Review of Decentralized Communications Technologies

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Abstract: The study represents the necessity of the decentralization in communications for ensuring high quality communications that are starting to use the broadband networks rather than Public Switched Telephone Network (PSTN). Further, the main modern technologies and solutions that can be used for such communications' implementation are considered. Skype and P2PSIP are the examples of such solutions. On the basis of these technologies, the conclusion that there are two main types of the decentralized architectures is drawn: peer network (full decentralization) and hybrid hierarchical network. Hereafter, the choice for hybrid hierarchical network, on the basis of comparison of these architectures by quality criteria and simplicity of development and support was made. This scheme has lesser "survivability" but it has lesser variability in a way that facilitates software development.

Key words: P2P, VoIP, Skype, internet communication, quality of communication

INTRODUCTION

Initially communication services were provided by the Public Switched Telephone Network (PSTN), intended directly for voice information's transmission. However with development of the broadband data transmission (BBA) for communication services' provision, the internet channels which continuously grow though at slow rates, started being used. So, according to Gartner at 2014 year end the VoIP market rose only to 1.3% for 2014. This is due the fact that market is rather big (the total volume for 2014 is estimated at 1.655 trillion dollars). Transition to use of uniform data transmission channel leads to the fact that quality of rendering of services starts influencing as characteristics which belong directly to communication and characteristics which belong to data transmission.

When performing communications it is necessary to pay attention both to reliability of communications and quality and security assurance. The internet can keep separate parts functional when there is a failure of network connectivity. Therefore, this property should be saved for the maximum use of internet's potential and the carried-out communications. The decent ralized systems of communications can also have this feature.

Ensuring simultaneous implementation of quality, connectivity and security requirements of the internet communications is very difficult. For example, the voice traffic, from one city in Asia to another, can go through a city in Europe that will inevitably affect delays and consequently will have an impact on quality. Besides transport and geographical aspect, non-optimal choice of routes within the country, research load and infrastructure of "the last mile", etc. can have an adverse effect on voice communication. The issues, concerning a building of network with high quality routes by decentralization of network components, participating in data transmission, will be considered within the study. The scheme of such communications' organization which can be used in VoIP development will be defined as a result.

TECHNOLOGY OF DECENTRALIZATION

Technologies of decentralization are lie at the basis of the internet. Decentralization ensures the stability of the network functioning through the use of a large number of nodes participators of the network, the duplication of functions for information storage and routing of data flows. Decentralization minimizes the probabilities of network's fall from attacks or hardware failures.

Architecturally, the decentralized networks are the generally peer networks based on equality of participants. Often there are no dedicated servers in such network and each node (peer) is both the client and the server simultaneously. Unlike architecture of the client server, the Peer-to-Peer (further P2P) organization allows to keep operability of a network in any quantity and any combination of available nodes. P2P approach gained the greatest distribution in file exchange (torrent) and financial (Bitcoin) networks.

The scientists and engineers pay attention to the use of P2P approach in realization of the distributed information collection and calculations. In particular, modeling of the d-dimensional decentralized P2P peer network is carried out by Shurkhovetsky (2011). The system of modeling peer network which nodes form

multidimensional information space is developed. The results of the experiments, conducted on the model, suggest that characteristics of the received peer network's architecture allow to use it in systems of the distributed data collection and processing.

The use of P2P approach for voice traffic's transmission began relatively recently. Skype became the innovator in realization of this functionality.

Primarily, Skype used the decentralized P2P architecture (Nechay, 2013) for data transmission. Skype users' directory was distributed by computers of Skype network's users that allowed to the network scaled easily to very big sizes (tens of millions users) without increase in expensive infrastructure of the centralized servers. Skype could route calls through the computers of other users. It allows users, who are behind NAT or firewall to connect with each other. However, it created an additional load on the computers and the channels of users, connected to the internet directly. Network scheme presented in Fig. 1.

The only central element for Skype is the authentication server that stores users' accounts and backup copies of their contact lists. The central server is necessary only for communication units. After connection was established, computers could send voice data directly to each other (if there is a direct link between them) or through the Skype-intermediary supernode. Previously, any computer which has apublic IP address and open TCP port for Skype could be supernode but then all supernodes were moved to Microsoft servers.

Before 2011-2012 the client of Skype could become supernode (supernode) in case if he hasa public IP address and open TCP port for Skype. In the supernode mode, Skype passed through itself "other" traffic on the principle of peer network.

After acquisition of the network by company Microsoft, since about 2011-2012, all supernodes and the

Fig. 1: Skype network topology

users' directory are implemented on the company's servers. The user-clients of Skype are prohibited to promote to supernodes. By means of supernodes' centralization, the Microsoft had increased opportunities for scalability, the variability of the network messages and links was added. In fact, the corporation gained control over communication sessions and user data. The conditions of Skype's use provide availability of the decrypted data to the network's owner, Microsoft employees or the affiliated companies and also providers of the internet. The Skype servers can automatically scan the sent texts and links from it for protection from spam and fraud; some links can be removed from messages. The admissibility of interception and manual processing of the sent text messages is also stipulated in the conditions.

The Skype protocol is closed and undocumented and can be only used by proprietary Skype Software that is why it is not possible to use or borrow the approaches realized in Skype. However, it is possible to claim about feasibility of the set applied scientific task.

Study of the voice message's concept by means of the decentralized networks attracts interest of many scientists and engineers. The developer, Efim Bushmanov posted Skype's protocol online. In the blog Skype-open-source, researcher explained that the code was reconstructed by the «reverse engineering» method.

The famous Western projects such as P2PNS, P2PSIP and OverSim, developed by Institute of Telematics, Karlsruhe Institute of Technology, Germany are devoted to the study of various aspects of modeling and implementation of P2P networks for voice transmission.

P2PNS (Peer-to-PeerNameService) is a distributed name service using peer-to-peer network. The main objective of the project P2PNS is the provision of reliable and efficient use of the SIP protocol for decentralized VoIP (P2PSIP) (Baumgart, 2008).

Peer-to-PeerSIP (P2PSIP) is a project which uses P2P-architecture in which Session Initiation Protocol (SIP, read further) executes session and state monitoring of calls between participants. The performers of the project note that SIP is applicable for work in P2P network protocol in which both end points of communication session carry out functions of the SIP server and the SIP client. It allows any two SIP clients to communicate directly, without the additional server (SIPSorcery, 2009).

Oversim the project, apparently, developed from two, described above, the purpose of which is to create a tool for modeling of P2P networks. The tool contains several models for various P2P protocols. The modeling of SIP application in the P2P environment can be an example of the tool's use. The works of Ingmar Baumgart
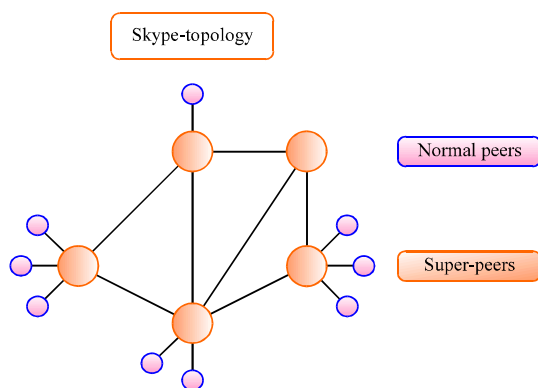
(Baumgart *et al.*, 2009), Bernhard Heep, Christian Hubsch, Amos Brocco are devoted to the description of properties and fields of this solution's appliance.

The study in SIP Sorcery's Blog is devoted to criticism of the realized P2PSIP approach. The problems of SIP protocol application for work in P2P networks and transformations of network addresses (SIPSorcery, 2009) are described in the study.

Internet Engineering Task Force (IETF) created the working group (P2PSIP) which develops the standard and finishes the protocol for realization of P2PSIP which is based on the RE source location and discovery protocol (RELOAD) (Jennings *et al.*, 2015). Nowadays, tools for the distributed conferences' organization Jennings are developing.

THE COMPARATIVE ANALYSIS OF POSSIBLE NETWORKS' ARCHITECTURES FOR PROTECTED TRANSMISSION OF VOICE DATA

Proceeding from the review of decentralization technologies two key approaches can be distinguished:

- Organization of the traditional client-server network's model of data flow (classical approach for corporate telephony)
- Organization of the decentralized network
- The decentralized hybrid hierarchical network
- Networks with full decentralization
- We will carry out a comparative evaluation of these approaches on the quality criteria of internet communications
- The possibility to use configurable routes
- Average grade of speech quality using quality rating
- Average network delay of media packets transmission (msec)
- Average deviation of media packets' network delay (jitter) (msec)
- Percent of unsuccessful calls this requirement is not related to the protocol directly, it refers to its implementation
- Average time of connection this requirement is not related to the protocol directly, it refers to its implementation

Additionally, the criteria, connected with development and maintenance of system in good operating condition should be written:

- Simplicity of development
- Load on users' works stations

It should be noted that decentralization for the transmission of voice traffic is not the goal, conversely, it is treated as a means for providing two key characteristics of communication: security and quality.

As exemplified in decomposition of Skype protocol, it is easy to prove that the decentralized hybrid networks are better suited for the organization of exchange of the stream traffic, known advantages of the decentralized networks are the reason for that:

- The rate of information exchange
- Absence of dependence on the centralized services and resources
- Security of network from different failures including robustness to extra technological intervention
- Expandability almost infinite opportunities for expansion of system resources
- Scalability emergence of new nodes doesn't lead to overloads of network's key elements

Hybrid approach in which supernodes of network have hierarchical structure and provide balancing and IP switching, promotes removal of known shortcomings of peer networks:

- Uncontrollability
- Security issues
- Informative inconsistency, uncertainty of information

Thus, two types of the distributed networks' structure were described:

- Full decentralization: all participants of network are equal in this option that allows to work in any configuration of participants (at least one participant is necessary). Such option limits the software operation, developed in this network it has to consider opportunity of any changes of network topology (the list of nodes and routes between them that leads to increase in traffic volume, transmitted over network)
- The hybrid scheme which differs from the scheme with full decentralization by reason that the servers which are used to network functioning coordination are applied. This scheme has lesser "survivability" but it has lesser variability and therefore, facilitates software development. The final comparison of schemes is presented in Table 1

Additional argument for the organization of partially decentralized, hybrid hierarchical network is successful approbation of this approach in the VoIP communications' market leader-Skype.

Table 1: Comparison of networks architectures for voice data transmission

| Comparision	Client-server	The decentralized hybrid hierarchical network	The network with full decentralization
Average grade of speech quality using quality rating	Average	Above the average	Above the average
Average network delay of media packets transmission (msec)	Average	Below the average	Below the average
Average deviation of media packets' network delay (jitter) (msec)	Average	Below the average	Below the average
Simplicity of development	Simple	Average	Complicated
Load on users' works stations	Low	Low	High
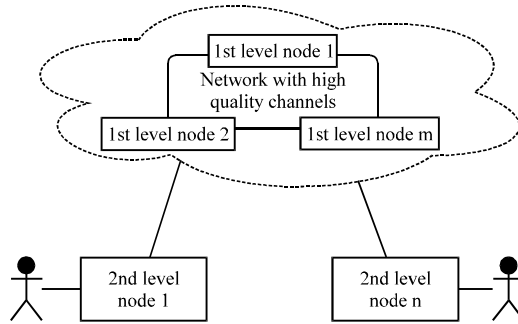
Fig. 2: The interaction pattern of nodes in hybrid network

Therefore, there are good reasons to use hybrid networks for ensuring high-quality of voice data transfer as a part of follow-up researches. The overall scheme will consist of two levels. The first level is static set of nodes that can choose the data flow route between themselves and have the best network channels. The second level is end users who connect to the first level nodes, selecting node by route quality. The interaction pattern is presented in Fig. 2. This scheme has issues that have to be solved within follow-up research:

- Determination of the initial node for connection
- Determination of the routes between first level nodes
- Determination of the first level nodes' creation logic need and sufficiency

CONCLUSION

The issues connected with improvement of internet communications' quality due to routes' improvement between communication end points are considered in the study. The need to improve the routes' quality follows directly from the necessity of using cloud model which will allow market share increasing for traditional VoIP products. The main architectures providing decentralization of communications were defined:

- Peer networks, Skype, P2PSIP are the examples
- Hybrid networks in which the network is divided into several levels of hierarchy, a prototype of such scheme is internet

Based on the analysis of advantages and disadvantages of these architectures for further researches, the hybrid scheme which has lesser "survivability" than peer network but has smaller variability and therefore, facilitates software development was chosen. The issues which have to be solved in further software development were defined:

- Determination of the initial node for connection
- Determination of the routes between first level nodes
- Determination of the first level nodes' creation logic need and sufficiency

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REFERENCES

Baumgart, I., 2008. P2PNS: A secure distributed name service for P2PSIP. Proceedings of the Sixth Annual IEEE International Conference on Pervasive Computing and Communications, March, 17-21, 2008, IEEE, Hong Kong, pp: 480-485.

Baumgart, I., B. Heep and S. Krause, 2009. OverSim: A scalable and flexible overlay framework for simulation and real network applications. Proceedings of the IEEE Ninth International Conference on Peer-to-Peer Computing, September 11, 2009, IEEE, Seattle, WA., USA., pp: 87-88.

Jennings, C., E.B. Lowekamp, E. Rescorla, S. Baset and H. Schulzrinne, 2015. Resource Location and Discovery (RELOAD) base protocol. Internet Eng. Task Force.

Nechay, O., 2013. A brief history of Skype: on a decade of revolutionary service. Comput.

SIPSorcery, 2009. P2PSIP: Or how to write a thousand RFC's and still not solve the problem. SIPSorcery.

Shurkhovetsky, P.P., 2011. Modelling of decentralized structured P2P network on the basis of mesh-topology for the problem of resource detection in globally distributed data processing systems. Newspaper Morgue, 2: 36-45.