ELCOM-90

Protocol Implementation Document (P.I.D.)

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1 Introduction

1.1 Purpose and scope of this document

In projects, in which ipConv shall communicate with systems of other vendors via the ELCOM-90 protocol, each party needs to know the capabilities of the communication partner (a partner can be Initiator, Responder or both) to ensure interoperability. Only the functional units (FUs), which are implemented in the user element (UE) of both partners can be used. These protocol implementation details are specified in the PID (Protocol Implementation Document or Protocol Interoperability Document).

1.2 Intended audience

The intended audience consists of the vendors of ELCOM-90 applications. Readers should be familiar with the ELCOM terms and the overall ELCOM communication concept.

1.3 References

[1] Technical Report No 3701: "ELCOM-90 Application Programming Interface"

[2] Technical Report No 3702: "ELCOM-90 Application Service Definition"

[3] Technical Report No 3703 "ELCOM-90 Application Protocol Specification"

[4] Technical Report No 3704: "ELCOM-90 Presentation Programming Interface"

[5] Technical Report No 3705: "ELCOM-90 Presentation Service Definition"

[6] Technical Report No 3706: "ELCOM-90 Presentation Protocol Specification"

[7] Technical Report No 3825: "ELCOM-90 User Element Conventions"

1.4 Definitions

PID	Protocol Implementation / Interoperability Document
FU	Functional Unit
UE	User Element, please refer to [7] for definition

1.5 Structure of this document

Chapter 2 provides an overview of the total communication system involved and gives an introductory description of the system's main functions and prerequisites. Chapter 3 describes the individual functional units that must be supported, with specific considerations. Chapter 4 describes details regarding event handling, quality codes and time stamps. Chapter 5 contains a listing of system parameter settings and configuration parameters. Chapter 6 contains a functional summary. The list of parameters and objects that will be exchanged between all systems involved, will be given in a separate document.

2 Overview

2.1 OSI model

All connected systems will use the OSI model given in figure 1. Layers 6 and 7 are used by the ELCOM-90 protocol, layer 5 is empty. Layers 3 and 4 are used by the TCP/IP protocol. Layers 1 and 2 are filled by Ethernet and LLC.

OSI Layer	Description	
7 Application	ELCOM-90 user element ELCOM-90 application protocol	ipConv ELCOM-90 Initiator / Responder protocol stack
6 Presentation	ELCOM-90 presentation protocol	
5 Session	(empty)	
4 Transport	TCP	
3 Network	IP	
2 Data Link	IEEE 802.3 (MAC)	
1 Physical	IEEE 802.3 (Ethernet)	

Figure 1: OSI model

2.2 Main functions

All connected ELCOM systems are built from the following basic components:

- ELCOM-90 Protocol, reference implementation or an own implementation

Vendor	Reference Version	Supplier
IPCOMM	NO	IPCOMM

- User Elements that supports version 1 class 3 of the protocol

The User Elements of the individual systems shall work in conformity with their own ELCOM-90 specification and according to [7]. The involved systems shall support all corresponding Initiator and Responder parts of the Functional Units (FUs), and all implemented FUs must operate as described in this document. The next chapter gives an overview of the functional units to be supported by the involved systems as Initiator and Responder.

3 Implementation Considerations

Details and considerations over the implementation of the in [7] described FUs are given in the next paragraphs.

3.1 Permanent association FU

This FU must be supported and will be used by unsolicited data transfer including mixed-data, requested data transfer and supervisory control data transfer.

At the connection phase the Responder system shall send the "timestamp" to the Initiator for consistency check of the groups. The "checksum" is not used and is always 0.

Dual computer handling / redundancy:

In the ipConv system, each protocol stack can be activated or deactivated by a single-point information indication the activity status of the system. Only if the system is active, the Initiator tries to establish TCP/IP connections and the Responder listens for incoming connections. If the system goes to passive mode, all TCP/IP connections are closed. Refer to the documentation of the appropriate protocol stack for further information.

3.2 Dynamic association FU

This FU should be supported and used by the group management and group definition FUs. The test association, see next paragraph, shall also use the dynamic association.

At the (re)connection of the group management and definition association, Initiator checks the validity of the configuration by the "timestamp", which shall be sent by the Responder in the control field. The "checksum" is not used and is always 0.

3.3 Test association FU

This FU must be supported conform table. The test association FU can also be invoked on associations already established for other FUs.

Supplier	Initiator	Responder
IPCOMM	NO	YES

3.4 Group configuration FU

This special FU is only used in an Initiator UE. The Initiator must support this FU in order to enable dynamic group configuration.

The naming (identity) of objects in the ELCOM-90 database of all systems is independent. A "cross reference" table must be used for coupling them.

All involved system, can handle ELCOM-object names which are at least 20 characters long.

When persistent groups are used then the used group numbers shall be mentioned in this paragraph.

Supplier	Persistent groups
IPCOMM	NO

3.5 Group management FU

This FU must be supported and will be used by the Initiator to modify dynamically group attributes in the Configuration Set of the Responder UE.

The following functions are used:

- **create**: create a new group (allocate a new set of attributes with specified values)

- **delete**: delete a single group (deallocate the corresponding set of attributes)

- **delete all groups**: deallocate the set of the attributes for all the groups

The **change group** function is not used, but the following table shows if it is supported:

Supplier	Initiator	Responder
IPCOMM	NO	NO

3.6 Group definition FU

This FU must be supported and will be used by the Initiator to define the object set of a group in the Responder UE.

Only the definition of the group is supported. The redefinition of the group is not done by change group function of the group management FU. If the Initiator system wants to change anything in the configuration set of the Responder for a given group, it must first delete the given group and then create and reconfigure the group. It is necessary to define groups by continuous and increasing index numbers and starting at 1.

3.7 Group Readout FU

This FU must be supported and can be used when persistent groups are involved in the communication.

Supplier	Initiator	Responder
IPCOMM	NO	YES

3.8 Requested Data Transfer FU

This FU shall be supported for activation upon an operator request or to enable the status check function (general interrogation). This FU must be activated by the Initiator system after having received the spontaneous management confirm, in the unsolicited or periodic data transfer FU. This feature must be implemented to establish a consistent data set when the unsolicited or periodic data transfer is started. This FU may be invoked by the Initiator system at any time to get a status check.

This FU must be supported over the association with the AE suffix (requested) according to [7]. This DRFU can also be used over two other communication links with suffices AB (unsolicited) and AC (periodic). The requested data transfer FU (DRFU) must be supported over all three communication links. When the Initiator system does the status check then this shall be done over the communication link with suffix AB for that groups who got permission over that link. The DRFU is not preferred over the communication link with suffix AC because of the restrictions in the ELCOM-90 User Element conventions [7]:

- page 5.2: "DRFU legal only if no Periodic Data Transfer FU invocation is currently active on the association in question"

- page 7.4: "Neither shall the Requested Data Transfer FU be invoked on a given association, if the Periodic Data transfer FU is already running on the same association"

- page 7.26: "Neither shall the Periodic Data transfer FU be running on a given association, if the Requested Data transfer FU is currently running on the same association".

To avoid race situations:

- The Responder must synchronize requested/initiated data transfer and spontaneous data transfer on the same group.

- The general interrogation must be performed upon the connection that is associated with the present group.

Support Requested Data Transfer FU:

Initiator:

Supplier	AB/BB	AC/BC	AE/BE
IPCOMM	NO	NO	YES

Responder:

Supplier	AB/BB	AC/BC	AE/BE
IPCOMM	YES	YES	YES

The following ELCOM-90 group types shall be supported:

- Status, used for representation of one and two bit status information, e.g. breakers

- Real and discrete, used for representation of floating point numbers and accumulator values, e.g. analog and digital measured values.

3.9 Periodically Requested Data Transfer FU

This FU must be supported for Time Tagged Data and Present Data sets but only on an association established with the AE suffix according to [7].

The following ELCOM-90 group types shall be supported:

- Status, used for representation of one and two bit status information, e.g. breakers

- Real and discrete, used for representation of floating point numbers and accumulator values, e.g. analog and digital measured values.

Support Periodically Requested Data Transfer FU:

Supplier	Initiator	Explanation
IPCOMM	NO	not yet implemented

3.10 Periodic Data Transfer FU

This FU must be supported. The Responder is responsible for the timing, therefore it uses a "priority class table". Each group can be configured with the parameter "priority class" which is done by the Initiator. The priority class table consists of 16 entries, which are maintained in the Responder system. Each entry (priority class) corresponded with a time interval. "Priority class" entry 0 shall not be used. The entries 2 until 15 must be filled as follows.

Priority class	Time distance in seconds
0	50
1	5 (minimum time interval)
2	8
3	10
4	12
5	15
6	18
7	20
8	25
9	28
10	30
11	32
12	35
13	40
14	45
15	50

Table 1: Priority class table

This priority class table is configurable as follows and priority class 0 means:

Supplier	Priority = 0 means	Configurable
IPCOMM	50 seconds	Yes, via the built-in web interface (Webconfig)

The following ELCOM-group types shall be supported:

- Status, used for representation of one and two bit status information, e.g. breakers

- Real and discrete, used for representation of floating point numbers and accumulator values, e.g. analog and digital measured values.

3.11 Unsolicited Data and Mixed Data Transfer FU

These FUs must be supported and will be used for transfer of process values. Unsolicited Data is a primary FU and has a secondary FU, the Unsolicited Mixed Data Transfer FU. The use of both FUs are described in this paragraph.

- The unsolicited data transfer is using the A-data service with only one data item with individual timestamp in each transmission. The A-data service can also be used with more data items of the same group, but all with the same timestamp, in the data message. This shall occur without delay as soon as a change of values is reported to the Responder.

- The unsolicited mixed data transfer is using the A-Mixed-Data service where many data values from any group can be packed together. A delay is implemented to buffer up a number of changed values before the transmission occurs. The delay is set by the responding system as a system parameter. The range of 1 to 5 seconds must be supported. **ipConv uses no delay, data is sent as fast as possible.**

The following ELCOM-90 group types shall be supported:

- Status, used for representation of one and two bit status information, e.g. breakers

- Real and discrete, used for representation of floating point numbers and accumulator values, e.g. analog and digital measured values.

The choice of using A-Mixed-Data or A-Data is normally a Responder responsibility and is initiated on base of performance rules. When A-Mixed-Data is used the buffer is sent after a time-out (configurable) or when the buffer is full (buffer length with minimum length of 30). When A-Data is used the buffer is sent immediately. **In the ipConv Elcom-90 Responder protocol stack it is configurable via web interface, whether A-Data or A-Mixed-Data is used.**

With the priority class parameter when ">0" is it possible to make distinction between sending group data by using different priority class values. Priority class 1 is the highest priority and priority class 15 is the lowest. It is recommended to use this priority mechanism in the Responder.

Error handling for A-Mixed-Data and A-Data

When an A-Mixed-Data indication is received with errors by the Initiator, this shall return an A-Mixed-Data-Error request to the Responder. The Responder shall then terminate the association and leave it to the Initiator to re-establish the association and activate the FU as described above. This procedure shall also be used when an A-Confirm-Data-Indication is received in the Responder UE with an error code.

Error handling Initiator and Responder:

Supplier	Initiator	Responder
IPCOMM	ACDRQ or AMDERQ is send No termination of association	Not resending unsolicited A-Data-Request No termination of association

3.12 Supervisory Control Data Transfer FU

This FU must be supported. One-phase (immediate execute) must be and two-phase (check-before-execute) commands may be supported. Setpoints can also be used.

The following rules apply for the use of the service primitives:

- Time Mode shall be set by Initiator to value "argument-not-used"

- All command comm. types must be supported

- Data: Group type *Binary Command* shall be supported. For command transfer only one command object in one invocation of the service.

The desired command value can be sent in the first (CBXC) and/or the second phase (EXC) of the two-phase command when two-phase commands are used.

Support one-phase commands:

Supplier	Initiator	Responder
IPCOMM	YES	YES

Support two-phase commands:

Supplier	Initiator	Responder
IPCOMM	YES	YES

Only the use of one-phase commands can be used, because some supplier do not support two-phase commands.

All the command and setpoint quality codes (see [7]) shall be supported. Unused quality codes:

Supplier	**NOT** used quality codes
IPCOMM	"Object blocked at RTU side"

3.13 Restart Reconfigure FU

This FU must be supported in the Initiator part of the User Elements in order to enable automatic group consistency checks upon start-up of the system. It is also used for recover after communication failures.

Supplier	Initiator
IPCOMM	YES

3.14 Restart Reactivate FU

This FU must be supported in the Initiator part of the User Elements in order to enable automatic restart of unsolicited or periodic data transfer.

Supplier	Initiator
IPCOMM	YES

4 Event Handling

In order to enable the different systems to work together in an efficient way it is necessary to provide some information on how the real-time event handling is performed.

4.1 Event handling for Responder systems

The indication will get the true time stamp of the associated event. If a true timestamp is not available a local timestamp will be added before the ELCOM telegram is sent to the ELCOM-90 Initiator. Then the indication event will be translated to an ELCOM binary status value and sent as A-Data or as A-Mixed-Data where the indication will be inserted into a transmission buffer. When A-Mixed-Data is used the buffer is sent after a timeout or when the buffer is full. When A-Data is used the buffer is sent immediately.

When the A-Mixed-Data is used the first event to be entered into the buffer will get its **timestamp** copied to the T parameter as a complete date and time value. Each consecutive data item will have an additional 16 bit timestamp value which is the number of milliseconds relative to the first element in the buffer. Please refer to [7] appendix A for details. The time values are taken "as it is" from the source, as described above. Thus no time zone or daylight saving time conversion will be done by ELCOM-90. **In ipConv it is configurable whether UTC or local time shall be used.**

When one-bit and two-bit indication values both are used in a vendors SCADA system, they must be correctly mapped on the ELCOM status type (2 bit).

The responder will support relevant **quality codes** according to [7].

The mapping from Responder SCADA flag to the ELCOM quality code for sending to Initiator system for Measure-groups, Status-groups and Discrete groups is listed in table 2.

RESPONDER SCADA flag	Measured OK	Manually entered OK	Estimated	Computed	Held, not OK
IPCOMM	OK	SB (substituted)	-	-	IV (invalid) NT (not topical) BL (blocked)

Table 2: Mapping Responder SCADA flags to ELCOM quality codes

4.2 Event handling for Initiator system

The indications received from ELCOM-90 will be translated from an ELCOM binary status value to an internal status value and stored in the process database.

The **timestamp** of the indication event from the ELCOM-90 telegram will be used to list the event in the SCADA event and alarm lists.

The time values is taken "as it is" from the ELCOM-90 telegram. Thus no time zone or daylight saving conversion will be done by ELCOM-90. **In ipConv it is configurable whether UTC or local time shall be used.**

The received **quality code** values of Responder systems and other defined in [7], will be converted to corresponding SCADA quality flags as follows:

INITIATOR SCADA flag	Measured OK	Manually entered OK	Estimated	Computed	Held, not OK
IPCOMM	OK	SB (substituted)	OK	OK	NT (not topical)

Table 3: Mapping ELCOM quality codes to Initiator SCADA flags

5 Configuration and system parameters

5.1 Configuration parameters each node

ELCOM node name, IP-address and portnumber, version, class and security per connection are mentioned in the table.

Vendor	IP-address(es)	Port number	UE	version / class	security / checksum
IPCOMM		5997	I,R	1 / 3	0 / 0

Table 4: configuration parameters

I = Initiator and R = Responder

Security class is not used. The checksum during consistency check is not used and has always the value 0.

5.2 System parameters

The minimum dimensions are:

Parameter	IPCOMM
maximum number of partners which can be handled	I = 255 R = 255
maximum number of IP addresses per partner	1
maximum numbers of objects per group	255
maximum number of groups for each partner	32767
maximum number of groups as marked spontaneous in the Responder for each partner	32767
total amount of objects	*
maximum length of the ELCOM-90 object identifiers (in characters)	255
time-out period for mixed data transfer in seconds (minimum/maximum)	0.0
one object can be a member of up to x groups	32767

Table 5: system parameters

* See Gateway Performance Chart

5.3 Vendor extended error codes

Elcom uses standard error codes 1-127. When vendors use other or extended error codes then they must be mentioned underneath.

Extended error codes:

Supplier	System-specific error/quality codes
IPCOMM	NONE

6 Functional Summary

Inventory and summary of which user elements (FUs) are used as **INITIATOR**:

Functional Unit	Needed	supported IPCOMM
Permanent association	YES	YES
Dynamic association	YES	YES
Test association	YES	NO
Unsolicited data transfer	YES	YES
Periodic data transfer	YES	YES
Requested data transfer real-time	YES	YES
Requested data transfer historical	NO	NO
Periodically requested data transfer	Possible	NO
Command transfer	YES	YES
* One-phase	YES	YES
* Two-phase	Possible	YES
Setpoint transfer	Possible	YES
Group management	YES	YES
* delete all groups	Possible	YES
* delete group	YES	NO
* change group	NO	NO
* create group	YES	YES
* persistent groups	NO	NO
Mixed data and mixed data error	YES	YES
Group definition	YES	YES
Group readout	NO	NO
Group types		
1 - Real values	YES	YES
2 - Status values	YES	YES
3 - Discrete values	YES	YES
5 - Binary command	YES	YES
6 - Analog setpoint values	YES	YES
7 - Digital setpoint values	YES	YES
Group types		
4 - Logical breaker Status values	NO	NO
8 - Text message	NO	NO

Inventory and summary of which user elements (FUs) are used as **RESPONDER**:

Functional Unit	Needed	supported IPCOMM
Permanent association	YES	YES
Dynamic association	YES	YES
Test association	YES	YES
Unsolicited data transfer	YES	YES
Periodic data transfer	YES	YES
Requested data transfer realtime	YES	YES
Requested data transfer historical	NO	NO
Periodically requested data transfer	YES	YES
Command transfer * One-phase * Two-phase	YES YES YES	YES YES YES
Setpoint transfer	Possible	YES
Group management * delete all groups * delete group * change group * create group * persistent groups	YES YES YES NO YES NO	YES YES YES NO YES NO
Mixed data and mixed data error	YES	YES
Group definition	YES	YES
Group readout	NO	YES
Group types 1 - Real values 2 - Status values 3 - Discrete values 5 - Binary command 6 - Analog setpoint values 7 - Digital setpoint values	 YES YES YES YES YES YES	 YES YES YES YES YES YES
Group types 4 - Logical breaker Status values 8 - Text message	 NO NO	 NO NO