A vision for 5G

The story behind Ericsson's
and Swisscom's co-design of
5G first, 5G fast and 5G wide

ERICSSON

swisscom

The Swiss blueprint for 5G first, 5G fast and 5G wide

Case study:
Swisscom

Industry:
Telecommunications

Executive summary

In April 2019, Swisscom became the first to launch commercial 5G in Europe. Since then, the leading service provider has hit 5G milestone after milestone, together with Ericsson, as part of its commitment to unleash faster 5G speeds for Swiss consumers and enterprises. Today, Swisscom delivers 5G coverage to 96% of the Swiss population — and still continues to build out both 5G capacity and coverage across dense urban hotspots, remote alpine regions and major transport routes. As Swisscom begins to prepare for the next chapter of 5G — with a fully standalone network and cutting-edge innovations — we take a closer look at the past, present and future of the groundbreaking Swisscom 5G vision.

Buried deep within the Flumserberg and Churfirsten mountain range, Lake Walen offers a perfect picture postcard of the Swiss pre-Alps. Here, in the winter months, hundreds of skiers and snowboarders can be found carving their way down the adjoining snow packed slopes toward the scenic lake below.

In late 2020, this alpine idyll provided the backdrop for thrill seekers of a different kind, with another need for speed. On the southern banks of the lake, engineers from Swisscom, Ericsson and Swiss Federal Railways (SBB) collaborated to develop a four-kilometer antenna corridor adjacent to a test railway track. Here, they would eventually test, develop and deliver world-first 5G throughput speeds of 1.2 Gbps and latency as low as 8 milliseconds — on a moving train.

Swisscom is a communications service provider that has grown accustomed to delivering world technology firsts, and this test was another proof point on a long list of 5G technology milestones between partners Swisscom and Ericsson. It is also one of many use cases which the Swiss service provider is developing today as it looks to unleash the next wave of 5G enterprise across Switzerland, Europe, and the world.
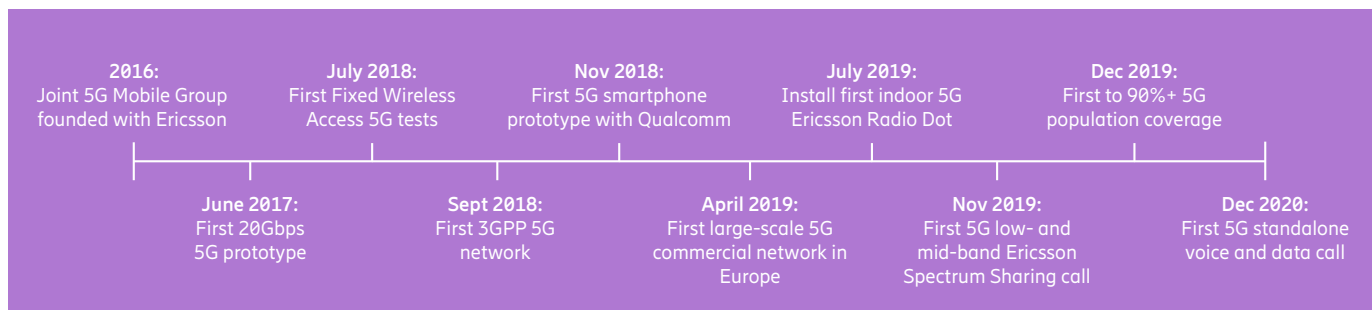
A story of Swiss innovation

At a tenth the size of California, Switzerland is a relatively small country with a high acumen for innovation. Over the past ten years, the alpine confederation has consecutively topped the Global Innovation Index, thanks to a combination of a strong local R&D network, a bourgeoning startup scene and a significant number of patent applications delivered year on year.

Swisscom, the incumbent service provider that served 57 percent of mobile subscriptions in the last year, powers this global innovation machine. With 5G, a connectivity infrastructure which is significantly faster, and more agile, responsive, integrable and secure than previous mobile generations, is extending its reach further than ever into Swiss industries and innovation ecosystems. Today, Swisscom is driving this change through world-class research and development together with local enterprise, start-ups and academia partners such as ETH Zürich and the Swiss Federal Institute of Technology in Lausanne.

"If you want to have the best network, you also have to prove it," says Klaus Liechti, Senior 5G Program Director at Swisscom. "Today, we have several 5G contracts with large business customers in the areas of public safety, transport, health and construction. To drive those use cases forward, we know it is important to be first. This is not always easy of course, and we must put in a lot of effort to test again and again and tick all the boxes. Even though Swiss engineering can be a little too precise sometimes, like with our watches; our technology firsts show that if it can work here in Switzerland, it really can work anywhere."

2016:
Joint 5G Mobile Group founded with Ericsson

July 2018:
First Fixed Wireless Access 5G tests

Nov 2018:
First 5G smartphone prototype with Qualcomm

July 2019:
Install first indoor 5G Ericsson Radio Dot

Dec 2019:
First to 90%+ 5G population coverage

June 2017:
First 20Gbps 5G prototype

Sept 2018:
First 3GPP 5G network

April 2019:
First large-scale 5G commercial network in Europe

Nov 2019:
First 5G low- and mid-band Ericsson Spectrum Sharing call

Dec 2020:
First 5G standalone voice and data call

An ambition to deliver the world's best network

Swisscom has built one of the best performing network architectures in Europe, with a dense base station site grid, low latency and high degree of redundancy to maximize network quality, that it systematically upgrades and optimizes through the latest software and products. As a measure of that, Swisscom is used to sitting at the summit of the annual industry benchmarks. In 2020, Swisscom sealed another victory in the Umlaut Connect test, setting the market's highest benchmark for network performance, as well as securing a spot in a host of other industry benchmarks including CHIP, Ookla and OpenSignal.

"We're very proud of our benchmarks," says Patrick Weibel, Head of Swisscom's 5G Program. "It's a strong proof point so that we can say to our customers 'we have the best network'. The competition is getting stronger in Switzerland, and it doesn't get easier. I still remember how it felt to lose for the very first time in 2016. The following year we came back even stronger, and I still remember the huge party we had after we won. Of course, what we do today is also only possible with a close collaboration with Ericsson. It's really a shared benchmark with the joint goal to provide the best network for our customers."

A new way of working with 5G

In 2016, Swisscom and Ericsson began a joint 5G mobile strategy group, founded to write the next chapter of a technology partnership going back more than forty years. This meant the partners could pool resources and senior expertise; engage more effectively with customers, chipset vendors and device manufacturers; and ultimately design, develop and deploy the perfect 5G rollout blueprint to quickly provide full coverage, high speed and to over time enable new types of services over the network.

 "The days when service providers only sold cell phones are over," says Patrick Weibel. "5G takes us deeper into other technology blocks such as IoT, Cloud and AI; and to be successful, there is no doubt that service providers have to play with that ecosystem. Through the joint mobile group with Ericsson, we now play an even bigger role in setting the pace of innovation and formulating this new 5G ecosystem. This is the way of working and it is helping us to develop revenue opportunities in segments that we did not think would be possible."

Staying ahead of the technology curve is important to Swisscom, but within that there is also a dangerous trade-off between being too early and not bringing the business value to customers. In 2016, Swisscom was early in engaging new enterprise customers through its 5G for Switzerland program, together with Ericsson. As part of this, the service provider introduced early 5G test networks in Lucerne, Bern, Geneva, Zurich and Burgdorf; an initiative which Patrick Weibel says helped to spur Industry 4.0 momentum and lay the groundwork for Europe's first commercial 5G deployment:

"Honestly, I never believed we would be the first in Europe, but we made it. Our first goal was to make the first 5G call in November 2018, however even as late as July 2018 the message was 'this will not be possible'. Everyone worked so hard — we were like a startup, with the best engineers from Swisscom, Ericsson, Qualcomm and Oppo."

In November 2018, the partners achieved the first 5G call on a Qualcomm test device — with speeds of 2Mbps. Only two months later, this increased to 1Gbps in the lab, this time using an Oppo device.

"When we got our hands on the first smartphone from Qualcomm, it was one of the best times in my life," says Patrick Weibel. "Of course, we took them straight to our customers. Finally, we had the tools to take 5G from a vendor environment into real 5G customer use case environments."

5G first, 5G fast, 5G wide

At 00:01 AM on April 17, 2019, Swisscom launched Europe's first large-scale commercial 5G network using the 5G-ready Ericsson Radio System, Ericsson end-to-end 5G transport network and, shortly after, Ericsson Spectrum Sharing.

The historic launch was the first commercial step on Swisscom's blueprint to bring 5G first, fast, and wide to Switzerland. This would be based on Ericsson's two-phase 5G deployment approach: firstly, to deploy 5G based on non-standalone architecture, using the existing 4G Evolved Packet Core (EPC) network, and ensuring a fast time to market; secondly, to deploy a full 5G standalone architecture using the fully cloud-native 5G Core.

Swisscom and Ericsson 5G innovation highlights

- June 2017: Achieve 20 Gbps 5G speeds at a test lab in Zurich

- February 2018: Begin trials of end-to-end network slicing for critical communication use cases

- September 2018: Achieve world-first multi-vendor 5G NR data call with commercial hardware and software

- November 2018: Achieve world-first 5G smartphone connection to a live 3500MHz 5G network

- April 2019: Switch on Europe's first commercial 5G network, followed by the market launch of 5G smartphones the following month

- July 2019: Achieve Europe's first data call over a live 5G commercial network using Ericsson's indoor 5G Radio Dot System

- November 2019: Achieve the first 5G mid-band spectrum sharing data call using Ericsson Spectrum Sharing (ESS)

- December 2019: Connect the first international 5G data call from Bern to Australia's Gold Coast using Ericsson Spectrum Sharing

- December 2019: Achieve 90%+ 5G population coverage

- December 2020: Successfully demonstrate Ericsson's Carrier Aggregation over a live 5G network

- December 2020: Achieve first voice and data call over a live 5G standalone network, laying a foundation for new, innovation-enabling 5G standalone networks

Sharing spectrum to be 5G first

Switzerland is a country with a diverse landscape and many unique deployment challenges. Beyond its populous urban and suburban centers lie vast areas of mountainous terrain, where subscribers' demands change with the seasons. To add to those challenges, Switzerland is also home to the strictest electromagnetic field (EMF) regulations in the world, where the power limits for base stations are ten times stricter than those prescribed by the EU.

Martin Schilling, Enterprise Architect of Swisscom's Access Network, says such restrictions have made Swisscom take a savvier approach to reusing spectrum, meaning that today, even when operating at 10-50 percent of the transmit power of most other major service providers, Swisscom can still deliver network speeds that are on par with the best in the world:

"The power on our mobile sites are limited forcing us to be extremely efficient both in how we densify our network through new sites and spectrum, but also how we reuse our existing spectrum and base station sites. Even before we started with 5G, we had no power left so we had to somehow compromise. While we could afford to cut a little from 2G and 3G, we absolutely did not want to compromise on performance or quality for our 4G customers."

Ericsson Spectrum Sharing was a critical piece of the puzzle that empowered Swisscom to overcome these challenges. This new software concept, developed by Ericsson engineers as part of the new 5G standard, made it possible for Swisscom to simultane-

ously deploy 5G and 4G on their existing 4G LTE hardware and low-band frequency division duplex (FDD) spectrum. It was deployed on the 5G-ready Ericsson Radio System.

"Having the ability to share spectrum between different carrier technologies really was a revelation moment for us," says Martin Schilling. "It became an extremely valuable part of our 5G network planning, not only because it allowed us to reuse spectrum for 5G and provide quick coverage, but also because it allowed us to share the transmit power between 4G and 5G."

Less than eight months after their initial launch of 5G services, in December 2019, Swisscom had achieved 90 percent 5G population coverage. This grew to 96 percent of the population a year later in December 2020, thanks to the Ericsson Spectrum Sharing technology.

For Swisscom, Ericsson Spectrum Sharing will continue to play an integral role as the service provider looks to deploy more 5G capacity to provide 5G Standalone services through the low-band FDD spectrum, where Martin Schilling says that Swisscom is also taking a novel approach:

"In addition to mid-band 5G deployments, today we also see that there are benefits in running 5G on FDD bands previously serving 2G. In fact, this has always been our idea since the beginning, to build a mixed 5G network for the future."

Switching off 2G networks

In April 2021, Swisscom switched off 2G in a move which the service provider had already lay the groundwork for as early as 2015.

In 1999, when construction work began in the Swiss alps on what today is the world's longest tunnel, the Gotthard Tunnel, Swisscom was naturally leading the drive to deploy 2G mobile infrastructure within the tunnel, serving both in-tunnel operations and those traveling on the trains. However, throughout the deployment planning, Swisscom was already clear about its ambition to sunset its 2G networks all those years into the future.

"We are used to working at low power," says Klaus Liechti, "which is why sunsetting legacy networks is a critical part of our network planning. By removing 2G, we have more spectrum and power to invest in the higher capacity and more efficient technologies. Through 3G and 4G LTE, we already cover 99 percent of the population, so we don't rely on 2G coverage as many other service providers do, which made it logical for us to begin with 2G."

Early in the phase-out planning, Swisscom were very active in engaging the wider technology ecosystem including vendors, end customers such as elevator- or traffic control system operators, and critically also the security ecosystem.
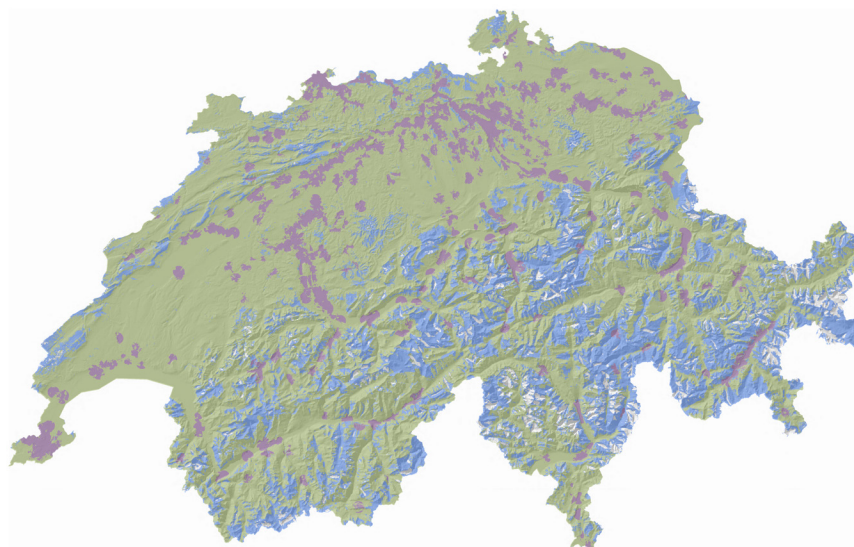
■ 5G (<2 Gbps)

■ 5G (<1 Gbps)

■ LTE

Since December 2020, Swisscom has delivered 5G coverage to 96% of the Swiss population

Focusing on customer value to deliver 5G fast

Data traffic is rising sharply in Switzerland, as indeed it is across much of the world. In 2019, Swisscom recorded a 29 percent growth in data traffic across its mobile networks. According to the Ericsson Mobility Report, this growth will continue at a compound annual growth rate of 26 percent across Europe over the next five years. And while today's smartphones consume an average of around 10 gigabytes per month in Europe, service providers must quickly face up to the reality that this will rise to as high as 46 gigabytes per month in Western Europe in coming years.

On the consumer side, this will be driven by new high-speed and low latency use cases such as consumer augmented- and virtual reality (AR/VR), mobile 5G gaming, and 4K video streaming. "We have been working very closely with many different technology partners to enable these market developments," says Patrick Weibel, "however, even with all these cool things we bring into our smartphone, hardly any customer is willing to pay one Swissfranc more. That is because we include 5G in all our subscriptions, whether it is basic or premium. As the revenue is not going up with that alone, we must find new markets and revenue opportunities, which is the focus of a lot of our work with Swiss enterprises today."

On a global level 5G-enabled business-to-business use cases could generate up to USD 700 billion revenue potential for service providers by 2030, according to forecasts in the Ericsson's 2030 Market Compass. In Switzerland, most of these opportunities will be found in the so-called "smart production" industries comprising logistics, energy, factory, mining, and airport use cases, according to a different 5G revenue report by Analysys Mason.

Today, Swisscom is already making significant headway in many of these areas with smart manufacturing, real-time quality assurance and remote maintenance use cases already in place with medical technology manufacturer Ypsomed, goods inspection corporation SGS, and heat pump supplier Meier Tobler respectively. Rhomberg Sersa Rail Group is just one of many other recent enterprise additions.

Delivering the low-latency and mission-critical demands of Industry 4.0 use cases will require a different approach to Quality of Service (QoS). Today, Swisscom already has the pieces in place to deliver full end-to-end network slicing across both core- and radio access networks, something demonstrated with Ericsson in 2018, to guarantee that new Industry 4.0 QoS requirements can be met across each use case slice.

Martin Schilling believes 5G RAN slicing could be the defining piece of a software puzzle that unlocks new opportunities for Swiss enterprises in coming years: "Traditionally, it's the radio access network that limits mobile connection quality the most, so from that perspective, having the ability to slice that network — to provide even better performance, quality, and reliability — will be a big part of serving tomorrow's mission- and business critical use cases." Swisscom also works relentlessly with network tuning, to ensure that performance demands are always met in terms of capacity and quality. "Reliability is not always a guarantee," says Klaus Liechti, "but we can design systems so that they are resilient and can recover themselves so that impact is limited and we relentlessly hunt for the improve the worst cells in the network, to raise the overall quality of our network."

Building density to extend 5G wide

Swisscom delivers one of the highest density networks in the world which today provides 99 percent 3G/4G area coverage and 96 percent 5G population coverage. Such an extensive densification strategy is necessary, partly to mitigate the strict EMF regulations, but also to deliver on the service providers commitment to provide coverage everywhere and high-capacity coverage exactly where it is needed.

Today, across urban and suburban areas as well as nationwide transport routes and ski resorts, Swisscom deploys mid-band 3600Mhz spectrum 5G so that it can deliver full data rates of up to 2Gbps to the mass market. In rural areas, where capacity demands are not as high, the service provider currently deploys 5G in the 2100MHz band and uses Ericsson Spectrum Sharing of 4G and 5G to not sacrifice 4G capacity.

Another example can be found across the nation's rail transport networks. Following its successful proof of concept with Swiss Federal Railways, Swisscom is today developing a similar pilot to provide 5G rail network coverage between the cities of Bern and Thun.

Patrick Weibel believes that pilots such as this will inevitably be key to enabling future consumer and industrial use cases on the nation's railways: "Our ambition is to extend capacity across one-to-two-thousand-kilometer rail corridors across Switzerland so that we can meet new data demands across railway control operations and passengers. For example, we are also engaged in another activity to develop in-transit consumer streaming services on trains. It is early, but we believe there will be increased monetization opportunities for telecom across rail networks through 5G."

Smart production
- Smart factories
- Mining
- Airports
- Logistics
- Energy

Smart urban
- Construction
- Urban 'hot spots'
- Stadiums
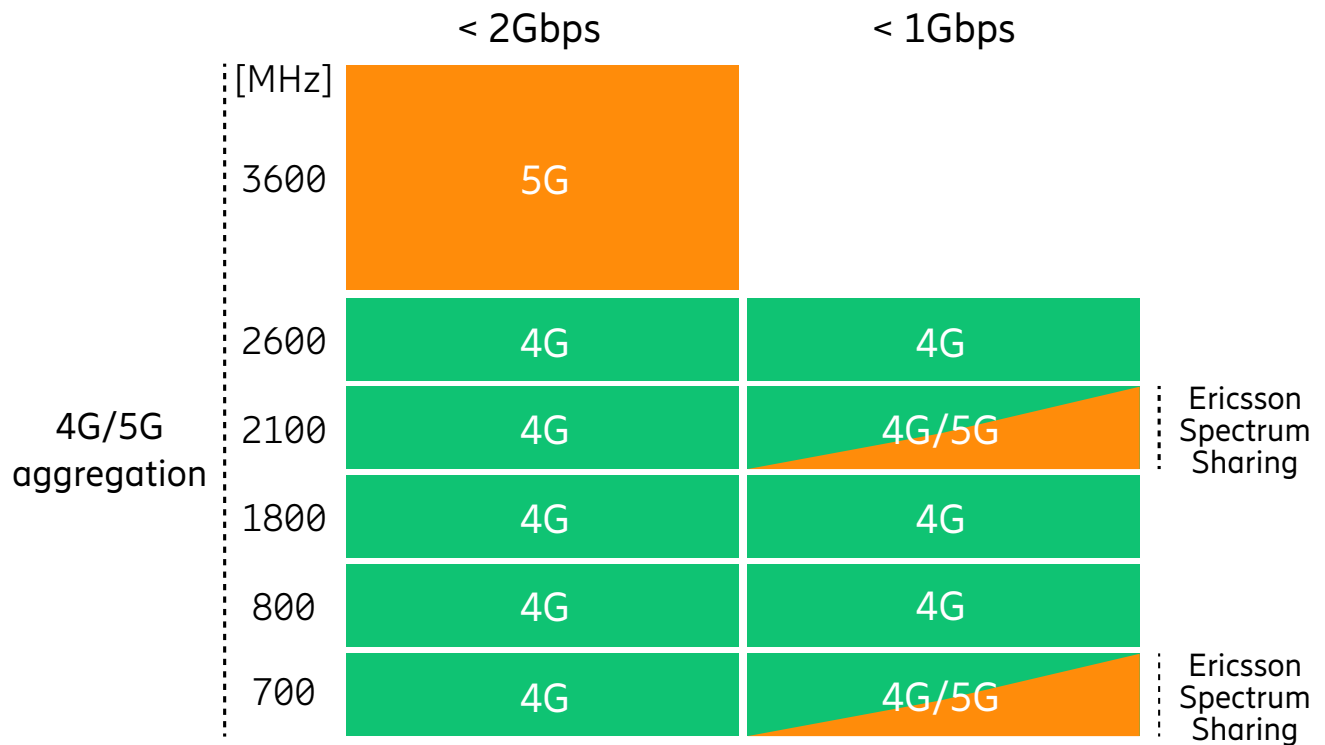- Smart automotive

Smart rural
- Fixed Wireless Access
- Agriculture

Smart public services
- Healthcare
- Municipalities
- Education
- Tourism

5G will unleash new revenue opportunities for service providers across many new market segments

	< 2Gbps	< 1Gbps	
[MHz] 3600	5G		
2600	4G	4G	
2100	4G	4G/5G	Ericsson Spectrum Sharing
1800	4G	4G	
800	4G	4G	
700	4G	4G/5G	Ericsson Spectrum Sharing

4G/5G aggregation

Swisscom makes smart, efficient use of its available spectrum thanks to Ericsson Spectrum Sharing and Carrier Aggregation

Increasing indoor cellular deployments

For indoor connectivity deployments, 5G cellular technologies provide a strong alternative to fixed broadband and Wi-Fi technologies, especially for latency-sensitive enterprise operations and to get a seamless mobile user experience. However, indoor solutions can also be deployed to add an extra 3G, 4G and 5G indoor capacity layer for consumers wherever it is needed in dense urban centers, to build on the base capacity provided by rooftop-level macro base stations.

Today, Swisscom is deploying the multi-vendor compatible Ericsson Radio Dot solution to do just that, something Swisscom's Martin Schilling says will continue to be key as part of their continued densification strategy: "As new 5G use cases emerge and the demand for capacity and coverage increases, our focus will be to increase our small cell deployments in cities and indoor spaces. Today, we are already deploying Ericsson Radio Dots in many public indoor spaces such as shopping malls, meaning that we can extend our network where the traffic needs it with up to 2Gbps speeds."

Soon, Swisscom will also look to introduce low- and mid-band Ericsson Carrier Aggregation a 5G software feature which it successfully tested in December 2020.

By aggregating wide-coverage low-band FDD frequencies (e.g., 700-900MHz) with high-capacity mid-band TDD frequencies (e.g., 3600MHz), Swisscom can extend its 5G mid-band population coverage by up to 50 percent, without increasing the number of radio deployments. This estimate is based on earlier Ericsson field tests with other partners worldwide.
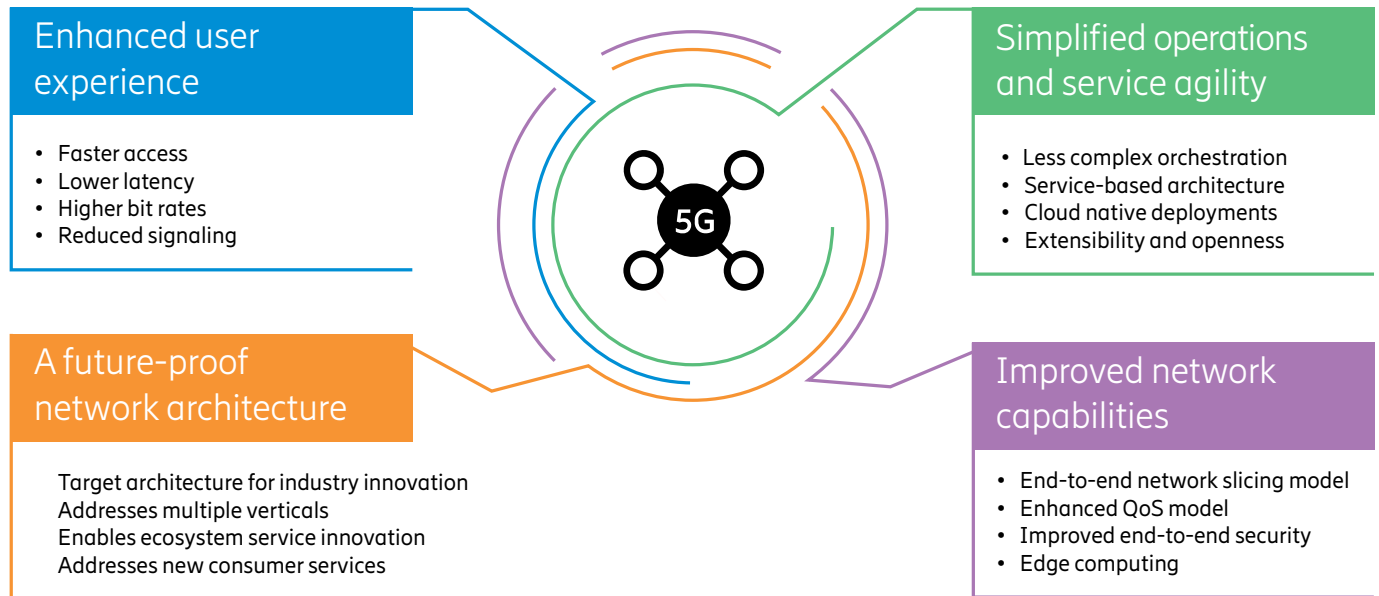
Building the ultimate 5G

Having delivered on its ambition to provide 5G first, 5G fast and 5G wide, the focus now for Swisscom is to build the ultimate version of 5G. In May 2021, the service provider extended its strategic partnership with Ericsson in a move which will also include the switch-on of 5G standalone. Swisscom, in fact, has already successfully showcased standalone architecture when, in December 2020, it delivered Europe's first voice and data call over a live 5G standalone network. However, for Swisscom, this journey is not just about the technologies. It is also about timing and to effectively support the Swiss digitalization journey.

"Our goal with 5G standalone is to increase our market share and address new markets with end-to-end slicing, low latency, edge computing, and local breakout deployments," says Patrick Weibel. "However, this is not just a question of switching to a new

architecture. For us, it is important that we deliver the right value at the right time for Swiss enterprise and our technology partners. To do that, we have to take that journey together."

In addition to providing the 5G coverage and speeds where needed, an enabler for this transformation to 5G Standalone will be the switch to Ericsson's dual-mode 5G Core, a solution that combines Evolved Packet Core (EPC) and 5G Core (5GC) network functions to a common multi-access and cloud-native platform, will deliver a user experience that is even more responsive, reliable, and secure.

Enhanced user experience

- Faster access
- Lower latency
- Higher bit rates
- Reduced signaling

Simplified operations and service agility

- Less complex orchestration
- Service-based architecture
- Cloud native deployments
- Extensibility and openness

A future-proof network architecture

Target architecture for industry innovation
Addresses multiple verticals
Enables ecosystem service innovation
Addresses new consumer services

Improved network capabilities

- End-to-end network slicing model
- Enhanced QoS model
- Improved end-to-end security
- Edge computing

5G standalone for consumers

With the move to 5G standalone, Swiss consumers will benefit from a much-improved smartphone experience through improved latency, responsiveness, battery lifetime, voice experience and security. It also delivers an incentive for service providers to try to find a new mass market 5G consumer potential beyond smartphones, such as smartphone-tethered AR (Augmented Reality) glasses and untethered AR glasses, as is currently being trialed in other parts of the world, e.g. South Korea.

"With 5G standalone, the opportunities for our customers will be fantastic and we will see a lot of new things moving the market in coming years," says Patrick Weibel. "This will begin with a better wireless experience such as improved voice, lower latency and more efficient management of battery resources. After that, it will develop into much more interactive and powerful consumer devices, like lightweight glasses for example. We are investigating all these technology use cases today, because we know that the device will of course be major driver. If the capabilities develop on the device side, then there will be big opportunities for sure."

5G standalone for industries

Swiss enterprises, on the other hand, will benefit through an architecture which offers increased support for high-reliability and time-sensitive industrial applications, in addition to increased end-to-end security and authentication, and improved integration with local IT operations.

"Today, in Swiss enterprises, we are offering low-latency and ultra-reliable wireless opportunities which have never really been there before," says Patrick Weibel. "We're working together with industries to learn how they work and find out where those value opportunities are, whether that be more efficient operations, more agile shop floors or simply the ability to retain network data on-premises. It's a really exciting time."

Each market is different, and the market drivers will not always be the same. One area where Swisscom has seen strong industry momentum, particularly among armed forces- and blue-light customers, has been through the deployment of Mobile Private Networks and Mission Critical Communication networks, where the key driver is not so much improved speeds and latency, but improved reliability and data privacy through local on-premises breakout deployments.

"Switzerland is a unique case," says Klaus Liechti. "We don't have much manufacturing, like in bigger countries, but we do have many international organizations and banks where the key market driver is not so much radio performance but increased end-to-end security. If we want to bring these organizations in to our network, it is crucial that we can guarantee the expected level of service and their own control of that. The plan today is to first develop those proof of concepts and then scale them across the market, just as we did with rail operator SBB last year. In fact, we have a saying here that if you can make it work in a train, then you can make it work in the rest of Switzerland. This is the power of 5G."

Innovating in the new 5G playground

To offer a glimpse into this future, Swisscom recently completed its 5G Startup Challenge which showcased the most creative, cutting edge and innovative technologies currently being developed across the Swiss 5G ecosystem.

The proof of concepts really give an indication of the true power of full 5G and include examples such as wireless high-definition 3D modelling technologies so that architects can view and alter 3D plans in a virtual world from any location, robotic teleoperation systems so that industries can operate in areas that are either too dangerous or too remote for humans, and advanced tethered drone technologies so that public safety organizations can gain immediate situational awareness from elevated perspectives at the push of a button.

"From a technology perspective, this is a really exciting time to be alive", says Patrick Weibel. "There are so many creative possibilities which we can deliver with a full end-to-end 5G platform, and we are very aware of our role in that. We are not just building the platform of the future; we are also building the ecosystem. Every day we take another step on that journey — learning more about industries, supporting the ecosystem to innovate. 5G is a playground for innovation and we will enjoy the next few years, that's for sure."

About Swisscom   Swisscom is the leading provider of communication, IT and entertainment in Switzerland. Outside of Switzerland, Swisscom operates Fastweb in Italy. Swisscom has more than 19,000 employees and is one of the most innovative and sustainable companies in Switzerland.

About Ericsson   Ericsson enables communications service providers to capture the full value of connectivity. The company's portfolio spans Networks, Digital Services, Managed Services, and Emerging Business and is designed to help our customers go digital, increase efficiency and find new revenue streams. Ericsson's investments in innovation have delivered the benefits of telephony and mobile broadband to billions of people around the world. The Ericsson stock is listed on Nasdaq Stockholm and on Nasdaq New York. www.ericsson.com