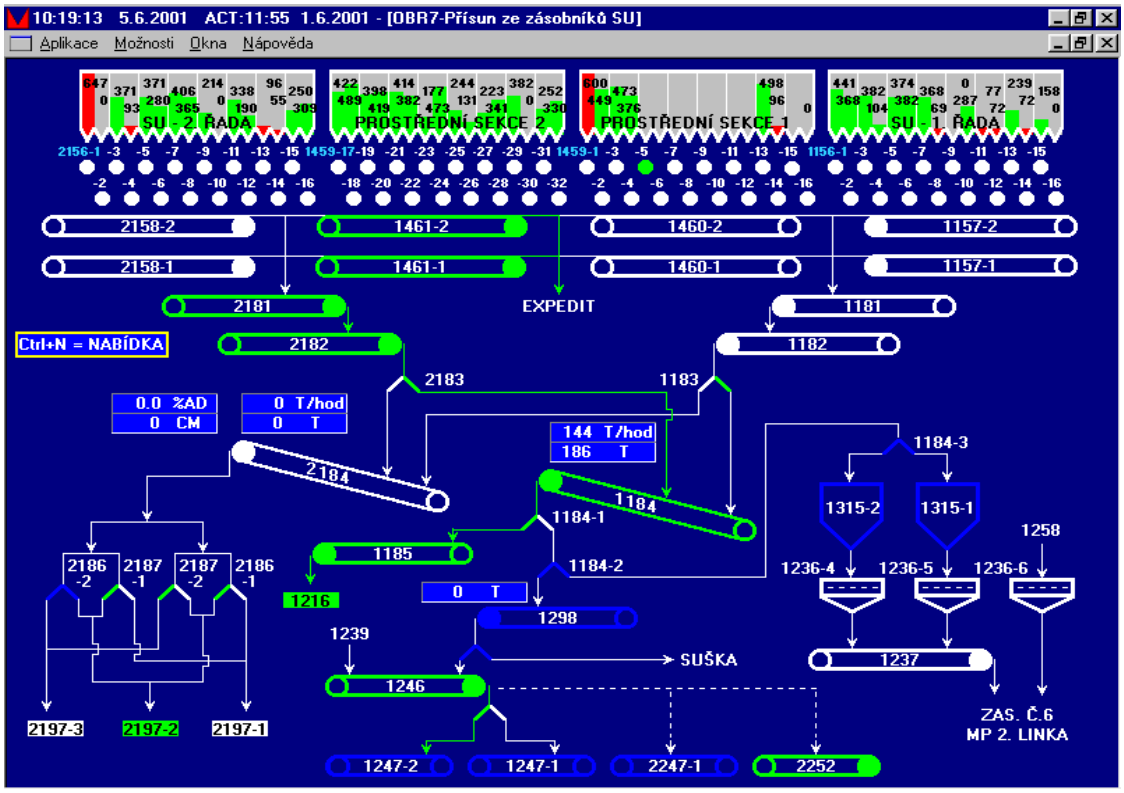


Fig. 13.4 Example of the SCADA system: visualization of technologies in coal preparation plant with SCADA system Promotic [Source: ATP Soukup s.r.o.]

Targets of SCADA systems:

- Visualization of technological processes
- Description of the controlled process
- Archiving of selected parameters of the controlled process
- Monitoring and archiving of alarms

- Reports on the progress of controlled processes
- Monitoring trends of selected parameters
- Viewing the process from the archive

Examples of SCADA systems: InTouch (Wonderware), Promotic (Microsys, Ostrava), IGSS, Web51,...

TASKS IN MANAGEMENT OF TECHNOLOGICAL PROCESSES

1. Optimization
2. Monitoring and checking of technological processes
    - Recording/Scanning values
    - Calculation of derived values
    - Checking exceeded limits
    - Displaying of operating variables
    - Historical data recording
3. Logical sequence control – PLC
4. Stabilization work mode – PID control
5. Advanced control methods - adaptive control, fuzzy control, export systems

14. INFORMATION SYSTEMS IN PUBLIC ADMINISTRATION

Information systems in the state and public administration, when compared to commercial sector, have two specifics:

a) Creation of information systems is influenced by the need to comply with valid legislation (the obligation to comply with all conditions of the applicable laws and regulations)
b) The influence of the political situation - after the change of leadership of government and public authorities may lead to a change of perspective on the strategy of IS / ICT

INFORMATION STRATEGY OF THE CZECH REPUBLIC

In 2000 Lisbon summit of the European Council approved a strategic objective to transform the European Union by 2010 into the most competitive and dynamic knowledge-based economy (i2010). This initiative has lead to the expansion of competitive digital economy. In 2001, the Czech Republic joined the Action Plan eEurope + 2003 and subsequently the i2010 initiative ("European Information Society for growth and employment").

Legislation of the Czech Republic concerning ICT:

- November 1996 the State Information System (ÚSIS) was founded, which took over the competences of the former Ministry of Economy in the field of the state information system.
- October 1998 –the Government Council for State Information Policy was created
- 2000 - Act No. 365/2000 on information systems of public administration came into force
- Telecommunications: 1 July 2000, Telecommunications Act No. 151/2000, Czech Telecommunication Office thus became an independent administrative authority in the scope of the Government of the Czech Republic (formerly fell under the Ministry of Economy and later under the Ministry of Transport and Communications)
- January 2003 - The Ministry of Informatics founded

THE MINISTRY OF INFORMATICS (2003-2007)

- Act No. 365/2000, The information systems of public administration,
- Act No. 127/2005, On Electronic Communications
- Law No. 29/2000, The Postal Services

- Act No. 227/2000, Electronic Signature
- Act No. 106/1999, On Free Access to Information
- Amendment on the 23rd March 2006 (passed the Directive of the European Parliament into the Czech legal system) - emphasizing the preference for electronic communications in office-work
- Act No. 127/2005, on Electronic Communications (transfers the regulatory framework of EU into the Czech law)
- Act No. 480/2004, about services of information providers - governs responsibilities, rights and obligations of persons providing information services and distribute commercial messages
- Document e-Česko (2006) - National Information and Communication Policy - strategic document of the Government in the development of the information society
- National Policy for High Speed Internet (2005)
- National Programme for Computer Literacy (NPPG, 2003)
- National Information Security Strategy (NSIS) - specifies the responsibility for information security

PROGRAM OF INTERNET LIBRARY (PIK)

The Czech Republic committed to promoting the use of information technology for the protection of cultural heritage and the collections in archives, libraries and museums.

PORTAL OF PUBLIC ADMINISTRATION

- Act No. 365/2000 On Information Systems of Public Administration As an Electronic Gateway to the Official Administrative Procedures
- http://www.portal.gov.cz

SYSTEM INTEGRATION

One of the problems sometimes encountered in the implementation of information technology and information systems, is the fragmentation of these systems. This can occur for many reasons - historical development, the absence of the concept of IT development, lack of finances or even erroneous decisions in building IT infrastructure. It is common that information systems are built gradually, by different suppliers. As a result, IT operates with low efficiency or with isolated systems, processing the same data. The same processes in different departments are handled by a variety of applications that had been developed independently.

For these reasons discipline has been established called "**system integration**". The word integration means interconnection. System integration's objective is to connect all components of IT / ICT to function as a single unit to be easily maintainable, extensible, and functioning in an optimal way.

For successful system integration, we must know the objectives to be achieved, and we know the resources we have available.

Today there are many companies in IT acting as "**system integrators**". If a company uses services of a systems integrator, it will expect a comprehensive solution. Mostly it is about the whole concept of building ICT, from hardware, infrastructure, network environment, the concept of IT security and application equipment (information system).

The objective of system integration is the union of all software components (subsystems) into one functioning unit that will work harmoniously and more effectively. Another objective is to map business processes and their coverage by applications, including the consolidation of applications (to ensure data sharing).

Objective of system integration is achieved when the individual systems mutually cooperate.

System integration, if well designed and implemented, often brings significant added value and reduction in operating costs.

The system integrator is a company that provides complete implementation of system integration for the customers. Usually on the basis of a contract the company is responsible for the complete integration and quality of software systems.

The integrator has to provide the following functions:

a) Ensuring the technical integration
b) Coordination of suppliers
c) Responsibility for the functionality of the IS / IT as a whole

EFFECTS AND RISKS OF SYSTEM INTEGRATION

System integration can deliver:

- Reducing overall response time on impulses from the environment
- Integration of corporate know-how
- Reducing errors and inconsistencies in information

On the other hand, system integration is connected with certain risks:

- Dependence on external suppliers of business
- Increased complexity of the system
- Demands on preparation of service providers
- Increased demands on users

The reasons for the introduction of outsourcing

- Economic benefits
- Personnel/Staff benefits / Savings in personnel
- Organisational benefits
- Benefits in administration
- Simplification of the company management

Levels of System Integration

1. Technology and data integration
2. Business process integration
3. Integration with enterprise environment (in IT)
4. Integration of vision and concepts (between company strategy and strategy of IT development)

Technological Integration

- **Data** - the creation of a unified company database which is shared by different applications and all users,
- **Hardware** - integration of individual hardware components into a single enterprise network
- **Software** - the interconnection of programs providing automation of various business activities (purchasing, production, sales, accounting, office work, etc.)
- **Integration of user interface** - to achieve a state where the various applications' principles of operation are standardized.

Data integration is often accomplished thanks to using **data warehouse**.

Application integration:

- EDI/EDIFACT– Electronic Data Interchange
- SOA – Service Oriented Architecture
- Web 2.0
- Mashup

BUSINESS PROCESS INTEGRATION

- Shortening of individual processes so as to ensure faster business response to external events (e.g. faster processing of incoming orders),
- Streamlining of processes to meet the required minimum corporate resources
- Optimization of processes to ensure the highest quality of product or service provided.

Business Process Integration is sometimes linked to Business Process Reengineering (BPR) – review and optimization of business processes.

Project and Process

PROJECT

- Specific sequence of actions leading to a goal
- One-off;
- Characterized by plan

PROCESS

- Specific sequence of actions designed to perform certain work;
- Repeatability;
- Characterized by a description of the course

Project management – a tool for the implementation of changes, leadership and project management.

Process management - focused on effectiveness and efficiency of repeatable processes.

MANAGEMENT OF CORPORATE ICT

Methodology and standards:

- ITIL
- CoBit
- ISO 20000
- ISO 9000 – quality management

ITIL (IT Infrastructure Library) is a set of books describing the way ICT service management (ITSM) and ICT infrastructure work. The IT service management uses a process-oriented approach - each activity in the process must deliver added value for the users. ITIL is based on best practices.

Top benefits of ITIL implementation by consulting firms:

• Savings in operating costs of IT services

• Improved quality and reliability of IT services (satisfied customers)

• Better use of ICT resources

• Fewer outages ICT systems

• Improved level of communication between IT and the customers / users.

ITIL objective is to ensure the availability, reliability and security of IS / IT.

COBIT (Control Objectives for Information and related Technology) have been developed as a generally accepted standard for good practices in management, control and audit of information technology.

COBIT puts into context:

- IT processes
- IT resources
- Information criteria

Basic IT processes are:

- Planning and organization
- Acquisition and Implementation
- Provision and Support
- Monitoring

IT resources according to COBIT:

- Applications
- Information
- Infrastructure
- Human Resources

Criteria for information according to COBIT are:

- Effectiveness
- Economy
- Credibility
- Integrity
- Availability
- Coincidence / Compliance
- Reliability

INTEGRATION WITH ENTERPRISE ENVIRONMENT

- *Optimally adapting company's conduct to suit the changing state of economic environment (or initiating changes that will be beneficial for the company)*
- Establishing close relations with major external partners (customers, suppliers, banks, information services),
- Using Internet to distribute and obtain information relevant to business management

INTEGRATION OF VISION AND CONCEPTS

- How to use IT to support the competitiveness of the company
- Which business processes to be supported or prioritized by the company's IT
- What effects from the implementation of new IS / IT project can be expected
- What are the priorities of these effects
- Who will be responsible for achieving individual goals
- What corporate resources will be spent on the development of IS / IT.

OUTSOURCING AND CLOUD COMPUTING

- **ASP (Application Service Provider)** - outsourced is an application that is running on the provider's hardware usually by using Internet links. The application is provided to a single company (Single Tenant Legacy Software).
- **SaaS (Software as a Service)** - the same as in ASP, with the difference that the application is offered as a service, it can benefit multiple companies simultaneously
- **Cloud computing** - the tenants are given the environment in which they can develop and implement their solutions, the provider supplies and looks after hardware, security, maintenance and updates (operating system, database, etc.). An example is the Windows Azure platform from Microsoft.

Outsourcing:

- Complete outsourcing
- Outsourcing of specific services
- HR outsourcing

Information Systems

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