BLACK BOX Catalogue Ltd
The Source for Connectivity

ISU9950 – Basic Unit with 1PRI/4BRI Lines activated
ISU995066 – to activate Built in SNMP agent
ISU995068 – to activate PRI port 2
ISU995070 – to activate BRI Ports 5 to 8

IntelliMux
User Guide

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Australia:

Black Box Network Services Australia P/L

Tel: 03-9879-7100
Fax: 03-9870-2955
Web Site: www.blackboxoz.com.au

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Declaration of Conformity

issued according to ISO/IEC Guide 22 and EN45014 under the sole responsibility of the manufacturer

BLACK BOX declares that the product:

Product name

IntelliMux

provided that it is installed, maintained and used in the application for which it is intended for, with respect of the "professional practices", relevant installation standards and manufacturer's instructions is in conformity to all applicable essential requirements of all applicable directives and conform to the following Product Specifications:

- EN60950 : 1992 (A1+A2+A3) Class II
- EN55022 : 1994 (A1+A2:1997) Class B
- EN50082-1 : 1992

complies with the provision of the **R&TTE** Council Directive **1999/5/EC** annex II.

The product may be connected to the following EEC Operators Recognised Interface(s):

I-411, I-412, I-430, I-431, G703, G704, Q931, Q932

The product is compliant with:

TBR4

Additional information: The product has been tested in a typical configuration.
The Technical File is kept at the Manufacturer's Premises:
15 Cradock Road, Reading, Berkshire RG2 OJT

Statement:	The IntelliMux may be used in the European Community provided that it is installed , maintained and used in the application for which it is intended for , with respect to the professional practice , relevant installation standards and manufacturer's instructions (see also CE declaration of conformity).
Destination of use:	The IntelliMux allows direct connection of PRI,BRI and 10-BaseT Ethernet LAN
Restricted use:	No function featured by the IntelliMux is of restricted use in the European Community.
Interfaces:	The IntelliMux may be connected to the following EEC Operators Recognised Interfaces:I-411, I-412, I-430, I-431, G703, G704, Q931, Q932.

Verklaring:	De IntelliMux mag gebruikt worden binnen de Europese Gemeenschap op voorwaarde dat het wordt geïnstalleerd , onderhouden en gebruikt voor de toepassing waarvoor het ontworpen is , met betrekking tot het professioneel gebruik , de relevante installatie richtlijnen en de richtlijnen van de fabrikant (zie ook de CE verklaring van conformiteit).
Toepassingsgebied:	De IntelliMux laat directe verbinding toe met PRI,BRI en 10-BaseT Ethernet LAN.
Beperkt gebruik:	Er is geen enkele functie aanwezig op de IntelliMux die niet gebruikt mag worden binnen de Europese Gemeenschap.
Interfaces:	De IntelliMux mag aangesloten worden op de volgende door de EEC operatoren erkende interfaces: I-411, I-412, I-430, I-431, G703, G704, Q931, Q932.

Déclaration:	Le IntelliMux peut être employé dans la Communauté Européenne à condition qu'il soit installé, entretenu et utilisé dans la fonction pour laquelle il a été conçu, en suivant les règles de pratique professionnelles, les standards d'installation d'application et les instructions du fabricant (voyez aussi la déclaration CE de Conformité).
Domaine d'utilisation:	Le IntelliMux permet la connexion directe de PRI,BRI et de 10-BaseT Ethernet LAN.
Restrictions d'usage:	Aucune restriction d'usage n'est d'application dans la Communauté Européenne en ce qui concerne les fonctions offertes par le IntelliMux.
Les interfaces:	Le IntelliMux peut être connecté aux Réseaux des Opérateurs de la CEE offrant les Interfaces reconnues suivantes: I-411, I-412, I-430, I-431, G703, G704, Q931, Q932.

Erklärung:	Der IntelliMux darf in der europaïschen Gemeinschaft benutzt werden, vorausgesetzt, er wird installiert, unterhalten und in der Funktion benutzt für die er entwickelt wurde, in dem die Regeln der Berufsausführung, sowie die vorgeschriebenen Installationsstandards und die Anweisungen des Fabrikanten berücksichtigt werden (siehe hierzu die Konformitätserklärung der EG).
Anwendungsbereich:	Der IntelliMux erlaubt die direkte Verbindung PRI, BRI und 10-BaseT Ethernet LAN.
Anwendungs-beschränkung:	In der europaïschen Gemeinschaft gibt es keine Anwendungsbeschränkung bezüglich der Funktionen die der IntelliMux bietet.
Verbindung:	Der IntelliMux darf an die Operatorennetzwerke der EWG angeschlossen werden die folgende 'Interfaces' bieten: I-411, I-412, I-430, I-431, G703, G704, Q931, Q932.

Declaración:	El IntelliMux puede usarse en la Comunidad Europea con tal de que sea instalado, mantenido y usado en la aplicación para la cual ha sido destinado ,con el respeto del las prácticas profesionales, normas de la instalación pertinentes e instrucciones del fabricante (también vea declaración de CE de Conformidad).
Destino de uso:	El IntelliMux permite la conexión directa de PRI, BRI redes Ethernet 10BaseT LAN.
Uso restringido:	Ninguna función ofrecida por el IntelliMux es de uso restringido en la Comunidad Europea.
Interfaces:	El IntelliMux puede conectarse a los Operadores de la CEE que ofrezcan los siguientes sinterfaces reconocidos: I-411, I-412, I-430, I-431, G703, G704, Q931, Q932.

Dichiarazione:	Il IntelliMux può essere usato nella Comunità Europea a condizione che sia installato, manutenuto ed usato nella applicazione per la quale è destinato, con rispetto delle pratiche professionali, degli standard di installazione attinenti e delle istruzioni del Costruttore (vedere anche la dichiarazione CE di Conformità).
Destinazione di uso:	Il IntelliMux permette il collegamento diretto di PRI, BRI reti 10-BaseT Ethernet LAN.
Uso ristretto:	Nessuna funzione offerta dal IntelliMux è di uso ristretto nella Comunità Europea.
Interfacce:	Il IntelliMux può essere collegato agli Operatori di Telecomunicazione della CEE che offrono le seguenti interfacce: I-411, I-412, I-430, I431, G703, G704, Q931, Q932.

General description

Introduction

Congratulations with the acquisition of your IntelliMux**: the Black Box smart BR and PR ISDN multiplexer.**

This equipment has been designed and produced according to our ISO 9001 certified Quality system to assure a first quality and highly reliable product.

This User Guide describes the IntelliMux which manages **least cost ISDN routing** (LCR) and **least cost ISDN switching** (LCS) for voice and data and solves the number portability problem. the IntelliMux is delivered in a table top housing with an external AC/DC power adapter.

Safety considerations

The following safety considerations apply to the IntelliMux equipment:

- The installation of this equipment is to be performed by qualified service personnel.
- The content of this document is directed towards qualified service personnel.
- This equipment is intended for in-house stationary use. It my not be subjected to water or condensation. It must be protected from excessive sand and dust.
- This equipment is not intended to be connected to an IT type power system. The socket outlet for this equipment must be near this equipment and must be easily accessible.
- The external power adapter must be put on free space for cooling purposes.
- The protective earth terminal on the equipment's backpanel must be connected to earth using an appropriate eyelet, fixed to a wire of at least 0.75 mm^2.

Power adapter:	use only:	AC/DC: HITRON HES 40B-10 DC/DC: POWERTECHNICS PT314
Power cord:	use only:	HO5 VV F 3G 075 cord
Circuit classification:	PR1 .. PR2:	TNV1
	BR1 .. BR8:	TNV1
	Control:	SELV
	Ethernet:	SELV

IMPORTANT SAFETY INSTRUCTIONS

Unplug the unit from the wall power outlet before installing.

To assure the safety of this product, the protective earth terminal on the equipment's backpanel must be connected to earth. Properly fix an eyelet at the end of an earth wire of at least 0.75 $mm^{2,}$. Fasten the eyelet tightly to the terminal by means of the appropriate screw.

SAFETY WARNING

To avoid damage to the equipment, please observe all procedures described in this chapter.

Ensure that the unit and its connected equipment all use the same AC power and ground, to reduce noise interference and possible safety hazards caused by differences in ground or earth potentials.

Unpacking

Rough handling during shipping causes most early failures. Before installation, check the shipping cardboard box for signs of damage. If the box is damaged, please place a claim to the carrier company immediately.

Selecting a site.

WARNING

Always place the unit on its feet without blocking the air vents.

Do not stack multiple units directly onto each other, as stacking can cause heat build-up that could damage the equipment.

Install the unit in an area free of extreme temperatures, humidity, shock and vibration.
Position it so that you can easily see and access the front panel and its control indicators.
Leave enough clearance at the back for cables and wires.
Position the unit within the correct distances for the different accesses and within 2m of a power outlet.

Installation and connection precautions.

The installation of this equipment is to be performed by qualified service personnel.
The content of this document is directed towards qualified service personnel.

ESD WARNING

The circuit boards are sensitive to electrostatic discharges (ESD) and should be handled with care. It is advisable to ensure an optimal electrical contact between yourself, the working area and a safety ground before touching any circuit board. Take special care not to touch any component or connector on the circuit board.

EMC WARNING

EMC compliant installation

The complete IntelliMux is fully EMC compliant. To ensure compliance with EMC directive 89/336/EEC, shielded cables have to be used.

NOTE

This equipment may be powered by an IT power system.

Abbreviations

Throughout this User Guide the following abbreviations are used:

2M	2 Mbit/s
64k	64 kbit/s
AC	Alternating Current
AIS	Alarm Indication Signal
ANSI	American National Standards Institute
AOC	Advice Of Charge
BRI	Basic Rate Interface
CLIP	Calling Line Identification Presentation
CLS	CLear Screen
CRC4	Cyclic Redundancy Check 4
CTS	Clear To Send
CSP	Carrier Select Prefix
DC	Direct Current
DDI	Direct Dialling In
DTE	Data Terminal Equipment
DCE	Data Circuit-terminating Equipment
EMI	Electro Magnetic Interference
EMC	Electro Magnetic Compatibility
EN	European Norm
EPROM	Erasable Programmable Read Only Memory
ETSI	European Telecommunication Standards Institute
FAS	Frame Alignment Signal
FE1	Fractional E1 (< 2Mbit/s)
FPR	Fractional Primary Rate
HB	Heart Beat
HTTP	Hypertext Transfer Protocol
HW	HardWare
IEEE	Institute of Electrical and Electronic Engineers
IMX	ISDN MultipleXer
ISDN	Integrated Services Digital Network
IPCP	IP Control Protocol
LAN	Local Area Network
LCP	Link Control Protocol
LED	Light Emitting Diode
LFA	Loss of Frame Alignment
LOS	Loss Of Signal
MIB	Management Information Base
MFAS	Multi Frame Alignment Signal
MSN	Multiple Subscriber Numbers
NFAS	Non Frame Alignment Signal
NMS	Network Management System
NLO	New License Operator

NT	Network Termination
PAP	Password Authentication Protocol
PPP	Point to Point Protocol
PRI	Primary Rate Interface
RAI	Remote Alarm Indication
RTS	Request To Send
SELV	Safety Extra-Low Voltage
SN	Serial Number
SNMP	Simple Network Management Protocol
SW	SoftWare
TCP/IP	Transmission Control Protocol/Internet Protocol
TE	Terminal Equipment
TEI	Terminal Equipment Identifier
TS	Time Slot
WWW	World Wide Web

Preface

How to use this guide

This User Guide has been organised as a series of hands-on sessions.
We have tried to introduce only those elements that you need in order to obtain the desired result. You should use the Reference Guide (appendix to this User Guide) to obtain detailed information.

To start working with the IntelliMux, you need the following materials:

- The IntelliMux package.
- A PC with a serial (COMx) and a LAN interface.
- ISDN cables, LAN cables, maybe also a HUB.
- Access to one or more Primary Rate and/or Basic Rate Interfaces.

What's in the IntelliMux package

When you open the IntelliMux package, you should find the following elements:

- The IntelliMux box.
- An external power adapter with a power cord.
- This User Guide and Reference Guide.
- A floppy disk containing an electronic copy of User and Reference Guide (MANUAL), the current SW (binary BIN format and compressed CPR format), and the current MIB.

In addition, you should have ordered a set of ISDN cables. The exact amount and type of cables depend on your specific application. Have a look at the product codes on the ISDN cables:

- EIU146567 : Straight ISDN cable 2.0 m to connect to the ISDN network.
- EIU153297 : Crossed ISDN cable 2.0 m to connect to PR ISDN terminals.
- EIU162350 : Crossed ISDN cable 2.0 m to connect to BR ISDN terminals.

The Reference Guide shows the layout of these cables.

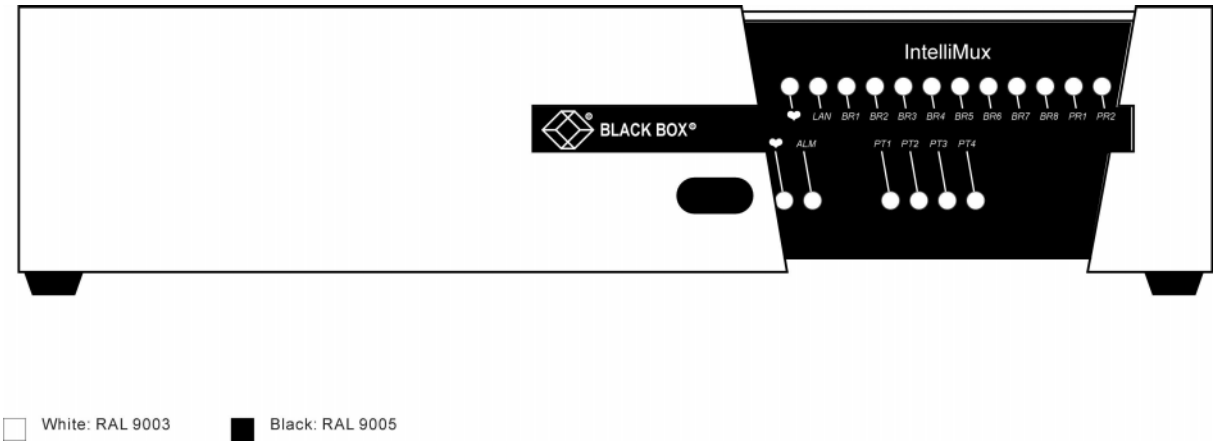
Options

When purchasing the IntelliMux, you should have selected some Software and Hardware Options.
Be sure to have this information within reach. The verification and activation of options will be discussed later when it is needed.

LED's and connectors on the IntelliMux.

The IntelliMux configuration contains only the IntelliMux module. The unit is powered through a locked power connector on the network module by using an external AC/DC power adapter. Optional other future extension boards can be put in the free slot of the housing.

Table top front view

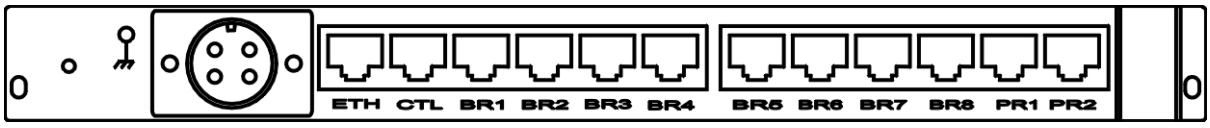


LED indications

On the IntelliMux, the LED indications on the frontpanel have the following definition:

LED	Status	Color	Description
HB	Off Blinking	 Green	Module not operational after failed selftest Module operational after successful selftest and failsafe timer expires
ALM	Off On	 Red	No active configuration error During selftest or Active configuration error
LAN	Off On	 Green	No reception of Ethernet data Reception of Ethernet data
BR1..8	Off On	 Green	Not activated Activated, no fault condition
PR1..2	Off On On On	 Green Yellow Red	Not activated Activated, no fault condition Activated, fault condition RAI Activated, fault conditions LOS, AIS or LFA

Table top rear view

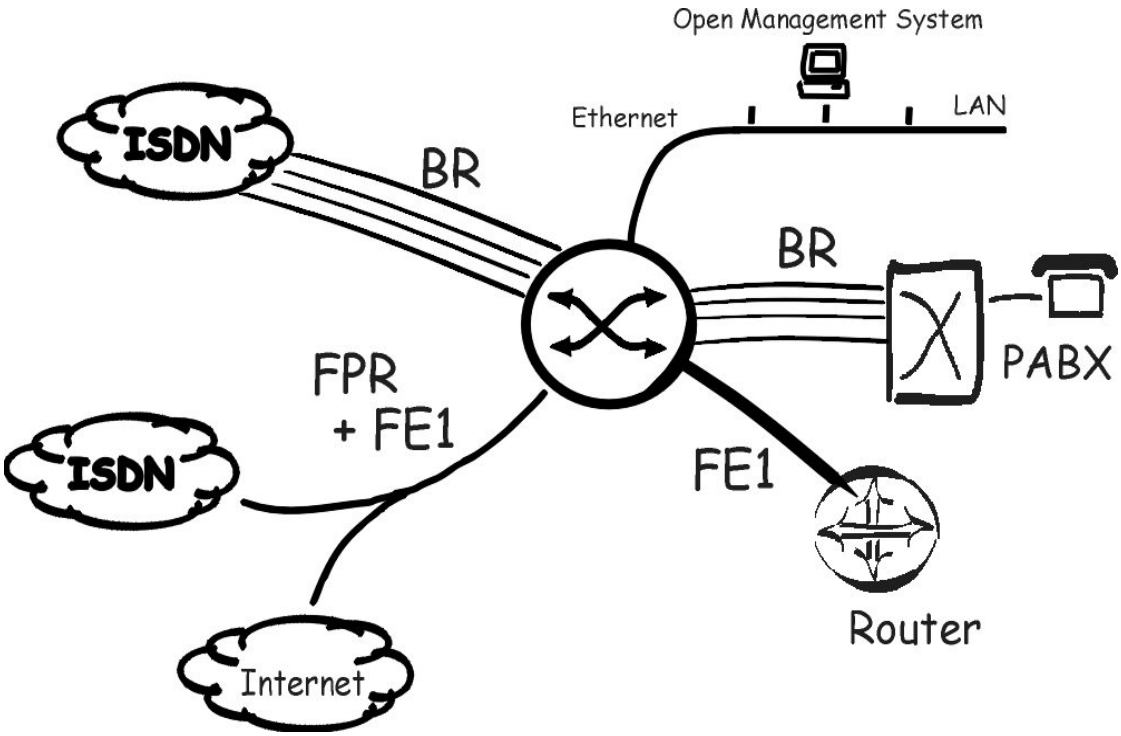


Interface connections

On the IntelliMux, the interfaces on the backpanel are used for the following connections:

Interface	Function
Ethernet	10Base-T interface for remote management
Control	RS-232 interface for local management
BR1	Interface to BRI link 1
BR2	Interface to BRI link 2
BR3	Interface to BRI link 3
BR4	Interface to BRI link 4
BR5	Interface to BRI link 5
BR6	Interface to BRI link 6
BR7	Interface to BRI link 7
BR8	Interface to BRI link 8
PR1	Interface to PRI link 1
PR2	Interface to PRI link 2

This results in the following complete setup:



REMARK! ***The PRx interfaces are only accessible on a RJ-45 connector only (120 ohm).If coax interfaces (75 ohm) are required, external dual baluns (e.g. BE-1 from RAD) must be used.***

Cable connections

Use the following cables to connect the IntelliMux:

Interface	Cable
To a NT	EIU146567 (DX C2**D**MM-R45-R45)
To a PRI TE	EIU153297 (DX C2**X**MM-R45-R45)
To a BRI TE	EIU162350 (DX C2**X**MM-R45-BRI)
Control	Straight V24/V28 cable
Ethernet	Straight Ethernet cable

BRI specifications

Protocol requirements

Protocol requirements
On the NT and TE lines only the Euro-ISDN (ETSI) protocol stack is supported. For the availability of other ISDN protocols, please contact DATAX or your local distributor.
Since different ISDN profiles are used in various countries, please make sure that the following ISDN requirements are met when ordering your NT line:

BRI	Requirements
Layer 1	• Point-to-point if the BRI is configured in TE mode; Point-to-point or Point-to-multipoint if the BRI is configured in NT mode
Layer 2	• Point-to-point with fixed TEI or automatic TEI, or Point-to-multipoint with a maximum of 2 devices attached if the BRI is configured in NT mode
Layer 3	• Availability of ISDN numbers by the DDI service • Presentation of Called Number for incoming calls

Termination

On ID-MUX TX & RX interchange circuit pairs of each BR interface are by default 100 ohm terminated.

Fail safe relays

The IntelliMux contains an on-board 'fail safe relay' feature which is disabled by default. Placing the appropriate jumpers as indicated in the table below, enables the feature, which means that :

- In power-down : a pair of BR interfaces (e.g. the BRI facing the network and the BRI facing the user) are directly connected together, bypassing the board circuits. It allows that e.g. network and user stay (directly) connected should the power supply fail.
- In power-up : the relays keep the pair connected during a time selected in Tfailsf (CGF.SYS.Tfailsf, default 20 s). Afterwards, the pairs are disconnected to insert the IntelliMux circuits again.

Note that the definition of the pairs is pre-established : L1-L2, L3-L4, L5-L6, L7-L8. The feature can be selected per pair separately, and requires the placement of 4 jumpers per pair. As stated before, the jumpers are removed by default.

BR1-BR2 (Line 1-Line 2)	**JP 104**	**JP 105**	**JP 154**	**JP 155**

BR3-BR4 (Line 3-Line 4)	**JP 204**	**JP 205**	**JP 254**	**JP 255**

BR5-BR6 (Line 5-Line 6)	**JP 304**	**JP 305**	**JP 354**	**JP 355**

BR7-BR8 (Line 7-Line 8)	**JP 404**	**JP 405**	**JP 454**	**JP 455**

Note : the reference guide contains a floorplan which indicates the location of the jumpers.

PRI specifications

Protocol requirements

On the NT and TE lines only the Euro-ISDN (ETSI) protocol stack is supported. Since different ISDN profiles are used in various countries, please make sure that the following ISDN requirements are met when ordering your NT line:

PRI	Requirements
Layer 1	• Use of CRC4 (if possible)
Layer 2	• Point-to-point operation with TEI=0
Layer 3	• Availability of ISDN numbers by the DDI service • Presentation of Called Number for incoming calls

Termination

The interchange circuits of the PR interfaces are fixed 120 ohm terminated.

Fail safe relays

The Fail safe relay option can be applied on the L9-L10 pair of PR interfaces. See also explanation under 'BRI specifications'.

PR1-PR2 (Line 9-Line 10)	JP 508	JP 509	JP 558	JP 559

Note : that the reference guide contains a floorplan which indicates the location of the jumpers.

Booting and Selftest

When powering up or resetting the IntelliMux, a selftest is executed which verifies the functionality of the module.

During the selftest, the following messages are displayed:

```
> BOOT BRTA5331 4.1
> Option [P64,H33791,S3,K1855485600]
> TIME....... 22:03:38,2001/02/06
> NVRAM......
> DPRAM......
> FLEX10K....   OK
> IFCONV.....
> MITEL......   OK
> ESCC.......
> SMC........   OK
> PCM........
> MIO........ Enabled
> L1: ISAC   OK,Enabled
> L2: ISAC   OK,Enabled
> L3: ISAC   OK,Enabled
> L4: ISAC   OK,Enabled
> L5: ISAC   OK,Enabled
> L6: ISAC   OK,Enabled
> L7: ISAC   OK,Enabled
> L8: ISAC   OK,Enabled
> L9: FALC   OK,Enabled
> L10: FALC   OK,Enabled
> Failsafe Timer..OK
```

If the selftest succeeds, the HB LED starts blinking and the system waits for the expiry of the FailSafe activation timer. The purpose of this timer is to drive the connected ISDN devices into a known idle state. By pressing a key on your terminal, the timer is stopped and the system proceeds as normal. In case the selftest fails, the last displayed message will indicate the internal failure. Meanwhile the HB LED remains off.

Remark! ***When returning the IntelliMux for repair due to a failing selftest, please mention this last displayed selftest message***.

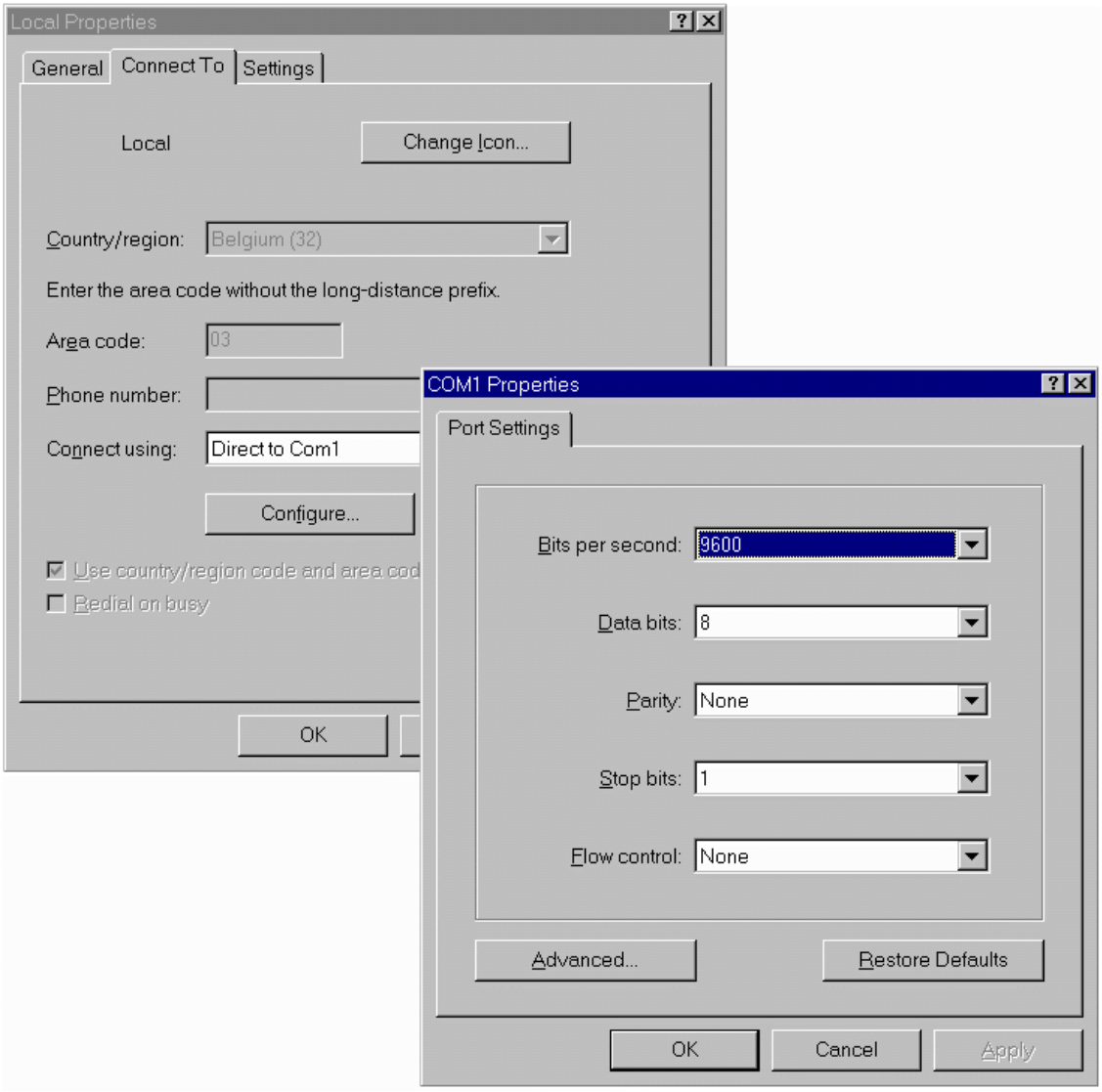
Getting started.

The command line and the screen interface.

To start interacting with the IntelliMux, connect a (straight) serial cable from your PC to the Control Port, and use the following settings on your terminal emulation program:

```
9600 baud, 8bit, no parity, 1 stop bit, no flow control.
```

In addition, select ANSI emulation with transmission of the function keys.
On a Win98 PC with Hyper-Terminal this results in the settings shown below.



Your first interaction with the IntelliMux may be something like this

```
? LOGIN
LOGIN ADM ADM <enter>
OK
<enter>
? LOGIN LOGOUT WIN SHOW CFG SET RESET MAINT REM
SHOW <enter>
SHOW ? TIME CFG STS ID LOG
SHOW TIME <enter>
12:06:51,1999/03/22
SH TI <enter>
12:06:56,1999/03/22
SH ID <enter>
BRTA5331 4.1 (IntelliMux)

PCode: BRTA/5025 1.0
Model:  IMX
SerNr: 00000002
MacNr: 00E0DE 000012
                -- <enter> stands for pressing the enter key
```

What you see is the command line interface of the IntelliMux. For this first example, we have explicitly indicated when you need to press the enter key. In the remainder of this manual, we will assume that you press enter when needed.

Note the following features of the command line interface:

- When you press <enter>, the IntelliMux will try to execute a command. If it does not find enough information, it prints out a help line starting with the part of the command that was understood, then a question mark, and then a list of words that it expects as valid continuation of the command. So, initially the IntelliMux shows that it expects you to log in, when you press 'show' with no arguments, then the IntelliMux shows the list of expected arguments.
- You can abbreviate commands. The rule is that you need to give enough of the word to make its interpretation unique. So you can use 'SH' for 'SHOW', but you cannot use 'S' because the IntelliMux does not know if you mean 'Show' or 'Set'.
- You can use the Up and Down arrow keys to call back previous lines.

This short example also shows you a few aspects of the IntelliMux:

- You need to log in. The different possibilities and restrictions will be explained later. For now just log in as the factory default administrator ADM.
- You can obtain information on the software release, the serial number of the product and some other identification elements using the command 'show id'. You will need this information whenever you need support with your IntelliMux.
- If the time is not correct then set it using the command SET TIME. By now, you should have learned enough to know how to do it.

One of the most used commands also happens to be one of the simplest: 'WIN'. This command gives you access to the configuration and status screens. Type it in and follow the annotated example.

```
WIN <enter> -- this calls the top level menu.

WIN
+------------+
|Cfg         |  -- CFG is highlighted. With the arrow keys, you can
|Sts         |  -- change the selection item.
|History     |  -- select CFG pressing <enter>.
+------------+
CFG
+------------+  -- You can nmove the selction using the arrow keys
|Sys         |
|Slot        |
|Line        |
|FixN64      |
|Route       |
|Clip        |
|AOCProf     |
|AOCHDay     |
|Oper        |
|PPP         |
|IP_StatRoute|
|IP_PortFW   |
+------------+  -- go back using the <esc> key. Or use <ctrl-X>

WIN
+------------+
|Cfg         |
|Sts         |
|History     |
+------------+  -- go back using the <esc> key. Or use <ctrl-X>

OK
```

Important: Depending on the software key options you have purchased (see also chapter 0 on page 36), some of the menu options might not be visible on your IntelliMux.
Throughout this manual, each screen snapshot shown applies to an IntelliMux with ALL software options installed.

There are a few things to be remarked here:

- The <esc> key may not work on your PC. Maybe you have an AZERTY keyboard and have CAPS-LOCK on, or your emulator does not support use of the <esc> key. In that case, use <ctrl-X> (pressing control and X simultaneously) to exit from the current level.
- When pressing the <esc> key twice in rapid succession, nothing happens at all. Indeed, the <esc> key cannot be correctly distinguished from the ANSI escape sequences unless there is some idle time after it. Be patient or use the <ctrl-X> key.

When referring to a sub menu or to a field in a sub screen, this will be indicated like this:

WIN.CFG.SYSTEM.IP

The above example refers to the configuration item that you can access by typing WIN first, then selecting CFG, then selecting System, and then finally moving to the IP field.
The instruction to set this field to a specific value will be given like this:

WIN.CFG.SYSTEM.IP := 192.168.3.1

The world according to IntelliMux.

Take a look at the items on the WIN.CFG menu. These items classify the building blocks used by the IntelliMux. Each class is really a small database:

System	This is a collection of general settings that have a system wide impact.
Slot	Each card in the IntelliMux is placed in a slot, and is assigned a slot number. The basic IntelliMux which consists of a single card is assigned slot 1. The extension card, if any, is placed in slot 2.
Line	The name line is used to indicate a PRI, a BRI, or an E1 interface. There are 10 lines that can be individually configured.
FixN64	The name fixed N times 64 channel is used to indicate a nailed-up datastream. There may be up to 64 nailed-up datastreams that may be individually configured.
Route	The route specifies how an ISDN call should be re-routed and redialled. There may be up to 300 route definitions.
Clip	This Label is a name identifying a group of CLIP checks, Search and Replace are used in the same manner as in the route table, but work on the CGN information element.
AOC_Profile	The AOC profile defines the charging pattern to be applied to a call, generated when Advice Of Charge is enabled.
AOC_Holiday	The AOC Holidays let you define the dates of the holidays for which a special charging profile can be configured.
Oper	The operator represents a user of the IntelliMux. Each user has an associated set of rights that determine the actions that are allowed. There may be up to 8 operators.
PPP	The PP entry defines various parameters to set up a PPP (Point to Point Protocol) connection.
IP_StatRoute	The IP_StatRoute entry allows you to define how IP traffic is to be routed to the interfaces of the IntelliMux. This entry will only be shown if you have the IP routing software option
IP_PortFW	The IP_PortFW entry allows you to define how incoming IP traffic for certain IP services need to be sent to, in the case IP Masquerading is set. This entry will only be shown if you have the IP routing software option.

Moving in and around the configuration screens. Editing fields.

The IntelliShare PRI provides two distinct views of the configuration databases:

- A browser oriented view. This shows multiple data entries on a single screen, be it with reduced information per record. The goal is to provide a quick overview and access.
- A record oriented view. This shows a single record with all available information.

As an example, select the route configuration screen (WIN.CFG.ROUTE).
This will show a configuration screen as shown below. Up to 10 entries are shown on a single page.

```
-Route-------------------------------------------------------------------0001--
N   Act LineIn     Search          Replace         LineOut    Calltyp   FailMi
1   On  1234------ *               *               --------9- --------- 0
2   On  --------9- *               *               1234------ --------- 0
3   Off ----------                                 ---------- --------- 0
4   Off ----------                                 ---------- --------- 0
5   Off ----------                                 ---------- --------- 0
6   Off ----------                                 ---------- --------- 0
7   Off ----------                                 ---------- --------- 0
8   Off ----------                                 ---------- --------- 0
9   Off ----------                                 ---------- --------- 0
10  Off ----------                                 ---------- --------- 0
```

Moving the cursor up and down allows selecting other entries. You can move up or down a whole page at once using the keys <ctrl-F> (forward) and <ctrl-B> (backward).
With the <tab> key, the next field of an entry can be selected. Within the field you can use the arrows to move over the contents.

This screen shows all the basic types of configuration fields that are available on the IntelliMux, so this is a good moment to try your editing skills.
First go to entry 3 (N=3), and use the <tab> character to go to the type field. This field is a choice field, and you can see the different choices by pressing the <spacebar>. Select the 'On' choice.
Use <tab> to go to the next field, then use the right arrow to go to the third dash. When you press the <spacebar>, a '3' will be indicated. Pressing again will bring back the '-'. This is a bitmap field and allows specifying a set of on/off choices. The value '3' is just a reminder to indicate that you are changing the third element.

Use tab to go to the next field. This is a text entry field, where you can enter a search pattern. For now, enter your name, then erase it again. There is no error checking on this kind of field.

Finally, go to the last field (which is a numeric field), and enter a value. You will note that the values are automatically corrected when you leave the field. Non-numeric values are replaced by 0 and numeric values are limited to their range. Try to enter 99 for example.

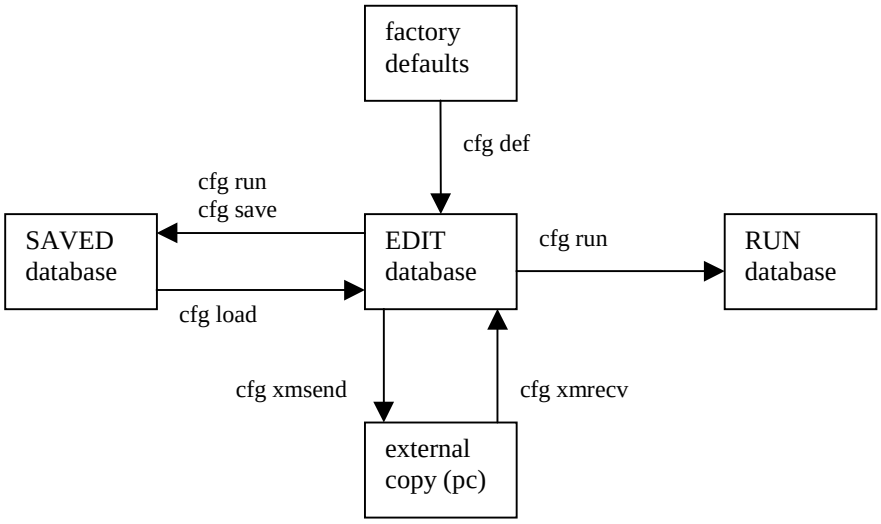
The same actions are also possible in the record view.
To obtain this view press F2, or <ctrl-W> (window) to obtain a window like this.

```
-Route-------------------------------------------------------------0001--
N       1
Act     On
LineIn  1234------
Search  *
Replace *
LineOut --------9-
Calltyp ---------
FailMin 0
ChgProf
```

This view only shows the entry with index 1, but then it is a little more eloquent. Use the forward and backward commands (<ctrl-F> and <ctrl-B> to go to the next or previous page. This time the jump is only 1 entry.
To go to route entry 95, the best thing to do is to use a sequence of <ctrl-F> commands in the browser view until you can place the cursor on entry N=95. Then switch to the record view and do whatever is needed on this entry.

Activating and restoring configurations.

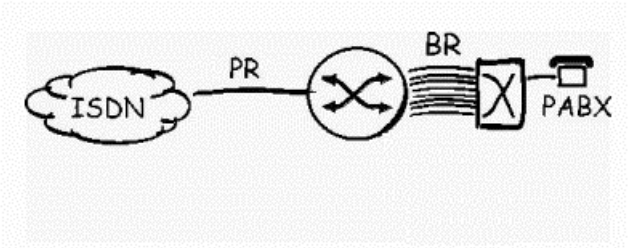
After all the changes you have made to the configuration, you may be wondering if you will ever get to the original state again. Well, the answer is yes.
First of all, all changes have been made to a “EDIT” copy of the configuration, which is different from the active (“RUN”) configuration. To make it even more challenging, there is a third copy of the configuration, which is stored in flash memory. There are a number of commands that allow you to manipulate these copies, as shown here.



In general, you will either use the command CFG RUN to save and activate the new configuration, or the command CFG LOAD to revert to the previous configuration.
If things go really wrong, you can always reload the factory default by using the command CFG DEF.

The factory defaults.

The factory default setup defines a Channel Bank ("BRI-to-PRI convertor"): 4 BRI lines are converted into a single PRI line. The BRI lines are connected with user equipment (possibly a PABX with Basic Rate interface to the network), and the PRI line is connected to the public network.
The IntelliMux will forward calls from the PRI to one of the BRI lines and vice versa, with no other modifications at all.



Before doing this, let us first look at the different screens and check their most important parameters.

To ensure that the factory defaults are loaded, perform the following tasks:

```
cfg def                                 -- load defaults in edit base
OK
cfg run                                 -- save and activate edit base
Saved and Activated
reset sys                               -- reboot the system
> BOOT BRTA5331 4.1
> ...
```

The reboot ensures that all changed settings are activated.

The System configuration

Most parameters are concerned with the LAN and Remote Management features of the IntelliMux, and will be considered further.

```
-Sys-------------------------------------------------------------------
N       1
Type    IMX                                AOCType AOC-D
Name    IMX                                AOCCTyp Unit
Log     20                                 AOCCurr
Trp     50                                 AOCMult 0.001
IP      192.168.099.001                    IPRoute Off
SubMask 255.255.255.000                    Masq    Off
Gateway 000.000.000.000                    MasqIP  000.000.000.000
PrimMgr 000.000.000.000                    RCNetIP 000.000.000.000
SecdMgr 000.000.000.000                    RCMask  000.000.000.000
RdComm  public
WrComm  netman
TrpComm trap
TLogOff 0
TFailSf 20
ClkSlve AUTO
AlmTime 00:00:00
HttpRef 0
AOCEnbl Off
```

Most parameters are concerned with the LAN and Remote Management features of the IntelliMux, and will be considered further. There are two parameters that you may need to understand at this moment:

- **TLogOff**: this parameter specifies the maximum idle time in seconds before local control and telnet sessions will be disconnected. Set this value to 0 if you don't want to be disconnected during your tests. Set it to a value less then 240 seconds to be logged out after doing nothing during this time.
- **TFailSafe**: this parameter specifies the boot start-up delay in seconds. This delay ensures that the operation of the equipment will be halted for at least TFailsf seconds. Without this delay, the network would not necessarily be aware that the IntelliMux has been reset, and this might result in calls not broken down properly. If the network is ETSI compliant, then it will be able to correctly recover from a boot if the delay is set to at least 20 seconds. Otherwise, you may need to set the timer to a value up to 90 seconds. The reference guide gives a full account of the need for this start-up delay.

The Slot configuration

```
-Slot-------------------------------------------------------------------0001
N       1
Type    IMX
Name    S1
```

For the standalone IntelliMux, there are no interesting parameters here.

The Line configuration

The Basic rate lines (L1 to L4) are connected to user equipment (of Automatic TEI type). The Primary rate line (L9) is connected to the public network (and therefore acts as a TE). The setup assumes that the public network does not support CRC4.

```
-Line-------------------------------------------------------0001--
N  Type Name              Act Sgn  Tei NT Crc4
1  BR   L1                On  Isdn 64  NT NoCRC4
2  BR   L2                On  Isdn 64  NT NoCRC4
3  BR   L3                On  Isdn 64  NT NoCRC4
4  BR   L4                On  Isdn 64  NT NoCRC4
5  BR   L5                Off Isdn 64  TE NoCRC4
6  BR   L6                Off Isdn 64  TE NoCRC4
7  BR   L7                Off Isdn 64  TE NoCRC4
8  BR   L8                Off Isdn 64  TE NoCRC4
9  PR   L9                On  Isdn 0   TE NoCRC4
10 PR   L10               Off Isdn 0   TE NoCRC4
```

Or by pressing F2 (ctrl-W):

```
-Line-------------------------------------------------------0001--
N       1
Type    BR
Name    L1
Act     On
Sgn     Isdn
Tei     64
NT      NT
Idle    x49
Crc4    NoCRC4
StrInc  0
EndInc  0
StrOutg 0
EndOutg 0
CLISrch
CLIRepl
AlmFrom ----------
Options --------
```

The important parameters here at this moment (you don't need to change them) are:

- **Type**: this parameter specifies whether the line is a Basic Rate ISDN line (provides 2 64KBit/s data channels) or a Primary Rate ISDN line (30 64KBit/s data channels). The type cannot be changed and is detected from the hardware.
- **Act**: this parameter specifies if the line can be activated or not.
- **Sgn**: this parameter specifies if the line is connected to a network that allows signalling using ISDN. This will not be the case if the line is used for a E1 leased line application.
- **NT**: This specifies whether the line behaves as TE (terminal equipment) or NT (network terminator). When the line is connected to a public network, then this field should say 'TE'. In this case, the cable on this interface is a straight ISDN cable.
  When the other side is some user equipment, such as a PABX, then this field should say 'NT'. The cable on this interface is a crossed ISDN cable.
- **Crc4**: This parameter is used for Primary Rate ISDN only, and describes how the physical link is checked for quality. In many cases, the Network provides a PRI line that is not checked for quality. In this case, the CRC4 procedures do not apply, and the setting must read 'NoCRC4'. You should ask the PRI provider whether CRC4 is supported or not. Alternatively, you can try both possibilities as explained further.
- **TEI**: This parameter is used for Basic Rate ISDN only (set it to 0 for lines of type PR), and describes how the NT identifies the TE. The value 0 is typically used for a "Point-to-Point" link. The value 64 represents an "automatic link". Values 1-63 represent a "Fixed link". Assigning this parameter correctly is critical and is discussed in detail further.

The FixN64 configuration

```
-FixN64-------------------------------------------------------------0001--
N  Act Name             NrTLineITSILineOTSOPContrl
1  Off F1               0  NONE 1  NONE 1  ----
2  Off F2               0  NONE 1  NONE 1  ----
3  Off F3               0  NONE 1  NONE 1  ----
4  Off F4               0  NONE 1  NONE 1  ----
5  Off F5               0  NONE 1  NONE 1  ----
6  Off F6               0  NONE 1  NONE 1  ----
7  Off F7               0  NONE 1  NONE 1  ----
8  Off F8               0  NONE 1  NONE 1  ----
9  Off F9               0  NONE 1  NONE 1  ----
10 Off F10              0  NONE 1  NONE 1  ----
```

At this moment, since we do not use nailed-up channels, the default off setting is all we need.

The route configuration

```
-Route--------------------------------------------------------------------0001--
N   Act LineIn     Search           Replace          LineOut    Calltyp
FailMi
1   On  1234------ *                *                --------9- --------- 0
2   On  --------9- *                *                1234------ --------- 0
3   Off ----------                                    ---------- --------- 0
4   Off ----------                                    ---------- --------- 0
5   Off ----------                                    ---------- --------- 0
6   Off ----------                                    ---------- --------- 0
7   Off ----------                                    ---------- --------- 0
8   Off ----------                                    ---------- --------- 0
9   Off ----------                                    ---------- --------- 0
10  Off ----------                                    ---------- --------- 0
```

The default provides two simple entries which have as effect that all calls coming in on lines L1 to L4 are routed to line L9 with no modification, and vice versa.

The important parameters are:

- **Act**: On activates the entry, off ignores it.
- **LineIn**: This specifies that the route will be evaluated for calls that start at the indicated lines. Note that it is possible to specify routes that behave identically for several call sources.
- **Search**: This specifies a pattern that will be matched on the telephone number that is called. The '*' indicates that all numbers will match with no exception.
- **Replace**: This specifies any modifications that will be done to the number when routing the call to the LineOut. The given search/replace combination specifies that the call will simply be forwarded with no modification.
- **LineOut**: This specifies the line to which the call will be routed whenever the route criteria are fulfilled.

The Operator configuration

```
-Oper-------------------------------------------------------------0001--
N Name RightsInfo
1 ADM  x7777
2 SUP  x0333
3 SYS  x0222
4 USR  x0111
5 O5   x0000
6 O6   x0000
7 O7   x0000
8 O8   x0000
```

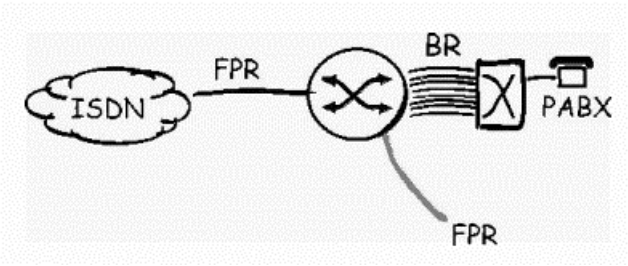
At this moment, we do not need to differentiate between several operators. So the default is ok.

Channel bank: The Factory default application.

Preparations.

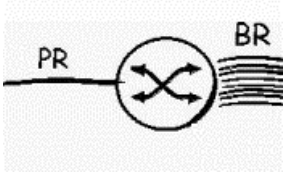
The factory default application implements a 4 Basic Rate (BRI) to 1 Primary Rate (PRI) convertor application (4 BRI Channel Bank).

Assume that you have a PABX with typically 4 to 8 BRI access lines (8 to 16 speech channels), and that you need to extend your bandwidth to the network (perhaps because you added a WAN router for Internet access). In this case, it may be worthwhile to replace the BRI access by a PRI access and achieve the installation as shown in the figure below (where FPR goes to the PRI interface of the router).



The first step to achieve this solution is to configure the IntelliMux to forward calls between BRI lines and a PRI line. This is the default configuration shown below.

With only minor modifications, also a 8 BRI Channel Bank can be configured. With the use of a second IntelliMux, it is even possible to configure a 16 BRI Channel Bank.



The factory default assumes that the PRI line is connected to a Network Terminator (NT), and that each BRI line is connected to a Terminal Equipment. The connection to a public network is a typical example of an NT. ISDN telephones and terminal adapters are typical examples of TE equipment. The PABX connector which normally "goes to the NT" is another example of a TE.

It is also possible to realise alternative setups using other TE/NT combinations, but you will need to make some modifications to the configuration in those cases. Note that ISDN telephones that rely on 'phantom power' for operation will not work with the IntelliMux.

Connecting the cables and setting the NT/TE configuration.

The interfaces of the IntelliMux are wired for TE operation. This means that normal straight cables can be used when connecting an IntelliMux interface to a NT equipment.
On the other hand, when connecting the IntelliMux to a TE equipment, crossed cables must be used.

There are two types of crossed cables that can be ordered for the IntelliMux :

- **Crossed BRI** (BLUE): used to connect an IntelliMux BRI interface to a BRI TE.
- **Crossed PRI** (BLUE): used to connect an IntelliMux PRI interface to a PRI TE.

In the example shown here, the cable on the PR side will be straight, while the cables on the BRI side will all be crossed. The PRI interface will act as TE, and the BRI interfaces will act as NT. You should check in the configuration screen (WIN.CFG.LINE.NT) that the NT/TE configuration for the lines is correct.

It is important to remark that the IntelliMux does not support the use of multiple TE devices on a single interface. The IntelliMux assumes that there is only one single device connected to the interface, and will not behave correctly should you try to connect multiple devices on the same line.

The physical connection.

Checking the PRI connections

When you insert the PRI cable, you should see that the PRI LED indicator turns GREEN.
Also, the following indication appears on your screen (if you are in the WIN interface you need to go back to the Command interface first):

```
12:07:0753  L9 PH AI    -- after inserting cable
12:07:0787  L9 DL UP
12:08:5982  L9 PH DI    -- after pulling out the cable
12:08:5983  L9 DL DOWN
12:08:5983  L9 PH AR
12:09:0753  L9 PH AI    -- after reinserting the cable
12:09:0787  L9 DL UP
```

What you see in action is the tracing feature of the IntelliMux. The IntelliMux has very extensive tracing facilities (check the reference guide), which are most helpful for trouble shooting. The above trace tells something like this:

> "At **12:07:07** (and **53**/100 seconds for who wants to know), on line **L9** of the IntelliMux (the first PRI), a **PH**ysical event was detected. It concerned an Activation Indication (**AI**). In other words, the physical connection is active which is good news."

Immediately after the PH AI indication, a DataLink event DL UP was detected, meaning that the DataLink was brought up. In contrast, the indication PH DI indicates that the line became deactivated. Similarly, the indication DL DOWN indicates that the DataLink was brought down.
If you don't see this, then something is wrong with the physical connection. Check that the LED for the PRI is Green. If not, then check your cabling and connection.

Verify also that the CRC4 settings are correct. You may change them in the configuration and check by trial and error. When changing CRC4, you also need to reset the equipment, either with power off or with the command "**RESET SYS**".
At the end of this exercise, the PRI line should be connected, and the PRI LED should be Green.

In case you are testing with a PRI TE instead of a PRI NT, you should change the configuration of L9 so that it specifies that the line interface should behave as a NT instead, and you should ensure that you use the crossed PRI cables (white). The verification is as shown above.

Checking the BRI connections

As with the PRI case, the BRI LED indicators will light up (GREEN) when the cable is inserted.

The important configuration parameter for BRI lines is the TEI (Terminal Endpoint Identifier).
Although there are (of course) exceptions, generally one of the following cases will be encountered:

- Point-to-Point link with TEI=0
  ISDN operators will usually provide this link only when explicitly requested and is the preferred way to connect a PABX with the public network.
- Automatic TEI link (TEI non-0).
  ISDN operators will provide and support this by default. End user equipment will usually also be configured in this manner.

You should verify the setting of the attached equipment, and configure the corresponding IntelliMux line as follows:

- WIN.CFG.LINE.TEI=0 for Point-to-Point links.
- WIN.CFG.LINE.TEI=64 for automatic TEI links in a point to point configuration.
- WIN.CFG.LINE.TEI=65 for automatic TEI links in a point to multipoint configuration (only if line configured as NT).

The TEI=0 setting will only allow communication with a BRI device that also has a TEI equals to 0. A TEI=64 setting will allow communication with a BRI device, whatever its TEI setting is configured for (fixed or automatic TEI). A TEI=65 setting will allow communication with multiple BRI TE devices (currently limited to 2 BRI devices). The IntelliMux will assign the different attached BRI devices with a unique TEI number. Note that this setting is only allowed if the line is configured in NT mode.
At the end of this exercise, the BRI LED should become Green whenever you try to use the line for communication. If you are testing with a BRI NT instead of a BRI TE then don't forget to change the configuration to TE and to use straight cables.

Using the trace capabilities.

Installations don't always go as smooth as described in the manuals, so a little help may be in place sometimes. The IntelliMux provides such help in the form of more or less detailed tracing information.

The tracing facilities of the IntelliMux are classified into a number of levels, each one more important than the previous one. For instance, the physical events shown above are considered rather important (level 40) which is why they are normally displayed.
The casual talking of the IntelliMux with the Network is normally not very interesting (level 8), so it is not displayed.

You can change this setting, using the set trace command:

```
SET TRACE L 8
```

This command instructs the IntelliMux to show all Line-related traces with level above 8 on the screen. You could also have said

```
SET TRACE L1 8
```

which instructs the IntelliMux to do it only for L1 (others would remain at their current level).
Doing this, you should be able to see a little more of what is actually happening between the IntelliMux and the attached equipment. For instance:

```
23:51:0150  L9 DL ST7  i _t203-ind 0
23:51:0150  L9 DL T    RR (00 01 01 01 x x 00 00)
23:51:0152  L9 DL R    RR (00 01 01 01 x x 00 00)
```

What you see here is that the IntelliMux and the Network are telling each other that they are ready to receive data (**R**eceiver **R**eady) on the datalink (**DL**). The '**T**' stands for transmit, the '**R**' for receive. On PRI lines and on BRI lines with TEI=0, you should see these messages every 10 seconds. Another sequence indicating the successful start of the communication between the IntelliMux and the network is this:

```
06:02:0010 L7 DL R SABME (02 01 7F )
06:02:0010 L7 DL T UA (02 01 73 )
```

If you do not see this, then check out the Troubleshooting section for a step by step check. Once this works, your physical and data link are functional, and you don't need to worry about it much more. So hide this detail by setting the trace level a bit higher:

```
SET TRACE L 20
```

Instead of looking at the traces, it is also possible to obtain key information on the status of the line by inspecting the Line status (WIN.STS.LINE). This should show something like this:

```
-Line-------------------------------------------------------------------0001--
N  Sts  PH   DL   DL2  BConn                              AlmFrom
1  ACT  Up   Down Down  --                                ----------
2  ACT  Down Down Down  --                                ----------
3  RES  Down Down Down  --                                ----------
4  RES  Down Down Down  --                                ----------
5  IDLE Down Down Down                                    ----------
6  IDLE Down Down Down                                    ----------
7  IDLE Down Down Down                                    ----------
8  IDLE Down Down Down                                    ----------
9  ACT  Up   Up   Down  --------------- ---------------   ----------
10 IDLE Down Down Down                                    ----------
```

The indication PH shows the **PH**ysical activation. The indication DL / DL 2 shows the **D**ata**L**ink statuses of the 2 possible datalinks. In this example, the PRI line is alive and ready for action. The BRI line is physically activated but there is no datalink. Note that the second datalink (DL 2) is only relevant if a line has been configured for Point-to-multipoint operation. Only in this case are multiple datalinks allowed. Note also that lines L3 and L4 have status "RES", meaning that a configuration change has been applied to these lines which requires a "RESET SYSTEM" in order to become active.

First tests.

The factory default application instructs the IntelliMux to forward calls between the PRI interface and the BRI interfaces. You can inspect this in the ROUTE configuration screen.
At this time, you should be able to make an outgoing call from a BRI TE equipment. Alternatively, you should be able to receive an incoming call from the PRI NT equipment.

Some successful connection examples are shown below. Note how the **C**all **C**ontrol (**CC**) messages are forwarded from one line to the other. Actually, the IntelliMux acts as a protocol convertor gateway, transforming Basic Rate ISDN into Primary Rate ISDN and vice versa.

```
outgoing call from L1 (BRI1)
06:46:0524  L1 PH AI
06:46:0524  L1 MDL TEI = 64
06:46:0527  L1 DL UP
06:46:0532  L1 CC R CR=-0001 ST00 Setup (0)
06:46:0532  L9 CC T CR=0002 ST00 Setup (0)
06:46:0541  L9 CC R CR=0002 ST01 CallProc (0)
06:46:0541  L1 CC T CR=-0001 ST06 CallProc (0)
06:46:0544  L9 CC R CR=0002 ST03 Alert (0)
06:46:0544  L1 CC T CR=-0001 ST09 Alert (0)
06:46:0665  L9 CC R CR=0002 ST04 Connect (0)
06:46:0665  R1 Connect 015339991
06:46:0665  L1 CC T CR=-0001 ST07 Connect (0)
06:46:0669  L1 CC R CR=-0001 ST10 ConnectAck (0)
06:46:1028  L1 CC R CR=-0001 ST10 Disconnect (16)
06:46:1028  L9 CC T CR=0002 ST10 Disconnect (16)
06:46:1035  L9 CC R CR=0002 ST11 Release (16)
06:46:1035  L9 CC T CR=0002 ST11 ReleasCmpl (0)
06:46:1035  L1 CC T CR=-0001 ST12 Release (16)
06:46:1035  R1 Disconnect 015339991
06:46:1041  L1 CC R CR=-0001 ST19 ReleasCmpl (16)
06:46:1056  L1 DL DOWN

Incoming call at L9
06:47:5358  L9 CC R CR=-0001 ST00 Setup (0)
06:47:5358  L1 CC B CR=0003 ST00 Setup (0)
06:47:5367  L1 DL UP
06:47:5369  L1 CC R CR=0003 ST01 Alert (0)
06:47:5370  L9 CC T CR=-0001 ST06 Alert (0)
06:47:5454  L1 CC R CR=0003 ST04 Connect (0)
06:47:5454  R2 Connect 159
06:47:5454  L9 CC T CR=-0001 ST07 Connect (0)
06:47:5461  L9 CC R CR=-0001 ST08 ConnectAck (0)
06:47:5461  L1 CC T CR=0003 ST10 ConnectAck (0)
06:47:5763  L1 CC R CR=0003 ST10 Disconnect (16)
06:47:5763  L9 CC T CR=-0001 ST10 Disconnect (16)
06:47:5770  L9 CC R CR=-0001 ST11 Release (16)
06:47:5770  L9 CC T CR=-0001 ST11 ReleasCmpl (0)
06:47:5770  L1 CC T CR=0003 ST12 Release (16)
06:47:5770  R2 Disconnect 159
06:47:5777  L1 CC R CR=0003 ST19 ReleasCmpl (16)
06:47:5791  L1 DL DOWN  (TEI 64)
```

Hunting group configuration

The factory default configuration specifies that the BRI lines are organised in a hunting group. This can be seen on the route screen (WIN.CFG.ROUTE). Calls coming in on the PRI line are routed to all the BRI lines at once.

The IntelliMux will present subsequent calls in a round robin manner to these lines (provided that there are free channels on the selected lines). In this way, 8 incoming calls will be routed to the 4 BRI lines in the sequence L1, L2, L3, L4, L1, L2, L3, L4.

```
-Route-----------------------------------------------------------------0002--
N       2
Act     On
LineIn  --------9-
Search  *
Replace *
LineOut 1234------
FailMin 0
Calltyp ---------
ChgProf
CliProf
```

Note that the hunting group facility will only work in a reliable way when using TEI=0 links. These Point-to-Point links are permanent, which means that they are all either active (In the Line status menu, you see PH=Up and DL=Up) or broken. In the case of automatic TEI links, the IntelliMux cannot possibly know in advance whether there is a device on a BRI line or not, and this may result in a call failure. A trace of this is shown below: the call is presented on a line which is dead, and this leads to a call failure because no one is answering the call.

```
Incoming call at L9, routed to L2 which has no attached device
06:55:1975  L9 CC R CR=-0002 ST06 Setup (0)
06:55:1977  L2 CC B CR=0004 ST00 Setup (0)
06:55:1978  L2 PH AR
06:55:2383  L9 CC R CR=-0002 ST06 Setup (0)
06:55:2384  L2 CC   CR=0004 ST01 T303 (10)
06:55:2384  L2 CC T CR=0004 ST01 Disconnect (0)
06:55:2782  L9 CC R CR=-0002 ST06 ReleasCmpl (18)
06:55:2782  L2 CC T CR=0004 ST11 ReleasCmpl (18)
06:55:2985  L2 PH DI
```

Status screens.

The IntelliMux provides additional information that can help you identify problems if any. This information can be accessed using the screen interface (WIN.STS).
Remark that the information in the status screens is refreshed every 10 seconds.

```
-Sys-------------------------------------------------------------------------
N Sts  Date       Time     ClkTrcHWErrs
1 ACT  1999/08/11 07:35:20 9  20 x0000
```

The System status screen shows the current date and time (which you can change with the SET TIME command) and shows that no specific hardware errors were detected at boot time. Of special interest is the CLK indication. This value indicates that the IntelliMux obtains the ISDN reference clock from the interface L9. In general, the IntelliMux will synchronise on any PRI interface that is connected to a network device (line acts as TE) interface and that provides a reliable clock. If no such PRI interfaces are found, then the IntelliMux will try to find a BRI interface which provides a reliable network device clock. If even this does not yield a dependable clock, then the IntelliMux will go in free run (it will generate its own local clock).

When the ClkSlve field in the system configuration (WIN.CFG.SYS) is set for a specific line (not AUTO), then this line will be the preferred line to synchronize on. If the preferred line doesn't supply a clock, then a suitable line will be selected, as described above.

```
-Slot------------------------------------------------------------------------
N Sts  SW               HW               LED
1 ACT  BRTA5331 3.0     00000002         gG-G-------GR--
```

The Slot status screen provides information that is associated to the particular card(s) in the IntelliMux box. The card in slot 1 is the IntelliMux ISDN interface card, and it is enabled. The self-check of the card was OK, and there were no errors or warnings. The software running on this card is version 3.0 and the hardware serial number is as shown. The LED status shows the indicators as they appear on the front panel. Small letters indicate blinking LEDs, large letters indicate steady LEDs, '-' indicates that the LED is Off.

```
-Slot-------------------------------------------------------------------------
N Sts  SW                   HW               LED
1 ACT  BRTA5331 4.1b.1      00000002         gG-G-------RR--
```

It is interesting to pull out the ISDN cable on L9. Press the refresh key (control-N), or wait 10 seconds. The screen is redrawn, and shows

The LED on Line L9 has become Red (check it). The system status also shows that the clocksource has disappeared (the system is now in Free Run).

```
-Sys--------------------------------------------------------------------------
N Sts  Date       Time     ClkTrcHWErrs
1 ACT  1999/08/11 07:36:27 0  20 x0000
```

When reinserting the cable, the L9 LED turns Green again, and the system derives its clock from the network again. The derivation of the system clock, and the consequent synchronisation of the whole system, will be discussed later. For now, just note that the IntelliMux always derives its clock from a NET entity, or goes into Free Run if no NET is available.

The Line Status screen provides information on the current state of the PRI lines.

```
-Line-------------------------------------------------------------------0001--
N  Sts  PH   DL   DL2  BConn                          AlmFrom
1  ACT  Up   Down Down  --                            ----------
2  ACT  Down Down Down  --                            ----------
3  RES  Down Down Down  --                            ----------
4  RES  Down Down Down  --                            ----------
5  IDLE Down Down Down                                ----------
6  IDLE Down Down Down                                ----------
7  IDLE Down Down Down                                ----------
8  IDLE Down Down Down                                ----------
9  ACT  Up   Up   Down  --------------- ---------------  ----------
10 IDLE Down Down Down                                ----------
```

- **PH**: this shows the physical state according to the ETSI norms. If you see NRM (normal) in it, then all is well. This indication is related with the "PH AI" traces we saw before.
- **DL / DL 2**: this shows whether the first / second datalink is On(Up) or Off(Down). This indication is related with the establishment of the datalink as we have seen before. If the datalink is down, then have a look at AlmFrom. If there is some line indicated here, then the origin of the problem is there. For BRI's in a Point-to-point configuration and PRI's which only support one datalink **DL 2** will always be down. The status of **DL 2** is only relevant for a BRI in Point-to-multipoint configuration, where multiple data-links are supported.
- **BConn**: as we will later see, this shows which B channels are in use.
- **AlmFrom**: this indicates which - if any - alarms cause the datalink on this line to be dropped.

For now, this ends the overview of status screens. We will come back to these and others later.

Final compatibility checks

Before configuring other applications, take the time to do some testing with the current installation because most problems that you may encounter will arise already at this stage. Try to use different kinds of telephone sets, isdn terminal adapters, fax machines and whatever you can put to use. Try outgoing and incoming calls.
The IntelliMux assumes that the equipment connected to it is ETSI-ISDN compliant. This is not always the case, and sometimes workarounds are needed to handle deviations. These workarounds are activated by specifying options in the line configuration menu.

Typically, such incompatibilities are signaled in the call failure cause. This is the value that is shown between parentheses in the disconnect or release message as shown below.

```
07:57:2529  L1 MDL TEI = 64
07:57:2531  L1 DL UP
07:57:2537  L1 CC R CR=-0002 ST00 Setup (0)
07:57:2537  L1 CC T CR=-0002 ST06 ReleasCmpl (100)
07:57:2558  L1 DL DOWN
```

The following cause values are possible indications of incompatibilities:

- cause 96: mandatory information element missing.
- cause 97, 98, 99, 101: message type problems.
- cause 100: invalid information contents.

Should these incompatibilities arise and lead to loss of functionality, then check the reference guide under line options, or contact support with a description of the equipment and a trace of the failure sequence. In this case, you should make a trace using trace level 9 or lower. This will provide a decoding of the incoming Level 3 messages that will allow the support engineers to identify the cause of any incompatibility.

```
01:39:3710  L1 MDL TEI = 64
01:39:3715  L1 DL UP
01:39:3720  L1 CC H 08 01 06 05 A1 04 03 80   --decoded incoming message
01:39:3720  L1 CC H 90 A3 18 01 89 70 10 80
01:39:3720  L1 CC H 32 32 32 32 32 32 38 35
01:39:3720  L1 CC H 36 35 36 35 32 33 33
01:39:3720  L1 CC R CR=-0006 ST00 Setup (0)   --interpreted incoming msg
```

SW Upgrade & Softkey Options.

Local SW Upgrade on the IntelliMux.

Since the SW on IntelliMux resides in Flash EPROM, a SW upgrade is as simple as a file transfer.

In general following upgrade procedure may be applied:

1. Make a backup of the IntelliMux configuration using X-Modem.
2. Log in via terminal access on Supervisor or Administrator level and enter the '**MAINT**' command from the Human Interface. Upon request of confirmation, enter 'Y' to proceed. The IntelliMux will confirm start-up of the maintenance menu.
   Note that the HB LED stops blinking.

```
? LOGIN LOGOUT WIN SHOW CFG SET RESET MAINT REM
MAINT
Start Upgrade Procedure [Y/N]: Y
Active
```

3. To enter the maintenance menu press the enter-button. The following commands are available:
   ID: shows the identification of the product.
   UPGRADE: starts the upgrade procedure.

4. Enter the '**UPGRADE**' command to start an X-modem file receive session (character 'C' will appear). After entering this command, the operator should send the 'imx.bin' file, which can be found on the 'SW' directory of the SW upgrade floppy.

```
? ID UPGRADE
UPGRADE
Erasing and waiting for <update>.BIN upload
C
```

5. As soon as the IntelliMux confirms receipt of the complete file, the new SW type and revision is displayed. At this point the operator should power down the IntelliMux to boot up the new software.

```
? ID UPGRADE
UPGRADE
Erasing and waiting for <update>.BIN upload
C..
OK
BRTA5331 3.0b
```

6. Power on the IntelliMux again. After a successful selftest the IntelliMux will start up with the factory default settings for the configuration. Note that the HB LED starts blinking again.
7. Depending on the type of SW upgrade, a previously stored configuration can be recovered completely or partially.

REMARK!
If some fault occurs during the X-modem file transfer, you must repeat the upgrade procedure as described above, with the following differences :

2. Instead of logging-in and entering the 'MAINT' command, power down the system and place jumper JP85 on the IntelliMux module (located behind the Ethernet connector).
   Power on the system again.
5. In addition to powering down the system remove jumper JP85 on the IntelliMux module.

Remote Software Upgrade

Apart from the possibility to upgrade the software through a local console port, you can also perform an upgrade remotely, i.e. over the LAN connection, or a remote PPP connection (see chapter "Managing the IntelliMux via the LAN" for configuring the IntelliMux for LAN access); (see chapter "Remote Control" for configuring the IntelliMux for a remote PPP connection). It allows you to upgrade the software from a distance, without the need for local access to the machine.

To perform a remote software upgrade, you need to follow following steps:
1. Log in on Supervisor or Administrator level
2. Enter the command:

```
maint remupgrade
```

3. The command will start an X-Modem session. ('C' characters will appear on your console). Send over the compressed **imx.cpr** file (***not*** **imx.bin**), to be found on the SW directory of the SW upgrade floppy.
4. From the moment the file has been received completely by the IntelliMux , the IntelliMux brings up a message, and will stop its normal functionality, i.e. all ISDN call processing will be stopped, and you will loose connection to the IntelliMux (the heartbeat will stop blinking). At that moment, the IntelliMux will start decompressing the file, which will take *a couple of minutes* to complete.

Important: Please, do not power down the IntelliMux while the decompression process is going on. Powering down the IntelliMux while decompressing the software will result in a complete loss of the software. If such a loss occurs, you'll need to follow the steps as described in the remark section of previous paragraph.

5. Once the decompression of the software is completed, the IntelliMux will reset automatically, and the new software will boot up (the heartbeat starts blinking again). You will have to restore your connection to the IntelliMux, and log in with Telnet to access the device.

Remark that the previous configuration stored inside the IntelliMux will be retained. As such, there is no need to save the configuration before upgrading the device and restoring it afterwards. However, as a safety measure, it's always wise to back up the configuration before upgrading. For instructions on backing up and restoring the configuration, see chapter "Saving and restoring cofigurations with Xmodem.

Softkey Options: Verification & Activation

In the basic offering, the IntelliMux is restricted to the use of 4 BRI lines (L1 to L4) and 1 PRI line (L9), and does not provide TCP/IP support (LAN access and remote control) and Advice Of Charge (AOC) generation. If you do not need the other PRI lines, TCP/IP or AOC, then this is the most economical solution for you. For more complex applications, you will require special software activation keys.
You may purchase additional options when ordering the IntelliMux, or later as an upgrade.
The following options can be purchased:

- ISU99066 : Allows the use of TCP/IP for local and remote Telnet and SNMP
- ISU99068 : Allows the use of the second PRI line (L10).
- ISU99070 : Allows the use of 4 additional BRI lines (L5 to L8).

To obtain information on the currently installed options, check the extended identification:

```
show id x
sh id x

BRTA5331 1.4b.1 (IntelliMux)
PCode: BRTA/5025 1.0
Model: IntelliMux
SerNr: 00000002
MacNr: 00E0DE 000012
Option [P64,H4095,S15,K1150231508]
OEM  : blackbox
Aug 31 2001  09:23:26
ISDNQ=PRTA5300 x.00.01
ISDNI=BRTA5320 x.00.01
5367 1.0 000 26.01.99
```

The options have been highlighted, and contain option information that is used by Black Box:

- P64: this is a product identification code.
- H4095: this is a hardware option set (every interface is represented by a bit).
- S15: this is a software option set.
- K11502315081: this is the option activation key value, which is determined from the serial number, and additional information residing at Black Box.

Descriptive info about the options installed can be obtained with the *show keys* command:

```
show keys

Hardware Keys:
Line 1234----9-
VXI Port 1234
Software Keys:
SNMP key
AOC key
IP Route key
```

When you choose to activate extended options, you need to contact Black Box Sales to acquire new option settings. You will need to provide the following information:

- the current options, as shown above
- the serial number of the equipment
- the required options (see table above)

After purchasing the additional options, you will receive a new option set from Black Box comparable to the one above. The installation and activation of the new option is done with a maintenance command :

```
maint opt
Enter Option Sequence (SERNR=9700002)
P:64
H:527
S:3
K:1684587753
Option [P64,H527,S3,K1684587753]
OK
```

The options will be activated at the next power up. You can verify this on the boot screen, which shows the enabled lines:

```
BOOT BRTA5331 4.1
Option [P64,H527,S3,K1684587753]
TIME....... 10:58:53,2001/08/31
<selftests>
 L1: ISAC   OK,Enabled
 L2: ISAC   OK,Enabled
 L3: ISAC   OK,Enabled
 L4: ISAC   OK,Enabled
 L5: ISAC   OK,Disabled
 L6: ISAC   OK,Disabled
 L7: ISAC   OK,Disabled
 L8: ISAC   OK,Disabled
 L9: FALC   OK,Enabled
 L10: FALC   OK,Disabled
 Failsafe Timer..OK
```

Managing the IntelliMux via the LAN.

Let us now consider management via the LAN interface.
For this to work, you need to have installed the Softkey option SK_SN (TCP/IP module).
If you have no LAN interface, or if you did not buy this option, then you can simply skip this chapter and proceed with the next chapter.

Configuring and installing for LAN access.

Before connecting the IntelliMux to the LAN, you need to obtain the following information from your network manager:

- A free IP address (a unique identification that will represent the IntelliShare PRI on the LAN).
- The netmask to be used (in most cases this will be 255.255.255.0 (class C network)).
- An access point to the LAN. In most cases this will be a port on a HUB.

If you want to try this out on your own, then you can create your own LAN. Proceed as follows:

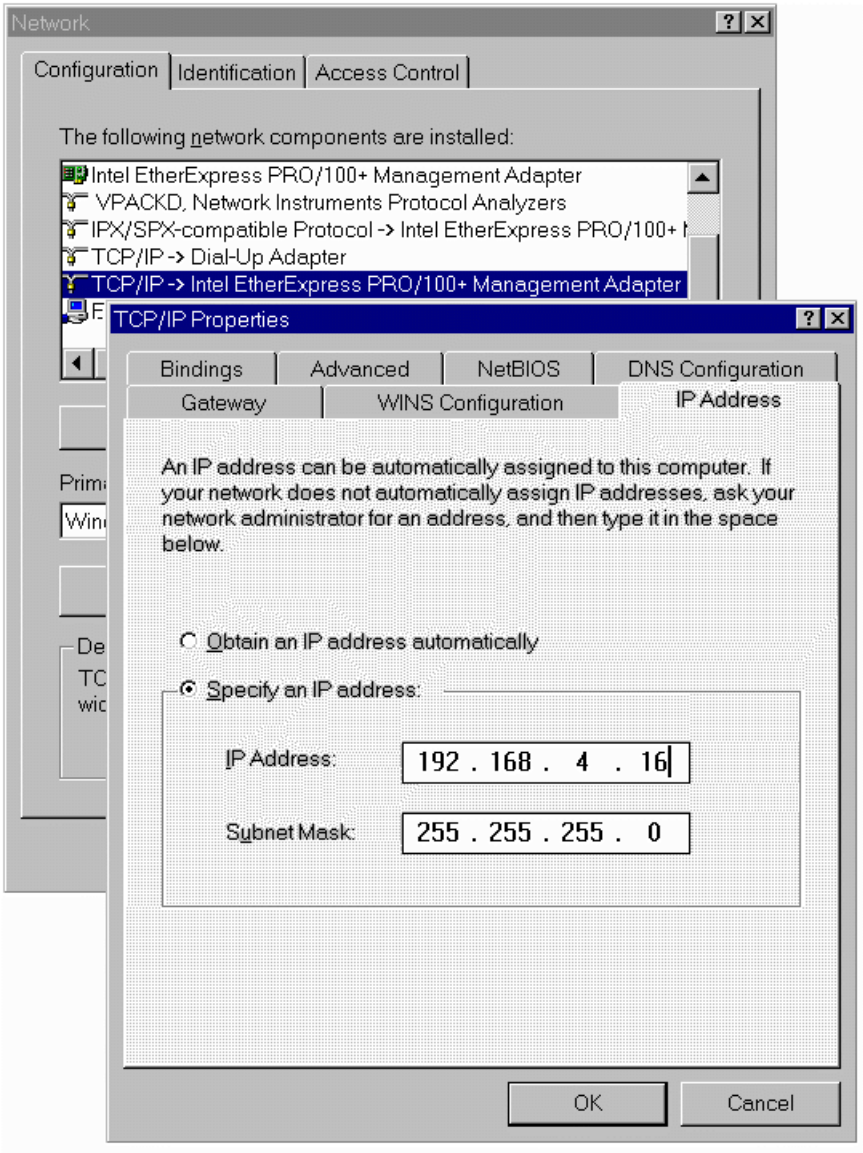
- You need a HUB with a few ports. Alternatively you can use a crossed Ethernet cable to connect directly between your PC and the IntelliMux. The layout is specified in the Reference Guide.
- You need to define your IP domain. For testing, you can use one of the 'private' internet domains (RFC1918), for instance 192.168.4.0 with netmask 255.255.255.0. In this case, you should configure your PC so that it uses an IP address on this network, say 192.168.4.16. You will probably need to restart your PC.
- You can then assign the IP address of the IntelliMux, say 192.168.4.15.

We are now ready to start the LAN configuration for the IntelliMux. This is done in the CFG.SYSTEM screen.

Assuming the test LAN, the minimal configuration required to interact with the IntelliMux is shown below. The highlighted fields have been changed.

```
-Sys-------------------------------------------------------------------
N       1
Type    IMX                              AOCType AOC-D
Name    IMX                              AOCCTyp Unit
Log     20                               AOCCurr
Trp     50                               AOCMult 0.001
IP      192.168.004.015                  IPRoute Off
SubMask 255.255.255.000                  Masq    Off
Gateway 000.000.000.000                  MasqIP  000.000.000.000
PrimMgr 192.168.004.016                  RCNetIP 000.000.000.000
SecdMgr 000.000.000.000                  RCMask  000.000.000.000
RdComm  public
WrComm  netman
TrpComm trap
TLogOff 0
TFailSf 20
ClkSlve AUTO
AlmTime 00:00:00
HttpRef 0
AOCEnbl Off
```

On your PC, assuming that you are using Win98, you should be able to verify that the "Network Neighbourhood Properties" resemble this:



Now power down the IntelliMux and the PC, and install one straight RJ45 cable between the PC and the HUB, and a second straight RJ45 between the IntelliMux LAN connector and the HUB.

Be careful to select the correct connector on the IntelliMux, and verify that you did not connect to the Uplink port of the HUB. Note that you can use straight ISDN cables for this since they are the same for ISDN and for Ethernet.

If you have no HUB, then connect the crossed Ethernet cable between the PC and the IntelliMux. Note in this case that a crossed Ethernet cable is different from a crossed PRI cable.

Basic tests for IP connectivity

Once you have finished this, check IP connectivity first using the PING program.
For this, start a DOS session on the PC, and type the following commands:

```
PING 192.168.4.15
```

You should receive a message indicating that an echo has been received. If this does not work, then try the following first:

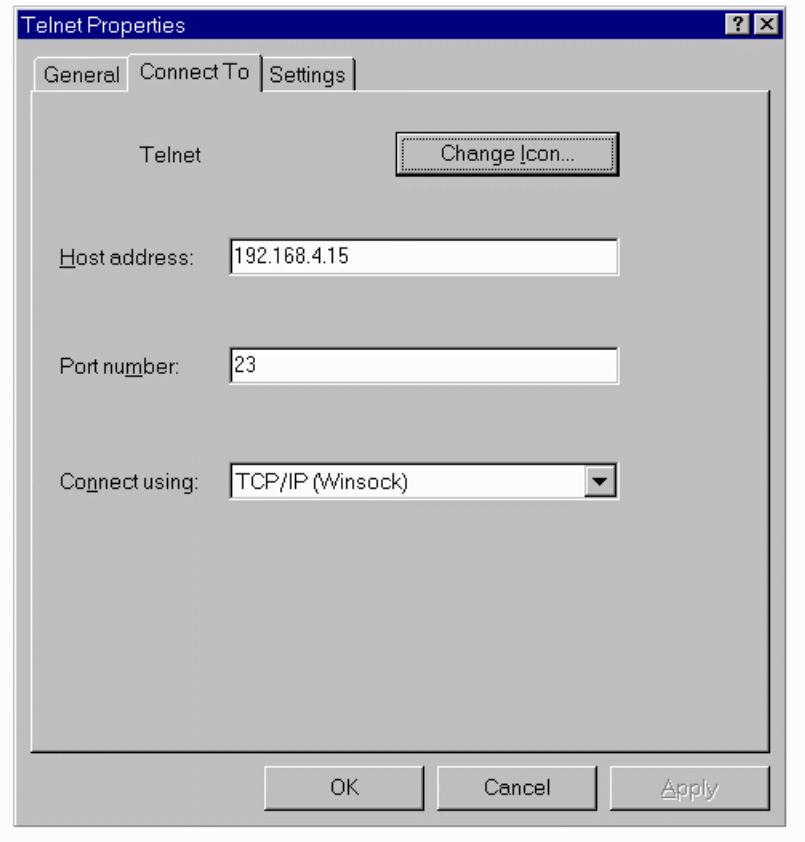
```
PING 192.168.4.16
```

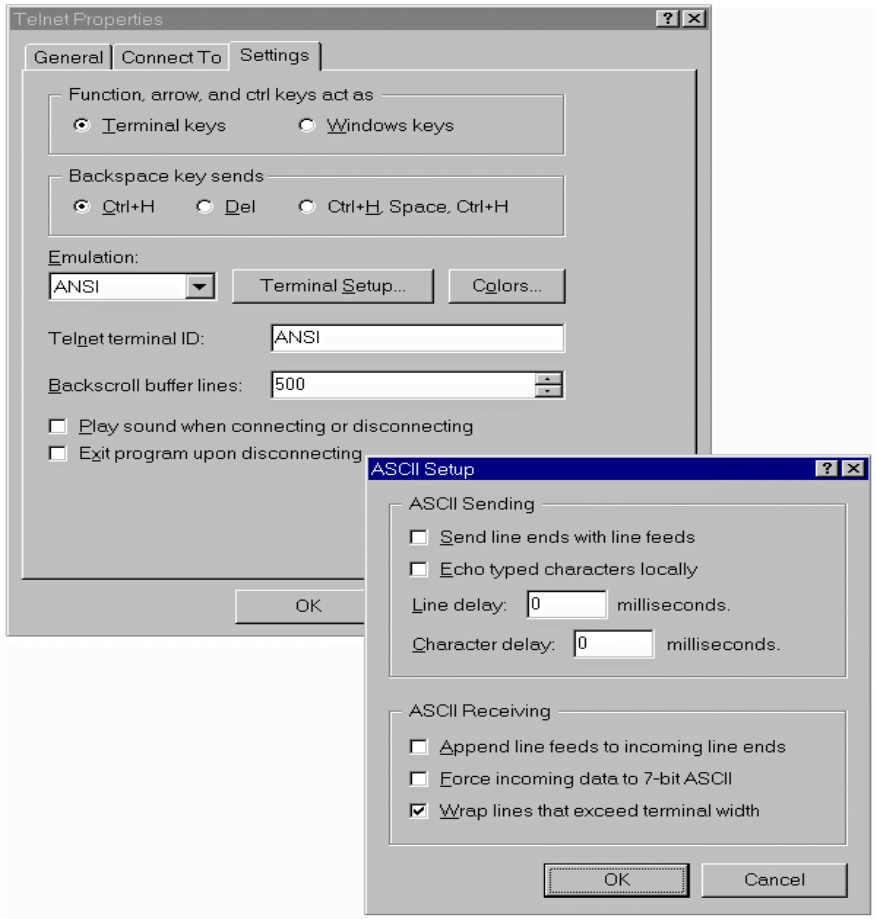
This is the IP address of the PC itself, so it should work. If it does not work, then you have a PC configuration problem. Otherwise you should first check the cable. Note also that the IntelliMux must be operational before pinging will work. During the boot delay, the IntelliMux will not respond to Ping requests. If this still not works, then refer to the trouble-shooting guide.

Assuming that everything got right, you are now ready to manage the IntelliMux via the LAN.

Telnet access to IntelliMux.

To illustrate Telnet access, let us try it out using Win98 HyperTerminal.
The settings required for our test LAN are as shown below. Apart from this, the terminal emulation settings should indicate ANSI with use of function keys (like it was for the serial connection).



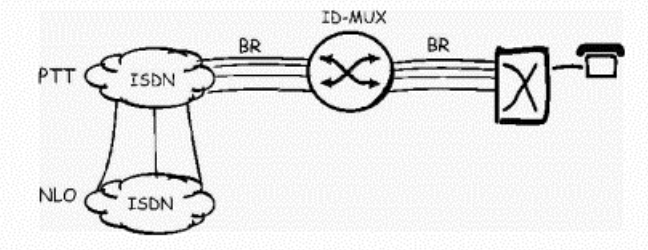


It is important to realise that a Telnet session cannot be executed simultaneously with a Local control port session. If you are logged in on the local control port, then starting Telnet will disconnect the local session, and display a message "Telnet Active". The reasoning behind this rude and appalling behaviour is that the local user - if he wishes - can always force access by disconnecting the LAN.

After configuring HyperTerminal, select the connect command or simply start typing. This will establish a connection via TCP/IP. Apart from this, the interaction between the IntelliMux and the user is identical to the interaction via the serial control port.

PR-REDIAL: Least Cost Routing using Carrier Prefix.

The application



This application exploits the possibility to select an alternative network operator using a carrier prefix before the phone number, such as dialling 1234032302887 instead of 032302887. The prefix 1234 is called a carrier prefix, and specifies the network operator that will handle the call.

New licence operators often specialise in specific types of connections such as long distance calls, which they can offer at significantly lower costs.

Routing these calls via the alternative operators is economically very attractive, but requires a change of habits and well informed users: every user has to know and decide which call should or should not be made using the carrier prefix.

The IntelliMux provides the means to relieve the users from this burden by analysing the called number and by adding the carrier prefix whenever desirable.

The configuration shown above demonstrates how to implement this for a PABX with 4 BRI interfaces. In a comparable way, the application can be created for a PRI PABX. Using the channel bank approach described in a previous section, it is also possible to provide Carrier Select features at the same time as converting 4 to 8 BRI lines into a single PRI.

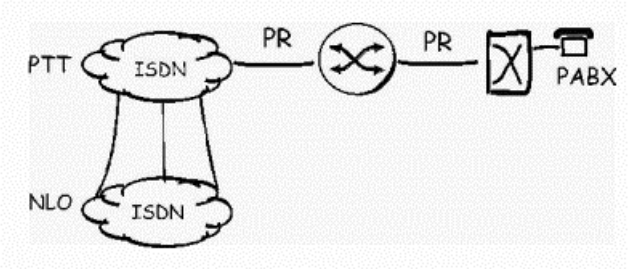
The Configuration

The application drawing shows how the IntelliMux is inserted between a BRI PABX and the BRI network. For this setup, you would need to acquire the Softkey option to activate lines L5 to L8. The first step would be to configure the IntelliMux for simple forwarding (comparable to the factory application, but this time going from BRI to BRI). In this case, you would start from the following configuration, and work your way through the "Factory Application" before continuing this setup.

```
-Line-------------------------------------------------------0001--
N  Type Name             Act Sgn  Tei NT Crc4
1  BR   L1 (pabx)        On  Isdn 64  NT NoCRC4
2  BR   L2 (pabx)        On  Isdn 64  NT NoCRC4
3  BR   L3 (pabx)        On  Isdn 64  NT NoCRC4
4  BR   L4 (pabx)        On  Isdn 64  NT NoCRC4
5  BR   L5 (net)         On  Isdn 64  TE NoCRC4
6  BR   L6 (net)         On  Isdn 64  TE NoCRC4
7  BR   L7 (net)         On  Isdn 64  TE NoCRC4
8  BR   L8 (net)         On  Isdn 64  TE NoCRC4
9  PR   L9               Off Isdn 0   TE NoCRC4
10 PR   L10              Off Isdn 0   TE NoCRC4
```

```
-Route-------------------------------------------------------------0009--
N   Act LineIn     Search           Replace          LineOut    Calltyp   FailMi
1   On  1--------- *                1234*            ----5----- --------- 0
2   On  -2-------- *                1234*            -----6---- --------- 0
3   On  --3------- *                1234*            ------7--- --------- 0
4   On  ---4------ *                1234*            -------8-- --------- 0
5   On  ----5----- *                *                1--------- --------- 0
6   On  -----6---- *                *                -2-------- --------- 0
7   On  ------7--- *                *                --3------- --------- 0
8   On  -------8-- *                *                ---4------ --------- 0
9   Off ----------                                   ---------- --------- 0
10  Off ----------                                   ---------- --------- 0
```

Another start configuration could have been a PRI (L9) to PRI (L10) forwarder.



Alternatively, the start configuration could also be the BRI(L1-L4) to PRI(L9) forwarder which is shown in detail in the Factory configuration. Anyway, it is assumed that you have verified that your setup is able to do basic forwarding before continuing with this application.
The only thing that needs to be added is information concerning the call destinations and the associated decision to add a carrier prefix. The place to add this information is the route configuration screen (WIN.CFG.ROUTE).

Consider the following configuration:

```
-Route-------------------------------------------------------------0009--
N   Act LineIn     Search           Replace          LineOut    Calltyp   FailMi
1   On  1--------- *                *                ----5----- --------- 0
2   On  -2-------- *                *                -----6---- --------- 0
3   On  --3------- *                *                ------7--- --------- 0
4   On  ---4------ *                *                -------8-- --------- 0
5   On  ----5----- *                *                1--------- --------- 0
6   On  -----6---- *                *                -2-------- --------- 0
7   On  ------7--- *                *                --3------- --------- 0
8   On  -------8-- *                *                ---4------ --------- 0
9   Off ----------                                   ---------- --------- 0
10  Off ----------                                   ---------- --------- 0
```

In this example, all outgoing calls are routed to the alternative carrier, by prefixing every called number with 1234. Incoming calls are of course not modified.

A more developed example is shown next. All inter-zonal and international calls are routed with carrier prefix, all the other calls use the original network. Note that this routing configuration does not use a one-to-one mapping of the BRI lines, but a group-to-group mapping.

```
-Route-------------------------------------------------------------------0005--
N   Act LineIn     Search           Replace          LineOut    Calltyp   FailMi
1   On  1234------ 0*               12340*           ----5678-- --------- 0
2   On  ----5678-- *                *                1234------ --------- 0
3   On  1234------ *                *                ----5678-- --------- 0
4   Off ----------                                   ---------- --------- 0
5   Off ----------                                   ---------- --------- 0
...
```

This is a simple example showing the priority rules for subsequent routes: as long as route R1 remains possible, route R3 – which is always possible – is not selected. On a phone that dials digit after digit, the IntelliMux will not forward the call until it is sure that route R1 cannot match. Of course, on a phone that calls all digits at once, the decision can be taken immediately.

In general, the decision to use route N will not be taken unless all routes before N have been invalidated. As a consequence, default routes should be placed at the end of the routing table. More specific search patterns should come earlier, with the most specific on top.

Routing schemes. Rules for matching and replacing patterns.

The matching takes place on the number that is being called, which is referred to as CDN.
The matching rules are based on the following syntax elements:

- a '?' (question mark) can match any single digit in CDN
- a '*' (asterix) can match with either the leading part or the trailing part of CDN.
- a digit matches with the same digit in CDN

During the match process, the wildcard elements obtain values. These values are used when the replacement is executed.

A few examples to make things clear:

CDN	Search	Replace	new CDN	Notes
123456	*	888*	888123456	
123456	12*	88812*	888123456	
123456	15*	88815*	No match	
123456	1??*	8881??*	888123456	
123456	1??*	10??0*	10230456	
123456	*56	*00	123400	note 1
123456	*??	*00??	12340056	note 1

- Note 1: Suffix matching is only possible if the called number is sent 'en bloc'. This is generally true for calls coming in from the network, but cannot be assumed for calls coming from the user.
- Search and Replace string can have 0 or 1 ‘*’ wildcard.
- If the Replace string contains wild cards, the Search string should have at least as many corresponding wildcards.

Testing and verifying status

The next trace (set the trace level at 10 to obtain this level of information: SET TRACE L 10) shows an example of a call using the above shown configuration (latter example).
Do not worry if you don't understand this: it's only to satisfy the experts.

```
17:15:4564  L2 CC R CR=-0007 ST00 Setup (0)
17:15:4565  L2 CC T CR=-0007 ST06 SetupAck (0)
17:15:4712  L2 CC R CR=-0007 ST25 Informatn (0)      -- digit '0'
17:15:4712  L1 CC T CR=0005 ST00 Setup (0)           -- route decided, replace done
17:15:4723  L1 CC R CR=0005 ST01 CallProc (0)  -- network has enough digits.
17:15:4724  L2 CC T CR=-0007 ST25 CallProc (0)
17:15:4728  L1 CC R CR=0005 ST03 Alert (0)
17:15:4728  L2 CC T CR=-0007 ST09 Alert (0)
17:15:4880  L1 CC R CR=0005 ST04 Connect (0)
17:15:4880  R2 Connect 12340                         -- the actually dialled number
17:15:4880  L2 CC T CR=-0007 ST07 Connect (0)
17:15:4884  L2 CC R CR=-0007 ST10 ConnectAck (0)
```

The status screen (WIN.STS.ROUTE) for the routes also provides some interesting information.

```
Route-------------------------------------------------------------------0001--
N   Sts  StateDate       Time     CausCDN                                LineOut
1   ACT  Ok   1999/11/19 16:38:25 16  1234                              9
2   ACT  Ok   0000/00/00 00:00:00 0                                     0
3   IDLE Ok   0000/00/00 00:00:00 0                                     0
4   IDLE Ok   0000/00/00 00:00:00 0                                     0
5   IDLE Ok   0000/00/00 00:00:00 0                                     0
6   IDLE Ok   0000/00/00 00:00:00 0                                     0
7   IDLE Ok   0000/00/00 00:00:00 0                                     0
8   IDLE Ok   0000/00/00 00:00:00 0                                     0
9   IDLE Ok   0000/00/00 00:00:00 0                                     0
10  IDLE Ok   0000/00/00 00:00:00 0                                     0
```

For each route the following information is shown:

- **CDN**: This is the most recent phone number that was dialled out on this route. It concerns the number after executing any replacements specified in the corresponding route configuration.
- **Cause**: This is the most recent call clearing cause that was received on this route. Refer to the reference guide for an overview of causes.
- **LineOut**: This is the most recent line selected for dialling out.

Finally, the history screens (WIN.HISTORY) provide you with additional statistics about the calls. There is a line history screen (WIN.HISTORY.LINE) and a route history screen (WIN.HISTORY.ROUTE). Both screens show accumulated statistics since the reset of the the IntelliMux.
The line history screen shows various statistics about calls occurred on a particular line.

```
Line--------------------------------------------------------0001--
N       1
AMaxIn  0
AMaxOut 0
AMinFre 2
APHDown 0
ACRCErr 0
AFrmErr 0
AConTim 0
AChrges 0
ErrSec  0
SErrSec 0
UnvlSec 0
```

This screen shows the maximum number (high watermark) of channels used for incalls and outcalls, the minimum number (low watermark) of free channels, the number of occurrences of level 1 going down on the line, the number of CRC errors and framing errors occurred since reset of the IntelliMux.
It also shows the total connection time and accumulative charges (if AOC is enabled).
It finally shows the *'Errored Seconds'* (ErrSec), the *'Severely Errored Secs'* (SErrSec) and *'Unavailable Seconds'* (UnvlSec). These three statistics are defined in the ITU spec G.821, and give you an indication about the quality of the line. These statistics are only relevant on PRI lines.

- An 'Errored Second', as defined by the G.821 spec is a second during which at least one bit error was detected on the line.
- A 'Severely Errored Sec' is a second during which at least one bit per thousand bits was erroneously (i.e. a Bit Error Rate (BER) of 10^{-3} was detected).
- An 'Unavailable Second' is the amount of seconds during which continually Severely Errored Seconds where detected, and this for at least 10 seconds in row.

The route history screen shows various statistics about routes selected for switching calls.

```
-Route-------------------------------------------------------------0001--
N       1
ACllAtt 1
AScCall 1
AFlCall 0
AConTim 317
ADblCnt 0
AChrges 0
```

This screen shows for the first route the number of call attempts, the number of successful calls, the number of failed calls, the total connection time and the number of occurrences the route was disabled, since reset. It also shows the accumulated charges for all calls occurred on this route.

Remark that a call is considered successful if a B-channel could be established. This means that in general, the call is successful when the setup message is correctly answered by e.g. a call proceeding. This implies that a call that is set up correctly, but is not answered by the remote party is considered as a successful call.

There are two situations where the IntelliMux will not even try a route, even if the phone number matches:

- If LineOut for the route is not available: this happens for instance when the LineOut cable is plugged out, and the IntelliMux can detect this, i.e. when LineOut is a PRI line or Lineout is a BRI lines configured with TEI=0. In this situation, the routing table will be searched further down for a possible match.
- If there are no channels available on the LineOut link: in this case, the IntelliMux will reject the call with a "No channels available" cause.

```
Example for a routing from L1234 to L9
17:21:5506  L9 PH DI F3_LOS
17:22:0448  L2 CC R CR=-0008 ST00 Setup (0)
17:22:0448  L2 CC T CR=-0008 ST06 SetupAck (0)
17:22:0815  L2 CC R CR=-0008 ST25 Informatn (0) -- digit 0, route decided
17:22:0815  L2 CC T CR=-0008 ST25 Disconnect (3)-- L9 in LOS, so No Route!
17:22:0854  L2 CC R CR=-0008 ST11 Release (16)
17:22:0854  L2 CC T CR=-0008 ST11 ReleasCmpl (0)
```

Saving and restoring configurations with XModem.

After finalising the correct configuration and the complete routing table, you will certainly want to keep the resulting configuration somewhere on a PC disk as a backup.
The IntelliMux provides the means to this, by using various upload and download features.

In this chapter, we will consider the XModem protocol.

The XModem protocol is an old but very simple and very commonly used protocol to upload or download files between PC's. With the IntelliMux you can use this protocol:

- CFG XMSEND sends the configuration from IntelliMux to PC
- CFG XMRECV receives on the IntelliMux from the PC.

The IntelliMux supports Xmodem over a Telnet session. With HyperTerminal for instance, it is possible to do XModem just like on a local link. Note however that not all terminal emulation programs support this feature.
The following example shows both kinds of transfer on a Win98 PC (using HyperTerminal).

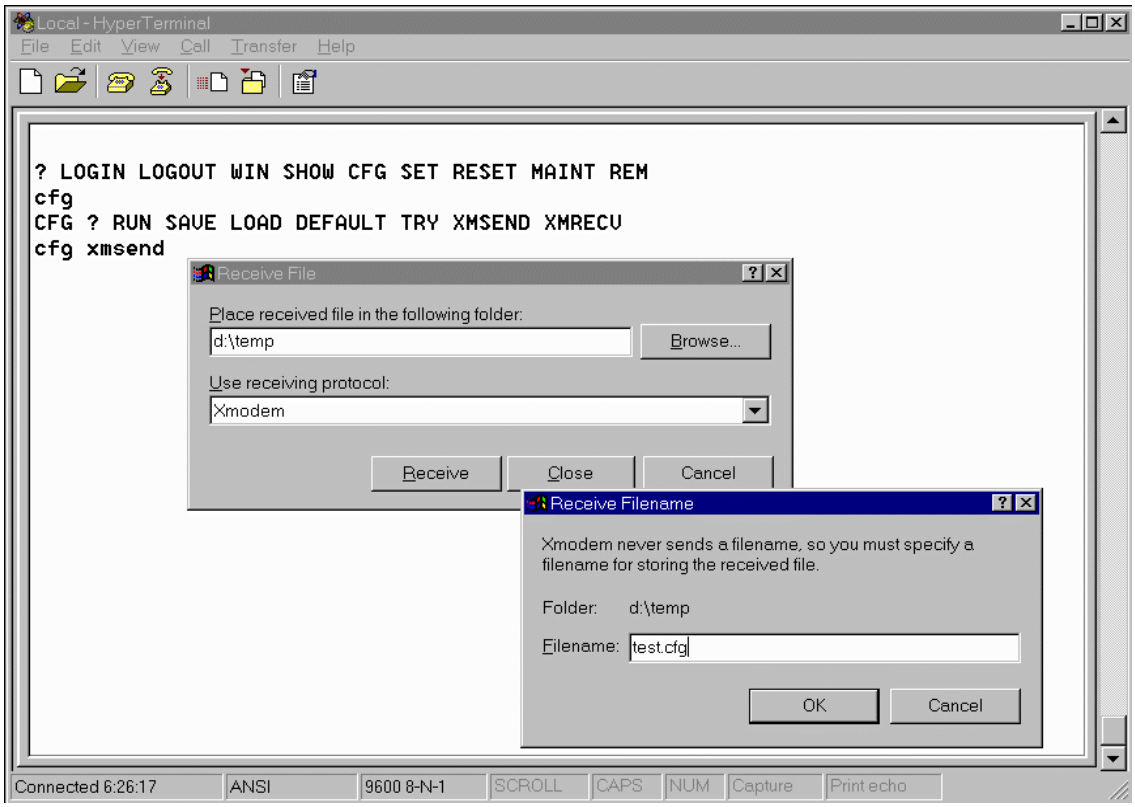
To start a download of the configuration in binary format to the PC, enter the command

```
CFG XMSEND CFG.BIN
```

To start a download of the configuration in text format to the PC, enter the command

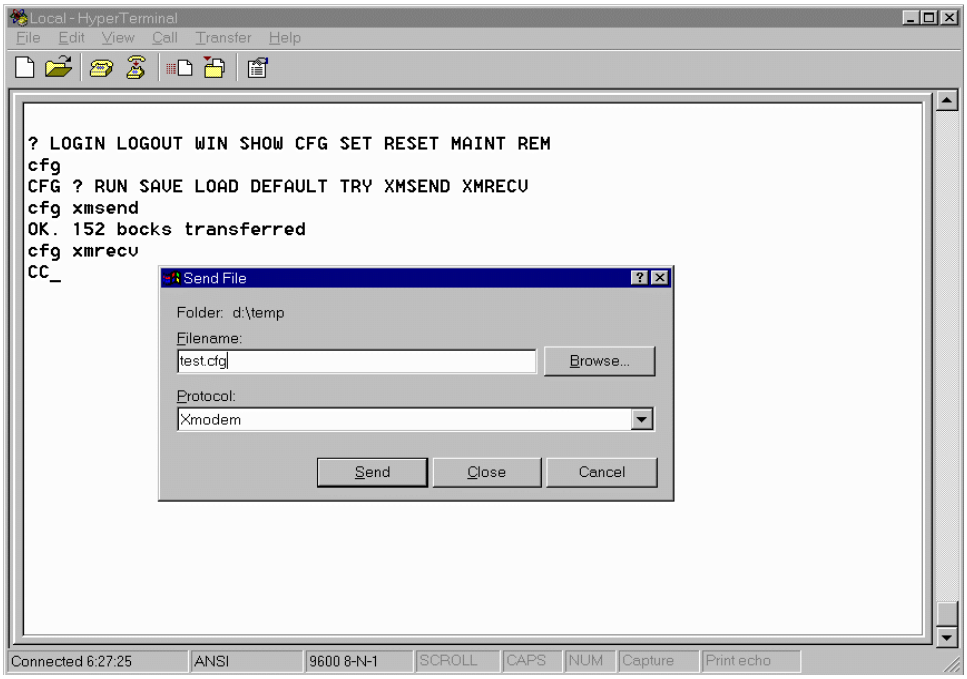
```
CFG XMSEND CFG.TXT
```

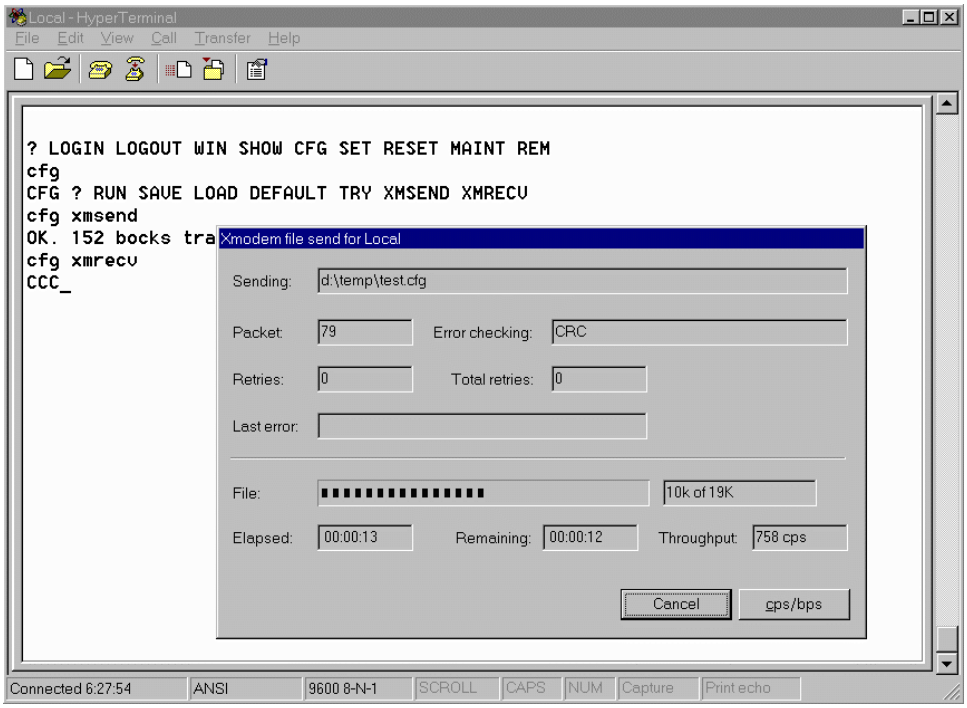
The IntelliMux is ready to start the transfer. On the PC, select the file transfer command, and choose to receive a file using the XMODEM protocol. Give a file destination and filename, and finally press the start button. After a few seconds, the file transfer will start.



The procedure for uploading is almost the same.

After entering the command "CFG XMRECV CFG.TXT" or CFG XMRECV CFG.BIN", the IntelliMux is ready to start receiving. The 'C' characters that appear on the screen are normal, and indicate that the IntelliMux invites the PC to start sending the file.





The syntax of the configuration in text format is similar to the syntax of the LISP programming language, and is described fully in the reference guide.

While a binary configuration file is generally useful to make a backup of the IntelliMux configuration in case its configuration gets lost, the text configuration file will normally be used to edit remotely the configuration of the IntelliMux, and upload it afterwards.

Remote Control.

And now for something completely different...

If the IntelliMux is installed at customer premises, the manager of the IntelliMux's may be interested in having remote access to the equipment via an ISDN B channel. The reasons for this can be the wish of the manager to check the operation of the equipment, or to provide remote support, or to control the routing table, etc…

The IntelliMux offers a standard way to do this, by providing TCP/IP connectivity over PPP via an ISDN B channel. This means that, once a PPP link has been established between the IntelliMux and the peer entity (read, the PC equipped with a ISDN adapter supporting PPP), all normal TCP/IP applications are possible: Telnet, SNMP.

There are two ways of establishing a Remote Control session: you dial in to the IntelliMux, or the IntelliMux dials a predefined number at a predefined hour of the day. We'll first discuss dialling into the IntelliMux.

To support remote control from your PC to the IntelliMux, the IntelliMux must be able to identify the incoming call as a remote control call. This is achieved by specifying the phone number to be used for Remote control. Moreover, for security reasons, it is required to specify the phone number of the calling device, which will be verified by the IntelliMux.
To simplify the PPP settings for the manager, the IntelliMux behaves as a PPP server, and if necessary assigns a IP address to the calling PPP client. As a result, the configuration required on a typical PC is pretty much the same as the one required to interact with a typical Internet Service Provider.
Finally, during establishment of the PPP connection, the IntelliMux will require a login verification using PAP (Password Authorization Protocol).

To support Remote Control, you will need to configure various PPP settings, as you can find in the PPP submenu (WIN.CFG.PPP) The configuration tasks required on the IntelliMux are shown below.

```
-PPP-------------------------------------------------------------
N       1
IPAddr  192.168.003.001
TimeOut 0
InCDN   *99
InCLI   *123
RemUser
RemPwd
OutCDN  0
OutCLI
OutLine ----------
LLine   NONE
LLStrTS 0
LLEndTS 0
```

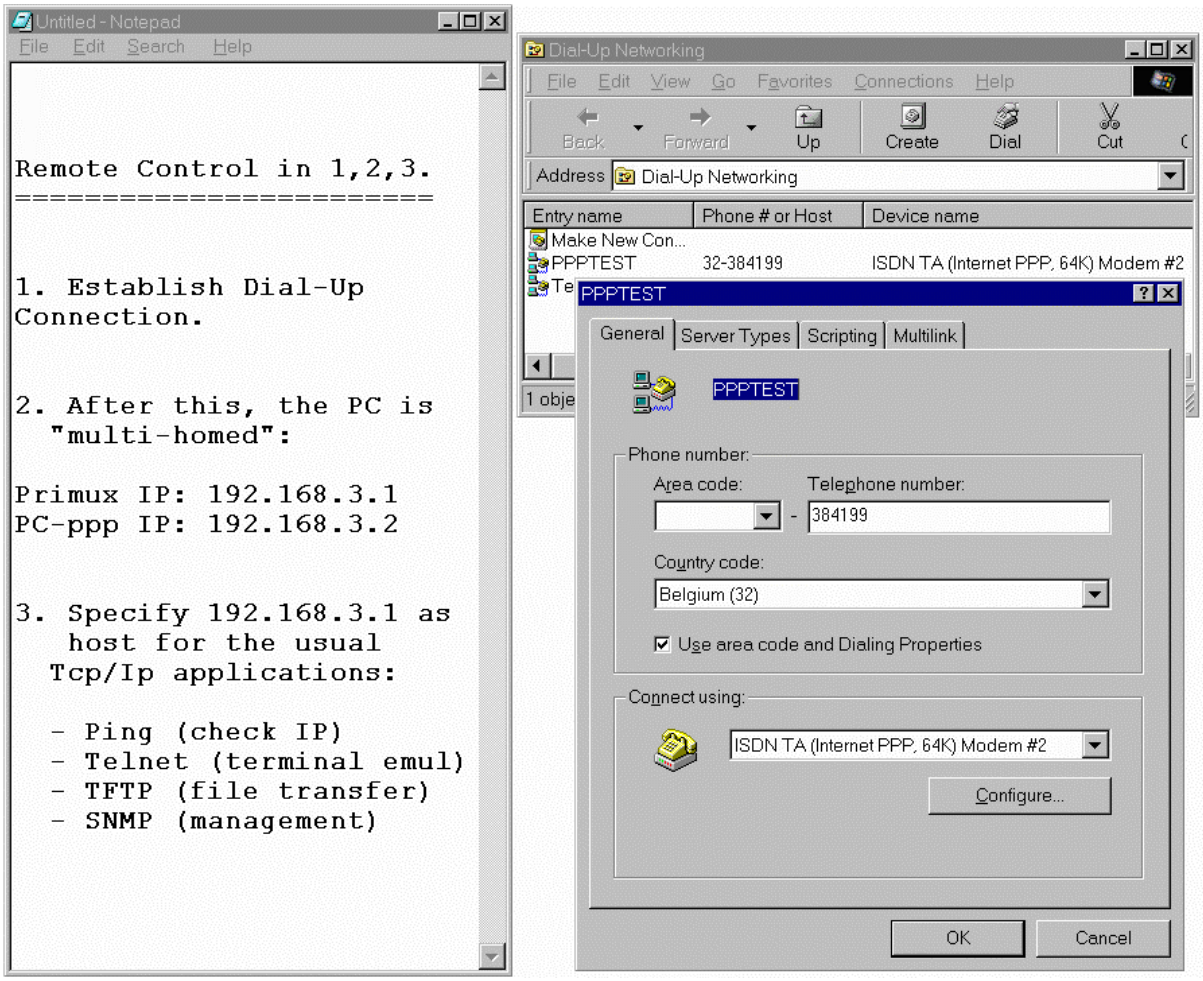
In this example, the phone number used for remote control (InCDN) is specified as *99. Note that this is a search pattern in the same way as search patterns were defined for the SHARE application (see chapter: Share). If this setting is too general, you can change it to be more specific. The example setting can be used to preconfigure an equipment in a more generic way allowing easier installation.
When a call is received with a called number that matches the pattern *99, the calling line identifier (CLI) (if present in the call setup) will be verified against the pattern *123 (as defined in the pppCLI field).

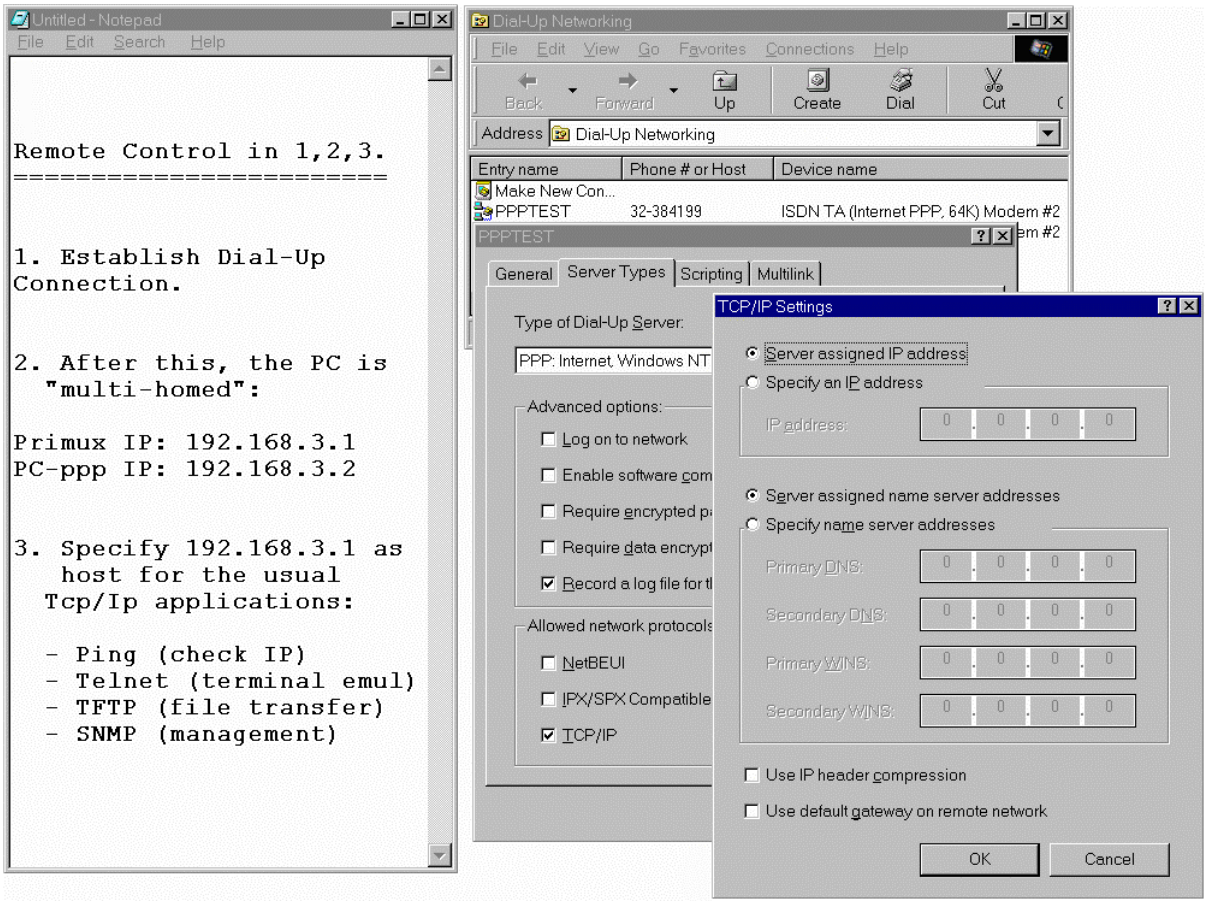
The IP address assigned to the remote control port of the IntelliMux is specified as 192.168.3.1.
This is an address that belongs to the so-called private networks.

This address can normally be used safely, unless the LAN network used by the client happens to be this same network (in this case, select another private network on the IntelliMux). As noted above, the IntelliMux will use this IP address in the negotiation with the client: by our convention, the IntelliMux will assign address IP+1 (192.168.3.2) to the PPP link at the client side, if the client side is not configured for an own PPP address.

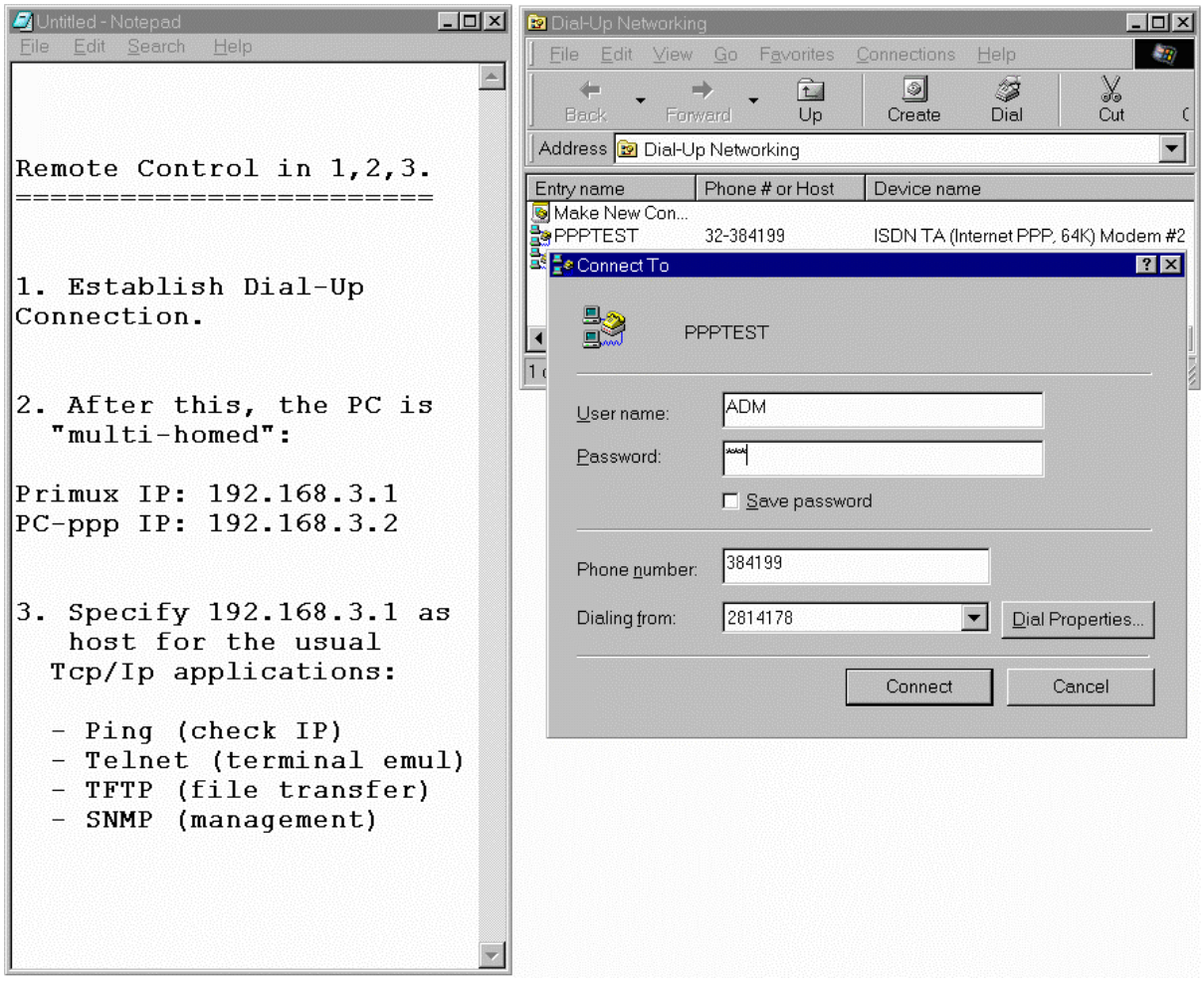
Once connected to the client, the IntelliMux will be identified to the client by the address 192.168.3.1.
This is all that is needed on the IntelliMux side.

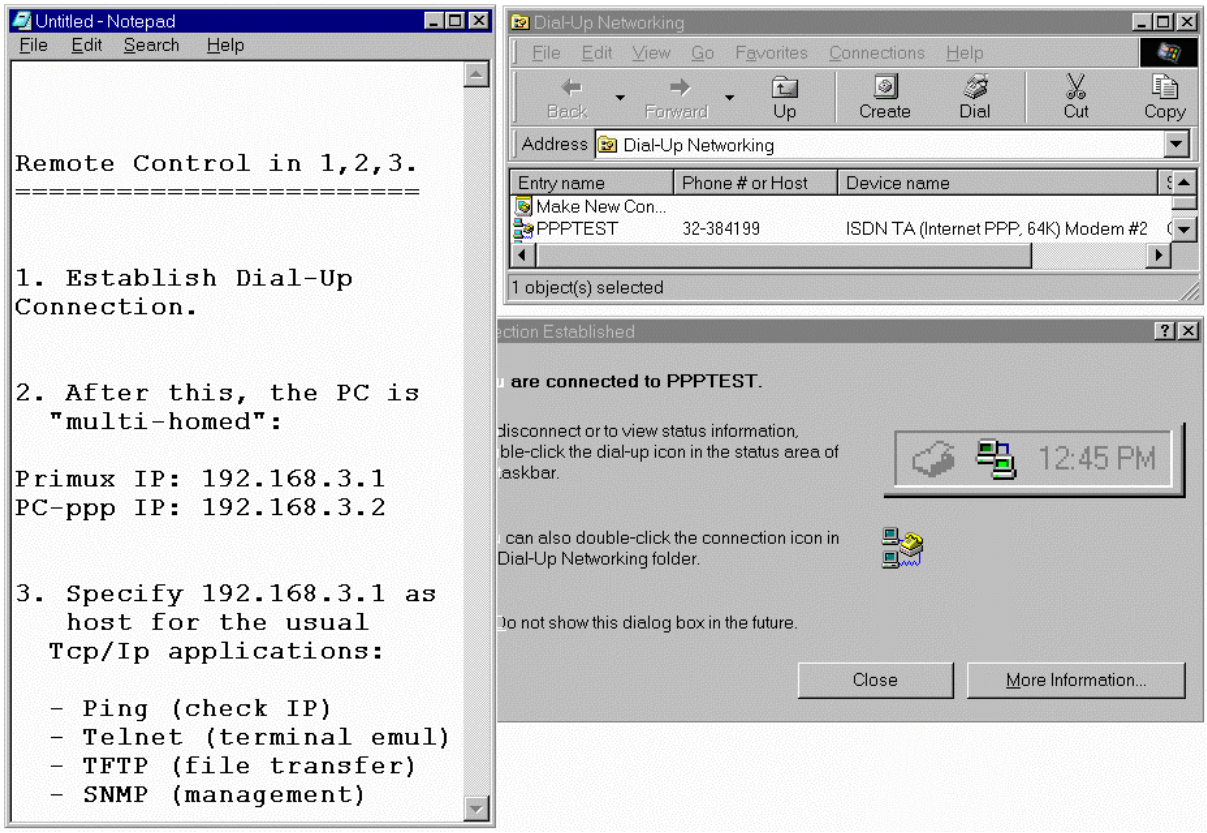
On the PC side, you need to have an installed ISDN TA adapter. External models are cheap, flexible and generally easy to install. You should ensure that the equipment supports basic PPP, which will be the case if it is able to connect to an Internet Service Provider.
Assuming a Win98 PC, a typical configuration may look as follows:





To establish the connection, select the Dial-Up entry, fill in the password, and connect. The username/password must be a username/ password belonging to one of the operators defined in the WIN.CFG.OPER screen.


Untitled - Notepad
File Edit Search Help
Remote Control in 1,2,3.
1. Establish Dial-Up Connection.
2. After this, the PC is "multi-homed":
Primux IP: 192.168.3.1
PC-ppp IP: 192.168.3.2
3. Specify 192.168.3.1 as host for the usual Tcp/Ip applications:
- Ping (check IP)
- Telnet (terminal emul)
- TFTP (file transfer)
- SNMP (management)
Dial-Up Networking
File Edit View Go Favorites Connections Help
Back Forward Up Create Dial Cut
Address Dial-Up Networking
Entry name Phone # or Host Device name
Make New Con...
PPPTEST 32-384199 ISDN TA (Internet PPP, 64K) Modem #2
Connect To
PPPTEST
User name: ADM
Password:
Save password
Phone number: 384199
Dialing from: 2814178
Dial Properties...
Connect
Cancel

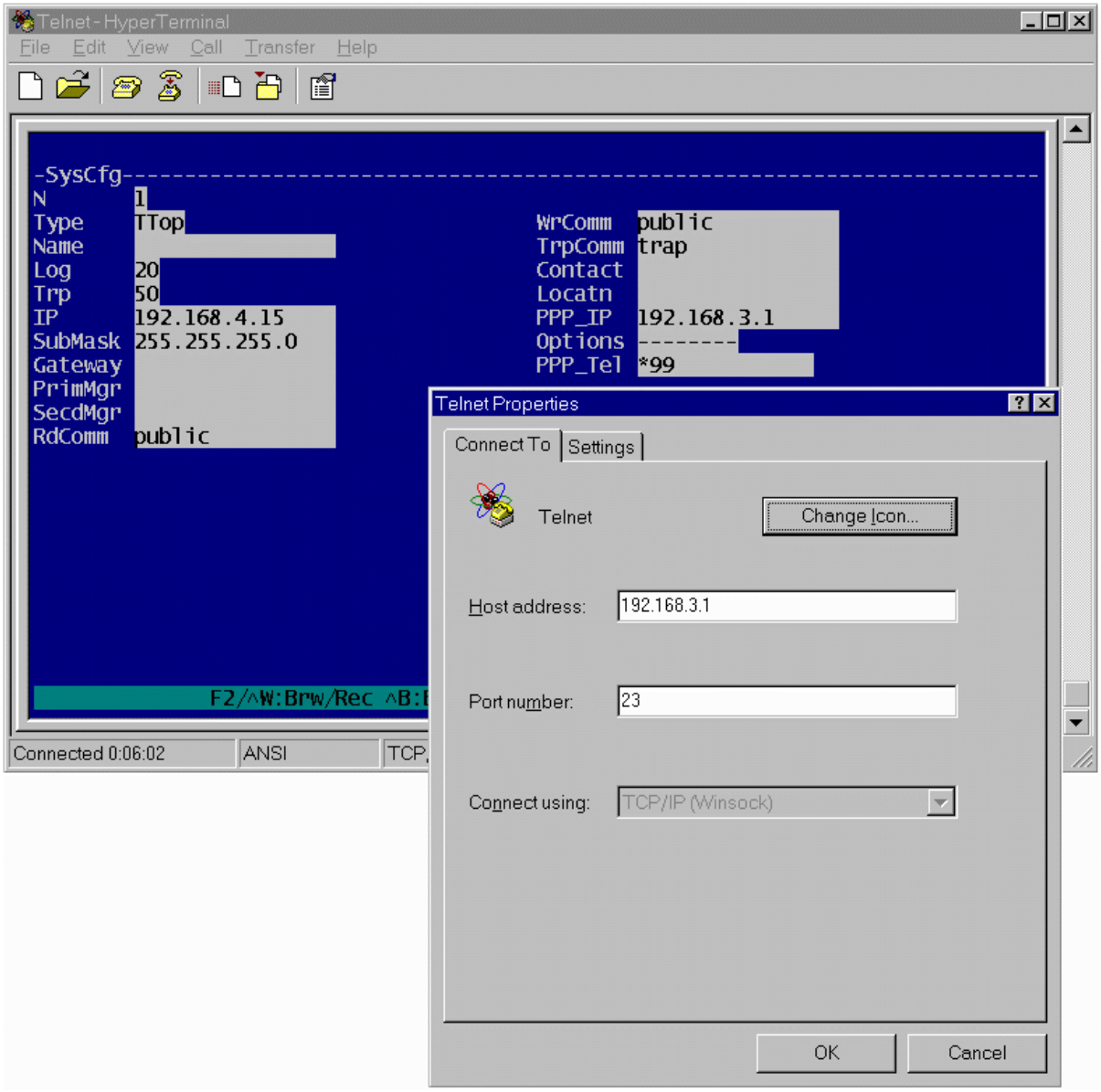


Now, IP-connectivity between the PC and the IntelliMux has been established.
Of course you don't believe it. Open a DOS Box and try this:

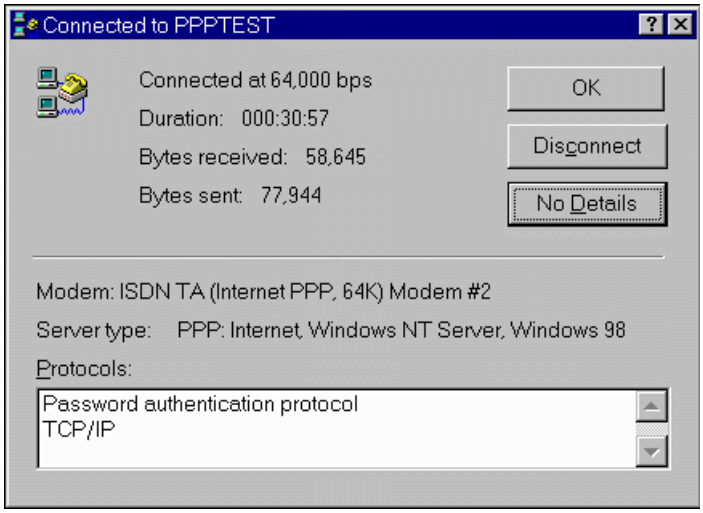
```
C:\WINDOWS>ping 192.168.3.1
Pinging 192.168.3.1 with 32 bytes of data:

Reply from 192.168.3.1: bytes=32 time=96ms TTL=32
Reply from 192.168.3.1: bytes=32 time=100ms TTL=32
Ping statistics for 192.168.3.1:
    Packets: Sent = 2, Received = 2, Lost = 0 (0% loss),
```

To start a Telnet session, set the remote host address to the IntelliMux IP. And make a connection.
Note that you do not need to log in again: the log in from the PPP session is also valid for all other interactions over the PPP link, provided of course that you do not log out.


Telnet - HyperTerminal
File Edit View Call Transfer Help
-SysCfg
N 1
Type TTop
Name
Log 20
Trp 50
IP 192.168.4.15
SubMask 255.255.255.0
Gateway
PrimMgr
SecdMgr
RdComm public
WrComm public
TrpComm trap
Contact
Locatn
PPP_IP 192.168.3.1
Options --------
PPP_Tel *99
F2/^W:Brw/Rec ^B:
Connected 0:06:02
ANSI
Telnet Properties
Connect To
Settings
Telnet
Change Icon...
Host address:
192.168.3.1
Port number:
23
Connect using:
TCP/IP (Winsock)
OK
Cancel

To end the PPP session, select the Dial-Up status window and choose disconnect:



As already mentioned, it is also possible to configure the IntelliMux to dial a predefined number at a certain moment in time, and establish a PPP session. Usually, you will want this kind of remote control, for example for collecting daily statistics through an SNMP management station.
To configure this, you have to change some parameters in the System Configuration Menu.

First you set the AlmTime (WIN.CFG.SYS.ALMTIME) parameter to a certain time of day, which will cause the IntelliMux to set up a call at that moment. The number that should be called is defined by the parameter OutCDN (WIN.CFG.PPP.OUTCDN).
In addition, you can define your own number, by filling in the OutCLI field (Calling Line Identifier) (WIN.CFG.PPP.OUTCLI). This can be handy for example to identify the IntelliMux that is calling the management station. The TimeOut (WIN.CFG.PPP.TIMEOUT) parameter can be filled in if you want the IntelliMux to cut the connection when nothing is received from the other side. If you keep the field to zero, then the connection stays up, regardless if traffic is received on the line or not.

You should also define the lines on which a remote control call is initiated, by filling in the OutLine bitmask WIN,CFG.PPP.OUTLINE) Fill Flag in this OutLine bitmask the lines on which a remote control call should be attempted. The IntelliMux will, when initiating the call, choose whatever line is free from the list of marked lines.

At last, make sure that the SNMP parameters are set correctly (for a full explanation on how to configure your IntelliMux for SNMP access, please refer to chapter SNMP). This implies that you need to set at least the PrimMgr and TrpComm parameters correctly in the System configuration table.
When the alarm time is reached, an SNMP trap will be sent to the SNMP management station, which allows the management station to automatically retrieve statistics from the IntelliMux.

Remark that the same fields also apply when a traps generated to a management station that is not located on the local LAN. In this case an outcall will be attempted to the number specified, and an SNMP trap will be sent. This trap generate an important event happens which requires the attention of an operator or management system. In other word, such a trap will be generated when a certain event has an importance level that is equal or higher than the system parameter ‘Trp’ (WIN.CFG.SYS.TRP). For a list of the possible events, and their corresponding levels, see the chapter on ‘Tracing, Logs and Traps’ in the Reference Guide.

Managing the IntelliMux with a web browser

Besides the ability to manage your IntelliMux through a Telnet connection, you have also the possibility to manage the IntelliMux through a built in web-interface. With the web-interface, managing the IntelliMux is user-friendlier than through a Telnet interface.
To be able to reach the IntelliMux with your web browser, you'll need to have installed the Softkey option SK_SN (TCP/IP module), as your web browser connects to the IntelliMux using the TCP/IP protocol.

Configuring your browser.

There are two ways you can access the web server of the IntelliMux. Or you have a direct LAN connection with your IntelliMux, or you remote dial-in to the IntelliMux.

In case you are directly connected to the IntelliMux, you must ensure that your TCP/IP stack is set up correctly. This basically means that you should follow the steps as described in chapter "Managing the IntelliMux via the LAN".

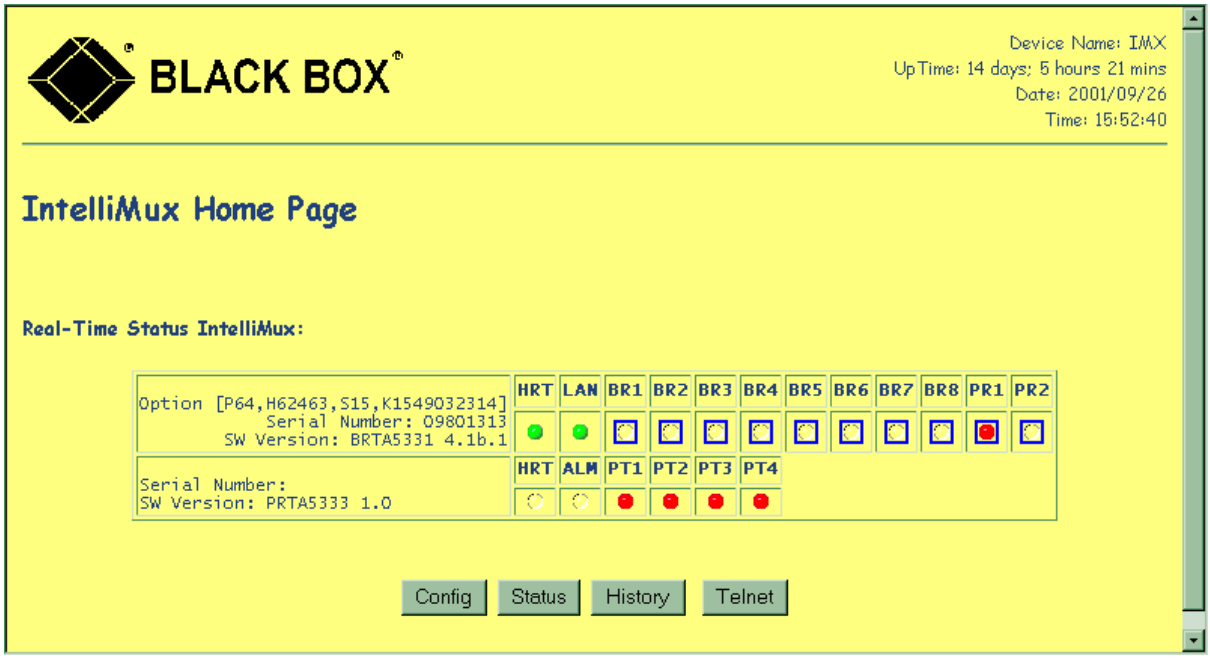
In case you have to dial in to the IntelliMux to reach it, you need to follow the steps as described in chapter, "Remote Control.".
Once you are sure you can reach the IntelliMux through TCP/IP (e.g. by pinging it), verify that your browser is configured correctly. This generally implies that your browser needs to be configured or for 'direct' (LAN) access, or that it uses a specific dial-up configuration, whatever is applicable.

Once you have verified this, open your Internet browser and point it to the IntelliMux. The simplest way to do this is by supplying the full IP-address of the IntelliMux as the Web Address, as in following example:

```
Address: http://192.168.004.015
```

Of course, if you have updated your Domain Name Server or hosts file with a name alias for your IntelliMux 's IP address, you can fill in this alias in the Address field of your web browser.
If you have problems connecting to the IntelliMux, verify that you entered the IP-address correctly. If your web browser is configured for using a proxy server, and your IntelliMux is connected to your local LAN, verify that you are allowed to reach local web servers from your browser (if you are using Microsoft's Internet Explorer, verify that in the LAN settings of the Internet Options dialog box, you checked the box 'Bypass proxy server for local addresses').

If you are able to connect to the HTTP server, you'll get an authentication box in which you need to enter a username and password. This username needs to be one of the operators defined in the WIN.CFG.OPERATOR menu. If you logged in successfully, the IntelliMux will show you its 'home' page, as in following example:



Now you are ready to control the IntelliMux using your web browser.

The IntelliMux web server.

IntelliMux Home page.

The home page contains following items:

- a simulated front panel of the IntelliMux. This front panel shows you the LEDs equivalent as the ones on the IntelliMux itself. If you have a VXI module installed, the corresponding LEDs will also be shown. It also shows the hardware and software options installed, the serial number, and the software version. Remark that you can click on the LEDs (for which a hyperlink is enabled) to jump to a summary page showing you the configuration, status, and history of the corresponding line.
- Links to the IntelliMux's configuration, status and history pages.
- A telnet button which launches your Telnet client and attaches it automatically to the IntelliMux.

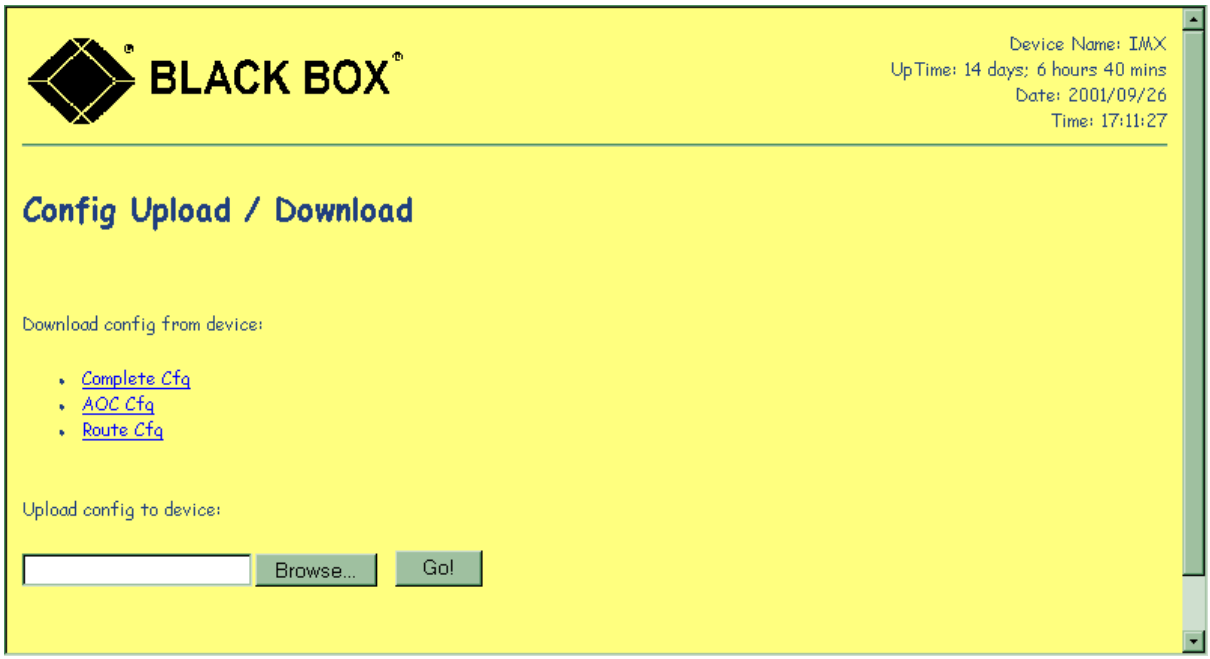
IntelliMux configuration, status and history pages

The IntelliMux configuration, status and history pages can be accessed through a series of buttons on the home page. All these pages provide a menu interface similar to what the ANSI interface gives you if you connect with Telnet.

Configuration pages

The configuration menu shows you the information contained in the "RUN" database. This is in contrast with the Telnet ANSI interface, which shows the config contained in the "EDIT" database.

Besides the config menu, the page contains also a link to download and/or upload *text* configuration information, as shown in following figure:



The 'Download Config' hyperlinks bring you to a new page containing the relevant configuration information in plain text format. You can store the info in this page to disk by saving it to a text file, using the 'File – Save As' function of your browser.

The 'Upload Config' field and buttons allow you to upload a configuration file to the IntelliMux. Supply the name of the file in the editable field directly, or click the browse button to search your local drive for it. Remark that you can only upload a *text* configuration file, with a syntax as described in the Reference Guide (see also chapter: "Saving and restoring configuration with Xmodem").
Once you selected a file, click the 'Go!' button to upload the file. Depending on the size of the file, this can take a couple of minutes. When the page is uploaded, the browser returns the success or failure status of the upload process in a new page.

Remark: The Config upload command uploads the ***edit*** database to the device. Similarly, the Config download command downloads the ***edit*** database from the device. In particular, if you want to make the uploaded configuration the running configuration, it's necessary to perform a 'cfg run' command from the Telnet console. Alternatively, you can supply the 'cfg run' command together with the configuration file. Simply add the line '`(Command, "cfg run")`' after the '`Database`' section. If the IntelliMux has stored successfully the configuration, the cfg run command will be performed automatically.

Status and History Pages

The Status and History buttons on the Home Page bring you to a page containing a menu allowing you to view status and history information. Additionally, they contain a hyperlink to download the Status and History information in text format.

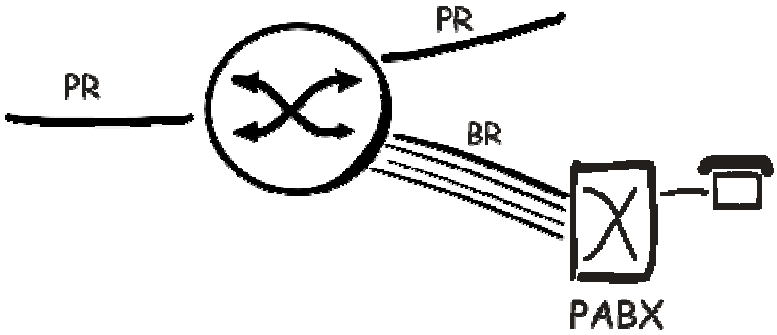
Remarks

- The HttpRef field in the system configuration (WIN.CFG.HTTPREF) allows you to supply the IntelliMux with an interval in seconds at which the IntelliMux web server will refresh pages with dynamic data (such as status tables). A value of 0 in this field disables the refreshing of pages. Make sure that you take a value large enough not to overload the communications link or the web server. It is advised that you set the timeout to at least 20 seconds.

- The IntelliMux currently allows up to 3 simultaneous HTTP connections. This means that only three web browsers can consult simultaneously web pages of the IntelliMux. If a fourth web browser tries to reach the IntelliMux, it will be refused by the IntelliMux, saying that no connection was possible to the IntelliMux.

SHARE: Sharing a single access with multiple users.

The application.



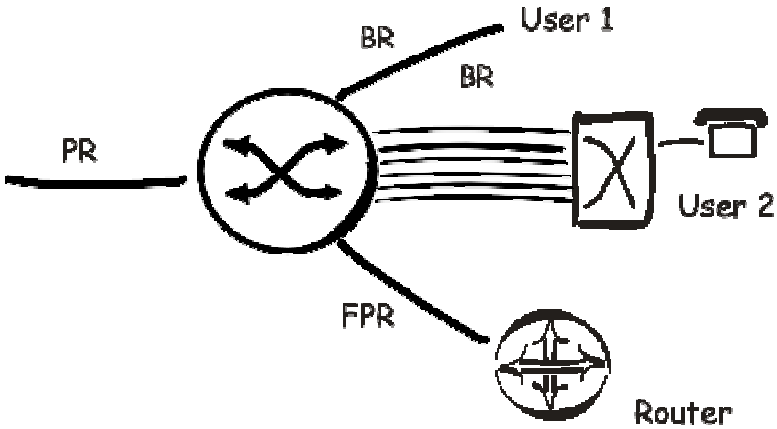
Today, most PRI access lines are used to feed a PABX. With the more common use of other equipment working on PRI lines (video conferencing systems, routers, etc..), the need has arisen to share a single PRI equipment with multiple user terminals. Consider as an example sharing the PRI interface between the company PABX and a company WAN router with PRI interface. In some cases, it is also interesting to have multiple PABX's on the same PRI.

The IntelliMux provides possibilities to split the assigned range of phone numbers over multiple User (TE) equipment, so that the Net PRI can effectively be re-used.
In addition, the IntelliMux provides the possibility to impose limits on the number of B channels that can be used by the respective users.

The configuration.

There are many possible configurations.

As an example, we will show how to share a single PRI (L10) access over 3 users: one PRI user (L9), one PABX user with 6 BRI lines (L1-6), and one user with a telephone on L7. L8 is a BRI access line which is reserved for special cases (e.g. as a last resort line when the PRI is out).



```
-Line-------------------------------------------------------------0009--
N  Type Name             Act Sgn  Tei NT Crc4
1  BR   L1 (User2)       On  Isdn 64  NT NoCRC4
2  BR   L2 (User2)       On  Isdn 64  NT NoCRC4
3  BR   L3 (User2)       On  Isdn 64  NT NoCRC4
4  BR   L4 (User2)       On  Isdn 64  NT NoCRC4
5  BR   L5 (User2)       On  Isdn 64  NT NoCRC4
6  BR   L6 (User2)       On  Isdn 64  NT NoCRC4
7  BR   L7 (User3)       On  Isdn 64  NT NoCRC4
8  BR   L8 (Net Help)    On  Isdn 64  TE NoCRC4
9  PR   L9 (User1)       On  Isdn 0   NT NoCRC4
10 PR   L10(Net)         On  Isdn 0   TE NoCRC4
```

The PRI line L10 has a range of 100 DDI numbers, which are distributed over the 3 users as follows: 60-79 go to user2, 80-89 go to user3, the other numbers are assigned to user1.

The BRI line L8 can be used by all users by using the prefix 13, and will establish a connection to the helpdesk of the PRI access operator.

```
-Route------------------------------------------------------------------0009--
N   Act LineIn     Search          Replace         LineOut    Calltyp   FailMi
1   On  123456---- *               *               ---------0 --------- 0
2   On  ------7--- *               *               ---------0 --------- 0
3   On  --------9- *               *               ---------0 --------- 0
4   On  ---------0 *6?             *6?             123456---- --------- 0
5   On  ---------0 *7?             *7?             123456---- --------- 0
6   On  ---------0 *8?             *8?             ------7--- --------- 0
7   On  ---------0 *               *               --------9- --------- 0
8   On  1234567-9- 13*             0123456789      -------8-- --------- 0
9   Off ----------                                 ---------- --------- 0
10  Off ----------                                 ---------- --------- 0
```

In this case, the route specifies that the incoming called number should be analysed, and that the routing is to be made based on the last 2 digits. This assumes that the incoming calls will provide the full called number at once (incoming set-up is en bloc). This is normally the case, although it is theoretically possible that the network does not give adequate called number information.

Restricting bandwidth

In the above example, the resources on the Net PRI are used on a first-come first-serve basis. If L9 uses up all B channels, then the other user will not have access to the network.

So you may wish to restrict the number of calls that can be made by each User, by using a method to reduce the number of channels available for User1. Since there are 7 user BRI lines for which B-channels need to be kept free, you have to make 14 (7 x 2 B channels per BRI line) lines on the PRI line to User1 unavailable.

Two methods can be used to achieve this: by restricting the channel range for incoming and outgoing calls on the PRI line for User1, or by creating a nailed-up loopback for a number of channels on this line.

The first method relies on the ability to reserve channels for incoming calls and outgoing calls, but works only if the User1 PRI line has a line configuration set to NT (which is usually the case). In our example, this would mean that we make only the first 16 channels available for incalls and outcalls, as configured in the next example:

```
-Line-------------------------------------------------------------0009--
N       9
Type    PR
Name    L9
Act     On
Sgn     Isdn
Tei     0
NT      NT
Idle    x49
Crc4    CRC4
StrInc  0
EndInc  15
StrOutg 0
EndOutg 15
AlmFrom ----------
Options --------
```

Line 9 is configured to use B-channels 0 to 15 for incoming calls (StrInc = 0, EndInc = 15), as well as for outgoing calls (StrOutg = 0, EndOutg = 15), which will force the IntelliMux to select a B-channel in this range for incoming and outgoing calls. Remark that '*Incoming*' and '*Outgoing*' is defined with respect to the IntelliMux, i.e. an incoming call is a call *entering* the IntelliMux, whereas an outgoing call is defined as a call *leaving* the IntelliMux.

Another practical usage of the fields StrInc, EndInc, StrOutg, EndOutg is for defining a range of B-channels for incoming calls, and a range of B-channels for outgoing calls. If for example you want to reserve B-Channels 0 to 15 for incoming calls, and B-channels 16 to 31 for outgoing calls, you would configure StrInc = 0, EndInc = 15, StrOutg = 16, EndOutg =31. Certain types of PABX's sometimes require such a configuration.
Please be careful when restricting B-channels for incoming or outgoing calls. If this is done inadvertently, wrong settings can result in a failure of the line to accept or originate calls!

The second method is actually a kind of trick, which consists of making the IntelliMux believe that some channels are reserved for nailed up channels. The normal use of nailed up channels will be seen further. In this case just consider the following configuration :

```
-FixN64-----------------------------------------------------------0001--
N  Act Name             NrTLineITSILineOTSOPContrl
1  On  Restrict User1   14 L9   17 L9   17 ----
2  Off F2               0  NONE 1  NONE 1  ----
3  Off F3               0  NONE 1  NONE 1  ----
4  Off F4               0  NONE 1  NONE 1  ----
5  Off F5               0  NONE 1  NONE 1  ----
6  Off F6               0  NONE 1  NONE 1  ----
7  Off F7               0  NONE 1  NONE 1  ----
8  Off F8               0  NONE 1  NONE 1  ----
9  Off F9               0  NONE 1  NONE 1  ----
10 Off F10              0  NONE 1  NONE 1  ----
```

Generally, nailed up channels are routed from one line (say L2) to another line (say L3).

The above configuration however specifies that 14 timeslots on L9 - starting with channel B17 - will be forced connected to themselves. This means that channels B17 to B31 are routed back to where they come from, thus creating a nailed-up (or fixed or forced) loopback.
In fact, these loopbacks are not the interesting aspect. The main result is that these 14 channels are not available anymore for switched ISDN calls. So this leads to the following situation:

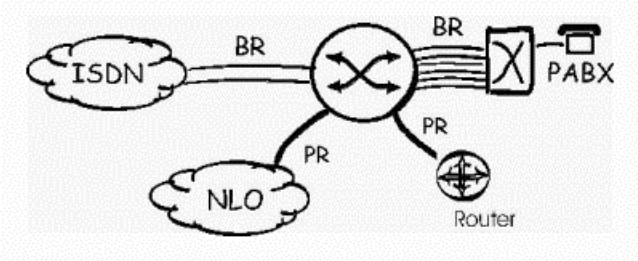
- User1 will be able to use at most 16 B channels (30 – 14 used for the nailed-up loopback)
- User2 will be able to use at most 12 B channels (6 BRI with no restrictions)
- User3 will be able to use 2 channels (no restriction imposed).

What happens if only 12 instead of 14 B channels would have been excluded? In that case, 2 B channels would become available on a first come first serve basis. By allowing User2 to use 7 BRI channels, there would be 2 B channels that are effectively shared by User1 and User2.

This same approach can also be used when the operator provides a Fractional PRI (where only a limited number of B channels on the PRI can be used by the customer). In this case however, the network operator will need to specify which channels need to be blocked.

CHOICE: Least Cost switching to an alternative Network Access Provider.

The application.



Providing telephone lines to the customer has finished being the monopoly of a single company.

This creates the situation where multiple network access lines are provided at the customer site, so that the customer is confronted with the need to choose.

This is where the CHOICE application comes in. As for the basic REDIAL application, the called number is analysed. Based on specifications in the routing table an alternative network can be selected.

The IntelliMux goes even further by providing the means to specify Fallback routes should the first choice be unavailable at the moment of making the call.

Configuration.

The example configuration shown above requires Softkey options for the second group of BRI lines (L5-8) and for the second PRI line (L10). We will assume that the New License Operator provides PRI access, which is installed on L10, and that the "Old" operator provides 2 BRI lines installed on L1 and L2. To complicate things a little bit, we will also assume that the user side consists of a BRI PABX which is using the remaining 6 BRI lines, and of a PRI line that is used by a router (L9). This allows us to configure the lines as follows:

```
-Line-------------------------------------------------------------0009--
N  Type Name             Act Sgn  Tei NT Crc4
1  BR   L1               On  Isdn 64  TE NoCRC4
2  BR   L2               On  Isdn 64  TE NoCRC4
3  BR   L3               On  Isdn 64  NT NoCRC4
4  BR   L4               On  Isdn 64  NT NoCRC4
5  BR   L5               On  Isdn 64  NT NoCRC4
6  BR   L6               On  Isdn 64  NT NoCRC4
7  BR   L7               On  Isdn 64  NT NoCRC4
8  BR   L8               On  Isdn 64  NT NoCRC4
9  PR   L9               On  Isdn 0   NT NoCRC4
10 PR   L10              On  Isdn 0   TE CRC4
```

All outgoing non-local calls should be routed to L10. However in case of a failure of the PRI line, calls should be routed to the BRI lines. All local calls should always be routed to the BRI lines.

For incoming calls, all calls ending with DDI values between 81 and 89 should be switched to the router. The other calls should be switched to the PABX.

```
-Route-------------------------------------------------------------------0006--
N   Act LineIn     Search          Replace          LineOut    Calltyp   FailMi
1   On  12-------0 *8?             *8?              --------9- --------- 0
2   On  12-------0 *               *                --345678-- --------- 0
3   On  --3456789- 0*              0*               ---------0 --------- 0
4   On  --3456789- *               *                12-------- --------- 0
5   Off ----------                                  ---------- --------- 0
6   Off ----------                                  ---------- --------- 0
7   Off ----------                                  ---------- --------- 0
8   Off ----------                                  ---------- --------- 0
9   Off ----------                                  ---------- --------- 0
10  Off ----------                                  ---------- --------- 0
```

Clock synchronization issues.

When using multiple networks, the issue of clock synchronization arises. Public networks are synchronized between them, so it is not really important which network will act as a provider of a clock source.

The IntelliMux always tries to slave on a NET (line which acts as TE), because the networks are supposed to give the clock. In the above example, L10, L1 and L2 are possible clock sources.

The default rule for clock slaving is that at startup, the IntelliMux will first try to select the first PRI network on which a clock is detected (L10 in the example). If no clock is detected, then the IntelliMux will try to detect a clock on the BRI lines.
One can overrule this default action by specifying a line on which clock slaving needs to take place. In this case, the IntelliMux will first try the specified line for clock slaving. If the clock slaving is impossible on the specified line (because e.g. the line is non-operational), then the default action, as previously described will be taken by the IntelliMux. If the specified slaving line becomes operational again, then this line will again be selected as line to slave the clock on.

The selection of the line to slave on can be done in the *ClkSlve* field in WIN.CFG.SYSTEM.

If you wish to use BRI lines for synchronization, then you should ask the BRI provider to ensure that the BRI lines remain activated all the time. This will generally be the case when a Point-to-Point connection (TEI=0) is ordered. In the case where there is no BRI clock either, the IntelliMux will use an onboard oscillator (Free Run). The selected clock can be checked in the System status screen as shown below.

```
-Sys---------------------------------------------------------------------------
N       1
Sts     ACT
Date    1999/08/12
Time    05:55:34
ClkSrc  9
Trc     20
HWErrs  x0000
```

The IntelliMux will automatically switch to another clock source if the current source is lost. In addition, the IntelliMux will give preference to a PRI clock source.

If you plan to use a private ISDN network along with a public network, then you should ensure that the private network itself is slaved on a clock provided by that public network. Note also that a PABX will normally slave on the clock given by the IntelliMux.

Advice Of Charge Generation

What is Advice Of Charge all about?

The generation of Advice of Charge (AOC) info allows an ISDN network to provide the caller with billing information about the current call. As such, the user can get notifications about the amount that he will get charged for his current phone-call. Remark that the Advice of Charge feature within ISDN only gives an *advice* about the amount that will be charged to the customer.

For example, in some circumstances the network won't be able to retrieve all charging information about the current call, so the charging information given could be incomplete or not present at all.

There are three possible forms of AOC:

- AOC-S: Advice of Charge at the start of the call. The network provides at the beginning of the call (e.g. in response to a Setup request) information on the billing that the network provider will apply to the call. It won't give any information about the amount billed, but supplies the user with a method to 'calculate' the bill, as function of various parameters. AOC-S is seldom used, and as such not often implemented in ISDN-equipment.
- AOC-D: Advice of Charge during the call. The network provides information about the charges for the call in progress at fixed time intervals. At the end of the call, the total charges for a call are also given (as AOC-E would do).
- AOC-E: Advice of Charge at the end of the call. This AOC form supplies the caller with the total amount charged for a call at the end of the call.

The charging info can be provided in *Currency* format or in *Charging Units* format. AOC supplied in Currency format returns charging info in the form of an amount of money in a well specified currency. AOC supplied in Charging Units returns charging info in the form of an amount of units charged, where one unit corresponds to a certain pre-defined amount of money.

There exist different methods to supply AOC information within the ISDN community: one is within a keypad information element, another is within a facility information element. The IntelliMux only supports AOC within facility information elements.

Generation of AOC by the IntelliMux.

The IntelliMux has the capability to generate Advice Of Charge information on its own, based on several configuration options. This way, you can supply your customers with information about the charges you apply to calls that they make.
The IntelliMux is capable of generating AOC-info during the call (AOC-D), and at the end of the call (AOC-E). This info can be supplied in both currency and units format.

Following are some situations where you might want to have the IntelliMux generate AOC information:

- When the network itself is not capable of generating AOC information on its own.
- When an alternative operator is reached by using a Carrier Select Prefix and the incumbent operator blocks any AOC info sent by the NLO. To circumvent this, the IntelliMux can supply the AOC information on its own.
- When adjustments are needed to the AOC info given by the network. For instance, for hotel chains, hotel customers are usually charged more for their phone calls than what is charged to the hotel-owner. In this case the IntelliMux could provide its own billing information to the hotel customers, regardless of what is charged to the hotel-owner.

Within the IntelliMux, the generation of AOC-info is done per route. This means that you configure a route for generating a certain charging pattern. So, if a call is switched through by the IntelliMux, the route taken for switching the call also determines the charges that will be sent to the originator of the call. This way, you can vary the charging depending on the number prefixes that are dialled, as well as on the type of the call (voice, data, …), as a route is selected based on these two criteria.

It is obvious that only the originator of the call will receive AOC information, and only if the line to which he is connected is configured as an NT (network) line.

Remark that for calls for which AOC is enabled, AOC messages received by the IntelliMux from the network side of the call will be filtered out, such that the originator of the call only receives AOC information generated by the IntelliMux itself. On the other hand, for routes for which no AOC is configured, AOC information received by the network will be passed through transparently.

As a safety measure, there is a built in mechanism that will restrict the number of AOC messages on a particular line to one AOC message per second, regardless of the actual AOC messages. This prevents that equipment receiving AOC information gets swamped with AOC messages.

Each call for which AOC is enabled will generate at the end of the call a trace message stating the total amount of money that has been charged for the call. Also, the history database has a *Charges* entry for each line and each route, showing the total cumulative charges applied to a line or route, since reset of the system.

Configuring the IntelliMux for generating Advice of Charge.

Before you start configuring the IntelliMux for generating Advice of Charge, make sure you have purchased the SK_AO softkey (see chapter SW Upgrade and Softkey Options).

To configure the IntelliMux for generating Advice of Charge info, you need to follow a couple of steps:

Start by checking that some system level parameters are set correctly, as shown in following figure:

```
-Sys-------------------------------------------------------------------------
N        1
Type     IMX                                 AOCType AOC-D
Name     IMX                                 AOCCTyp Currency
Log      20                                  AOCCurr USD
Trp      50                                  AOCMult 0.01
IP       192.168.099.001                     IPRoute Off
SubMask  255.255.255.000                     Masq    Off
Gateway  000.000.000.000                     MasqIP  000.000.000.000
PrimMgr  000.000.000.000                     RCNetIP 000.000.000.000
SecdMgr  000.000.000.000                     RCMask  000.000.000.000
RdComm   public
WrComm   netman
TrpComm  trap
TLogOff  0
TFailSf  20
ClkSlve  AUTO
AlmTime  00:00:00
HttpRef  0
AOCEnbl  On
```

If the highlighted fields in above snapshot are not visible, you don't have AOC softkey installed

First, make sure that the flag *AOCEnbl* is set to *On*. This flag will enable or disable the generation of AOC information for all calls. It is a convenient way to disable the generation of AOC info globally in case for example the PABX becomes overloaded due to the generation of AOC messages.
Secondly, you need to define in the *AOCType* field the type of AOC information to be generated: AOC-D or AOC-E. AOC-D enables the generation of AOC information while the call is in progress, while AOC-E only supplies a total amount charged at the end of the call. AOC-D has the advantage that the caller gets regular notifications about the amount he has been charged already, but has the disadvantage that the equipment receiving the info needs to be powerful enough to interpret the AOC messages quick enough. AOC-E only gives an amount at the end of the call, but poses a lesser load on the equipment.

Thirdly, you define the type of AOC information to be generated in the *AOCCtyp* field. If you choose *Currency*, AOC info will be generated in currency format. In this case, the *AOCCurr* and *AOCMult* fields apply. The *AOCCurr* field allows you to specify the abbreviated string (max. 4 characters) for the currency type string applied (e.g. BEF, USD, FRF, ...). The *AOCMult* field defines the multiplier that should be used for the charged amount. For example, if you define a charging of 625 per time interval in the charging profile (see further on) and a multiplier of 0.01 is chosen, then the real charge applied will be an amount of 6.25 of the currency defined in the *AOCCurr* field per time interval.

If you choose *Unit* as the type of AOC information to be generated, then all charging will be supplied in units, in which a unit corresponds with a predefined amount of money. Remark that in this case, the *AOCCurr* and *AOCMult* fields are not applicable.

Once the system parameters are defined correctly, you need to configure each route with the necessary information about the charging applied to that route. The information about the conditions in which charging needs to be generated, and the amount of charges is actually contained in what is called a 'Charging Profile'.

The 'Charging Profile' defines all the characteristics of the charging applied to a call, and as such determines the complete charging pattern for the call. A route record will refer to this charging profile to generate the necessary AOC charging for a call established on that route.

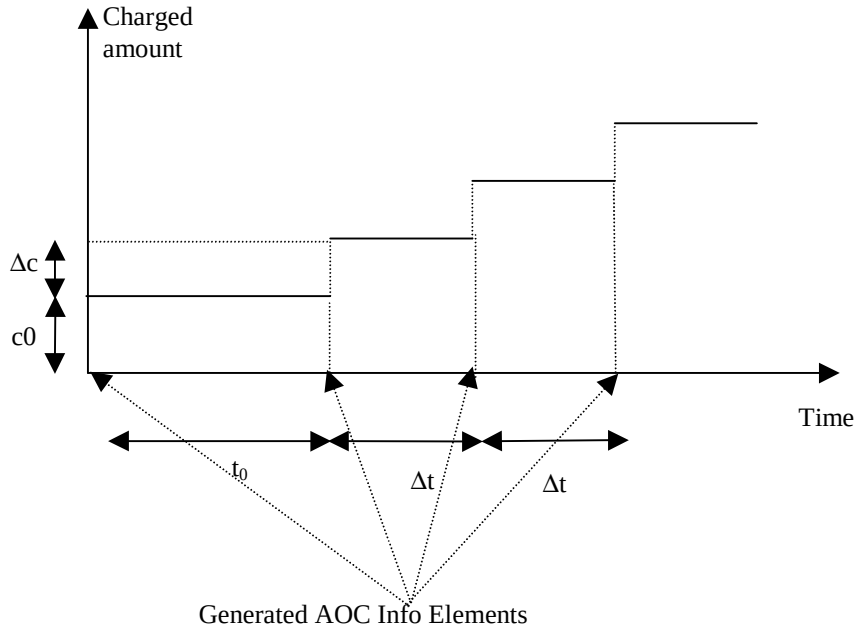
The IntelliMux stores charging profiles in a separate 'Charging Profile' database, which can be retrieved from the AOC_Profile menu option (WIN.CFG.AOC_PROFILE). The layout is shown in following example:

```
-AOCProf-------------------------------------------------------------0001--
N   Act Label            Days     StrEndc0me  t0    DeltaCDeltaT
1   On  weekday peak     -MTWTF-- 8  18 165   60    80    60
2   On  weekday off-peak -MTWTF-- 18 8  165   120   80    120
3   On  weekend          S-----SH 0  24 100   120   100   120
4   Off                  -------- 0  0  0     0     0     0
5   Off                  -------- 0  0  0     0     0     0
6   Off                  -------- 0  0  0     0     0     0
7   Off                  -------- 0  0  0     0     0     0
8   Off                  -------- 0  0  0     0     0     0
9   Off                  -------- 0  0  0     0     0     0
10  Off                  -------- 0  0  0     0     0     0
```

A Charging profile has the following parameters:

- Act: Activates the charging profile
- Label: a name that defines the charging profile, and through which it will be referenced from the route configuration (see further on)
- Days: bitmask of the days of the week for which the charging profile will apply. It has the format SMTWTFSH, where the first S stands for Sunday, M stands for Monday, and so on. The H stands for Holiday, and allows the user to select the profile for holidays. The holidays are defined in a separate database (see further on).
- StrTime: Start hour of the day for which the profile applies.
- EndTime: End hour of the day for which the profile applies. The time zone defined by the StrTime and EndTime parameters starts at StrTime and runs *until* the defined EndTime hour; that is not including the EndTime hour. Remark that the time zone defined by the StrTime and EndTime parameters can cross the midnight boundary, i.e. one can define a period from 18 h in the evening (6 pm) to 8 h the next morning (8 am).
- c0: The initial charged amount, which will be applied as soon as the call is connected.
- t0: The initial time interval in seconds for which the initial charging c0 applies.
- DeltaC: The incremental charge applied to a time interval DeltaT.
- DeltaT: The time interval in seconds after which a new increment DeltaC is applied.

The last four parameters define the charging pattern over time. With those parameters, one can define a charging profile as shown in following figure:



You define a 'free of charge' charging profile by setting the c0 and DeltaC parameters to 0. The t0 and DeltaT parameters will be ignored in this case.
You define a 'flat rate' charging profile by setting the DeltaC parameter to 0. The t0 and DeltaT parameters will be ignored in this case.
Looking back at the previous example, you can see that the first profile 'weekday peak' defines a charging profile for the week days at peak hours (between 8 am and 6 pm), with an initial charging of 165 units or currencies (depending on the system level parameter AOCCtyp) during the first 60 seconds, and then an incremental charging of 80 units or currencies. The second profile, 'weekday offpeak' defines a charging profile during off-peak hours (between 6 pm and 8 am next morning), which is half as expensive as the 'weekday peak' profile.

Once you have defined all charging profiles that apply to your case, it is time to configure the routes to use a certain charging profile. This is done by setting the ChgProf field in the Route configuration to the label of the charging profile. The following example sets the first route entry to use the charging profile labelled 'weekday peak'.

```
-Route-----------------------------------------------------------0001--
N       1
Act     On
LineIn  1234------
Search  *
Replace *
LineOut --------9-
Calltyp ---------
FailMin 0
ChgProf weekday peak
```

It's of course possible to have multiple routes referring to the same charging profile.

You can configure holidays through the menu 'Holiday' (WIN.CFG.AOC_HOLIDAY). The format is shown in following figure:

```
-AOCHDay-------------------------------------------------------------0001--
N  Act Date
1  Off 01/01
2  Off 01/01
3  Off 01/01
4  Off 01/01
5  Off 01/01
6  Off 01/01
7  Off 01/01
8  Off 01/01
9  Off 01/01
10 Off 01/01
```

The Date field allows a month and day (in this order!) to be entered for the holiday you want to configure.

Remark that you can (and mostly will) define multiple charging profiles with the same label in the charging profile database.

In this case, if a route refers to a charging profile label, the first charging profile will be selected that matches the label *and* matches the time of day and day of the week. This way, you can define different charging profiles for different time zones, or for different days of the week.
For example, you might define two charging profiles with the label 'USA charging', one for peak hours, and one for off-peak hours, as in following figure:

```
-Route---------------------------------------------------------------0004--
N       4
Act     On
LineIn  1234------
Search  001*
Replace 001*
LineOut --------9-
Calltyp ---------
FailMin 0
ChgProf USA charging
```

If your route table contains a route that routes calls to the USA (e.g. by having a called number prefix that matches the international call prefix for the USA), you set the charging profile label for this route to 'USA charging', as shown in following figure:

```
-AOCProf-------------------------------------------------------------------
0001--
N   Act Label            Days     StrEndc0me  t0    DeltaCDeltaT
1   On  USA charging     SMTWTFSH 8  18 25    60    15    60
2   On  USA charging     SMTWTFSH 18 8  25    30    15    30
3   Off                  -------- 0  0  0     0     0     0
4   Off                  -------- 0  0  0     0     0     0
5   Off                  -------- 0  0  0     0     0     0
6   Off                  -------- 0  0  0     0     0     0
7   Off                  -------- 0  0  0     0     0     0
8   Off                  -------- 0  0  0     0     0     0
9   Off                  -------- 0  0  0     0     0     0
10  Off                  -------- 0  0  0     0     0     0
```

Each call on this route will have associated a 'USA charging' profile which matches the time of day and day of the week.

Criteria for selecting a Charging Profile.

When a route is activated for a call, a charging profile needs to be selected for that route. The selection of a charging profile is based on the following:

The charging profile database is searched for the first profile that matches the label defined in the route configuration. Then, the current time of day and the day of the week are verified if they match the StrTime, EndTime and Days fields. If they do, then this profile will be selected. If not, the charging profile database is searched further on for an entry with the same label.

If no charging profile is found, then the IntelliMux will assume a *free of charge* call, i.e. this means that a charging info will be generated of 0 currencies or units at the end of the call.

If a charging profile is selected for a certain route, and the time of the day by-passes the time zone of the charging profile, another profile will be selected with the same label, as described in previous procedure.

Because of the fact the charging profile database is searched from top to bottom, it is important that you order charging profiles with the same label such that the most specific ones come first.

Calling Line Identification (CLIP)

Controlling the Calling Line Identification (CLIP).

The CLI (calling line identifier) identifies the originator (his phone number) of a call.
A check on the CLI is often used in end equipment as an additional security check. By verifying that the originator of the call is a known party, the risk of unwanted 'visitors' is reduced.

A second instance where the CLI is important is to identify the calling part towards the remote side for charging purposes. If the end user equipment specifies its own phone number in the CLI, then a more refined charging is possible.
In the situation where multiple customers are sharing a single PRI line, a control of the CLI is necessary to ensure that phone costs will be correctly assigned to the customer who makes the call.

A third case where control over the CLI is helpful occurs when calls are routed to two different networks. As each network uses its own subscriber numbers, a replacement of CLI numbers may be needed depending on the network to where the call is routed.

Using a CLI check on incoming calls.

Suppose that you wish to limit the routing of incoming calls to a well-defined group of remote users (which we call GROUP1 in this example). To do this, we need to specify that there is a CLIP check on the route, and we need to specify the CLIP check.
In the example below, we specify that route 1 will be enabled for all remote users in the DDI range 2325600 to 2325699, and to the remote user with phone number 2321357. As there are no other Clip checks with this label, an incoming call from a remote user other than those specified will be rejected.

```
-Route-------------------------------------------------------------------0001--
N       1
Act     On
LineIn  12345678--
Search  *10
Replace *10
LineOut ---------0
Calltyp ---------
FailMin 0
ChgProf
CliProf GROUP1
```

```
-Clip--------------------------------------------------------------------0001--
N    Act   Label      Search          Replace
 1   On    GROUP1     *23256??        *23256??
 2   On    GROUP1     *2321357        *2321357
 3   Off
```

If the CLIProfile in the route entry is not specified, then no CLIP check is made.
If the CLIProfile is specified, then is is required that the incoming call contains a valid CLI information, and that this CLI matches one of the Clip checks specified in the Clip table.
The CLIP check is part of the routing decision. If the Clip check fails, then an alternative route may be valid (in the example for instance, you could specify a default route to Lineout 9 without CLIProfile which would route the other incoming calls to Line 9 instead of Line 10).

Controlling the CLI of outgoing calls.

Assume that two customers are sharing a single PRI line.
The first customer (CUST1) is connected on the second primary rate (line L10) and has subscriber number 2329900 to 2329999.
The second customer (CUST2) is connected on basic rate line L1 and has subscriber number 2311111 and a MSN number 2315555.
To ensure that outgoing calls from either customer will always have a correct CLI information, the following configuration may be used:

```
-Route-----------------------------------------------------------------0001--
N       1
Act     On
LineIn  ---------0
Search  *
Replace *
LineOut --------9-
Calltyp ---------
FailMin 0
ChgProf
CliProf CUST1
```

```
-Route-----------------------------------------------------------------0002--
N       2
Act     On
LineIn  1---------
Search  *
Replace *
LineOut --------9-
Calltyp ---------
FailMin 0
ChgProf
CliProf CUST2
```

```
-Clip------------------------------------------------------------------0001--
N    Act   Label      Search          Replace
 1   On    CUST1      23299??         23299??
 2   On    CUST1      *               2329900
 3   On    CUST2      2311111         2311111
 4   On    CUST2      2315555         2311555
 5   On    CUST2      *               2311111
 3   Off
```

In this case, valid CLI's from customer1 and 2 will be passed through, while invalid or missing CLI information will be replaced by their respective base subscriber number.

The IntelliMux as IP-Router

The Application

Suppose you want to connect your internal LAN to the Internet through an ISDN connection. Until now, you had to have a dedicated router equipped with an ISDN BRI port, configured to dial up your Internet Service Provider (ISP) whenever you wanted to reach the Internet. Moreover, it required in many cases every host on your LAN to have a unique Internet address. As Internet addresses are nowadays very scarce (and expensive…), this approach is not feasible anymore if you have a lot of hosts on your LAN that need to be connected to the Internet.
With the DATAX IP Routing software option, you have everything to solve your Internet access problems. With this software option, you can transform your IntelliMux into a performant Internet access router. The IP Routing software option allows every host on your LAN to connect to the Internet through an ISDN dial-up connection or fractional E1 leased line, without the need to acquire an Internet IP address for each connected host.

The configuration

Connecting to the Internet through a 64 kbit ISDN dial-up connection.

This configuration example shows you how to configure the IntelliMux to dial up an ISP whenever traffic needs to be routed to the Internet. All you need to get started is an Internet account from your ISP, and a telephone number to dial in. Of course, verify that your ISP is accessible through ISDN. Because most of the ISPs today offer free dial-up Internet access, this is a very economical way to connect all the hosts on your LAN to the Internet.

Configuring the IntelliMux for Internet access basically involves the activation of the IP router functionality, and the configuration of the information you received from your ISP into the PPP configuration table.
Before you start configuring the IntelliMux, make sure you have purchased the ISU…….. Soft key.
Next, you need to configure some systems level parameters, as shown in following figure:

```
-Sys-------------------------------------------------------------------
N       1
Type    IMX                                AOCType AOC-D
Name    IMX                                AOCCTyp Unit
Log     20                                 AOCCurr
Trp     50                                 AOCMult 0.001
IP      192.168.099.001                    IPRoute On
SubMask 255.255.255.000                    Masq    On
Gateway 000.000.000.000                    MasqIP  000.000.000.000
PrimMgr 000.000.000.000                    RCNetIP 000.000.000.000
SecdMgr 000.000.000.000                    RCMask  000.000.000.000
RdComm  public
WrComm  netman
TrpComm trap
TLogOff 0
TFailSf 20
ClkSlve AUTO
AlmTime 00:00:00
HttpRef 0
AOCEnbl Off
```

- The IP field is the LAN IP address of your IntelliMux. Make sure that this is a unique IP address on your LAN, and belongs to your LAN's network IP address. The Network IP address is determined by masking the IP address with the bitmask as defined in the SubMask field. The network address in the above example is 192.168.099.000.
- Make sure that the IPRoute flag is set to on. This flag will enable the router functionality within the IntelliMux. This means that IP packets received on the LAN/ISDN interface, can be routed to the ISDN/LAN interface.
- In most cases, you will want the Masq field set to on. This flag will give you the possibility to activate IP Masquerading. IP Masquerading (also called Network Address and Port Translation (NAPT), sometimes Port Address Translation (PAT)), is a technique, described in RFC 2663, to translate private IP addresses of internal hosts into one unique Internet address. As such, it is a technique to allow multiple hosts to have connections to the Internet, using only one public Internet address. If you dispose of only one Internet IP address (either explicitly given by your ISP, or negotiated between your ISP's router and the IntelliMux when you set up a connection), you surely want this field to be set to on.
  However, if you want to connect two *private* IP networks together through a BRI or leased line, you don't necessarily need this feature.

The MasqIP, RCNetIP and RCMask fields in the System configuration table are not important for dialup connections, so let's take a look now at some settings in the PPP configuration table. The Point to Point Protocol (PPP) is the most important protocol to connect a device to an Internet Service Provider over a WAN link (in our case the ISDN dialup link). To connect successfully to your ISP provider, it is important that you set some PPP attributes correctly.

For dialup purposes, the highlighted PPP fields are important:

```
-PPP-------------------------------------------------------------------------
N       1
IPAddr  000.000.000.000
TimeOut 300
InCDN   *99
InCLI   *
RemUser MyISPAccount
RemPwd  MyISPPassword
OutCDN  031234567
OutCLI
OutLine 1---------
LLine   NONE
LLStrTS 0
LLEndTS 0
```

- In most instances, the first parameter, IPAddr should be set to 000.000.000.000. This parameter denotes the IP address of the IntelliMux's side of the ISDN connection. As your ISP normally provides this IP address as part of the PPP negotiation process, you can safely set this parameter to 000.000.000.000.
- The Timeout parameter is an idle timeout in seconds after which the ISDN connection will be dropped.
- The RemUser and RemPwd parameters refer to the account you received from your ISP. Remark that these entries are case-sensitive.
- The OutCDN parameter is the phone-number to be dialled to reach your ISP
- The OutCLI parameter is 'your' phone-number, which you only want to provide in case the other side does a security check on it.
- The OutLine is the bitmask of lines on which the dial-up connection will be tried. The first free line in the bitmask will be tried.

If you configured these parameters correctly, you should now be able to make a connection to the Internet. Remark however that the IntelliMux won't make a connection as such. It will only start the connection setup when it received a packet on its LAN interface for which he decides that it should be routed to the Internet. This connection method is called *Dial On Demand*, which means that connections are only set up when there is a need for.

Now how will the computers on your LAN know that they should forward IP packets destined for the Internet to your IntelliMux? That's a topic for next paragraph.

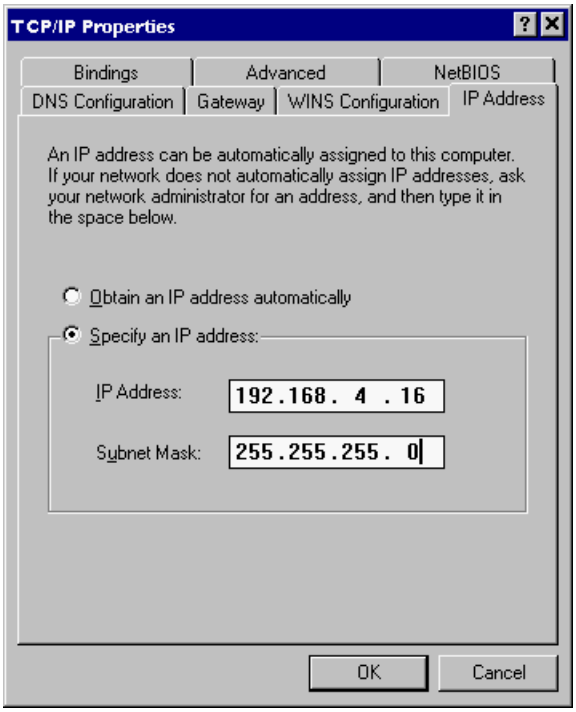
Configuring your LAN for Internet access through the IntelliMux

To allow your computers on the LAN to talk to the Internet through the IntelliMux, it is important that some IP parameters are set correctly on them. You will need to configure following parameters:

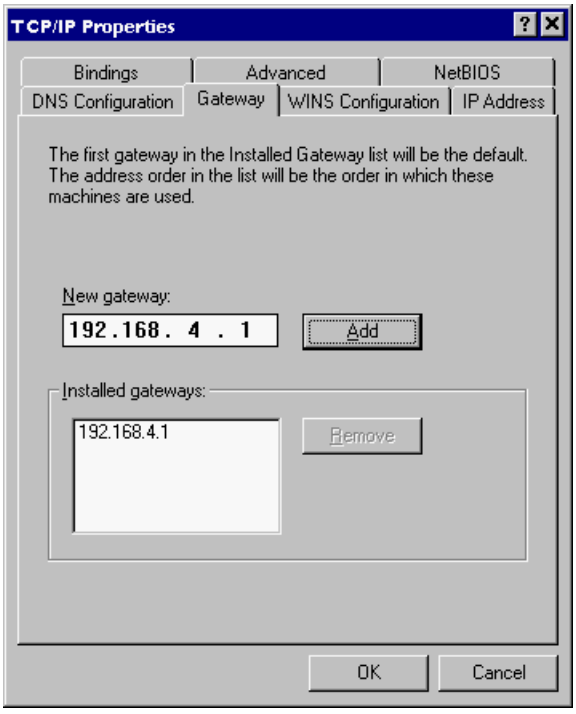
- You can choose the *IP address* of your computer as you want, but be sure that it belongs to the same subnet as the LAN IP address of your IntelliMux. It is advisable that the LAN's subnet is a private subnet (i.e. a subnet belonging to the range 192.168.0.0 to 192.168.255.255).
- The *Default Gateway* on your computer should point to your IntelliMux. More specifically, this means that the Default Gateway should be equal to the *LAN* IP-address of the IntelliMux. This is the IP-address as found in the WIN.CFG.SYS.IP field. Remark that this is *not* the IP address you received from your ISP.
- The *Primary and secondary DNS server* address must be set to the DNS addresses you received from your ISP. These addresses point to hosts of your ISP that are responsible for translating Internet 'names' (such as www.blackbox.com) to real IP addresses.

As an example, suppose you decide to take for your LAN a network address of 192.168.4.0. Then, you could assign the LAN IP address of your IntelliMux 192.168.4.1, and your PC's LAN IP address 192.168.4.16. If your ISP Primary and Secondary DNS addresses are respectively 195.130.132.17 and 195.130.132.18, you should configure your Windows 98 computer's network card's TCP properties as follows:

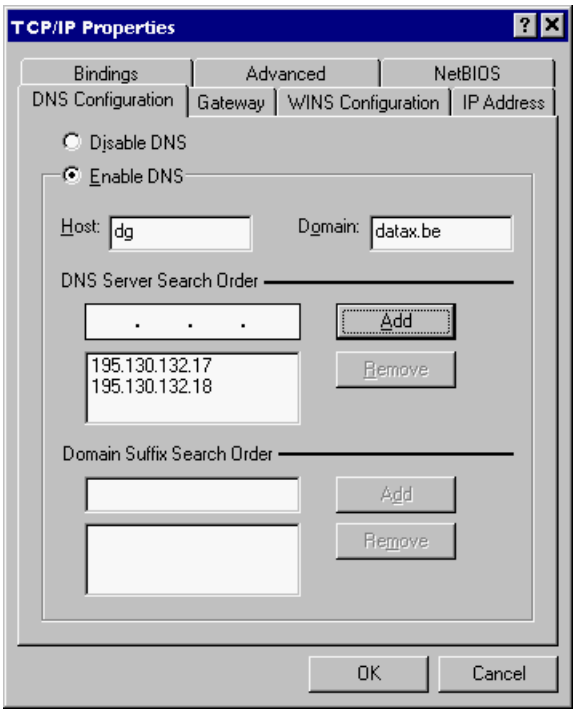
IP Address:



Gateway



DNS Configuration:



Connecting to the Internet through a Fractional E1 leased line.

Although a 64 kbit dialup connection will be more than sufficient for small offices, larger offices will probably want to connect to the Internet using higher speeds. Moreover, if the Internet is frequently accessed, it will be more cost effective to have a permanent Internet connection. In this case, you might want to opt for a dedicated Fractional E1 leased line. The IntelliMux currently supports Fractional E1 connections with a speed of up to 256 kbps.

Configuring your IntelliMux for this setup is very similar to configuring it for dial-up access.
First, set the parameters in the system configuration table the same way as for dial-up access. Second, you need to configure the PPP settings corresponding to the screen snapshot below:

```
-PPP-------------------------------------------------------------------------
N       1
IPAddr  192.168.003.001
TimeOut 0
InCDN   *99
InCLI   *
RemUser MyISPAccount
RemPwd  MyISPPassword
OutCDN
OutCLI
OutLine ----------
LLine   L9
LLStrTS 1
LLEndTS 4
```

- In a leased line configuration, the IP address of the local WAN interface normally will be fixed and given by your ISP beforehand. In this case, you will have to enter this IP address into the IPAddr field of the PPP configuration table.
- The RemUser and RemPwd fields need to contain the username and password of your ISP account.
- The LLine field should contain the line on which the PPP connection needs to be initiated.
- The LLStrTS should contain the first timeslot of your fractional E1. (timeslots on the IntelliMux are assigned from 0 to 31; remark however that timeslot 0 is unavailable, as it is the timeslot that contains the framing signals of the E1).
- The LLEndTS should contain the last timeslot of your fractional E1. As the IntelliMux supports a maximum throughput of 256 kbps, only a maximum of 4 consecutive timeslots can be assigned.

In a leased line configuration, a couple of additional fields in the system configuration table require some attention. These are highlighted in the following screen snapshot:

```
-Sys-------------------------------------------------------------------------
N       1
Type    IMX                                AOCType AOC-D
Name    IMX                                AOCCTyp Unit
Log     20                                 AOCCurr
Trp     50                                 AOCMult 0.001
IP      192.168.099.001                    IPRoute On
SubMask 255.255.255.000                    Masq    On
Gateway 000.000.000.000                    MasqIP  000.000.000.000
PrimMgr 000.000.000.000                    RCNetIP 194.007.215.000
SecdMgr 000.000.000.000                    RCMask  255.255.255.000
RdComm  public
WrComm  netman
TrpComm trap
TLogOff 0
TFailSf 20
ClkSlve AUTO
AlmTime 00:00:00
HttpRef 0
AOCEnbl Off
```

- The MasqIP field denotes the IP address that will be used for Masquerading, i.e. it is the address that will be used in translating IP addresses of your internal private IP network to a public Internet address. If you don't fill an IP address in this field, the Masquerading IP address taken will be the IP address of the WAN interface of the IntelliMux, i.e. it will be the IP address filled in the WIN.CFG.PPP.IPAddr field. You should only fill in the MasqIP field when you want the Masquerading address to be different from the WAN Interface address (for example because the WAN Interface address belongs to a private network), and you have a public Internet address at your disposal that can be used as the Masquerading address.
- Once the IntelliMux has a connection to the Internet, you can manage the IntelliMux from the Internet using your web browser or telnet program. In this case, you should point your browser or telnet program to the Masquerading IP address your IntelliMux uses. This is of course very handy, but poses also a potential security problem, as every Internet user would be able to connect to your IntelliMux. This is especially true in a leased line configuration, where the IntelliMux is permanently connected to the Internet, and uses a fixed Internet IP-address.
  To cope with this security issue, you can fill in the RCNetIP and RCMask fields. These fields denote the network address from which remote control is allowed. In the above example, this would mean that only hosts on a 194.007.215.000 network are allowed to have a telnet or web browser connection with the IntelliMux. All accesses from other networks will be blocked. We'll discuss security issues in greater detail in a next paragraph.

Troubleshooting your Internet connection.

To verify your connection with the Internet, a IPRoute status table is provided with various status information on your Internet connection:

```
-IPRoute-------------------------------------------------------------
N Sts  MsqAddr          WANConn   MsqSess
1 ACT  000.000.000.000 Off       0
```

- The MsqAddr field is the address to which all source addresses of outgoing packets are translated to. If you have enabled Masquerading, you should see here a public Internet address (if you didn't configure your own Masquerading address, this will be an address received from your ISP).
- The WANConn field denotes the type of access you have to the Internet. Values are *Off* (no connection established), *Dialup* or *Leased*.
- MsqSess: This gives you an indication on the number of connections currently established with the Internet. Each TCP connection results in an equivalent internal Masquerading session.

If you encounter problems connecting to the Internet, here are some guidelines you can follow:

:

If your IntelliMux is configured for Internet dial-up access	

No dialup connection is made when I want to reach the Internet	• Verify that the following parameters are set on your IntelliMux:
	  • IP Router functionality is enabled (WIN.CFG.SYS.IPROUTE field is set to on).
	  • The PPP access method is set to dial-up (WIN.CFG.PPP.ACCESS field is set to Dialup)
	  • In the IP Routing table, there is a route defined to the WAN, i.e. verify that you have a default route set to the WAN
	• Verify that the network address of your host and of the IntelliMux is the same.
	• Verify that your host's default gateway points to the LAN IP address of the IntelliMux.

A dialup connection is made, but when I look in the IPRoute Status menu, I see that the WANAccess field is set to 'off'.	This indicates that the PPP negotiation process with your ISP's router failed. Here are some reasons: • Your account's username or password is incorrect. On your IntelliMux, you should see the following message: '*PPP remote login: Invalid user/pwd*'. Verify the WIN.CFG.PPP.REMUSER and WIN.CFG.PPP.REMPWD settings. • Your ISP's router doesn't support Password Authentication Protocol (PAP). Check with your ISP.
A dialup connection is made, and in the IPRoute Status menu, I see that the WANAccess field is set to 'dialup'. However, I don't get any response from the Internet to my queries.	The PPP negotiation process was successful, but there is a routing problem between the IntelliMux and the ISP. Here are some reasons: • Verify that Masquerading is enabled (WIN.CFG.SYS.MASQ field is set to on). • Check that the MasqAddress field in the IPRoute status menu (WIN.STS.IPROUTE.MSQADDR) is set to a public Internet address. • Verify that your host is configured with the DNS IP addresses you received from your ISP.

If your IntelliMux is configured for leased-line Internet access	
When I look in the IPRoute Status	This indicates that the PPP negotiation process with the remote router

menu, I see that the WANAccess field is set to 'off'.	failed. Here are some reasons: • The remote router is not configured for PPP over HDLC. Both HDLC and PPP should be enabled on your remote router. • The range of timeslots assigned for IP-routing doesn't match the range defined on your remote router. • Your account's username or password is incorrect. On your IntelliMux, you should see the following message: '*PPP remote login: Invalid user/pwd*' Verify the WIN.CFG.PPP.REMUSER and WIN.CFG.PPP.REMPWD settings. • The remote router was unsuccessful in its authentication towards the IntelliMux. In this case, you'll see on the IntelliMux logger the following message: '*PPP local login: Invalid user/pwd*'. For security reasons, the IntelliMux always requests authentication from the remote. The account should be an operator as defined in the OPER configuration table, which has PPP privileges (i.e. the first bit of its Rights field of the operator should at least be 1). • Your remote router doesn't support the Password Authentication Protocol (PAP).
In the IPRoute Status menu, I see that the WANAccess field is set to 'leased'. However, I don't get any response from the Internet to my queries.	The PPP negotiation process was successful, but there is a routing problem between the IntelliMux and the ISP. Here are some reasons: • The IP address negotiation between the IntelliMux and the remote router was unsuccessful. Verify the WIN.CFG.PPP.IPADDR field on the IntelliMux, and the settings on your remote router. • If Masquerading is required, verify that Masquerading is enabled (WIN.CFG.SYS.MASQ field is set to on). • If Masquerading is required, verify the MasqAddress field in the IPRoute status menu (WIN.STS.IPROUTE.MSQADDR). • Verify the IP routing table of the IntelliMux. At least one route should point to the remote router. • Verify that your host is configured with the DNS IP addresses you received from your ISP.

How to secure your network from malicious attacks.

As you are probably aware of, connecting your LAN to the Internet means that your network becomes vulnerable to malicious attacks from the Internet. Therefore, it is of a great importance that you spend a great deal of time to secure your network and the IntelliMux. In this paragraph, we want to give you an overview of potential security issues, and how the IntelliMux can cope with those.

The most common attack on your network is what is called an *intrusion*, which means that some malicious Internet user is able to use your computer on your LAN for whatever reason. To be able to do this, the attacker must have the possibility to set up a direct TCP connection from his computer to your computer. For this, one thing he needs to know is your computer's IP address, and the type of TCP services your computer runs. Moreover, he must be able to establish an incoming TCP connection to a host on your LAN.

Therefore, a basic defense strategy is to
- disallow incoming connections from the Internet.
- hide your internal IP addresses and internal TCP services for an ordinary Internet user.

The Masquerading technique, used by the IntelliMux, has the pleasant feature that incoming Internet connections are impossible. Moreover, the Internal LAN IP addresses and services are effectively invisible from

the Internet, as Masquerading translates the internal IP addresses into one public Internet address. As such, enabling Masquerading on the IntelliMux effectively protects your network from intrusion. This also means that you need to be aware of the following:

Important: when Masquerading is disabled, the IntelliMux can *not* guarantee the security of your network. If you configure your IntelliMux to act only as an IP router, without Masquerading, you need to add a security device, such as a Firewall, to protect your network against malicious attacks.

A next step in securing your network is to make sure that your gateway to the Internet (in your case the IntelliMux), is secured on itself, i.e. that no one can break into the device and change your configuration. The IntelliMux provides two protection mechanisms for attacks to itself:

- by restricting access to the device
- by protecting access with username / passwords.

The first is assured by configuring the RCNetIP and RCMask fields correctly, as already explained in previous paragraph. These fields allow control to the device only from hosts with an address belonging to the network specified by them. If you want to restrict access to one host, simply specify its IP address in the RCNetIP and set the RCMask field to 255.255.255.255.

Remark that if these fields are set, they apply to *all* types of access from *all* types of interfaces. More specifically, a Telnet or HTTP access originating from your local network will also be checked against these fields. If you want access from your local network, you will need to enter into these fields the network IP address of your local network.

The second protection mechanism involves setting the usernames and passwords to appropriate values. Remark that the default IntelliMux configuration is supplied with standard users, for which their password has been set default to the username.

Important: It is strongly advised that you review all the default user accounts of the IntelliMux, and set their user names and passwords to appropriate values.

Remark also that you can set each user with read / right / execute and protocol permissions. It is important that you choose carefully which users have what types of permissions on your IntelliMux.
For a complete explanation of the different types and levels of permissions, please refer to the reference guide.

Advanced IP-Router configuration

Configuration of static routes

The IntelliMux allows you to define up to 10 static routes. An IP route entry basically defines on what criteria the IntelliMux uses to route packets to a particular interface. You can enter IP routes in the IP_StatRoute configuration table.

```
-IP_StatRoute-----------------------------------------------------0001--
N  Act NetAddr         NetMask         Gateway         Intface
1  On  000.000.000.000 000.000.000.000 000.000.000.000 WAN
2  Off 000.000.000.000 000.000.000.000 000.000.000.000 WAN
3  Off 000.000.000.000 000.000.000.000 000.000.000.000 WAN
4  Off 000.000.000.000 000.000.000.000 000.000.000.000 WAN
5  Off 000.000.000.000 000.000.000.000 000.000.000.000 WAN
6  Off 000.000.000.000 000.000.000.000 000.000.000.000 WAN
7  Off 000.000.000.000 000.000.000.000 000.000.000.000 WAN
8  Off 000.000.000.000 000.000.000.000 000.000.000.000 WAN
9  Off 000.000.000.000 000.000.000.000 000.000.000.000 WAN
10 Off 000.000.000.000 000.000.000.000 000.000.000.000 WAN
```

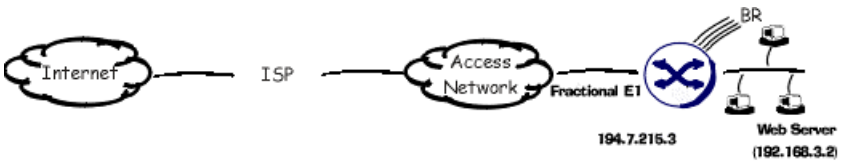
How does this routing work?

Suppose the IntelliMux receives a packet with a destination address of 194.7.215.16. First it will verify the address against the network address of its local LAN. If the destination address belongs to the network address of its LAN, it will send the packet to its LAN interface. If there is no match, the IntelliMux will scan the routing entries defined in the IP_StatRoute configuration table, from top to bottom. The destination address of the packet is checked against the NetAddr and NetMask fields of each entry. If the packet's destination address belongs to the network address as defined by the NetAddr and NetMask fields, the packet will be sent to the Gateway address as filled in the Gateway field on the configured interface (WAN or LAN). If no match is found, the packet is dropped, and the IntelliMux returns an ICMP 'host unreachable' packet.
If the route points to the WAN interface, it is not necessary to fill in the Gateway address, as this is always the address of the remote router on the WAN link, which the IntelliMux has discovered during the PPP negotiation process.

Remark that one entry is by default already filled in: a default route to the WAN interface. This basically means that all packets that are not destined for the local LAN are routed to the WAN (dialup or leased-line) interface. This is exactly the purpose of an Internet access router.
In most circumstances, you won't need to change the default settings in the IP_StatRoute configuration table. The only circumstance where you want to add a route is when you have multiple routers on your network, connecting other IP networks. In this case, you will need to add a route for each network that is behind the router on your network. The gateway will in that case be the router itself.

Enabling Port Forwarding on the IntelliMux.

As already mentioned in a previous paragraph, Masquerading only allows outgoing connections (from your local network to the Internet). This is in many cases sufficient and even desirable. However, in some circumstances, you still want to allow incoming traffic, for example to provide access to an internal web server.



Suppose you have a web server on your LAN with address 192.168.3.2, that you want access from the Internet. To allow this, add an entry to the Port forwarding table as in following screen snapshot:

```
-IP_PortFW-------------------------------------------------------0001--
N  Act DstPorAddress
1  On  80    192.168.003.002
2  Off 0     000.000.000.000
3  Off 0     000.000.000.000
4  Off 0     000.000.000.000
5  Off 0     000.000.000.000
6  Off 0     000.000.000.000
7  Off 0     000.000.000.000
8  Off 0     000.000.000.000
9  Off 0     000.000.000.000
10 Off 0     000.000.000.000
```

The DstPort field denotes the type of service, denoted by its TCP port number. For HTTP, the TCP port number is 80. The Address field denotes the IP address of the server that hosts the TCP service to be accessed from the Internet.
To access the web server, you have to point your browser to the Masquerading IP address, *not* the IP address of the web server itself. In our case, the address of the web server, as seen from the Internet is *194.7.215.3*, not *192.168.3.1*. As you see, Masquerading still masks the internal IP address of the host, even if it is accessible from the Internet.
A DstPort value of 0 acts as a wildcard, i.e. all services will be routed to the designated server. This is useful if you have an internal firewall, which is configured to block all unwanted services.
There is a potential conflict if you activate port forwarding for services also supported by the IntelliMux itself, namely telnet and HTTP. In this case, remote control to the IntelliMux for these services is not possible, except if the request came from a host that belongs to the network as designated by the system fields RCNetIP (WIN.CFG.SYS.RCNetIP) and RCMask (WIN.CFG.SYS.RCMask). Instead, the request will be forwarded to the host defined in the port forwarding table.

Remarks

- The IntelliMux can only support one PPP session at a time. In particular, this means that if your IntelliMux has a dial-up or leased line connection with a remote router, you can *not* have a dial-in remote control session. In other words, if a router connection is established, you can not manage the IntelliMux at the same time with a dial-in connection. In that case, you should manage the IntelliMux with HTTP or Telnet through the router connection it established. For example, if the IntelliMux has a connection with the Internet, you should manage the IntelliMux over the Internet.
- Remark that Masquerading is not transparent for all Internet applications. In particular, all applications that contain in their packets references to IP addresses are not sure to work correctly when Masquerading is enabled. Examples of applications that are not working reliably with Masquerading are:
  - RealAudio
  - H.323 (i.e. Microsoft Netmeeting)
  - Quake
- If Port Forwarding is enabled for one of the services with which you manage the IntelliMux (such as HTTP or Telnet), you can only access the IntelliMux if the network from which you want to access the IntelliMux has a network address equal to the one filled in the RCNetIP and RCMask fields of the system configuration table. Otherwise, requests will be transferred to the server referred to by the entry in the Port Forwarding table.
- If you enable Port Forwarding for FTP services, please remind that you should forward both TCP ports 20 AND 21 to have FTP functional. Also, remark that in this case only *passive* FTP connections will be allowed.

SNMP.

Introduction.

SNMP or "Simple Networking Management Protocol" is a standard that has been developed to allow the management of equipment in a uniform way.

To achieve this, every manageable object (read: configuration parameter) is uniquely identified using a sequence of numbers. For instance, the field WIN.STS.SLOT.SW is specified as:

```
1.3.6.1.4.1.1398.1.9.3.2.2.1.9          -- (the field WIN.STS.SLOT.SW)

iso(1).org(3).dod(6).internet(1).private(4).enterprises(1).Blackbox(1398)
.blackboxTelecomProducts(1).IntelliMux(9).STS(3).SlotSts(2).
slotStsTable(2).slotStsEntry(1).slotStsSW(9)
```

The definition of these numbers, along with additional information on the associated fields, is collected in a file which is known as a MIB ("Management Information Base").
For the IntelliMux, this file is called ‘imx.mib’. This file must be loaded in the NMS (Network Management System), so that this system is able to access and represent the defined objects.

The example below shows the use of SNMP over a PPP Dial-Up connection.
The remainder of this section assumes that you have basic understanding of SNMP management. Otherwise you will need to find yourself some education before adventuring in this 'Simple' matter.

Configuring the IntelliMux for SNMP: basic settings

```
-Sys-------------------------------------------------------------------------
N       1
Type    IMX                                AOCType AOC-D
Name    IMX                                AOCCTyp Unit
Log     20                                 AOCCurr
Trp     50                                 AOCMult 0.001
IP      192.168.004.015                    IPRoute On
SubMask 255.255.255.000                    Masq    On
Gateway 000.000.000.000                    MasqIP  000.000.000.000
PrimMgr 192.168.005.001                    RCNetIP 000.000.000.000
SecdMgr 000.000.000.000                    RCMask  000.000.000.000
RdComm  public
WrComm  netman
TrpComm trap
TLogOff 0
TFailSf 20
ClkSlve AUTO
AlmTime 00:00:00
HttpRef 0
AOCEnbl Off
```

The following elements can (must) be defined:

- **IP**: the IP address assigned to the unit. Ask your network manager.
- **SubMask**: defines the local subnet. On a class C network: 255.255.255.0
- **Gateway**: only required if the NMS is not on the same subnet.
- **PrimMgr**: NMS IP address. Only required if traps must be sent to the NMS.
- **SecdMgr**: Required if access is limited to 2 NMS's. Otherwise, any NMS passes.
- **RdComm**: This must correspond to the read community on the NMS station.
- **WrComm**: This must correspond to the write community on the NMS station.

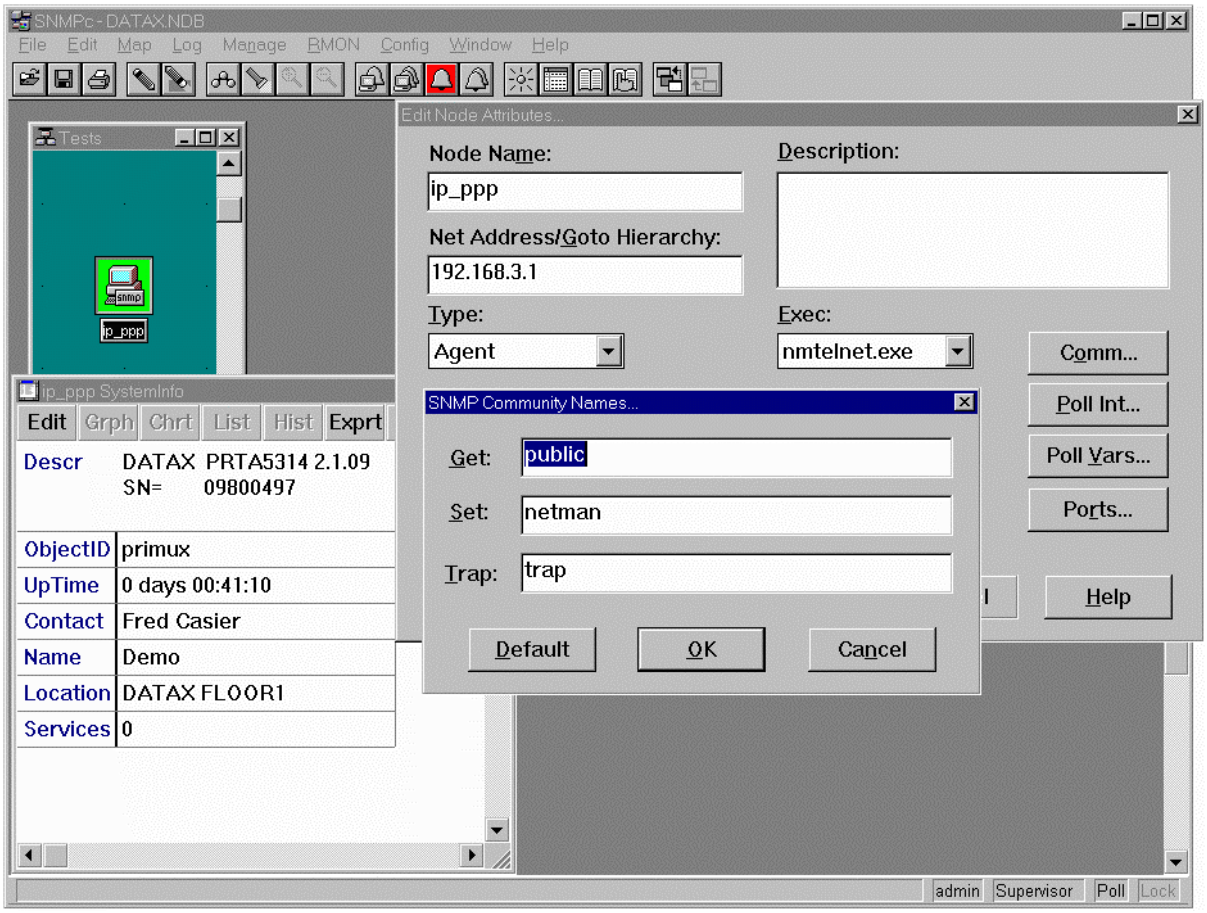
- **TrpComm**: The trap community name is given by the IntelliMux along with the traps.
- **Trp**: The trap detail level (0-99, a lower value gives more traps).

The fields Contact and Location are used by the IntelliMux in the Mib-II system group.
After modification the configuration must be activated, and the system must be reset.

Installation and verification

Apart from the above configuration on the IntelliMux equipment, it is necessary to install the private IntelliMux MIB on the NMS. This MIB is delivered by Black Box on the disk accompanying the equipment. In general, there is some option such as "LOAD MIB" which can be executed on the NMS.

The example below shows a basic SNMP access to the standard MIB-II system group, using the "SNMPc Network Manager" from Castle Rock Computing Inc, along with some of the required configuration settings. You may notice that this example uses SNMP over a Dial-Up PPP connection.



Verification of the installation can be done in the following steps:

- **PING**: Verification of the network connectivity.
  Enter PING <ip> from the NMS and check that the IntelliMux is sending replies. If not, then check cabling, the IP address and subnet mask. This test must succeed.
- **SNMP-MIB2:** Verification of basic SNMP access.
  On most NMS's there is a generic interface to the Mib-II system group. Perform a GET for this group and check that the equipment responds with the relevant information. If not, then check that the community names used by the NMS correspond with those configured on the unit. Note that small/capital case is significant.
- **SNMP- IntelliMux MIB**: Verification of the MIB integration within the NMS.
  One of the parameters in the system group is the System Object Identifier (ObjectID). This is a number which identifies the kind of equipment. Most NMS stations will translate this number to the symbolic

string defined in the private MIB ("IntelliMux " for the IntelliMux). If this is not the case, it may be an indication that the MIB was not loaded or that some syntax error was encountered. Reload the mib and check any warnings.
Most NMS have a "MIB-Browser" which allows to navigate the private mib and execute GET commands for groups and tables. Check that GET operations are possible. Do not worry at this moment if the response contains all '*' characters (see operational issues). If GET's do not succeed, then there may still be MIB compilation problems. Check that the MIB corresponding with the equipment has been loaded.

- **SNMP-Traps:** If a primary manager (= manager to whom the IntelliMux will send traps) is configured, then check that traps are successfully handled. A simple test for this is to perform a "RES SYS" command on the IntelliMux. This will generate a standard WARM-BOOT trap. Note that the trap manager should not be a Dial-Up IP!

On most NMS's it is possible to define custom menu's and icons. You may wish to do this at this instant. Also, if possible, associate a Telnet command with the icon: this is generally an easier way to configure the equipment than using SNMP.

Accessible parameters.

The IntelliMux MIB is divided into the following main sections:

- CFG: the read-only copy of the configuration (running configuration)
- STS: the read-only status information
- HISTORY: the read-only history information
- TRP: the last generated trap

The IntelliMux parameters cannot be changed through SNMP. Changing the configuration must be done either via Telnet (the most common approach), or via a HTTP file upload (containing the “CFG RUN” command), as described in chapter 0.
The only parameters that can be modified through SNMP are the writable MIB-II System Group parameters (e.g. name, contact, location).

Traps

Traps are messages that are sent by the equipment to a "primary" network management system.

On the IntelliMux, these messages correspond to the Trace messages that are also shown on the screen. In order to limit the amount of traffic generated in this way, it is possible to specify a level of importance (WIN.CFG.SYS.TRP). This level is used in the same way as the Trace level and as the Log level: every event which has an importance equal to or more than the level specified by TRP will be sent to the manager whose IP address is specified in WIN.CFG.SYS.PrimMgr (if not specified, then traps are disabled).

A simple test for this is to perform a "RES SYS" command on the IntelliMux. This will generate a standard WARM-BOOT trap.

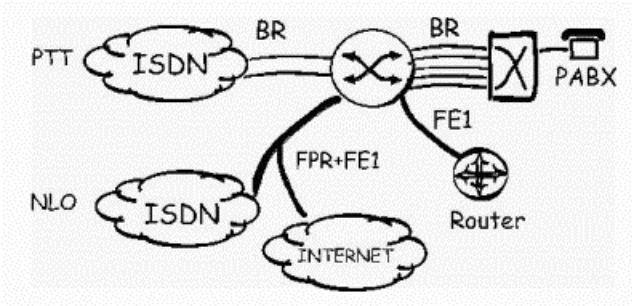
If the Primary Manager’s IP address belongs to the local subnet, then traps will be sent on the local LAN.

However, if you specify a trap manager IP address that is not belonging to the local subnet (i.e. for which the subnet doesn’t correspond to the subnet address of the IP address specified in the WIN.CFG.SYS.IP field) *and* you didn’t specify a gateway address (i.e. the WIN.CFG.SYS.GATEWAY field is 0), then an ISDN outcall will be tried to the ISDN number supplied in the WIN.CFG.PPP.OUTCDN field, if it is not empty. This ISDN number should correspond to the ISDN call-in number of the trap manager. With this functionality, you can have IntelliMux's call in remotely to a central management system, notifying the management system about serious events.

To avoid the possibility of a flood of outcalls in case a serious problem generates a huge amount of traps, only one such an alarm call can happen per hour, i.e. after a successful alarm call is generated, a second alarm call will only be made after at least an hour. Remark that an alarm call won’t be retried if it failed a first time.

COMBI: Fractional E1 and ISDN combined

The application.



Many companies are confronted with the need for leased lines along with the need for switched (dial up) lines. The IntelliMux provides an attractive solution for this situation, which can be exploited by operators who are able to combine nailed up circuits and ISDN controlled circuits on a single PRI (or BRI) line.

An example is the use of nailed up circuits for online Internet Access, combined with support for a conventional PABX.

Configuration.

The example application is a variation on the CHOICE application. This time however, the router is using a nailed-up (Drop-and-Insert) fractional E1. In this scenario, the New License Operator provides this fractional E1 datapath along with circuit switched ISDN B channels on the same PRI (L10 in this example).

The settings for the CHOICE application were defined as follows:

```
-Line-------------------------------------------------------------------0009--
N  Type Name              Act Sgn  Tei NT Crc4
1  BR   L1                On  Isdn 64  TE NoCRC4
2  BR   L2                On  Isdn 64  TE NoCRC4
3  BR   L3                On  Isdn 64  NT NoCRC4
4  BR   L4                On  Isdn 64  NT NoCRC4
5  BR   L5                On  Isdn 64  NT NoCRC4
6  BR   L6                On  Isdn 64  NT NoCRC4
7  BR   L7                On  Isdn 64  NT NoCRC4
8  BR   L8                On  Isdn 64  NT NoCRC4
9  PR   L9                On  Isdn 0   NT NoCRC4
10 PR   L10               On  Isdn 0   TE CRC4
```

```
-Route------------------------------------------------------------------------0006--
N   Act LineIn     Search          Replace         LineOut    Calltyp   FailMi
1   On  12-------0 *8?             *8?             --------9- --------- 0
2   On  12-------0 *               *               --345678-- --------- 0
3   On  --3456789- 0*              0*              ---------0 --------- 0
4   On  --3456789- *               *               12-------- --------- 0
5   Off ----------                                 ---------- --------- 0
6   Off ----------                                 ---------- --------- 0
7   Off ----------                                 ---------- --------- 0
8   Off ----------                                 ---------- --------- 0
9   Off ----------                                 ---------- --------- 0
10  Off ----------                                 ---------- --------- 0
```

In addition, we must specify that a number of B channels of the PRI lines are switched through in a fixed manner. This is done in the FixN64 configuration menu. Assume that 8 channels (512KB/s) are reserved for the

internet router, and that the operator has placed these channels at positions B24-B31. The router expects to find these channels at timeslots B1-B8. Then the following configuration is needed:

```
-FixN64-------------------------------------------------------------------
0001--
N  Act Name             NrTLineITSILineOTSOPContrl
1  On  Multilink PPP    8  L10  24 L9   1  ----
2  Off F2               0  NONE 1  NONE 1  ----
3  Off F3               0  NONE 1  NONE 1  ----
4  Off F4               0  NONE 1  NONE 1  ----
5  Off F5               0  NONE 1  NONE 1  ----
6  Off F6               0  NONE 1  NONE 1  ----
7  Off F7               0  NONE 1  NONE 1  ----
8  Off F8               0  NONE 1  NONE 1  ----
9  Off F9               0  NONE 1  NONE 1  ----
10 Off F10              0  NONE 1  NONE 1  ----
```

```
-FixN64-----------------------------------------------------------0001--
N       1
Act     On
Name    Multilink PPP
NrTS    8               -- number of PPP channels
LineIn  L10             -- L10 (operator PRI)
TSIn    24              -- start at B24
LineOut L9              -- user1 PRI
TSOut   1               -- start at B1
```

The above configuration will provide a fixed interconnection between B24 on L10 and B1 on L9, between B25 on L10 and B2 on L9, and so on for 8 channels.
This can also be seen in the line status screen (after activation of the changes, and reset of the system) which shows that some of the B channels are in use.

```
-Line--------------------------------------------------------------0001-
-
N  Sts  PH DL BConn                                 AlmFrom
1  ACT  Up Dn  --                                   ----------
2  ACT  Dn Dn  --                                   ----------
3  ACT  Dn Dn  --                                   ----------
4  ACT  Dn Dn  --                                   ----------
5  ACT  Dn Dn  --                                   ----------
6  ACT  Dn Dn  --                                   ----------
7  ACT  Dn Dn  --                                   ----------
8  ACT  Dn Dn  --                                   ----------
9  ACT  Dn Dn  NNNNNNNN------ ---------------- ----------
10 ACT  Dn Dn  -------------- --------NNNNNNNN ----------
```

It is important to note that the IntelliMux switches individual B channels, not an aggregated multi-band. Internally, the IntelliMux maintains the time relations between the different channels. However, it does not try to fix time differences that may have been introduced between B channels on their way through the operator's network. In practice, this means that the router should be configured to use the different channels with a "Multilink PPP" protocol, rather than a "single channel PPP" protocol.

For the PABX, nothing needs to be changed. It is still allowed to assume that it has access to all channels. The IntelliMux will do whatever is needed (channel negotiation, checking of available channels) to ensure correct operation.

As a consequence, this operation can be combined with any of the applications described in prior chapters.

If your IntelliMux is equipped with a Multi I/O (MIO) extension card (VXI module) , you can also define a fixed interconnection between multiple channels on an ISDN line and one of the intelligent ports of the VXI module. This way, you can route consecutive ISDN B channels to a device which supports a V35, V36 or X21 interface (typically a router). This allows you to aggregate data received on multiple consecutive B channels onto a serial byte stream.

Other applications

The IntelliMux is a versatile equipment that can be used in many different applications. This manual only shows a few typical applications that serve to explain the configuration menus. Additional application examples are regularly added in " IntelliMux Application Notes".

VXI Module: Fractional E1 on a V35, V36 or X21.

The application

The COMBI application describes how a fractional E1 leased line circuit can be extracted from a fractional PRI and routed to one of the G704 interfaces. In many cases, this will prove to be a perfect solution. However, your end equipment may be equipped with a serial interface instead. If this is the case, then the VXI module is for you. Since the data is delivered as a serial stream, it is important that the sequence of timeslots can be treated as a single "big" slot: the time consistency must be maintained within this sequence of slots. Check this with the provider in case of uncertainty.

The VXI module is an optional extension card that can be placed in the same housing as the main card, and that provides up to 4 V35, V36 or X21 compliant interfaces. The selection between V35, V36 and X21 is made through the use of the correct cable.

Enabling the VX ports.

First of all, you should ensure that the IntelliMux firmware is enabled for operation with the VXI module. Boot the IntelliMux and look carefully at the boot messages. Expect to see something like this:

```
> [other boot messages]
> VXI 1---  .. Enabled
```

This indicates that the IntelliMux firmware is enabled for port P1 on the IntelliMux. This is the normal case if you ordered the VXI module together with the IntelliMux. If more than 1 port is enabled, you will see them as shown below (ports 1,2,3,4 enabled).

```
> [other boot messages]
> VXI 1234  .. Enabled
```

To enable additional ports on the VXI module, you need to install the SoftKey options. Please contact the manufacturer for more details.

V35, V36 and X21 Cables

The VX interface is generic. The choice between a V35, V36 or a X21 interface is made by ordering the correct type of cable.

- DX_C2_VX_V35_T : V35 Cable
- DX_C2_VX_V36_T : V36 Cable
- DX_C2_VX_X21_T : X21 Cable

In the human interface screens, the control signals are indicated as follows:

On Screen	V35, V36 meaning	X21 meaning
S	D**S**R	does not exist
C	D**C**D	I
T	D**T**R	T
M	T**M**I	does not exist
L	**L**L	does not exist
D	**D**L	does not exist

Configuration.

Example

As an example, assume that your provider delivers a fractional PRI on line L9 with a fractional E1 in slots 24 til 31 (512 Kb/s), and with ISDN in slots 1 to 23 (16 used for ISDN signalling). The ISDN channels are routed to the PABX as shown in several previous examples. The fractional E1 stream is routed to VX port P1 using the FixN64 menu.

```
-FixN64-------------------------------------------------------------0001--
N  Act Name             NrTLineITSILineOTSOPContrl
1  On  Fract-E1         8  L9   24 P1   1  ----
2  Off F2               0  NONE 1  NONE 1  ----
3  Off F3               0  NONE 1  NONE 1  ----
4  Off F4               0  NONE 1  NONE 1  ----
5  Off F5               0  NONE 1  NONE 1  ----
6  Off F6               0  NONE 1  NONE 1  ----
7  Off F7               0  NONE 1  NONE 1  ----
8  Off F8               0  NONE 1  NONE 1  ----
9  Off F9               0  NONE 1  NONE 1  ----
10 Off F10              0  NONE 1  NONE 1  ----
```

```
-FixN64-------------------------------------------------------------0001--
N       1
Act     On
Name    Fract-E1        --
NrTS    8               -- number of subsequent timeslots
LineIn  L9              -- L9 (operator PRI)
TSIn    24              -- start at B24
LineOut P1              -- VX interface P1
TSOut   1               -- use 1 for VX interface
PContrl ---             -- normal behaviour for control lines
```

Note that "Lineout" is now not really the G704 line interface, but the VX port interface instead. Since the VX datastream is serial, there is no need to specify a starting timeslot on P1, so use 1.

The field PControl specifies how the VX control signals should be used. Note that the VX port will only act on these settings when the port is active (i.e. when the port is specified in an active FixN64 configuration line).

The default settings ("----") specify that:

- The clock will be delivered by the VX port to the end equipment (typical DCE behaviour). The VX uses RxClk (CT115) as well as TxClk (CT114) to deliver the clocks.
- The DSR (and CTS) control signals will be asserted by the VX port as a reaction on the DTR of the end equipment.
- The DCD signal will be asserted when the corresponding PRI line interface is physically active. When maintenance conditions are active, then the behaviour of DCD differs as described below.

When toggled ON, non-default behaviour is selected:

'X'	Use of 'External Clocking'. The VX port delivers the RxClk (CT115) for the RX data. It is assumed that the DTE will synchronize on this signal for received data, and will produce its own clock for the data that it transmits to the DCE. This clock is transmitted on Tx'Clk (CT113). The VX port then uses Tx'Clk to receive the Tx data.
'S'	The DSR signal is always asserted (when the VX port is enabled and active)
'C'	The DCD signal is always asserted (when the VX port is enabled and active)

Status indications and LED behaviour.

Basic status indication is available from the slot status screen (WIN STS SLOT). The second line shows information on the VXI hardware (serial number) and firmware version. Also, the current state of the LEDs can be seen (in this case, port P1 shows a red led).

```
-Slot-------------------------------------------------------------0001--
N Sts  SW               HW               LED
1 ACT  PRTA5331 3.0     09700630         g--RR----------
2 ACT  PRTA5333 1.0     09800301         b   R---------

-FixN64-----------------------------------------------------------0001--
N  Sts  PortSts
1  ACT  --------
2  IDLE --------
3  IDLE --------
4  IDLE --------
```

The port specific information (status of the control signals) can be seen in the FixN64 status screen (WIN STS FIXN64). The PControl field shows the status of the signals "XSCMTLD".

X	**Off** indicates (normal) internal clocking. **On** indicates external clocking (CT113 clock from DTE).
S	**Off**/**On** indicates that DSR and CTS to the DTE are **Off**/**On**.
C	**Off**/**On** indicates that DCD to the DTE is **Off**/**On.**
M	**Off** indicates that there are no maintenance conditions. **On** indicates that either local loop (LL) or digital loop (DL) are active
T	**Off**/**On** indicates the status of the DTR signal delivered by the DTE.
L	**Off**/**On** indicates that the internal Local Loop has been activated
D	**Off**/**On** indicates that the internal Digital Loop has been activated.

The LEDs also provide status information. Note however that the Heartbeat and Alarm LEDs are not active on the VXI module. The LEDs for the ports P1, P2, P3 and P4 will act as follows:

Off	Port is not enabled (Softkey) or not active (No config line in FixN64).
Green	Data is being routed from an active G704 interface to the VX port.
Red	Corresponding G704 interface is not activated or not working.
Yellow	Maintenance condition exists.

Maintenance conditions

It is possible to set the VX port in a local or digital loop using the maintenance commands.
When a loop is active the port LED will turn yellow and the TMI signal will be asserted.

To set a local loop for P1, use the command **SET LOOP LL P1**
To set a digital loop, use **SET LOOP DL P1**
To turn off the loops, use **SET LOOP OFF P1**

Note that the VX Port will not act on the maintenance signals that can be delivered over the V35, V36 interface.

SW Upgrade on the VXI module.

Since the SW on the VXI module resides in FLASH EPROM, a SW upgrade is as simple as a file transfer.
In general the following upgrade procedure may be applied:

1. Connect ANSI terminal to the control port of the VXI module by using appropriate conversion cable : insert jack plug into jack receptacle on front of the VXI module.
   Note that the serial speed of the control port is now set to 9600 bit/s. Change the speed setting on your ANSI terminal if necessary.

2. Enter the '**BOOT**' command from the Human Interface.
   Note that the VXI LED's turn yellow.

3. Once in the maintenance menu, the following commands are available:
   ID: shows the identification of the product.
   UPGRADE: starts the upgrade procedure.

4. Enter the '**UPGRADE**' command to start an X-modem file receive session (character 'C' will appear). After entering this command, the operator should send the 'vxi.bin' file which can be found on the 'SW' directory of the SW upgrade floppy.

```
? ID UPGRADE
UPGRADE
Erasing and waiting for <update>.BIN upload
C
```

5. As soon as the VXI confirms receipt of the complete file, the new SW type and revision is displayed. At this point the operator may power down the IntelliMux.

```
? ID UPGRADE
UPGRADE
Erasing and waiting for <update>.BIN upload
C..2668 Pkts.
OK
PRTA5333 1.0
```

6. Power on the IntelliMux again. After a successful selftest the VXI module will start up with the factory default settings for the configuration.

REMARK!
If some fault occurs during the X-modem file transfer, you must repeat the upgrade procedure as described above, with the following differences :

2. Instead of logging-in and entering the 'BOOT' command, power down the system and place jumper JP65 on the VXI module (located behind the LEDs).
Power on the system again.
5. In addition to powering down the system remove jumper JP65 on the VXI module.

Basic Troubleshooting.

Introduction.

So it has happened: you configured the IntelliMux, attached some cables, turned on the power, and... it does not work. You have verified that the configuration is correct, and you have checked the status screens (see the discussion in "Factory Default"). Still it does not work.
Don't panic. The IntelliMux provides a lot of help in troubleshooting, and with the systematic approach described here you will be able to identify and resolve most problems that occur during installation.

The very first thing to do is to turn off the power to the IntelliMux and wait half a minute. This may help to calm you down, although the basic goal is to ensure that all timers in the connected equipment have timed out. So we will start from a well known state.

While you are waiting, make a sketch of the configuration if you had not done this already.

There are 3 things that will be checked in the following sections:

1. **Physical Link Check**:
   Verify the physical connection (cables, physical parameters).
2. **Datalink Check**:
   Verify that it is possible to exchange information between the IntelliMux and the connected equipment in a reliable way.
3. **Network Link Check**:
   Verify that the IntelliMux and the connected equipment are able to exchange call information.

To make troubleshooting easy, start the system with the cables not attached. After logging into the human interface, issue the following command:

```
SET TRACE L9 0
```

This command instructs the IntelliMux to provide a maximum of troubleshooting information for everything that concerns the use of LINE 9 (the first PRI). Of course, use another line number when troubleshooting another line.

The Physical Link.

Primary rate and Basic rate are different types of physical interfaces, so installation and verification will also be different.

Straight and crossed cables

The IntelliMux can be used in configurations where the ISDN interfaces may either be connected to NT (Network Termination, generally the public network) or TE equipment (Terminal, generally user equipment or the "outgoing" side of a PABX).

If connected to an NT, then the corresponding IntelliMux interface must be configured to act as TE, and a straight cable must be used to connect both.

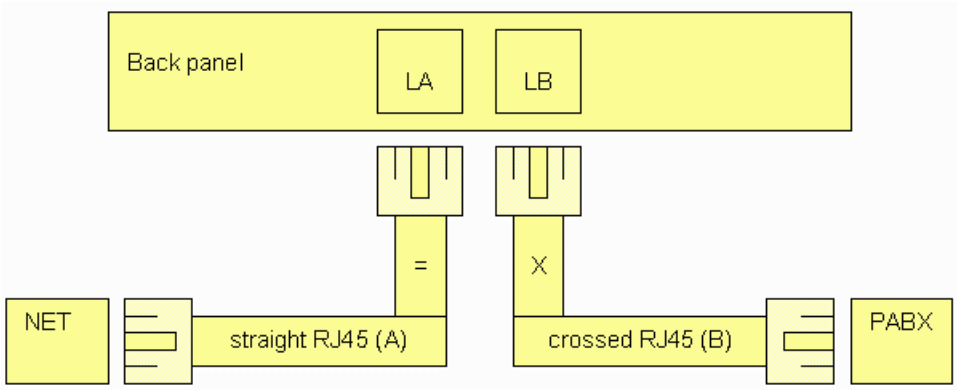
If connected to a TE, then the corresponding IntelliMux interface must be configured to act as NT, and a crossed cable must be used. Crossed cables for BRI are different from crossed cables for PRI.

So as a first step, you should verify the NT/TE configuration in the Line menu (WIN.CFG.LINE.NT: type WIN, then select CFG, then LINE, then check the NT parameter).

Depending on this setting, the following cable is to be used:

- Use a straight cable to connect the IntelliMux to a Network Terminator.
  In this case, the line interface acts as a TE.
- Use a crossed cable to connect to Terminal Equipment.
  In this case, the line interface acts as a NT.

Basic Cabling between NT and TE equipment.



Cabling with IntelliMux: Straight to a NT, crossed to a TE.

- Crossed BRI: Use the BLUE cables, marked as 'Crossed BRI'.
- Crossed PRI: Use the BLUE cables, marked as 'Crossed PRI'.

Note that the crossed cable is symmetrical, there is no "In" and "Out". This knowledge can be helpful if you have troubles: turn around the cable and insert it again. If you get another behaviour or other trace messages, then something is wrong with one of the leads in the cable: throw it away.
Of course, you should never connect a BRI interface to a PRI interface, no matter what type of cable..

PRI physical connection.

If the cabling is right, then you should see that the LED indicator of the corresponding line is either GREEN or ORANGE. The LED indicator for the PRI line is related to the state of the physical link as follows:

- **OFF**: The line is not in use, either because you did not turn it on in the line configuration, or because the Softkey Option for this line has not been acquired.
- **RED**: There is no received signal. Probably a cable problem or maybe the other equipment is not functioning.
- **ORANGE**: The physical link is partly OK. Probably a cable problem or a CRC4 problem.
- **GREEN**: The physical link is OK.

Also, the following indication appears on your screen (if you are in the WIN interface you need to go back to the Command interface first):

```
22:27:2151  L9 PH AI    -- after inserting cable
22:36:0498  L9 PH DI    -- after pulling out the cable
22:36:0881  L9 PH AI    -- after reinserting the cable
```

If you don't see this, then check your CRC4 setting (WIN.CFG.LINE.CRC4). You may change this in the configuration and check by trial and error. When changing CRC4, you also need to reset the equipment, either with power off or with the command "**RESET SYS**".
At the end of this exercise, the PRI line should be connected, the PRI LED should be Green, and you should see the above traces when inserting the cable.

BRI physical connection

Contrary to the PRI case, the BRI LED indicators will not necessarily light up when the cable is inserted. The reason for this is that the connected equipment may choose not to activate the line until it is needed. Typically, the public network will deactivate lines whenever possible to reduce power consumption. So don't panic if the LED remains off.

Instead, try to activate the line by initiating a communication. If the BRI is connected to a network, then arrange for a call to come in. If connected to a telephone set, then simply try to call out.
Don't worry if communication fails: if the BRI LED turns Green for a few moments then you have proven that the physical connection is working and you are ready to continue with this test.
The LED indication is as follows:

- **OFF**: The Line is not active (in general a normal situation)
- **GREEN**: The Line is physically activated.

As for the PRI, the IntelliMux will show traces indicating changes in the physical condition of the interface.

BRI Point-to-Point and Point-to-Multipoint

As mentioned, the physical link may be dropped by the NT after some time. This is commonly the case when the operator offers the NT for a **Point-to-Multipoint** operation. This means that multiple devices can use the same "S-bus" to communicate with the NT. The devices are then distinguished from one another by the use of a TEI value (which is sent within every message between a specific TE and the NT).

In most cases this TEI value is assigned by the NT whenever a TE tries to communicate for the first time (**Automatic TEI assignment**).
Alternatively, it is possible to order a BRI line that remains active all the time. By convention, such a **permanent** link is identified by a TEI value (see Datalink discussion) which is set to **0**. In addition, the operator will assume that a **Point-to-Point** connection is used (implying that there is a single TE connected to the NT).

It is important to remark that the IntelliMux does not support the use of multiple TE devices on a single interface.
The IntelliMux assumes that there is only one single device connected to the interface, and will not behave correctly should you try to connect multiple devices on the same line.

At the end of this exercise, the BRI LED should become Green whenever you try to use the line for communication.

Checking the datalink.

Now that you are sure about the cabling, the time has come to have the IntelliMux do some talking with the attached equipment. Be sure that the trace level has been set to a value lower than 8 (e.g. SET TRACE L9 0 to see all details).

PRI Datalink.

If all is well, then you should see something like this every 10 seconds (L9 refers to the first PRI interface):

```
23:51:0150  L9 DL ST7  i _t203-ind 0
23:51:0150  L9 DL T    RR (00 01 01 01 x x 00 00)
23:51:0152  L9 DL R    RR (00 01 01 01 x x 00 00)
                                    -- or
23:51:4161  L9 DL R    RR (02 01 01 01 x x 00 00)
23:51:4161  L9 DL T    RR (02 01 01 01 x x 00 00)
                                    -- or both
23:52:1163  L9 DL ST7  i _t203-ind 0
23:52:1163  L9 DL T    RR (00 01 01 01 x x 00 00)
23:52:1167  L9 DL R    RR (02 01 01 01 x x 00 00)
23:52:1168  L9 DL T    RR (02 01 01 01 x x 00 00)
23:52:1168  L9 DL R    RR (00 01 01 01 x x 00 00)
```

What you see here is that the IntelliMux and the Network are telling each other that they are ready to receive data (**RR = R**eceiver **R**eady) on the datalink (**DL**). The '**T**' stands for transmit, the '**R**' for receive.
If you do not see this, then plug out the PRI cable, wait 20 seconds, and plug it in again. You should see something like this (note that in some cases you may need to be patient for up to 1 minute):

```
02:22:3696  L9 PH AI
02:22:3696  L9 DL T SABME (00 01 7F )
02:22:3700  L9 DL R    UA (00 01 73 )
02:22:3700  L9 DL UP
02:22:4704  L9 DL R    RR (02 01 01 01 )
02:22:4704  L9 DL T    RR (02 01 01 01 )
```

This trace shows that the datalink (DL) has been established normally (SABME asks to start communication and UA acknowledges). After this, the RR messages should be seen every 10 seconds.

Alternatively, you may see something like this:

```
02:24:1375  L9 PH AI
02:24:1375  L9 DL T SABME (02 01 7F )
02:24:1379  L9 DL R SABME (02 01 7F )
02:24:1475  L9 DL T SABME (02 01 7F )
02:24:1538  L9 DL R SABME (02 01 7F )
02:24:1576  L9 DL T SABME (02 01 7F )
02:24:1677  L9 DL T SABME (02 01 7F )
02:24:1697  L9 DL R SABME (02 01 7F )
02:24:1777  L9 DL DOWN
02:24:1779  L9 MDL Error L
02:24:1781  L9 MDL Error L
02:24:1783  L9 MDL Error L
02:24:1785  L9 MDL Error G
02:24:1857  L9 DL R SABME (02 01 7F )
02:24:1859  L9 MDL Error L
```

Clearly something is wrong, and the reason here is that both sides disagree upon their role as either NT or TE. On the physical level it is possible to interwork by using crossed cables. On the logical ISDN level however, it is necessary that one side acts as NT and the other side acts as TE.
If this error occured, then change the line setting:

```
WIN.CFG.LINE.NT:= change it
```

Do a CFG RUN, and then a RESET SYS and try if things are better. Of course, it is better to think and enquire about this if there are doubts: then you know for sure.
Instead of looking at the traces, it is also possible to obtain key information on the status of the line by inspecting the Line status (WIN.STS.LINE). This should show something like this:

```
-Line-------------------------------------------------------------0001--
N  Sts  PH   DL   DL 2 BConn                                AlmFrom
1  ACT  Up   Down Down  --                                  ----------
2  ACT  Down Down Down  --                                  ----------
3  RES  Down Down Down  --                                  ----------
4  RES  Down Down Down  --                                  ----------
5  IDLE Down Down Down                                      ----------
6  IDLE Down Down Down                                      ----------
7  IDLE Down Down Down                                      ----------
8  IDLE Down Down Down                                      ----------
9  ACT  Up   Up   Down  --------------- --------------- ----------
10 IDLE Down Down Down                                      ----------
```

The indication PH shows the **PH**ysical activation. The indication DL shows the **D**ata**L**ink status. In this example, the PRI line is alive and ready for action. The BRI line is physically activated but there is no datalink. (Note by the way that lines L3 and L4 have status "RES", meaning that a configuration change has been applied to these lines which requires a "RESET SYSTEM" in order to become active).

BRI Datalink .

The BRI case is somewhat more complicated than the PRI case, due to the TEI configuration. TEI stands for Terminal Endpoint Identifier, and is a number that is assigned to the TE. This number allows an NT to distinguish between different TE devices on the same S-bus. When discussing the physical connection between the NT and the TE, it was noted that the following conventions are used by operators:

- Permanent Link = Point-to-point link = link with TEI 0.
- Non-permanent = Point-to-Multipoint = link with TEI non-0.

IntelliMux acting as TE or NT on a point-to-point (TEI=0) link.

If you know that your ISDN connection is using a permanent link, then configure TEI=0 (WIN.CFG.LINE.TEI = 0), and refer to the PRI datalink discussion for the further troubleshooting.
Otherwise or if in doubt, then configure the IntelliMux for automatic adaptation (WIN.CFG.LINE.TEI=64). In this mode the IntelliMux will be able to interwork with all types of equipment. The drawback of this approach is that the IntelliMux will not assume that the link is permanent, and will therefore not be able to stop using unconnected or failed BRI interfaces.

IntelliMux ***acting as NT in automatic mode (TEI=64).***

The TEI=64 setting will instruct the IntelliMux to support automatic TEI negotiation with the TE as well as fixed TEI. If the TE is using automatic TEI, then the following interaction can be seen when attaching the cable for the first time (possibly you need to make a call to start):

```
03:48:3165  L1 DL R UINFO (FC FF 03 0F 88 3E 01 FF )
03:48:3165  L1 MDL TEI = 64
03:48:3165  L1 DL T UINFO (FE FF 03 0F 88 3E 02 81 )
```

Alternatively, if the TE is using fixed TEI, then you will see this (the TEI value may vary):

```
04:05:5796  L1 MDL TEI = 3
04:05:5796  L1 DL R SABME (00 07 7F )
```

IntelliMux ***acting as TE in automatic mode (TEI=64).***

```
04:17:1708  L1 DL R UINFO (02 FF 03 08 01 01 05 A1 )
04:17:1709  L1 CC R CR=-0001 ST00 Setup (0)
04:17:1709  L1 CC T CR=-0001 ST06 ReleasCmpl (3)
04:17:1716  L1 DL T UINFO (FC FF 03 0F 3F 3B 01 FF )
04:17:1720  L1 DL R UINFO (FE FF 03 0F 3F 3B 02 81 )
04:17:1720  L1 MDL TEI = 64
04:17:1720  L1 DL T SABME (00 81 7F )
```

An example of correct interaction is (case of incoming call):
Once this works, your physical and datalink are functional, and you don't need to worry about it much more. So hide this detail by setting the trace level a bit higher:

```
SET TRACE L 20
```

IntelliMux acting as NT in point to multipoint mode (TEI=65).

The TEI=65 setting will instruct the IntelliMux to point to multipoint mode with support for automatic TEI negotiation with the TE's as well as fixed TEI. This setting effectively allows communication with 2 TE's on the same line. Each TE will receive a TEI from the IntelliMux, if it is configured for automatic TEI. Otherwise, the IntelliMux will accept the TEI as given by the TE.

Remark that point to multipoint mode is only supported if the line is configured as NT!

The following trace is an extract of a call setup on a point to multipoint link.

```
19:22:3128  L1 CC B CR=0001 ST00 Setup (0)
19:22:3129  L1 DL T UINFO (02 FF 03 08 01 01 05 04 )
19:22:3136  L1 DL R UINFO (FC FF 03 0F 00 56 01 FF )
19:22:3136  L1 MDL TEI = 64
19:22:3136  L1 DL T UINFO (FE FF 03 0F 00 56 02 81 )
19:22:3138  L1 DL R SABME (00 81 7F )
19:22:3138  L1 DL T    UA (00 81 73 )
19:22:3138  L1 DL UP (TEI 64)
19:22:3140  L1 DL R UINFO (FC FF 03 0F 45 96 01 FF )
19:22:3140  L1 MDL TEI = 65
19:22:3140  L1 DL T UINFO (FE FF 03 0F 45 96 02 83 )
19:22:3142  L1 DL R  INFO (00 81 00 00 08 01 81 01 )
19:22:3142  L1 DL T    RR (00 81 01 02 )
19:22:3143  L1 CC H 08 01 81 01 18 01 8A
19:22:3143  L1 CC R CR=0001 ST01 Alert (0)
19:22:3143  R2 Connect 5555
19:22:3144  L9 CC T CR=-0003 ST06 Alert (0)
19:22:3145  L9 DL T  INFO (00 01 00 02 08 02 80 03 )
19:22:3145  L1 DL R SABME (00 83 7F )
19:22:3146  L1 DL T    UA (00 83 73 )
19:22:3146  L1 DL UP (TEI 65)
19:22:3151  L1 DL R  INFO (00 83 00 00 08 01 81 01 )
19:22:3152  L1 DL T    RR (00 83 01 02 )
19:22:3152  L1 CC H 08 01 81 01 18 01 8A
19:22:3152  L1 CC R CR=0001 ST04 Alert (0)
19:22:4149  L1 DL R    RR (00 81 01 01 )
19:22:4149  L1 DL T    RR (00 81 01 03 )
19:22:4159  L1 DL R    RR (00 83 01 01 )
19:22:4159  L1 DL T    RR (00 83 01 03 )
19:22:4235  L1 DL R  INFO (00 81 02 00 08 01 81 07 )
19:22:4235  L1 DL T    RR (00 81 01 04 )
19:22:4235  L1 CC H 08 01 81 07
19:22:4235  L1 CC R CR=0001 ST27 Connect (0)
```

You clearly see that two devices ask for a TEI value. The IntelliMux assigns two TEI values, respectively 64 and 65, to the two TE's.

If you configure your TE's for fixed TEI values, be sure that you choose *different* values for their TEI's. It is a general rule that all devices should have *unique* TEI values.

The network link.

With the trace level set at 20, all network link messages are shown on the trace. This typically results in sequences like these (examples taken from the factory default configuration):

```
outgoing call from L1 (BRI1)
06:46:0524  L1 PH AI
06:46:0524  L1 MDL TEI = 64
06:46:0527  L1 DL UP
06:46:0532  L1 CC R CR=-0001 ST00 Setup (0)
06:46:0532  L9 CC T CR=0002 ST00 Setup (0)
06:46:0541  L9 CC R CR=0002 ST01 CallProc (0)
06:46:0541  L1 CC T CR=-0001 ST06 CallProc (0)
06:46:0544  L9 CC R CR=0002 ST03 Alert (0)
06:46:0544  L1 CC T CR=-0001 ST09 Alert (0)
06:46:0665  L9 CC R CR=0002 ST04 Connect (0)
06:46:0665  R1 Connect 015339991
06:46:0665  L1 CC T CR=-0001 ST07 Connect (0)
06:46:0669  L1 CC R CR=-0001 ST10 ConnectAck (0)
06:46:1028  L1 CC R CR=-0001 ST10 Disconnect (16)
06:46:1028  L9 CC T CR=0002 ST10 Disconnect (16)
06:46:1035  L9 CC R CR=0002 ST11 Release (16)
06:46:1035  L9 CC T CR=0002 ST11 ReleasCmpl (0)
06:46:1035  L1 CC T CR=-0001 ST12 Release (16)
06:46:1035  R1 Disconnect 015339991
06:46:1041  L1 CC R CR=-0001 ST19 ReleasCmpl (16)
06:46:1056  L1 DL DOWN

Incoming call at L9 (PRI)
06:47:5358  L9 CC R CR=-0001 ST00 Setup (0)
06:47:5358  L1 CC B CR=0003 ST00 Setup (0)
06:47:5367  L1 DL UP
06:47:5369  L1 CC R CR=0003 ST01 Alert (0)
06:47:5370  L9 CC T CR=-0001 ST06 Alert (0)
06:47:5454  L1 CC R CR=0003 ST04 Connect (0)
06:47:5454  R2 Connect 159
06:47:5454  L9 CC T CR=-0001 ST07 Connect (0)
06:47:5461  L9 CC R CR=-0001 ST08 ConnectAck (0)
06:47:5461  L1 CC T CR=0003 ST10 ConnectAck (0)
06:47:5763  L1 CC R CR=0003 ST10 Disconnect (16)
06:47:5763  L9 CC T CR=-0001 ST10 Disconnect (16)
06:47:5770  L9 CC R CR=-0001 ST11 Release (16)
06:47:5770  L9 CC T CR=-0001 ST11 ReleasCmpl (0)
06:47:5770  L1 CC T CR=0003 ST12 Release (16)
06:47:5770  R2 Disconnect 159
06:47:5777  L1 CC R CR=0003 ST19 ReleasCmpl (16)
06:47:5791  L1 DL DOWN
```

The IntelliMux assumes that the attached equipment is ETSI-ISDN compliant. This is not always the case, and sometimes workarounds are needed to handle deviations. These workarounds are typically activated by specifying options in the line configuration menu.

Often, such incompatibilities are signaled in the call failure cause. This is the value that is shown between parentheses in the disconnect or release message as shown below.

```
07:57:2529  L1 MDL TEI = 64
07:57:2531  L1 DL UP (TEI 64)
07:57:2537  L1 CC R CR=-0002 ST00 Setup (0)
07:57:2537  L1 CC T CR=-0002 ST06 ReleasCmpl (100)
07:57:2558  L1 DL DOWN
```

The following cause values are possible indications of incompatibilities:

- cause 96: mandatory information element missing.
- cause 97, 98, 99, 101: message type problems.
- cause 100: invalid information contents.

Should these incompatibilities arise and lead to loss of functionality, then check the reference guide under line options, or contact support with a description of the equipment and a trace of the failure sequence. In this case, you should make a trace using trace level 0. This will provide a decoding of the incoming L3 messages that will allow the support engineers to identify the cause of any incompatibility. The following excerpt shows a typical hex decoding of an incoming setup that can be used to identify the exact cause of incompatibilities should they arise.

```
01:39:3710  L1 MDL TEI = 64
01:39:3715  L1 DL UP (TEI 64)
01:39:3720  L1 CC H 08 01 06 05 A1 04 03 80   --decoded incoming message
01:39:3720  L1 CC H 90 A3 18 01 89 70 10 80
01:39:3720  L1 CC H 32 32 32 32 32 32 38 35
01:39:3720  L1 CC H 36 35 36 35 32 33 33
01:39:3720  L1 CC R CR=-0006 ST00 Setup (0)   --interpreted incoming msg
```