JUNIPER RESEARCH'S 2021 TECH & TELCO MEGATRENDS

Whitepaper

JUNIPER RESEARCH

1.1 Introduction

For the past ten years, Juniper Research has been bringing out a set of end of year predictions in which we look at the key technologies, devices and services that we expect to have a disruptive impact in the next year. In previous years, we have chosen a distinct list of ten top trends, however given the unprecedented disruption caused by COVID-19, we have decided to come up with four megatrends that contain a list of niche predictions under that umbrella.

After this, Juniper Research will then explain further specific trends which we believe will occur under the umbrella of the megatrend.

1.2 Megatrend: AI-accelerated Automation in Operations

The disruptive impact of 2020 has required many industries to adapt rapidly to variable conditions; making services or solutions that deliver greater degrees of automation and autonomy critical to continuation of service. Supply chain disruptions, reduced demand from end users, increasing reliance on online services and increased Internet traffic have all occurred in 2020; creating a unique set of circumstances that is accelerating automation.

We anticipate that the impacts of the COVID-19 pandemic will carry through until 2021, as service providers continue to adopt efficiency- and cost-saving operations after the pandemic has ended. In the wake of the pandemic, old business models are simply no longer suitable.

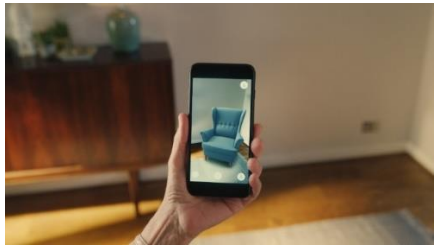
As a result of these changes, AI has come to the fore in how it can deliver efficiency savings and better services, meaning that AIaaS (AI-as-a-Service) models have gained in popularity over the past years, with adoption set to rise further in 2021. These capabilities will reshape how many markets work, which we will explore in our sub trends below.

1.2.1 Rapid Expansion of Extended Reality within Online and Mobile Commerce

With retail struggling in the wake of the pandemic, retailers are expected to invest further into extended reality, as the shift away from ‘bricks-and-mortar’ retail to online services gathers pace.

A number of smartphone and tablet vendors have invested heavily in maximising augmented reality over devices, such as Apple and Samsung. We expect further app development and roll-out of services in 2021, as the pandemic brings into sharp focus the need for further innovation to enable effective omnichannel commerce. We anticipate strong growth with furniture retailers, such as Ikea, but we also anticipate strong prospects in the cosmetics space with virtual make up.

Figure 1: Ikea AR App



Source: Medium

There will be two main groups that benefit from these developments. Firstly, retailers, who are missing out on purchases in physical locations, can migrate services to online retail models and attract users via extended reality. These apps can be a major draw for consumers.

Secondly, consumers will benefit, as with augmented reality, they are able to have an experience that is close to a physical retail experience. It therefore makes it much easier to enjoy a traditional retail experience in a non-traditional setting.

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1.2.2 Pandemic to Increase Investment into Chatbot Automation Capabilities

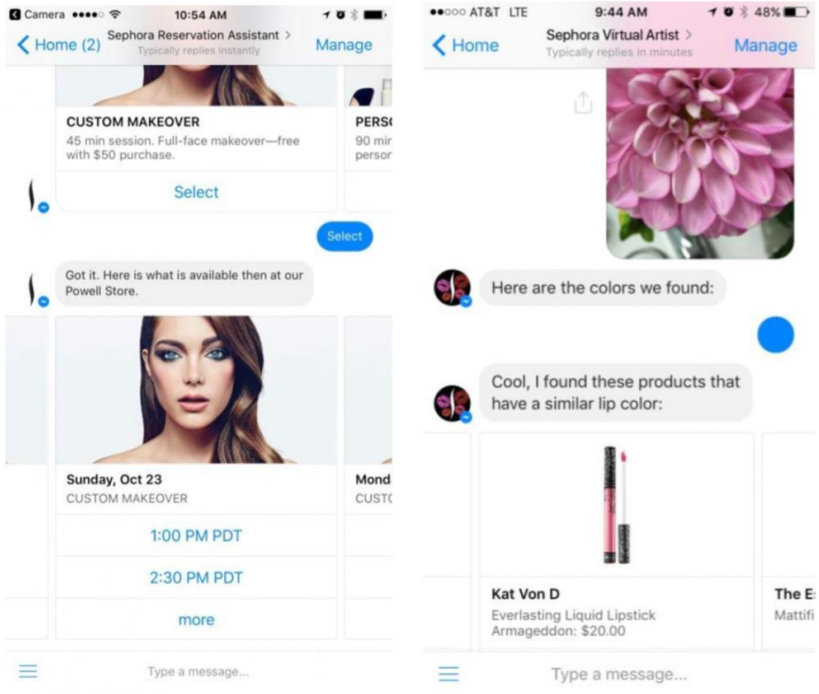
As we discussed above, the pandemic has disrupted the retail market and accelerated retailers' digitalisation efforts, with more enterprises adopting the concept of omnichannel retail. This is primarily because consumer attitudes have shifted as a result of the pandemic. We expect physical visits to retail outlets to begin recovering next year; however, it is unlikely to return to pre-COVID levels in 2021.

As such, we expect automation in retail powered by chatbot capabilities will become increasingly critical. As such, we anticipate that machine learning and data collections will be key to increasing chatbot capabilities in 2021.

The growth in the use of chatbots in the retail environment will have numerous benefits. This will lead to improved experiences through streamlined customer service offerings and tailored promotions.

It will also benefit retailers, who will gain cost and time savings through automation, ultimately improving customer experiences and aiding customer retention.

Figure 2: Sephora Chatbot



Source: Chatbot Guide

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1.2.3 Blockchain to Escape the Hype, but Only in Certain Areas

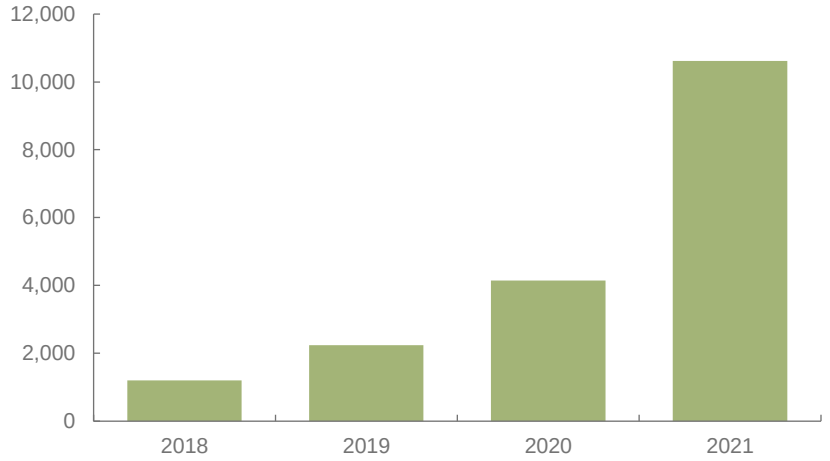
Blockchain, despite being hyped to a vast degree over many years, it has failed to reach its true potential. We anticipate that blockchain will finally start to reach its true potential in 2021, with traction in food provenance and asset tracking.

2020 has seen several notable partnerships in the blockchain world, including R3 and IBM partnering to offer R3 and its blockchain platform Corda more widely. Given IBM can be considered a competitor with all the work it has done with Hyperledger, this was an unexpected development, and shows that the market is maturing. There have also been several specific solution partnerships, such as Mastercard and GrainChain in food provenance.

We have also seen major interest in supply chain tracking from large vendors across multiple vectors, including Dole Foods for food tracing, and automotive manufacturers such as Volvo for cobalt tracing.

We believe that 2021 will see these partnerships translate into firm deployments that will have major impacts, significantly changing the trajectory of blockchain deployments.

Figure 3: Global Retail Businesses Using Blockchain for Asset Tracking 2018-2021



Source: Juniper Research

There will be a number of benefits to both businesses and consumers from this. Blockchain adoption will increase transparency in supply chains and enable automation, benefiting businesses significantly. For consumers, transparent provenance, in both food and consumer goods, will enable consumers to make more ethical purchase decisions.

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1.3 Remote Solutions for Working and Operations to Establish New Frameworks

The biggest impact the COVID-19 pandemic has had on the workplace has been the shift to remote working.

This has left workplaces scrambling to use video conferencing software like Zoom and Microsoft Teams to meet and co-ordinate, but with multiple surveys showing that a majority of those forced to work from home because of the pandemic want to continue to do so to some degree. As part of this, we expect to see the use and development of virtual workspace tools, beyond simple remote tracking, flourish.

Tools that allow simultaneous working, and the organic sharing of perspectives and insights alongside the project being worked on will come to the fore. The lessons of the past year will be put to development of new forms of software that go beyond video conferencing to allow for ongoing simultaneous collaboration; bringing all these functionalities together into holistic platforms.

The human element of remote working has also come into sharp focus, with elements of remote work platforms being introduced to enable employees to feel more connected in the absence of physical interaction.

The inability to access job sites during periods of lockdown has also highlighted the need for remote access to a variety of different industries utilising IoT technologies, with technologies for remote SIM provisioning in particular becoming a vital part of device management.

This will happen in 2021 because the year will bring new opportunities for companies to think about what they have already done. With 2020 highlighting the difficulty of accessing such systems in person, 2021 will bring an opportunity for businesses to retool their IoT devices with eSIMs and other elements that enable remote monitoring and management

The move to remote working for many in 2020 was a scramble, and so 2021 will bring an opportunity for employers to be more deliberate and planned about what they offer in terms of remote working, as well as having a refresh of departmental budgets and the case already made for remote working to a large degree.

This means that 2021 will bring more tools to enable that, as employers look for solutions to better manage remote working and make it more accessible. 2021 will see a boom in solutions that not only enable remote working but provide for the tracking and collaboration that make it productive, as well as providing ways to connect that which was not connected before; expanding the reach of technology into many more workplaces.

1.3.1 Virtual Workspace Innovation to Accelerate as the Future of Work Evolves

Our first subtrend is that we predict that there will be virtual workspace innovation that will go further than it did in 2020, as what constitutes the workplace and collaboration has changed. This will spur the development of new forms of interaction to replace face-to-face meetings. While Zoom and the like have now become common - tools to make video

conferencing and collaboration more productive by integrating production tools into video conferencing software.

The latter part of 2020 has also seen several specialised remote working software tools launch, from Salesforce's Sales 360 Cloud, Dockabl's Clink and in-house developments like Netflix's in-house NetFX platform. These will only accelerate in use in 2021, with more workers now content to work from home, and more companies adapting their policies to incorporate expanded and permanent remote working capabilities.

The biggest beneficiaries of this change will be those companies that can adapt their work practices to remote working more easily, and so take the most advantage of the expanded talent pool and more flexible work patterns that working from home enables.

No longer necessarily required to relocate for jobs, we expect remote working for highly skilled work will become far more common, and the means by which that remote work is governed will become part of the incentive package used to attract top talent to these roles. This means that the solutions need to be intuitive and appealing beyond their function, in order to help differentiate a particular company's role from those of its competitors.

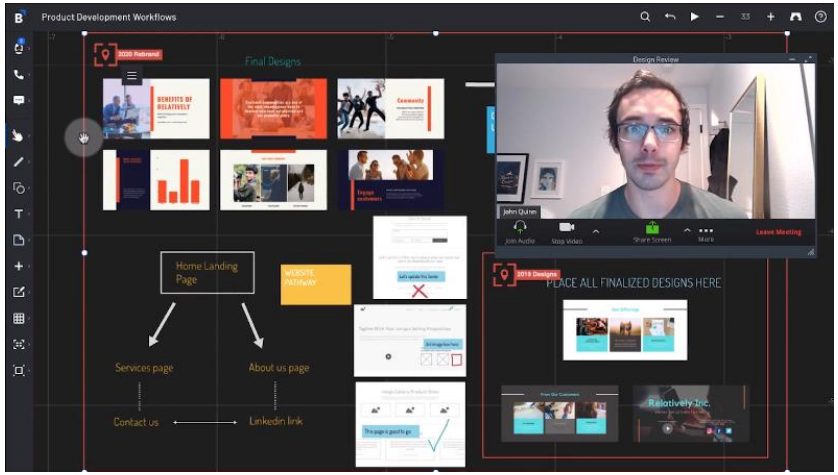
In particular, we expect to see innovation around what virtual meetings entail, which may include specialised use of AR and VR for those industries that require more in-depth presentation and simulation of ideas and designs. This will become particularly prevalent in the CAD space, where design space and workspace for coding new designs will easily merge into one work interface.

Platforms like this can easily be extended to social environments too, in order to allow workers to 'be together' remotely in the same virtual space. However, these will not see huge adoption in 2021 thanks to the cost of setting up VR environments for workers.

Google, Microsoft, and Oracle will be some of the bigger players to capitalise on this trend, having all the capabilities in place to bring conferencing and productivity together in cloud-supported platforms.

We also expect smaller players like Prysm, Bluescape and Immersed to expand with more customers and capabilities following a year of expansion in 2020.

Figure 4: Bluescape Collaborative Workspace Example



Source: Bluescape

Some of these will likely be acquired by larger firms, particularly those looking to make larger plays into the business productivity space.

However, these acquisitions will not land in 2021, as it will take some time for their worth to be shown to any potential acquirers.

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1.3.2 Multiservice Subscriptions to Proliferate

One of the ways that these all-encompassing collaboration software platforms can monetise is through subscriptions, by now a very common method for interacting with business software, and we expect to see multiservice subscriptions proliferate in 2021.These services have been present for some time in the shape of delivery and video content from Amazon Prime, and Apple joined the market with the Apple One service.

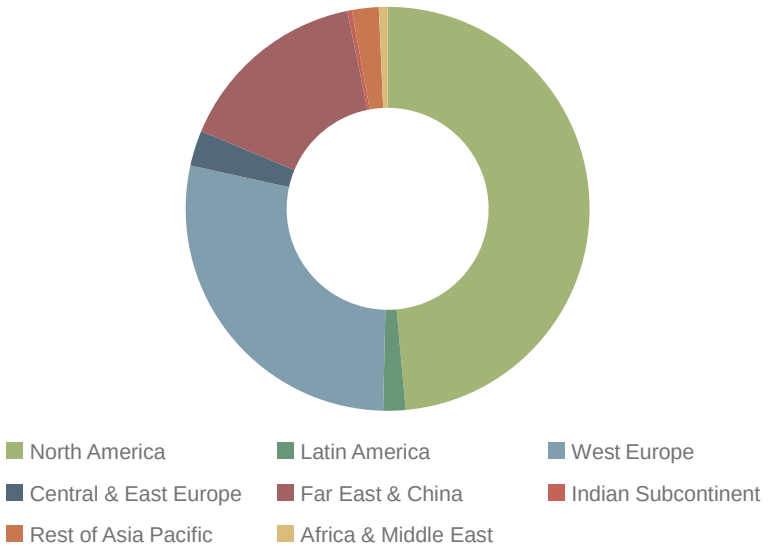
We believe 2021 will also be the year that multiservice subscriptions emerge as a noticeable trend within the consumer space; generating over $42 billion in revenue next year.

Multiservice subscriptions within the video-on-demand space are already prevalent; several players, including MNOs as well as pure VOD vendors, offer bundled deals with multiple providers as part of a single package. 2021 will see more general providers make these kinds of deals, as not all providers have the capability to offer multiple services of their own as a subscription bundle.

However, we believe that this will be most successfully used by companies that already have these kinds of capabilities in-house; potentially folding unprofitable areas of the business into subscription service in order to maintain a presence in the area.

This trend will serve to make multiservice providers more appealing to consumers, as they can see they are getting more for their money.

Figure 5: Multiservice Subscription Revenue, 2021, Split by 8 Key Regions



Source: Juniper Research

Apple has made claims that the Apple One is 'everything for the entire family, for one incredible price'; leaning hard on the value proposition of the service.

This emphasises the relatively low marginal benefit for these companies, in that each additional service cannot be used at full price.

This is likely to raise concerns from competition authorities, particularly in the EU, with some cases investigating this already underway. This will pull the landscape in different directions; while multiservice subscriptions will prove popular, they will have to make the case to competition authorities that they are not acting anti-competitively, which means that Apple and Google in particular will have to tread carefully to avoid that accusation. We've already seen this with Apple, who have emphasised benefits to the consumer in part to avoid the US definitions of monopolistic behaviour, which requires harm to the consumer be demonstrated.

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1.3.3 eSIM Management Tools to Enable Intelligent Control

The pandemic has created many instances where change of established processes has essentially been forced to change. However, there has always been a need for increased efficiency in IoT deployments and reduce costs of owning and operating IoT networks.

The uncertain climate that the pandemic has created has only intensified this need. As a result, we expect a rapid uptake of eSIM management tools in 2021. eSIM

management tools enable eSIMs to download and change operator subscription profiles.

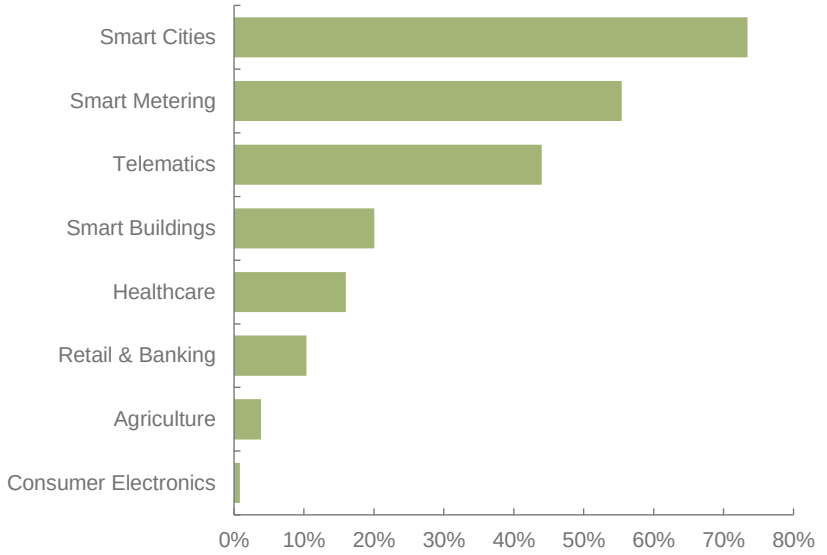
The management of embedded modules allows remote management of the deployment of connections. For traditional SIMs, the implementation process still needs to be completed at the location where the device will operate. RSP (Remote SIM Provisioning), enabled by the standards for embedded modules, allows much of this process to be done before deployment at a location where multiple devices can be configured at the same time.

Once the device is in the correct position, RSP enables the device to be connected to cellular networks remotely, with marginal physical interaction. This greatly reduces the need for specialists that need to implement a multitude of devices that are spread out across a large geographical area; a process that would have been made increasingly difficult during the early stages of the pandemic.

However, the learning curve for implementing these frameworks and processes for onboarding is steep and has taken time.

The pandemic has been accelerated by the impact of COVID-19 by placing a greater emphasis on the benefits of IoT connectivity in certain industries. In the early stages of the pandemic, established roll-out procedures became redundant and IoT service users needed to adopt these new frameworks quickly. eSIM management tools will experience significant uptake and we expect these frameworks to become more commonplace in 2021.

Figure 6: Proportion of M2M SIMs that are Embedded SIMs (%), Split by 8 Select Industries, 2020



Source: Juniper Research

We expect IoT network users to benefit greatly from this. Whilst many high spending IoT users have begun the migration towards this ecosystem, there are still numerous IoT users who will continue to rely on old established methods.

However, once the benefits of these frameworks become clearer, we expect IoT platforms and SIM management platforms to experience a clear uptake in services even after the impacts of pandemic are all but gone. We also expect IoT platforms to benefit from this uptake as the

frameworks provide efficiency gains that accelerate the rollout of IoT devices globally.

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M2M: Key Verticals, Technology Analysis & Forecasts 2019-2024

1.4 Digital Health & Well-being Enter the Mainstream

The pandemic has meant that digital health services that have previously struggled to gain traction, including telemedicine, have been adopted at a large scale across the world.

With healthcare practitioners unable to physically meet with their patients, these digital services have become a vital part of healthcare provision. Telemedicine has had to step in to fill the gap and facilitate healthcare delivery, with medical practitioners having to embrace digital solutions to provide services to patients. However, telemedicine alone will not be enough, and the specific challenges of the pandemic have highlighted the need to develop digital medicine and wellness tools more broadly.

Not all forms of interaction between patients and clinicians will be replaced by telemedicine. In most cases, digital forms of monitoring and treatment will be used alongside interpersonal contact.

Despite the relaxing of FDA rules during 2020, which were relaxed to allow more digital medicines to reach the market, there have not been many approvals through the Pre-Certification programme since March. We therefore expect 2021 to be a bigger year for digital health than 2020, as more firms develop platforms that qualify for the Pre-Cert programme, which will extend to cover a variety of different measures to contend with COVID-19, as well as more long-running medical developments.

With the barriers to digital health starting to finally break down, we expect 2021 to be the year that a wide range of digital healthcare tools will take their place in the overall healthcare system, including ways to improve COVID-19 track and trace systems using technology. Innovation has already occurred on the software side here, with specialised hardware developed in some regions.

This will become more generalised, as technology companies find ways to adapt existing devices to new healthcare uses, particularly around shared technology like Bluetooth.

The pandemic has also made people more aware of their health. We anticipate that 2021 will bring a range of health and wellness tools to allow people to be more proactive in looking after their general health. This will also be leveraged by healthcare systems directly, as digital innovation in this area will be necessary to deal with the scale of mental health problems caused by the lockdowns and pandemic, which healthcare systems will begin to reckon with next year.

1.4.1 Digital Therapeutics to Become Major Part of Healthcare Delivery

Our first sub-trend is that we expect digital therapeutics to become more thoroughly integrated into overall healthcare systems, therefore becoming a major part of healthcare services.

We classify digital therapeutics as medical treatment that is partly or wholly digital. This is distinct from using digital tools to diagnose, or digital platforms to connect with a patient.

The promise of digital therapeutics has not been fully realised during 2020 in several markets, particularly the US, because of the many stakeholders within the healthcare system that have to approve or incorporate digital therapeutics in order for them to be used. There have been moves to make digital therapeutics quicker to implement through the FDA's Pre-Certification programme, which is due to come out of its testing phase in 2021. While there are still some legislative hurdles, we believe this new phase of the programme will accelerate interest in digital medicine.

The biggest sign of this has been the growing number of partnerships between payers and providers in 2020, with many healthcare insurers offering digital therapeutics as part of their programmes. However, state-backed providers have been relatively slow to implement digital therapeutics, particularly for mental health. COVID-19's impact will change that in 2021, as the necessity for a more indirect approach to mental health becomes necessary to cut its costs.

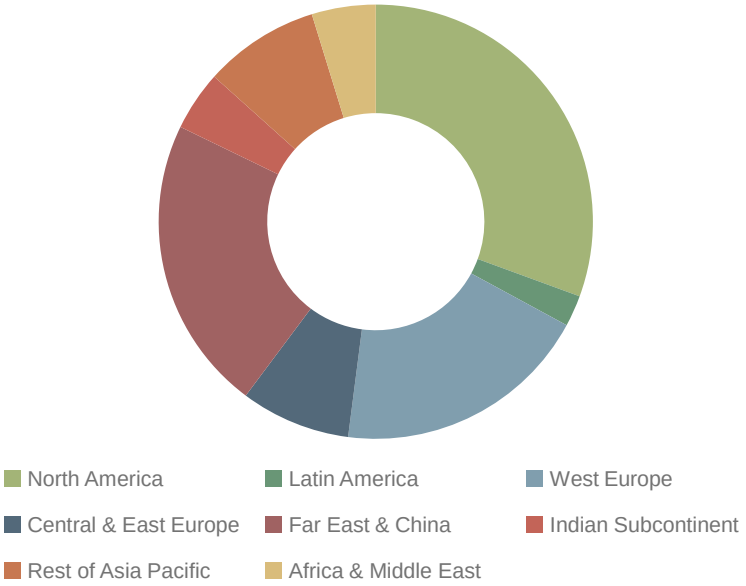
Employers will also develop more capabilities in this area. While offerings to date have been the incorporation of digital wellness tools, we anticipate that employers will want to provide digital therapeutics to ease the mental health burden caused by the pandemic.

The primary beneficiaries of this will be digital therapeutics providers, as they will be able to reach more patients with the approval that they need in order to provide treatment. We also expect digital therapeutics provision for mental health conditions to help ease the load for healthcare providers; making healthcare provision less strained in some areas.

This will have its biggest impact in those areas where insurers are part of the healthcare system, as they can promote digital therapeutics as a competitive advantage; accelerating their adoption.

The biggest stumbling block here will be that the administrative side for rates, reimbursement and the like will not be in place, but with the benefits of digital therapeutics becoming clear throughout 2020 as they have often been offered to healthcare workers for free, there should be little hesitance in deploying them once they are available.

Figure 7: Number of Users of Digital Therapeutics (m), 2021: 44 million



Source: Juniper Research

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1.4.2 Wearables Key to Combatting Spread of COVID-19, Once Privacy Concerns are Addressed

In addition to digital medicine, there have been a large number of ways technology is being leveraged to address the spread of the pandemic. The use of wearables is proving a key part of this, with the ability to track location and/or physiological symptoms being the focus of a range of initiatives.

We have already seen the Singaporean government issuing a device intended to aid in contact tracing, and the Bluetooth SIG is working on a standard specification for contact tracing protocols, that will be able to turn most wearables and smartphones into contact tracing devices.

We expect the work of this group to have its biggest impact in 2021, as the primary goal of the specification is to target those without a smartphone, with children and the elderly being a particular focus. This will mean that new devices need to be developed, which will take time to deploy, particularly in those communities that have a mistrust of medical practice.

This will also help reach lower-income communities, who have been some of the hardest hit by the virus but must be handled with care.

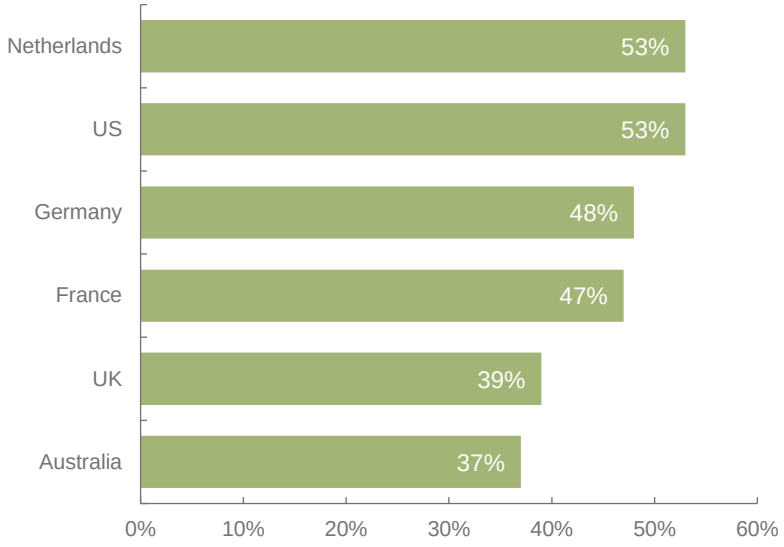
These developments stand to benefit everyone, should they be able to slow the progress of the virus. More immediate beneficiaries will be the wearables companies, as these initiatives will make their devices medically necessary under certain situations.

The gathered data, even if treated with all due concern for privacy, will give a material advantage to those companies that can deploy and promote the more advanced biometric solutions at a large scale.

Several groups have already highlighted privacy concerns, as various organisations, from governments to medical organisations, will have access to private medical data of users, which needs to be handled with enough care that it gives enough confidence for people to actually make use of the system. This is particularly the case for devices that track biometrics in order to potentially give an early warning to the wearer that they have the disease before they show any symptoms.

This will take some time to overcome, which is why we believe this will have its biggest impact in 2021, rather than 2020.

Figure 8: Proportion of People Uncomfortable with their Data Being Used for Contact Tracing (%)



Source: Juniper Research/Okta

This is especially true as people with lower incomes are less likely to already have a wearable that can aid in this effort, and so will need to be supplied with devices from a government body in order to fully participate in such tracking.

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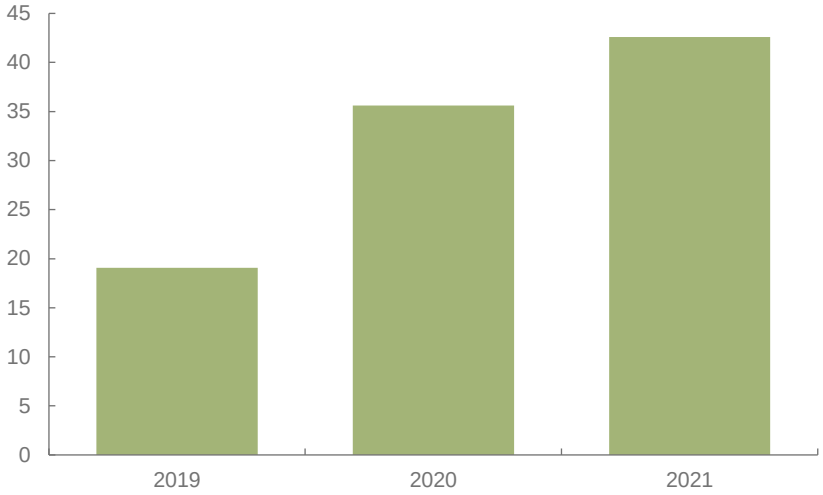
1.4.3 Concept of Sexual Wellness to Drive Sextech Adoption

We anticipate that sextech device adoption will increase in tandem with the growth of the sexual wellness trend.

For clarity: connected sextech devices, as opposed to traditional sex toys, are compatible with smartphones; enabling users to remotely control their devices via Bluetooth or Wi-Fi. This category includes, but is not limited to, connected vibrators, connected kegel exercisers and intimate companion robots.

A combination of lockdown measures in multiple countries, high confidence in online retail, and increased spare time were responsible for the growth in sextech adoption during the COVID-19 pandemic, with the number of connected sextech devices in use increasing from 19 million in 2019 to 36 million in 2020.

Figure 9: Total Number of Sextech Devices in Use (m), Global, 2019-2021



Source: Juniper Research

Whilst there will still be an increase in sextech device adoption next year, we do not expect this increase to be quite as significant as the growth between 2019 and 2020. We believe that growth in the demand for sextech devices during 2021 will be driven by the increasing inclusion of these devices within the concept of 'sexual wellness'. It is important to note that sexual wellness products also include apps, websites, and audio content, which can be highly valuable to users.

With sexual wellness service providers covering a variety of content, including sex education information, sex and relationship therapy services and sexual advice, we expect that sexual wellness will be progressively viewed as part of the 'Health & Wellbeing' space, rather than being stunted under the label of 'adult content'. This transition will bring more awareness to sexual wellness, through consumers becoming more exposed to the concept.

We expect that the number of retail distribution channels offering sextech devices will increase next year, as the growth of the sexual wellness 'trend' continues to accelerate during 2021. As the sexual wellness movement continues to gain traction, there will be increased demand for connected sextech devices.

We also believe that an increasing number of specialist sextech retailers will emerge next year, in order to capitalise on this demand. As a direct result of the growth in specialist retailers, the scope of retail distribution channels offering sextech devices will increase. Consumers will therefore gain greater access to sextech devices; driving market spend.

This will enable sextech device manufacturers to re-invest their profits into their research and development plans; ultimately resulting in a wider product portfolio. Consumers will benefit from this increased investment; experiencing a greater choice of hardware to suit different requirements.

This process will quickly emerge as a virtuous circle, with both consumers and device manufacturers benefiting from the growth of sexual wellness.

Related Research

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1.5 Intelligent Connectivity - Rapidly Evolving in Post-Pandemic World

We are predicting 2021 will experience an increase in intelligent connectivity; rapidly evolving as the impacts of the pandemic slowly reduce.

'Intelligent connectivity' refers to new solutions that make network-based services more resilient.

We believe that the key word in networking in 2021 will be resilience. The market shock of the pandemic has shone a light on operations' resilience to short and sharp changes to market conditions. As a result, several operators, users and service providers have needed to change operational procedures in response.

We do not believe that network operators have by and large dealt well with the shifts in demands for data, however operation of other service providers who could benefit from increased or intelligent connectivity have suffered from the pandemic.

We have certainly identified areas which will need further evolution or need to adapt over 2021. These include the use of licensed and unlicensed spectrum, such as the ownership of network hardware, and who will manage the networks in order to maximise the resilience of operations

Given the unprecedented market shocks that we have all experienced this year, the end game for network users will be increasing their resilience.

These range from the geographical coverage of the network, whether it be national or local, or device density; outlining how many devices will be in operation in a given area.

The emergence of this in 2021 is largely down to the emergence of 5G and new Wi-Fi standards that enable services that require ultra-low latency.

This is most notable in industries, such as manufacturing and engineering, that require such low latencies that previous technologies simply do not suffice.

We believe that this area of latency is a real key network aspect that is set to be highly demanded over 2021 – and, in turn, we expect a demand for some emerging new technologies that can provide this.

However, these new technologies change the ability of connectivity, and as we know from extensive marketing activities over the last two or three years, there are still use cases over 5G that are yet to be fully explored.

1.5.1 Increasing Development of Private Network Capabilities in 2021

Private cellular networks have emerged as a key new revenue stream for mobile network operators over previous years. The high data rates of LTE networks were well suited to the growing use cases in sectors such as engineering, manufacturing and distribution centres. However, the emergence of 5G technologies is likely to further grow the demand for these networks.

In instances where there is a high density of connections/sensors, or the need for ultra-low latency, 5G will be high demand as LTE networks will not suffice in these scenarios.

Over 2021, we expect a focus on evolving network architectures that can be modified to meet the needs of end users which we believe will be greatly demanded in search of this greater resilience.

Network slices will play a pivotal role too, as standalone 5G technology becomes an increasingly prevalent technology and is implemented into private network service offerings.

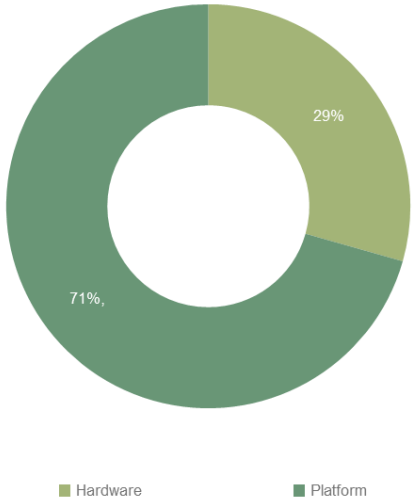
Whilst previous interest has been in leveraging 4G technologies for private networks, the emergence of 5G and the development of CBRS, or Citizen Broadband Radio Service, in the US will present new business models for operators, IoT platforms and system integrators to offer private network services.

We also expect two things to occur in 2021;

- A greater uptake of CBRS in the US, particularly by operators wishing to free up their own spectrum by using the network for ad hoc services.
    a) Freeing up of spectrum for IoT purposes will allow operators to keep their own spectrum for mobile subscribers and other IoT connections. For static IoT platforms, a CBRS-type platform can be used.
- Europe will likely begin exploring similar CBRS services in response to the COVID pandemic.

Additionally, technologies such as the Wi-Fi 6 standards are also anticipated to have an impact in 2021, by offering similar services to 5G networks although through a different technology and monetisation.

Figure 10: Global IoT Market Value in 2020, Split by Hardware & Platform: $94 billion



Source: Juniper Research

Whilst Wi-Fi has always been an option for IoT users, the increasing presence of connectivity and IoT devices has often meant that Wi-Fi capabilities have not been sufficient for large scale use cases.

It has often been hindered by low data rates, high latency and an inability to connect a necessary amount of connections to the network. There is also the rising usage of low power IoT connectivity and the anticipated

increased investment in low power devices across industries including smart cities and agriculture.

We expect existing users of IoT technologies will benefit from this trend. As they search for resilience in their networks, the greater choice of technologies will open up new services that they can adopt to accomplish this. These include real-time monitoring of the network and devices, as well as lower latency across networks.

Secondly, the IoT networks will benefit from these emerging technologies as new services attract high spend IoT users. These IoT service providers will need to provide a valuable proposition to increase the uptake and we fully expect the new capabilities of emerging technologies to enable them to accomplish this.

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1.5.2 Increasing Network Virtualisation Owing to Standalone 5G Network Rollouts

Operators are continually looking to reduce the operational expenditure of networks, and we expect operators to use the launches of standalone 5G networks to increase virtualisation.

Overall, COVID-19 has had little impact on operators' ability to roll out 5G infrastructure. Indeed, operators are pressing ahead with standalone 5G network roll-outs as we speak, and we expect operators to capitalise on these roll-outs.

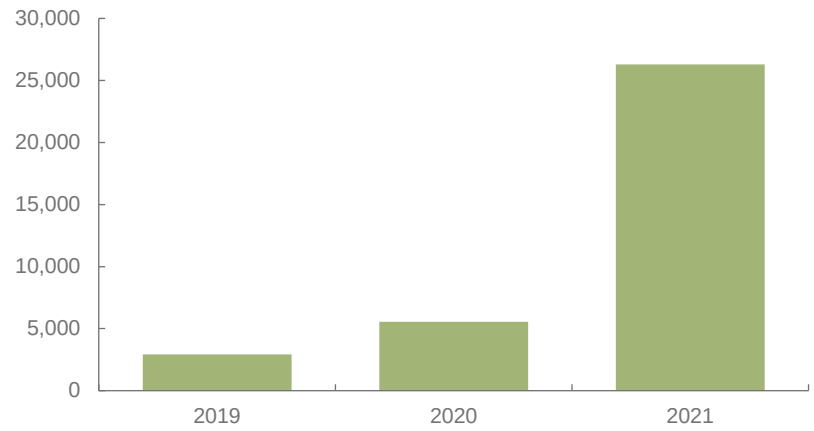
The next stage in the evolution of 5G is the development and roll-out of standalone 5G networking architecture. Operators are keen to migrate to users to 5G and in some instances are offering pricing similar to 4G to encourage users to do so. Standalone 5G will accelerate this, as extra costs and rising customer expectations make it difficult for individual operators to match clients' needs.

As cellular technology network iterations progress, the extent of virtualisation and the level of the network that is defined by software increases; this in turn reduces both operational and capital expenditure for operators. Therefore, the migration of subscribers to 5G networks, which has been faster than previously anticipated, will drive operators to virtualise networks in 2021.

Standards for this architecture will bring a large number of benefits to operators such as wide network coverage and a migration from virtual evolved packet cores to next generation cores. This migration will enable a greater separation of network planes, and allow for more virtualised network functions, which in turn enables operators to launch new services to consumers in a faster and more efficient manner.

The majority of these upgrades are expected to occur in the core of networks. A large proportion of standalone 5G network roll-outs were done as non-standalone 5G networks were launched in 2019. As a result, many of the edge network upgrades can be done via a software update or reconfiguring the hardware that is already present.

Figure 11: Global Mobile Data Traffic Carried Over 5G Networks (PB), 2019-2021



Source: Juniper Research

As networks increasingly migrate to an IP-based mode of operation, standards in both the telecommunications and IoT spaces will continue to rely on operators having increased virtual networks and is therefore in operators' best interest to keep virtualising their networks to remain competitive.

Obviously, operators stand to gain the most from these roll-outs. The reduction in capital expenditure cannot be understated, however the extent of increasing network virtualisation depends on how many of its subscribers the operator can migrate to newer networks.

Operators with a high number of subscribers on networks that are not 4G or 5G are likely to need to keep many network operations open to continue service. However, those operators who have launched 5G, or even standalone 5G, should be the first to benefit next year.

1.5.3 Security Concerns of Consumer IoT Devices to be Eased by Emerging 'Confidential Computing' Protocols

We define confidential computing as the process of increasing the areas in which data is encrypted.

Whilst encryption is typically done when the data is at rest or in transit, there are few standards on protecting this data when the data is being processed. However confidential computing standards encrypt data when it is in use.

The Confidential Computing Consortium already includes members such as Alibaba, Arm, Google Cloud, Huawei, Intel, Microsoft and Red Hat.

We have seen significant interest so far this year and we expect this to accelerate next year.

Confidential computing is key to migrating more processes to cloud services, edge processing and IoT devices. There needs to be an additional level of security for end users. However, protecting data in use is notably difficult as programmes and applications need to have clear access to the data; meaning that established encryption of protection protocols are essentially ineffective.

Confidential Computing leverages hardware to isolate the data or functions that need to be protected when being processed. This is then stored in the TEE (trusted execution environment), where it cannot be viewed unless authorised.

This reduces the risk of cyber-attacks when the data is most vulnerable. Many enterprise users have often been wary of adopting cloud services for fear that data could be stolen during the processing of data when in the cloud, however the introduction of TEEs would mitigate these fears if implemented correctly.

So why 2021? There has already been large backing from large tech conglomerates for the protocol, with efforts to promote the service really taking shape this year. Given the development time, we expect a greater focus on rolling out the service in 2021, with network users that rely on cloud services being amongst the first to adopt the technologies.

Given the high-profile nature of lost data in cybersecurity attacks, we expect high interest into any solution that can better safeguard sensitive data. Once again, this feeds back into our key word for networks in 2021 – resilience. The wide reach of network services means there is a large surface area for attack, and IoT end users will expect this resilience moving forward.

The onus is on network security providers to highlight the benefits of confidential computing to end users in order to maximise the potential growth of the service.

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