RELIABILITY AND OTHER PROBLEMS OF A NEW SOLUTION FOR LONG DISTANCE CALLS

Enyedi Szilárd*, Liviu Miclea*, Gavril Toderean**

*Technical University of Cluj-Napoca, *Department of Automation, **Department of Telecommunications*
Observatorului 2/2, Cluj-Napoca, Romania
Tel: +40-264-401820, tel/fax: +40-264-594469
{Szilard.Enyedi, Liviu.Miclea}@aut.utcluj.ro; Gavril.Toderean@com.utcluj.ro

Abstract: The paper presents some reliability aspects of a new, low-cost way of making long distance voice phone calls, called MoIP[1]. It uses Voice over IP[2] technology, implemented on various mobile phone platforms, and mainly GPRS as data carrier. With the proposed solution, the cost is theoretically over ten times lower than current call costs, without any extra hardware.

Key words: long distance call cost, VoIP, MoIP, mobile platform, GPRS.

1. INTRODUCTION

1.1. Generalities

Long distance phone calls are expensive. Telephone services, especially mobile services, have come a long way; even international phone calls have lost their luxury status. Phone companies turned to VoIP[3], and call costs dropped consistently. Still, these prices can be further reduced. The key is the same VoIP.

1.2. The questions

Why cannot we use mobile phones with VoIP for long distance calls, replacing dedicated international voice connections with cheap Internet connections?

What if we used our fixed – or even better – mobile phone to build a data connection with our talk partner, and use VoIP to talk? Even if we do not use GPRS[4], but a dial-up connection, it would still be much cheaper than a classic phone call. Obviously, our talk partner would need the same VoIP setup as ours. We called this voice communication method "MoIP", for "Mobile over IP". Of course, there are many ways to use this technology: calls from mobile to a PC, from a PC to a mobile, but the most exciting is from mobile to mobile, without any extra hardware.

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[1] **MoIP** – Mobile over IP, the name we gave to our solution of voice communication with GPRS and VoIP.
[2] **IP** – Internet Protocol, the basic protocol for transferring data through the Internet.
[3] **VoIP** – Voice over IP, a technique mostly used to transport voice through the Internet.
[4] **GPRS** – General Packet Radio Service, an always-on data transfer mechanism used in mobile phone networks.

2. A NEW IDEA

2.1. Generalities

There are partial VoIP solutions for mobile phones, for example PTT[5] systems, where the partners take turns in talking, because the communication is half-duplex.

The new idea: using the same voice encoding/decoding scheme as classic GSM [1], but dial-up or GPRS as data channel, instead of the classic GSM voice channel, a mobile phone could send and receive voice at a much lower cost than currently.

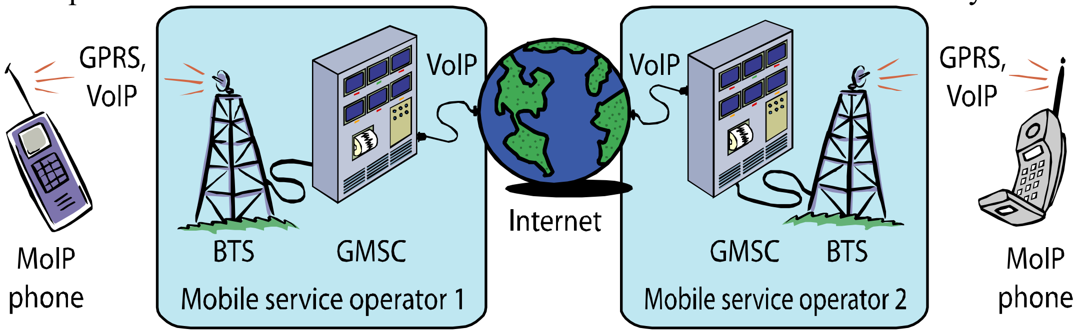

Figure 1 – Proposed MoIP system structure. Only the phones actually know that the data is VoIP. BTS[6] [1] and GMSC[7] [1] are standard components of the GSM system.

However, as we will discuss later, there are many reliability problems, inherent to the not-so-reliable GPRS communication method used.

Both talk partners have mobile phones with the VoIP/GPRS software installed. When they talk, the mobile phones encode the speaker's voice and send it as data, through GPRS, to the other mobile phone, which receives and decodes it.

2.2. Example cost estimation

Figures, at the time of writing this article: standard full-rate[8] GSM encoded voice transmission speed is 13 kbps; the lowest per-minute voice connection fee for Orange Romania is 0.09$/min in the network, 0.14$/min in other national networks; the highest GPRS cost at Orange Romania is 2$/MB. Let us calculate the cost for one minute of GPRS data transmission, at 13kbps:

$$1MB = 1024kB \quad \ldots\ldots\ldots\ldots \quad 2\$$$

$$13kbps \approx 1.3kBps \quad \ldots\ldots\ldots\ldots \quad x$$

$$x = \frac{1.3kBps \cdot 2\$}{1024kB} \approx 0.00254\$/\text{s} \approx 0.15\ \$/\text{min}$$

Orange Romania is currently offering mobile dial-up service at 0.01$/min, during the evening, at 9.6kbps, still higher than the 6.5kbps required for half-rate[9] GSM

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[5] **PTT** – Push To Talk, a radio technique, where the user pushes a button, talks, then releases it, so that the talk partner can talk.

[6] **BTS** – Base Transceiver Station, usually one for each GSM cell.

[7] **GMSC** – Gateway Mobile Services Switching Centre, a bridge between the mobile GSM network and another network – in our case, the Internet.

[8] **FR, Full-rate GSM** – in simple terms, it is the standard GSM system data transmission speed at which the speaker's voice is transmitted from the speaker's phone to the listener's phone. The speed is 13 kbps. There is also EFR, Enhanced Full Rate, with higher voice quality.

[9] **HR, Half-rate GSM** – standard, lower quality voice transmission speed in GSM networks. 6.5kbps.

voice transmission, not to mention that GPRS speed is usually 28kbps. With adequate choice for the vocoders, one may achieve full-duplex communication.

If we were able to use GPRS as channel for sending the voice, call costs would be greatly reduced (**ten times**), especially international call costs, where dedicated voice connections jump over 1$/min, while the GPRS connection remains the same.

3. IMPLEMENTATIONS

3.1. Java 2 Micro Edition

Java 2 Micro Edition, included in most new mobiles, is the mobile phone variant of the widely used programming language Java[10]. The user just selects and downloads the j2me[11] program – midlet – into his or her phone, and runs it.

3.2. BREW

BREW[12] is somewhat similar to j2me, with the difference that the programs can be written in the C++ programming language, compiled and then executed on a BREW-enabled device.

3.3. Symbian

Symbian is an operating system in itself, rather than just an application platform. It is used mainly in smartphones[13]. Its main advantage is that the programs for Symbian are fast, because they run machine code, rather than interpreted, like j2me.

3.4. PalmOS

Just like Symbian, PalmOS is an operating system. Formerly only for electronic organizers, the newer versions of PalmOS can handle voice communications and GPRS.

3.5. Dedicated hardware

The most efficient implementation would be in hardware, preferable in ASIC[14] circuits. For now, we are looking forward to implement experimentally some of the MoIP functionally in FPGA[15].

4. PROBLEMS

4.1. Bandwidth

Standard full-rate GSM [1] uses 13kbps, half-rate is 6.5kbps [1]. Even classic GSM dial-up (9.6kbps) should suffice for the purpose, with the right codecs.

On the other hand, vocoders[16] have evolved since GSM was implemented, they are now more bandwidth- and/or quality-efficient than standard GSM coding. Some

[10] **Java** – a popular programming language, mainly because it offers platform independence.
[11] **j2me** – Java 2 Micro Edition, a subset of the Java language's second version.
[12] **BREW** – Binary Runtime Environment for Wireless, a mobile application platform from Qualcomm, Inc.
[13] **Smartphone** – a mobile phone that has also many other functions, e.g. electronic organizer.
[14] **ASIC** – Application-Specific Integrated Circuit, an IC designed for a specific purpose.
[15] **FPGA** – Field Programmable Gate Array, an all-purpose integrated circuit, in which the designer can change the connections between the logic gates many times.
[16] **Vocoder** – Voice Coder, software and/or hardware component that compresses voice before transmission, so that it can be sent on a low bandwidth channel, while maintaining intelligibility.

vocoders are also bandwidth-adaptive[17], so that bandwidth changes, typical for GPRS, do not disturb the transmission.

4.2. Processing power

Is the processor and j2me (or other implementation) powerful enough for a software voice codec[18]?

4.2.1. Floating or fixed point

The program or user should decide whether to use hardware floating point calculus (real time, high quality), emulated floating point (maybe not real time, high quality) or hardware fixed point/integer (real time, low quality).

4.2.2. Hardware codec

If the j2me (or other) implementation allows it, the phone's hardware voice codec can be used. There is no computational problem, but voice quality and transfer size has little control (HR, FR, EFR) if any control at all.

4.3. Setting up a connection

If I have a MoIP-enabled phone, and I know that the person, who I want to call, also has such a phone, how do I find out his/her IP address, necessary for the VoIP connection? Another problem is how do I tell him/her to start the MoIP program on his/her phone?

4.3.1. Fixed IP addresses

If the two mobile phones have IP addresses[19] that never change, the two talk partners can communicate their own addresses to each other when they first meet, and use that address whenever they need to talk to each other.

Unfortunately, due to scarcity of IP addresses, mobile service operators assign dynamically a new IP address to each device that initiates a new GPRS connection.

4.3.2. Non-stop connected GPRS

If none of the two parties disconnect from GPRS, IP addresses will not change. Because on a GPRS connection, data transmission is taxed by amount, not by connection time, the mobile phone may remain connected all the time.

4.3.3. Communicate IP addresses

The basic problem is that we know the other’s phone number, but not the IP address.

The obvious solution is connect to GPRS and get own IP address, then make a classic voice phone call and tell each other the IP addresses. After that, the two talk partners connect with MoIP, using the previously noted IP address of each other. The

[17] **Bandwidth-adaptive** – communication software and/or hardware, which monitors the available bandwidth of the channel, and is able to change the number of transmitted bits accordingly.
[18] **Codec** – Coder/decoder, software and/or hardware component that is able to encode and decode signals.
[19] **IP address** – a 32 bit numeric identifier of devices connected to the Internet. For simplicity, we may consider that each Internet-connected device has its own IP address that is unique on the whole Internet.

disadvantage is that they still have to make a classic phone call, although short. The whole idea of our solution is to avoid expensive classic voice calls.

4.3.4. Send IP address in SMS

This is somewhat less expensive than making a call: the two parties connect to GPRS to get an IP address, and then send an SMS[20] message to each other, specifying their own IP address. After finding out the other's IP address, they may proceed to the MoIP connection. Costs are marginal, one SMS message per party. Currently, Orange Romania taxes $0.07 per SMS message sent. The 160 character limit of SMS is well beyond the 15 characters needed for an IP address (which is of the form xxx.xxx.xxx.xxx).

4.3.5. Dynamic DNS

Just like the DNS[21] system in the Internet world, we could build a system to associate phone numbers with IP addresses. We know the previous, but not the latter.

One possible solution:

- The program finds out own assigned IP address and sends it automatically to the other party's phone.
- Then, it scans received SMSs periodically, to find the other party's IP address.
- When it found the other's IP address, it connects.

Note that "Dynamic DNS", used here, is not the same as the Dynamic DNS Service already used on the Internet.

4.3.6. Hub-based connection

A computer connected to the Internet could be used as a hub[22], whose IP address is known to both talk partners. Both partners' programs send own IP addresses to the hub and retrieve the others' the same way.

Benefits: costs less than SMS version (see above); the hub is very simple.

4.4. Authentication

Making a successful connection is not the only problem. How do I know for sure that the person I am connected to is indeed the Prime Minister? If I made a classic phone call, not MoIP, I would have some guarantee from the service operator that the phone number I called indeed belongs to the Prime Minister. However, with GPRS, there are ways to forge[23] someone's IP address. Not to mention the Prime Minister has to be certain of my identity as well.

4.4.1. Phone number based

This is actually based on Caller ID[24]. This works with a direct phone-to-phone contact, for example the SMS solution. We are not sure how safe Caller ID is, maybe one could forge their own phone number as well, in Caller ID.

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[20] **SMS** – Short Message Service, a popular way of sending cheap text messages between mobile phones.
[21] **DNS** – Domain Name System, a name resolution system at the basis of the Internet.
[22] **Hub** – generic term for a hardware device, computer or software, where all cables or connections meet.
[23] **Forge** – use a false as original.
[24] **Caller ID** – a phone service in which the called telephone displays the caller's phone number. Available for both fixed and mobile phone services.

4.4.2. Digital signature based

A safer authentication method would be PGP[25] private key signature, or some other, less computational method. Can be used with any solution, even voice (confirming by voice the message fingerprint[26]).

4.5. Speech privacy

The assurance that only my call partner can understand what I am saying is a basic requirement for a modern voice communication system.

4.5.1. Software-implemented encryption

Some powerful encryption algorithms exist, that could be implemented. The problem is the low processing power of mobile phone hardware.

4.5.2. Hardware-implemented encryption

GSM and CDMA (for BREW) encryption functions from the hardware are much faster than software. However, the encryption algorithms used in GSM are secret.

If MoIP is implemented entirely in hardware, with ASICs or FPGAs, powerful encryption algorithms can be used.

4.6. Speech lag

The biggest problem of VoIP, and, inherently, MoIP, is delay (lag).

Dedicated – and quite expensive – VoIP connections have affordably low delay, because the connection has guaranteed bandwidth.

For GPRS, however, the mobile service operator does not guarantee reliability and a minimal sustained bandwidth.

5. CONCLUSIONS

In this paper, we presented some reliability aspects of a new, low-cost way of making long distance voice phone calls, called MoIP.

Using VoIP through GPRS is a cost-effective, but often unreliable solution. True, the cost reduction is tenfold, especially for international calls, but the low processing power of mobile phones' hardware and public nature of the Internet impose serious limitations on the voice quality, and the privacy of the conversation.

We will continue to work on different implementations of the proposed MoIP solution.

6. REFERENCES

1. Sorina Zăhan, (1998), *Digital Telephony in Telecommunication Networks – Access, Transport, Management* (Romanian), Ed. Albastră.

7. DISCLAIMER

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[25] **PGP** – Pretty Good Privacy, an authentication/encryption system, widely used especially for important e-mails. It uses public and private keys to encrypt the message or authenticate the sender of the message.

[26] **Digital fingerprint** – a mathematical number, the result of the application of a hashing algorithm on a message, unique for every message.