IT900
Host Interface Command Set
User Guide

February 2011

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Chapter 1. Introduction

1.1 Scope

This document describes the interface for host applications operating above the IT900 modem, on which the Y-Net protocol stack resides. Before reading this document, it is recommended to review *IT900 Y-Net Protocol Stack Overview* in order to gain an in-depth understanding of the Y-Net protocol.

Readers of this document will benefit from:

- Guidelines for creating new applications using the host interface.
- In-depth understanding of the Y-Net protocol stack interface with host applications (from the host perspective).
- Ability to choose correct Y-Net stack and IT900 modes and settings most fit for the individual requirements of a host application.
- Knowledge of IT900 architecture and its hardware interface with an external microcontroller on which host applications reside.
- Complete and detailed understanding (format and functionality) of the commands supported by the host interface to implement host applications above IT900.

1.2 Document Organization

The remainder of the document is organized as follows:

- Chapter 2 describes the procedure required for developing basic plug and play host applications for novice IT900 developers and/or simple network installation scenarios.
- Chapter 3 provides a general description of the physical (UART) and logical (command set) interface between IT900 and the host application.
- Chapter 4 consists of an in-depth description of advanced options for the development of host applications. This section is intended for developers that require more flexible applications and requires an understanding of the stack, modem processes and options.
- Chapter 5 consists of the format and structure of the commands supported by the command set.

Chapter 2. Developing Basic Host Applications

Figure 2.1 illustrates the high-level procedure required for developing basic plug and play host applications that form a logical network and enable transmission and reception among modems in a network of IT900 modems configured to their default settings.

To convert this procedure into working code, the interface description in Chapter 3 and a minimal subset of the command set presented in Chapter 5 should be reviewed and implemented.

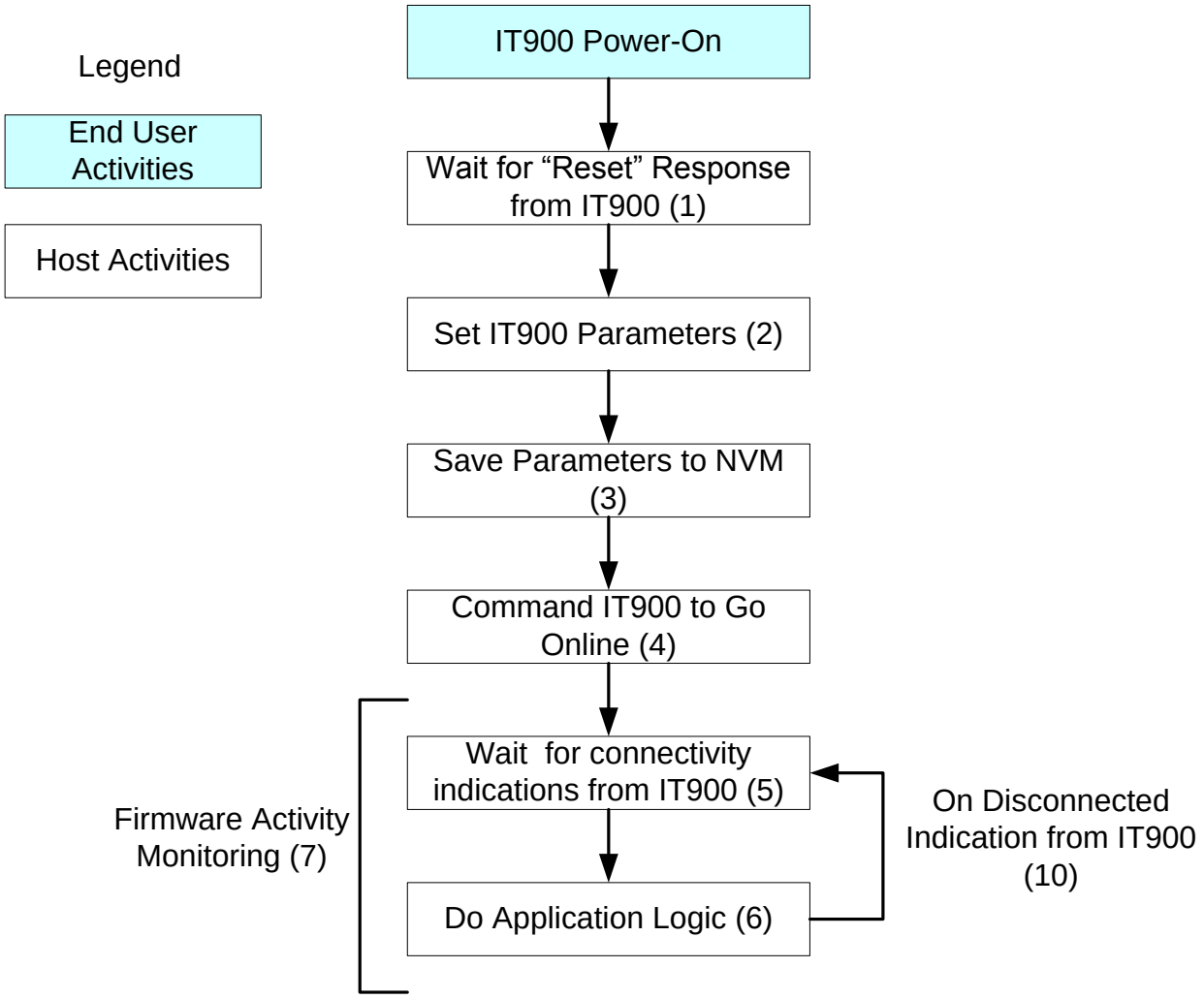

Figure 2.1: Step by Step Instructions for Forming a Logical Network

(1) "Reset" response primitive (see Section 5.4.2.1) is issued to the host upon IT900 power-on. The Host should detect Reset response to validate proper wake-up of IT900 microcontroller. Prior to the "Reset" response primitive, a BSP "Welcome" message is issued and may be discarded by the application – see Appendix B.4 for more details about BSP.

(2) This step should be performed to override the IT900's default settings upon the first power–up, to repair corrupt parameters or due to applicative considerations (see Appendix B).

IT900's default configurations are a RS node configured to FCC in a single logical network environment (network size is 10 nodes) without any restrictions on admission using warm start.

Configuration of IT900 parameters is accomplished by sending a "Set Device Parameters" request primitive (see Section 5.4.4.2(. The most typical configurations required to override the above defaults are as follows (**configurations order is critical)**:

- The S/N (Serial Number) is a globally unique 16-byte sequence (different than all 0x00 or 0xFF) to be defined and configured by the application*. To configure the S/N of a node use the 'Set Device Parameters' command, where the 'Table Type' field should be set to "S/N" and the 'Index' field to 0xBAAB. To ensure S/N uniqueness among customers, the S/N value should be determined according to the instructions provided on Appendix B.6.
- When the regional settings should be different than FCC (i.e. ARIB or CENELEC), send the "Set Predefined Parameters" command (see Section 5.4.3.1). The "Region" field should be set according to the operating band (ARIB or CENELEC).
- **For the NC node only**:
  - Set the "Operation Mode" parameter to "NC".
  - Set the "NC Database Size" parameter to the Maximal number of RS that are allowed to join the network. The NC will define it databases size according to this parameter.
- Set the "**Network Size**" parameter to the number of nodes participating in the **physical** network, keeping in mind that in one **physical** network there maybe multiple **logical** networks). It is required to set an identical value to all nodes participating in the network.

> **Important Note**
> Setting the "**Network Size**" parameter is critical for the NL management to operate properly:
> - Setting it too low causes excessive management traffic and might degrade network performance.
> - Setting it too high causes slower reaction by the Y-NET Stack management processes.

(3) Saving the parameters settings is performed by sending "Save Device Parameters" command (see Section 5.4.3.4). Once the parameters are stored, IT900 will retrieve the settings from the NVM on subsequent power-up (i.e., no need to repeat step (2) every time IT900 is turned on).

(4) Command IT900 to Go Online by sending the "Go Online" request primitive (see Section 5.4.2.2). Once the device goes online, data and management services will become active and available to the host.

(5) In RS nodes, wait for "Connected to NC" indication from the IT900 (see Section 5.4.6.9). At this point the RS is ready to send messages to the NC.

In NC nodes, wait for "Network ID Assigned" indication from the IT900 (see Section 5.4.6.12). When received, the NC is ready to connect new RS to its network. From this point on, the NC will be continuously informed about new RS connections by "New Connection to NC" indications arriving from the IT900 (see Section 5.4.6.11) and indicating link establishment with the newly connected RS.

(6) Application logic operations may include application messages transmission using the "Packet Tx" command (see Section 5.4.5.1) and according to the instructions on Section 4.2.2.2.1, handle "Rx Intra/Inter-networking packet" indications from IT900 (see Sections 5.4.5.3 and 5.4.5.4), handle management indications from IT900, handle application user interface logic, perform HAL operation, etc.

Applicative recommendations and considerations are provided in Appendix C.

* The S/N settings is not mandatory when using IT900 PIMs manufactured by Yitran as these PIMs are pre-flashed with a unique S/N during production.

(7) It is recommended to implement firmware activity monitoring logic by periodically polling the External Host Interface (optionally using the NOP command) and verifying correct response from the IT900. If no response is received from the IT900, the Host should issue a reset sequence.

For devices that require very high reliability using the IT900 in the chip version (i.e., not in the PIM version) the IT900 provides an "activity monitor" Pin (P1_4) that may be used by an external circuitry to monitor correct operation. This pin toggles every 0.8 ± 0.1 sec for all bands, beside CA2, for which it is 1.2±0.1 sec. If the pin toggle-period is longer than 1.7 sec, the IC should get a reset sequence. For further details, refer to the *IT900 Data Sheet* document.

(8) The NC application can retrieve information concerning the Remote Stations participating in the network using the 'Get Node Information' command (see Section 5.4.5.5). Using this command, the NC application may be exposed to the Node ID, Parent ID, Serial Number and Connectivity status of any RS in the logical network.

(9) The NC application may track any change in connectivity status with RS using the "Connectivity Status with RS" indication (see Section 5.4.6.5).

(10) The RS application may occasionally receive a "Disconnected from NC" indication (see Section 5.4.6.10). The RS application should wait till it is reconnected to the NC, as described in Step 5, in order to continue transmitting messages to the NC.

The indications and responses to the host application over time for an NC node implementing the above procedure are illustrated in Figure 2.2.

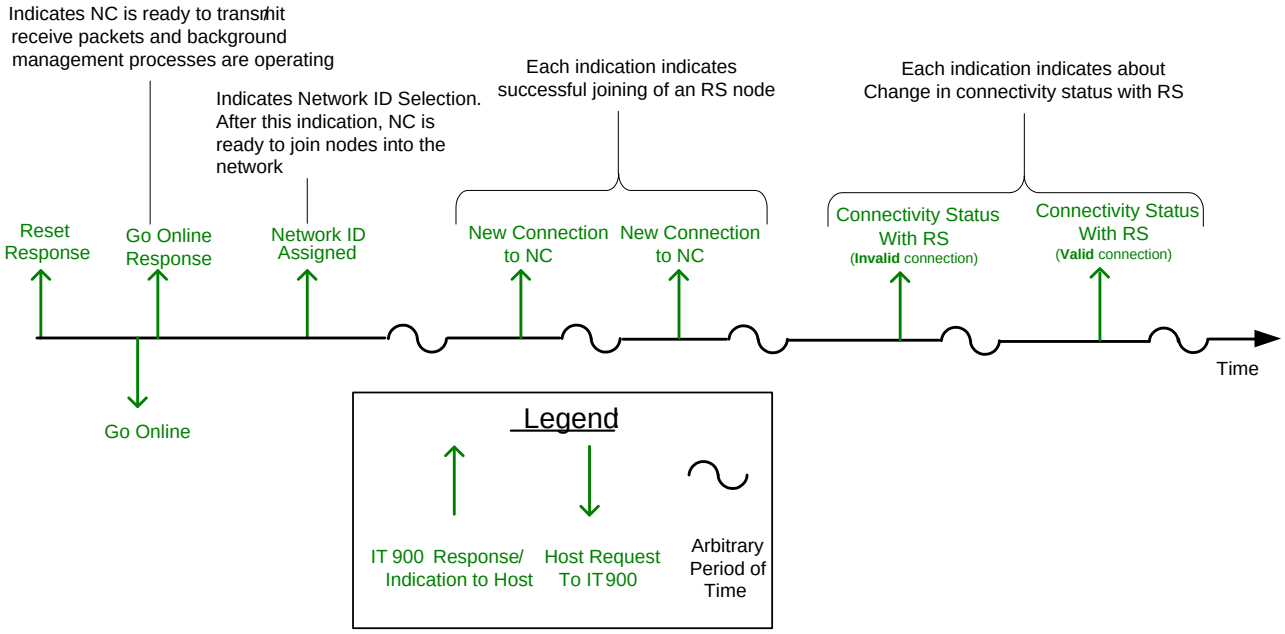

Figure 2.2: IT900 Indications/Responses to Host over Time (NC)

The indications and responses to the host application over time for an RS node implementing the above procedure are illustrated in Figure 2.3.

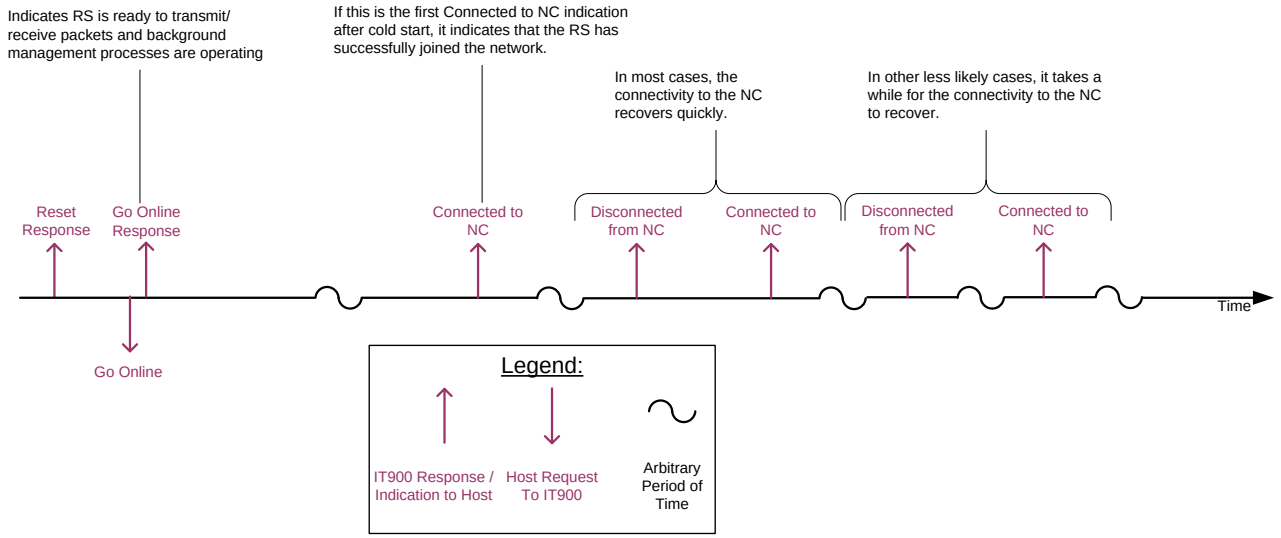

Figure 2.3: IT900 Indications/Responses to Host over Time (RS)

Chapter 3. General Description of the Host Interface

3.1 Introduction

The architecture of IT900 consists of pre-programmed firmware integrated on the flash memory of an M16/C60 microcontroller on which Yitran's Y-Net protocol stack is implemented.

IT900 uses UART0 as the communication interface with a host application. IT900 serves as a "closed" PLC modem chip. An external host and application controller is required to implement application layer functionality. The host controller connects to IT900 through a full-duplex UART physical interface. A command set protocol provides the logical interface between the host controller and IT900.

The subsections below provide a general description of the physical and logical interface between IT900 and the host application as follows:

- UART interface description (see Section 3.2).
- Command Set Protocol overview (see Section 3.3).
- UART interface guidelines (see Section 0).

3.2 UART Interface Description

3.2.1 Physically Connecting IT900 to an External µC

The hardware interface between IT900 and an external host µC is described in Figure 3.1 and in Table 3.1.

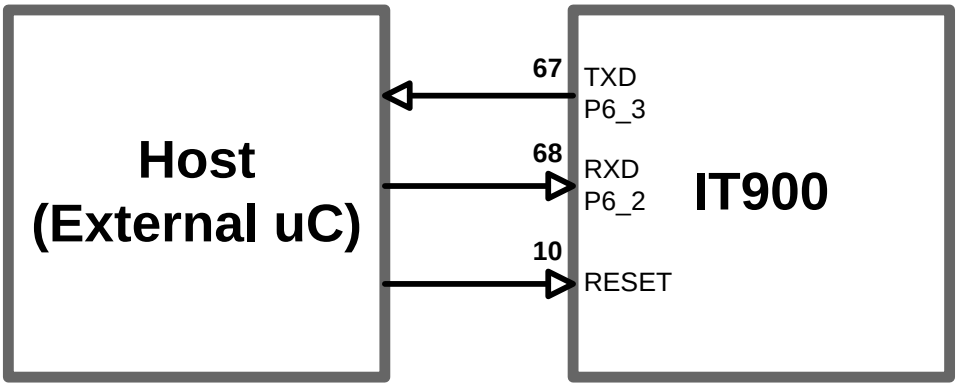

Figure 3.1: Hardware Interface between Host and IT900

Pin Name	Pin Number	Interface Function	Description
P6_3	67	TXD	UART data output (IT900 → Host)
P6_2	68	RXD	UART data input (Host → IT900)
RESET	10	RESET	RESET (active low)

Table 3.1: IT900 Interface to Host - Pins Description

Important Note

All the hardware devices connected to IT900 (i.e. power supplies, external micro controllers, USB connection to PCs, etc.) must be connected to the same GND (ground). IT900 is sensitive to different grounding sources. **Unrecoverable faults may be experienced due to use of different grounding sources.**

3.2.2 UART Communication Parameters

The communication parameters of the UART Host interface should be set to the values detailed in Table 3.2.

Parameter	Value	Comment
Communication Rate [bps]	960000 or 38400	Fast/Slow baud rate select: uC which don't support fast UART baud rates may select slow baud rate mode. The selection between Fast and Slow rate is preformed using P6_0 (pin 70) as detailed below • P6_0 = '1': Fast baud rate (default value is 960000) • P6_0 = '0': Slow baud rate (default value is 38400).
Data [bits]	8	
Parity [bits]	0	
Stop [bits]	1	
Flow Control	Off	

Table 3.2: UART Interface Parameters

The host may configure the UART to a baud rates different than default by sending a "Set Device Parameters" command (see Section 5.4.3.2) and configuring the "UART Fast Rate (Div 100)" or "UART Slow Rate (Div 100)" parameter (see Appendix A.1). IT900 will use the new baud rate in the next power-up.

3.3 Command Set Protocol Overview

3.3.1 Command Set Primitive Definitions

The logical interface between IT900 and the host application (over UART) is based on a simple command set protocol supporting the following primitive types:

- **Request:** the host application sends a Request primitive to IT900 requesting to initiate its service or command.
- **Response:** IT900 sends a Response primitive to the host application in response to the above Request primitive.
- **Indication:** IT900 issues Indication primitives when it is required to inform the host application of significant networking events.

Commands in the host interface command set (see Chapter 5) consist of the structure of individual primitives.

3.3.2 Synchronization on Command Start (Command Start Byte)

In order to simplify synchronization on the interface commands, all IT900 primitives (Request/Response/Indication) use a constant value in the first byte of the command. The host application should discard any Response or Indication sent from the IT900 with an inappropriate starting byte. In the opposite direction, IT900 will start the decoding of commands sent by the host, only once an appropriate start byte was received.

3.3.3 Command Groups by Services

The commands in the command set are separated into a number of groups:

- **Embedded Services Commands:** provide cross-layered, general system services such as Free Memory, Write/Read NVM and Get Version.
- **Stack Services Commands:** provide cross-layered services required by the Y-Net protocol stack such as Reset, Go Online, etc.
- **Configuration and Monitoring Commands:** provide set, get or save parameters from one of IT900 configuration tables.
- **NL Management Commands:** monitor NL Management parameters, interface with services that require information from the host application and report about significant networking events.
- **Data Commands:** handle the transmission and reception of data packets as well as access to the source routing table.

3.4 UART Interface Guidelines

3.4.1 Full-Duplex Operation

The UART communication between the host application and IT900 is full duplex. Therefore, when the host sends a request primitive to IT900, IT900 may simultaneously send a response or indication to the host. The host application should be designed to handle the full-duplex communication channel.

3.4.2 Single Host Requests

IT900 can handle a single host request until it issues a response primitive. Therefore, the host application must not transfer request primitives to IT900 prior to receiving a response for the previously sent request primitive.

3.4.3 Receiving Packets while Waiting for Response from IT900

The host application should support reception of data packets while waiting for a response primitive.

3.4.4 Watchdog Resets

Although unlikely, IT900 may reset itself at any time due to an internal watchdog circuit. This is indicated by receiving the Reset response primitive (see Section 5.4.2.1), without the host application sending a Reset request primitive or performing hardware reset. The host application should also implement 200 msec timeout for the duration between two consecutive bytes in a packet received from IT900. Timeout expiry indicates that IT900 reset occurred and bytes received prior to this trigger should be discarded.

In addition, periodic firmware activity monitoring is recommended (see Appendix C).

3.4.5 Response Timeout

The host should wait for a response primitive from IT900 after sending a request primitive for 20 seconds. Timeout expiration without reception of a response primitive from IT900 indicates an error. Note that the response will almost always arrive much faster than the timeout and is set high to support long IT900 processes (write to EEPROM, remote configuration, etc.).

3.4.6 Request Timeout

The timeout between two consecutive bytes composing Request packet should be less than 4ms. If the timeout exceeds 4ms, the Request packet will be discarded by the stack.

3.5 EEPROM

Using an external EEPROM is mandatory for NC. For a RS the EEPROM is optional. Further information on the EEPROM requirements is provided in the table below.

The different EEPROM capacity options are detailed in Table 3.3.

EEPROM Capacity	Supports RS	Supports NC	Supports Remote Version Download
None	+		
256Kbit	+	+	
1Mbit	+	+	+

Table 3.3: EEPROM Capacity Options

Chapter 4. Developing Advanced Host Applications

4.1 Introduction

The following subsections provide in-depth details on advanced options supported by IT900 for developing host applications. It is assumed that the reviewer of this section has experience developing simple host applications above IT900, as described in Chapter 2. Further applicative considerations and recommendations are provided in Appendix C.

- Host involvement in Y-Net stack processes (see Section 4.2).
- IT900 indications/responses to host over time in different modes of operation (see Section 4.3).

4.2 Host Involvement in Y-Net Stack Processes

4.2.1 Introduction

The typical involvement of the host in the Y-Net stack processes and services is summarized in the following sub-sections as follows:

- Section 0 summarizes host involvement in data services provided by IT900.
- Section 4.2.3 summarizes host involvement in the management services provided by IT900.
- Section 4.2.4 summarizes host involvement in other miscellaneous services provided by IT900.
- In each sub-sections the following information will be detailed:
    - Brief process description (from the host perspective).
    - Related commands and indications.
    - Related configurations.

4.2.2 Data Services

4.2.2.1 Introduction

The host processes related to the Y-Net data services are as follows:

- Transmission process (see Section 4.2.2.2).
- Reception process (see Section 4.2.2.3).
- Routing management (see Section 4.2.2.4).

4.2.2.2 Transmission (Tx) Process

4.2.2.2.1 Brief Process Description

The Y-Net stack transmission process is explained in the *Y-Net Protocol Stack Overview* document.

From the host perspective, the transmission process can be performed at any time by sending a Packet Tx request primitive (see Section 5.4.5.1.1). This will cause the host to receive two consecutive response primitives (see Section 5.4.5.1.2).

The NC may transmit intranetworking Unicast messages to RS using the S/N of the destination RS or its Node ID using the Tx Packet Command (see Section 5.4.5.1). This is accomplished by setting the “Data Service Type” field to “Intranetworking Unicast over S/N” or using the “Intranetworking Unicast”, respectively.

RS can transmit to NC Unicast packets by setting the Node ID of the Destination Node to 0x0001 (which is always assigned to the NC) and setting the "Hops" field to 16 in the Tx Packet Command (see Section 5.4.5.1).

Transmission between RS can be performed using Direct Unicast Service. To activate Y-Net stack Direct Unicast Service (detailed in the *Y-Net Protocol Stack Overview* document), set the "Hops" field to 0 (default value) and set the destination's ID in the Tx Packet Command (see Section 5.4.5.1).

4.2.2.2.2 Related Command(s) and Indication(s)

The commands related to the transmission process are detailed in Table 4.1.

#	Command/Indication	Purpose	Station Type	Reference
1	Configuration and Management Commands	Set the configurations related to the transmission service (usually during initialization).	NC/RS	Section 5.4.3
2	Tx Packet Command	Transmit the payload	NC/RS	Section 5.4.5.1

Table 4.1: Tx Process – Related Command(s) and Indication(s)

4.2.2.2.3 Related Configuration(s)

The configurations related to the transmission process are detailed in Table 4.2.

#	Parameter	Affect on Process	Station Type	Reference
1	Network ID	The Network ID used to identify the transmitter's Network ID when transmitting intranetworking packets.	NC/RS	Appendix A.1
2	Node ID	The Node ID that will be used to identify the transmitter's Node ID when transmitting intranetworking packets.	NC/RS	Appendix A.1
3	Modulation	Modulation used to transmit packets.	NC/RS	Appendix A.1
4	UN ACK Repeats	The number of unacknowledged repetitive transmissions used by the MAC when transmitting packets using the Repetitive Un-acknowledgement transmission service.	NC/RS	Appendix A.1
5	ACK Retries	The number of retransmission while waiting for ACK by the receiver used by the MAC when transmitting packets using the Unicast with Acknowledgement transmission service.	NC/RS	Appendix A.1
6	Send V1 Packets	IT900 will transmit payload in D1 packet format.	NC/RS	Appendix A.1

Table 4.2: Tx Process – Related Configurations

4.2.2.3 Reception (Rx) Process

The Y-Net stack reception process is explained in the *Y-Net Protocol Stack Overview* document.

From the host perspective, the reception process can be performed at any time by receiving an Rx Intranetworking Packet or Rx Internetworking Packet Indication primitive (see Sections 5.4.5.3 and 5.4.5.4, respectively).

The NC may decide whether to receive Rx Intranetworking Packets from RS containing the S/N of the transmitter or the RS Node ID. This is accomplished by setting the "Source node address type at receiver host" parameter to "By S/N" or to "By Node ID", respectively (see Appendix A.1).

4.2.2.3.1 Related Command(s) and Indication(s)

The commands related to the reception process are detailed in Table 4.3.

#	Command/Indication	Purpose	Station Type	Reference
1	Configuration and Management Commands	Set the configurations related to the reception service (usually during initialization).	NC/RS	Section 5.4.3
2	Rx Packet Indications	Receive internetworking/intranetworking packet	NC/RS	Section 5.4.5.3 through 5.4.5.4

Table 4.3: Rx Process – Related Command(s) and Indication(s)

4.2.2.3.2 Related Configuration(s)

The configurations related to the reception process are detailed in Table 4.4.

#	Parameter	Affect on Process	Station Type	Reference
1	Network ID	The Network ID used to identify the receiver's Network ID.	NC/RS	Appendix A.1
2	Node ID	The Node ID that will be used to identify the receiver's Node ID.	NC/RS	Appendix A.1
3	Modulation	The modulation used to receive packets.	NC/RS	Appendix A.1
4	Rx Filter	MAC will only forward packets to NL if they satisfy the filter conditions.	NC/RS	Appendix A.1
5	Source node address type at receiver host	The address of the source node in the received intranetworking packet indication will be: By S/N if flag is set to 1 By logical address if flag is set to 0.	NC/RS	Appendix A.1

Table 4.4: Rx Process – Related Configurations

4.2.2.4 Routing Management

The Y-Net stack routing service is explained in the *Y-Net Protocol Stack Overview* document.

From the host perspective, the routing process is fully automatic and can be enabled or disabled by configuration. When routing service is enabled (default), the host may monitor the routing path and its validness by sending 'Get Node Information' request primitive.

4.2.2.4.1 Related Command(s) and Indication(s)

The commands related to the routing process are detailed in Table 4.5.

#	Command/Indication	Purpose	Station Type	Reference
1	Configuration and Management Commands	Set the configurations related to the routing process (usually during initialization).	NC/RS	Section 5.4.3
2	Get\Delete Node Information	Enables to Obtain\Delete routing information from NC database (i.e., Link Status, Node Parent)	NC	Section 5.4.5.5 and 5.4.5.6
3	Get NC Database Size	Enables to retrieve the total number of entries and the index of the last occupied entry in the NC database.	NC	Section 5.4.5.2

Table 4.5: Routing Management – Related Command(s) and Indication(s)

4.2.2.4.2 Related Configuration(s)

The configurations related to the routing process are detailed in Table 4.6.

#	Parameter	Affect on Process	Station Type	Reference
1	Network size	Automatically defines the Y-Net stack reaction time of background network routing processes (route validation, route recovery, etc'). This parameter should be set to the number of stations in the physical network (the physical network can contain multiple logical networks) and it must be identical for all RS participating in the network.	NC/RS	Appendix A.1
2	NC Database Size	Defines the number of entries in the NC's Routing and Addressing databases. The value of this parameter should be set to the maximal number of nodes allowed to participate in the logical network.	NC	Appendix A.1
3	NL Mng Enabled	Enables/Disables the Adaptive Routing and Automatic addressing services.	NC/RS	Appendix A.1

Table 4.6: Routing Management – Related Configurations

4.2.3 Management Services

4.2.3.1 Introduction

The processes related to the Y-Net Stack network formation services are as follows:

- Logical network creation process (see Section 4.2.3.2).
- Network admission control processes (see Section 4.2.3.3).
- Addressing management (see Section 4.2.3.4).
- Cold/Warm start modes (see Section 4.2.3.5).
- Dynamic Routing Processes (see Section 4.2.3.6).

4.2.3.2 Logical Network Creation Process

The logical network creation process of the Y-Net stack is explained in the *Y-Net Protocol Stack Overview* document.

From the host perspective, there are two methods for creating a logical network:

- **Automatic (default)** – the NC selects a unique Network ID automatically and the host is indicated after the Network ID is selected. In automatic mode, once a node is set as an NC, the creation of the logical network is completely automatic and transparent. IT900 sends "Network ID Assigned" indication (see Section 5.4.6.12) to the host when the unique Network ID is assigned. The duration of the process is approximately 15 seconds and traffic over the power line is required for it to complete.
- **Forced** – the host is responsible to configure a unique Network ID manually. In this case, the host should send a "Set Device Parameters" request (see Section 5.4.3.2.1) for setting the NL Management "Network ID Selection Mode" and "Forced Network ID" parameters (see Appendix A.1) to "Forced" and to the selected Network ID value, respectively. The forced Network ID assignment process will include reception of "Network ID Assigned" indication (see Section 5.4.6.12) from IT900.

The host of the NC can expect RS nodes to join its logical network after the selection of the Network ID is successfully complete. Note that after the NC selects a Network ID, it will restore it from NVM on subsequent power-ups.

4.2.3.2.1 Related Command(s) and Indication(s)

The commands related to the logical network creation process are detailed in Table 4.7.

#	Command/Indication	Purpose	Station Type	Reference
1	Configuration and Management Commands	Set the configurations related to the routing process (usually during initialization).	NC/RS	Section 5.4.3
2	Network ID Assigned	To notify the host of an NC node that the logical network was established.	NC	Section 5.4.6.12

Table 4.7: Logical Network Creation Process – Related Command(s) and Indication(s)

4.2.3.2.2 Related Configuration(s)

The configurations related to the logical network creation process are detailed in Table 4.8.

#	Parameter	Affect on Process	Station Type	Reference
1	NL Mng Enabled	Activates IT900 background processes when enabled.	NC/RS	Appendix A.1
1	Network size	Automatically defines the Y-Net stack reaction time for the background network admission control processes (joining time, time for leaving the network due to no connectivity to any node in the logical network). This parameter should be set to the number of stations in the physical network (the physical network can contain multiple logical networks) and it must be identical for all RS participating in the network.	NC/RS	Appendix A.1
3	NC Database Size	Defines the number of entries in the NC's Routing and Addressing databases. The value of this parameter should be set to the maximal number of nodes allowed to participate in the logical network.	NC	Appendix A.1
4	Operation Mode	Should be set to NC for the creation process to initiate.	NC/RS	Appendix A.1
5	Net ID Selection Mode	Set to "Auto" for automatic Network ID Selection (default). Set to "Forced" (in conjunction with the "Forced Network ID" parameter) for manual Network ID selection.	NC	Appendix A.1
6	Forced Network ID	Defines the forced Network ID used if the "Network ID Selection Mode" parameter is set to "Forced"	NC	Appendix A.1

Table 4.8: Logical Network Creation Process – Related Configurations

4.2.3.3 Network Admission Control Process

The network admission control processes of the Y-Net stack are explained in the *Y-Net Protocol Stack Overview* document.

Network admission control from the host perspective is divided as follows:

- **Admission Process** (only in NC nodes) – The NC is responsible to admit RS to its logical network. When the NC admits a new RS to its network, the NC will receive a "New Connection to NC" indication (see Section 5.4.6.11) containing the admitted RS information. The joining time of new RS depends on the "Network Size" parameter (see Appendix A.1). The admission process is based on the "NC Admission Mode" parameter (see Appendix A.1) as follows:
    - **"Auto" –** the "NC Admission Mode" parameter is set to "Auto", no additional host involvement will be required.
    - **"S/N Range"** – the "NC Admission Mode" parameter is set to "S/N Range", the "Number of S/N msb to Compare" parameter (see Appendix A.1) should be set in conjunction to enable the host to automatically filter out join requests from RS with msb S/N different than the NC msb S/N.
    - "**Application Mode**" – the "NC Admission Mode" parameter is set to "Application Mode", the host will receive a "Get Admission Approval from Application" indication when new RS

requests to join the logical network. The NC should decide whether to admit the RS to its logical network and to indicate its response to IT900 by using the "Admission Approval Response from Application" command. In this mode, the NC may attach the Node Key of the RS (different than the Node Key configured to the NC). The NC is not notified about RS that were once admitted to the network and are registered in the Address Database. In order to readmit RS nodes by the application, the NC should delete the S/N of the RS from NC Databases using the "Delete Node Information" command (see Section 5.4.5.6).

- "**S/N Range or Application Mode**" – When the "NC Admission Mode" parameter is set to "S/N Range or Application Mode", the host is required to configure the "Number of S/N msb to Compare" parameter as in "S/N Range" mode, and will receive a "Get Admission Approval from Application" indications that require its "Admission Approval Response from Application" commands as in "Application Mode".

- **Node Key Approval Process** - In NC nodes, set the "Node Key" parameter to the default Node Key that the NC will use to admit nodes to its logical network. The host may indicate to admit RS using a different Node Key when its "NC Admission Mode" is set to "Application Mode" or to "S/N Range or Application Mode". In RS nodes, set "Node Key" parameter to the key used by the RS to accept its admission from an admitting NC. To disable the RS Node Key Approval process, set all the "Node Key" parameter bytes to 0x00. This will cause the RS to approve admission response from any admitting NC.
- **RS Admission Response** – RS will receive "Connected to NC" indications (see Section 5.4.6.9) to indicate that they were admitted successfully to the network. RS may receive an "Admission Refuse" indication (see Section 5.4.6.8), not only during the admission stages but also after it was already admitted to a logical network (the NC continuously validates the RS admission parameters). This indication in RS nodes indicates that the RS was not admitted to the logical network or had to leave its logical network. The RS will rejoin a logical network automatically and will be notified by a "Connected to NC" indication (see Section 5.4.6.9) when successfully rejoining the network.

4.2.3.3.1 Related Command(s) and Indication(s)

The commands related to the network admission control processes are detailed in Table 4.9.

#	Command/Indication	Purpose	Station Type	Reference
1	Configuration and Management Commands	Set the configurations related to the routing process (usually during initialization).	NC/RS	Section 5.4.3
2	New Connection to NC	To notify the host of an NC that a new RS joined its logical network.	NC	Section 5.4.6.11
3	Connected to NC	The first indication arriving to the host of an RS indicates that the RS was admitted to a logical network.	RS	Section 5.4.6.9
4	Admission Refuse	Indicates that the RS was not admitted to the logical network (or had to leave its logical network). The RS will rejoin a logical network automatically (will be notified by a "Connected to NC" indication when successfully rejoining the network).	RS	Section 5.4.6.8
5	Get Admission Approval from Application (in conjunction with Admission Approval Response From Application)	The NC host receives this indication when new RS attempt to join the network when its "NC Admission Mode" parameter is set to "Application Mode" or "S/N Range or Application Mode". The NC should decide whether to admit the RS to its logical network and to indicate its response to IT900 by using the "Admission Approval Response From Application" command. The NC may attach a specific Node Key of the RS (different than the Node Key configured to the NC).	NC	Section 5.4.6.7 and 5.4.6.1
6	Delete Node Information	The NC is not being notified about RS that were once admitted to the network, and are registered in its Databases. In order to readmit RS nodes, the NC should delete the S/N of the RS from its Databases using this command.	NC	Section 5.4.5.6

Table 4.9: Network Admission Control Processes – Related Command(s) and Indication(s)

4.2.3.3.2 Related Configuration(s)

The configurations related to the network admission control processes are detailed in Table 4.10.

#	Parameter	Affect on Process	Station Type	Reference
1	NL Mng Enabled	Activates IT900 network admission control background processes when enabled.	NC/RS	Appendix A.1
2	Network size	Automatically defines the Y-Net stack reaction time of background network admission control processes (joining time, time for leaving the network due to no connectivity to any node in the logical network). This parameter should be set to the number of stations in the physical network (the physical network can contain multiple logical networks) and it must be identical for all RS participating in the network.	NC/RS	Appendix A.1
3	NC Database Size	Defines the number of entries in the NC's Routing and Addressing databases. The value of this parameter should be set to the maximal number of nodes allowed to participate in the logical network. In case NC Databases are full, the RS will not be able to join the network.	NC	Appendix A.1
4	Operation Mode	Should be set to NC for the addressing processes by the NC to initiate. Should be set to RS for the addressing processes by the RS to initiate.	NC/RS	Appendix A.1
5	Node Key	In NC nodes, set the "Node Key" parameter to the default Node Key that the NC will use to admit nodes to its logical network (unless the host indicates to admit RS using a different Node Key). In RS nodes, set "Node Key" parameter to the key used by the RS to accept its admission from an admitting NC. To disable the RS Node Key Approval process, set all the "Node Key" parameter bytes to 0x00. This will cause the RS to approve admission response from any admitting NC.	NC/RS	Appendix A.1
6	NC Admission Mode	The NC sets the "NC Admission Mode" parameter to the selected admission mode (default is "Auto"). Setting the "NC Admission Mode" to "S/N Range" or to "S/N or Application" modes should be set in conjunction with the "Number Of S/N msb to Compare" parameter.	NC	Appendix A.1
7	Number Of S/N msb to Compare	The "Number of S/N bits to compare" parameter is relevant only in the "S/N Range" or the "S/N Range	NC	Appendix A.1

#	Parameter	Affect on Process	Station Type	Reference
		or Application" admission modes are used. In "S/N Range" mode, when receiving a request to join from an RS, the NC will compare msb of its S/N with the joining RS msb of its S/N. On match, the NC will admit the RS to the network. This parameter defines the number of msb to use for comparison.		

Table 4.10: Network Admission Control Processes – Related Configurations

4.2.3.4 Addressing Management Processes

The addressing management processes of the Y-Net stack are explained in the *Y-Net Protocol Stack Overview* document.

Addressing management from the host perspective is divided as follows:

- **Unique Network ID Selection** – detailed in the *Y-Net Protocol Stack Overview* document.
- **Unique Node ID Assignment to RS** - The NC is responsible for assigning unique logical addresses to RS when the RS joins the network. From the NC host perspective, the NC will receive a "New Connection to NC" indication (see Section 5.4.6.11) containing the Node ID of the newly connected node. The NC Node ID will always assign itself 0x0001 as its Node ID. From the RS host perspective, the first "Connected to NC" indication (see Section 5.4.6.9) received indicates that the RS has a valid logical addresses. The time to assign a unique Node ID to an RS depends on the "Network Size" parameter (see Appendix A.1).
- **Address Database Management** - The NC application can retrieve and delete address data from the NC database using the "Get Node Information" and "Delete Node Information" commands, respectively (see Sections 5.4.5.5 and 5.4.5.6).
- **Node ID Conflicts Detection And Resolution** (within the same logical network) – From the NC host perspective the application is completely unaware of the underlying background management process that ensures that Node ID conflicts are resolved. Only the RS host will know of the resolution of the Node ID by receiving a "Admission Refuse" indication (see Section 5.4.6.8) with a "Duplicate Node ID" value in the Refuse Reason field. The background Y-Net stack processes rejoins that RS to a logical network automatically. It should be noted that MSB of the S/N (configurable by the "Number of S/N bytes in Address database" parameter) of all nodes in the same logical network should be unique (only these S/N bytes will be checked for Node ID conflicts in the NC). The time to detect and resolve Node ID conflicts depends on the "Network Size" parameter (see Appendix A.1).
- **Network ID Conflicts Detection and Resolution** (among overlapping logical networks) – In automatic "Network ID Selection Mode" (see Appendix A.1), Y-Nt stack management services ensure that the Network ID remain unique. The NC will be notified about resolution of conflicts by "Network ID Assigned" indication (see Section 5.4.6.12) from IT900. The time to detect and resolve Network ID conflicts depends on the "Network Size" parameter (see Appendix A.1).

4.2.3.4.1 Related Command(s) and Indication(s)

The commands related to the addressing management processes are detailed in Table 4.11.

#	Command/Indication	Purpose	Station Type	Reference
1	Configuration and Management Commands	Set the configurations related to the routing process (usually during initialization).	NC/RS	Section 5.4.3
2	New Connection to NC	To notify the host of an NC that a new RS joined its logical network.	NC	Section 5.4.6.11
3	Connected to NC	This indication arriving to the host of an RS when the RS had no logical address (disconnected from a logical network) can be used to indicate that the RS has a logical address.	RS	Section 5.4.6.9
4	Get/Delete Node Information	In NC node, these commands enable obtaining or deleting Remote Station address information from the NC database.	NC	Sections 5.4.5.5 and 5.4.5.6
5	Get NC Database Size	Enables to retrieve the total number of entries and the index of the last occupied entry in the NC database.	NC	Section 5.4.5.2
6	Admission Refuse	Receiving this indication by RS host with a ”Duplicate Node ID” in the Refuse Reason field indicates that the Node ID of the RS conflicts with the Node ID of another node in the network. The RS will rejoin a logical network automatically (will be notified by a “Connected to NC” indication).	RS	Section 5.4.6.8
7	Network ID Assigned	To notify the host of an NC that a Network ID conflict was detected and resolved (new Network ID will be assigned).	NC	Section 5.4.6.12

Table 4.11: Addressing Management Processes – Related Command(s) and Indication(s)

4.2.3.4.2 Related Configuration(s)

The configurations related to the addressing management processes are detailed in Table 4.12.

#	Parameter	Affect on Process	Station Type	Reference
1	NL Mng Enabled	Should be enabled to activate IT900 logical addressing management background management processes.	NC/RS	Appendix A.1
2	Network size	Automatically defines the Y-Net stack's reaction time of background addressing processes (address allocation, addressing conflict resolution and time for addressing database entries aging in the NC). This parameter should be set to the number of stations in the physical network (the physical network can contain multiple logical networks) and must be identical for all RS participating in the network.	NC/RS	Appendix A.1
3	Net ID Selection Mode	Enables to detect and resolve Network ID conflicts when set to "Auto".	NC	Appendix A.1
4	Operation Mode	Should be set to NC for the addressing processes by the NC to initiate. Should be set to RS for the addressing processes by the RS to initiate.	NC/RS	Appendix A.1
5	Number of S/N bytes in Address database	The number of S/N bytes saved in the NC address database per RS.	NC	Appendix A.1
6	Network ID	Network ID automatically set by the logical addressing management processes.	NC/RS	Appendix A.1
7	Node ID	Node ID automatically set by the logical addressing management processes.	NC/RS	Appendix A.1
8	S/N	For setting the S/N of a node use 'Set Device Parameters' command. The 'Table Type' field should be set to "S/N" and 'Index' field to 0xBAAB.	NC/RS	5.4.3.2

Table 4.12: Addressing Management Processes – Related Configurations

4.2.3.5 Cold/Warm Start Modes

The cold/warm start modes of the Y-Net stack is explained in the *Y-Net Protocol Stack Overview* document.

From the host perspective, the startup mode is configured by sending a "Set Device Parameters" request (see Section 5.4.3.2.1) for setting the NL Management "Warm Start Enabled" (see Appendix A.1) parameter. This parameter defines the start up procedure followed on subsequent power-ups (Warm Start if enabled).

4.2.3.5.1 Related Command(s) and Indication(s)

The commands related to the cold/warm start modes are detailed in Table 4.13.

#	Command/Indication	Purpose	Station Type	Reference
1	Reset command	After reset, cold/warm start parameters are loaded from NV memory.	NC/RS	Section 5.4.2.1
2	Go Online command	After Go Online, cold/warm start parameters are used by NL management.	NC/RS	Section 5.4.2.2
3	Configuration and Management Commands	Set the configurations related to the routing process (usually during initialization).	NC/RS	Section 5.4.3

Table 4.13: Cold/Warm Start Modes – Related Command(s) and Indication(s)

4.2.3.5.2 Related Configuration(s)

The configurations related to the cold/warm start modes are detailed in Table 4.14.

#	Parameter	Affect on Process	Station Type	Reference
1	NL Mng Enabled	Warm/Cold start is relevant only when enabled. If disabled, the RS will retain its Node ID and Network ID from the parameters on power-up, regardless of the "Warm Start Enabled" parameter.	NC/RS	Appendix A.1
2	Warm Start Enabled	Enable for Warm-Start, and disable for Cold-Start	NC/RS	Appendix A.1
3	Parent address	Saved in Warm Start mode.	NC/RS	Appendix A.1
4	NC address	Saved in Warm Start mode.	NC/RS	Appendix A.1
5	Distance from NC	Saved in Warm Start mode.	NC/RS	Appendix A.1

Table 4.14: Cold/Warm Start Modes – Related Configurations

4.2.3.6 Dynamic Routing Processes

The dynamic routing processes of the Y-Net stack are explained in the *Y-Net Protocol Stack Overview* document.

Dynamic routing from the host perspective is divided as follows:

- The node should use the "Set Device Parameters" command (see Section 5.4.4.2) to configure the appropriate modes and options that will be used by the dynamic routing services:
  - The most critical configuration for the dynamic routing services to operate correctly is the "Network Size" parameter (see Appendix A.1). The time for route discovery, recovery and optimization in the RS as well as the time for routing database entries aging depends on the correct configuration of this parameter.
  - Enabling the "Parent Mode Enabled" parameter enables the node to serve as a parent in the tree topology maintained by the dynamic routing services (enabled by default).
- The NC can monitor its connectivity conditions by sending the 'Get Node Information' Command (see Section 5.4.5.5).
- The RS host can monitor its connectivity conditions by reading the "Parent Address", "NC Address" and "Distance from NC" parameters (see Appendix A.1) using the "Get Device Parameters" command (see Section 5.4.3.3).
- In the RS, "Disconnected from NC" and "Connected to NC" indications (see Section 5.4.6.10 and 5.4.6.9, respectively) define the nodes connectivity conditions.
- Applicative recommendations per indication for the RS as well as Routing related applicative recommendations for the NC are detailed in Appendix C.

4.2.3.6.1 Related Command(s) and Indication(s)

The commands related to the dynamic routing processes are detailed in Table 4.15.

#	Command/Indication	Purpose	Station Type	Reference
1	Configuration and Management Commands	Sets the configurations related to the routing process (usually during initialization).	NC/RS	Section 5.4.3
2	Disconnected from NC	This indication arriving to the host of an RS indicates that the RS has no link with NC.	RS	Section 5.4.6.7
3	Connected to NC	This indication arriving to the host of an RS indicates that the RS is connected to the NC.	RS	Section 5.4.6.9
4	Get Node Information	Enables to obtain the node's Connectivity Status' (indicates the validness of the node's routing path and its siblings) from NC Database.	NC	Section 5.4.5.2
5	Get NC Database Size	Enables to obtain the total number of entries and the index of the last occupied entry in the NC database.	NC	Section 5.4.6.5
6	Connectivity Status with RS	Indicates about any change in connectivity status with RS (Valid or Invalid connection)	NC	Section 5.4.6.5

Table 4.15: Dynamic Routing Processes – Related Command(s) and Indication(s)

4.2.3.6.2 Related Configuration(s)

The configurations related to the dynamic routing processes are detailed in Table 4.16.

#	Parameter	Affect on Process	Station Type	Reference
1	NL Mng Enabled	Activates IT900 dynamic routing background processes when enabled.	NC/RS	Appendix A.1
2	Network size	Automatically defines the Y-Net stack's reaction time of background dynamic routing processes (time for route discovery, route recovery, route optimization and time for routing database entries aging in the NC). This parameter should be set to the number of stations in the physical network (the physical network can contain multiple logical networks) and it must be identical for all RS participating in the network.	NC/RS	Appendix A.1
3	NC Database Size	Defines the number of entries in the NC's Routing and Addressing databases. The value of this parameter should be set to the maximal number of nodes allowed to participate in the logical network.	NC	Appendix A.1
4	Operation Mode	Should be set to "NC" for the addressing processes by the NC to initiate. Should be set to "Adaptive (RS)" for the addressing processes by the RS to initiate.	NC/RS	Appendix A.1
5	Parent address (read only)	The Node ID of the optimal parent node set by the dynamic routing services.	NC/RS	Appendix A.1
6	NC address (read only)	The Node ID of the NC set by the dynamic routing services (will always show 0x0001 while connected to a logical network).	NC/RS	Appendix A.1
7	Distance from NC (read only)	The distance in hops from the NC set by the dynamic routing services.	NC/RS	Appendix A.1
8	Parent mode enabled	When enabled the node will be allowed to serve as a parent node in the tree topology generated by the dynamic routing services (i.e. connect other RS under it).	NC/RS	Appendix A.1

Table 4.16: Dynamic Routing Processes – Related Configurations

4.2.4 Miscellaneous IT900 Services

4.2.4.1 Non-Volatile Memory Services

IT900 provides general purpose NVM services of reading from and writing to non-volatile memory in sections specifically assigned for host applications (see section 5.4.1.4 and 5.4.1.5).

Host applications can use these services to save application related parameters and databases and for recovering these after power-up. A common example for using these services is for differentiating the first power-on from subsequent power-on sequences. During the very first power-on, the initialization sequence may be different, since it requires setting the operating band, the network size, and save parameters.

To differentiate between the first power-on and from subsequent power-on sequences, a host application can use the IT900 non-volatile memory and save its own parameter indicating that the first power-on was properly completed. Following power-on, the host application will perform the initialization sequence (first time or subsequent) based on the saved parameter in the non-volatile memory.

4.2.4.2 Remote Configuration

IT900 may not be accessible once installed in the field. Therefore, remote configuration services enable the user to change device parameters via the power line.

Remote configuration services enable one to send the following remote commands to host applications:

- Set predefine parameters
- Set Device parameters
- Get Device parameters
- Save Device parameters

An indication of the remote command's status (after the command is executed on the remote node) is provided to the host application in the form of a received packet indication with the payload structured as a local command response.

The exact definition of how to use the remote configuration services is detailed in Section 5.4.4

4.2.4.3 Distributed Parameters

The IT900 NC provides a Distributed Parameters service that allows for updating RS Parameters (i.e. Network Size) remotely during network run-time. Once the Distributed Parameters List is set, the parameters update process will be preformed automatically by the Y-Net stack.

The main advantage of this service over the Remote Configuration option is that the Distributed Parameters process is performed automatically using the NL maintenance (management) messages and therefore without "wasting" additional bandwidth on dedicated remote configuration packets.

The "Set Distributed Parameters List" command is detailed in Section 5.4.6.3. A common example for using this service is when network size is extended and an update in Network Size parameter value is needed.

This service will not be useful when different values are required for different RS in the network.

4.3 IT900 Indications/Responses to Host over Time in Different Modes of Operation

IT900 Indications/Responses to Host over Time in Different Modes of Operation for NC nodes are illustrated in Figure 4.1.

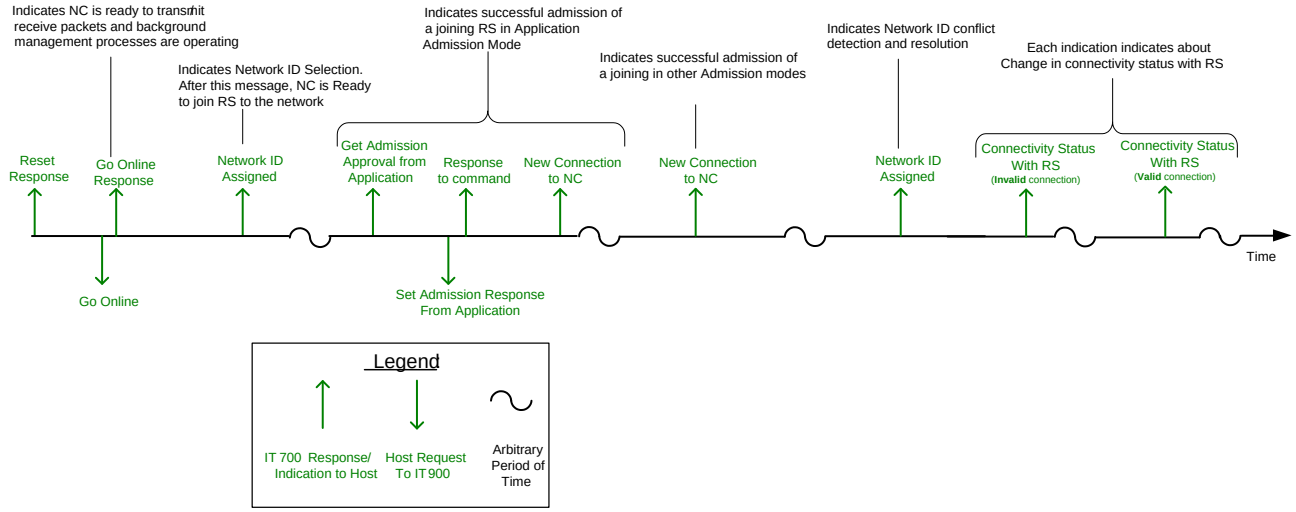

Figure 4.1: IT900 Indications/Responses to Host over Time in Different Modes of Operation (NC)

IT900 Indications/Responses to Host over Time in Different Modes of Operation for RS nodes are illustrated in Figure 4.2.

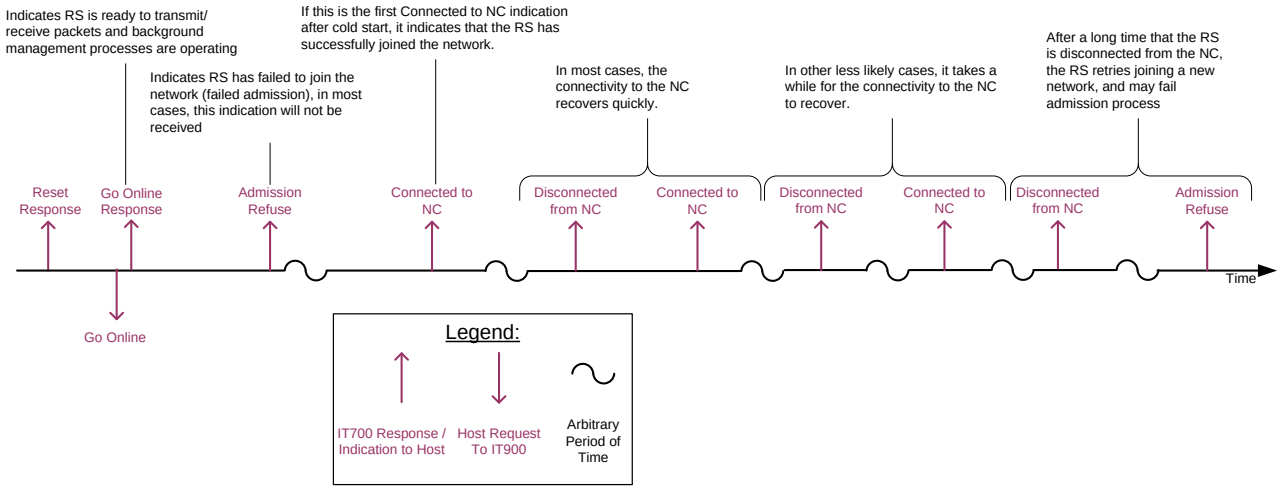

Figure 4.2: IT900 Indications/Responses to Host over Time in Different Modes of Operation (RS)

Chapter 5. Command Set

5.1 General Description

The host interface supports the following primitive types:

- **Request:** the host application sends a Request primitive to IT900 requesting to initiate its service or command.
- **Response:** IT900 sends a Response primitive to the host application in response to the above Request primitive.
- **Indication:** IT900 issues Indication primitives when it is required to inform the host application of significant networking events.

The Interface Commands are separated into a number of groups:

- **Embedded Services Commands** — provide cross-layered, general system services such as Free Memory, Write/Read NVM and Get Version.
- **Stack Services Commands** — provide cross-layered services required by the Y-Net protocol stack such as Reset, Go Online, etc.
- **Configuration and Monitoring Commands** — provide set, get or save parameters from IT900 configuration table.
- **NL Management Commands** — monitor NL Management parameters, interface with services that require information from the host application (for example, Admission Approval Response From Application) and provide indications to the host about significant networking events (for example, Connected to NC, Disconnected From NC).
- **Data Commands** — handle transmission and reception of data packets as well as access to routing tables.

5.2 Command Structure

Figure 5.1 shows the general structure an IT900 command:

Command Start	Length	Type	Opcode	Command Data	Checksum
1 BYTE	2 BYTE	1 BYTE	1 BYTE	N Bytes	1 BYTE

Figure 5.1: General Command Structure

Note: Each Byte is sent lsb first.

Table 5.1 describes the fields of the Host commands:

Field	Size (bytes)	Subfield	Size (bits)	Value	Description
Command Start	1			0xCA	Constant value for all commands
Length	2	LSB	8		Number of bytes following this field (**excluding the Checksum field**)
		MSB	8		
Type	1	Protocol Version	5	0 – 31	Any received packet will be filtered according to the Protocol Version field. This will ensure that an incorrect command set will not be handled. For IT900, these bits will always be **ZERO**.
		Packet Type	3	**0** — Request **1** — Response **2** — Indication	The Opcode of the packet for "Response" type will be identical to the opcode of the "Request" packet to which it is responding.
Opcode	1	Service Type	3	**0** — Embedded Services **1** — Stack Services **2** — Configuration & Monitoring Services **3** — Data Services **5** — Management Services	The Command Opcode is composed of two fields – three **msb** that indicate the NL interface service type and five **lsb** that indicate the specific service command.
		Service Subtype	5	0 – 31	
Command Data	N	Varies Dependent on Command			Data of Specific command (Optional).

Field	Size (bytes)	Subfield	Size (bits)	Value	Description
Checksum	1			0 – 0xFF	The Check-Sum field is calculated in the following manner: $(\sum_{i=1}^{N+4} a_i) \bmod 256$ i — index of the byte of the command N — length of the command Data field *Note that the Checksum calculation includes all bytes of the packet with the exception of the Command Start Byte (value 0xCA) and the checksum byte itself.*

Table 5.1: Field Description of the General Host Command Structure

5.3 Command Set Summary

The following provides a summary of commands available for configuring and operating a power line network utilizing IT900.

5.3.1 Embedded Services Commands

Table 5.2 summarizes IT900 Interface Embedded Services commands:

Command Name	Primitive Type(s)	Opcode	Description	Section
No Operation (NOP)	Request/ Response	0x00	This command is used for assuring the device presence by receiving a response from this command.	5.4.1.1
Get Version	Request/ Response	0x01	This command retrieves IT900 version number.	5.4.1.2
Get Free Memory	Request/ Response	0x02	This command retrieves the size of modem free RAM.	5.4.1.3
Read From NVM	Request/ Response	0x05	This command reads data from the user application section in NVM.	5.4.1.4
Write to NVM	Request/ Response	0x06	This command writes data to the user application section in NVM.	5.4.1.5

Table 5.2: Embedded Services Commands Summary

5.3.2 Stack Services Commands

Table 5.3 summarizes IT900 Interface **Stack Services** commands:

Command Name	Primitive Type(s)	Opcode	Description	Section
Reset	Request/ Response	0x20	This command resets IT900 device. The NL management initializes based on its start mode (cold or warm start) and the MAC, PHY and peripheral hardware are reinitialized.	5.4.2.1
Go Online	Request/ Response	0x22	This command sets the device into the Online state. In this state the device can receive and send packets.	5.4.2.2
Go Offline	Request/ Response	0x23	This command sets the device into the Offline state. In this state the device cannot receive or send packets.	5.4.2.3

Table 5.3: Stack Services Command Summary

5.3.3 Configuration and Monitoring Commands

5.3.3.1 Local configuration

IT900 NL Interface configurable parameters are stored in configuration tables. In each "Configuration" command there is a field that determines the parameter index.

Table 5.4 summarizes Configuration commands for parameters in tables detailed above:

Command Name	Primitive Type(s)	Opcode	Description	Section
Set Predefined Parameters	Request/ Response	0x40	This command replaces the specified parameter table with a predefined one, stored in the NVM.	5.4.3.1
Set Device Parameters	Request/ Response	0x41	This command changes at least one parameter in the specified device configuration table.	5.4.3.2
Get Device Parameters	Request/ Response	0x42	This command reads at least one parameter from the specified device configuration table.	5.4.3.3
Save Device Parameters	Request/ Response	0x43	This command saves a parameter table from the specified device configuration table memory into NVM. This command may be used to save the entire parameter table after changing one or more entries, or after setting it to a predefined region.	5.4.3.4
Remote Parameters Changed	Indication	0x4C	This indication is sent by the modem when parameter was remotely changed	5.4.3.5

Table 5.4: Configuration Services Commands Summary

5.3.3.2 Remote Configuration

This set of commands allows the application to remotely configure the parameters in the RS. The format of the remote configuration commands is described in Section 5.4.4.

5.3.4 Data Commands

Table 5.5 summarizes the Data Services commands:

Command Name	Primitive Type(s)	Opcode	Description	Section
Tx Packet	Request/ Response (x3)	0x60	This command sends a data packet to the network. This command has three possible responses.	5.4.5.1
Get NC Database Size	Request/ Response	0x65	This command returns the total number of entries and the index of the last occupied entry in the NC database.	5.4.5.2
Rx Packet	Indication	0x68	When the NL receives a packet from the network, it processes the data and sends the packet to the host application.	5.4.5.3 and 5.4.5.4
Get Node Information	Request/ Response	0x69	This command is a query to retrieve node information from the NC Database. The query returns the Node ID, Parent ID, Serial Number and Connectivity Status. The query keys can be index in the NC Database, Node ID or Serial Number.	5.4.5.5
Delete Node Information	Request/ Response	0x6A	This command deletes node information from the NC's databases. The key for node deletion can be an index in NC Database, Node ID or Serial Number. The command can also request deletion of entire data (concerning all nodes) from the NC Database.	5.4.5.6

Table 5.5: Data Services Commands Summary

5.3.5 NL Management Commands

Table 5.6 summarizes Management Services commands:

Command Name	Primitive Type(s)	Opcode	Description	Station Type	Section
Admission Approval Response From Application	Request / Response	0xA4	This commands sets the Admission Response to the NC	NC	5.4.6.1
Leave Network	Request	0xA6	This command forces the node to leave the network	NC/RS	5.4.6.2
Connectivity Status with RS	Indication	0xB1	Indication that Connection with RS is invalid.	NC	5.4.6.5
Node Left Network	Indication	0xB3	Indication that an RS Left Network	NC	5.4.6.6
Get Admission Approval From Application	Indication	0xB8	Indication to application to provide NC admission response.	NC	5.4.6.6
Admission Refuse	Indication	0xB9	Indication of Admission Refusal.	RS	5.4.6.8
Connected to NC	Indication	0xBA	Indication that the Node is now Connected to the NC.	RS	5.4.6.9
Disconnected From NC	Indication	0xBB	Indication that the Node is now Disconnected from the NC.	RS	5.4.6.10
New Connection to NC	Indication	0xBE	Indication about the Node's New Connection to an NC.	NC	5.4.6.11
Network ID Assigned	Indication	0xBF	Indication of Network ID assigned.	NC	5.4.6.12

Table 5.6: Management Services Commands Summary

5.4 Command Set Detail

5.4.1 Embedded Services Commands

5.4.1.1 No Operation (NOP)

This command is used by the application to assure device presence and operation by receiving the response from this command.

5.4.1.1.1 Request

Figure 5.2 describes the "No Operation" command request:

Command Start	Length		Type	Opcode	Checksum
0xCA	0x02	0x00	0x00	0x00	0x02

Figure 5.2: "No Operation" Command Request

Table 5.7 describes the fields of the "No Operation" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2 (Type + Opcode)	1st Byte: 0x02 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x00
Checksum	1	Constant	0x02

Table 5.7: "No Operation" Command Request Fields

5.4.1.1.2 Response

Figure 5.3 describes the "No Operation" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x03	0x00	0x01	0x00	0x01	0x05

Figure 5.3: "No Operation" Command Response

Table 5.8 describes the fields of the response to the "No Operation" command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x00
Command Data	1	Dummy	0x01
Checksum	1	Constant	0x05

Table 5.8: "No Operation" Command Response Fields

5.4.1.2 Get Version

This command retrieves IT900 firmware version number.

5.4.1.2.1 Request

Figure 5.4 describes the "Get Version" command request:

Command Start	Length		Type	Opcode	Checksum
0xCA	0x02	0x00	0x00	0x01	0x03

Figure 5.4: "Get Version" Command Request

Table 5.9 describes the fields of the "Get Version" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x02 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x01
Checksum	1	Constant	0x03

Table 5.9: "Get Version" Command Request Fields

5.4.1.2.2 Response

Figure 5.5 describes the "Get Version" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x06	0x00	0x01	0x01	Status	

Status	Software Version
1 Byte	3 Bytes

Figure 5.5: "Get Version" Command Response

Table 5.10 describes the fields of the response to the "Get Version" command:

Field	Bytes	Description		Value
Command Start	1	Constant		0xCA
Length	2	Number of bytes in Command Data field +2		1st Byte: 0x06 2nd Byte: 0x00
Type	1	Response		0x01
Opcode	1	Constant		0x01
Status	1	Command execution Status		0x00 — command failed 0x01 — command executed successfully
Software Version	3	The Device firmware version. Format: M.mm.bb. M – Major; mm – Minor; bb – Build	1st Byte — Major	
			2nd Byte — Minor	
			3rd Byte — Build	
Checksum	1	Response value depends on "Command Data" field		Calculated at run time

Table 5.10: "Get Version" Command Response Fields

5.4.1.3 Get Free Memory

This command retrieves the size of device free RAM

5.4.1.3.1 Request

Figure 5.6 describes the "Get Free Memory" command request:

Command Start	Length		Type	Opcode	Checksum
0xCA	0x02	0x00	0x00	0x02	0x04

Figure 5.6: "Get Free Memory" Command Request

Table 5.11 describes the fields of the "Get Free Memory" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x02 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x02
Checksum	1	Constant	0x04

Table 5.11: "Get Free Memory" Command Request Fields

5.4.1.3.2 Response

Figure 5.7 describes the "Get Free Memory" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x07	0x00	0x01	0x02	Parameters	

Status	Free Memory
1 Byte	4 Bytes

Figure 5.7: "Get Free Memory" Command Response

Table 5.12 describes the fields of the response to the "Get Free Memory" command:

Field	Bytes	Description	Response
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x07 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x02
Status	1	Command execution Status	0x00 — command failed 0x01 — command executed successfully
Free Memory Size	4	Size of available RAM (in little-endian format: LSB – MSB)	
Checksum	1	Response value depends on "Command Data" field	Calculated at run time

Table 5.12: "Get Free Memory" Command Response Fields

5.4.1.4 Read from NVM (User Area)

This command reads data from the user sector of the NVM**.**

5.4.1.4.1 Request

Figure 5.8 describes the "Read from NVM User Area" command request:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x07	0x00	0x00	0x05	Parameters	

Address	Number of data bytes
4 Bytes	1 Byte

Figure 5.8: "Read from NVM User Area" Command Request

Table 5.13 describes the fields of the "Read from NVM User Area" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x07 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x05
Address	4	Start address of desired sector	Address + Num of bytes (<1024)
Number of bytes	1	Number of bytes to read	0–255
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.13: "Read from NVM User Area" Command Request Fields

5.4.1.4.2 Response

Figure 5.9 describes the "Read from NVM User Area" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	LSB	MSB	0x01	0x05	Parameters	

Result	Data from EEPROM
1 Byte	variable

Figure 5.9: "Read from NVM User Area" Command Response

Table 5.14 describes the fields of the response to the "Read from NVM User Area" command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	Variable length
Type	1	Response	0x01
Opcode	1	Constant	0x05
Result	1	Command Execution Result	**0x00** — command failed **0x01** — command executed successfully
Data	Variable		
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.14: "Read from NVM User Area" Command Response Fields

5.4.1.5 Write to NVM (User Area)

This command writes data to the user sector of the NVM.

5.4.1.5.1 Request

Figure 5.10 describes the "Write to NVM User Area" command request:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	LSB	MSB	0x00	0x06	Parameters	

Address	Data
4 Bytes	variable

Figure 5.10: "Write to NVM User Area" Command Request

Table 5.15 describes the fields of the "Write to NVM User Area" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2.	variable
Type	1	Request	0x00
Opcode	1	Constant	0x06
Address	4	Start address of desired sector	
Data	variable	Data to be written to the NVM	
Checksum	1		Calculated at run time

Table 5.15: "Write to NVM User Area" Command Request Fields

5.4.1.5.2 Response

Figure 5.11 describes the "Write to NVM User Area" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x03	0x00	0x01	0x06	Status	

Figure 5.11: "Write to NVM User Area" Command Response

Table 5.16 describes the fields of the response to the "Write to NVM User Area" command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x06
Status	1	Command Execution Result	**0x00** — command failed **0x01** — command executed successfully
Checksum	1		Calculated at run time

Table 5.16: "Write to NVM User Area" Command Response Fields

5.4.2 Stack Services Commands

5.4.2.1 Reset

This command initiates a Soft RESET of IT900 and reinitializes all parameters from NVM.

5.4.2.1.1 Request

Figure 5.12 describes the "Reset" command request:

Command Start	Length		Type	Opcode	Checksum
0xCA	0x02	0x00	0x00	0x20	0x22

Figure 5.12: "Reset" Command Request

Table 5.17 describes the fields of the "Reset" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x02 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x20
Checksum	1	Constant	0x22

Table 5.17: "Reset" Command Request fields

5.4.2.1.2 Response

Figure 5.13 describes the "Reset" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x03	0x00	0x01	0x20	Status	

Figure 5.13: "Reset" Command Response

Table 5.18 describes the fields of the response to the "Reset" command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x20
Command Data	1	Status	**06** — non-volatile memory is not connected - NO EEPROM **07** — Command Executed Successfully **08** — There are invalid parameters in the non-volatile memory - RETURN TO FACTORY DEFAULTS OCCURRED **32** — DLL initialization failure - FATAL ERROR DURING INITIALIZATION OF DLL **64** — DLL was initialized in Auto ON-line mode - IN AUTO ONLINE MODE **66** — DLL was initialized in Safe mode - IN SAFE MODE
Checksum	1	Response value depends on "Command Data" field	Calculated at run time

Table 5.18: "Reset" Command Response Fields

5.4.2.2 Go Online

This command sets the device into the online state. In this state the device can receive and send packets

5.4.2.2.1 Request

Figure 5.14 describes the "Go Online" command request:

Command Start	Length		Type	Opcode	Checksum
0xCA	0x02	0x00	0x00	0x22	0x24

Figure 5.14: "Go Online" Command Request

Table 5.19 describes the fields of the "Go Online" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x02 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x22
Checksum	1	Constant	0x24

Table 5.19: "Go Online" Command Request Fields

5.4.2.2.2 Response

Figure 5.15 describes the "Go Online" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x03	0x00	0x01	0x22	Status	

Figure 5.15: "Go Online" Command Response

Table 5.20 describes the fields of the response to the "Go Online" command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x22
Status	1	Command execution Status	**0x00** — command failed **0x01** — command executed successfully
Checksum	1	Response value depends on Command Data field	Calculated at run time

Table 5.20: "Go Online" Command Response Fields

5.4.2.3 Go Offline

This command sets the device into the Offline state. In this state the device cannot receive and send packets.

5.4.2.3.1 Request

Figure 5.16 describes the "Go Offline" command request:

Command Start	Length		Type	Opcode	Checksum
0xCA	0x02	0x00	0x00	0x23	0x25

Figure 5.16: "Go Offline" Command Request

Table 5.21 describes the fields of the "Go Offline" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x02 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x23
Checksum	1	Constant	0x25

Table 5.21: "Go Offline" Command Request Fields

5.4.2.3.2 Response

Figure 5.17 describes the "Go Offline" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x03	0x00	0x01	0x23	Status	

Figure 5.17: "Go Offline" Command Response

Table 5.22 describes the fields of the response to the “Go Offline” command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x23
Status	1	Command execution Status	**0x00** — command failed **0x01** — command executed successfully
Checksum	1	Response value depends on Command Data field	Calculated at run time

Table 5.22: “Go Offline” Command Response Fields

5.4.3 Configuration and Management Commands

5.4.3.1 Set Predefined Parameters

This command replaces one or more parameter configuration table with a predefined one, stored in the Flash. Each of the different regions/bands (FCC, ARIB, CENELEC A and CENELEC B) has its own predefined parameter table.

5.4.3.1.1 Request

Figure 5.18 describes the "Set Predefined Parameters" command request:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x04	0x00	0x00	0x40	Parameters	

Table Type	Region
1 Byte	1 Byte

Figure 5.18: "Set Predefined Parameters" Command Request

Table 5.23 describes the fields of the "Set Predefined Parameters" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x04 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x40
Table Type	1	Constant	**0xFF**
Region	1	Region (For instructions on setting Factory Defaults refer to 5.4.6.12A.2)	**0x00** — FCC **0x01** — ARIB **0x02** — CENELEC A **0x03** — CENELEC B 0x05 — CENELEC A3 0xFF – Return to Factory default
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.23: "Set Predefined Parameters" Command Request Fields

5.4.3.1.2 Response

Figure 5.19 describes the "Set Predefined Parameters" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x03	0x00	0x01	0x40	Status	

Figure 5.19: "Set Predefined Parameters" Command Response

Table 5.24 describes the fields of the response to the "Set Predefined Parameters" command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x40
Status	1	Command Execution Status	**0x00** — command failed **0x01** — command executed successfully
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.24: "Set Predefined Parameters" Command Response Fields

5.4.3.2 Set Device Parameters

This command allows the user to set parameters for applications which do not meet the predefined/standard scenarios.

5.4.3.2.1 Request

Figure 5.20 describes the "Set Device Parameters" command request:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	LSB (2N+5)	MSB (2N+5)	0x00	0x41	Parameters	

("N" = the number of parameters to be set.)

Table Type	Index	Parameter 1		Parameter N
1 Byte	2 Bytes	2 Bytes		2 Bytes

Figure 5.20: "Set Device Parameters" Command Request

Table 5.25 describes the fields of the "Set Device Parameters" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: LSB of 2N+5 2nd Byte: MSB of 2N+5 (Where "N" = the number of parameters to be set.)
Type	1	Request	0x00
Opcode	1	Constant	0x41
Table Type	1	The configuration table to be updated. The Configurable Parameters table is detailed in Appendix A.1. For instructions on setting Factory Defaults refer to Appendix A.2.	0x05 — Serial Number (S/N) 0x06 – Configurable Parameters 0x08 – Factory Defaults
Index	2	Index of the first parameter to be changed in the configuration table. A few parameters may be configured at once, only if they are sequential.	For 'Table Type' 0x05 set this field to 0xBAAB For 'Table Type'0x06, 0x08 see valid indexes in Appendix A.1
Parameters	2N	The content of this field depends on the 'Table Type' field.	For 'Table Type' 0x05 — 16 bytes should be sent (8 WORDS) For 'Table Type'0x06, 0x08 – array parameters values to be set
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.25: "Set Device Parameters" Command Request Fields

5.4.3.2.2 Response

Figure 5.21 describes the "Set Device Parameters" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x03	0x00	0x01	0x41	Status	

Figure 5.21: "Set Device Parameters" Command Response

Table 5.26 describes the fields of the response to the "Set Device Parameters" command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x41
Status	1	Command Execution Status	**0x00** — command failed **0x01** — command executed successfully
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.26: "Set Device Parameters" Command Response Fields

5.4.3.3 Get Device Parameters

This command reads at least one parameter from the device configuration tables.

5.4.3.3.1 Request

Figure 5.22 describes the "Get Device Parameters" command request:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x07	0x00	0x00	0x42	Parameters	

Table Type	Index	Count
1 Byte	2 Bytes	2 Bytes

Figure 5.22: "Get Device Parameters" Command Request

Table 5.27 describes the fields of the "Get Device Parameters" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x07 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x42
Table Type	1	The configuration table to be read: • The Configurable Parameters table is detailed Appendix A.1. • For description on Factory Defaults and Factory Defaults Validness options refer to Appendix A.3 • The Debug Counters table is detailed Appendix A.2	0x05 — Serial Number (S/N) 0x06 –Configurable Parameters 0x08 – Factory Defaults 0x09 - Factory Defaults validness 0x0B – Debug Counters
Index	2	Index of the first parameter, in the configuration table, to read.	For 'Table Type' 0x05 set this field to 0xBAAB For 'Table Type' 0x06, 0x08, 0x09 see valid indexes in Appendix A.1
Parameters	2	Number of parameters to read	N — ignore in case of S/N
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.27: "Get Device Parameters" Command Request Fields

5.4.3.3.2 Response

Figure 5.23 describes the "Get Device Parameters" command response:

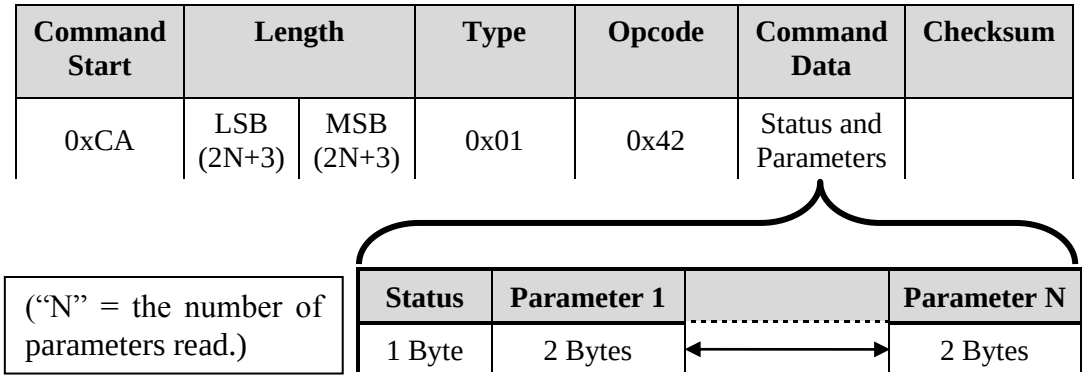

Figure 5.23: "Get Device Parameters" Command Response

Table 5.28 describes the fields of the response to the "Get Device Parameters" command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	2N+3 (Where N = the number of parameters read.)
Type	1	Response	0x01
Opcode	1	Constant	0x42
Status	1	Command execution Status	**0x00** — command failed **0x01** — command executed successfully
Parameters	16 or 2N	The content of this field depends on the 'Table Type' field of the "Get Device Parameters" Request command.	For 'Table Type' 0x05 - 16 bytes S/N For 'Table Type' 0x06, 0x08, 0x0B- Array of parameters in length of 2N (N is the number of parameters to be read). For 'Table Type' 0x09 - Array of Factory Default Validity indicators in length of 2N (each Validity indicator is 2 bytes). The parameter's Factory Default is valid (Factory Default is already set) if the value is 0x0000 and invalid (Factory Default is not set) if value is 0xFFFF
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.28: "Get Device Parameters" Command Response Fields

5.4.3.4 Save Device Parameters

This command saves current parameters of one or more tables from the device RAM into the NVM.

5.4.3.4.1 Request

Figure 5.24 describes the "Save Device Parameters" command request:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x03	0x00	0x00	0x43	Table Type	

Figure 5.24: "Save Device Parameters" Command Request

Table 5.29 describes the fields of the "Save Device Parameters" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x43
Table Type	1	Constant	0xFF
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.29: "Save Device Parameters" Command Request Fields

5.4.3.4.2 Response

Figure 5.25 describes the "Save Device Parameters" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x03	0x00	0x01	0x43	Status	

Figure 5.25: "Save Device Parameters" Command Response

Table 5.30 describes the fields of the response to the "Save Device Parameters" command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x43
Status	1	Command Execution Status	**0x00** — command failed **0x01** — command executed successfully
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.30: "Save Device Parameters" Command Response Fields

5.4.3.5 Remote Parameters Changed

This indication is sent by the modem when parameter was remotely changed

Figure 5.26 describes the "Remote Parameters Changed" indication:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	LSB	MSB	0x02	0x4C		

Table	Index	Num of Params	First Param Value	Src Port	Src Address
1 byte	2 bytes	2 bytes	2 bytes	1 byte	N bytes

Figure 5.26: "Remote Parameters Changed" Indication

Table 5.31 describes the fields of the "Remote Parameters Changed" indication:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2 (N is the Source Address field length)	1st Byte: 11+N 2nd Byte: 0x00
Type	1	Indication	0x02
Opcode	1	Constant	0x4C
Table	1	Parameters Table where parameter was changed	**0x06**
Index	2	Index of first parameter that was changed	0 — Maximal Configuration Table Index
Number of Parameters	2	Number of parameters that were changed	1 — Maximal Configuration Table Index
First Parameter Value	2	Value of first parameter that was changed. In case more than one parameter was changed, other values can be read using 'Get Parameter' command.	0 – 0xFFFF
Source Port	1	Source port of the application that caused parameters change	0 - 15
Source Address	N	Source address of the node that caused parameters change: If Configuration command sent using **Internetworking packet** - S/N will be presented. Address length (N) =16 If Remote Configuration command sent using **Intranetworking packet** - Logical ID will be presented. Address length (N) = 2.	
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.31: "Remote Parameters Changed" Indication Fields

5.4.4 Remote Configuration Commands

Through the use of Data Commands (see Section 5.4.5.1), the NC can configure the network parameters of a RS. To disable the option for changing parameters values remotely, refer to the 'Remote Configuration Enable' parameter in Appendix A.1.

5.4.4.1 Set Predefined Parameters

This command replaces one or more parameter configuration tables of a remote device with a predefined one, stored in the Flash of the remote device.

5.4.4.1.1 Request

In order to send the Set Predefined Parameters command to the remote station, the NC application should perform the following:

- Format the entire command (see Section 5.4.3.1.1) including command header, length and Checksum fields.
- Send the Packet TX request (see Section 5.4.5.1) with the following parameters:
  - Data Service Type — according to the requested remote configuration service (Intranetworking Unicast/Broadcast/Unicast over S/N, Internetworking Unicast/Broadcast).
  - Destination Port — 1.
  - Destination address — according to the required data service type and the required target ID.
  - Payload: the command that was formatted at Step 1.
  - All other TX parameters (priority, gain, Ack, etc) should be set according to the application requirements.

5.4.4.1.2 Response

The response will be received via the Intranetworking RX Packet indication (see Section 5.4.5.3) or via the Internetworking RX Packet indication (see Section 5.4.5.4). **The Source Port field in the RX indication is set to 1**. The payload of this packet indication contains the entire structure of the Set Predefined Parameters response (see Section 5.4.3.1).

5.4.4.2 Set Device Parameters

Request — Perform the procedure described in Section 5.4.4.1.1. In Step 1, use Set Device Parameters Request command structure (see Section 5.4.3.2).

Response — As described in Section 5.4.4.1.2. The payload of this packet indication contains the entire structure of the Set Device Parameters response (see Section 5.4.3.2.2).

5.4.4.3 Get Device Parameters

Request — Perform the procedure described in Section 5.4.4.1.1. In Step 1, use Get Device Parameters Request command structure (see Section 5.4.3.3).

Response – Perform the procedure described in Section 5.4.4.1.2. The payload of this packet indication contains the entire structure of the Set Predefined Parameters response (see Sections 5.4.3.2.2and 5.4.3.2).

5.4.4.4 Save Device Parameters

Request — Perform the procedure described in Section 5.4.4.1.1. In Step 1, use Set Device Parameters Request command structure (see Sections 5.4.3.2.25.4.3.2).

Response — erudecorp eht mrofrePdescribed in Section 5.4.4.1.2. The payload of this packet indication contains the entire structure of the Set Predefined Parameters response (see Section 5.4.3.1).

5.4.5 Data Commands

5.4.5.1 Packet Tx

This command is used by the Host to send data over the power line.

5.4.5.1.1 Request

Figure 5.27 describes the "Packet Tx" command request:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	LSB	MSB	0x00	0x60	Table Type	

Host Tx Header	Host Tx Payload
9+N Bytes	1–1472 Bytes

Tx Flags	Destination port	Target ID
8 Byte	1 Bytes	N Bytes

Figure 5.27: "Packet Tx" Command Request

Figure 5.28 describes the "Tx Flags":

Data Service Type	Priority	Ack Service	Hops	Gain	Tag	Encrypt
1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	2 Bytes	1 Byte

Figure 5.28: "Tx Flags"

Table 5.32 describes the fields of the “Packet Tx” command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	11+N – 1486 1st Byte: LSB 2nd Byte: MSB
Type	1	Request	0x00
Opcode	1	Constant	0x60
Data Service Type	1	0 — Intranetworking Broadcast 1 — Intranetworking Unicast 2 — Intranetworking Unicast over S/N 3 — Internetworking Broadcast 4 — Internetworking Unicast	0 – 4
Priority	1	Packet priority in the network 0 = Normal 1 = High 2 = Emergency * Recommended to use Normal priority	0 -2
Ack Service	1	Packet transmission service 0 = No ACK 1 = ACK required	0 -1
Hops	1	Maximal Number of hops for repeated packet * Recommended to set to value of ‘Max Network Depth’ parameter (default value is 8)	1 – Max Network Depth
Gain	1	Transmitter gain value. 0 is lowest, 7 is highest.	0–7
Tag	2	Session tag value, which helps to identify the command answer.	1–65535
Encrypt	1	Flag for encrypted messages	0,1
Destination Port	1	Target application port	0–15
Destination Address	N	**For Data Service Type = 1 —** Use destination’s short address Address Length (N) = 2	0 - 4

Field	Bytes	Description	Value
		For Data Service Type = 2 or 4 — Use destination's S/N Address Length (N) = 16	
		For Data Service Type = 0 or 3 — This field should not be used N = 0	
Payload	L	Packet payload	1–1760
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.32: "Packet Tx" Request Command Request Fields

5.4.5.1.2 Response

There are two types of response packets for the Packet TX Command – one for packet admission (response 1) and one for packet transmission (response 2).

5.4.5.1.2.1 Packet Tx Admission Response (Response 1)

Figure 5.29 describes the "Packet Tx" command response 1:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x07	0x00	0x01	0x60	Response Parameters	

Status	Response Number	Result	Tag
1 Byte	0x01	1 Byte	2 Bytes

Figure 5.29: "Packet Tx" Command Response 1

Table 5.33 describes the fields of Response 1 to the "Packet Tx" admission command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x07 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x60
Status	1	Command execution Status	**0x00** — command failed **0x01** — command executed successfully
Response Number	1	Constant	1 (Tx Admission Response)
Result	1	0 = **Accepted** 1 = **Rejected —** no memory 2 = **Rejected —** Fatal error — Bad packet syntax, structure, length etc. 3 = **Rejected** — Node ID wasn't found in Node ID Database (this response is valid only if "Tx Type" field =2)	0–3
Tag	2	Session tag value (the same value as in the command).	1 – 65535 **1st Byte**: TAG LSB **2nd Byte**: TAG MSB
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.33: "Packet Tx" Admission Command Response 1 Fields

5.4.5.1.2.2 Packet Tx Transmission Response (Response 2)

Figure 5.30 describes the “Packet Tx” command response 2:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x09	0x00	0x01	0x60	Response Parameters	

Status	Response Number	Result	Routed	Tx Count	Tag
1 Byte	0x03	1 Byte	1 Byte	1 Byte	2 Bytes

Figure 5.30: “Packet Tx” Command Response 2

Table 5.34 describes the fields of Response 2 to the "Packet Tx" transmission command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x09 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x60
Status	1	Success/fail	0–1
Response Number	1	Constant	3 (Tx Transmission Response)
Result	1	0=Transmitted Successfully 1=N/A 2=No Acknowledge 3=No Resources (Target) 4=Blocked 5=Unknown error	0 – 5
Routed	1	0 = single hop flag 1 = the packet was routed	0–1
Tx Count	1	Number of actual transmissions to the line	
Tag	2	Session tag value (the same value as in the command).	1–65535 **1st Byte**: TAG LSB **2nd Byte**: TAG MSB
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.34: "Packet Tx" Transmission Command Response 2 Fields

5.4.5.2 Get NC Database Size (NC Only)

This command returns the total number of entries (Max Size) and the index of the last occupied entry (Current Size) in the NC database.

5.4.5.2.1 Request

Figure 5.31 describes the "Get NC Database Size" command request:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x03	0x00	0x00	0x65	0x01	

Figure 5.31: "Get NC Database Size" Command Request

Table 5.35 describes the fields of the "Get NC Database Size" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x65
Command Data	1	Constant	1
Checksum	1	Constant	0x69

Table 5.35: "Get NC Database Size" Command Request Fields

5.4.5.2.2 Response

Figure 5.32 describes the "Get NC Database Size" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x07	0x00	0x01	0x65	Entry Parameters	

Status	Max Size	Current Size
1 Byte	2 Bytes	2 Bytes

Figure 5.32: "Get NC Database Size" Command Response

Table 5.36 describes the fields of the response to the "Get NC Database Size" command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x07 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x65
Status	1	Command Execution Status	**0x00** — command failed **0x01** — command executed successfully
Max Size	2	Number of entries in the NC database	
Current Size	2	Index of last occupied entry in the NC database	
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.36: "Get NC Database Size" Command Response Fields

5.4.5.3 Rx Intranetworking Packet

Figure 5.33 describes the "Rx Intranetworking Packet" indication:

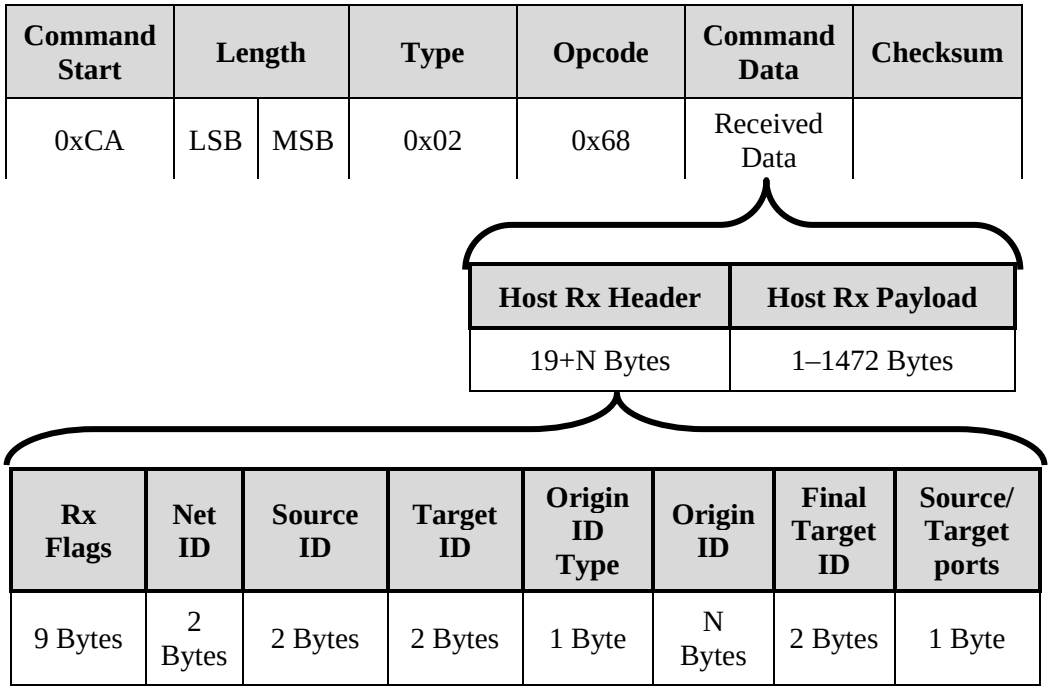

Figure 5.33: "Rx Intranetworking Packet" Indication

Figure 5.34 describes the Rx Flags:

Rx Type	Data Service Type	Modulation	SQ	Tx Service	Priority	CW	Repeated	Tx Result
1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte

Figure 5.34: "Rx Flags"

Table 5.37 describes the “Rx Intranetworking Packet” indication fields:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	23 – 1486 1st Byte: LSB 2nd Byte: MSB
Type	1	Indication	0x02
Opcode	1	Constant	0x68
Rx and Modulation type	1	Bits 0-3 Rx Type: 0 = to a device in other network 1 = to other device in my network 2 = to me 3 = retransmitted packet 4 = spoofed packet 5 = any malformed packet Bit 4 – Modulation type: 0 = DCSK 1 = DCSK Turbo Bits 5-7: Reserved	
Data Service Type	1	Received packet type. Can be one of the following: 0 = Unicast 1 = Broadcast	0–1
Modulation Rate	1	0x00 – DCSKT0 0x01 = DCSKT1 0x02 = DCSKT2 0x03 = DCSKT3	For DCSK Turbo modulation: 0x00 – 0x16 For DCSK Modulation:

Field	Bytes	Description	Value
		0x04 = DCSKT4 0x05 = DCSKT5 0x06 = DCSKT6 0x07 = DCSKT7 0x08 = DCSKT8 0x09 = DCSKT9 0x0A = DCSKT10 0x0B = DCSKT11 0x0C = DCSKT12 0x0D = DCSKT_TD0 0x0E = DCSKT_TD1 0x0F = DCSKT_TD2 0x10 = DCSKT_TD3 0x11 = DCSKT_TD4 0x12 = DCSKT_TD5 0x13 = DCSKT_TD6 0x14 = DCSKT_TD7 0x15 = DCSKT_TD8 0x16 = DCSKT_TD9 0xFE = DCSK - SM 0xFC = DCSK - RM 0xFB = DCSK-ERM	0xFB, 0xFC, 0xFE
SQ	1	Signal quality	DCSK modulation: 0-31 (0 is lowest quality) DCSK Turbo: 0 – 255 (0 is lowest quanlity)
Tx Service	1	**Intranetworking** transmission service 8, 9 = unacknowledged packet 10 = acknowledged packet 11 = fragmented (long) packet	8 – 11
Priority	1	Packet priority in the network, 0, 1 = Normal 2 = High 3 = Emergency	0 – 3
CW	1	CW for adaptive back-off algorithm	0 – 15

Field	Bytes	Description	Value
Repeated	1	Retransmission flag 0 = the packet was not retransmitted by this device 1 = the packet was retransmitted by this device	0 – 1
Tx Result	1	Transmission result, it is valid only for retransmitted packets (Repeated = 1) 0 = Okay 1 = No acknowledge 2 = Blocked 3 = Target device has no resources 4 = Hop count expired, the packet was not transmitted	0 – 3
Net ID	2	Network ID of the packet	0 –1023
Source ID	2	ID of the transmitter	1 – 2047
Target ID	2	ID of the target device in the network	0 – 2047
Origin ID Address Type	1	0 — short—Address Length (N) = 2 1 — S/N—Address Length (N) = 16	0–1
Origin ID	N	Indicates packet's source short address in case "Origin ID Address Type" field = 0 or source S/N "Origin ID Address Type" field = 1	0.–.2047 for short address 1 – 2^{16}-1 for S/N
Final ID	2	ID of packet's final destination	0 – 2047
Source and Target Port	1	Port of the application that sent the packet represented by bits 0–3 Port of the target application represented by bits 4–7	Source port — 0 – 15 Target port — 0 – 15
Payload		Packet payload	
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.37: "Rx Intranetworking Packet" Indication Fields

5.4.5.4 Rx Internetworking Packet

Figure 5.35 describes the "Rx Internetworking Packet" indication:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	LSB	MSB	0x02	0x68	Received Data	

Host Rx Header	Host Rx Payload
26 Bytes	1–1472 Bytes

Rx Flags	Source SN	Source/Target ports
9 Bytes	16 Bytes	1 Byte

Figure 5.35: "Rx Internetworking Packet" Indication

Figure 5.36 describes the "Rx Flags":

Rx Type	Data Service	Modulation	SQ	Tx Service	Priority	CW	Repeated	Tx Result
1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Bytes	1 Byte	1 Byte	1 Byte

Figure 5.36: "Rx Flags"

Table 5.38 describes the "Rx Internetworking Packet" indication fields:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	29 – 1486 1st Byte: LSB 2nd Byte: MSB
Type	1	Indication	0x02
Opcode	1	Constant	0x68

Field	Bytes	Description	Value
Rx and Modulation type	1	Bits 0-3: Received packet type. Can be one of the following: 0 = to a device in other network 1 = to other device in my network 2 = to me 3 = retransmitted packet 4 = spoofed packet 5 = any malformed packet Bit 4 – Modulation type: 0 = DCSK 1 = DCSK Turbo Bits 5-7: Reserved	
Data Service Type	1	Received packet type. Can be one of the following: 0 = Unicast 1 = Broadcast	0–1

Field	Bytes	Description	Value
Modulation	1	0x00 = DCSKT0 0x01 = DCSKT1 0x02 = DCSKT2 0x03 = DCSKT3 0x04 = DCSKT4 0x05 = DCSKT5 0x06 = DCSKT6 0x07 = DCSKT7 0x08 = DCSKT8 0x09 = DCSKT9 0x0A = DCSKT10 0x0B = DCSKT11 0x0C = DCSKT12 0x0D = DCSKT_TD0 0x0E = DCSKT_TD1 0x0F = DCSKT_TD2 0x10 = DCSKT_TD3 0x11 = DCSKT_TD4 0x12 = DCSKT_TD5 0x13 = DCSKT_TD6 0x14 = DCSKT_TD7 0x15 = DCSKT_TD8 0x16 = DCSKT_TD9 0x19 = DCSK - SM 0x1A = DCSK - RM 0x1B = DCSK-ERM	For DCSK Turbo modulation: 0x00 – 0x16 For DCSK Modulation: 0xFB, 0xFC, 0xFE
SQ	1	Signal quality	DCSK modulation: 0-31 (0 is lowest quality) DCSK Turbo: 0 – 255 (0 is lowest quanlity)
Tx Service	1	**Internetworking** transmission service 0x10, 0x0D - unacknowledged packet	0x10, 0x0D
Priority	1	Packet priority in the network, 0, 1 = Normal 2 = High 3 = Emergency	0 – 3
CW	1	CW for adaptive back off algorithm	0 – 15

Field	Bytes	Description	Value
Repeated	1	Retransmission flag 0 = the packet was not retransmitted by this device 1 = the packet was retransmitted by this device	0 – 1
Tx Result	1	Transmission result, it is valid only for retransmitted packets (Repeated = 1) 0 = OK 1 = No acknowledge 2 = Blocked 3 = Target device has no resources 4 = Hop count expired, the packet was not transmitted	0 – 3
Original Source S/N	16	Indicates packet source's S/N.	$1 – 2^{16}-1$
Source and Target Port	1	Port of the application that sent the packet represented by bits 0 – 3 Port of the target application represented by bits 4 – 7	Source port — 0 – 15 Target port — 0 – 15
Payload		Packet payload	
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.38: "Rx Internetworking Packet" Indication Fields

5.4.5.5 Get Node Information (NC Only)

This command is a query to retrieve node information from the NC Database. The query returns the Node ID, Parent ID, Serial Number and node connectivity status. The query key can be a Node ID, Serial Number or an index in NC Database.

5.4.5.5.1 Request

Figure 5.37 describes the "Get Node Information" command request:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	LSB	MSB	0x00	0x69	Query Info	

Query Key Type	Query Key
1 Bytes	N Bytes

Figure 5.37: "Get Node Information" Command Request

Table 5.39 describes the fields of the "Get Node Information" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 + N 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x69
Query Key Type	1	The Node Information is retrieved according to one of the following key types - 0 = Index in NC DB 1 = Node Id 2 = Serial number	0-2
Query Key	**N** For Query Key type 0, 1 - **N=2** For Query Key 2 - **N= Number of S/N bytes in Address database** (For query key type 2, length depends on the number of bytes used for serial number entry. The length can be between 1 and 16 - the default is 4 bytes.)	For Query Key Type 0, this field contain index of NC database. The range of valid indexes in NC database can be retrieved from the 'Get NC Database Size' command (see Section 5.4.5.2). For Query Key Type 1, this field should contain Logical Node ID For Query Key Type 2, this field should contain Node Serial Number	For Query Key Type 0 – **1- Network Size** For Query Key Type 1 - **1- 2047** For Query Key Type 2- **1 – (2^{16}-1)**
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.39: "Get Node Information" Command Request Fields

5.4.5.5.2 Response

Figure 5.38 describes the "Get Node Information" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x18	0x00	0x01	0x69	Node Info	

Status	Node ID	Parent ID	Serial Number	Connectivity Status
1 Bytes	2 Bytes	2 Bytes	16 Bytes	1 Byte

Figure 5.38: "Get Node Information" Command Response

Table 5.40 describes the "Get Node Information" command response fields:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2		1st Byte: 0x18 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x69
Status	1	Command execution Status	**0x00** – command failed **0x01** – command executed successfully or entry not found
Node ID	2	Node logical ID	1 - 2047
Parent ID	2	Parent logical ID	1 - 2047
Serial Number	16	Device serial number. The total number of bytes presented in this field is 16 but the number of relevant bytes is defined according to **Number of S/N bytes in Address database** parameter. Unused bytes are padded with zero and should be discarded.	$1 – (2^{16}-1)$
Connectivity Status	1	The Connectivity Status field defines the connection status between the node and the NC.	**0** – Disconnected from Network **1** – Connected to Network with good connection quality. **2** – Connected to Network but connection quality may be poor
Checksum	1	Value depends on "Command Data" field	

Table 5.40: "Get Node Information" Command Response Fields

5.4.5.6 Delete Node Information (NC Only)

This command deletes node information from the NC database. The key for node deletion can be an index in the database, Node ID or Serial Number. The command can also request deletion of the entire database which will cause the NC to lose all network routes and addresses.

5.4.5.6.1 Request

Figure 5.39 describes the "Delete Node Information" command request:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	LSB	MSB	0x00	0x6A	Delete Info	

Delete Key Type	Delete Key
1 Bytes	N Bytes

Figure 5.39: "Delete Node Information" Command Request

Table 5.41 describes the fields of the "Delete Node Information" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 + N 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0x6A
Delete Key Type	1	The Node Information is deleted according to one of the following key types - 0 = Index in NC's database 1 = Node Id 2 = Serial number 3 = All data in NC's database	0-3
Delete Key	**N** For Delete Key type 0, 1 - **N=2** For Delete Key 2 - **N= Number of S/N bytes in Address database** (For Delete key type 2, length depends on the number of bytes used for serial number entry. The length can be between 1 and 16 - the default is 4 bytes.) For Delete Key 3 - **N=0**	For Delete Key Type 0, this field contain index of NC's database. The range of valid indexes in NC database can be retrieved from the 'Get NC Database Size' command (see Section 5.4.5.2). For Delete Key Type 1, this field should contain Logical Node ID For Delete Key Type 2, this field should contain Node Serial Number For Delete Key Type 3 this field doesn't exist	For Delete Key Type 0 – **1- Network Size** For Delete Key Type 1 - **1- 2047** For Delete Key Type 2- **1 – (2^{16}-1)**
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.41: "Delete Node Information" Command Request Fields

5.4.5.6.2 Response

Figure 5.40 describes the "Delete Node Information" command Response:

Command Start	Length		Type	Opcode	Status	Checksum
0xCA	0x18	0x00	0x01	0x6A	1 byte	

Figure 5.40: "Delete Node Information" Command Response

Table 5.42 describes the fields of "Delete Node Information" command response:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2		1st Byte: 0x18 2nd Byte: 0x00
Type	1	Response	0x01
Opcode	1	Constant	0x6A
Status	1	Command execution Status	**0x00** – command failed **0x01** – command executed successfully
Checksum	1	Value depends on "Command Data" field	

Table 5.42: "Delete Node Information" Command Response Fields

5.4.6 Management Commands

5.4.6.1 Admission Approval Response from Application (NC Only)

This command sets the admission response to the NC. The application should respond using this command within 1 second after receiving the 'Get Admission Approval from Application' Indication (see Section 5.4.6.7).

5.4.6.1.1 Request

Figure 5.41 describes the "Admission Approval Response From Application" command request:

Command Start	Length		Type	Opcode	Admission Result	Admission Data	Checksum
0xCA	0x21	0x00	0x00	0xA4	2 bytes	29 bytes	

Figure 5.41: "Admission Approval Response from Application" Command Request

Table 5.43 describes the fields of the "Admission Approval Response from Application" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x21 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0xA4
Admission Result	2		0x2000 — Refuse, 0x0000 — Admit

Field		Bytes	Description	Value
Admission Data	Node's S/N	16	Remote Node's S/N	
	Admission Message ID	5	The value of this field needs to be copied from the 'Admission Message ID' field of the 'Get Admission Approval from Application' (see Section 5.4.6.7).	
	Node Key	8	This field should contain the Node Key of the admitting node. If the Node Key option is disabled or if the same Node Key value is set in all devices of the network, this field needs to be copied to the 'Node Key' field of the 'Admission Approval Response from Application' Command (see Section 5.4.6.1). Otherwise, the application is responsible to set this field with Node Key value of admitting Remote.	
Checksum		1	Value depends on "Command Data" field	Calculated at run time

Table 5.43: "Admission Approval Response from Application" Command Request Fields

5.4.6.1.2 Response

Figure 5.42 describes the "Admission Approval Response from Application" command response:

Command Start	Length		Type	Opcode	Status	Checksum
0xCA	0x03	0x00	0x01	0xA4	1 byte	

Figure 5.42: "Admission Approval Response from Application" Command Response

Table 5.44 describes the fields of the response to the "Admission Approval Response from Application" command response fields:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Request/Response	0x01
Opcode	1	Constant	0xA4
Status	1	Command Execution Status	**0x00** — command failed **0x01** — command executed successfully
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.44: "Admission Approval Response from Application" Command Response Fields

5.4.6.2 Leave Network

This command requests a Node to leave the network. In case of RMT, the station will try to reconnect, in case of NC, the station will try to establish a new network (a new Net ID will be allocated)

5.4.6.2.1 Request

Figure 5.43 describes the "Leave Network" command request:

Command Start	Length		Type	Opcode	Checksum
0xCA	0x02	0x00	0x00	0xA6	0xA8

Figure 5.43: "Leave Network" Command Request

Table 5.45 describes the fields of the "Leave Network" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x02 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0xA6
Checksum	1	Constant	0xA8

Table 5.45: "Leave Network" Command Request Fields

5.4.6.2.2 Response

This command is exceptional in the sense that it does not provide a Response in reaction to the Leave Network Request. Since the modem resets itself after receiving this Request, the application should expect a Reset Response (see Section 5.4.2.1.2) in reaction to the Leave Network Request.

5.4.6.3 Set Distributed Parameters List (NC Only)

The command defines the distributed parameters list. The parameters within this list will be distributed automatically by the Y-Net stack via NL Management messages.

5.4.6.3.1 Request

Figure 5.44 describes the "Set Distributed Parameters List" command request:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	LSB (3N+3)	MSB (3N+3)	0x00	0xA8	Parameters	

("N" = the number of parameters to be set.)

Number of Params (N)	Parameter 1 Index	Parameter 1 Value		Parameter N Index	Parameter N Value
1 Byte	1 Bytes	2 Bytes		1 Bytes	2 Bytes

Figure 5.44: "Set Distributed Parameters List" Command Request

Table 5.46Table 5.43 describes the fields of the "Set Distributed Parameters List" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: LSB 2nd Byte: MSB
Type	1	Request	0x00
Opcode	1	Constant	0xA8
Number Of Params (N)	1	Number of Parameters which will be distributed	
Params	3N	Index and Value of parameter/s to be changed. The Number of parameters to be changed is determined according to the "Number of Params" field	
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.46: "Set Distributed Parameters List" Command Request Fields

5.4.6.3.2 Response

Figure 5.45 describes the "Set Distributed Parameters List" command response:

Command Start	Length		Type	Opcode	Status	Checksum
0xCA	0x03	0x00	0x01	0xA8	1 byte	

Figure 5.45: "Set Distributed Parameters List" Command Response

Table 5.47 describes the fields of the response to the "Set Distributed Parameters List" command:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Request/Response	0x01
Opcode	1	Constant	0xA8
Status	1	Command Execution Status	**0x00** — command failed **0x01** — command executed successfully
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.47: "Set Distributed Parameters List" Command Response Fields

5.4.6.4 Get Distributed Parameters List (NC Only)

The command retrieves distributed parameters list.

5.4.6.4.1 Request

Figure 5.46 describes the "Get Distributed Parameters List" command request:

Command Start	Length		Type	Opcode	Checksum
0xCA	0x02	0x00	0x00	0xA9	0xAB

Figure 5.46: "Get Distributed Parameters List" Command Request

Table 5.48 describes the fields of the "Get Distributed Parameters List" command request:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x02 2nd Byte: 0x00
Type	1	Request	0x00
Opcode	1	Constant	0xA9
Checksum	1	Constant	0xA9

Table 5.48: "Get Distributed Parameters List" Command Request Fields

5.4.6.4.2 Response

Figure 5.47 describes the "Get Distributed Parameters List" command response:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	LSB (3N+3)	MSB (3N+3)	0x01	0xA9	Parameters	

("N" = the number of parameters to be read.)

Number of Params (N)	Parameter 1 Index	Parameter 1 Value		Parameter N Index	Parameter N Value
1 Byte	1 Bytes	2 Bytes		1 Bytes	2 Bytes

Figure 5.47: "Get Distributed Parameters List" Command Response

Table 5.49 describes the fields of the "Get Distributed Parameters List" command response:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: LSB 2nd Byte: MSB
Type	1	Request	0x01
Opcode	1	Constant	0xA9
Number Of Params (N)	1	Number of Parameters in distributed parameters list	
Params	3N	Index and Value of parameter/s in distributed parameters list. The Number of parameters is determined according to the "Number of Params" field.	
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.49: "Get Distributed Parameters List" Command Response fields

5.4.6.5 Connectivity Status with RS (NC Only)

This message provides an indication if there is a change in connectivity status between the RS and NC. If the connection status between RS and NC becomes invalid, this indication will be sent to the application and the Connectivity Status field will indicate an invalid connection. When Connectivity Status becomes valid again, the indication will be sent to application and the Connectivity Status field will indicate valid connection.

Note that this Indication is not sent on first connection of RS to NC. Instead, the "New Connection to NC" Indication is sent to NC application.

Figure 5.48 describes the "Connectivity Status with RS" indication:

Command Start	Length		Type	Opcode	Node ID	S/N	Connectivity Status	Checksum
0xCA	0x15	0x00	0x02	0xB1	2 bytes	16 bytes	1 byte	

Figure 5.48: "Connectivity Status with RS" Indication

Figure 5.50 describes the fields of the "Connectivity with RS" indication:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x15 2nd Byte: 0x00
Type	1	Indication	0x02
Opcode	1	Constant	0xB1
Node ID	2	Remote Node ID	
S/N	16	Remote's Serial Number. 16 bytes are included in this field but the number of valid bytes depends on number of bytes saved in Address DB.	
Connectivity Status	1	Defines the status of connection between the RS and NC	0 – Invalid connection 1 – Valid connection
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.50: "Invalid Connection with RS" Indication Fields

5.4.6.6 RS Left the Network (NC Only)

This Indication informs the NC application that a RS has left the network.

Figure 5.49 describes the fields of the "RS Left the Network" indication:

Command Start	Length		Type	Opcode	Node ID	S/N	Reason	Checksum
0xCA	0x15	0x00	0x02	0xB3	2 bytes	16 bytes	1 byte	

Figure 5.49: "RS Left the Network" Indication

Table 5.51 describes the fields of the "RS Left the Network" indication:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x15 2nd Byte: 0x00
Type	1	Indication	0x02
Opcode	1	Constant	0xB3
Node ID	2	Node ID of RS that left the network	
S/N	16	Serial Number of RS that left the network. 16 bytes are included in this field but the number of valid bytes depends on number of bytes saved in Address DB.	
Reason	1	Defines the status of connection between the RS and NC	0x00 - No Reason 0x01 - Improved to Other network 0x02 - Left because of No Parent 0x03 - Left by RS Application Request
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.51: "RS Left the Network" Indication fields

5.4.6.7 Get Admission Approval from Application (NC Only)

This message provides an indication to the application that a NC admission response is required. The application should respond to this indication using the Admission Approval Response from Application (see Section 5.4.6.1) within 1 second.

Figure 5.50 describes the "Get Admission Approval from Application" indication:

Command Start	Length		Type	Opcode	Admission Data	Checksum
0xCA	0x1F	00	0x02	0xB8	29 bytes	

Figure 5.50: "Get Admission Approval from Application" Indication

Table 5.52 describes the fields of the "Get Admission Approval from Application" indication:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x1F 2nd Byte: 0x00
Type	1	Indication	0x02
Opcode	1	Constant	0xB8
Node's S/N	16	Admitting Remote S/N	
Admission Message ID	5	The value of this field needs to be copied to the 'Admission Message ID' field of the 'Admission Approval Response From Application' Command (see Section 5.4.6.1).	
Node Key	8	This value indicates the Node Key value of NC. The value of this field needs to be copied to the 'Node Key' field of the 'Admission Approval Response From Application' Command (see Section 5.4.6.1) unless a unique Node Key value is used for Remotes.	
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.52: "Get Admission Approval from Application" Indication Fields

5.4.6.8 Admission Refuse

This message provides an indication of Admission Refusal

Figure 5.51 describes the "Admission Refuse" Indication:

Command Start	Length		Type	Opcode	Refuse Reason	Checksum
0xCA	0x04	0x00	0x02	0xB9	2 bytes	

Figure 5.51: "Admission Refuse" Indication

Table 5.53 describes the fields of the "Admission Refuse" Indication:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	0x04
Type	1	Indication	0x02
Opcode	1	Constant	0xB9
Refuse Reason	2		0x1000 — DB Full 0x2000 — Application 0x3000 — No Reason 0x4000 — S/N not in range 0x5000 — Duplicate Node ID 0x6000 — Wrong Node ID 0x7000 — Wrong Confirm Key
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.53: "Admission Refuse" Indication Fields

5.4.6.9 Connected to NC

This message provides an indication about a node becoming connected to the NC

Figure 5.52 describes the “Connected to NC” Indication:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x0A	0x00	0x02	0xBA	Parent Info	

Parent ID	NC Node ID	Distance to NC	Reserved
2 Bytes	2 Bytes	1 Byte	3 Bytes

Figure 5.52: “Connected to NC” Indication

Table 5.54 describes the “Connected to NC” Indication fields:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x0a 2nd Byte: 0x00
Type	1	Indication	0x02
Opcode	1	Constant	0xBA
Parent ID	2	Direct Parent Node ID	
NC Node ID	2	NC Node ID	1
Distance	1	Distance to NC	0 – max network depth
Reserved	3	Reserved	
Checksum	1	Value depends on “Command Data” field	Calculated at run time

Table 5.54: “Connected to NC” Indication Fields

5.4.6.10 Disconnected From NC

This message provides an indication of a Node disconnection from the NC

Figure 5.53 describes the "Disconnected From NC" Indication:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x03	0x00	0x02	0xBB	Disconnect Reason	

Figure 5.53: "Disconnected From NC" Indication

Table 5.55 describes the "Disconnected From NC" Indication fields:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x03 2nd Byte: 0x00
Type	1	Indication	0x02
Opcode	1	Constant	0xBB
Disconnect Reason	1	Disconnect Reason	0 — Parent Unstable 1 — NVR NAck 2 — Infinity 3 — Init 4 — Can't start timer 5 — NVR Refused 6 — NVR Enq 7 — Invalid Node ID 10 — disconnected by application request
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.55: "Disconnected From NC" Indication Fields

5.4.6.11 New Connection to NC (NC Only)

This message is applicable to the NC only. The message gives an indication of the New Connection of a node to the NC.

Figure 5.54 describes the "New Connection to NC" indication:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x06	0x00	0x02	0xBE	Entry Parameters	

Node ID	Parent ID
2 Bytes	2 Bytes

Figure 5.54: "New Connection to NC" Indication

Table 5.56 describes the "New Connection to NC" indication fields:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x06 2nd Byte: 0x00
Type	1	Indication	0x02
Opcode	1	Constant	0xBE
Node ID	2	New Station's Node ID	
Parent ID	2	New Station's Parent ID	
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.56: "New Connection to NC" Indication Fields

5.4.6.12 Network ID Assigned (NC Only)

This message is applicable to the NC only and gives an indication about the Network ID assigned to the NC. Figure 5.55 describes the "Network ID Assigned" indication:

Command Start	Length		Type	Opcode	Command Data	Checksum
0xCA	0x04	0x00	0x02	0xBF	Net ID	

Figure 5.55: "Network ID Assigned" Indication

Table 5.57 describes the "Network ID Assigned" indication fields:

Field	Bytes	Description	Value
Command Start	1	Constant	0xCA
Length	2	Number of bytes in Command Data field +2	1st Byte: 0x04 2nd Byte: 0x00
Type	1	Indication	0x02
Opcode	1	Constant	0xBF
Net ID	2	New Network ID	
Checksum	1	Value depends on "Command Data" field	Calculated at run time

Table 5.57: "Network ID Assigned" Indication Fields

Appendix A. Parameters Tables

This section details the IT900 Parameters Tables. The "Parameter" field consists of 2 Bytes in the little-endian format.

Index	
LSB	MSB

Figure 5.56: Configuration Tables "Parameter" Field Structure

A.1 Configurable Parameters Table

Table 5.58 details the Configurable Parameters, their indexes and default values. The 'Requires Reset' column indicates the parameters that require modem Reset when the value is changed.

Parameter	Index #	Value	"ROM" Default	Description	Requires Reset
UART Fast Rate (Div 100)	0x0005	24 – 9600	9600	Enabled to specify UART baud rate different than the default. The specified value will be multiplied by 100 to get the actual baud rate. Valid only when P6_0 is pulled up.	+
Network ID	0x0018	1– 0x03FF	0	Network ID part of logical address	+
Node ID	0x0019	1– 0x07FF	1	Node ID part of logical address	+
Modulation	0x001A	0,1	0	Modulation modes: 0= Auto Rate Control 1= Auto Rate Excluding DCSK Rates (only DCSK Turbo rates are used)	
UN ACK Repeats	0x001C	0– 0x00FF	0	Un-Acknowledged Repeats – number of required repeats.	
ACK Retries	0x001D	0– 0x00FF	4	Acknowledged Retries – number of required retries with acknowledge request.	
Parent address	0x0020	1 – 0x07FF	0	Parent Node ID - **Read Only**	+
NC address	0x0021	0-1	0	NC Node ID - **Read Only**	+
Distance from NC	0x0022	1 – 0x00FF	255	Distance (in Hops) between RS and NC - **Read Only**	+

Parameter	Index #	Value	"ROM" Default	Description	Requires Reset
Forced Network ID	0x002E	1– 0x3FFF	0	Setting the Forced Network ID manually. Used in conjunction with the "Network ID selection mode" when it is set to 'Forced' (see index 0x0206)	+
Operation Mode	0x0031	0,3	0	The station can function either as NC or as a RS 0 = Adaptive Mode (RS) 3 = NC	+
Network size	0x0038	5– 0xFFFF	10	The number of stations in the physical network (the physical network can contain multiple logical networks). All related timers are set automatically when this value is changed. Must be set to the same value for all stations in the network.	+
NC Database Size	0x005B	2-1400	10	This parameter defines the maximal number of RS which will be allowed to join the NC's logical network. The size of all NC related databases is set automatically when this value is changed.	+
Number of S/N bytes in Address database	0x003A	1–16	4	Number of S/N bytes in the Address database. This value also defined the minimum number of S/N LSBs that should be unique. The Node Information DB must be cleared before changing the value of this parameter.	+
Number Of S/N msb to Compare (in S/N Range Admission mode)	0x003B	1–127	8	This value defines the number of S/N MSBs to be compared in S/N Range Admission mode.	
NC Admission Mode	0x003C	0–3	0	The NC can function in the following Admission Modes: 0=Auto 1=S/N Range 2=S/N Range & App Mode 3=App Mode	+

Parameter	Index #	Value	"ROM" Default	Description	Requires Reset
Node Key (Bytes 0-7)	0x004E – 0x0055	0–255	0	To set byte X of Node Key, use Set Device Parameters with Index 0x004E+X.	+
Operation Band	0x5F	1-5	0	**Read Only** 0 - FCC 128 – ARIB 2 – CENELEC A 3 – CENELEC B or CENELEC A2 4 – CENELEC A3 5 – CENELEC A4 To Set operation band use the 'Set Predefined Parameters' Command detailed at section 5.4.3.1	+
Max Network Depth	0x0072	2-16	8	Maximal number of hops in the network. Must be set to the same value for all stations in the network.	+
UART Slow Rate (Div 100)	0x0089	24 – 9600	384	Enabled to specify UART baud rate different than the default. The specified value will be multiplied by 100 to get the actual baud rate. Valid only when P6_0 is pulled down	+
Auto configuration	0x0100	0 — Disabled 1 — Enabled	0	The modem is initialized and set to online mode, automatically, after reset	+
Send V1 Packets	0x103	0–1	0	Setting the flag to 1 enables transmission of packets in D1 format.	+
Source node address type at receiver host (relevant only for NC)	0x0104	0–1	0	The address of the source node in the received intranetworking packet indication will be: By S/N if flag is set to 1 By logical address if set to 0.	

Parameter	Index #	Value	"ROM" Default	Description	Requires Reset
Rx Filter	0x0107 – 0x010C	0–1	0x0107(M)—1 0x0108(D)—0 0x0109(N)—0 0x010A(I)—0 0x010B(C)—0 0x010D(MR)—0 0x010E(OR)—0	Set to 0x0000 to filter packet type Set to 0x0001 to forward packet type Legend: "M" — Mine (packets whose destination is the receiver Node) "D" — Other Device (same logical network) "N" — Other Network (different logical network) "I" — Imposter. "C" — Malformed (bad CRC/length). "MR" — My Repeated packets. "OR" — Other Repeated packets.	
NL Mng Enabled	0x0200	0–1	1	Setting the flag to 1 activates the NL Management background processes.	+
Warm Start Enabled	0x0202	0–1	1	If enabled, warm start will take place when powered on 1 — Warm Start 0 — Cold Start	+
Parent mode enabled	0x0203	0–1	1	If enabled, the station can function as a parent. 1 — Enabled 0 — Disabled	
Network ID selection mode	0x0206	0–1	0	Network ID can be selected automatically or set manually by the application 0 = Auto 1 = Forced	+
Remote Configuration Enable	0x020D	0-1	1	If enabled, the modems will allow Configuration of parameters remotely.	
Remote Version Download Enable	0x020E	0-1	1	If enabled, the modems will allow Version Download procedure to be preformed remotely.	

Table 5.58: Configurable Parameters

A.2 Debug Parameters

Table 5.59 details the IT900 Debug Parameters and their indexes.

Parameter	Index #	Description
LOAD_L	0	Number of Received & Transmitted BYTES for period time of 10 seconds - LSB
LOAD_H	1	Number of Received & Transmitted BYTES for period time of 10 seconds - MSB
BLOCKED_L	2	Number of Blocked packets in period time of 10 seconds - LSB
BLOCKED_H	3	Number of Blocked packets in period time of 10 seconds - MSB
RX_ALL_L	4	Number of received packets - LSB
RX_ALL_H	5	Number of received packets - MSB
RX_MINEL_L	6	Number of “My” received packets - LSB
RX_MINE_H	7	Number of “My” received packets - MSB
RX_BC_L	8	Number of “Broadcast” received packets - LSB
RX_BC_H	9	Number of “Broadcast” received packets - MSB
TX_ALL_L	10	Number of any transmitted packets - LSB
TX_ALL_H	11	Number of any transmitted packets - MSB
TX_BC_L	12	Number of “Broadcast” transmitted packets - LSB
TX_BC_H	13	Number of “Broadcast” transmitted packets - MSB
TX_NOACK_L	14	Number of transmitted packets with no ACK - LSB
TX_ NOACK _H	15	Number of transmitted packets with no ACK - MSB
TX_BLOCK_L	16	Number of blocked transmitted packets - LSB
TX_ BLOCK _H	17	Number of blocked transmitted packets - MSB
TX_SUCCESS_L	18	Number of successful transmissions - LSB
TX_ BLOCK _H	19	Number of successful transmissions - MSB
LASTHOP_L	20	Number of packets that weren’t retransmitted due to zero hop count - LSB
LASTHOP_L	21	Number of packets that weren’t retransmitted due to zero hop count - MSB
NUM_OF_CONNECT_TO_NETWORK	38	Number of successful connections to NEW network

Parameter	Index #	Description
DICONNECT_FROM_NETWORK_COUNTER	39	Number of disconnections from network
NETWORK_IMPROVMENT_COUNTER	40	Number of network improvements
PARENT_IMPROVMENT_COUNTER	41	Number of parent improvements
PARENT_DISCONNECT_COUNTER	42	Number of disconnections from parent
PARENT_CONNECT_COUNTER	43	Number of connections to parent
DOUBLE_ADDRESS_COUNTER	44	Number of double address events
NUMBER_OF_STATIONS_I_HEAR	49	The Number of stations I can hear directly

Table 5.59: Debug Parameters

A.3 Configurable Parameters Factory Defaults

All configurable parameters have default values that are stored in the Flash ("ROM" defaults). However, the user may request to use different default values. Factory default parameters are one time programmable and may be programmed at the manufacturing stage to comply with specific user requirements.

Not all parameters must be set in factory default. If the parameter's Factory Default value is set, the IT900 loads parameters from the factory default. If the parameter's Factory Default value is not set, the IT900 loads parameters from the "ROM" default.

Note: Configurable parameters factory defaults are not available for the IT900 beta release.

The parameters where it is highly recommended to change the default values to factory default values are:

- **Region**: Related set of parameters must be set as a factory default if the user region is not FCC. Otherwise, the modem may return to an FCC value if the non-volatile memory content is corrupted.
- **Serial Number (S/N)**: If this parameter is not set the modem may lose its serial number. A modem without a serial number cannot join the Y-Net network.

To define specific Factory Default values follow the procedure described below:

- Check if a parameter's Factory Default value is set, and therefore Valid, by using the "Get Device Parameters Command" (see Section 5.4.4.3). The 'Table Type' field of this command should be set to 'Factory Defaults validness' (0x09). The 'Index' field is defined according to the parameter's index as detailed in the Configurable Parameters Table in Appendix A.1 The S/N index is an exception for this case – see description about S/N indexes below.
- If a parameter's Factory Default value is not set, and therefore invalid, use the "Set Device Parameters Command" (see Section 5.4.3.2). The 'Table Type' field of this command should be set to 'Factory Defaults' (0x08). The 'Index' field is defined according to the parameter's index as detailed in the Configurable Parameters Table on Appendix A.1 The S/N index is an exception for this case – see description of S/N indexes below.
- To check factory default validity or set the factory default value of a S/N, use the following indexes (the S/N indexes are not part of the parameters table detailed in Appendix A.1):
    - Index 96 – S/N Bytes 0 and 1
    - Index 97 – S/N Bytes 2 and 3
    - Index 98 – S/N Bytes 4 and 5
    - Index 99 – S/N Bytes 6 and 7
    - Index 100 – S/N Bytes 8 and 9
    - Index 101 – S/N Bytes 10 and 11
    - Index 102 – S/N Bytes 12 and 13
    - Index 103 – S/N Bytes 14 and 15
- After setting Factory Defaults there is no need to use the "Save Device Parameters" command.

Appendix B. IT900 Initialization

B.1 Introduction

This appendix describes the initialization modes performed internally by IT900. The modes and options for initializing IT900 are as follows:

- NL management start up modes (Warm/Cold Start) is detailed in Appendix B.2.
- Parameters configuration process during initialization is specified in Appendix B.3.
- Recovery from initialization with corrupt parameters during initialization using "Safe mode" initialization is detailed in Appendix B.5.
- Rules for setting the S/N are specified in Appendix B.6.

B.2 NL Management Start Up Modes

The NL management module of an RS node will be initialized based on its start mode as follows:

- In warm start mode, IT900 uses the NL management databases it was set with before it was powered off (i.e., conserve logical address, link with parent state, parent Node ID and distance from NC).
- In cold start mode, IT900 will reset the NL management databases and then requires readmission to a logical network.

B.3 Parameters Configuration Process During Initialization

After the very first power-on of IT900, or after setting IT900 with default settings, the default configuration settings will be set in IT900's RAM and NVM.

The host interface enables the user to modify the configuration settings in the IT900 RAM (see Section 5.4.3.2) and to save configuration settings to the NVM (see Section 5.4.3.4).

The last configuration settings saved to the NVM will be loaded from the NVM to IT900's RAM on subsequent IT900 power-on events.

In the event of a strong injection of noise (such as an EMC pulse), writing to the NVM may be externally corrupted. IT900 will discover a NVM corruption as it continuously validates the integrity of the contents of the NVM. If IT900 detects that the content is corrupted it will return to default configuration settings. The application should detect and handle such failure by monitoring the Reset Response. If the IT900's Reset Response 'Status' field is set to "Invalid parameters in NVM", the application will act as if it's the modem's first power-on by modifying the configuration settings and storing it in the NVM.

B.4 BSP (Board Support Package)

The BSP module is responsible for validation of IT900 FW (Firmware) on the flash and for supporting the local and remote FW update processes.

The BSP module provides a set of BSP Interface commands. The BSP commands are differentiated from non BSP commands by the 'Start' field value which is set to 0xCC (non BSP commands 'Start' field is 0xCA).

In order to put the modem in 'BSP Mode', the user should respond to the BSP "Welcome" message that is sent by the modem on every power-up prior to the Reset Response. The user should discard the "Welcome" message to enter normal operation mode.

Figure 5.57 describes the BSP "Welcome" message:

Start	Length		Type	Opcode	Status	Checksum
0xCC	0x03	0x00	0x01	0x04	0x01	0x09

Figure 5.57: BSP "Welcome" Message

If local FW update is required, the user should enter BSP mode (by answering the Welcome message), erase the Flash and write the new FW using the BSP interface commands. The BSP Interface commands used for this procedure are out of the scope of this document.

B.5 Safe Mode

As part of the startup sequence after reset, IT900 loads parameters stored in the non-volatile memory (NVM). The host application may inadvertently set the values of the parameters such as to cause a bad startup sequence, which may result in repeated resets. Safe mode allows IT900 to startup using the default parameter values stored in the firmware, thus guaranteeing successful completion of the startup sequence. The host application may then read and correct corrupt values stored in the non-volatile memory. Sometimes IT900 will issue a Reset Response (see Section 5.4.2.1) to the host application indicating "**Invalid parameters in NVM**" in the "**Command Data**" field of the response.

The procedure for recovery from parameters corruption in IT900 is as follows:

- To enter Safe Mode, set IT900 pin P1_4 to logical "0".
- Resetting IT900 will cause it to wake up with default parameters.
- Set pin P1_4 to logical "1" (P1_4 as an internal pull-up).
- Apply proper configuration to IT900 and save settings to NVM.

B.6 S/N Settings

To ensure S/N uniqueness among customers, Yitran produces a 5-bytes Client Unique Code sequence, which will be set to bytes 12-16 (MSBs) of the S/N. Bytes 1-11 (LSBs) are the Client's Address Space which will be used by the customer to assure uniqueness within its inventory. To obtain the Client's Unique Code when approaching product manufacturing Contact Yitran Customer Support.

Figure 5.58 describes the S/N Fields:

S/N (Hex)	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Client's Unique Code					Client's Address Space										

Figure 5.58: S/N Fields Description

Appendix C. Applicative Recommendations

The host application should take into consideration the following applicative recommendations and considerations:

- Dynamic routing recommendations and indications (see Appendix C.1).
- Bandwidth considerations (see Appendix C.2).
- Recommendations for polling based applications (see Appendix C.3).

C.1 Dynamic Routing Recommendations and Indications

- RS Connectivity with NC
  - Indication of connectivity with the NC from the Y-Net Stack indicates communication with NC is available.
  - Indication of no connectivity with the NC from the Y-Net Stack indicates communication with the NC is unavailable.
  - If data transmission from RS to NC is critical, consider using buffers and application level acknowledgements for uncertainty periods and for higher communication reliability.
- NC Connectivity with RS
  - Indication from the Y-Net Stack that a new RS joined the network indicates proper communication with the joining RS.
  - The 'Connectivity Status' field from the 'Get Node Information' response indicates status of the communication link with that RS
  - If data transmission from NC to RS or its siblings is critical, consider using buffers and application level acknowledgements for uncertainty periods and for higher communication reliability.

C.2 Bandwidth Considerations

IT900 is designed for low-mid bandwidth applications; therefore network performance will experience a degree of degradation when overwhelmed with transmissions.

The rate of transmissions for the entire network (i.e., not per node) should not exceed range of 9-25 transmission per second in FCC, 7-19 transmission per second in ARIB, 4-11 transmission per second in CENELEC A and 4-8 transmission per secondCENELEC B. Lower rates are highly recommended.

Host applications should avoid burst transmissions as much as possible (regardless of the selected rate). Bursts can be sent from a single node transmitting multiple transmissions fast or from multiple nodes (i.e., more than 10) transmitting simultaneously. Therefore, host transmissions should be spread as randomly and evenly as possible over time. The host can assume congestion in its surrounding network when receiving blocked transmission indications from IT900.

Note that unless the application is properly designed, direct links with the NC tend to bottle-neck for many application types. Such problems can be avoided by careful design of the application.

C.3 Recommendations for Polling Based Applications

The following section provides recommendations for RS polling methods.

There are two main methods for RS polling:

- Polling RS according to NC database index.
    - Send a "Get Node Information" query with the Database Index (see Section 5.4.5.5) in order to retrieve the Node ID of a RS in a specific index. The index value can vary from index 1 to the last occupied entry in the NC database. The last occupied entry can be obtained using the "Get NC Database Size" command (see Section 5.4.5.2).
    - Check the "Connectivity Status" field of "Get Node Information" query response and validate it indicates "Connected to Network".
    - Send a "Packet Tx" command (see Section 5.4.5.1) to poll the RS. Set the RS Node ID in the "Destination Address" field and "Intranetworking Unicast" in the "Data Service Type" field.

- Polling RS according to S/N list maintained by the application.
    - Send a "Packet Tx" command, set the RS S/N in the "Destination Address" field and "Intranetworking Unicast Over S/N" in the "Data Service Type" field (see Section 5.4.5.1).
    - Since the "Connectivity Status" of the RS is not validated automatically when using "Intranetworking Unicast Over S/N" (or any other data service), it is recommended that the application validates the "Connectivity Status" (by sending Get Node Information" query with S/N as query KEY) before polling the node.

The expected transmission rate, due to the polling implementation, should be estimated such that it does not exceed the channel utilization, based on the bandwidth considerations given in Appendix C.2.

Appendix D. Frequently Asked Questions (FAQ)

This is an informative appendix consisting of the most frequently asked questions about topics related to IT900 technology in general and more specifically IT900 host interface.

Q: Does IT900 work with IT700/IT800?

A: Yes.

Q: Can I use the non-volatile memory to save application parameters?

A: There is an option for saving application parameters to NVM (see Section 4.2.4.1).

Q: Is the EEPROM required for working with IT900?

A: EEPROM is mandatory for NC nodes only.

Q: How do I determine the node type (RS or NC)?

A: See "Set Device Parameter" command (see Section 5.4.3.2) and "Operation Mode" parameter (see Appendix A.1).

Q: Can I configure the baud-rate of UART interface between IT900 and an external host µC?

A: There is an option for configuring the UART baud-rate to a value different than the default (see Section 3.2.2).

Q: How do I determine the nodes connected to my network?

A: You can use the "Get Node Information" command in the NC (see Section 5.4.5.5).

Q: Can I use the target node S/N in order to transmit a packet?

A:

- Option 1 – Internetworking Unicast.
- Option 2 – Intranetworking Unicast over S/N (from NC to RS only). In this transmission mode IT900 will convert the Destination's S/N (given as part of the transmission fields) to the logical ID and sends a regular Intranetworking Unicast packet over the power line.

For transmitting from the RS to the NC, use intranetworking Unicast with the Node ID = 1 as the destination Node ID field (the Node ID of the NC is always set to 0x0001).

Q: How do I initialize IT900?

A: The initialization process of IT900 is detailed in Appendix B. The Set up process enabling a host to work with IT900 is detailed in Chapter 2.

Q: How do I set the modem's operation band?

A: See "Set Predefined Parameters" command (see Section 5.4.3.1). Note that the band should be set according to the hardware surrounding the chip components.

Q: Why do I get a big percent of "blocked" response when I transmit packets?

A: Transmission requests from the application controller enter a limited sized packet queue which buffers packets pending for transmission for a limited time period. When the queue size is exceeded or when a packet is held in the queue more than a given timeout, it will not be transmitted and will be counted as a "blocked" packet.

A single Tx command to IT900 will lead to two responses to the application:

- The first response is sent after the packet is placed in the transmission queue. After this response the application is allowed to post the next command to IT900.
- The second response provides the transmission results. When using IT900, the application does not need to wait for the packet to be transmitted on the line in order to initiate the next command.

Since the serial interface data rate is faster than the rate of transmission over the power line, when transmitting from an external application without any delay between packets you may enter a situation that the number of packets in queue is increasing constantly and you will observe a big percent of blocked packets.

Q: Is it possible to send a message between two RS?

A: Communication between two RS is possible if they have direct physical link between them (there are no routing capabilities between 2 RS).

Q: Do I need to initialize the device before starting to transmit data on the power line? What is the Auto Start used for?

A: IT900 has to be initialized according to the description in Appendix B. The Auto Start option should be used in case there is no option for an application controller to continuously monitor data sent from IT900 (i.e. can miss the "Reset" response).

Q: Does Extremely Robust Mode (ERM) really just sends each packet 4 times, or is there more to ERM than that? For example, is there any change in encoding or interleaving that might improve robustness more than the obvious mathematical factor of 4 due to sending each packet 4 times instead of once?

A: The ERM mode was created to overcome impedance modulation. In ERM mode each Symbol is sent 4 times **in the same packet** and the interleaving is between symbols and not within symbols, creating a much longer and much more robust interleaving series. Therefore ERM modulation has great value in increased coverage especially in conditions with long burst noises, or location that suffer from strong channel attenuation.

Q: How do I set the device address?

A: By default, a unique logical address will be assigned automatically by IT900 and should not be set by the user.

Q: My application "knows" the S/N of nodes participating in the network. How can I determine the logical address provided to these nodes?

A: Use the "Get Node Information" command (see Section 5.4.5.5).

Q: Which packet filtering should I use

A: By default, applications should enable only "mine" packets. All other packets (as not being mine) should be filtered out for the application by IT900.

Q: What is the difference between the broadcast repeating and Unicast routing?

A: Broadcast Repeating - when a Broadcast packet is received, the node first checks if it already repeated this packet or if the number of allowed hops to transmit the packet is exceeded. If so, it will not repeat the packet. If not so, it will broadcast the packet to the line. This method may cause high congestion of transmissions as many unnecessary transmissions may take place using this flooding mechanism.

Unicast Routing – Unicast Routing enables transmission only by the minimal set of nodes that are on the correct route to the destination and doesn't cause network overload. Unicast packets sent from the NC to RS are routed using Source Routing. Unicast packets sent from RS to the NC are routed using Table Routing.

Q: Does the Y-Net support mesh network?

A: The Y-Net network supports mesh network with two limitations:

- The NC needs to be online most of the time
- The RS need to have direct communication with each other.

Q: Does Y-Net support "self healing" of nodes that losses connection with the network? Is this an automatic process? What happen if there is no alternative route?

A: The processes of connecting to network, link optimization, link recovery (self healing) are all automatic processes handled by the Network Layer in IT900. Nodes will "self heal" only if an alternative route physically exists. In case the node has no alternative route (no physical communication to any node in the network) there is no option to reconnect to the network (you can't find an algorithm that finds an alternative route when there is no physical link). A node which loses its link will continuously keep on searching for an alternative route. The NL not only provides link recovery it also assures that the link to/from the NC is the optional link available. An RS connects to the network with distance of three hops from the NC, after some time the power line conditions changes and a link with 2 Hops distance from NC becomes optional – that RS will automatically optimize its link by replacing its parent and its distance to the NC to 2 hops.

Q: What is the bandwidth used for the Network Layer maintenance?

A: The data generated for Network Layer formation and maintenance is planned not to exceed 10% of total network capacity (maximum bandwidth). This means that the internal IT900 timers for background network processes must depend on the number of nodes participating in the physical network. The timers are configured automatically according to the "Network Size" parameter (see Appendix A.1). The "Network Size" should be configured to the maximal number of nodes operating under the same physical network.

Q: Sometimes after shutdown of an NC, the Node ID of RS is set to 0x0001. Is this expected? Is this the default?

A: Once a node looses connection with its parent it will try for some time to reconnect to another parent. After it fails to reconnect to a parent, it will set its address to default (Network ID = 0, Node ID = 1) and try to rejoin to any available network.

Q: What happens if I send a packet to the address of the RS itself? (2 bytes Node ID or 16 bytes S/N)? Does it get transmitted at all, or just loop backed inside remote?

A: When you transmit an Intranetworking Unicast to your own Node ID, the packet will be looped back without going to the power line. When you transmit an Internetworking Unicast to your own S/N, the packet will go to the power line and filtered by all nodes.

Document Control

Rev	Date	Description
1.0	February 1, 2011	- Initial Release
1.1	July 7, 2011	- Table 3.3 corrected: EEPROM size option from 32Kbit to 256Kbit - Table 5.58 corrected: UART Slow Rate (Div 100) index # from 0x008B to 0x0089 - Table 5.18 Command Data corrected
1.2	November 8, 2011	- Table 5.58 Modulation Parmeter corrected. - Table 5.37 Modulation Rate field: DCSK SM, DCSK RM and DCSK ERM values corrected. -Table 5.10 "Get Version" Command Response**:** Software Version 'Value' colum deleted. -Section 5.4.6.5 "Connectivity Status with RS (NC Only)" description clarified.

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