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MASSIVE IOT IN THE CITY

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MASSIVE IOT IN THE CITY

Cost-effective connectivity is a prime driver for IoT services uptake. Cellular networks are well-suited to enable this due to their ubiquitous deployments worldwide and the ease with which they can be upgraded to handle many potential IoT use cases. Additionally, cellular networks can handle traffic from a massive number of IoT devices in dense urban environments with minimal network capacity impact

IoT can be segmented into critical and massive applications. Critical IoT applications have stringent requirements on availability, delay and reliability; examples include traffic safety, automated vehicles, industrial applications and remote surgery in healthcare.

Massive IoT, on the other hand, is characterized by a very large number of connections, small data volumes, low-cost devices and stringent requirements on energy consumption; examples include smart buildings, smart metering, transport logistics, fleet management, industrial monitoring and agriculture.

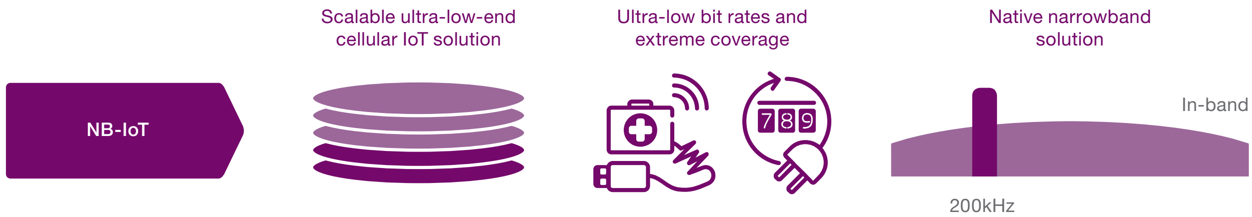
Complementary IoT technologies

These two segments represent a vast range of use cases with varying connectivity requirements. Cellular networks are suitable to support both segments, although no single technology is suited for all potential scenarios. To meet the use case requirements of different potential massive IoT applications, several cellular IoT technologies are being standardized, including Extended Coverage-GSM-IoT (EC-GSM IoT), Cat-M1 and Narrow Band-IoT (NB-IoT). These solutions can complement one another depending on technology availability, use case requirements and deployment scenarios. For instance, EC-GSM serves applications for all GSM markets, Cat-M1 supports a wide range of IoT applications, including content-rich ones, and NB-IoT is streamlined for ultra-low throughput applications and offers excellent coverage and deployment flexibility. Whether operators choose one or a combination of these solutions will depend on several factors, such as technology coverage, network technology strategies and targeted market segments.

Ultra-low-end massive IoT applications

To examine the capability of cellular networks to carry IoT traffic, knowledge about real IoT services scenarios and their network impact is important. Our scenario includes a traffic model consisting of a range of different IoT services, and includes assumptions on message size and traffic intensity per device, as well as the number of devices deployed in a dense urban environment. It focuses on ultra-low-end IoT applications with limited demands on throughput, such as metering and monitoring use cases, as these are expected to be the first massive IoT services deployed in many markets.

NB-IoT: tailored for ultra-low-end IoT applications



Traffic characteristics of deployed massive IoT connected devices in a city scenario

	WATER METERS	ELECTRICITY METERS	GAS METERS	VENDING MACHINES	BIKE FLEET MANAGEMENT	PAY-AS-YOU-DRIVE
Typical message size	100 bytes	100 bytes	100 bytes	150 bytes	150 bytes	150 bytes
Message interval	12 hours	24 hours	30 minutes	24 hours	30 minutes	10 minutes
Device density	10,000/km^2	10,000/km^2	10,000/km^2	150/km^2	200/km^2	2,250/km^2

Massive IoT traffic scenario

A dense urban environment with 10,000 households per km^2 – similar to the central area of London, Beijing or New York – was used as the base for a massive IoT services scenario. A selection of connected device types were assumed to be deployed in the area, including water, gas and electricity meters, vending machines, rental bike position monitors and accelerometers in cars[1] monitoring driver behavior. Traffic characteristics for each device are summarized in the diagram above.[2] The number of connected devices used in this scenario represents a mature, large scale massive IoT scenario. During an initial rollout phase device densities will be lower and the corresponding traffic load will not be as high.

The services represent a realistic range of massive IoT use cases that are expected to be deployed in an urban environment.[3]

Deployment environment and traffic models differ for these services: a remote-controlled meter may face an indoor coverage challenge, while a device mounted on a bike is usually found outside. The traffic intensity from meters may be once per day, whereas other devices may need to transmit every 10 minutes.

The data traffic for massive IoT devices is small; the typical data packet for a service is about 100-150 bytes, accounting for a payload of the device ID, time stamp and report data values.

Additionally, each packet has IP overhead and higher layer headers of around 65 bytes; the Media Access Control (MAC) layer overhead is 15 bytes, and standard control signaling within the mobile network is 59 bytes per event for uplink. In total, each event generates around 250-300 bytes to be transmitted by the IoT device.

The figure on the following page shows the resulting traffic demand. It clearly demonstrates that, despite the very high device density, the small traffic per device limits the traffic per area unit to a few kilobits per second (kbps) per km^2. As a comparison, mobile broadband traffic is approaching gigabit per second (Gbps) per km^2 in dense urban areas.

[1] Calculation based on an average of one car per household and every fourth in traffic
[2] In this scenario, the traffic is uplink dominated, as downlink traffic for application acknowledgement (ACK) and control plane signaling (RRC) between the device and the radio access network is comparably small
[3] Orange, Ericsson, "Traffic Model for legacy GPRS MTC" (February 15-19, 2016), document GP 160060, 3GPP GERAN meeting #69

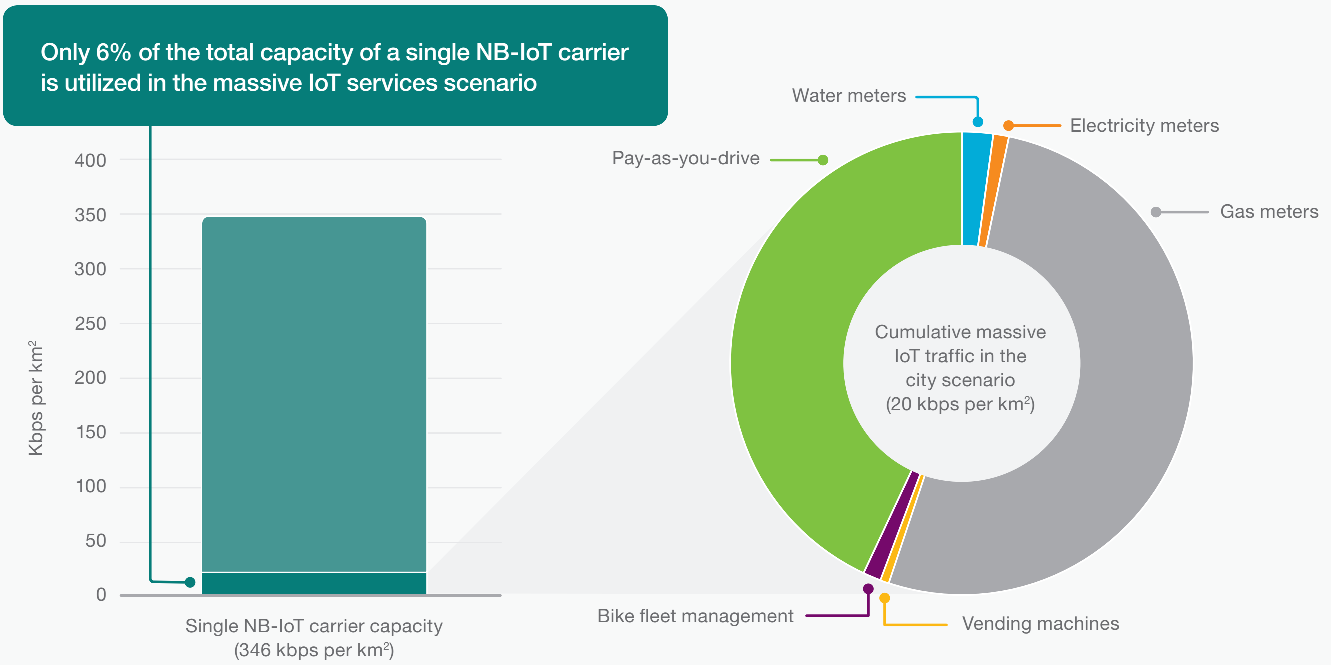
Deployment of a NB-IoT carrier for a massive IoT services scenario

NB-IoT is tailored for ultra-low-end IoT applications. The highest instantaneous data rate that a base station can communicate with a device is 227/250 kbps in downlink/uplink, while the sustained maximum throughput per device is 21/63 kbps. This is sufficient for supporting the services featured in the city scenario. Although its capacity is lower than that for mobile broadband, system level simulations show that one 180 kHz NB-IoT carrier can carry tens of kbps – depending on carrier configuration. Assuming that a single NB-IoT carrier is deployed on 3 sector sites, with a typical inter-site distance of 500 meters for an urban environment, an area capacity of hundreds of kbps per km^2 is achieved. This is much larger than the massive IoT services traffic demand in our dense urban city scenario.

The figure below illustrates the cumulative massive IoT traffic versus the capacity of a single NB-IoT carrier in our city scenario. The aggregate traffic from all the massive IoT services adds up to about 6 percent of the total available capacity, indicating that a 15-fold increase in massive IoT traffic volume over the considered scenario could be supported before another NB-IoT carrier is needed. As a side note, Cat-M1 supports even higher data rates and capacity than NB-IoT.

In addition to the capacity required for the traffic, coverage for reaching devices in challenging positions is necessary. For this reason, NB-IoT and Cat-M1 are designed to provide significantly better coverage than GSM and LTE. This improved coverage allows the radio signal to penetrate an additional couple of walls, or an Infrared Reflective (IRR) metalized glass window. Devices deployed deep indoors or in basements – typical locations for meters – can be reached.

Traffic versus capacity of a single NB-IoT carrier



Enabling business opportunities

Cellular networks can handle a large number of massive IoT devices with minimal network capacity impact. Our scenario shows that a single NB-IoT carrier – deployed in a guard band or in-band occupying around 2 percent of a 10 MHz LTE carrier – significantly exceeds the needs of the considered massive IoT services. These findings imply that an initial NB-IoT deployment will also be able to support other types of services, with potentially higher data demand and traffic intensity.

Generally, the effort for an operator to upgrade an existing network to support IoT traffic may be small, but the potential value it could generate is significant. Providing connectivity to tens of thousands of IoT devices from a single base station is an essential enabler for new business opportunities.

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