TECHNICAL REPORT

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SUBJECT/TASK (title)

ELCOM-90 Application Service Element, User's Manual

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RESULT (summary)

This document describes a specific implementation of the ELCOM-90 Service Element, also called the Reference Version. The Reference Version is available on different Unix and Windows platforms.

The document describes how to manage an ELCOM-90 installation at different platforms. The Application Programming Interface (necessary to develop User Elements utilizing the ELCOM-90 services) and the operation management of the ELCOM-90 service element are described.

This .03 version of the document is an updated version of the .02 version. The updates are mainly information regarding the Windows version of the ELCOM-90 Reference Version. Future updates and new versions will NOT be published for this reason. New versions will only be submitted when technical changes are made.

Please see SINTEF's homepage at: http://www.sintef.no/ELCOM-90. From here you can download the latest version of all relevant documents as pdf-files for free.

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KEYWORDS

SELECTED BY AUTHOR(S)	Data Communication	Control Centres
	Energy management	ELCOM-90

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1 SCOPE

This document describes a specific implementation of the ELCOM-90 Service Element, also called the Reference Version. The Reference Version is available on different Unix platforms, as well as Linux and Windows.

The scope of the document is twofold. It describes the operation management of ELCOM-90 Service Element, and it is a guide in how to use the Application Programming Interface (API) from the C language.

1.1 OPERATION MANAGEMENT OF ELCOM-90 SERVICE ELEMENT

The following topics are covered:

- the installation of the ELCOM-90 Service Element Software
- starting and stopping of ELCOM-90
- the ELCOM-90 supervisor
- the trace and log facilities
- an overview of the error message system

- all of which are necessary or helpful tools to manage and operate the ELCOM-90 Service Element Software System.

1.2 USER ELEMENT IMPLEMENTATION GUIDE

Chapter 6 of this document describes the reference version of the Application Interface Programming library for the C language. Programmers using Fortran may reference to [1] for a description of the API callable from Fortran. This implementation does <u>not</u> provide an API to the Presentation Layer, as described in [4]. When implementing an ELCOM-90 User Element, the document [7] describes in detail how to use ELCOM-90.

2 INTRODUCTION

The ELCOM-90 communication system is an OSI-based service element to cover the needs for information exchange in a multi-processor hierarchical process control system which consists of hardware and software from different manufacturers. The ELCOM-90 system was originally designed to cover the communication needs within or between power utilities.

The present reference versions of ELCOM-90 Service Element are available for various UNIX platforms operating systems as well as Linux and Windows platforms. The Unix implementations supports TCP/IP or X.25 as transport or network protocols. The Windows version supports only TCP/IP network protocol. For the TCP/IP protocol, optional strong authentication and encryption is available by encapsulating the TCP/IP connection with TLS (Transport Layer Security, sometimes referred to as SSL).

2.1 ASSOCIATED DOCUMENTS

The Elcom-90 documentation set consists of the following individual documents, referred to by this document:

[1]: TR 3701: **ELCOM-90 Application Programming Interface Specification**

[2]: TR 3702: **ELCOM-90 Application Service Element. Service Definition**

[3]: TR 3703: **ELCOM-90 Application Service Element. Protocol Specification**

[4]: TR 3704: **ELCOM-90 Presentation Programming Interface Specification**

[5]: TR 3705: **ELCOM-90 Presentation Service Definition**

[6]: TR 3706: **ELCOM-90 Presentation Protocol Specification**

[7]: TR 3825: **ELCOM-90 User Element Conventions**

[8]: TR A3933: **ELCOM-90 Local Conventions**

[9] TR A4687: **PONG. The ELCOM net-watch procedure for TCP/IP networks**

[10] TR A5835: **Elcbas/SEA for Windows. Administrators Guide.**

[11] TR A6196: Securing Elcom-90 with TLS.
SINTEF Energy Research, Trondheim

2.2 HARDWARE PLATFORM AND OPERATING SYSTEMS

This User Manual covers all the platforms where ELCOM-90 Reference Version is available. When this report is published, the ELCOM-90 Reference Version is available on

HP Tru64,
HP-UX
Sun Solaris
Red Hat Enterprise Linux 5

Windows XP, Vista and Windows 7
Windows Server 2003, 2003 R2, 2008 and 2008 R2

See Release Notes for information regarding Operating System Version. When ELCOM-90 is made available on a new platform, a new version of this document will only be published, if installation on the new platform requires any changes in the report. Otherwise release of ELCOM-90 on the new platform will just refer to this document.

3 SYSTEM OVERVIEW

3.1 MAIN MODULES

The ELCOM-90 Reference Version consists of the following modules:

1) the ELCOM-90 Service Element (ELCOM-90 provider) which consists of
   A) the Application-layer (A-provider)
   B) the Presentation-layer (P-provider)
   C) the timer system
2) the supervisor
3) the log/trace sub system
4) the application library (A-lib)
5) the adaptation sub system.

Figure 1 shows the main modules of an ELCOM-90 system.

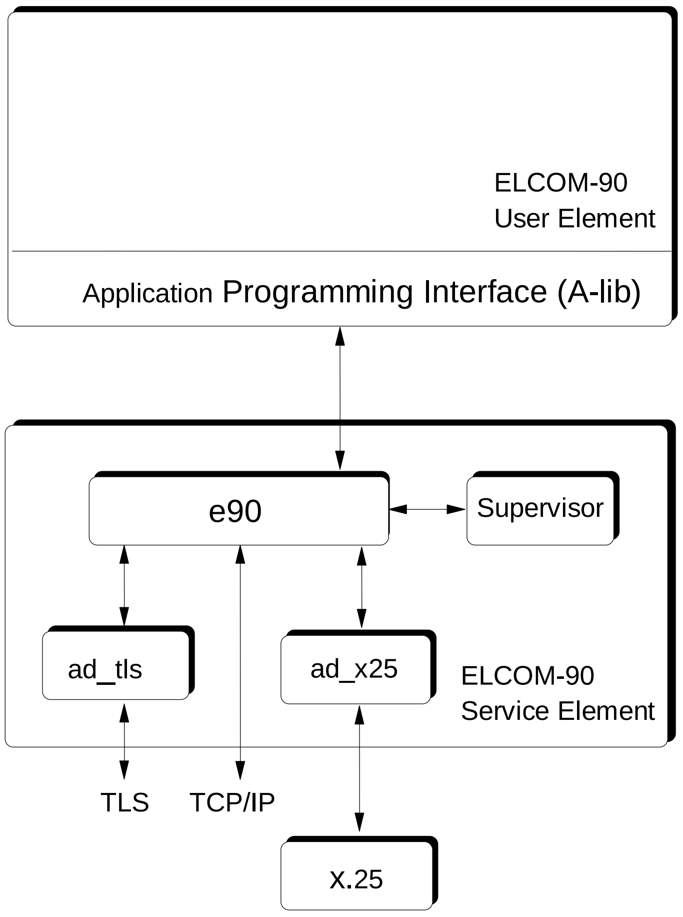


Figure 1. The main modules of an ELCOM-90 system.

1) The *ELCOM-90 provider* is the heart of the system. It is logically divided into three separate modules:

   * the A-provider
   * the P-provider
   * the timer system.

   The ELCOM-90 provider is one software process called e90.
   The A-Provider handles the application protocol.
   The P-provider is responsible for the handling of the presentation protocol.
   Timer supervision of messages is done by both protocols. The timer system supports both protocols with the basic timer mechanisms.

2) The *Supervisor* is used to control the ELCOM-90 provider, e.g. start or stop it, turn the log on or off. The user interface is menu-oriented, though not X-windows or Windows based. The supervisor is a separate program called superv. Its user interface is described in chapter 7 of this document.

3) The *log/trace system* is a common set of routines used by the A- and P-providers. It is controlled from the supervisor.

   The *log system* will register occurred events and the corresponding actions on a file. An occurred event is the reception of a message or the expiration of a timer. The corresponding action is usually that one or more messages are sent to higher or lower layers. The log can be turned on and off. The A- and P-providers are controlled independently. The log file must be decoded. This can be done with the supervisor. It is possible to select parts of the logged information, e.g. with regard to PDU type, connection identification, errors etc.

   The *Trace system* is a similar system. With the trace system turned on it is possible to follow the control flow through the providers. When special parts of the code is executed, this is registered in the trace. Routine entry and exit are registered, as well. The trace level can be chosen between 1 and 5. Level 1 will just give additional information for error conditions while level 5 will give subroutine name and parameters at routine entry and exit. A and P can be controlled independently. The trace is written on a file which can be read by a standard text editor. No decoding is necessary. This information is intended for debugging of the ELCOM-90 provider.

4) The *Application Programming Interface library* (A-lib) provides the interface between the user program and the ELCOM-90 provider. A-lib conforms to the ELCOM-90 Application Programming Interface Specification. There are two sets of subroutine names; represented respectively by small or capital letters. This makes it possible to use the A-lib from both a FORTRAN and a C written application. The Fortran subroutine set is represented in capital

letters and will be converted from Fortran to C. A-lib will use TLI or sockets as IPC (Inter Process Communication) mechanism between itself and the ELCOM-90 provider depending on platform type. Several applications can use the ELCOM-90 provider simultaneously. It is possible to let the ELCOM-90 provider run on one computer and the applications run on another computer.

5) The ELCOM-90 provider is able to use X.25 (only Unix versions) or TCP/IP, including TCP/IP wrapped in TLS as underlying protocols. They will be called ELCOM-90 transport protocols. To support these various protocols, an adaptation process is developed. This is used to support the X.25 protocol. The TCP/IP interface (without TLS) is handled directly by the P-provider. Therefore, in such case an adaptation process is not needed.

   The adaptation process and the ELCOM-90 provider may reside on different machines. Necessary information about this is found in the configuration file (see chapter 6 of this document).

4 INSTALLATION GUIDE UNIX AND LINUX

The ELCOM-90 software is delivered as a tar-file (typically compressed). This will unpack into a directory elcom, with four subdirectories:

- the *bin* subdirectory contains all binaries, configuration and text files;
- the *include* subdirectory contains the public include file, e90pub.h, for the elcom application interface (alib);
- the *lib* subdirectory contains the link library, libelc_alib.a, for the elcom application interface (alib), and may contain shared libraries used at runtime (depending on the platform);
- the *test* subdirectory contains the elcom FAT test programs

The following files are typically included in the *bin* directory, may vary slightly depending on platform:

e90:	The ELCOM-90 provider.
ad_x25:	Adaptation process for X.25.
ad_tls:	Adaptation process for TLS
elc-conf:	Configuration file for the ELCOM-90 installation.
elc-rout:	Legacy routing configuration file, mostly used for X.25.
starte90prov:	Startscript for ELCOM-90 provider (e90). The script contains definition of error file and should be adjusted according to your installation directory system. Used when starting e90 from the supervisor (superv).
starte90adap:	Startscript for adaptation process. Used by the provider to start adaptation processes if used (ad_x25 and/or ad_tls). Should be adjusted as required.
*.txt:	The mandatory text files - elcom.text: Text strings used by elcom-90 supervisor - general.text: Text strings used by the trace and log facilities - error.text: Error text strings.
prov-alive:	Empty file used as lock file for the provider. The file must be created before starting the provider.

ad_tls.log_config:	Configuration file for the ad_tls logging (using log4cxx).
elc-xcp:	Sample xcp configuration file.

For a description of configuration files, see chapter 6.

Notes:

If the user element programs are not situated with configuration file (elc-conf), an environment variable ELCOMPATH may be used to point at the directory containing this file.

The ad_tls program may use one or more shared libraries supplied in the *lib* subdirectory. This may require setting an environment variable for the loader (typically LD_LIBRARY_PATH), so that these libraries can be found. The starte90adap file should contain a suitable example of this.

5 INSTALLATION GUIDE WINDOWS

5.1 System Requirements

The Windows version of Elcom-90 is supported on all current, supported versions of Windows, currently including:

- Windows XP
- Windows Vista
- Windows 7
- Windows Server 2003 and 2003 R2
- Windows Server 2008 and 2008 R2

In general, the most recent service pack is recommended. Older versions of Windows, including Windows NT and Windows 2000 are not supported.

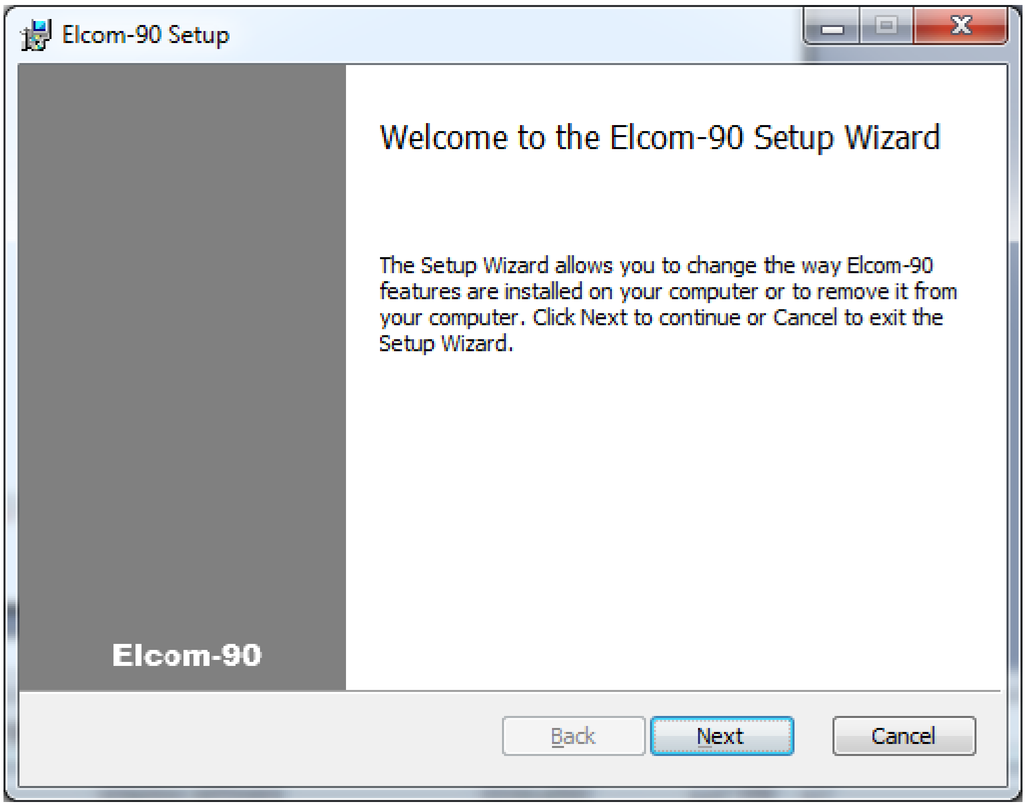
Elcom-90 for Windows is currently only supported as a 32-bit application, but will run on 64-bit Windows versions. Note that user elements using the supplied alib library will also need to be 32-bit applications.

Hardware requirements will depend on the size of the Elcom configuration, but in most cases a pc meeting the minimum requirement for the selected OS will run Elcom-90.

5.2 Installation Procedure

The Elcom-90 Software uses Windows Installer version 3., which is available from Microsoft if missing from the system. Start the installation by running the ElcomSetup.msi windows installer file.

Once the installation is started, you should get this window:

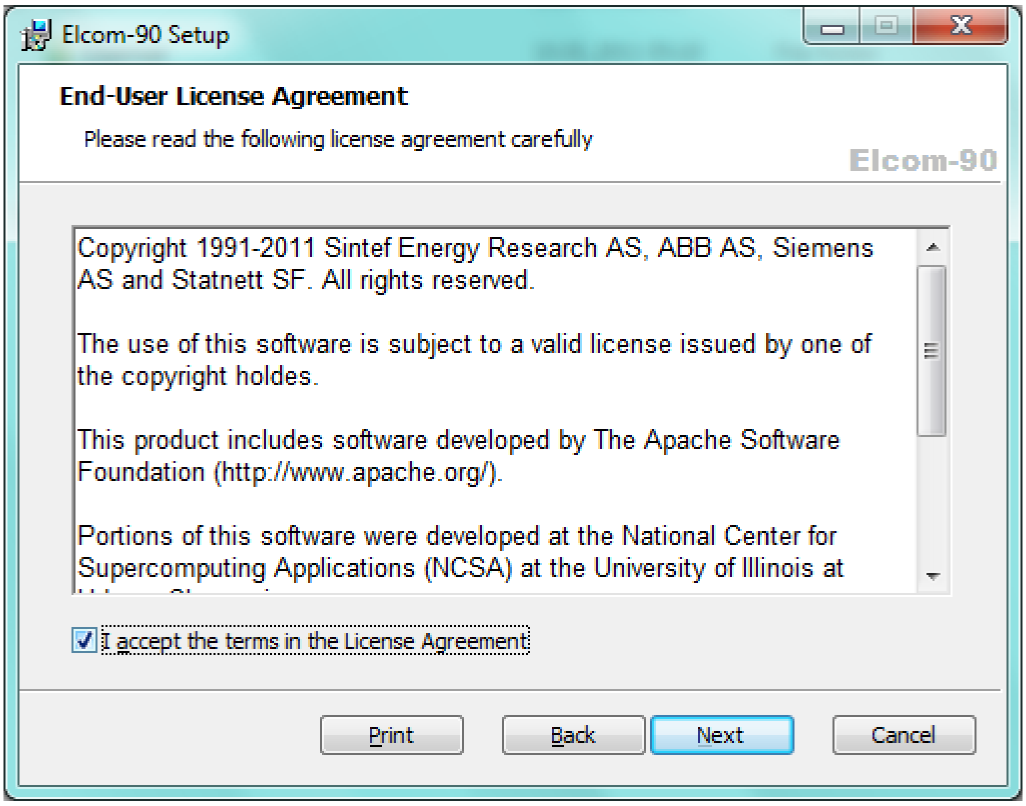


Welcome to the Elcom-90 Setup Wizard

The Setup Wizard allows you to change the way Elcom-90 features are installed on your computer or to remove it from your computer. Click Next to continue or Cancel to exit the Setup Wizard.

Figure 1 Elcom-90 Setup: Start Screen

You will then need to accept a license agreement prior to continuing:



End-User License Agreement

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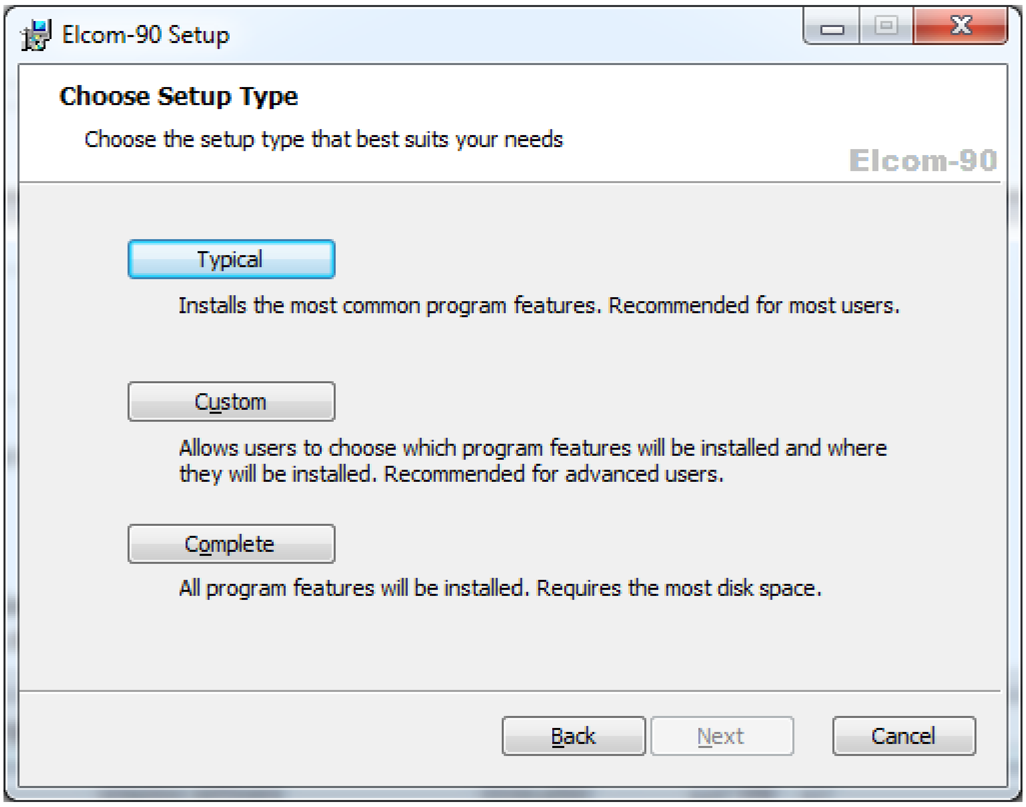
Portions of this software were developed at the National Center for Supercomputing Applications (NCSA) at the University of Illinois at

[✓] I accept the terms in the License Agreement

Figure 2 License Agreement Dialog

Select the installation type to continue.



Elcom-90 Setup

Choose Setup Type

Choose the setup type that best suits your needs

Elcom-90

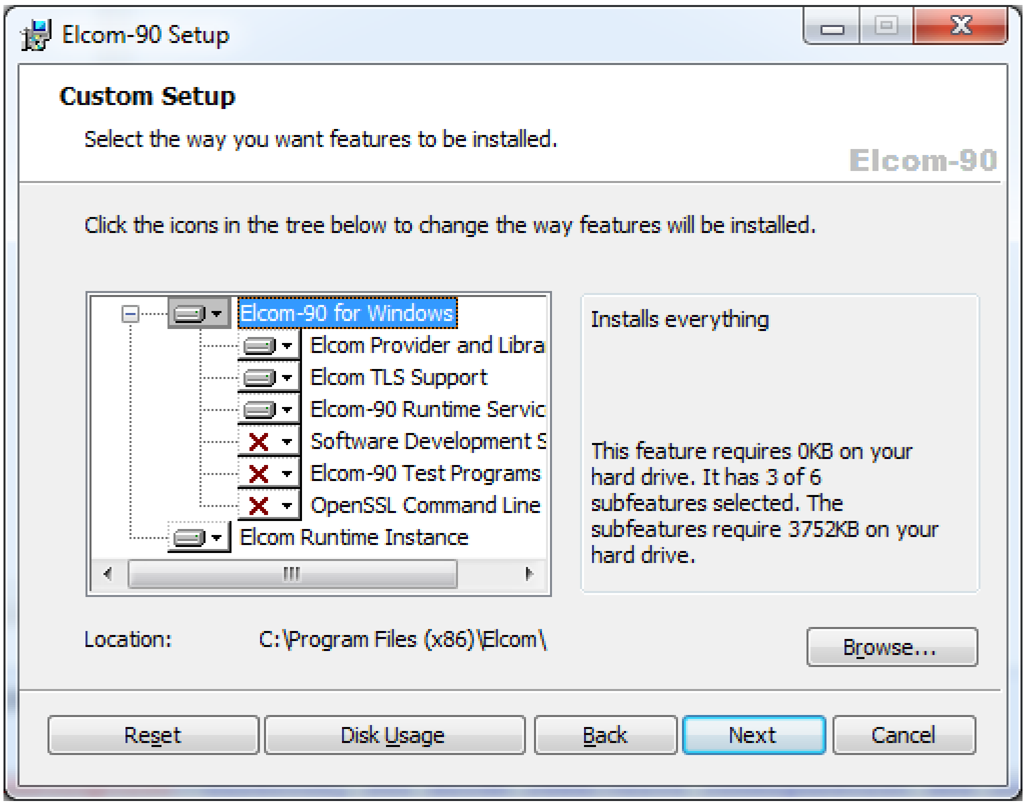
Installs the most common program features. Recommended for most users.

Allows users to choose which program features will be installed and where they will be installed. Recommended for advanced users.

All program features will be installed. Requires the most disk space.

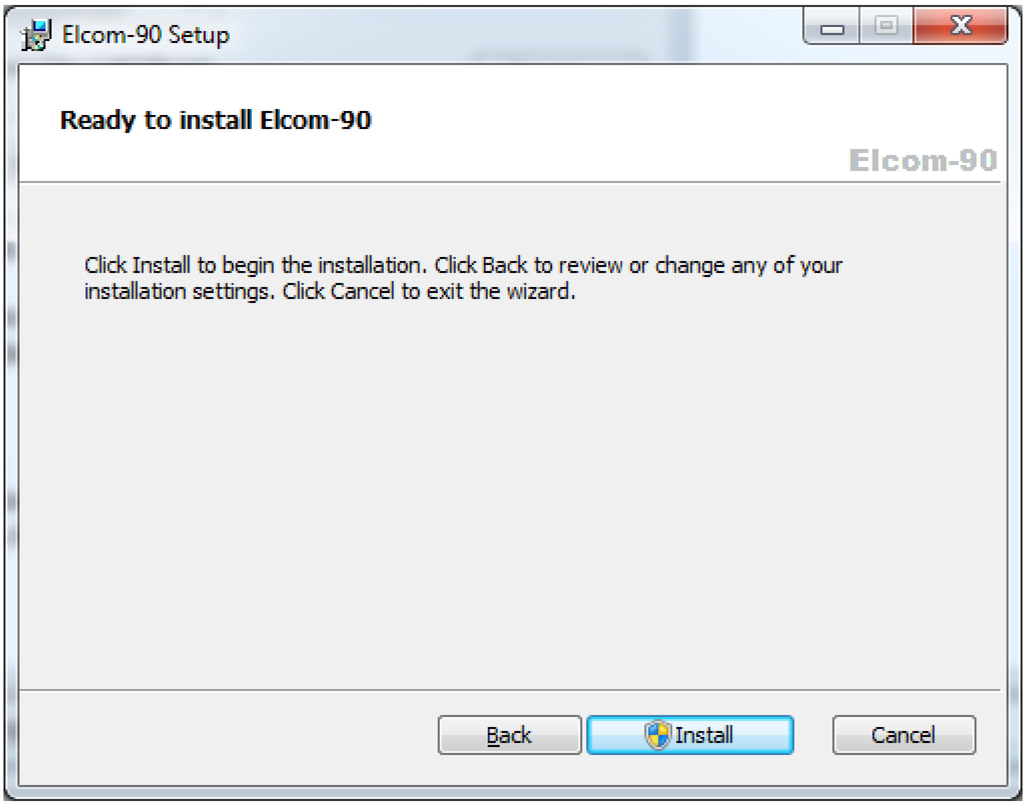
Figure 3 Installation Type Dialog

Select Custom to allow detailed selection of components, Typical for a standard runtime installation or Complete to install everything (Components selected for a Typical installation is shown below).


Elcom-90 Setup
Custom Setup
Select the way you want features to be installed.
Elcom-90
Click the icons in the tree below to change the way features will be installed.
Elcom-90 for Windows
Elcom Provider and Libra
Elcom TLS Support
Elcom-90 Runtime Servic
Software Development S
Elcom-90 Test Programs
OpenSSL Command Line
Elcom Runtime Instance
Installs everything
This feature requires 0KB on your hard drive. It has 3 of 6 subfeatures selected. The subfeatures require 3752KB on your hard drive.
Location: C:\Program Files (x86)\Elcom\
Browse...
Reset
Disk Usage
Back
Next
Cancel
Figure 4 Custom Setup Dialog

This dialog also allows you to change the directories for the executables, by selecting the 'Elcom-90 for Windows' node, and clicking Browse..., or the run-time files directory, by selecting the 'Elcom Runtime Instance' node. The selectable components are described below.

Next will bring up the installation confirmation dialog, press Install here to perform actual installation. Depending on the Windows version and configuration, the OS may prompt for a confirmation before proceeding.



Click Install to begin the installation. Click Back to review or change any of your installation settings. Click Cancel to exit the wizard.

Figure 5 Installation Confirmation Dialog

After completing the setup, reboot the system if requested to.

5.3 Selectable Components

The following is a brief description of the components that can be selected using the Custom setup type:

- Elcom Provider and Library -- This is the core runtime files for Elcom-90, including the protocol provider and the dll for the Elcom Alib library.
- Elcom TLS Support -- This is adaptation program for communicating using TLS (encrypted Elcom).
- Elcom-90 Runtime Service -- This is the Windows service wrapper for Elcom, which allows all the Elcom process to be run as a single Windows service).
- Software Development Support -- This is the header file and link library for building user elements for Elcom.
- Elcom-90 Test Programs -- These are the test programs used for the tests in the Elcom-90 FAT procedure.
- OpenSSL Command Line Utility -- This is the openssl command line utility, which may be used to generate certificates for Elcom over TLS.

5.4 Runtime directory

The Custom setup type allows you to select the Elcom runtime directory, containing log and configuration files. The default will be to use a separate directory from the executables, specifically the common application data folder, with the subfolders Elcom\run (%ALLUSERSPROFILE%\Elcom\run). On Windows XP and 2003 this will typically be:

c:\Documents and Settings\All Users\Application Data\Elcom\Run

whereas on newer windows version, the directory will typically be

c:\ProgramData\Elcom\Run

Note that these directories are often hidden, so that it may be necessary to use 'Show hidden Files' in the Windows Explorer.
The installation will copy the files from the templates folder (under the installation folder) to the run-time folder, but will not overwrite the files if they already exist.

5.5 Files Installed

The following files are installed on the system (for a complete install):

Name	Directory	Type	Usage
ad_tls.exe	bin	Program	Elcom-90 adaptation for TLS
e90.exe	bin	Program	Elcom-90 protocol provider
elcman.exe	bin	Program	Elcom Manager Umbrella service
elcman.ini	templates	Config	Configuration for elcman.exe
superv.exe	bin	Program	Elcom-90 supervisor
curses.dll	bin	Library	Emulation of unix curses (for superv.exe)
elc_alib.dll	bin	Library	Elcom-90 alib
libapr-1.dll	bin	Library	Apache portable run-time
log4cxx.dll	bin	Library	Apache log4cxx library
libeay32.dll	bin	Library	OpenSSL library
ssleay32.dll	bin	Library	OpenSSL library
elc-conf	templates	Config	Elcom-90 provider configuration
elc-route	templates	Config	Elcom-90 provider route file
elcom.txt	templates	Config	Elcom-90 static text file
error.txt	templates	Config	Elcom-90 static text file
general.txt	templates	Config	Elcom-90 static text file
ad_tls.log_config	templates	Config	Configuration for log4cxx logging in ad_tls
elc-xcp	templates	Config	eXtended Communication Parameter file, sample
openssl.cnf	templates	Config	Configuration file for openssl.exe
ecap-a.exe	bin	Program	Elcom-90 FAT program, capacity test
ecap-b.exe	bin	Program	Elcom-90 FAT program, capacity test
eld-a.exe	bin	Program	Elcom-90 FAT program, load test
eld-b.exe	bin	Program	Elcom-90 FAT program, load test
elt-a.exe	bin	Program	Elcom-90 FAT program, functional test
elt-b.exe	bin	Program	Elcom-90 FAT program, functional test
openssl.exe	bin	Program	OpenSSL utility program
elc_alib.lib	lib	Library	Elcom-90 alib for linking
e90pub.h	include	Include file	Elcom-90 definitions

5.6 Upgrade Procedure

Use the same kit for upgrading the software. The kit will automatically uninstall any prior version as part of an upgrade. Reboot the computer if prompted to do so. An upgrade will normally maintain configuration files from the previous install.

After the upgrade, the Elcom Runtime service must be restarted manually.

6 CONFIGURATION

6.1 Overview

Most of the elcom configuration settings is done in a file called elc-conf. the same config file is used by the elcom provider (e90), the adaptation processes and user elements linked to the elcom alib. For the provider and adaptation processes, the file must be found in the current working directory. For user elements, an environment variable, ELCOMPATH, can be used to locate the file instead. (the variable should then contain the directory name).

Some settings in the config file must always be present in some form, whereas other are only required with a particular usage (e.g. if a specific transport is used). The programs will generally complain and exit if a certain setting is missing, in which case it should be added to the file.

The following settings are always required:

- ELC_ERRFILE
- TCP_DEV_1
- SUPERV_SELECTOR
- USER_SELECTOR
- PROV_HOST_ADDR
- ADAPT
- NO_OF_TCP_DEV
- NO_OF_X25_DEV
- NO_OF_ISOT_DEV
- ALOG_FILE
- PLOG_FILE
- LOCK_FILE (not on windows)

6.2 Configuring for TCP/IP communications

To use TCP/IP communications, the NO_OF_TCP_DEV variable should be set to 1, and a valid TCP_SELECTOR must be supplied, being the TCP/IP port number used by remote partners to connect to this elcom system.

6.3 Configuring for TLS communications

To use TLS communications, the following settings must be supplied.

- ADAPT set such that bit 3 (0x8) is set.
- ADAP_SRTSCRIPT
- TLS_PROV_SELECTOR set to the public port for TLS communications.
- TLS_AP_SELECTOR
- TLS_AP_HOST_ADDR
- TLS_SELECTOR

- TLS_CA_CERT
- TLS_MY_CERT
- TLS_PRIVATE_KEY

To use TLS, you will as a minimum require a private key and the corresponding X.509 certificate, as well as the certificate for the certificate authority (CA) that issued the certificate. This identifies the current node for other systems, which must then have the same CA certificate, in order to validate the individual partner certificates.

The private key and own certificate may be kept in a single file, and the TLS_PRIVATE_KEY setting omitted.

The key and certificate files should be in PEM format.

Depending on how the user element is programmed, the installation may also use an xcp file to define the mapping between partner addresses and certificate names. This file allows the use of TLS without modifying the user element code, but adds configuration complexity, and may not be desirable when there are many partners. Without an xcp file, the user element handles configuration of certificate names, as described later. The use of an xcp file is specified with the setting XCP_FILE in elc-conf, pointing to the actual file. The format of the xcp file is described later in this chapter.

6.4 Configuration variables defined by the file elc-conf

The file contains some TCP portnumbers. Find free portnumbers in /etc/services. Usually portnumbers are from 5995-5999. Edit /etc/services according to your choice (this is not required for elcom operation).

ADAPT

Meaning:	Specification of protocol adaptation in use
Read by:	A- and P-provider
Default value:	0 (no adaptation)
Configuration guideline:	The variable is a bit mask that describes for which protocols adaptation is used. Each protocol type is reserved a bit: TCP : value 0 (no adaptation for TCP protocol) X.25 : value 2 ISOT : value 4 TLS : value 8 The "ADAPT" variable will be the sum of the values for the protocols with adaptation. E.g. adaptation for X.25 and ISOT will be specified: ADAPT=6.

ADAP_SRTSCRIPT

Meaning:	File containing a script to start the adaptation processes.
Read by:	A- and P-provider
Default value:	starte90adapt
Configuration guideline:	A script file will be delivered with the ELCOM software. The file must be modified according to your system.

ALOG_FILE

Meaning:	Name of and path for file to be used for coded log information from the A-provider.
Read by:	A- and P-provider
Default value:	ap-log.dat
Configuration guideline:	The file is created by the provider. Name and path to the file must be filled in according to your system.

ELC_ERRFILE

Meaning:	Name of and path to the text file defining error messages for the ELCOM system.
Read by:	A- and P-provider, A-lib, Supervisor, Accept test programs
Default value:	../bin/error.txt
Configuration guideline:	The file is located in the "bin" subdirectory of ELCOM and is named error.txt. Path to the file must be filled in according to your system.

ELC_TEXTFILE

Meaning:	Name of and path to the text file containing text strings with various elcom information.
Read by:	Supervisor, Accept test programs
Default value:	../bin/general.txt
Configuration guideline:	The file is located in the "bin" subdirectory of ELCOM and is named general.txt. Path to the file must be filled in according to your system.

ISOT_AP_HOST_ADDR
TCP_AP_HOST_ADDR
X.25_AP_HOST_ADDR
TLS_AP_HOST_ADDR

Meaning:	IP address for adaptation process host
Read by:	A- and P-provider, adaptation process
Default value:	None
Configuration guideline:	IP address for the machine running the given adaptation process must be filled in (refer host file).

ISOT_AP_IPCDEV
TCP_AP_IPCDEV

X.25_AP_IPCDEV

Meaning:	Device/controller for IPC with provider process (TCP/IP)
Read by:	Adaptation processes
Default value:	None
Configuration:	Choose a TCP/IP device on the adaptation process host. Not used by adaptation for TLS.

ISOT_AP_SELECTOR
TCP_AP_SELECTOR
X.25_AP_SELECTOR
TLS_AP_SELECTOR

Meaning:	Port numbers for listen SAPs in the adaptation processes for incoming requests from the provider.
Read by:	A- and P-provider, Adaptation processes
Default value:	5995.
Configuration:	TCP port numbers that must be unique to the system.

ISOT_DEV_x

Meaning:	A set of variables describing names of devices/controllers for ISO Transport.
Read by:	A- and P-provider, Adaptation process
Default value:	None.
Configuration guideline:	For each of the devices specified in "NO_OF_ISOT_DEV" a device name must be given. E.g. ISOT_DEV_1=/dev/isotp. These variables are only required if NO_OF_ISOT_DEV > 0.

ISOT_PROV_SELECTOR
TCP_PROV_SELECTOR
X.25_PROV_SELECTOR
TLS_PROV_SELECTOR

Meaning:	Port numbers used for listen SAPs in the provider for incoming requests from adaptation processes.
Read by:	A- and P- provider, Adaptation process
Default value:	5996.
Configuration guideline:	TCP is used as IPC mechanism between the provider and the adaptation processes. Thus, these selectors are TCP port numbers which must be unique to the system.

ISO_SELECTOR

Meaning:	T-selector used for listen SAP for incoming requests from remote ELCOM providers using ISO Transport protocol for lower level communication.

Read by:	A- and P-provider, or ISO Transport adaptation process.
Default value:	None
Configuration guideline:	This is an ISO Transport selector which must be unique to the system.

LOCK_FILE

Meaning:	Name of and path to the file used to signal that the provider is running.
Read by:	A- and P-provider, supervisor, Alib.
Default value:	prov-alive
Configuration guideline:	The file is empty but must be created before the provider can be started. The file is called a lock file because the provider sets a lock on the file when it is running. This lock can be checked by the Supervisor to verify the status and to get the PID (process identification) of the provider process. The lock file is not used on windows.

MAX_FD_UACEP

Meaning:	Number of UACEP's per file descriptor (TLI connection or socket)
Read by:	A-lib
Default value:	10
Configuration guideline:	If many ELCOM Application associations (UACEP's) are used between Application user and the provider it is possible to split the information transfer between different TLI or socket connections. The default value will cause a new connection to be established for every tenth UACEP. If the variable is omitted, the value will be set to 10 (a new connection is established for every 10th UACEP).

NO_OF_ISOT_DEV

Meaning:	Number of ISO transport devices/controllers
Read by:	A- and P-provider, Adaptation process
Default value:	0
Configuration guideline:	The provider will open a listen SAP for each device. "ISOT_SELECTOR" (see above) will be used as Transport selector.

NO_OF_TCP_DEV

Meaning:	Number of TCP devices/controllers
Read by:	A- and P-provider, Adaptation process
Default value:	1
Configuration guideline:	There must be at least one TCP/IP device (TCP is used as protocol for IPC). The provider will open a listen SAP for each device. "TCP_SELECTOR" (refer below) will be used as port number for all devices. Set this to 0 to disable use of TCP transport (e.g. to use only encrypted (TLS) communications).

NO_OF_X.25_DEV

Meaning:	Number of X.25 devices/controllers
Read by:	A- and P-provider, Adaptation process
Default value:	0
Configuration guideline:	The provider will open a listen SAP for each device. "X.25_SELECTOR" (see below) will be used as subaddress.

PLOG_FILE

Meaning:	Name of and path to file to be used for coded log information from the P-provider.
Read by:	A- and P-provider
Default value:	pp-log.dat
Configuration guideline:	The file is created by the provider. Name and path to the file must be filled in according to your system.

PONG_TIMER

Meaning:	Number of seconds between each check of TCP/IP connection to a partner, using “Pong” [9].
Read by:	P-provider
Default value:	0
Configuration guideline:	A value of 0 means that this check is not performed. If this check is activated, a test of the liveness of the remote part will be performed. If a connection is broken, all connections to this partner will be aborted.

PROV_HOST_ADDR

Meaning:	Internet address used to identify host for a provider.
Read by:	A-lib, Adaptation process
Default value:	System dependent
Configuration guideline:	TCP is used as IPC between the Application users (A-lib) and the ELCOM provider. Since the users may run on another machine they must know the IP address for the provider host machine.

ROUTE_FILE

Meaning:	Name of and path to file that contains routing information for outgoing calls from the provider.
Read by:	A- and P-provider, Adaptation process
Default value:	elc-route
Configuration guideline:	The ELCOM system includes a default route file located in the "bin" subdirectory, which must be modified to fit your current system. The configuration variable is used to specify the name and location of this file. Note that the route file is only used by some adaptations for X.25 in the current version.

SUPERV_SELECTOR

Meaning:	Port number used for listen SAP for incoming requests from the Supervisor.
Read by:	A- and P-Provider
Default value:	5999
Configuration guideline:	This is a TCP port number which must be unique to the system.

SUPERV_SRTSCRIPT

Meaning:	File containing a script to start the ELCOM provider process.
Read by:	Supervisor
Default value:	starte90prov
Configuration guideline:	A script file will be delivered with the ELCOM software. The script must be modified according to your system.

SUPERV_TEXTFILE

Meaning:	Name of text file containing various texts for the Supervisor i.e. menus etc.
Read by:	Supervisor
Default value:	../bin/elcom.txt
Configuration guideline:	The file is located in the "bin" subdirectory of ELCOM and is named elcom.txt. The path for the file must be filled in according to your system.

TCP_DEV_x

Meaning:	Name of devices/controllers for TCP
Read by:	AP provider, Adaptation process
Default value:	System dependent
Configuration guideline:	For each of the devices specified in "NO_OF_TCP_DEV" a device name must be given. E.g. TCP_DEV_1=/dev/tcp. Since TCP is used as protocol for IPC at least one device must be specified. The same device can, however, be used for lower level communication with TCP. Note that the value of this is not used for the current, sockets-based provider, but must still be present in the configuration file.

TCP_SELECTOR

Meaning:	Port number used for listen SAP for incoming requests from remote ELCOM providers using TCP for lower level communication.
Read by:	A- P-provider, Adaptation process.
Default value:	5997
Configuration guideline:	This is a TCP port number which must be unique in the system.

TLS_CA_CERT

Meaning:	The file name of the file containing the certificate(s) for the valid certificate authorities when using TLS communication.
Read by:	Adaptation process.
Default value:	ca-cert.pem
Configuration guideline:	The file is a text file in PEM format.

TLS_MY_CERT

Meaning:	The file name of the file containing the certificate representing this system in Elcom/TLS communications. The certificate must be issued by one of the certificate authorities in TLS_CA_CERT.
Read by:	Adaptation process.
Default value:	partner_2.cert
Configuration guideline:	The file is a text file in PEM format.

TLS_PRIVATE_KEY

Meaning:	The file name of the file containing the private key for the certificate in TLS_MY_CERT.
Read by:	Adaptation process.
Default value:	partner_2.cert
Configuration guideline:	The file is a text file in PEM format. On multiuser systems it is important to set permissions on this file so that other users cannot access it.

TLS_SELECTOR

Meaning:	Port number used to listen for incoming requests from remote ELCOM providers using TLS for lower level communication.
Read by:	Adaptation process.
Default value:	5991
Configuration guideline:	This is a TCP port number which must be unique in the system.

USER_SELECTOR

Meaning:	Port number used for listen SAP for incoming requests from user entities.
Read by:	A- and P-provider
Default value:	5998
Configuration guideline:	This is a TCP port number which must be unique in the system.

X.25_CUDATA

Meaning:	Data for the "Call user data" field used by the X.25 protocol
Read by:	Adaptation process for X.25
Default value:	ELCOM-83

Configuration guideline:	Must be set to ELCOM-83 when using X.25.
X.25_DEV_x	
Meaning:	A set of variables describing name of devices/controllers for X.25.
Read by:	A- and P-provider, Adaptation process
Default value:	System dependent
Configuration guideline:	For each of the devices specified in "NO-OF_X.25_DEV" a device name must be given. E.g. X.25_DEV_1=/dev/x25/dev1. These variables are only required id NO_OF_X.25_DEV > 0. For Alpha OSF1, this value is usually ELCOM (Used as Filter Name).

X.25_SELECTOR	
Meaning:	X.25 subaddress used for listen SAP for incoming requests from remote ELCOM providers using X.25 for lower level communication.
Read by:	A- and P-provider, or adaptation process for X.25
Default value:	None
Configuration guideline:	This is an X.25 subaddress which must be unique to the system. Must be removed/commented out on Alpha/OSF1

XCP_FILE	
Meaning:	The XCP file (eXtended Communication Parameters) is currently used to handle mapping between remote addresses and TLS certificate names.
Read by:	A- and P-provider.
Default value:	None
Configuration guideline:	When using an XCP file, the use of TLS instead of TCP is transparent to the user elements. To let the user elements handle configuration and validation of certificate names, omit the XCP file.

6.5 The elc-xcp configuration file

The elc-xcp (xcp is a mnemonic for eXtended Communication Parameters) configuration file defines the mapping between partner addresses and certificate names. This allows TLS to be used without changes to the user element code at the cost of added configuration complexity. The XCP_FILE setting in elc-conf defines if this file is used or not (as well as the name of the file – it does not need to be called elc-xcp). Programming for TLS if an xcp file is not used is described in chapter 9.

A simple xcp file for one partner can look like:

```
# Lab test configuration for Elcom TLS
192.168.50.2:5991 CONNECT_USING=TLS;PARTNER_CERT=STATNETT_RCCS
```

Comments start with '#', and there is one line for each address that is mapped. The address is matched against the addresses in the elcom **aconrq** call as follows:

- For incoming connections (responder), the initiator address is matched. If a match is found, the configured certificate name is compared with the name in the partners actual address, and if not matching, the call is closed, with a result code of 20 returned to the remote partner.
- For outgoing connections (initiator), the acceptor address is matched. If a match is found, the configured certificate name will be compared to the certificate name of the remote responder. If not matching, the call will be closed, with a result of 21 returned to the local user element.

The remaining parameters on the line supply the parameters for the matched address, one or more separated by semicolons. Currently this is supported for TLS only, and should hence follow the format in the sample:

- CONNECT_USING should have the vale TLS.
- PARTNER_CERT should contain the certificate name for the partner (i.e. the CN field of the X.509 certificate).

You should supply as many lines in the xcp file as you have addresses for your TLS partners. If a connect request is received from TLS not matching any line in the xcp file, the call will be rejected with a result code of 20. For outgoing connections, if an address is not found in the xcp file, an unencrypted connection will be attempted. If the address points at a TLS port, this will fail with error code 30.

7 OPERATION AND SUPERVISION

7.1 Windows

7.1.1 Starting and stopping the software

When running Elcom-90 as a service, this service can be started and stopped as any other windows service, e.g.:

– By using the services control panel applet (under Administrative Tools in Windows 2000 and newer).

– By using the services MMC snap-in in Windows 2000 and newer (available e.g. in the Computer Management Console from Administrative Tools, or Manage from the context menu on My Computer).

– By using the NET command from a command line window:

```
net start ElcomRuntime (to start the service)
net stop ElcomRuntime (to stop the service)
net start (to list active services)
```

The command is not case sensitive, and the long service name may be used if quoted.

The Elcom Manager service may also be paused/continued, but this is only intended for testing (a pause implies suspending the main thread of all child processes).

The elcom provider and adaptation for TLS can also be run as regular command window programs.

7.1.2 Using Operating System Tools To Monitor the Software

Some useful commands are:

 The control panel services applet, to verify that the Elcom Manager service is running.

 Alternatively, the ‘net start’ command without a service name lists running services.

 The ‘netstat’ command lists active TCP/IP connections, and is useful to verify if Elcom is connected. Look for the specified Elcom port (e.g. 5997):
o In the local address column for connections where the local system is responder.
o In The remote address column for connections where the local system is initiator.

 The task manager can be used to verify if the processes of a running Elcom system are active:
o Look for e90.exe (protocol) and elcman.exe (the service/watchdog program).

7.1.3 Using Other Tools

Some useful third-party tools are available:

 From sysinternals (http://www.sysinternals.com):
o Process explorer – a better task manager
o Tcpview – a dynamic TCP/IP connection viewer
o Dbgview – for dynamic log viewing (if configured in the .log_config files).

 A useful, freeware network sniffer, ethereal, is available from http://www.ethereal.com

7.2 Unix

Starting the ELCOM-90 provider process can be done in the following ways:

1. By the start script 'starte90prov'.
2. By using the elcom-90 supervisor.
3. By typing 'e90&' at your keyboard.

The usual way is to use method 1. The script is either started from the system rc file or by the user. If initiated by the rc file, ELCOM-90 will be running when the system is (re)started.

Method 2 gives the user the possibility to interfere with the provider, change log/trace criteria, do temporary starts or stops of the ELCOM-90 provider etc. Use of the ELCOM-90 supervisor is explained in chapter 6.

Method 3 initializes ELCOM-90 from your terminal, and could be used to check the stability of the software at startup time. Apart from this, method 1 or 2 should be preferred.

8 ADDRESSING

8.1 Addressing

The ELCOM-90 transport protocols are:

1) TCP/IP
2) ISO Transport protocol (Not implemented)
3) X.25 (Not implemented on Windows)
4) TLS, or TCP/IP wrapped in TLS, for encryption and authentication

According to [1] the address consists of four parts:

1) Length of lower level part of the address
2) Lower level part of the address

3) Length of the A-suffix
4) A-suffix (or P-selector)

The lower level part of the address is the transport protocol address. It will vary according to the specific protocol. This is new in ELCOM-90, it is necessary to provide a transport protocol identifier to the address.

The format of the lower level part of the address will then be:

1) Protocol identifier field (1 byte)
2) Transport protocol address.

The protocol identifier field is binary coded, and the values defined are:

1) 128: X.25
2) 129: ISO transport protocol
3) 130: TCP/IP
4) 131: Reserved for future use (ISO ACSE and Presentation)
5) 132: Reserved for future use (ISO NSAP)

If the protocol identifier field has a value in the range "0" - "9" (ASCII) this is interpreted as the old format (ELCOM-83), i.e. an X.25 DTE number.

The ELCOM provider will pass the transport protocol addresses transparently on to the underlying service. No format conversion will take place. Hence, the application must present the transport protocol address to the ELCOM provider in the same format as the underlying communication product expects it.

The adaptation process will in principle receive the same information as the P-provider will send to the process interface for the protocol in question. This means the protocol identifier is stripped off when the address is sent to the adaptation process.

For X.25 the address information is sent as BCD digits (i.e. in the way X.25 expects it). The length of the call address field is in number of bytes. If there are an odd number of BDC digits, the nibble of the last byte has the value of 0xF (hex), which is the "padding value". See Appendix A for details about address formats.

9 PROGRAMMING FOR TLS

When using TLS for TCP/IP, Elcom connections are authenticated and encrypted. For the authentication, X.509 certificates are used. When properly configured, the adaptation for TLS will validate the certificates according to one or more certificate authorities, but as a final step in the authentication, the certificate name, i.e. the ‘Canonical Name’ field, is compared with local configuration, to verify that this is the correct partner.

This check can be done in the provider using an xcp file, as described in the configuration chapter, or it can be done by the user element. This is controlled by whether an xcp file is present or not. If this file is present, the use of TLS is transparent to the user element.

The following sections describe how the user elements should handle certificate names when the xcp file is not present.

When using TLS, the TCP/IP address format is still used. The certificate name is passed using the security information field in the user data.

9.1 Encoding of the security information field for TLS

The reference version uses the security information field of the connect user data to transfer the certificate name between the provider and the user elements (when an xcp file is not used). Note that this information is not transmitted over the network, so protocol behaviour is not changed.

The encoding of user data is described in detail in[7]. For TLS usage, a security information field is used with **aconrq** (supplied by the user element) and **aconi** (supplied by the provider).

The security information field for **aconrq**/**aconi** will start at octet 2 (counting from 0) in the user data.

- The first octet contains the length of the security information field (not including the length byte itself), i.e. the length of the certificate name + 1, for TLS,
- The second octet is the security options field. For TLS this should be 0x40 (security class 4, no other options).
- The remaining octets are the actual certificate name.

The maximum length of the security information field is 66 octets (this can be reduced if other user data is supplied), including the length octet. This gives a maximum certificate name length of 64.

9.2 Certificate handling in the initiator

The initiator should supply the certificate name configured for a partner in the user data as described above, when calling **aconrq**. The adaptation for TLS will compare this to the partners actual certificate, and reject the connection if they do not match, returning a result code of 21, Responder certificate mismatch, in the corresponding **aconc** call.

9.3 Certificate handling in the responder

The responder needs to compare the certificate name passed up from the provider with the certificate name configured for the partner in question (based on the initiator address received). The responder will receive a certificate name with the **aconi** call. If the certificate name does not match the configured name, the responder should reject the call with a result code of 20, certificate reject by responder, in the following **aconrs** call. For **aconrs,** no TLS information is needed.

10 SERVICE INTERFACE PROCEDURES WHEN CALLED FROM C

This chapter describes the various Application Programming Interface Procedures when called from an application written in C. The parameter specifications are the same as described in "**ELCOM-90 Application Programming Interface Specification**" (written for FORTRAN applications) with the exception mentioned below.

The first element in an array in a FORTRAN program will be given index no 1 (one), while the first element in a C-array will be given index no 0 (zero). These changes applies to the following parameters:

t	used in: **adtrq, adti, actrq, acti, actrs, actc, amdrq,**
cf	used in: **agmrs, agmc, adgrs, adgc**
result	used in: **adgrs, adgc**

In the procedure call specification, output arguments are underlined while input arguments are not.

The parameter types used in the C programming interface which are **not** standard C types are:

bool	=	**unsigned char, TRUE = 1, FALSE = 0**
octet	=	**unsigned char**
octets	=	**unsigned char**
rr_values	=	**integer (ranging from 0 to 255)**

```
typedef unsigned char bool:
typedef unsigned char octet;
typedef unsigned char octets;

typedef enum {
        a_r0, a_rcl, a_rc2, ...... a_rc19,
        a_r20, ......a_r29,
        a_rc30, ,,,
        ...........
        a_r254,
        a_runknown                /* 255 */
}rr_values;
```

The description of the various values of **rr_values** is found in [1].

Three additional status return values have been implemented for this Elcom implementation:

Status = -6	'Temporary unavailable (Try again)'. This may be returned on some platforms if the adaptation process for X.25 is not running.
Status = -7	'Operation cancelled due to local error'. This is returned when the provider can't complete this call. Eg. if the address does not match the addresses in the routing table, this error can be given instead of Illegal parameter.
Status = -8	'Incompatible version'. This is used when an ELCOM-90 system communicates with an ELCOM-83 system. If the user is not aware of this and issues an ELCOM-90 primitive, the provider will return this status.

10.1 INITIATION

10.1.1 ainit

***Function*:** Initiates the Application Service Provider.

Call:
void ainit (<u>*status*</u>)

int * status;

10.2 ATTACHMENT AND DETACHMENT PROCEDURES

10.2.1 aatt

Function:	Make a binding from a User Entity to the A-provider.

Call:

void aatt	*(entity_id, a_suffix, u_acep, type, <u>status</u>, <u>p acep</u>)*
int	entity_id;
octets *	a_suffix;
int	u_acep;
int	type;
int *	status;
int *	p_acep;

10.2.2 adet

Function:	Release the association between a User Entity and the A-provider.

Call:

void adet	*(entity_id, p_acep, <u>status</u>)*
int	entity_id;
int	p_acep;
int *	status;

10.3 CONNECTION ESTABLISHMENT PROCEDURES

10.3.1 aconrq

Function: Request the A-provider to establish an Application Connection.

Call:

void aconrq (p_acep, version, initiator, acceptor, user_data, length, status)

```
int             p_acep;
int             version;
octets *        initiator;
octets *        acceptor;
octets *        user_data;
int             length;
int *           status;
```

10.3.2 aconi

Function: Receive a Connect Indication initiated by a calling User.

Call:

void aconi (p_acep, status, version, initiator, acceptor, user_data, length)

```
int             p_acep;
int *           status;
int *           version;
octets *        initiator;
octets *        acceptor;
octets *        user_data;
int *           length;
```

10.3.3 aconrs

Function:	Send a response to a received Connect Indication.

Call:

void aconrs	*(p_acep, version, initiator, acceptor, result, user_data, length, status)*
int	p_acep;
int	version;
octets *	initiator;
octets *	acceptor;
rr_values	result;
octets *	user_data;
int	length;
int *	status;

10.3.4 aconc

Function:	Receive a Connect Confirmation.

Call:

void aconc	*(p_acep, status, version, initiator, acceptor, result, user_data, length)*
int	p_acep;
int *	status;
int *	version;
octets *	initiator;
octets *	acceptor;
rr_values *	result;
octets *	user_data;
int *	length;

10.4 CONNECTION TERMINATION PROCEDURES

10.4.1 arelrq

Function:	Initiate the termination of a Connection.

Call:

void arelrq	*(p_acep, user_reason, <u>status</u>)*
int	p_acep;
octet	user_reason;
int *	status;

10.4.2 areli

Function:	Receive a Release Indication initiated by the other User.

Call:

void areli	*(p_acep, <u>status</u>, <u>user_reason</u>)*
int	p_acep;
int *	status;
octet *	user_reason;

10.4.3 arelrs

Function:	Initiate a response to a received Release Indication.

Call:

void arelrs	*(p_acep, result, <u>status</u>)*
int	p_acep;
rr_values	result;
int *	status;

10.4.4 arelc

Function:	Receive a Release Confirmation.

Call:

void arelc	*(p_acep, <u>status</u>, <u>result</u>)*
int	p_acep;
int *	status;
rr-values *	result;

10.4.5 apabt

Function:	Receive a provider initiated Abort Indication.

Call:

void apabt	*(p_acep, <u>status</u>, <u>reason</u>)*
int	p_acep;
int *	status;
rr_values *	reason;

10.5 GROUP MANAGEMENT

10.5.1 agmrq

Function: Transfer a Request for Group Management to remote User.

Call:

void agmrq *(p_acep, function, gtype, gnr, gsize, objlength, persist, static, priority_class, status)*

int	p_acep;
int	function;
int	gtype;
int	gnr;
int	gsize;
int	objlength;
bool	persist;
bool	static;
int	priority_class;
int *	status;

10.5.2 agmi

Function: Receive a Group Management Indication from the remote User.

Call:

void agmi *(p_acep, status, function, gtype, gnr, gsize, objlength, persist, static, priority_class)*

int	p_acep;
int *	status;
int *	function;
int *	gtype;
int *	gnr;
int *	gsize;
int *	objlength;
bool *	persist;
bool *	static;
int *	priority_class;

10.5.3 agmrs

Function:	Return a Response on a received Group Management Indication.

Call:

void agmrs *(p_acep, function, gtype, gnr, cf, result, status)*

int	p_acep;
int	function;
int	gtype;
int	gnr;
int *	cf;
rr_values	result;
int *	status;

10.5.4 agmc

Function:	Receive a Confirmation on a transmitted Group Management Request.

Call:

void agmc *(p_acep, status, function, gtype, gnr, cf, result)*

int	p_acep;
int *	status;
int *	function;
int *	gtype;
int *	gnr;
int *	cf;
rr_values *	result;

10.6 GROUP DEFINITION

10.6.1 adgrq

Function:	Transfer a Group Definition Request to the remote User.

Call:

void adgrq	*(p_acep, gtype, gnr, index1, index2, objid, <u>status</u>)*
int	p_acep;
int	gtype;
int	gnr;
int	index1;
int	index2;
octets *	objid;
int *	status;

10.6.2 adgi

Function:	Receive a Group Definition Indication from remote User.

Call:

void adgi	*(p_acep, size, <u>status</u>, <u>gtype</u>, <u>gnr</u>, <u>index1</u>, <u>index2</u>, <u>objid</u>)*
int	p_acep;
int	size;
int *	status;
int *	gtype;
int *	gnr;
int *	index1;
int *	index2;
octets *	objid;

10.6.3 adgrs

Function: Respond to a received Group Definition Indication.

Call:

void adgrs (p_acep, gtype, gnr, index1, index2, cf, result, status)

```
int        p_acep;
int        gtype;
int        gnr;
int        index1;
int        index2;
int *      cf;
int *      result;
int *      status;
```

10.6.4 adgc

Function: Receive a Confirmation on a transmitted Group Definition Request.

Call:

void adgc (p_acep, size, status, gtype, gnr, index1, index2, cf, result)

```
int        p_acep;
int        size;
int *      status;
int *      gtype;
int *      gnr;
int *      index1;
int *      index2;
int *      cf;
int *      result;
```

10.7 READOUT OF GROUP DEFINITION

10.7.1 aggrq

Function:	Request the remote User for a specific Group Definition.

Call:

void aggrq	*(p_acep, gtype, gnr, index1, index2, status)*
int	p_acep;
int	gtype;
int	gnr;
int	index1;
int	index2;
int *	status;

10.7.2 aggi

Function:	Receive an Indication on a Request for a Group Definition readout.

Call:

void aggi	*(p_acep, status, gtype, gnr, index1, index2)*
int	p_acep;
int *	status;
int *	gtype;
int *	gnr;
int *	index1;
int *	index2;

10.7.3 aggrs

Function:	Return a readout of requested Group Definition.
Call:	
void aggrs	(p_acep, gtype, gnr, persist, static, priority_class, gsize, index1, index2, objlength, objid, result, status)
int	p_acep;
int	gtype;
int	gnr;
bool	persist;
bool	static;
int	priority_class;
int	gsize;
int	index1;
int	index2;
int	objlength;
octets *	objid
rr_values	result;
int *	status;

10.7.4 aggc

Function:	Receive a requested Group Definition readout.
Call:	
void aggc	*(p_acep, size, status, gtype, gnr, persist, static, priority_class, gsize, index1*, index2, objlength, objid, result)
int	p_acep;
int	size;
int *	status;
int *	gtype;
int *	gnr;
bool *	persist;
bool *	static;
int *	priority_class;
int *	gsize;
int *	index 1;
int *	index2;
int *	objlength;
octets *	objid;
rr_values *	result;

10.8 INFORMATION TRANSFER

10.8.1 aitrq

Function:	Request the remote User for information from a Group.

Call:

void aitrq	*(p_acep, gtype, gnr, index1, index2, to, dt, t_unit, periods, status)*
int	p_acep;
int	gtype;
int	gnr;
int	index1;
int	index2;
int *	to;
int	dt;
int	t_unit;
int	periods;
int *	status;

10.8.2 aiti

Function:	Receive an Init Transfer Indication.

Call:

void aiti	*(p_acep, status, gtype, gnr, index1, index2, to, dt, t_unit, periods)*
int	p_acep;
int *	status;
int *	gtype;
int *	gnr;
int *	index1;
int *	index2;
int *	to;
int *	dt;
int *	t_unit
int *	periods;

10.8.3 adtrq

Function: Transfer one group of information from a group to the remote user or indicate an erroneous initiation of data transfer.

Call:

void adtrq *(p_acep, gtype, gnr, transmod, index1, index2, t, more_d, data, length, result, status)*

```
int            p_acep;
int            gtype;
int            gnr;
int            transmod;
int            index1;
int            index2;
int *          t;
bool           more_d;
octets *       data;
int            length;
rr_values      result;
int *          status;
```

10.8.4 adti

Function: Receive information from a (sub)group or an error indication from the remote User.

Call:

void adti *(p_acep, size, status, gtype, gnr, transmod, index1, index2, t, more_d, data, length, result)*

```
int            p_acep;
int            size;
int *          status;
int *          gtype;
int *          gnr;
int *          transmod;
int *          index1;
int *          index 2;
int *          t;
bool *         more_d;
octets *       data;
int *          length;
rr_values *    result;
```

10.8.5 acdrq

Function: Confirm the reception of the last ADTI in a sequence of ADTIs received from the remote User, or report an error situation.

Call:

void acdrq (p_acep, gtype, gnr, transmod, result, status)

```
int            p_acep;
int            gtype;
int            gnr;
int            transmod;
rr_values      result;
int *          status;
```

10.8.6 acdi

Function: Receive a Confirm Data Indication.

Call:

void acdi (p_acep, status, gtype, gnr, transmod, result)

```
int            p_acep;
int *          status;
int *          gtype;
int *          gnr;
int *          transmod;
rr_values *    result;
```

10.8.7 asmrq

Function: Request the remote User to start or stop spontaneous information transfer.

Call:

void asmrq (p_acep, function, gtype, gnr, status)

```
int            p_acep;
int            function;
int            gtype;
int            gnr;
int *          status;
```

10.8.8 asmi

Function: Receive a Spontaneous Management Indication.

Call:

void asmi *(p_acep, status, function, gtype, gnr)*

int	p_acep;
int *	status;
int *	function;
int *	gtype;
int *	gnr;

10.8.9 asmrs

Function: Respond to a received Spontaneous Management Indication.

Call:

void asmrs *(p_acep, function, gtype, gnr, result, status)*

int	p_acep;
int	function;
int	gtype;
int	gnr;
rr_values	result;
int *	status;

10.8.10 asmc

Function: Receive a Spontaneous Management Confirmation.

Call:

void asmc *(p_acep, status, function, gtype, gnr, result)*

int	p_acep;
int *	status;
int *	function;
int *	gtype;
int *	gnr;
rr_values *	result;

10.8.11 actrq

Function:	Transfer one Command or Setpoint Data Block to the Remote Side.

Call:

void actrq	*(p_acep, gtype, gnr, index1, index2, t, time_mode, com_type, data, length, status)*
int	p_acep;
int	gtype;
int	gnr;
int	index1;
int	index2;
int *	t;
int	time_mode;
int	com_type;
octets *	data;
int	length;
int *	status;

10.8.12 acti

Function:	Receive one Command or Setpoint Data Block from the Remote Side.

Call:

void acti	*(p_acep, size, status, gtype, gnr, index1, index2, t, time_mode, com_type, data, length)*
int	p_acep;
int	size;
int *	status;
int *	gtype;
int *	gnr;
int *	index1;
int *	index2;
int *	t;
int *	time_mode;
int *	com_type;
octets *	data;
int *	length;

10.8.13 actrs

Function: Respond to one Command or Setpoint Data Block.

Call:

void actrs	*(p_acep, gtype, gnr, index1, index2, t, time_mode, com_type, data, length, result, status)*
int	p_acep;
int	gtype;
int	gnr;
int	index1;
int	index2;
int *	t;
int	time_mode;
int	com_type;
octets *	data;
int	length;
rr_values	result;
int *	status;

10.8.14 actc

Function: Receive an A-Command-Transfer Confirmation Data Block from the RTU side.

Call:

void actc	(p_acep, size, status, gtype, gnr, index1, index2, t, time_mode, com_type, data, length, result)
int	p_acep;
int	size;
int *	status;
int *	gtype;
int *	gnr;
int *	index1;
int *	index2;
int *	t;
int *	time_mode;
int *	com_type;
octets *	data;
int *	length;
rr_values *	result;

10.8.15 amdrq

Function:	Send Spontaneous Mixed Data.

Call:

void amdrq	*(p_acep, t, data, length, <u>status</u>)*
int	p_acep;
int *	t;
octets *	data;
int	length;
int *	status;

10.8.16 amdi

Function:	Receive Mixed Data Indication.

Call:

void amdi	*(p_acep, size, <u>status</u>, <u>t</u>, <u>data</u>, <u>length</u>)*
int	p_acep;
int	size;
int *	status;
int *	t;
octets *	data;
int *	length;

10.8.17 amderq

Function:	Report that an error is detected in the Data Field of a received AMDI.

Call:

void amderq(p_acep, gnr, result, <u>status</u>)

int	p_acep;
int	gnr;
rr_values	result;
int *	status;

10.8.18 amdei

Function:	Report that an error is detected in the Data Field of a received AMDI.

Call:
void amderq(p_acep, gnr, result, <u>status</u>)

int	p_acep;
int	gnr;
rr_values	result;
int *	status;

10.9 TEST CONNECTION

10.9.1 atcrq

Function:	Test that the remote User can be reached and is alive.

Call:

void atcrq	*(p_acep, <u>status</u>)*

int	p_acep;
int *	status;

10.9.2 atci

Function:	Receive an A-Test-Connection Indication.

Call:

void atci	*(p_acep, <u>status</u>)*

int	p_acep;
int *	status;

10.9.3 atcrs

Function:	Respond to a received A-Test-Connection Indication.

Call:

void atcrs	*(p_acep, result, <u>status</u>)*
int	p_acep;
rr_values	result;
int *	status;

10.9.4 atcc

Function:	Receive an A-Test-Connection Confirmation.

Call:

void atcc	*(p_acep, <u>status</u>, <u>result</u>)*
int	p_acep;
int *	status;
rr_values *	result;

10.10 EVENT WAITING PROCEDURES

10.10.1 aswait

Function:	Wait for some event significant to the User on a given ACEP.

Call:

void aswait	*(p_acep, timeout, <u>status</u>, <u>event</u>)*
int	p_acep;
int	timeout;
int *	status;
int *	event;

10.10.2 agwait

Function:	Wait for some event significant to the User on any ACEP.

Call:

void agwait	*(entity_id, timeout, <u>status</u>, <u>u_acep</u>, <u>event</u>)*
int	entity_id;
int	timeout;
int *	status;
int *	u_acep;
int *	event;

11 SUPERVISOR GUIDE

The ELCOM-90 Supervisor is a user tool to control and supervise the ELCOM-90 provider process.

The Supervisor program is menu-based and provides the user with context-sensitive help on the various functions.

The ELCOM-90 supervisor includes the following functions:

- Start/Stop/Restart of the A- and P-providers. (Only Unix)
- Control of the Log system
- Control of the Trace system
- Display of Status and Configuration information.
- Forced Disconnect of individual connections.

The start function uses shell script to start the provider process.

The control of the log system involves not only turning the log function on or off, but enables the user to select decode levels for interpretation of the logged information.

The trace function enables the user to turn the trace on or off and to select wanted trace level.

The configuration and status functions display information regarding configuration (compile date, maximum number of UACEPs etc.) and status information (the number of active UACEPs, and what state they are in etc.).

The user can terminate one specific connection with the forced disconnect menu option.

11.1 USER INTERFACE

When the Supervisor is invoked it will run as a Menu Oriented Full Screen application.

The supervisor is started in a command shell (Unix) or cmd window(Windows) by moving to the supervisor's "home" directory and executing the command:

superv

The menu system only supports one type of menu orientation, that is horizontal menus: On top of the screen one line contains a list of commands available. A command is executed by moving the cursor to that command and press *ENTER* or *DOWN*, or by typing the first characters of the command. The command may lead to another line of commands on the next line (several levels of commands), or that the command is executed. The command name that is executed is highlighted.

11.2 MMI FUNCTIONS

11.2.1 Functions

The ELCOM-90 Supervisor will supply the user with the following functions:

- Start the providers (Only Unix)
- Stop the providers (Only Unix)
- Reset the providers
- Forced Disconnect of individual connections
- Display of Status and Configuration information
- Start the Log
- Stop the Log
- Close the Log
- Decode the Log
- Change the Trace Level
- Start the Trace
- Stop the Trace.

These functions will now be described in more detail, as they appear in the command tree.

11.2.2 Start of the providers (Only Unix)

Start providers assures a correct sequenced start of the A- and P-providers.

The Supervisor tries to start the A/P-provider by "Kicking off" a script which again starts the provider process. The Supervisor then sends a "RESET-ENTITY" message on the IPC-port to the provider. It waits a certain time for an acknowledge from the provider. If no acknowledge is received, an error message is displayed.

If the provider is already running, this will be indicated.

If the provider is not started correctly, and the reason is not indicated when the script is run, the process will write error information to a standard error file. The Supervisor may then automatically display the last few lines of that error file indicating the type of error which has occurred. This could in some cases lead to some confusion on your screen or window.

11.2.3 Stop the providers (Only Unix)

Stop Providers will stop the provider process. The command is located on level 2 in the command tree under the *PROVIDER-CONTROL* level 1 command.

Before the process is stopped, the providers will take the following actions to stop ongoing activity:

- Deactivate all active timers
- Detach PCEP's ("forced")
- Send A-P-ABORT to all ACEP's
- Close LOG-files
- Close TRACE-files.

The Supervisor first checks if the provider is up and running. If this condition is true, it sends a special stop request to the provider. If the provider is not able to respond to the stop request for one reason or another, the Supervisor stops the provider process abruptly.

11.2.4 Reset the providers

Reset providers sets the providers back to initial state. The command is located under the *PROVIDER*-CONTROL level 1 command in the command tree.

The Supervisor sends a "RESET-ENTITY" command to the provider, which takes the following actions:

- Disconnect network connections.
- Deactivate all active timers
- Stop data transfer
- Initialize data
- Close LOG-files
- Close TRACE-files.

Reset is only allowed if the provider process is active.

11.2.5 Forced Disconnect

On invoking the *FORCED-DISCONNECT* command the user is prompted to input the UACEP number to be disconnected. The command is located under the *PROVIDER-CONTROL* level 1 command.

The Supervisor sends a "*FORCED-DISCONNECT"* command to the provider, which in turn terminates the specified connection. If no connection exist with the UACEP number specified by the user or an error occurs during the execution of the command, a message will be displayed to notify the user.

The information needed to "kill" a specific connection will be available to the user through the "Status" command (ref. 7.2.6.).

11.2.6 Status information

The Status function will display information regarding to either the A- or the P-provider. The command is divided on level 2 in an *A-PROVIDER* and an *P-PROVIDER* option. On level 3 the user can select *ASAP* or *PACEP* under the *A-PROVIDER* level 2 command and *PSAP* or *PPCEP* under the *P-PROVIDER* level 2 command.

The *ASAP* command will display the following information:

- User Entity identifier
- Number of *PACEP's*

The *PACEP* command will display the following information:

- *PACEP* identifier
- State
- Substate

The *PSAP* command displays:

- *PSAP* identifier
- Service User Entity - identifier (A-Provider)
- Number of *PPCEP*'s

The *PPCEP* command displays:

- *PPCEP* identifier
- State
- Connection type
- *PPCEP* blocked up to A. That is, if the A-Provider of flow-control reasons have blocked the P-provider from sending more information up.
- *PPCEP* blocked down to transport/network. That is, if the P-provider has attempted to send data to the lower layer, and the lower layer has refused to accept the data, the P-Provider will block the A-Provider from sending more data down to the P-Provider.

The information described above will be presented to the user in the INPUT/OUTPUT field.

11.2.7 Configuration information

Invocation of the Configuration function will present to the user the A- and P-providers configuration data. The commands are invoked by choosing either the *A-PROVIDER* or *P-PROVIDER* command from the menu under the *CONFIG* level 1 command.

A-PROVIDER will display various Application entity information, and *P-PROVIDER* will display the state time limits and connections related to the Presentation Entity.

The configuration information for the A- and P-providers will be presented to the user in the INPUT/OUTPUT field.

11.2.8 Log

By activating the log function the user can initiate, stop and decode the logging of events.

- Start log initiates logging of the desired provider (A or P). Current log state is reported in a supervisory field. A- and P-provider use separate log files.

- Stop log disables (ongoing) logging of the A- and P-provider respectively. The corresponding log file is not closed, which makes it possible to restart logging without destroying the file content, ie. execute start log.

- Close log disable logging and closes the corresponding log file. The log file content can be converted by DECODE log.

- DECODE log formats the log file content into readable form. On the two first lines in the INPUT/OUTPUT field the user is asked to input the names of the files were the information to be decoded is located and where the decoded information is to be stored. In the lower part of the input/output area the user selects what information he wants extracted from the log file.

To know what to select from the log file, it might be useful to study more closely the possibilities that exists.

A typical log block is built up in the following manner:

```
Event occurred   :   P-Attach                                Ppcep:0
Time             :   8.15.47 ( e.t. 7999 )       Date: 24.10.91
State-change     :   sta1 : Idle ==> sta2 : Ready for connect
Message dump     :   0  56  0  1  98  98  0  2  0  2  0  14
```

The information under the message dump heading always relates to the event on the first line.

The content of the log block tells the user what event happened, on what PPCEP the event happened at what time/date it happened, what state change the event led to and what information the package contained. The numbers presented in the parentheses immediately following the time, represent an internal millisecond counter. This is added to help the user distinguish between log blocks received on the same second. In the example below the log block also contains the events that was generated in the "upwards" and the "downwards" direction, as a result of the incoming event. The field "TLI-error" will contain the currently active text reference to the value in the system variable t_error.

```
Event occurred     :   P-Connect request                PPCEP: 1
Time               :   8.15.51 ( e.t. 8445 )           Date: 24.10.91
State.change       :   sta2: Ready for connect ==> sta3: Establishing lower level
Ppenerated         :   P-Connect request answer        Ngenerated: Network Connect VC request
TLI-error          :   No message currently available
Message dump       :   0  58  0  1  17  130  0  2  23  109  130  67
                       46  51  0  0  0  0  0  0  0  0  0 ..........
```

The user can select to decode one, several or all the different events that have occurred in the two providers in the input field under the decode command. To decode all of the events the user answers yes(Y) on the line "All Information: N", to decode only the log blocks that contain an error, the user answers yes (Y) on the line "All log blocks with error code unequal zero: N". On the next lines the user can select one or several of the PPCEP, P-PDU and P-SDU identifiers, alone or separated by a comma. If the user wants to decode all log blocks related to PPCEP's 1,2,3 and 4, he would have to write after the heading "All log blocks for this set of PPCEP's":   " 1,2,3,4" or "1:4". In general, commas are used to separate single numbers and colon is used to indicate a range of values.

The following P-PDU ID values can be selected from the Supervisor/P-provider log decode function:

0	:	Connect Request/ Connect Indication
1	:	Connect Response/ Connect Confirmation
2	:	Release Request/ Release Indication
3	:	Release Response/ Release Confirmation
8	:	Data Request/ Data Indication

The following P-SDU ID values can be selected from the Supervisor/ P-provider log decode function:

56 :	Presentation Attach
57 :	Presentation Detach
58 :	Presentation Connect request
59 :	Presentation Connect indication
60 :	Presentation Connect response
61 :	Presentation Connect confirm

62 : Presentation Release request
63 : Presentation Release indication
64 : Presentation Release response
65 : Presentation Release confirm
66 : Presentation Provider Abort
67 : Presentation Data request
68 : Presentation Data indication
69 : Presentation Data acknowledge

The following N.SDU ID values can be selected from the Supervisor/ P-provider log decode function:

8 : Network Connect VC request
9 : Network Connect VC indication
10 : Network Connect VC response
11 : Network Connect VC confirm
12 : Network Disconnect VC request
13 : Network Disconnect VC request failure
14 : Network Disconnect VC indication
15 : Network Data request
16 : Network Data request failure
17 : Network Data indication
18 : Network Data Accept request
19 : Network Data Accept request failure
20 : Network Data Accept indication
21 : Network Reset request
22 : Network Reset indication
23 : Network Reset response
24 : Network Reset confirm

By choosing the A.PROVIDER option under the "LOG" heading, the user is presented a similar screen to that of the P-PROVIDER option.

PROVIDER-CONTROL	STATUS	CONFIG	LOG	TRACE	QUIT	[Level 1]
A-PROVIDER	P-PROVIDER					[Level 2]
!START	!STOP	!CLOSE	**DECODE**			[Level 3]

Input file name to decode: **/usr/elcom90/testvers/bin/ap-log.dat**
Input file name to write decoded information: **ap-log.txt**

Selection Criteria:

All Information: **N**
All log blocks with error unequal zero: **N**

All log blocks for this set of PACEP's:
All log blocks for this set of A-PDU's:
All log blocks for this set of A-SDU's:
All log blocks for this set of P-SDU's:

```
_______General Status Information_____________________________________________
Log - A: OFF          Trace: ON                   |      Provider: RUNNING
Log - P: OFF          Trace Level:  3             |      Connection to Providers: UP
______________________________________________________________________________
```

The following A-PDU ID values can be selected from the Supervisor/ A-provider log decode function:

1	:	Group Management Request
2	:	Group Management Response
4	:	Connect Request
5	:	Connect Response
8	:	Define Group Request
9	:	Define Group Response
10	:	Get Group Request
11	:	Get Group Response
16	:	Spont-Mgnt Request
17	:	Spont-Mgnt Response
24	:	Init Transfer
32	:	Send Data
33	:	Confirm Data
34	:	Send Mixed-Data Request
35	:	Send Mixed-Data Error Request
46	:	Command Transfer Request
47	:	Command Transfer Response
64	:	Test Connection Request
65	:	Test Connection Response
255	:	Error PDU

The following A-SDU ID values can be selected from the Supervisor/A-provider log decode function:

3	:	Application Attach
4	:	Application Detach
5	:	Application Connect request
6	:	Application Connect indication
7	:	Application Connect response
8	:	Application Connect confirm
9	:	Application Release request
10	:	Application Release indication
11	:	Application Release response
12	:	Application Release confirm
13	:	Application Release abort
14	:	Application Group-Mgnt request
15	:	Application Group-Mgnt indication

16	:	Application Group-Mgnt response
17	:	Application Group-Mgnt confirm
18	:	Application Def-Group request
19	:	Application Def-Group indication
20	:	Application Def-Group response
21	:	Application Def-Group confirm
22	:	Application Get-Group request
23	:	Application Get-Group indication
24	:	Application Get-Group response
25	:	Application Get-Group confirm
26	:	Application Init-Transfer request
27	:	Application Init-Transfer indication
28	:	Application Data-Transfer request
29	:	Application Data-Transfer indication
30	:	Application Confirm-Data request
31	:	Application Confirm-Data indication
32	:	Application Spontan-Mgnt request
33	:	Application Spontan-Mgnt indication
34	:	Application Spontan-Mgnt response
35	:	Application Spontan-Mgnt confirm
36	:	Application Test-Connection request
37	:	Application Test-Connection indication
38	:	Application Test-Connection response
39	:	Application Test-Connection confirm
40	:	Application Command-Transfer request
41	:	Application Command-Transfer indication
42	:	Application Command-Transfer response
43	:	Application Command-Transfer confirm
44	:	Application Mixed-Data request
45	:	Application Mixed-Data indication
46	:	Application Mixed-Data-Error request
47	:	Application Mixed-Data-Error indication
48	:	Application Timeout
49	:	Application user ack
50	:	Application provider ack

In addition the P-SDU's that are mentioned earlier can be selected. The Decode Log commands can only be invoked after the corresponding Log file is closed.

11.2.9 Trace

The Trace function enables the user to turn trace on and off and to set trace levels.

11.2.9.1 Change Trace Level

The commands are used to change the current trace level for the providers. The commands will cause a signal to be sent to the providers. A designated signal handling routine change the internal value of the Trace level in the provider.

Default Trace level is 1. (Trace level 1 is the "lowest" trace level, giving the smallest amount of data output).

Trace levels can be turned up and down during Trace sessions.

11.2.9.2 Start Trace

The "TRACE ; START" command enable the Trace function for the providers. The provider will make a Trace output corresponding to the current Trace level (which can be the default value or a modified value). The output is made to the file "tracefile" located on the providers "home" directory.

The providers will output information in ASCII format, which allows the user to inspect the trace information directly, for example with the UNIX function "tail -f".

If a Start Trace command is given to a provider for which trace is already active, this will be indicated.

11.2.9.3 Stop Trace

The "TRACE ; STOP" command is used to disable Trace session. The command will turn the Trace off by sending a command to the provider, and close the corresponding Trace file. A Stop Trace command will not affect the Trace level.

A Stop Trace command is only valid if Trace is active for the given provider.

11.2.10 Quit

This functions exits the user to the operating system shell.

12 APPLICATION AND PRESENTATION PROVIDER

The application and presentation providers are implemented as one single process, which handles the specified function of the A- and P-protocol. The process is called 'e90'.

As stated in chapter 1, there are tools available to control the providers' behaviour during runtime;

- the log system
- the event trace system
- error messages

12.1 THE LOG SYSTEM

The log is started and stopped by the ELCOM-90 supervisor (see chapter 7).

The log system gives an output of each event or message sent or received by the A- or P-provider. The events are registered by event type, date/time, connection identity, event generated upwards/downwards, state changes caused by the event, errors occurred during event processing and a message dump.

The status of the log system (as seen in the status field of the Supervisor) can be *on, off* or *closed*. The meaning of these states is explained below in a brief description of the functions to control the log system.

The adaptation process has no log facility.

<u>Start Log</u>
Starts a log session. The provider sets the status of the log system to *on*. The result of the command depends on the current log status. If the log system is *closed* the provider opens the log file and enable as new log session. If the log system is *off*, the provider resumes the current session without destroying the information previously written to the file.

<u>Stop Log</u>
Stops a log session. The provider will set the status of the log system of *off*. The log file will not be closed, allowing the user to restart the log session without destroying the contents of the log file (refer Start Log).

<u>Close Log</u>
Stops a log session and closes the log file for the provider. The provider sets the status of the log system to *closed*. If a start command is issued after a close command, the contents of the log file will be overwritten.

<u>Decode Log</u>

Decodes the information in the log file and writes the decoded information to a file, which then can be printed. The status of the log system must be *closed* before the Decode Log command can be invoked.

12.2 THE EVENT TRACE SYSTEM

The trace system is a levelled debugging facility used in the providers, A-lib and the adaptation process. Calls to the trace system are implemented as a macro which includes code to print trace information only if the constant *TRACE_ON* is defined (can be done by a compiler option).

The trace system is typically used to print additional information when serious errors or unexpected situations occur and to print information to indicate when parts of the code is executed.

Five trace levels are defined:

1. Additional information by error conditions.
2. Various information (low output volume).
3. Various information (medium output volume).
4. Routine names (printed at routine entry).
5. Routine names and parameters (printed at routine entry and exit).

In the adaptation process the three lowest levels trace levels have more specific meaning:

1. Used primarily when connections are blocked/unblocked (ie. flow-control changes).
2. Exchanged AD PDUs between the P-provider and the adaptation process.
3. TLI calls and network specific calls.

The volume of printed information increases with the level number (Level 1 represents lowest volume, Level 5 highest). Default level is 1. When the trace system is turned on, information for current trace level and lower trace levels will be printed. The status of the trace system is displayed in the Supervisor status field.

The trace information is written to designated files; one for the provider (*tracefile*) and one for the Application Programming Interface Library (*alib-trace*). All information is in readable form (ASCII) and can be inspected continuously be means of the UNIX command *tail* (with option -f).

Trace for the providers can be controlled by a set of Supervisor commands:

Start Trace
Starts a trace session. A Start-Trace command is sent to the provider. The provider opens the trace file, and enables trace. Finally, the provider sends a response to the Supervisor, which updates the Trace status field on the screen according to the returned status.

Stop Trace
Stop a trace session. The Supervisor sends a Stop-trace command to the provider. The provider disables trace and closes the trace file. A response is then sent to the Supervisor, which updates the trace status on the screen according to the returned status.

Increase Trace Level
This command increases the current trace level in the given provider. The Supervisor invokes *kill* to send a signal to the provider to change the trace level. The signal handling routine in the provider increases a global variable containing the trace level. The use of signals, assures that the change in trace level takes place "immediately".

Decrease Trace Level
The command decreases the current trace level in the given provider. The command is handled analog to "Increase Trace Level".

The A-lib trace can only be controlled by modifying two trace variables (be means of a debugger):

trace_on	0(trace off) / (trace on)
trace_level	1,2,3,4,5

The trace for the adaptation process is controlled by using the *kill* command. The signal *SIGUSR1* is used to increase the trace level, and SIGUSR2 is used to decrease the trace level.

12.3 ERROR MESSAGE

All parts of the ELCOM system use the same procedure to print error messages at the standard error output stream. The format of the error messages is shown below:

Date-and-time Originator (source-file-name, line-number): Error-description Additional information.

Example:
91/11/11 08.45.02 ELCOM AP-COMMON (/usr/elcom90/src/prov-loop.c, line 1532): Unable to create listen SAP. Couldn't allocate address.

The "Error description" in the error messages is fetched from the ELCOM error text file (refer ELCOM configuration variable ELC_ERRFILE) by means of a unique error number. A range of error numbers has been reserved for each part of the ELCOM system. In the ELCOM error text file the allocated error numbers are assigned corresponding texts. The ranges are assigned as follows:

0	-	99	Application Programming Interface Library
100	-	199	Application Provider
200	-	299	Presentation Provider
300	-	399	Supervisor
400	-	449	Timer subsystem
450	-	549	IPC subsystem
550	-	649	AP Common (code common for A- and P-provider)
650	-	719	Adaptation process, general part
720	-	749	Adaptation process, TCP/IP specific part
750	-	769	Adaptation process, X.25 specific part
770	-	799	Adaptation process, ISO Transport specific part

The error number is passed as argument to the routine that prints error messages, which translates the number to the corresponding text by using the ELCOM error text file.

Error messages from A-lib deserve a special comment. Normally, errors occurring in A-lib are only reported to the caller by means of the status argument in the calls to the library.

Since error messages are printed to the standard error output stream they can easily be redirected to a file.

Unix/Linux:

If we for example wanted to print error messages from the ELCOM provider to a file called *e90.err*, we simply start the provider as follows: **e90 2>e90.err**

Windows:

The file elcman.ini configures the name of the Elcom error message file.

APPENDIX A: ADDRESS FORMATS

The length of the parameters **Initiator** and **Acceptor** as used in ACONRQ/aconrq, ACONI/aconi, ACONRS/aconrs and ACONC/aconc is defined to be (**x+1**)+**(y+1**) octets, where x is the number of octets in the lower part of the address (network dependant) and y is the number of octets in the A suffix (max 2).

The format of the Initiator and Acceptor when TCP/IP is used as shown in the following table where one element represents one octet:

x=length of lower part (=17)
TCP_ID (= 82 hex)
AF_INET part one (= 0)
AF_INET part two (=2)
port no. (1. octet)
port no. (2. octet)
ip address (1. octet)
ip address (2 octet)
ip address (3. octet)
ip address (4. octet)
0
0
0
0
0
0
0
0
y=length of A-suffix (= 2)
A-suffix (1. octet)

A-suffix (2. octet)

For X.25 there are two legal formats.

Most used for X.25 is the old ELCOM 83 format:

Octet 1	x=length of lower level part
	DTE-no digit 1 (ASCII)
	DTE-no digit 2 (ASCII)
	. . .
	DTE-no digit x (ASCII)
	y=length of A-suffix (=2)
	A-suffix octet 1 (ASCII)
Octet x + y + 2	A-suffix octet 2 (ASCII)

In the new X.25 format the address information is sent as BCD digits (ie. in the way X.25 expects it). The lenght of the call address field is in number of bytes. If there is an odd number of BCD digits, the last nibble of the last byte has the value of 0xF (hex), which is the "padding value".

Octet 1	x=length of lower part	
	x=25_ID (= 80 hex)	
	DTE-no digit 1. (BCD)	DTE-no digit 2. (BCD)
	DTE-no digit 3. (BCD)	DTE-no digit 4. (BCD)
	. . .	. . .
	DTE-no digit n-1	DTE-no digit n (or 0xF)
	y=length of A-suffix (=2)	
	A-suffix octet 1 (ASCII)	

Octet x + y + 2	A-suffix octet 2 (ASCII)

APPENDIX B: X.25 CONFIGURATION ON ALPHA/TRU64

When installing X.25 under Tru64 a Filter and a Template for ELCOM has to be defined. This is done using /user/sbin/wansetup advanced. The necessary parameters will then be inserted in x25startup.ncl. Example:

```
create node 0 x25 access filter ELCOM
set node 0 x25 access filter ELCOM priority 1100
set node 0 x25 access filter ELCOM call data value %x454c434f4d2d3833 -
   , call data mask %xffffffffffffffff
set node 0 x25 access filter ELCOM security filter Default
create node 0 x25 access template ELCOM
set node 0 x25 access template ELCOM dte class datapak_n
set node 0 x25 access template ELCOM call data %x454c434f4d2d3833
set node 0 x25 access template ELCOM packet size 256
set node 0 x25 access template ELCOM window size 7
set node 0 x25 access template ELCOM -
   throughput class request [0..0]
set node 0 x25 access template ELCOM reverse charging false
set node 0 x25 access template ELCOM fast select not specified
set node 0 x25 access template ELCOM charging information false
set node 0 x25 access template ELCOM transit delay selection 0
set node 0 x25 access template ELCOM end-to-end delay [0..0]
set node 0 x25 access template ELCOM expedited data not specified
set node 0 x25 access template ELCOM nsap mapping false

enable node 0 x25 access application  ELCOM
```

APPENDIX C: LEGACY ROUTE FILE FORMAT

The original e90 provider design used TLI as a transport API, with a configuration file (typically called elc-route) specifying mapping of target addresses to TLS devices. With the current sockect-based implementation, this functionality is not available, but some X.25 adaptation implementations still use the route file. This appendix contains the documentation for the route function.

Selection of outgoing lines

The P-provider will be able to use several transport protocols at the same time. In addition it is necessary to select the right device/controller. One machine may have two X.25 lines - one for a private X.25 network and one for a public X.25 network. The P-provider must know which goes where.

The P-provider will read an *address routing file* at system startup. The table will contain the relationship between the transport protocol address and the TLI or sockets main device (i.e. device/controller) the P-provider shall use. The address can be specified in a hierarchical way. It is thus possible to direct traffic to a different address over another X.25 line. The same principle applies to TCP/IP. Traffic to one subnetwork can be sent via one Ethernet controller while traffic to another sub network can be sent via another (Ethernet/FDDI/token ring) controller.

There are two routing tables; the primary routing table and the secondary routing table. The P-provider will first check the primary routing table for match. If no match is found, it will search the secondary table.

However, with the primary/secondary routing table it is possible to let the P-provider search for a match in the primary routing table and to try to establish a connection via the controller/device indicated. If this fails, the P-provider could search for a match in the secondary routing table and try that one. Then the ELCOM provider would automatically switch to a fall-back solution if the primary route fails. (See section 4.2.2 for details on the address routing file).

The adaptation process will use the routing tables if necessary. This depends on the product used. Some products offer similar functionality (e.g. Sun X.25). The routing file is not used for such products.

Configuration variables defined in elc-route

The file elc-route shows the routing tables for different protocol stacks and addresses. The file shows primary and secondary routes which will be kept in separate tables initiated at P-provider startup time.

NOTE: For SUN-OS and Solaris systems this file is not used as routing information. For HP-UX and OSF the elc-route file must be set according to the system (see below).

Below is explained how this file is constructed:

The layout of a line in the address file is as follows:

protocol_type:format,address,device

format:	=	[b | d] ** b: Binary (default) ** d : binary coded Decimal (BCD)
protocol_type :	=	[X.25 | ISOT | TCP | ISOA | ISON] ** Corresponds to second octet in the new address format
address :	=	** Address, or part of address
device :	=	** Name to identify the "line" out of the machine for this route (device/controller name, link number etc.).

The address must be specified according to the address format. Binary represented addresses will be interpreted as numbers in the C language with a leading 0x to indicate a hexadecimal number, a leading O (letter 'O') to indicate an octal number, otherwise a decimal number. The punctuation mark '.' is used to separate each octet of a binary address. Addresses in Binary Coded Decimal representation is specified as a sequence of (decimal) digits in the range 0 to 9.

Wildcard ('*' asterisk) can be used for parts of addresses to make several addresses match one address specification in the address file. This is especially useful for non-hierarchical addresses such as TCP addresses (where the port number precedes the IP address; refer example below). Wildcard can be used at any location in the address specification and will be relevant for the given location only (byte or half of a byte depending on format specified).

If the address is omitted, the specified device will be used for all addresses of the given protocol type with no matching preceding lines in the address file ("default route"). The format specified is in this case irrelevant. A default route will be present for all protocol types in use.

The plus sign '+' in the first column indicates the start of secondary route information.

Information after the comment separator '#' will be ignored.

An example of an address file is given below.

```
#
```

```
#               ROUTING TABLE FOR ELCOM-90
#
#               Primary routes:

X.25:d,02624,/dev/X.25/dev1                     # BCD address
X.25:d,04*24,/dev/X.25/dev2                     # BCD address with wildcard
X.25:,,/devX.25/dev0                            # Default X.25 route

TCP:b,0x0.0x2.*.*.130.67.46,/dev/TCP/dev0           # For any port number
TCP:b,0x0.0x2.0x17.0x6d.130.67.46,/dev/TCP/dev0  #Complete address
TCP:,,/dev/tpimux/tcp                               #Default TCP route

+
#               Secondary routes:
TCP:,,/dev/TCP/dev0                                 #Default secondary  TCP route
```

If one route from the system can be used for all addresses for a specific protocol type, only a default specification matching all addresses for the protocol (like the ones shown above) is required.

APPENDIX D: OPEN SOURCE LICENSES

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