Proprietary Extension for

COMMON-ISDN-API

Version 2.0

Echo Cancellation Support
for Voice Applications

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Eicon Networks

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Motivation: Voice communication applications over CAPI like voice relay or voice over IP systems might have to deal with a substantial delay in the transmission path. In this case even weak echoes where the subscriber on one end hears his delayed own voice are unpleasant. Echoes might originate from 4-wire to 2-wire conversion in the PSTN and from electrical and acoustical coupling within a peer telephone set. The most convenient way to avoid these echoes is to insert a line echo canceller that prevents the audio signal sent to the ISDN line from leaking back to the application.
The following **COMMON-ISDN-API** extension enables an application to activate echo cancellation for telephony connections. Provision was made to support automatic disabling upon detection of the echo canceller disable tone according to G.164 and G.165 in order to allow proper operation of modem and fax devices. Bypassing due to detection of the disabled tone is signaled to the application to allow for further action on this event.

Release notes: The following changes have been incorporated into this document since the first version from 14.3.2000:

- A note has been added to define which type of echo canceller is available through this facility, in which direction it operates and on which kind of connection.
- The position of the echo canceller unit with regard to the DTMF and line interconnect function has been clarified.
- The functions 3 *Freeze echo canceller coefficients*, 4 *Resume echo canceller coefficient update* and 5 *Reset echo canceller coefficients* have been deleted.
- Function 0 *Get supported services* has been added and default values have been defined.
- A short explanation for the non-linear processing option has been added. Non-linear processing must be explicitly enabled now.
- Parameters have been added to enable an application to influence the position of the adaptive echo canceller filter. A fixed pre-delay can be given or, if supported, it can be left up to the **COMMON-ISDN-API** implementation to find the best pre-delay to tightly cover all echo components in the signal.
- A new indication has been added to signal release of echo canceller bypassing.
- The echo cancellation facility has been added at two places in the description of FACILITY_REQ where it was missing in an enumeration of all specified facilities.
- Details from facility selector 5 *Line Interconnect* have been deleted.
- The motivation text has been clarified.

Additional changes since the second version from 30.4.2001:

- The description of the echo canceller position has been clarified. A figure has been added to illustrate the placement.

Additional changes since the third version from 11.5.2001:

- The description of the default of parameter *Tail length in ms* has been refined to explicitly allow a **COMMON-ISDN-API** implementation to determine an appropriate tail length dynamically.

Additional changes since the fourth version from 21.6.2001:

- The message coding has been changed to be more generic and extensible. There is a clear definition now about which parameters applies to which function. The echo canceller information parameter in the FACILITY_CONF has been defined using existing info values.

Additional changes since the fifth version from 23.7.2001:

- Clarified the bit order in the field *Echo canceller disable tone-detection* which is contained in the word *Options* of struct *Echo canceller request parameter* in the case of function 0x0001 (Enable line echo canceller operation).
- The base text taken from the **COMMON-ISDN-API** specification and references to the Line Interconnect facility have been updated according to the 4th edition of the **COMMON-ISDN-API V2.0** document.
- The echo canceller unit has been added to the figures that illustrate the data paths that are switched in the line interconnect block through bits in the *Data path* parameter of the *LI Connect Request Participant* and *LI Request Parameter* struct.
- Adapted the code points to the latest list of approved **COMMON-ISDN-API** extensions.
- Deleted parts of the base text that are not related to the echo canceller.

4.2.2.7 CAPI_GET_PROFILE

Applications call CAPI_GET_PROFILE to retrieve capability information from **COMMON-ISDN-API**. **COMMON-ISDN-API** copies information about implemented features, the total number of controllers and protocols supported by the requested controller to a 64-byte buffer passed by the calling application. The application must ignore unknown bits. **COMMON-ISDN-API** sets every reserved field to zero. CAPI_GET_PROFILE fills the buffer with the following structure:

Type	Description
2 bytes	Number of installed controllers, least significant byte first
2 bytes	Number of supported B-channels, least significant byte first
4 bytes	Global Options (bit field): [0]: Internal controller supported [1]: External equipment supported [2]: Handset supported (external equipment must also be set) [3]: DTMF supported [4]: Supplementary Services (see Part III) [5]: Channel allocation supported (leased lines) [6]: Parameter *B channel operation* supported [7]: Line Interconnect supported [8]: Broadband Extensions supported [9]: Echo cancellation supported [10]...[31]: reserved
4 bytes	B1 protocol support (bit field): [0]: 64 kbit/s with HDLC framing, always set. [1]: 64 kbit/s bit-transparent operation with byte framing from the network [2]: V.110 asynchronous operation with start/stop byte framing [3]: V.110 synchronous operation with HDLC framing [4]: T.30 modem for fax group 3 [5]: 64 kbit/s inverted with HDLC framing. [6]: 56 kbit/s bit-transparent operation with byte framing from the network [7]: Modem with all negotiations [8]: Modem asynchronous operation with start/stop byte framing [9]: Modem synchronous operation with HDLC framing [10]...[31]: reserved
4 bytes	B2 protocol support (bit field): [0]: ISO 7776 (X.75 SLP), always set [1]: Transparent [2]: SDLC [3]: LAPD in accordance with Q.921 for D-channel X.25 (SAPI 16) [4]: T.30 for fax group 3 [5]: Point-to-Point Protocol (PPP) [6]: Transparent (ignoring framing errors of B1 protocol) [7]: Modem error correction and compression (V.42 bis or MNP5) [8]: ISO 7776 (X.75 SLP) modified supporting V.42 bis compression [9]: V.120 asynchronous mode [10]: V.120 asynchronous mode supporting V.42 bis [11]: V.120 bit-transparent mode [12]: LAPD in accordance with Q.921 including free SAPI selection [13]...[31]: reserved

4 bytes	B3 protocol support (bit field): [0]: Transparent, always set [1]: T.90NL with compatibility to T.70NL in accordance to T.90 Appendix II. [2]: ISO 8208 (X.25 DTE-DTE) [3]: X.25 DCE [4]: T.30 for Group 3 fax [5]: T.30 for Group 3 fax with extensions [6]: reserved [7]: Modem [8]...[31]: reserved
24 bytes	reserved for **COMMON-ISDN-API** use
20 bytes	Manufacturer-specific information

CAPI_GET_PROFILE information structure

5.1 FACILITY_REQ

Description

This message is used to handle optional facilities on the controller or facilities related to connections identified by Controller, PLCI or NCCI. At the moment, facility support is defined for handsets, DTMF, V.42 bis, Supplementary Services, power management wakeup and echo cancellation.

Handset, DTMF, V.42 bis, Supplementary Services, power management wakeup and echo cancellation support are optional **COMMON-ISDN-API** features. In the case that **COMMON-ISDN-API** does not support these facilities, an appropriate information value is returned in the **FACILITY_CONF**.

DTMF can not be used with all B protocols. Normally it is used with 64 kbit/sec speech and T.30 audio. Supplementary Services may be used with all B protocols. Normally they are used with speech services. However, hold/retrieve, terminal-portability functions and especially call forwarding are defined operations for other services such as data communications as well. Line Interconnect is also primarily intended for speech services but may also be used for data applications. The use of power management wakeup is independent of the selected B channel protocol. Echo cancellation can only be used with telephony.

FACILITY_REQ	Command	**0x80**
	Subcommand	**0x80**

Parameter	**Type**	**Comment**
Controller/PLCI/NCCI	dword	Depending on the facility selector
Facility selector	word	**0x0000:** Handset **0x0001:** DTMF **0x0002:** V.42 bis **0x0003:** Supplementary Services (see Part III) **0x0004:** Power management wakeup **0x0005:** Line Interconnect **0x0006:** Broadband Extensions **0x0007:** Controller Events **0x0008:** Echo cancellation
Facility request parameter	struct	Facility-dependent parameters

5.2 FACILITY_CONF

Description

This message confirms the acceptance of the **FACILITY_REQ**. Any error is coded in the parameter *Info*.

FACILITY_CONF	Command	**0x80**
	Subcommand	**0x81**

Parameter	**Type**	**Comment**
Controller/PLCI/NCCI	dword	Depending on the facility selector
Info	word	**0:** Request accepted **0x2001:** Message not supported in current state **0x2002:** Incorrect Controller/PLCI/NCCI **0x2007:** Illegal message parameter coding **0x3008:** No interconnection resources available **0x300B:** Facility not supported **0x3011:** Facility specific function not supported
Facility selector	word	**0x0000:** Handset **0x0001:** DTMF **0x0002:** V.42 bis **0x0003:** Supplementary Services (see Part III) **0x0004:** Power management wakeup **0x0005:** Line Interconnect **0x0006:** Broadband Extensions **0x0007:** Controller Events **0x0008:** Echo cancellation
Facility confirmation parameter	struct	Facility-dependent parameters

Note

In case of facility selector **3** (Supplementary Services) this message may allocate a new PLCI (in the case of resuming a suspended call). This PLCI must be released later by means of **DISCONNECT_IND** / **DISCONNECT_RESP**.

If a **COMMON-ISDN-API** implementation supports the facility selector **4** (power management wakeup) its behavior has to differ from one that does not support the facility selector **4**.

5.3 FACILITY_IND

Description

This message is used to indicate a facility-dependent event originating on a controller or connection identified by the facility-dependent parameter *Controller*/*PLCI*/*NCCI*.

FACILITY_IND	Command	**0x80**
	Subcommand	**0x82**

Parameter	**Type**	**Comment**
Controller/PLCI/NCCI	dword	Depending on the facility selector
Facility selector	word	**0x0000:** Handset Support **0x0001:** DTMF **0x0002:** V.42 bis **0x0003:** Supplementary Services (see Part III) **0x0004:** reserved **0x0005:** Line Interconnect **0x0006:** Broadband Extensions **0x0007:** Controller Events **0x0008:** Echo cancellation
Facility indication parameter	struct	Facility-dependent parameters

Note

In case of facility selector **0** (Handset Support) this message may allocate a new PLCI (in the case that the handset goes off-hook). This PLCI must be released later by means of **DISCONNECT_IND** / **DISCONNECT_RESP**.

5.4 FACILITY_RESP

Description

With this message, the application acknowledges receipt of a facility indication message.

FACILITY_RESP	Command	**0x80**
	Subcommand	**0x83**

Parameter	Type	Comment
Controller/PLCI/NCCI	dword	Depending on the facility selector
Facility selector	word	**0x0000:** Handset Support **0x0001:** DTMF **0x0002:** V.42 bis **0x0003:** Supplementary Services (see Part III) **0x0004:** reserved **0x0005:** Line Interconnect **0x0006:** Broadband Extensions **0x0007:** Controller Events **0x0008:** Echo cancellation
Facility response parameters	struct	Facility-dependent parameters

Echo canceller request parameter (struct)

0x0000 Get supported services
Parameter does not apply (coded as struct with length 0)

0x0001 Enable line echo canceller operation

Options	word	[Bit 0]: Enable non-linear processing [Bit 2..1]: Echo canceller disable tone detection 00: Ignore echo canceller disable tone 01: Reserved 10: Bypass echo canceller upon detection of phase reversed 2100 Hz (operation according to G.165) 11: Bypass echo canceller upon detection of phase reversed or phase continuous 2100 Hz (operation according to G.164 and G.165) [Bit 3]: Adaptive pre-delay
Tail length in ms	word	Length of the adaptive echo cancellation filter in milliseconds. If set to 0, the **COMMON-ISDN-API** implementation determines an appropriate tail length.
Pre-delay length in ms	word	Length of the pre-delay in milliseconds that can be used to offset the echo cancellation filter to tightly cover the echo components. Applies only if options bit 3 (adaptive pre-delay) is not set.

Note: Non-linear processing usually improves the echo suppression ratio but might incorporate variable gain in the signal path. If the specified tail or pre-delay length is not supported, a COMMON-ISDN-API implementation shall select the best approximation to this length.

0x0002 Disable line echo canceller operation
Parameter does not apply (coded as struct with length 0)

Echo canceller confirmation parameter (struct)

0x0000 Get supported services

Echo canceller info	word	0x0000: Request accepted 0x3011: Facility specific function not supported
Supported options	word	[Bit 0]: Non-linear processing supported [Bit 1]: Bypass echo canceller upon detection of phase reversed or phase continuous 2100 Hz (operation according to G.164 and G.165) supported [Bit 2]: Bypass echo canceller upon detection of phase reversed 2100 Hz (operation according to G.165) supported [Bit 3]: Adaptive pre-delay supported
Supported tail length in ms	word	Maximum supported length of the adaptive echo cancellation filter in milliseconds. If 0, only the default (0: the **COMMON-ISDN-API** implementation determines an appropriate tail length) is supported for the parameter *Tail Length in ms*.
Supported pre-delay length in ms	word	Maximum supported length of the pre-delay in milliseconds.

0x0001 Enable line echo canceller operation

Echo canceller info	word	0x0000: Request accepted 0x3011: Facility specific function not supported

0x0002 Disable line echo canceller operation

Echo canceller info	word	0x0000: Request accepted 0x3011: Facility specific function not supported

Echo canceller indication parameter (struct)

0x0001 Bypass indication

Bypass event	word	1: echo canceller bypass due to continuous 2100 Hz 2: echo canceller bypass due to phase reversed 2100 Hz 3: echo canceller bypass released

Facility Selector (word)

The purpose of the parameter *Facility selector* is to identify the requested **COMMON-ISDN-API** facility.

The defined values are:

0 **Handset (external ISDN equipment)**
1 **DTMF (Dual Tone Multi-Frequency)**
2 **V.42 bis Compression**
3 **Supplementary Services (described in COMMON-ISDN-API Part III)**
4 **Power management wakeup**
5 **Line Interconnect**
6 **Broadband Extensions**
7 **Controller Events**
8 **Echo cancellation**

This information element appears in:

FACILITY_REQ
FACILITY_CONF
FACILITY_IND
FACILITY_RESP

Facility Request Parameter (struct)

The purpose of the parameter *Facility request parameter* is to offer additional information concerning the message FACILITY_REQ.

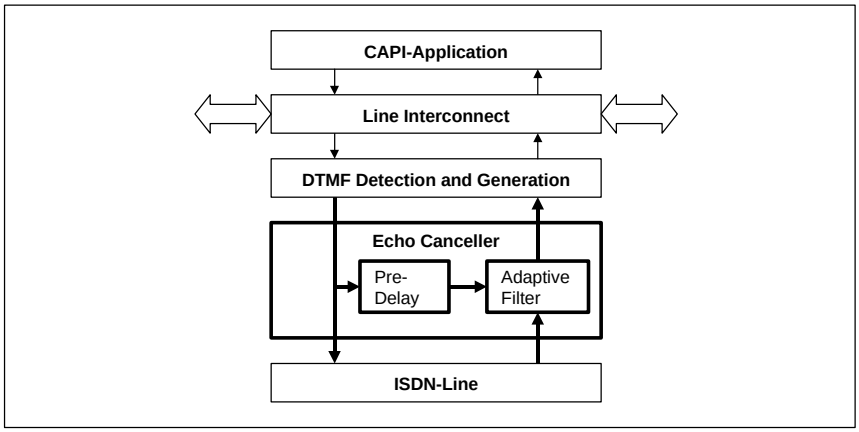
This parameter is coded as a structure with the following elements depending on the value of *Facility selector*:

Facility selector:

8 **Echo cancellation:**

Function	word	0: Get supported services 1: Enable line echo canceller operation 2: Disable line echo canceller operation 3 to n: Reserved
Echo canceller request parameter	struct	Echo canceller request parameter

The purpose of the line echo canceller is to cancel echoes originating from 4-wire to 2-wire conversion at the far end of a PSTN connection and from electrical and acoustical coupling within a peer telephone set. It thus prevents the audio signal sent within the physical connection specified by the PLCI of the FACILITY_REQ from leaking back to the application. The position of the echo canceller function is nearest to the ISDN line as shown in the following figure. I.e. the signal of the DTMF and line interconnect unit that is sent to the ISDN line is also subject to echo cancellation.



Position of the echo canceller with respect to other function blocks

This information element appears in:

FACILITY_REQ

Facility Confirmation Parameter (struct)

The purpose of the parameter *Facility confirmation parameter* is to offer additional information concerning the message FACILITY_CONF.

This parameter is coded as a structure with the following elements depending on the value of *Facility selector*:

Facility selector:

8 Echo cancellation:

Function	word	0: Get supported services 1: Enable line echo canceller operation 2: Disable line echo canceller operation 3 to n: Reserved
Echo canceller confirmation parameter	struct	Echo canceller confirmation parameter

This information element appears in:

FACILITY_CONF

Facility Indication Parameter (struct)

The purpose of the parameter *Facility indication parameter* is to offer additional information concerning the message FACILITY_IND.

This parameter is coded as a structure with the following elements depending on the value of *Facility selector*:

Facility selector:

8 **Echo cancellation:**

Function	word	0: Reserved 1: Bypass indication 2..n: Reserved
Echo canceller indication parameter	struct	Echo canceller indication parameter

This information element appears in:

FACILITY_IND

Facility Response Parameter (struct)

The purpose of the parameter *Facility response parameter* is to offer additional information concerning the message FACILITY_RESP.

This parameter is coded as a structure with the following elements depending on the value of *Facility selector*:

Facility selector:

8 **Echo cancellation:**
Parameter does not apply (coded as structure with a length of 0)

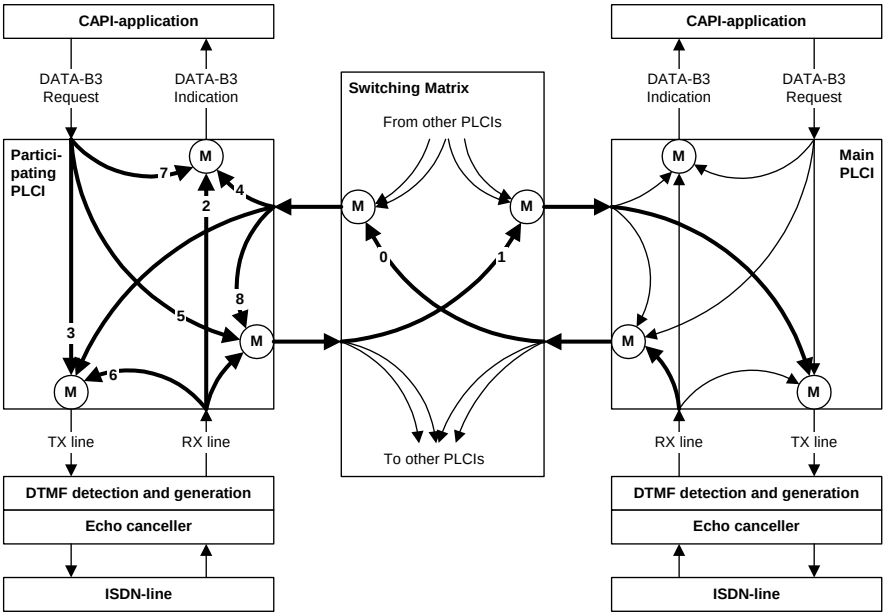
This information element appears in:

FACILITY_RESP

LI Connect Request Participant (struct)

Participating PLCI	dword	Identifier of entity to be interconnected to entity identified by PLCI in main-part of FACILITY_REQ
Data path	dword	see figure below. Bit field, coding as follows: [0]: Enable data-transmission from main PLCI to participating PLCI [1]: Enable data-transmission from participating PLCI to main PLCI [2]: Enable monitoring of channel-data for participating PLCI [3]: Enable mixing for participating PLCI [4]: Enable monitoring of all data which is sent to channel of participating PLCI [5]: Enable mixing of DATA_B3_REQ of participating PLCI to channels of all interconnected PLCI [6]: Incoming line-data will be looped back. [7]: Incoming application-data (DATA_B3_REQ) will be looped back (DATA_B3_IND) [8]: Incoming conference-data will be looped back. [9 to 31]: reserved

Note: If Bit 2 is set, DATA_B3_INDs will be generated for the participating PLCI if it has a layer-3-connection, otherwise DATA_B3_INDs will stop coming in. If Bit 3 is set, all DATA_B3_REQs transferred for participating PCLI will be mixed to all other data sent to the channel of the participating PLCI. If Bit 4 is set, all interconnection data – even of later interconnected entities - which is sent to the channel of the participating PLCI will also be mixed into the DATA_B3_INDs of the participating PLCI. If bit 5 is set, all DATA_B3_REQs which are transferred for the participating PCLI will also be mixed into the channels of all interconnected entities – even if they are interconnected later on.



Model of switching and conferencing facility
Data paths 0..8 denote the connections set through bits [0]..[8] respectively in the *Paricipating Interconnect Mask*.
The result of the Mixing operation (M) depends on the B protocol. For speech it enables simultaneous conversation between n parties. Data paths within a PLCI are not subject to clock adaptation. Synchronisation takes place at the transition to/from the switching matrix.

This information element appears in:

LI Request Parameter

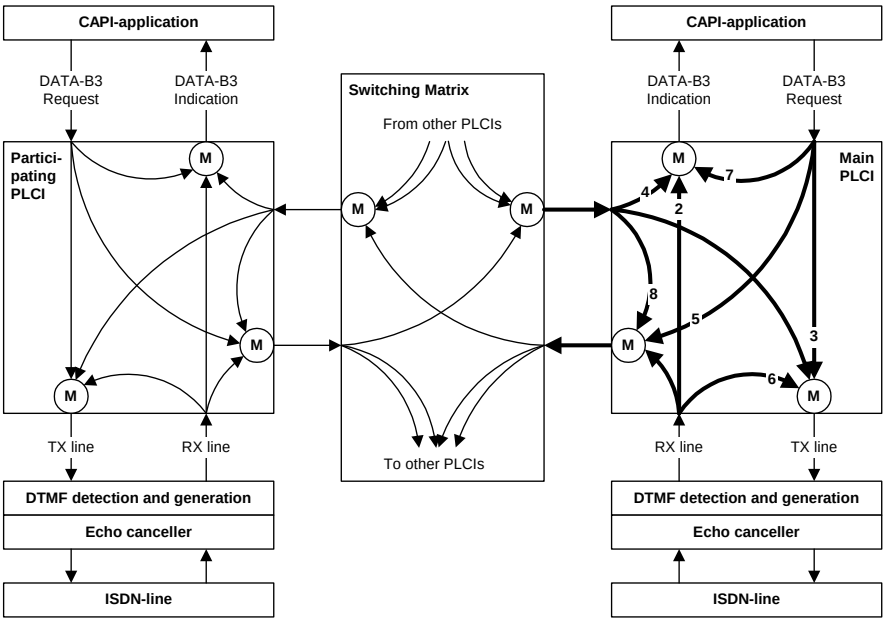
LI Request Parameter (struct)

0x0000 Get Supported Services
Parameter does not apply (coded as struct with length 0)

0x0001 Connect

Data path	dword	See figure below. Bit field, coding as follows: [0]: reserved [1]: reserved [2]: Enable monitoring of channel data for PLCI in main-part of FACILITY_REQ [3]: Enable mixing into data channel of PLCI in main-part of FACILITY_REQ [4]: Enable monitoring of channel data of all PLCIs interconnected to PLCI in main-part of FACILITY_REQ [5]: Enable mixing into data channel of all PLCIs interconnected to PLCI in main-part of FACILITY_REQ [6]: Incoming line-data will be looped back. [7]: Incoming application-data (DATA_B3_REQ) will be looped back (DATA_B3_IND) [8]: Incoming conference-data will be looped back. [9 to 31]: reserved
LI Connect Request Participant	struct	Sequence of participant-structs for the interconnection with the PLCI in main-part of FACILITY_REQ

Note: If Bit 2 is set, DATA_B3_INDs will be generated for the main PLCI if it has a layer-3-connection, otherwise DATA_B3_INDs will stop coming in. If Bit 3 is set, all DATA_B3_REQs transferred for the main PCLI will be mixed to all other data sent to the channel of the main PLCI. If Bit 4 is set, all interconnection data – even of later interconnected entities - which is sent to the channel of the main PLCI will also be mixed into the DATA_B3_INDs of the main PLCI. If bit 5 is set, all DATA_B3_REQs which are transferred for the main PCLI will also be mixed into the channels of all interconnected entities – even if they are interconnected later on. If the two lowest bits of a Participant Interconnect Mask are 0, a Line Interconnect indication “Disconnect” will be generated. In all other bit-combinations a Line Interconnect indication “Connect” will result in case of success. General interconnect-behavior may also change depending on the value of bit 9 of the parameter *Info mask* in the LISTEN_REQ (early B3).



Model of switching and conferencing facility:
Data paths 2..8 denote the connections set through bits [2]..[8] respectively in the *Main PLCI Data Mask*.
The result of the Mixing operation (M) depends on the B protocol. For speech it enables simultaneous conversation between n parties. Data paths within a PLCI are not subject to clock adaptation. Synchronisation takes place at the transition to/from the switching matrix.

0x0002 Disconnect

LI Disconnect Request Participants	struct	Sequence of participant-structs to be removed from the inter-connection to the PLCI in main-part of FACILITY_REQ.

This information element appears in:

Facility Request Parameter

