The Right Choice in Modem Selection

In order to gain a better understanding of the difference between LTE Cat 1 and LTE Cat 4 we will first discuss the need for cellular IoT and give a brief definition of the technologies before undertaking a more detailed evaluation.

The evolution of cellular IoT transpired in direct response to the popularity and ubiquity of IoT technologies and protocols that have become common place within todays connectivity landscape. The need for low-power consumption and wide-area networks has grown unabated with the traditional cellular offering previously not being ideal due to consuming too much power and increased costs for most low data rate IoT deployments. However, the market needed the level of guaranteed service and infrastructure that could only be deployed by the cellular providers coupled with low power and wide-area coverage. The new generation of cellular technologies, LTE Cat 1 and LTE Cat 4 resolve the power and cost problem while retaining the guaranteed service and infrastructure benefits.

LTE Cat 1 represented the original response offering a robust and viable alternative using existing LTE network based on the 3GPP Release 8 protocol. This offered a ready built and global infrastructure for IoT deployments.

Since the initial release there have been many further iterations in fact 14, the most prominent and widely adopted remain Cat 1 and Cat 4 which align to most of the today's IoT requirements as shown in **Table 1**. The question of whether to use Cat 1 or Cat 4 really comes down to your application and choice of technology stack.

Application Comparisons	
CAT - 1	CAT - 4
Digital Signage	CCTV
Car Parking Payment	Video Surveillance
Kiosks	Smart Cities
Security Systems	Alarm Notification Systems
Gaming Machines	Environmental Monitoring
Healthcare	Asset Tracking
Elevator Systems	Telematics
ATMs	ANPR
Payment Systems	Agriculture
Energy Utilities	Security Systems
Water Utilities	Food and Beverage

In the creation of your technology stack, you will need a gateway or a device connection to the internet driving automated conversion of your data and offering a method of displaying that data in a portal. Siretta, the Industrial IoT Company, offers a range of market leading Cat 1 and Cat 4 modem solutions. They come in industrial enclosures with their own antenna and power supplies and are pre-certified, secure and ready for immediate deployment reducing time to market. The only decision to consider is do I need Cat 1 or Cat 4?

The main variances are found when examining data rates in both the downlink and uplink, along with power requirements. However, additional selection criteria for consideration includes:

- Geographic location: continent, country
- Type of data: numeric data, text, video streaming
- Interface type: RS232, USB, Wi-Fi, Ethernet
- Software Options: Over the air upgrade (FOTA), TCP stack, IP services
- OS Support: Windows, Linux, Mac

Data rate requirements and power consumption are in most cases pre-determined by end application. LTE Cat 4 offers an uplink speed ten times faster and a downlink speed fifteen times faster than LTE Cat 1 measured in Mbps. In examining speed and power requirements Cat 4 devices are better aimed at higher data rates. For anything video based that is essential in real time viewing.

It is however feasible that your product and data requirements may fall between Cat 1 and Cat 4, and that you could have a degree of flexibility on your data rate. This being the case you have two further options to consider, power consumptions and the cost of airtime. There is always a trade off in any design, unfortunately the higher the data rate the higher the power consumption generating a higher cost airtime contract.

Currently there are a number of products available with LTE Cat 1 and LTE Cat 4 that offer ultra low power modes such as Siretta's ZETA-NLP-LTE1 which is an LTE Cat 1 ultra low power industrial modem. This is achieved by reducing the actual connection to the network effectively holding the device in standby until data is required. In this mode power can be reduced to around 1 milliamp making this perfect for remote devices which Siretta supports.

Cat 1 Low Power Devices		**Cat 4 Low Power Devices**	
Mode of Operation	12V	Mode of Operation	12V
Ultra low power mode enabled registered on network in idle state	1215 uA	Low power mode enabled registered on network in idle state	12.4 mA
Ultra low power mode enabled registered on network with socket connected in idle state	1290 uA	Low power mode enabled registered on network with socket connected in idle state	12.7 mA
Normal power mode with registered IP address in idle state	11.3 mA	Normal power mode with registered IP address in idle state	13.1 mA
Normal power mode with IP socket connected and transmitting data	86.1 mA	Normal power mode with IP socket connected and transmitting data	85.1 mA
Normal power mode with active data call in progress	130.4 mA	Normal power mode with active data call in progress	133.2 mA

As can be seen in **Table 2** above even the lowest power version of the LTE Cat 4 device uses significantly more power than the lowest power LTE Cat 1 Device.

In addition to your primary decision around speed and power consumptions there are other concerns to consider. Both LTE Cat 1 and LTE Cat 4 can cover the majority of frequency bands and it will be necessary to select the model required for the specific region of deployment as globally there are 72 bands with no device capable of covering them all. Selection will be by territory. **See table 3:**

	Region				
Frequency MHz	Europe	North America	Asia	Africa	Oceania
450	✔		✔		
600		✔			
700	✔	✔	✔	✔	✔
750		✔			
800	✔	✔	✔	✔	✔
850		✔	✔		✔
900	✔		✔	✔	
1500	✔		✔		
1800	✔		✔	✔	✔
1900		✔	✔		
2100	✔	✔	✔	✔	✔
2300	✔	✔	✔		✔
2500		✔	✔	✔	
2600	✔	✔	✔	✔	✔
3500	✔		✔		
3700	✔				

Connection to OEM equipment needs some thought, most modems offer RS232 interfaces which is supported by new and legacy equipment in the field, some have a parallel ports and additionally some provide general purpose interface (GPIO). Most have built in readers for a SIM card and socket connections for external antennas, usually by SMA. They have a status LED and power connection either fixed or plug in. All modems have an interface for setting up and generally this is through the RS232 port or can be remotely using a web browser and the device communicating through an internet connection. Additionally, some devices communicate directly using Linux or Windows CE and can be integrated into the user equipment software. This can save time and cost.

As described LTE Cat 4 devices generally have more user interfaces such as GPIO, ADC (Analog to Digital Convertor) and additional serial ports. **Table 4** below is a comparison of 2 such devices.

CAT - 1	CAT - 4
1 x RS232 serial port interface (9-wire)	3 x General Purpose Inputs (0V-42V tolerant)
1 x USB 2.0 FS	2 x General Purpose Outputs ()V-42V @1A)
1 x RJ12 power connection (5-42V)	1 x Analog to Digital Interface (0-42V range)
	1 x RS232 debug serial port (3-wire interface)
	1 x Peripheral Power Interface / Output Supply (Vcc)

Making the decision on which device to select is made easier using Siretta's Modem Selector Tool. Siretta has various models available for LTE Cat 1, both the low power ZETA-NSP-LTE1 and ultra low power ZETA-NLP-LTE1, in addition to LTE Cat 4 with the high performance ZETA-N-LTE, ZETA-NEP-LTE4 with GPIO, secondary serial port & ADC and ZETA-GEP-LTE4 with GPIO, secondary serial port, ADC & GNSS. The ZETA range of products also provide backwards compatibility to the existing European 3G / UMTS and 2G / GSM cellular networks.

LTE Cat 1 VS LTE Cat 4

The selection between LTE Cat 1 and LTE Cat 4 is almost always predetermined by the application and data rate requirements. As seen in many typical IoT solutions the data packages are typically small with power consumption remaining a primary factor. Although there are 14 iterations under the 3GPP, LTE Cat 1 and LTE Cat 4 remain the nearest equivalent to LPWAN and will continue to be a critical component of the cellular solutions within the IoT space. Additionally, by being part of a licensed band it is expected that QoS (quality of service) and SLA's (service level agreements) will ensure a more robust answer to your connectivity requirements both now and moving forwards in an ever competing market.

The solution architect of course still retains a significant degree of influence on the standards used and by choosing to use lower data rates they can reduce costs in elements such as airtime. It is however worth a note that lower bandwidths can potentially reduce quality or increase the time of transmission.

Once the decision on data has been made, the user can determine how feature rich the interface will be. For some users it may still be necessary to choose LTE Cat 4 even with lower data rate requirements to gain GPIO or additional inputs required for their technology stack. Alternatively LTE Cat 4 can offer benefits on power usage for transmitting large files compared with LTE Cat 1.

Siretta are a leading manufacturer and developer of IoT products, IoT software and IoT solutions with a specialty in providing these for Industrial markets and business to business applications. Siretta have extensive knowledge and experience within IoT with a focus on cellular technologies in support of 2G (GPRS), 3G (UMTS), 4G (LTE), NB-IoT and LTE Category M. Products include cellular modems & terminals, routers, cellular network analysers, RF antennas, RF adapters and low loss RF cables.