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Preparing your core network for 5G RedCap

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Introduction

This white paper discusses 5G Reduced Capability (RedCap) Internet of Things (IoT) devices using less bandwidth and more latency than traditional 5G devices making the technology far more suitable for mass adoption. IoT is a network of interconnected devices that exchange data with other connected devices and the cloud. An IoT ecosystem consists of processors, sensors, batteries, and communication hardware to collect, send, and act on data they acquire from their environments. With 5G, data-transfer speeds will increase considerably, 5G can be 10 times faster than LTE networks. This increase in speed will allow IoT devices to communicate and share data faster than ever. The speed & latency it offers has the potential to support new business models, change processes, and improve business performance. However there are some challenges to the 5G network that stem from IoT devices, which need to be addressed. 5G compatible IoT devices are presently very complex, costly, and not suitable for mass adoption.

Types of IoT devices

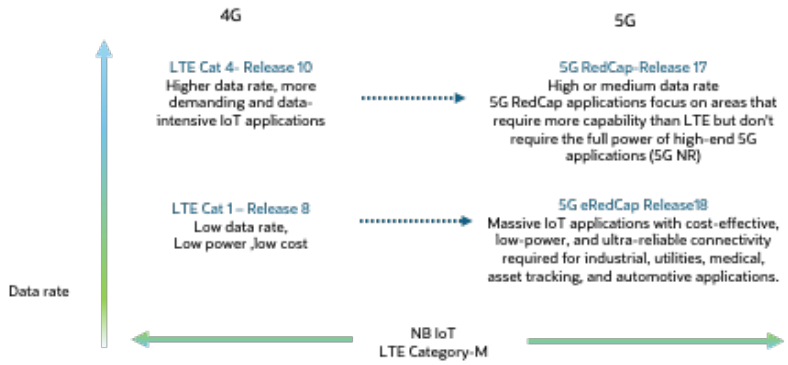
Depending on the business requirement and number of transmissions IoT use cases can be massive or critical. Critical IoT needs regular or even constant data transmission, whereas Massive IoT is defined by a set number of data transmissions per day. Critical IoT applications have stringent requirements of availability and reliability for examples, traffic safety (vehicle to everything), industrial applications, and remote surgical operations in healthcare. Massive IoT is used when broad coverage is needed for large devices with small data volumes instead of focusing on the connection's speed. For example, these devices can function in challenging radio conditions. With Massive IoT ensuring that data is transmitted is crucial as it involves connecting anything from hundreds to millions of devices. Some of the use cases are asset management, fleet management (logistics), smart metering, connected farming and smart spraying, and smart city applications.

For connecting massive, low cost, low data rate IoT devices, Narrow Band IoT (NB IoT) or LTE Cat M technology is used. NB-IoT limits the bandwidth to a single narrow band of 200khz, offering peak downlink speeds of 26kbs in Release 13 in 2021 and 127 kbps in Release14 in 2022. LTE-M offers a data rate of 1Mbps for 3GPP Release 13, rising to 4Mbps for Release 14, meaning greater mobility, and voice capability over the network. Both NB-IoT and LTE-M fulfil the 5G massive machine-type communications (mMTC) requirements and are therefore components of both 4G and 5G since Release-15.

For high and mid-speed IoT connections , LTE Cat1 and LTE Cat 4 have been used. Both categories are within the LTE standard. LTE Cat-1 has lower data rates compared to LTE Cat-4. LTE Cat 1 was Released in 2009, Cat 1 offers basic cellular connectivity for IoT devices. It offers lower data rates,10 Mbps downlink, 5 Mbps uplink and focuses on low power, low cost applications. LTE Cat 4 was introduced later in 2012, Cat 4 offers significantly higher data rates,150 Mbps downlink, 50 Mbps uplink and supports a wider range of network adaptations. This makes it suitable for more demanding and data-intensive IoT applications.

However, for leveraging new capabilities of 5G like network slicing, precise monitoring, and real time visibility, legacy technology will not suffice. **5G RedCap** is a new device platform that bridges the capability and complexity gap between the extremes in 5G today with an optimized design for mid-tier use cases. When compared to 5G enhanced mobile broadband (eMBB) devices that can support gigabits per second of throughput in the downlink and uplink, 5G RedCap devices can efficiently support 150 Mbps and 50 Mbps in the downlink and uplink. 5G RedCap is seen as the next step in the evolution path from LTE for most IoT devices. With a peak data rate more than 4G Cat 1 and comparable with Cat 4, 5G RedCap expands to accommodate new use cases with increased reliability.

Figure 1. Transition path from 4G to 5G IoT devices.



What is 5G RedCap?

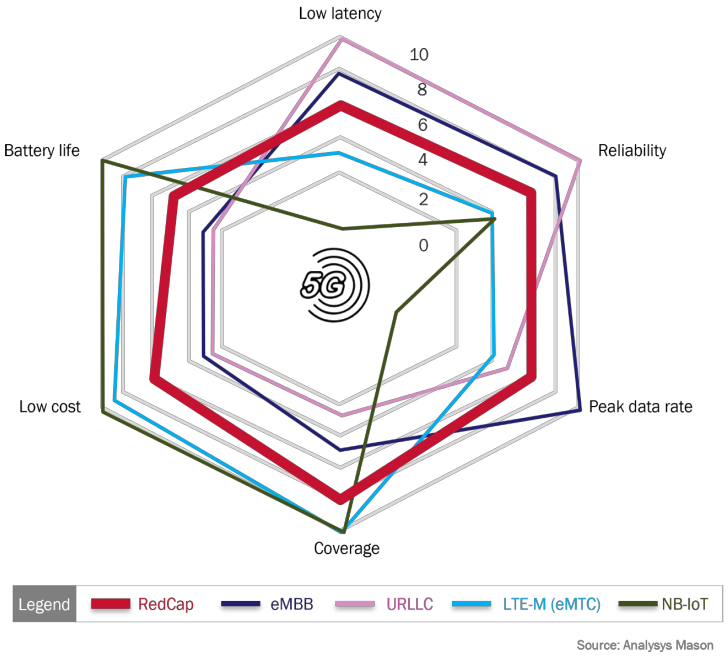
5G RedCap is a new 5G standard, initially termed as 5G NR-Light introduced in Release 17 is designed to address the use cases in between the high speed Enhanced Mobile Broadband (eMBB), ultra-reliable low latency (URLLC) and low-throughput, battery-efficient, massive machine-type communications technologies.

The aim is to reduce the capability of classic 5G NR devices to lower their complexity, cost, and power consumption while still supporting a high or medium data rate to enable consumer and industrial IoT applications, such as wearables, video surveillance, industrial sensors, and so on.

5G RedCap applications focus on areas that require more capability than LTE but don't require the full power of high-end 5G applications (5G NR). 5G RedCap provides a middle ground of connectivity, leveraging some of 5G's advanced capabilities (such as low latency, high reliability, and higher peak data rates), as well as outperforming 5G eMBB in terms of component cost and battery life.

5G RedCap technology is designed for the mass adoption of devices and chip sets with reduced throughput and bandwidth. Due to a balanced combination of capabilities, 5G RedCap is ideal for mid-range IoT applications like extended reality (XR) glasses, industrial sensors, smart watches, health monitors, and more.

Figure 2. 5G RedCap latency, data rate, coverage.



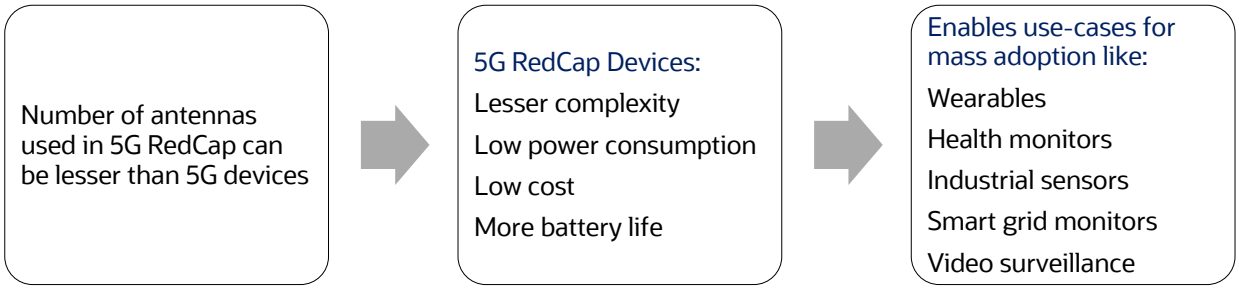
Source: Analysys Mason

5G RedCap enhances IoT use cases

The number of antennas used in 5G RedCap devices is also fewer than in 5G devices. The reduced complexity contributes to more cost efficient 5G RedCap devices, longer battery life due to lower power consumption, and a smaller device footprint which enables new designs for a broad range of use cases. 5G RedCap can support peak data rates much higher than LTE Cat1 backing applications that require more data throughput, like video surveillance or smart grid monitoring.

5G RedCap offers similar latency to existing 4G LTE technologies, which is much lower than the latency in most LPWAN technologies like NB-IoT. This means that 5G RedCap can support applications that require near real-time data communication, such as industrial sensors and smart grid applications. 5G RedCap can also help to improve the power efficiency of IoT devices, which can extend the battery life of these devices. This is especially important for applications that use battery-powered devices, such as wearables or sensors.

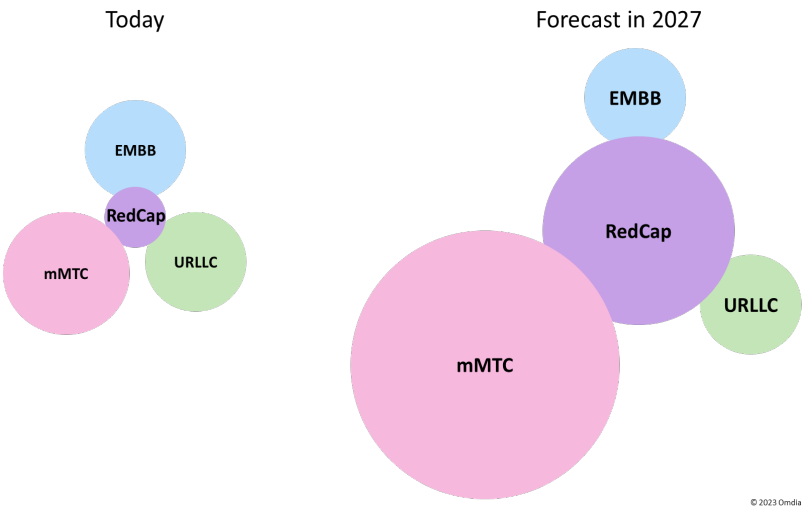
Figure 3. 5G RedCap can use lesser antenna compared to 5G.



5G RedCap market

5G RedCap modules today generally cost 50% to 60% less than conventional 5G NR modules, thus facilitating adoption of the technology with lower upfront capital expenditure (CapEx) costs as per ABI research.The growth of this market can be attributed to the increasing demand for industrial sensors, support needed for the video surveillance industry, and popular wearable applications across the globe. According to research from Omdia, most of the 5G development has been focused on eMBB and URLLC, however the IoT module shipments forecast shows massive IoT (mostly NB-IoT and LTE-M) is overtaking the eMBB and URLLC shipments. 5G RedCap development remains in the middle of the two. By 2027, 5G RedCap market share is forecasted to increase sizably.

Figure 4. 5G RedCap expected market growth.



5G RedCap positioning

LTE-M and NB-IoT are Low Power Wide Area Networks (LPWAN) developed for low data rate IoT devices. 5G RedCap and 5G eRedCap (5G RedCap is being further refined in terms of latency and bandwidth in upcoming release 18 as, "5G eRedCap"), both these technologies will sit alongside LPWAN and 2G/3G. Once 2G and 3G phase out in a few years , there will be a big gap between LPWAN and 5G. 5G RedCap will eventually replace 4G Cat-1 to Cat-4.

Connectivity plays an important role for IoT devices deployment. Many of these IoT devices life span is about 10 to 20 years (Omdia). There is an overall desire to ensure the underlying technology evolution will not impact the viability of the IoT device. Choosing the right connectivity for IoT devices is crucial for business viability.

5G RedCap trade offs

The 5G RedCap devices have peak rates and complexity similar to low end LTE device categories such as Cat-2, Cat-3, or Cat-4. Telecom operators can leverage their existing network infrastructure (without new hardware deployments) and support 5G RedCap devices with a software upgrade. However, as per Omdia, to bring down the cost, there are a number of trade-offs in terms of performance:

Fewer antennas: 5G RedCap devices can use fewer antennas than standard 5G devices. This reduces the cost of the device and the complexity of the design.

Lower maximum bandwidth: 5G RedCap devices have a maximum bandwidth of 20MHz, compared to 100MHz or more for standard 5G devices. This reduces the amount of data that can be transmitted, but it is sufficient for many IoT applications.

Different transmission mode: 5G RedCap devices support half-duplex frequency division duplex (FDD) transmission, while standard 5G devices support full-duplex FDD transmission. This reduces the cost of the device, but it also means that 5G RedCap devices cannot transmit and receive data at the same time.

Single carrier support: No support for carrier aggregation and support for single connectivity to support 5G Standalone (SA) mode only. Supports 5G power Class 3 to extend battery life.

It is important to ensure that the trade-offs of reducing complexity do not affect the requirements of the deployment.

How is Oracle supporting service providers in 5G RedCap technology?

Oracle Communications 5G core solutions are architected with cloud native principles from the ground up with no repurposed legacy code. Oracle focuses on the control plane components of the 5G core with the belief that this is the most critical part of a carriers' 5G network. Oracle has a complete suite of cloud native applications and secure network infrastructure solutions, designed to support communications service providers (CSPs) as they evolve their network and grow revenue. Oracle's 5G core has been running successfully in many tier 1 operators' networks globally. Oracle is aligned on the development of 5G RedCap and its impact on IoT use cases and the business value it provides to service providers.

The license cost of using 5G core for eMBB IoT devices are much higher compared to 5G RedCap IoT devices. However, the economy of scale of 5G RedCap outperforms the eMBB IoT use cases.

Realizing the requirement of 5G RedCap, Oracle has introduced 5G core network function licenses for Reduced Capability devices over and above NB IoT. Functionality includes signaling, policy, and database network functions. These new SKUs are aligned to 3GPP defined functionality for 5G RedCap. Communications Service Providers (CSP) catering to 5G RedCap IoT devices can leverage these new SKUs enabling higher ROI on launched RadCap business services. Reliability, cost efficiency, flexibility, and scalability are some of the key benefits to the service providers for unleashing the true potential of 5G RedCap.

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Glossary

3GPP	3rd generation partnership project
5G eRedCap	5G Enhanced Reduced Capability
5G-NR	5G New Radio
5G-NR light	5G New Radio Light
5G RedCap	5G Reduced Capability
eMBB	Enhanced mobile broadband
FDD	Frequency division duplex
IoT	Internet of Things
LPWAN	Low Power Wide Area Network
LTE	Long-term evolution
LTE-M	Long-term evolution machine type communication
mMTC	Massive machine type communication
NB-IoT	Narrowband Internet of Things
RedCap	Reduced apability
URLLC	Ultra-reliable low latency communications
XR	Extended reality

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