voopIX: Building free VoIP infrastructure for Academic, Science and Educational Institutions in Croatia entirely based on Open Source software

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Abstract- One of many services that CARNet has in its network is called voopIX, which main goal is to provide free telephony service between CARNet member institutions by using Voice over IP standardized protocols and open source solutions. The main goal of this project is to interconnect existing legacy PBXes on institution premises by using VoIP gateways to transform traditional telephony standards (for example ISDN PRI connections) to VoIP. VoopIX project is entirely built and maintained by CARNets employees. At this time our reports show that, even in this early stage, we can terminate around 4% of all calls from institutions that are now using our system. We predict that this will grow to 10-15% of all calls and that will cut costs for about 2.000.000 EUR yearly in Croatia.

I. INTRODUCTION

CARNet, as a Croatian NREN (National Research and Educational Network), builds and maintains a well established high-speed IP network that for years was reserved for academic and science institutions in Croatia with approximately 300 connections. In 2004 network was considerably expanded to reach other educational (primary and secondary schools) and currently there are more than 3000 active connection points.

CARNet is one of few NRENs in Europe that doesn’t provide only connectivity to GÉANT and commodity Internet, but also provides number of services on top of the fast network infrastructure, ranging from videoconferencing to hosting several centralized services in CARNet data centers.

One of many services that are run on CARNets network is called voopIX, which main goal is to provide free telephony service between more than 3000 CARNet member institutions, but also to encourage movement from legacy PBX (Private Branch Exchange) solutions to modern VoIP based solutions on top of which new services and possibilities could be implemented.

The starting idea of this project is to interconnect existing PBXes on institution premises by using VoIP gateways to transform traditional telephony standards (for example ISDN PRI connections) to VoIP, and then to transfer data across CARNets IP network.

VoopIX project was designed, built and it is currently maintained by CARNets employees. It is considered to be the biggest VoIP implementation based on Open Source in Croatia [1].

Since the project is in production for more than three years now, and was preceded by additional two years of testing, and has proved to be an excellent solution in our environment, new possibilities and additional services that are explored now that can be offered to member institutions.

II. CHALLENGES OF BUILDING NATIONAL VOIP NETWORK INFRASTRUCTURE

This project is a kind of evolutionary one. It all started some four years ago with just two institutions with seven locations trying to establish VoIP interconnectivity. Since this initial solution proved to be technically easy to implement and the quality was excellent, it was expanded to other member institutions.

Fig 1. Logical full-mesh of the voopIX network with two institutions connected to two neighboring core nodes for redundancy. VoopIX core network can run without a single core server without interruption.
First challenge was to build redundant and resilient core network that can accept thousands of parallel phone calls through the network. That was done in year 2005 when first five core servers were installed and brought first VoIP backbone to production.

The other key challenge was to build a custom made VoIP gateway appliance that can suit our needs on VoIP side and to be able to connect legacy PBXs on other side. Designing, building and testing the appliance took more than a year, which was done entirely in CARNet. The voopIX appliance has several features that are not available in standard equipment available around the globe. For example, there is a built-in failover switch that can bypass our appliance and reconnect PBX back to Telco in case of appliance failure.

Other challenges include the management, security, fault and performance monitoring tools for the whole network. User web interface is also provided institutions users for configuration and billing purposes.

III. WHERE ARE WE NOW AND WHERE WE WANT TO GO?

At time of writing of this paper we have connected more than seventy largest institutions in Croatia that include Ministry of Science, Education and Sports, several Agencies and Universities and some of the largest faculties in Croatia. It may seem that this is still far away from the final number of 3000 locations, but voopIX team has decided to concentrate on the largest institutions with largest telephony installations in this phase of the project. It is planned to expand voopIX network at least three to four times in year 2011, and are still working on the smaller appliance for the smaller institutions (for example small schools on islands and rural areas).

On the other hand, voopIX also started to connect several institutions across Europe and USA and we really hope to reach the goal of globally connecting academic, science and educational institutions. Some improvements were already made to our core network in order to be able to handle additional load from our foreign partners.

IV. COSTS SAVINGS

In year 2009 CARNet has conducted survey among future voopIX users and combined those data with statistics of already connected members. It was done in order to understand breakdown on type and volume of outgoing telephony calls placed from member institutions. Collected data is now automatically updated with current statistics in order to keep information on potential costs savings up to date.

<table>
<thead>
<tr>
<th>Outgoing calls destination</th>
<th>Percentage</th>
<th>Kn/monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra city</td>
<td>33%</td>
<td>645.400</td>
</tr>
<tr>
<td>Inter county</td>
<td>17%</td>
<td>325.920</td>
</tr>
<tr>
<td>International</td>
<td>10%</td>
<td>1.841.000</td>
</tr>
<tr>
<td>Mobile phones</td>
<td>30%</td>
<td>1.724.000</td>
</tr>
<tr>
<td>Intra voopIX calls</td>
<td>10%</td>
<td>752.000</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100%</td>
<td>5.288.320</td>
</tr>
</tbody>
</table>

Table I. Combined survey and statistics data on call type breakdown with volumes in Kunas

This savings estimates were done on a fully deployed network, and it is interesting to point out that this project has budget of only a fraction of monthly savings until now.

V. TECHNICAL OVERVIEW

From the beginnings it was decided to build entire network around Open Source software. For the VoIP part there was a lot of in-house experience at that time with Asterisk IP PBX, so it was decided to use this software for the entire network. This decision might seem a little odd at this time since Asterisk is rarely used in this configuration, but it proved to be good option for voopIX [2].

First of all core network was built which is distributed across Croatia, at this time consisting of five servers running Asterisk. Those five servers do have full-mesh.
logical interconnection between them with DUNDi [2] protocol running on top of that. One server can be faulty at any time without service disruption.

On the customer premises, at CARNet member institutions, custom built voopIX appliance is installed, which is actually a small diskless Linux server running Asterisk. There are three ways how we can connect our appliance in institution: integration with existing PBX for routing purposes only, integration in hybrid mode, and using appliance as IP PBX.

If we use appliance just for forwarding calls inside the voopIX cloud, then it is connected between the legacy PBX and Telco lines (usually ISDN PRI, but can be other types of connection) where it can “intercept” calls. Those calls that are available in our system are rerouted through voopIX and all others are connected through the Telco lines as before the appliance installation.

Hybrid installation is also possible when there is a need to expand number of internal phones, but the current PBX cannot accept additional phones. In this way the institution, instead of purchasing new PBX or expanding the existing one it can just purchase required number of additional IP phones which then will be connected to our appliance.

Hybrid installation could also be a step toward to full VoIP installation, when we finally remove old PBX and remain only with voopIX appliance and IP phones.

After initial installation and testing done by CARNet employees, appliance is connected to CARNets IP network and configured for production environment.

When the appliance is firstly started it registers with two of the neighboring core servers by using IAX2 [3] protocol registration service. Only when it becomes available in core servers IAX2 registration table, institution numbers are published in the voopIX cloud.

Several tests were concluded where transition times were measured from registered to unregistered status and backwards. They have averaged to less than half a second, which ensures that we have highly dynamical cloud almost instantly up to date.

Since voopIX is based on its own appliance, instead of just simple VoIP gateways, it was possible to deploy even more advanced features that could not be deployed in other situations. Those may be additional features that are not currently available (like voice menus, call recording + delivery via email, etc.) on the legacy PBX, or may be an expensive and unwanted upgrade to an aged equipment.

One of most used function is the ability to install soft phones on users laptop or mobile device and to connect to their PBX from abroad or from home. This is done in such way that the user actually gets his number from the office phone, and when someone gives him a call, both phones ring. All outgoing calls are billed in a same way as the outgoing calls from the office phone are billed.

“Skype-to-legacy PBX” calls are also supported, which are all routed through voopIX infrastructure. It was done by using Skype for Asterisk drivers, which are actually the only licenses that were purchased for this project.

A number of centralized services are also used for providing logging (Syslog NG), fault monitoring (Nagios), graphs and performance monitoring (Munin), Accounting (FreeRADIUS and mySQL), and finally configuration and user management (Puppet server/client). As with the Asterisk, all these services are based on Open Source software.

On the end, ENUM-to-DUNDI [4] gateway was developed, which allows bridging of these two different VoIP worlds and to be able to make calls in both directions.

VI. CONCLUSION

While there are several similar projects in Europe (Hungary, Portugal, Czech Republic, etc.), our project is unique in a way that it uses exclusively Open Source software. Since the inception of this project, almost every month, we open a new page of new possibilities that can be included in our project.

The challenging part of using Open Source solution is the need to have extra in-house engineers and system administrators that cannot rely on strong support from vendors as with commercial solutions.

CARNet is constantly in touch with all of our partners in Croatia and abroad in a way that we can have flow of ideas running in both directions. CARNet is looking forward to have opportunity to transfer acquired knowledge and experience to others.

On a technical side of a story, CARNet tends to use Open Platform idea, which actually enables in future to switch from currently running software to anything else that could become available or more attracting. If this project was bounded to a single platform or single vendor, this could be an issue that could be solved only by replacement of all customer premises equipment.

LITERATURE


