The Study of SDH STM-1 Add-Drop Multiplexer Architecture

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ABSTRACT In this paper, a flexible architecture is proposed for implementing SDH STM-1 Add-Drop Multiplexers (ADM-150). This system architecture is divided into two parts, transmission circuit packs and controllers. Transmission circuit packs provide the SDH standard traffic to flow on the fiber and the controllers are designed to meet the OAM&P requirements. The flexible TeleCOM-BUS-like bus architecture utilized in the ADM-150 allows a variety of E1 and E3 service mapping. The Unidirectional Path-Switched Ring (UPSR) configuration is also supported in this ADM-150 architecture.

I. Introduction

Synchronous Digital hierarchy (SDH) is proposed by ITU as a newly adopted worldwide transmission standard for the purposes of the mid-span meets (transmission equipment provided by different vendor can be connected directly), management of the entire network in term of the Operations, Administration, Maintenance, and Provisioning (OAM&P) via embedded operations channels (EOCs), and supporting the application interfaces. The SDH equipments can not only be used in point-to-point transmission system, but also in the loop carrier, local network, and long haul area to provide cost efficient management of the growth in bandwidth and provisioning of new customer services.

SDH Add-Drop Multiplexer (ADM) is the basic equipment in SDH which can be flexibly used in many applications. ADM can not only support existing digital signals (E1 and E3, ..., etc.) transportation, but provides a wide range of lightwave terminal equipments applications. This paper will focus on the system architecture design of the SDH STM-1 ADM (ADM-150) currently being devel-

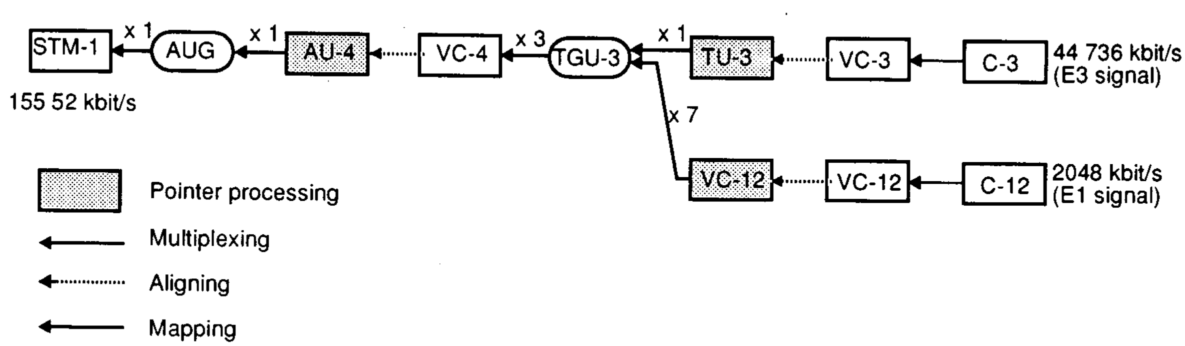

Fig. 1 Mapping Hierarchy Used in CCL's SDH ADM-150

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oped in Computer & Communication Research Laboratories (CCL).

II. System Architecture Design

II.A. System Functional partition:

Fig. 1 shows the mapping hierarchy used in CCL's ADM-150. This mapping hierarchy is a subset of that described in [1]. Based on this mapping hierarchy and Bellcore TR-TSY-000496, the SDH ADM-150 system can be partitioned into the following subsystems: Common Unit subsystem, Synchronization subsystem, Operation Interface Module (OIM) subsystem, High-speed Termination subsystem, and Low-speed Termination subsystem as shown in Fig.2 [2]. The functions of each subsystem are described as follows:

Common Unit Subsystem The common unit subsystem is responsible for controlling the system maintenance, administration, and provisioning. The maintenance functions consist of fault detection, fault isolation, and fault recovery to keep system working well. The administration functions consist of system administration and memory administration. The provisioning functions consist of system operation mode setting.

Synchronization Subsystem Timing for the synchronization to the ADM-150 is taken either from an external synchronization source, the received STM-1 signal, or from its local clock, depending on the network application. Also shown in fig. 2 is a synchronization interface (E1 interface) for a CO application with external timing.

Operations Interface Module Subsystem Operations Interface Module (OIM) provides local craftsperson access, local alarm indications, and an interface to remote operations systems. The SDH ADM-150 uses the OIM to connect to local or remote craftsperson interfaces, and to connect to required and optional operations links that allow maintenance, provisioning, and testing features.

High-Speed Termination Subsystem The ADM-150 interfaces two full duplex STM-1 signals to both the east side and the west side NEs. Each high-speed STM-1 interface is capable of transporting one AU-4 signal as defined in ITU G.709 [1]. The ADM-150 AU-4 SPE supports asynchronous E1 and E3 transport. High-speed termination also accesses and processes certain information carried in the SDH overhead.

Low-Speed Termination Subsystem The

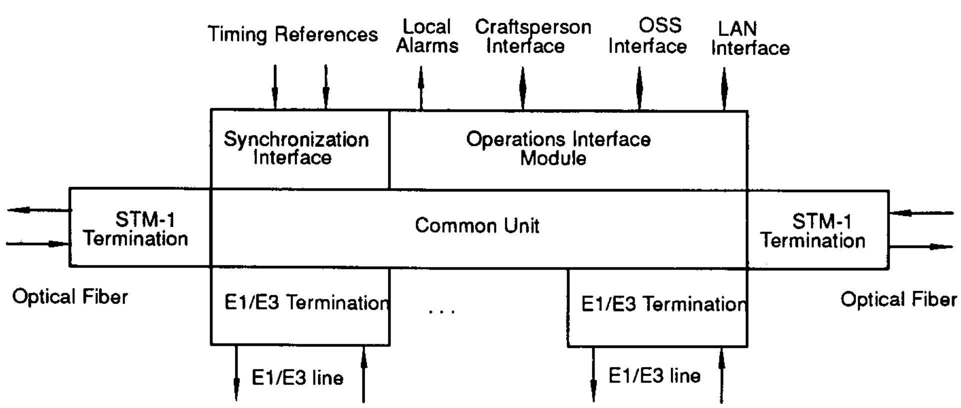

Fig. 2 The ADM-150 System Diagram

ADM-150 interfaces one or more full duplex E1 signals. The ADM-150 also provides low-speed E3 interfaces. The ADM-150 multiplexes up to 63 E1s or equivalent signals (e.g., 3 E1s) into an STM-1 bit stream. As shown in Fig.1, each TU12 is used to carry an E1 payload through the lower mapping path, while the E3s are mapped onto the VC-4 SPE via a predetermined VC-3 as depicted on the upper mapping path. The low-speed service is flexibly mapped onto the high-speed transport signal via the TeleCOMBUS-like bus interface.

II.B. System Architecture:

Some examples of SDH multiplexer block diagrams are described in ITU G.782 [3]. Based on the multiplexer Type IIIa in [3], the system architecture of CCL's SDH ADM-150 is derived as shown in Fig. 3. It mainly consists of two parts: transmission circuit packs and controllers. For transmission part, the system bus design is mainly based on the well-known TeleCOMBUS structure. The TeleCOMBUS-like bus structure eases the design of flexible service mapping and upgrading. In order to support Unidirectional Path-Switched Ring (UPSR) configuration, the low-speed mappers can be configured to dual feed the mapped services to both two ADD buses and drop a service from either DROP bus. The following subsections will describe the modules of the system.

E1 Mapper (E1M) E1M provides the interfaces between the bipolar E1 line signal and the 19.44 MHz TeleCOMBUS-like bus on the backplane. E1M converts the E1 bipolar line signal into TTL level 2.048 MHz clocks and 2.048 Mb/s data and maps the data to a pre-determined TU12 time slot in the VC-4 SPE, and vice versa. E1M also provides the controller interface to PMU for performance monitoring.

Low Speed Module, E3 (E3M) The E3M provides the interfaces between the bipolar E3 line signal and the TeleCOMBUS-like bus in the back-

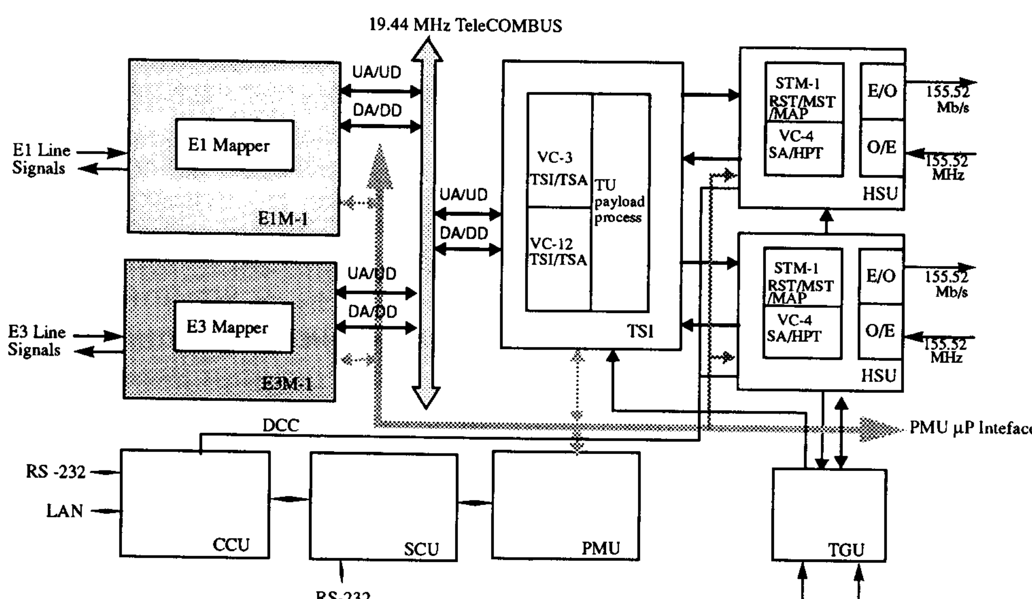

Fig. 3 ADM-150 System Architecture

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plane. The E3M provides bi-directional transportation of E3 signal by mapping the E3 signal to a predetermined VC-3 SPE and vice versa. E3M also provides interface to PMU for performance monitoring.

Time-Slot Interchange Unit (TSI) To efficiently and flexibly manage the bandwidth in SDH networks (e.g., an ADM UPSR). the TSI provides the time slot interchange and assignment (TSI & TSA) functions on a per VC-12 or VC-3 basis. It also provides the TeleCOMBUS-like bus interface for low-speed service mapping.

High-Speed Unit (HSU) The HSU is responsible for processing the Section Overhead (SOH) and Path Overhead (POH). HSU provides alarm detection and generation to PMU for performance monitoring. The DCC bytes, user byte (F1), and Orderwire byte (E1) are also extracted and inserted by the HSU. The E/O (electrical to optical converter) and O/E (optical and electrical converter) is responsible for transmitting and receiving the STM-1 optical signal.

Timing Generation Unit (TGU) The TGU is responsible for providing a 19.44 MHz clock and distributing it to the whole the ADM-150 shelf. The TGU generates the 19.44 MHz master clock from three clock sources: external E1 input (external timing mode), recovered clock (line timing & through timing modes), and local crystal oscillator (free running mode). The phase-locked loop circuitry is used to generate accurate timing. The selection of clock sources depends on the system applications and is controlled by PMU. The TGU also interfaces to PMU for performance monitoring.

Controller The ADM-150 controller architecture is logically hierarchical in two levels as shown in Fig. 4. The SCU is responsible for controlling the whole system for the functions in terms of OAM&P. The PMU is the execution unit for system maintenance, including alarm surveillance, performance monitoring (PM), TSI memory administration, and protection switch. The CCU provides the operations interfaces for remote and single-ended OAM&P activities. The operations interfaces include X.25 (OSS), Local Area Network (LAN), and DCC interfaces. The inter-board communications are through the dual-port RAMs which reside in the PMU and CCU boards, respectively.

System Control Unit (SCU) The SCU is a microprocessor-based monitor and control unit and responsible for processing system-wide information. It functions as the master relative to the PMU and CCU. SCU provides a RS-232 interface to craftsperson for local OAM&P. It handles the system maintenance and administration. It can show the system statuses and present the abnormal conditions to the craftsperson. SCU also interfaces to PMU for collecting performance monitoring, alarm, and protection switch information and to CCU for remote OAM&P.

Performance Monitoring Unit (PMU) The PMU is responsible for performance monitoring data collection. It interfaces to all the transmission circuit packs, TGU, and SCU. PMU replies the SCU with the performance monitoring data and reports the hardware packs/units abnormal conditions to SCU. The dual-port RAM is used for inter-board communication. To keep system running without interrupting the service, PMU also controls the protection switch mechanisms. It needs to detect the failures of circuit packs and activates the protection switch. The memory administration for TSI/TSA management is also performed in PMU.

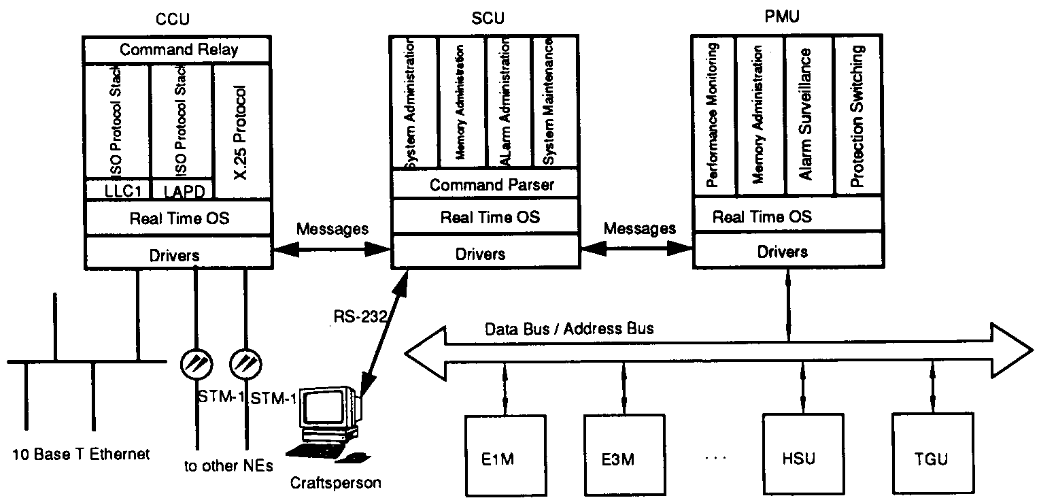

Fig. 4 STM-1 ADM-150 Controller Architecture

Communication Control Unit (CCU) In order to support the TMN internetworking and the operations interfaces, the CCU needs to provide the protocol stacks for forwarding, routing, and terminating messages. Based on the functional specifications, the CCU has to provide the X.25, DCC, and 10BaseT Ethernet interfaces. The X.25 interface is used for connecting to Operation Support Systems (OSS), which mainly manage the NEs. The DCC is used for CO to CO (inter-office) data communication and OAM&P operations. The Ethernet interface is used for local (intra-office) data communication and OAM&P operations. Remote OAM&P operations or single-ended maintenance is activated by the craftsperson. Craftsperson issues commands to SCU and SCU passes the commands to CCU through dual-port RAM. CCU encapsulates the commands with the protocol stacks and sends them out to corresponding targets.

III. Conclusion

In this paper, an SDH STM-1 ADM architecture being developed in CCL is described. This ADM architecture can be flexibly configured to convey a variety of low-speed services due to its highly modularized structure. The TeleCOMBUS-like bus design facilitates the future upgrading and service migration. The ADM-150 also provides complete control functions and interfaces for OAM&P and has the capability to support UPSR configuration for SDH network applications

IV. References

[1] International Telecommunication Union, ITU, "General Aspects of Digital Transmission System (G.709)," Mar. 1993

[2] Bellcore, "SONET Add-Drop Multiplexer Equipment Generic Criteria." TR-TSY-000496 Issue 2, Sep. 1989

[3] International Telecommunication Union, ITU, "General Aspects of Digital Transmission System: Terminal Equipments (G.782)," 1990

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