2G Migration to NB-IoT or CAT-M

Siretta

Enabling Industrial IoT

2G Migration to NB-IoT or CAT-M

Around a decade ago the primary communication method for M2M (machine to machine) was via text messages on the 2G network, mobile phones were the size of house bricks and the internet was built with 22k modems.

The demand for connected devices grows by the hour, these demands dictating technological advancements

Network providers like Vodafone, Deutsche Telekom and AT&T realised that 35% of 2G traffic relates to data flows for IoT and therefore the need to develop a 2G replacement. Release 13 (June 2016) of the 3GPP specification included a new standard specifically for industrial IoT.

China mobile have an installed parking system in Wuxi using NB-IoT, Athens Greece have a similar system installed, Vodafone, O2 and Deutsche Telekom have all been testing NB-IoT whilst still continuing to maintain 2G networks.

Unless you are based in the US you will be able to continue with 2G for some time, in the rest of the world you have the option of both 2G and NB-IoT. Many devices are now being designed for NB-IoT with a 2G fall back

Power consumption always remains a consideration. The power consumed by 2G and 4G is significant. It is not dependent on the type of transmission but more on the useable signal range. LTE requires less power than GSM. This is down to improvements in technology with better error correction, more efficient PA's (Power Amplifiers) and more sensitive receivers; all improving the overall link efficiency.

GSM has a link power of around -113dBm
LTE is lower power around -120dBm

A difference in the power level of 3dBm is a doubling of the power, so the LTE signals require a quarter of that of GSM. Due to inverse square law of radio propagation a quarter of the power means double the distance.
All being equal an LTE cell can be twice the distance as a GSM cell.

Currently LTE uses this performance increase to provide services with higher data rates which enable services like streaming video and television. With low latency and high data rates typically 50ms and 10Mb. The standard rule of radio signals apply.

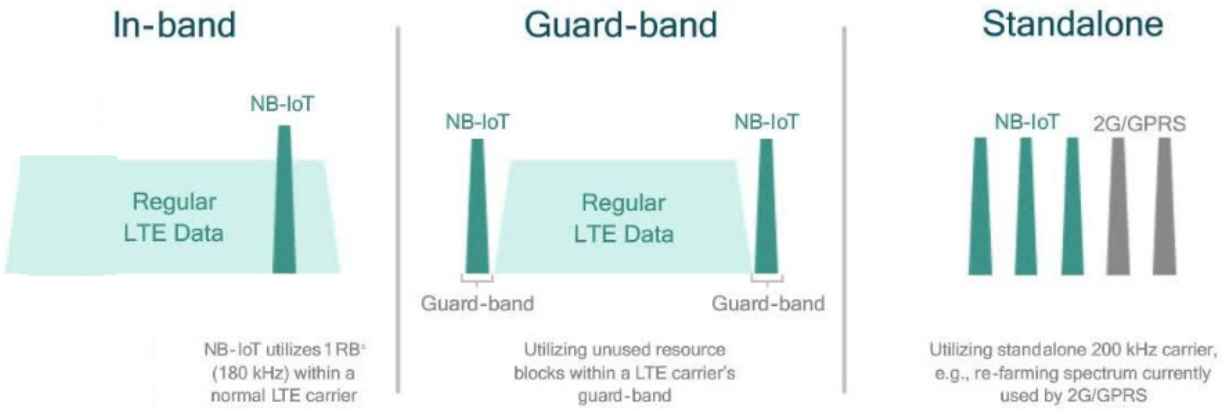
$$\frac{\text{Transmit Power x Distance}}{\text{Bandwidth}} = \text{Performance}$$

LTE has 4x the performance of 2G

If we reduce the bandwidth for LTE NB-IOT then we also increase the performance

The 3 GPP specification not only reduces the bandwidth it also reverts to half duplex and increased latency, the roaming function is removed which adds up to a very slim transmission method; when coupled with the greater performance of LTE the general performance and power over 2G systems will be considerable.

When considering the spectrum, most radio designers are aware that it remains a very crowded place. It is in all our interests to reduce the usage for future services and to minimise background noise in the environment. 2G uses 30khz to 200khz bandwidth at a range of frequencies 850/900/1800/1900MHz. It is a TDMA (time domain multiple access) signal and a half duplex service



Parameter	CAT-M1 (CAT M)	NB-IoT
Bandwidth	1.4MHz	200KHz
Modes of Operation	In-Band	In-Band, Guard-Band, Standalone (GSM bands)
Duplex mode	HD-FDD/FDD/TDD	HD-FDD (TDD under discussion)
Peak Data Rate	375Kbps (HD-FDD), 1Mbps (FDD)	50Kbps HD-FDD (not yet decided in 3GPP)
UL Transpit Power	23dBm 20dBm	23dBm, lower power under discussion
VoLTE	Will be supported	Not supported
Mobility Support	Full Mobility Support	No Connected Mobility (only idle mode reselection)

Within LTE and depending on which of the 20 plus frequencies are allocated, bandwidths up to 60Mhz are used. LTE is full duplex and uses 2 frequencies for up and down links; these are divided by 'Guard' bands. Both FDD (frequency division duplex) and TDD (time division duplex)

LTE-NB IoT In comparison can use the same frequencies as full LTE but is half duplex and only requires one frequency. It can also use TDD signals in the Guard Bands which means more efficient use of the spectrum.

Also under the 3GPP Release 13, another standard was included: CAT-M and like NB-IoT it is a sub set of the LTE standard.

CAT-M has some differences to NB-IoT with a wider bandwidth of 1.4Mhz, however the higher data rates possible removes the ability to use the GSM bands.

In addition, the higher data rates and bandwidth allow VoLTE (voice over LTE). The power level on both standards are virtually the same. CAT-M also supports roaming which is not available in NB-IoT. Currently both standards are being promoted by the network operators.

Currently NB-IoT will deploy faster and is the best choice for fixed location devices like remote water pumping stations, parking and utility meters.

CAT-M has the added benefit of roaming and voice. This makes it better suited to robot equipment, fire and security with voice alarms etc.

Both NB-IoT and CAT-M have advanced radio design which gives up to 4x the power efficiencey.

If you have existing 2G installations there is no immediate panic to redesign. However, for new designs, it makes good sense to take advantage of the low power and spectrum benefits of NB-IoT or CAT-M.

Siretta Case Study In Brief

Electric Vehicle Charging

Elektromotive used Siretta IoT solutions to monitor their mobile electric vehicle charging bays for: use, performance, service needs and payment processing.

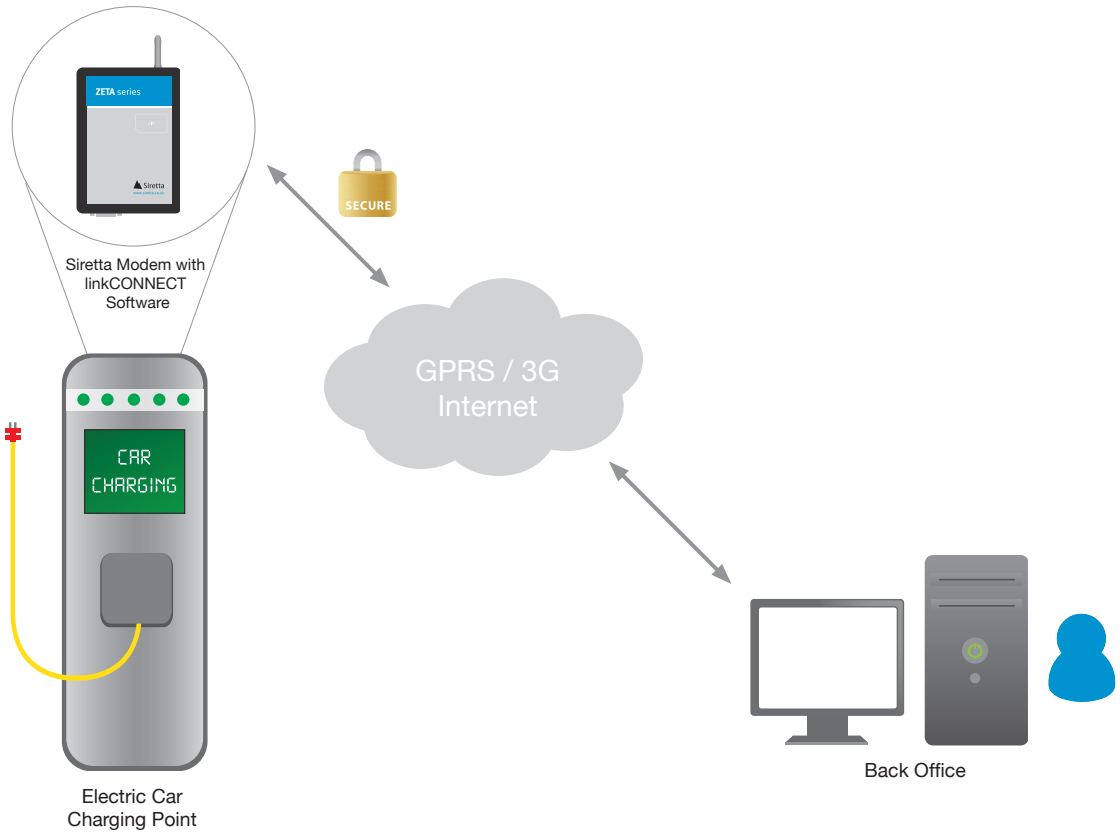
Elektromotive are a UK based design and manufacturing company providing private vehicle electric charging points in public spaces.

Their operations also cover the maintenance of each station based on periodic inspection and machine reported faults.
Secure data connections that are reliably 'always-on' are required for payment as well as for predictive maintenance of the charging stations.

The location of charging stations meant that a broadband connection was not always available. Apart from that, given the minute amount of data that was exchanged between the charging station and the back office, a broadband connection was not a cost effective solution.

As part of the feasibility process for connecting charging stations wirelessly for the payment etc, various short range and long distance wireless technologies were tested.

GSM mobile communication was selected over all others as the operating technology for connecting the charging stations, due to the vast mobile network available, as well as being cost effective due to the small, and infrequent, amounts of data being transmitted.



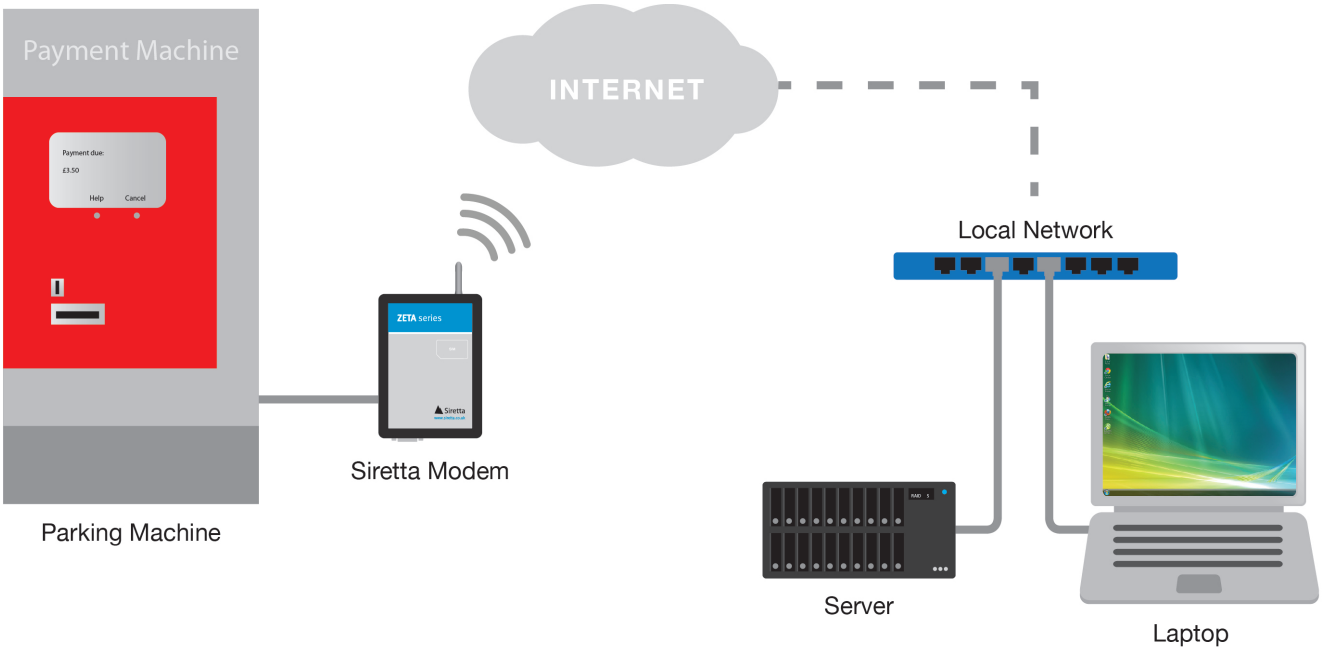
GSM also offers multiple options for connectivity, such as, sending data over GPRS, CSD or via SMS, ensuring that you can connect one way or another.

The LinkCONNECT modems incorporated some bespoke software for Elektromotive.

Siretta linkCONNECT modems offer a secure and uninterrupted connection with GPRS, CSD and SMS, allowing redundancy measures to be applied as required.

Siretta Case Study In Brief

Car Park Machines



For a number of years Siretta has been working closely with a leading manufacturer of parking management systems. This innovative company has a significant worldwide presence and continues to develop it's remote monitoring solution with Siretta at the heart of the communication link.

The parking management system includes parking machines which take cash payments internally and card payments via the cellular network.

The use of this wireless connectivity means that monitored parts of the machine can send real time information back to a central location for:

» The coin box fill status

» Ticket stock levels

» Tamper Alarm Alerts

The alerts back to the enterprise allows resources to be deployed where the need is greatest, providing the information required to:

» Optimise preventative maintenance and workforce movements

» Save on operational costs

» Monitor cash security

Alerts can be sent via SMS or email to relevant personnel on their mobile devices. This means response to faults and ticket stock low alerts is swift, ensuring machines are returned to operation as quickly as possible.

The back end system will also log "day to day" transactions, providing an audit trail, and reports, from which detailed analysis can be performed.

The Siretta modem was chosen for:

» High reliability

» Ability to work with the client's legacy products

» Wireless connection from remote locations to a back office web based system

» Use of the cellular network with a GPRS connection

The test phase allowed the client to give a thorough evaluation of the ZETA 2G modem

The client chose to go with 2G ZETA product based on product reliability and development of the product to interface with the TTL signal levels found on the client's legacy products.

By selecting Siretta, the client has future-proofed their parking systems, been able to move from 2G modems to 3G/4G modems, taken advantage of the ZETA's core features and it's standard enclosure footprint.

Modem Product Outline

What can be done:

- INTERNET ENABLE EXISTING EQUIPMENT USING THE CELLULAR NETWORK
- SWITCH BETWEEN NETWORK TECHNOLOGIES USING STANDARD FOOTPRINT
- UTILISE THE SAME 'AT' COMMAND SET ACROSS TECHNOLOGIES
- ENHANCE EXISTING APPLICATIONS WITH LITTLE OR NO DESIGN EXPERTISE
- OFFER VALUE ADDED SERVICES TO YOUR REAL ESTATE
- USE PROVEN RELIABLE TECHNOLOGY WITHIN SOLUTIONS
- REDUCE DEVELOPMENT RISK AND COST
- EVALUATE PERFORMANCE PRIOR TO STARTING EMBEDDED DESIGN

ZETA Series Modems (NLP/NSP/NEP/GEP)

SIM slot

LED Status Indicators

NLP/NSP Model

NEP Model

GPIO Connector

NLP/NSP/NEP Models

RS232 USB Serial Port

Cellular Antenna SMA Female connector

RJ12 Power Connection

GEP Model

RJ12 Power Connection

Cellular Antenna SMA Female connector

GPS Antenna SMA Female connector

Modem Ultra Low Power

The choice of modem is defined by its end purpose and location. A remote site monitoring sensors once an hour will have different needs to a modem deployed in a payment terminal with higher volumes of data traffic. Contact our sales team or technical department if you need advice on the most appropriate model.

NB-IoT (ULTRA LOW: Power & bandwidth)

Sensors, Air Quality, Smoke Detection, Moisture Monitoring, Structure Stability, HVAC

Cat M (ULTRA LOW: Power, bandwidth & latency)

Traffic, Parking, ANPR, Telemetry, Environmental Monitoring, Utility Meter Reading, Vending Machines, Tank Level Monitoring, Asset Tracking

ZETA-NLP Power Enhancements

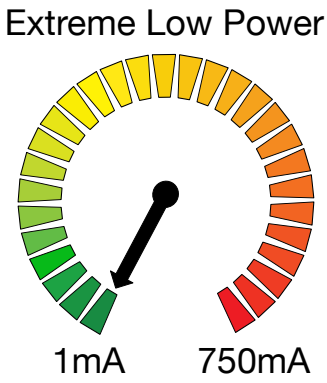
The ZETA-NLP has been designed to operate in an ultra low power state. There have been a number of enhancements made to the functional operation of the unit to help accommodate low power operation in normal use. When running in full power mode the unit makes use of a very efficient power supply and all components have been optimised for reduced current loss across the entire design.

ZETA-NLP Low Power Mode

The ZETA-NLP has a special mode of operation which forces the unit to drop down to a super low power state where the modem is still operational and registered on the network but is functionally asleep. This allows for the modem to remain connected to the network and be ready to send and receive data using a fraction of the energy normally required.

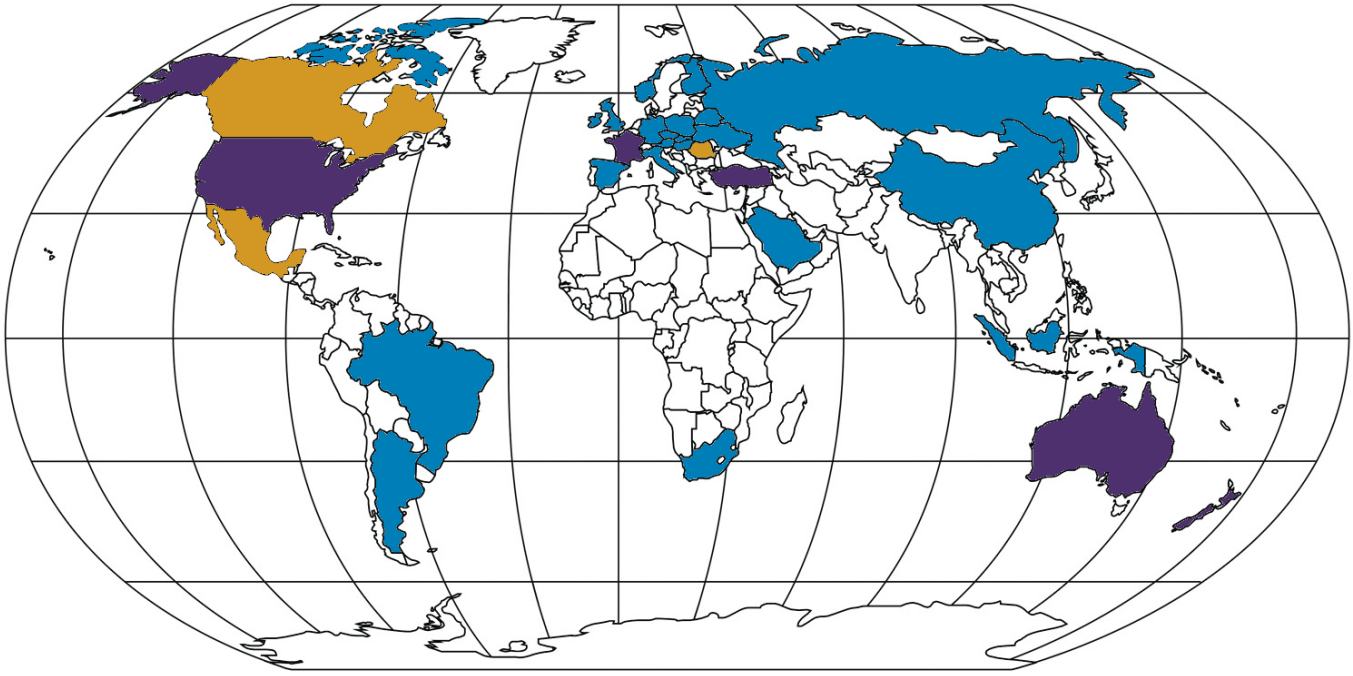
This super low power modes allow the device to work from a small battery charged by a small solar panel which facilitates device placement in remote locations

Mode of Operation	7V	12V	42V
Low Power mode enabled, registered on network in idle state	1.3 mA	715 uA	485 uA
Low power mode enabled, registered on network with socket connected in idle state	1.42 mA	780 uA	495 uA



Regional Deployment

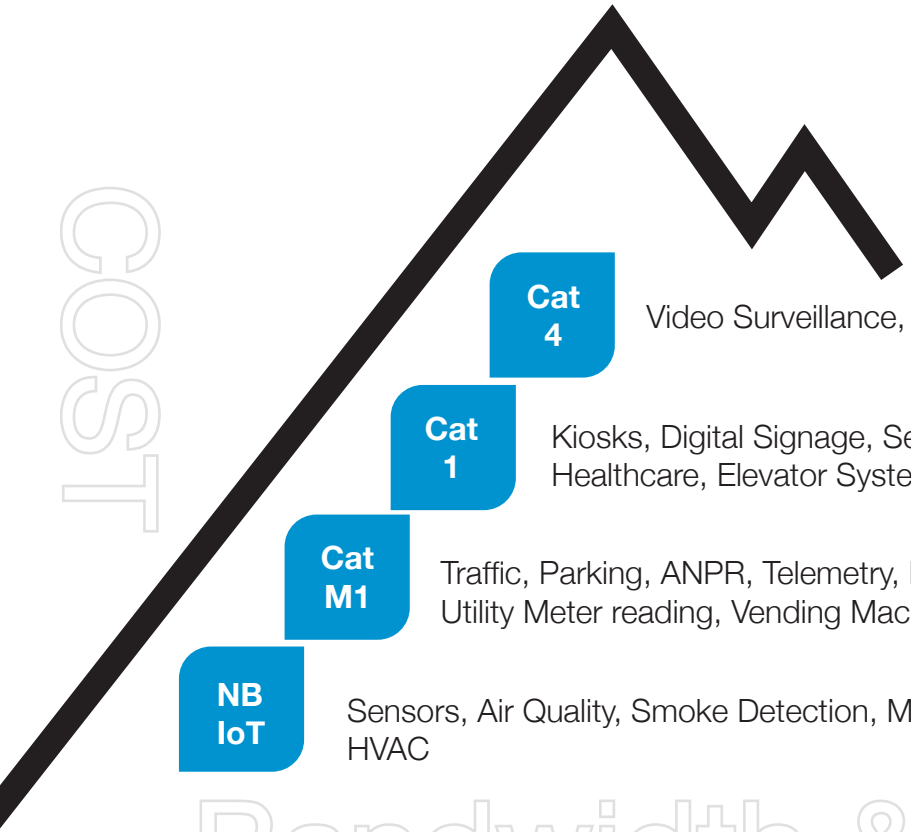
2G support throughout the world differs greatly for existing data applications. Check providers in region to find out when the cut-off dates are. One thing is clear though, deployment of NB-IoT and LTE CAT-M means new projects should be based around this technology and migration should be made as soon as possible to avoid loss of systems and critical data.



LTE and NB-IoT

LTE Only

NB-IoT



Embedded Software Support

When developing your application you may decide to use an external micro controller to manage your applications functionality. Depending on your exact requirements you may need to have the added flexibility of using an external microprocessor to manage power constraints or enable high performance functionality.

You also have the option to use the embedded software development environment included within the cellular engine on the Siretta ZETA family of modems.

All the modules used within the ZETA modem family support the Telit IoT AppZone embedded development environment which is available for use out-of-the-box and can be developed to suit your exact application requirements.

Telit AppZone

Telit AppZone is a high-level optimized standard C development environment that has been developed as an integrated platform to run within the cellular module and provides an advantageous “all-in-one” solution. This allows you to save time and money because the M2M module can perform all the key tasks normally associated with an external microprocessor.

The development environment offers a flexible platform whether you are planning on developing a new tracking application, an innovative healthcare device, a trend-setting Automatic Meter Reading component or any other M2M application. The Telit AppZone could meet your needs whilst minimizing your development effort and design costs. The end result is a much faster TTM (Time to Market).

Some of the key distinguishing features of AppZone include:

- Fast Interrupt Latency (130µsec)
- AT command tunneling
- Multi-tasking with IPC feature and application priority
- Over-The-Air (OTA) updates
- Low power consumption (Deep Sleep mode 75µA)
- File System and memory (FS NVM, Flash and RAM)

Telit AppZone - Lightweight, fast and efficient

AppZone lets you take full advantage of the hardware features and capabilities of your Siretta modem, enabling software development across product families. The AppZone IDE is the reference workbench and development tool for all Telit based products, supporting the multiple programming environments available for different modules and technologies.

AppZone C is the flagship application framework for cellular products. It is lightweight, runs on RTOS and delivers optimized performances and fast response. The framework includes a full set of APIs programmable in C language, enabling access to the modem, hardware, peripherals, operating system and other services. Ease of integration of 3rd party libraries, protocol stacks and peripherals. Available across all cellular technologies and form factors.

IoT AppZone supports Python for Telit legacy modules.

Modem Key Definitions

Term	Definition
2G	2nd Generation Mobile Telecommunications
3G	3rd Generation Mobile Telecommunications
ADC	Analog to Digital Converter
AMR	Automatic Meter Reading
AT	Attention
CBS	Cell Broadcasting Service
CPLD	Complex Programmable Logic Device
CSD	Circuit Switched Data
EGNOS	European Geostationary Navigation Overlay Service
GND	Ground
GPI	General Purpose Input
GPIO	General Purpose Input Output
GPO	General Purpose Output
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communications
I/O	Input/Output
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LTE	Long Term Evolution
M2M	Machine to Machine
MSAS	Multi-functional Satellite Augmentation System
PA	Power Amplifiers
RB	Resource Blocks
RF	Radio Frequency
RS232	Radio Sector
RX	Receive Signal
RXD	Receive Signal
SIM	Subscriber Identity Module
SMA	Sub Miniature Version A
SMS	Short Message Service
TTFF	Time To First Fix
TTL	Transistor - Transistor Logic
TX	Transmit Signal
TXD	Transmit Signal
UART	Universal Asynchronous Receiver/Transmitter
UMTS	Universal Mobile Telecommunications System (Same as 3G)
USB	Universal Serial Bus
WAAS	Wide Area Augmentation System
Vcc	Positive Power Supply
Vin	Input voltage

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