Logic model in a problem of designing of distributed information systems

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Abstract

The paper examines a problem of construction of logic model of information networks (IN). The model is aimed at creating non-homogeneous enterprise-wide networks easily and effectively.

Two approach to building such models are examined. Shorts of these approaches are noted and compromise adaptive technique of synthesis of IN is proposed. Necessity of adequate model for this technique is concluded and a new logic model of IN is proposed.

The logic model comprises compositional model and model of structure. Compositional model is defined as decomposition of Information System object. Substantiation of such decomposition has been proposed. According to decomposition five basic object classes are defined.

Model of structure defines four layers of interoperations among IN stations and three basic types of object's relationships.

Two stages technique of model analysis is proposed. The first stage is reflexing user's layer of abstraction and based on analysis of system's goal. Decomposition of the global system's goal is perfomed and finished by reaching of layer of some elementary goals that can be achieved by using ordinary services.

On the second stage IN is examined at system layer of abstraction. A possibility of data communication among servers and clients is analyzed. This analisis is founded on basic relationships among objects.

The offered model, having small dimension and sufficient completeness, can form the basis for development of practically aplicable techniques of building of heterogeneous information networks.

1 Introduction

It is an obvious fact that today modern information technologies are widely used in various fields of human activity. One of the benefit in applying of IT is a possibility to cooperate data, experts's knowlege and efforts (Kotomin & Putilov 1994). This causes growing actuality of the problem of designing distributed information systems (DIS) aimed to make this cooperation easy and effective.

The report (Structural-algorythmic... 1995) presented the techniques of synthesis the DIS, based on hierarchical model of system. The basic idea of the considered techniques consists of synthesis "from below – upwards", that is elementary components of the system are realized, then they are combined into a complete unit. The idea is quite simple. However, when constructing the systems connected to computer facilities, realization of the formal apparatus is always bounded up with restrictions of opportunities of particular software and hardware means (computers, communication facilities, software). There is a contradiction that is caused by the condition that the developed theoretical methods are inapplicable to real objects.

There are two obvious ways to settle this contradiction. The first is to develop formal models with primary binding to particular facilities. The second is to create new soft- and hardware that are appropriate to developed formal model.

Both approaches, however, have serious drawbacks. Development of a formal model is time consuming. And when the formal model of the chosen facilities are developed these facilities can become outdated. The second approach is inefficient because of large financial expenses and produces potentially unique hard/software.

2 Adaptive synthesis

A method of adaptive synthesis, stated in the report (1995), can be used as a compromise approach. The idea of the method consists of subsequent application of the two named approaches under condition of their priorities. First, there is made an attempt to determine facilities that are appropriate to the considered objects of formal model taking into account the imposed restrictions. If the given operation fails either designing of new facilities that are appropriate to the model is done or the formal model is corrected. The algorithm of the method is shown in Figure 1.

As mentioned above, the priority in the considered approach to design DIS is given up to use typical (marketed) facilities. One of the most important steps in the considered algorithm is to make a choice of facilities that correspond to the model's objects. To make this choice it is necessary to have the formal model of the system's structure that reflects basic functional blocks and modules of marketed information tools and the networking hard/software. Such a model has to define the main classes of objects and relations among them and has to be simple, low-dimension and flexible to cor-

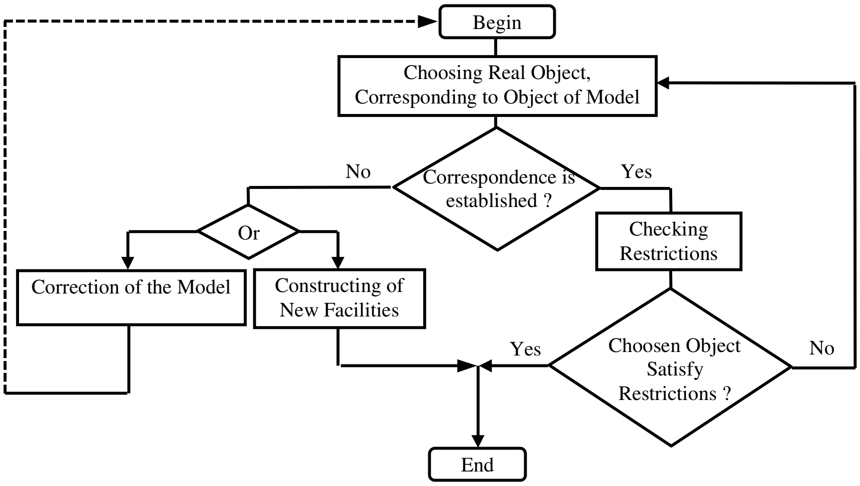

Fig.1.Algorithm of the adaptive synthesis.

respond to as many real objects as possible.

Architecture of information systems is traditionally analyzed using an OSI model defining seven classes of objects and interactions among them. But in case of the problem of choice of marketed facilities this model is not so useful. For example, we can't find any realization of a presentation level protocol and even a transport level protocol that are marketed as standalone facilities. So we have to define a new, more common, model that reflects "reality of the IS market".

3 Results

The following model of DIS based on the comparison of different marketed information tools and networking hard/software and engineering practice is proposed.

The model of the system's structure is based on the decomposition of the global object, namely Distributed Information System that is shown in Figure 2.

The first step of the decomposition is dividing the system into the two subsystems. These are Transport subsystem (TS) and Information processing/presenting subsystem (IPS). The reason of this division is that the principles and techniques of realisation and the aims of the objects of lower four(five) and of the rest of the levels of the OSI model are quite different.

Other steps of the decomposition are made according to the following reasons:

1. By defining the main utilized information resourses we can divide all objects of IPS into two classes: Services that realise these resourses and make them available for using and Clients that

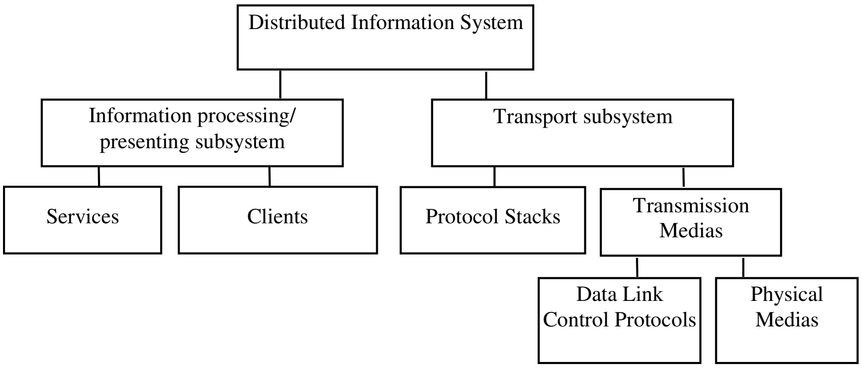

Fig. 2. Decomposition of the system's structure.

utilize these resources generating corresponding resourse requests. Subsequent decomposition is not useful because marketed realisations of the considered objects appears as integral facilities and usually we can't choose different separate parts of such servers and clients. For example, if we decide to use NetWare™ file service we can't choose any presentation layer protocol other than NCP (NetWare Core Protocol).

2. The minimal set of components that is necessary to make the information transmission possible is an exchange rules set (Data transmission protocol) and Transmission media. We shall notice, that the same Data transmission protocol can function on different Transmission medias. Subsequent decomposition is unuseful due to the reasons mentioned above - Data transmission protocols appear as integral protocol stacks. For example, TCP protocol realises most of transport layer functions and is hard binded to the appropriate network layer protocol -IP. The only thing that can be changed there is some auxilary protocols such as routing protocols. It is proposed to take into account possibilities of using different auxilary protocols by stating them as object's attributes.
3. Transmission media is formed by Data Link Control protocols and Physical media. Besides we can, for example, make Ethernet to run on a coaxial or twisted pair cable.

Considired decomposition gives a model of system's structure that defines five classess of objects. There is some kind of puzzles and the next task is to connect items in the right order. Now the designer has to choose appropriate real objects of these classes and to combine them into the whole system. To perform this task we have to define relations among the objects.

The following Figure 3 illustrates the four level model of relations among the system's objects.

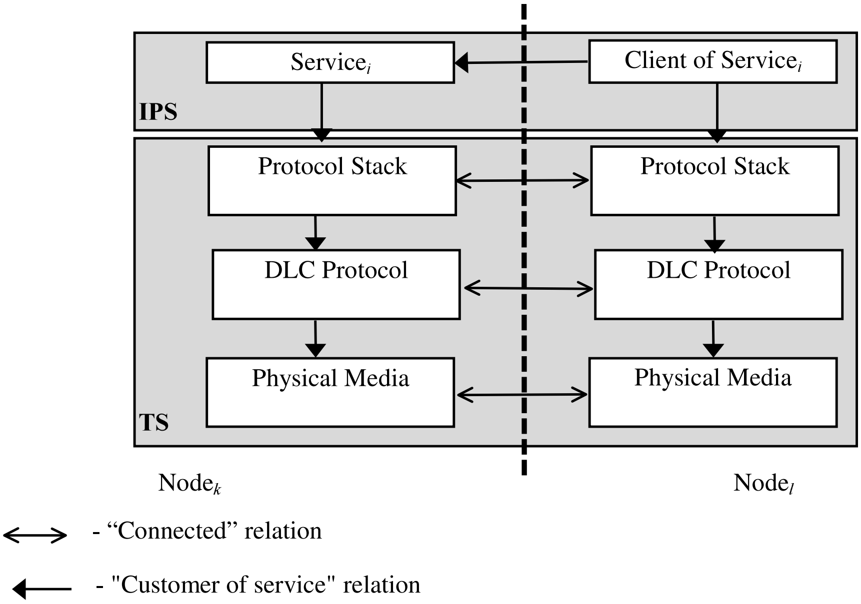

Fig. 3. Model of object’s relations.

This model defines three types of binary relations among the objects. They are:

1) Symmetric transitive “Connected” relation;
2) Antisymmetric “Customer of service” relation (or revers to it “Service provider” relation);
3) Relation of equivalence.

“Customer of service” relation defines the role which the given object plays in information exchange.

The relation of equivalence binds the objects with identical functionality. For example, different realisations of the same protocol stack.

The “Connected” relation is necessary for data communications between a pair of objects. This relation can bind the objects as placed in the same network node, as in physically different nodes.

Here comes the definition of three basic situations when a pair of objects is connected.

a) Within the given network node a pair of objects is connected if one of them is a customer of service provided by the other.
b) Within the given network node a pair of objects is connected if the objects are of the same class and retranslation of data among them is perfomed.
c) The objects are placed on different nodes, both of them are of a DLC (Data Link Control) class and both are connected to the same transmission media.

Other situations when objects are connected are determined by three listed bases. To define such situations let us introduce the following notions.

O_{ij} - object of *i* class, where *j* is an unique identifier of the object within the given class;

$\Leftrightarrow$ - relation of equivalence;
$\leftrightarrow$ - "Connected" relation.

Following Boolean functions define this relations on objects plurality

$$Fe(O_{ik}, O_{il}) = \begin{cases} 1, \text{ if } O_{ik} \Leftrightarrow O_{il}; \\ 0, \text{ else}; \end{cases}$$

$$Fc(O_{ik}, O_{jl}) = \begin{cases} 1, \text{ if } O_{ik} \leftrightarrow O_{jl}; \\ 0, \text{ else}; \end{cases}$$

Using the introduced notions we can write Boolean function determining the "Connected" relation among the objects of *i* class numbered *k*, *l* as follows

$$Fc'(O_{ik}, O_{il}) = Fe(O_{ik}, O_{il}) \wedge Fc(O_{ik}, O_{i-1m}) \wedge Fc(O_{il}, O_{i-1n}) \wedge Fc(O_{i-1m}, O_{i-1n}),\ i \geq 2.$$

4 Conclusions

In conclusion a few words about the initial stages in constructing DIS models. To reduce dimension of the model and at the same time to save its completeness it is proposed to use functional-goal approach (Ignatiev et al. 1986). This approach is based on decomposition of the system's global goal. The decomposition is finished when the layer of some elementary goals (tasks) is reached. In our case these tasks must be performed by appropriate information network services. Thus, the obtained model will potentially correspond to the goals of the designed system.

The offered model of DIS, having small dimension and sufficient completeness, can form the basis for development of practically applicable techniques of synthesis for distributed information systems.

References

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