Special Article on Link Systems
Realization of Low-Bit Rate Circuit Multiplexer (L-MUX)

We have realized L-MUX as a link system compactly equipped with functions such as multiplex, cross connect and interface conversion with exchange equipment, in order to apply to short-haul transmission networks and common channel signalling networks.
This paper describes function outline of the equipment and the main technology being applied.

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Preface

In order to cope with a rapid increase of cellular phone traffics for PDC (Personal Digital Cellular Telecommunication System), construction of short-haul transmission networks between exchanges and base stations and common channel signalling networks has been promoting. This short-haul transmission network is a high-bit rate transmission network with 50Mbit/s path, and low-bit rate circuits (less than 6Mbit/s) such as access circuits and pager control circuits are concentrated at CN (Connection Node). L-MUX (Low-Bit Rate Circuit Multiplexer) is realized as a multiplex equipment for STM (Synchronous Transfer Mode), efficiently multiplexing these low-bit rate circuits to 50Mbit/s path and equipped with switching function.

This paper describes background of the realization of this equipment, the outline of this equipment's function and main technology to be applied.

Background of the Realization

The following main problems lay in the existing transmission equipment in examining construction of short-haul transmission networks and common channel signalling networks.

① Due to constraints of fixed mapping lay in the existing transmission equipment, low-bit rate circuits are not efficiently accommodated with high-bit rate path. (In case of 1.5Mbit/s, accommodation efficiency is 42%).

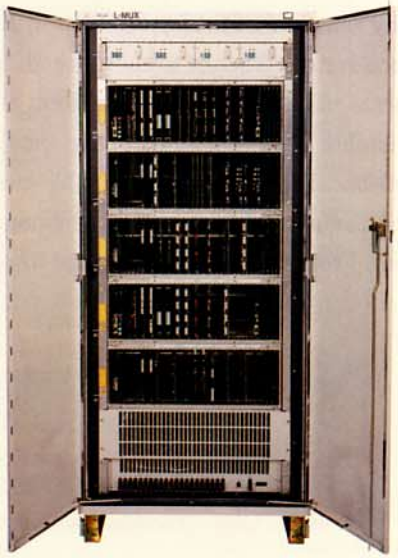
② As there are I interface (ITU-T I431a) besides existing intra-office interface, inter-equipment interface at CN station of short-haul transmission network, eqipment to connect these interface to directly doesn't exist.

③ Service consisting of 1 HW (High Way) at base station cannot provide service at the time of transmission network failure.

In order to solve these problems, we realized L-MUX, which has accommodation ratio of 100% by full mapping, has I interface, has function to connect directly with SDH (Synchronous Digital Hierarchy) as well as to switch for saving path at the time of transmission network failure.

Outline of Equipment

L-MUX is a multiplexer which has cross connect function over 2,400 CHs per equipment, and has multiplex conversion function connecting any interface with 64kbit/s and enables



Picture 1 Photograph of L-MUX Front

to connect with NTT leased lines.

The photograph of L-MUX front and the main parameters of L-MUX are shown in Picture 1 and Table 1, respectively, and L-MUX equipment configuration is described in (Figure 1).

L-MUX is composed of basic unit and extension unit, and the unit is split into blocks which can mount interface with the same kind of circuit speed, considering improvement of operation and maintenance and simplifying equipment management.

L-MUX has interfaces from 64kbit/s to 150Mbit/s, accom-

Table 1 Parameters of L-MUX

Item	Parameters		
Cross Connect Capacity	2,400CHs or more (bi-directional passing capacity)		
150Mbit/s Optical Interface	intra-office (1.31 μm, 400m), inter-office (1.31 μm, 40km/1.55 μm, 80km/1.31 μm, 80km)		
50Mbit/s Optical Interface	intra-office (1.31 μm, 400m), inter-office (1.31 μm, 40km/1.31 μm, 80km)		
6.3Mbit/s Optical Interface	6.3M OIF1L1	HSD (service of NTT leased lines) 1.5M/6.3MDSU point U for short distance	
6.3Mbit/s Electric Interface	6.3M EIF1	Secondary User-Network Interface point T	
2Mbit/s Electric Interface	2M EIF1	For 2Mbit/s intra-office	
1.5Mbit/s Electric Interface	1.5M EIF1	Primary User-Network Interface (ITU-T I.431a) point T	
Subscriber Interface	144K OCU	Point U for HSD64/128	
	PRI-C	Primary User-Network Interface (ITU-T I.431a) point T	
	LBRI	Basic User-Network Interface (ITU-T I.430a) point U	
	144K IF1	Basic User-Network Interface (ITU-T I.430a) point T	
	144K IF2	Basic User-Network Interface (ITU-T I.430a) I-DSU	
	CH-P	VF OCU 64KIF	
Test Functionality	Circuit test by PN pattern signal		
Redundancy Configuration	Interface Part	section/path	With redundancy (current 1 : spare 1), without redundancy
		package	With redundancy (current N : spare 1), without redundancy
	Clock Part		With redundancy (current 1 : spare 1)
	TSW Part		With redundancy (current 1 : spare 1)
Monitoring Control Interface	Logical Interface : S Interface Physical Interface : Ethernet (Protocol is TCP/IP)		
Reception Clock	64kHz+8kHz (−0.4kHz)		
Power supply Condition	DC−48V		
Frame Configuration	HiPAS mounted		

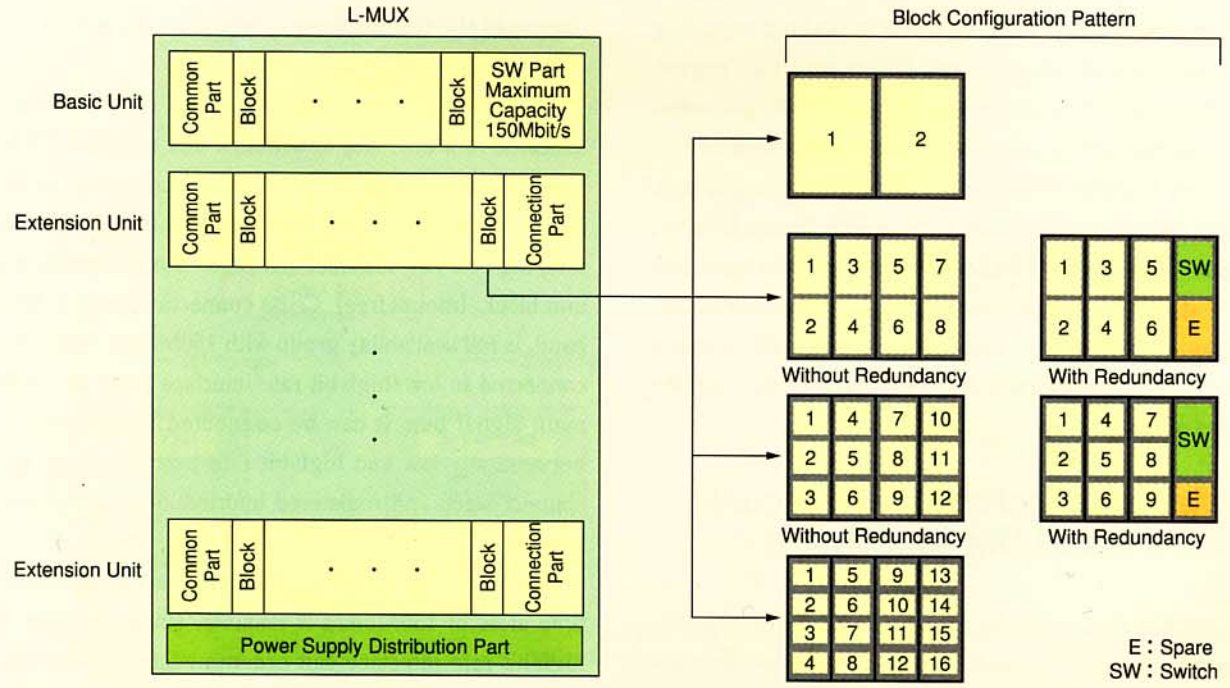


Figure 1 L-MUX Equipment Configuration

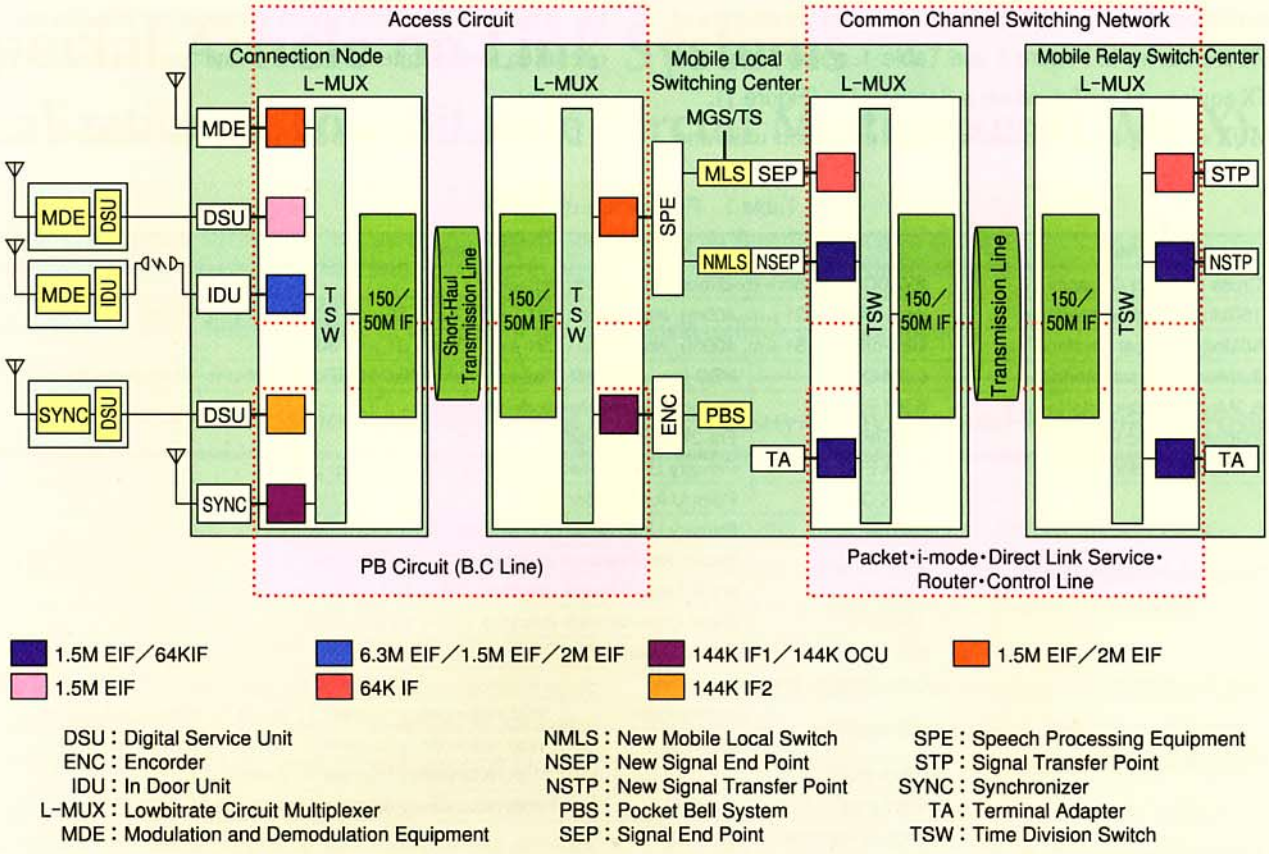


Figure 2 L-MUX Application Example for Service Nodes

modating various circuits and easily realizes cross connection (such as changing accommodation, etc) of more than 2,400CHs. As for redundancy function, current N : spare 1 switching function of point T interface is realized regarding some kind of low-bit rate packages. At the same time regarding 50Mbit/s, 150Mbit/s interfaces of high-bit rate packages, accommodated path can be saved through 2 kinds of switching function (current 1 + spare 1) ; section switching or path switching by using information bit of a path frame. Besides, clock and Time Division Switching packages also have current 1 + spare 1 switching function. Thus, at the time of current channel failure, it is automatically switched to spare channel and improves reliability. Figure 2 shows applied examples of L-MUX.

Full Mapping Technology by Mount-Free and Cross Connection

At L-MUX, a mount-free by means of 150Mbit/s main signal bus within frame unit and a full availability group cross connection with 150Mbit/s capacity, configuring to TSW (Time Division Switch) -SSW (Space Division Switch) -TSW, were adopted. Each low-bit rate signal is therefore, randomly multiplexed (mapped) toward high-bit rate signal of 50M, 150Mbit/s and facilitates easy cross connection. Figure 3 illustrates the full mapping composition by mount-free and cross connection.

At low/high-bit rate interface parts, required bands are allocated to a time slot of 64kbit/s unit to which 150Mbit/s main signal bus is designated, but by common use of main signal bus at 150Mbit/s between intra-frame units, low-bit rate/high-bit rate interface packages can be mounted at any unit block. (mount-free). Cross connection part, on the other hand, is full availability group with 150Mbit/s capacity and is connected to low/high-bit rate interface parts by 150Mbit/s main signal bus. It can be connected between time slots between any low and high-bit rate part according to cross connect setup and registered information that operator designated.

Therefore, full mapping that can be accommodated in all time slots of 150Mbit/s is feasible, since any time slot of high-bit rate interface can accommodate without any constraint about position for mounting low-bit rate part package. Realization of cross connection is also facilitated.

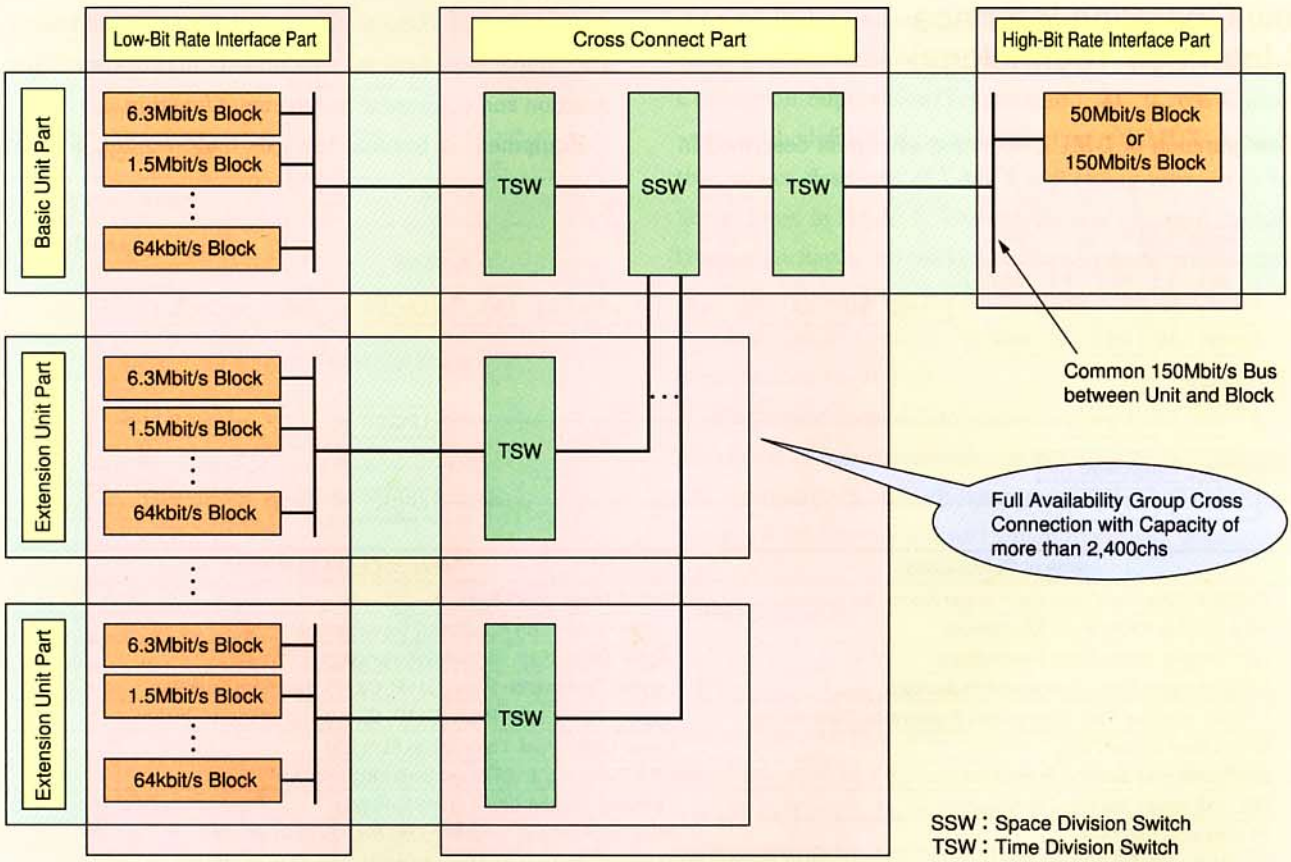


Figure 3 Full Mapping Composition by Mount Free and Cross Connect

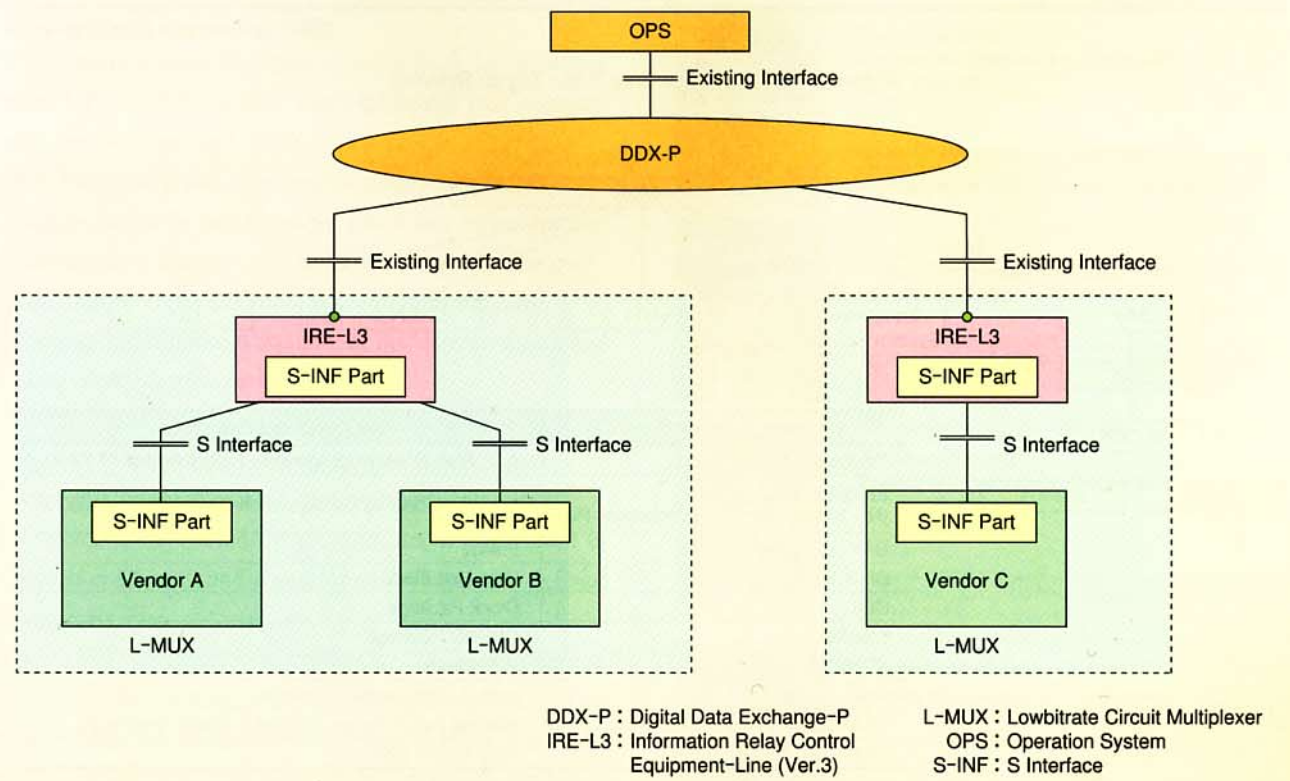
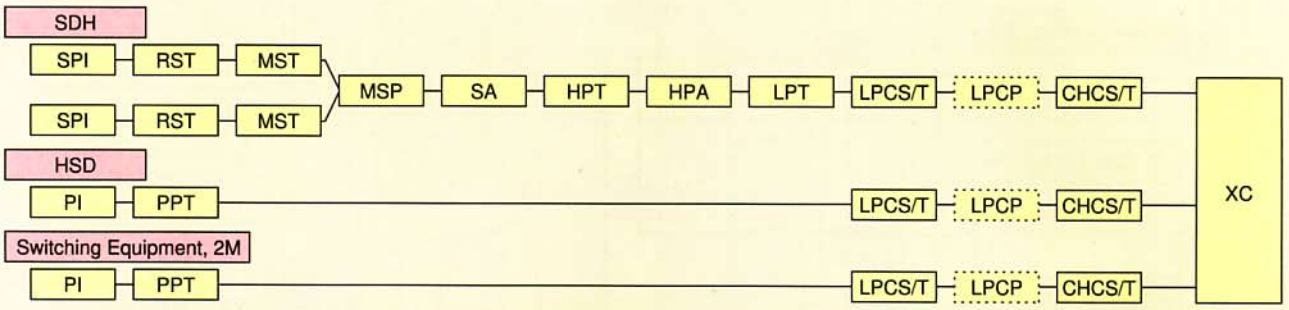


Figure 4 L-MUX Operation System Configuration

New Operation Interface (S Interface Technology)

Configuration of L-MUX operation system is described in Figure 4. Monitoring and controlling of equipment are conducted via IRE (Information Relay Control Equipment), an OPS (Operation System) that mounts network management function and equipment management function.

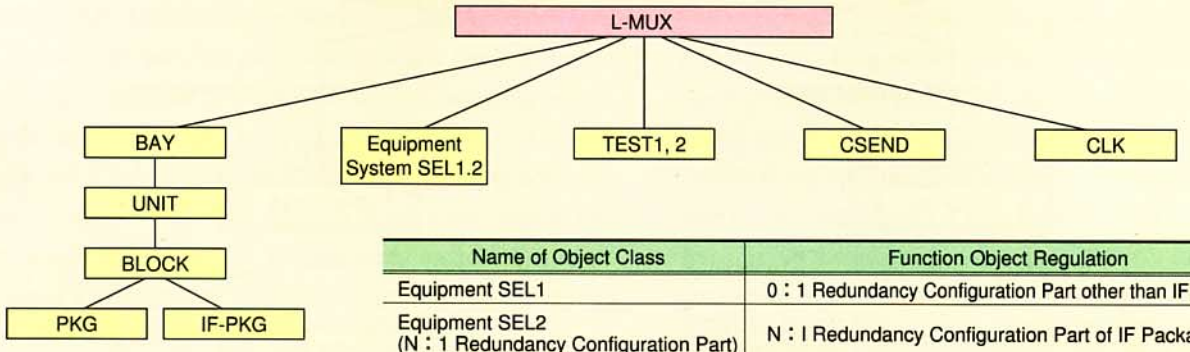
Equipment is heading towards multi-vendor, S interface



Name of Object Class	Function Object Regulation
CHCS/T (Channel Connection Supervision/Termination)	Circuit Termination Function
HPA (Higher Order Path Adaptation)	Higher Order Path Adaptation Function
HPT (Higher Order Path Termination)	Higher Order Path Termination Function
LPCP (Logical Path Connection Protection)	Logical Termination Pass (C11P, C21P) Switching Function
LPCS/T (Logical Path Connection Supervision/Termination)	Logical Termination Pass (C11P, C21P) Termination Function
LPT (Lower Order Path)	Lower Order Pass Termination Function
MSP (Multiplex Section Protection)	APS Switching and Forced Switching from OPS
MST (Multiplex Section Termination)	Terminal Section Termination Function
PI (Physical Interface)	Physical Interface Function other than SDH Interface
PPT (Physical Path Termination)	Physical Termination Function other than SDH Interface
RST (Regenerator Section Termination)	Relay Section Termination Function
SA (Section Adaptation)	AU Pointer Termination/Insert
SPI (SDH Physical Interface)	Physical Termination Function of SDH Interface
XC (Cross Connect)	Cross Connect Function

SDH : Synchronous Digital Hierarchy

Figure 5 Object Class Tree (Main Signal System)



Name of Object Class	Function Object Regulation
Equipment SEL1	0 : 1 Redundancy Configuration Part other than IF Package
Equipment SEL2 (N : 1 Redundancy Configuration Part)	N : I Redundancy Configuration Part of IF Package
BAY (Equipment)	Frame
BLOCK	Intra-Unit Block
CLK	Clock Package
CSEND	CSEND Package
IF-PKG	IF Package
PKG	F/W of CPU Loaded Package
TEST1, 2	Internal Test Function of SDH and HSD Interfaces
UNIT	Intra-Frame Unit

Figure 6 Object Class Tree (Equipment System)

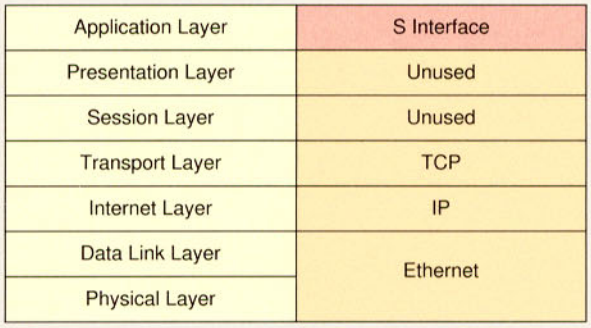


Figure 7 S Interface Protocol Stack

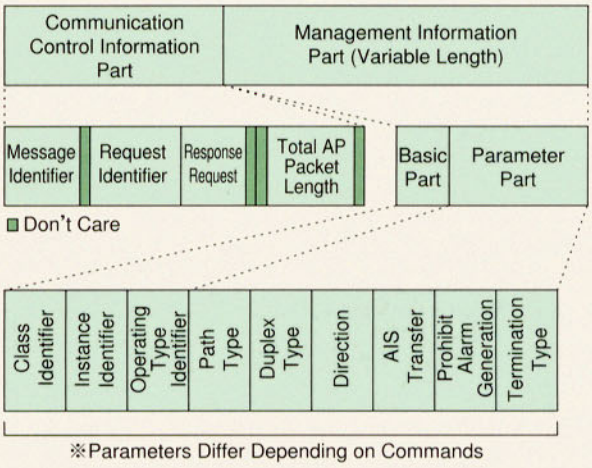


Figure 8 S Interface Telegram Format

with following characteristics was adopted as interface between OPS (including IRE) and equipment that compatible with this tendency at L-MUX.

① Flexibly coping with changes in operation contents
② Improvement in development efficiency of equipment management function part and equipment function part
③ Centralization of equipment management software
④ Flexible installation of equipment management part and equipment function part
⑤ Independent technical development of equipment management function part and equipment function part
⑥ Applying to function of newly developed equipment

S interface is expressed by all functions of equipment in FO (Function Object), and a unit for each function is defined as object class.

Object class has definitions expressing logical communication function and physical equipment function. Object class tree expressing communication function of L-MUX is given in Figure 5. Considering SDH transmission network termination function, logical block defined in ITU recommendation G782 was used, but physical PPT (Path Termination), LPCS/T (Logical Path Connection Supervision/Termination), LPCP (Logical Path Connection Protection), CHCS/T (Channel Connection Supervision/Termination), XC (Cross Connect) were newly defined as peculiar function of L-MUX. As well as this, object class tree of L-MUX expressing equipment function is given in Figure 6. The condition of mounted packages, types of packages and package unit correspond to this category. Protocol stack of S Interface is shown in Figure 7. S Interface operates as upper application of TCP and information is transmitted via TCP/IP.

Telegram format of S Interface is shown in Figure 8. It is composed of communication control information part which has information to realize communication management, and management information part which has object information.

Conclusion

This paper described L-MUX that multiplexes STM signals compatible with PDC traffic. On the other hand, we have just started to realize equipment that multiplexes ATM signals toward IMT-2000. In line with the future trend of transmission network, we are planning to substantiate link system equipment such as economizing optical 2.4G system and improving optical connectors, etc.