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Data Communication of Synchronous Digital Hierarchy over WAN

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Abstract: *Synchronous Digital Hierarchy (SDH) is a type of digital transmission system developed for providing a reliable and higher bit rate capacity for optical fiber. This work refers to the installation and commissioning of the TJ100CPr4 (Tejas Series) STM-1 Module in ring topology to Router 2811. This connection is tested for transmitting files on WAN Network. Thus, this work refers to the successful establishment of Ethernet and PCM Link providing respectively,100 Mbps and 2 Mbps data rates for transmission.*

Though similar work is already existing in the communication domain, this article provides technical documentation and a stepwise process for the practical implementation of the Synchronous Digital Hierarchy. The documentation provides insights for students of digital communication.

Key Words: *WAN, SDH, telecommunication, Data, Putty Configuration, PCM Link Tester, STM-1Module (TJ100CPr4), Router, Data transmission, Ethernet., Installation, Synchronous Digital Hierarchy.*

1. INTRODUCTION:

SDH is a standard for digital signal transmission that uses dedicated frames called Synchronous Transfer Modules (STM). The STM has at a variety of levels named STM-1 or 4 or 16, 64) for efficient signal transmission. The SDH also includes bytes for network maintenance and management, enabling dynamic network management and real-time monitoring.To implement SDH ,one has to be familiar with ADM and The TJ100CPr4

a) **The Add-Drop Multiplexer (ADM) :** ADM is a fundamental piece of equipment in SDH that can be employed in diversified services such as the transportation of existing digital signals and it offers a wide range of light wave terminal equipment applications. The ADM allows for the insertion and extraction of signals through a process called byte interleaving multiplexed mode, which reduces signal loss, equipment complexity, and cost.
b) **The TJ100CPr4**: It has been commonly used equipment for installation and commissioning in SDH networks and it is an STM-1 type that has services of DS3, E3, and E1. The SDH network is made up of network elements with a set of standard speed and frame structures, using different network equipment to increase network flexibility. The SDH signal transmission is possible with the synchronous transfer modules. The rate of transmission is as shown in table 1.

Table 1: The rate of transmission

Sr No	Type	Information rate
1	STM -1	155.52 Mbit/s
2	STM-4	622 Mbit/s
3	STM-16	2.5 Gbit/s

A standard for transmitting digital signals that use dedicated frames is called Synchronous Transfer Modules (STM). for efficient signal transmission, multiplex levels of 1,4, or 16 can be used with the Add-Drop Multiplexer.
ADM is a crucial component of SDH equipment that can be used in a variety of applications, such as the transportation of existing digital signals and it also offers a wide range of light wave terminal equipment applications. ADM enables the insertion and extraction of signals through a process called byte interleaving multiplexed mode, which reduces signal loss, equipment complexity, and cost. SDH also includes bytes for network maintenance and management which helps in dynamic network management and real-time monitoring. The TJ100CPr4 is a commonly used equipment for installation and commissioning in SDH networks.

2. LITERATURE REVIEW:

The article by Chia-wen Lin describes the benefits of using Add-Drop Multiplexing (ADM) in the SDH network. This technique allows for the easy addition or removal of network connections without impacting the overall system and also enables bypassing of the system to provide delay-free transmission. ADM is an important aspect of SDH architecture and it helps in the efficient and cost-effective management of the network. [1].
Cisco's (SDH) manual offers a primer on the “Synchronous Digital Hierarchy system” as well as an overview of the many customization possibilities for the STM-1 module [2].
The frame placement supervising systems for STM-1 are described in by D. Bajic,. The study also investigates some of the specific problems that can appear during the process of putting such a solution into action. [3].
"ITU-T Recommendation G.707," places the details of the requirements for the design of STM-N signals at the digital network.[4]
A unit-level, specifications , description of the TJ100CPr4 SDH network element, may be found in the "Tejas Instruments Manual on Hardware Description of STM-1 Module," which is available on Tejas Instruments' website. The Tejas family of products has TJ100CPr4 for synchronous fiber optic transmission.[5].

3. MATERIALS:

The TJ100CPr4 Module is a member of a group of products that are designed to deliver client services across SDH networks at a low cost through the aggregation of multiple services. It is a STM-1 product that is one unit high and has integrated E1, E3, and DS3 services in the base. The PXAT card is an additional component that provides two optical interfaces with STM-1 capacity and serves as a processor, cross-connect, aggregate, and tributary card.

Fig. 1- TJ100CPr4 STM-1 Module

In addition to, the PXAT provides additional E1 and E3/DS3 interfaces under three different configurations. The configurations are shown in following table 2.

Table 2 configurations

	Configuration	E1	E3/DS3 interface	FX+ FE
a	**C1:**	08	--	2 each
b	**C2:**	21	01	---
c	**C3:**	---	01	---

About TJ100CPr4 STM

TJ100CPr4 Front View with 8 E1 Interface and 2FE+2FX ports

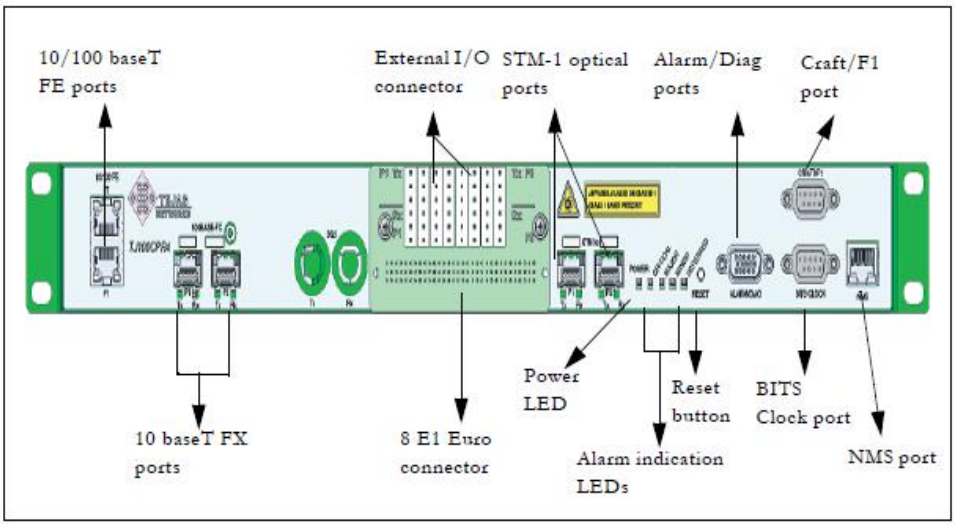

Fig. 2- Front Panel of TJ100CPr4 Module

TJ100CPr4 STM has 2 interfaces with support of optics and 3.3 volts supply on the board. Both AC and DC power supply can be used. The optical power is monitored thoroughly. 2.048 MHz clock is used as a reference for synchronization of nodes.

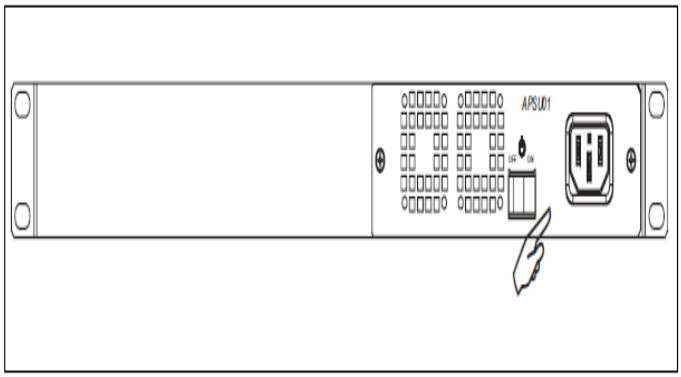

Fig. 3- Front Panel of TJ100CPr4 Module

When the signal gets lost next pulse is used as a trigger for reference. The conditions such as temperature greater than the threshold. opened door are indicated via alarms. .
Network Element (NE) user interface is useful to indicate dangerous situations with alarms.

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4. METHOD:

A) Installation: -Installation is done in three steps

1. The network element is unpacked
2. On the rack the chassis is mounted
3. Proper cabling is done wherever mentioned

B) Commissioning: - Commissioning is done in two steps

1. Operation
2. Performance Qualification

The steps of installation and commissioning can be summarized as in figure 4.

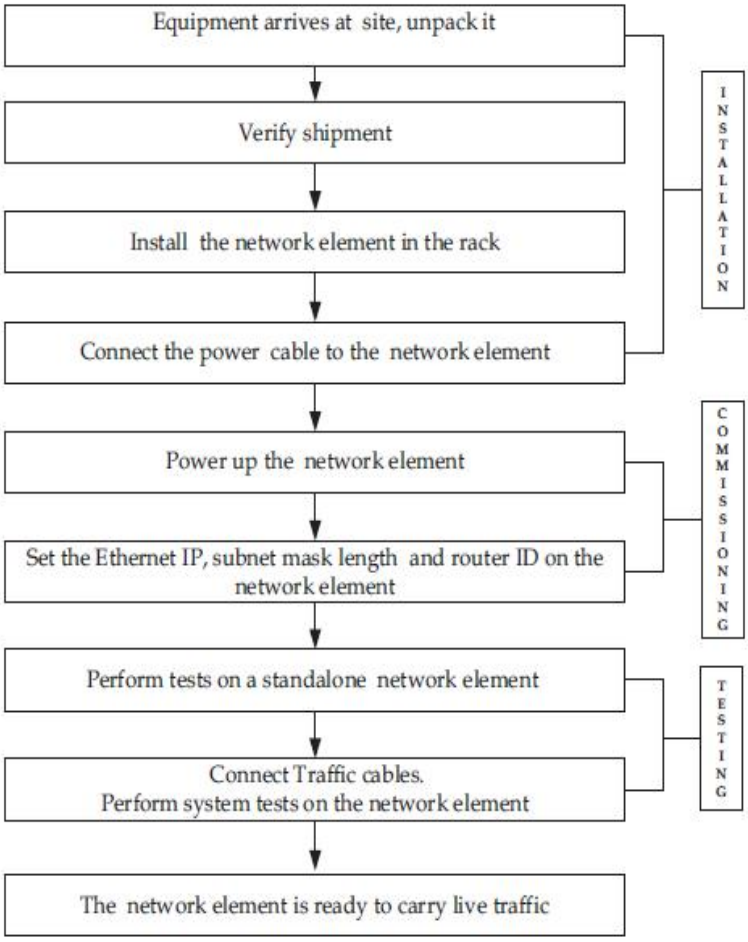

Fig. 4- Flowchart of Installation & Commissioning

C) Network Design:-For the implementation Ring toplogy is used .Each node is connected to two of its neighbors on both sides permitting data to flow in both directions,as per requirements. The design of interconnection could be for WAN or LAN . As per the type of configurations the varied.Network cards are utilised.

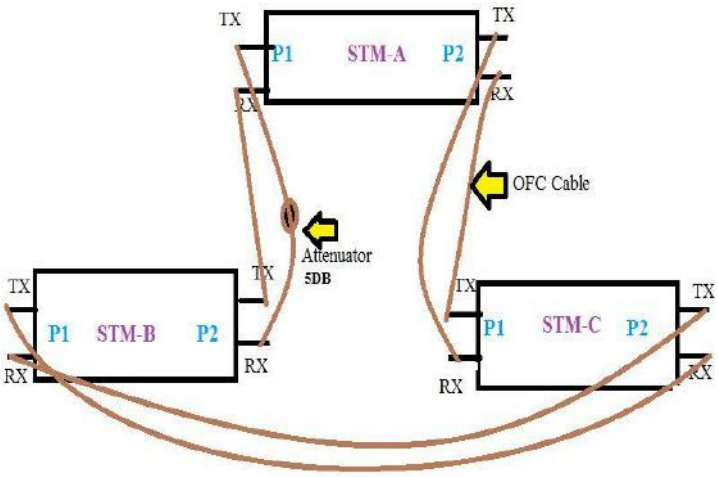

Fig. 5 :STM-1 Connection in Ring Topology

We have connected Ports of STM-A Device to Ports of STM-B as well as Ports of STM-C also. Like TX & RX of STM-A Port (P1) is connected to Port (P2) of STM-B TX & RX as shown in figure 5. As we have implemented the Ring topology, device a sends data in form of packets to next device depending on the direction chosen. The journey of packets happens by traversing ring path until the destination is reached.

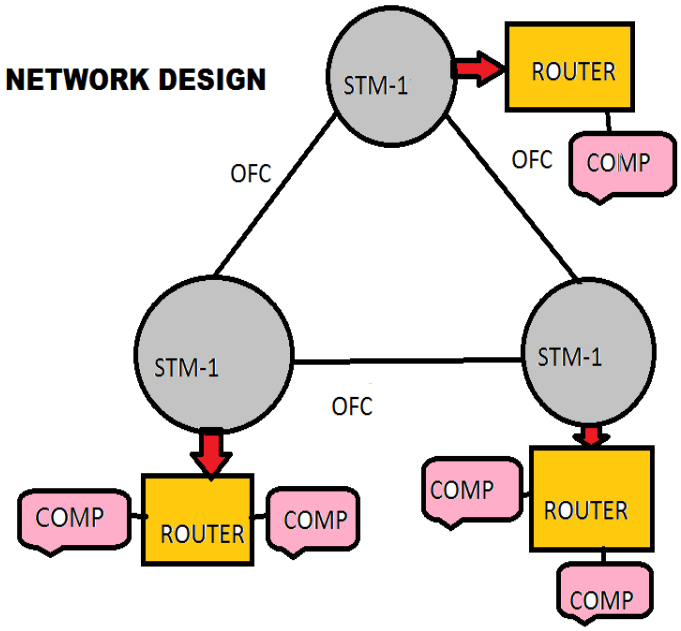

Fig. 6: Network Design

As shown in figure 6, STM1 modules are connected to routers, and computers using ring topology. The two important things in the ring topology implementation are as follows.

a) Faults and indications

The important feature in the implementation is finding the faults and alerting with alarms. The alarms are activated as per the level of errors like critical errors, minor errors, etc. The system is providing the obtain to stop and refresh or report the event to the control unit, or to show the warnings

b) _PCM Link Tester

There is a need of measuring errors in the links. With loopback method, error count is measured for implementing the PCM Link Tester.

Fig 7:PCM Link Tester

The PCM link printer appears like any other electronics lab equipment but has an in-built printer in it. The equipment is useful for maintenance testing purposes.

5. RESULTS & DISCUSSION:

We have implemented a ring topology TJ100CPr4 STM Module. Router 2811, a Fast ethernet cable, and a PCM tester are used for implementation.

Table 3: The test is done on the active network with PCM Link and Ethernet cable

Parameter	Actual Data Rate	Measured Data Rate	Error Count
1. Ethernet cable	100Mbps	100 Mbps	0%
2. PCM Links	2 Mbps	2 Mbps	0%

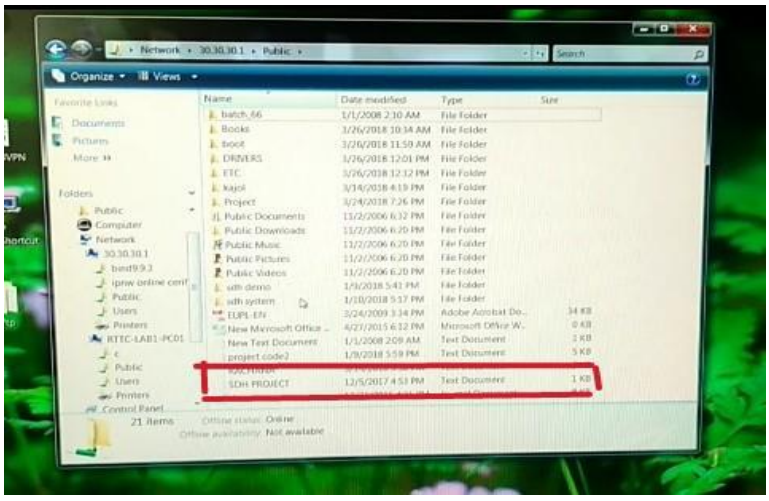

Fig.8- File Received at Network to destination B

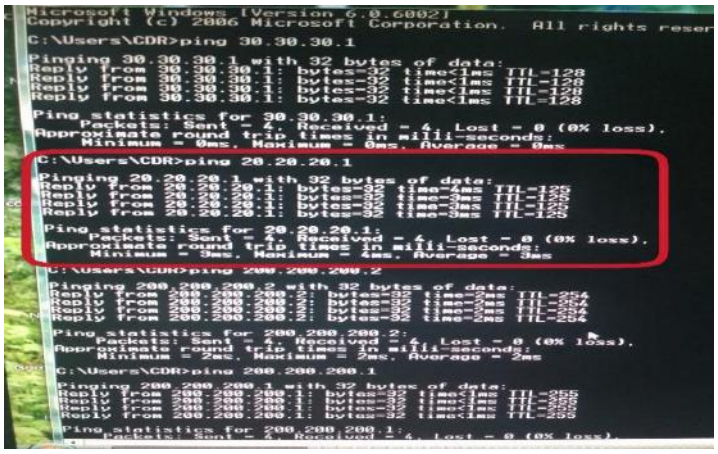

Fig. 9:View on Command Prompt

Fig-8 shows we have used a command prompt to the check connection between two networks using the “Ping” command. Using this command to check whether network A is connected to B or not through IP Address that we have assigned during configuration. If the command is successful then we received Lost-0. These results are shown in above fig.9

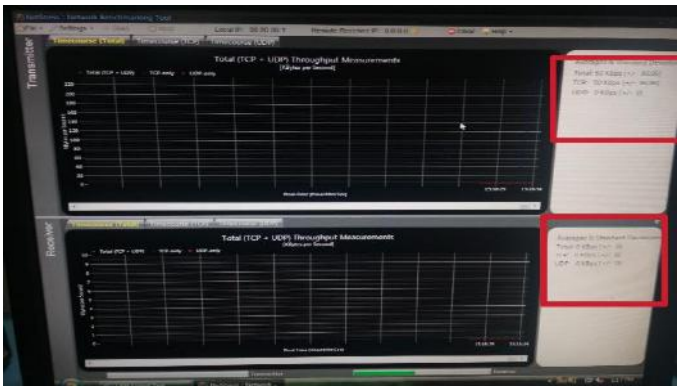

Fig.10- Result of LAN Speed Tester Software

Fig-10 shows the speed that we measured on LAN Speed Tester Software Successfully.

Fig.-11 Back Panel of Cisco router 2811

Fig.-12 Front Panel of Cisco router 2811

The overall cost of this system is about 4,70 lakhs Indian rupees.

Table. 4- Bill of Material

Sr. No	component	Cost	Quantity	Total Cost in Rs./-
1	TJ100CPr4 STM Module	35000/-	3	1,05,000/--
2	Router 2811	1,19,473/-	3	3,58,419
3	Fast Ethernet cable	170/-	4	680/-
4	Cable Tester	5,500/-	1	5500/-
				4,69,599/-

6. CONCLUSION :

In This work, we have transmitted Data over WAN Network through an optical fiber cable which is connected to SDH STM-1 Network Elements. We can achieve the Desired Data Rate by combining the PCM Link Directly.
We have used 1 PCM link to connect station 1 to many others.
PCM is offering 2 Mbps data rate and Actual Data communication over SDH Optical Fiber Cable Network with a Data Rate of 2 Mbps has No Error Loss. Also, we have tested the Protection of Network Successfully.

Table 5- Different STM Module standard Bit Rates

SDH LEVELS	BIT RATE
—	51.84 Mbps
STM-1	155.52 Mbps
STM-4	622.08 Mbps
—	1244.16 Mbps
STM-16	2488.32 Mbps
STM-64	9953.28 Mbps

Though this work is implemented in practice by world years ago, the paper is an attempt to document the stepwise procedure for the practical implementation of the SDH.

7. FUTURE SCOPE:

The documentation is mainly useful for academic study. The data transmission process and digital communication with synchronous digital hierarchy are documented here. The future scope of our work is to maximize the data rate from 155.52 Mbps up to 9953.28 Mbps by using a different STM Module. We can transmit files with a higher data Rate. The further experimentation of alternatives to software or hardware techniques of synchronous digital hierarchy will be a great achievement in the telecommunication field.

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