

KAPITEL 4 / CHAPTER 4<sup>4</sup>

## BASIS FOR INNOVATION IN THE COMPUTERIZATION OF SOCIETY

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## Introduction

In this chapter, the authors have tried, in the context of the high rate of innovation in the computerization of society, to highlight the immutable in their view basic concepts and their definitions, which make it possible to understand the essence of the ongoing transformations. As Confucius said, "the right name is the right understanding". The paper considers the main stages and levels of the implementation of enterprise automation systems and components of their structures. A formula for describing the concept of "CS architecture" is proposed, a generalised structure of a WEB-system and its safe implementation is given [1, 2, 5].

We live in that wonderful time when the half-life of knowledge is 1 to 2 years. At the same time, not only the names of the specialties are changing, but new ones are appearing as well.

For example, the specialties of our department in these years 1964 – 2015 have been transformed during its existence as follows:

- Calculation and resolution instruments and devices
- Electronic computing machines - Intelligent computer systems and networks -

Computer systems and networks

- Computer engineering
- What's next?

What do our basic terms mean - Machine? System? Complex?

### 4.1. Machine? Computer System( CS)? Computer Complex (CC)?

Consider the hierarchy of concepts (Figure 1).

**A computer (machine, computer) is a generalised concept corresponding to a Program-Controlled Device that processes digital information represented in binary notation.** Used in the home, in conversation without specifying its technical specifications. Technically,  $A\ computer = PCD + 2n$ .

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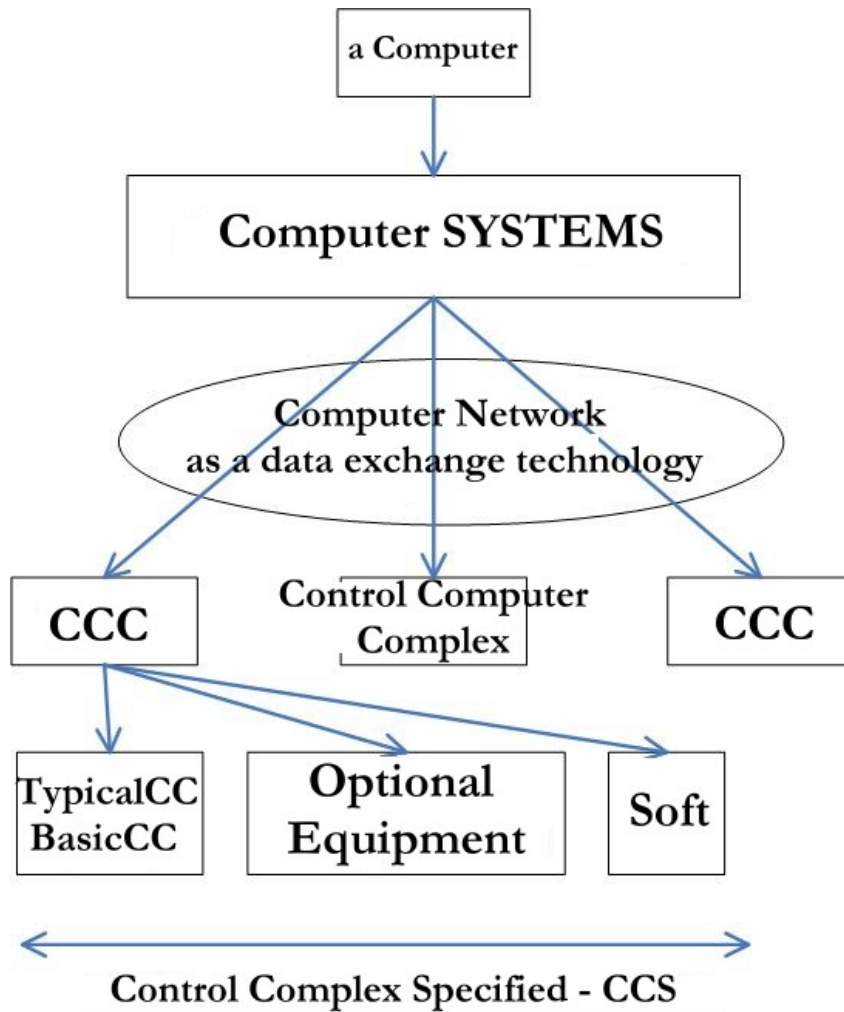


Figure 1 - Hierarchy of key concepts

**SYSTEM (computer system (CS), information system (IS), intelligent information system (I2S) is the result of selection or design where the requirements for the characteristics of the system to perform certain tasks are defined.**

That is, the required processor clock speed, number of processors, amount of RAM and external memory, video boards, signal input/output modules.

Modern constructive definition according to ISO IEC 15288-2005: a system is a combination of interacting elements organised to achieve one or more set objectives.

What are these elements?

A CS can be made (assembled) in-house from one or more Control Computer Complexes (CCCs). In other words, the CS is broken down into a number of CCCs when designing the CS.

*A CCC is a unit of production of the manufacturer (supplier) of the CS for an object of automation.*



The CCC consists of a TYPICAL (BASIC) CCC, or TCC, or BCC. There can be up to some variants of such TCCs. For example, TCC for office, for gamer, for student (budget variant), for servers, etc. Customer can supplement the basic configuration with modules and devices, as well as with software in accordance with SPECIFICATION. The resulting CCCs are called SPECIFIED COMPLEXS (CCS)

All CCSs are combined into a system by means of an information network. In this case, *NETWORK is the technology for organising data exchange between CCSs in the CS.* This is the definition of NETWORK in the LEAST sense of the word.

Network is an integral part of the CS and should be designed when designing the SYSTEM! A special place among modern systems is occupied by WEB-systems.

#### 4.2. WEB-systems

In order to define a WEB system, it is necessary to know what the INTERNET and the WWW, or WEB, are.

INTERNET is a set of *geographically distributed CSs* and networks interacting with each other based on a standard protocol stack based on *the Open Systems Interconnection (OSI) model* through *data transmission channels to share information, software and technical resources* of the network.

In fact, the *INTERNET is an infrastructure* for hosting and transmitting the above resources.

And the WEB (WWW) - is a *network of interconnected information resources in the INTERNET by means of URL - Uniform Resource Locator - a uniform locator (method locator) of resources* (Figures 2,3).

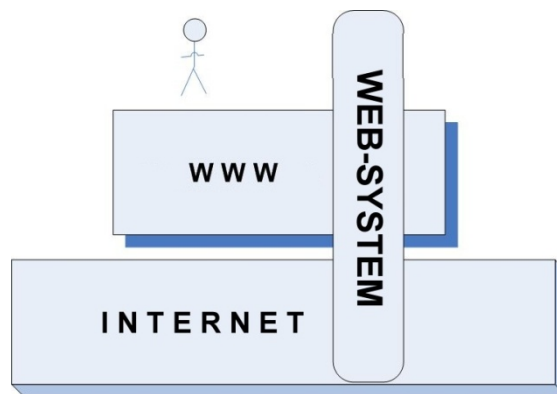
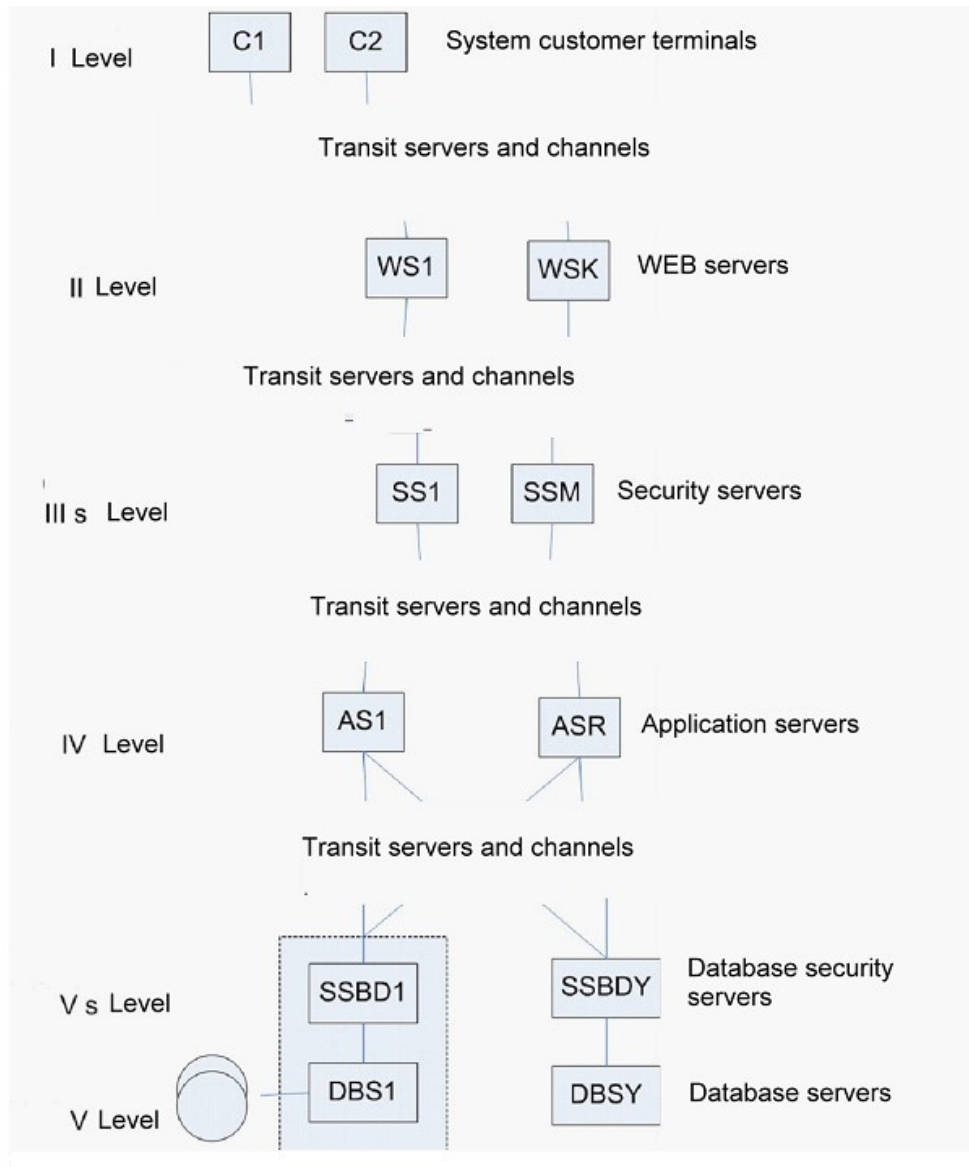


Figure 2 – General structure of the WEB system



**Figure 3 – An example of a complex distributed secure WEB system [5]**

### 4.3. CS architectures and structures

An important characteristic of CS is ARCHITECTURE (ACS).

It can formally be represented as the following formula

$$ACS = Goals \cap (\delta \text{ types of Ware}) = Goals \cap (HardWare + SoftWare + MathWare + InfoWare + LingvoWare + OrgWare + MetWare + MetroWare)$$

This formula uses well-known components or terms. Let us briefly note their purpose:



- HW - complex of technical means; The HW is a set of technical means for data entry, processing, storage, display, output and transmission, switching and routing. Sometimes referred to as information infrastructure.

- MathW - a set of mathematical models, methods and algorithms for problem solving.

- SoftWare is a set of system and application programs (operating systems, compilers and interpreters of programming languages, program editors and debuggers, libraries of subprograms and functions, application software packages, etc.).

- Info Ware - a set of methods and tools that regulate the interaction of employees with technical means and among themselves during the development and operation of the information system.

- LingvoW is a set of linguistic tools that ensure the adequate functioning of language in the CS in a particular sphere.

- OrgW - a set of methods and means that regulate the interaction of workers with technical means and among themselves during the development and operation of an CS (organisational structure).

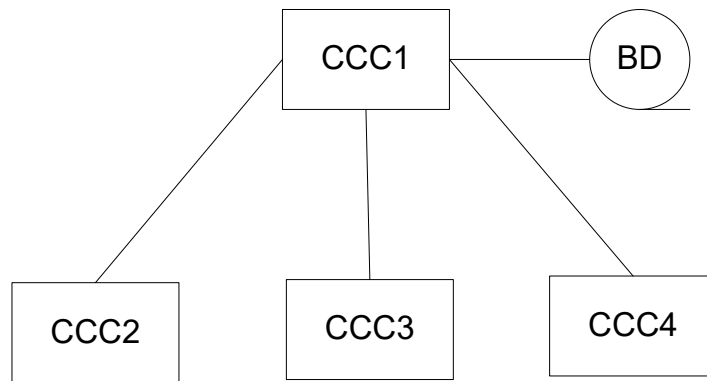
- MetWare - A set of all the tools needed to provide effective training for staff. This is usually a set of documentation and videos.

-MetroWare - approval and application of metrological norms, rules and procedures for measurement performance (MMP), as well as development, manufacture and application of technical means to ensure the uniformity and required accuracy of measurements.

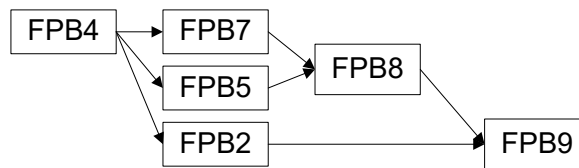
The development of the CS is accompanied by a change in system requirements and some concepts, which is referred to as the development of a PARADigm in computerization.

One of the characteristics of ware types is structure. *Structure is a set of elements of any nature and the links between them.*

The technical structure of a computer system consists of CCC and channels of inter-unit machine links (Figures 4,5).



**Figure 4 - Technical structure of the CS**



**Figure 5 - Functional and programmatic structure of the CS (piece of  $\varphi$ -transaction [3])**

a shows the structure of a computer system from a real project.

The structure of a  $\varphi$  -transaction consists of a sequence of FPB and links between them. The information support structure consists of database arrays and information flow links. There can be combined types of structures e.g. software and hardware structures.

#### 4.4. Stages in the formation of the hierarchy of automated systems enterprises

Having dealt with the problems of automation of various enterprises for more than 40 years and having analyzed stages and perfection of computer systems in enterprises the authors propose a generalized structural scheme of various enterprise automation structures (Figure 6).

1. Older control systems (SC)

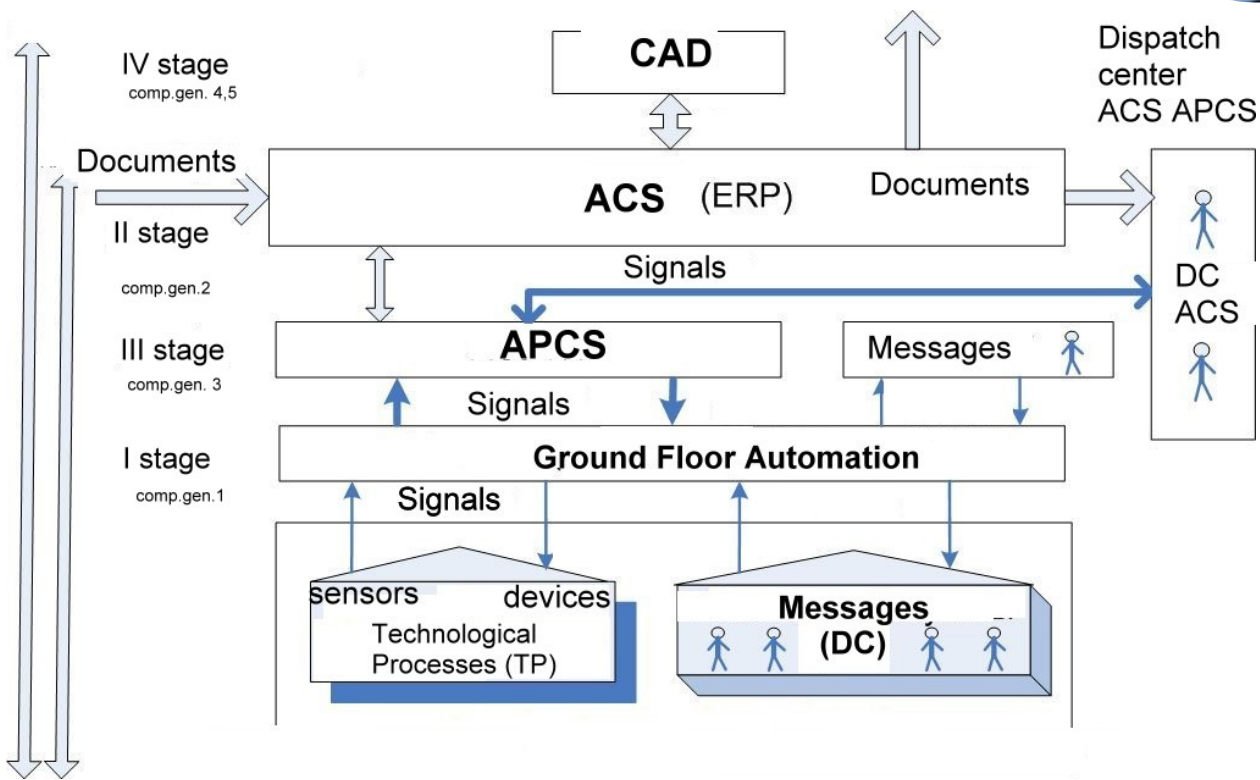
$$SC = TP + GFA + \text{Control Desk}$$

2. First generation. Enterprise Control Systems (ECS)

$$ECS = SC + ACS$$

3. Second generation - Integrated Plant Management System (IPMS)

$$IPMS = ACS + APCS + SC + DC$$



**Figure 6 - Levels and stages of implementation CS for integrated automation enterprises [3]**

4. Third generation - Flexible Automated Production (FAP)

FAP = IPMS + CAD

CAD - Computer Aided Design System

ERP (Enterprise Resource Planning, European standard) is an organisational strategy for integrating production and labour management, financial management and asset management operations.

**4.5. The Paradigm of computerization**

Innovation in computerisation in industry and transport leads to a change in terminology and rules for the implementation and use of new computer systems. Innovation on a global scale can be represented by the shifting paradigms of computerisation described in the table. It presents the main user requirements for new systems as a hierarchy of characteristics of performance, interface, user access to data. The top positions in the table correspond to higher priorities. each paradigm is associated with a change in the naming of systems. The table shows the variations of



these names. In fact, there are no clear boundaries between when paradigms change completely, they go away gradually with new generations of computer system users and developers (table 1).

(Paradigm - (from Greek "example, model, pattern") - a set of fundamental scientific attitudes, ideas and terms accepted and shared by the scientific community and uniting the majority of its members. It ensures the continuity of the development of science and scientific creativity).

**Table 1 - Innovation in light of the paradigm of computerisation**

<b>Computerization Paradigm</b>			
<b>Computers (CS)&gt;&gt;</b>	<b>Information Systems (IS)&gt;&gt;</b>	<b>Intellectual Systems (IntS)&gt;&gt;</b>	<b>Socio-Technical Systems (STS)</b>
performance	access to data here and now	intelligent interface	social networks, access to data «here and now», IoT
interface	interface	access to data «here and now»	intelligent interface
access to data	performance	performance	performance
1944 - 2000	2000 - 2010	1991 - now	2000 - now

In addition to the requirements for the three main characteristics, the paradigm also includes the dominant types of computer system support.

**Conclusions**

This work proposes a systematic and historical approach to the analysis of the state and prospects of innovation in the field of computerization. The work is based on the clarification of names and definitions of basic terms. Examples are given of the improvement of structural schemes and functions of computer systems for various purposes. The characteristics of shifting computerization paradigms are described. The paper can be useful for engineers and students in computer science and engineering.