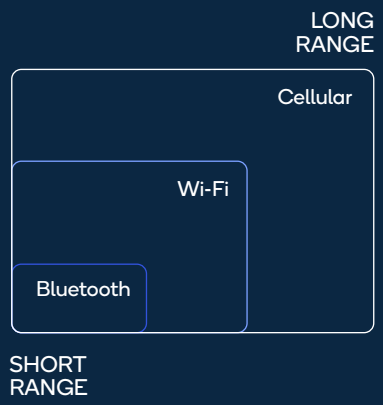
Qualcomm
developer network

Connectivity options for IoT developers

A spectrum of connectivity options



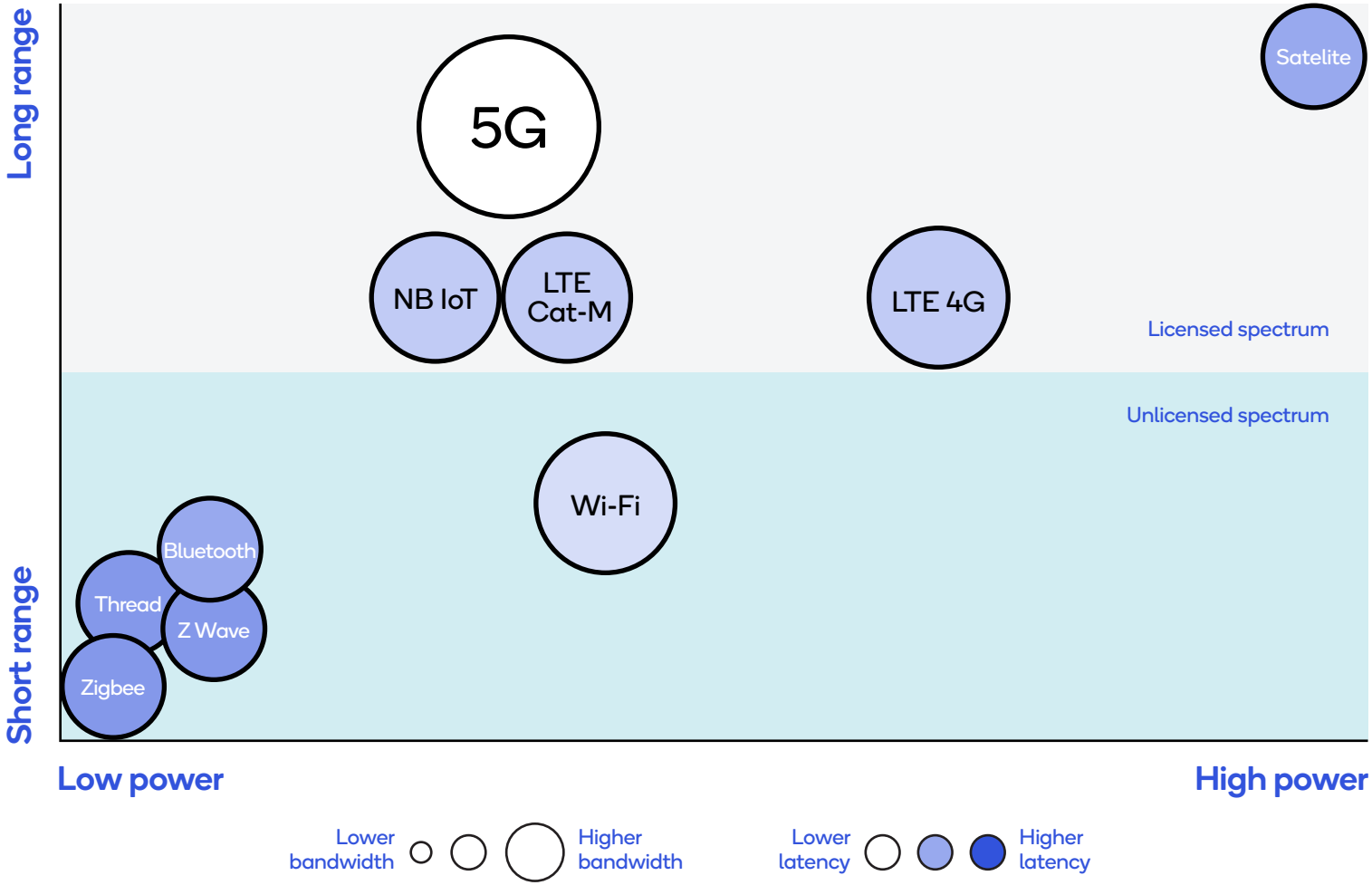
When it comes to developing and deploying your IoT applications, there are a number of variables to consider in order to identify the ideal connectivity technology. The starting point is usually range – long-range cellular technology from 5G, LTE, LTE Cat-M1, NB IoT, and even 3G; to shorter range technologies like Wi-Fi, Bluetooth, Zigbee, and Thread.

In the early days of IoT, there were limited connectivity choices based on the tradeoffs between range, power, and bandwidth requirements. Today and in the future, there are even more connectivity options to consider, each with its own unique requirements. From latency, security, and mesh capabilities to wireless edge options, mobility and more, the wide array of factors can make choosing a connectivity option overwhelming.

For example, an IoT device in the field such as a sensor on an oil well, may be very remote, requiring both long range connectivity such as that provided by a satellite, and battery life that must last up to ten years. On the other hand, a smart doorbell at your house would need to be optimized for more localized short-range connectivity like Wi-Fi and may have a hardwired electrical connection. And in between, exists a whole spectrum of possibilities that developers should know about.

In this e-book we review the difference between the long-range and short-range connectivity options, a variety of technical and business considerations and use cases, and the foundational technologies and tools we offer to help you transform your industry and keep your projects future focused.

A spectrum of connectivity options



Long range, cellular connectivity

Long range connectivity is typically based on licensed spectrum such as that employed by satellite and cellular technologies (**2G**, **3G**, **LTE**, and **5G**). They require the use of a Subscriber Identity Module (SIM) card or Embedded SIM (eSIM), and a connectivity subscription purchased from a telecom operator or carrier.

Low Power Wide Area Networks (**LPWA**), a 3GPP technology, is a recent development designed specifically to support IoT devices. LPWA has been optimized for smaller devices transmitting and/or receiving relatively small amounts of data that typically isn't time sensitive (e.g., non real-time), but over a longer range. LPWAs run on the cellular LTE network (which means a SIM card or eSIM is still required) and includes **Narrow Band IoT** (**NB-IoT**) and **LTE Cat-M1** radio technologies.

5G (as it becomes available) is the next protocol to consider for IoT. It will further enhance LTE capabilities with longer range, while facilitating lower power consumption, more devices per base station, lower latency, higher reliability, and technology that allows for enhanced mobility of devices.

Range for these technologies can be 1 to 5km in urban areas and up to 40 km in rural areas, However, range is dependent upon the type of cellular infrastructure in use, and other environmental factors such as line of sight and interference due to foliage, metal, etc. 5G will work across a millimeter wave (mmWave) signal, which supports ultra-reliability for applications where a range of 500 meters or less will suffice.

Cellular/Licensed Technologies for Longer Range

TECHNOLOGY	FREQUENCY	DATA RATES	DESCRIPTION
2G/3G	1.6 to 2.0 GHz	144 Kbps to 2 MBps	Suited for devices that connect infrequently and/or don't send/receive much data. 2G is generally not available anymore, so consider migrating to 4G, NB-IoT, or LTE-M as 3G availability wanes.
LTE (4G)	3 to 300 GHz	1 Gbps < 3 to 10 Mbps	Current cellular standard and used widely for phone calls. IoT devices can be both mobile (e.g., mobile routers in emergency vehicles) and fixed (e.g., sensors installed at a remote station).
Narrow Band IoT (NB-IoT)	200 kHz	up to 10's of Kbps	Suited for rural and indoor coverage amongst a large number of devices. Supports long battery life (10 years or more in some cases), and the simplicity of NB-IoT processors helps reduce costs. Suited for asset tracking and monitoring systems.
LTE Cat-M1	1.4 MHz	up to 1 Mbps	Suited for rural, underground, and indoor settings. As it supports limited bandwidth and long battery life, LTE Cat-M1, can be used for static, long-life assets with minimal data transfer needs.
5G	2 to 8 GHz (expected)	100 Mbps to 1 Gbps (expected)	5G is undergoing its initial rollout in early 2019 and is expected to co-exist with 4G for some time. 5G is expected be effective for IoT deployments such as smart cities and autonomous cars and immersive real-time XR experiences.

Short range connectivity

Shorter-range options include **Wi-Fi**, **Bluetooth**, **Zigbee**, **Z-Wave**, and **Thread**. These technologies are not subject to government regulations (i.e., these fall under unlicensed spectrum) so no SIM is required. They typically use less power or are often directly connected to a power source. These factors make them less expensive to deploy in their limited range. They are typically used with only one device or can be combined to include multiple devices in a mesh configuration.

Technologies for Short Range

PROTOCOL	FREQUENCY	DATA RATES	RANGE	DESCRIPTION
Wi-Fi (802.11 a, b, g)	2.4 GHz and 5 GHz	600 Mbps max, but 150 to 200 Mbps typical.	10 to 100 m	Commonly used by both consumer and commercial-oriented smart devices and allows for connectivity through Wi-Fi routers. Wi-Fi provides the highest data rates of the short-range technologies. And is best suited for stationary, home/office-based applications.
Bluetooth Low Energy (BLE)	2.4 GHz (ISM)	25 Mbps (Smart/BLE)	50 to 150m (Smart/BLE)	Supports both peer-to-peer communications and mesh networks which allows for programmable zones. Used in wearables, smart homes, automotive, and healthcare devices that require low power.
Zigbee	2.4 GHz	250 Kbps	10 to 300 m	Designed for mesh networks of low powered devices. Used in home automation products as well as monitoring and control devices.
Z-Wave	900 MHz (ISM)	10 to 100 Kbps	To 100 m	Used in home automation products as well as monitoring and control devices.
Thread	2.4 GHz (ISM)	N/A	N/A	Used primarily for home automation.
Near-field Communication (NFC)	13.56 MHz (ISM)	100 to 420 Kbps	10 cm	Typically used for contactless payment systems, electronic tickets, and other applications where devices are temporarily moved within really close proximity of each other.

Broad use cases for the connectivity landscape

The chart on the next page outlines some broad use cases and where they are situated in connectivity landscape

- **Massive IoT**: Refers to larger environments that can range from confined areas like stadiums to open areas like cities that use a large number of devices. Power and range requirements are generally high, as is the bandwidth to support all of these devices.

  Connectivity options can range from Wi-Fi to LTE and 5G when deployed in the area.

- **Industrial IoT** (IIoT): Environments such as factories or large commercial complexes generally require small to medium range real-time communication between a variety of edge devices and on-site servers.

  This can be accomplished with Wi-Fi, LPWA, or mesh networks like Bluetooth. Private Networks, usually with LTE are set up to control the data flow within a geographic area.

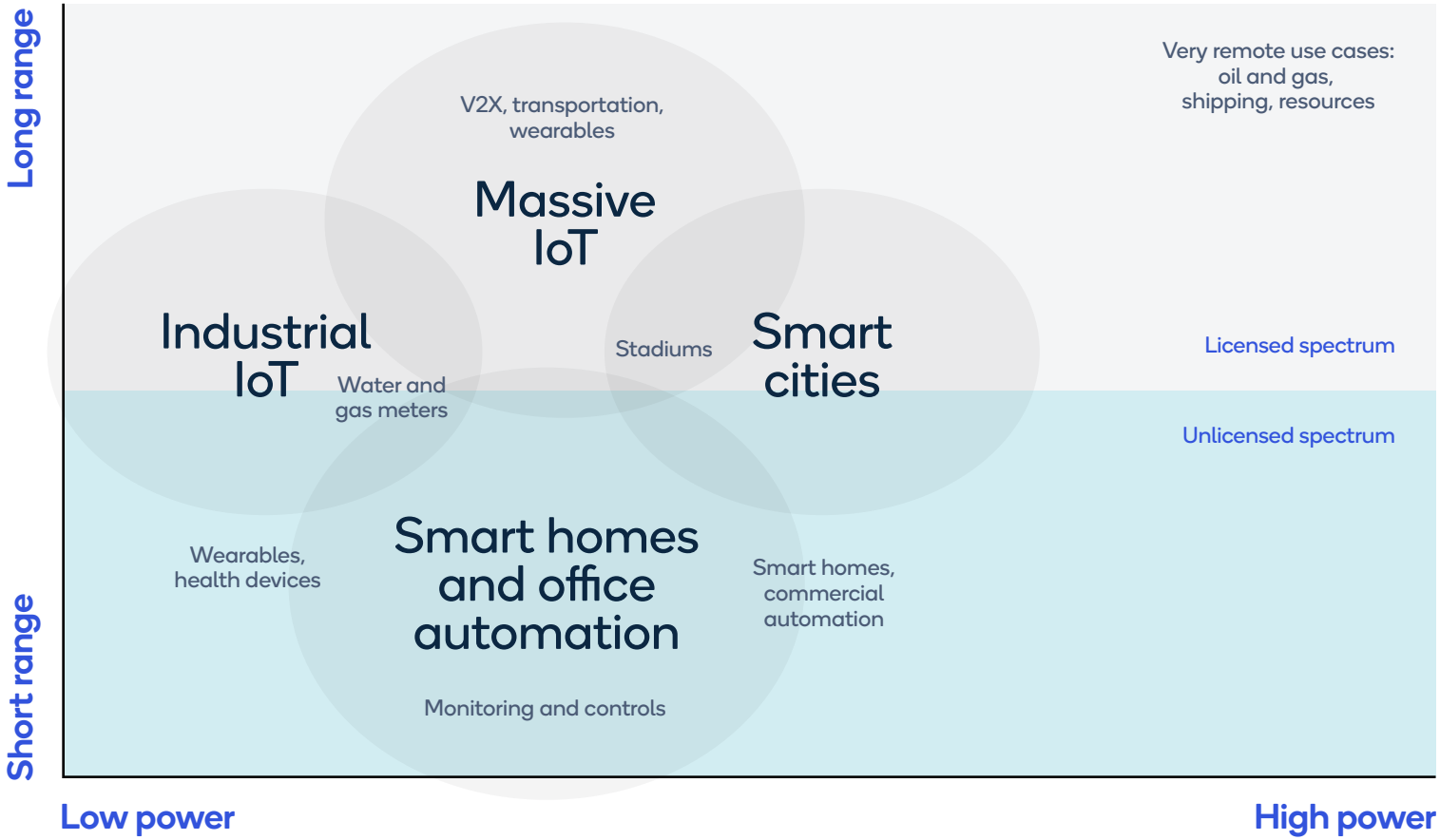
- **Smart Cities**: Devices and hotspots span a wide area and use both long range and high power. Many factors such as interference or obstructions to lines-of-site can reduce reliability.

  LTE and LPWA are often used, with the incoming 5G standard expected to eventually augment and replace LTE. Wi-Fi can also be used for some civic office applications where security issues are less restrictive.

- **Smart Home and Office Automation**: Much like IIoT, homes and offices have a smaller coverage area, but with a wide variation of device types. Communication sessions may range from sporadic to real time.

Localized connectivity options such as Wi-Fi, Zigbee, and Bluetooth are typically used. Our eBook on Elements for Developing an Integrated Smart Home outlines some great examples.

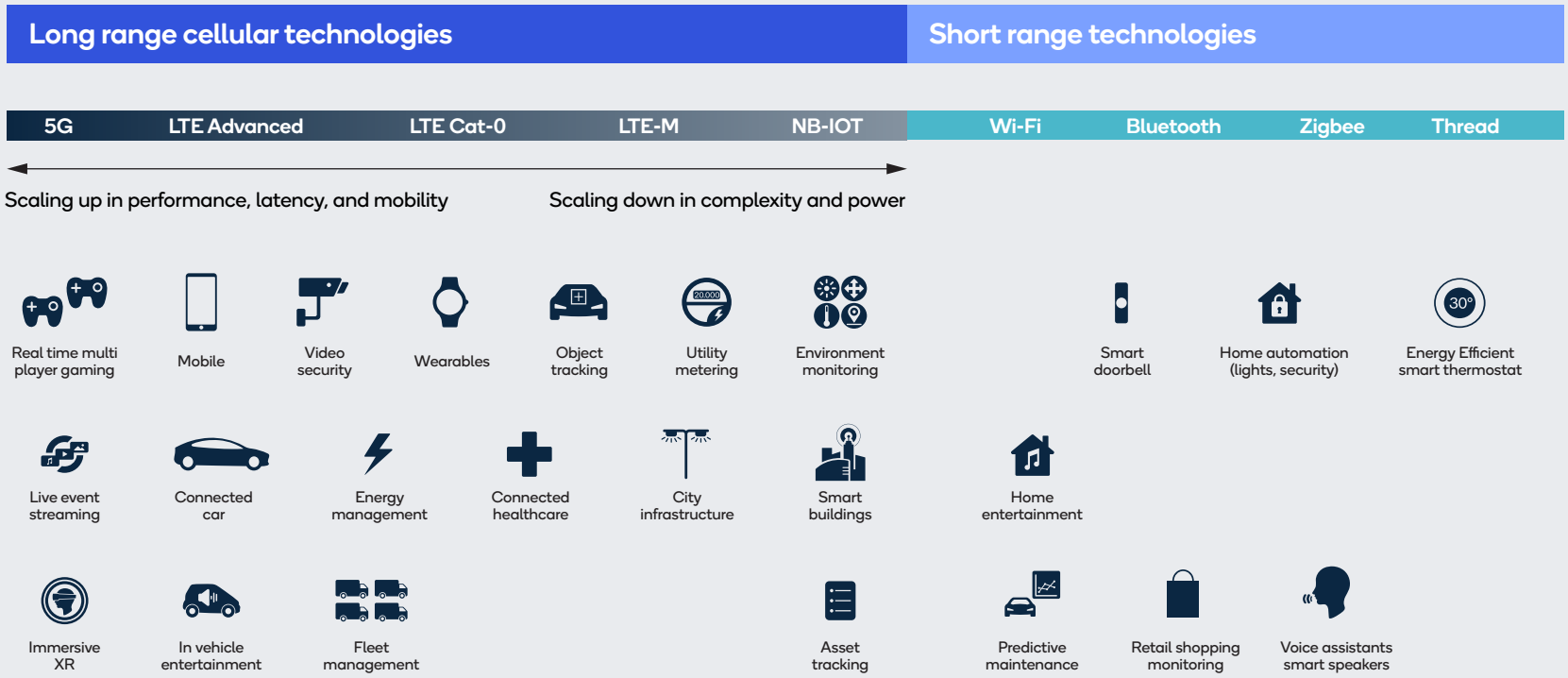
Broad use cases for the connectivity landscape



What will you make?

Once you understand your connectivity options and your technical and business variables, you can confidently build your application!

TIP: Be sure to include flexibility in your planning as changes could occur. For instance, new and additional data may be needed or new business requirements are added which might require a different type of connectivity.



Developer Resources

Qualcomm Technologies, Inc. has been providing many of the foundational technologies that propelled the mobile age and is transforming the scope of IoT. Below are developer tools and solutions we offer to help you transform your industry and keep your Internet of Things (IoT) projects future focused.

5G

Qualcomm® Snapdragon™ X50 5G Modem – a 5G modem supporting the mmWave signal range providing up to 5 Gbps. This modem is to be used in conjunction with the Qualcomm® Snapdragon™ 855 Mobile Platform.

4G LTE, NB-IOT

Qualcomm® Snapdragon™ X20 4G LTE Modem – a 4G LTE modem that is included in platforms like the Snapdragon 845 Mobile Platform.

Qualcomm® MDM9206 IoT Modem and next generation Qualcomm® 9205 LTE Modem - multi-mode connectivity solution useful for developing LTE Cat-M1 and NB-IoT solutions.

Qualcomm® MDM9207 IoT Modem – Connectivity solution useful for Smart city and Industrial IoT solutions.

Qualcomm® LTE IoT SDK – working with ecosystem players who deliver Development Kits and Reference Device Kits and cloud providers including Alibaba Cloud, Microsoft Azure IoT, CMCC OneNet, Gizwits Cloud and Ericsson IoT Accelerator have our LTE IoT SDK pre-integrated with their Cloud Device Agents on LTE IoT Chipsets.

Wi-Fi/Bluetooth

QCA4010/12 – a low-power microcontroller (MCU) with integrated Wi-Fi for IoT applications. This unit includes expanded memory and multiple interfaces to connect with sensors, displays, and actuators.

QCA4004 – dual-band, cost-optimised Wi-Fi SoC that allows developers to add Wi-Fi to IoT devices

QCA4531 – two stream (2x2) 802.11b/g/n single-band programmable Wi-Fi System-on-Chip (SoC) or IoT devices.

QCA9377-3 – provides power efficient Wi-Fi and Bluetooth connectivity on a single chip. Used for a wide range of devices such as home automation, wearables, and industrial controllers

Bluetooth/Zigbee/Thread

QCA4020 and QCA4024 – tri-mode (dual band Wi-Fi, BLE and 802.15.4) and dual-mode (BLE, 802.15.4) SoCs. Used for devices that utilize a wide range of interoperability between communication protocols.

CSR101x Series – SoCs featuring a BLE radio, single mode stack, PCB antenna connectivity, and the ability to draw power from a 3V coin battery.

CSR102x Series – BLE SoCs are suitable for IoT devices including wireless remote controls, simple smart watches, home automation solutions, and beacons.

CSRB534x – a platform with dual-mode turnkey SoCs for wireless gaming accessories and embedded modules for IoT.

Innovate with us

Qualcomm Developer Network (QDN) is a comprehensive program designed to equip the next generation of mobile pioneers to develop what's next. Our collection of software and hardware tools and resources is designed so you can build upon our foundational technologies in new and ways, creating the power to transform products, enrich lives and even transform entire industries.

Our SDKs and SW can help you optimize your development for our platforms with tools that tap into the CPU, GPU, and DSP. Supported hardware development kits and modules based on our technologies can help you create innovative products quickly and easily. And we're here to help you tap into what's next with tools to get you started developing for artificial intelligence (AI), XR (VR/AR), IoT, and Robotics.

At Qualcomm Developer Network, our aim is to help you kick-start your development by being the catalyst for your vision, today, tomorrow, and in the future. Welcome to the Age of Invention.

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