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Network Security – Is IP Telephony Helping The Cause?

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Abstract

The major players in the Public Branch Exchange (PBX) market are moving rapidly towards the implementation of IP Telephony. What will be the effect on network security overall? Will the push to IP Telephony damage the good work already devoted to security networks? As more doorways open up on our networks there is an increased chance we have opened another unseen vector for hackers and other malicious organisation or individuals to access the data stored on server and users workstations, corrupting that data or destroying it. Is it better from a security perspective to have IP telephony only between PBX equipment – a significant saving in itself or is it imperative that an organisation have IP telephony to the desktop? Is there any real difference, once IP Telephony is past the network boundary does it matter if it also appears at the desktop? What about the future with collaboration and unified collaboration? This paper will discuss a number of implementations and attempt to understand the pros and cons of each. No one solution is going to fit all networks but hopefully this paper will be able to increase our understanding of the dangers and therefore allow for the development of robust solutions.

Keywords

VoIP, IP Telephony, Network, Security, SIP, H.232, Firewall, IDS

INTRODUCTION

IP telephony, also referred to as Voice over Internet Protocol (VoIP) and internet telephony, is still in its infancy to a large extent in the corporate world. Although it has been used for some time by home PC enthusiasts it is only now pushing into the business market in any large meaningful way. Products such as Skype, developed by Nikolas Zennstrom and Janus Friis, are a peer to peer (p2p) IP telephony application (also known as a Soft Phone) that has been in use for some time by the general internet community (Skype 2006a). The idea is that each and every node on the network is considered a peer and can communicate directly with each other or through a relay host, that is each node has server and client capabilities (Wolff 2004), This type of topology is also known as a mesh network. The contrast here is that in a traditional network there would be servers which provide data and application services, and clients who use the data and applications. This is termed a client/server network and for any transfer to occur the server would have to be online and accepting connections. This is a bottle neck in that all communication is reliant on the server having sufficient bandwidth to handle all the requests. P2P on the other hand routes data via the most efficient route considering congestion and destination, thereby circumventing bottlenecks or other congestion. This solution requires no hardware changes, except for the purchase of a headset / microphone which will plug into the PC or laptop.

Other implementations include more robust, and possibly more secure, commercial solutions offered by large communications companies such as Alcatel-Lucent, Nortel, Cisco and Mitel amongst others. These solutions require the replacement of current PBX equipment and the installation of IP based PBX's. This works in a similar way to a normal PBX except that it uses the existing network infrastructure within the organisation and can transmit voice communications over corporate IP backbones between branch offices, both nationally and globally.

This push towards IP telephony means that IT security professionals will need to retrain and gather vast amounts of knowledge and skills to enable them to install and maintain these networks as well as protect networks from attack through this new infrastructure. The term IP telephony has also been used to refer to more than just VoIP, including all types of communications such as fax, video conferencing, and instant messaging (IM) services. The term Unified Communications is more appropriate if the different mediums are combined into one package (Reed *et al* 1999). Some may conclude that it is only data and as such can be handled by normal security such as firewall and IDS configurations but this is not necessarily the case (Kuhn *et al* 2005, p3). With the ability to send data via the IP telephony link how can the network administrator ensure that data is not

compromised and distributed via this new service? With a data network there are ways of checking that certain corporate sensitive data is not being transmitted external to the organisation but can the same be done for VoIP and IM? This danger or vulnerability is the reason behind the need for network separation, a completed risk evaluation needs to be conducted to ensure that the risks can be removed, reduced, or mitigated (Gerschefske, 2006).

The NIST SP 800-58 publication (Kuhn *et* al 2005) lists nine points to consider when deploying VoIP. Whilst most of them involve changes or extensions to existing systems, the number of factors to be considered, and the scope they cover should be cause for concern for any network security manager.

1. Deploy appropriate network architecture
2. Ensure that the organization has examined and can manage or mitigate the risks to their information, system operations, and continuity of essential operations when deploying VOIP systems
3. Special consideration should be given to emergency services communications, because automatic location service is not available with VOIP in some cases
4. Agencies should be aware that physical controls are especially important in a VOIP environment and deploy them accordingly
5. Evaluate costs for additional power backup systems that may be required to ensure continued operation during power outages
6. VOIP-ready firewalls and other appropriate protection mechanisms should be employed. Agencies must enable, use, and routinely test the security features that are included in VOIP systems
7. If practical, "soft phone" systems should not be used where security or privacy are a concern
8. If mobile units are to be integrated with the VOIP system, use products implementing Wi-Fi Protected Access (WPA), rather than 802.11 Wired Equivalent Privacy (WEP)
9. Carefully review statutory requirements regarding privacy and record retention with competent legal advisors

This paper does not try to discuss the technical aspects of IP telephony such as jitter, latency, delay, quality of service, or how data is routed. The hope is to raise the awareness of the reader to the possible dangers as well as positives of the technology, so long as appropriate security is installed and maintained. The effects, or potential effects, of IP telephony on network security are also discussed.

THE BENEFITS

The benefits of IP telephony are numerous. An organisation can save significant money by utilising the existing network cabling infrastructure, bypassing the public switched telephone network (PSTN) and associated carrier costs, hotdesking, telecommuting, and move towards unified communications. There is some discussion that the start up cost of implementing a VoIP network will negate the cost savings (Gareiss, 2007; Rendon, 2002; Yoke, 2005) although over the longer term the reduction in infrastructure and call costs will benefit the organisation. Also, as with all technology, the expected improvements to security and IP telephony protocols will see it evolve into a robust and secure implementation (Kerravala, 2007). The cost savings when occupying a new office are even more significant, as the cabling can be theoretically halved due to only needing the network cabling, rather than having to install dedicated phone lines. Allowing the voice and data communications to run over the same physical media can also lead to problems which will be examined later.

Currently, to install another telephone within an organisation requires cabling to be installed, cross connects installed in the appropriate wiring cabinets, a phone number installed in the PBX, as well as other incidental issues (Kerravala, 2007). These factors, in addition to the disruption to the office environment, are less than ideal. To install another IP telephone, the organisation hands a telephone to the user, it is plugged into the Ethernet outlet and it is logged in with a password. There is some programming to be done in the PBX, such as adding the users name to the phone system, enabling the switch port, and setting access the voicemail system – all of which can be semi automated, but this is a far more simple installation. If the installation is for an existing user, once they have logged on the phone will have access to that user's phone book, speed dials, voicemail, etc. This leads on to the case of telecommuter, if this worker has access to moderately high speed internet connection then they could connect via a VPN across the internet to the organisations network and have all the data and communications facilities as if they were in the office (York, 2007) the customer would be none the wiser that the consultant was not in the office.

The organisation may take this even further by reducing the overall cost of infrastructure by reverting all the sales staff and admin staff to telecommuters, enabling the vast majority of their workforce to work from home or

other place of their choosing. This scenario is currently implemented in limited fashion as discussed above with geographically dispersed call centres but there is potential, especially when unified communications becomes the norm and broadband internet connectivity is more widespread, for this to become normal business practice. This scenario would have to wait for true Unified Communications to mature. Staff and management need group contact for the organisation to manage itself and prosper, weekly (or monthly) meetings need to be held where all staff can discuss the current goings on and this can only really be done for the telecommuter once Unified Communications if mature enough to support all the video conferencing and data sharing with reliability and security.

For organisations with multiple offices across the country or the globe, a staff member can be contacted as if they are at their desk no matter where they are. Using the telecommuter scenario if an executive is travelling and has a layover en route they can connect through the hotel or airports broadband access by VPN and conduct business seamlessly. All this leads to the vulnerabilities to the organisation and its network that will be discussed in later sections. There are already a multitude of organisations that draw on new start up call centres in different time zones to provide 24 hour customer service but relatively few existing organisation have incorporated IP telephony into their internal communications systems.

ATTACK VECTORS FOR IP TELEPHONY

The vulnerabilities with IP telephony cover the full range of Confidentiality, Integrity, and Authenticity but also can include Non-Repudiation through hacking and spoofing of call setup data. Data, both conversational and setup, can be compromised through corruption, theft, and manipulation (Ackermann *et al* 2001). With data transiting unknown network elements once it has left the confines of the organisations internal infrastructure, data can be manipulated by many elements much the same as traditional data but given that telephones are not considered new technology the user does not have the same awareness of deception that they may otherwise have with newer technology (Bell, 2007). There is little guarantee that the audio component is unmodified and the level of confidence that the originating and destination points are true cannot be confirmed either. Bell (2007) also reported that there has already been an instance of PBX hacking with the potential for hackers to call each end of an international call and connect them together with the PBX owner being responsible for the call. He also state that unlike credit card companies and banks where there is a history of allowing for the customer to declare fraudulent transactions on the account, telephony carriers are not so lenient.

The organisation along with its security and network managers must understand that VoIP is susceptible to the same vulnerabilities as other data networks such as spoofing of phone number, redirection of calls (man in the middle), Spam over IP telephony (SPITing), direct attacks on IP telephony infrastructure such as gateways and proxies, and of course Denial of Service (DoS). Some current security components and procedures can inhibit VoIP functionality so VoIP friendly processes should be developed. Firewalls can pose a significant inhibitor to successful VoIP functionality (Kuhn *et al*., 2005).

To set up a VoIP call there needs to be a number of ports opened for the call setup, shutdown, and conversation these ports need to be dynamic so that no unused ports are left open where an attacker could access the system. It has been documented that some IP phones can be turned into eavesdropping devices (Espiner, 2007), for some this is a feature others it may be an unforseen vulnerability. If the organisation has used best practice and separated their data and voice networks this vulnerability is less likely as the attacker needs to gain access to the voice network. Gaining access to this vulnerability is far easier if the networks are not separated. Furthermore, if data and voice are not separated bandwidth issues could degrade the voice services if the appropriate security and priority is not applied creating much heartache and frustration for the network administrator (Kuhn *et al*., 2005).

Eavesdropping

The other vulnerability is that if appropriate data security is not employed the IP telephony traffic could be captured as it traverses the internet towards its destination with the data and conversation recovered. This is a remote attack not unlike capturing documents being emailed between offices. How many organisations encrypt or sign documents before allowing them out into the wilds of the internet? Such an attack could be conducted as either a man in the middle attack or through a sniffer. Packet capture is not new, and there are both free and commercial packages available to capture network traffic, including VoIP traffic, which allow for reconstruction of data streams, and also voice conversations if IP telephony is being used. Although this type of attack is possible, the reality is that eavesdropping is rare on LANs

Denial of Service (DoS)

This type of attack is possible in nearly every form of network communication (Collier, 2005) That is both wired and wireless networks, and also for most protocols, and not specific to IP Telephony. The concern with DoS attacks in IP Phone networks is that the VoIP channel can be used as a conduit through which the network can be flooded with so called voice traffic, thereby preventing legitimate data traffic from being able to be transmitted. As with other DoS style attacks IP telephony networks are susceptible to attacks due to programming errors, flawed implementation of software, or basic network flooding (Collier, 2005). Denials of Service attacks have already been reported such as a router running Cisco's CallManager Express IOS that has a flaw which allowed malformed packets to cause the device to reboot. Multiple malformed packets would cause the device to continually reboot (Cisco, 2006; Keating, 2005).

It is understandable that the majority of vendors would be reluctant to advertise that their product has, or is potentially vulnerable to attack yet it is hoped that they are working to resolve any issues that may be discovered. It is left to the research community to discover vulnerabilities with most products, not just VoIP. Although an organisation may follow best practice and segregate the voice network from the data network they will usually have a single connection to the internet and or external network so any DoS attack on the organisation will affect both the data and voice networks. This is an example of how traditional attacks can flow through to the voice network.

Of course physical security is imperative to protecting the network from DoS as anyone who has access to the "demarcation" point within the property can disconnect the organisation from the outside world or conduct a number of other attacks – if you have access to the physical equipment, you own the network and its services.

SPITTing

This term refers to using IP phones to make marketing and other nuisance type calls, similar to email spam. The fear is that marketers would setup systems which auto-dialled phone numbers in a database to leave advertising messages. There was concern that the so-called inexpensiveness of IP telephony would make this a significant network security threat, However, detailed analysis has shown that termination costs as well as legal and regulatory issues have prevented this from becoming a significant problem (Orans, Munch & Cowles, 2005, pp2-3). In addition to these aspects, there is also a fundamental difference between email spam and telephone marketing. Because you still need to make a phone call to a traditional phone, there is a cost involved for every call made. This differs from email spam in that it is essentially free.

Toll Fraud

This vulnerability with IP telephony is something that has been around for 40 years or more. Phone phreaking or gaining unauthorised access to the phone system and then making calls or even selling the ability to make calls is also known as toll fraud. The ability of an IP telephony network to be accessed by users who are geographically dispersed also means that an attacker could access the IP PBX with little more difficulty than hacking into a server. This attack generally focuses on the gateway device but as described in the published vulnerability with the Alcatel-Lucent IP-Touch phone traditional attacks on the data network could lead to the voice network coming under attack (NIST, 2007).

Proprietary Protocols

There are a few different protocols for VoIP including Session Initiated Protocol (SIP), H.232, media gateway control protocol (MGCP) and Megaco/H.248 (Gupta & Shmatikov, n.d.; Kuhn et al., 2005). SIP and H.232 are the leaders currently but neither has gained superiority. The PROTOS project has produced a test suite to evaluate implementation level security and robustness of various SIP implementations and discovered numerous vulnerabilities. Of the nine implementations assessed, only one passed, with eight failures (Wieser & Laakso, 2005).

All these protocols are still maturing and each have their advantages and disadvantages. There are arguments regarding the capabilities of each protocol and whether they do what they claim to do given the level of maturity. Additionally, implementing the wrong protocol could be casue issues for the organisation. SIP for example doesn't support video conferencing very well and if the organisation relies heavily on this communications channel then a third party add-on will be required (H.232 versus SIP: A Comparison, n.d.). This can increase the organisations vulnerability either directly or via the combining of the two applications. This is not to say that H.232 does not have faults of its own, NIST SP 800-58 (2005) refers to H.232 as a wrapper that encapsulates a number of other protocols such as H.225 and H.245. H.232 has firewalls as its Achilles heel whereas SIP has Network Address Translation (NAT). The security manager just needs to be aware of the configuration and that there are new unknown vulnerabilities and must act accordingly.

DISCUSSION

There are a multitude of organisations offering various IP telephony solutions, as mentioned in previous paragraphs. Most, if not all, vendors claim to have a robust solution with respect to security, but this may not necessarily be the case. Already there have been several identified threats that should raise concerns within the security profession. The general categories of threats are vishing, spitting, denial of service, spoofing, and tunnelling.

The security stance of the organisation will determine to some extent what solution is acceptable, for example if the organisation deals with government or military contracts would a p2p application that has access to both voice and data communications through the lack of segregation be suitable? It could be expected that within 5 years all new telephony installations will be IP based, this is based on information that most PBX providers have decided to legacy their current TDM PBX devices with all new models being IP based although there is still add-ons that allow for TDM access – refer to the new product descriptions from the major vendors.

The implementation of IP telephony also has a wider social impact to the community of allowing all the mothers, fathers, frail and caregivers who would normally be at home supporting children or the frail to return to the workforce if so desired, enabling them to generate income for themselves. This paper has not dwelt on these significant and positive social aspects of IP telephony and Unified Communications although its implementation would be the same as for the telecommuter or travelling executive but it is worth noting the potential.

Attacks currently used against traditional data networks can be perpetrated against the VoIP service. Although this adds another vector for the malicious hacker, it does not indicate that VoIP has generally increased the level of vulnerability to the corporate data network. From a risk analysis stand point, the vulnerabilities and threats have not increased; there is just an increase in the likelihood that an event may occur. There are vulnerabilities where an IP phone can be placed into hands free mode without interaction from the user. This has been witnessed with the Alcatel and other systems. Although there is an indication on the phone of its status, the user may not be in a position to see it and conduct confidential conversations which could be overheard. Also, a telecommuter may conduct sensitive business conversations in a public café or airport lounge, leaving the conversation to be overheard by anyone again compromising corporate data and intelligence. These personnel must be made aware of the dangers and trained in procedure that will prevent such compromises.

A final point on Unified Communications with the term – "Are we there yet?" With modern organisations we have data networks allowing email, fax from the desktop, instant messaging, and so on. With the advent of VoIP we currently have unified communications; do we need to marry all these services into one application? Instant messenger applications also abound that can be locked into the corporate network (deny wider internet access) which can enhance the organisations productivity. To create this unified communications environment a multitude of different applications are required, but is that not a good thing, no one point of failure? What happens in the unified communications environment if the application fails? The organisation may be lost, no phone, no email, no data transfer. This is of course a worst case scenario but unified communications goes in the face of best practice which is to spread the services amongst a number of vendors so the organisation was not reliant on a single entity, not being held hostage to a single vendor. The dangers of unified communications could be far more devastating than the implementation of VoIP.

The solution

There is no single solution to the added issues that IP telephony brings, but it does serve to reinforce existing tenets of network security and defences. Organisations that already have appropriate security mechanisms in place should need to do no more than make the relevant changes to policy, with procedural changes flowing from this. eg. firewall rules, and user education. Orans, Munch & Pescatore (2005, pp2-3) make the following recommendations in relation to securing the IP telephone network infrastructure:

1. The IP-PBX Server. An IP telephony aware firewall should be used to protect the IP-PBX server. It is also recommended that network based IPS be used to protect against DoS and signalling attacks. A host based IPS should be used to protect the underlying operating system of the IP-PBX
2. The network. A VLAN should be used to separate voice from data traffic. This is only possible with dedicated IP telephony handsets, and not so called IP softphones. Traffic should be prioritised in the VLAN such that malicious traffic cannot flood the network.
3. Eavesdropping. Use of selective encryption to protect against eavesdropping.

A blessing in disguise?

If anything, it may be possible that the publicity, both positive and negative, that VoIP has attracted will serve to make systems administrators and information security officers more aware of security threats, and lead to an overall increase in network security. The use of VoIP may introduce a vector by which user education can be used as a vessel to not only introduce information about VoIP security and risks, but also about network security in general to higher levels of management and other organisational stakeholders..

Although eavesdropping, spoofing, and the like have been discussed as serious vulnerabilities, VoIP can also protect against it when considering intra and inter office communications. It must be assumed that at least some of the conversations transiting the traditional voice services and PSTN are discussing confidential information, by enabling VoIP and encryption the organisation can have a certain level of confidence that these conversations transiting the internal network and to branch offices via the organisations backbone network are protected. H.232 improvements include a specification for AES and Triple DES encryption of the voice packets whereas SIP does not but SIP is running at the application layer and leaves the encryption to lower transport layers (Gupta & Shmatikov, n.d.; Kuhn et al., 2005).

CONCLUSION

The conclusion can be drawn that data and voice networks should be separated, if not physically then at least virtually through VLAN configurations. IP phones and IP telephony networks as a whole are vulnerable to eavesdropping attacks as well as most traditional attacks like DoS, Spoofing, SPAM (SPITing), and the like. Security managers and their network administrators need to work together to develop defences that will protect the organisation from attacks and ensure business continuity. So long as appropriate security is installed such as network segregation, encryption on conversations that are sensitive, and the removal of handset hands free abilities where appropriate, VoIP and IP telephony should not add significantly to the vulnerabilities of the organisations data network. It may even be an eventuality that the increased publicity that VoIP has received will lead to better network security overall, as the use of VoIP may allow information security managers to better educate decision makers at higher levels of the organisational hierarchy about network security in general.

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