BC95&BC95-G&BC68 Application Design Guide

NB-IoT Module Series

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About the Document

History

Revision	Date	Author	Description
1.0	2018-06-20	Hayden WANG/ Evan WU	Initial
1.1	2018-06-21	Hayden WANG/ Evan WU	Updated description of unsolicited information about firmware upgrade state in the process of firmware upgrade via DFOTA

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1 Introduction

At present, Quectel NB-IoT modules are mainly applied to following application scenarios:

- Fixed applications with data transmission: such as water meters, gas meters and smoke detectors.
- Fixed applications with remote control: such as street lights and shared laundry machines.
- Mobile applications with data transmission: such as shared bicycles and activity trackers.
- Mobile applications with remote control: such as electric motor controllers.

This document illustrates design guidelines for the four application scenarios mentioned above in order to help customers deploy NB-IoT terminals based on Quectel NB-IoT modules under different network deployment environments, such as a change on EARFCN (E-UTRA Absolute Radio Frequency Channel Number) values and a switch from intra-frequency to inter-frequency.

This document is applicable to following Quectel NB-IoT modules:

- BC95 B657SP5 version or later
- BC95-G B300 version or later
- BC68 B300 version or later

2 Application Design Guidelines

This chapter provides design guidelines and recommendations for different application scenarios of Quectel NB-IoT modules.

2.1. Fixed Applications with Data Transmission

Fixed applications with data transmission feature a fixed deployment location and periodic data transmission service. They are kept in sleep mode most of the time, and they only receive downlink data when an uplink data transmission is initiated (no need for receiving paging messages). Such terminals have high requirements on power consumption and success rate of data transmission rather than the timeliness of data transmission. Therefore, it is recommended to comply with the following design requirements.

2.1.1. Requirements on Network Configurations

Table 1: Requirements on Network Configurations for Fixed Applications with Data Transmission

No.	Parameter	Configuration Requirement
1	eDRX	Disabled
2	PSM	Enabled

NOTE

Please confirm the configuration settings of these parameters with corresponding network operators since they are determined by the core network.

2.1.2. Application Design Guidelines

Table 2: Design Guidelines for Fixed Applications with Data Transmission

No.	Design Guideline	Description
1	Timeout period for the MCU to register on network after start-up	It may take a long time for the MCU to register on network when in deep coverage or when the network changes, so the timeout period for the MCU to register on network after start-up is recommended to be at least 300s.
2	Enable cell reselection function	a) In order to ensure that the module can be camped on a better cell in terms of signal strength and quality, it is recommended to enable the cell reselection function of the module. For BC95 B657SP5 or later versions, BC95-G B300 or later versions, and BC68 B300 or later versions, the cell reselection function is enabled by default. b) If the cell reselection function is disabled, make sure the module is in minimum functionality mode (can be queried by **AT+CFUN?** command), and then the MCU sends **AT+NCONFIG=CELL_RESELECTION,TRUE** to enable the cell reselection function.
3	Start an uplink data transmission with RAI identifiers	Start an uplink data transmission with RAI identifiers (e.g.: **AT+QLWULDATAEX=3,AA34BB,0x0001**) for indicating the core network to release the current RRC connection immediately so as to let the module enter idle mode. Then the module will automatically enter PSM after the idle timer expires.
4	If it needs to power off the module, it must delay for at least 15s after the module enters idle mode	After the module enters idle mode, it must wait for at least 15s before powering off the module, so that the network can configure the T3324 timer to ensure the module has enough time to complete the cell reselection procedure.
5	If it needs to power off the module, **AT+CFUN=0** must be executed before power-off.	Before powering off the module, the MCU needs to send **AT+CFUN=0** command to the module to trigger the module to save the EARFCN values and send a message to detach from network.
6	Data transmission service	a) When starting a data transmission via Huawei OceanConnect IoT platform, if "**+CME ERROR: 513**" error is returned (**AT+CMEE=1** has been set; 513: TUP not registered), the MCU will attempt to re-send the data after a delay of 20s; if the re-send is failed for 3 times continuously, the MCU will enter the exception handling process (Refer to **No.7** below).

		b) During a normal data transmission, if no downlink data is received within 60s in data interaction process, it will be regarded as a data service failure due to timeout, and the MCU will attempt to re-send the data; if the re-send is failed for 3 times continuously, the MCU will enter the exception handling process (Refer to *No.7* below).
7	Exception handling process	If it fails to register on network or transmit data, then the MCU executes **AT+NRB** (Reboot the module) → **AT+CFUN=0** (Enter minimum functionality mode) → **AT+NCSEARFCN** (Clear Stored EARFCN values) → **AT+CFUN=1** (Enter full functionality mode) → **AT+CGATT=1** (Attach to network), and tries to register on network and re-sends the data. If the re-registration or re-send still fails, it will retry for 3 times according to the back off algorithm. If it still fails, the MCU will power off the module. In such case, the module will try to register on network when the next round of data transmission is initiated.
8	Support the module's firmware upgrade via DFOTA	During a firmware upgrade process via DFOTA, no AT command can be sent and the module cannot be powered off. It is recommended that the uninterruptible power supply time should be 30 minutes. The module outputs "**FIRMWARE DOWNLOADING**" via the main port to indicate that the firmware has started upgrading, **"FIRMWARE UPDATE SUCCESS"** to indicate that the upgrade is successful and "**FIRMWARE UPDATE OVER**" to indicate that the upgrade is completed.

2.1.3. Flowchart of Design Guidelines
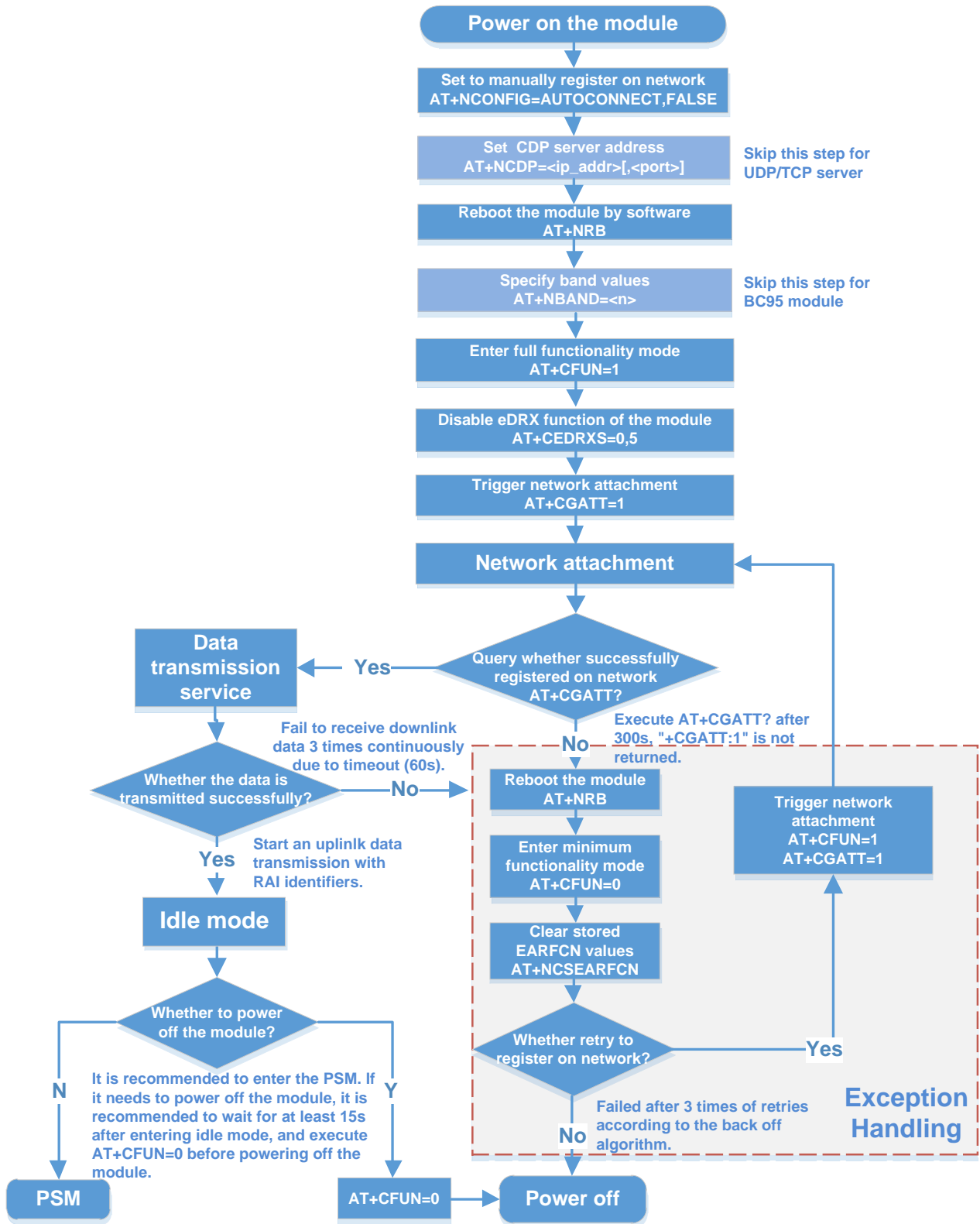
Figure 1: Flowchart of Design Guidelines for Fixed Applications with Data Transmission

2.2. Fixed Applications with Remote Control

Fixed applications with remote control feature a fixed deployment location. They are usually powered with an external power supply and kept in connected mode most of the time. Meanwhile, they are required to receive real-time downlink data. Such terminals have high requirements on timeliness of data transmission rather than power consumption. Therefore, it is recommended to comply with the following design requirements.

2.2.1. Requirements on Network Configurations

Table 3: Requirements on Network Configurations for Fixed Applications with Remote Control

No.	Parameter	Configuration Requirement
1	eDRX	Disabled
2	PSM	Disabled

NOTE

Please confirm the configuration settings of these parameters with corresponding network operators since they are determined by the core network.

2.2.2. Application Design Guidelines

Table 4: Design Guidelines for Fixed Applications with Remote Control

No.	Design Guideline	Description
1	Timeout period for the MCU to register on network after start-up	It may take a long time for the MCU to register on network when in deep coverage or when the network changes, so the timeout period for the MCU to register on network after start-up is recommended to be at least 300s.
2	Enable cell reselection function	a) In order to ensure that the module can be camped on a better cell in terms of signal strength and quality, it is recommended to enable the cell reselection function of the module. For BC95 B657SP5 or later versions, BC95-G B300 or later versions, and BC68 B300 or later versions, the cell reselection function is enabled by default.

|		
		b) If the cell reselection function is disabled, make sure the module is in minimum functionality mode (can be queried by **AT+CFUN?** command), and then the MCU sends **AT+NCONFIG=CELL_RESELECTION,TRUE** to enable the cell reselection function.
3	If it needs to power off the module, **AT+CFUN=0** must be executed before power-off.	Before powering off the module, the MCU needs to send **AT+CFUN=0** command to the module to trigger the module to save the EARFCN values and send a message to detach from network.
4	Data transmission service	a) When starting a data transmission via Huawei OceanConnect IoT platform, if "**+CME ERROR: 513**" error is returned (**AT+CMEE=1** has been set; 513: TUP not registered), the MCU will attempt to re-send the data after a delay of 20s; if the re-send is failed for 3 times continuously, the MCU will enter the exception handling process (Refer to *No.5* below). b) During a normal data transmission, if no downlink data is received within 60s in data interaction process, it will be regarded as a data service failure due to timeout, and the MCU will attempt to re-send the data; if the re-send is failed for 3 times continuously, the MCU will enter the exception handling process (Refer to *No.5* below).
5	Exception handling process	If it fails to register on network or transmit data, then the MCU executes **AT+NRB** (Reboot the module) → **AT+CFUN=0** (Enter minimum functionality mode) → **AT+NCSEARFCN** (Clear Stored EARFCN values) → **AT+CFUN=1** (Enter full functionality mode) → **AT+CGATT=1** (Attach to network), and tries to register on network and re-sends the data. If the re-registration or re-send still fails, it will retry for 3 times according to the back off algorithm. If it still fails, the MCU will power off the module. In such case, the module will try to register on network when the next round of data transmission is initiated.
6	Support the module's firmware upgrade via DFOTA	During a firmware upgrade process via DFOTA, no AT command can be sent and the module cannot be powered off. It is recommended that the uninterruptible power supply time should be 30 minutes. The module outputs "**FIRMWARE DOWNLOADING**" via the main port to indicate that the firmware has started upgrading, "**FIRMWARE UPDATE SUCCESS**" to indicate that the upgrade is successful and "**FIRMWARE UPDATE OVER**" to indicate that the upgrade is completed.

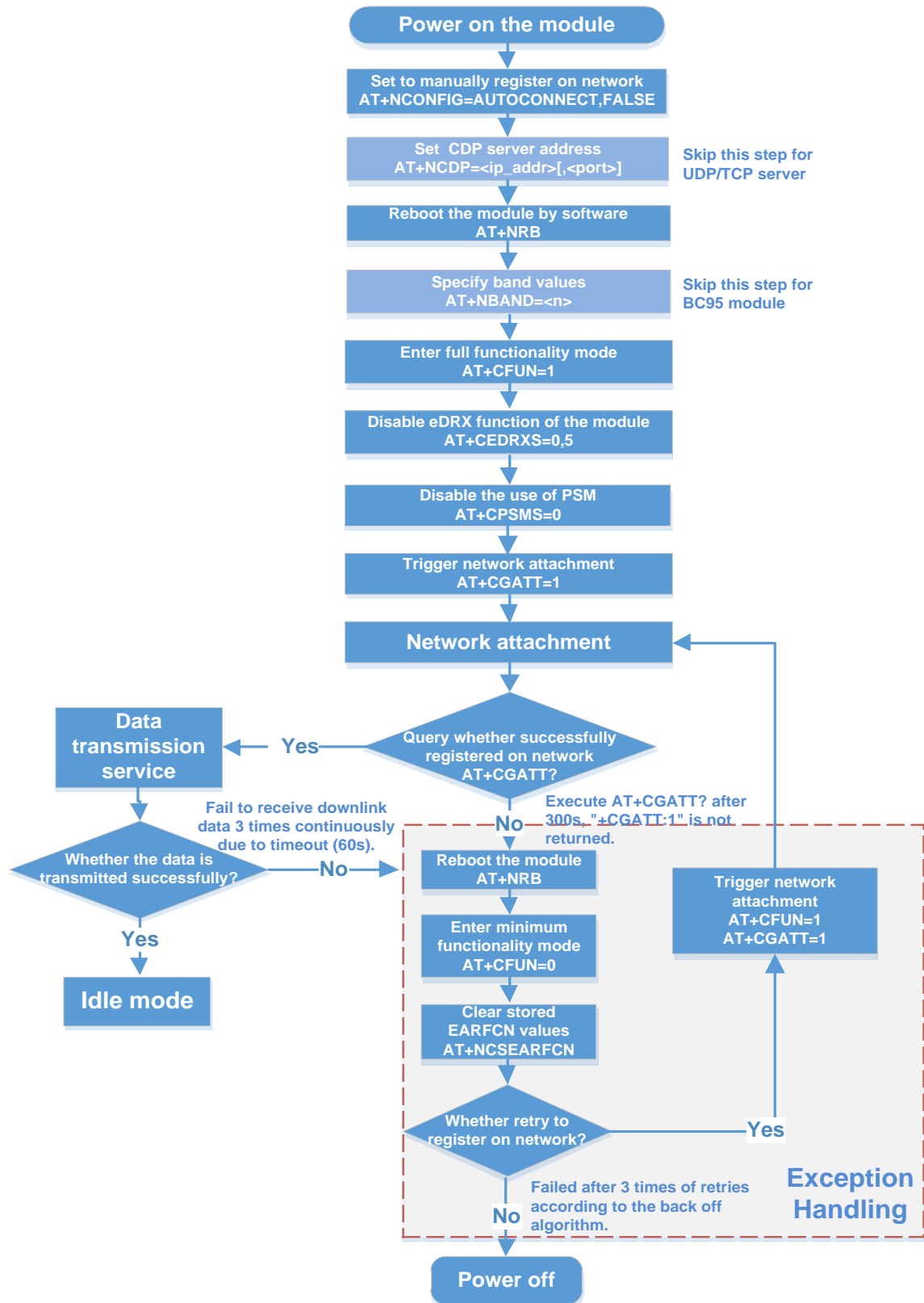## 2.2.3. Flowchart of Design Guidelines

Figure 2: Flowchart of Design Guidelines for Fixed Applications with Remote Control

2.3. Mobile Applications with Data Transmission

Mobile applications with data transmission will start a data transmission while they are moving. They only receive downlink data when an uplink data transmission is initiated (no need for receiving paging messages). Such terminals have high requirements on power consumption rather than timeliness of data transmission. Therefore, it is recommended to comply with the following design requirements.

2.3.1. Requirements on Network Configurations

Table 5: Requirements on Network Configurations for Mobile Applications with Data Transmission

No.	Parameter	Configuration Requirement
1	eDRX	Disabled
2	PSM	Enabled

NOTE

Please confirm the configuration settings of these parameters with corresponding network operators since they are determined by the core network.

2.3.2. Application Design Guidelines

Table 6: Design Guidelines for Mobile Applications with Data Transmission

No.	Design Guideline	Description
1	Timeout period for the MCU to register on network after start-up	It may take a long time for the MCU to register on network when in deep coverage or when the network changes, so the timeout period for the MCU to register on network after start-up is recommended to be at least 300s.
2	Enable cell reselection function	a) In order to ensure that the module can be camped on a better cell in terms of signal strength and quality, it is recommended to enable the cell reselection function of the module. For BC95 B657SP5 or later versions, BC95-G B300 or later versions, and BC68 B300 or later versions, the cell reselection function is enabled by default. b) If the cell reselection function is disabled, make sure the module is in minimum functionality mode (can be queried by

		AT+CFUN? command), and then the MCU sends **AT+NCONFIG=CELL_RESELECTION,TRUE** to enable the cell reselection function.
3	Start an uplink data transmission with RAI identifiers	Start an uplink data transmission with RAI identifiers (e.g.: **AT+QLWULDATAEX=3,AA34BB,0x0001**) for indicating the core network to release current RRC connection immediately so as to let the module enter idle mode. Then the module will automatically enter PSM after the idle timer expires.
4	If it needs to power off the module, **AT+CFUN=0** must be executed before power-off.	Before powering off the module, the MCU needs to send **AT+CFUN=0** command to the module to trigger the module to save the EARFCN values and send a message to detach from network.
5	Data transmission service	a) When starting a data transmission via Huawei OceanConnect IoT platform, if "**+CME ERROR: 513**" error is returned (**AT+CMEE=1** has been set; 513: TUP not registered), the MCU will attempt to re-send the data after a delay of 20s; if the re-send is failed for 3 times continuously, the MCU will enter the exception handling process (Refer to *No.6* below). b) During a normal data transmission, if no downlink data is received within 60s in data interaction process, it will be regarded as a data service failure due to timeout, and the MCU will attempt to re-send the data; if the re-send is failed for 3 times continuously, the MCU will enter the exception handling process (Refer to *No.6* below).
6	Exception handling process	If it fails to register on network or transmit data, then the MCU executes **AT+NRB** (Reboot the module) → **AT+CFUN=0** (Enter minimum functionality mode) → **AT+NCSEARFCN** (Clear Stored EARFCN values) → **AT+CFUN=1** (Enter full functionality mode) → **AT+CGATT=1** (Attach to network), and tries to register on network and re-sends the data. If the re-registration or re-send still fails, it will retry for 3 times according to the back off algorithm. If it still fails, the MCU will power off the module. In such case, the module will try to register on network when the next round of data transmission is initiated.
7	Support the module's firmware upgrade via DFOTA	During a firmware upgrade process via DFOTA, no AT command can be sent and the module cannot be powered off. It is recommended that the uninterruptible power supply time should be 30 minutes. The module outputs "**FIRMWARE DOWNLOADING**" via the main port to indicate that the firmware has started upgrading, **"FIRMWARE UPDATE SUCCESS"** to indicate that the upgrade is successful and "**FIRMWARE UPDATE OVER**" to indicate that the upgrade is completed.

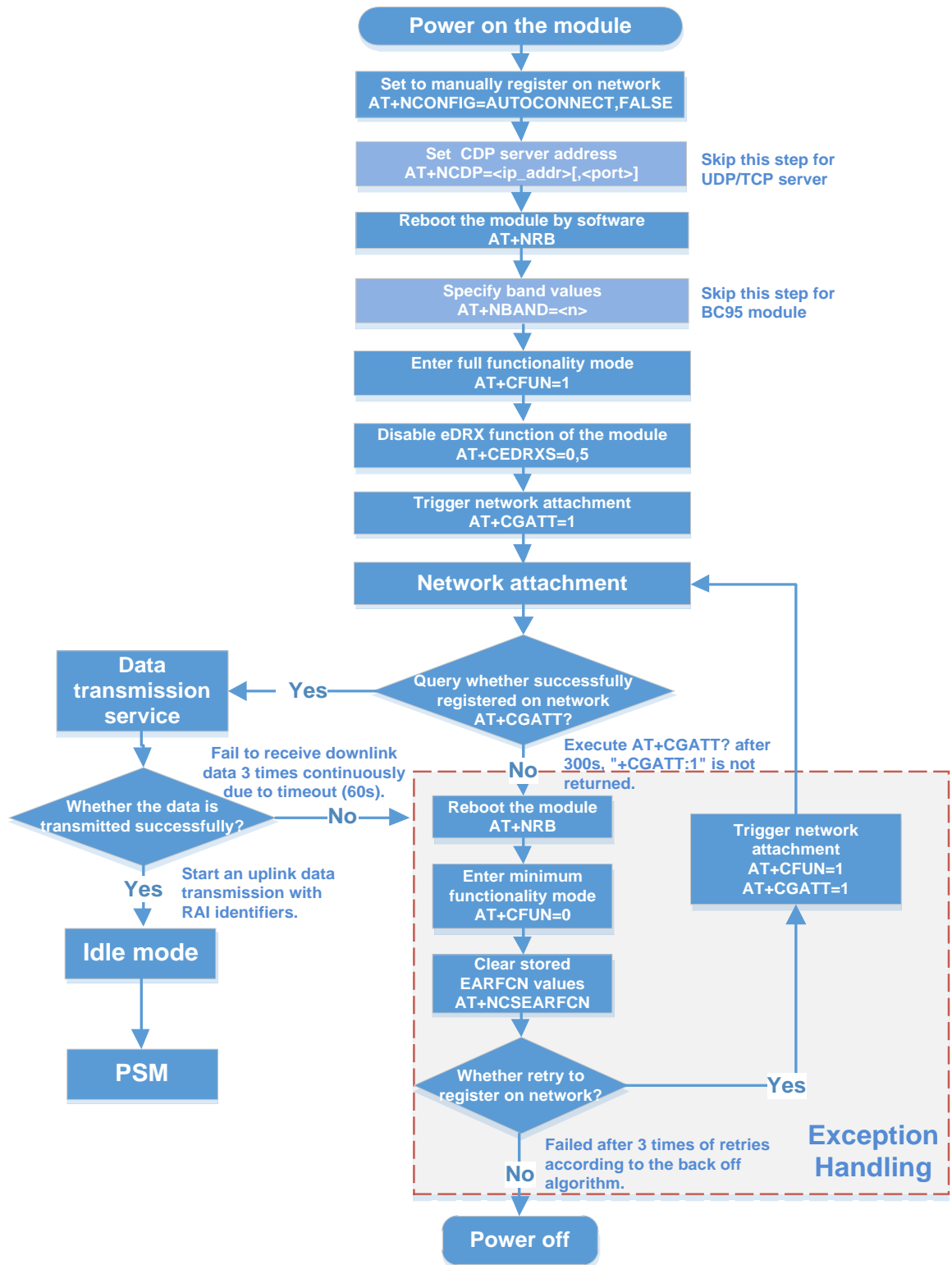## 2.3.3. Flowchart of Design Guidelines

Figure 3: Flowchart of Design Guidelines for Mobile Applications with Data Transmission

2.4. Mobile Applications with Remote Control

Mobile applications with remote control are kept in a moving state and in connected mode most of the time. They are required to receive real-time downlink data and report real-time uplink data. Such terminals are usually rechargeable and have high requirements on timeliness of data transmission rather than power consumption. Therefore, it is recommended to comply with the following design requirements.

2.4.1. Requirements on Network Configurations

Table 7: Requirements on Network Configurations for Mobile Applications with Remote Control

No.	Parameter	Configuration Requirement
1	eDRX	Disabled
2	PSM	Disabled

NOTE

Please confirm the configuration settings of these parameters with corresponding network operators since they are determined by the core network.

2.4.2. Application Design Guidelines

Table 8: Design Guidelines for Mobile Applications with Remote Control

No.	Design Guideline	Description
1	Timeout period for the MCU to register on network after start-up	It may take a long time for the MCU to register on network when in deep coverage or when the network changes, so the timeout period for the MCU to register on network after start-up is recommended to be at least 300s.
2	Enable cell reselection function	a) In order to ensure that the module can be camped on a better cell in terms of signal strength and quality, it is recommended to enable the cell reselection function of the module. For BC95 B657SP5 or later versions, BC95-G B300 or later versions, and BC68 B300 or later versions, the cell reselection function is enabled by default. b) If the cell reselection function is disabled, make sure the module is in minimum functionality mode (can be queried by

		AT+CFUN? command), and then the MCU sends **AT+NCONFIG=CELL_RESELECTION,TRUE** to enable the cell reselection function.
3	Start an uplink data transmission with RAI identifiers	Start an uplink data transmission with RAI identifiers (e.g.: **AT+QLWULDATAEX=3,AA34BB,0x0001**) for indicating the core network to release the current RRC connection immediately so as to let the module enter idle mode. Then the module will automatically enter PSM after the idle timer expires.
4	If it needs to power off the module, **AT+CFUN=0** must be executed before power-off.	Before powering off the module, the MCU needs to send **AT+CFUN=0** command to the module to trigger the module to save the EARFCN values and send a message to detach from network.
5	Data transmission service	a) When starting a data transmission via Huawei OceanConnect IoT platform, if "**+CME ERROR: 513**" error is returned (**AT+CMEE=1** has been set; 513: TUP not registered), the MCU will attempt to re-send the data after a delay of 20s; if the re-send is failed for 3 times continuously, the MCU will enter the exception handling process (Refer to *No.6* below). b) During a normal data transmission, if no downlink data is received within 60s in data interaction process, it will be regarded as a data service failure due to timeout, and the MCU will attempt to re-send the data; if the re-send is failed for 3 times continuously, the MCU will enter the exception handling process (Refer to *No.6* below).
6	Exception handling process	If it fails to register on network or transmit data, then the MCU executes **AT+NRB** (Reboot the module) → **AT+CFUN=0** (Enter minimum functionality mode) → **AT+NCSEARFCN** (Clear Stored EARFCN values) → **AT+CFUN=1** (Enter full functionality mode) → **AT+CGATT=1** (Attach to network), and tries to register on network and re-sends the data. If the re-registration or re-send still fails, it will retry for 3 times according to the back off algorithm. If it still fails, the MCU will power off the module. In such case, the module will try to register on network when the next round of data transmission is initiated.
7	Support the module's firmware upgrade via DFOTA	During a firmware upgrade process via DFOTA, no AT command can be sent and the module cannot be powered off. It is recommended that the uninterruptible power supply time should be 30 minutes. The module outputs "**FIRMWARE DOWNLOADING**" via the main port to indicate that the firmware has started upgrading, **"FIRMWARE UPDATE SUCCESS"** to indicate that the upgrade is successful and "**FIRMWARE UPDATE OVER**" to indicate that the upgrade is completed.

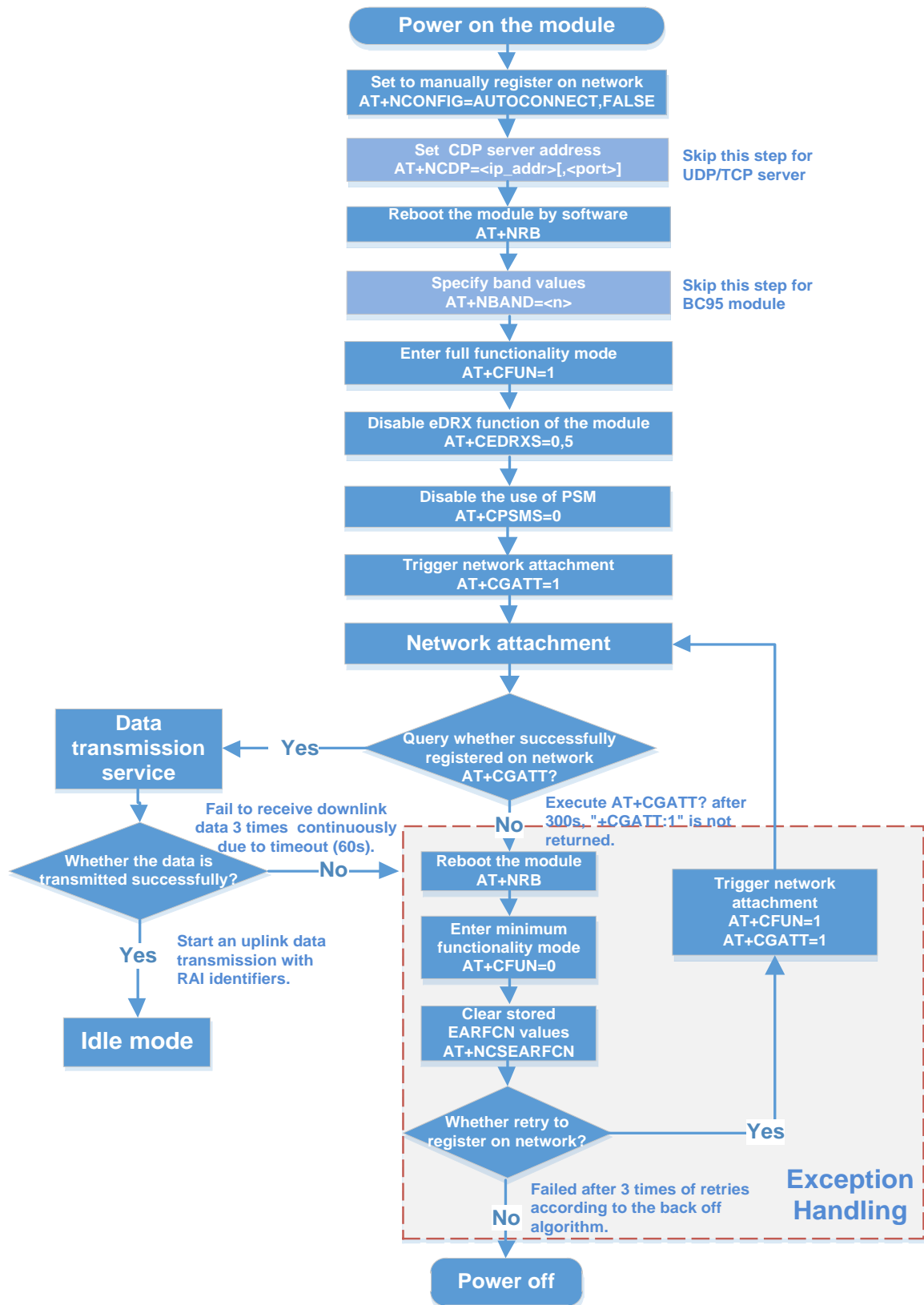## 2.4.3. Flowchart of Design Guidelines

Figure 4: Flowchart of Design Guidelines for Mobile Applications with Remote Control

3 Supplementary Notes

3.1. Conventional Maintenance and Test Means

- The terminals should be capable of reporting network-related information and such information can be displayed on the platform: such as EARFCN values, cell ID, enhanced coverage level (ECL), signal strength (RSRP) and signal noise ratio (SNR), which can be obtained via **AT+NUESTATS** command.
- A local port is available on the terminals for the module to upgrade the firmware, view log information and modify the configurable parameters.

3.2. Brief Introduction of Related AT Commands

This chapter briefly introduces some related AT commands regarding to the application design guidelines. For more details, please refer to *document [1]*&*[2]*.

Table 9: Brief Introduction of Related AT Commands

No.	AT Command	Description
1	**AT+NCONFIG=CELL_RESELECTION,TRUE**	Enable cell reselection function of the module
2	**AT+NCONFIG=AUTOCONNECT,FALSE**	Disable automatic network registration of the module
3	**AT+CEDRXS=0,5**	Disable eDRX function of the module
4	**AT+CGATT=1**	Trigger the module for network attachment
5	**AT+CGATT?**	Query whether the module is registered on network successfully
6	**AT+NRB**	Reboot the module
7	**AT+CPSMS=0**	Disable the use of PSM for the module

8	**AT+NSOSTF=<socket>,<remote_addr>,<remote_port>,<flag>,<length>,<data>**	Can be used to send UDP data with flags for indicating the core network to release the current RRC connection immediately so as to let the module enter idle mode.
9	**AT+QLWULDATAEX=<length>,<data>,<mode>**	Can be used to send CoAP data with RAI identifiers for indicating the core network to release the current RRC connection immediately so as to let the module enter idle mode.
10	**AT+NUESTATS**	Query EARFCN values, cell ID, ECL, RSRP and SNR information of the last cell that is camped on.
11	**AT+NCSEARFCN**	Clear EARFCN values stored by the module. This command takes effect only when **AT+CFUN=0**.
12	**AT+CFUN=<n>**	Set the functionality level of the module

4 Appendix A References

Table 10: Reference Documents

SN	Document	Note
[1]	Quectel_BC95_AT_Commands_Manual	BC95 AT commands manual
[2]	Quectel_BC95-G&BC68_AT_Commands_Manual	BC95-G&BC68 AT commands manual
[3]	Quectel_BC95_DFOTA_User_Guide	BC95 DFOTA upgrade guidance
[4]	Quectel_BC95&BC95-G&BC68_RAI_Application_Note	BC95&BC95-G&BC68 RAI application note

Table 11: Terms and Abbreviations

Abbreviation	Description
CoAP	Constrained Application Protocol
EARFCN	E-UTRA Absolute Radio Frequency Channel Number
ECL	Enhanced Coverage Level
eDRX	Extended Discontinuous Reception
MCU	Microprogrammed Control Unit
PSM	Power Saving Mode
RAI	Release Assistant Indication
RSRP	Reference Signal Received Power
SNR	Signal Noise Ratio
UDP	User Datagram Protocol