Road to 5G Outlook 2016

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Welcome

Five Alive

Ok, it might be a bit too early to say that 5G is alive, but believe it or not the once embryonic concept is not too far away from being delivered. Least, that's what today's telecommunications industry is pinning its hopes on. In today's technology industry there exists a constant striving for the next big thing; not only from a societal expectation perspective, but perhaps more significantly from a business management and revenue generation angle.

5G will be the next big thing, its future "bigness" is yet to be fully understood, but it in all likelihood its impact hasn't been understated. As consumer and enterprise-ready technologies continue to develop at an ever-increasing pace, a whole new generation of goods and services await enablement from the next generation of wireless technology. There are fewer greater examples than that of full-scale global IoT, or the rapidly increasing popularity surrounding Virtual Reality and its expected impact on gaming, commerce, and perhaps most significantly the mobile network.

This report, produced by Telecoms.com Intelligence, aims to help set the scene on current attitudes towards the successor to LTE, as well as a deep dive into expected B2C and B2B services, whilst also considering challenges around the network itself and the radio requirements it brings with it.

To gain the view points of the Telecoms.com audience, we ran an in-depth questionnaire with more than 800 industry professionals; the data from which features heavily throughout this report, to ensure that you are being provided with the most current perspectives of a global telecoms audience.

The following whitepaper will, hopefully, shed some light on what your industry is doing at the moment, what it wants from 5G and how it plans to get there.

We hope you find this report useful in laying out your roadmap for 5G.

Many thanks,

Tim Skinner

Tim Skinner
Head of Intelligence
Telecoms.com

Attitude problems

Key takeaways:

5G will be here before 2020

according to half of the respondents, indicating a nearer-term launch date than commonly believed.

Massive IoT support is the most important feature of 5G

according to exactly one third of respondents. Surprisingly, just 19% said the same for pure mobile download speed.

Talk of 5G is premature

think 41% of the audience, with plenty of work still to be done on LTE first. An additional 46% of respondents think the industry is developing 5G before understanding what we need it to do.

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Telecoms.com Intelligence, the industry analysis arm of Telecoms.com, works closely with its partners to thoroughly research and create educational services for its readership. In 2015 alone we generated more than 25,000 leads for our clients across more than 50 campaigns.

A consultative and collaborative approach with our dedicated analysis team ensures the creation of truly unique content, highly regarded throughout the industry. Telecoms.com Intelligence services combine statistical analysis and broad industry knowledge to effectively deliver insight and analysis through the use of webinars, bespoke surveys, white papers and more. All campaigns are supported with extensive marketing campaigns, to guarantee quantifiable business leads for our clients.

Since its launch in 2001, Telecoms.com attracts more than 86,000 unique visitors and 173,000 page views on a monthly basis. The recently redesigned website also provides a newer and easier-to-navigate resource directory from which to access Intelligence content.

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Attitude problems

Activity around 5G has begun to bubble away nicely in 2016; as operators the world over have begun R&D projects in earnest to assess early use cases and the available technology options.

On a societal level, the rate of technological innovation witnessed over the last half a decade has given birth to a constant desire for the next big thing at the earliest opportunity. It's not inconceivable to suggest the modern consumer is already thinking "I'm over 4G, when will it get faster again?". That, in itself, is one of the biggest challenges telcos face as they begin assessing their options for the fifth generation of wireless technology.

And therein lies the problem. As 2G, to 3G, to 4G demonstrated what is, on the face of things, a rudimentary acceleration of download speeds; consumer expectation suggests that 5G will simply be faster than 4G. But as this report will investigate, the many facets of 5G far surpass the fundamental requirement for more speed; as latency, ubiquity of coverage and IoT support all form a major part of the telco's thinking when devising new technology and business strategies for 2020 and beyond.

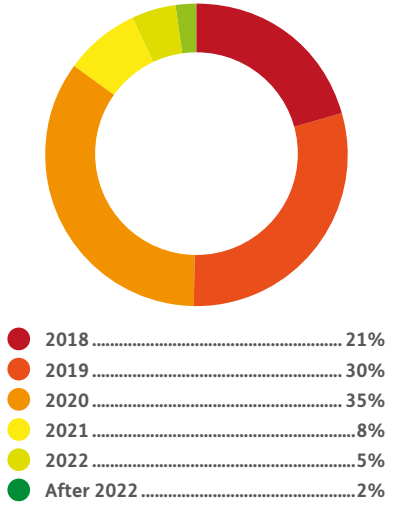
4G and the global deployment of hundreds of LTE networks presented operators with a fundamental shift in revenue models. While previous eras relied on voice and SMS revenues as a primary source of income, IP-based data consumption on an LTE network saw the tides turn towards video consumption in what has, since the early part of the decade, become an unrelenting wave of data consumption growth as user expectations now demand continuous, limitless connectivity to what content they want, and when they want it.

That expectation is only set to continue as the world gets ready for 5G. However, not only will operators need to match consumer expectations for video, but a new wave of data hungry services are on the verge of breaking into the mainstream. While applications like Pokémon Go – it had to be mentioned in here somewhere – present augmented reality as a new medium for entertainment and commercial opportunity, its virtual counterpart VR had its breakthrough year in 2016. While it's early days for VR, soon we'll be seeing data-heavy streaming of content or video games requiring ultra-fast uplink and downlink speeds combined with near 1 millisecond latency.

2020 is the fabled date when, if you were to believe everything you read, everything in the world is going to change. 5G will arrive, IoT device connections will run into the tens of billions, carbon emissions will hit an all-time low, cars will drive themselves and we'll be building a base on the moon. With that in mind, and to set the scene for this year's Road to 5G Outlook, we asked the audience to tell us when they thought the first commercial rollout of 5G will likely take place. › See Fig. 1

Figure 1

When do you think the first commercial rollout of 5G will happen?



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Somewhat surprisingly, just over half the audience (51%) said 5G will arrive before 2020, with 21% saying 2018 and the remaining 30% being slightly more cautious in saying 2019. With some operators already engaging with 5G trials in the real world, a pre-2020 launch date is entirely feasible. Of the remaining respondents, 35% said 2020 will be the start date, with 8% voting for 2021, 5% looking at 2022, and just 1% saying 5G will not be here until after 2022.

But before we can consider real-world rollouts, trials will be needed. And it looks as though 2018 will be the year with the most amount of activity, according to the audience. 55% say 2018 will see the first real-world trial of 5G, with 21% and 17% saying 2019 and 2020 respectively. Responses in favour of post-2020 5G trials were, predictably, minimal.

Much is made of 5G's potential to change telecoms, and the question over which of its commonly-touted features will be the most advantageous is a fairly divisive discussion. The next question in this opening section of the survey presented respondents with a list of 5G features, and asked them to select which one will be the most important. By far and away, the majority of respondents believe incorporating support for IoT devices and applications will be the most important or desirable facet of 5G functionality. With IoT due to really take off around the same time 5G is predicted to arrive, there's a plethora of use-cases for internet of things which will require the latency, ubiquity and uplink/downlink speeds afforded by the next generation of wireless technology. 33% of the audience believes that supporting IoT will be the most important feature of 5G.

Perhaps less surprising are the results for the joint-second most commonly identified 5G feature identified by the audience. 19% of the audience said increased download speed, and low latency respectively. Elsewhere in the polling for this question, ubiquitous coverage and network reliability both scored 10% of the votes from our 837 respondents respectively, while integration with the Cloud was voted for by 8%. See Fig. 2

In light of how essential IoT support was considered to be by the audience, one would assume IoT would be near the top of the list when it comes to respondents' perception of the primary use cases for 5G. When asked to pick their top two use cases, 43% of respondents considered Consumer IoT – such as the smart home – to be the most beneficial 5G use case. Enterprise and Industrial IoT use cases weren't far behind either, in second place with 39%.

Elsewhere, the exponentially growing trend towards video consumption shows little sign of relenting, and 24% say ultra-high definition (UHD) video streaming will be the biggest 5G use case. That certainly seems like a very feasible use case considering recent growth of video, while some of the Far Eastern operators, such as SK Telecom, have been trialling 8K mobile video streaming. The technology might be there from a network perspective, but such a high quality of video streaming will require the device on which it is playing to actually be capable of realising such a resolution. 4K smartphone screens are yet to permeate the market, so it may be some time before 8K is a reality. At any rate, the question over whether 8K is even necessary on a small mobile screen looms large over this one.

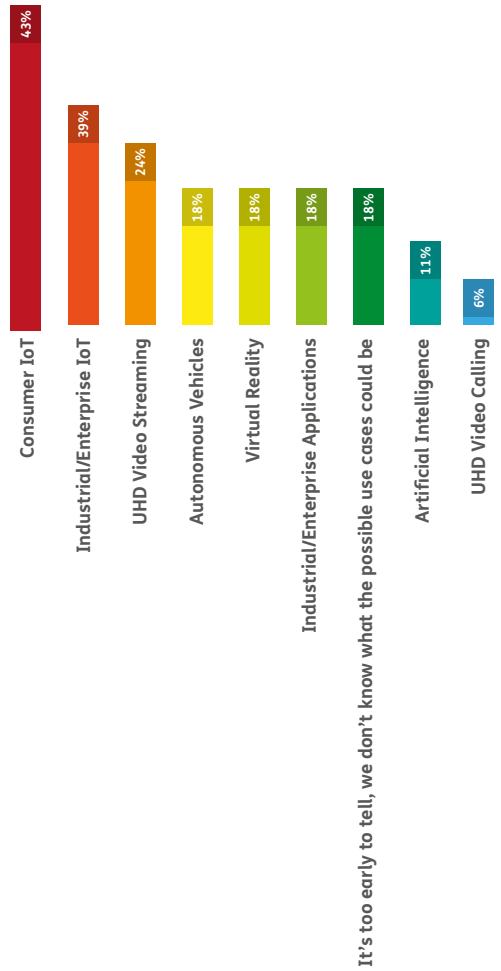
Further down the list of 5G use-cases sees Autonomous Vehicles, Virtual Reality and Enterprise Application of 5G all sit on 18% respectively, while AI and UHD Video Calling came in at 11% and 6%. The audience was also given the opportunity to select an answer stating that we just don't know yet – and 18% of the audience chose that answer, saying "it's too early to tell, we don't know what the possible use cases could be".

With the hype cycle for 5G approaching its peak, if it's not there already, it is important to understand specific attitudes to the build of 5G network infrastructure, what it will be defined by and what the motivating factors are for operators and network builders alike. Judging by the results of the next question in the survey, there's a general consensus that now is the time to be assessing options for 5G, that it is the right time to be doing so. There's also general agreement that the industry understands what it needs to do before beginning work on 5G.

Confirming this, when asked to rank specific statements on a scale of "Strongly Agree" to "Strongly Disagree", the most strongly disagreed with statement of the bunch said "Talk of 5G is far too premature, we're not even nearly done with 4G yet", a statement with which 59% of the audience disagreed. ›

Figure 2

What do you see as being the primary use-cases for 5G?



Similarly too with the statement "The industry is developing 5G technology before understanding what we need to do", although while 54% disagreed with this, 46% did agree – suggesting there is an element of the industry which is unsure of the direction it needs to take and further definition is required.

The most strongly agreed with statement in the lot, though said the definition of 5G requirements comes down to the end-user and what they desire. "5G will be defined by its use-cases and what the end-user requires of it", agreed 85% of the audience. Meanwhile, almost three quarters of respondents said they believe a "build it and they will come" approach will also drive 5G development, with 73% agreeing that "5G will be defined by the technology driving it – build it and they will come.

Finally, for this question, we threw a rather hyperbolic curve ball into the mix by simply stating "5G will change everything" – a sentiment which divided opinion almost exactly in half, with 53% agreeing that will be the case and the converse 47% disagreeing.

The notion of 5G changing everything, however, does draw into question the role of the telco in this 5G era. It is a generally accepted belief that operators are in need of updating their revenue streams to ensure they stay relevant in an age of competing communications providers in the form of OTT players or rival IoT network suppliers such as Sigfox. With that in mind, we asked the audience how they see the role of the operator changing once 5G becomes a commercial reality.

While two thirds of the audience remain confident the operator will, in one way or another, position themselves as integral to the future digital ecosystem; there's an existential crisis growing from exactly 33% of respondents. That 33% is made of respondents selecting two different answers; 14% said the operator will be required to provide fundamental uplink/downlink connectivity and nothing more, with a slightly larger 19% saying the operator will become more peripheral during 5G as other service providers come to the fore.

On a slightly more optimistic note, 35% said the operator will be at the very centre of a digital future, providing every device and service consumers utilise; while 32% said the operator will instead help to enable the development of sophisticated communications technology in society.

The penultimate question of this opening section to the survey sought to debunk theories over the sort of speeds we can expect to experience in the 5G era. Operator and vendor partnerships in recent months have proudly announced ludicrous downlink speeds being achieved using 5G technologies in a variety of trialling environments – more than 70 Gbps has been mentioned in some places.

The expectation, however, is somewhat tempered in comparison. See Fig. 3

Two thirds of the audience believe that a sub-1 Gpbs mobile broadband download speed will be required to achieve their intended use cases for 5G. Achieving an eye-watering 1 Gbps should fulfil the requirements for the vast majority of use-cases we will likely see for the foreseeable future, and 67% of the audience believe that to be the case. Conversely, 18% believe more than 1 Gbps will be required, and 15% say that more than 2 Gbps is what they expect to need in order to deliver 5G services. Typically speaking, however, it looks as though somewhere between 500 Mbps and 1 Gbps is the sweet spot, according to 25% of respondents.

Finally, we wanted to clarify whether we fully understand what 5G needs to be and the level of impact it will have on telecoms as we know it. In a simple "yes, no, don't know" question, more than half of the audience think we don't know the extent to which 5G will change communications, and that we don't sufficiently understand exactly what 5G will be. This ambiguity is emphasised further considering another 15% said they don't know. Just under 30% are confident we know exactly what to expect.

"There is a tide in the affairs of men. Which, taken at the flood, leads to fortune."

Shakespeare's words in Julius Caesar ring truer today for the telecoms industry than they perhaps ever have. If operators can harness this 5G tide while its potential begins to floods, great fortune shall follow. The road to 5G today looks to be headed in a variety of possible directions. But as further trials are conducted; as greater industry collaboration and standardisation activity occurs; and as technology evolves; the blurred vision of multiple roads will focus into one, hopefully smoothly paved, road ahead.

We hope you find this report enjoyable and insightful as you prepare for your 5G journey. ■

Figure 3

What level of mobile broadband download speed do you think is needed for your intended uses of 5G?

<100 Mbps	10%
100-250 Mbps	17%
250-500 Mbps	15%
500 Mbps – 1 Gbps	25%
1-2 Gbps	18%
>2 Gbps	15%

> "Not only will operators need to match consumer expectations for video, but a new wave of data hungry services are on the verge of breaking into the mainstream

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Key takeaways:

100% availability will be the single most important feature of 5G;

believe over a third of respondents with just over a quarter saying the same for sub-millisecond latency.

39% of the Telecoms.com audience reckon

IoT smart home services of the future will fall into a monthly mobile, domestic and IoT multiplay bundle.

30% of respondents fear for the telco in the IoT era,

thinking 5G will provide rudimentary connectivity while consumer tech firms will begin adopting their own connectivity solutions, like Sigfox.

About Mitel:

Mitel (Nasdaq:MITL) (TSX:MNW) is a global market leader in enterprise and mobile communications providing seamless communication and collaboration services. Our portfolio of mobile + cloud + enterprise solutions delivers unique and advanced communications to more than 60 million business users in more than 100 countries, and 130 Mobile Service Providers including 15 of the top 20 mobile carriers in the world. We offer cloud communications deployment options such as public, private and hybrid and mobile cloud. Our mobile communications deliver real time and hosted services to Mobile Service Providers such as VoLTE, VoWiFi, ViLTE and Advanced Messaging.

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In the previous section of this survey we asked readers what they thought would be one of the biggest elements of 5G, but in order to more fully understand how 5G will affect telecoms services we asked the question again but with more detailed options for respondents to choose from.

The overwhelming favourite from our 830+ respondents suggest that 100% reliability and availability will be the single most important facet of a 5G service required for delivering new content and services. 100% availability is one of the biggest challenges for any network, and that is particularly the case for the forthcoming next generation wireless network. 36% of respondents believe this will be the most significant important factor for delivering new services on a 5G network.

5G's distinguishing features are commonly touted as being lightning fast download speeds as well as sub millisecond latency. While some might argue that a more deterministic approach to latency requirements is the way forward – whereby network latency is adjusted dynamically to suit the requirements of each service – there's a significant proportion of the industry that believes sub millisecond is the most important service-enabling feature of 5G; 26% no less. To put the term "sub-millisecond" in to context, today's LTE networks in North America exhibit a lowest latency speed of 57 milliseconds, which was managed by Sprint in Q2 2016. Suffice it to say that there's still a fair amount of work that needs to be done, and while all parties involved with 5G R&D say they're targeting low latency, specific numbers or trial-based achievements are yet to be cited.
See Fig. 1

Elsewhere, ubiquitous coverage was targeted by 19% of the audience, and pure download speed came in a somewhat surprising fourth place, with just 15% saying that will be the most important facet of 5G. So from the telecoms industry we're seeing a shift in approach to the specific requirements or capabilities of a 5G network, and a removal of the previous mind sets referred to in the opening section of this survey. Wireless network evolution is set to be far more than just a rudimentary upgrade in speed.

Coming back to the point on latency, however, and one of the main use-cases for an almost latency-free wireless network is the connected car. Connected cars, autonomous vehicles or driverless cars are one of the most hyped up examples of a technology begging for the arrival of 5G. Work is ongoing with the development of early stage examples of self-driving cars with certain elements of the driving experience becoming automated; although in order to achieve the full driverless experience – if society should ever allow it – a fully integrated IoT and 5G network needs to be in effect. ›

Figure 1

What is the most important facet of a 5G service required for delivering new content and services?

- Purely download speed 15%
- Uplink speed 4%
- Sub-millisecond latency 26%
- Ubiquitous coverage 19%
- 100% reliability and availability 37%

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As this section of the survey will focus more exclusively on the use-case scenarios around 5G, we sought to gain some attitudes on how the next generation of wireless technology will enable new opportunities for operators in the connected cars market.

On the face of things, it would appear that the majority of the audience believes telematics solutions for the automotive industry will form part of a new revenue channel for operators. 38% of all respondents said operators will be able to bundle wholesale data services to car manufacturers, allowing the auto manufacturer to offer a MVNO package in addition to their telematics solution. Ostensibly this would mean operators distribute data to a manufacturer, like BMW, as a white label solution which would then be repackaged and sold on to consumers as part of a monthly vehicular service.

29% of the audience echo the sentiment of acting as more of a wholesale provider in this case, saying that there's more value for operators in being an enabler of connected cars than a direct provider. Conversely, just under a quarter of respondents believe a connected car service has the potential to be a new business to consumer service offering for operators, saying "Connected car data packages will be bundled into a monthly consumer multiplay package by the carrier." 10% also agreed with this sentiment, believing operators will be the principal provider of connected car services, rather than an enabler.

A similar trend was observed in the following question, too, which focussed more exclusively on smart home offerings for operators to their consumers in a 5G era. 39% strongly believe that domestic Internet of Things (IoT) services for consumers will be bundles into a monthly package. This approach may require significant readjustment of strategies and technologies to enable and bill an entirely new suite of connected services. See Fig. 2

Meanwhile, 23% of the audience believe 5G will face considerable competition in the form of other application-specific networking solutions; and this is an attitude agreed with by a larger proportion of the audience. With non telco-specific networks emerging around the growth of the IoT, 30% of respondents say that various tech firms won't wait for telcos to connect them, and that they'll begin sorting out their own connectivity solutions to help tie in a range of customers into one specific brand – "consumer electronics firms will begin offering their own connectivity packages based on proprietary networks like Sigfox and LoRa".

With this form of new market player representing an alternative approach to IoT connectivity, we thought it best to gain some sort of clarification on the perception of these players from the audience. We asked our audience of telecoms professionals the following question: "do you agree that proprietary IoT networks (i.e. Sigfox, LoRa) present a significant threat to carrier revenues?"

It would appear to be the case that the telecoms industry is all in favour of a broader market full of emerging network providers, in aid of driving greater innovation and collaboration while IoT and 5G remain yet-to-be completely defined prospects. 39% of respondents disagree with the aforementioned statement, saying that for IoT to truly flourish multiple industries need to collaborate, including competing connectivity standards. Elsewhere, 24% said telcos actually need to adopt these forms of IoT network, like LoRa, to bolster and complement their 5G network services. An additional 24% said it's too early to tell, while just under 14% said that these competitors encroach on the telco's primary market and detract from existing or potential revenue streams.

With much of discussion so far relating to consumer related services, the next question in this section focussed on enterprise connectivity and how operators can seek to monetise business revenue streams in the eras of 5G.

By and large, operators seem to believe that while a wealth of opportunity exists to serve enterprise customers, and 92% of respondents either agreed or strongly agreed with a statement echoing that sentiment. Meanwhile, the requirement for more agile network infrastructure management is certainly how a high percentage of the audience sees 5G for enterprise users working out. There was an 80% agreement rating from respondents with a statement which said "delivering MVNO-like services will mean dedicating a dynamic network slice based on customers' specific needs". ›

Figure 2

How do you think operators will primarily handle IoT services in a 5G era?

- Domestic IoT services for consumers will be bundled into a monthly package 39%
- Consumer electronics firms will begin offering their own connectivity packages based on proprietary networks like Sigfox and LoRa 30%
- Ad-hoc or application –specific networking solutions will compete with 5G 23%
- There will be no interworking of IoT for consumer bundles and 5G..... 8%

> "5G's distinguishing features are commonly touted as being lightning fast download speeds as well as sub millisecond latency.

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Again we come back to the notion of 5G enabling operators to become wholesale data providers for large scale enterprises mobilising a sizeable workforce. In this case we presented respondents with a statement which said "we need to enable enterprise customers to act as a private MVNO in their own right, using 5G", a statement which received an agreement rating of 70% from the audience.

The statement which seemed to resonate most negatively with respondents, however, suggested that nothing will change for enterprise services in the 5G era. Nearly two thirds, 64%, disagreed with this sentiment, once again reinforcing our previous assertion that operators will be faced with a rapidly changing landscape when it comes to delivering services, content and communications facilities over 5G.

Our two penultimate questions in this section sought to find out respondents' attitudes towards specific 5G services, and the impact of next generation content and communications services. To help us ascertain which will be most lucrative for operators compared to which will have the biggest impact on society in general; we asked two very similarly phrased questions ever so slightly nuanced from each other. The first asked "Which 5G services to do you think will have the biggest impact on service revenues for operators?", while the second asked "Which 5G services do you think will have the biggest impact on society?"

Respondents were allowed to select two answers from a pre-determined list of answers. "Other" was an option, however less than 1% of respondents chose to provide an alternative solution to the list presented.

Unsurprisingly, two IoT-related answers sat at the top of the tree for each question. IoT Connectivity and Connected Cars proved to be, by some distance, the most popular and hotly-anticipated two services that 5G will enable and impact revenues and societies. In terms of impact on revenues, 61% said IoT Connectivity will be the most significant source of new money, while 37% vouched for Connected Cars, progress on which has been ramping up significantly over the last few months.

Additionally, 29% said Enterprise Connectivity will be the most lucrative 5G service, as Virtual Reality, 8K Video Streaming, Embedded Communications and Live Event Multicam Streaming was voted for by 18%, 17%, 15% and 14% of the audience respectively.

Societally, it was a very similar distribution of votes among respondents, although there was seemingly more optimism for VR as a societal disruptor than a telecoms revenue. 26% of respondents seem to think it will be one of the biggest 5G services to be taken up by consumers and society in general. Additional information on voting behaviour can be seen in the accompanying graph here. See Fig. 3

To conclude, we wanted to determine the aggression with which respondents are approaching 5G infrastructure development, and interestingly it would appear that a softly-softly approach is typically being favoured over a fast-and-furious mind set. Just 23% of respondents selected answers which indicate a more frantic desire to be first-to-market; of which, 11% said "we need to get 5G into the market as soon as possible, and risk cannibalising service revenue to get a dominant position", while 12% said "if we are late to market with 5G we will lose too much ground on our competitors".

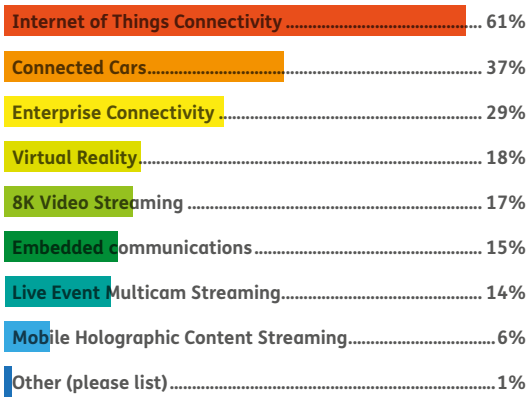
This mind set was in stark contrast to the remaining 77% of the audience which divided itself into two, rather more patient, camps. The first of which saw 42% of respondents suggest that 5G will be such a monumental shift in technology that users require a thorough education-based approach, saying: "we need to educate our user base on what 5G actually is and what it can do for users, instead of letting them think it's just faster broadband".

The remaining 35% of the audience said there is a need to make 5G a clear and standardised service globally before they can consider begin roll out.

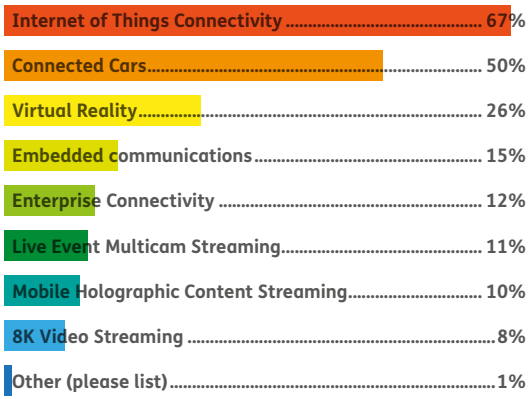
What the results of this section suggest is that there is a high level of direction and clarity of desire from the audience as they begin embarking on their 5G journey. While further education and a level of patience is visibly necessary, the optimism with which respondents answered a variety of paradigms proved that telecoms operators are keen to ensure they are placed at the epicentre of this new era for wireless technology. ■

Figure 3

Which 5G services do you think will have the biggest impact on service revenues for operators?



Which 5G services do you think will have the biggest impact on society?



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“On the face of things, it would appear that the majority of the audience believes telematics solutions for the automotive industry will form part of a new revenue channel for operators. 38% of all respondents said operators will be able to bundle wholesale data services to car manufacturers, allowing the auto manufacturer to offer a MVNO package in addition to their telematics solution.

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The key takeaway from the survey, suggesting that the central focus of 5G should be 100% availability, is not surprising when we think about the strengths and differentiation that the mobile carrier has when compared to the alternative connectivity solutions that are evolving. There are other means to deliver ultimate bandwidth or best-efforts connectivity, but for mission critical applications the term “carrier grade” still holds meaning.

In the current marketing wars between equipment vendors highlighting their “speeds and feeds” approach to 5G it is easy to lose sight of the real demands that the market is making on 5G. Undifferentiated high bandwidth connectivity is neither valuable to the mobile carrier nor useful to the businesses that are driving demand for 5G networks through their emerging applications and services.

The interest in operators in new business models where they can offer services directly to consumers but also enable other businesses to leverage network assets through private “slices” of the 5G network resonates very well with what we see emerging as a faster moving and more agile mobile ecosystem. Differing use cases and differing business models will require the 5G network to be highly configurable and allow carrier services to co-exist with business operated services.

This dynamic service environment is the natural habitat of software innovators and integrators, so that while the headlines today are being grabbed by speed records and Rf spectrum allocation, the real value generation of 5G will come from the service framework that enables the monetization and consumption of these bandwidth resources.

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RAN, RAN, as fast as you can

Key takeaways:

Spectrum availability is the biggest challenge

facing the radio access network in a 5G era, believe more than a third of respondents.

Nearly three quarters of the audience

says mobile download speeds of less than 1 Gbps are most realistic for the 5G RAN.

68% of the audience

will not be launching a complete 5G radio network with a "big bang" switchover, instead favouring gradual implementation while integrating LTE.

About InterDigital:

InterDigital, Inc. designs and develops advanced technologies that enable and enhance mobile communications and capabilities. Since our founding in 1972, our engineers have designed and developed a wide range of innovations that are used in digital cellular and wireless products and networks, including 2G, 3G, 4G and IEEE 802-related products and networks.

For over four decades, InterDigital has been a pioneer in mobile technology and a key contributor to global wireless standards. Our team of more than 170 engineers –approximately 80 percent of whom hold advanced degrees, including over 50 PhDs – has unparalleled expertise in major mobile connectivity and content delivery technologies. Since 2000, InterDigital has spent close to $1 billion on technology research and development.

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RAN, RAN, as fast as you can

Such is the hype and anticipation around the next generation of wireless communication technology that it can seem like 5G is expected to be a technological panacea, offering all things to all people. But essentially it will be the fifth major evolution of a radio access network (RAN) technology that first manifested itself in the early 1980s.

This section of the Telecoms.com Road to 5G Outlook 2016 focuses on the RAN that will comprise the core of the new technology. We seek respondents' views on the likely characteristics of the 5G RAN and what technological and practical solutions it needs to offer. The result is a great sense of what the telecoms industry expects from the 5G RAN and what they intend to do with it when it arrives.

To start with we asked respondents to pick the one use-case they think will drive the deployment of the 5G RAN. The clear winner was 'massive IoT', with 47% of respondents selecting that option. In the eyes of many 5G and IoT have become umbilically linked, with the prospect of billions of connected IoT devices only thought possible with a new wireless infrastructure.

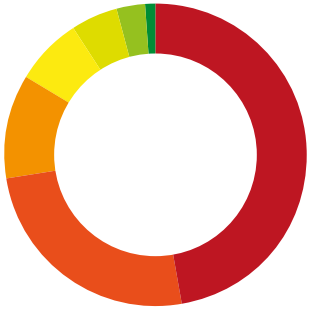
In practice 5G will need to have at least two distinct branches, each catering to quite different needs. The traditional massive increase in performance remains a key feature, but in parallel 5G will need to accommodate countless embedded sensors periodically transmitting small packets of data to the cloud and receiving instructions in return. 5G will need to cater for a far more diverse range of needs than any previous mobile communications technology generation and the fact that almost half of our respondents identify IoT as the main driver of the standard is testament to that.

Having said that the other major 5G deployment drivers were more geared towards the utilization of increased bandwidth, with 25% of respondents identifying video traffic as a key use-case and 11% anticipating virtual reality applications will hasten the 5G roll-out. See Fig. 1

While some manifestations of VR may require high bandwidth for content streaming they will also be reliant on a third major feature expected of 5G: low latency. Current 4G latencies in the 50 ms range are fine for voice calls and connecting to the internet but things like VR and remote control are much more sensitive to latency, to such an extent that they essentially won't work unless latency gets a lot closer to zero. Infrastructure vendors are already publicly targeting 1 ms latency and things like VR and realtime gaming, which was chosen by 5% of respondents, will benefit significantly from such advances. ›

Figure 1

Which of the following do you expect to drive the deployment of the 5G radio network?



- Massive IoT 47%
- Video traffic 25%
- Virtual Reality applications 11%
- Social media 7%
- Online (Real time) gaming 5%
- Tactile Internet 3%
- Other (please specify) 1%

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Our second question approached the future 5G roll-out from the opposite direction and asked respondents to pick the single most challenging element facing the radio access network. While coverage and capacity, understandably, receive a fair amount of acknowledgement from the audience as a major challenge for the guys building out radio networks; it is unsurprising to see spectrum availability feature clear ahead of the rest as the most difficult technical consideration for the 5G RAN. 34% of the audience favoured spectrum availability as the biggest challenge for the RAN.

The bandwidth requirements of 5G mean higher frequency spectrum will be fundamental, in bands higher than 28 GHz – also known as millimetre wave. Physical properties of these higher frequency waves mean the capacity and potential bandwidth is far greater, however the maximum distance of the wave is far shorter than waves of much lower frequency. We can liken the physical properties of frequency waves with, if you will, a spring or coil which when fully compressed is wider and shorter, but when stretched becomes longer yet more narrow. 15% of the audience consider the specifics of harnessing high frequency spectrum to be the primary challenge.

Other challenges of note considered by the audience include the capacity of the transport network connecting to the basestations in the RAN, with 18%; ensuring basestation coverage (17%) and spectral efficiency (16%). See Fig. 2

The convention of deploying a RAN using a variety of interconnected basestations and small cells has proved to be a headache when transposing the concept into a 5G context. With that in mind, alternative approaches are being considered by many global operators; the principal one being the idea of deploying a cell-less architecture providing connectivity and user tracking regardless of cell location. 31% of the audience consider this to be main way of handling continuity of cellular coverage for mobile users of 5G, when asked. Meanwhile, 29% of the audience is eager to continue with traditional methods of providing cellular coverage, saying a mesh network of small cell basestations providing broad coverage with handoff between cells is how they plan on approaching the issue. A greater proportion of respondents are unsure of which approach to adopt, however, with 40% saying greater clarity is required on which frequencies they plan on utilising before being able to plan for 5G cellular coverage.

As alluded to earlier in this section of the survey, speed, coverage and latency are widely thought of as the three selling points for the adoption of 5G. Our next question asked the audience to identify which characteristic of the radio network will be the single most important.

To some surprise, download speed featured lowest of the possible five characteristics, with just 12% of respondents deeming it to be the most significant. While speed will be necessary, as evidenced with the variety of high-bandwidth consuming services highlighted earlier in this report, the audience see the specific speeds on show as less integral to the success of 5G as other functions. ›

Figure 2

What would you consider to be the biggest challenge to radio access for 5G networks?

- Spectrum availability 34%
- Transport network capacity 18%
- Basestation coverage 17%
- Spectral efficiency 16%
- High frequency spectrum 15%

Figure 3

Which of the following radio characteristics of 5G do you believe is the most important?

- 100% reliability and uptime 30%
- <1 millisecond latency 28%
- Ubiquitous coverage 19%
- IoT support 12%
- Download speed 12%

> “Infrastructure vendors are already publicly targeting 1 ms latency and things like VR and realtime gaming, which was chosen by 5% of respondents, will benefit significantly from such advances.

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100% reliability and uptime was seen by 30% of respondents as the most important radio characteristic of 5G, closely matched to the 28% which vouched for sub-millisecond latency instead. Ubiquitous coverage and support for IoT each gained less than one fifth of the votes, with the former attracting 19% and the latter 12%. See Fig. 3

Coming back to the discussion surrounding network speed however, much has been made of the potential of 5G to deliver eye-watering download speed. Pre-deployment, lab-based trials have seen speeds entering the realm of tens of gigabits per second; the immediate necessity of which is not totally obvious, but it's nice to know it should be possible at some point.

The challenge of achieving such speeds in densely populated areas, however, is one difficult to replicate in lab trials today. Some 4G networks claim that, using carrier aggregation technology, speeds of upwards of 300 Mbps are achievable in the real-world, though many if not most consumers will ever benefit from such potential. We wanted to gain more of an understanding as to what our readers believe is a feasible level of download speed from 5G in densely populated urban areas. While there's an optimistic 30% that believes more than 1 Gbps will be totally achievable, such optimism is tempered by the remaining 70% that doesn't. Of that 70%, 23% see 500 Mbps to 1 Gbps as most likely, whereas 34% believe somewhere between 100 Mbps and 500 Mbps is most realistic. A slightly more pessimistic 8% think less than 100 Mbps is still the most likely outcome.

With all this talk of the next generation RAN, it's easy to forget that LTE is still likely to form a big part of the future mobile network. 4G fallback will definitely need to be considered in the early stages of 5G as it grows and, occasionally, falters; so we wanted to gain operator attitudes towards a range of statements relating to the integration of 5G and LTE.

On the face of things, it appears as though work will continue to take place on upgrading LTE over the next few years while 5G begins being rolled out. On a scale of Strongly Agree to Strongly Disagree, respondents gave a general 93% agreement rating to a statement which highlighted this very message – "We will continue to enhance our LTE network and slowly integrate new 5G technology", it read.

Meanwhile, a similar 91% of respondents said the imperative nature of backwards compatibility and fall-back to LTE cannot be understated while work on 5G roll out continues. Conversely, just 32% of the audience reckon they will approach 5G roll out with an all-in-one delivery strategy, as the opposing 68% disagreed with a statement saying "We are going to launch a complete 5G radio network with a "big bang" switchover.

The final set of questions in this survey sought more technical opinions on emerging technologies which could enable this next-generation 5G RAN. Network slicing is one of those trends, in which a specific part of the network (a slice) is designated towards specific functions or services. This virtual network slice is able to use a deterministic approach to allocating the required resources, bandwidth or latency, for the service it is hosting; thus enabling greater efficiency in the use of network resources.

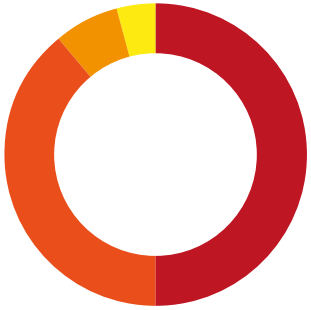
The audience believes, by and large, that massive IoT services will be the greatest beneficiary of network slicing, with 63% believing the ability to scale bandwidth, latency and traffic prioritisation for machine based communications and data will deliver the greatest benefit. Additionally, the load placed on the network by TV and video services saw 28% of respondents identify that as the biggest use case for network slicing. Just 9% of the audience believe vehicle connectivity (V2X) will require its own network slice.

Rounding off our questions on network slicing, 74% of respondents believe a standardised interface for backhaul networks is required to enable the dynamic networking technology, with 26% disagreeing with the notion.

After gaining attitudes towards network slicing, our penultimate question of the Road to 5G Outlook 2016 wanted to understand the view of the audience with regards to Cloud-RAN, otherwise known as a Virtualized RAN. Simply put, a Cloud-RAN (C-RAN) architecture allows for open and more dynamic control of basestations using cloud and virtualization technologies to facilitate more efficient, faster, less latent and more programmatic radio access for users. As with many cloud-based technologies, the benefits are compelling, and with this question we asked what the biggest driver for C-RAN architectures would be. ›

Figure 4

Where do you think 5G RAN will be most easily rolled out?



- Different approaches for each will be required..... 50%
- Dense urban areas..... 39%
- Rural locations..... 7%
- Neither will be a challenge..... 4%

"To some surprise, download speed featured lowest of the possible five characteristics, with just 12% of respondents deeming it to be the most significant

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33% of respondents said reduced OPEX is the most compelling; while narrowly behind on 31% was enhanced network agility. Meanwhile, 22% cited effective traffic management, whereas just 8% and 6% of the respondents opted for better interference management and lower power consumption. See Fig. 4

When discussing the RAN it is often easy to solely consider urban rollout of radio architecture; and our final question sought to understand if users had also been considering wider, further-reaching geographies. 39% of respondents said urban areas will be the most easily rolled-out location for the 5G RAN, while just 7% said rural will be easier. Exactly half of respondents, however, stated that unique approaches will be required for each, further adding to the complexity of the challenge ahead. Just 4% of the audience was confident enough to say that neither urban or rural roll outs will be a challenge.

What this section of the survey has illustrated is that the prospect of designing and rolling out a radio access architecture capable of delivering 5G is a long, convoluted and intricate journey. At this stage, it's fair to say that a high level of R&D is still required to determine the appropriate path down this 5G road; while clarity of strategy and standardisation initiatives will surely aid the vast number of operators providing mixed opinions on some of the industry's most pressing concerns at this juncture. ■

> The audience believes, that massive IoT services will be the greatest beneficiary of network slicing, with 63% believing the ability to scale bandwidth, latency and traffic prioritisation for machine based communications and data will deliver the greatest benefit.

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The answers to Q2 confirmed that spectrum is the biggest perceived 5G challenge, with 49% of the responses if you combine the "spectrum availability" and "high frequency spectrum" answers. The spectrum allocation and harmonization process within ITU and the government agencies (e.g. the FCC) will continue until 2019, but, in parallel, we are designing 5G to be to be forward compatible with the current cellular bands and for the 24-86 GHz bands.

5G is targeting three distinct requirements/ markets: 1) Enhanced Mobile Broadband; 2) Massive IoT; and 3) Ultra-reliable and Low Latency Communication (which includes V2X, mission critical applications, etc.). Looking at the biggest drivers of 5G in Q1, we see that the respondents were almost equally split between Massive IoT (47%) and Enhanced Broadband applications (48% by combining the video traffic, VR applications, social media and online gaming responses).

It should be noted that V2X and mission critical applications were not proposed Q1 survey responses and as a result could not be selected, but the answers to Q3 give us insight into how important respondents believe ultra-reliability (30%) and low-latency (28%) to be for 5G.

The question of feasible download speeds (Q4) was also interesting in that it revealed that 53% of the respondents believed that download speeds higher than 500 Mbps were feasible in urban settings. If respondents interpreted "feasible" to mean "expected" or "average" as opposed to "peak" speeds, then the industry seems to have strong beliefs on the upcoming "New Radio (NR)" air interface being designed in 3GPP to complement LTE-A Pro.

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