

# Challenges for VoIP Technologies in Corporate Environments

Anton Kos  
University of Ljubljana  
Faculty of Electrical Engineering  
E-mail: anton.kos@fe.uni-lj.si

Borut Klepec  
Triglav Insurance Company  
Ljubljana  
E-mail: bklepec@zav-triglav.si

Sašo Tomažič  
University of Ljubljana  
Faculty of Electrical Engineering  
E-mail: saso.tomazic@fe.uni-lj.si

## Abstract

VoIP has not been adopted as fast as it has been expected some years ago. Part of the reason for this situation lies in the fact, that some downsides of its deployment were not known or communicated to early adopters. The implementation was therefore more complex, demanding and expensive than anticipated. As benefits of VoIP are well known, this article focuses mainly on its possible downsides that can slow down its implementation.

When deciding about VoIP implementation the reasons and concerns against it can be divided into its technical and its non-technical part. The main non-technical reasons are of economic nature (new equipment and return on investment), internal organisational structure (separate departments for voice and data communications), human resources (lack of appropriate expertise), and business risks (implementation problems and reliability).

The main technical reasons are presumably low voice quality (VoIP call is of lower quality than PSTN call), early implementation problems (the system might not work flawless under certain network architectures – NAT, PAT, firewall, encryption), evolving standards and interoperability (more standard sets that do not work with each other, unknown future penetration of this standards, boxes from different vendors can not be integrated into one system). Despite all the VoIP market is growing and companies are introducing this technology for different reasons, which often vary greatly.

## 1. Introduction

Technologies and mechanisms for the transmission of voice over IP networks were very promising some years ago and they stay the same today, but the adoption rate in corporate private networks is still rather modest. The three main reasons, why customers would be interested in introduction of VoIP (Voice over IP) technology are lower costs of calls, lower cost of infrastructure and the integration of voice and data applications. As it seems these reasons for VoIP are not strong enough to speed up the adoption of the new technology. On the other hand company decision-makers can identify some important

obstacles that are preventing quicker deploying of VoIP solutions. In the following article we try to identify challenges, which are to be faced in the future of VoIP technologies.

According to Ashton, Metzler & Associates [5] analysis the three main drawbacks for VoIP deployment are:

- deployment is more difficult than anticipated,
- users complain about voice quality,
- VoIP system is more difficult to manage than anticipated.

In the same study we can find, that the three main benefits of VoIP deploying are:

- cheaper calls between company sites,
- VoIP systems are cheaper to administer,
- it is easier to deploy new integrated applications.

Clearly, introducing such compelling technology in enterprise bring both benefits and drawbacks. Today we cannot say that carrying voice over IP network is a wise solution for every organisation regardless of its industry type, geographic topology, internal organisation or the way it communicates with customers. The deployment of VoIP should therefore be carefully considered for each individual case.

As the benefits of VoIP are well known and advertised, the drawbacks are far less communicated. In the following sections we will concentrate on the main reasons for slow introduction of VoIP technology and divide them into those with non-technical background and into those with technical background.

## 2. Economic, Organisational and Other Non-technical Reasons

If we observe only technical reasons we may easily miss the big picture. The decision making process in companies is very different from one to another and it definitely has influence on how future strategic plans are defined. Let us

look at the main factors that should be considered before the decisions about the introduction of VoIP technologies are made.

## 2.1. Economic Reasons

The idea of bypassing relatively expensive public-switched long distance voice services seems quite compelling. But for the last few years those prices are falling and this argument is losing its strength. Economic reasons depend heavily on existing geographic locations, between which most voice calls are made. Regarding the survey [4] cost savings is probably not the primary driver for VoIP, and some companies do not even see any real benefit of VoIP for call cost reduction.

Among economic reasons we must also consider the availability of budget for purchasing new equipment. If a company has recently invested heavily into its communications infrastructure, it is less likely that it will want (or be able) to spend a lot of money for the new technology without really good reasons, clear objectives and high money savings.

Most organisations have made significant investment in their existing voice communications recently. They are concerned about protecting this investment while migrating to a converged network model. Therefore a low risk migration path is required from the two separated to one converged networks.

## 2.2. Internal Organisational Structure and Human Resources

Some companies have separate departments for voice and computer network infrastructure. Internal organisation structure can play significant role when new projects are to be investigated and planned. Clearly it is easier to deploy new converged voice/data technologies in organisation, where both voice and data communications are covered within the same department.

Case study described in [8] present such an example, where full responsibility for data, voice and video services is mentioned as one of the key factors for the decision about full-scale VoIP transition.

Many organisations also face the problem of human resources. In the scope of VoIP, this problem is more expressed with organisations that have two separate departments or expert teams – one for voice and one for data communications. While both teams can be highly skilled in their fields, they may not know much of the other. Transition to one converged network is therefore a difficult task for both. But even if both networks are covered within the same department, there could just not be enough expertise in VoIP. That could make its

deployment difficult, slow, unreliable and therefore more costly.

## 2.3. Business Risks and Concerns

Because VoIP technology is relatively new, potential customers have implicit fear from its implementation problems. This risk is present because of several reasons: necessary capital investment, requirement of qualified personnel with the new knowledge, complexity of VoIP, lack of known references, security issues, and because of its unknown and unproven reliability. IT managers are also concerned about the interoperability problems and the need for using tools for measuring and troubleshooting VoIP quality.

In PSTN services we are used to »five nines<sup>1</sup>« reliability (99.999%). In rare instances when data network is down we can still use telephone calls to continue communicating with our customers and within the company. This cannot be done in converged network, so network reliability become even more critical as it is today. Because some specific details of individual company environment may not be known beforehand, deploying VoIP could push that organisation into the unknown. Proper planning, assessment and management is therefore of crucial importance.

Regardless of unified converged networks in use, organisation may still want to have some backup telephone system<sup>2</sup>, because the risk of being inaccessible for its customers is just too high. However, PBX is inherently no more reliable than other (data) network equipment [7], [10]. What makes voice communications more reliable is that organisations recognise that voice is mission critical and therefore all planning, management and operation procedures are carefully executed. That is unfortunately not always the case with data networks.

Availability [%]	Service down time per year	
	Hours	Minutes
97	262	48
98	175	12
99	87	36
99.9	8	46
99.99	0	53
99.999	0	5

Table 1: Unavailability of service per year

<sup>1</sup> The five nines apply to PBX or local exchange equipment and not the end-to-end network availability. The overall network availability is therefore lower and in the range of 3-4 nines.

<sup>2</sup> This setting of course negates the advantages of the unified converged network for voice and data communications.

Some studies [10] show, that VoIP service availability in internet can achieve around 98%, which is still pretty far from what PSTN offers today (99.9% to 99.99%), but it is quite comparable to mobile telephone networks that achieve availability between 97% to 99%. However, we have no information of any article, which will study the availability of corporate VoIP implementations. Since percents on a yearly scale do not tell much, let us present it as figures in numbers of hours and minutes that the service is unavailable during one-year period (see table 1).

If we have a look at the numbers, 98% availability might seem high. But if we look at the number of hours the service is unavailable, the picture is a bit different. 175 hours is almost 20 workdays. If we optimistically presume, that only a quarter of this downtime happens during actual work hours, that still leaves us with full 5 workdays. And that might be just unacceptable for many businesses. Comparing that with 99.9% or 99.99% availability that gives us the same optimistic downtime of only good 2 hours for the first and a negligible 20 minutes for the second figure.

If we summarise, the two main risks are quality and reliability which have been a concern since the introduction of VoIP. By deploying voice/data convergence enterprises will most likely not be satisfied with reliability, which will be below that of PSTN.

### 3. Technical Reasons

Besides the mentioned non-technical reasons, there are quite a few technical reasons that would have to be addressed and considered before VoIP is deployed.

#### 3.1. Presumable Low Quality of Voice Calls

From the very beginning technologies transferring voice over packets network has suffered for low quality compared with POTS. Today this situation is changed substantially because of the usage of new techniques [2] and the introduction of some basic QoS mechanisms in local area networks and on WAN interfaces, like priority queuing [1] or other advanced queuing techniques. But substantial resources in terms of equipment and management are still needed to maintain voice quality calls close enough to toll quality of POTS. Main demands for IP network, which are used for transferring voice, are high availability and low predictable delay. The quality of voice calls can be affected by raised network load, for example because of the introduction of a new application. Therefore tools for continuous call quality measurement and troubleshooting are needed, which were not needed before.

Among typical voice quality problems in VoIP implementations are syllable clipping, garbled speech and crackling. Reasons for this may be in insufficient use of interleaving on WAN links and prioritisation methods or extensive packet losses. Large file transfers together with

absence of interleaving and advanced proper prioritisation certainly lead to poor voice quality. A converged network must be able to separate each traffic type and handle it according to its unique requirements. This finding again requires infrastructure that supports QoS. It should be mentioned, that QoS introduces additional planning, equipment, maintenance, expertise, and nonetheless costs.

Another approach to maintain reliably, high quality voice communication is using so called auto-switched PSTN backup [9]. A proprietary technology checks the quality of the IP connection between switches and if necessary automatically launches a backup connection over the PSTN. The switchover is transparent for the users. But the problem with that solution is that again the company must maintain two separate networks. That again negates some of the advantages of VoIP.

#### 3.2. Problems with Early Implementations

Early adopters have discovered some annoying problems with VoIP implementations in real corporate environments. There are well known issues with traversing VoIP traffic through NAT-s (Network Address Translation), PAT-s (Port Address Translation), firewalls, and encryption, which pose additional problems with security and performance [3]. The common denominator of the above problems is that layer 3 or layer 4 addresses are included in higher layer payloads. Network nodes do not generally look into those payloads. When network addresses are changed in the layer 3 (NAT) or layer 4 (PAT) headers, they are not changed in the payload of higher layer protocols. The consequence is generally that one can initiate a call from such a network, but cannot be called from outside of it. The similar problem arises with encryption where network nodes, even if they do have that functionality, cannot see what is inside the payloads of higher-level protocols as they are encrypted.

However, these problems are solvable with new voice-aware firewalls or application gateways. But that of course includes additional effort, time and money that one has to put into this solution.

Another problem might be in the finding, that for optimal VoIP performance some parameter tuning is necessary. In opposition to POTS, the quality of calls using VoIP is not given by default but requires additional effort.

VoIP technology can introduce a large amount of new traffic to network. Extent of additional voice traffic should be estimated and considered before any implementation.

#### 3.3. Evolving Standards and Interoperability

Historically regulators have recognised the importance of the voice market by strictly regulating it, while data has developed in a far less regulated environment. Standards

for VoIP and its support are still evolving; therefore developers have difficulties delivering and maintaining device interoperability with other vendors. Areas of QoS protocols and QoS mechanisms are also still being developed.

We also have a few incompatible call-signalling protocols, H.323 was standardised by ITU in 1996 and has been updated twice since. The umbrella of standards covers everything that one would need for multimedia communication over packet networks (Voice and video coders, message transfer, signalling, multicasting, etc.). Because of that it is inevitably quite complex. It describes everything from phone to gateway signalling, gatekeeper operations and other. One could say that H.323 is a system. Consequently it is a fairly closed set of standards and new functionality cannot be added easily.

On the other hand IETF promoted SIP can be best described as a building block that can be integrated in different systems that include VoIP. It is an application layer signalling protocol that is more open and flexible than H.323. It is quickly gaining popularity and is taking over the lead from H.323. Numerous other protocols are also emerging: SGCP, MGCP, Megaco/H.248, Skinny, and SDP.

The debate of regulating it strictly versus not regulating it at all is ongoing. There are pro's and con's for each option. Good examples of each approach are GSM (strictly regulated voice network) and IP networks (lightly regulated data network). VoIP is from both worlds and it is difficult to say which approach would work best. As always, the time will tell.

The decision for one of the protocols is therefore very difficult. It is anticipated that SIP will be the dominant protocol from the phone to the gateway and H.323 from the gateway to the PSTN. The decision on which set of protocols to implement is therefore extremely difficult as companies would like to see their investments to last and pay-off eventually.

#### 4. Conclusion

Despite many hesitations VoIP market is growing every year. Equipment, primarily VoIP gateways as a key element in enterprise installation, is gaining in performance and capacity. Decision-makers on the customer side are usually not too impressed only by new technology, although it may look promising. They wish to buy solutions that save money or bring opportunities for greater efficiency. They are mainly interested in customer loyalty and in increasing revenues. The key drivers for VoIP today are most likely networking and location transparency together with value-added applications [5]. It seems that purely cost-cutting reason is losing its strength.

Corporate users must carefully analyse their preferences and ask themselves if introducing voice/data convergence through deployment of VoIP technologies bring any advantage to their business. It is unsuitable to make any relevant conclusions either from successful or unsuccessful previous implementations. However, it is very appropriate and useful to use experience from other cases and build a complex picture of possible advantages and disadvantages of adopting VoIP technology in specific corporate environment.

#### 5. References

- [1] B. Klepec, Anton Kos: Performance of VoIP Applications in a Simple Differentiated Service Network Architecture, International Conference on Trends in Communications EUROCON 2001, Bratislava
- [2] Anton Kos, B. Klepec: Techniques for Performance Improvement of VoIP Applications, 11th IEEE Mediterranean Electrotechnical Conference, IEEE MELECON 2002, May 7-9 2002, Cairo, Egypt.
- [3] Cisco Systems: VoIP Traversal of NAT and Firewall, available at <http://www.cisco.com>, (date 29. August 2003)
- [4] Ashton, Metzler & Associates: The Rapidly Changing Enterprise WAN Marketplace, September 2001, available at <http://www.catapult.net/resources/papers.html>, (date 29. September 2003)
- [5] J. Metzler: The successful deployment of VoIP, COMNET 2003, available at <http://www.webtorials.com>, (date 29. August 2003)
- [6] Webtorials: 2003 VoIP State of the Market Report, August 2003, available at <http://www.webtorials.com>, (date 8. September 2003, registration required)
- [7] Cisco Systems: The Strategic and Financial Justification for IP Communications, White paper, available at <http://www.cisco.com> (date 8. September 2003)
- [8] L. Liebmann: Real-World VoIP Migration, Business Communications Review, May 2001
- [9] Quintum Technologies; Across China, Case study, available at <http://www.quintus.com> (date 08. September 2003)
- [10] W. Jiang, H. Schulzrinne: Assessment of VoIP Service Availability in the Current Internet, PAM 2003 Workshop, available at <http://www1.cs.columbia.edu/~wenyu/>, (date 30. October 2003)