Getting started with the X-CUBE-CELLULAR cellular connectivity Expansion Package for STM32Cube

Introduction

The X-CUBE-CELLULAR Expansion Package enables connectivity over cellular networks. The network access technology depends on the cellular modem used. It can be LTE Cat M or NB-IoT, with possible 2G fallback.

This user manual provides:

- A brief content description of the X-CUBE-CELLULAR Expansion Package for STM32Cube
- Instructions to start the hardware composed of a board based on an STM32 microcontroller associated with a modem, and to exchange data through a cellular network by means of X-CUBE-CELLULAR firmware

1   Acronyms

Table 1 presents the definitions of the acronyms that are relevant for a better contextual understanding of this document.

Table 1. Acronyms

Acronym	Definition
CLI	Command-line interface
DB	Data brief (STMicroelectronics document type)
eSIM	Embedded SIM
FAQ	Frequently asked questions
FW	Firmware
HW	Hardware
ICC	International circuit card
IDE	Integrated development environment
IP	Internet protocol
MCU	Microcontroller unit
PC	Personal computer
RN	Release note (STMicroelectronics document type)
SIM	Subscriber identity module
UM	User manual (STMicroelectronics document type)

The X-CUBE-CELLULAR Expansion Package runs on the STM32L4 32-bit microcontrollers based on the Arm® Cortex®-M4 processor.

Note: Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

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2 Overview of available documents

Table 2 lists the main documents useful for getting X-CUBE-CELLULAR started.

Table 2. **References**

ID	Description
[1]	Release note: The main RN is available at the root of the X-CUBE-CELLULAR Expansion Package. The main RN provides a link to the *Cellular RN*, which contains all information about the current delivery[1].
[2]	Data brief: *Cellular connectivity software expansion for STM32Cube* data brief (DB3582). The DB summarizes X-CUBE-CELLULAR features and presents the main license terms associated with the Expansion Package. It is available from STMicroelectronics web site at *www.st.com*.
[3]	User manual: *X-CUBE-CELLULAR cellular connectivity Expansion Package for STM32Cube* user manual (UM2426). The UM provides the detailed information needed to use X-CUBE-CELLULAR and adapt it to users' needs. It is available from STMicroelectronics web site at *www.st.com*.
[4]	Wiki: *Cellular LTE CatM / NBIoT overview*. This page contains application examples, document references, and links to regularly updated STM32 cellular material. It is available from STMicroelectronics wiki at *wiki.st.com*.

1. *Read carefully the associated RNs as they provide important information about the "Cellular" delivery. The "Cellular framework RN" contains a FAQ, which is regularly updated.*

Note: *An STMicroelectronics video is available on YouTube™ to help users to start with their cellular-to-cloud kits. Reach this video through C2C pages on www.st.com or directly at https://youtu.be/b2-37F7wcaI on YouTube™.*

3 Hardware and firmware setup

3.1 Connect hardware

To start using X-CUBE-CELLULAR, the user needs:

- A PC
- A Type-A to Micro-B USB cable
- An STM32L4-based master hardware combined to, or associated with a cellular modem (refer to [2], [3] or [4] for possible solutions)

The PC is used to power HW, program FW, and display STM32 FW traces and results onto a serial terminal.

The ST-LINK USB driver, available as STSW-LINK009 on STMicroelectronics web site at *www.st.com*, is mandatory and must be installed on the PC. It is needed to program FW onto the STM32 microcontroller.

Follow the next five steps to connect the HW:

1. If the STM32 microcontroller and modem are on separate boards, connect these boards together.
   Note: On the modem board, the modem module is on the upper side.
2. Connect the antenna.
3. All the boards compatible with X-CUBE-CELLULAR provide a SIM slot, which makes it possible to use a plastic SIM instead of an eSIM. If this option is selected, insert the SIM card.
4. Connect the *STLink* port of the STM32 board with the PC by means of the USB cable.
5. See that a new drive corresponding to the STM32 board is available on the PC, resulting from the previous installation of the ST-LINK USB driver.

3.2 Activate the eSIM (optional)

Refer to [4] and the related pages for the latest information.

3.3 Program firmware into the STM32 microcontroller

This section explains how to select binary firmware and program it into the STM32 microcontroller.

Binary FW is delivered as part of the X-CUBE-CELLULAR Expansion Package, for each supported IDE: STMicroelectronics STM32CubeIDE, IAR Systems® IAR Embedded Workbench® or Keil® MDK-ARM.

For a given board, the binaries are located in `Projects\<Board-Name>\Demonstrations\Cellular`.

The IP mode (LwIP or modem-socket) used in the binary is part of the file name. See for instance two binaries produced for the BG96 modem:

- `iar_bg96_lwip_v<x.y.z>.bin` for the LwIP mode
- `iar_bg96_socket_v<x.y.z>.bin` for the modem-socket mode

See as another example the two binaries for the Type 1SC modem:

- `iar_t1sc_lwip_v<x.y.z>.bin` for the LwIP mode
- `iar_t1sc_socket_v<x.y.z>.bin` for the modem-socket mode

Note: *There are two configuration modes concerning the location of the IP stack:*

- *Either the IP stack runs on the STM32 microcontroller (LwIP mode)*
- *Or the IP stack used is located in the modem (modem-socket mode)*

Only the LwIP mode is available when the modem does not include an IP stack or no AT command is available to expose the socket interface.

The main interests of the modem-socket mode is to reduce the STM32 memory footprint and make STM32 exchanges with the modem simpler. The main drawback of the modem-socket mode is lower performance.

Refer to the Cellular RN in [1], which presents STM32 FW size figures (Flash memory and RAM) for both IP modes.

Note: *STM32 FW for STM32L496 devices ("L496") can be used on the 32L496GDISCOVERY Discovery board (with screen) as well as host board of the P-L496G-CELL02 Discovery kit (screenless).*

When HW and PC are connected by means of the USB cable, the related drive is available on the PC. Drag and drop the chosen FW into that drive. Wait a few seconds that the FW file disappears from the file manager: this indicates that FW is programmed into the STM32 MCU.

Note: *The X-CUBE-CELLULAR Expansion Package provides all the source files needed to build FW for the various supported IDEs.*

3.4 Modem firmware version

The modem factory FW version in user's HW may not be compliant any longer with the latest X-CUBE-CELLULAR version.

The *Cellular RN* indicates which modem FW version must be used (refer to [1]). The modem FW version must be checked in the serial terminal trace and updated if needed.

4 Run X-CUBE-CELLULAR firmware

4.1 Functional content of the X-CUBE-CELLULAR Expansion Package

X-CUBE-CELLULAR provides one application called *Cellular App* that allows user to send and receive data over the TCP or UDP protocols with an Echo server. It also allows the use of a ping command to ping remote hosts. It provides the throughput at the application level (not at the air interface).

4.2 Set the serial terminal configuration for X-CUBE-CELLULAR firmware

Start Tera Term, select the proper connection (featuring the *STMicroelectronics* name), and set the parameters (the baud rate is different from the one referred to in Section 3.2 Activate the eSIM (optional)):

- Terminal
  - [**New line**]
    - ◦ [**Receive**]: AUTO
    - ◦ [**Transmit**]: CR
  - [**Local echo**] selected
- Serial
  - [**Baud rate**]: 115200
  - [**Data**]: 8 bit
  - [**Parity**]: none
  - [**Stop**]: 1 bit
  - [**Flow control**]: none
  - [**Transmit delay**]: 10 ms each

4.3 Start X-CUBE-CELLULAR firmware

Restart the board by pressing the black reset button.

Traces are displayed on the serial terminal.

4.4 Run-time configuration

During firmware execution, the command-line interface (CLI) is entered by pressing the [**return**] key. For example, the `help` command lists all available components.

Table 3 lists the available commands.

Table 3. *Cellular App* available commands

Command	Object
help	Help command
cellularapp	*Cellular App* commands
echoclient	*Echo* client commands
ping	*Ping* commands
trace	Trace management
csp	Power management
comlib	Com library commands
cst	Cellular service task management
atcmd	Send an AT command
modem	Modem configuration management

Command examples:

- `cst info`: provides information about cellular network
- `trace off` : stops the trace
- `echo off`: stops the *Echo* application

The CLI and traces are displayed on the same terminal.

5   Deep dive in X-CUBE-CELLULAR

Refer to [3] to know more about the possibilities of the X-CUBE-CELLULAR Expansion Package.
Connect to [4] and the related wiki pages for regularly updated additional information.

Revision history

Table 4. Document revision history

Date	Version	Changes
22-May-2019	1	Initial release.
22-Jul-2019	2	Introduced STM32CubeIDE support. Reorganized document structure and updated *Section 2 Overview of available documents*, *Section 3.2 Activate the eSIM (optional)*, *Section 3.3 Program firmware into the STM32microcontroller*, and *Section 3.4 Modem firmware version*.
9-Apr-2020	3	Added the *MQTT Client* and *COM Client* demonstrations: • Added *Section 4.6 MQTT Client demonstration* and *Section 4.7 COM Client demonstration* • Updated *Section 4.1 Functional content of the X-CUBE-CELLULAR Expansion Package*
2-May-2021	4	Focused X-CUBE-CELLULAR on LTE Cat M or NB-IoT cellular communication with the *Cellular App* application: • Updated Introduction • Updated Functional content of the X-CUBE-CELLULAR Expansion Package • Removed *PING Client demonstration*, *HTTP Client demonstration*, *MQTT Client demonstration* and *COM Client demonstration* Simplified the document and referred to the X-CUBE-CELLULAR wiki pages for regularly updated information: • Updated Overview of available documents, Activate the eSIM (optional) and Deep dive in X-CUBE-CELLULAR • Updated Program firmware into the STM32 microcontroller, Modem firmware version, Start X-CUBE-CELLULAR firmware and Run-time configuration • Removed *Troubleshooting*

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IMPORTANT NOTICE – PLEASE READ CAREFULLY