AUTOMATIC BILLING SYSTEM FOR CISCO ANALOG TELEPHONE ADAPTOR ATA 186/188

Rosen Ivanov

Technical University of Gabrovo, BULGARIA
E-mail: rs-soft@ieee.org

Abstract: This paper presents an automatic billing system that can serve up to 5 Cisco ATAs. It is based on Beck's system on chip SC12. Proposed system can be used where the professional billing software is not the best solution - small offices, game clubs, call shops, etc. The main function possibilities of the system are as follows: call price calculation using various pricing schemes, fiscal document printing, on-line phone number analyses, and WEB reporting.

Keywords: VoIP billing, Internet Telephony, Analog Telephone Adaptors

1. INTRODUCTION

Internet telephony [1], also known as voice over IP (VoIP) enables people to use the Internet or corporate intranets as the transaction medium for telephone calls. The advantages of Internet telephony are as follows: it is cheaper for end user to make VoIP call than a circuit-switched call, because operators can avoid paying interconnect charges; an Internet telephony call only takes up to 6-8 kbps bandwidth, while old circuit-switched telephony takes 64 kbps bandwidth.

One of the biggest challenges for every VoIP service provider is customers billing that is part of accounting process [2]. Completing billing manually is not only very costly to the VoIP service provider, but also prone to errors. Automatic billing systems make some billing clerks obsolete and further reduce a company's expenses.

An IP telephony system can be built by utilizing necessary hardware and software in the current IP infrastructure as shown in Figure 1.

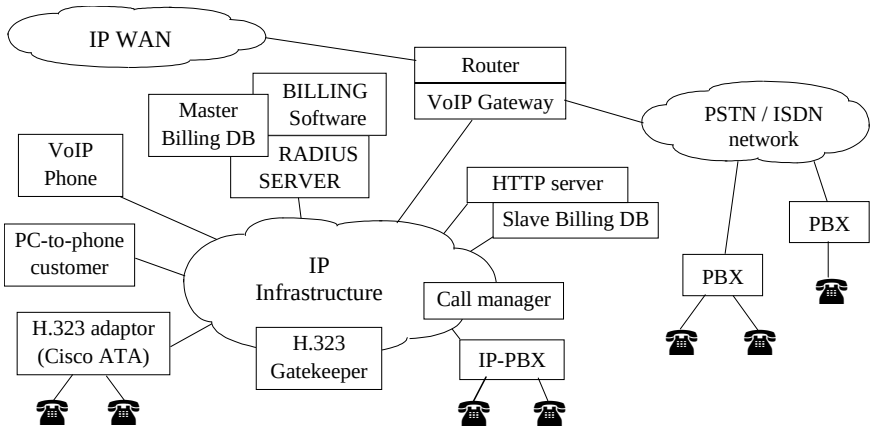

Fig. 1. An example for VoIP / data network configuration

Using routers and gateways to connect Private Branch Exchange (PBX) from Personal Switching Telephony Networks (PSTN) can carry voice traffic over data IP networks. Long distance calls can be routed over the Wide Area Network (WAN) link. Call management software and VoIP terminals are deployed in the existing IP networks at each remote site.

To support VoIP, standards as International Telecommunication Union (ITU-T) H.323 and Session Initiation Protocol (SIP), are being recommended and developed. The dominant standard is H.323 [4] that is series of recommendation to enable multi-media (voice, data, and video) communications in packet-switched networks. The VoIP is based on reduced functions of the H.323 for voice only support.

Up to date VoIP billing systems [6, 7] are used with any Remote Authentication Dial-In User Service (RADIUS) server which supports the VoIP functionality and provide the ability to define the structure of authentication and accounting tables. RADIUS uses a single authentication server to centralize security on networks with large modem pools. Professional billing systems have billing software built inside of the RADIUS server. This architecture provides high processing speed and data security.

When number of customers is small (game clubs, small offices, and etc.) professional billing software is not the best solution. This paper describes VoIP billing system for Cisco ATA 186/188 [3] which works as VoIP (H.323) terminal. The system can handle simultaneously up to 10 regular analog phones.

2. BILLING SYSTEM ARCHITECTURE

The Cisco ATA allows regular analog telephones to operate on IP-based telephony networks. Cicso ATA supports two RJ-11 ports (that can connect to any analog telephone device) each with an independent phone number. Both ports work simultaneously. An Ethernet RJ-45 10Bate-T (ATA186) or 10/100Bate-T (ATA188) uplink port is used to connect ATA to an HUB or switch. The architecture of proposed billing system is shown in Figure 2.

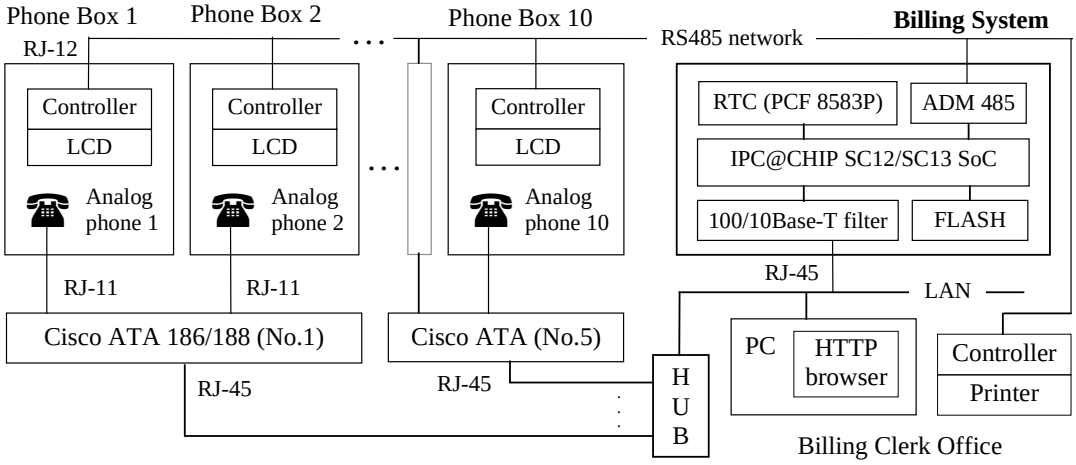

Fig. 2. Billing System Architecture

The billing system is based on Beck's System on Chip SC12 [8]. This single-chip personal computer with a built-in controller AMD186@20MHz and hardware-software possibilities for operation in network environment can handle at this moment up to 5 Cisco ATA 186/188. The system's customers can see information about their phone call on LCD display from Display Electronik GmbH (DEM 20231SYH, 20x2 STN matrix):

call status, phone number, call time, and call price.

For the particular solution following modules of SC12 are used:

- Ethernet transceiver (10 Base-T): connection to LAN;
- IDE interface: access to external Compact Flash disk (64MB from SanDisk GmbH);
- Serial interface configured as RS485: connection with LCD and printer controllers;
- I2C interface: connection with Real Time Clock (RTC): billing software uses RTC to obtain call date and time;
- Internal Flash disk: billing system code and configuration files;
- Internal DRAM.

3. BILLING SYSTEM SOFTWARE

Cisco ATAs support H.323 stack. The Q.931 signaling messages are carried in TCP packets and provides logical connection between the calling and called parties. The H.245 media and conference control protocol is used for the two connected parties after Q.931 establishment to exchange information. Real Time Protocol (RTP) and Real Time Control Protocol (RTCP) are used for actual media transmission.

The proposed billing system uses NPrintf capability of Cisco ATAs. Integrated in ATA UDP client sends in real-time information related to the call signaling and processing events (Figure 3).

```
0113596635004 active @0x3eb05a06 (GK @0x3fff0373)
...
Q931->0:Connect
...
OpenRtpRxPort(0,0x0,10000):1
RTP Rx Init: 0, 0
...
RTP Tx Init: 0, 0
[0]DTMF 1 , insum:606826
SIGNAL OOB CallChannel[0] digit[49] 31 10000
...
SCC->(0 0) <cmd 11>
H245<-0:EndSessionCmd 1
0: Close RTPRX
```

Fig. 3. Information from Cisco ATA UDP client

To activate this ATA's feature IP address and port of UDP server must be initialized (via WEB Configuration page or TFTP). For each ATA an UDP server is activated. These servers are part of billing software. They are runned under control of multi-task Real Time Operation System (RTOS) of SC13 and analyze information from UDP clients (number entering, dialing, call duration).

Proposed billing system supports various number of pricing schemes: destination of the call, call duration, day of week, time of day, discounts and promotions. The billing system database written in external Flash disk contains all fixed, mobile, pager and satellite entries extracted from the ITU-T E.164 [?] database. At this time database holds about 500,000 entries. System administrator can update E.164 database via FTP session.

The software is built as a set of separate modules.

3.1. Description of the most important modules

3.1.1. INIT. This module initialize hardware and software according to values of variables from system configuration file CHIP.INI (section INIT): ATA IP addresses,

UDP ports, number of phone lines, file specification of configuration files and E.164 database, and etc.

3.1.2. UDPSERVER. Each UDP server listen described in INIT section UDP port. UDP servers analyze information in UDP datagrams and if necessary send information to LCD display via RS485 interface. We use a 6-state model to describe the status of each telephone line:

- Status 1, “No action”;
- Status 2, “Phone number entering”;
- Status 3, “Dialing”;
- Status 4, “Call in progress”;
- Status 5, “Hang up”;
- Status 6, “Show result”.

Figure 4 shows used state model, where s_i represents state i, i=1-6 and $s_{i,j}$ represents transaction from the state i to the state j.

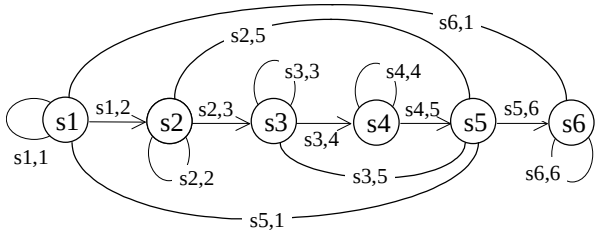

Fig. 4. Phone line 6-state model

3.1.3. LCDCONTROL. This module sends to the each LCD controller messages that must be displayed on the display.

3.1.4. On-line phone numbering analyses (OPNA). This module analyzes each entered digit during state 2 and recognizes country code and city of called party. To do this module uses information extracted from the E.164 database. The system customers must enter phone number in international format with prefix “00” in beginning. OPNA module parses phone number to country code (CC), national destination code (NDC), and subscriber number. The customer can see on LCD country and city name immediately after country and city code has been recognized, as shown in Figure 5. When an invalid number has been entered OPNA via LCDCONTROL module sends an alert message to customer.

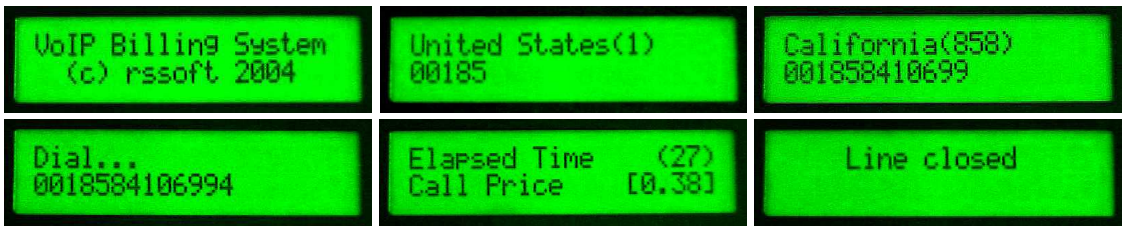

Fig. 5. An example for information displayed on LCD

3.1.5. HISTORY. For each phone call this module writes to the external Flash compact disk following information: phone line number (1-10), phone number, call date and time, call duration, and call price. This information is used when a report must be generated.

3.1.6. PRINT. After each call this module sends billing information to the printer. Communication with the PRINT module is realized by a message exchange. PRINT task waits for print messages. When a message is received the message exchange manager wakes PRINT task up.

3.1.7. REPORT. Most of current billing systems advertise some kind of WEB interface. The fact that the SC13 has a CGI WEB interface allows authorized persons (administrator and billing clerks) to receive information about calls in HTML or plain ASCII text format.

There are two types of reports:

- Off-line reports (call statistics);
- On-line report (current status of phone lines).

When off-line report is needed user can use following filters: phone line number, geographic region (Europe, North America, etc.), country and call date / time interval. Search engine allows for country code to country name and city code to city name conversions and vice versa. REPORT module can be used and as an ISDN and PSTN phone number analyzer.

An example for off-line report in HTML format using various filter combinations is shown in Figure 6 and Figure 7.

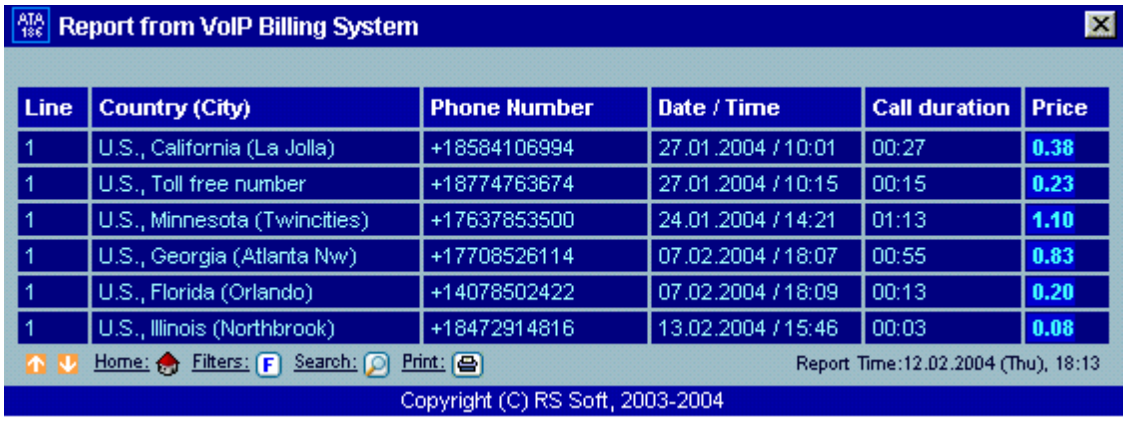

Fig. 6. Off-line report in HTML format
(Filters: Phone line=1, Country=U.S.A., Date=20.01.2004-15.02.2004)

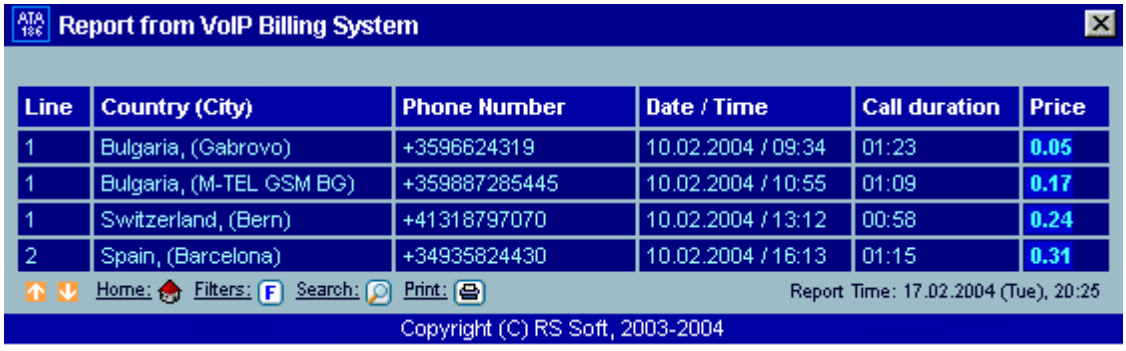

Fig. 7. Off-line report in HTML format
(Filters: Geographic region=Europe, Date=10.02.2004)

The administrator after an authorized HTTP request can see status of all phone lines in real time as shown in Figure 8.

Fig. 8. On-line report (phone line status)

3.1.8. UPGRADE. This module scans the status of FTPS (FTP Server) system task. When an upgrade of data or system configuration file has been detected software reboots the system (SC12).

3.1.9. SECURITY. Security task enables only WEB server and FTP server. To guarantee system security all other servers integrated in SC12 (Telnet, TFTP, PPP, and UDP config) are disabled. Software reboots the SC12 when fatal error has been occurred: invalid opcode, TCP/IP error, stack overflow, and etc.

4. CONCLUSIONS

Automatic billing system for Cisco ATA 186/188 has been developed. The main functional possibilities and advantages are as follows:

- Analyze information from up to 5 ATAs;
- Local call status visualization on LCD;
- Fiscal document printing;
- Support various pricing schemes (call duration, day of week, time of day, discounts, etc.);
- Remote on-line data and configuration files upgrades;
- WEB reporting;
- E.164 database searching;
- International phone number analyses;
- Improved security.

The number of served ATAs can be increased when Beck's SC13 (80186@40MHz, 10/100 Base-T) is used instead SC12. In this case no changes in system's printed circuit board are needed.

5. REFERENCES

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