# Design and Implementation of a Management System for HDSL Equipment

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*Abstract* – **This paper presents a solution of the management system for the HDSL equipment PP-HTU2, which has been developed on the basis of a chip-set solution. The management system is designed according to ITU-T TMN concepts and consists of the management station (manager) and management agents in HDSL modems. It can be extended to support multiple HDSL links. The presented concept is generally applicable to design of management systems for xDSL equipment**

*Keywords* – **HDSL, TMN, manager, agent, management layer**

## I. INTRODUCTION

One of the most talked-about areas in the telecommunications industry today is the digital subscriber line (DSL) technology. DSL may be offered as ISDN DSL (IDSL), high-bit-rate DSL (HDSL), symmetric DSL (SDSL), asymmetric DSL (ADSL) or very high speed DSL (VDSL). This group of technologies is frequently referred to as "xDSL".

Leading world chip-set manufacturers today offer a wide spectrum of xDSL chip-set solutions. These solutions usually include digital signal processor (DSP) and analog front end (AFE) circuits, which together compose an xDSL transceiver [1]. Besides, xDSL chip sets should include various mapping and framing functions, depending on the type of technology. The DSP and the mapper/framer are controlled and configured by an external general purpose controller - modem host.

Development of an xDSL modem using the particular chip-set solution includes design of the microcontroller environment, modem interfaces and the power unit. Basic software design can be significantly simplified, since software drivers for programmable chips are usually provided by the chip-set manufacturer.

However, the design of a management system is not straightforward, since it is not available by the chip-set manufacturer and strongly depends on the modem working environment. This paper presents a solution of the proprietary management system designed for a HDSL system based on the chip-set solution. The management system is designed according to ITU-T TMN concepts and the appropriate ETSI standard [2].

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The rest of the paper is organized as follows. Section II. presents a brief overview of the PP-HTU2 HDSL system. An overview of the implemented management functions, according to TMN concepts, is supplied in Section III. Section IV describes components of the management system: the management agent and the manager. The management agent is described in details in Section V. Section VI contains description of the manager, that is a PC Windows management workstation. Section VII presents the future work, related to extensions of the realized management system. Concluding remarks are presented in Section VIII.

## II. THE PP-HTU2 HDSL MODEM DESIGN

PP-HTU2 is a HDSL modem developed in the Telecommunication Department of Mihailo Pupin Institute. PP-HTU2 is a stand-alone, single-pair modem, designed according to the ETSI standard TS 101 135 [2].

On the DTE side modem supports: non-channelized ITU-T G.703 interface, V.35 data interface or an additional Ethernet module interface.

Block scheme of the PP-HTU2 modem is depicted in Fig. 1. Design is based on the Metalink MtH2400 HDSL chip set, which comprises: Mapper/Framer (M/F), customized DSP and AFE. M/F and DSP are programmable circuits, which are controlled by the modem host. Basic M/F and DSP software drivers are provided by chip set manufacturer.

M/F circuit is configured to satisfy the requirements for non-channelized HDSL system implementation. M/F forms a HDSL core frame, preserves the integrity of user data, supports application requirements and provides resources for specific O&M functions. M/F adds HDSL overhead to the user data, including an 8-bit embedded operation channel (EOC) and 48 Z bits, available for O&M and control functions. Thus, the total bandwidth available for control operations equals 9.3kb/s.

DSP performs all the digital functions of the single pair transceiver chip-set to achieve high quality, echo free signal and optimal decoding. These functions include 2B1Q encoding, scrambling/descrambling, adaptive echo canceling, linear equalization, timing recovery and a proprietary adaptive Near Maximum Likelihood (NML™) decoding algorithm. The NML™ algorithm exhibits superior performance over conventional Decision Feedback Equalizer (DFE) transceivers by providing a range extension of up to 25%.

AFE provides all the active circuitry needed to connect the DSP to an external compromise hybrid and an HDSL line transformer.

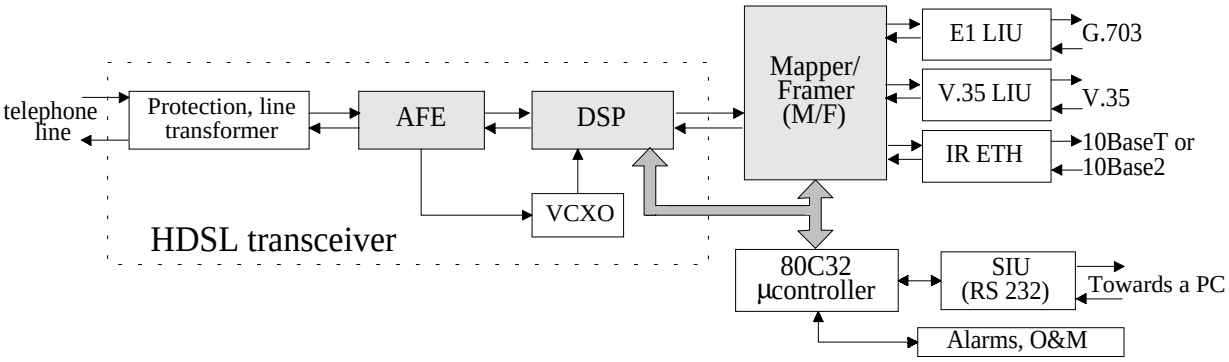


Fig 1. Block diagram of the PP-HTU2 HDSL modem.

AFE comprises analog processing and digitalization of the received signal, generation and shaping of the transmitted pulses and control of the clock recovery.

Host is a standard 80C32 microcontroller with the corresponding environment. DTE line interface units (E1 LIU and V.35 LIU) are designed using commercially available components. Ethernet self-learning bridge module IR-ETH providing either 10BaseT (UTP) or 10Base2 (BNC) LAN interface is also supported. Serial interface unit (SIU) provides support for RS-232 serial interface to connect the modem with the PC management workstation.

## III. Management Functions

The PP-HTU2 management system implements various O&M functions, which are classified in the following functional areas, according to TMN concepts [3]:

- Fault management,
- Configuration management,
- Performance management,
- Security management.

Fault management comprises alarm surveillance, fault localization and trouble administration. Alarm surveillance includes monitoring and detection of alarm events, e.g., loss of carrier and loss of frame synchronization. Fault localization includes diagnostic tests reports, start-up procedure control, support of various control loopbacks, BER (Bit Error Rate) testing, CRC errors counting and AIS (Alarm Indication Signal) test for DTE G.703 interface. Trouble administration is available through reports created at the management station.

Configuration management includes DTE equipment identification, modem status reporting and link status reporting.

Performance management comprises monitoring of transmission quality and performance monitoring according to the ITU-T Recommendation G.826 [4]. Transmission quality is estimated based on calculations of parameters like echo input/output ratio, signal – noise ratio, noise margin, etc. Performance monitoring includes detection and counting of the errored seconds (ES), severely errored seconds (SES), unavailable seconds (UAS) and error-free seconds (EFS), as well as the background block errors (BBE). These performance parameters are calculated and stored on the 15 minutes and 24 hours basis.

Security management implements vertical access security for testing functions, e.g., BER testing, AIS testing and control loopbacks. The access to those functions is permitted to authorized users only.

The management layers [5] are organized as follows:

- EML – Element Management Layer,
- NML – Network Management Layer,
- SML – Service Management Layer.

The EML manages local and remote modem on an individual basis.

The NML is present rudimentary, through permanent monitoring of the modem link status and modem status.

The SML comprises management system reports handling, maintaining statistical data on 24-hours basis, modem information reports, etc.

## IV. Components of the Management System

The management system (Fig. 2 ) consists of the following components:

- The manager, that is a PC based management workstation with the proprietary software,
- The management agent implemented in PP-HTU2 modem.

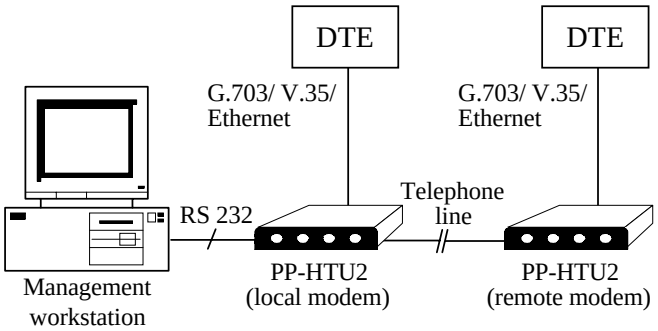


Fig. 2. PP-HTU2 with the management system

PC workstation is connected to one of PP-HTU2 modems by a serial RS-232 interface. This modem should be referred to as local, while the other is remote. The exchange of information between the local modem and the PC workstation is performed by means of a simple character-oriented link

level protocol.

In most of cases operator at the PC workstation requests the appropriate management operation or information and waits for the modem report. In particular situations modem can send reports without the previous operator's request, e.g., alarm reports, status reports, etc.

BER test and main loopback controls can be initiated either from the management workstation or from the modem front panel (local or remote) by pressing the proper button. During the execution of these operations the appropriate LED indications have to be turned on. Operations can be terminated either from the PC or the front panel, independently on the initiating device

## V. The Management Agent

The management agent at the PP-HTU2 modem implements all functions of the EML layer. The agent is realized on the host 80C32 hardware platform, in C programming language.

Most of the O&M functions listed in Section III are implemented by means of the programmable mapper/framer circuit (see also Fig. 1), which can be accessed through a number of programmable registers. These functions include BER testing, CRC errors counting, control loopbacks and AIS generation. Performance parameters (ES, SES, EFS, UAS and BBE) are stored in the appropriate data structures on 15 minutes and 24 hours basis.

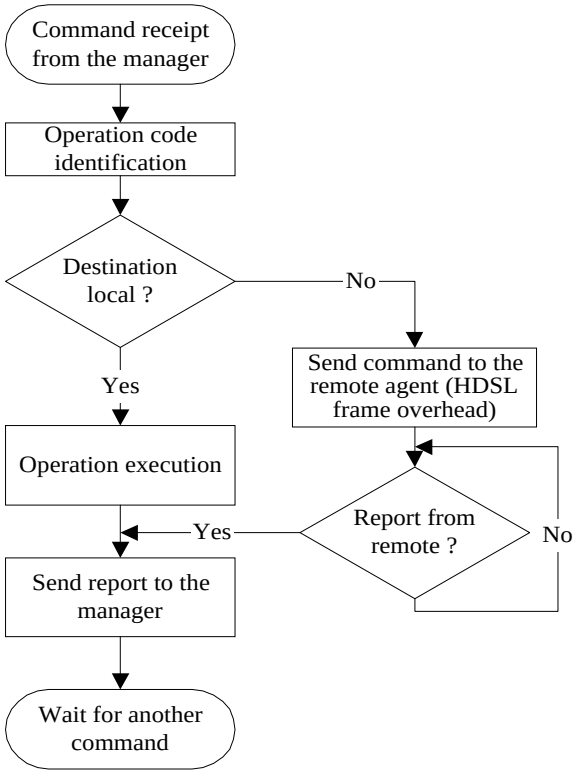


Fig. 3. Basic flow-chart of the local management agent

The management agent of the local modem receives manager's request (from the PC workstation), identifies operation code and destination (whether the request refers to local or remote modem), executes the command or forwards the command to the remote modem. Basic flow-chart is presented in Fig. 3.

The management agent of the remote modem permanently checks for the HDSL frame overhead to detect an O&M command. When it receives an O&M command, it executes the requested operation and returns the report to the local modem, through the HDSL frame overhead.

When the local or remote command is executed, the local management agent creates the appropriate report and forwards it to the manager (PC workstation).

The exchange of management information between local and remote PP-HTU2 modem is performed by means of Z bits [2] in the HDSL frame overhead. Fig. 4. illustrates the basic protocol implemented for the exchange of O&M information.

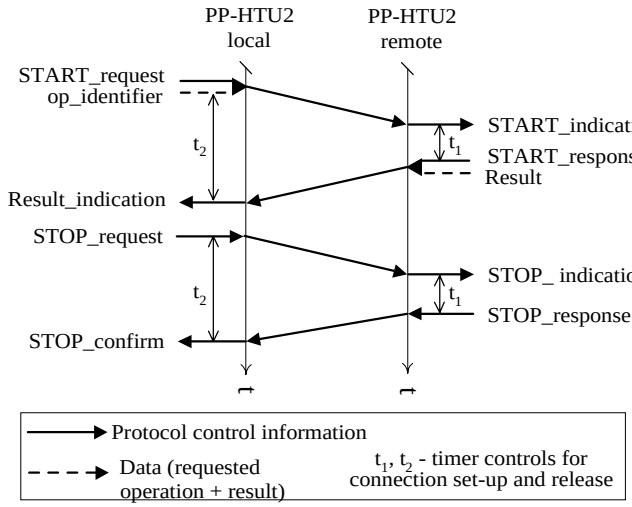


Fig. 4. Basic protocol for O&M information exchange

The procedure is slightly more complicated for BER testing. When the local management agent receives the command for BER test initiating, it forwards this command to the remote management agent. The remote agent then sends the appropriate test pattern. The local agent performs BER metering and forwards the test results both to the PC workstation and to the remote modem. The appropriate LED indicators should be turned on, in both modems, in accordance with the test results.

## VI. The Management Workstation

The manager is implemented as a proprietary PC Windows application, which encompasses the NML and SML layer functions. The application is developed using object-oriented design, in C++ programming language, by means of the MS Visual Studio 6.0 and relying on the standard MFC (Microsoft Foundation Classes). Supported operating systems are: Windows 95, Windows 98, Windows 98 SE, Windows 2000 and Windows NT.

The user interface is designed through a standard MS Windows graphic user interface.

The main menu consists of the following items:

- "Report" – enables standard Windows file manipulation, i.e. opening, closing, saving and printing of the report.

Report is a file containing all commands issued to an agent (modem), agent responses and error reports.

- "Commands" – enables the operator to select and send a request to the modem. The option "Special Commands" refers to an operation which should change the normal operation of PP-HTU2 system, e.g., BER test, AIS generation, control loopbacks. The access to special commands is allowed only to authorised persons, through a user password.
- "Options" – includes various options related to the program, e.g., parameters tuning (saving parameters, printing parameters), clear screen option, password change, etc.
- "Alarm" – displays the status of the alarm buffer, which contains alarm events and modem recovery events, sorted by date and time.
- "Help" – a standard MS Windows help system, containing detailed explanations of all program capabilities. Help is also available during manipulation with the program (by pressing the F1 button).
- "Exit" – enables the exit from the program.

Modem status as well as modem link status are permanently available on the top of screen.

Communication between the manager (PC application) and the agent (modem) is displayed as a pop-up dialogue and in the main window. Modem report or error report appears in a pop-up dialogue, as a response to the previous command. Error reports appear in red colour.

Besides, all events, sorted by date and time, are displayed in the main window. Thus, the operator can have an instant response to his request, but he can also inspect the report in the main window. The operator can optionally select the type of data that he wants to be displayed in the main window.

## VII. Future Work

Future work is focussed towards the design and development of the rack variant of PP-HTU2. Configuration of the PP-HTU2 system and the management system is depicted in Fig. 5. The idea is to extend the management system to DTE interfaces (e.g. PCM devices).

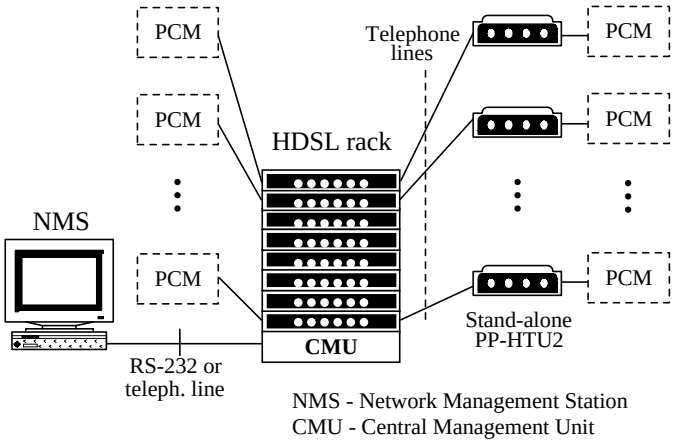


Fig. 5. The rack variant: configuration of the PP-HTU2 system

HDSL rack has to be equipped with a specific hardware and software, that is the Central Management Unit (CMU), which provides the interface between rack modems and the manager – NMS (Network Management Station). Communication between the CMU and the NMS should take place through the serial RS-232 interface or a pair of voice-band modems, over a telephone line.

The NMS software should provide significant extensions in comparison with the manager of a single point-to-point PP-HTU2 system, described in Section VI, particularly in design of the NML layer. The NML has to provide unified addressing of all network elements, editing of the graphical view of the network (network editor), permanent presence of the network view with status indications of individual element and each link between the two elements and a detailed graphical outlook of each individual element status.

Other extensions mainly concern the SML layer, particularly providing richer capabilities of handling statistical data. The later also includes the capability of performing analysis of statistical data (e.g. performance parameters, transmission quality parameters, etc.) periodically or on-demand and building of the appropriate reports.

## VIII. Conclusion

A solution of the management system for the HDSL equipment PP-HTU2 has been presented. The management system is designed according to ITU-T TMN concepts and the appropriate ETSI standard for HDSL equipment. The system consists of the PC Windows management station (manager) and management agents in HDSL modems.

The system should be extended to support multiple HDSL links, as well as the DTE equipment. The presented concept is generally applicable to design of management systems for xDSL equipment

## Acknowledgement

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