UK 5G Innovation Network

HOW DO YOU IDENTIFY YOUR CONNECTIVITY REQUIREMENTS?

MANUFACTURING

INTRODUCTION

From the Industrial Revolution to Industry 4.0, manufacturing has always been a cornerstone of the UK economy. Continuous innovation has been the driving force behind this, but today–more than ever–manufacturers are under constant pressure from shrinking margins and increasing demands to boost factory agility while enhancing safety and security.

Spurred by shorter product lifecycles and the impact of COVID-19, these longstanding challenges are made even more complex by rising energy prices, the need for agility and emerging skills gaps. Not forgetting obligations to operate more sustainably. All of which means, things have got to change.

5G could play an important role in tackling these challenges. Research from Vodafone indicates that the application of new digital technologies such as 5G and IoT in manufacturing could add £3.6bn to the sector's GVA in 2025, rising to £6.3bn in 2030.

However, surprising though it might seem for us to say this, 5G is not always the answer. It is important to first understand the challenges you want to solve, the specific needs you have, and then determine the most appropriate technology. This guide has been designed to offer pragmatic, practical guidance to connectivity helping you to understand how 5G compares to other connectivity solutions and determine if 5G is indeed the answer.

70%

OF UK BUSINESSES ARE ALREADY DEPLOYING OR PLANNING TO DEPLOY 5G

Source: UK5G survey of 300 decision makers, April 2022

WHAT ARE YOUR CONNECTIVITY OPTIONS?

1/ Wired connectivity

What is it?

Wired - or fixed - internet connectivity is the most common type of local area network technology and involves a hardwired connection, typically via ethernet cables, to the internet. Long considered a fast, relatively cheap and reliable option for manufacturers, it is often seen as the workhorse of connectivity across the sector and is best suited to scenarios where connectivity needs - and workers - are rooted to a fixed location. However, with the promises of Industry 4.0 and increasing pressure to improve operational efficiency, it may not always be the best option available, especially for new factory builds.

Advantages

- Cost-effective
- When configured and utilised properly, wired networks can provide unparalleled reliability. As soon as the hubs, switches, and cables are installed, you have a reliable network at your disposal; wired connections are also not influenced by other network connections in the vicinity, unlike their wireless counterparts. As a result, it is typically the de-facto option when connectivity is mission-critical i.e. controlling robot arms suitable for most factory floor systems
- Administrators can exercise a high level of user access control with relative ease as wired networks are not visible to devices on other networks. Networks can only be accessed via a physical cable connection, meaning fixed connectivity solutions are accepted as offering the greatest security

Limitations

- Connectivity is rooted in a set location; this lack of mobility offers far less flexibility to manufacturers with an agile set-up and evolving production requirements
- Installing cables might not always be possible in a complex factor setting. A single ethernet cable has a maximum 100-metre length. Although additional hardware, such as a fibre optic cable, can extend the operating distance up to two kilometres, there is a maximum achievable distance before data loss, or data transfer delays, are significant
- Wired networks are difficult to extend without considerable effort and disruption; this is time-consuming and costly, especially in comparison to wireless connectivity solutions
- Connecting industrial equipment to a local network brings the cost and inconvenience associated with running, tracing, and fire-proofing cables and cable trays
- Many of the technologies associated with Industry 4.0, such as AR training and remote assistance, are not practical or safely deployable with wired connectivity

2/ Wi-Fi 6

What is it?

Wi-Fi 6 is the next generation of Wi-Fi. Its advanced capabilities include 75% lower latency and four times higher capacity than its predecessor; a much higher theoretical speed of 9.6 Gbps (up from 3.5 Gbps on Wi-Fi 5); and greater flexibility, accommodating many manufacturing use case requirements. Wi-Fi 6 also brings additional security with Wi-Fi Protected Access 3 (WPA3) which aims to bolster authentication security and encryption.

Advantages

- Suitable for flexible, agile manufacturing set-ups: no cables means connectivity can move around the factory with workers - boosting efficiency and productivity
- Operates on an unlicensed spectrum, making it available to all
- Ubiquitous existing Wi-Fi solutions make for an simple upgrade path
- Deployment is often easy and requires limited technical competence (users can establish one or a few access points themselves) - although this may not be true for more complex use case requirements and configurations

- Today Wi-Fi 6 equipment is typically less expensive than its 5G counterpart (but may not necessarily have the same ecosystem of apps around it)
- Mainstream enterprise wireless solutions currently outperform 5G in terms of device ecosystem, network cost and ease of deployment

Limitations

- Wi-Fi is still mostly a “best-effort” system; its reliability and availability cannot be guaranteed making it unsuitable for anything mission-critical i.e. related to worker safety
- With wireless networks, one network is visible to the other which can affect the performance of your connection: since Wi-Fi operates on an unlicensed spectrum the possibility of interference is higher, which can result in slower speeds, higher latency, frequent disconnects and sometimes an inability to connect to a Wi-Fi signal at all
- Services will start to degrade more quickly than cellular connectivity when there is a higher number of users (although Wi-Fi 6 brings improvements for multiple users)
- Areas with high concentrations of metal i.e. reinforced walls and machinery, can block Wi-Fi
- Not well suited to use cases that require outdoor connectivity
- Wi-Fi 6 offers significant security improvements, but only offers security and assurance on the network side, making it a less secure option than wired or cellular
- Wi-Fi 6 devices require a Wi-Fi 6–compliant access point to get the full speed, latency, and capacity improvements, meaning some replacement of kit is required to get the full functionality
- With a Wi-Fi system there could be “multiple hops” as you move around the factory (whereas cellular delivers seamless coverage from the one source), impacting the speed and ease of scaling

3/ Cellular: 5G

What is it?

5G is the fifth-generation technology standard for cellular networks, operating on a licensed spectrum, either shared or dedicated. The network can provide 50x more speed, 10x less latency, and 1,000x more capacity than 4G/LTE — enabling it to connect to more devices and transmit more data than ever before, delivering fast connectivity and significantly enhanced user experiences.

Significantly for mission critical applications, for instance where loss of connectivity could impact worker safety, 5G offers high availability at 99.999%. 5G can be deployed through public networks (that anyone can use), private networks (dedicated spectrum that only your organisation can use over which you have total control) or hybrid networks (where a mobile network operator provides a slice of its own network exclusively for an organisation to use).

Critically, 5G networks eliminate many of the bottlenecks associated with applying 4G to the factory floor,

Advantages

- Suitable for flexible, agile manufacturing set-ups: no cables mean connectivity can move around the factory with workers - boosting efficiency and productivity
- Unlike Wi-Fi, 5G networks operate on a licensed spectrum, with the option to secure dedicated spectrum, offering greater reliability and minimising chances of interference
- 5G is able to pick up in areas where Wi-Fi 6 can't reach – for example, when IoT devices move outside of an indoor space, a sensor can still connect via 5G, creating flexibility for workers and augmenting a large, campus-wide manufacturing environment
- 5G is better able to support use cases with critical low latency requirements
- Better suited to mission-critical use cases than Wi-Fi due to greater flexibility in the physical level for cellular to configure performance and make intelligent trade-offs to maintain quality of service. Multiple base stations can offer even greater assurance - although this comes at additional cost
- It is also not affected by lots of metal in factory settings
- Advanced security compared to previous cellular generations, giving extra confidence to manufacturers. Cellular offers an element of certification on the network and device side, offering additional assurance compared to Wi-Fi
- Private networks - available with 5G and 4G - offer greater control and flexibility, including the ability to configure the network to your exact requirements i.e. focus on uplink
- Operating expenses are typically lower than Wi-Fi according to research from Ericsson
- Decentralised infrastructure provides 5G with a wider, less-costly means of providing connectivity to facilities in remote areas; the closeness of cell sites to industrial zones and remote areas also means more reliable access to wireless networks which is required to support Industry 4.0 business models

90%

5G NETWORKS MAY USE AS MUCH AS 90% LESS ENERGY PER BIT OF DATA TRANSFERRED COMPARED TO 4G NETWORKS.

THIS SIGNIFICANTLY REDUCES ENERGY EXPENSES, CONTRIBUTING TO A REDUCTION IN PRODUCTION COSTS OF INDUSTRIAL PRODUCTS.

Source: Nokia, December 2020

Limitations

- Comparatively high deployment costs, although an increasing portfolio of solutions should provide lower entry points
- Can be complex to install: manufacturers may also need to invest in new skills to manage private 5G networks increasing ongoing running costs
- Although improving, 5G has limited device availability, especially in certain spectrum bands
- Indoor coverage can be patchy with cellular, especially in buildings with reinforced walls. This may mean that to secure robust indoor coverage, manufacturers have to look at other vendors beyond mobile network operators and hybrid networks to secure connectivity
- While 5G offers improved security and reliability compared to previous cellular generations and Wi-Fi, fixed connectivity still offers greater assurance on both measures
- To gain the full benefits that 5G can offer, the introduction of stand-alone capabilities will be required

Identifying Your Connectivity Requirements

While understanding the advantages and limitations of each connectivity solution can help to guide your thinking, it is important to be led by the business challenge rather than start from the assumption that you need a certain technology.

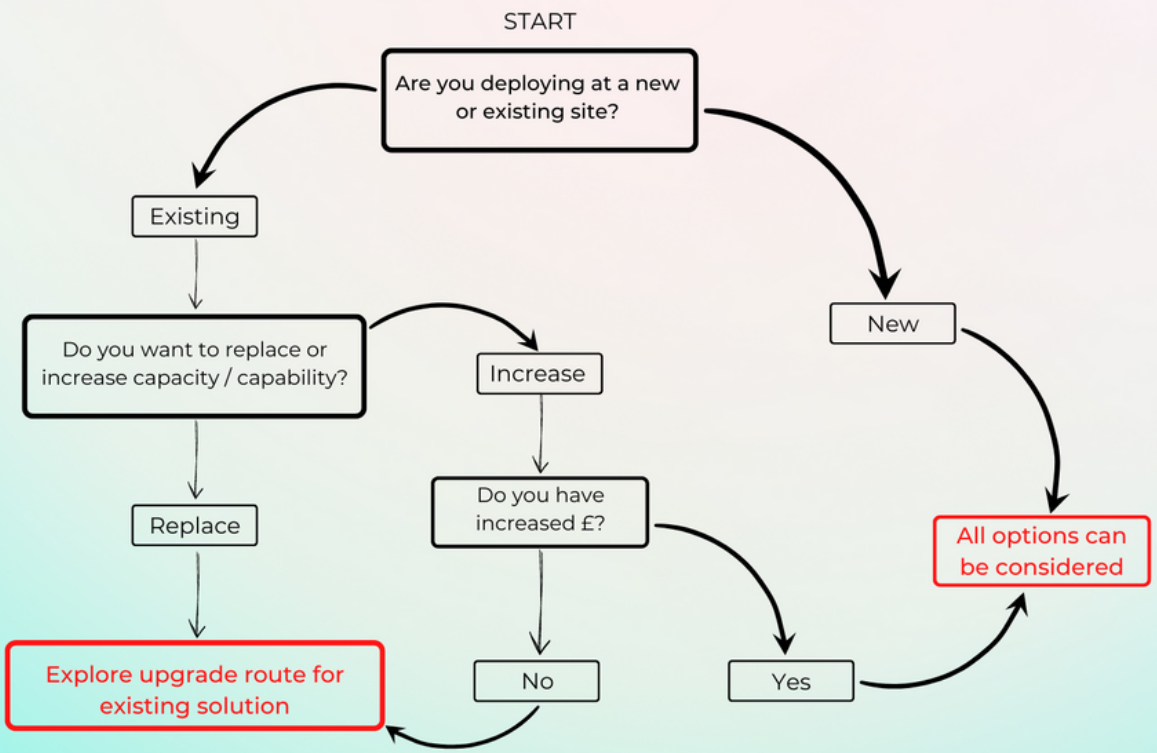
For most manufacturers, identifying your business needs and requirements is a highly nuanced process and the UK5G Supplier Directory can direct you to Systems Integrators and Consultants who can guide you through this process.

We have outlined here a decision tree to help you understand the sorts of things you will need to consider.

This is not all-encompassing - there are other factors that come into play, like whether you need public or private connectivity and what appetite your organisation has for securing a dedicated spectrum - but this has been designed to kick-start your thinking, enabling you to have meaningful and informed discussions with suppliers.

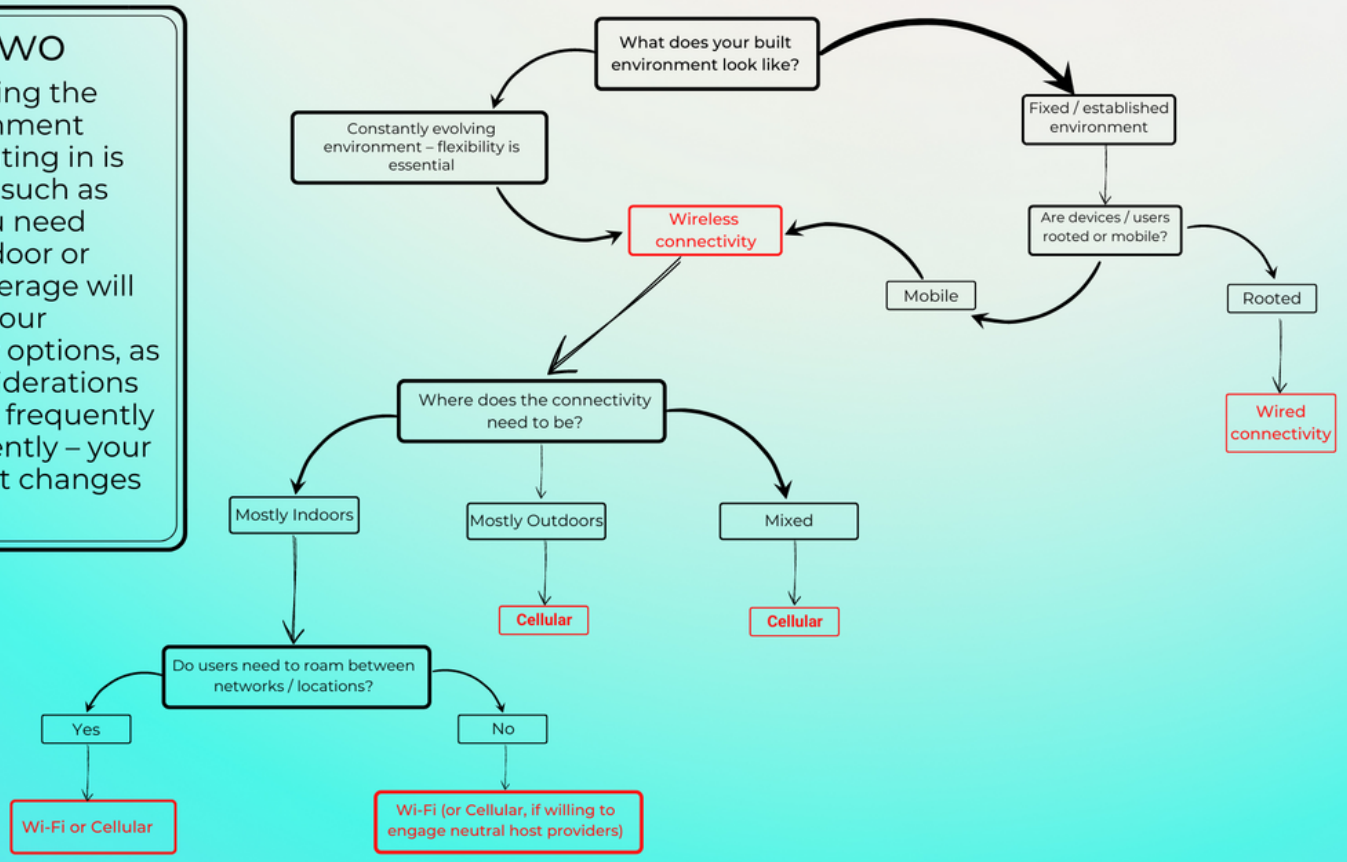
Stage One

First, it's important to identify your starting position. Are you building a brand new facility? If so, all options are on the table, but if you're looking at an existing site then you'll need to consider the appetite to upgrade and further invest in your connectivity.



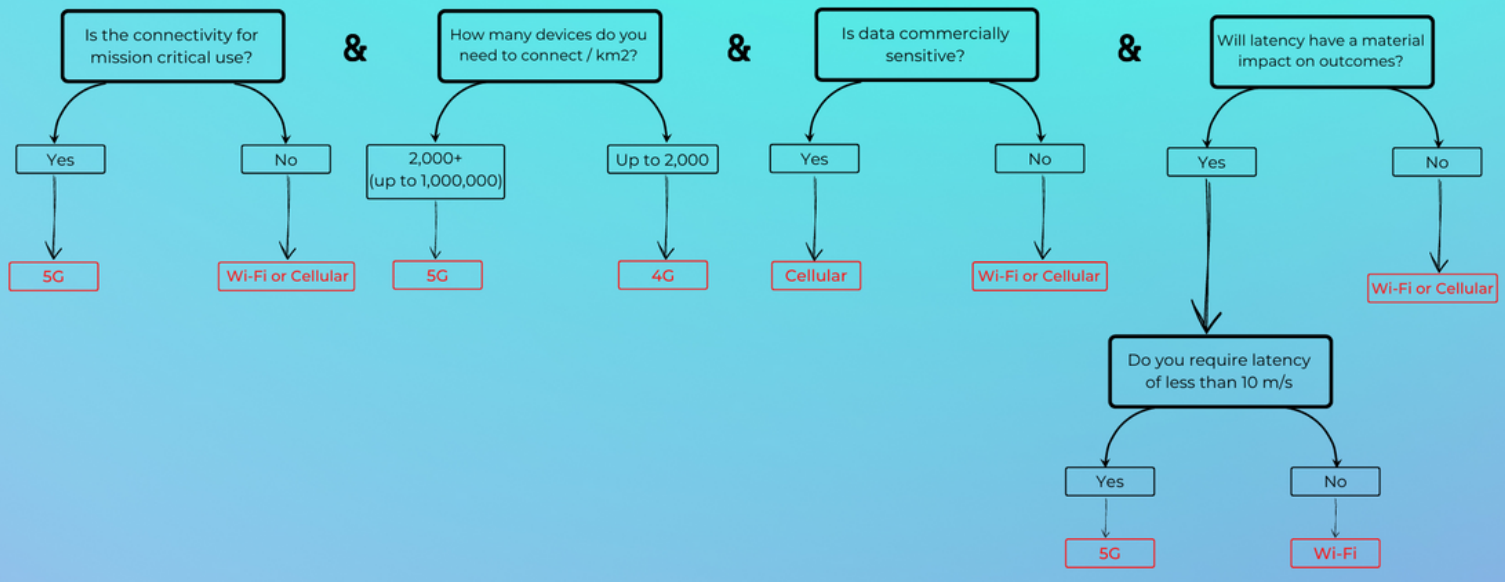
Stage Two

Understanding the built environment you're operating in is key. Factors such as whether you need primarily indoor or outdoor coverage will determine your connectivity options, as well as considerations around how frequently – or infrequently – your environment changes and evolves.



Stage Three

When assessing wireless connectivity, there are a number of factors that can influence the possible solutions available. Consideration of these factors is not necessarily linear, and the relative importance of these factors will vary across organisations. Unlike stages one and two therefore, the factors here should be reviewed in parallel.



Exploring use cases

Hopefully by now you have a better understanding of the key connectivity solutions available and the sorts of questions you should be asking to define your needs.

Of course, there is no such thing as the perfect connectivity option for a particular use case, it really does depend on a combination of factors that will be specific to each organisation, including the solutions you already have in place; the skills you have internally; the broader set of use cases you want to deploy; your appetite to innovate; and of course, available budget.

Looking across your organisation as a whole, it's likely that a blend of connectivity solutions will be most appropriate and solutions such as 5G and Wi-Fi.

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Below is a list of some key manufacturing use cases and a guide as to which connectivity solutions could deliver those use cases.

This should provide a useful starting point for your own considerations and discussions.

Use Case	Wired	Wi-Fi 6	4G	5G
AR/VR		X - although increased latency may cause "motion sickness" feeling for users		x
Industrial IoT		x	X - with limitations in the number of sensors that can be connected within an area	x
Digital twins		X - unlikely to be suitable for scenarios with a real-time critical interaction between the digital twin and the physical element	X - with limitations in the number of sensors that can be connected within an area	x
Quality control: machine vision, robot inspections etc.		X - may not be best suited for environments where robots need to safely move around human workers	X - unlikely to be suitable for high value manufacturing with the need for rapid intervention or for environments where robots need to safely move around human workers	X - particularly suited for high-value manufacturing where rapid intervention has significant financial benefits, and use of robots for inspections in areas with human workers (for collision avoidance)
Robots / drones / cobots	X - fixed robots / cobots only e.g. robotic arms	X - robots and cobots only		X - robots, cobots and drones
Surveillance	X - mission-critical / safety-related	x		X - mission-critical / safety-related
Connected & autonomous vehicles including remote operation			x	X - remote operation and ability to intervene in case of emergency
Supply chain				x

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