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Is ultra-low latency critical to the 5G business case?

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Executive Summary

It is clear that 5G needs to be far more than merely a much faster 4G, to justify the huge investments that operators will make in these networks in the 2020s. A significant aspect of the return on investment (ROI) case for 5G rests on its ability to take a dramatically enhanced role in the enterprise, industrial and government sectors. By enabling or accelerating their digital transformations, 5G will deliver new monetization opportunities to operators, and a bigger role in enterprise value chains.

In a survey of 86 operators, over 70% said that brand new revenue streams, mainly from enterprise, would be critical to their 5G business case. But achieving those new revenues will depend on deploying 5G in a new way – one in which network investment and optimization focus on more than data speeds, and focus on 5G's most important differentiators. Foremost among these is the ability to support ultra-reliable low latency communications (URLLC), which will underpin a host of entirely new applications for enterprises and consumers. By guaranteeing an extremely rapid response to data requests (below one millisecond for many applications), and enabling mission-critical reliability, 5G will open up many high value use cases for enterprises and operators.

While URLLC has often been associated with public safety or emergency response, its value reaches well beyond life-critical applications. It can greatly enhance the experiences and processes in a wide range of sectors, from next-generation immersive gaming to mobile factory robotics and drones generating real time data streams.

However, to support most of these use cases will require more than just deploying a 5G network that conforms to the latest release of 3GPP specifications. These do address the sub-millisecond latencies that 5G standards require, but there are many ways to implement and optimize the networks, to deliver optimal, differentiated performance for a wide range of applications and sectors. Achieving that extremely optimized network performance requires significant investment, which must be justified by the potential for operators to monetize the emerging URLLC use cases.

The areas where uptake may be highest and fastest – particularly in immersive gaming and entertainment - may not, necessarily, support the strongest business case for 5G operators, if users have limited willingness to pay a premium, or the value chain is dominated by non-operators.

Many operators are currently evaluating which industries and applications will open up the most immediate and promising monetization opportunities. Areas where near term demand for URLLC is combined with high revenue potential for operators include healthcare and smart cities, while in the medium term, manufacturing and logistics use cases related to robotics and drones look promising.

These 'driving use cases' can support an accelerated ROI case for URLLC, and the resulting network can, in time – and when combined with other advances like network slicing – support a greatly extended range of applications in many sectors.

This paper examines the use cases where enterprises believe URLLC will have the biggest impact on their businesses, and where the richest base of driving use cases may be found for operators in different markets. The findings are based on surveys of 86 operators and over 100 enterprises (see below), about their deployment plans and business cases for 5G, and particularly their requirement for URLLC.

It emerges that URLLC will be required, or desirable, in a wide range of use cases, and operators will benefit from adopting a multi-layered approach. This can initially make the ROI case based on near term, moderate value opportunities in sectors such as smart cities. The return on investment in the URLLC network can then be enhanced by the addition of high value, critical use cases, which may take longer to emerge; as well as by broadening the platform's reach to lower value, but high volume consumer applications.

This investment will not just deliver additional revenue opportunities but other commercial benefits such as reduced churn or higher enterprise customer satisfaction.

To target these business benefits, operators need to start planning now for ways to deploy 5G with full support for URLLC, and that will entail important choices about underlying technology and optimization.

NOTES ON THE DATA SOURCES

This white paper was commissioned by AccelerComm from Rethink Technology Research. The key findings of this paper are based on two surveys conducted by Rethink in the second quarter of 2020. One asked 86 service providers about their deployment priorities, use cases and business models for 5G in the period from 2020 to 2026. All respondents were planning to deploy 5G commercially and at scale during that period. The second survey was of over 100 enterprises in Europe, North America and Asia-Pacific, across multiple vertical sectors, about their requirements from 5G, to support their key use cases in the period to 2025.

The importance of very low latency in 5G

Much of the excitement about 5G has been about its versatility. For the first time, a mobile broadband network would be designed, from the outset, not just to deliver higher data rates, but to support other requirements for wireless connectivity, particularly those coming from industry.

As many sectors embarked on digital transformation and Industry 4.0 initiatives, enterprises were asking for wireless capabilities which were typically only available on expensive, proprietary networks. Support for massive numbers of devices, enhanced security, ubiquitous coverage – all these were important, but the capability that would really differentiate 5G from other networks was ultra-reliable low latency communications (URLLC).

To support URLLC applications, there are challenging requirements for low latency – the time between a data request and a response. According to the IMT-2020 requirements, which underpin 5G standards, end-to-end latency should be 4 milliseconds or less (sub-5ms) for an enhanced mobile broadband application, but less than 1ms for URLLC (E2E latency refers to the time from source to destination, or the outward half of the data request's round trip).

Of course, there is a gap between specifications and real-world commercial implementations, and achieving sub-1ms latency is a significant challenge for vendors and operators. The complexity and cost of deploying a network capable of URLLC must be justified by the potential commercial upside this enables.

So, as commercial 5G networks roll out and users start to test the real world experiences they enable, is URLLC really as important as anticipated, and how does it impact on the 5G business case for operators and for enterprises?

This paper will focus on why these measures to reduce latency matter to businesses of many kinds, and how 5G helps to enable their requirements. It will also examine how 5G can best be implemented to minimize latency, what investment that will require from operators, and how it will impact on their commercial differentiation and opportunities, especially in enterprise markets.

WHAT IS LOW LATENCY?

From an end user's point of view, latency describes the delay between an application requesting data and receiving it. End-to-end 5G latency refers to the outward journey – from source to destination; the full round trip involves other factors such as Internet speed.

Lower delays can greatly impact on the quality of experience for services such as interactive gaming and make them more realistic. In industrial settings, low latency is important in the rising trend to use near -real time streams of data to make AI-supported decisions – supporting a remote engineer on an industrial site, or controlling mobile factory robots in real time, alerting vehicles to the best route in a city, are examples.

In services that require absolute reliability, such as emergency response, the low latency needs to be coupled with critical availability so that the required level is guaranteed, resulting in URLLC.

In wireless communication terms, low latency relies on the time it takes for the request and response to make the round trip from the device. That involves three stages in the journey:

- Air interface latency – this is the time from the data being available at the base station to send and being passed to the application within the device. The time includes all the processing within the base station and the device. This is targeted to be reduced to between 1ms and 4ms in 5G, from 10ms in LTE.

- End-to-end mobile latency – this includes the whole journey from device to cell tower through core network and gateways to the Internet point of presence. This is targeted to be reduced from 30-50ms in LTE to below 1ms for the most demanding 5G use cases.

- Round trip Internet latency – this is the total time from, for instance, input from a game player, to the time that input is seen by the game server in the cloud.

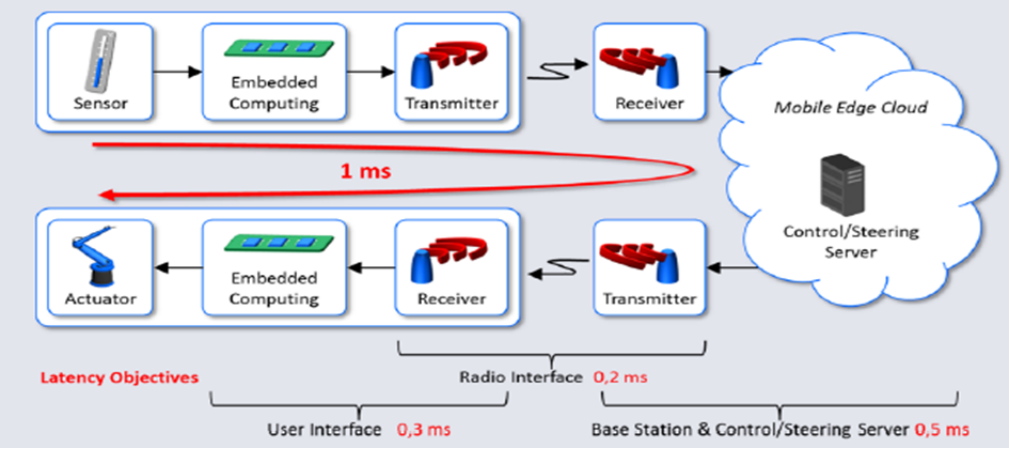


Figure 1. Typical latencies for different types of mobile application

Achieving the minimum latencies in the first two cases relies on a combination of factors:

- The 5G standards, particularly specifications in 3GPP Releases 16 and 17 (and beyond) specifically address air latency and end-to-end latency in the RAN and 5G core.

- Like any standards, these will only have the maximum effect on real world performance if they are implemented in the most efficient way. Part of this relies on optimal engineering in the radio itself – for instance, the most efficient implementation of key technologies such as forward error correction (FEC).

- End-to-end latency also relies on engineering the whole network in a new way, with all the links between devices, radios, cores and gateways optimized for rapid response.

Of course, when considering round trip Internet latency, factors such as the efficiency of the website are out of the control of the 5G operator. In critical applications, this will be addressed in two ways. Some 'IoT' applications will not rely on the Internet at all but on fully controlled data and processing. Those that do use the Internet, or other external sources, will increasingly rely on 5G being integrated with edge computing, so that data processing and storage takes place closer to the end user, reducing delay.

IS URLLC REALLY CRITICAL TO 5G BUSINESS CASE?

The 5G standards, as explained, enable operators to deploy their networks with far lower guaranteed latencies than was previously possible with a wireless platform. However, merely deploying 5G base stations does not automatically deliver sub-5ms air latency, let alone 5ms end-to-end mobile latency. These will require careful engineering and optimization of the network, from selecting radios that support the most advanced technologies to minimize latency, to planning the end-to-end paths for data and signalling.

That entails additional upfront and operational cost, compared to deploying a generic mobile broadband (MBB) network (see Chapter 3). In 4G, and early 5G, most networks have been implemented in an MBB-focused way, to deliver maximum data rates and capacity, and maximum cost efficiency, for generic mobile broadband usage such as content streaming.

But operators recognize that, for many of them, these 'fat pipes' will not be sufficient to deliver on key KPIs such as market share increase, increased ARPU (average revenue per user), or ROI (return on investment). In a recent survey of 86 mobile, converged and private network operators, conducted by Rethink Technology Research in the third quarter of 2020, 72% of respondents said that brand new revenue streams were 'essential' or 'very important' to justify their investment in 5G networks.

Among those operators, two-thirds believed some incremental revenues could be achieved by differentiating their quality of experience (QoE) for existing services – for instance, a richer experience for video, gaming or

augmented reality applications. But over 80% said they would also need to address new enterprise use cases in order to make the 5G business case add up. In both cases, lower latency was considered important to supporting those new revenue streams (Figure 2).

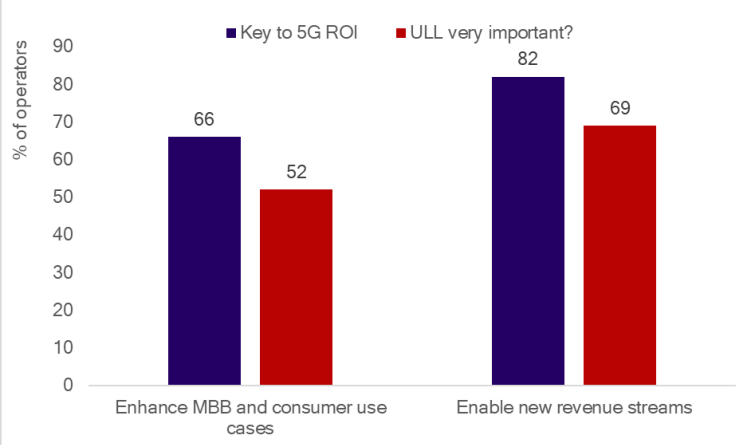


Figure 2. Key strategies to achieve 5G return on investment within 5 years of first commercial deployment, and the importance of very low latency

When will the key demand for URLLC be found in the near term?

Figure 2 highlighted the potential importance of URLLC in the 5G business case, and that for many operators, the biggest opportunities lie in the enterprise and industrial markets. This is because 5G, unlike its predecessors, will enable many industries to implement applications and processes that are impossible to achieve with other fixed or mobile connections, particularly those that require URLLC combined with high speed mobility and ubiquitous coverage – capabilities that are not supported by fibre.

To date, these opportunities have been relatively untapped by mobile operators, even to support enterprise use cases that can be enabled by 4G. They provide cellular devices and data plans to companies, of course, and many innovative businesses have been built on smartphone applications. But 3G and 4G have rarely provided the primary infrastructure for applications requiring critical availability and performance. This was partly because the older standards lacked certain key capabilities, such as low latency response, and partly because the networks were often not deployed to reach deep into buildings, which limited usability.

In 5G, there is a wider diversity of capabilities, as outlined above, and the demand from enterprises is growing as they embark on digital transformation processes, which often require users, machines, vehicles and sensors to be connected everywhere they go. That will drive demand for 5G, and should make it more worthwhile for operators to invest in optimized connectivity and indoor coverage (see Chapter 3).

But before operators make the decision to invest in additional capabilities, geared to industrial requirements, they will need to be confident that the demand really will materialize, along with the willingness by enterprises to invest in the new services, and in what timeframe that will occur.

DEMAND FOR LOW LATENCY IS NOT CONFINED TO CRITICAL SERVICES

Rethink conducted a survey of over 100 enterprises in developed economies in mid-2020, to assess the level of requirement for networks with sub-5ms latency, and when this requirement is likely to become important to their businesses. The results reinforce the finding that, though URLLC is often associated with relatively niche opportunities such as public safety, in fact, URLLC demand is considered important for a wide range of industries and use cases. In fact, the sectors which indicate they need sub-5ms capabilities in the near term (between now and the end of 2022) are led by a sector which does not have critical availability requirements - entertainment, arts and sport.

Indeed, this sector will drive many of the early deployments of services that are enhanced by very low latency, especially in the application of augmented and virtual reality (AR/VR) to cloud gaming, immersive sports and other consumer applications. However, as we will argue in Chapter 3, in many markets, these will be the most challenging applications for mobile operators to monetize effectively. This paper will focus primarily on B2B and industrial applications, whose overall market size may be smaller, but where profitability potential, and the value chain

role available to the operator, will often be larger. That, in turn, will provide a more attractive return on investment (ROI) case.

As Figure 4 shows, about half of enterprises surveyed in this sector say they will need sub-5ms connectivity (in line with IMT-2020 requirement for 4ms latency or less for eMBB applications) by the end of 2022 in order to deliver defined and quantified business benefits such as increased revenues, larger addressable market or expansion into new applications. The figure rises to about 80% by the end of 2024.

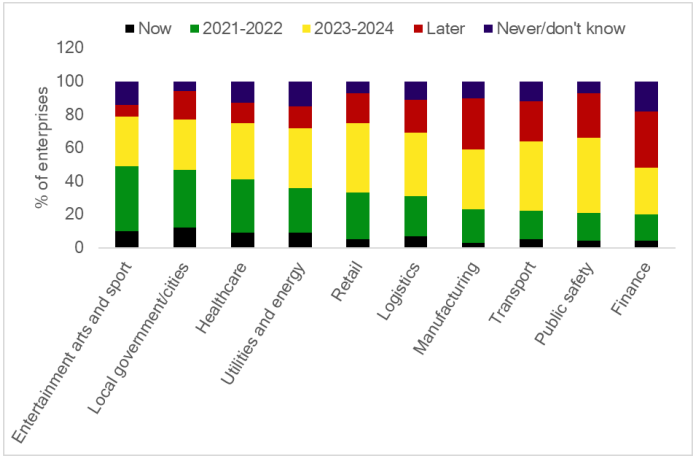


Figure 3. Timescale in which enterprises believe they will need sub -5 ms capabilities, by sector (Source: enterprise survey)

The sectors which came next in terms of their urgent need for lower latency wireless connectivity were local government including smart cities, and healthcare. In both cases, at least 75% aim to be harnessing sub-5ms 5G connectivity before the end of 2024 to support new or enhanced services and business processes.

Both these sectors are examples of industries which do have some mission critical applications, which might require even lower latencies, coupled with ultra-high reliability. However, the survey revealed that typically, the first applications to use URLLC would be less critical, and often in the 1-2 year timeframe, while the URLLC services would be phased in a little later, often in 2023 or 2024. In local government, for instance, interactive and AR-enhanced citizen and tourist services would typically be introduced before wide-scale intelligent transport routing.

FOR SOME SECTORS, HOWEVER, GUARANTEED URLLC IS ESSENTIAL

For the most critical applications, URLLC 5G connectivity becomes essential rather than a 'nice to have'. Figure 5 indicates the sectors which consider sub-5ms (or even lower) latency to be essential to their emerging applications and business processes. In some cases, the new connectivity is considered essential to accelerate changes that are already happening, and in others it will enable something new.

This reveals a very different pattern of adoption between the verticals. The leading industries – public safety, transport, manufacturing and energy - share certain characteristics. They are all sectors which make heavy investments in infrastructure, often critical in nature; are undergoing significant process transformations to introduce automation and digital intelligence; and require very wide coverage, directly or to link to their supply chains and customers.

The two sets of results show that there are two layers of URLLC demand – to support business critical processes and to support service enhancement. Entertainment companies may be leading the way in offering URLLC-enhanced services, for instance, but these will accelerate their business expansion rather than being fundamental to it. By contrast, some use cases in the safety, manufacturing or energy sectors would be impossible without guaranteed URLLC.

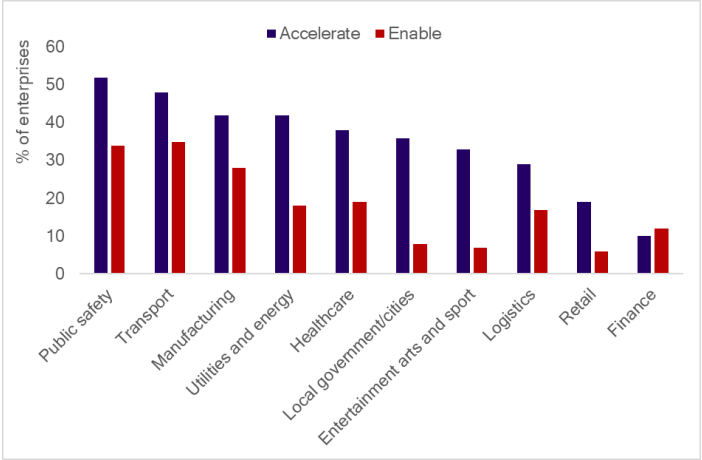


Figure 4. % of enterprises for which sub-5ms latency is an essential requirement for 5G, and those which would accelerate their adoption if supported

And in each vertical, there are many use cases which can be enhanced or enabled by very low latency levels. There may be a key 'driving use case' which decides the level of spending and urgency that each enterprise will place on low latency connectivity, but most organizations indicate that, once they have access to these high-quality networks, they will leverage them to enhance a rising variety of applications.

The diversity of what a URLLC 5G network may be asked to support is highlighted in Figure 6, which summarizes the top five use cases that were selected by survey respondents in four leading verticals. From the operator's point of view, this will make it important not just to deploy very low latency 5G, but to ensure it has a full platform in place that can support a wide range of application behaviours, developers and partners.

Public safety	Transport	Manufacturing	Healthcare
Image recognition	V2X	Mobile robots	Remote consultation
Surveillance drone	ITS	AR support	AR training
Rescue robot	Platooning	Digital twin	Telerehabilitation
ADAS emergency vehicles	VR navigation	Autonomous vehicle	Robotic rehabilitation
Smart ambulance	Transport drones	Predictive factory floor	Real time AI diagnostics

Figure 5. Top 5 use cases selected by respondents in 4 sectors – those in which URLLC was considered most important. Source: enterprise survey

How does very low latency fit into a successful 5G operator business model?

The 'two-layer' nature of URLLC adoption – for enabling critical requirements and for enhancing non-critical services – is good news for operators since it indicates that there is a diversity of demand for URLLC capabilities, so their return on investment will not be wholly reliant on a relatively small number of absolutely critical applications.

This is an important point. When 5G standards were first being discussed and defined, ultra-low latency was the 5G capability that gained the greatest level of attention, mainly because it would enable cellular networks and operators, for the first time, to provide a more flexible alternative to fiber in mission critical applications in sectors such as public safety. But while these markets hold out the promise of high value pro-

jects, they are relatively small and specialized. For many operators, a bigger addressable market will be needed to encourage the investment in a network optimized for URLLC.

In fact, as the enterprise survey indicated, low latency plays a part in each of the three points in the famous triangular vision of 5G use cases, set out by 3GPP and NGMN (see Figure 7), which splits use cases into eMBB (enhanced mobile broadband), URLLC (ultra-reliable low latency communications) and mMTC (massive machine-type communications).

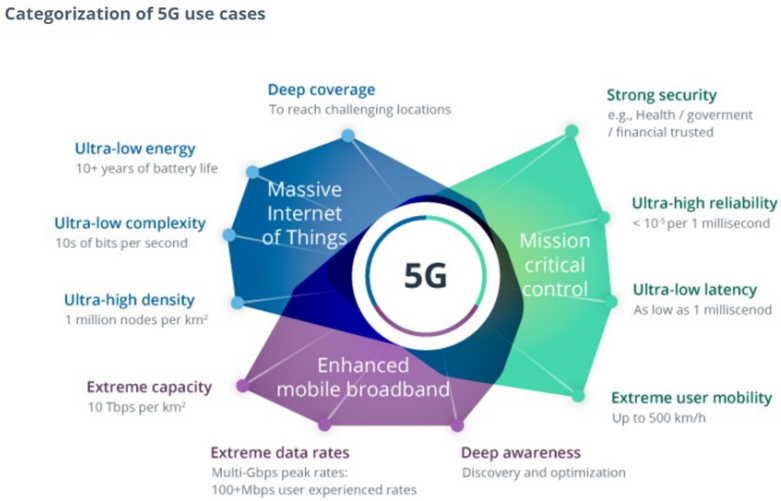


Figure 6. Categorization of 5G use cases (Source: 3GPP/NGMN)

While URLLC has garnered most of the attention when it comes to latency discussions, in fact, URLLC is also highly relevant to enhancing use cases in other use case categories too.

These may not require critical response, but shorter delays can greatly enrich the experience of mobile broadband applications such as interactive gaming. And while the massive MTC category is focused on supporting vast numbers of devices and sensors, the more enterprises rely on near-real time flows of data from these end points, to support AI-enhanced decisions for applications such as predictive maintenance, the more a fast response will improve the results, and therefore add to the operator's value and differentiation.

INVESTMENT IN URLLC WILL HAVE A BROAD ADDRESSABLE MARKET

This diversity is important to the operator's business case, because deploying URLLC comes with significant ROI considerations of its own (see 3b). There will be additional cost compared to rolling out a mobile broadband network alone, therefore it is clearly important that the broadest possible addressable market can be targeted.

Figure 8 indicates how the addressable revenues in the core URLLC market can be supplemented, once an operator has invested in an optimized low latency network, by differentiating itself for less critical URLLC enterprise applications, gaining market share in that burgeoning sector. Rethink forecasts that the URLLC market, in terms of telco revenues from connectivity and associated services, will be worth $42bn globally in 2026, up by a CAGR of 95% from 2021, the first year when we expect to see meaningful 5G-enabled revenues in this market.

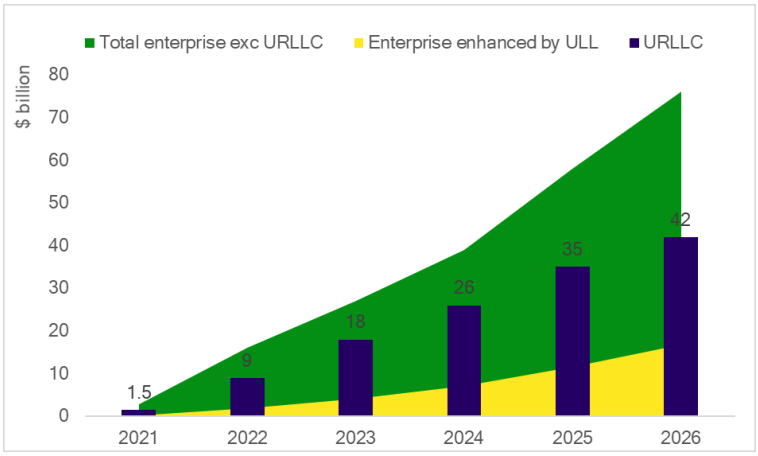


Figure 7 Projected 5G revenues from enterprise and URLLC, with the proportion of non-URLLC enterprise market where URLLC will be a significant differentiator

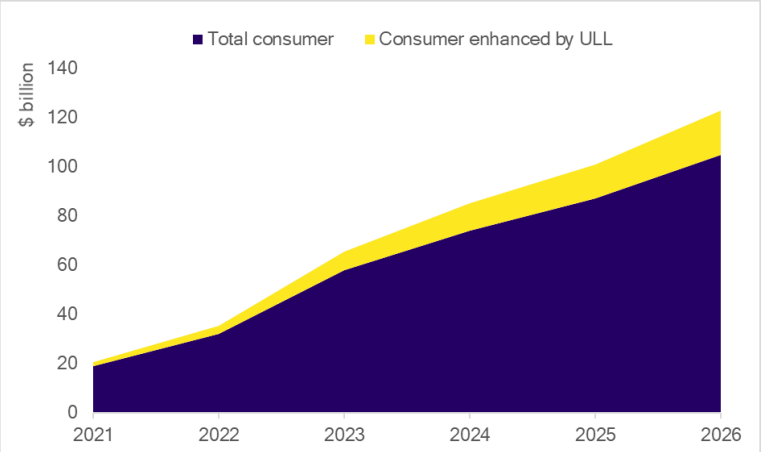
But operators with a high-quality low latency network will also be in a strong position to address other enterprises which are increasingly placing value on URLLC response, even for non-critical applications. We calculate that, in an enterprise 5G market that will grow by 94% CAGR to $76bn by 2026, services that will be enhanced or enabled by URLLC will be worth $16.7bn, or 22% of the total, and will have a CAGR in 2021-2026 of 127%.

The same pattern is seen in the consumer and B2C market (Figure 9). Although this paper has focused on B2B use cases, there are many applications in operators' more established consumer markets which can be enabled or enhanced by URLLC. In a few markets, such as South Korea, consumer willingness to pay a premium for advanced multimedia experiences such as AR/VR gaming may justify investment in URLLC in

its own right. For many operators, having implemented URLLC to support targeted B2B customers, the ROI can be improved further by extending the capabilities to consumers, perhaps in a separate 'network slice'.

In the B2C sector, the addressable market where a URLLC-capable 5G network will be a clear differentiator will reach 17% of the total by 2026, by our modelling – a smaller percentage than in the enterprise, but in a larger total market. By 2026, operators' consumer 5G revenues will reach $105bn, a CAGR of 41% since 2021, but those enabled or enhanced by URLLC will be worth almost $18bn, and will have grown by 64%.

Figure 8. Projected 5G consumer and B2C revenues, with the proportion where URLLC will be a significant differentiator



DIFFERENT LEVELS OF LATENCY AND CRITICALITY WILL REQUIRE DIFFERENT LEVELS OF INVESTMENT

To target the full diversity of markets where URLLC will be a significant differentiator requires a strong ROI plan and willingness to invest upfront in the most advanced technologies to deliver very low latency response.

A generic 5G deployment will deliver some latency improvements because of the efficiency of the radio standards, but to support demanding URLLC requirements, additional engineering cost and effort will be required.

Some network equipment will boast lower latencies or better guaranteed levels, because the vendor has chosen components that optimise this area of performance. For instance, error correction is essential to

ensure reliability of a transmission despite interference or poor signal strength. The technologies to enable error correction, such as channel coding, have been greatly enhanced in the 5G standards to improve accuracy and reduce delays. However, these standards can be implemented in different ways – AccelerComm's error correction IP can be configured to significantly reduce latency enabling support of numerology 3 for the most advanced 5G networks.

There are other investment considerations beyond selecting premium equipment. URLLC applications often require far more ubiquitous network coverage than mobile operators typically provide, even reaching into underground or very remote locations. Some enterprise URLLC services may require only localized optimization of connectivity, perhaps from an edge node to a campus, but others are network-wide – gamers who have chosen an operator for its improved quality of experience will expect to find that wherever they go.

The operator, then, needs to decide on the right investment priorities to maximize the ROI, which means being confident about the use cases that will deliver strong revenue or market share uptick in its particular environment.

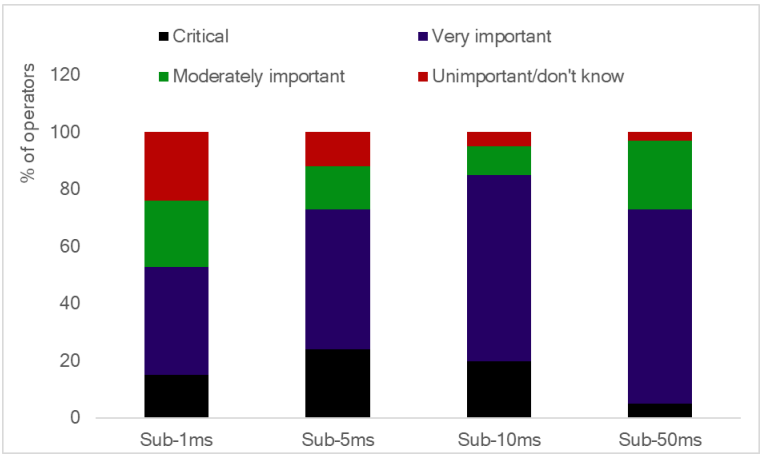
Of course, there will be different maximum latency rates that different applications can tolerate, as well as different surrounding network requirements such as coverage or rapid mobile hand-off. In each case, operators will decide whether the build-out and optimization costs for supporting a particular use case align well with the revenue opportunity.

Figure 9. Typical round trip latencies required by different use case categories

Round trip latency	Typical use cases
≤1ms	Mobile factory robotics Motion control Tactile Internet
3-5ms	Smart grid Intelligent transportation
6-20ms	Automated guided vehicles Remote control
100ms	Process automation
350ms	Speech recognition
500ms	Facial recognition
800ms	Standard Internet search

Figure 10 indicates typical latencies required for different classes of application, from sub-1ms, real time applications such as factory control to standard Internet searches, which can be effective at latencies of 800ms or more.

Figure 10. % of operators considering various levels of low latency to be critical or very important to their business models by 2025



The operators which responded to our survey were already evaluating the cost/benefit analysis for the various levels of latency. As Figure 11 shows, two-thirds consider that implementing more stringent latency levels than in LTE is very important to their 5G business case – 65% said this of sub-10ms latency, while 20% said that sub-10ms was critical to their business.

And almost half consider the more challenging latency levels, below 5ms, to be very important, with 38% believing that sub-1ms would be very important. A total of 39% believe that either sub-5ms or even sub-1ms latencies will be critical to their planned business models, because such capabilities will enable them to target the most demanding, and therefore high value, applications, as well as the broadest range of sectors, while providing a clear point of differentiation from rivals.

COSTS MUST BE WELL ALIGNED TO THE VALUE OF THE TARGETED APPLICATIONS

Of course, there is little revenue potential or differentiation in supporting a slightly faster Internet search. The 5G business case, for operators which want to expand into new user bases, is increasingly weighted towards the applications in the sub-5ms class. This entails a different assessment of cost, risk and return than a familiar MBB deployment.

A network that is tailored to support URLLC will typically be the most costly to deploy. According to the survey, operators would expect a nationwide URLLC-capable network to incur 10% to 12% additional cost compared to a generic MBB-capable deployment, and about 6% compared to a network optimized for non-critical low latency applications such as VR/AR gaming.

But set against the cost premium of the most advanced URLLC networks, are the high value of some contracts that require full reliability and the lowest latencies, and these networks will also be able to support all the other, less critical low latency applications, adding to their revenue potential.

In this ROI assessment, 76% of the operators surveyed, which plan to enable URLLC, said that network slicing would be key to the business model. That will enable them to partition a virtual, optimized slice of the 5G network to dedicate to the mission critical use cases and customers, while still enabling URLLC in other slices to support gaming or less critical enterprise applications. This means a network could be virtually sliced to support different use case categories, including a dedicated slice for public safety, whose communications would typically have to take priority over everything else, and for other URLLC users. Additional slices might be provisioned to support other industrial URLLC applications, and for consumer applications requiring very reliable response, such as immersive cloud gaming. In time, operators envisage deploying large numbers of slices, such that individual enterprises might have their own connectivity, fully tailored to their needs; and these might be dynamically provisioned to meet an application's latency and bandwidth needs at any one time.

A URLLC NETWORK SHOULD DELIVER MORE BUSINESS CASE BENEFITS THAN REVENUE ALONE

As in any good business case, the ROI for investing in a network with ultra-low latency capabilities will not rely entirely on increased revenue potential, though this will be central. Those operators which are considering investing in URLLC capabilities that go beyond the baseline supported in 5G are targeting an array of other tangible and intangible benefits.

The main KPIs, apart from revenue growth, that the operators said were impacted by URLLC related to (Figure 12):

- quality of experience and brand new experiences, which help drive usage levels and satisfaction, especially among consumers
- increased strategic position and penetration in enterprise markets
- more efficient use of network resources, which in turn reduces opex
- ability to shift the balance of the business towards higher value customers and services, which impacts on profitability
- reduction in churn, especially in enterprises

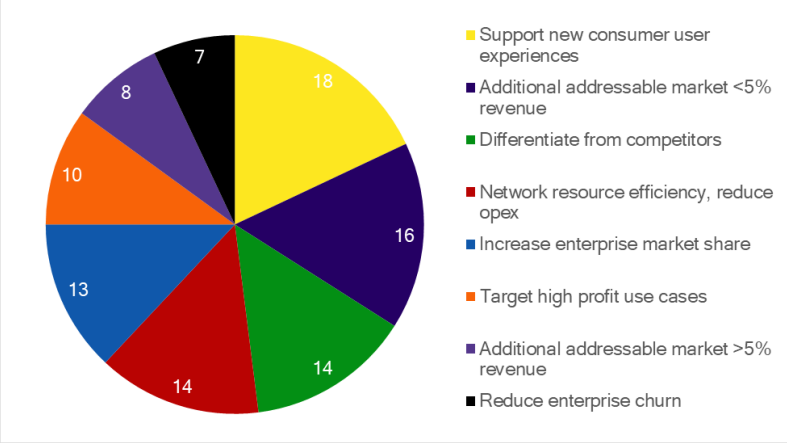
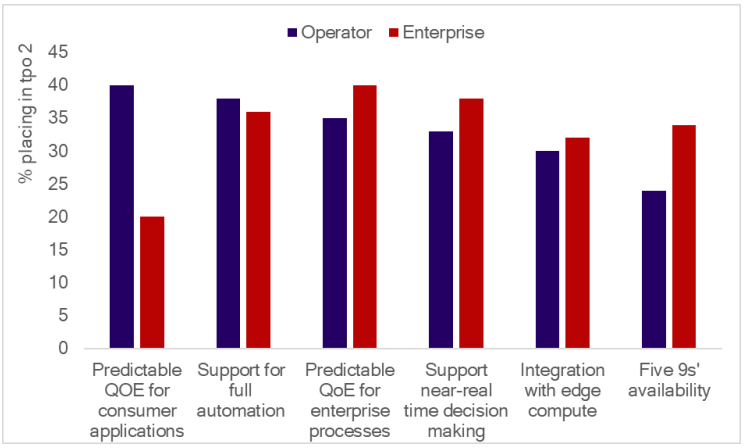


Figure 11. The most important KPI to which URLLC will contribute by 2025 - % of operators (respondents were first asked to name all the relevant KPIs. They then ranked a list of the eight KPIs cited most often).

This list reminds us that, while expanded enterprise revenue is the overriding commercial motivation to enable URLLC, for most operators, there are also important benefits for the MNOs' more established business cases. In implementing URLLC-optimized 5G, often in conjunction with edge computing, operators can support the needs of enterprise customers (B2B and B2C), but also enhance quality of experience for their own direct consumer subscribers.

Figure 13 shows some contrast in how enterprises see the benefits of URLLC, compared to the operators enabling it. When asked to name their top two commercial benefits from URLLC, 40% of enterprises chose predictable QoE for their own internal processes, especially where these were mission critical (such as their industrial control or infrastructure monitoring systems). This was followed by support for real time decision making (38% placed in the top two) and 'five 9s' availability – a subset of QoE which underpins many critical applications (34%).

Figure 13. Most important commercial enhancements enabled by URLLC – operators and enterprises



For operators, the most important commercial impact will come from predictable QoE for consumers, for applications such as VR/AR gaming or high-quality video streaming. Among enterprises, even those supporting B2C services, this took a lower priority than support for critical internal or supply chain processes. Both groups rated support for full automation of networks, operations and assets as a key benefit.

This final finding sounds a note of caution – there is a challenge for operators to ensure they build networks that can support their enterprise customers' priorities as well as their own, even where these may be somewhat different. This is more about the surrounding infrastructure and applications – a URLLC network can equally support high quality interactive gaming and industrial robotics, but the choice of locations for cell sites and edge nodes, the developer tools, and the surrounding service platforms will be very different.

Some operators may choose to focus their URLLC capabilities on very specific verticals, or just on differentiating their own consumer services. But there is far greater potential for those which build up a diverse set of applications and partners on top of their URLLC 5G connectivity, and those which think ahead to architectural innovations such as network slicing. A joined-up approach based on the foundation stone of optimally deployed URLLC capabilities will deliver a rich variety of benefits for operators and enterprises.

Conclusion and key recommendations for service providers

This paper has demonstrated that URLLC can greatly enhance the business case for 5G, despite the additional investment required to support these capabilities optimally. Operators which make this commitment will have significant opportunities to generate new revenue streams, to take an enhanced role in the value chain in many industries, and to differentiate themselves from competitors.

To achieve these commercial benefits will require careful planning and evaluation of the operator's specific market landscape. A generic approach, either to technology or use case prioritization, will not suffice. Successful operators will communicate now with enterprises and associated ecosystems to understand their requirements and identify the verticals and use cases in which near term demand is combined with high monetization potential and an open value chain. These driving use cases will then deliver a successful first-stage ROI case for URLLC, and the basis of a platform on which a far wider range of industries, applications and revenue streams can be supported.

About AccelerComm

AccelerComm is the company supercharging 5G with Optimisation and Latency Reduction IP. It provides LDPC, polar and turbo FEC solutions which enable optimal performance of communication systems and solves the challenges that would otherwise limit the speed of 5G, namely the error correction decoding that is required to overcome the effects of noise, interference and poor signal strength. For more information please visit: www.accelercomm.com

ACCELERCOMM
SUPERCHARGED WIRELESS

Bristol & Exeter House
Lower Approach Road
Temple Meads
Bristol
BS1 6QS
United Kingdom

Tel. +44 (0) 1173 291480
Tel. +44 (0) 1179 257019

www.rethinkresearch.biz

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