WHITEPAPER

# SWITCH ON INNOVATION: 5G AND THE FUTURE OF SMART CITIES

## HOW NEXT GENERATION NETWORKS AND IOT TECHNOLOGIES WILL TRANSFORM OUR CITIES

C&K

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# INTRODUCTION

The press has been awash with predictions about the impact of 5G:  the future is wireless, and it's really fast. 5G data networks are expected to transform our lives more dramatically than any technology shift since the Internet itself, from downloading movies at lightning speed on our smartphones to controlling our homes, cars and just about everything from a single device.

That's because 5G will spawn an intelligent ecosystem of connected devices that will harvest massive amounts of data to change the way we work, live, and play. Coupled with emerging technologies like the Internet of Things (IoT), artificial intelligence (AI), extended reality, and blockchain, 5G promises to make us safer, smarter, and able to react more quickly.

While 4G gave a major boost to the mobile Internet capabilities of 3G, 5G is poised to revolutionize communications more significantly. It will form our communications infrastructure in much the same way roads, trains, and power grids formed our industrial infrastructure.

Quantitative futurist Amy Webb, founder of the Future Today Institute, says 5G technology will enable "city-scale networks and city-scale spatial computing. Not just the IoT as it relates to your home environment but a city where devices and sensors and all sorts of things are connected."

In this new hyper-connected world, the "smart city" concept will finally become a reality. Cameras and sensors will track vehicle and pedestrian traffic, monitor environmental factors, improve emergency and municipal services, and generally optimize overall city operations for the well-being of its citizens.

The economic potential of 5G is so significant that many of the benefits probably aren't yet apparent to us. At the dawn of 4G no one could have predicted the new business models that would emerge from mobile broadband such as Uber, AirBnB and Facebook. In the same way, 5G could create entirely new services we have yet to imagine.

While some say the technology is overhyped, we're still years away from 5G's nationwide commercial rollout. Some analysts predict we won't see widespread deployment of strong 5G services in the U.S. until 2022 or 2023.

> 5g Will Spawn An Intelligent Ecosystem Of Connected Devices That Will Harvest Massive Amounts Of Data To Change The Way We Work, Live, And Play.

Still, the prospect of new capabilities from 5G is fueling excitement as design engineers, technologists, and urban planners ponder the possibilities.

Electronic switches will play a key role in supporting this evolution, from 5G infrastructure to the applications, use cases, and devices that will power tomorrow's smart cities.

# WHAT IS 5G?

The transition to 5G cellular networks is about more than just smartphones. It will also affect many other kinds of devices, such as industrial robots, drones, security cameras, and cars that send traffic data to one another.

Strictly speaking, 5G is a set of technical ground rules that define the workings of a cellular network, including the radio frequencies used and how various components like computer chips and antennas handle radio signals and exchange data.

The G in this means generation of wireless technology. Each generation of wireless technology has brought unique capabilities and benefits for consumers and businesses. 1G was introduced in the 1980s as the first mode for mass mobile communications, enabling simple calls between mobile phones. 2G was introduced in the 1990s offering greater security through digital encryption, versus analog signals, and allowed for data services such as SMS.

3G emerged in 2003 and made way for the eventual smartphone revolution, offering higher speeds and bridging mobile devices to the Internet. 4G was released in 2012 with faster speeds and mobile content from streaming.

> 5G promises a big leap forward in terms of mobile technology and brings three new aspects to the table: greater speed (to move more data), lower latency (to be more responsive), and the ability to connect a lot more devices at once (for sensors and smart devices). In general, 5G use cases can be broadly categorized into three main types of connected services:

- ENHANCED MOBILE BROADBAND: 5G will offer faster, more uniform data rates and lower latency and cost-per-bit that will support new immersive experiences such as virtual reality (VR) and augmented reality (AR), as well as make our smart phones better.
- MISSION-CRITICAL COMMUNICATIONS: 5G will enable new services that can transform industries with ultra-reliable/available low-latency links—such as remote control of vehicles, remote infrastructure, and medical procedures.
- MASSIVE INTERNET OF THINGS: 5G will connect a massive number of embedded sensors in devices and other infrastructure by scaling down data rates, power and mobility to provide extremely low-cost solutions.

Many countries consider 5G as a competitive advantage as faster networks could help spread the use of artificial intelligence and other cutting-edge technologies.

> According to a research report by IHT Research, economists estimate the global economic impact of 5G in new goods and services will reach $12 trillion by 2035 as 5G moves mobile technology from connecting people to people and information, toward connecting people to everything.

# 5G INFRASTRUCTURE

5G is currently undergoing testing and poised to launch in some markets later this year. The infrastructure to support enhanced mobile broadband, IoT, and mission-critical applications will require network performance to increase 10-fold over current levels across all network parameters, as measured by latency, throughput, reliability, and scale. To get there, mobile operators will need to invest in all network domains, including spectrum, radio access network (RAN) infrastructure, transmission, and core networks.

This investment will initially focus on key areas such as data centers, edge computing, network transformation, 5G network protocols (also known as 5G IP), and modems. Electronic switches and components will play an important role across this spend which is estimated to exceed $326 billion by 2025 according to research firm Moor Insight & Strategy.

Other switch technology used for 5G will support Radio Frequency (RF) tuning for infrastructure devices—such as antennas and base stations—and in the Industrial Internet of Things (IIoT) where connections, sensors, and processors are all low power but need to actuate things like circuit breakers, a lamp post, a robotic arm, or an HVAC system.

Many elements of 5G technology build on 4G networks, rather than representing a complete departure—and that means mobile operators can take an evolutionary approach to infrastructure investment. Investing in wireless power for 5G will help, but cost-saving efforts and other alternative approaches such as network sharing and new revenue models through IoT, the IIoT, and smart cities will help achieve maximum benefit for 5G and keep the rollout from being too costly or too slow.

The expansion of 5G will finally unleash the true potential of smart cities, providing the backbone for a range of new connected services. Whether it's helping fight traffic congestion, improving the ways cities monitor and manage vital services, or enabling autonomous mobility, 5G will become an ever more critical tool for the cities of the future.

By 2025, the global market for smart-city services—from healthcare to transportation to energy security—is estimated to reach $2.57 trillion, according to Grand View Research. Those investments will largely hinge on network providers' ability to relay massive amounts of data among connected devices and systems in near real-time.

# LAYING THE GROUNDWORK FOR SMART CITIES

Cities that tap into the power of 5G connectivity will be better positioned to drive improvements in public safety, transit, utilities, public Wi-Fi access, and emergency preparedness. That's good news, as the United Nations Department of Economic and Social Affairs says 68% of the world's population will live in cities by 2050.

Smart cities that are laying the groundwork include Singapore, London, Barcelona, Dubai, Tokyo, several cities in China, New York, Sacramento, Columbus, and Austin, among others.

In Asia, Singapore will see an early rollout of 5G as the government doubles the number of licenses from two to four in an effort to transform industries and provide Singapore with a distinct competitive advantage in the APAC region. Singapore has already proved itself a smart-city leader, winning the Smart City Expo World Congress in 2018 for its investment in in technology and connectivity infrastructure that is helping to drive city services like e-government.

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In the U.S., Sacramento is poised to leapfrog smart-city deployment with the first scaled commercial practical implementation of 5G. It was one of the first cities in the world to go live with the technology based on a fixed wireless 5G specification. Planned initiatives include public-safety and pedestrian monitoring, traffic-congestion monitoring and free public Wi-Fi in parks.

In Europe, London has the ambitious goal to be the smartest city in the world by 2020. To achieve this, the mayor of London is encouraging participation in both the public and private sectors. The city is launching over 20 initiatives that will tackle urban challenges. Projects like Connected London bring 5G connectivity to all areas, while the mayor's initiative will provide free Wi-Fi in public spaces.

# SMART CITIES USE CASES

Imagine a city that reacts to the world around it, taking information from the people within it, processing data from sensors on roads, vehicles, buildings, and much more to improve sustainability and the quality of life for all. Thanks to 5G, this will now be possible—and the possibilities are endless. Here are uses cases, some of which are deployed or being piloted in smart cities around the world today:

- TRANSPORTATION:

Autonomous cars will become a reality, helping people get to work more efficiently and eliminating social exclusion for those that cannot drive. The passenger experience will be vastly improved, with an enhanced in-car experience for passengers including entertainment systems and business communications tools.

Drivers will benefit from smoother commutes facilitated by vehicular communication systems that wirelessly link vehicles and roadside units to provide real-time traffic alerts and safety warnings. Public transportation waits will be shortened by leveraging real-time location intelligence to improve traffic flow throughout the city.

In time, autonomous vehicles will become the new norm. Less people will own cars. Instead, commuters, tourists and day trippers to the mall will summon transport from a manufacturer's fleet via a connected app. Connected Autonomous, Sharing, Electrification or CASE will change the concept of the automobile and provide wide-ranging services related to transportation in the future.

Shipping and logistics companies will benefit from telematics and fleet-management tools that combine video data, machine vision technology, and vehicle data to ensure efficient, timely and accurate delivery in cities for retailers and businesses.

- MUNICIPAL SERVICES:

Sensors in trash cans will trigger automatic alerts each time a container is filled up to automate waste collection. Logistics software, mobile apps and in-vehicle monitors will make the waste-management process simpler while also ensuring the driver is safe.

Smart parking technology will enable parking operators to remotely and automatically monitor parking occupancy rates in real time using vehicle detection sensors, smart parking meters, and cameras with automated vehicle license plate recognition capabilities. Understanding the data from the technology will help city planners optimize the flow of traffic and reduce congestion.

Smart bicycle and electric scooter infrastructure will help reduce pollution and support healthier, more productive commuters. GPRS-enabled bike locks with smart payment

systems will facilitate a smooth user experience. AI-enabled platforms will help bike-sharing operators redistribute bikes across cities when and where they are needed.

- PUBLIC SAFETY:

New communications networks will link surveillance cameras with police bureaus and police officers. Intelligent video analysis platforms will manage video resources and meet a variety of service needs, including real-time surveillance, video browsing, data sharing, and evidence collection. Impacts in this area are already being seen as doorbell cameras are providing actionable intelligence to police departments across the country and helping them apprehend criminals.

Environmental and infrastructure monitoring will be achieved through sensors on buildings, light posts and infrastructure, along with climate and pollution data provided by citizens, to better control pollution and reduce costs and environmental impact.

Emergency services will also be better equipped to pinpoint the exact location and best route to reach victims, potentially savings lives. Drones will get into the action, providing potentially life-saving information in hard-to-reach or congested areas around accidents or natural-disaster areas.

# THE FASCINATING ROLE SWITCHES PLAY IN POWERING CONNECTED DEVICES AND SMART CITIES

Much of the technology focus in Smart Cities and 5G is on improved wireless communications, broadening sensor technology and energy efficiency, including devices that are completely battery-free.

> However, without suitable switches 5G technology infrastructure, IoT, and smart-city applications would not exist as we know them today or reach their future potential.

Below are some smart-city use cases and design considerations using C&K switches that design engineers can keep in mind as they envisage the development of these next-generation and greenfield technologies:

## SWITCHES IN SMART TRANSPORTATION

Smart transportation often includes telematics and fleet-management solutions that have mounted security cameras on rear-view mirrors. They can combine video data, machine vision technology, and vehicle data to ensure efficient, timely and accurate delivery in cities for retailers and businesses.

These solutions also help keep drivers and cargo safe by recording vehicle events such as sudden deceleration or impact.

Rugged and robust tactile pushbutton switches are required to allow users to select menu options and record events. Given the space restrictions, C&K's KMR series are often used as they have an excellent tactile feel with four levels of actuation force available, in a footprint of just 4.6mm x 2.8mm.

## SWITCHES IN SMART SHIPPING CONTAINERS

Smart containers are tracked and monitored with GPS through wireless communications nodes. Connectivity is often provided by cellular networks that require a SIM card connector. C&K's CCMO3 Mk2 SIM/SAM card holder is available with a choice of six or eight contacts and fixed or hinged covers, offering mechanical life up to 50,000 cycles. In addition, tamper devices such as C&K's ZMA and ZMS series snap acting switches alert users if the tracking device is removed from the container.

## SWITCHES IN SMART MUNICIPAL SERVICES

Short-term rental bicycles are becoming a hallmark of progressive smart cities. These bicycles are placed in key locations and users can unlock them (and start the billing cycle) using an app on their smartphone.

The smart locks rely on switch technology, such as C&K's ZMS series. These subminiature snap-acting switches detect if the lock has been opened, and their compact body size makes them ideal for the restricted space inside the lock. Available with both high and low over-travel options, these rugged devices are rated at 100,000 cycles and are IP65 sealed against moisture ingress.

## SWITCHES IN SMART HOMES

In our homes, IoT-connected devices automate more functions every day, and control security through cameras and remote door locks. Energy costs are on the rise, and the IoT increasingly controls lighting and heating/cooling to ensure that it is used efficiently with maximum convenience.

IoT nodes are generally small, allowing them to be placed exactly where needed. This leads to space constraints, meaning that switches need to be equally small, yet robust. Even at this small size, switches are fundamental to programming, configuring and using IoT devices, and

a failure of the switch means failure of the node.  C&K switches are rigorously tested and offer cycle counts of 500,000 and above – ideal for many years of service.

Given the highly portable nature of many IoT devices, switches used in them are likely to be used outdoors and will be subject to moisture and contact corrosion. For these applications, C&K switches are available with gold plating to mitigate corrosion and provide ingress protection up to IP67 to keep moisture out.

The sound and feel of a switch as it operates (the “haptics”) are incredibly important in confirming the switch actuation as well as conveying the image of a high quality product. This is a particular area of expertise within C&K; not only does it tune the haptics of its standard products for common applications, but it has a dedicated lab to customize haptics for any specific application.

# CONCLUSION

5G is rapidly moving us into an era of increased sophistication and automation controlled by billions of small devices that will create huge amounts of data every second of every day.

These devices are found in our homes, offices, factories and hospitals, and in our smart-city infrastructure. This market hardly existed a decade ago and is already worth hundreds of billions of dollars annually.

> This staggering range of devices and applications all have one thing in common; they rely on one or more switches to be able to function.

As one of the world’s leading switch suppliers, C&K makes switches for all types of smart-city, smart home, and smart manufacturing applications. C&K offers over 55,000 standard products and 8.5 million switch combinations including many that are used in industrial applications. C&K products include tactile, pushbutton, snap-acting, toggle, rocker, detect, DIP, keyswitch, navigation, rotary, slide, switchlock, thumbwheel, smart card readers, high-rel connectors and custom assemblies – and many of these can be customized to suit your particular application.

For over 90 years the strongest brands in the world have relied on C&K for their custom switch design and manufacturing. The reason they keep coming back is because we consistently achieve the precise look, feel, sound, and experience they are looking for in a custom switch.

# ABOUT THE AUTHOR

**Craig Thomson, Director Global Portfolio & Markets**

Craig Thomson is responsible for driving product and market vision for C&K Switches. Craig brings his 20+ years' experience in product management and new product development to this role in which he successfully enables customer product designers and engineers to solve complex engineering challenges. He has led the development of solutions that have driven end-customer innovations in the medical, automotive, aerospace, industrial, high-end consumer electronics and telecommunications markets.