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**WORLD REPORT**

November 2019

# Dawn of the 5G Era

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# From the Editor

**Zia Askari**
*Editor, TelecomDrive.com*

# 5 Future-Ready Disruptions That 5G Can Drive

Giving shape to innovative applications and use cases - 5G networks will offer an unprecedented leap in bandwidth speeds. In a 5G scenario, downlink peak data throughput could reach 20 Gbps, while uplink peak data rates could be as high as 10 Gbps. Most importantly, 5G will reduce latency and improve overall network efficiency.

Streamlining network architectures will deliver end-to-end latency requirements of less than 5 ms. This will allow 5G to offer ultra-reliable low-latency communication for innovative machine-to-machine and public safety applications.

As it delivers new infrastructure solutions, 5G will depend on an end-to-end digital service transformation, which will minimise OPEX, deliver efficiencies, and drive revenue growth.

Here are five of the most innovative use cases that can shape new era of 5G communications, sooner than we think.

**Connected Automotive**

Connected Car market is set for a radical transformation today, as the role of connectivity grows beyond legacy entertainment and convenience functions, developing into a critical enabler of safer, more sustainable mobility.

Key technology trends driving the mobility revolution - autonomous driving, cooperative mobility, vehicle life-cycle maintenance and sensor data crowdsourcing require secure, reliable, low-latency and high-bandwidth connectivity.

5G will provide enhanced situational awareness and high precision navigation through high bandwidth, low latency streams from other vehicles, and roadside infrastructure.

**Smart Manufacturing**

Innovation is at the heart of manufacturing. Major developments include the moves toward lean manufacturing, digitalization, and greater flexibility in work processes and production. Recent times have also seen a strong shift in favor of the industrial Internet of things (IoT).

Mobile telcos can assist manufacturers and logistics centers with their smart manufacturing transformations. 5G network slicing and MEC enable mobile telcos to offer a variety of value-added services on top.

**Connected Energy**

Many energy management companies, in developed and emerging markets are starting to rely on Distributed Feeder Line Automation Systems and this can be enabled seamlessly with the help of 5G network. Feeder line automation systems are particularly invaluable for integrating renewable energy generation into energy grid operations.

Benefits of such a system include reduced Operations & Management costs and improved reliability. It is necessary for the feeder line automation system to have access to very low latency communications, such as 5G.

**5G eHealth**

Today there are a lot of healthcare professionals who have begun to integrate solutions such as remote audio/video diagnosis, remote surgery, resource databases, and remote health monitoring using wearables/portable devices.

The healthcare industry has the opportunity to develop a fully personalized medical advisory service that is complemented by doctor-driven AI medical systems connected by 5G.

Healthcare professionals have begun to integrate solutions such as remote audio/video diagnosis, remote surgery, resource databases, and remote health monitoring using wearables/portable devices.

**5G Enabled Smart City**

A smart city holds a competitive advantage in that it can be proactive rather than reactive to the needs of its residents and businesses. To become a smart city, civic authorities not only need to invest in data sensors that can take the pulse of the city but video surveillance cameras that can monitor the flow of traffic and the safety of its neighborhoods.

5G can enable novel smart city application scenarios such as body-worn cameras, and in-vehicle cameras which are used by Emergency First Responders and also individual car owners.

The enhanced features of the latest video surveillance cameras such as high frame rates, HD video and WDR (Wide Dynamic Range, which allows for imaging even in challenging lighting conditions) will contribute to significant new data traffic being generated.

Driven by 5G networks, Telcos can create an advantage in offering Artificial Intelligence to enhance their cloud services. AI can enable computers to interpret large amounts of data in the form of images, sound, and text. AI will enable face recognition, vehicles, license plate recognition or other video analyses.

## CONTENT

# Dawn of the 5G Era

## *How 5G technology will ultimately change connectivity as we know it and alter the DNA of our digital experience*


Today we are standing right on the doorstep of the 5G world. When the Wright brothers invented the airplane, it fundamentally altered how we experience traveling from one place to the other.

It wasn't just about speed. Yes, it was great getting from New York to London in less time. But flight also gave us thrill of defying gravity and soaring to new heights.

Just as the airplane fundamentally changed the traveling experience and set off a chain reaction of innovation, so too does 5G promise to alter connectivity as we know it and change the nature of our digital experience in a completely new way.

Some say that "5G" merely means faster connection speeds. However, it goes beyond that. As it matures, 5G is expected to alter the very DNA of our user experience in dramatic, exciting ways—from leisure to healthcare to retail to manufacturing to finance and beyond.

To imagine what's coming, it helps to look back where we've been. How would your business be faring if you never adopted any mobile technology beyond the 2G world? It's like opting to keep the abacus instead of upgrading your team to computers and spreadsheets.

As part of our special story on 5G Possibilities and Beyond - we are examining some of the most important key drivers of 5G innovation. We'll look

at 5G as a new experience—and as a possible enabler of radically new ways to do business.

Finally, we'll also look at a timeline of our path to 5G, and what you can do to prepare for what promises to be the next great, world-and-mind altering experience.

**Key Drivers**

Several catalysts are accelerating the genesis of a 5G world. The need for network technologies to work in harmony Businesses and organizations find themselves in an increasingly complex network world.

In the realm of network services, a retailer or restaurant may need VPN (virtual private network) while also being able to provide access to public Wi-Fi®.

An enterprise now must move efficiently across multiple clouds and cloud platforms for processing, networking, colocation, and content delivery. As businesses navigate wireline and wireless networks, they are turning to software-defined networking (SDN) and network function virtualization (NFV).

SDN and NFV unbind network services that were once bound. The ability to divide these services into smaller, software-driven functions lets businesses, operators, and cloud providers deploy and configure these services where and how they need them. They also enable businesses to expand and contract network bandwidth based on need.

With the tides of data continuing to rise, businesses must transform through virtualization and automation to optimize the cost and scale of the experiences they want to create. Businesses must also manage mobile devices, apps, and a variety of voice and collaboration tools so their teams can connect across geography, platforms, and devices.

All these separate networks, solutions, and connections create potential chaos and gaps. They lack interoperability — or at most have spotty, hard-to-set-up interoperability.

It's a bit like the frayed end of a rope, with individual fibers unbound and sprouting in different directions. That end of the rope is weaker. Developing the technology that has the capability to allow the convergence of wireline and wireless networking is like taking the frayed end of the rope and weaving it back into a unified whole.

From the core of their network all the way to the far reaches of their digital technologies, organizations want an entire tech ecosystem that integrates all these services, solutions, and products seamlessly so they work in concert. And they want more control, visibility, and personalization. It's the nature of the on-demand society in which we live, exemplified by trends like the consumerization of IT.

The cybersecurity arms race between businesses and digital criminals 5G means new opportunities for businesses to innovate. It also means more opportunities for bad actors and hackers to innovate. For example, edge clouds and IoT devices have multiplied at an exponential rate.

While they represent new capabilities and services that enhance businesses, they also represent a mind-boggling amount of new endpoints and threat planes. These can be doors into the network — ways hackers can get to your data and assets.

As 5G technologies coalesce and codify, businesses want the 5G world and network — and the capabilities it can enable, all wrapped in security. Though the standards for the 5G core are still in flux, we do have indications that it will have some cool and effective features like common authentication between different access networks, new security key concepts, edge proxies, and more.

**Unleashing Emerging Experiences**

Today, 4G is enabling many use cases. We are familiar with the Internet of Things (IoT), augmented reality and virtual reality (AR/VR), artificial intelligence and machine learning (AI/ML), autonomous vehicles, and drones. However, being able to use these tools in a distributed, highly dynamic, and mobile way has come with its challenges. There are some things not yet possible with our current network bandwidth, latency, and compute power.

For example, for users to get the best experience from their VR headsets and apps they need an extremely low motion-to-photon ratio—that's the time it takes for the data to respond to your movements and reconfigure the VR image.

When you move your head, the VR display should instantaneously reflect it in your virtual world. The greater the delay between your movement and what you see, the more "off" your virtual world appears. If it gets too jittery, it can make you feel seasick since your brain sees one type of

motion, but your inner ear feels another reality. The dissonance between the two is annoying at best and sickness-inducing at worst.

If all content is local to the device then processing is faster. However the more dynamic the content is (e.g. non-localized; the device app relies on data transport and interactions from the network), there's a greater chance this data will cause nausea due to data latency.

The goal of the medium is true immersion — creating an illusion so real that it tricks the human brain completely. To give you sense of scale, the typical refresh speeds for a computer screen are approximately 80ms. However, for AR/VR, the industry is driving the conversation toward the Vestibulo-Ocular Reflex (VOR) — the neurological process by which the brain coordinates eye and head movements to stabilize images on the retina.

This is critical to synchronizing virtual and real objects to create a coherent view. The entire VOR process takes the brain 7ms, a more than 10x reduction over screen-to brain propagation.

Today's VR systems recommend a latency of <20ms for standard performance, and very low latency (<7ms) is even better. For this reason, developers and inventors want even lower latency to realize what they envision for the next iterations of VR.

While some level of AR/VR is here today, in most cases it's localized content, and to do a distributed and dynamic push of content based on analytics, it's imperative that latency is as low as possible.

Remember, we said that 5G is more than speed — it's an entire experience. 5G will do more than lower our latency — it will be able to create interactive personalized experiences, potentially even based on what you like and where you are. These dynamic AR/VR experiences will need to rely on extreme amounts of compute power, data flow, and low latency.

And if every millisecond counts for virtual reality, think how much low latency means to the autonomous car user experience? For passengers and pedestrians alike, it's a matter of life and death as to how fast the data travels and the quality of that data once it reaches its location.

The innovation around these vehicles alone is expected to spur the global market for autonomous driving sensor components: $4B by 2020, $15B by 2025, and $25B by 2030 - The stakes are high: safety, performance, and reliability will need a network that delivers high speeds and data quality with ultra-low latency. Further, piecing together service, connectivity, and security as many companies of today may not cut it. Autonomous cars, and other new solutions, will need tighter integration between the application and the transport network.


Google's self-driving car currently generates 3.6 TB of data per hour and for optimal performance, needs the ultra-low latency 5G promises. We're not there yet. A lot of processing will be done in the car, but some amount of macro data will be needed for the car to see things like cyclists that aren't as easy to predict as cars in a platoon, or for sharing data from other cars or smart cities. This is the intra/ inter-connectedness that 5G promises.

**5G as a New Technology Fabric**

We say 5G, but what does it mean? Remember, it's not only speed — it's user experience. This section provides an overview of what we believe 5G will ultimately be able to deliver.

Not just another G — how future 5G and complimentary technologies will change the DNA of the user experience. Let's say you live in the suburbs and you drive to work.

It's about 20 miles to the downtown office once you hit the interstate. Ten years ago, the commute wasn't too bad, but now it's congested and slow. How do you improve your commuter experience?

Capacity is one consideration. You can make the Interstate wider, adding more lanes from one end of the commute to the other so you can accommodate more traffic. Speed is another consideration. You can raise the speed limit and get faster cars on the routes.

Proximity is a third consideration. You can move closer to the office — so essentially you live on the edge of your office's property. Because while speed is important, if you only live 3 blocks away and ride a scooter, you'll get there in less time than if you bought a Ferrari and zoomed down an uncongested Interstate at 190 mph

for 20 miles. But one downside is the cost of real estate — you may not be able to afford as many square feet of living space near the office as opposed to the suburbs, but your commute experience is better.

Traffic management is your final consideration for making your end-to-end commuting experience amazing. You could create HOV (high occupancy vehicle) lanes on the interstate and put programmable lanes on the surface streets around the Interstate. HOV lanes create priority lanes with less traffic for certain types of vehicles.

And programmable lanes, often seen around sports stadiums, route traffic based on current congestion information. You improve how the road treats you — not how you treat the road.

The stakes are high: safety, performance, and reliability will need a network that delivers high speeds and data quality with ultra-low latency. Further, piecing together service, connectivity, and security as many companies do today may not cut it.

**Now let's translate the analogy.**

Capacity is bandwidth. 5G will ultimately not only support a better experience per device, but also for more attached devices, such as AR goggles, machines, sensors, and drones. 5G will and its architecture will theoretically be like adding many more lanes to a 4-lane interstate.

Speed is how fast the data can travel. As 5G evolves, a 5G network will be like giving each car an engine with incredible top speeds and then raising the speed limit to allow for ultra-rapid transit time.

Proximity is the power of the edge. The 5G network (core and RAN) is designed from the get-go to be flexible and better suited for edge deployment.

It brings compute resources and services closer to your work and home. Services that currently reside in a central cloud outside the mobile network can be pushed to the edge so they're on the doorstep of the devices. It will improve overall experience, end-to-end latency — not just network latency.

Traffic management is, as the name implies, how you manage data traffic across hyper-busy networks so it travels with reliability. Network slicing lets network operators open dedicated virtual networks over a common network infrastructure to provide functionality specific to the service or customer. It's like opening HOV lanes on the wireless network.

> ***5G is a conglomeration of technologies that will elevate user experience***

Today we have a better Class of Service (CoS) app that can re-route traffic around jams or accidents on your route — but tomorrow virtual networks can be created on the mobile network that could essentially help the mobile network be MPLS-like.

5G is more than just speed. It is a conglomeration of technologies that will elevate and enrich the user experience from end to end.

**User Experience = Speed + Latency + Reliability**

**The foundation of 5G**

Many components of 5G are still being developed and perfected. Still, some communications companies have been conducting field tests in several cities (more on that later). These are the basic concepts underlying a 5G world.

What will your business look like: Use cases from the new industrial revolution In this section, we look at how you can bridge the gap between today and the future. We'll also look at different industries and the ways 5G is projected to enhance user experience in each sector.

**Laying the foundation now for 5G later**

Before we look at future-looking 5G use cases, it's instructional to list some key preparations you should consider having in place so that you're ready for 5G.

*SDN and NFV* — The more you can virtualize your network through SDN and NFV the readier you will be to add the features and upgrades made possible by 5G. When the network has more variables, you will be able to adjust quickly and efficiently on the fly thanks to software.

*Cloud competence* — Where is your organization when it comes to colocation, cloud networking, a content delivery network, cloud disaster recovery, and virtual data centers?

*Cybersecurity* — Do your security plan and capabilities cover your network from one edge to the other? Can you manage threats through strong threat intelligence? Do you have in place security for data and apps, the network and the cloud, mobile endpoints and devices, and IoT?

**Healthcare**

Leaders in the healthcare industry agree that patient experience is paramount. Improving the healthcare experience is a key trend that will determine whether healthcare providers succeed or fail.

*Current tech trends:* Wearable health devices, health monitoring and diagnostic apps, telemedicine, AI for process automation in hospitals, cybersecurity to protect electronic patient records

*Predicted trends:* Value-based care (rising costs of care, electronic

medical records, personalized care and precision medicine, payment reforms and patient engagements); pressure to maintain profitability (staff productivity, facility efficiency, process streamlining, cost reduction— all while being innovative); growing patient demands (patients consume healthcare differently, virtualization of care, rise of informed and cost-clarity consumers, emerging social applications and new competitors); infrastructure readiness (expanding ecosystem to meet the customer where they are, infrastructure readiness and interoperability, cybersecurity and information access)

**Future Potential 5G use cases:**

5G will begin to help solve business problems that drive revenue realization, helping healthcare providers be more profitable, efficient, smarter, secure, and most importantly more effective in caring for the patient.

Getting an annual exam or calling the doctor's office when you are sick will become less necessary. Wearables and home sensors will provide near-constant monitoring of your health and can alert you and your healthcare provider about potential ailments or abnormalities.

5G will be the intersection of network, cloud, and services. We're moving these things and distributing parts of the core so that capabilities will be at the edge and thus closer to you and your device.

Remember our traffic analogy? Now your devices will have much greater capacity, speed, proximity, and traffic management.

Telehealth will no longer be just about enabling connectivity in traditional brick-and-mortar healthcare facilities. Now we will have connected care almost everywhere. Remote patient monitoring and mobile health applications that Americans can access on their smartphones or tablets while at home or work will be part of a new and seamless way of delivering costeffective, direct-to-consumer healthcare.

In terms of preventative care, your health wearables will calculate daily recommendations and prompt you based your medical records, real-time vitals, and projected needs.

Healthcare providers will be building an entire ecosystem that creates highly responsive, effective, patient-centric experiences.

**Retail**

We're already trending toward selling consumers experiences — not just selling things. Retail will continue evolving toward rich, experience-based shopping.

*Current tech trends:* Retailers are using data and solutions from different types of endpoints to trigger customer-requested targeted marketing; retailers are also able to collect tremendous amounts of data from customers and their behaviors, enabling AI personalization (recommending products, sending coupons for what you've purchased, redesigning home pages instantaneously based on social media profiles); smart digital price tags Predicted trends: (1) creating the optimal fusion of the virtual and physical worlds to create intensely personalized shopper experiences; (2) in-store 3-D printers to create custom products; (3) VR and AR to virtually try on clothing, virtually remodel and redecorate your home, or holographically teleport to potential destinations to help you decide where to book your next vacation

> ***5G will begin to help solve business problems that drive revenue realization***

**Future 5G use cases:**

With customer consent, when customers walk past your storefront, your store will be able to sense them, and based on the compute power happening right at the edge of each device and location, you can virtually clothe the customer in your latest fashions that match the customer's current and predicted preferences — and render the customer in their new wardrobe on high definition screens in the store window instantaneously.

Sensors will also be able to detect how well customers like what they see based on advanced facial recognition algorithms that can interpret subtle expressions and eye movements and show different wardrobe items that trigger more positive responses. All virtually instantaneously.

Retailers can save these personalized digital ads and create follow up marketing campaigns just for that customer.

A home improvement store may have a remodel kiosk that pulls up your floorplan and lets you walk through each room in your house in VR, changing the color of each room, switching out furniture or appliances, or even adding a new wing on the house to see how it looks.

**Finance**

Just as those in the healthcare industry recognize that they need to create better patient experiences through technology, so too does the finance industry realize that they must create better customer experiences. As consumers and businesses turn more and more to mobile and online banking, those financial services that can make that digital interaction exceptional will find themselves leading the pack of the new fintech landscape.

Current tech trends: Online and

mobile banking and investment firms are causing the rapid shrinking of physical banks and locations; evolving cyberattacks from multiple entry points and vectors are plaguing the industry; AI bots help quickly resolve customer service issues for online interactions in finance; insurers are using IoT and AI to gather and process volumes of data that help them create better pricing models that save them and their customers money Predicted trends: (1) Digital-only banking will continue to reduce the size and need of the physical locations; (2) real-time risk assessments and alerts will inform investing and budgeting decisions; (3) an Uber-like sharing economy will upend banking services by matching providers and users of capital.

You will be able to create financial and insurance services experiences that are highly customized, recommending products and services based on predictive models. High-resolution video will let your customers summon your in-person or AI representatives for "anywhere" consultations.

An AI cyber-immune system will send threat intelligent defender cells (like white blood cells) from one edge of an institution's network to the other, actively patrolling for hacker probes, patching security weak points, and evolving to match new threats. This will be augmented by new identification methods using AI and facial recognition.

Insurance companies will be able to dispatch drones for insurance investigations or even use holographic teleportation for adjusters to tour damaged property and inspect vehicles and provide benefits more rapidly.

**Manufacturing**

Manufacturers are using current IoT and cloud advancements to streamline processes, reduce overhead, and boost revenue. Current tech trends: IoT devices to provide realtime feedback, optimize shipping and storage conditions, and send alerts for repairs and preventive maintenance; create smart factories with integrated IT to collect and process data for both sides of the supply chain; moving data for storing, managing, and processing needs to the cloud.


*Predicted trends:* (1) IoT "neural" network where IoT smart sensors, fueled by edge computing power and AI, create a connected manufacturing "brain" that optimizes, reacts, and calibrates from one end of the manufacturing process to the other—informed by the intelligence at each node and endpoint; (2) robots that mimic human capabilities are used for dangerous, highrisk jobs currently filled by humans ; (3) AR/VR schematics

5G's high capacity, wireless flexibility, and low latency performance make it a natural choice to support the gathering of operational intelligence.

As networks grow and become smarter, they will produce far more information than their predecessors. Manufacturers that can capture and crunch these numbers can produce actionable intelligence that increases productivity.

When the network gives advanced warning that a piece of specialized equipment needs a repair, augmented reality using low-latency 5G-enabled headsets will make technicians more efficient.

Level-one technicians can travel to a site and have engineers at headquarters guide them through the repair process remotely via 5G networks, using context-sensitive 3D animations to walk them through the necessary steps.

Finally, 5G will enable manufacturers to drive more functionality closer to the edge of the network. Because this network technology's reliability is so high and its latency so low, equipment can communicate wirelessly with back-end systems for time-critical operations in ways that were not possible before.

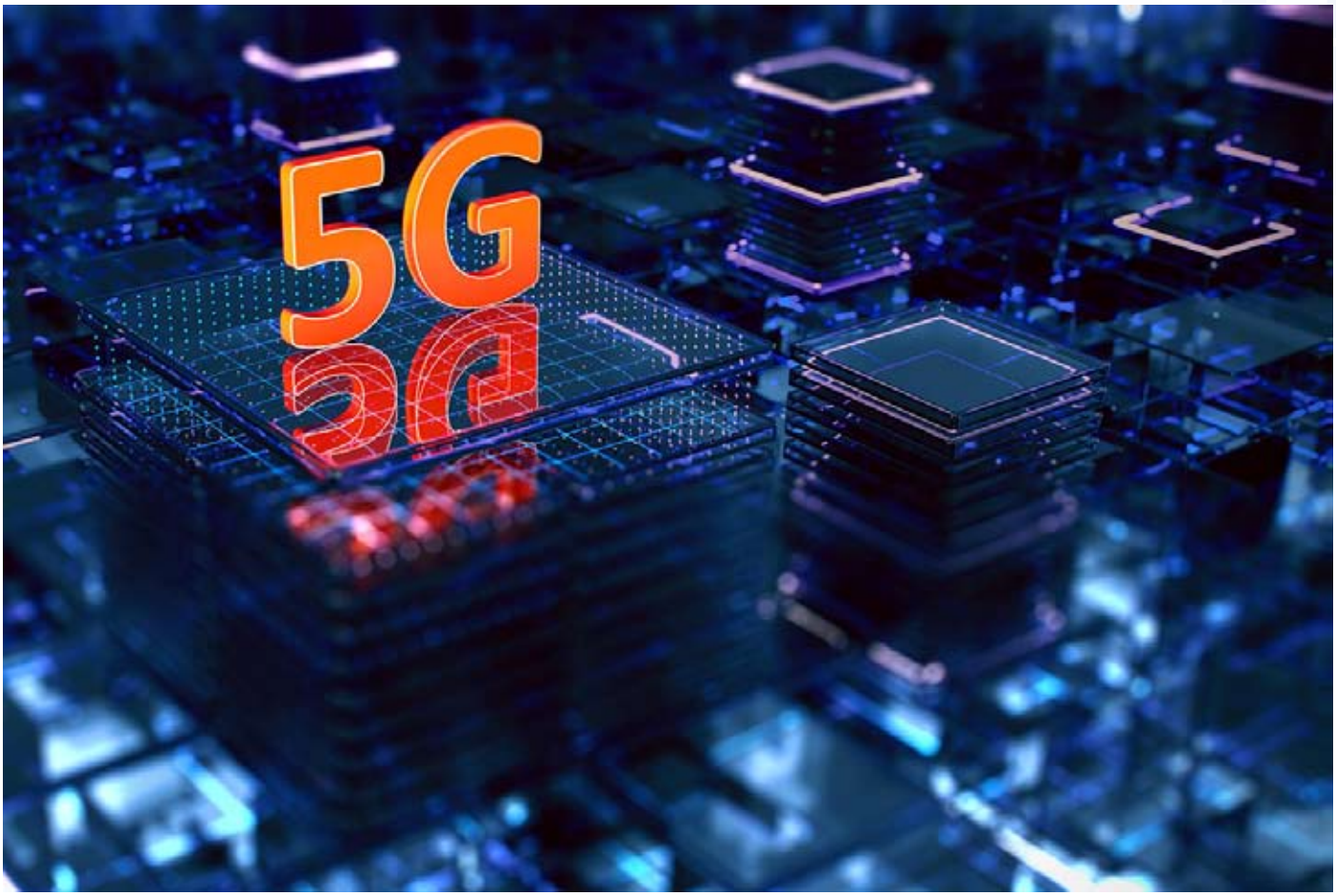
Some of these scenarios have elements that project into a future that seems wholly in the realm of science fiction. But that's the point of the types of experiences and advancements that 5G will accelerate.

Meanwhile, some of the applications in the use cases are near-cousins of things you may be relying on today. Critical to how fast you can hit the ground running with 5G will be the strength, breadth, and depth of your current network, cloud services, IoT, mobility, and cybersecurity.

But it's not an understatement to say that most of our computing paradigms need to change to lay the groundwork for the next first-mover advantage.

# Tecnotree | Enabling Future-Proof Monetization in 5G Era

By Indrajit Chaudhuri, Chief Product & Technology Officer at Tecnotree Corporation




Over the last few years, the Telecom companies have experienced diminishing returns due to market saturation, price competition and the rise of over the top (OTT) competitors. Their traditional revenue generating services like SMS based messaging services or voice calls has been almost killed by players like WhatsApp.

On top of that, also premium SMS based VAS services from partners have died with the shift in IP and App based delivery models of those services. Obviously, data revenue has been increasing for most of the operators around the world with the move to better network technologies – from 3G to 4G/LTE and now with 5G.

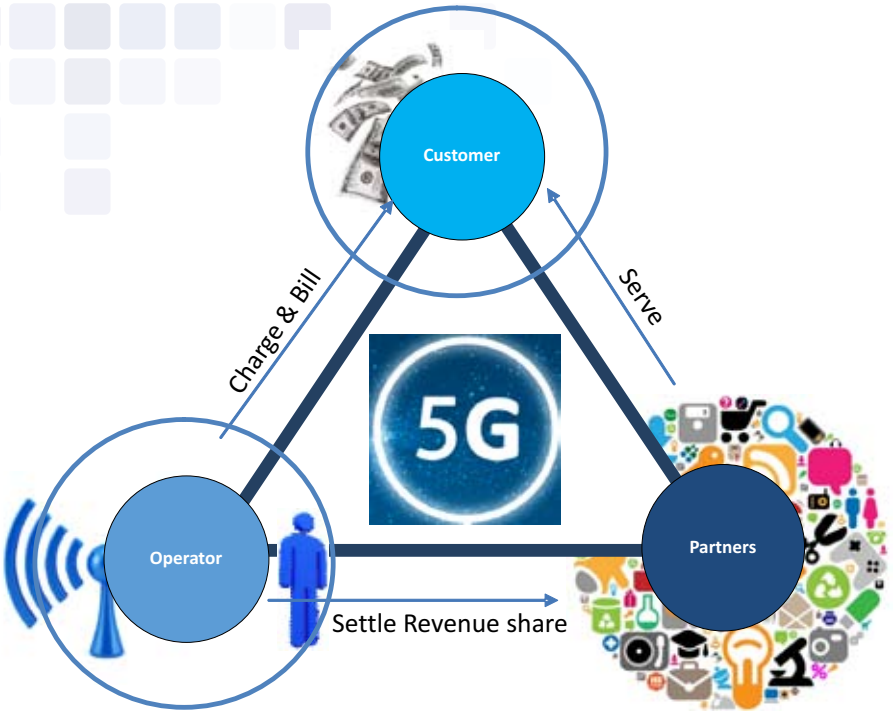
Over the last 12 months, lot of enthusiasm has gathered around 5G and experimental roll-outs are happening, but, very few operators seem to be absolutely clear about how to improve their revenues with the new 5G investments.

With 5G, there are new technical enablers like higher speed, lower latency, and network slicing helping specific use cases - streaming video and AR/VR apps with high speed; drones, connected cars & remote surgery with low latency; network slicing can bring in QoS differentiated offerings targeted to different application and business segments.

The ability to support massive amount of simultaneous connections at lower latency will also support varied IoT use cases and applications. The real question is to find out what will be the killer applications and services which will help the operators to monetize their investments. Key question is that whether there will be new value chains emerging to support new business models enabled by 5G.

We, at Tecnotree, with 40 years of global telecom experience, believe that the future monetization models will be based on the current pillars of strength of the various players: Customers (Consumers & Enterprises), Operators and Partners.

In a situation, where the next winning digital services are yet unknown, it is quite difficult for operators even to start building those by themselves and take the risks. Partnering with companies who provide new-age digital services is definitely the option that the operators can think of. It demands an ecosystem to be in place with which continuous innovation from the market can be brought in front of the operator's subscriber base for faster go-to-market and adoption. This is quite different from the traditional approach of doing business with partners from an operator's point of view.




Currently, it takes a long time to integrate & roll-out partner offerings to the market through the operator's own channels and Business Support System (BSS). Once a partner is selected, the offering needs to be created in a product catalog with configurable pricing parameters, bundling options and service configuration parameters in order to provision the service for a customer.

Next is to integrate billing and subscription management systems for invoicing, collection & settlement with the multiple partners in case of a complex multi-party offering. Once it is launched, apart from the needs to offer an omni-device self-serve application for consumers, the operator's sales agents would also need to know about the new services, pricing and offers.

They also need to be educated about how to sell the non-traditional new Digital/IoT services. Traditionally, with a very limited number of new services launched, the operators tried to manage it with minimum changes in the existing BSS system. However, even if this approach has worked to some extent in the past with a very limited number of partners, it has become a major challenge for the operators to roll-out new digital services on a continuous basis with more and more partners.

Also, looking at it from a new Digital services partner's viewpoint, it's always a go-to-market challenge for those companies who are bringing innovative new services to the market. It also takes time to partner with an operator due to their lower risk-taking appetite as well as limited expertise in the new areas of business.

However, such start-ups or new age companies are typically hungry for new business and would welcome faster go-to-market partnerships with operators, as they have a huge captive audience.

As such, there should be a natural tendency between all the players to come together and work towards benefiting from the capabilities of new 5G networks. Consumers & Enterprises are looking forward to great new services brought to them to enrich their life and automate their business, while Digital Services and App providers are experimenting with new services and hungry to reach more and more customers, and Operators have the reach, network and infrastructure to sell, provision, charge & bill for the services from the subscribers.

The speed and agility required, to compete in the marketplace and to bring great consumer experiences with new services mandates a very efficient and effective Digital BSS system that can help the operators to build an ecosystem for digitally connected communities and empower them. The key focus of such a Digital BSS system would be on the following:

1. ***Digital Products:*** In a 5G world, the BSS needs to have capabilities required to provide a self-onboarding system for the partners to register, create offers and push those to the operator's product catalog for bundling and propagation to all sales channels. The product catalog needs to understand, capture and propagate the provisioning parameters for the service offering and seamlessly enable catalog driven order fulfilment. Idea of a single customer identity is extremely important across the services, since traditionally customers have been identified by the service id/MSISDN number

in a typical CRM system. Having a single customer profile and id, allowing multiple services from both the operator and partner to be associated with the customer, to manage periodic subscriptions, try & buy models, target, re-target customers for new services sales, would require the whole customer domain applications to behave in a new-age Digital manner, in contrast to legacy systems.

2. ***Digital Platform:*** Along with the product capabilities, we believe that operators can build a strong platform business based on certain key APIs being opened up for consumption by partners – be it KYC/Customer profile APIs to partners for validation of customers, or be it billing and invoicing APIs to allow new businesses like Billing As a Service or Invoicing As a Service for SMEs. Additionally, many operators who have successfully implemented Mobile Money services can open up their Mobile Money Wallet APIs for partner integration. Today's killer apps like messaging when successfully deployed across geographies by an operator group, can also be tomorrow's super-app for performing various transactions over messaging interface. The operator's can also create new businesses by exposing and metering those APIs for consumption by partners.
3. ***Digital Delivery & Operations:*** While it is important to build new functional & platform capabilities to address the ecosystem needs, it is of utmost importance to remember that agility and speed are key to building a customer-focused ecosystem. The speed of introduction of new services has to match the likes of the Facebook's and Google's of the world – which means CI/CD to be deployed, features, functions and UX to be A/B tested and continuously improved for better customer experience and also understanding of customer behaviour to make data-driven decisions based on AI & ML. Containerisation of the software stack plays a vital role in that for providing rolling software upgrades with zero downtime and self-healing capabilities.

5G based new network capabilities will also bring in a new opportunity for MVNOs to succeed in their vision of becoming the AirBnb's and Uber's of the telecom world, whereby they would not require the infrastructure or the services to make a business out of it. They need to just focus on creating an ecosystem with partners which delivers the best new consumer experiences to the market, faster than traditional telcos, have the right software play to make all this happen.

Indrajit Chaudhuri, Chief Product & Technology Officer at Tecnotree Corporation

Tecnotree understands both the opportunities and challenges faced by the operators with the new 5G investments. In absence of a clear business model for the new huge investments, many of the operators are in a wait & watch mode, while only a few are trying out new innovative business models. We have been working hand-in-hand with our key customers globally to help them Digitize and Transform their IT systems with Tecnotree Digital BSS Suite 5 which not only addresses the operator's need for Digital Transformation, but also helps in creating an ecosystem with partners to create new monetization models.

New monetization models on APIs, partner services can already be implemented now to have the infrastructure ready to compete and win in a new 5G world!

# AI, Microservices and the Future of OSS

***Combining AI and OSS can efficiently drive automated network operations for tomorrow's telcos***

The Internet of Things (IoT) and 5G are proving to be major evolutionary impulses in the telecommunications industry. Both demand a high degree of network complexity, innovation and flexibility, together with faster networks than ever before and even completely new business models and ways of thinking about services and how they are delivered.

In this era of reinventing telecoms, CSPs who take all this on board will come out on top of the game – but in order to do so they must find ways to raise levels of automation.

In fact, automation in telecommunications is already fairly mature. Software-defined networking (SDN) and network function virtualization (NFV) have allowed operators to separate physical network functions and software resources to create an ecosystem ripe for swift innovation and higher revenues.

SDN is common now in data centers for service automation. In order to truly evolve in this sphere, CSPs need to take the next step – deploying SDN to automate operations too. To make this possible, they need to harness the power of artificial intelligence (AI) and machine learning (ML).

The challenge lies in the smart application of intelligent algorithms for OSS. Such algorithms should be capable or taking a holistic view of the network, understanding prevailing and historic status, assessing available resources and service demand, and ultimately recommending action based on these factors. This isn't

100 per cent automation – intelligent algorithms still need to be activated – but once deployed such a solution will be capable of learning from network and service events.

Traditional AI and ML solutions learn on the basis of static models that rely on supervision and offline data training. Artificial intelligence for future operations takes a different approach, with reinforced learning allowing the OSS to operate in real-time environments, collect, assess and react to data, run continuous simulations of potential scenarios, and take or recommend action to influence service provisioning.

Thus, a closed loop of automation is created, in which – due to the simulation aspect – the network needs to be able to calculate several steps ahead of real time. In this model, static and dynamic data supply real-time information to the AI and ML engine, which scrutinizes changes in the network via a reinforcement agent. This reinforcement agent interacts with the simulated environment in discrete time steps, each time choosing one of several available actions which can be sent to the simulated environment. Based on a rapidly expanding library of observations and simulated actions, the OSS can update automatically to respond to the most recent real-time changes in the network.

The time, effort and costs involved in switching to OSS automation based on this model may seem overwhelming to an executive preparing a business case for transformation. Yet operators will see clear benefits. Decision-making will speed up exponentially, allowing operators to become proactive instead of reactive, and to eliminate many network issues automatically – before they become a potentially costly problem for customers. In addition, professionals in an operators' IT department will spend far less time on troubleshooting and repetitive tasks and focus on strategic initiatives that can help the organization take full advantage of the opportunities offered by 5G and IoT technologies.

## Transforming OSS/BSS with Microservices

The telecom industry stands at a critical juncture today. Traditional offerings, which until a few years ago accounted for a major portion of its revenues, are increasingly getting commoditized. Amid intense competition from over-the-top (OTT) service providers, average revenue per user (ARPU) and profit margins continue to decline for communication service providers (CSPs) worldwide.

> ***As service complexities increase, telecom companies will have to spend big on IT in order to provision services***

To add to the industry's challenges, customer expectations around on-demand, flexible services, and enhanced personalization of offerings, keep evolving at an unprecedented pace.

To ensure sustained relevance in a fast-changing business landscape, CSPs are looking to transform into innovative digital service providers, unlock new revenue streams. This paper outlines the important internal measures that CSPs need to undertake, with regard to upgrading their core IT architectures, to be future-ready.

We explore the microservices variant of service-oriented architecture (SOA) that helps systems become sleeker, flexible, and more agile.

## IT Spend Optimization Won't Suffice

The pace at which the telecom industry is developing nextgeneration offerings such as 5G network, IoT systems, and virtual reality solutions highlights its growing efforts to reposition itself through digital transformation. For these ambitious initiatives to yield the desired business results, CSPs must first redo their IT landscapes.

As service complexities increase and technological changes necessitate new investments, telecom companies will have to spend big on IT in order to provision services as well as run seamless operations. is expected to rise going forward,. At the same time, the need for service agility is now more than ever, for telcos to be able to reduce customer churn and maximize customer lifetime value (CLV). Therefore, CSPs have to strike a delicate balance between cost reduction and infrastructure improvements that will fuel revenue growth.

Recognizing this imperative, many CSPs have initiated an overhaul of their business IT systems to rationalize infrastructure spend while adding new service functionalities.

However, for CSPs to really crack the digital transformation code, merely optimizing spend would not be enough. They must completely revamp their traditional business processes and IT models to reduce the time-to-market, and deliver a distinctly superior and differentiated customer experience.

## Moving from Transactional to Automated OSS/BSS

Today, the business applications of most telecom companies are characterized by complex, rigid legacy systems that are well past their sell-by dates. Apart from entailing an

onerously high total cost of ownership (TCO), these systems offer limited scalability and flexibility for addition of new features, thus adversely affecting customer service.

Any upgrades most often require compliance with elaborate procedures that directly impact business agility, and subsequently, customer satisfaction. This undermines any initiatives the CSPs may have rolled out to enhance customer experience, as the core functionalities largely remain unchanged.

Telecom operators, therefore, should initiate an overhaul of their IT architectures to make their operational support systems (OSS) and business support systems (BSS) truly flexible, agile, and responsive to fast-changing customer requirements. Existing OSS and BSS, which are primarily transactional in nature, need to be made automated and event driven.

For instance, front-end and back-end workflows built around manual logging of customer service requests should be automated, enabling instant provisioning and self-service options. Such a transition, if successful, will make OSS and BSS capable of effectively self-managing the entire service lifecycle, thereby reducing both TCO and customer attrition.

## Microservices: Build Easy, Build Faster

The key test of an OSS/BSS transformation exercise will be its ability, or the lack thereof, to provision the various IT functionalities in a flexible, open, and standardized manner.

In order to ensure this, CSPs should adopt the microservices software architecture. The architecture is based on the principle of breaking down large, complex IT systems into multiple easily manageable and autonomous constituents,each of which addresses a particular business requirement.

Microservices are essentially small, flexible, and completely self-contained software modules that can perform a specific operation independently. Another advantage of embracing this framework is that, unlike from-scratch software implementations, microservices do not require recoding of existing applications for feature enhancements. Incorporating a new functionality is as simple as adding one more independent component or module that fits neatly with existing dimensions.

This simpler approach to delivering new services, and optimizing existing ones, paves the way for rapid, frictionless, and cost-effective IT upgrade and maintenance. Moreover, microservices, which typically are built using Agile and DevOps methodologies, can help CSPs scale their OSS/BSS implementations in line with dynamic business requirements.

For many CSPs, however, transitioning to the world of microservices remains a challenge, largely due to two reasons. Developing applications as collections of loosely coupled, autonomous services requires a software development

approach that is fundamentally different from conventional ones used to build large monolithic applications.

Therefore, this requires a completely different skill set. Secondly, the prevalent culture at many telecom IT organizations may not be open to wide-scale innovations in their basic architecture principles, preferring instead the status quo of existing software frameworks the company is familiar with. Microservices are essentially small, flexible, and completely self-contained software modules that can perform a specific operation independently.

**Roadmap for Microservices Rollout**

For CSPs looking to boost agility through OSS/BSS transformation, we propose the following four-step roadmap for the adoption of microservices:

Break up applications by domain: Existing OSS/BSS applications are mostly fragmented, built and maintained in silos, and involving heterogeneous technologies. They also use various disparate product and service catalogues that adversely impact automation and service provisioning. As a first step, CSPs must identify and segregate all applications under the relevant functional domains, and then break down the underlying functionalities into the requisite services.

**Identify the microservices; develop services catalog:**

Based on the consumption patterns of other upstream systems, identify a standard set of services for each business entity. Besides defining the services for basic transactions, classify additional services to support UI features, such as dashboards for applications, 360-degree customer profiling, and service agents.

After listing all mandatory and optional services, organizations should identify the corresponding microservices to be deployed, depending on the volume of data handled and operational requirements. Make sure each microservice delivers the requisite functionality in a consistent and reusable manner, and becomes the master of a specific data domain.

Build the UI and processes that will consume microservices: Implement standard application programming interfaces (APIs), typically REST APIs, to facilitate interaction between various microservices. Execute business processes through a 'choreography model' that lets the microservices manage different interactions directly.

Enable the communication layer through a simple 'message bus' built around 'smart end points and dumb pipes' which are lighter and simpler than the Enterprise Service Bus.

Finalize implementation architecture: Out of the multiple microservices implementation approaches available, one of the possible options could be using the open source Netflix OSS stack methodology. Under this approach, you first develop the core microservices using the popular Spring Boot, whose wide-ranging features foster rapid development of individual components. You can also use out-of-the-box dependencies such as Eureka and Zuul to augment the Netflix stack.

Adopting this implementation methodology will also help you leverage JPA support for RDMBS, enable REST services, ensure service façade using Feign Client, and use the Spring Actuator for monitoring the services. Alternatively, you may consider other options such as the Amalgam8 or Apache Zookeeper.

**Driving Agility with Microservices**

As CSPs seek to transform business and operating models, agility will play a vital role in enabling superior customer experience. Transitioning to microservices can help realize this goal, and adapt effectively to a rapidly changing business environment. Organizations will also realize significant financial savings, and boost operational efficiency, by avoiding unnecessary efforts and time that would otherwise have been spent on new code development, end-to-end testing, and service disruption management.

For CSPs looking to build superior service agility, considering microservices as part of their integral IT architecture is no more just a choice. It is the pressing need of the hour that can empower them to become truly responsive to their customers.

**AGILITY to support digital operations transformation of hybrid networks**

Advances in technology and competition from agile Over-The-Top (OTT) players means that Communication Service Providers (CSPs) face significant threats and challenges to their current business models. CSPs must digitally transform their operations to head off this OTT threat.

The Future OSS will demonstrate the opportunity to implement a unifying architectural framework for all the complementary paradigms: Physical, SDN, NFV, Autonomic Management and Control, E2E Orchestration of Services and Resources, Assurance platforms, and Big Data analytics for network management & control, which have so far been developed in silos.

The Future OSS is a new and holistic approach to enable agility and create an operating model for CSPs. This is a top-down approach that defines the management of hybrid networks (virtual and legacy) and has a more complete vision compared to pure virtualized networks taken by other blueprints in the industry.

# TETRA Today and Tomorrow - Trusted - Always - Everywhere

By TCCA's TETRA Industry Group

***On a sunny Friday 4 November 1994, the founders of the TETRA Memorandum of Understanding (MoU) – known today as TCCA – assembled in Copenhagen, hosted by Telecom Denmark. Comprising user organisations and manufacturers, the MoU was designed to ensure that Terrestrial Trunked Radio (TETRA) technology had a timely introduction to the market, and that potential users could learn about the benefits of this new PMR standard.***

***TCCA celebrates its 25th anniversary year beginning on 4 November 2019. Now The Critical Communications Association, it continues to spearhead the development of the TETRA standard while driving forward standards for critical broadband services over commercial networks. TETRA remains strong in the market despite the advance of broadband. In this article, TCCA's TETRA Industry Group looks at why TETRA continues to be the trusted bearer for critical communications.***

Sometimes, your mobile phone won't connect a call immediately. Sometimes, the 3G/4G data network isn't strong enough to let you stream music, or post on social media. But mostly, those situations do not result in loss of life. For professional radio users however, the connection has to be instantaneous, the data network capable of carrying critical messaging at all times. Otherwise, tragedies can unfold, people can die – both from the public and from the first responder community.

That's why critical users rely on TETRA technology for their voice and narrowband data communications. Today, two decades on, TETRA remains the accepted digital radio standard for critical communications. TETRA is an ETSI global open standard where the focus is on meeting the mission- and business-critical communications needs of public safety and security agencies and an increasingly wide range of other market sectors.

The first TETRA voice network in the world was implemented at Gardermoen Airport in Norway in 1997. Since then the standard has undergone continuous development, work that continues today to ensure TETRA is ready for the next 20 years. In its current version, TETRA supports voice communication and packet and circuit switched data transfer, short data messages, and an increasing number of critical data applications. TETRA networks are used around the world by governments for public safety, military and defence and other public services, and in a wide range of vertical sectors. The largest public safety TETRA networks in the world safeguard Great Britain (Airwave) and Germany (the BOS digital radio network). The North American market was opened up to TETRA technology in 2012, and networks are already in place in the USA and Canada for transport and utilities.

Specifically designed and optimised to serve mission critical organisations and their users, TETRA is scalable, allowing networks to be built on both small and nationwide scales.

Picture courtesy of Hytera

The excellence of the standard has also led to its adoption across many business-critical organisations, with new networks being implemented worldwide. Networks are typically built redundant at multiple levels and without a single point of failure. The ultimate fallback mode is Direct Mode Operation (DMO), where TETRA terminals can talk to each directly, irrespective of network availability.

Mission critical communication users often operate in dangerous situations within challenging environments. Trusted communications are crucial for these users and it is essential that critical users can control the communications, and that the quality of services supports user requirements and operational processes. Interoperability and prioritisation are vitally important in order for communications to work effectively between users/user organisations and enable efficient switching between routine and emergency communication.

The design and build of mission- and business-critical networks requires special expertise – a skill TETRA vendors and integrators have a proven record of delivering. The worlds of first responders and other

critical users are so vastly different than that of consumers; they need to be supported by specific critical expertise and networks.

ETSI has developed and enhanced the TETRA standard over many years, bringing the number of dedicated features and functions today to well over 300. As an open standard, TETRA provides multi-vendor choice, allowing customers to switch between suppliers without sacrificing their investment or the multitude of functions and features TETRA provides.

TETRA networks are designed to fulfil very high availability levels – typically between 99.95 to 99.999% for operation of TETRA core and access (base station) components. This level of availability can only be achieved by using redundancy to protect against equipment failures. Link redundancy is essential to achieve high network-wide coverage availability to enable TETRA radio users to stay in contact with the control room and other TETRA radio users outside the coverage area of the base station. As a last resort, TETRA base stations support local fallback mode, allowing TETRA radio users to continue communication within the base station coverage area when no links are available to the core infrastructure.

When dealing with mission critical communication, time is of the essence as even a small delay can mean the difference between life and death. Similarly, with business critical communication, instantly available communication and information is vital to ensure a minimum of downtime and thereby a minimum of economic losses. TETRA is built for such situations. Call setup is immediate, and important calls can be given pre-emptive status to ensure timeslot availability, with caller given instant visual and audible feedback if the called party is unreachable or busy. Short Data Service (SDS) messages are delivered instantly so can also be used for emergency purposes.

Communication security is an essential prerequisite. Protection against eavesdropping and manipulation of voice and data as well as the exclusion of third-party use are therefore indispensable requirements for critical communication systems. This is particularly true against the background of increasing cybercrime. TETRA's security features, developed by mission critical communication experts, are modular and complement each other to meet the security requirements of mission critical applications. They are an integral part of the standard and thus guarantee security even when using devices and infrastructure from different manufacturers. The TETRA standard supports powerful mutual authentication of devices and the network. This makes it possible for a TETRA system to control the access to it and for a device to check if a network can be trusted. In addition, applications enable authentication down to the user level. If a device is lost or stolen it is fundamental in a mission critical environment to exclude this device from using the network, and TETRA supports different options for a direct secure temporary or permanent disabling over the air. As any air interface is vulnerable to eavesdropping, TETRA provides encryption of user and signalling information over the air interface between devices and infrastructure, both for individual and group communications.

The use of several encryption algorithms, both standard and proprietary, is also supported. End-to-end encryption service can be realised in TETRA in any number of ways. This means that a user organisation may easily tailor an end-to-end encryption system to its own requirements. This flexibility is essential and unique in TETRA, and can be implemented in many forms for different user groups, and is constantly updated to guarantee secure communication beyond 2030.

To meet the wide variety of requirements and use cases, devices need to be robust enough to withstand use in extreme environments while still delivering return on investment through length of service. Products are designed from first principles to be mission critical and secure, negating the need for constant security patches. Devices operate in a real time manner, performing their communications tasks within strict performance criteria, and have predictable and repeatable responses to all critical actions (e.g. emergency button press), regardless of how the device is being used. In addition, all TETRA devices are subject to TCCA's stringent and independently managed interoperability testing process, ensuring that a wide variety of cost effective compatible solutions from multiple vendors are available.

As well as the implementation of new TETRA networks around the world, many existing TETRA networks are being upgraded, and some have maintenance contracts beyond 2035. There is no other technology that can match TETRA for mission-critical voice, and its enhancements will see the standard co-existing with and complementing the emerging critical broadband networks. It is clear that the efforts made all those years ago to build a mission critical technology that is truly fit-for-purpose have paid off, and the development of the standard is ongoing to ensure it continues to meet and exceed the expectations of the most demanding of users. We're looking forward to the next 25 years of TCCA and TETRA.

*TCCA's TETRA Industry Group comprises representatives from Airbus, DAMM, Etelm, Funk-Electronic Piciorgros, Hytera, Leonardo, Motorola, Rohill and Sepura,*

# LoRaWAN – Can Bring Unlimited Innovation to Life


***LoRaWAN is a democratizing technology that can make IoT solutions available to all, especially in countries that have historically been the last to benefit from digitization. The technology has great potential to drive unprecedented innovation to life.***

**Donna Moore, CEO & Chairwoman, LoRa Alliance®** ***speaks with*** **Zia Askari from TelecomDrive.com** ***about the importance of connecting the unconnected and how LoRaWAN can play a critical role there.***

**According to you, what are the three most compelling factors that can contribute towards the success of LoRaWAN in today's scenario?**

First, LoRaWAN® is an open standard specifically developed for massive Internet of Things (IoT) applications due to the long-range, low-power consumption connectivity it provides. It has been developed by industry experts with security natively included and key components such as firmware updates over the air (FUOTA), which are critical to scale massive IoT deployments.

LoRaWAN is very cost effective to deploy and affords long battery lifetimes, so sensors in the field can remain in place for up to 10 years. A successful standard needs a robust certification program, and ours has been designed to meet the interoperability requirements of network operators and ensure that certified products are tested against the specifications so devices will perform as intended over the long term.

The LoRa Alliance® has invested heavily in the certification program thought the development of the Certification Test Tool (LCTT). The LCTT is a precertification testing tool designed for use at a device

manufacturer's own facility to pretest and prove a device design before shipping it for formal certification testing.

This benefits members by allowing full testing and regression testing of their device at their location, saving time and money by allowing them to debug and finalize their designs prior to starting the formal certification process.

Second, LoRaWAN offers flexibility in terms of deployment, which can be via public or private networks. A public network operator is any LoRaWAN network aimed to openly monetize connectivity or end-to-end services to third parties. Private LoRaWAN networks are not open to third-party monetization. In this scenario, smart cities and businesses roll out their own LoRaWAN networks to meet their specific business use case or application requirements.

There are currently more than 120 network operators providing public network coverage in more than 140 countries, but beyond this, if a public network isn't desirable depending on the use case, a private network can be installed. This is especially useful in remote areas where cellular connectivity isn't available or would be cost prohibitive, and we are also seeing very strong adoption of LoRaWAN for private network installation among enterprise users.

Third, LoRaWAN is an open standard, using an unlicensed spectrum (ISM band), which affords more flexibility for business models as businesses are not tied to one specific service provider. Already regarded as the de facto standard for unlicensed low power wide area networking (LPWAN), it is leading the market and is trusted by large-scale customers as proven by millions of deployed devices.

In addition, the LoRaWAN standard has been developed and deployed by our substantial ecosystem of 500+ member companies globally, which provide all of the necessary components to deploy successful IoT solutions. If someone has an application they want to bring to market or deploy in the field today, LoRaWAN is a proven standard, has the most certified devices and is supported by the most extensive ecosystem—from chip through to cloud. The variety of products and services can be found in our LoRaWAN Showcase https://lora-alliance.org/showcase.

**Telecom operators and government agencies are trying their best to drive connectivity to the unconnected parts/remote areas/rural communities. How can LoRaWAN help in this direction?**

LoRaWAN is the leading networking technology for rural and remote areas that are lacking cellular connectivity, as anyone can set up a LoRaWAN network in any location. Some of the strongest applications for the technology are those where no other options are available (ranches, wildlife tracking, etc.).

Compared to cellular, the equipment costs are much lower, and an end user could either set up their own network or bring in a partner from the LoRa Alliance ecosystem to set up and manage the network for them.

This allows users to take advantage of different business models, investing in capital expenditures or paying service fees, depending on their preference. Once a network is up and running, multiple applications can run simultaneously without a need to invest in additional infrastructure.

LoRaWAN can be viewed as a democratizing technology—making IoT solutions available to all, especially in countries that have historically been the last to benefit from digitization. These countries arguably could benefit the most through cost-efficient solutions that can be installed without existing wireless infrastructure. This allows these countries to make a real impact in terms of management and conservation of resources and societal benefits.

**We are living in an age of NFV, where operators are openheartedly virtualizing network functions in order to do more and achieve more. However, security of networks and securing devices (end points) has always been a top priority for telecoms. How do you make sure that LoRaWAN is a secured technology? Is there anything special with this technology that can be achieved to optimize network security?**

The LoRaWAN protocol is optimized for low-power consumption and is designed to support large networks with millions of devices. Innovative LoRaWAN features include support for redundant operation, geolocation, low-cost and low-power applications. Devices can even run on energy-harvesting technologies enabling the mobility and ease of use of IoT. Security is a fundamental need in all of these applications, so it has been designed into the LoRaWAN specification from the very beginning.

LoRaWAN security is designed to fit the general LoRaWAN design criteria: low-power consumption, low implementation complexity, low cost and high scalability. As devices are deployed in the field for long periods of time (years), security must be future-proof. The LoRaWAN security design adheres to state-of-the-art principles: use of standard, well-vetted algorithms and end-to-end security.

The following fundamental properties are supported in LoRaWAN security: mutual authentication, integrity protection and confidentiality. Mutual authentication is established between a LoRaWAN end device and


the LoRaWAN network as part of the network join procedure. This ensures that only genuine and authorized devices will be joined to genuine and authentic networks.

LoRaWAN MAC and application messaging are origin authenticated, integrity protected, replay protected, and encrypted. This protection, combined with mutual authentication, ensures that network traffic has not been altered, is coming from a legitimate device, is not comprehensible to eavesdroppers, and has not been captured and replayed by rogue actors.

LoRaWAN security further implements end-to-end encryption for application payloads exchanged between the end devices and application servers, and is one of the few IoT networks to do so.

**On the developer side, how is the organization looking to drive innovation within the develop community? And how are you engaging with the independent software vendors (ISV) communities in order to drive innovation on LoRaWAN?**

The LoRa Alliance has a member ecosystem of more than 3,000 members working on behalf of our 500+ member companies and institutions, from chip to cloud, that supports customers and developers alike. Additionally, there are thousands of developers worldwide using LoRaWAN and driving innovation across our ecosystem. Our ecosystem engages with the developer community to understand their needs and identify how the LoRa Alliance can support them as they develop solutions using the LoRaWAN protocol.

We host and facilitate workshops around the world, as we recently did in India, with member-driven workshops during LoRaWAN Live. There's no question that software has a key position in solution development, and we work to provide resources and access to the expertise they need to drive innovation.

**What kind of future-ready and society-friendly innovations can we expect from LoRaWAN in the coming years?**

The applications that can benefit from LoRaWAN are virtually endless, I'm constantly amazed at the new ideas our members bring forth that will have a meaningful impact on people, animals and the planet. As society looks to make cities smart, the technology can be leveraged to monitor infrastructure, prevent leaks and accidents, improve water and air quality, and conserve precious resources through water, soil and air monitoring.

Just one example from Japan is that utilities there have implemented LoRaWAN sensors that, when they sense movement of the earth that foreshadows an earthquake, a LoRaWAN message is automatically sent out to shut off all the gas meters, preventing explosions. In India, a solution was recently implemented to track tigers so that forest rangers and people living in villages near to their habitat can know where they are, preventing injury or death for both humans and tigers. In terms of cities, LoRaWAN can be used to control lights to keep citizens safe, monitor building occupancy to save resources, ease traffic congestion by making parking easy. As I said, the use cases are truly endless for how LoRaWAN can be used to improve the daily life of the planet's citizens and the health of the planet itself.

# Taking SD WAN to the Next Level with Automation

By Susan White

As Enterprises become increasingly digital, SD-WAN has already proven to be the essential ingredient to transform the WAN. From easy access to cloud applications to fast activation of new branch offices and lower costs, there are a multitude of reasons why SD WAN is one of the highest growth services in the industry.

CSPs are addressing this market with managed SD-WAN offerings which currently represent about half of the market at this time. Yet it is becoming an increasingly crowded market with many deployment options for enterprises to choose from, including DIY, cloud managed services, system integrators etc. For CSPs to be successful in capturing a greater share of this lucrative market, standing out from the crowd will be critical. Whilst initial deployments are underway, CSPs can improve their efficiency and competitiveness in a number of ways and ultimately use SD-WAN as a foundation to capture a greater share of the B2B market.

## More Automation – It's Time to Scale

Early deployments were of modest scale, with a few select enterprise customers and several hundred sites. While SD-WAN was an essential 'ticked box' to compete for new enterprise business, many CSPs preferred to lead with their more lucrative, long established and higher priced MPLS offerings, which of course came with higher margins. The strategic focus is now changing, however, and CSPs are acquiring new enterprise customers at a rapid rate, but are struggling to provide a fast turnaround.

The reason is due to partial automation. SD-WAN vendors have automated some tasks including configuration and zero touch provisioning of CPE devices. However, the problem as CSPs scale to acquire 100s enterprises customers with 1000s sites, is at the service layer. Today, service provisioning of SD-WAN is mostly done manually with legacy OSS. With service orchestration, CSPs can fully automate service provisioning, assurance and the entire lifecycle of the service. Standard data models, such as YANG, drive the intent based orchestration and MEF's LSO framework provides the essential standards based APIs to interconnect with north and south bound components.

## Simplifying Multivendor Through Automation

The first SD-WAN managed services centred around a single vendor solution for the SD-WAN controller and CPE devices. Commercial offers

were build from the feature set the particular vendor supported. Today, the market reality has evolved to where every CSPs has or plans to move to a multivendor SD WAN. Whether it's to increase their chances of winning an Enterprise contract due to vendor preferences, or to address different feature sets for different markets, multivendor is a market necessity.

Accomplishing this is no simple task. With a multivendor scenario, CSPs have exponentially more complexity that includes supply chains, OSS/BSS integration and customisations, and specialised vendor training, not to mention the support of multiple vendor technical GUIs that are completely different to each other.

The answer to simplify brings us back to automation with the service orchestration we mentioned earlier, providing the necessary abstraction layer across the multiple SD-WAN controller instances and uCPE managers. It does not matter if the functionality is in an enterprise or CSP data center or public cloud, as it will orchestrate across any cloud. Service orchestration therefore unifies and streamlines all the offerings with a single OSS/BSS integration point, and using the MEF Presto APIs between the SD-WAN controllers and service orchestration, integration is simplified even further.

**Adding 3rd Party Value Added Services to Increase Revenue**

Most SD-WAN vendors have some virtualized value added services built into their offers – such as security or WAN optimisation. However, adding other 3rd party value added services can not only increase the competitiveness of the offer, but also create up-sell opportunities to increase revenue.

For this CSPs need to adopt universal CPE (uCPE), on which multiple VNFs from any 3rd party vendor can reside at the enterprise premises, and Network Orchestration (or MANO) to automate the provisioning and lifecycle management of these VNF resources at the uCPE or in the data center. Network orchestration should also take care of the important function of VNF licence management that will be critical in a multivendor environment.

**Automate from a Digital User Experience Portal**

With multiple vendor SD-WAN and value added services in place, interacting with all the individual technical portals from each vendor becomes untenable. This is where a unified self-service portal becomes an invaluable tool in goal of end to end automation, using MEF LSO Legato APIs to the service orchestration. A single integrated user interface allows the enterprise customer to configure new sites, set up rules and policies, define topology and monitor and trouble shoot everything end to end. It also provides a consolidated abstraction layer that enables easier bundling, unbundling and service change management using a single interface. This means while VNFs/controllers can be added or removed, the user interface remains the same – providing an intuitive and CSP branded window to everything. And this powerful capability can be also be given the enterprise customer with varying degrees of control.

**Expanding to the SMB market to Increase B2B Scope**

Whilst CSP offers have mostly focused on the large enterprise to date, the sweet spot will be the SMB market. The challenge here is getting the price points and selling strategy right and aligned correctly, and typically here, the direct sales force strategy just isn't a viable or efficient option. With a digital marketplace, CSPs have an e-commerce platform to sell their SD-WAN offers via the web. SMB customers can easily select, purchase and activate SD-WAN and value added service through an intuitive window. With pricing packages linked to a CSPs billing application, CSPs can compile service bundles that not only include SD-WAN/VAS services, but can also include cloud IT and IoT services also such as Microsoft 365 or unified comms services. Entire digital service bundles can also be created and priced to expand into the lucrative SMB market.

**Call to Action**

For CSPs to truly differentiate in today's market, it's time to take SD-WAN to the next level; not only to increase efficiency but penetrate deeper into the B2B market. A good reference model can be found in the MEF Proof of Concept 'Orchestrated Virtualized Multivendor SD-WAN Services' to be showcased at the MEF19 event, 18-22 November 2019, in Los Angeles. Now is the time for CSPs to be thinking strategically about effective automated customer outreach, business and technical process flows, process standardization and of course, delivering an appropriate enterprise-centric customer experience. Put all this together effectively, and CSPs have a great opportunity to take the major share of the SD-WAN market with these high value managed service offerings.

***About the Author***

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# Israel Export Institute – Driving Global, Meaningful Innovation

***With an aim to drive innovation that is meaningful and can enable positive change – Israel Export Institute has been playing a unique role towards encouraging organizations towards enabling and sustaining innovation.***

***Adiv Baruch, CEO, Israel Export Institute speaks with TelecomDrive.com about the importance of innovation and how Israel export Institute is enabling innovation on the global turf.***

**How is the Israel Export Institute encouraging organizations in terms of creating and sustaining innovation on global turf?**

We at the Export institute look to the future, examining the challenges the world is going to face. We then work to present the Israeli technologies and solutions that will provide the appropriate response to these challenges.

Our experts know the industry and understand the business needs. With access to all major trade and business resources, we can help screen relevant information, establish qualified contacts, and foster success.

And through our cooperation with the various missions of the Foreign Trade Administration (FTA) deployed and operating around the world, we have a wide perspective and the ability to listen and understand the needs of the world.

Israel is a nation of innovation – we have the ability to develop products which do the world good. Although we are not charged with encouraging innovation – there are professional governmental entities responsible for that aspect – we make sure that the innovation created in Israel is accessible to the world.

On one hand we make it possible for Israeli companies to conduct export within a professional working infrastructure, and on the other hand we provide the countries of the world with the best exposure to the Israeli industry, so it can supply them with an appropriate response for their specific challenges.

**What kind of efforts are you making in order to attract young**

**entrepreneurs at local level - to enable and help them innovate on global turf? Please share any examples of companies where the institute had played a key role.**

The Israel Export Institute has a vast infrastructure of professional knowledge and experience, gained over more than 60 years of penetrating new markets.

Our extensive efforts aid in making this knowledge accessible to those young entrepreneurs:

Awareness |how to think globally, how to operate in the international arena

Education |focused training programs for company executives. Over the years, thousands of individuals have participated in the training programs organized by us. The training programs cover many fields – starting with the most basic matters of international transport and shipping, customs regulations, business English and culminating with the most complex issues of overseas marketing strategy, business intelligence and databases as a source of identifying possible partnerships and business opportunities.

National Pavilion | Each year we manages dozens of Israel's national pavilions at leading trade shows around the world, so the Israeli exporters can promote the export of their products and technologies. Participating in the national pavilion gives companies an advantage in location, in participation costs and in gaining greater exposure. Young companies with limited abilities can enjoy our assistance in order to participate in the world's leading tradeshows even without a great deal of resources on their part. They receive full services for all their needs, from A to Z; and most importantly, they get to take part in B2B meetings we arrange for them in advance with potential international partners.

B2B |young startup companies can take part in business activities focused on their needs, according to predetermined market goals and the company's potential. This activity is conducted either in a specific meeting for each company or in the framework of delegations visiting Israel or road shows abroad. we also convenes international conferences and exhibitions in Israel for industries in which Israel has global leadership.

The Israel export institute have a technology industries division and a consumer goods division, segmented by industry-specific departments and we assists companies from all the different sectors: HLS , Agro technology, Cleantech , Mobile, Dental, Fintech, Medical device and Digital Health, Digital Media, Water Technology, Cyber, Content Film TV and Music,Automotive, FoodTech, Fresh Produce and wine, Food and Beverage, Cosmetics and Toiletries, Home and Family Products, Fashion and Textiles.

**How is the government supporting such initiatives? And what is the roadmap that you see for the near future?**

The Israeli government is a full partner in all our activities since the day the institute was established. We are a non-profit organization, funded by the government and the private sector and we work in cooperation with all of them. We cooperate with all the relevant governmental ministries, including the Ministry of Economy, Ministry of Foreign Affairs, Ministry of Agriculture, The Innovation Authority, Digital Israel, the Manufacturers Association of Israel (MAI), the Chambers of Commerce and others. This cooperation is expected to continue in the future in all the activities we have planned.

Due to this cooperation, we work in coordination with the ambassadors of the Ministry of Foreign Affairs and the commercial attachés of the Foreign Trade Administration (FTA) of the Ministry of Economy and Industry who are deployed all around the world.

Our partnership with the government ministries is both financial and in terms of the work itself. We are in synch regarding all the needs of the Israeli industry and the solutions the world is searching for.

In review of the various entities operating in Israel in this field, we are essentially the most objective organization, committed to the business community and working together with the government in order to best serve Israeli companies.

**How can global companies take advantage of unique talent in your destination? What help is being provided by the government in this direction?**

The Israel Export Institute is the premier gateway for doing business with all Israeli companies currently operating in Israel. We have the knowledge and experience to map out and present the local industry in the most optimal way. We are the strategic partner to Israeli business opportunities, from formal delegations and international conferences to private one-on-one meetings. We match Israeli opportunities to the companies' needs so they can make the most of what the market has to offer.

IEICI offers access to relevant businesses and government resources in any field. With our expertise in Israel's leading industries, we can provide the information the international companies need in order to connect, negotiate and do business with the Israeli industry.

International companies get the chance to meet us during designated events or special events we "tailor" specifically to their needs. Our close cooperation with the missions of the Foreign Trade Administration enables us to reach key elements within international companies and allows them to come to us and discover Israeli innovation.

# Consumer 5G services point to fixed-mobile convergence

***So far, mobile operators have struggled to come up with compelling new use cases for 5G in the consumer market. LTE already does a decent job of streaming video, so the key to monetizing 5G for this market lies in exploiting the enhanced reliability it offers***

***By Mark Newman, Chief Analyst, TM Forum***

In a recent blog about the difference between 4G and 5G, UK operator EE offers a realistic assessment of the benefits of 5G: "Unlike 3G to 4G, 5G is not a replacement for 4G. It adds another layer to the network to provide more capacity in the busiest parts of the UK's busiest cities."

Nevertheless, there is enough demand for high-quality mobile broadband services that it's reasonable to believe that as soon as the most popular devices incorporate 5G and a reasonable level of coverage is achieved, the consumer market for 5G mobile broadband will rapidly take off.

## Which services?

As part of our survey on future business models, we asked communications service providers (CSPs) which of the main consumer services and use cases for 5G will have the biggest impact now and in the future. More than half of respondents said they believe enhanced mobile broadband with unlimited pricing plans will be most impactful in the short and long term (see image below).

However, mobile operators will seek to bundle content with their 5G pricing plans, just as they have with their higher-end LTE packages. South Korean telcos have been particularly active in this regard. SK Telecom has acquired exclusive live e-sports content for its 5G users and has uploaded a large library of virtual reality (VR) videos onto its platform.

Rival operator LG Plus says that augmented reality (AR) and VR account for 20% of its 5G traffic. In practice, the availability of AR and VR content requiring 5G will be driven by the Android and Apple ecosystems. Indeed, the dominance of these ecosystems makes it extremely difficult for operators to compete in terms of bringing new services and business models to market.

Gaming is the other consumer service that is tipped for success with 5G because of its requirement for low-latency connectivity. Vodafone has partnered with cloud gaming developer Hatch to offer its 5G customers a free three-month trial that gives users access to more than 100 mobile games.

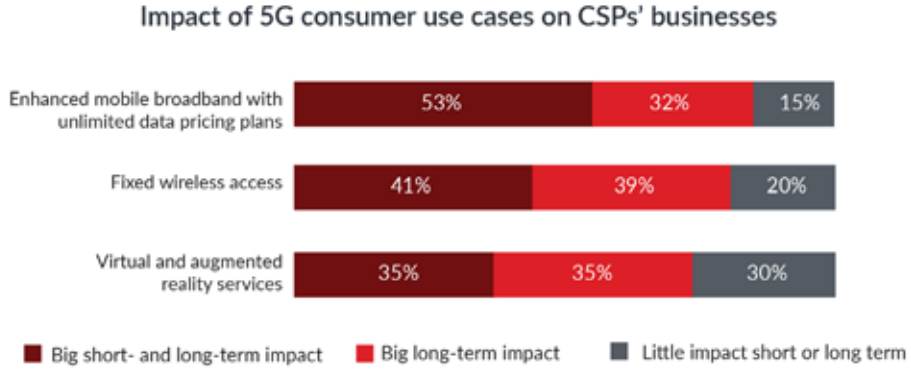
One option for operators is to create a dedicated gaming network slice that guarantees low-latency connectivity. Finnish operator Elisa has already said that its prices will vary based on speed and latency.

## Unlimited pricing

When it comes to pricing plans for broadband services, CSPs have always treated fixed and mobile services very differently. In most countries, fixed broadband usage is unlimited and pricing depends on speed, regardless of usage levels. Mobile broadband prices, on the other hand, are typically based on usage. Operators have tried, but generally failed, to sustain a price premium for high-speed mobile services. But this is changing.

The comparison of early 5G pricing plans chart (see image below) which shows 5G pricing plans for five early entrants, suggests a drift towards unlimited data pricing – even if in many cases the plans include caveats and exemptions.

Further analysis of operators' 5G pricing strategies reveals that all launches include unlimited voice and texts. In most markets 5G is available only for plans with the biggest data buckets, and in some cases it is available only with unlimited data



usage. In addition, most early entrants are pricing 5G at a significant premium over LTE. Finally, some operators are bundling content with 5G (for example, SK Telecom has secured exclusive rights to broadcast e-sports events).

**Mobile broadband**

It is likely that most mobile operators will follow the trend of launching at least one unlimited or nearly unlimited pricing plan for 5G. This means that when viewed holistically – from a capacity, performance, use case and commercial perspective – 5G is beginning to look a lot like the high-speed broadband business.

It is much too early to understand how this apparent convergence of fixed and mobile networks will play out. However, some potential scenarios illustrate the implications: Operators will be able to offer a combination of fixed and mobile network connectivity with the same capabilities, meaning that the customer does not need to know if the connection is 'fixed' or 'mobile'.

If 5G and fixed broadband services can deliver the same capabilities, then there should be a strong case for a convergence in terms of pricing. In general, consumers spend less on mobile broadband than home broadband.

The distinction between home broadband and mobile broadband could begin to blur. 5G increases the potential for cord-cutting for those homes well served by 5G mobile networks. For example, Verizon's 5G mobile broadband services offers unlimited data and unlimited tethering.

Another aspect of convergence in the 5G era relates to pricing strategies. While mobile operators have priced mobile broadband services based on volume of data consumed (regardless of speed), fixed broadband providers price services based on throughput.

But in July UK operator Vodafone announced an overhaul of its mobile pricing which includes 5G, switching from the conventional approach of prices based on inclusive data to unlimited data usage with prices based on speed. This approach is already used in Switzerland and Finland.

**Lasting premium?**

In most early 5G launches, operators have priced 5G at a significant premium over LTE. The one exception is in South Korea where it is 5% to 10% cheaper. While South Korean operators are keen to start moving traffic away from their congested LTE networks, operators in other countries are under no such pressure. They are happy to test the market for 5G and capture any price-insensitive early adopters before the market matures, more devices become available and competition from other operators arrives.

Vodafone Group CEO Nick Read gave some interesting insight into pricing strategies in his address to shareholders to announce the financial results for the first quarter of 2019. "In the UK, we intend to target the base with our new Be Unlimited offers," he said. "However, we will also target new customers, as we are effectively a challenger in the UK consumer market. This is why we've priced 5G at zero premium, in contrast to Germany, where we are charging an additional €5 per month on our lower plans."

Whether 5G can sustain a price premium – be it just for incumbent operators or for the market as a whole – is unclear. When CSPs launched LTE services, they priced them at a premium over 3G, but within the first couple of years premiums disappeared.

Given that the performance enhancement of LTE over 3G was arguably greater than that from LTE to 5G (for example, video streaming was not possible before LTE), it is difficult to see how premiums will last. Furthermore, early 5G adopters are already having to pay a premium over LTE because of the higher cost of devices.

Comparison of early 5G pricing plans

| | Monthly cost | How much data? | Plan details |
|---|---|---|---|
| SK telecom | $46 | 8GB | Speeds decrease to 1Mbps after data cap |
| | $62 | 150GB | Speeds decrease to 5Mbps after data cap |
| | $74 | 200GB | At the end of December, price will rise to $78 per month and a cap of 200GB of data |
| | $104 | 300GB | Data is unlimited until end of December |
| verizon | $85 | Unlimited | Always subject to throttling and only offers slow hot-spot speeds and 480p video |
| | $95 | Unlimited | First 22GB of data are unthrottled; also includes 15GB of LTE hot spot and 720p video |
| | $105 | Unlimited | First 75GB of data are unthrottled; also includes 20GB of LTE hot spot and 720p video |
| EE | $37 | 20GB | |
| | $45 | 40GB | |
| | $51 | 50GB | Fastest speeds, no throttling |
| | $57 | 60GB | |
| | $63 | 100GB | |
| elisa | $56 | Unlimited | Speed 1Gbps |
| | $45 | Unlimited | Speed 600Mbps |
| vodafone | $28 | Unlimited | Maximum speed 2Mbps |
| | $31 | Unlimited | Maximum speed 10Mbps |
| | $36 | Unlimited | Maximum speed available |

TM Forum, 2019

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# Tapping into the World's Innovation Hot Spots

***Designing the Global Innovation Equation***

During the twentieth century, the world watched as the United States churned out innovation after innovation. Now, however, the tables are turning. Many other countries are placing innovation at the top of their national agendas. From Singapore to Finland, from Chile to China, countries around the world are designing novel approaches to innovation strategy.

They are creating forward-looking education and talent-development policies, pouring money into large-scale initiatives, and snapping up new assets in the form of intellectual capital and infrastructure.

There's a whole new world of innovation opportunities opening up for your company—if you know where to look. Dozens of countries sponsor programs to lure innovative enterprises to their home territories. Singapore offers tax relief, employee training, and R&D grants to life sciences firms that locate there. India provides talent management for some of the world's most sophisticated technology development work. Finland is becoming a global center for innovative design.

To capitalize on these and other innovation hot spots, identify which countries' offerings best fit your company's innovation strategy. Be prepared to mix and match. For example, Nile Therapeutics, a biopharmaceutical firm, uses intellectual property from Italy and conducts clinical tests in Eastern Europe. The company employs eight people rather than the 100 that similar firms require.

What does this new "innovation world" mean for companies, and what are the implications for the people who lead them? Executives can now

weigh different national approaches to innovation in terms of their firms' strategic requirements. High-tech start-ups can be "born global" by availing themselves of talent, capital, R&D tax credits, regulatory relief, and specialized facilities in such innovation hot spots as Helsinki, Singapore, and Shanghai.

Companies can also position themselves as "systems integrators," which incorporate the elements of the models that are most appropriate for their strategies. Indeed, corporate strategists have more opportunity than ever to pick and choose from best practices and resources across the globe and combine them in new and unpredictable ways. In doing so, they can practice what I call innovation arbitrage, taking advantage of differences in regulatory environments as well as in the cost of talent, specialized services, and other inputs to the innovation process.

### The Focused Factory

The focused-factory innovation model combines a clear strategic intent with a concentration of infrastructure and high-octane talent in an effort to discover and deploy new solutions to big challenges. Countries such as Singapore and Denmark, for instance, focus their innovation investments on a handful of industries or research fields.

Singapore has made an impressive commitment to scientific research, illustrated by its plan to increase funding for R&D projects in life sciences, clean technology, and digital media from 2.6% to 3% of GDP by 2010, despite the economic downturn. If a company conducts research in any of those areas and sets up a facility in Singapore, the government will consider providing tax relief, state-of-the-art infrastructure, training for technical staff, and research grants covering up to 40% of expenses.

So far, the Singaporean government has devoted more resources to the life sciences than to any other field. Witness the creation in 2003 of Biopolis, a 2-million-square-foot biomedical research center. Singapore scours the world for both established scientific leaders and top postdoctoral students to work at the center, which is on track to employ 4,000 researchers on-site by 2015. Located close by will be another 6,000 scientists in fields such as materials science, clean technology, and digital media, which is housed in its own facility, called Fusionopolis. (The U.S. National Institutes of Health, which currently employs approximately 10,000 scientists, serves as a useful benchmark.) Biopolis has become a globally recognized center for stem cell research, and although it's too soon to tell whether Nobel Prize–winning breakthroughs will emerge from Biopolis, articles from researchers based there have been published in major peer-reviewed journals such as Cell and Nature.

Scientists are attracted to the center by the facilities and the amenities (the neighborhood boasts gourmet restaurants, world-class retail, an extreme-sports facility, and a variety of cultural venues); their companies appreciate the welcoming regulatory environment. GlaxoSmithKline (GSK), for example, founded its Centre for Research in Cognitive and Neurodegenerative Disorders at Biopolis.

Singapore is just one of several countries hosting focused factories; companies that want to leverage their existing patents and intellectual property—say, in wireless technology, precision manufacturing, or clean technology—might also look to Finland and Denmark. Emerging economies such as Chile and Vietnam have focused factories as well.

### Innovation World

China, currently the world's center of outsourced manufacturing, will be the next hub of brute force innovation. The Chinese Politburo has set itself the concrete goal of turning China into an innovation-driven country by 2020.

To that end, China has chosen 10 of its leading universities to receive extra funding in order to achieve world-class status. It is noteworthy that Chinese institutions of higher education doubled in number, from 2,000 to 4,000, between 2002 and 2005. The goal is to churn out well-educated specialists in every area of science and technology.

By churning out well-educated scientists, China will become the next hub of brute force innovation.

The Chinese automobile industry offers a glimpse of the brute force model in action. Thanks to an outpouring of educated innovators from Chinese universities, there are now an estimated 50 car companies in China, producing a Precambrian explosion of new business models and automobile designs. Many of these companies will fail, but some may prove to be world-beaters. Warren Buffett's recent $230 million investment in BYD Company, a Chinese maker of batteries for electric cars, signals his awareness of the potential for Chinese R&D.

China offers innovation advantages to other kinds of companies, as well. Microsoft, for instance, recently celebrated the 10th anniversary of its Beijing research center. The company has found that the center allows it to tap expert and junior Chinese talent at a comparatively low price. Microsoft supports the work of top Chinese academics (some of its scientists are also part-time faculty members at Chinese universities such as Tsinghua, Fudan, Beida, and Jiao Tong) and encourages researchers to publish their work and participate in academic conferences. It also funds projects selected by the National Research Fund of China. In return for all this, Microsoft can gain access to a trove of IP and build invaluable collaborative

relationships.

Firms considering the brute force model will need to establish long-term relationships with local universities, venture incubators, trade associations, and other potential partners. Service providers that target the entrepreneurial community—such as specialty consultants, professional-services firms, and venture capitalists—may also wish to find ways to set up research operations in countries offering plenty of brute force.

India, for example, is shifting its role as the world's back office to that of innovation epicenter. The country is doing this by partnering the best graduates of its Indian Institutes of Technology with Indians who have trained at such universities as Stanford, MIT, and Cambridge and are now thriving in Western economies. Indian entrepreneurs who have already made their mark in Silicon Valley are now cementing commercial ties to their homeland in globalized technology enterprises. As this occurs, India's resident creative class is becoming more influential, cosmopolitan, and skilled.

Moreover, India is now managing the talent pools of other countries as part of its global strategy. As the country moves up the innovation chain, some of the early-stage work originally done there is migrating elsewhere. Tata, for example, now outsources some of its IT development assignments to Chile and Ecuador and in 2005 acquired a Chilean financial-services back-office outsourcing firm. By exporting its own back-office work, Tata has been able to move up the value chain.

## Large-Scale Ecosystems

Several countries have developed end-to-end innovation systems combining stewardship mechanisms, funding bodies, research institutions, and structures for business and academic collaboration, all in support of an overall national strategy.

Finland's innovation system was designed, in part, as a response to the cataclysmic economic change in 1991, occasioned by the collapse of the Soviet Union. In one stroke, a significant percentage of Finland's foreign trade vanished, plunging the country into recession. Faced with an economic near-death experience, the country decided to focus on education, science, and technology and to improve its innovation capability.

## Innovation in Finland

Today, Finland enjoys a well-run innovation system benefiting from strong governmental stewardship.


Finnish investment in public education has resulted in a number one worldwide ranking by the Organisation for Economic Cooperation and Development (OECD) and the World Economic Forum.

The government allocates funding flexibly and across a range of public and private players, most notably via Tekes and Sitra—the national industrial R&D fund and the national innovation fund, respectively. Sitra subsidizes a variety of initiatives that have included user-centered design, new kinds of health care services, food and nutrition, and energy conservation.

One of the best examples of Finland's large-scale, holistic approach to innovation is Aalto University, which is scheduled to open its doors in the autumn of 2009. Named for the legendary Finnish architect and designer but referred to locally as Innovation University, the new institution will be the result of the merger of three established universities: Helsinki's School of Economics, University of Art and Design, and University of Technology.

Established with close to $1 billion in new funds, Aalto will develop curricula and stimulate research to explore novel, commercially significant ideas. One planned "design factory" at the university will focus on human-centered, or "universal," design for products that can be used by any adult, regardless of age or physical ability.

The university also has ambitious plans to foster research in specific areas, such as technology that promotes health, wellness, and quality of life for the elderly. In bringing together experts from disparate arenas including design, media, and technology to develop new approaches to common problems, the university manifests the Finnish government's conviction that innovation will come from cross-disciplinary efforts.

Small countries like Finland are self-contained environments. The moment you land there, you meet relevant players and have the opportunity to set up important alliances. In a way, such an ecosystem is akin to the Japanese keiretsu, with its shared purpose, common managerial culture, and intricate web of financial connections.

But the fast pace of networking can trip you up if you aren't fully prepared or don't have the requisite alliance-management skills. Word can quickly spread about your deficiencies as a potential partner. The tight interweaving of elements in an innovation ecosystem and the many informal connections among the players also mean that an incorrect approach can lock you out, perhaps for good.

### Systems Integration: The Mix-and-Match Approach

The advent of a global marketplace for innovation means that the astute company—whether a start-up or an incumbent—can choose from among the foregoing models and blend country and corporate strategies into a "systems integration" approach. Consider the case of Nile Therapeutics, a San Francisco–based biopharmaceutical firm. Nile is developing a compound licensed from an Italian university and conducts comparatively rapid, cost-effective clinical tests in Eastern Europe.

As more countries start providing innovation services, companies can take advantage of the best resources available worldwide. Pharmaceutical firms, for example, can tap India, which excels in drug testing for diabetes and infectious diseases as well as in medicinal chemistry. China provides manufacturing and market access, plus an army of scientists and engineers. Even off-the-beaten-track Vietnam offers services that can help firms interested in the treatment of tropical diseases.

In playing the role of a systems integrator, a company might ask the following questions: What are the best new fields to consider? How do we combine various ingredients? How can we best create risk capital for novel ideas? What are the most supportive environments for us? What kind of strategic foresight and planning processes do we need?

The United States is especially well-positioned to serve as a base for innovation systems integration. The country has the cultural diversity, global reach, reputation for innovation, talent base, infrastructure, educational institutions, and scientific resources to transform the global innovation


landscape. By increasing its efforts in areas such as green energy and health care, the United States could reposition itself as a global innovation leader. Silicon Valley, an area with a rich mix of skills, ethnicities, and resources, as well as abundant educational, institutional, and even familial connections, could serve as a model for a U.S. approach.

These are early days for global innovation. Although a few nations have pioneered the models discussed here, the map is still developing. As new centers of excellence are built and hot spots emerge, so will new models. Patterns of competition will also evolve as models collide. Regional dynamics will shift as countries grow into their roles as innovation leaders.

### The Driving Forces of Global Innovation

Traditionally, we have thought of innovation as the output of a particularly hot team or company, or the result of a specific geographic or industrial concentration of the kind that made Silicon Valley great. But today, four trends are reversing U.S. dominance in innovation and ushering in an era of global innovation:

The rise of innovation as a currency of global competition. After World War II, the United States pioneered business models that were fundamental to a general understanding of innovation. Today, the American dream has become the global dream. An international style of business—heavily influenced by values of openness, exploration, and risk taking—has emerged, and it speaks English. Moreover, American culture has been increasingly in-sourced by non-U.S. firms such as Toyota, which established a key design studio in Newport Beach, California.

The global war for talent. Talented young scientists, designers, and entrepreneurs can be attracted anywhere by the right incentives, professional opportunities, and creative ambiance. Consider a small country with few natural resources that wants to invest in cutting-edge research in synthetic biology. If the country pays 10 leading scientists $1 million each annually and spends another $100 million to build a world-class research institute, it becomes a player in a strategic industry, yielding incalculable financial and social returns over time.

### Innovation as a national agenda

Several dozen nations now explicitly embrace innovation as a national priority and systematically develop innovation strategies, infrastructure, mini–Manhattan projects, and human capital initiatives. Various approaches are coalescing into distinct innovation

models. Sweden's governmental agency Vinnova, for example, manages state funding for R&D and employs some 300 professionals.

China has listed innovation as a priority in its 11th five-year economic development plan. Specifically, the country focuses on what it calls "indigenous innovation," the encouragement of locally generated intellectual capital. At the other end of the size spectrum is a Singapore Economic Development Board initiative that invites the world to innovate in Singapore and Singapore to innovate for the world.

**The power of networks**

As innovation capability continues to globalize, networks are becoming increasingly important. An entrepreneur can now access resources on a worldwide basis—and thus realize competitive advantage well beyond her weight class. Networks accord an important role to so-called brokers: individuals and companies that are able to link talents and assets separated by geographic location, time zone, language, culture, and business practice in ways that generate value. Countries such as Denmark are now actively pursuing a broker role in such emerging areas as sustainability.

To make the most of the global market for innovation services, executives must understand the emerging models when considering where to make their direct investments. In deciding where to place a new factory, research lab, or customer insight center, it is important to weigh both national and corporate strategies.

Tapping the world's innovation resources involves more than deciding where to establish facilities and how much to invest in the effort. It's also about knitting together different strengths within and outside the firm's walls. Companies building their innovation strategies must also think long-term—in a sense, they are working to acquire membership in a club with very particular codes and cultural norms, which can carry evolving benefits. They must cultivate the skills of relationship building and alliance management in order to become trusted members of the local community. Once they establish roots in Singapore, Finland, Brazil, and other innovation hot spots, they stand to benefit in unimagined ways.

**Hotspots of Innovation**

Silicon Valley in California State in the United States and Bangalore in India, as well as Shanghai in China, are known to be hotspots of innovation wherein they attract the best talent and the most number of startups as well as entrepreneurs compared to the other regions and cities in the same country or even worldwide.

Indeed, Silicon Valley and Bangalore are household names for anyone who is remotely associated with the Tech Industry given their reputations for being innovation hotspots.


While there are other regions in the world that are also in the race to become innovation clusters, there are some regions such as these that continue to thrive and prosper as far as innovation is concerned.

To start with, Silicon Valley has become what it is now due to conscious and deliberate policies followed by the state of California to attract the best talent from around the world to invest and work there.

Further, its proximity to world-class universities meant that students graduating from those universities saw it as a natural progression from academia to working arrangements wherein they flocked to Silicon Valley to seek their fortunes.

Similar is the case with Bangalore where the pioneers of the Indian IT (Information Technology) Industry such as NR Narayana Murthy and Azim Premji setup their base here which meant that after their success, there were others who wanted to do so likewise and hence, flocked to Bangalore.

**How Other Regions and Cities Can Emulate Them**

Next, what these regions have and other regions find it hard to emulate is that all of them have entrepreneurial ecosystems that are capable of incubating, nurturing, and fulfilling the dreams and aspirations of entrepreneurs.

In other words, the combination of investors who can fund their ventures and incubate their dreams to become realities as well as the needed infrastructure and logistics apart from human resources that are needed to nurture them, and more importantly, the fact that these regions have the extra edge that helps them fulfill the conditions needed to successfully run and manage the ventures meant that these regions succeeded whereas

others either failed or struggled.

In addition, the political stakeholders also played an important part wherein they provided the incentives and the tax breaks as well as the subsidies in the form of cheap land and other aspects to actively encourage investors and entrepreneurs as well as topnotch talent from premier universities to come and settle in these regions to pursue their ambitions.

Indeed, the fact that there is a competition underway in India between cities and regions wishing to replicate the Bangalore experience means that there definitely are political drivers behind the emergence of any region or city to become innovation hubs.

## The Wisdom of Crowds Effect

While all these aspects are important, a crucial and perhaps one of the most important reasons why these regions and cities emerged as innovation hubs has to do with the people component.

In other words, the "Wisdom of Crowds" effect wherein once people start flocking to a particular region; others would follow suit meant that both Silicon Valley and Bangalore scored heavily in this respect wherein the initial impetus became a stampede among both investors and potential employees to live and work there.

Indeed, while there are many reasons for people and talent to congregate in these regions, one of the most commonly cited reason is geography, and climate wherein Westerners started to congregate in Bangalore because of its proximity to important institutions of excellence as well as its salubrious climate.

Even Silicon Valley is known for its hospitable weather and tolerance to other cultures that makes Asians prefer to live and work there due to the prevailing liberal environment and favorable climate.

Apart from this, the fact that California has some of the most liberal laws that encourage multicultural living means that this is yet another factor behind its emergence as an innovation hub.

## Innovation Hotspots in Europe

***All digital roads lead to Tallinn, Estonia's forward-thinking capital city and innovation hotspot.***

The "E" in Estonia might as well stand for electronic. Smallest of the three Baltic states, this country, centered on its capital, Tallinn, is a global leader in digital innovation that unites people.

It's the first nation to declare Internet access a basic human right, first to accept digital signatures for most transactions, first to institute online voting, and, this year, one of the first nations with crazy-fast 5G network capability. Estonia's dizzying shift from Soviet state to high-tech hub catapulted Tallinn onto the world stage.

Global innovation incubators are seeding startups like Starship Technologies, a maker of "delivery robots," by the co-founders of Skype (another Estonia e-invention). The new Telliskivi Creative City hub is drawing crowds to its arts shops and cafes. But the headliner this year (into 2020) is the celebration of Estonia's centennial as a republic, to be saluted with scores of events—and loads of Estonian pride.

## Bulgaria: The tech hotspot of Eastern Europe

Bulgaria has been well known as a "captured state", where highly profitable business is primarily linked to several oligarchy groups. But under that surface, a new wave of highly scalable and cost-effective innovative companies is coming, which might be an opportunity for the country to overcome its current situation and take over its economic freedom.

The annual study Innovationship maps the high tech and digital businesses in Bulgaria, a sector which doesn't differ much from the EU statistically.

Raycho is building microsatellites that might disrupt the space research. Spas is 3D printing skin tissue that is about to change the way clinical trials are conducted nowadays and accelerate the process by years.

Dimitar is developing software that turns a smartphone into public transport ticket. Julian's product allows a car to start only in case it scans the owner's fingerprints. Hristo can convert the children's power on the playground into electricity. Svilen builds an unmanned aircraft that will redefine the cargo sector.

Companies like Endurosat, Printivo, Tickey, Biodit, Playground Energy or Dronamics have the potential to disrupt whole industries globally. Unfortunately, outside the ecosystem of startups and venture capitalists, too little is known about them, even in Bulgaria. The reason is partly the lack of visibility and data, and that is one issue the annual study Innovationship solves.

## An ecosystem to watch

The ecosystem of innovative digital businesses, as well as the Bulgarian IT sector in general, exists laterally to the state, which means with minor support. However, between 2012 and 2016 the 20 Million Euro funds that actually catalysed its development were deployed to private fund managers by the Government.

In 2017 Bulgaria has a stabilizing and growing ecosystem, which consists of more than 35 co-working and hackerspaces across the country, up to 40 different organizations forking for promoting and supporting entrepreneurship, several pre-accelerator programs, a mix of funding vehicles - up to 10 funds and accelerators and a growing angel investment network. Today Bulgaria has an ecosystem of mainly

micro (70%) and small (26%) digital companies.

It's a highly positive trend that the Bulgarian digital business shows stable financial performance and exports to foreign markets, mainly EU (42%). Only 9% of those companies are still not generating incomes, 78% of them export and export accounts for more than two-thirds of their turnover.

Following the global trends, Bulgarian startups develop products and services based on technologies such as machine learning, blockchain, cloud computing, big data, biometry and others.

The most typical clients of Bulgarian startups are other businesses and corporations, which might partly explain the fact that local innovations are not widely known to a broader audience. Bulgaria still has no prominent consumer product such as Skype or Spotify, but there are fast growing and successful companies such as pClowd, which outperforms Dropbox by upload speed and security of storage or Chaos Group, the Academy Award Winner for special effects in Hollywood productions in 2017.

From outsourcing to products

Software Corporations have known Bulgaria as one of the great outsourcing destinations for years. Global companies such as IBM, VMware, SAP and HP employ thousands of Bulgarians as technical supporters, developers and engineers. Unlike ten years ago, when the outsourcing boom had just begun, now most of them have R&D teams and excellence centers in Bulgaria, developing core products. Even Viber has its core development team in Sofia.

An interesting finding of Innovationship is that the local Bulgarian startup ecosystem is following a similar trend. About 40% of the Bulgarian digital companies work in the outsourcing domain now, but there are substantial reasons to believe this is only a phase of the ecosystem's development.

## Romania Becoming a Preferred Innovation Destination

***Competitive advantages include 20m population and communist legacy of excellence in science***

At first glance Romania seems an unlikely base for cutting-edge tech start-ups. Even regular visitors associate it with misty mountains, medieval churches and potholed roads. But US wearable technology company Fitbit's acquisition of Romania's Vector Watch in January seemed to confirm that Romania's science-savvy workforce, a sizeable and growing domestic market, and EU membership make it a promising European destination for tech investors.

Romania has been a favoured IT outsourcing destination for many years, with competitive advantages including its domestic market of 20m, one of Europe's fastest-growing economies, and young graduates with good language skills. The country can also build on its communist legacy of excellence in science, mathematics, and technical education.

The focus is shifting to using these to develop homegrown innovative companies. Compared with most other central and eastern European countries, Romania has the advantage of numbers — more human resources. It's easier to find talent. Being part of EU is also an advantage compared with Ukraine, which is bigger in size and has a lot of talent, but is going through a tough period.

In turn, entrepreneurship has been boosted by the demand for skilled professionals; when one company fails, it is easy for its employees to find work elsewhere. Furthermore, rents are relatively low — around half those in Berlin, according to InvestRomania. Salaries, while rising, are affordable by western European standards, with the annual average for a software developer coming in around €17,000. A number of cities now boast budding start-up scenes, most notably Bucharest and the Transylvanian university city of Cluj, as well as Brasov and Timisoara. Romanian start-ups raised €11.3m in 2016, while the total value of exits was €72m (counting only publicly known figures), according to Bogdan Ceobanu, a former entrepreneur now in the European Commission's start-ups and innovation unit. In the first eight months 2017, funding rose to €38.4m.

This was largely driven by Romania's biggest-ever series A round — $30m raised by UiPath, a developer of robotic process automation software that has big multinational clients.

Another Romanian success is Clever Taxi, a developer of ride-hailing apps acquired by Daimler's mytaxi in June for an undisclosed sum. Clever Taxi was founded in 2010 and has 17,000 drivers and 600,000 customers in Romania — an example of how the size of the local market allows Romanian start-ups to scale up. As with Vector Watch, the acquisition is expected to boost research and development in Bucharest.

Overseas companies often have "Romanian DNA". When Facebook acquired video advertising optimisation start-up LiveRail for a reported $400m-500m in 2014, the Romanian government and press pointed out that two of its founders were Romanian and the company had an office in Cluj. Social analytics platform UberVU, acquired by Canadian social media company Hootsuite for $15m-20m in 2014, was also founded by Romanians.

It is fairly normal for tech entrepreneurs from smaller and emerging markets to establish themselves in places like Silicon Valley, Berlin, London. They take advantage of established start-up ecosystems and have more chances to meet investors and partners.


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