PIAFS Specifications

Published Date of Original Japanese Version
June 1998 version 1.1
March 1997 version 1.0

Mobile Internet Access Forum

General notes for the English version of the PIAFS Specifications.

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Attached form

Name of the applicant	Name of invention	Application number	Remarks
Nippon Telegraph and Telephone Corporation	(1) Data communication retransmission method (2) Mobile data communication system (3) Data communication retransmission method and its equipment	Toku kai hei 8-213974 Toku kai hei 8-223644 Toku kai hei 7-284380	Applied in U.S.A., U.K., France, Germany and China
Sony Corporation	(4) Data communication method	Toku gan hei 8-21379	Applied to U.S.A., U.K., Germany, France, Netherlands, Italy, Spain, Australia, Korea, Taiwan, China, Canada, Singapore, India, Indonesia and Thailand

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1. Summary of Protocol

This transmission system uses PHS's 32 kbit unlimited digital bearer and provides transmission control procedures (comparable to OSI reference model layer 2) for high quality data transmission.
The positioning of these specifications is shown below.

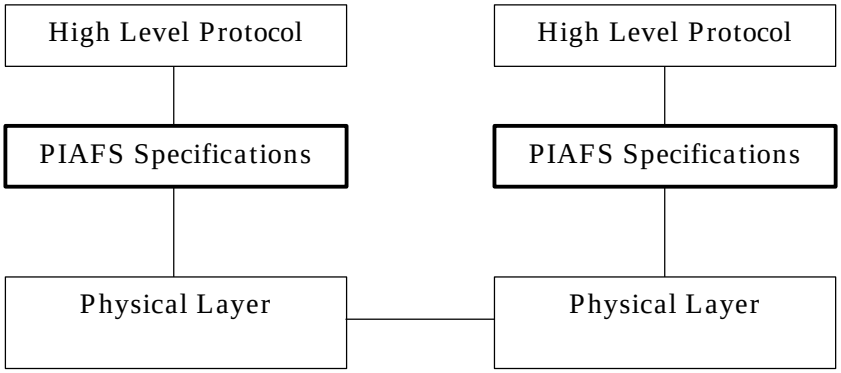


Illustration 1.1 Communication environment using PIAFS specifications

High level protocol in the above situation refers to the protocol that depends on an application program such as Fax, PC, and Internet communications. Physical Level refers to the level that converts the transmission format which is output in these specifications to a compatible type with the physical lines.

1.1 PIAFS Components

The PIAFS specifications is made up of inband negotiation specifications and ARQ transmission control specifications.

Inband Negotiation Specifications
This negotiation is set up in order to enable the handling of future image transmission and future new systems.

ARQ Transmission Control Procedures
Error control procedures placed in Layer 2 in the PHS communication phase.

1.2 Services Provided

PIAFS Specifications offer the following services to High Level Protocol.
- Set and release data link.
- Error free transmission accomplished by detection of the error, and then re-sending the message or correcting the error.
- Provides two complete transmission lines.
- Flow Control
- Bit Transparency
- Continuous linked data transmission
- High level throughput channel provisions under the high bit error ratio

• Messages disassembly and assembly

As an option, data compression via ITU-T standard V.42bis method loading is possible. It is possible to choose whether this function is on or off when the parameters are being set at the time of communications.

2. Inband Negotiation

Inband negotiation is the process of choosing one data link protocol out of multiple data link protocols through the occurrence of terminal negotiations before data link establishment in order to choose the data link.

2.1 Inband Negotiation Positioning

Illustration 2.1.1 indicates the positioning of inband negotiation. The inband negotiation part chooses one protocol from Data Transmission Protocol, Real Time Protocol, and Future Protocol by inband negotiation.

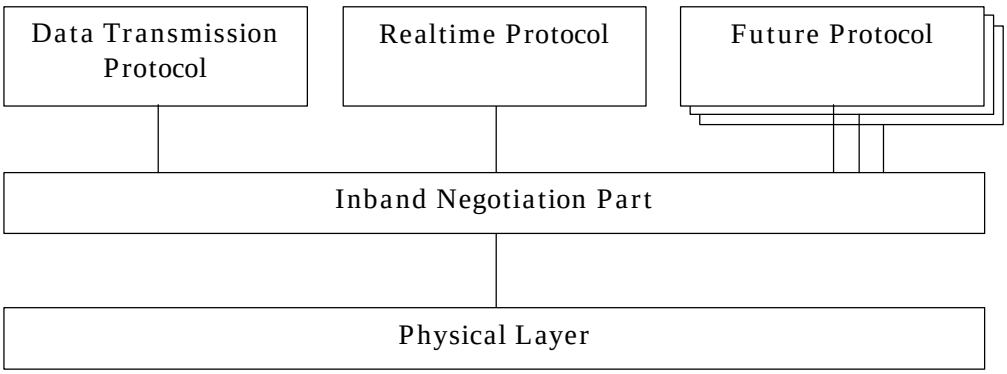


Illustration 2.1.1 Inband Negotiation Positioning

Note: The Real time Protocol is described in the technical document of PIAFS Real time Protocol specification.

2.2 Inband Negotiation Specifications

2.2.1 Frame Structure

640 bit

MSB LSB

FI	filled with 1	Data Length	SYNC	Option	Negotiation Classification	P1	P2	—	Pn	filled with 1	FCS
4	13	7	32	40	8	8	8		8		32

Illustration 2.2.1 Inband Negotiation Frame Structure

(1) FI

Used to discern frames

Bit	4	3	2	1	
	1	0	0	0	Negotiation Frame
	1	0	0	1	Negotiation Frame (Including Synchronization Frame function)

(2) Data Length

The data length from SYNC to Pn is indicated by the byte count. For instance, when up to P2 is set, the data length is 12.

(3) SYNC

Used to establish synchronous frames. The detect conditions force the agreement of all bits without allowing any error.

0 1 0 1 0 0 0 0 1 1 1 0 1 1 1 1 0 0 1 0 1 0 0 1 1 0 0 1 0 0 1 1

(4) Negotiation Classification

Used to indicate Negotiation Classification

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	0	Request: Negotiation request to the other side
	1	1	1	1	1	1	1	1	Reception: Reception response to a negotiation request
	0	0	0	0	0	0	0	1	Rejection: Rejection response to a negotiation request
	Other								Reserved

(5) P1, P2, ... Pn

Used to indicate Protocol Classification

P1: First Priority Protocol Classification
P2: Second Priority Protocol Classification
Pn: nth Priority Protocol Classification

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	1	Data Transmission Protocol
	0	0	0	0	0	0	1	0	Real Time Protocol
	Other								Reserved

- When it is not necessary to indicate protocols beyond protocol 2, only P1 is set.
- Multiple settings of identical protocol classifications must not be made in P1 - Pn.
- When the negotiation classification is on "reception," set the chosen protocol classification to P1.
- When the negotiation classification is on "rejection," do not set anything to P1 – Pn but make them "filled with 1."

(6) FCS

Used to detect frame errors. The generator polynomial expression follows the ITU-T recommendation V.42 (LAPM option) CRC 32. (See 3.2.6)

(7) Option

In the case of FI: 1000 (Negotiation Frame) the option domain should be "filled with 1."
In the case of FI: 1001 (Negotiation Frame [including synchronization function]) the option domain has the structure shown in Illustration 2.2.2. The method of using this domain is identical to Data Transmission Protocol 3.1.4.7 (synchronization classification), 3.1.4.8 (common sequence number), 3.1.4.9 (same sequence number), 3.1.4.10 (confirmation response number), and 3.1.4.11 (synchronization rejection reason indication).

Option (40)				
Synchronization Classification	General Sequence Number	Reception Serial Sequence Number	First Received Serial Sequence Number	Synchronization Rejection; Reason Indicator
8	8	8	8	8

Illustration 2.2.2 Option domain (Negotiation Frame [including synchronization frame function])

2.2.2 Negotiation Specifications

(1) The data link initiation side sets the available protocol in order of priority to the negotiation frame P1 - Pn, and sends "Request" (negotiation classification: request) to the other side. After that, it starts the "reception" (negotiation classification: reception) wait timer (TN001: 15 seconds) and keeps sending "request" to the other side until it receives a "reception." If there is only one usable protocol, only set P1. If there are multiple usable protocols, set P1, P2, ... Pn in order of priority. When the data transmission protocol is not set in P1 - Pn, set FI to :1001
(negotiation frame [including synchronization frame function]) and the option domain information must be set according to the specifications prescribed by the data sending protocol.
Furthermore, when the data transmission protocol is not set in P1 - Pn, set FI to :1000, and the option domain must be set to "filled with 1."

(2) The data link non-initiation side chooses only one of the usable protocols in order of requested priority among the usable protocols indicated by the received P1 - Pn. Actually, the requested first priority protocol will choose the first priority protocol when it is usable by the side that did not initiate the data link, and when the first priority protocol is unusable but the second priority protocol is usable, it will choose the second priority protocol. Afterwards, the protocol is chosen by the same specifications.

(3) The side that does not initiate the data link sets the chosen protocol to P1 (P2 and beyond are not set), and repeatedly sends "reception" to the side initiating the data link.
When the chosen protocol is the data sending protocol, set FI to 1001 (negotiation frame[including synchronization frame function]) and the option domain information must be set according to the specifications prescribed by the data sending protocol. (FI must not be set to 1000.)
When the chosen protocol is not the data sending protocol, set FI to 1000, and the option domain must be set to "filled with 1."

(4) When the side initiating the data link receives "reception" from the other side, it stops the "reception" waiting timer (TN001), chooses the protocol indicated by reception frame P1, and completes the negotiation. After that, the side initiating the data link performs the data link establishment action.
When the received frame FI is 1001 (negotiation frame [including synchronization frame function]), it means that the ARQ frame synchronization and RTF measurement are completed.

(5) If the side that did not initiate the data link does not have a usable protocol indicated by the received P1 - Pn, it does not set anything in P1 - Pn, and repeatedly sends "rejection" to the other side L times. L is 20. When it receives "rejection" (negotiation classification: rejection), the side initiating the data link stops the reception wait timer and releases the physical link.

(6) When there is a conflict as shown in Illustration 2.2.3, negotiation cannot be done correctly.
However, sometimes the protocol chosen by negotiation and the protocol indicated by "reception" sent to the other side do not agree, and in this case, because the mismatching can be detected at each data link initiating side, data link initiation cannot be performed in a mismatched state. However, after a mismatch has occurred, negotiation initiation can be resta

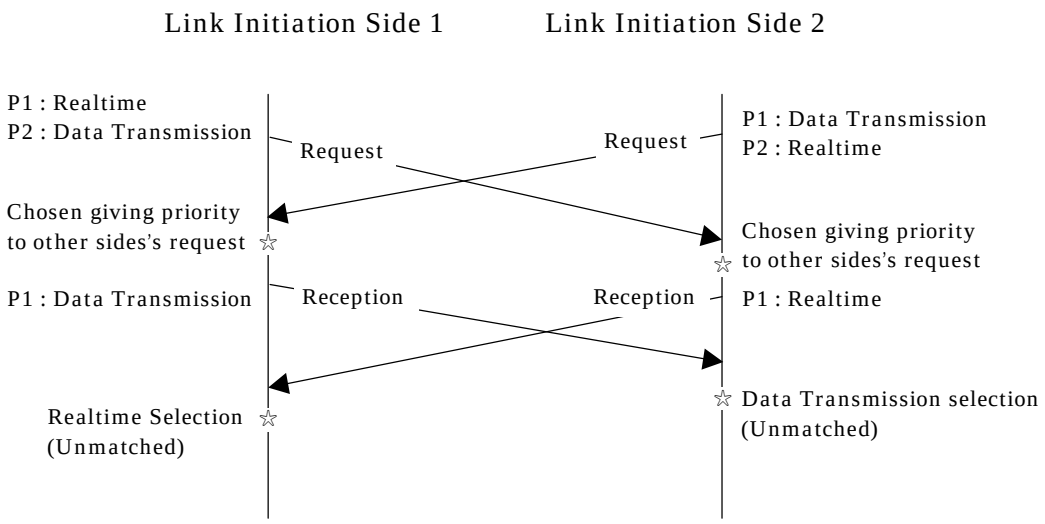


Illustration 2.2.3 Negotiation Conflict Sequence (Negotiation Unmatched)

2.3 System Constant Table

- "Reception" wait timer (TN001)
  A timer that waits to receive a "Reception" or "Rejection" from the other side after sending a "request." This timer value is 15 seconds.

- Repeated "Rejection" sending number (L)
  The number of times to repeatedly send "Rejection" when no protocol can be chosen in response to a "Request" from the other side. The prescribed number is 20 times.

3. ARQ Sending Control Procedures

3.1 Frame Components

In this section, the receiving and sending frame components in this sending method are shown. It also describes each frame component and the field formats occurring within each frame. ARQ state transition is shown in Attachment 1.

Each ARQ frame is differentiated according to its use into the following 3 types:

Synchronization Frame, Control Frame, and Data Frame. The frame length is the protocol (See 3.2.4 Control Signal Method) decided upon through both side's negotiation, but this text describes 640 [bit] (80 byte) lengths. Other frame lengths are reserved for future expansions.

3.1.1 Synchronization Frame

A frame sent to establish ARQ frame synchronization. Within the synchronization frame, the following 3 types differentiated by "Synchronization Classification" domain exist:
Synchronization Request, Synchronization Reception, and Synchronization Rejection.
At the time of initial synchronization / re-synchronization sequence initiation, the data link

initiation side sends a synchronization request. The side that did not initiate the data link is in a state of waiting, and after receiving the appropriate frame, sends the synchronization reception to the initiating side. When it has received a synchronization request but for some reason cannot respond, it sends a synchronization rejection together with the reason for rejection. The synchronization frame detection requires "SYNC Match," "FI Confirmation," and "No-error CRC."
The synchronization sequence is initiated under the following conditions:

(1) When the data link is initiated. (The frame structure follows in-band negotiation frame [including synchronization frame function] which is described in Illustration 2.2.1)

(2) When an ARQ reception frame repeated FCS error has been detected. (The frame structure follows the structure described in the illustration below.)

(3) When a synchronization frame is received while transmitting a control frame or a data frame.

Note: When the terminal station apparatus can detect a PS state, the synchronization sequence can be initiated either at the PS's TCH switchover or at the time of H.O completion.

MSB LSB

FI (4bit)	Filled with “1” (12bit)	“1” (1bit)	Data length (7bit)	SYNC (32bit)	Synchronization classification (8bit)	General sequence number (8bit)*	Reception sequence number (8bit)*	Confirmation response number (8bit)*	Synchronization rejection reason indicator (8bit)*	filled with “1” (64bit)

filled with “1” (160 bit)

filled with “1” (160 bit)

filled with “1” (128 bit)	FCS (32 bit)

* See the individual items described later

- The synchronization request and synchronization reception data length is 8. The synchronization rejection data length is 9.
- The synchronization rejection reason indicator portion occurring within the synchronization request and reception is not significant data, but is “all 1”.

3.1.2 Control Frame

A frame for sending and receiving the control information field of ARQ control parameters etc., at the terminal (End-End).

Continuous frame identifier bit (1 bit)

MSB ↓ LSB

FI (4 bit)	FFI (6 bit)	FBI (6 bit)		Data length (7 bit)	Control information (136 bit)

Control information (160 bit)

Control information (160 bit)

Control information (128 bit)	FCS (32 bit)

3.1.3 Data Frame

Continuous frame identifier bit (1 bit)

MSB ↓ LSB

FI (4 bit)	FFI (6 bit)	FBI (6 bit)		Data length (7 bit)	Data (136 bit)

Data (160 bit)

Data (160 bit)

Data (128 bit)	FCS (32 bit)

See the items described later for detailed usage instructions regarding the above 3 frames. The field format occurring in each domain is shown here.

3.1.4 Field Format

The bit sending sequence in each field starts from MSB.

3.1.4.1 FI (Frame Identifier)

MSB	0	0	0	0	LSB	Synchronization frame
	0	0	0	1		Control frame
	0	0	1	0		Data frame (with ARQ)
	1	0	0	0		Negotiation frame
	1	0	0	1		Negotiation frame (Including synchronization frame function)
Other						Reserved

3.1.4.2 FFI (Feed Forward Information)

MSB	0	0	0	0	0	0	LSB	*
	0	0	0	0	0	1		Frame number = 1
				• •				• •
	1	1	1	1	1	1		Frame number = 63

*Frame number “0” is set in the following situations
(1) When data for re-sending control does not exist in the frame.
(2) Fixed value FFI within the control frame.

3.1.4.3 FBI (Feed Back Information)

A domain showing the request frame number within ARQ control

MSB 0 0 0 0 0 0 LSB	*
0 0 0 0 0 1	Frame number = 1
• •	• •
1 1 1 1 1 1	Frame number = 63

*Frame number “0” is set in the following situations
(1) Fixed value FBI within the control frame.

3.1.4.4 Continuous Frame Identifier Bit

A domain indicating whether a continuous frame exists within the control frame or the data frame.

0	Single or last frame
1	Intermediate frame (when there are repeated frames)

3.1.4.5 Data Length

Data length is indicated by the area where significant data exists greater than the data length domain within the ARQ frame and less than the FCS domain in byte units. Data length in the synchronization request/ synchronization reception is "8", data length in the synchronization rejection is "9", and data length in the control frame (including the continuous frame) indicates the control information field in each frame. However, as for the control frame byte 73, it is not significant data. (For "data length" of the data frame, see 3.2.5.2 data comparison process.)

MSB 0 0 0 0 0 0 0 LSB	No data
0 0 0 0 0 0 1	1 byte
•	•
1 0 0 1 0 0 1	73 byte
Other	(Not currently used)

3.1.4.6 SYNC

32 bit pattern is shown below. The detect conditions force the agreement of all bits without allowing any error. Further, the sending order is from the leftmost bit.

MSB | 0 1 0 1 0 0 0 0 1 1 1 0 1 1 1 1 0 0 1 0 1 0 0 1 1 0 0 1 0 0 1 1 | LSB

3.1.4.7 Synchronization Classification

The data link initiating side sends a synchronization request, and a synchronization reception is sent as a response to having received the synchronization request. When link initiation can not be achieved, a synchronization rejection is sent. When the synchronization request sender receives synchronization rejection as the response, the synchronization request transmission is stopped.

MSB 0 0 0 0 0 0 0 0 LSB	Synchronization request
1 1 1 1 1 1 1 1	Synchronization reception
0 0 0 0 0 0 0 1	Synchronization rejection
Other	Reserved

3.1.4.8 Shared Sequence Number

A number counted independently by the data link initiating side and the non-initiating side. Every time a synchronization request, synchronization reception, or synchronization rejection is sent, it is incremented by 1, beginning at the starting time of synchronization request sending. When the value exceeds "255," it will be incremented after being reset to "1". This number is used for RTF measurement. This number's initial value is 1.

MSB 0 0 0 0 0 0 0 0 LSB	Reserved
0 0 0 0 0 0 0 1	Number 1
0 0 0 0 0 0 1 0	Number 2
0 0 0 0 0 0 1 1	Number 3
• •	• •
1 1 1 1 1 1 1 0	Number 254
1 1 1 1 1 1 1 1	Number 255

3.1.4.9 Same Sequence Number

A number that increments by 1 beginning at the starting time of synchronization reception or synchronization rejection sending. When the value exceeds "255," it will be incremented after being reset to "1". This number is used for RTF measurement. This number's initial value is 1.
However, the appropriate domain within the synchronization request is fixed at "1".

MSB 0 0 0 0 0 0 0 0 LSB	Reserved
0 0 0 0 0 0 0 1	Number 1
0 0 0 0 0 0 1 0	Number 2
0 0 0 0 0 0 1 1	Number 3
• •	• •
1 1 1 1 1 1 1 0	Number 254
1 1 1 1 1 1 1 1	Number 255

3.1.4.10 Confirmation Response Number

The shared sequence number attached to the first received synchronization request is copied to the confirmation response number of synchronization reception or synchronization rejection, and synchronization reception or synchronization rejection is sent. This number is used for RTF measurement. The appropriate domain within the synchronization request is fixed at "1".

MSB 0 0 0 0 0 0 0 0 LSB	Reserved
0 0 0 0 0 0 0 1	Number 1
0 0 0 0 0 0 1 0	Number 2
0 0 0 0 0 0 1 1	Number 3
• •	• •
1 1 1 1 1 1 1 0	Number 254
1 1 1 1 1 1 1 1	Number 255

3.1.4.11 Synchronization Rejection Reason Indicator

When a synchronization request has been received but for some reason no response is possible, a synchronization rejection is sent together with the reason for rejection. This synchronization rejection indicator explains the reason for sending synchronization rejection.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	1	-	-	-	-	Normal Event Class
					1	1	1	1	Other Normal Class
	0	0	1	0	-	-	-	-	Unusable Resource Class
					1	0	0	0	DTE Busy
					1	0	0	1	Temporary Fault
					1	1	1	1	Other Unusable Resource Class
	0	0	1	1	-	-	-	-	Un-utilizable Services Class
					1	1	1	1	Other Un-utilizable Services Class
	0	1	0	0	-	-	-	-	Currently Unprovided Services Class
					1	1	1	1	Other Currently Unprovided Services Class
	0	1	0	1	-	-	-	-	Invalid Information Content Class
					1	0	0	0	Terminal Attribute Mismatch
					1	1	1	1	Other Invalid Information Content Class
	0	1	1	0	-	-	-	-	Procedural Error
					0	1	0	1	ARQ State and Signal Mismatch
					0	1	1	0	Timer Time-out
					1	1	1	1	Other Procedural Error Class
	1	0	0	0	-	-	-	-	Other Specifications
					0	0	0	1	Engaged in Voice Communications
					1	1	1	1	Other Specifications Class
	Other								Reserved

3.1.4.12 Control Information

The control information is transmitted by the control frame, and is a transmission method which expects reception confirmation of the frame from the control frame receiver side every time a control frame is sent. The control information coding is as shown below.

Sequence number	Control information classification identifier	Byte 1
Control information content identifier		Byte 2
• • •		
Reception result/Rejection reason (Reason indicator)		Byte 73

(1) Control Information Classification Identifier

Bit	4	3	2	1	
	0	0	0	1	Request
	0	0	1	0	Notification
	1	0	0	0	Reception (Request Reception)
	1	0	0	1	Rejection (Request Rejection)
	1	0	1	0	Response (Notification Response)
	1	0	1	1	Continuous Frame Transmission Allowance

(2) Sequence Number

The sequence number is shown in modulo 16, and identifies the correspondence between the control information (Request, Notification) sent by the control initiating side and the reception confirmation signal (Reception, Rejection, Response, Continuous Frame Transmission Allowance) sent from the initiated side. The initial value of this sequence number is "0".

(3) Control Information Contents Identifier

Identifies the contents of the information indicated by byte 3 and lower.

3.1.4.13 FCS (Frame Check Sequence)

A domain that detects frame errors. The contents are CRC-32.The generator polynomial follows the ITU-T recommendation V.42 (LAPM option).

FCS32 [bit]

Contents

CRC-32 bit

3.1.5 Bit Sending Order

The sending order to the frame circuit is: FI, Control Field, Information Field, FCS. All information is sent in order from the most significant bit to the least significant bit. The control frame's information field is in byte units, and again each byte is sent from the most significant bit.

3.2 Action Sequence

3.2.1 Link Establishment

3.2.1.1 Data Link Initiation Side

In this procedure, a negotiation frame is transmitted first in order to establish ARQ frame synchronization when there is a communication request from a high level module. After that, the synchronization reception wait timer (T001: 15 seconds) is initiated and the detection of the negotiation frame (negotiation classification: reception, including synchronization function, synchronization reception) from the other side is performed. In case of time-out, the high level module is notified of the communication request failure.
When the negotiation frame (negotiation classification: request, including synchronization function, synchronization request) from the other side is detected, the synchronization is considered accomplished, the synchronization reception wait timer (T001) is stopped, initial setting of internal parameters, etc. and the negotiation of communication parameters(See Section 3.2.4.Control Signal System) are performed. The data link establishment is completed at the time when the negotiation is done correctly, and high level module is notified of the establishment of the communication request, thus the communications become active. In case the negotiation of communication parameters is not completed correctly due to mismatching of the parameters, etc. the high level module is notified of the communication request failure.

3.2.1.2 Data Link Initiation Reception Side

When the negotiation frame (negotiation classification: request, including synchronization function, synchronization request) from the data link initiation side is detected, transmission of the negotiation frame (negotiation classification: reception, including synchronization function, synchronization reception) is performed. After that, a post-synchronization-reception-transmission timer (T002: 15 seconds) is initiated and the detection of a control frame (request) of the other side is performed. In case of time-out, the high level module is notified of the synchronization establishment failure.
When the control frame (request) from the other side is detected, the synchronization is considered accomplished, the post-synchronization-reception-transmission timer (T002: 15 seconds) is stopped, the initial setting of internal parameters, etc. and the negotiation of communication parameters (See Section 3.2.4 Control Signal System) are performed. The data link establishment is completed at the time when the negotiation is done correctly, and high level module is notified of the synchronization establishment, thus the communications become active. In case the negotiation of communication parameters is not completed correctly due to mismatching of the parameters, etc. the high level module is notified of the synchronization establishment failure.

3.2.2 Link Release

3.2.2.1 Release Control Initiation Side

in this procedure, a control frame (data link release) requesting link release is sent when there is a release request or an internal link release request from the high level module. After that, the confirmation wait timer (T101: 10 seconds) is initiated and the detection of a response confirmation frame from the other side is performed. In case of time-out, the link is considered released, so the high level module is notified of the link release and the communications are finished.
When the response confirmation frame is detected from the other side, the link is considered

released, the confirmation wait timer (T101) is stopped, the high level module is notified of the link release and the communications are finished.

3.2.2.2 Release Control Initiation Reception Side

In case the link release is possible, the side which received the control frame requesting link release notifies the high level module of the link release, and finishes the communications after sending the continuous response confirmation frame for this control frame K times. K is 20.

3.2.3 Frame Synchronization and RTF Measurement Method

In this section, the ARQ synchronization sequence and RTF (the parameter for defining the frame distance until retransmission) measurement procedures that are executed at the same time are described. In order to set the most appropriate RTF value, this protocol uses a system that measures and sets up the response delay time each time a call is connected.
In this protocol, it is not absolutely necessary to synchronize Air Frame timing and the ARQ frame.

3.2.3.1 Synchronization Sequence Initiation Conditions

The synchronization sequence is initiated under the following conditions:

(1) When the data link is initiated. (The frame structure follows "in-band negotiation frame (including synchronization frame function)" which is described in Illustration 2.2.1.)

(2) When an ARQ reception frame repeated FCS error has been detected. (The frame structure follows the structure described in Illustration 3.1.1.)

(3) When a synchronization frame is received while transmitting a control frame or a data frame, and when the terminal station apparatus can detect a PS state, the synchronization sequence can be initiated either at the PS's TCH switchover or at the time of H.O completion.

(Note) The "synchronization" stated in this section is the ARQ frame synchronization in the terminal (End-End), not the air frame or the ARQ frame synchronization.

3.2.3.2 ARQ Frame Synchronization Sequence

3.2.3.2.1 Initial Synchronization Sequence

In the initial ARQ frame synchronization, the negotiation frame (including synchronization frame function) is used. Following the rules below, ARQ frame initial synchronization can be established. (See Section 2.2.2 Negotiation Specifications and Section 3.2.1.1.)

1: In tandem with transmitting the negotiation frame (negotiation classification: request, including synchronization function, synchronization request) from the data link initiation side, the synchronization reception wait timer (T001: 15 seconds) is initiated. From the time

that the negotiation frame (negotiation classification: request, including synchronization function, synchronization request) transmission is begun, the "shared sequence number" in the option domain increases in increments of "1" and the "same sequence number" and the "confirmation response number" in the option domain are set at "1."

2: When data link initiation reception side receives the negotiation frame (negotiation classification: request, including synchronization function, synchronization request), it sends the negotiation frame (negotiation classification: reception, including synchronization function, synchronization reception) and initiates the post-synchronization-reception-transmission timer (T002: 15 seconds). From the time that the negotiation frame (negotiation classification: reception, including synchronization function, synchronization reception) transmission is begun, the "shared sequence number" and the "same sequence number" in the option domain increase in increments of "1." Moreover, the option domain "shared sequence number" attached to the very first negotiation frame (negotiation classification: request, including synchronization function, synchronization request) received from the data link initiation side is copied and written into the option domain "confirmation response number" of the negotiation frame (negotiation classification: reception, including synchronization function, synchronization reception).

3: By the data link initiation side receiving the negotiation frame (negotiation classification: reception, including synchronization function, synchronization reception), the ARQ synchronization is established and the synchronization reception wait timer is stopped. Simultaneously, the RTF measurement becomes possible and the communication parameter negotiation (See Section 3.2.4 Control Signal System for details) occurs.

4: When a control frame (request) from the other side is detected in the data link initiation reception side, synchronization is considered accomplished, the post-synchronization-reception-transmission timer (T002: 15 seconds) is stopped and the communication parameter negotiation (See Section 3.2.4 Control Signal System for details) occurs.

5: In case the synchronization reception wait timer (T001) or the post-synchronization-reception-transmission timer (T002: 15 seconds) is time-out, the ARQ synchronization establishment becomes failure, and high level module is notified of the data link establishment failure.

6: When there is a conflict in data link initiation, the priority is given to the processing from the other initiation side. In other words, when receiving a synchronization request from the other side while sending synchronization request, stop sending the synchronization request from this side but perform processing for the synchronization request from the other side. Illustrations 3.2.3 and 3.2.4 show the synchronization sequence when there is a conflict in the data link initiation side. In this case, the both sides operate as the "data link initiation side" in each communication phase after establishment of the initial synchronization.

(Note) ARQ frame synchronization detection is subject to "SYNC matching," "F1 confirmation" and "No CRC error."

3.2.3.2.2 Initial Synchronization Sequence

When conditions (2) and (3) of Section 3.2.3.1 are fulfilled during communications, re-synchronization of the ARQ frame is performed. The synchronization frame provided in frame configuration 3.1.1 is used in the ARQ frame re-synchronization. Following the rules below, ARQ synchronization can be established. (See Charts 3.2.1 and 3.2.2)

3.2.3.2.2.1 The Data Link Initiation Side

1: In tandem with transmitting the synchronization frame (synchronization request), the data link initiation side initiates the synchronization reception wait timer (T001: 15 seconds) and detects the synchronization frame (synchronization reception) from the other side. At this point, the "shared sequence number" increases in increments of "1" from the time when the synchronization frame (synchronization request) transmission is begun, and the "same sequence number" domain and the "confirmation response number" domain in the synchronization request are set at "1."

2: By receiving the synchronization frame (synchronization reception), ARQ synchronization is established and the synchronization reception wait timer (T001) is stopped. Simultaneously, the RTF measurement becomes possible and the negotiation of ARQ parameters (See Section 3.2.4 Control Signal System for details) is performed.

3: In case the synchronization reception wait timer (T001) is time-out, the ARQ synchronization establishment becomes failure, and high level module is notified of the synchronization establishment failure.

(Note) ARQ frame synchronization detection is subject to "SYNC matching," "F1 confirmation" and "No CRC error."

3.2.3.2.2.2 The Data Link Initiation Reception Side

1: When conditions (2) and (3) of Section 3.2.3.1 are fulfilled during communications, the data link initiation reception side initiates the synchronization request wait timer (T003: 15 seconds) and enters call waiting status of synchronization frame (synchronization request) from the other side.

2: When receiving the synchronization frame (synchronization request) from the other side, it stops the synchronization request wait timer and simultaneously initiates the post-synchronization-reception-transmission timer (T002: 15 seconds) and transmits the synchronization frame (Synchronization reception). From the time when the synchronization frame (synchronization reception) transmission is begun, the "shared sequence number" and the "same sequence number" increase in increments of "1." Moreover, the "shared sequence number" attached to the very first synchronization frame (synchronization request) received at the data link initiation reception side from the data link initiation side is copied and written into the domain of "confirmation response number.

3: When a control frame (request) is detected from the other side, the synchronization is

considered accomplished, the post-synchronization-reception-transmission wait timer (T002: 15 seconds) is stopped and negotiation of the ARQ parameters (See Section 3.2.4 Control Signal System for details) is performed.

4: In case each timer (T002 and T003) is time-out, ARQ synchronization establishment is considered failure, and high level module is notified of the synchronization establishment failure.

(Note) ARQ frame synchronization detection is subject to "SYNC matching," "F1 confirmation" and "No CRC error."

3.2.3.2.2.3 When Both Sides Operate as the Data Link Initiation Side

When .both sides operate as the data link initiation side as shown in Item 6. of Section 3.2.3.2.1, a conflict in synchronization frames (synchronization request) may occur even at the time of ARQ frame re-synchronization initiation. Although in such a case, processing from the other initiation side is given priority. In other words, when receiving a synchronization request from the other side while transmitting the synchronization request, the transmission of the synchronization request from this side is stopped and perform the processing for the synchronization request from the other side. Illustrations 3.2.3 and 3.2.4 show the synchronization sequence when there is a conflict in the data link initiation side.

3.2.3.3 RTF Measurement Method

RTF value is measured at the data-link initiation side, and the data-link initiation reception side is notified through the control frame after synchronization is established. The specifications at the data-link initiation side are shown below.

1: At the point when the synchronization reception is received from the data-link initiation reception side, the following numerical values are detected.
( )shared sequence number presently being sent along with the synchronization request/ synchronization reception.
( ) the same sequence number accompanying the synchronization reception from the other side.
( ) the confirmation response number accompanying the synchronization reception from the other side.
2: RTF={ +510-(+)} Mod255+2+N is calculated and RTF is set. The value of constant N is 2.
3: When "RTF- N<2, 60 RTF-N," data-link release sequence is entered into.
4: The RTF value measured by the data-link initiation side is notified to the data-link initiation reception side through the control frame.

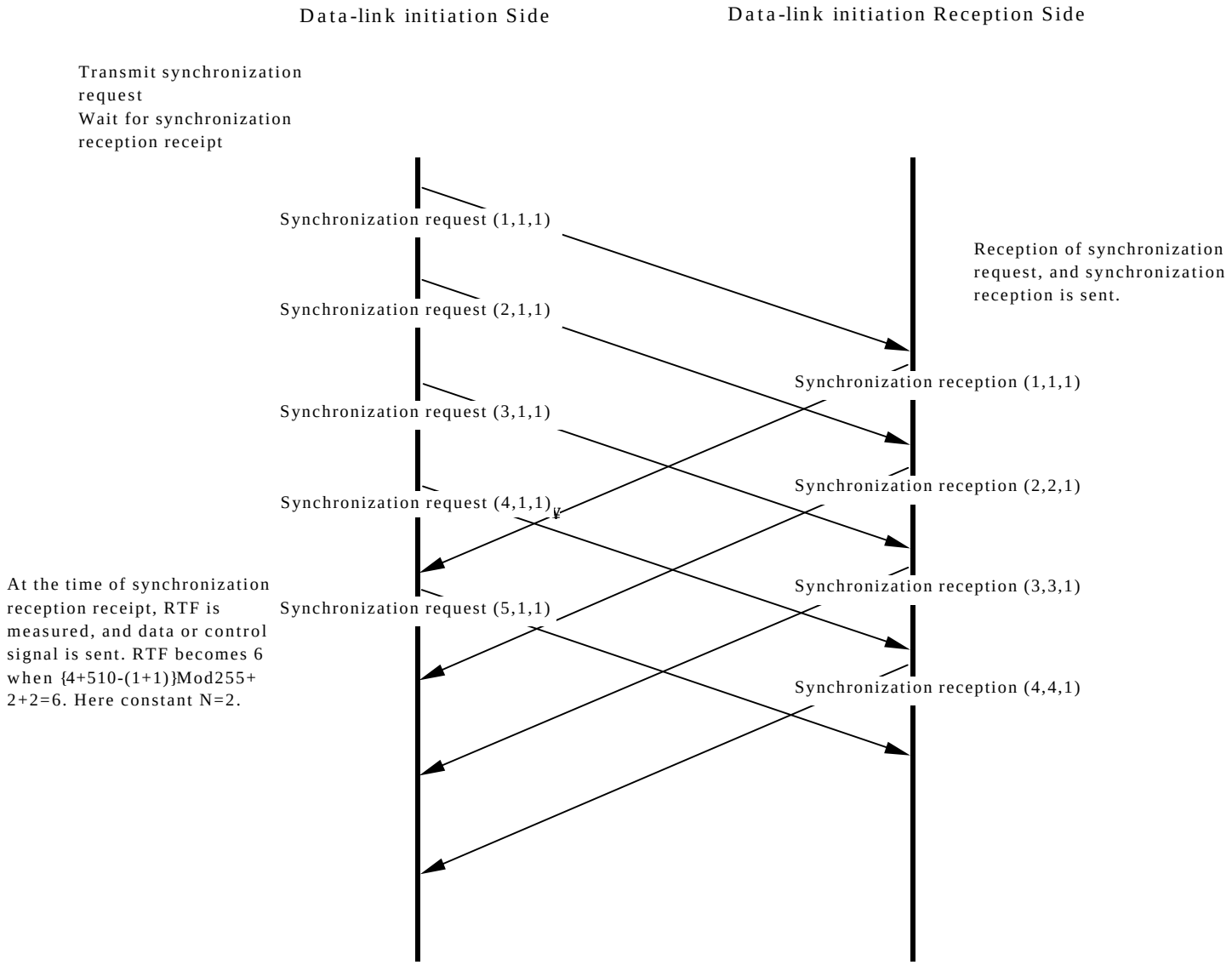
3.2.3.4 ARQ Frame Rejection Sequence

When the synchronization request is received but you cannot respond for some reason, instead of the synchronization reception, the synchronization rejection with its rejection reason in the reason indicator is sent continuously L times. In order to simplify the

processing of the ARQ synchronization processing area, the "shared sequence number," "same sequence number," and the "confirmation response number" processing method is done in the same way as the synchronization request.
The value of L is 20.
When the data-link initiation side has received a synchronization rejection, the synchronization request transmission and the synchronization reception wait timer T001 is stopped and the high level module is notified of the data-link establishment rejection. (See Illustration 3.2.5)

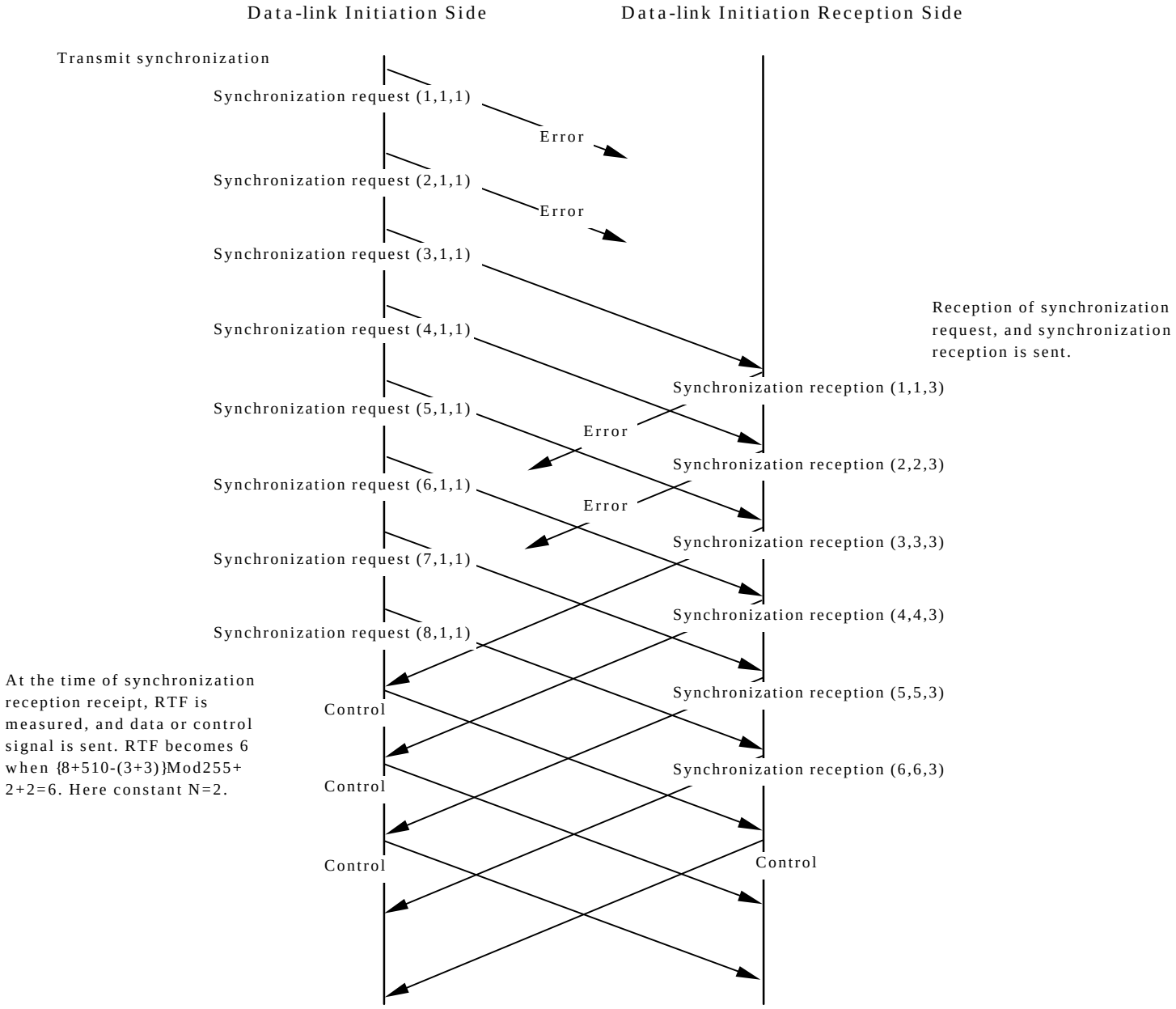
3.2.3.5 Sequence Illustration Examples

Illustration 3.2.1 shows the synchronization sequence example, including RTF measurement, when there is no error in the circuit.
Illustration 3.2.2 shows the synchronization sequence example, including RTF measurement, when there is error in the circuit.
Illustration 3.2.3 shows the synchronization sequence example when there is conflict in the data-link initiation, and when there is no error in the circuit.
Illustration 3.2.4. shows the synchronization sequence example when there is conflict in the data-link initiation, and when there is error in the circuit.
Illustration 3.2.5 shows a sequence example of data-link initiation rejection.



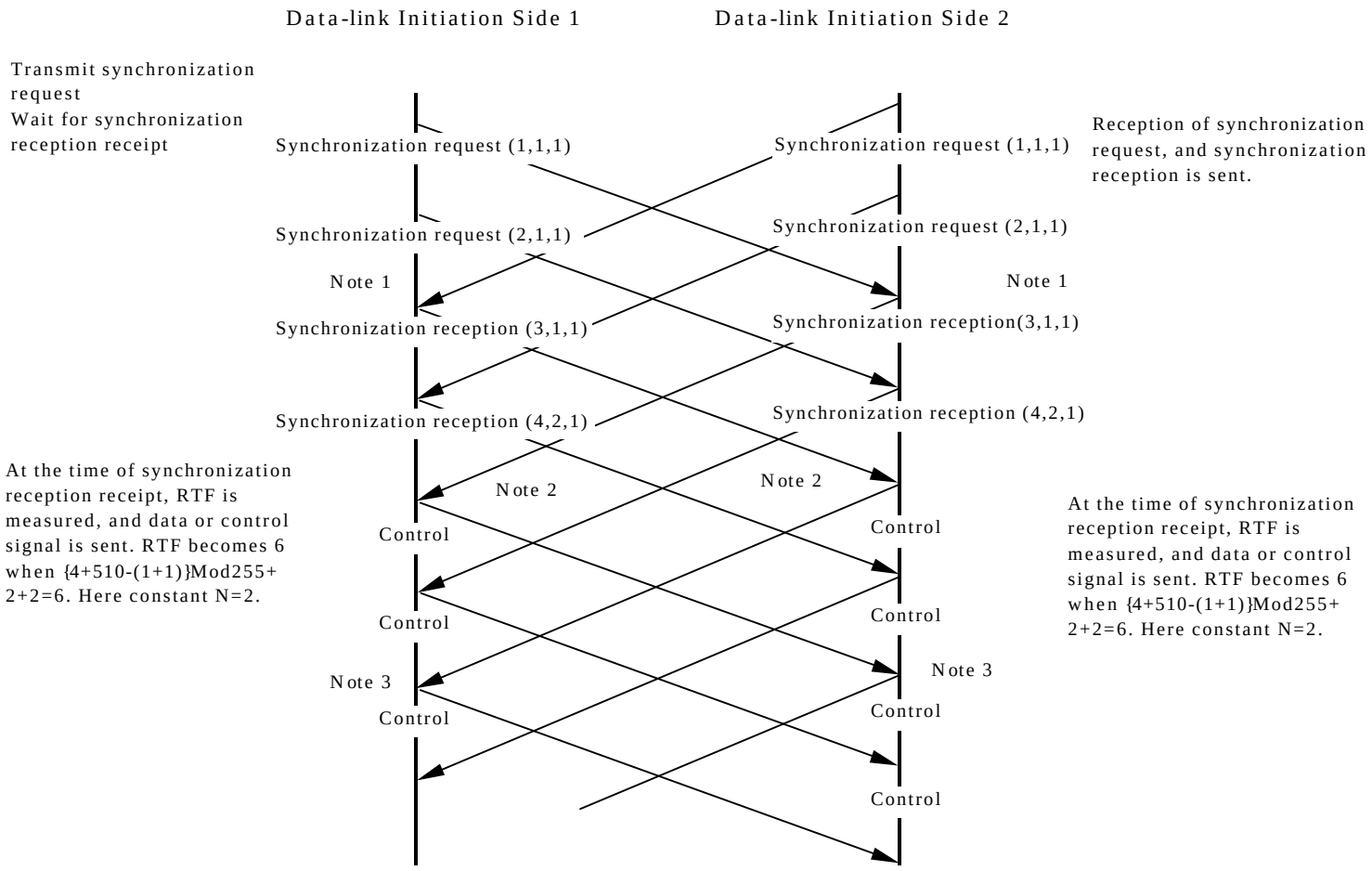
Example: Synchronization request or synchronization reception (shared sequence number, same sequence number, confirmation response number).

Illustration 3.2.1 ARQ Frame Synchronization Sequence (no circuit error)



Example: Synchronization request or synchronization reception (shared sequence number, same sequence number, confirmation response number).

Illustration 3.2.2 ARQ Frame Synchronization Sequence (with circuit error)



Example: Synchronization request or synchronization reception (shared sequence number, same sequence number, confirmation response number).

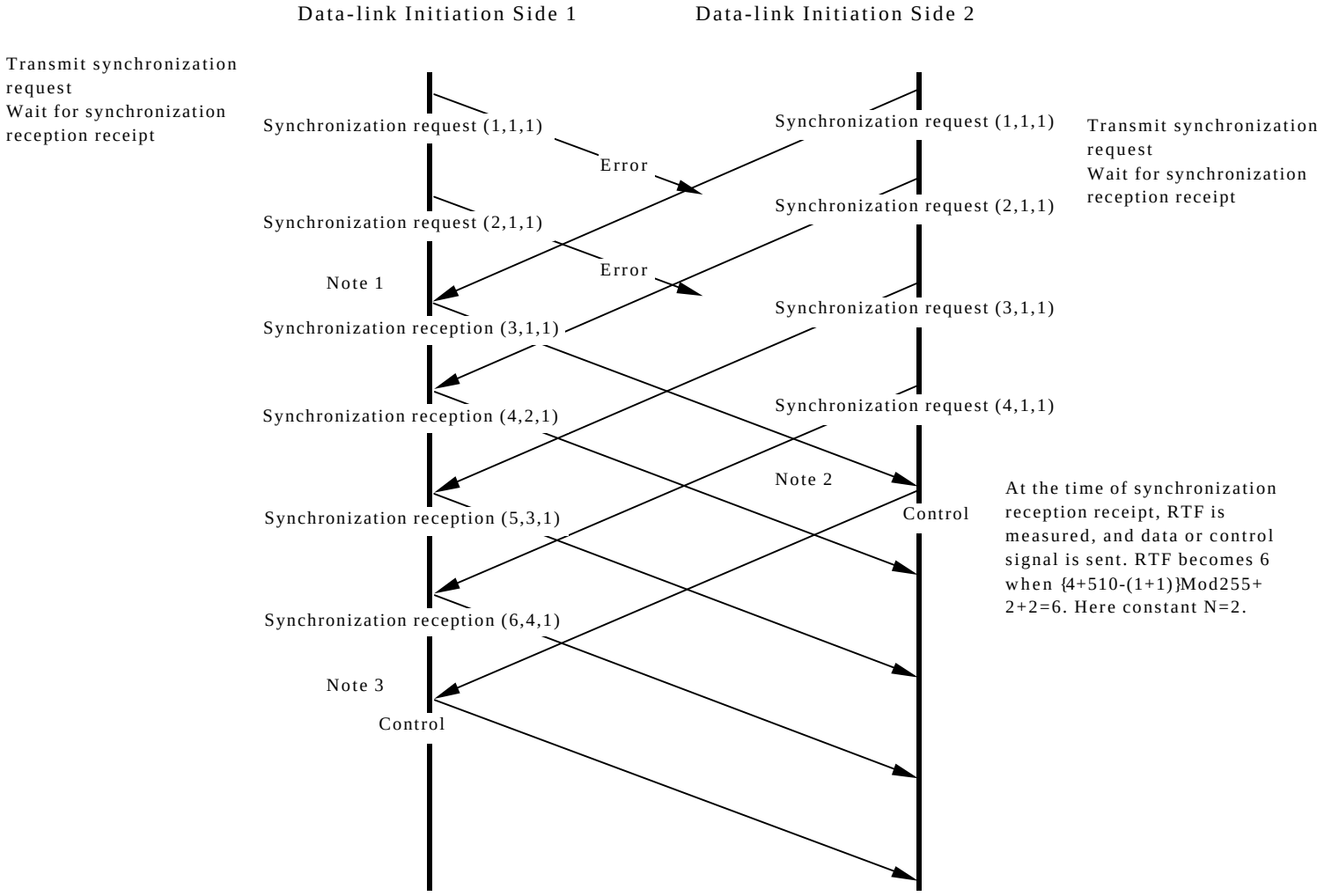
Note 1: The initiation sides are 1 and 2, and are sending a synchronization request, but because they received a synchronization request, they send a synchronization reception.

Note 2: The initiation sides are 1 and 2, and sending a synchronization reception, but because they received a synchronization reception, they measure the RTF value, and notify the RTF value through the control frame.

Note 3: After notification of the RTF value through the control frame, they send a response through the control frame.

Note 4: RTF measurement is performed separately at the initiation sides 1 and 2, and then each notifies the other side. The RTF value is compared with the measured value and the notified value, and larger value is set as the RTF.

Illustration 3.2.3 ARQ Frame Synchronization Sequence
(initiation side conflict, no circuit error)



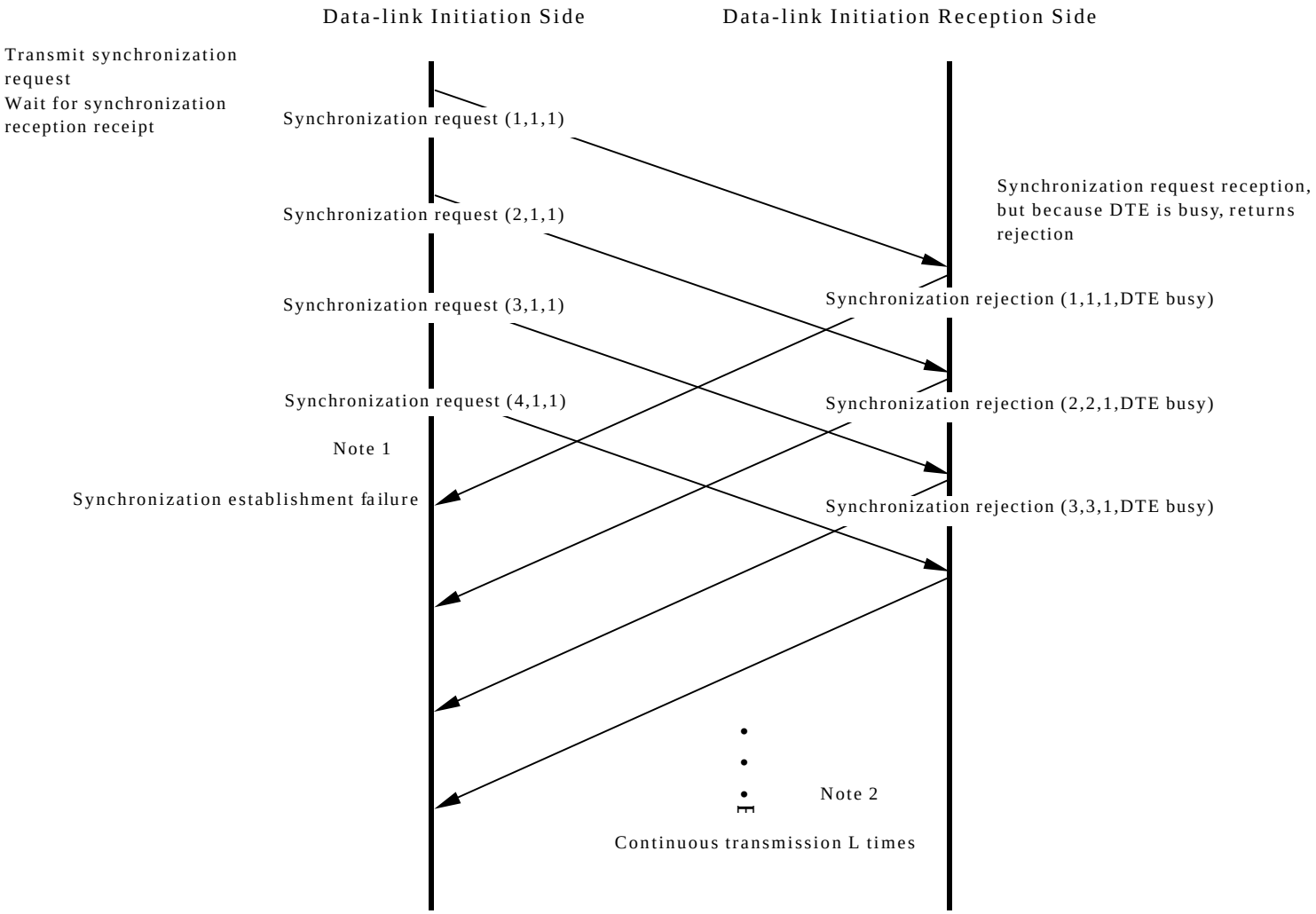
Example: Synchronization request or synchronization reception (shared sequence number, same sequence number, confirmation response number).

Note 1: The initiation side is 1, and sending a synchronization request, but because it received a synchronization request, it sends a synchronization reception.

Note 2: The initiation side is 2, and sending a synchronization request, but because it received a synchronization reception, it measures the RTF value, and notifies the RTF value through the control frame.

Note 3: At initiation side 1, when, without receiving a synchronization response it is notified of the RTF value through the control frame by initiation side 2, it sets the notified RTF value.

Illustration 3.2.4 ARQ Frame Synchronization Sequence
(initiation side conflict, circuit error exists)



Example: Synchronization request or synchronization reception (shared sequence number, same sequence number, confirmation response number).
Synchronization rejection: (shared sequence number, same sequence number, confirmation response number, reason indicator.)

Note 1: The initiation side is sending a synchronization request, but because it received a synchronization rejection, it recognizes a synchronization establishment failure and stops its synchronization request transmission.

Note 2: After sending the continuous rejection L times, the initiation reception side stops. L is 20.

Illustration 3.2.5 ARQ Frame Synchronization Rejection Sequence

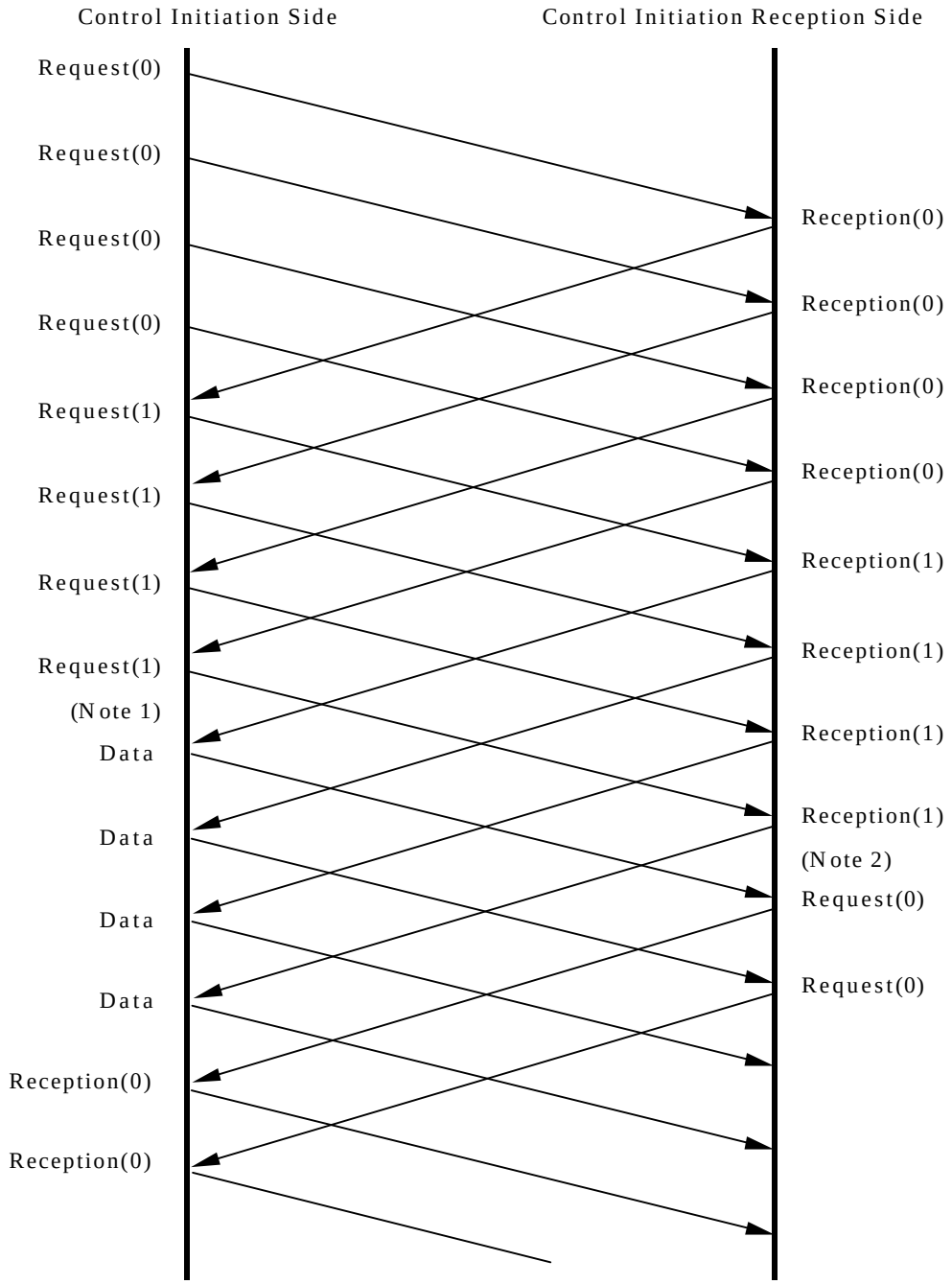
3.2.4 Control Signal System

3.2.4.1 Control Information Transmission System

Control information sent from the control initiation side are of two types: request and notification. As for reception confirmation relating to a request, if the request is permitted, then it is recepted, and if the request is not permitted, it becomes a rejection.
The response corresponds for reception confirmation regarding notification,.
The control information's transmission system is the system that anticipates control frame reception confirmation of the initiation reception side's answer as a reception/response/ rejection/continuous frame transmission is possible (called the confirmation frame hereafter) at those times when the request/response's control frame from the control initiation side is sent.
When the control frame transmission is requested, even when there is data that should be sent, the control frame is given priority and sent, and the control initiation side repeatedly sends a control frame with identical contents until a confirmation frame is received.
When transmitting a continuing control frame, confirmation frame reception from the initiation reception side is waited for, and then sends the next control frame.
In order to identify each control frame being continuously sent, a sequence number is established in the control information. By the sequence number accompanying the control information sent from the initiation side being returned as the confirmation number, the initiation side can identify which confirmation frame goes with which control frame. The sequence number's modulo number is 16, and these sequence numbers become independent in the terminal. The initial value of the sequence number at the time of initiation is 0.
The relationship of the transmission and reception of the control frame are shown in Illustration 3.2.4.1.
On the initiation side, after receiving the confirmation frame, and when there is no control information which should be continuously sent, it sends the data frame. On the initiation reception side, by sending the incrementally increased sequence number or data frame, it can recognize that the confirmation frame has reached the other side. Until then, the initiation reception side continues to send the confirmation frame even when there is data that should be sent.
It is okay to extend the control information across multiple ARQ control frames. In this case, it is indicated in the continuous frame identification bit (0: single or last frame; 1: a middle-area frame (when frames are continuous)) that a continuous frame exists.
When the control frame is in conflict with the other side, the control frame processing from the other side takes priority. In other words, when you are in the middle of sending a control frame and you receive a request or notification control frame from the other side, you stop transmission of your control frame, and perform the control processing of the request or notification, and send back a confirmation frame. Illustrations 3.2.4.2 and 3.2.4.3 show control when the control frames conflict.
When ARQ synchronization processing is initiated during transmission of a control frame,after completing ARQ re-synchronization, send the control frame. In this case, the control information and sequence number sent before the ARQ synchronization processing are saved.

The same is done when a control frame conflict occurs during the continuous frame transmission.
The processing of the re-synchronization during transmission of the control information is shown in Illustration 3.2.4.4.
There are two cases for processing regarding requests (when a continuous frame exists).
The first case, as illustrated in 3.2.4.5, is when a request of continuous frame exists' is responded to by continuous frame transmission possible;' after all the requests are received, they are processed all at once. In that case, at the control initiation response side, the results of the processing are indicated (reception/ rejection) in the last frame (when there is no continuous frame). The second case, as illustrated in 3.2.4.6, is when for each request a separate processing is performed. At times when the control initiation side is continuously controlling (continuous frame exists), when a rejection is received from the initiation reception side, as shown in Illustration 3.2.4.7, the control in use is ended.
Processing as related to notification (a continuing frame exists) can only be processed all at once, and for notification of continuous frame exists' the response is continuous frame transmission possible.'

In reception, the content of significant information in the request is copied and sent back.
However, there are times when reception may be sent back even when a part of a parameter is not permissible, and that is shown in the reception's last byte as the reception result. For example, it is the version information of the communication parameter setting. For this information, negotiation is possible, and when the side requested can't provide the requested version of the protocol, it sends back the versions it can provide to the request side. If it is possible for the request side to communicate through the changed version, communication continues as-is. When impossible to communicate (the request side does not have the changed version of the protocol), the data-link is released. In cases when the requested side can't permit the negotiation not possible' parameter, in the rejection, in order to indicate the rejected request parameter, the in-use parameter's information field are set at ALL "1." (See Section 3.2.4.3 for details.)
The last byte in the request, notification, response, and continuous frame transmission possible are set to reserved (ALL1). The confirmation frame wait timer is uniformly set at 10 seconds for the request/notification frames. The data-link release is performed during the timer time-out. Also, When the ARQ re-synchronization is initiated during a control frame transmission, this timer is reset (this means the timer is stopped, and re-initiated).
Hereafter, when control information content is added in the control frame, and control information is sent that you can't recognize, this control information's contents are not considered significant information, and are discarded. However, even if it is possible to set all the significant information, reception's reception results are possible to be partially set. These processes are the same for processing of requests (continuing frame exists), and as shown in Illustration 3.2.4.8, the control initiation reception side performs the processing for the request at the point where it decides that there is no significant information in the continuing frame.

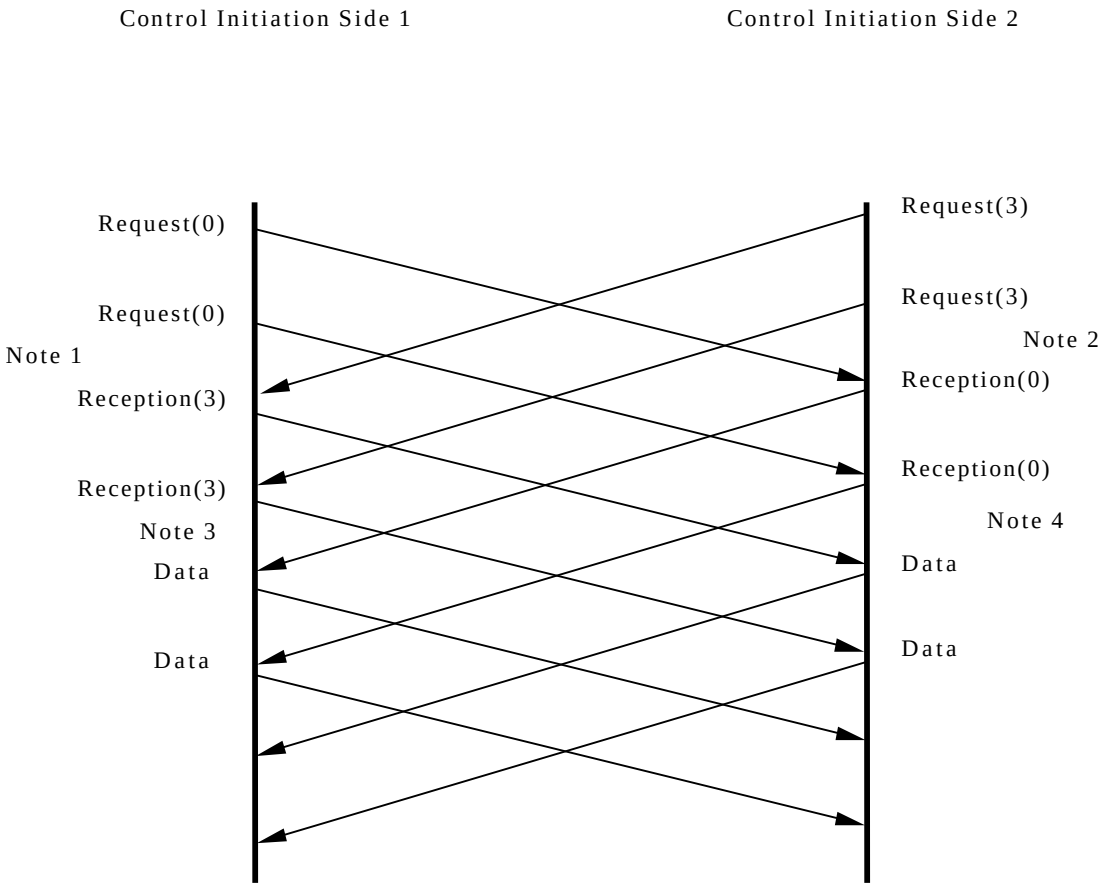


Note 1: Receive "reception (1)," and when there is no control information to be sent, send data.

Note 2: Because the confirmation was made for sending "reception (1)," send the next frame that should be sent. Here, it would be "request (0)" control frame.

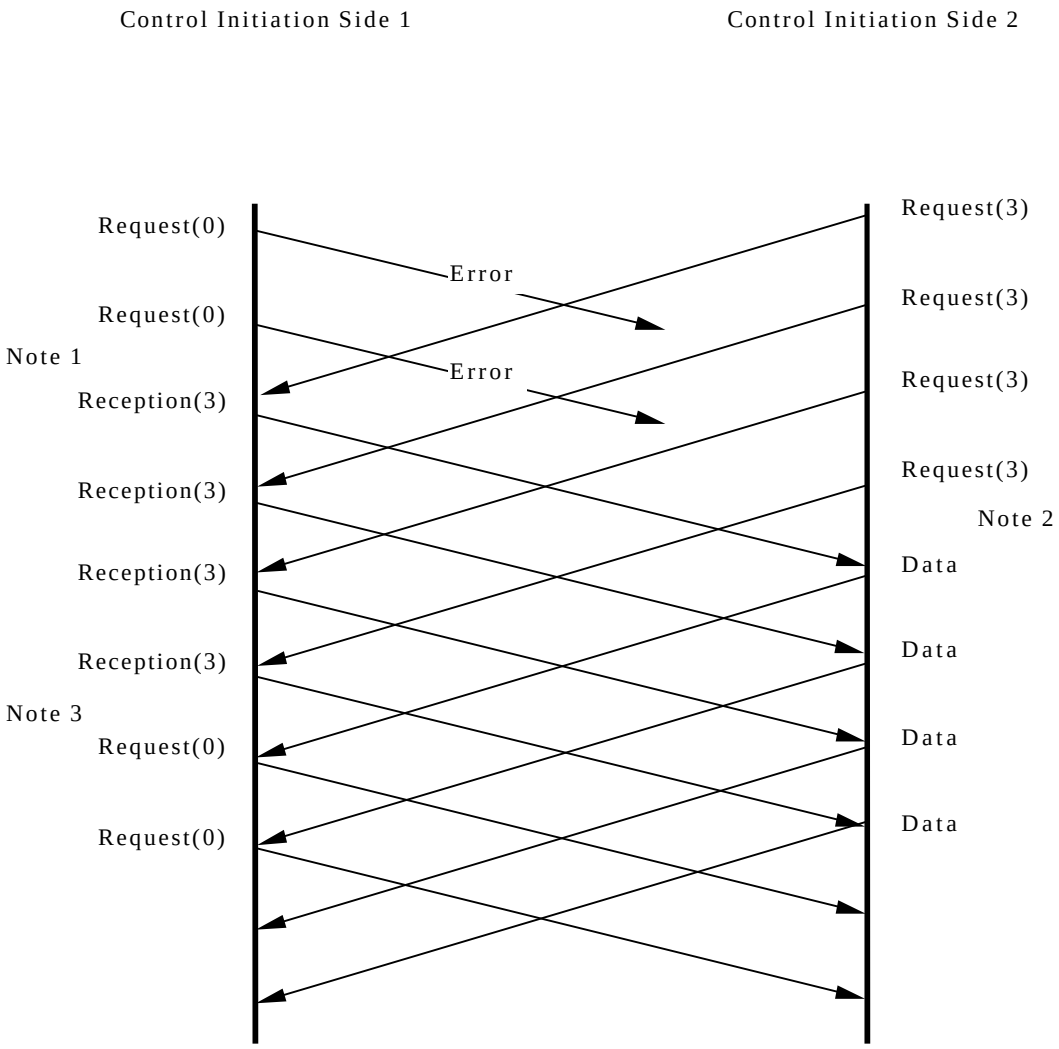
Note 3: The numbers in ( ) are the transmission sequence numbers.

Illustration 3.2.4.1 Sending and Receiving Control Frames



Note 1: Because the initiation side 1 has sent request (0)'s control frame but received request (3)'s control frame from the initiation side 2, the processing of request (0) is temporarily stopped and request (3) is processed first, then reception (3) is sent.
Note 2: Because the initiation side 2 has sent request (3) but received request (0), reception (0)'s control frame is sent.
Note 3: Data is sent because reception (0) regarding request (0) has been received.
Note 4: Data is sent because reception (3) regarding request (3) has been received.
Note 5: The numbers in ( ) are the transmission sequence numbers.

Illustration 3.2.4.2 Conflict Control of the Control Frames (no error)



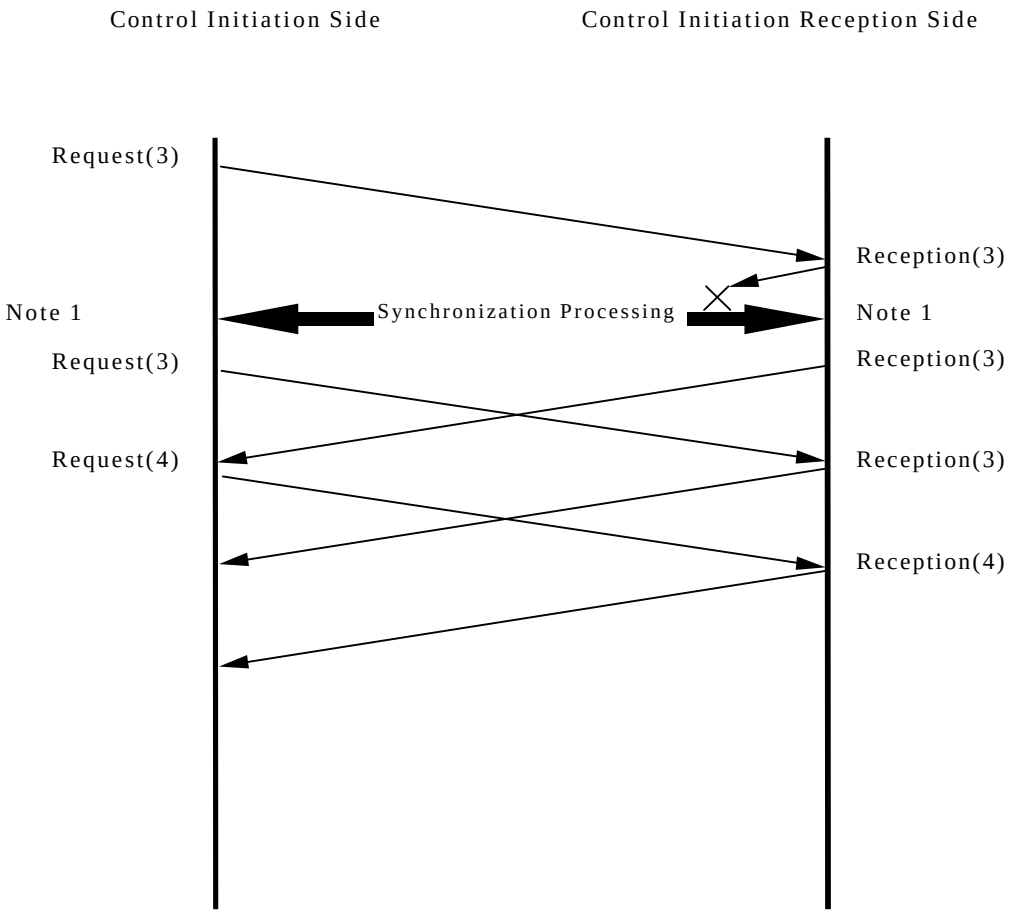
Note 1: Because the initiation side 1 has sent request (0)'s control frame but received request (3)'s control frame from the initiation side 2, the processing of request (0) is temporarily stopped and request (3) is processed first, then reception (3) is sent.

Note 2: Because the initiation side 2 has sent request (3) but received reception (3), data is sent.

Note 3: Because the initiation side 1 has received data from initiation side 2, request (0), which had been stopped temporarily, is sent..

Note 4: The numbers in ( ) are the transmission sequence numbers.

Illustration 3.2.4.3 Conflict Control of the Control Frame (with error)



Note 1: After completing ARQ synchronization, control frame transmission is started. The control initiation side starts with request (3), and the control initiation reception side
starts with transmission of reception (3)'s control information. Information before ARQ re-synchronization should be saved even after ARQ re-synchronization.

Illustration 3.2.4.4 Re-synchronization during control information transmission

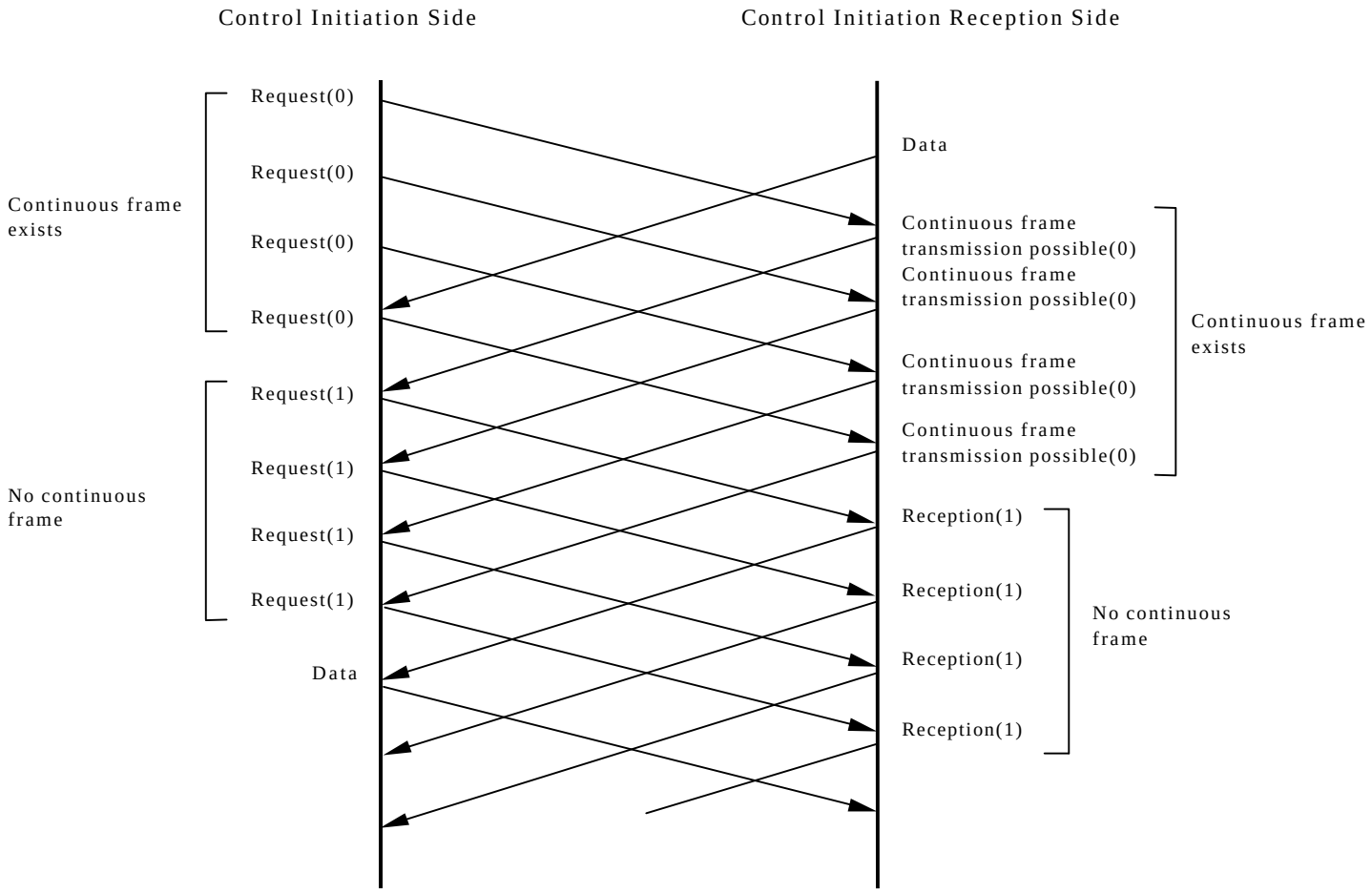


Illustration 3.2.4.5 When Processing Request All At Once

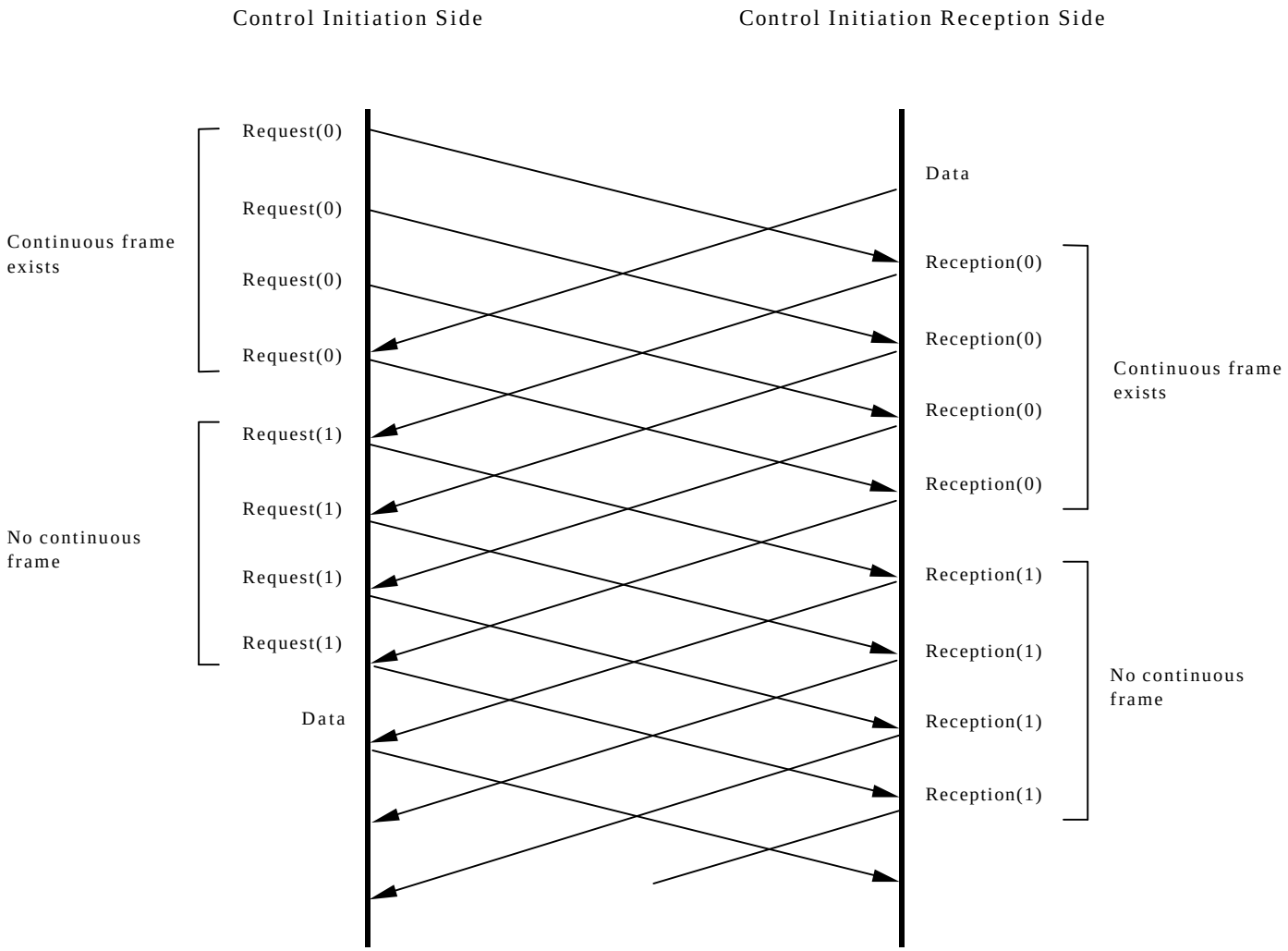


Illustration 3.2.4.6 For Processing Each Request Individually

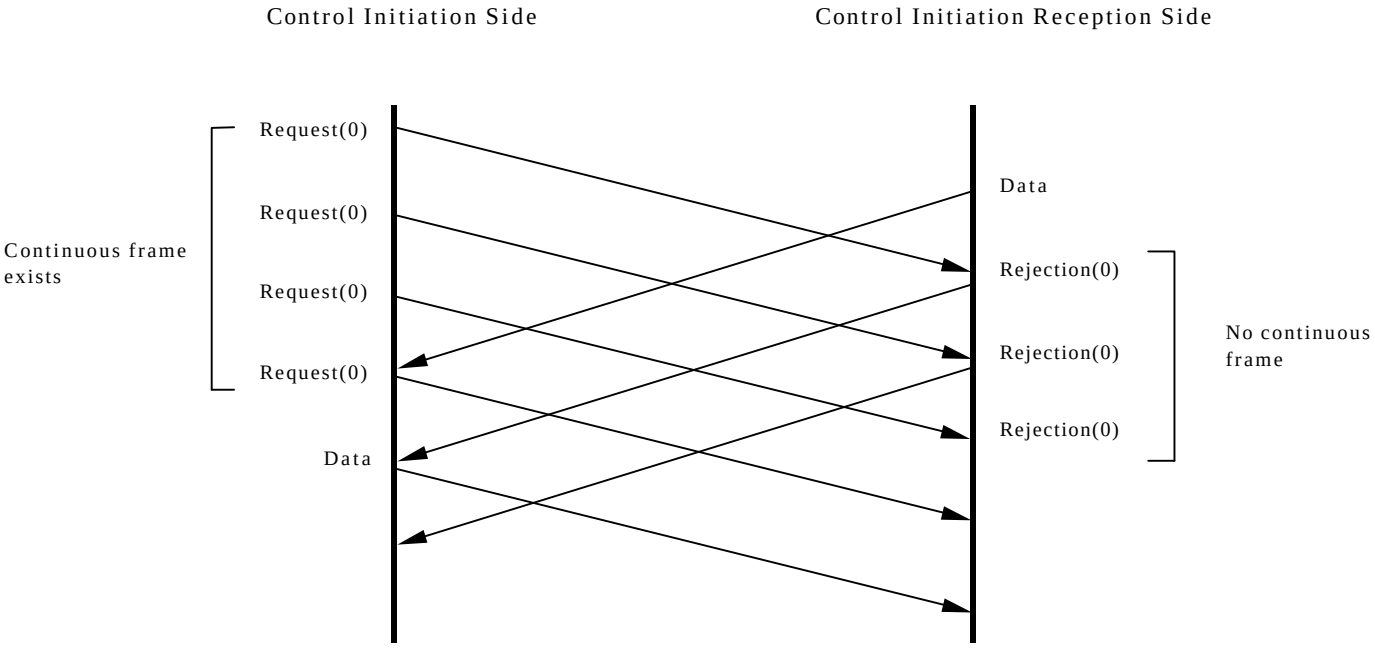
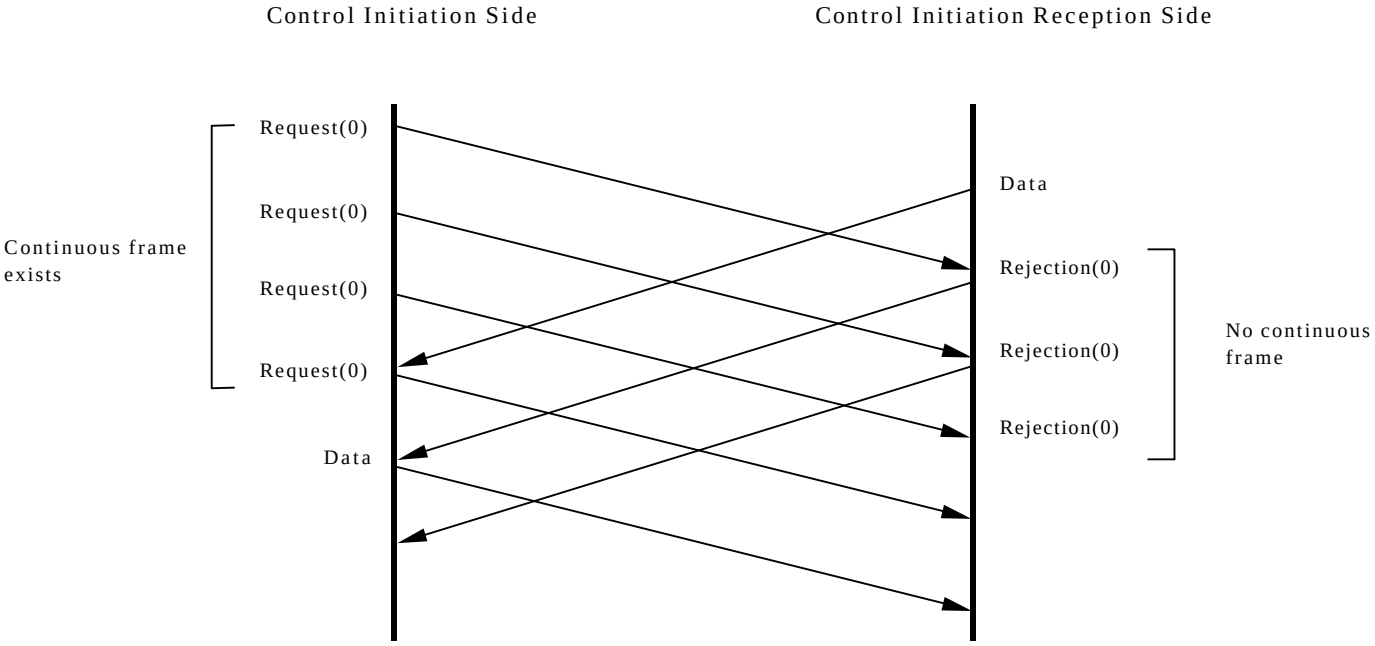


Illustration 3.2.4.7 When "Rejection" Is Received From The Non-initiating Side



Note: Reception's Received Result is "Partial Setting is Possible"

Illustration 3.2.4.8 When the Side Not Initiating Control Determines that there is No Significant Information in the Continuous Frames

3.2.4.2 Control Information Coding

Control Information Coding is as Shown Below

Sequence number	Control information classification identifier	Byte 1
Control information content identifier		Byte 2
• • •		
Reception result/Rejection reason		Byte 73

(1) Control Information Classification Identifier

Bit	4	3	2	1	
	0	0	0	1	Request
	0	0	1	0	Notification
	1	0	0	0	Reception [Request Reception]
	1	0	0	1	Rejection [Request Rejection]
	1	0	1	0	Response [Notification Response]
	1	0	1	1	Continuous Frame Transmission Allowance

(2) Sequence Number

The sequence number of the contents indicated by the control information classification indicator is shown in modulo 16, and identifies the correspondence between the control information (Request, Notification) sent by the control initiating side and the reception confirmation signal (Reception, Rejection, Response, Continuous Frame Transmission Allowance) sent from the non-initiating side. The initial value of this sequence number is "0".

(3) Control Information Content Identifier

Identifies the information contents shown in byte 3 and lower.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	0	Continuous Frame Transmission Allowance
	0	0	0	-	-	-	-	-	Control Information concerning the Data Link Establishment
				0	0	0	0	1	Communication Parameter Setting
	0	0	1	-	-	-	-	-	Control Information during Communications
				0	0	0	0	1	ARQ Parameter Setting
	0	1	0	-	-	-	-	-	Control Information concerning Data Link Release
				0	0	0	0	1	Data Link Release
	0	1	1	-	-	-	-	-	All Other Control Information
				0	0	0	0	1	User Information
			Other						Reserved

(4) Control Information Contents

(a) Communication Parameter Setting (Data Length: 10)
This message performs the communication parameter setting of this transmission process, and is the very first ARQ control message to be sent from the control initiating side when ARQ communication is begun. (Once ARQ communications are in progress, this message will not be transmitted.)

Sequence Number	Control Information Classification 0001 / 1000 / 1001 Request / Reception / Rejection	Byte 1
Control Information Content Identifier 0 0 0 0 0 0 0 1 Communication Parameter Setting		Byte 2
ARQ Data Transmission Protocol Version		Byte 3
ARQ Control Information Transmission Protocol Version		Byte 4
Measured RTF Value		Byte 5
Data Compression Method Identifier		Byte 6
Coding Words Total Number (Parameter P1)		Byte 7
Maximum Letter Line Length (Parameter P2)		Byte 8
Frame Length		Byte 9
Maximum frame number (M)		Byte 10
Reserved : 11111111		Byte 11-72
Reception Result/Rejection Reason		Byte 73

1. ARQ Data Transmission Protocol Version (Byte 3)
This parameter notifies of the protocol version relating to data transmission in the ARQ. This information can be negotiated by the terminal. Hereafter, in cases where multiple versions exist, the lower version will be chosen in the negotiation.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	1	Version 1
			Other						Reserved

2. ARQ Control Information Transmission Protocol Version (Byte 4)
This parameter notifies of the protocol version relating to control information transmission in the ARQ. The protocol regulations relating to the ARQ synchronization system are included in this protocol version. This information can be negotiated by the terminal.
Hereafter, in cases where multiple version s exist, the lower version will be chosen in the negotiation.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	1	Version 1
			Other						Reserved

3. Measured RTF Value (Byte 5)
Notification of the measured RTF value is done through the exchange of the ARQ synchronization frame. In the ARQ data-link transmission protocol Version 1, the measured RTF value is measured by the data-link initiation side, and notification of the measurement results to the data-link initiation reception side is done through this parameter.
In cases when the data-link initiation side has conflicted, the measured RTF value and the other initiation side's notified RTF value is compared, and the largest RTF value is set.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	1	1	3
	0	0	0	0	0	1	0	0	4
					:				:
	0	0	1	1	1	0	1	1	59
			Other						Reserved

4. Data Compression System Identifier (Byte 6)
This parameter designates the data compression system when ARQ data communication is performed. This information can be negotiated by the terminal. In negotiations with V.42bis and ‘no compression,' ‘no compression' is given priority.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	0	No compression
	0	0	0	0	0	0	0	1	V.42bis
			Other						Reserved

5. Coding Words Total Number (Byte 7)
This parameter designates Parameter P1 of the data compression system (V.42bis).
When the data compression system identifier (byte 13) is set to ‘no compression,' this parameter becomes invalid. This information can be negotiated by the terminal. In the negotiation, the smaller value is chosen.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	0	Reserved
	0	0	0	0	0	0	0	1	512
	0	0	0	0	0	0	1	0	1024
	0	0	0	0	0	0	1	1	2048
	0	0	0	0	0	1	0	0	4096
				Other					Reserved

6. Maximum Letter Line Length (Byte 8)
This parameter designates Parameter P2 of the data compression system (V.42bis). At times when data compression is not performed, this parameter becomes invalid. This information can be negotiated by the terminal. In the negotiation, the smaller value is chosen.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	0	Reserved
	0	0	0	0	0	1	1	0	6
	0	0	0	0	0	1	1	1	7
				:					
	0	0	1	0	0	0	0	0	32
				:					
	1	1	1	1	1	0	1	0	250
				Other					Reserved

7. Frame Length (Byte 9)
This parameter performs the setting of the ARQ frame length. This information can be negotiated by the terminal. In the negotiation, the smaller value is chosen. However, in ARQ data transmission protocol Version 1, this parameter has a fixed value of 80.
"During-communication change possibility identifier"

Bit	8	
	0	Frame length change during communication is not possible
	1	Reserved (frame length change during communication is possible)

7	6	5	4	3	2	1	
1	0	1	0	0	0	0	80
			Other				Reserved

8. Maximum Frame Number M (Byte 10)
This parameter is the number of modulos, and is set through the initial negotiation. This information can be negotiated by the terminal. In the negotiation, the smaller value is chosen.
Also, in ARQ data transmission protocol Version 1, after setting the communication parameters (during transmission), the parameters cannot be changed, but for purposes of later expansion, the during-communication change possibility identifier' is provided in the MSB. Taking into account communications via satellites, we would hope to be able to set this value at 63.
"During-communication change possibility identifier"

Bit	8	
0	During transmission, the maximum frame number change not possible.	
1	Reserved (During transmission, the maximum frame number change is possible.)	

7	6	5	4	3	2	1	
0	0	1	0	0	0	0	16
				:			
0	1	1	1	1	1	1	63
Other							Reserved

9. Reception Result (Byte 73)

Through the reception message, this parameter indicates the reception result of the request message

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	0	All settings possible (OK)
	0	0	0	0	0	0	0	1	Some settings possible (Note 1)
	Other								Reserved

Note 1: The ‘some settings possible' indicates that the request message reception side changed the requested parameters. In cases where the request message transmission side cannot permit the changed parameters, data-link release is performed.

10. Rejection Reason (Byte 73)

Through the rejection message, this parameter indicates the reason for rejection of the request message.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	1	Description error
	0	0	0	0	0	0	1	0	Setting not possible
	Other								Reserved.

(b) ARQ Parameter Setting (Data length: 3)

During ARQ communication, every time ARQ synchronization is initiated, the RTF is measured by the data-link initiation side, and after completion of ARQ synchronization, the measured RTF value of the data-link initiation side is sent to the data-link initiation reception side using this control frame.

Sequence Number	Control Information Identification 0001 / 1000 / 1001 Request / Reception / Rejection	Byte 1
Control Information Contents Identifier 0 0 1 0 0 0 0 1 ARQ Parameter Setting		Byte 2
Measured RTF Value		Byte 3
Reserved : 1 1 1 1 1 1 1 1		Byte 4 72
Reception/Rejection Reason		Byte 73

1. Measured RTF Value (Byte 3)
This parameter indicates the measured RTF value.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	1	1	3
	0	0	0	0	0	1	0	0	4
					:				:
	0	0	1	1	1	0	1	1	59
			Other						Reserved

2. Reception Result (Byte 73)
Through the reception message, this parameter indicates the reception result message of the request message.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	0	All settings possible
	0	0	0	0	0	0	0	1	Some setting possible (Note 1)
			Other						Reserved

Note 1: The ‘some settings possible' indicates that the request message reception side changed the requested parameters. In cases where the request message transmission side cannot permit the changed parameters, data-link release is performed.

3. Rejection Reason (Byte 73)
Through the rejection message, this parameter shows the reason for rejecting the request message.

Bit	8	7	6	5	4	3	2	1	
	All								Reserved

Note: This is for future expansion, and in ARQ data transmission protocol Version 1, the rejection frame is not transmitted.

(c) Data-link Release (data length: 2)
This is for requesting data-link release on the other side. This sequence example is shown in Illustrations 3.2.4.9, 3.2.4.10, and 3.2.4.11.

Sequence Number	Control Information Identification 0001 / 1000 / 1001 Request / Reception / Rejection	Byte 1
Control Information Contents Identifier 0 1 0 0 0 0 0 1 Data-link Release		Byte 2
Reserved: 1 1 1 1 1 1 1 1		Byte 3 72
Reason Indicator/Reception Result/Rejection Reason		Byte 73

1. Reason Indicator
In the request message, this parameter is used in order to indicate the reason for the performance of data-link release.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	1	-	-	-	-	Normal event class
					0	0	0	0	Normal release
					0	0	0	1	Normal release; data-link continuation forbidden
					0	0	1	0	Normal release; data-link continuation (Note 1)
					1	1	1	1	Other normal classes
	0	0	1	0	-	-	-	-	Resource use not possible class
					1	0	0	0	DTE busy
					1	0	0	1	Temporary obstruction
					1	1	1	1	Other resource use not possible classes
	0	0	1	1	-	-	-	-	Service Utilization not possible class

				1	0	0	1		Request parameter setting not possible
				1	0	1	0		Request parameter setting not possible presently
				1	1	1	1		Other service utilization not possible classes
0	1	0	0	-	-	-	-		Service not yet provided class
				0	0	0	1		Not yet provided parameter indication
				1	1	1	1		Other service not yet provided classes
0	1	0	1	-	-	-	-		Invalid information content class
				1	0	0	0		Terminal attribute not matched
				1	1	1	1		Other invalid information content classes
0	1	1	0	-	-	-	-		Sequence error
				0	0	0	0		Essential parameters insufficient
				0	0	0	1		Information content undefined or not yet provided
				0	1	0	1		ARQ condition and signal not matched
				0	1	1	0		Timer expires
				1	1	1	1		Other sequence error classes
1	0	0	0	-	-	-	-		Other peculiarities
				0	0	0	1		During voice call
				1	1	1	1		Other peculiar classes
		Other							Reserved

(Note 1) Use for the case of protocol shift in same data-link.

2. Reception Result [Reception] (Byte 73)
Through the reception message, this parameter notifies the data-link release request side that the data-link has been released. The reception message transmits repeatedly K times. In this case, K is 20.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	0	Data-link release completion
			Other						Reserved

3. Rejection Reason [Rejection] (Byte 73)
Through the rejection message, this parameter notifies the data-link release request side that the data-link cannot be released.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	1	Data-link release not possible
	1	0	0	0	0	0	1	0	Data forwarding (unforwarded data exists)
			Other						Reserve

(d) User information (Data length: 3~)
This is used to convey user information. In the contents of the information field, there are no limits, and the user information's use method is also up to the user. However, in cases where non-understandable user information requests are received, a rejection accompanied by a 'setting not possible' reason is sent. Also, even when non-understandable user information notification is received, that response to the notification is sent.

Sequence Number	Control Information Identification 0001 / 1000 / 1001 / 0010 / 1010 Request/Reception/Rejection/Notification/Response	Byte 1
Control Information Content Identifier 0 1 1 0 0 0 0 1 User Information		Byte 2
User Information Content Identifier		Byte 3
User Information		Byte 4 72
Reception Result/Rejection Reason		Byte 73

1. User Information Content Identifier (Byte 3)
This parameter indicates the contents of the user information.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	1	
				:					User defined
	0	1	1	1	1	1	1	1	
				Other					Reserved

2. Reception Result [Reception] (Byte 73)
Through the reception message, this parameter indicates the reception results of the request message.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	0	All settings possible
	0	0	0	0	0	0	0	1	Some settings possible(Note1)
	0	0	0	0	0	0	1	0	
				:					User defined
	0	1	1	1	1	1	1	1	
				Other					Reserved

Note 1: The 'some settings possible' indicates that the request message reception side changed the requested parameters. In cases where the request message transmission side cannot permit the changed parameters, data-link release is performed.

3. Rejection Reason [Rejection] (Byte 73)
Through the rejection message, this parameter indicates the reason for rejecting the request message.

Bit	8	7	6	5	4	3	2	1	
	0	0	0	0	0	0	0	1	Description error
	0	0	0	0	0	0	1	0	Setting not possible
	0	0	0	0	0	0	1	1	
					:				User defined
	0	1	1	1	1	1	1	1	
				Other					Reserved

(e) Continuous Frame Transmission Possible (Data length: 2)
When the continuous frame identification bits of "request" and "notification" are set to "continuing frame exists," it permits the control frame transmission side to transmit the continuous frame.

Sequence Number	Control Information Identification 1011 Continuous Frame transmission possible	Byte 1
Control Information Content Identifier 0 0 0 0 0 0 0 0 Continuous Frame transmission possible		Byte 2
Reserved: 1 1 1 1 1 1 1 1		Byte 3 72
1 1 1 1 1 1 1 1		Byte 73

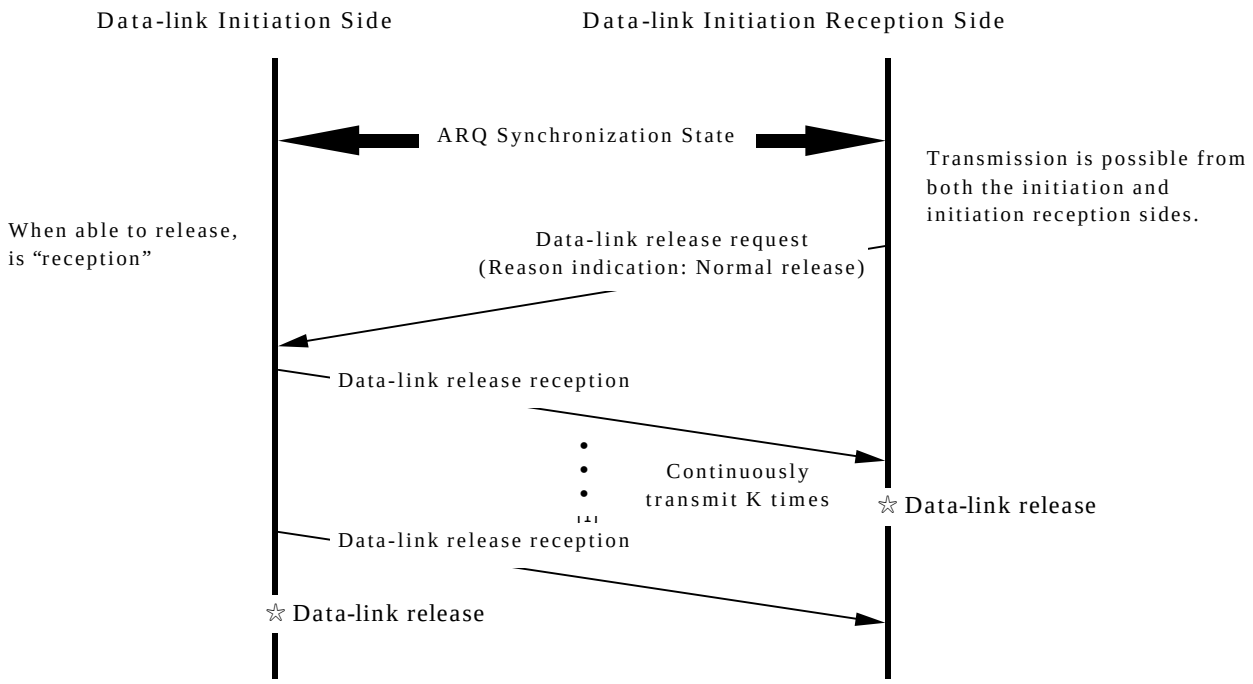


Illustration 3.2.4.9 ARQ Data-link Release Successful

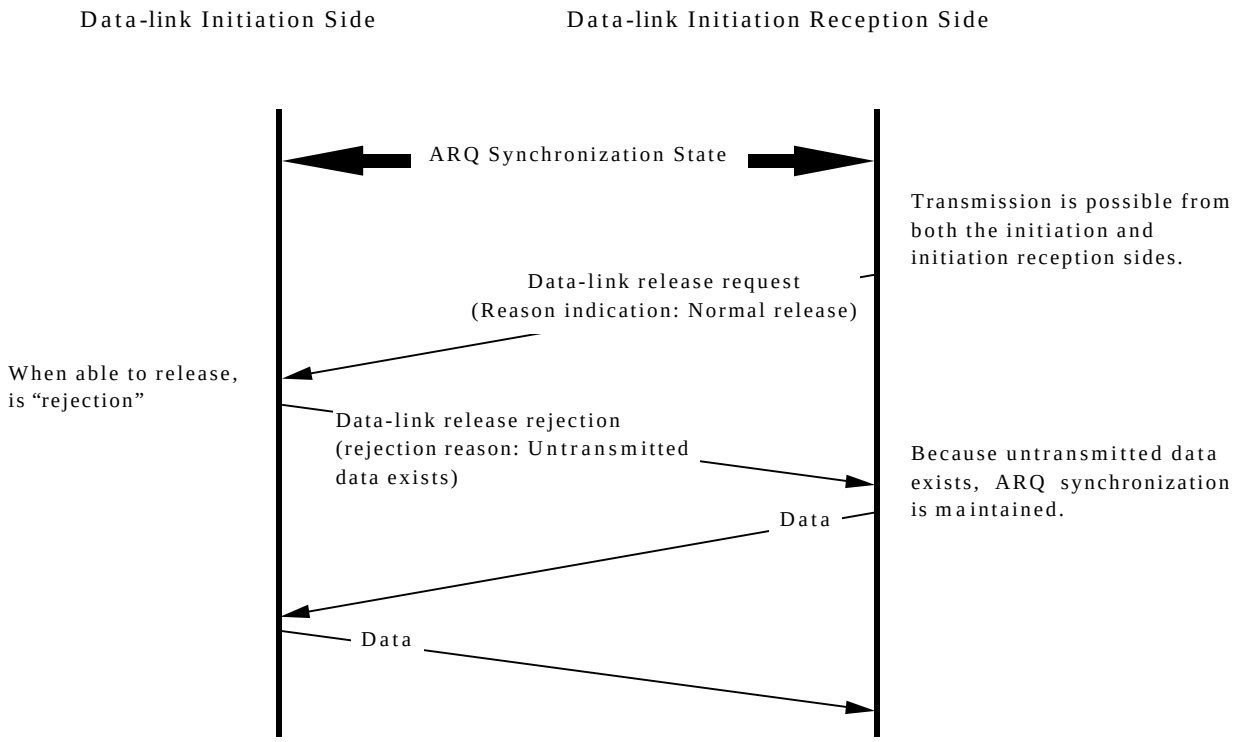
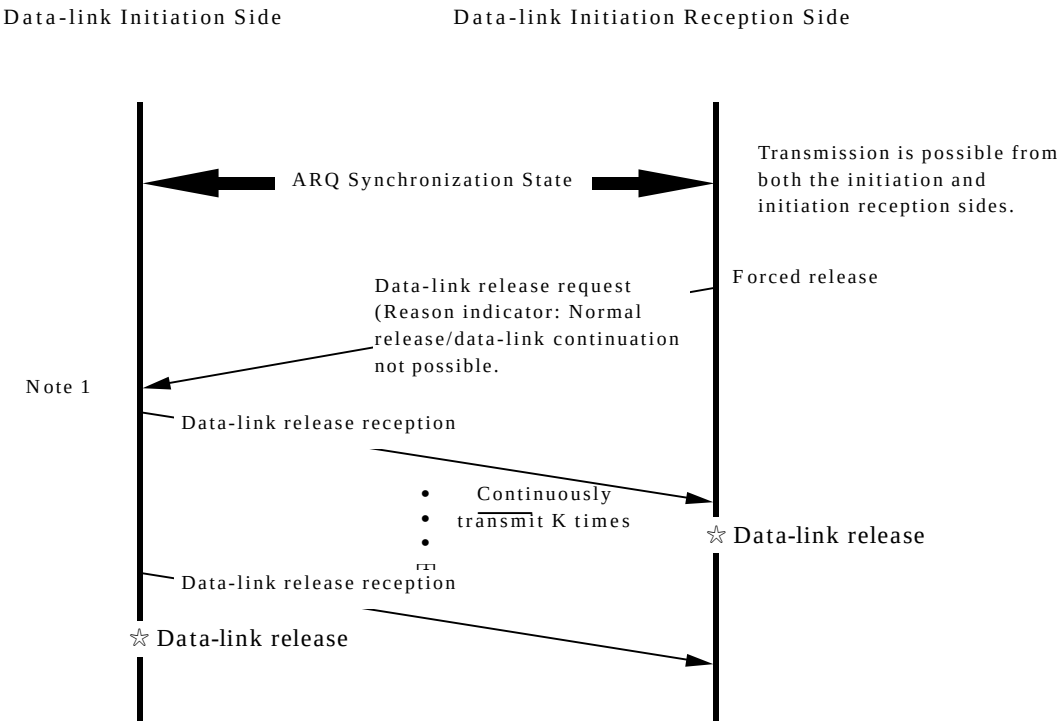


Illustration 3.2.4.10 ARQ Data-link Release Rejection



Note 1: When the reason indicator is "normal disconnection/data-link continuation not possible," it means that the data-link must be forced to release.

Illustration 3.2.4.11 ARQ Data-link Release

3.2.4.3 Communication Parameter Negotiation

In order for both the initiation side and initiation reception side to set their possible use communication parameters, "communication parameter setting" or "ARQ parameter setting" parameters are sent through the control frame, and negotiated through the terminal. When negotiation fails, data-link release is performed because connection is not possible. Parameters that are possible to negotiate and those connection rules are shown below. (For details of control information contents, see 3.2.4.2.) Also, Illustration 3.2.4.12 shows a sequence example of when a successful communication parameter is set with no parameter changes; Illustration 3.2.1.13 shows a negotiation success sequence; Illustration 3.2.1.14 shows a negotiation failure sequence; Illustration 3.2.1.15 shows the negotiation conditions when there are conflicting control frames. When negotiations conflict, the initiation side retains in memory its requested parameters, and at the point it receives the other side's communication parameters, it takes the received parameters and its own transmitted parameters and compares and chooses following the negotiation rules.

(1) Negotiation Possible Parameters

Communication parameter settings:

- ARQ data transmission protocol version
- ARQ control information transmission protocol version
- Measured RTF value
- Data compression system identifier
- Coding words total number (P1)
- Maximum letter line length (P2)
- Frame length
- Maximum frame number

ARQ parameter setting:

- Measured RTF value

(2) Negotiation Rules

(a) ARQ data transmission protocol version

At present, only Version 1 exists, but in the case that through coming expansions multiple versions do exist, the lower version is chosen.

(b) ARQ control information transmission protocol version

At present, only Version 1 exists, but in the case that through coming expansions multiple versions do exist, the lower version is chosen.

(c) Measured RTF value

The larger value of the measured RTF is chosen.

(d) Data compression system identifier

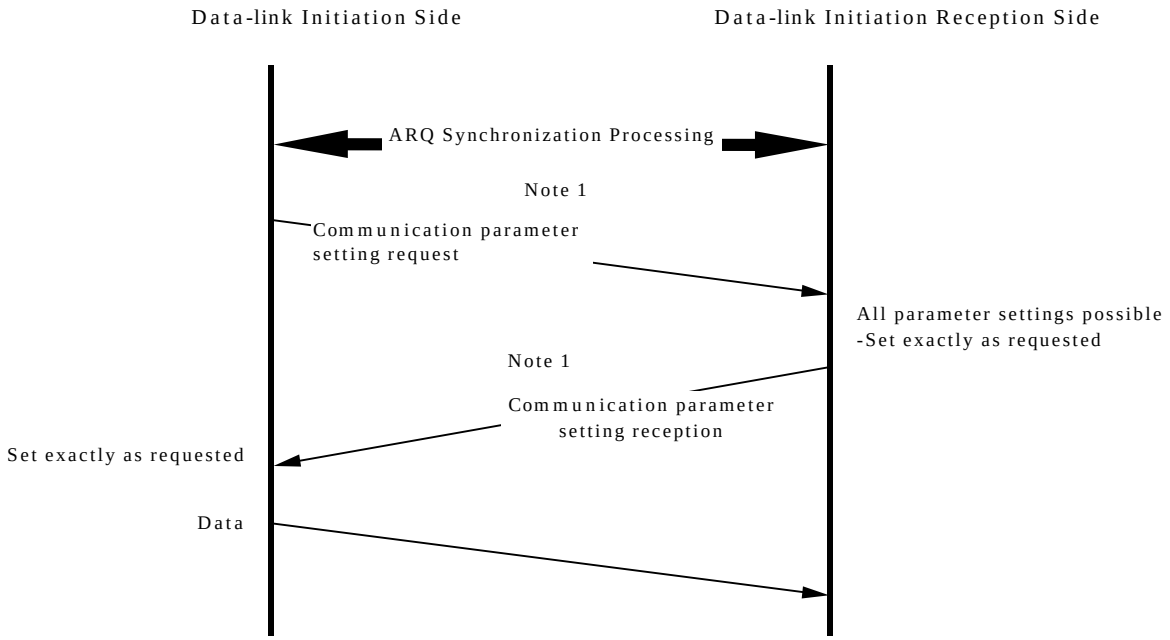
With the V.42bis and ‘no compression,' ‘non-compression' is given priority and chosen.

(e) Code word total number (P1)
The smaller of the values is chosen.

(f) Maximum letter line length (P2)
The smaller of the values is chosen.

(g) Frame length
The smaller of the values is chosen.

(h) Maximum frame number
The smaller of the values is chosen.



Note 1: An actual bit-coding example is given in Attachment 8.

Illustration 3.2.4.12 Successful Communication Parameter Setting

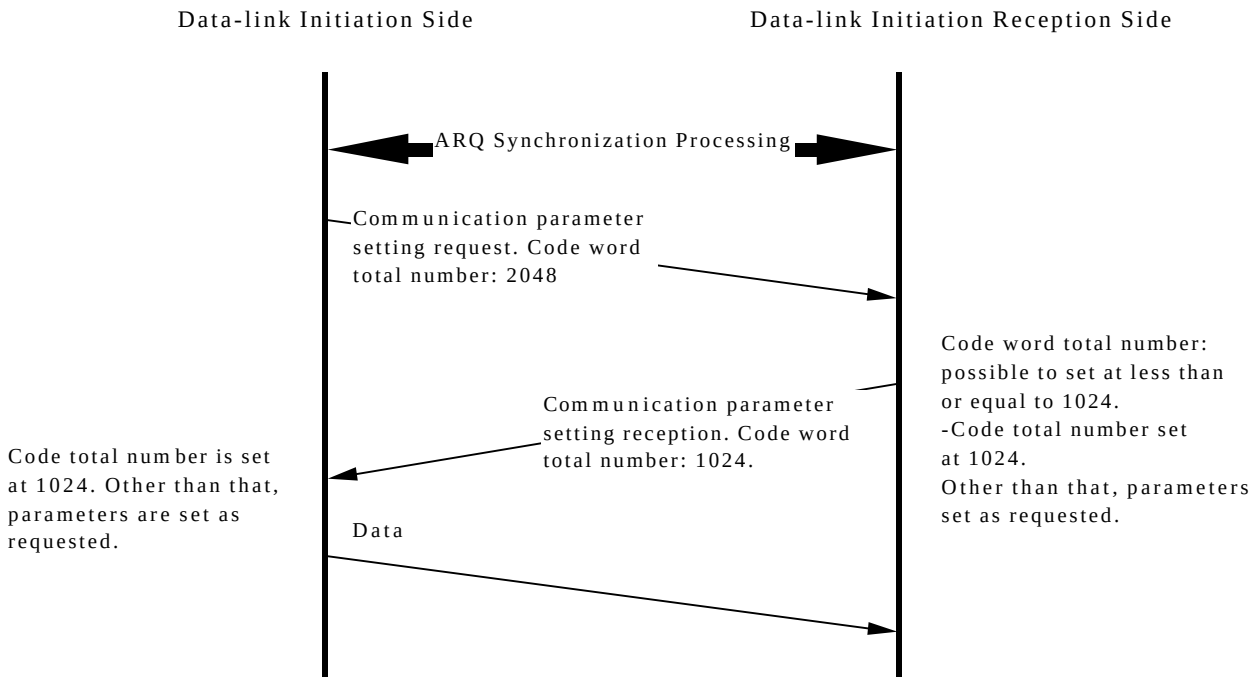
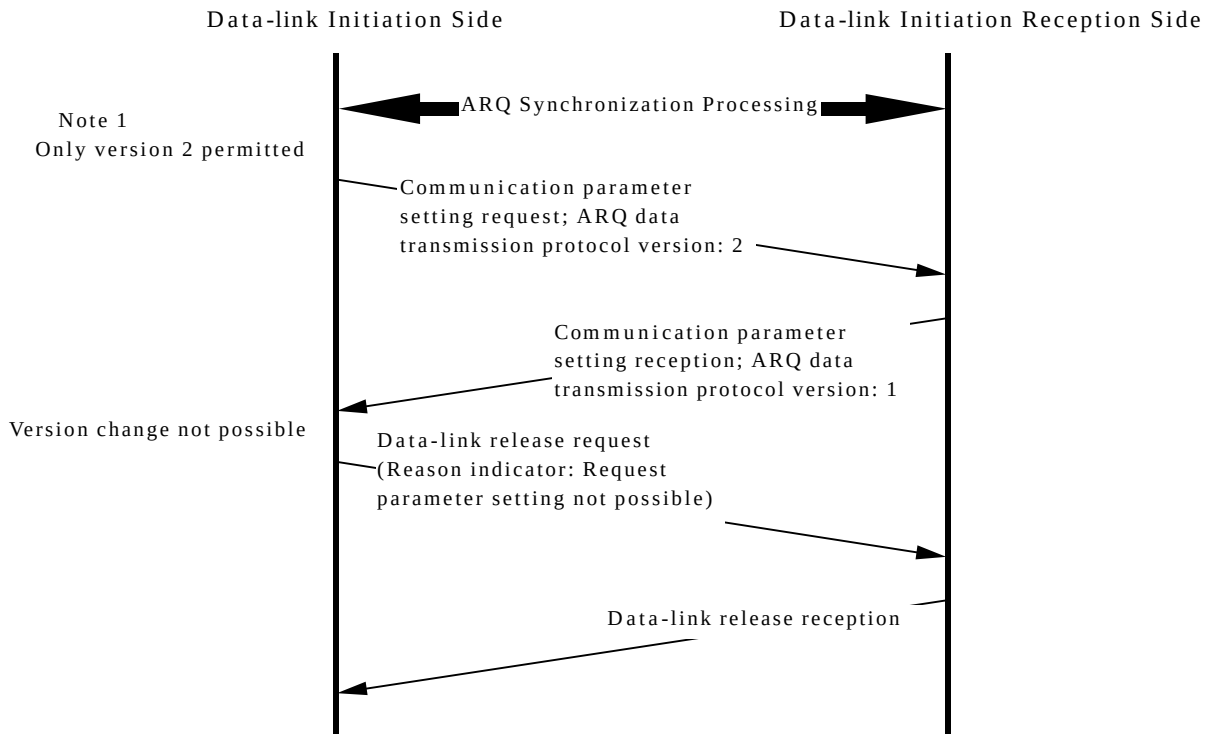
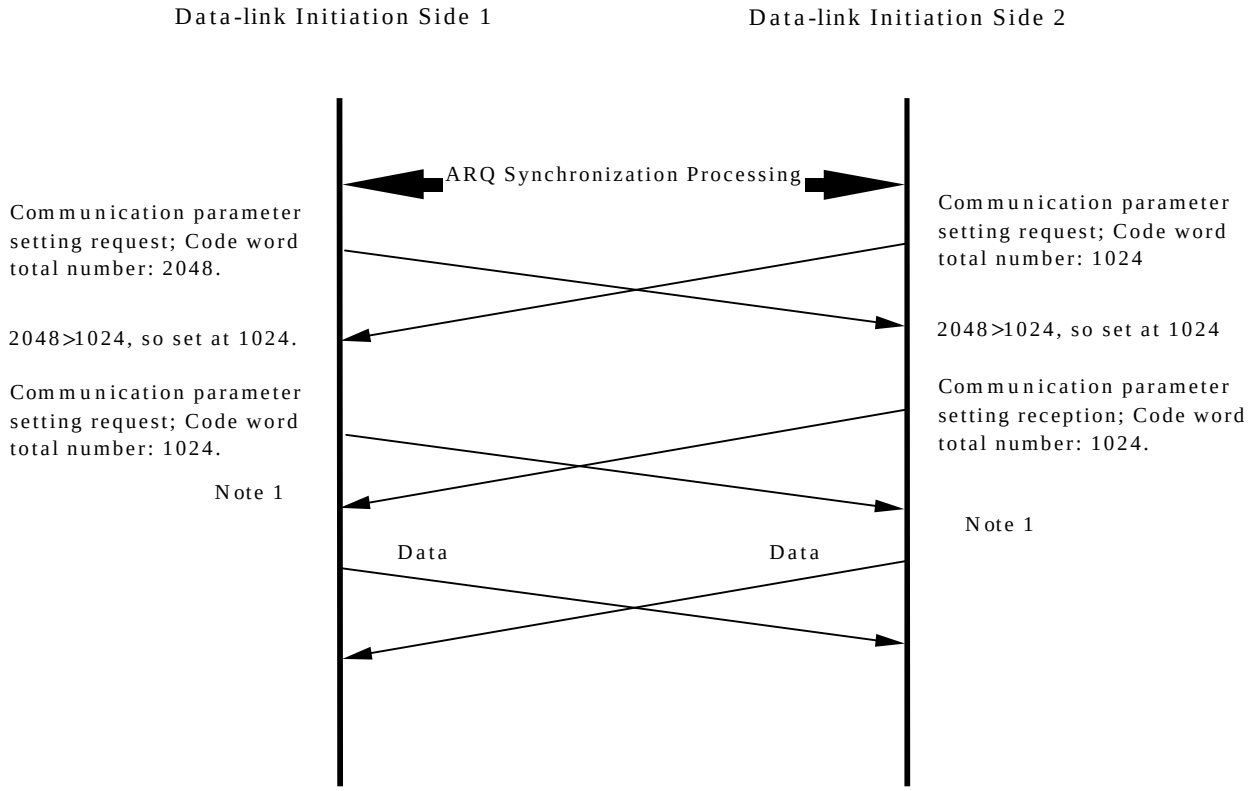


Illustration 3.2.4.13 Successful Communication Parameter Negotiation



Note 1: In the case of version upgrade in future, there is the possibility of user setting, etc.

Illustration 3.2.4.14 Communication Parameter Negotiation Failure



Note 1: Even in cases of conflict, according to negotiation rules, both have the same values set.

Illustration 3.2.4.15 Negotiation of Communication Parameter Conflict

3.2.5 Data Frame Retransmission Control System

The error control in the data frame employs Selective Repeat (SR)-mode ARQ, retransmitting error frames only. Flow control is assimilated through the ARQ data frame processing section. If continuous frame errors above the number of times stipulated are detected, the re-synchronization process is initiated. Also, in order to achieve efficient transmission number return mode SR ARQ in the limited buffer, the very last byte in the user data domain within the data frame is used, and modulo control is performed.

3.2.5.1 ARQ Control

Basic actions are shown below. Action flow is shown in Illustrations 3.2.5.1, 3.2.5.2,and 3.2.5.3.

3.2.5.1.1 Definition of FFI

FFI indicates the frame number.

MSB 0 0 0 0 0 0 LSB	*
0 0 0 0 0 1	Frame number = 1
• •	• •
1 1 1 1 1 1	Frame number = 63

*Frame number “0” occurs in the following cases :
(1) When the subject of retransmission control data does not exist within the frame.
(2) It is the fixed value for FFI in the control frame.

3.2.5.1.2 Definition of FBI

FBI indicates the request frame number.

MSB 0 0 0 0 0 0 LSB	*
0 0 0 0 0 1	Frame number = 1
• •	• •
1 1 1 1 1 1	Frame number = 63

*Frame number “0” occurs in the following cases :
(1) It is the fixed value for FBI in the control frame.

3.2.5.1.3 Data Transmission Side Processing (FFI Decision Processing)

- Increase incrementally from the present requested frame (this is indicated in FBI), and repeatedly retransmit until the Maximum outstanding frame (Note). However, in cases

where data that should be sent is not in M (maximum frame number) frames, transmit only frames in which data exists.

- As stated above, in the midst of the repetition, transmit the frame requested by the FBI. However, ignore FBI less than the RTF. This RTF is measured and set at the same time of ARQ frame synchronization establishment. (See materials on synchronization establishment sequence.)
- When the data that should be sent is all gone, FFI=0, and the frame with data length=0 is sent.

Note: The “outstanding frame" is a frame that can be sent without waiting for reception confirmation from the other side, and that maximum number is the maximum outstanding frame number. The maximum outstanding frame number and the modulo number's have the following relationship.

Maximum outstanding frame number = modulo number-1

Control flow is shown in Illustration 3.2.5.2.

3.2.5.1.4 Data Reception Side Processing (FBI Decision Processing)

- The error frame in the FCS is canceled.
- In the feedback information (FBI), the oldest unreceived frame number is inserted as the request frame.
- When there are flow control requests due to DTE reception processing delay, the update processing of the request frame is not performed. Until the buffer-full condition is canceled, the progression of the ARQ protocol is restrained by not changing the content of the FBI.
- Within the reception data frame, frames that are judged as being identical frames by the FFI=0 frame and reception comparison processing (see 3.2.5.2) have the FBI taken out and canceled. Control flow is shown in Illustration 3.2.5.3.

3.2.5.2 Data Comparison Processing

In order to make the application of the transmission number return mode SR ARQ within the limited outstanding frame number possible, the following processes are performed at the time that data is assembled at the data transmission side and at the time of data reception at the reception side.

Data construction time: In cases where more than 73 bytes of significant information exist.
If within the last 1 byte in the data domain within the data frame (called the data domain below) presently being constructed, and the 1 byte in the data domain before the 1 Mod are identical, that 1 byte is sent through the next frame.
In its place, 1 byte is inserted in all the 1 bytes in the data domain before the 1 Mod that have inverted 8-bit bit lines. Therefore, in this case, the significant information becomes 72 bytes. In cases where the last 1 byte in the data domain within the data frame presently being constructed and the 1 byte in the data domain before the 1 Mod differ, it is constructed as-is. The significant information in this case is 73 bytes.

In cases where the significant information doesn't fill the 73 bytes:

The last 1 byte in the data domain inserts 1 byte of 8-bit bit lines, which inverts all 1 bytes in the frame before the Mod 1.

Data Reception time: The last 1 byte of the data domain within the data frame presently being transmitted is compared and monitored with the last 1 byte of the data domain within the buffer used for reception frames with the identical number. In cases where the last 1 byte in the data domains are equal, the user data in the reception frames are canceled.

Note 1: The initial value of ARQ transmission frame buffer's last 1 byte is a all 0. Thus, in the initial transmission data frame after link establishment, when there are not 73 bytes of significant data, the data domain's last 1 byte are All 1, as based upon Illustration 3.2.5.4.

Note 2: The initial value of the ARQ reception frame buffer's data domain's last 1 byte is All 0.

Note 3: When no user data exists, data comparison processing is not performed.

Illustration 3.2.5.4 shows comparison processing flow at the time of data transmission (when constructing new data), and Illustration 3.2.5.5 shows comparison processing flow at the time of data reception.

Below, the principles of data frame construction at the data transmission side are indicated as "Notes." Also, in the illustrations, the ARQ frame is expressed as the first-level 20-byte X 4.

Note 1: When no user data exists in the data domain within the frame (data length=0), up through the data domain's "1~72 bytes," "1" is inserted. In this case, the data domain's 73rd byte is reserved (default All 1).

↓Continuous frame classification bit (1 bit)

FI:0010	FFI:000000	FBI: Follow FBI decision processing	0	Data length: 0000000	Data (17 byte). Filled with 1

Data (20 byte) : filled with 1

Data (20 byte) : filled with 1

Data (15 byte) : filled with 1	Reserved (8 bit) Default : filled with 1	FCS (32 bit)

(Shaded areas are the data domain)

Note 2: When user data of bytes exist in the data domain within the frame, up through the data domain's + 1 byte~72 byte insert "1." In this case, for the 73rd byte in the data domain, data comparison processing is followed.

Example 1: When 20 bytes of user data exists

↓Continuous frame classification bit (1 bit)

FI:0010	FFI: Follow FFI decision processing	FBI: Follow FBI decision processing	0	Data length: 0010100	Data (17 byte): User data

Data (3 byte) : User data	Data (17 byte) filled with 1

Data (20 byte) : filled with 1

Data (15 byte) : filled with 1	Follow data comparison processing	FCS (32 bit)

(Shaded areas are the data domain)

Example 2: When 72 bytes of user data exists.

↓Continuous frame classification bit (1 bit)

FI:0010	FFI: Follow FFI decision processing	FBI: Follow FBI decision processing	0	Data length: 1001000	Data (17 byte): User data

Data (20 byte) : User data

Data (20 byte) : User data

Data (15 byte) : User data	Follow data comparison processing	FCS (32 bit)

(Shaded areas are the data domain)

Example 3: When more than 73 bytes of user data exists

↓Continuous frame classification bit (1 bit)

FI:0010	FFI: Follow FFI decision processing	FBI: Follow FBI decision processing	Follow continuous bit supplement principles	Data length : Follow data comparison processing result	Data (17 byte): User data

Data (20 byte) : User data

Data (20 byte) : User data

Data (15 byte) : User data	Follow data comparison processing	FCS (32 bit)

(Shaded areas are the data domain)

3.2.5.3 Actions During Frame Synchronization Processing

3.2.5.3.1 Actions at Time of Link Establishment

Perform initialization of internal state variables and memory content.

3.2.5.3.2 Actions When Frame Synchronization Processing is Initialized During Communications

When a set repeated frame error is detected while in the data frame sending mode, the re-synchronization process is entered. If re-synchronization processing is initialized, the internal ARQ state variables are saved. The internal state variables are shown in Illustration 3.2.5.1. At the time when frame synchronization is established, the saved internal state variables are initialized,and ARQ actions are resumed.

3.2.5.3.3 RTF

RTF is also measured for each synchronization establishment sequence initialization, and is reset.
When the measured RTF value or the RTF value notified via the ARQ control frame is outside of the set boundary, release of the data link is performed.

3.2.5.3.4 Maximum Frame Number M

The frame number's repeated unit (modulo number) in the ARQ control is negotiated through the control frame at the time communications begin as the maximum frame number M. In this case, the data transmission side and the reception side choose the smaller. Taking communication via satellite into consideration, we hope to set this value at 63.

[Data Transmission Side Processing (FFI decision processing)]

Internal Parameters for Control Use

V (S1) : Stored Request Frame Number
V (S2) : Transmission Frame Pointer
T(I) : For the round trip delay time corresponding to each frame number, the monitor timer I = 1 ~ M.
However, the maximum value for T (i) should be more than 2M.
N (S) : The next transmission frame number (Content of FFI)
N (R) : Contents of the FBI within the reception frame (Backward information from the other side.)
RTF : The set round trip delay time.
M : The maximum frame number set through negotiations through the control frame.

Initial Value of Each Parameter

V (S1) =1, V (S2) = 0, T (I) = 0, N (S) = 0

[Data Reception Side Processing (FBI Decision Processing)]

Internal Parameters for Control Use

V (R1) : Request Frame Number
N (S) : Reception Frame Number (FFI content from the other side.)
N (R) : Content of the FBI of the frame transmitted. (Backward information sent to the other side.)
RF (I) : The flag corresponding to each received or unreceived frame number, I = 1~M
(RF (I) == 0 : unreceived, RF (I) == 1: received)

Initial Value of Each Parameter

V (R1) = 1, N(R) = 1, RF (I) = 0

Illustration 3.2.5.1 Internal State Variables

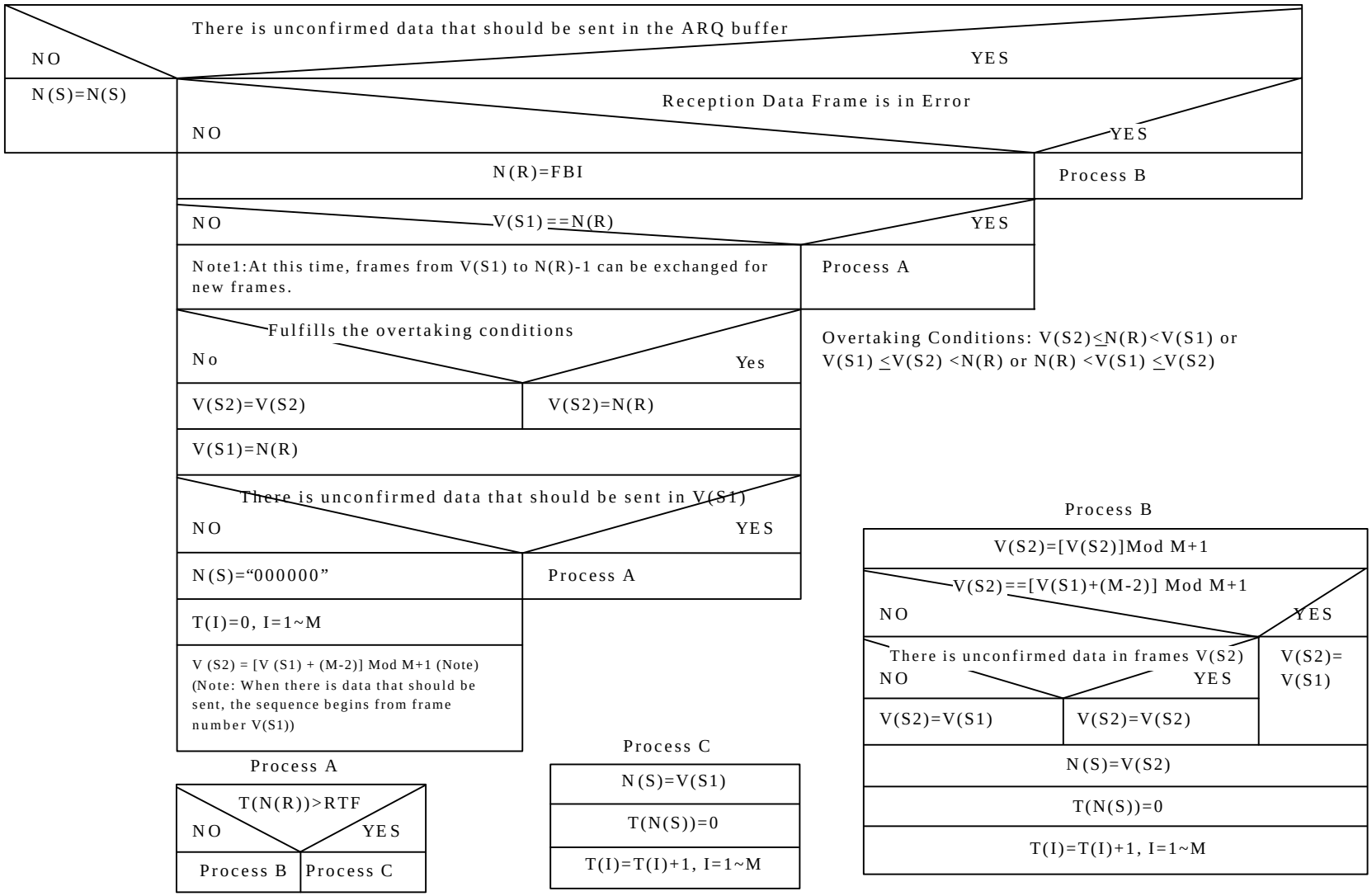
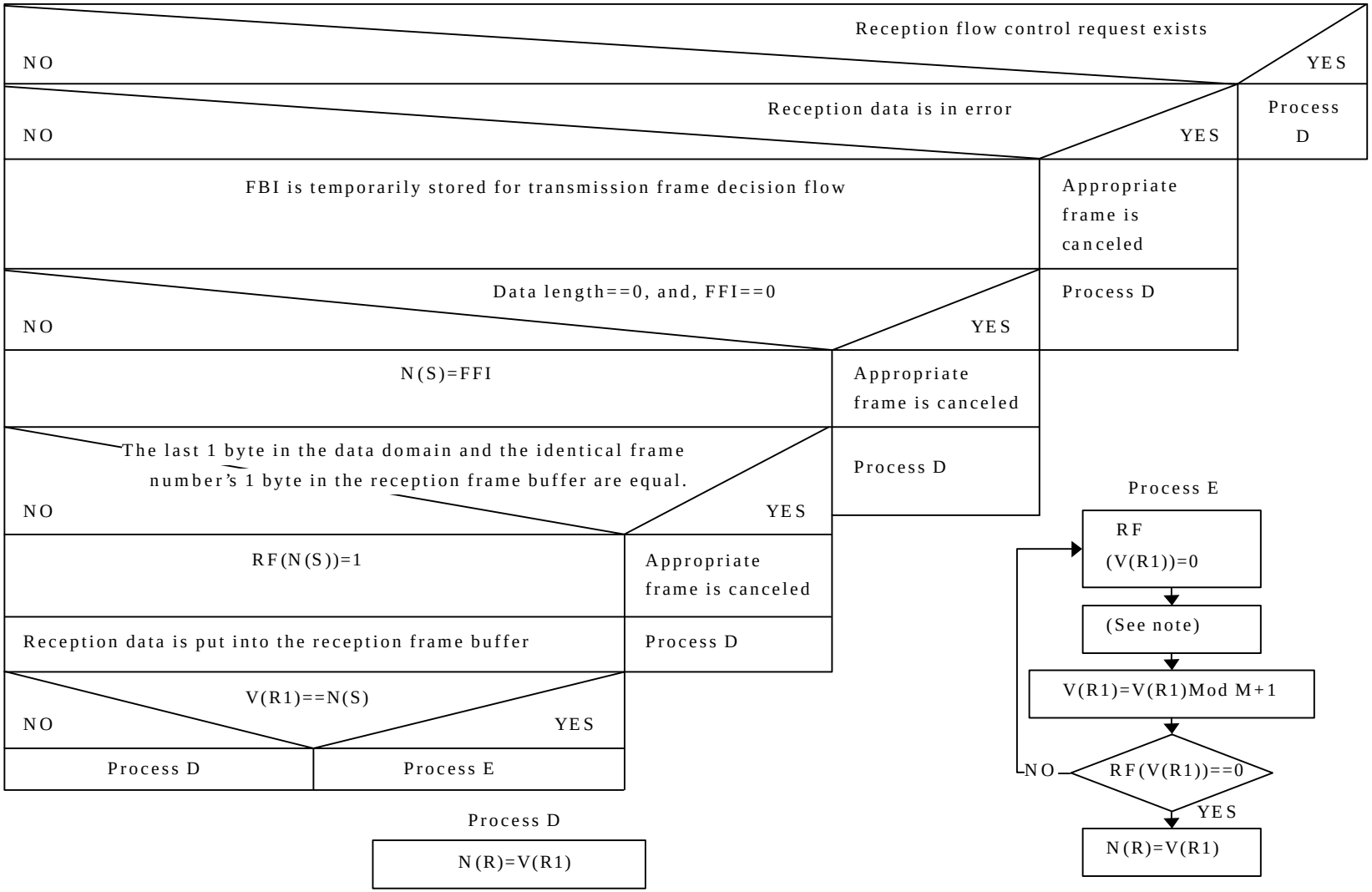


Illustration 3.2.5.2 Sending Frame (FFI) Decision Flow



Note: At this point, the frame of number V(R1) can be passed to the upper level.

Illustration 3.2.5.3 Request Frame(FBI)Decision Flow

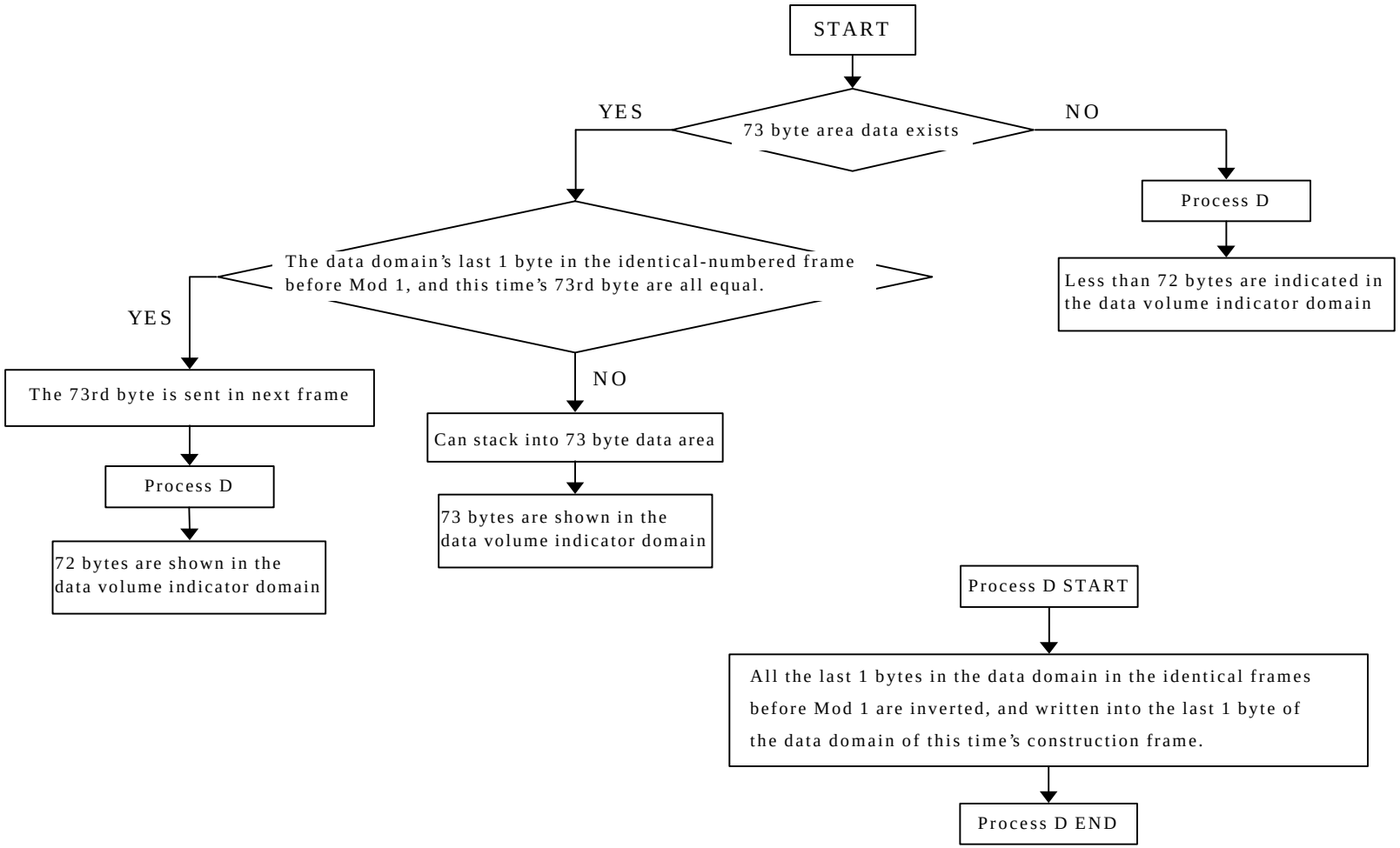


Illustration 3.2.5.4 Flowchart at Time of Frame Construction

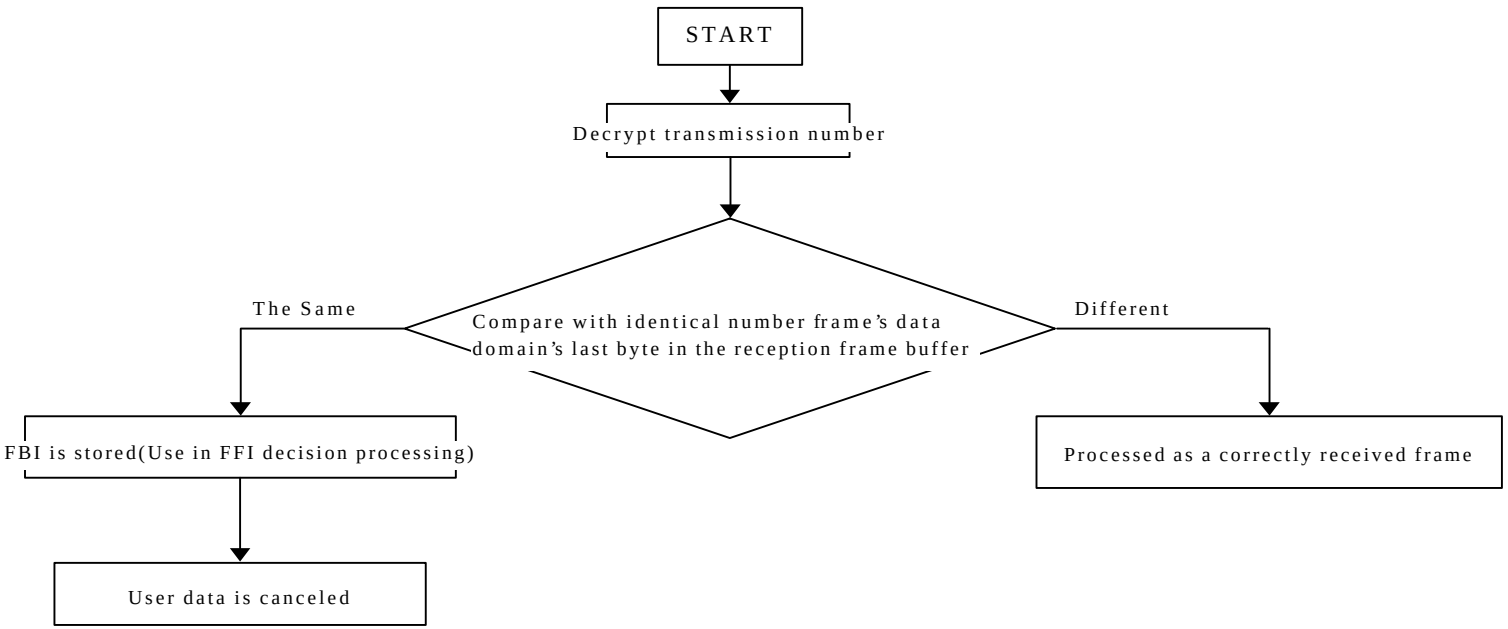


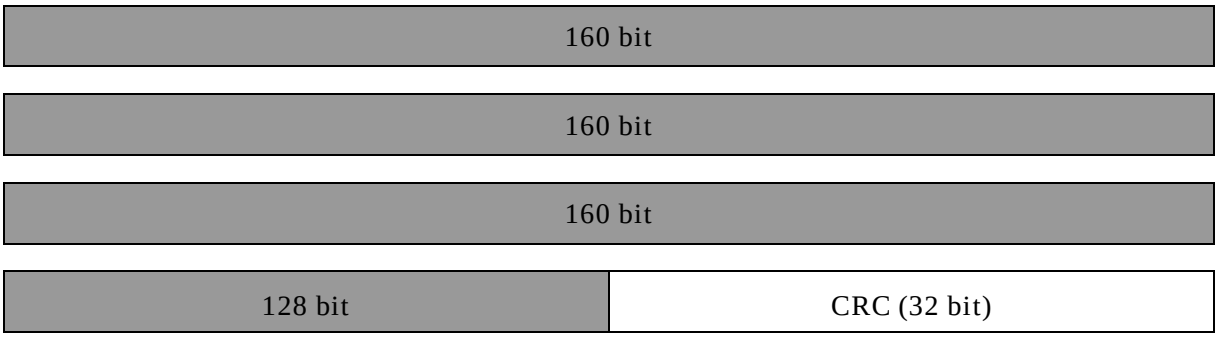
Illustration 3.2.5.5 Flow relating to Comparison Processing at the Reception Side

3.2.6 Error Detection Method

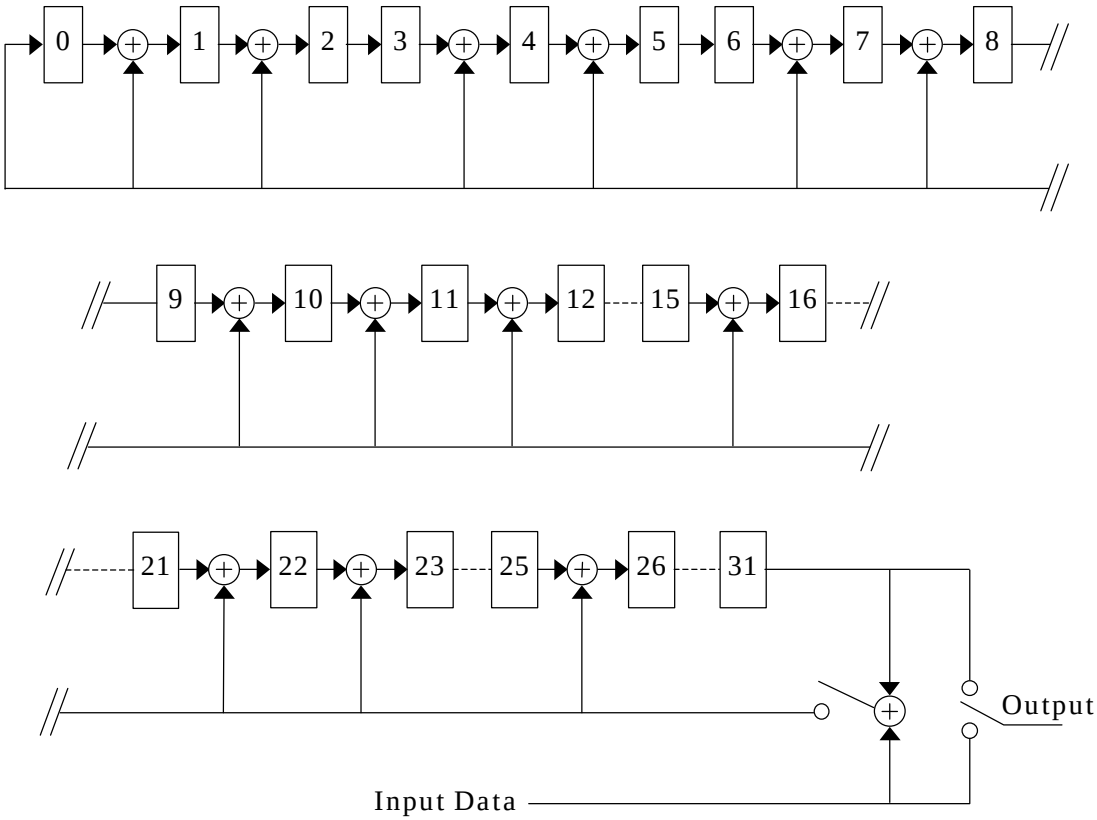
For purposes of error detection, each frame includes 32 bits of FCS in the 640 bits.
The content of the FCS (32 bits) is the CRC32 bit, and the generator polynomial follows the ITU-T recommendation V.42 LAPM option.

3.2.6.1 CRC

Within the frame below (total: 640 bit), CRC is performed in the shaded areas (total: 608 bit).



CRC follows the generator polynomials below. Encoding uses the usual remaining bits.
(Note: When transmitting bits, inversion of the remaining bits isn't performed.)
$G(x)=1+x+x^2+x^4+x^5+x^7+x^8+x^{10}+x^{11}+x^{12}+x^{16}+x^{22}+x^{23}+x^{26}+x^{32}$



All register initial values are “1.” This is set at every frame.

3.2.7 Data Partitioning/Assembly

3.2.7.1 Transmission Side Processing

On the transmission side, when the data passed on from the high module is larger than the 1 ARQ frame, or when there are other reasons, one data can be partitioned and sent in multiple ARQ frames. Notification to the reception side of this partitioned information is shown in the continuous frame classification bit.

The partitioning specifications of the data frame are indicated below.

(1) When partitioning is not performed and one data is carried by one data frame, set to "Single or Last Frame."

(2) When one data is partitioned into multiple data frames, the last partitioned data frame is set to "Single or Last Frame," and the data frames previous to that are set to "Intermediate Frame."
As an exception, there is the possibility of each partitioned data frame being set to "Intermediate Frame," and the last data frame with no data is set at "Single or Last Frame" being transmitted.

(3) When from the high-level module the attribute [Single/Complete] [Continuing] is clearly given in one data, when the data is [Single], the above processes 1 and 2 are performed, but when the data has the [Continuing] attribute, all partitioned data frames must be sent as [intermediate frames.]

3.2.7.2 Reception Side Processing

On the reception side, data assembly is performed based upon the continuous frame classification bit information.

(1) The received [Intermediate frame] data frame assembly is performed until the [Single or Last Frame] data frame is received, and at the point where the [Single or Last Frame] data frame is assembled, it is passed on to the high-level module as one data.

(2) [Single or Last Frame] data frames received as a continuous relationship concluding state' are at that point passed on to the high-level module as one data.

(3) When data is passed to the high-level module, when one data can clearly be given the attribute of [Single/Complete] or [Continuing], information being assembled can be passed on to the high-level module at a convenient time under the attribute of [Continuing].

3.2.8 Data Compression/Expansion Area Actions

When performing data compression/expansion, it conforms to the ITU-T V.42bis specifications. The corresponding actions of the protocol control area and data compression/expansion areas when V.42bis is employed in this protocol are given below.

3.2.8.1 Handling ITU-T V.42bis

(a) Parameter negotiation (see ITU-T V.42bis Section 5.1)
Whether data compression/expansion exists or not and those parameters values [Code words total number]. [Maximum character line length] are defined in the control sequence's "ARQ control frame [communication parameter settings] request," and this and the "ARQ control frame (reception)" from other side are decided upon by reciprocal exchanges.
However, these parameters and data compression/ expansion existence are set only at the time of data-link initiation, and are not changed during communications.

(b) Parameters
Within the parameters regulated by V.42bis, the values are defined as follows.
(1) V.42bis data compression request (P0) : Towards both sides (fixed)
(2) Code word total number (P1) : 512, 1024, 2048, 4096 (Standard value is 2048)
(3) Maximum character line length (P2) : 6~250 (Standard value is 32)

(c) Data Compression/Expansion Area Initialization (see ITU-T V.42bis Section 5.2)
After completion of parameter negotiations, by the protocol control area sending the C-INIT request primitive to the data compression/ expansion area, the initialization of the data compression/ expansion is performed. At this time, notification of the agreed upon parameter values through negotiation.

(d) Connection Establishment (see ITU-T V.42bis Section 5.3)
When the C-INIT confirmation primitive is received from the data compression area, the protocol control area notifies the upper layer that data forwarding has begun.

(e) Data Transmission and Reception Mediation of the Upper Layer and Data Compression/Expansion Area Spaces (see ITU-T V.42bis Section 5.2)
When the connection is established, the protocol control area requests that encoding begin of data received from the upper layer. In order to encode data, the protocol control area sends the C-DATA request primitive to the data compression area. This primitive is used to instruct the encoding of data. Also, in cases where C-DATA notification primitive is received from the data expansion area, the control area transmits the decoded data to the upper layer. At this time, flow control is necessary in order to prevent data loss due to buffer overflow.

(f) Data Transmission and Reception Mediation of the Data Compression/ Expansion Area and Error Control Area Space. (see ITU-T V.42bis Section 5.5)

When the C-TRANSFER notification primitive is received from the data compression area, the protocol control area requests compressed data transmission to the error control area. When data is received from the error control area, the protocol control area sends a C-TRANSFER request primitive to the data expansion area.

(g) Data Forwarding Acceleration (see ITU-T V.42bis Section 5.7)

The specifications for the protocol control area sending a C-FLUSH request primitive to the data compression/ expansion area conforms with V.42bis. However, in order to guarantee the data bytes, the following sections' specifications have been added for actions when sending the C-FLUSH request primitive.

(h) Next Transmission Data's Byte Guarantee

In the cases below, in order to guarantee the next transmission data's byte partitioning, the protocol control area transmits the 0 of the necessary bit count after the data. Furthermore, the initialization of the dictionary accompanying this process is not performed when:

(1) the FLUSH control code words have been sent. (When the C-FLUSH request primitive has been issued.

(2) the ETM control words have been sent. (When transitioning from the data compression mode to the transparent mode.)

(I) Actions when Receiving C-ERROR (see ITU-T V.42bis Section 5.8)

The C-ERROR notification is used to notify the protocol control area that the data compression/ expansion area has detected an error (specification error or synchronization loss).

When a C-ERROR notification primitive is received, the protocol control area immediately performs a data link release. The conditions for the decoder sending a C-ERROR notification primitive conform to the V.42bis specifications.

3.2.9 System Constants Table

●Synchronization Reception Wait Timer (T001)
A timer for the time from the sending of a synchronization frame (synchronization request) until the detection of a synchronization frame (synchronization reception) from the other side.
This timer value is 15 seconds.

●Post-Synchronization-Reception-Transmission Timer (T002)
A timer for the time from the sending of a synchronization frame (synchronization reception) until the detection of a control frame or a synchronization frame (synchronization reception) from the other side. This timer value is 15 seconds.

●Synchronization Request Wait Timer (T003)
A timer for the time from the detecting of the continuous FCS Error EF max until the detection of a synchronization frame (synchronization request) from the other side. This timer value is 15 seconds.

●Confirmation Concerning the Control Frame Wait Timer (T101)
This is a confirmation frame wait timer for the control frame's request/ notification frame.
This timer value is uniformly 10 seconds.

●Continuous FCS Error Count (EFmax)
As a trigger to initiate the re-synchronization process during communications, it regulates the continuous FCS error count. The EFmax regulated count is 20.

●Margin Constant N Used at the Time of RTF Calculation
A margin is affixed at the time of RTF calculation. This value is 2.

●Synchronization Rejection Repeated Transmission Frequency (L)
The frequency of repeatedly sent synchronization rejection frames when, in response to the synchronization request from the other side, the synchronization process is rejected. The regulated frequency is 20 times.

●Data Link Release Reception Repeated Transmission Frequency (K)
The data link release receptions of repeated transmission frequency in regards to the data link release request from the other side. The regulated frequency is 20 times.

●Frame Length
The frame length of each synchronization, control, and data frame is fixed at 80 bytes.

Attachments

These Attachments are Reference Materials

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Attachment 1: ARQ State Transition

1. ARQ Process Tier Structure

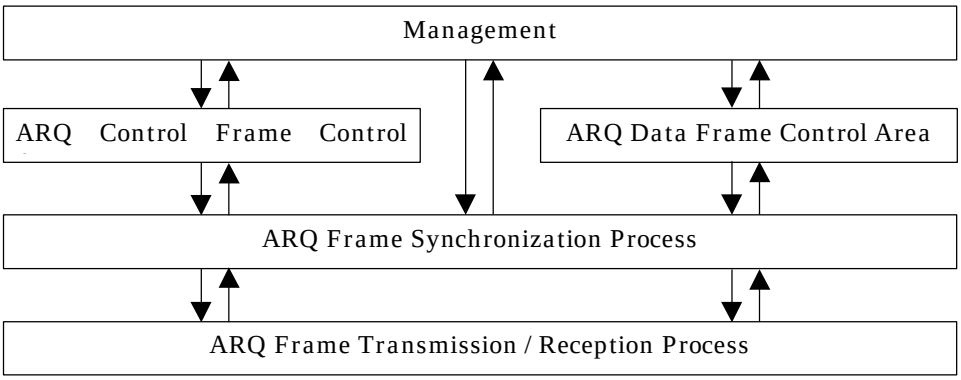


Illustration 1 ARQ Process Tier Structure

2. State Transition

2.1 ARQ Frame Synchronization Process Area

2.1.1 ARQ Frame Synchronization Process Area State Transition Illustration

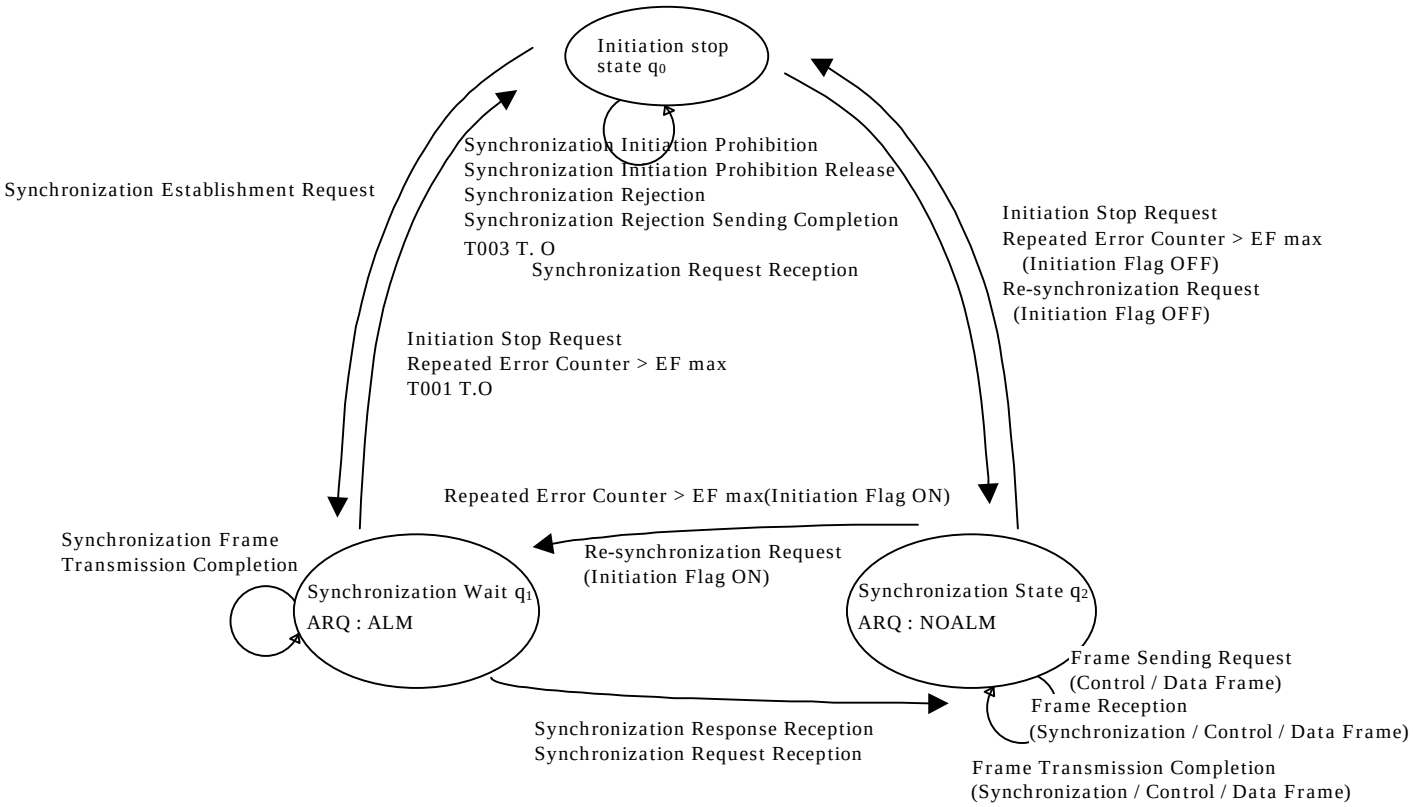


Illustration 2 ARQ Frame Synchronization Process Area State Transition Illustration

2.1.2 ARQ Frame Synchronization Process Area SDL Illustration

: State

: Primitive from a Lower Level

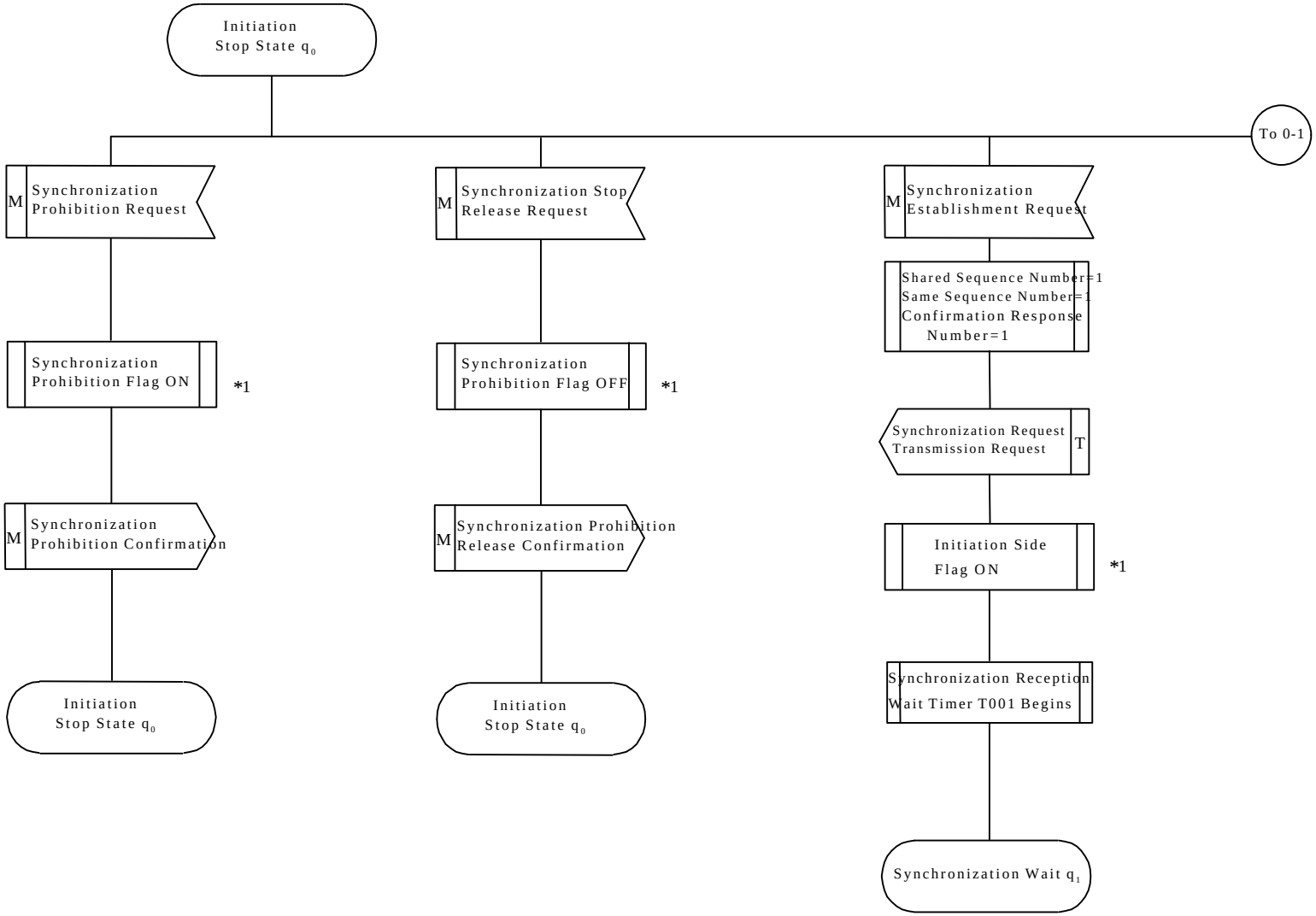
: Primitive to a Lower Level

: Primitive to a Higher Level

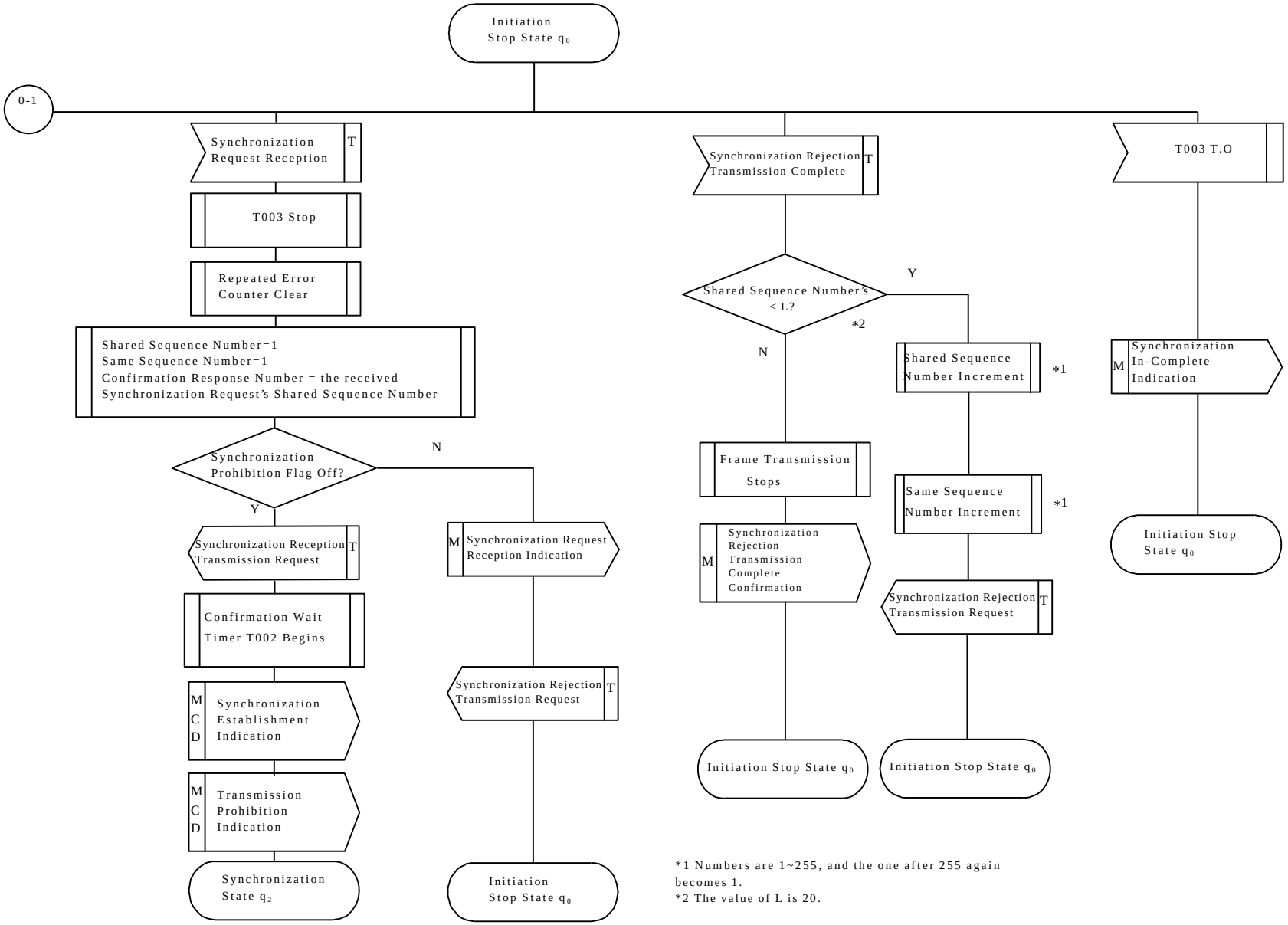
: Primitive from a Higher Level

: Procedure Call

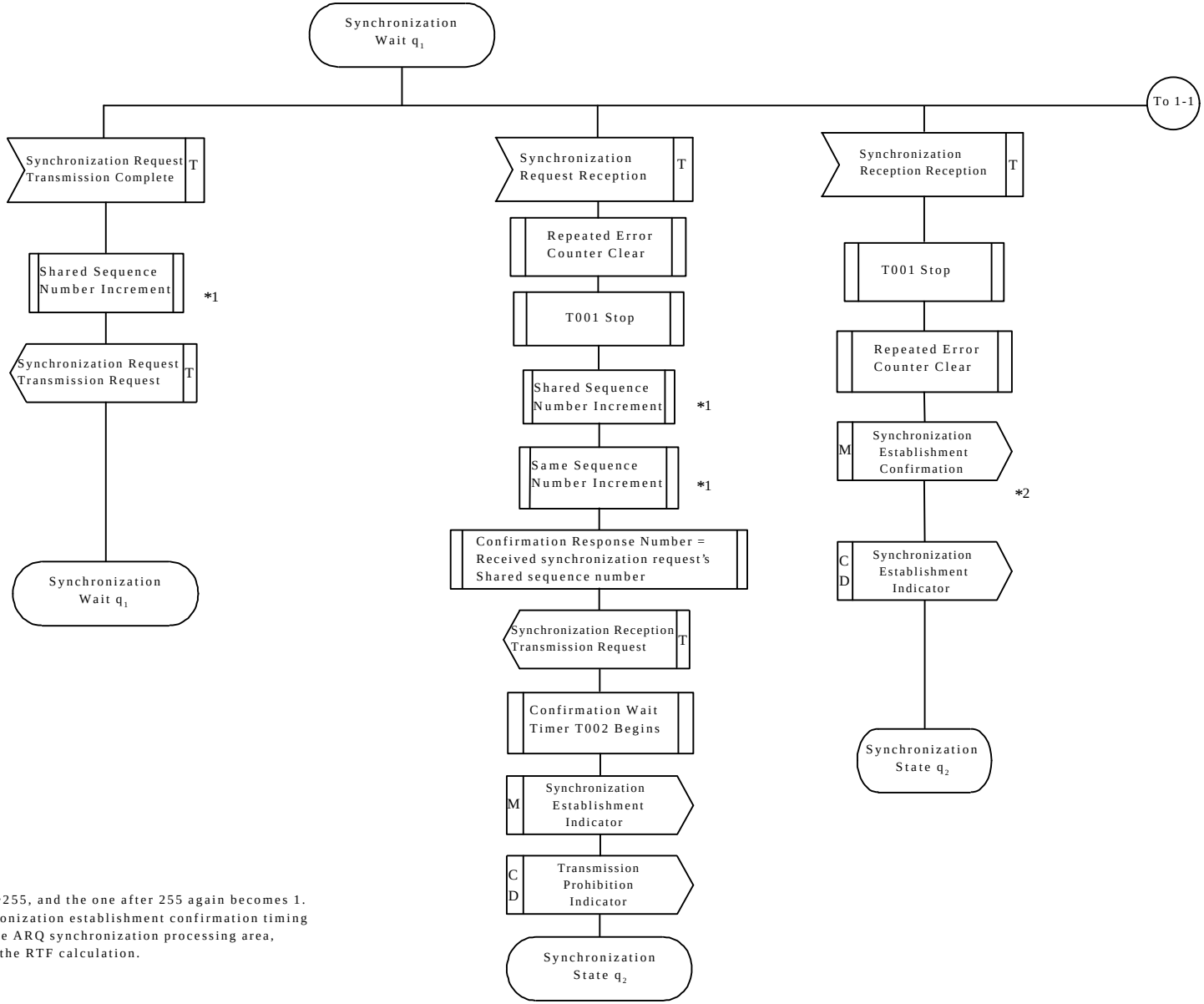
M: Management
C : ARQ Control Frame Control Area
D : ARQ Data Frame Control Area
T : ARQ Frame Transmission / Reception Process Area



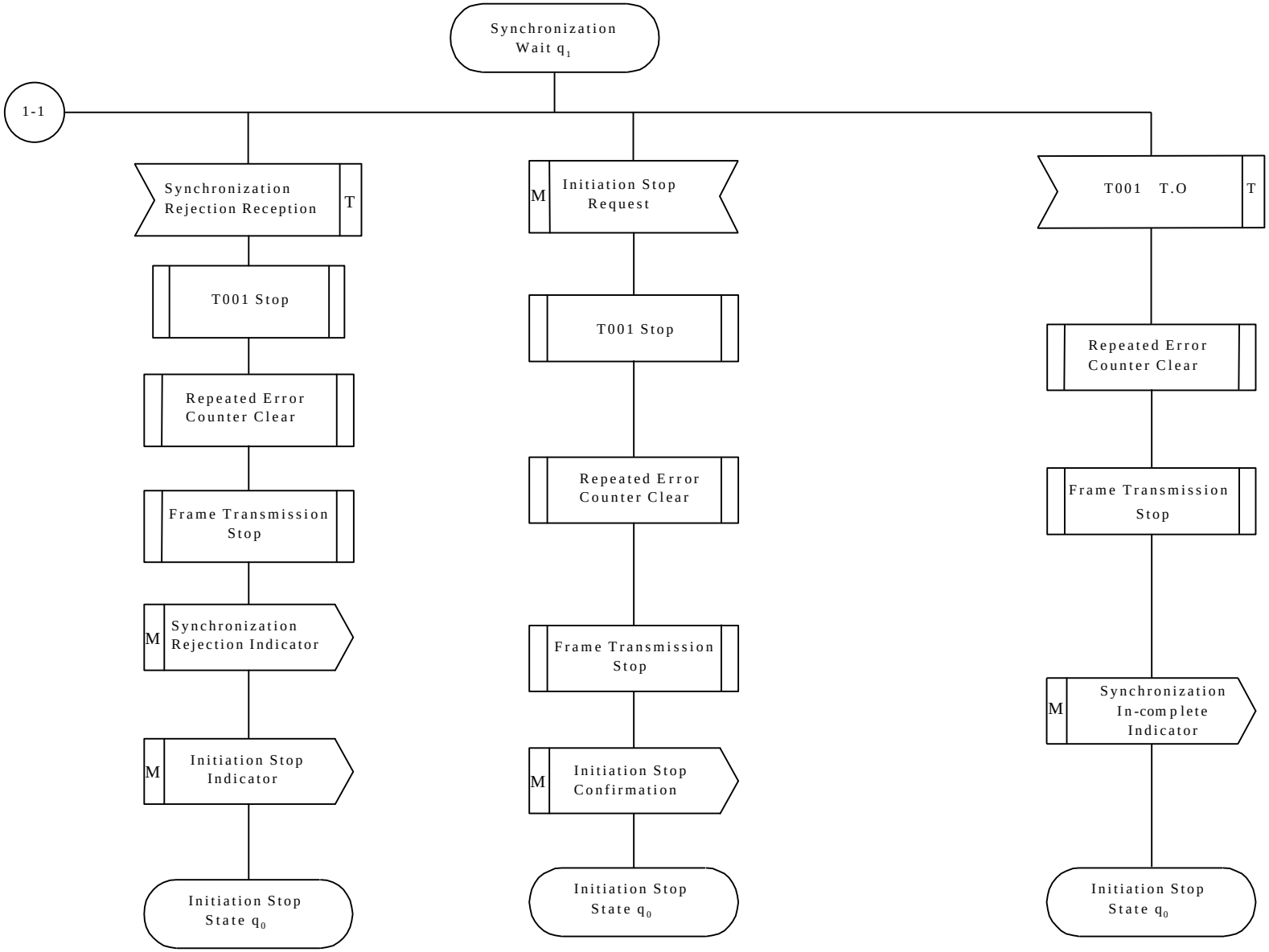
*1 The initial value of the Initiation Side Flag and the Synchronization Prohibition Flag is OFF.

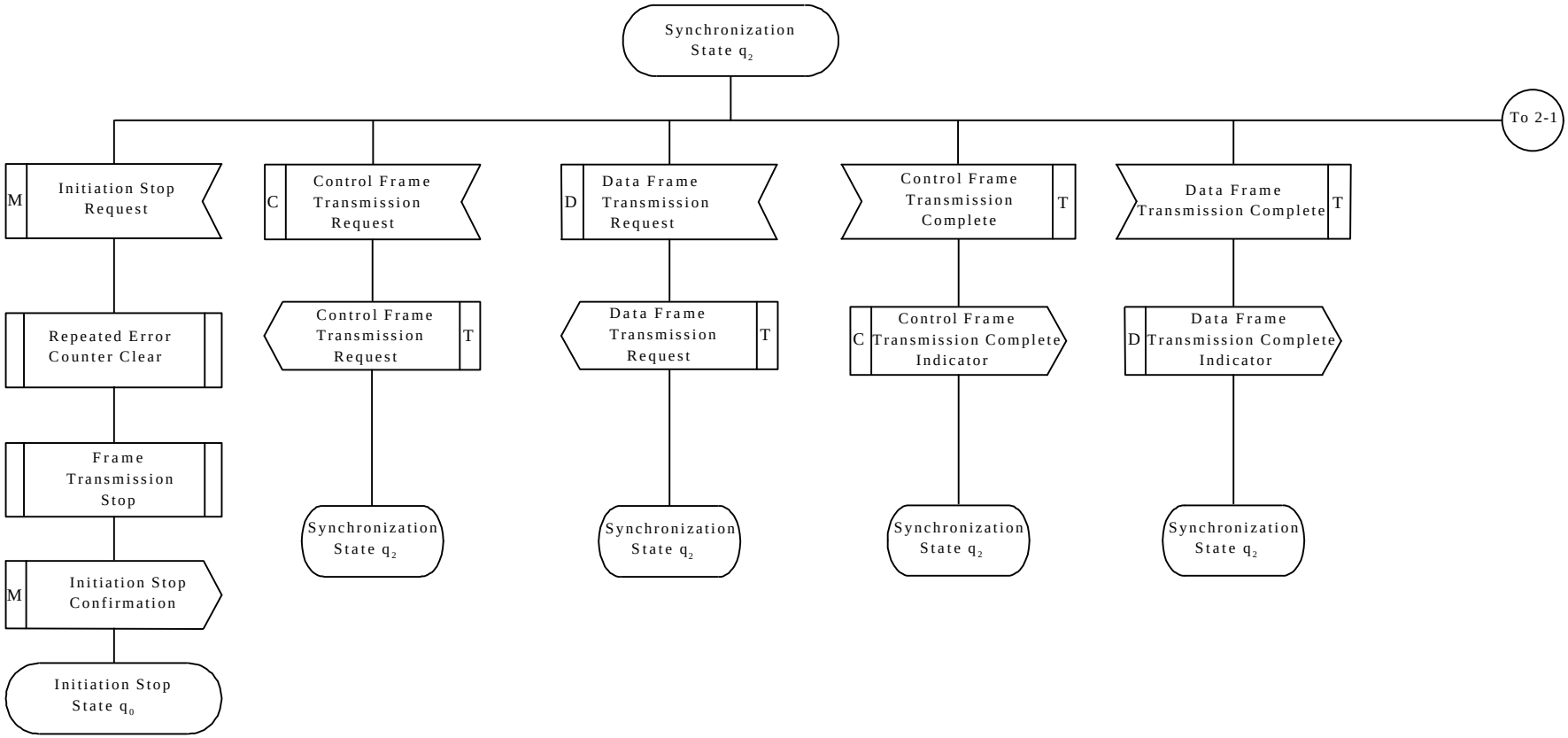


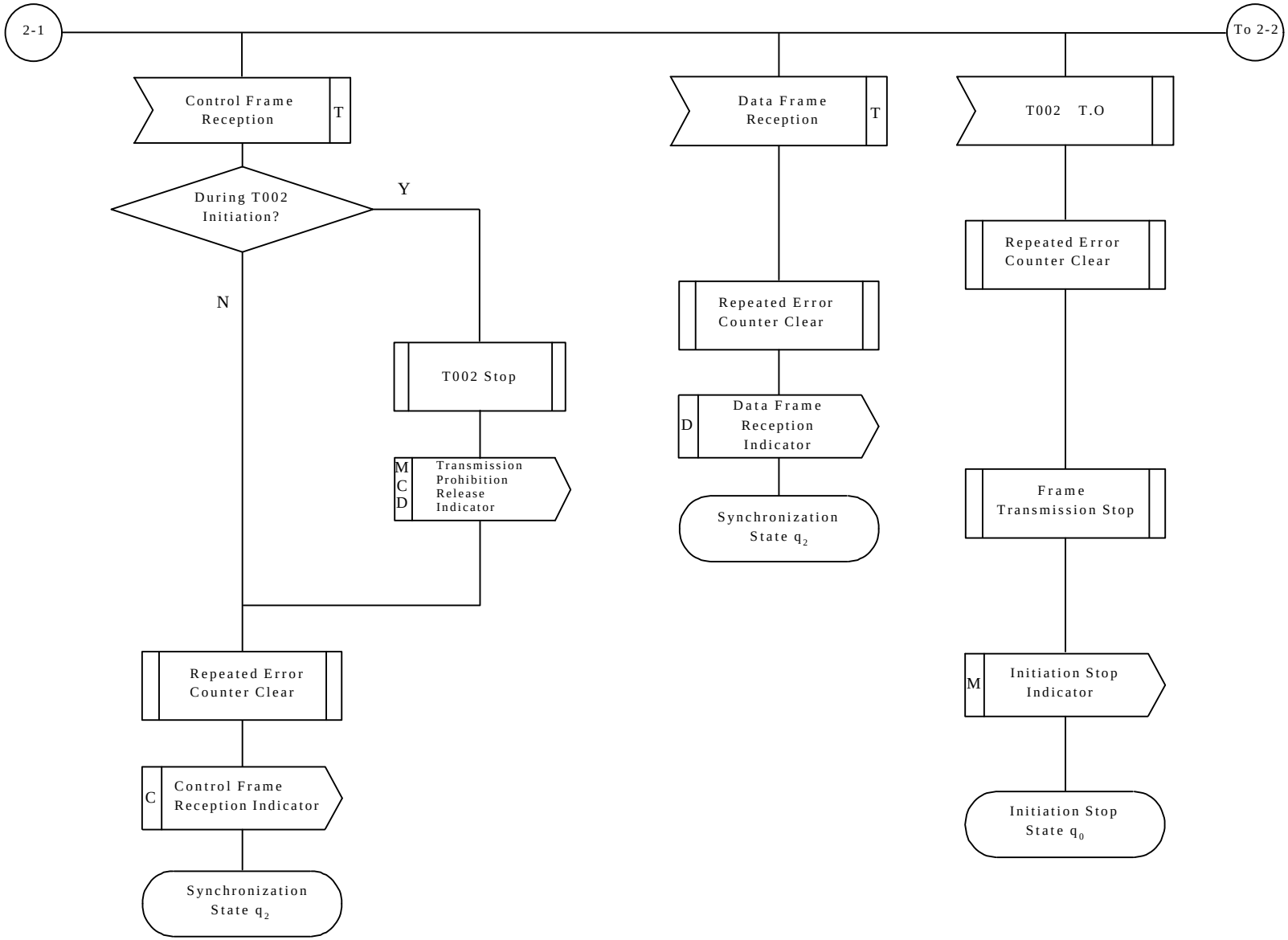
*1 Numbers are 1~255, and the one after 255 again becomes 1.
*2 The value of L is 20.

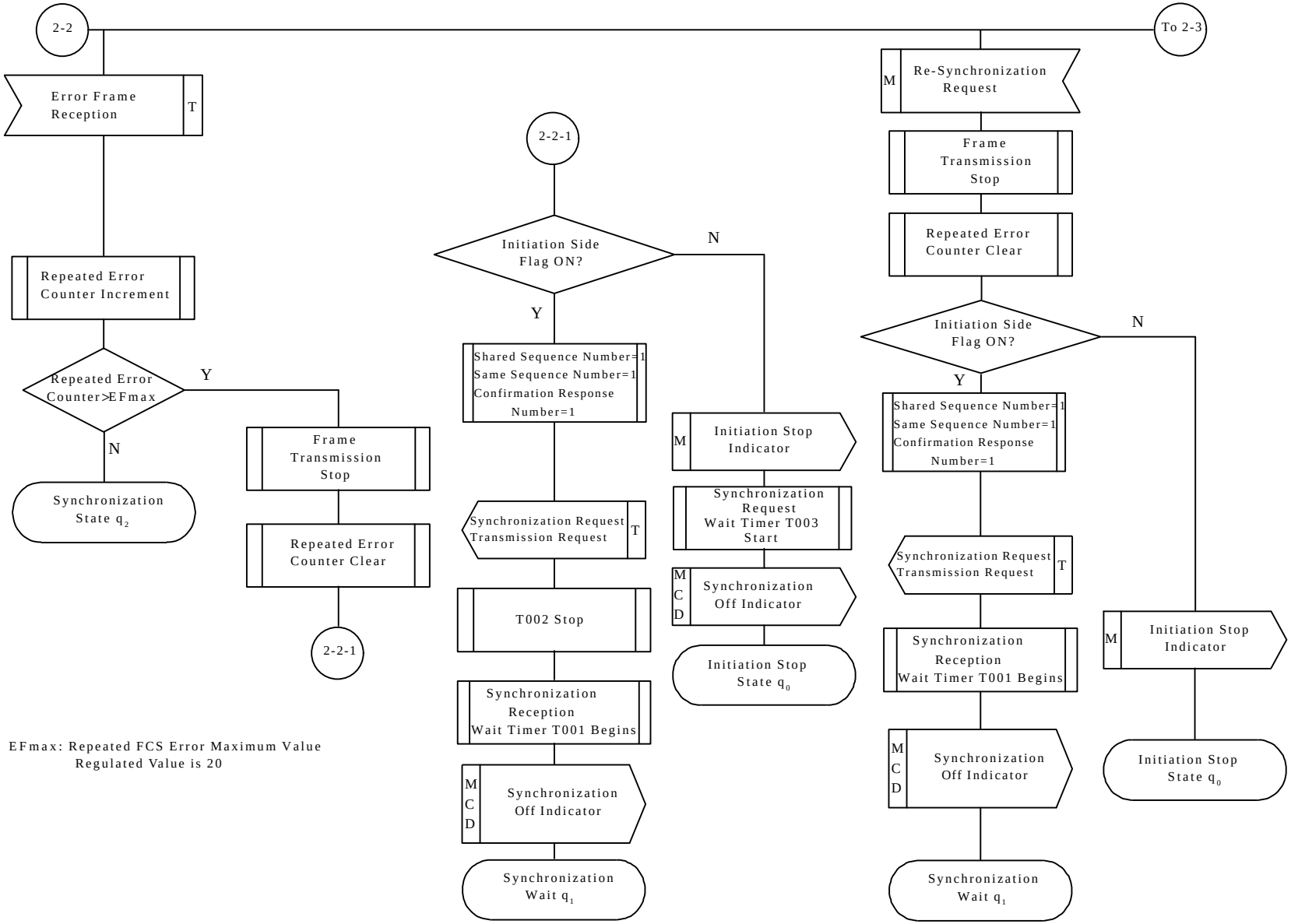


*1 Numbers are 1~255, and the one after 255 again becomes 1.
*2 M is the synchronization establishment confirmation timing received from the ARQ synchronization processing area, which performs the RTF calculation.

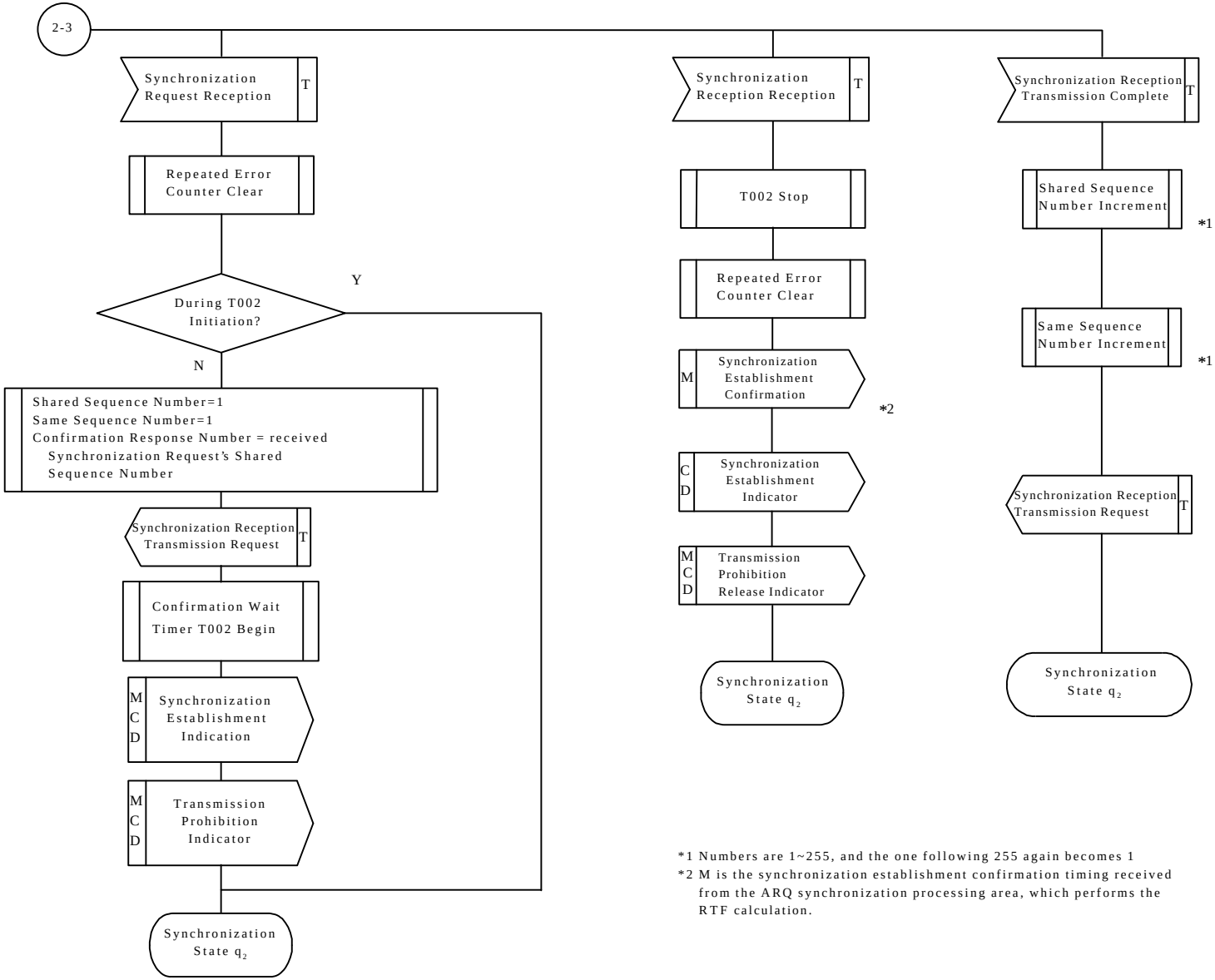

Synchronization Wait q_1
1-1
Synchronization Rejection Reception
T
T001 Stop
Repeated Error Counter Clear
Frame Transmission Stop
M
Synchronization Rejection Indicator
M
Initiation Stop Indicator
Initiation Stop State q_0
M
Initiation Stop Request
T001 Stop
Repeated Error Counter Clear
Frame Transmission Stop
M
Initiation Stop Confirmation
Initiation Stop State q_0
T001 T.O
T
Repeated Error Counter Clear
Frame Transmission Stop
M
Synchronization In-complete Indicator
Initiation Stop State q_0


Synchronization State q_2
To 2-1
M
Initiation Stop Request
C
Control Frame Transmission Request
D
Data Frame Transmission Request
Control Frame Transmission Complete
T
Data Frame Transmission Complete
T
Repeated Error Counter Clear
Control Frame Transmission Request
T
Data Frame Transmission Request
T
C
Control Frame Transmission Complete Indicator
D
Data Frame Transmission Complete Indicator
Frame Transmission Stop
Synchronization State q_2
Synchronization State q_2
Synchronization State q_2
Synchronization State q_2
M
Initiation Stop Confirmation
Initiation Stop State q_0


2-1
To 2-2
Control Frame Reception
T
During T002 Initiation?
Y
N
T002 Stop
M
C
D
Transmission Prohibition Release Indicator
Repeated Error Counter Clear
C
Control Frame Reception Indicator
Synchronization State q_2
Data Frame Reception
T
Repeated Error Counter Clear
D
Data Frame Reception Indicator
Synchronization State q_2
T002 T.O
Repeated Error Counter Clear
Frame Transmission Stop
M
Initiation Stop Indicator
Initiation Stop State q_0



EFmax: Repeated FCS Error Maximum Value
Regulated Value is 20



*1 Numbers are 1~255, and the one following 255 again becomes 1

*2 M is the synchronization establishment confirmation timing received from the ARQ synchronization processing area, which performs the RTF calculation.

2.1.3 Timer

Timer Abbreviation	Timer Name	Timer Value
T001	Synchronization Reception Wait Timer	15 Seconds
T002	To Be Exact, “Communication Parameter Setting Wait Timer”	15 Seconds
T003	Synchronization Request Wait Timer	15 Seconds

2.1.4 Primitive Tables

Table 1 : ARQ Frame Synchronization Processing Area ⇄ Management (Q ⇄ M)

ARQ Frame Synchronization Processing Area Management		ARQ Frame Synchronization Processing Area Management	
Primitive	Meaning	Primitive	Meaning
Synchronization Request Reception Indicator	Is used to notify the reception of "synchronization request" under the condition of "prohibitation flag's ON", to management. (When "prohibitation flag's OFF", it notifies a "synchronization establishment indicator" to the management through a "synchronization request reception")	Synchronization Establishment Request	Requests synchronization initialization. The ARQ frame synchronization processing area receives this and transmits a synchronization request.
Synchronization Establishment Confirmation	Notifies management that in response to a synchronization request, a synchronization reception was received. When management receives this primitive, it performs an RTF calculation.	Initiation Stop Request	Requests synchronization initiation stop.
Synchronization Establishment Indicator	Notifies management that in response to a synchronization request a synchronization reception was received, and a synchronization state was established.	Re-Synchronization Request	Requests performance of re- synchronization processing.
Synchronization Rejection Indicator	Notifies management in cases where a synchronization request was sent, but a synchronization rejection was received from the other side.	Synchronization Prohibition Request	Used to request a synchronization processing prohibition. Through the reception of this primitive, the ARQ frame synchronization processing area turns the synchronization prohibition flag to ON.
Synchronization Rejection Transmission Complete Confirmation	Notifies that the transmission comletion on specified times of the synchronization rejection.		
Synchronization Incomplete Indicator	Notifies management that a synchronization request was sent, but reception from the other side wasn't transmitted back, and at T001 timer time-out became Synchronization Incomplete.	Synchronization Prohibition Cancellation Request	Used to request a synchronization processing prohibition cancellation. Through the reception of this primitive, the AQR frame synchronization processing area turns the synchronization prohibition flag to OFF.
Synchronization Prohibition Confirmation	Notifies that in response to a synchronization prohibition request from management, the synchronization prohibition flag was turned ON. While the synchronization prohibition flag is ON, a synchronization rejection is transmitted in response to a synchronization request from the other side.		
Synchronization Prohibition Cancellation Confirmation	Notifies that the synchronization prohibition flag was turned OFF in response to a synchronization prohibition cancellation request		
Synchronization Off Indicator	Notifies that the ARQ synchronization processing area's synchronization is out of sync.		
Activation Stop Indicator	The primitive that notifies that the ARQ synchronization processing area has stopped activation without a request from management.		
Activation stop confirmation	The primitive that notifies that the ARQ synchronization processing area has stopped activation with a request from management.		
Transmission Prohibition Indicator	Notifies that the ARQ synchronization has established although the control frame and the data frame transmission are disabled.		
Transmission Prohibition Cancellation Indicator	Notifies that the control frame and the data frame transmission are enabled.		

Table 2 : ARQ Frame Synchronization Processing Area⇄ARQ Control Frame Control Area (Q⇄C)

ARQ Frame Synchronization Processing Area ARQ Control Frame Control Area		ARQ Frame Synchronization Processing Area ARQ Control Frame Control Area	
Primitive	Meaning	Primitive	Meaning
Synchronization Establishment Indicator	Notifies that synchronization was established	Control Frame Transmission Request	Requests transmission of control frame, together with its contents.
Control Frame Transmission Complete Indicator	Notifies that the control frame was transmitted.		
Control Frame Reception Indicator	Notifies that the control frame was received, together with its content.		
Synchronization Off Indicator	Notifies that synchronization is out of sync.		
Transmission Prohibition Indicator	Notifies that the ARQ Synchronization has established although the control frame and the data frame transmission are disabled.		
Transmission Prohibition Cancellation Indicator	Notifies that the control frame and the data frame transmission are enable.		

Table 3 : ARQ Frame Synchronization Processing Area⇄ARQ Data Frame Control Area (Q⇄D)

ARQ Frame Synchronization Processing Area ARQ Data Frame Control Area		ARQ Frame Synchronization Processing Area ARQ Data Frame Control Area	
Primitive	Meaning	Primitive	Meaning
Data Frame Reception Indicator	Notifies that a data frame was received, together with its content.	Data Frame Transmission Request	Requests transmission of data frame, together with its content.
Synchronization Off Indicator	Notifies that synchronization is out of sync.		
Synchronization Establishment Indicator	Notifies that synchronization has been established.		
Data Frame Transmission Complete Indicator	Notifies that the data frame was transmitted.		
Transmission Prohibition Indicator	Notifies that the ARQ Synchronization has established although the control frame and the data frame transmission are disabled.		
Transmission Prohibition Cancellation Indicator	Notifies that the control frame and the data frame transmission are enable.		

Table 4 : ARQ Frame Transmission and Reception Processing Area⇄ARQ Frame Synchronization Processing Area (T⇄Q)

ARQ Frame Transmission and Reception Processing Area ARQ Frame Synchronization Processing Area		ARQ Frame Transmission and Reception Processing Area ARQ Frame Synchronization Processing Area	
Primitive	Meaning	Primitive	Meaning
Synchronization Frame Transmission Complete	Notifies that synchronization frame has been sent.	Synchronization Frame Transmission Request	Requests transmission of synchronization frame together with its content.
Synchronization Frame Reception	Notifies that the synchronization frame has been received, together with its content.	Control Frame Transmission Request	Requests transmission of control frame together with its content.
Control Frame Transmission Complete	Notifies that the control frame has been transmitted.	Data Frame Transmission Request	Request transmission of data frame together with its content.
Data Frame Transmission Complete	Notifies that the data frame has been transmitted.		
Control Frame Reception	Notifies that the control frame has been received, together with its content.		
Data Frame Reception	Notifies that the data frame has been received, together with its content.		
Error Frame Reception	Notifies that the error frame has been received, together with its content.		

2.2 ARQ Control Frame Control Area

2.2.1 ARQ Control Frame Control Area State Transition Chart

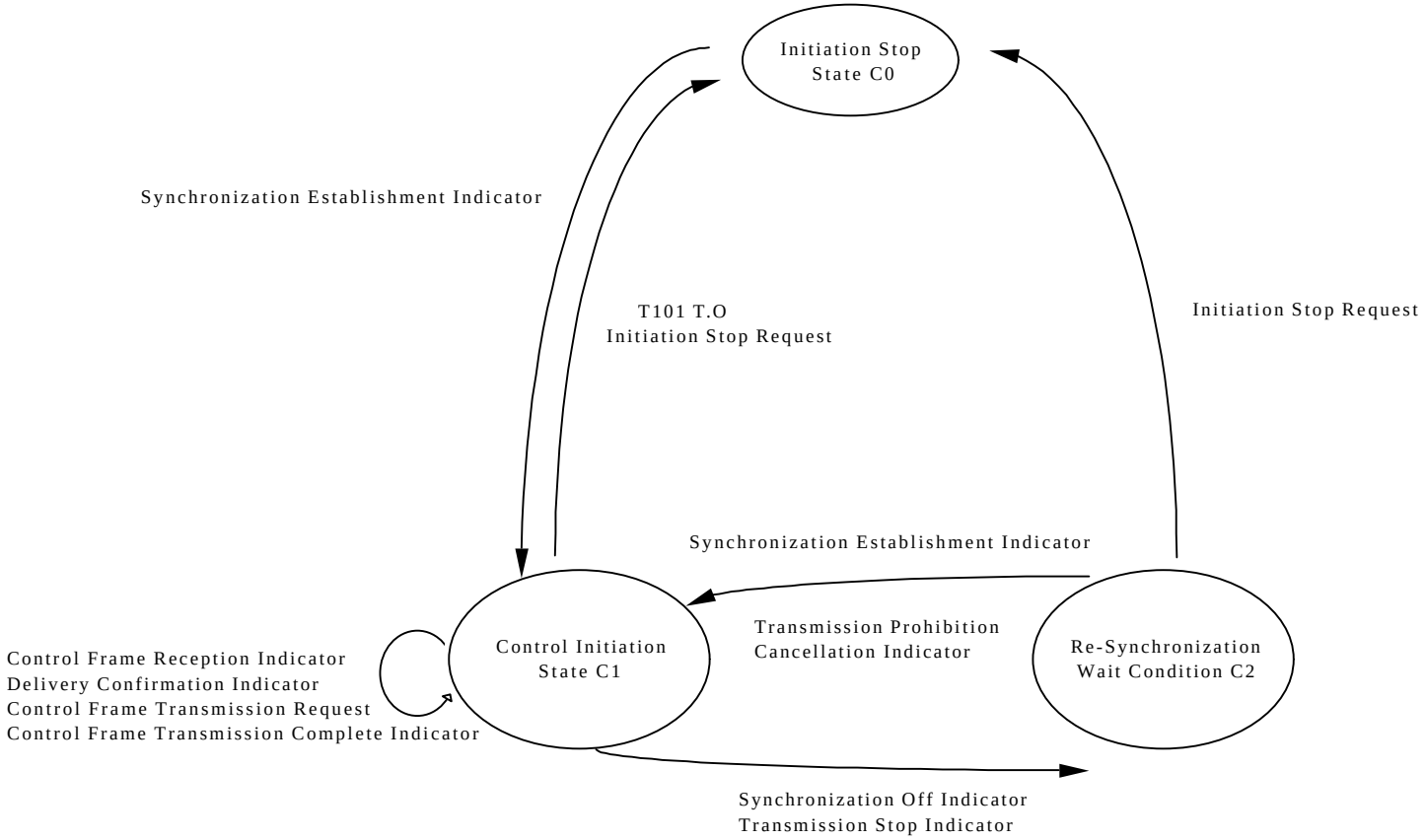
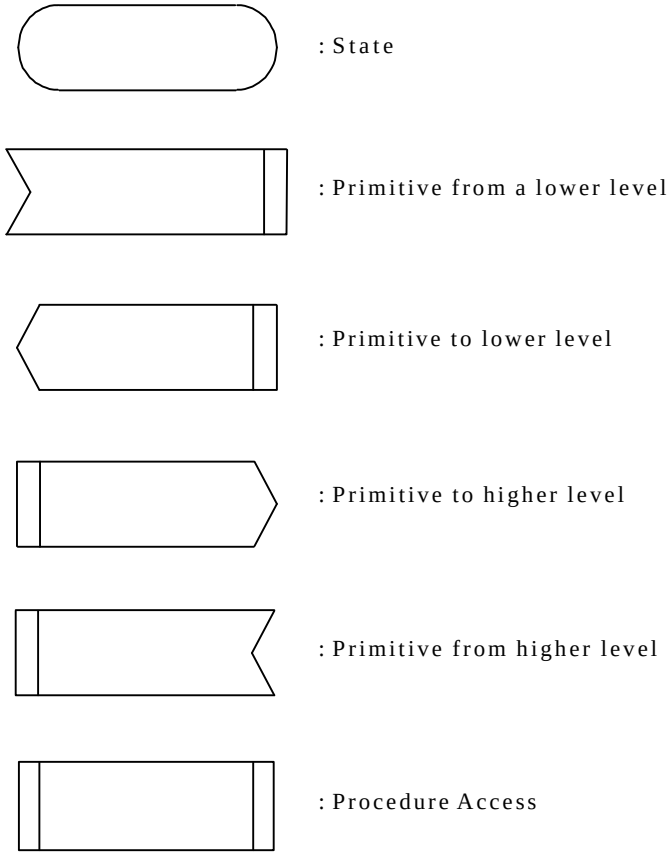
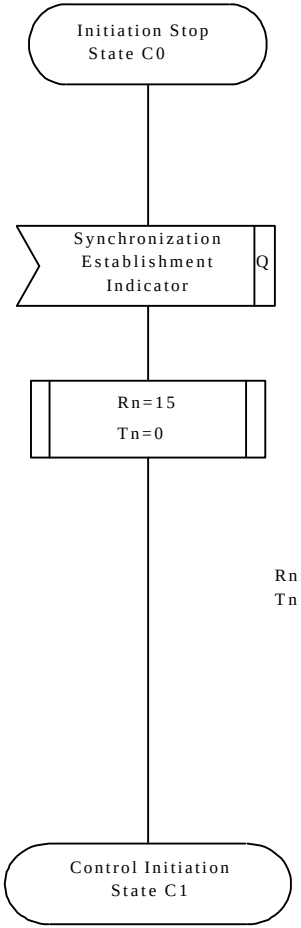


Chart 1: Control Area State Transition Chart

2.2.2 ARQ Control Frame Control Area SDL Chart

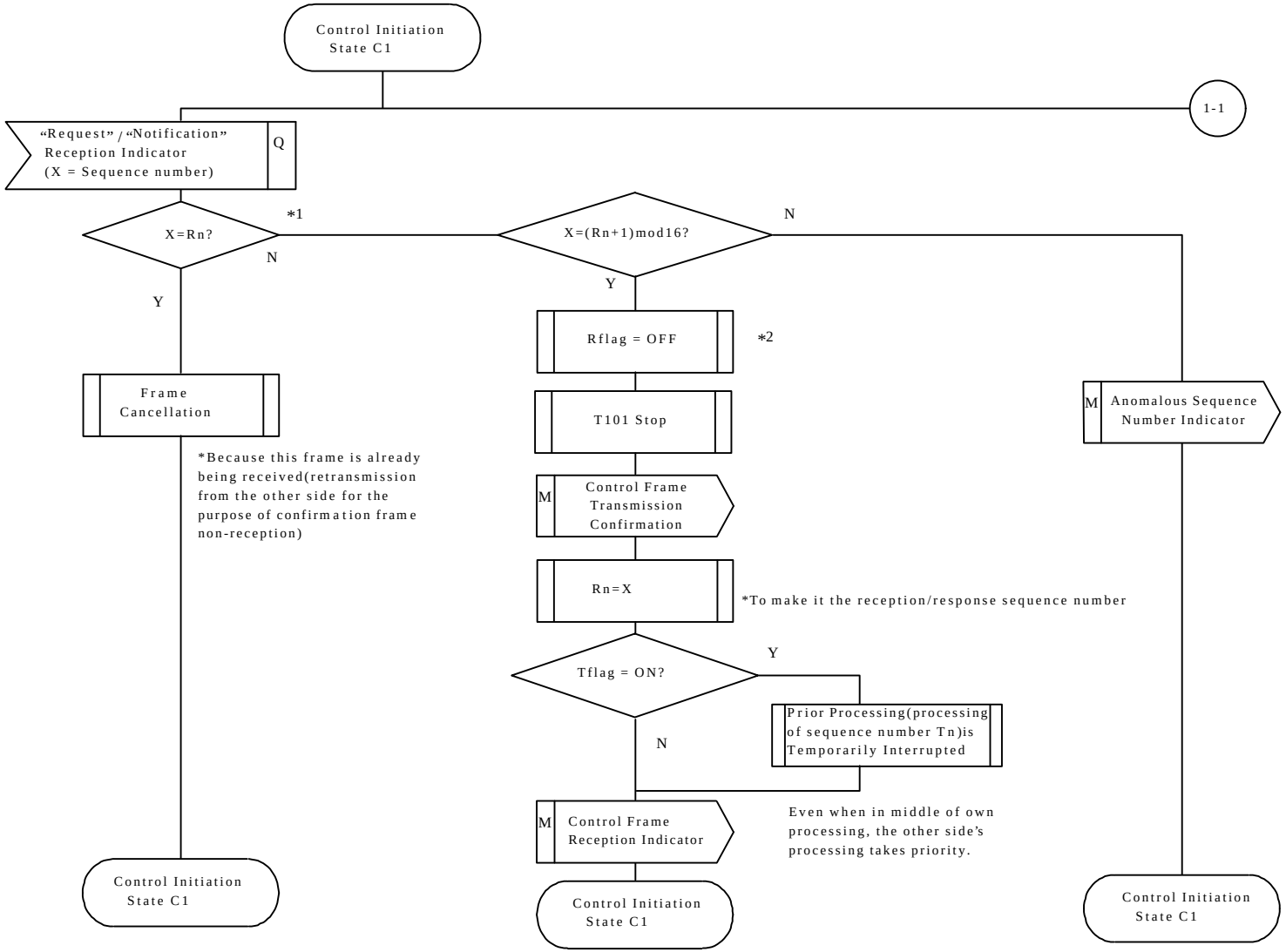


M : Management
Q : ARQ Frame Synchronization Processing

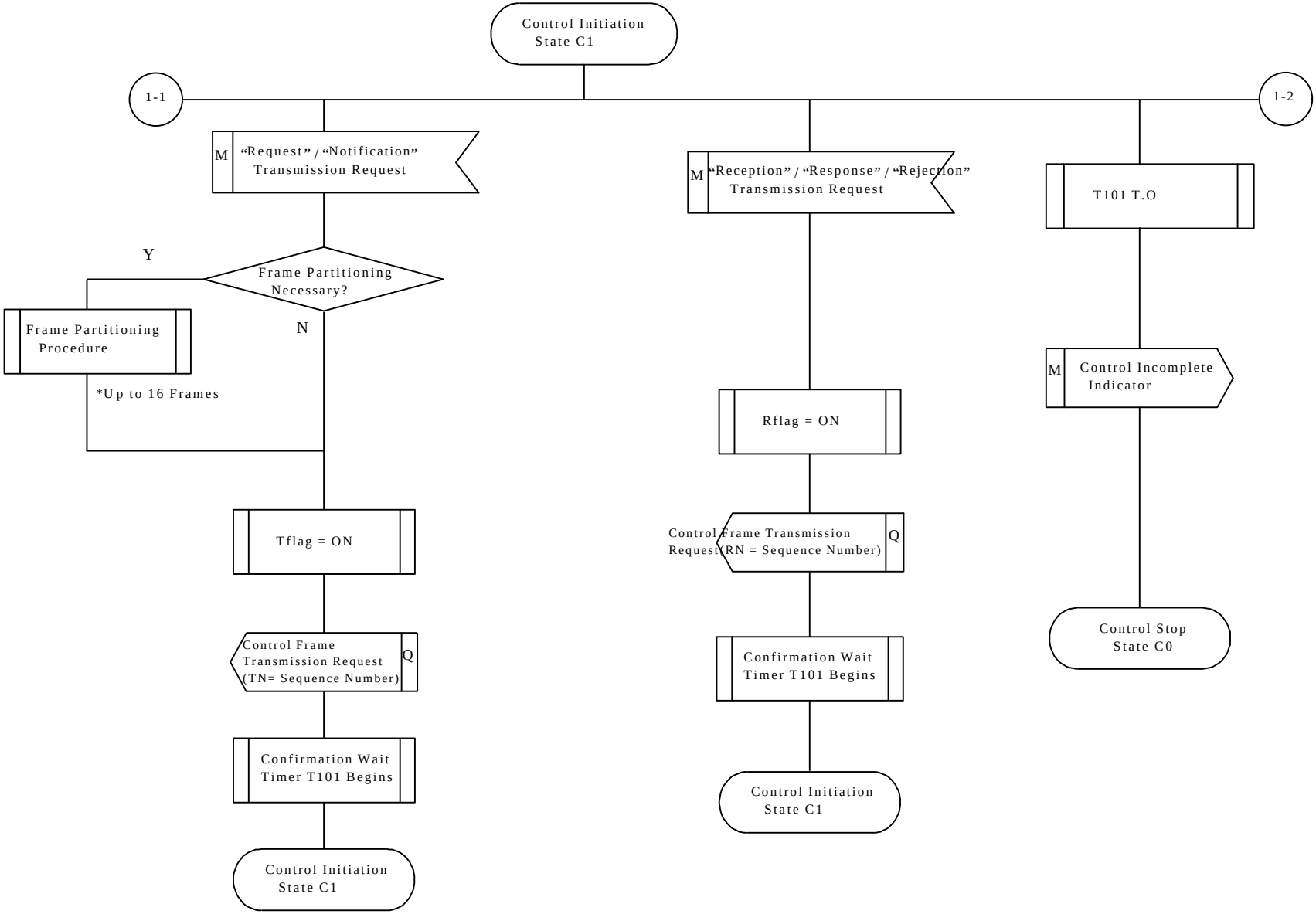


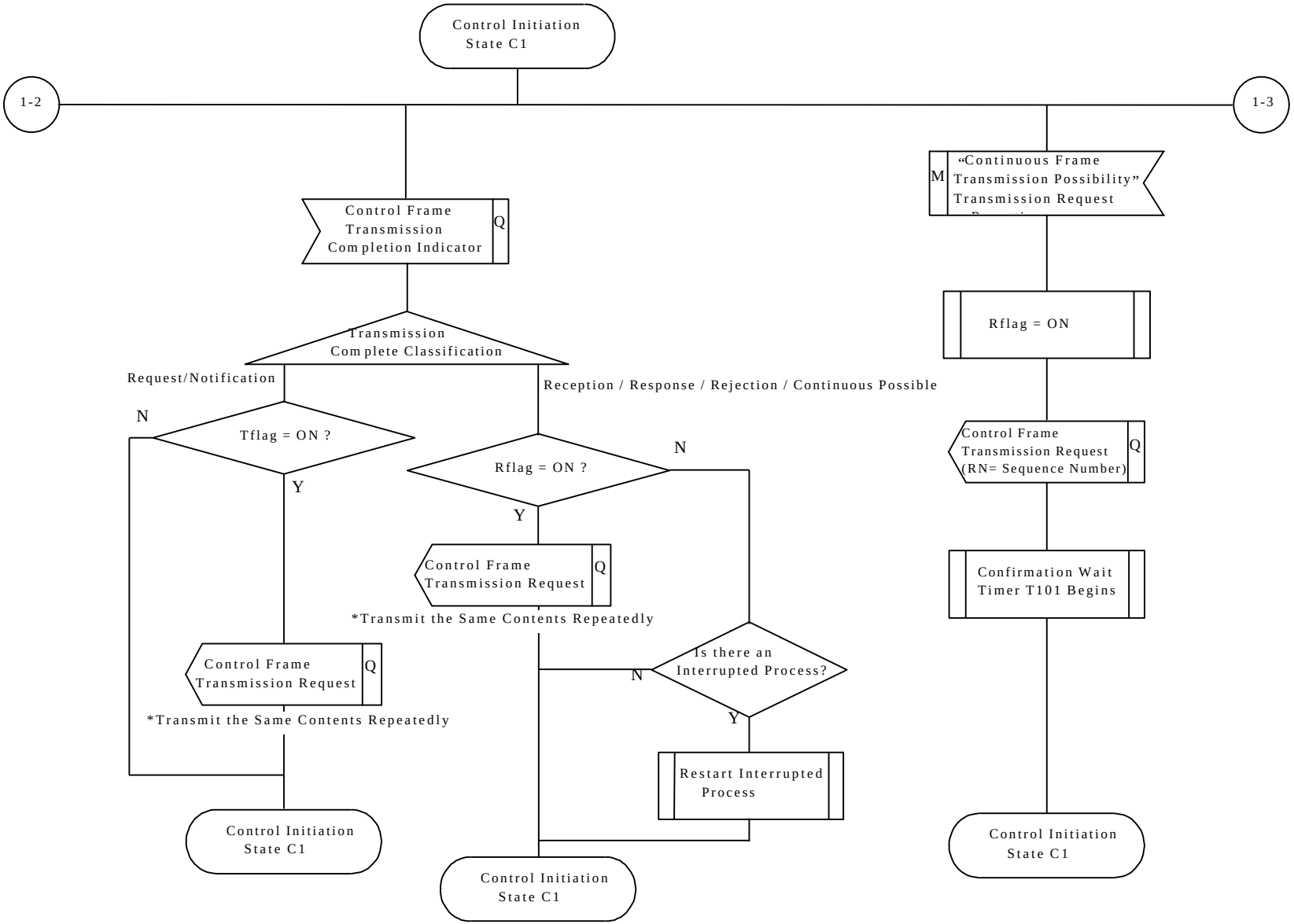
Rn: Received Sequence Number
Tn: Transmitted Sequence Number

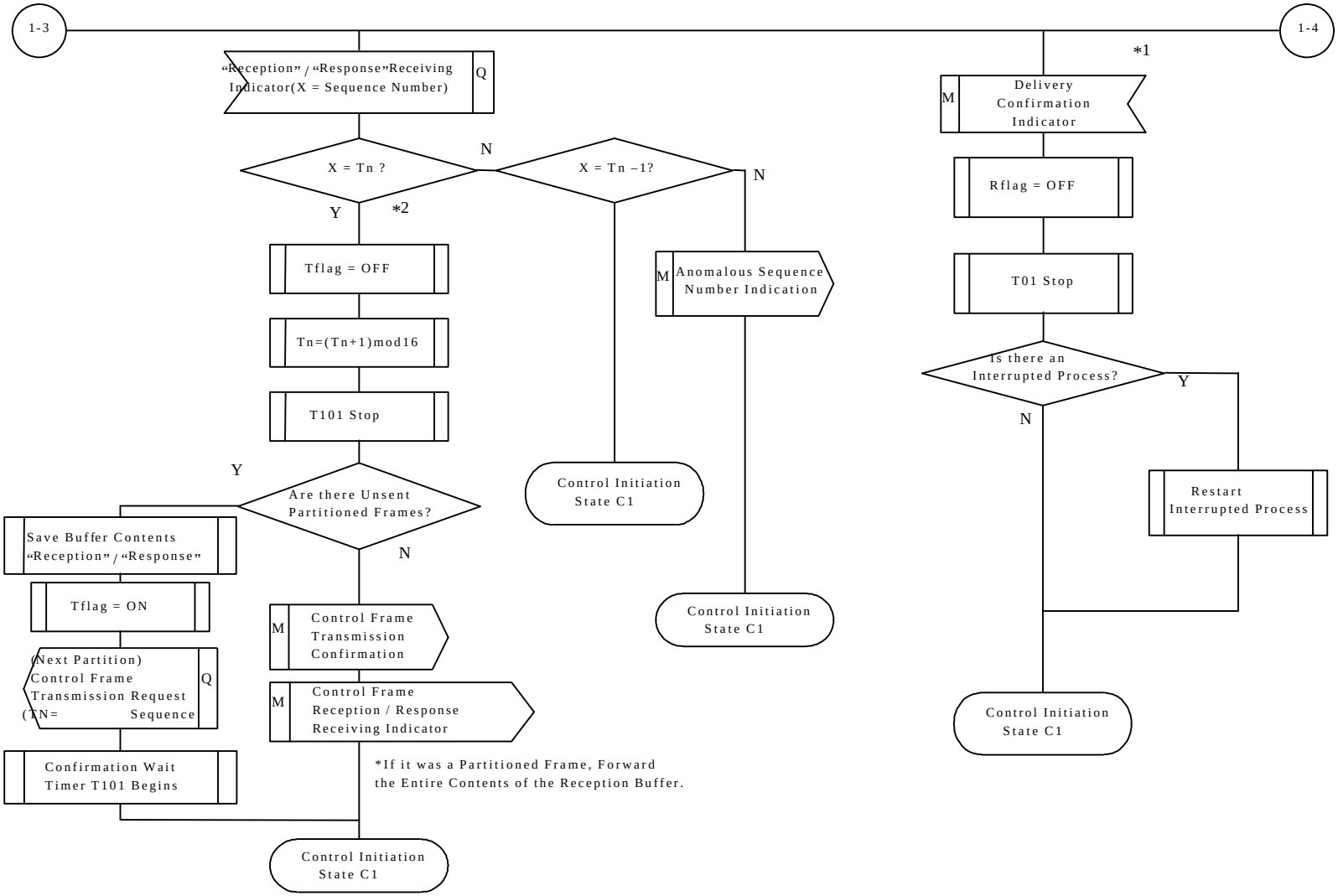
*The initial value of Unreceived flag Unconfirmed flag(R flag/T flag) is OFF.
*The control frame's transmission sequence number starts from"0."



*1 : the very first reception sequence number is "0."
*2 :There are times when it is already OFF. At times when it is ON, through the incremental sequence number's control frame reception in response to a reception(or response), it is the process for turning the Unconfirmed flag(Rflag) OFF.

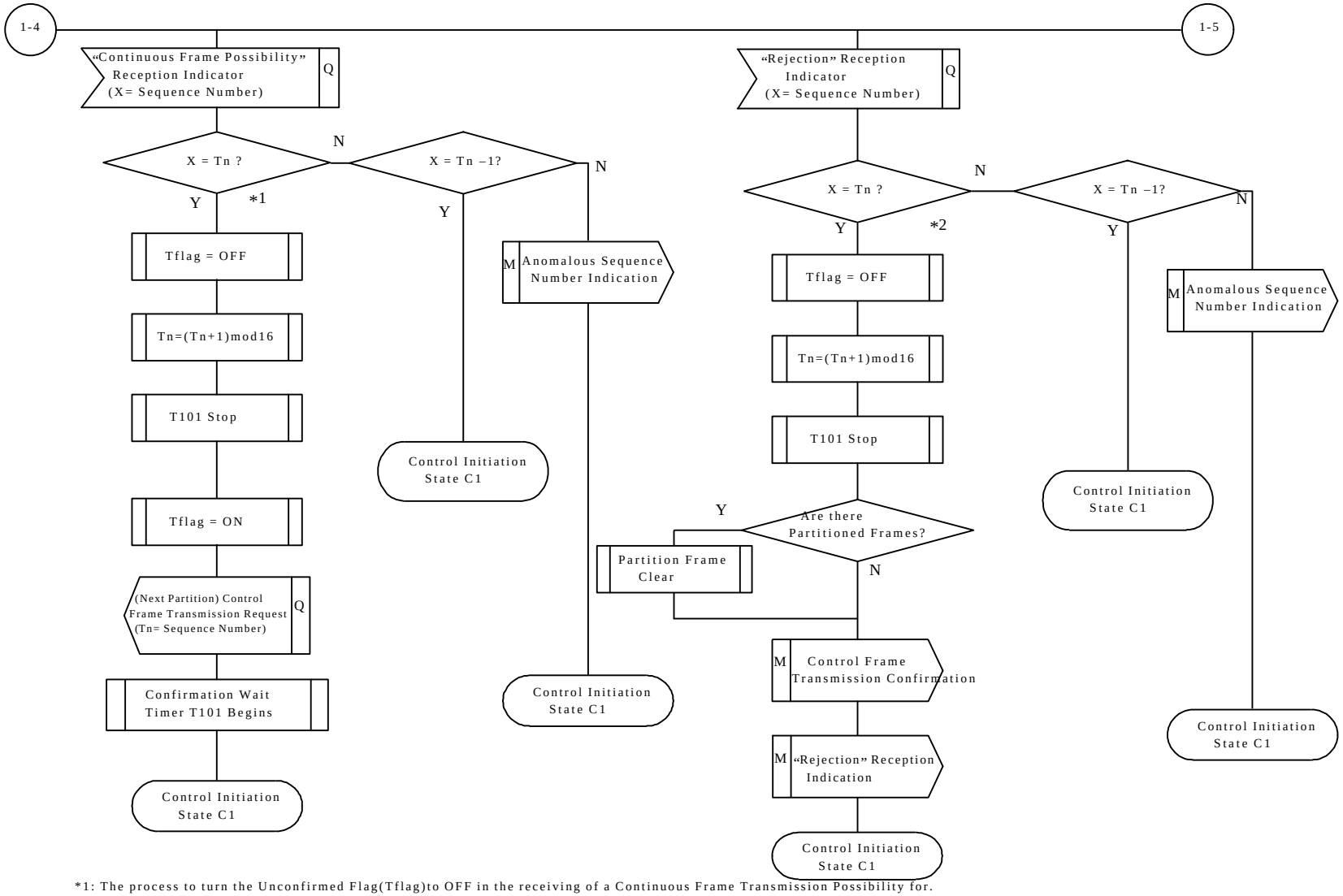

Control Initiation State C1
1-1
1-2
M
"Request" / "Notification" Transmission Request
Y
Frame Partitioning Necessary?
N
Frame Partitioning Procedure
*Up to 16 Frames
Tflag = ON
Control Frame Transmission Request (TN= Sequence Number)
Q
Confirmation Wait Timer T101 Begins
Control Initiation State C1
M
"Reception" / "Response" / "Rejection" Transmission Request
Rflag = ON
Control Frame Transmission Request (RN = Sequence Number)
Q
Confirmation Wait Timer T101 Begins
Control Initiation State C1
T101 T.O
M
Control Incomplete Indicator
Control Stop State C0


Control Initiation State C1
1-2
1-3
Control Frame Transmission Completion Indicator
Q
Transmission Complete Classification
Request/Notification
Reception / Response / Rejection / Continuous Possible
N
Tflag = ON ?
Y
Rflag = ON ?
N
Y
Control Frame Transmission Request
Q
*Transmit the Same Contents Repeatedly
Control Frame Transmission Request
Q
*Transmit the Same Contents Repeatedly
Is there an Interrupted Process?
N
Y
Restart Interrupted Process
Control Initiation State C1
Control Initiation State C1
M
"Continuous Frame Transmission Possibility" Transmission Request
Rflag = ON
Control Frame Transmission Request (RN= Sequence Number)
Q
Confirmation Wait Timer T101 Begins
Control Initiation State C1



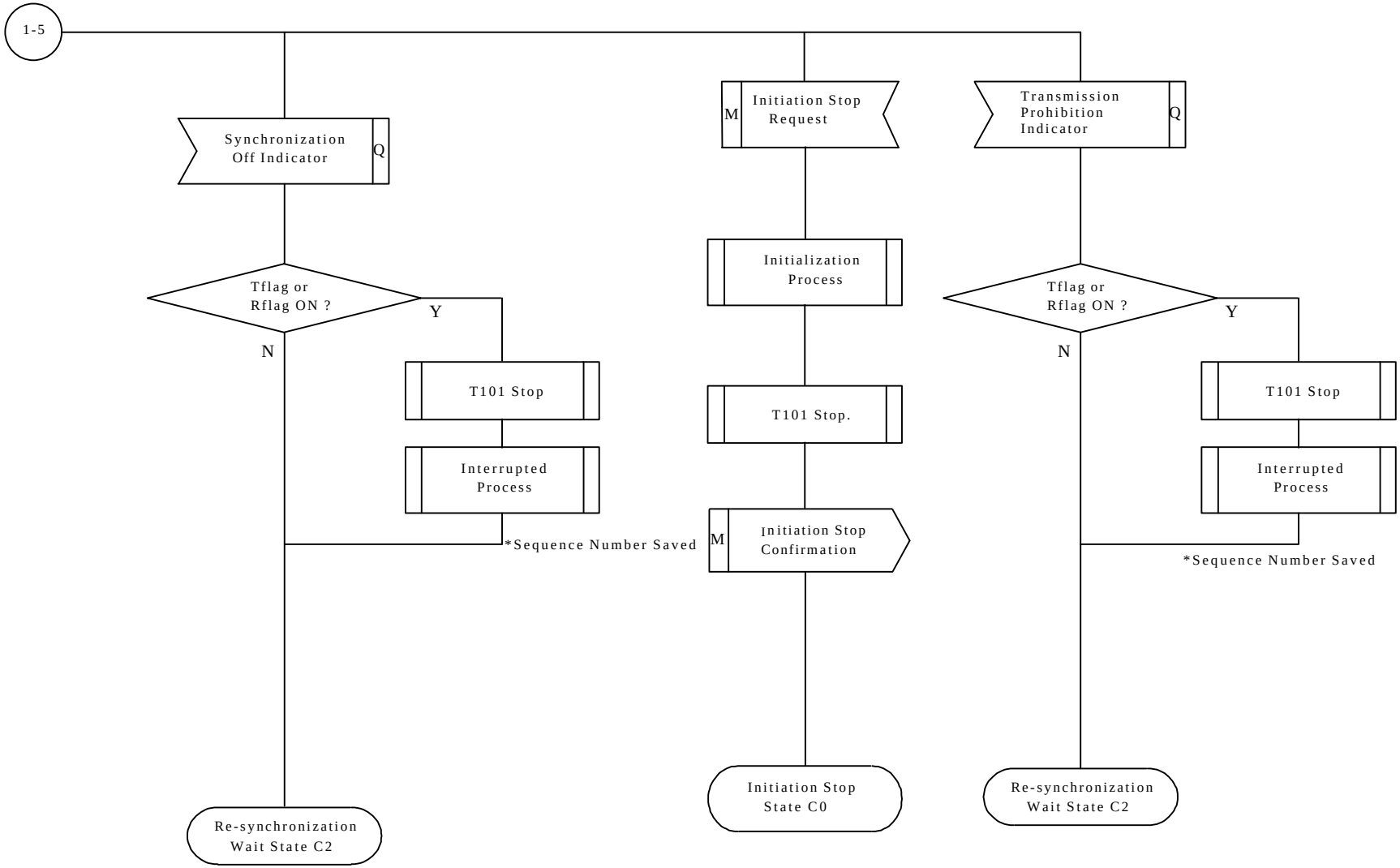
*1: The process of setting the Unconfirmed Flag(Rflag)to OFF, because although Reception(or Response)was sent, there was. notification from M that Reception(or Response)transmission was confirmed because a data frame was received.

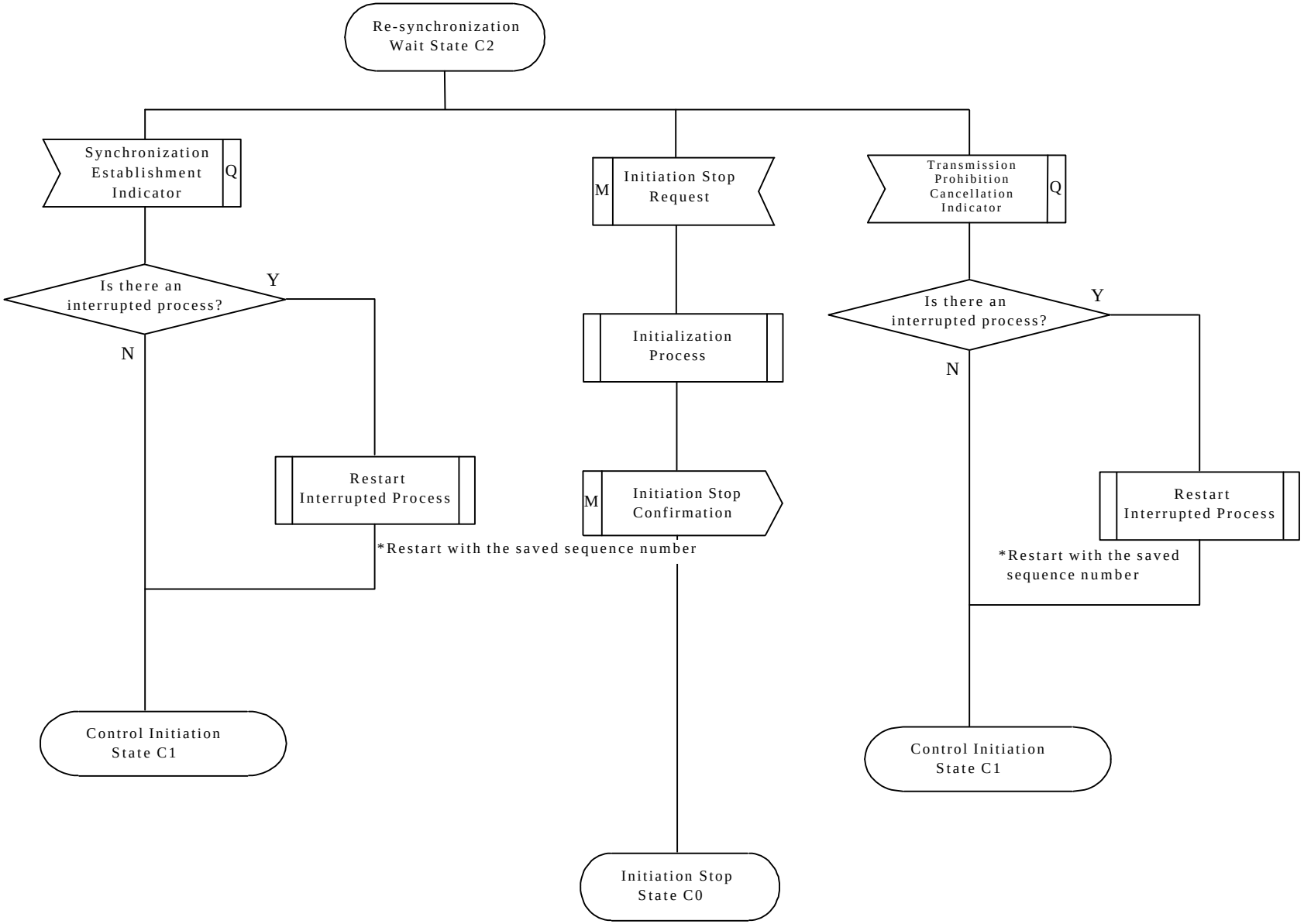
*2: The process to turn the Unconfirmed Flag(Tflag)to OFF in the receiving of a Reception(or Response)for the Request(or Notification)with the same sequence number.



*1: The process to turn the Unconfirmed Flag(Tflag)to OFF in the receiving of a Continuous Frame Transmission Possibility for. the partitioned Request(or Notification)with the same sequence number.

*2: The process to turn the Unconfirmed Flag(Tflag)to OFF in the receiving of a Rejection for the Request with the same sequence number.


1-5
Synchronization Off Indicator
Q
Tflag or Rflag ON ?
Y
N
T101 Stop
Interrupted Process
*Sequence Number Saved
Re-synchronization Wait State C2
M
Initiation Stop Request
Initialization Process
T101 Stop.
M
Initiation Stop Confirmation
Initiation Stop State C0
Transmission Prohibition Indicator
Q
Tflag or Rflag ON ?
Y
N
T101 Stop
Interrupted Process
*Sequence Number Saved
Re-synchronization Wait State C2


Re-synchronization Wait State C2
Synchronization Establishment Indicator
Q
Is there an interrupted process?
Y
N
Restart Interrupted Process
*Restart with the saved sequence number
Control Initiation State C1
M
Initiation Stop Request
Initialization Process
M
Initiation Stop Confirmation
Initiation Stop State C0
Transmission Prohibition Cancellation Indicator
Q
Is there an interrupted process?
Y
N
Restart Interrupted Process
*Restart with the saved sequence number
Control Initiation State C1

2.2.3 Parameters

Parameter Abbreviation	Parameter Name	Parameter Value
T101	Control Transmission Confirmation Wait Timer	10 Seconds
Rn	Received Sequence Number	An integer from 0 15 (mod 16)
Tn	Transmitted Sequence Number	An integer from 0 15 (mod 16)
Rflag	The Other Side's Saved Sequence Unconfirmed Flag (Receiving Flag)	0 / 1
Tflag	This Side's Saved Sequence Unconfirmed Flag (Transmitting Flag)	0 / 1

2.2.4 ARQ Control Frame Control Area Primitive

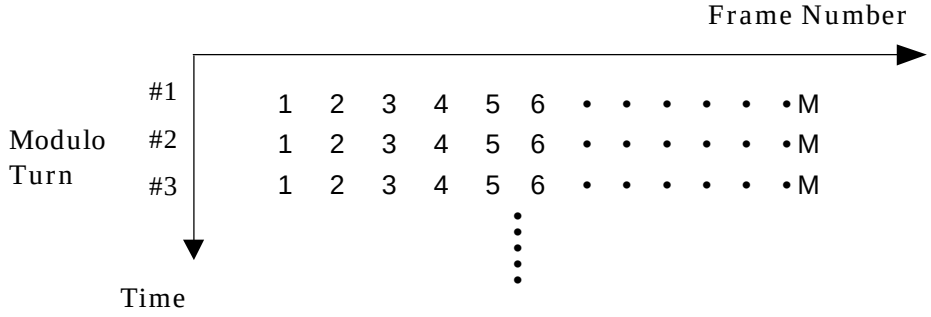
Table 1: ARQ Control Frame Control Area ⇄ Management (C ⇄ M)

ARQ Control Frame Control Area Management		ARQ Control Frame Control Area Management	
Primitive	Meaning	Primitive	Meaning
Control Frame Transmission Confirmation	Notifies that control frame was transmitted	Control Frame Transmission Request	Requests to transmit control frame together with its contents
Anomalous Sequence Number Indicator	Notifies that received frame number was anomalous	Delivery Confirmation Indicator	Notifies that reception (or response) delivery has been confirmed by receiving a data frame
Control Frame Reception Indicator	Notifies that control frame has been received, together with its contents	Activation Stop Request	Requests activation stop of the control area
Control Incomplete Indicator	Notifies that control frame delivery could not be confirmed		
Activation Stop Confirmation	Notifies that the control task has stopped Activation		

Table 2: ARQ Frame Synchronization Process Area⇄ARQ Control Frame Control Area (Q⇄C)

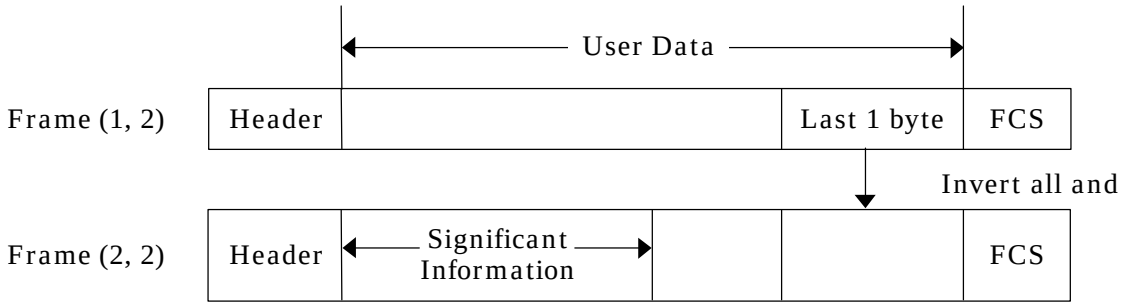
ARQ Frame Synchronization Process Area ARQ Control Frame Control Area		ARQ Frame Synchronization Process Area ARQ Control Frame Control Area	
Primitive	Meaning	Primitive	Meaning
Synchronization Establishment Indicator	Notifies that synchronization has been established	Control Frame Transmission Request	Requests to transmit control frame together with its contents
Control Frame Reception Indicator	Notifies that control frame has been received, together with its contents		
Control Frame Transmission Completion Indicator	Notifies that control frame has been transmitted		
Synchronization Off Indicator	Notifies that synchronization is out of sync.		
Transmission Prohibition Indicator	Notifies that the control frame transmission is disable, tempolary.		
Transmission Prohibition Cancellation Indicator	Notifes that the control frame transmission is enable.		

Attachment 2: Comparison Processing at Time of Data Construction

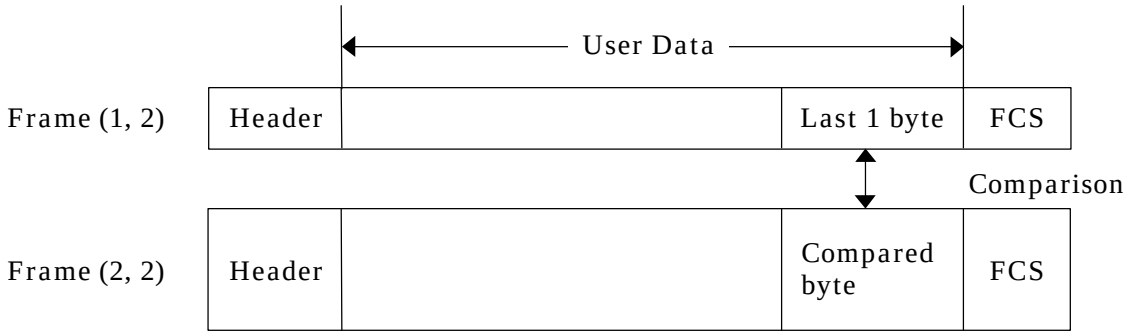


<u>When Constructing Modulo Turn #2 Frame Number 2's (2,2) Frame</u>

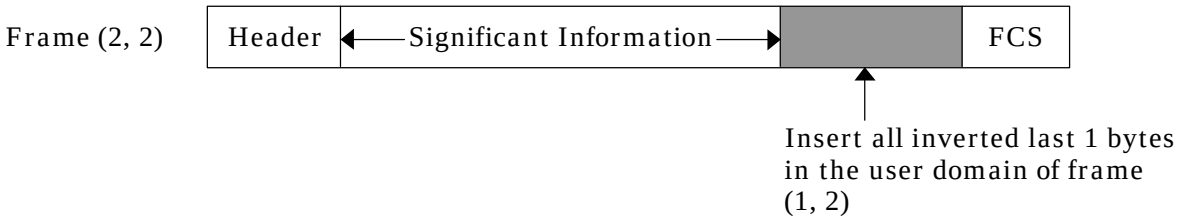
Example 1: At the point where frame (2,2) is constructed, when user data that should be sent does not fill up the maximum byte count that can be transmitted in 1 frame.



Example 2: At the point where frame (2,2) is constructed, when user data that should be sent exceeds the maximum byte count that can be transmitted in one frame.

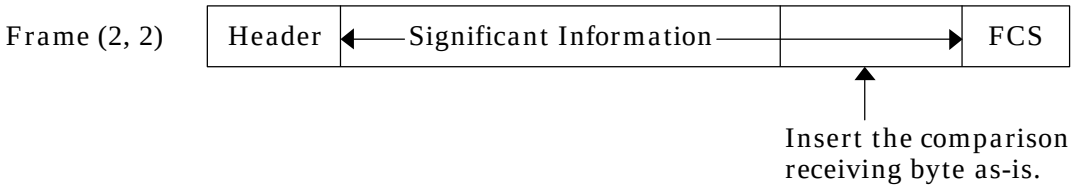


When comparison result is equal:



The comparison receiving byte becomes the lead of frame (2,3)

When comparison result differs:

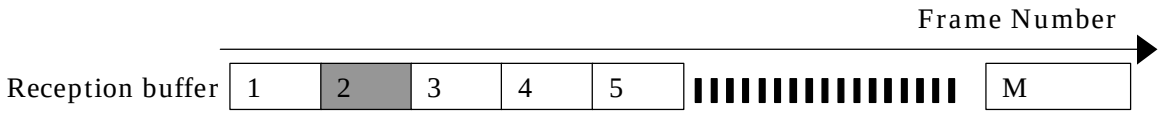


- Frames other than modulo turn #2 also each have comparison processing performed with the corresponding modulo #1's frame.

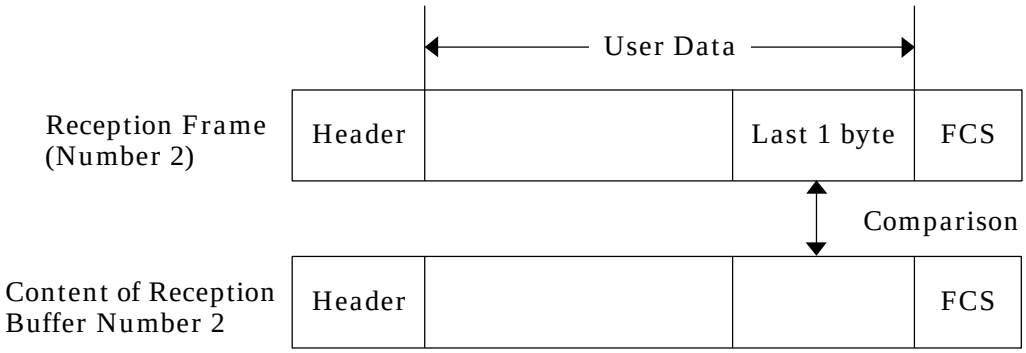
- Are done the same way for modulo turn #2 and #3.

- Comparison processing is performed in the adjacent modulo turn space. In other words, in the above examples, it is okay if the last 1 bytes are equal in modulo turn #1 and #3's identical number frame user-data domains.
  (Note: The content of the header is FI, FFI, FBI, and data length.)

Attachment 3: Comparison Processing at Time of Data Transmission



Example 1: When transmission number 2's frame is received.



<u>When comparison result is the same:</u>
Except for the FBI content, canceled as already received data.

<u>When comparison result differs:</u>
Update reception buffer content as fresh reception data.

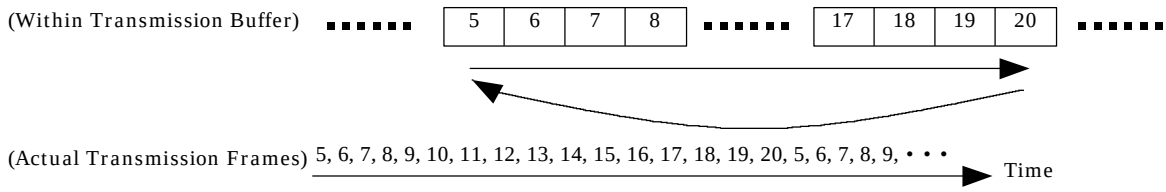
Attachment 4: Basic Actions of ARQ Control

1. Basic Principles

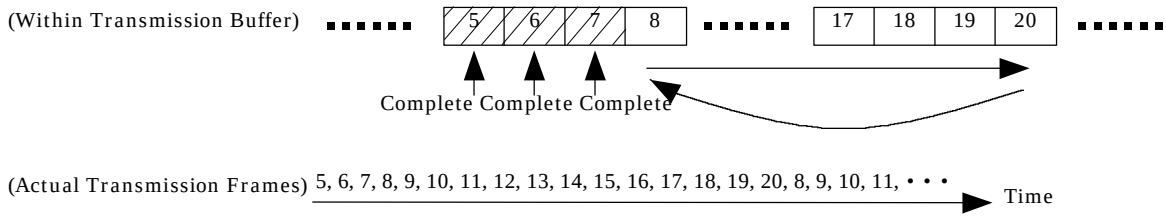
1.1. Data Transmission Side

Basic Principle 1: When there is no transmission line error, existing frames with unconfirmed data are repeatedly transmitted. However, frames exceeding the maximum outstanding frame count must not be transmitted.

Example 1: When existing frames with unconfirmed data are from "5" to "20," from "5" to"20" are repeatedly transmitted.

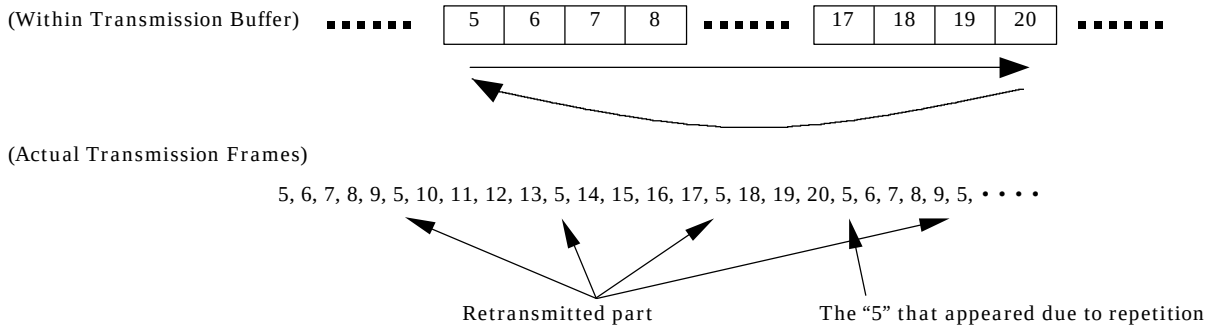


Example 2: When in the example above, when existing frames with unconfirmed data are changed to from "8" to "20,"' from "8" to "20" are repeatedly transmitt



Basic Principle 2: When error exists in the transmission line, in the middle of the above repetitions, the requested frame from the reception side is transmitted.

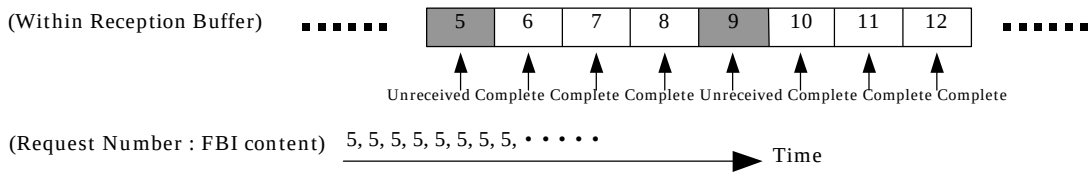
Example 3: When existing frames with unconfirmed data are from "5" to "20," and additionally the data reception side has requested frame #5, based upon the RTF value, "5" is retransmitted. In this example, RTF=4.



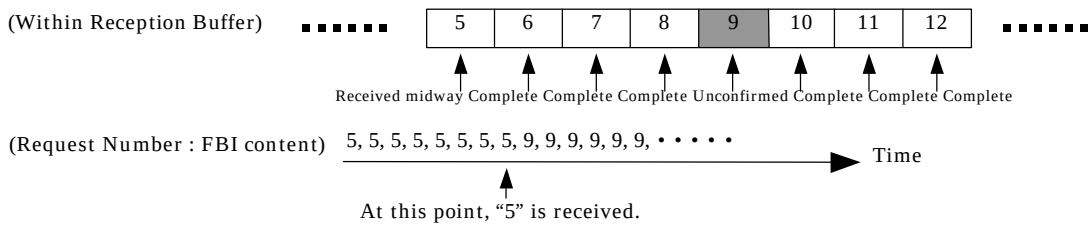
1.2 Data Reception Side

Basic Principle 1: Always continuously requesting the next wanted frame.

Example 4: When "5" is unconfirmed.



Example 5: When in the above example "5" is correctly received midway through.



2. Action Examples of ARQ Control

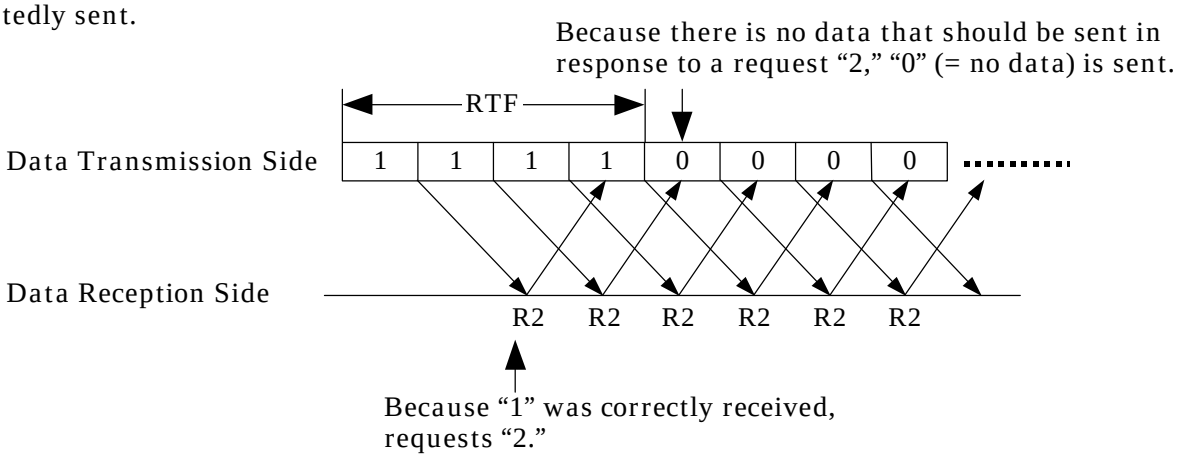
Explanation of Symbols

1	Frame transmission of frame number 1 (FFI content)
R2	Requesting frame number 2's frame (FBI content)
RTF	Response delay time
→	No error in transmission line
⇢	Error in transmission line

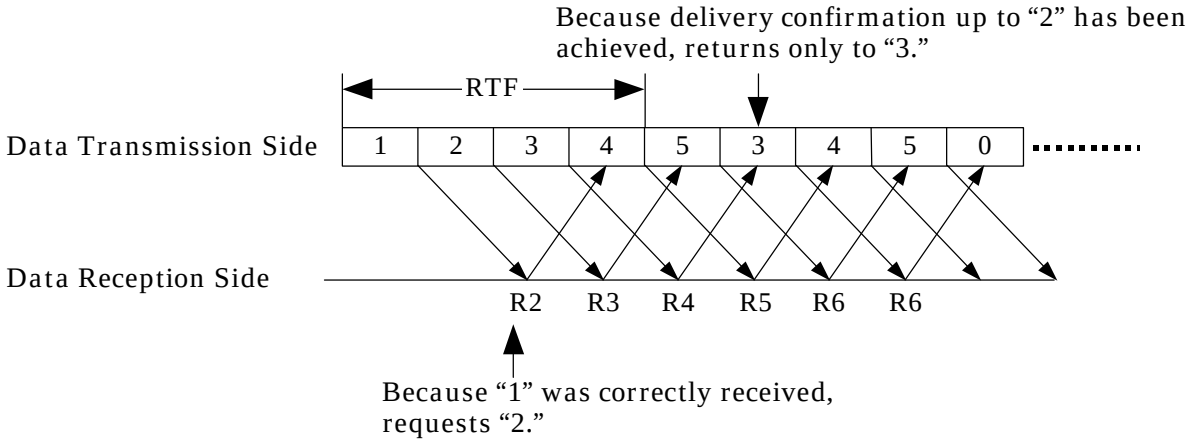
2.1 When there is no error in transmission line

Example 1: When only 1 frame is unconfirmed.

When data that should be sent does not exist even within the RTF, the identical frame is repeatedly sent.

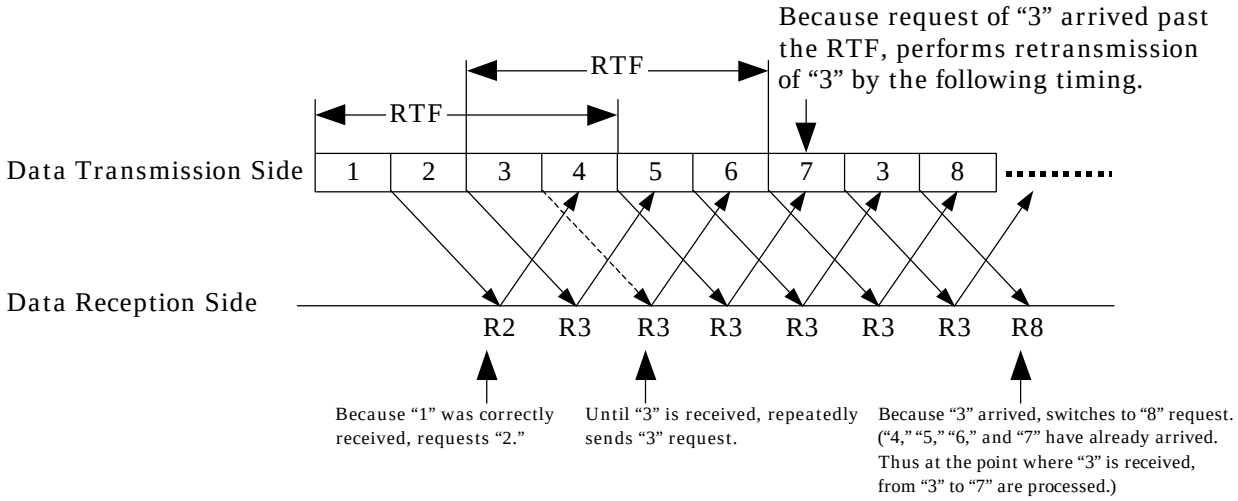


Example 2: When multiple frames are unconfirmed (frames that should be sent are from "1" to "5.")

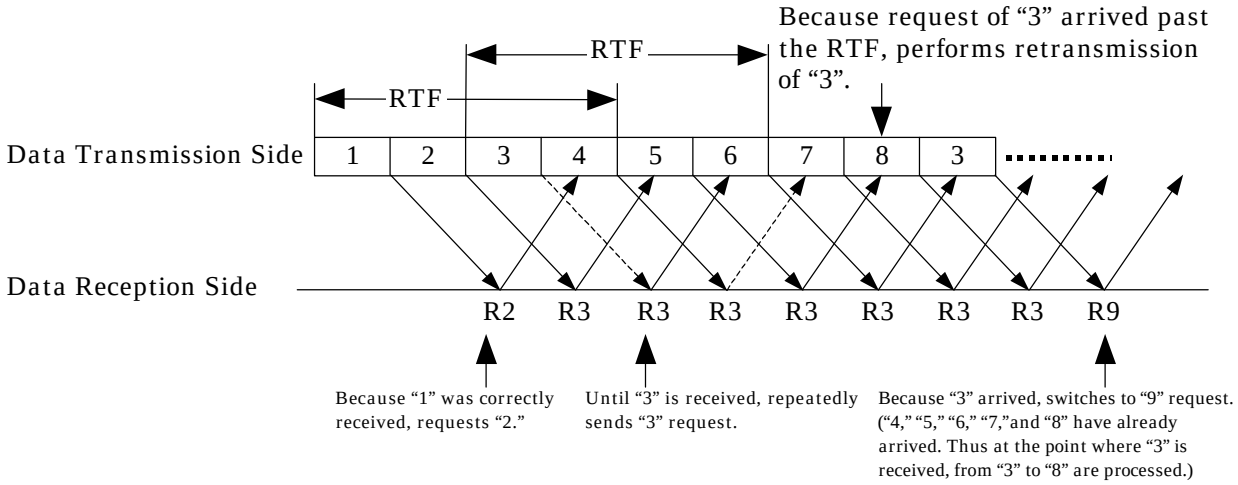


2.2 When there is transmission line error

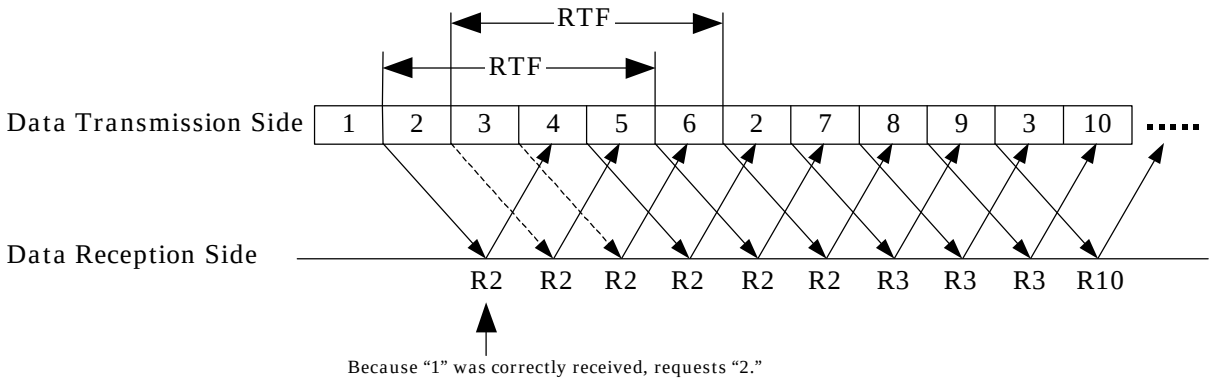
Example 3: When there is 1 frame error (No error in return frame)



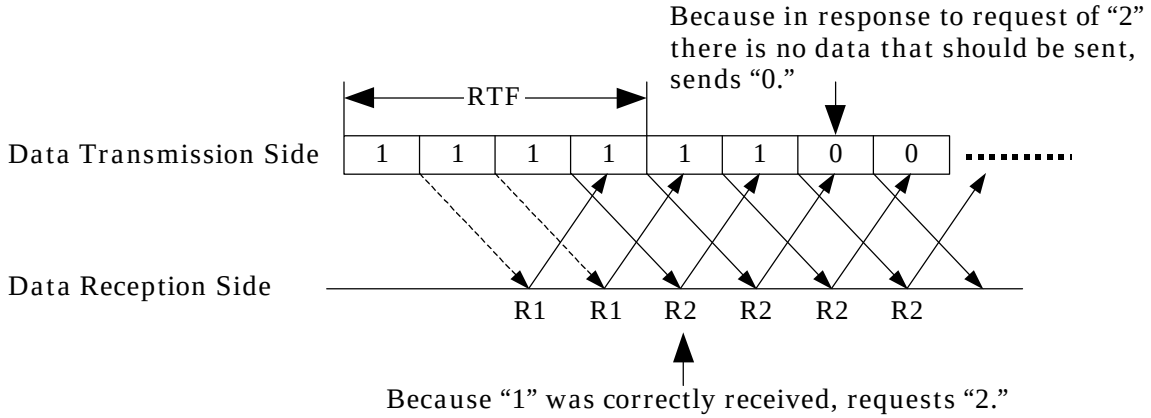
Example 4: When there is one frame error (Error exists in return frame)



Example 5: When there are multiple frame errors (No error in return frame)

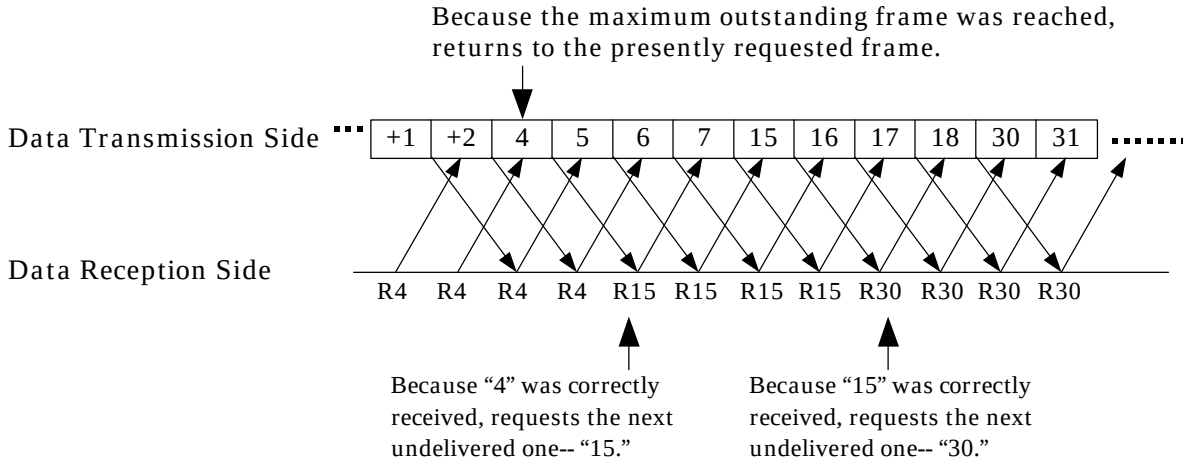


Example 6: When only 1 frame is unconfirmed



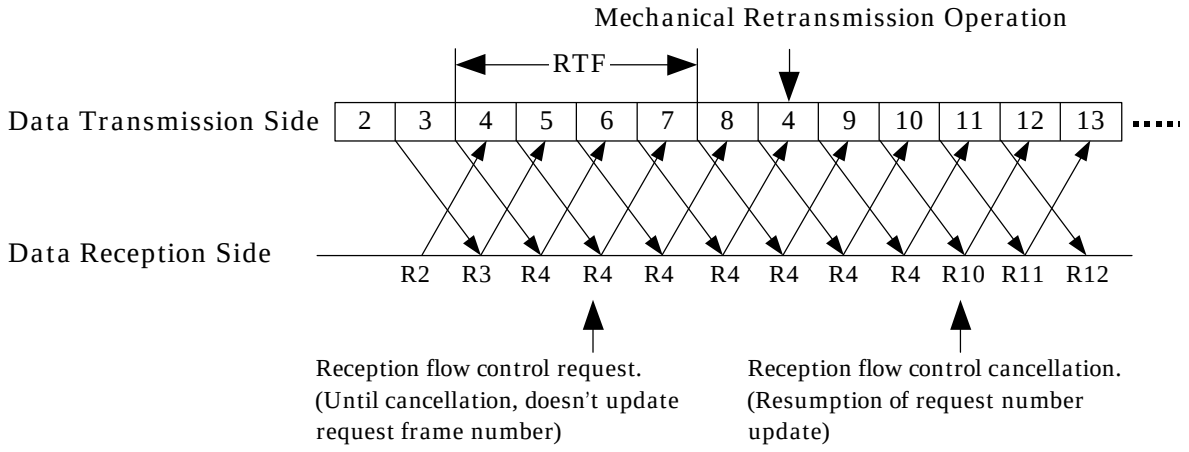
2.3 When up to maximum outstanding frame is transmitted (Maximum outstanding frame count = modulo count - 1)

Example 7: When the presently requested frame number is "4," it is possible for the transmission side to transmit the next modulo turn up to "2" without delivery confirmation, and after that returns to "4." However, in the frames appertaining to the next modulo turn, here a "+" is attached to indicate it. Also, as the condition of the reception buffer frames, the unreceived frames are "4," "15," and "30."



2.4 When reception flow control is requested

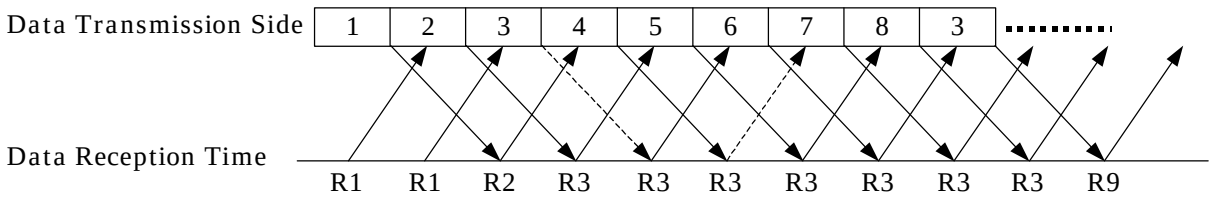
Example 8: When reception flow control is requested, can be handled without updating the request frame number.



3. Changes in Internal State Variables

The changes in internal state variables in Example 4 are shown below.

Data transmission side internal variables and initial values	Processing result (When reception timing from other side serves as a trigger)										
V(S1):1	1	1	1	1	2	3	3	3	3	3	
V(S2):0	1	2	3	4	5	6	7	8	8	9	
N(S):1	1	2	3	4	5	6	7	8	3	9	
N(R):-	-	-	1	1	2	3	3	-	3	3	
T(1):0	1	2	3	4	5	6	7	8	9	10	……
T(2):0	1	1	2	3	4	5	6	7	8	9	
T(3):0	1	2	1	2	3	4	5	6	1	2	
T(4):0	1	2	3	1	2	3	4	5	6	7	
T(5):0	1	2	3	4	1	2	3	4	5	6	
T(6):0	1	2	3	4	5	1	2	3	4	5	
T(7):0	1	2	3	4	5	6	1	2	3	4	
T(8):0	1	2	3	4	5	6	7	1	2	3	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	



Data transmission side internal variables and initial values

Processing result (When reception timing from other side serves as a trigger)

V(R1):1	1	1	2	3	3	3	3	3	3	3	9	
N(S): -	-	-	1	2	-	4	5	6	7	8	3	
N(R) : 1	1	1	2	3	3	3	3	3	3	3	9	
RF(1):0	0	0	0	0	0	0	0	0	0	0	0	
RF(2):0	0	0	0	0	0	0	0	0	0	0	0	……
RF(3):0	0	0	0	0	0	0	0	0	0	0	0	
RF(4):0	0	0	0	0	0	1	1	1	1	1	0	
RF(5):0	0	0	0	0	0	0	1	1	1	1	0	
RF(6):0	0	0	0	0	0	0	0	1	1	1	0	
RF(7):0	0	0	0	0	0	0	0	0	1	1	0	
RF(8):0	0	0	0	0	0	0	0	0	0	1	0	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		

Attachment 5: Regarding the Handling of the Continuous Frame Identification Bit

The use-method of the continuous frame identification bit regulated by PIAFS is left up to the mounting, but in these reference materials, two mounting examples are given.

1) When the Top Layer Doesn't Detect a Data Unit

When the equipment mounted on PIAFS is utilized the same as a modem (V.32, etc.,) used by a personal computer, the space between PIAFS mounting equipment and DTE are connected by a non-synchronization serial signal (EIA232C), and the logical interface of this data link and the top layer becomes a byte unit (See chart 1)

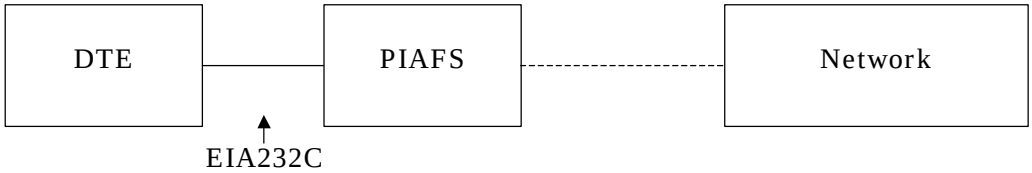


Chart 1: Structure of Data Communication Equipment (Example 1)

In this case, in PIAFS's data-link processing, after the recepted byte unit data is combined in an appropriate size (e.g., the maximum data length of 73 bytes), it is set in an ARQ frame and transmitted. At this time, the continuous frame identification bit is set to 0 (single frame). The reception side's data-link processing fetches the data, in order, from the correctly received ARQ frame, and after partitioning, notifies DTE by non-synchronized interface through byte units. The transmission side's condition is shown in Chart 2.

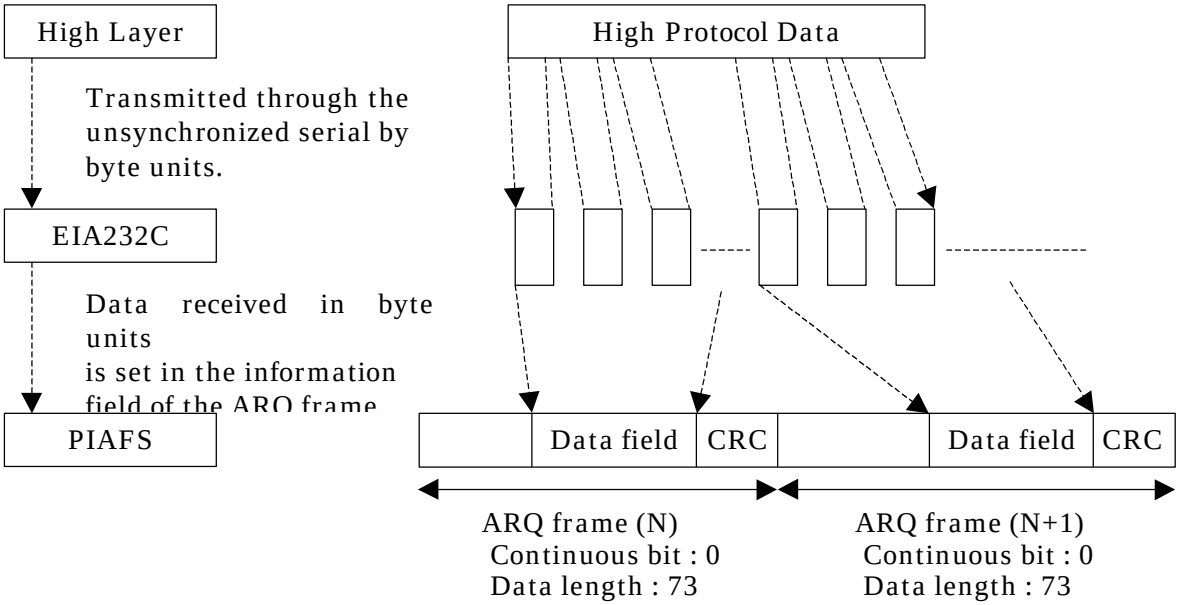


Chart 2: The Flow of Transmission Data 1

2) When the High Layer Detects Data Units

In cases when a protocol that detects data units such as IP (Internet Protocol) is mounted in the high layer, PIAFS's mounting equipment is connected through a bus-mode interface (FIFO, shared memory, etc.,) such as a LAN adapter loaded on a personal computer, and logical interface becomes the data-unit unit size chosen at the time of mounting.

Chart 3: Structure Example of Data Communication Equipment

In this case, in the PIAFS data-link processing, the received data unit is partitioned in the ARQ frame and transmitted. The partitioned continuous frame identification bit(s) in the ARQ frame of the last ARQ frame are 0 (last frame), and all other continuous identification bits of the ARQ frame are set at 1. In the data-link processing on the reception side, the correctly received ARQ frames are combined, and data units are constructed to notify the high layer. The conditions at the transmission side are shown in Chart 4.

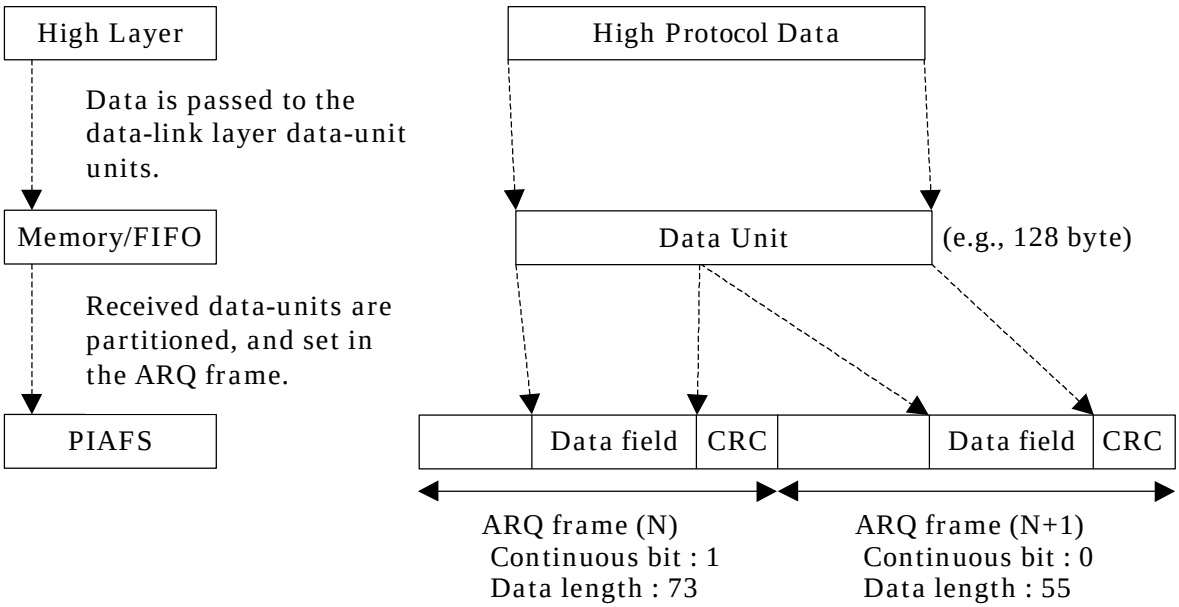


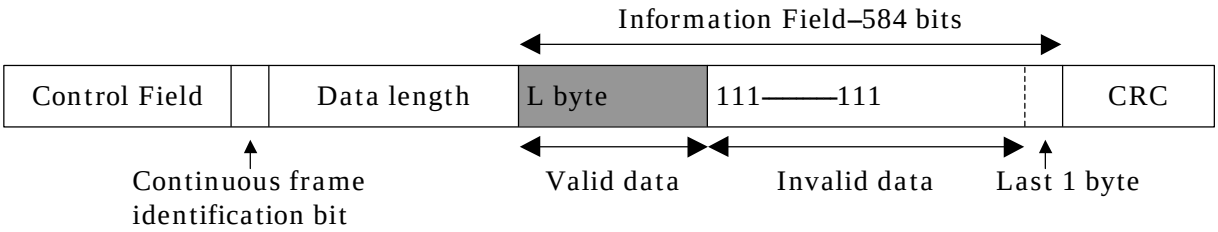
Chart 4: The Flow of Transmission Data 2

Attachment 6: Reception Side Processing through Effective Abbreviation Frame System (Optional)

When, on the transmission side, of the information fields (584 bits) within the frames that should be sent, except for the valid data indicated by the data length and the last 1 byte of data, and after all the remaining parts (invalid data domains) have been embedded at All 1,' it transmits a frame affixed with a error detection code, and on the data reception side, the invalid data domains from the data length of the received frames are detected, and after those domains are permutated to All 1,' the system that performs error detection is the Effective Abbreviation Frame System.
By this, in cases where the valid data length is short, it is possible to improve the frame's error factor.
In these specifications, for all the synchronization frames, control frames, and data frames, the frame format has been regulated so that the effective abbreviation frame system can be applied, but processing at the reception side is optional.

1. Regulation of the Transmission Side (Must see 3.2.5)

On the transmission side, the actually valid data byte length in the data length in each frame is stored. Also, except for the valid data and the last 1 byte within the information field, the invalid data domain becomes All 1.' The regulations for frame formatting at the transmission side is shown in Chart 1.



Format regulations :

Data length; Stores valid data length L
Invalid data domain: ‘All 1’ embedded.

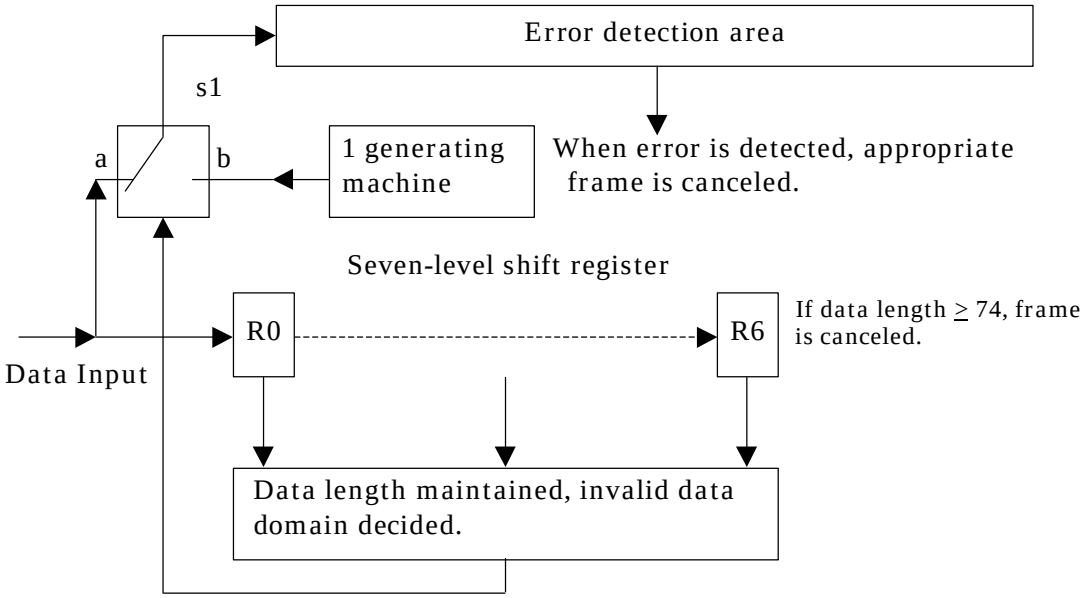
Chart 1: Frame Format Regulations at the Transmission Side

The data length in the data frame stores the valid data length (0~73). Also the data length in the synchronization frame and control frame is found in 3.1.4.5.

2. Reception Side Processing (Optional)

At the reception side, for received frames the following processing is performed.
(1)The data length is read off from the received frame.
(2)If the data length is greater than 74 bytes, the appropriate frame is canceled.
(3)The invalid data domains within the information field (584 bit) are specified by the data length.(The last 1 byte in the information field is excluded from the invalid data domain.)
(4)All 1' is embedded in the invalid data domain section.

(5)Perform error detection of appropriate frames through the CRC.
(6)Frames with errors detected are canceled.
In Chart 2, one example of the reception side's error detection method is shown.



Gate signal g : For data from d0 to d23, switch s1 = a
For valid data space from data d24 to d599, s1 = a.
For invalid data space from data d24 to d599, s1 = b
For data from d600 to d639, s1 = b.

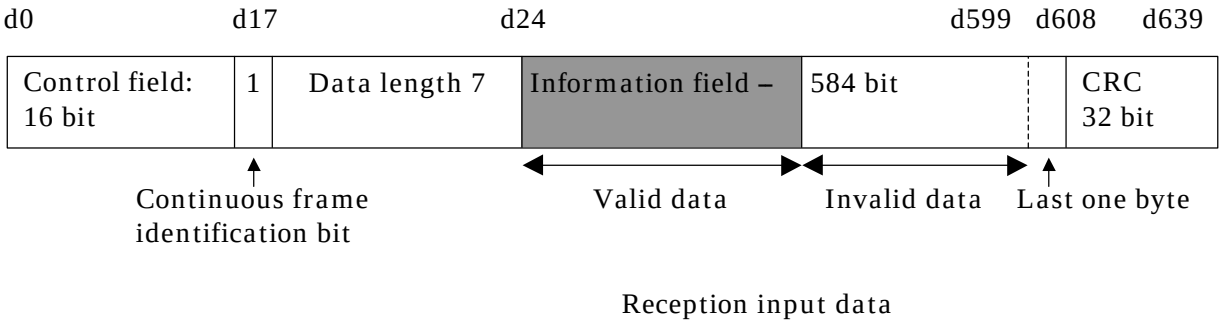


Chart 2: One Example of Error Detection Method of Reception Side

Attachment 7: Mounting Example when EIA232C Uses a Later-level Interface Connected to External Equipment

When PIAFS employs mounted equipment in the same way as a modem (V.32, etc.) is used in personal computer communication, PIAFS's later-level interface becomes a non-synchronized/non-specified serial signal (EIA232C). (See Chart 1)

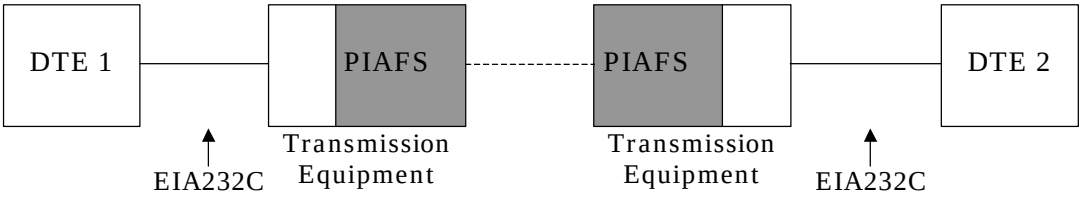


Chart 1: When Later-Level Interface is Non-Synchronized/Non-Specified

When PIAFS has received a break signal from DTE 1, it is necessary for it to transmit a break signal to the other side. However, since the break signal is a different, special signal than regular in-channel data, PIAFS cannot transmit a break signal as a data frame. Therefore the break signal is transmitted using the control frame's user information (user information content identifier: 01).

When transmitting a break signal, during the time of execution of the V.42bis compression it is necessary to achieve matching of the compression/expansion area's dictionaries at the data transmission and reception sides. To do that, when there is V.42bis compression, accompanying the break signal, the break requesting side must notify whether or not the transmission data has been canceled. The notification of whether the data has been canceled or not is performed using byte 4 of the user information.

When there is no V.42bis compression, notification of the existence/ non-existence of data cancellation is not especially necessary.

The processing when V.42bis compressions exists is shown below.

(1) Cases of Buffer Non-breakdown Breaks

ARQ internal state variables are saved, and after break processing is completed, the saved internal state variables are used as initial values, and ARQ actions are resumed.

(2) Cases of Buffer Breakdown Breaks

Transmission Side Processing

-Initialize compression area dictionary. (Refer to ITU-T V.42bis 5.6)

-Initialize transmission data buffer in ARQ control.

-After completion of break processing, the ARQ actions are resumed after initialization of the internal state variables in the FFI decision processing. (Resume ARQ control from frame number 1.)

<u>Reception Side Processing</u>

-Initialize expansion area dictionary. (Refer to ITU-T V.42bis 5.6)

-Initialize reception data buffer in ARQ control.

-After completion of break processing, the ARQ actions are resumed after initialization of the internal state variables in the FBI decision processing.

Also, it is assumed there will be such cases where DTE 2 is substituted by equipment such as a modem, etc., and that that equipment is operated from DTE 1. In that case, when it is

necessary to transmit an AT command concerning the equipment through the control frame, it is transmitted through the user information (user information content identifier: 02.) Moreover, when it is necessary to transmit the result concerning that AT command through the control frame, it is sent through the user information (user information content identifier: 03).

The above bit-coding examples are shown in Attachment 8.

Attachment 8: Control Information Content Coding Examples

1. Communication Parameter Setting

1.1 Communication Parameter Setting Request Communication Parameter Reception, All Settings Possible.

In response to the "Requests" on the left, because the reception side was All Settings Possible," the "Request" and "Reception" bytes 2~10 (shaded area) are the same.

Communication Parameter Setting Request								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number "0"				Control Information Identification "Request"				Byte 1
0	0	0	0	0	0	0	1	
Control Information Content Identifier "Communication Parameter Setting"								Byte 2
0	0	0	0	0	0	0	1	
ARQ Data Transmission Protocol Version "Version 1"								Byte 3
0	0	0	0	0	0	0	1	
ARQ Control Information Transmission Protocol Version "Version 1"								Byte 4
0	0	0	0	0	0	0	1	
Measurement RTF Value "6"								Byte 5
0	0	0	0	0	1	1	0	
Data Compression Method Identifier "V. 42 bis"								Byte 6
0	0	0	0	0	0	0	1	
Encoded Words Total Count P1 "2048"								Byte 7
0	0	0	0	0	0	1	1	
Maximum Character Line Length P2 "32"								Byte 8
0	0	1	0	0	0	0	0	

Communication Parameter Setting Reception								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number "0"				Control Information Identification "Reception"				Byte 1
0	0	0	0	1	0	0	0	
Control Information Content Identifier "Communication Parameter Setting"								Byte 2
0	0	0	0	0	0	0	1	
ARQ Data Transmission Protocol Version "Version 1"								Byte 3
0	0	0	0	0	0	0	1	
ARQ Control Information Transmission Protocol Version "Version 1"								Byte 4
0	0	0	0	0	0	0	1	
Measurement RTF Value "6"								Byte 5
0	0	0	0	0	1	1	0	
Data Compression Method Identifier "V. 42 bis"								Byte 6
0	0	0	0	0	0	0	1	
Encoded Words Total Count P1 "2084"								Byte 7
0	0	0	0	0	0	1	1	
Maximum Character Line Length P2 "32"								Byte 8
0	0	1	0	0	0	0	0	

Change Possible During Transmission Identifier “Change Not Possible”	Frame Length “80”							Byte 9
0	1	0	1	0	0	0	0	
Change Possible During Transmission Identifier “Change Not Possible”	Maximum Frame Number (M) “63”							Byte 10
0	0	1	1	1	1	1	1	
Reserved								Byte 11 72
1	1	1	1	1	1	1	1	
Fixed Value								Byte 73
1	1	1	1	1	1	1	1	

Change Possible During Transmission Identifier “Change Not Possible”	Frame Length “80”							Byte 9
0	1	0	1	0	0	0	0	
Change Possible During Transmission Identifier “Change Not Possible”	Maximum Frame Number (M) “63”							Byte 10
0	0	1	1	1	1	1	1	
Reserved								Byte 11 72
1	1	1	1	1	1	1	1	
Reception Result “All Settings Possible”								Byte 73
0	0	0	0	0	0	0	0	

Chart 1 : Communication Parameter Setting Request Communication Parameter Reception, All Settings Possible

1.2 Communication Parameter Setting Request Communication Parameter Reception, Partial Settings Possible

In response to the "Requests" on the left, on the reception side it is not possible to set the otal word encoding count at "2048." It is then changed to "1024" (byte 7), and the "Reception Result" is "Partial Settings Possible."

Communication Parameter Setting Request								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number “0”				Control Information Identification “Request”				Byte 1
0	0	0	0	0	0	0	1	
Control Information Content Identifier “Communication Parameter Setting”								Byte 2
0	0	0	0	0	0	0	1	
ARQ Data Transmission Protocol Version “Version 1”								Byte 3
0	0	0	0	0	0	0	1	
ARQ Control Information Transmission Protocol Version “Version 1”								Byte 4
0	0	0	0	0	0	0	1	
Measurement RTF Value “6”								Byte 5
0	0	0	0	0	1	1	0	
Data Compression Method Identifier “V. 42 bis”								Byte 6
0	0	0	0	0	0	0	1	
Encoded Words Total Count P1 “2048”								Byte 7
0	0	0	0	0	0	1	1	
Maximum Character Line Length P2 “32”								Byte 8
0	0	1	0	0	0	0	0	

Communication Parameter Setting Reception								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number “0”				Control Information Identification “Reception”				Byte 1
0	0	0	0	1	0	0	0	
Control Information Content Identifier “Communication Parameter Setting”								Byte 2
0	0	0	0	0	0	0	1	
ARQ Data Transmission Protocol Version “Version 1”								Byte 3
0	0	0	0	0	0	0	1	
ARQ Control Information Transmission Protocol Version “Version 1”								Byte 4
0	0	0	0	0	0	0	1	
Measurement RTF Value “6”								Byte 5
0	0	0	0	0	1	1	0	
Data Compression Method Identifier “V. 42 bis”								Byte 6
0	0	0	0	0	0	0	1	
Encoded Words Total Count P1 “1024”								Byte 7
0	0	0	0	0	0	1	0	
Maximum Character Line Length P2 “32”								Byte 8
0	0	1	0	0	0	0	0	

Change Possible During Transmission Identifier “Change Not Possible”	Frame Length “80”							Byte 9
0	1	0	1	0	0	0	0	
Change Possible During Transmission Identifier “Change Not Possible”	Maximum Frame Number (M) “63”							Byte 10
0	0	1	1	1	1	1	1	
Reserved								Byte 11 72
1	1	1	1	1	1	1	1	
Fixed Value								Byte 73
1	1	1	1	1	1	1	1	

Change Possible During Transmission Identifier “Change Not Possible”	Frame Length “80”							Byte 9
0	1	0	1	0	0	0	0	
Change Possible During Transmission Identifier “Change Not Possible”	Maximum Frame Number (M) “63”							Byte 10
0	0	1	1	1	1	1	1	
Reserved								Byte 11 72
1	1	1	1	1	1	1	1	
Reception Result “Partial Settings Possible”								Byte 73
0	0	0	0	0	0	0	1	

Chart 2: Communication Parameter Setting Request-Communication Parameter Reception, Partial Settings Possible

2. ARQ Parameter Setting Request

2.1 ARQ Parameter Setting Request ARQ Parameter Reception, All Settings Possible

In ARQ data transmission protocol Version 1, other than outside the measurement RTF value, the initial setting parameters are used. In response to a "request" from the left, because the reception side was “All settings possible," the "Request" and "Reception" bytes 2~3 (shaded area) are the same.

ARQ Parameter Setting Request								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number “8”				Control Information Identification “Request”				Byte 1
1	0	0	0	0	0	0	1	
Control Information Content Identifier “ARQ Parameter Setting”								Byte 2
0	0	1	0	0	0	0	1	
Measurement RTF Value “7”								Byte 3
0	0	0	0	0	1	1	1	
Reserved								Byte 4 72
1	1	1	1	1	1	1	1	
Fixed Value								Byte 73
1	1	1	1	1	1	1	1	

ARQ Parameter Setting Reception								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number “8”				Control Information Identification “Reception”				Byte 1
1	0	0	0	1	0	0	0	
Control Information Content Identifier “Communication Parameter Setting”								Byte 2
0	0	1	0	0	0	0	1	
Measurement RTF Value “7”								Byte 3
0	0	0	0	0	1	1	1	
Reserved								Byte 4 72
1	1	1	1	1	1	1	1	
Reception Result “All Setting Possible”								Byte 73
0	0	0	0	0	0	0	0	

Chart 3 : ARQ Parameter Setting Request ARQ Parameter Reception, All Settings Possible

3. Data-link Release

3.1 Data-link Release Request Data-link Release Reception

Data-link Release Request								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number “5”				Control Information Identification “Request”				Byte 1
0	1	0	1	0	0	0	1	
Control Information Content Identifier “Data-link Release”								Byte 2
0	1	0	0	0	0	0	1	
Reserved								Byte 3 72
1	1	1	1	1	1	1	1	
Reason Indicator “Normal Release”								Byte 73
0	0	0	1	0	0	0	0	

Data-link Release Reception								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number “5”				Control Information Identification “Reception”				Byte 1
0	1	0	1	1	0	0	0	
Control Information Content Identifier “Data-link Release”								Byte 2
0	1	0	0	0	0	0	1	
Reserved								Byte 3 72
1	1	1	1	1	1	1	1	
Reception Result “Data-link Release Complete”								Byte 73
0	0	0	0	0	0	0	0	

Chart 4 : Data-link Release Request Data-link Release Reception

3.2 Data-link Release Request Data-link Release Rejection

Data-link Release Request								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number “5”				Control Information Identification “Request”				Byte 1
0	1	0	1	0	0	0	1	
Control Information Content Identifier “Data-link Release”								Byte 2
0	1	0	0	0	0	0	1	
Reserved								Byte 3 72
1	1	1	1	1	1	1	1	
Reason Indicator “Normal Release”								Byte 73
0	0	0	1	0	0	0	0	

Data-link Release Rejection								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number “5”				Control Information Identification “Rejection”				Byte 1
0	1	0	1	1	0	0	1	
Control Information Content Identifier “Data-link Release”								Byte 2
0	1	0	0	0	0	0	1	
Reserved								Byte 3 72
1	1	1	1	1	1	1	1	
Rejection Result “Untransmitted Data Exists”								Byte 73
1	0	0	0	0	0	1	0	

Chart 5 : Data-link Release Request Data-link Release Rejection

4. User Information

4.1 User Information (Break) Request User Information (Break) Reception

"Request" and "Reception " bytes 2~4 (shaded area) are the same.

User Information Request								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number “12”				Control Information Identification “Request”				Byte 1
1	1	0	0	0	0	0	1	
Control Information Content Identifier “User Information”								Byte 2
0	1	1	0	0	0	0	1	
User Information Content Identifier “Break”								Byte 3
0	0	0	0	0	0	0	1	
User Information “Transmission Data is Not Canceled” (see note)								Byte 4
0	0	0	0	0	0	0	0	
(No Significant Information)								Byte 5 72
1	1	1	1	1	1	1	1	
Fixed Value								Byte 73
1	1	1	1	1	1	1	1	

User Information Reception								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number “12”				Control Information Identification “Reception”				Byte 1
1	1	0	0	1	0	0	0	
Control Information Content Identifier “User Information”								Byte 2
0	1	1	0	0	0	0	1	
User Information Content Identifier “Break”								Byte 3
0	0	0	0	0	0	0	1	
User Information “Transmission Data is Not Canceled”								Byte 4
0	0	0	0	0	0	0	0	
(No Significant Information)								Byte 5 72
1	1	1	1	1	1	1	1	
Reception Result “Break Complete”								Byte 73
0	0	0	0	0	0	0	0	

Note: The coding of the break user information (byte 4) is 0x00 "data is not canceled," and 0x01 "transmission data was canceled."

Chart 6 : User Information (Break (Data is not Canceled)) Request User Information (Break)Reception

4.2 User Information (AT Command) Request User Information (AT Command) Reception
"Request" and "Reception" bytes 2~5 (shaded area) are the same.

User Information Request								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number "12"				Control Information Identification "Request"				Byte 1
1	1	0	0	0	0	0	1	
Control Information Content Identifier "User Information"								Byte 2
0	1	1	0	0	0	0	1	
User Information Content Identifier "AT Command"								Byte 3
0	0	0	0	0	0	1	0	
User Information "A" (see note)								Byte 4
0	1	0	0	0	0	0	1	
User Information "T"								Byte 5
0	1	0	1	0	1	0	0	
(No Significant Information)								Byte 6 72
1	1	1	1	1	1	1	1	
Fixed Value								Byte 73
1	1	1	1	1	1	1	1	

User Information Reception								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number "12"				Control Information Identification "Reception"				Byte 1
1	1	0	0	1	0	0	0	
Control Information Content Identifier "User Information"								Byte 2
0	1	1	0	0	0	0	1	
User Information Content Identifier "AT Command"								Byte 3
0	0	0	0	0	0	1	0	
User Information "A" (see note)								Byte 4
0	1	0	0	0	0	0	1	
User Information "T"								Byte 5
0	1	0	1	0	1	0	0	
(No Significant Information)								Byte 6 72
1	1	1	1	1	1	1	1	
Reception Result "All Settings Possible"								Byte 73
0	0	0	0	0	0	0	0	

Note: An example of transmitting AT command "AT."

Chart 7 : User Information (AT Command/AT) Request User Information (AT Command/AT) Reception

4.3 User Information (AT Command Result) Notification User Information (AT Command Result) Response

User Information Notification								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number "12"				Control Information Identification "Notification"				Byte 1
1	1	0	0	0	0	1	0	
Control Information Content Identifier "User Information"								Byte 2
0	1	1	0	0	0	0	1	
User Information Content Identifier "AT Command Result"								Byte 3
0	0	0	0	0	0	1	1	
User Information (AT Command Result)								Byte 4 ~72
Fixed Value								Byte 73
1	1	1	1	1	1	1	1	

User Information Response								
8	7	6	5	4	3	2	1	Bit / Byte
Sequence Number "12"				Control Information Identification "Reception"				Byte 1
1	1	0	0	1	0	1	0	
(No Significant Information)								Byte 2 ~72
1	1	1	1	1	1	1	1	
Reserved								Byte 73
1	1	1	1	1	1	1	1	

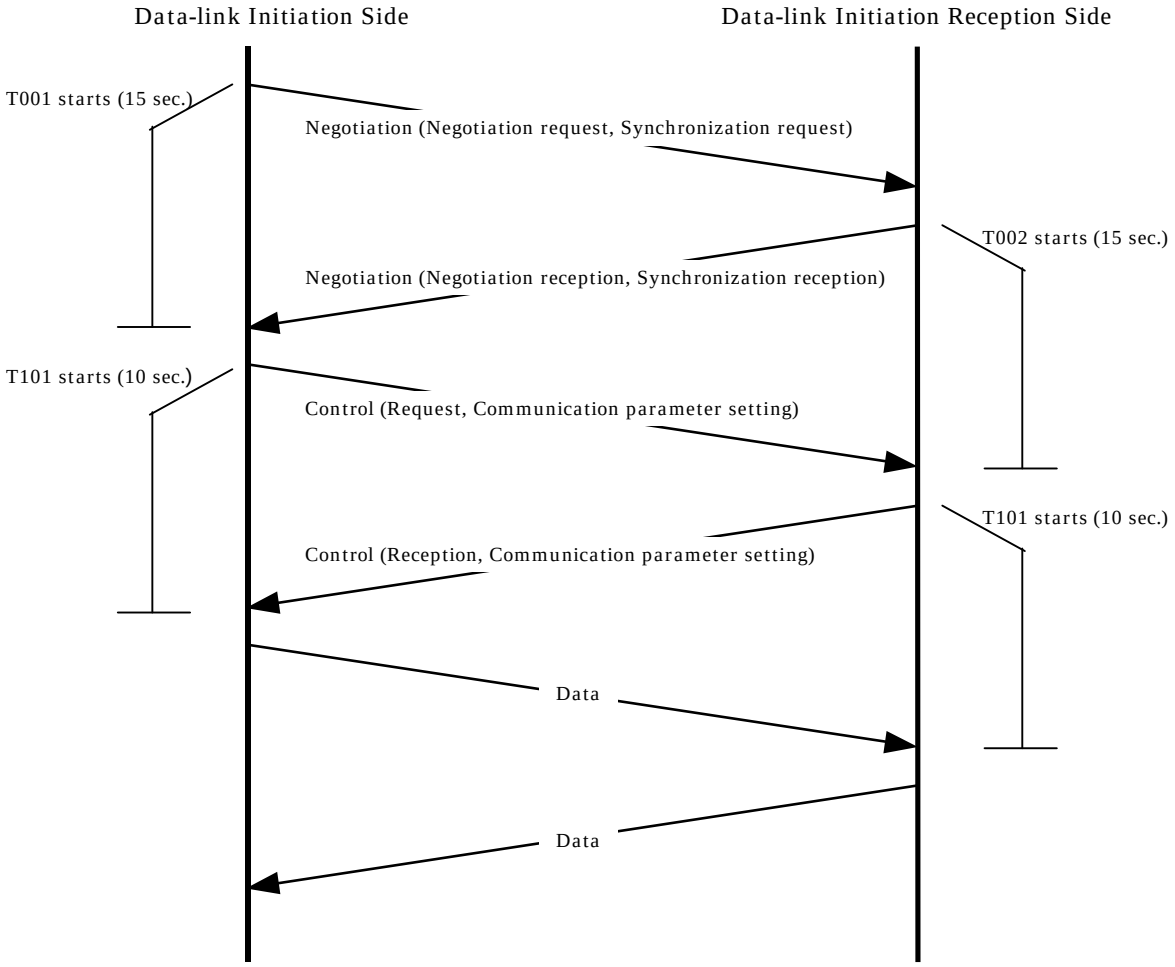
Chart 8 : User Information (AT Command Result) Notification User Information (AT Command Result) Response

Attachment 9 Sequence Examples

General sequence are shown in this attachment.

9.1 Data Link Establishment Sequence

Illustration 9.1 shows the data link establishment sequence.



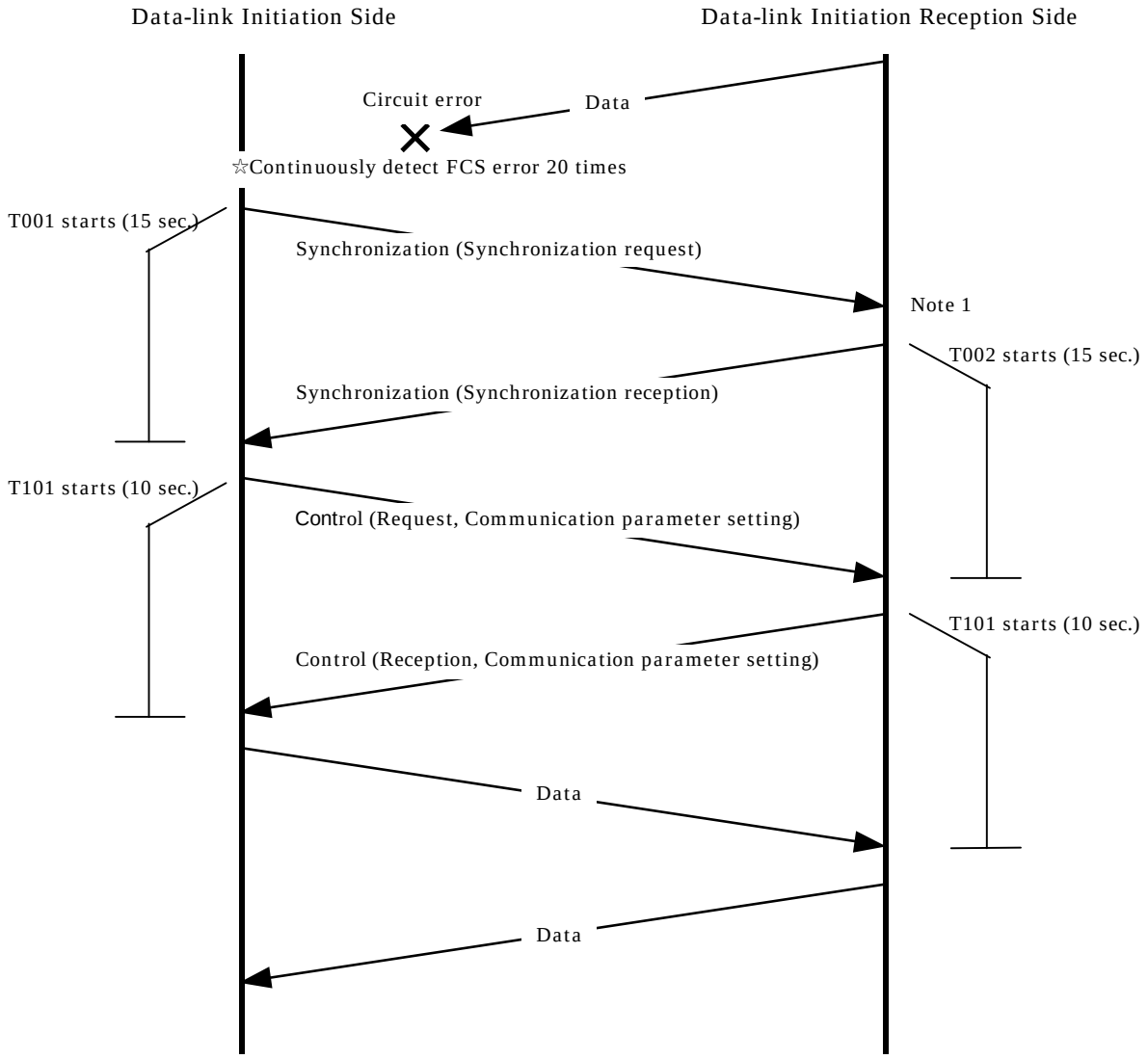
Example: Negotiation (Negotiation classification, Synchronization classification)
Control (Control information classification identifier, Control information content identifier)

: Timer stops.

Illustration 9.1 Data-link Establishment Sequence

9.2 ARQ Re-Synchronization Sequence During Communications

Illustrations 9.2.1 and 9.2.2 show the ARQ re-synchronization sequence during communications.

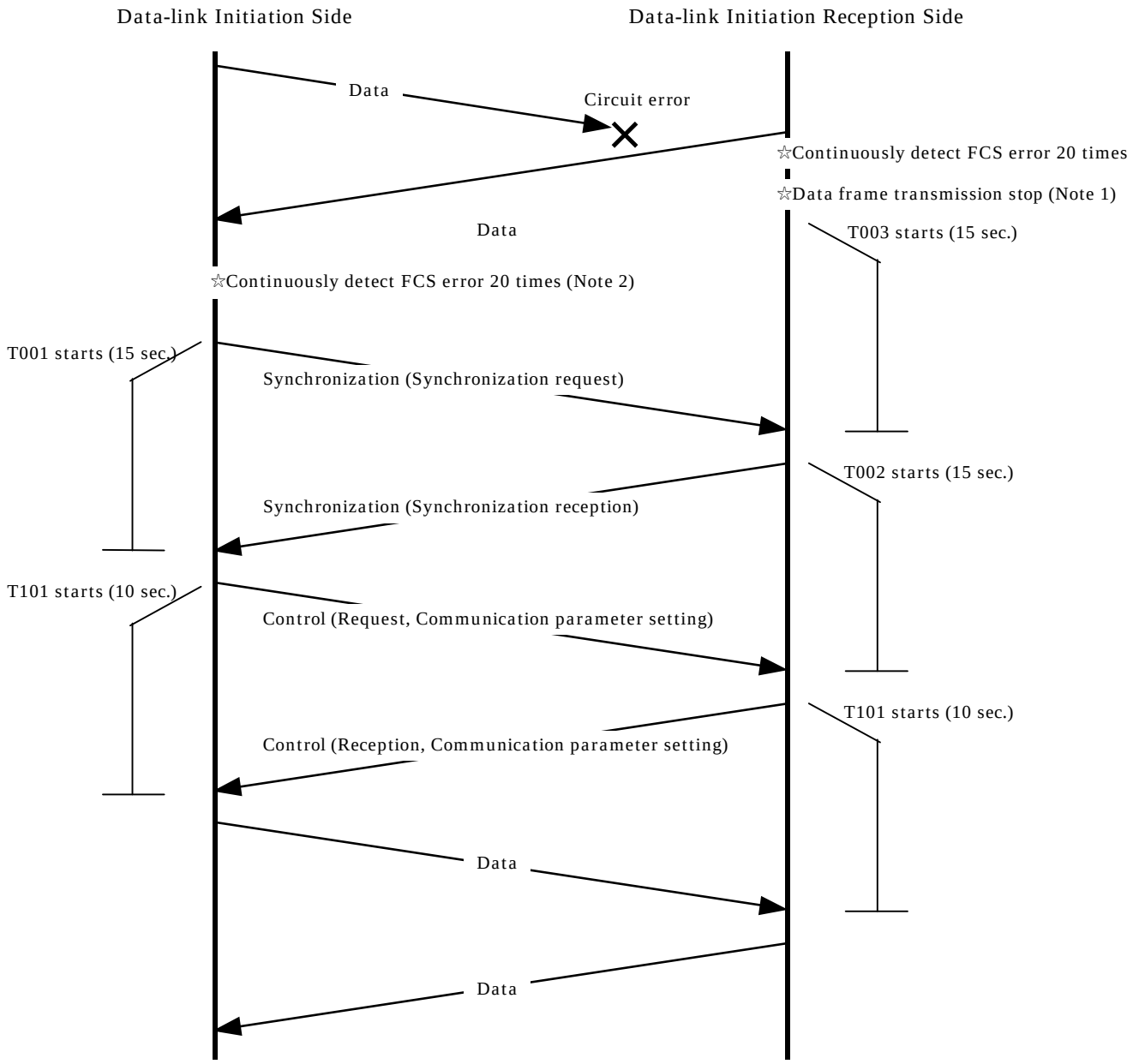


Example: Synchronization (Synchronization classification)
Control (Control information classification identifier, Control information content identifier)

: Timer stops.

Note 1: When the timing of synchronization frame which is transmitted from the data-link initiation side and that of the data frame which has been received immediately before the synchronization frame are the same, ARQ re-synchronization processing is initiated even at the data-link initiation reception side by receiving the synchronization frame (synchronization request). Also, when those timings are different, synchronization frame (synchronization request) is not received by the data-link initiation reception side and the ARQ re-synchronization processing is initiated by continuous detection of FCS errors 20 times.

Illustration 9.2.1 ARQ Re-Synchronization Sequence during Communications
(At the time of re-synchronization initiation from the data-link initiation side)



Example: Synchronization (Synchronization classification)
Control (Control information classification identifier, Control information content identifier)

: Timer stops.

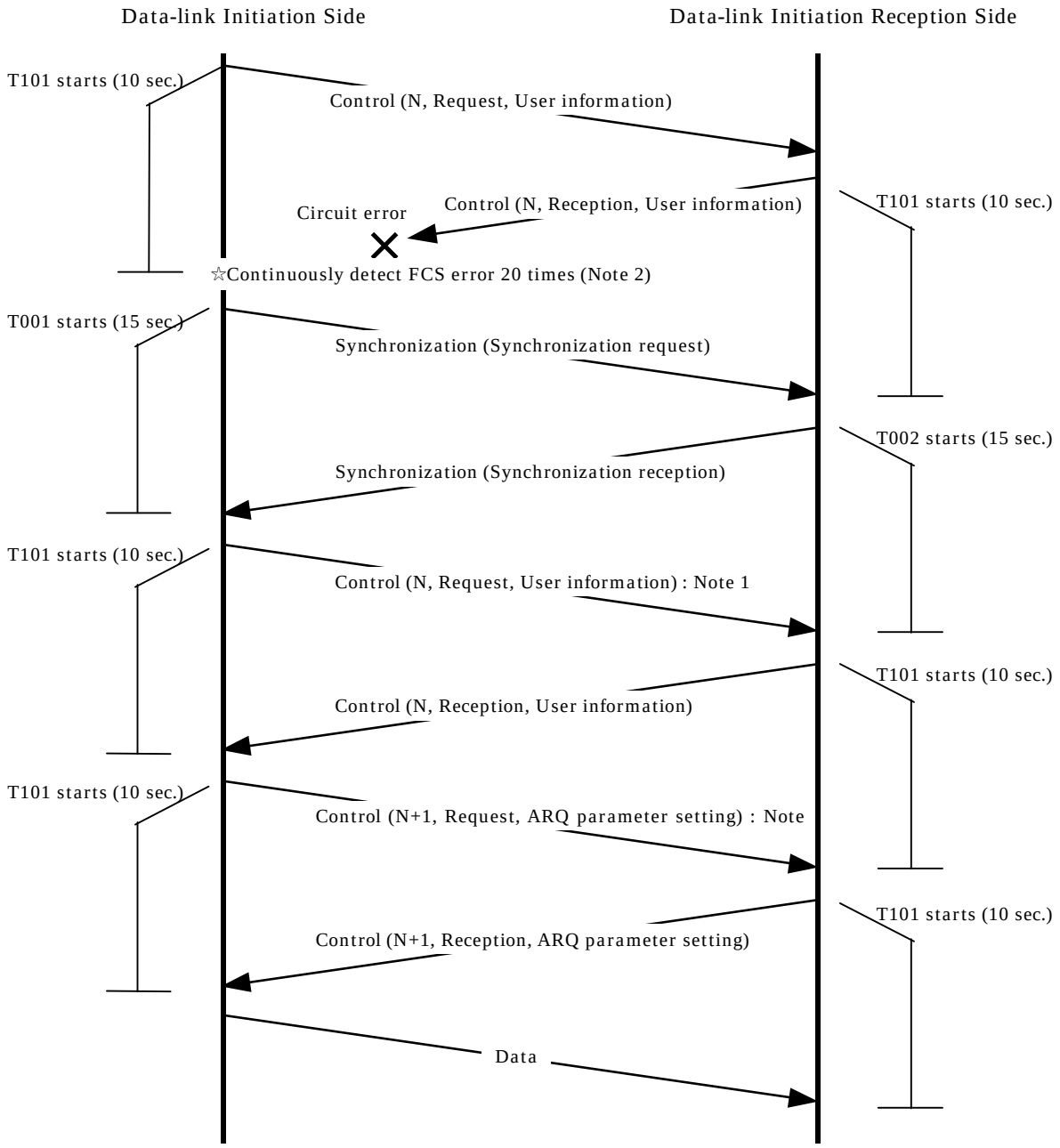
Note 1: Since FCS errors are detected continuously 20 times at the data-link initiation reception side, frame transmission is stopped.

Note 2: Since the data-link initiation reception side stops frame transmission, FCS errors are detected continuously 20 times and ARQ re-synchronization processing is initiated

Illustration 9.2.2 ARQ Re-Synchronization Sequence during Communications
(At the time of re-synchronization initiation from the data-link initiation reception side)

Attachment 10 ARQ Re-Synchronization Processing During Control Frame Transmission

In case ARQ re-synchronization occurs during transmission of control information by control frame, the contents of control information being transmitted is saved and the transmission of the control frame is stopped. The transmission of the saved control information is resumed after completion of ARQ re-synchronization processing. Illustration 10.1 shows an example of the sequence when ARQ re-synchronization processing initiates after continuous detection of FCS errors at the data-link initiation side during transmission of user information by control frames.



Example: Synchronization (Synchronization classification)
Control (Sequence number, Control information classification identifier, Control information content identifier)
: Timer stops.

Note 1: User information is transmitted by control frames before FCS error detection but the delivery was not confirmed, therefore, it will be resent after completion of ARQ re-synchronization.

Note 2: Since delivery of the previous control frame is confirmed, the RTF value measured in ARQ re-synchronization processing will be notified by control frames (ARQ parameter setting).

Illustration 10.1 ARQ Re-Synchronization Sequence during Control Frame Transmission

PIAFS Specifications

Published Date of Original Japanese Versions

March 1997 version 1.0

June 1998 version 1.1

Published by Mobile Internet Access Forum

PIAFS Specifications English Printed in October 1999