Intelligent Modeling of Unified Communications Systems Using Artificial Neural Networks

Oleksii Ivanov [1[0000-0001-6119-4134]], Liudmyla Koretska [2[0000-0002-4284-4936]] and Volodymyr Lytvynenko [3[0000-0002-1536-5542]]

[1, 2] Khmelnytskyi National University, Khmelnytskyi, Ukraine
[3] Kherson National Technical University, Kherson, Ukraine
1ivanovov@ukrtelecom.ua
[2] sorokinaluda2908@gmail.com
[3] immun56@gmail.com

Abstract. A Unified Communications System (UCS) is defined by a process that combines all means of communication into a universal communication system that enables reliable connection of the system's users at any time and place to exchange information. The purpose of the UCS is to simplify business processes by facilitating communication between people. A characteristic feature of the UCS is its ability to allow two or more users to use several ways to communicate and transmit information. Unified service enables every employee to perform their duties better and faster, and companies - to change their business processes, making them more efficient and optimized to meet customer expectations and market demands. This increases the efficiency of the business processes of a company of any size and at the same time reduces the total cost of owning a communication infrastructure, which gives the enterprise an additional advantage over its competitors. The proposed model of the mechanism of optimization of the information exchange methods for UCS provides the implementation of the selection mechanism of the optimal IEM for specific subscribers in a certain time period given the real distribution of methods of information exchange between specific subscribers. This will minimize unproductive waste of working time and significantly increase the ergonomics of the technological process. The model and algorithm for implementing the above mechanism form the basis of developing an intelligent decision support system for defining telecommunication service delivery strategies.

Keywords: Unified Communications System (UCS), Unified Service, Mechanism of Optimization of the Information Exchange Methods., Artificial Neural Network, Decision Support System (DSS), Information Exchange Methods (IEM).

1 Introduction

To date, unified communications are represented by hardware and software products based on the following major components [1-4]:

- IP-telephony - integrated solutions allow to set up a modern telephone network, spanning from multiple subscribers within a small enterprise (SOHO) or remote office to up to several hundred thousand subscribers in a distributed network of a large corporation.
- Call Center - a hardware and software complex designed to automate and improve the efficiency of processing a large number of calls coming from customers, partners, and others, whether by phone, e-mail or company website.
- Video conferencing - a way of interaction that enables effective communication between the central office and regional units, in the media, for setting up distance learning, etc.
- Teamwork tools - multimedia conferences, conference calls, situation centers, etc. They constitute a single system of setting up and running audio, video and web conferences that use a web browser to collaborate on documents (in particular, in the case of distance learning, slideshows, presentations and sharing other educational materials), editing files, text chat, whiteboarding, etc.
- Unified messaging system - includes the function of voice messaging (voicemail), listening to your e-mail on your phone, ability to check voicemail via the Internet, send, receive and forward fax documents.
- Mobility - allows you to use a single phone number, providing call routing to the device, which makes it most convenient for the user to talk at any time - using an office, home or mobile phone. Combined GSM / Wi-Fi phone devices allow employees to stay connected both in the office premises and wherever mobile coverage is available, providing switching between networks.
- Presence control - a service that uses dynamic location information and allows users to check their colleagues' availability in real time and connect with them quickly with the most convenient means of communication at the moment.

The evolution of unified communications is represented on Fig. 1 [3].

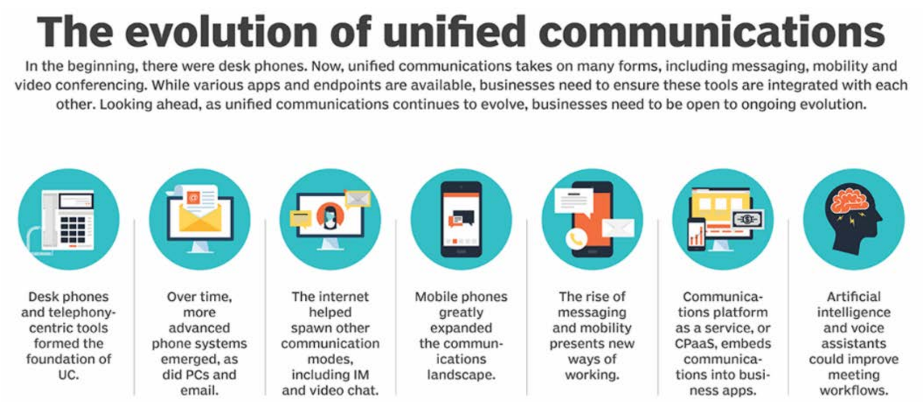

Fig. 1. Evolution of unified communications [3]

To date, the design and realization of the intelligent decision support system for defining telecommunication service delivery strategies is the actual task for Ukraine.

2 Literature Review

Let's analyze the literature in search of known models, methods, tools for defining telecommunication service delivery strategies.

In telecommunications, complex service systems rapidly develop. Their aim is producing ICT services. Increased complexity is based on the convergence of industry information technologies, telecommunications and media. Operators of the telecommunication network can modify their business strategies: they can no longer produce ICT services in a vertically integrated way but must sell previous services as providers to other ICT service providers. Modular service concepts, which are known from Service Science and IP research, can be used for this task. ICT service modules, called Enabling Services, are provided on Service Delivery Platforms to support service development [5].

Businesses are increasingly turning to operators as a single mechanism for networking solutions that go beyond simple communication from basic Internet and telephone lines to cloud computing and more sophisticated networking features that may be traditionally provided by IT professionals or system integration providers. With the growing emphasis on new trends that consume data in the enterprise space, such as M2M, IoT and cloud services, face the challenge of not only managing the delivery of a new era of services but also creating new and innovative solutions capable of long-term connectivity and 100% customer reliability [6].

Five strategies to improve customer experience in telecoms: employing omnichannel support, implementing a customer-centric culture, deploying AI-based digital tools, investing in visual engagement, going back to basics with the human touch. IDC estimates that 75% of enterprise applications will use AI services by 2021 [7].

In [8] there is a strategy implemented by implementing actions aimed at maintaining product quality to satisfy consumers, by developing innovative and diversified products, as well as package offers, simplified tariffs and transparency bills, implementing international relations, mainly in Latin America (Brazil and Argentina). Adopting such a strategy required the operator to redesign the corporate organization, making it more subtle and flexible, horizontally developing teamwork, dialogue and successful interaction between management and operational staff to speed up the decision-making process.

The traditional organizational structure of telecommunications companies is often ill-equipped to overcome the significant challenges – such as the complexity of the systems concerned and the associated cost pressures – posed by this changing environment. Telecommunications companies can increase the efficiency of their operations and better synchronize the elements of the technological system with the help of artificial intelligence components. The technological and organizational capabilities of AI components allow telecommunications companies to build a strong foundation, which allows them to offer enhanced innovation and enhanced customer experience, which is now required by a new breed of consumers [9].

So, to date using of AI components for the UCS is *an actual task*. Let's analyze the literature in search of using of AI components for communications systems.

The paper [10] is a study of the application of Artificial Neural Networks for problem-solving and optimizing the performance in different communication systems. Artificial neural networks are being used for spectrum sensing, pattern recognition and many applications in wireless communication.

A number of current applications of neural networks to telecommunications are summarized in [11] and some relevant topics for future research in this field provide.

In [12] a brief overview of signal recognition approaches is presented - classical methods, new machine learning and deep learning schemes expand from modulation recognition to wireless technology recognition with the continuous development of wireless communication system.

In [13], for the first time in the field of optical camera communication systems, an equalizer based on an artificial neural network (ANN) is used using an adaptive algorithm to increase the data rate.

In the paper [14] the review of the use of machine learning in various spheres of communications is given and two examples of application in wireless networks are considered.

In [15] there is an approach of using ANN for predicting the quality of software system for accounting and billing of the provision of services for access to the Internet. In [16, 17] there is an approach of using ontologies for evaluating the sufficiency of information in specifications of requirements of software system for accounting and billing of the provision of services for access to the Internet.

So, the known models, methods, tools for defining telecommunication service delivery strategies don't solve the task of developing an intelligent decision support system for defining telecommunication service delivery strategies. *The aim of this research* is of developing an intelligent decision support system for defining telecommunication service delivery strategies.

3 A Decision Support System Based on Using the Most Convenient IEM in a Certain Amount of Time

A characteristic feature of a modern UCS is the ability to use several methods of establishing communication and transmitting information between clients, regardless of their location and the type of equipment used. This can be a combination of a landline or cellphone, software on a smartphone or desktop computer, voice and email, fax and instant messaging, multimedia conferencing, and more.

One way of utilising this capability of UCS is to use a system that would, at some point in time, determine the optimal way for information exchange for a pair (or a group) of subscribers. For example, when users are participating in a video or audio conference, incoming phone calls are not desirable, and in some situations are not allowed. The same applies to a lunch break when an employee is not sufficiently focused on the production process. Such a system should include an individual work schedule of each user, based on which the selection of the optimal type of communication for the information exchange between certain users at a certain time would take place.

Fig. 2 presents a schematic model that includes a mechanism to optimize the use of information exchange methods (IEM) as the main component of this structure. Although this model is assumed to be scalable, certain limitation is required for the operation of the optimization mechanism. This limitation can be considered as a constant value, for example, during the learning of the neural network (T_l).

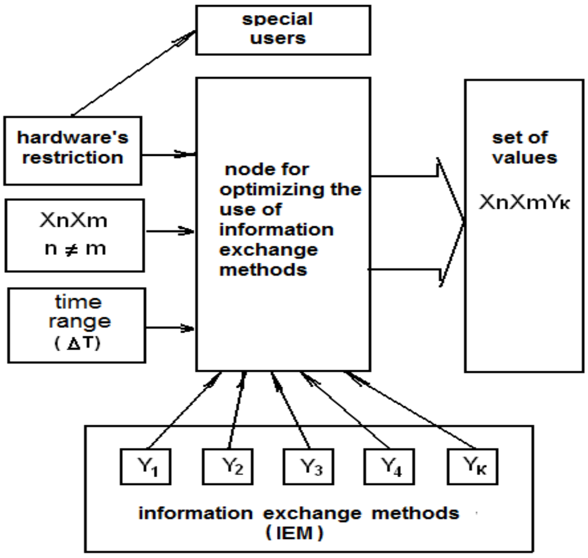

Fig. 2. Schematic model of the mechanism of optimization of the information exchange methods

The model also defines the concept of "special users". These may be subscribers with a distinct work schedule (general manager, internal security service, etc.). The "*XnXm*" block determines the input vector for the optimization unit to function and, together with the values of Y, generates a set of combinations of specific users and corresponding AEs. The product of *Xn Xm Yk* is the output value and characterizes a specific SIO for a given pair of subscribers at a particular moment in time.

4 Artificial Neural Network as "robot-assistant"

The task of finding the optimum method of information exchange is complex and difficult to formalize, since the configuration of information exchange is usually hard to predict and describe by the known mathematical methods used in telecommunications (Teletraffic Theory, Mass Service Systems (MSS), Markov Models, etc.).

The author proposes to solve this problem with artificial neural networks (ANN). Fig. 3 presents a schematic simplified structure of a neural network

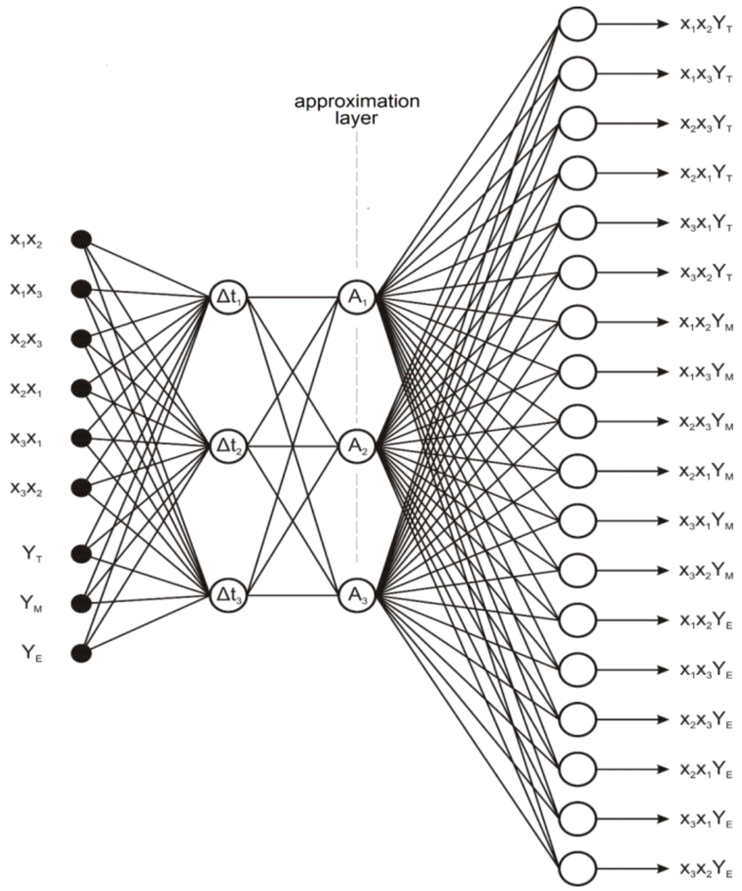

Fig. 3. ANN Structure

Fig. 3 shows the structure of a neural network for three subscribers $X = \{ X_1, X_2, X_3 \}$ and three time intervals $T = \{ \Delta t_1, \Delta t_2, \Delta t_3 \}$, where: Δt_1 – 9.00-11.00; Δt_2 – 11.00-15.00; Δt_3 – 15.00-18.00.

The architecture of the developed ANN corresponds to a rectilinear multilayer perceptron. The input layer of the ANN reflects the set IEM noted above when considering the structural scheme for optimizing the provision of telecommunications services. There are two hidden layers of neurons in ANN: $T = \{ \Delta t_1, \Delta t_2, \Delta t_3 \}$ and $A = \{ A_1, A_2, A_3 \}$.

The first one shows time intervals of a certain length and the second one is approximate and is intended to approximate a function. In general, both hidden layers can be considered as one approximation. In this case, the accuracy of the approximation increases due to the increase in the number of neurons in the hidden layer.

Functionality of the output layer of ANN corresponds to the choice of the optimal way of information exchange at a certain period of working time.

For the activation of neurons in the multilayer perceptron, we adopt sigmoid and jump functions, which are most suitable for the ANN of this type.

ANN is trained via the widely described in the literature algorithms of perceptron training using the error correction learning rule. *Algorithm learning and functioning of the network* constitutes in the following:

- A1.1. Assign values to weight coefficients W randomly or following the inputs from the experts.
- A1.2. Enter the input vector corresponding to the sets X X ,Y .
- A1.3. Enter the values of the X ,X ,Y outputs of the training sample of the untrained network.
- A1.4. Enter the number of iterations for the ANN training.
- A1.5. Set the learning speed .
- A1.6. Obtain weight coefficients .
- A1.7. Introduce an input vector for the operation of the ANN and obtaining the functionals.
- A1.8. End of algorithm.

5 Conclusions

The proposed model of the mechanism of optimization of the information exchange methods for UCS provides the implementation of the selection mechanism of the optimal IEM for specific subscribers in a certain time period given the real distribution of methods of information exchange between specific subscribers. This will minimize unproductive waste of working time and significantly increase the ergonomics of the technological process. The model and algorithm for implementing the above mechanism form the basis of developing an intelligent decision support system for defining telecommunication service delivery strategies.

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