Electro Rent

Get Ahead with 5G
The Future Has Arrived. Are You Ready?

Contents

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Executive Summary
The wide-ranging impact of 5G

The impact of the fifth-generation of mobile network (5G) technology cannot be underestimated. With 5G technologies and applications, we are on the verge of some of the most significant scientific and industrial developments the world has ever seen. Consumer adoption of the Internet of Things (IoT), business acceptance of the Industrial Internet of Things (IIoT), and the ubiquity of the Internet of Everything (IoE) will enable billions of people, machines, and devices to share massive amounts of data, high-resolution images, and HD video streams in real time.

5G technology will be the catalyst that accelerates the pace of change in many industries—including automotive, transportation, manufacturing, and healthcare—and across our society. This paradigm shift, combined with ongoing developments in artificial intelligence and machine learning, augmented and virtual reality, 3D printing, quantum computing, biotechnology, nanotechnology, and genomics will lead to new scientific discoveries and advancements in business innovation, efficiency, and productivity.

With 5G as an enabling technology, we are on the verge of some of the most significant scientific and industrial developments the world has ever seen.

In what some have termed the Fourth Industrial Revolution, (Source: World Economic Forum, what it means, how to respond.) the Internet of Everything will combine connected devices, machine-to-machine (M2M) communications, automation, and robotics with virtually unlimited

processing power, bandwidth, and storage capacity, leading to disruptive innovation, new business models, innovative products and services, novel manufacturing techniques, and new transportation solutions.

While we cannot know what might be possible when 5G applications are fully deployed, some practical applications include self-driving cars; automated delivery drones and commercial fleets; automated manufacturing and supply-chain management; remote surgery; and smart homes, buildings, factories, and cities.

In the coming decades, the world is likely to see some of the most important advancements it has ever seen in manufacturing, technology, consumer convenience, resource management, energy conservation, healthcare, agriculture, telecommunications, and transportation—all of which have the potential to increase living standards and quality of life for millions of people around the world.

The future is here. Are you ready?

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Get Ahead with 5G
Who Will Gain First-Mover Advantage?

Transformative developments such as semiconductors, personal computers, the internet, smartphones, and the cloud have led to significant improvements in education, literacy, and quality of life for millions of people around the world. Similarly, 5G will fundamentally transform our society by improving how we communicate, share information, enjoy free time, and manufacture and distribute products. By enabling real-time connections among billions of people, machines, and devices, 5G will lead to widespread advancements in innovation, convenience, automation, efficiency, productivity,and safety.

5G will transform how we communicate, share information, produce products, and enjoy our free time, leading to advancements in innovation, automation, efficiency, productivity, and safety.

The imperceptible lag of 5G enables mission-critical applications such as self-driving vehicles and commercial fleets, factory automation, remote surgery, and numerous aviation / military / defense applications.

Why 5G?

To accommodate the expected explosion in internet-connected devices via the Internet of Things (IoT), a massive increase in bandwidth will be required. When Industrial IoT (IIoT) and the Internet of Everything (IoE) become widely accepted, the result will be a threefold increase in cellular and non-cellular connections to 25 billion by 2025. (Source: The Mobile Economy 2018, GSMA Intelligence.)

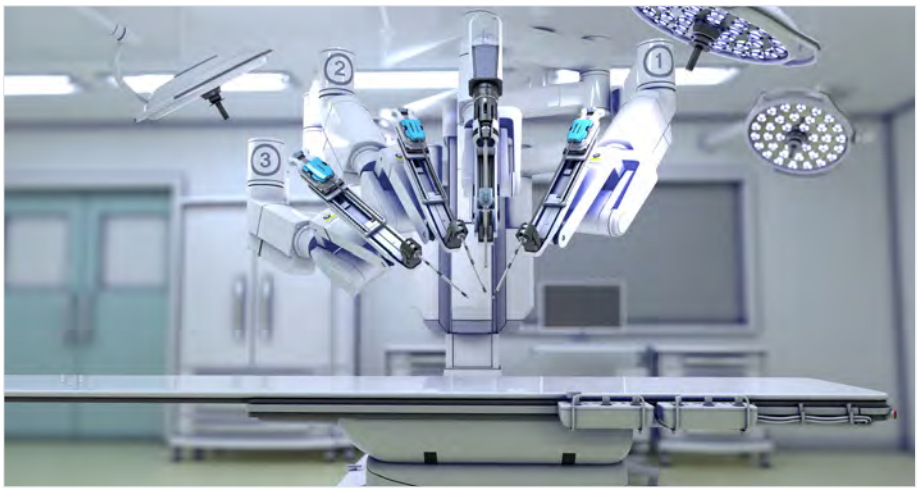
5G Latency

5G offers many compelling advantages, including the ability to serve as a single global standard, the ability to accommodate capacity increases without the need for successive network iterations, virtually unlimited

bandwidth, and low latency. 5G latency—the delay between data request and transfer—is expected to be in the range of 1 ms to 2 ms, which compares to 50 ms on a 4G network.

This imperceptible lag enables a host of mission-critical applications where delay would be unacceptable such as self-driving vehicles, remote-controlled commercial delivery vehicles, autonomous public-transportation fleets, industrial automation, remote robotic surgery, and aviation/military/defense applications. On the lighter side, 5G will support powerful virtual and augmented reality applications, as well as real-time HD video sharing and cloud gaming.

Remote Surgery or Robotic Telesurgery



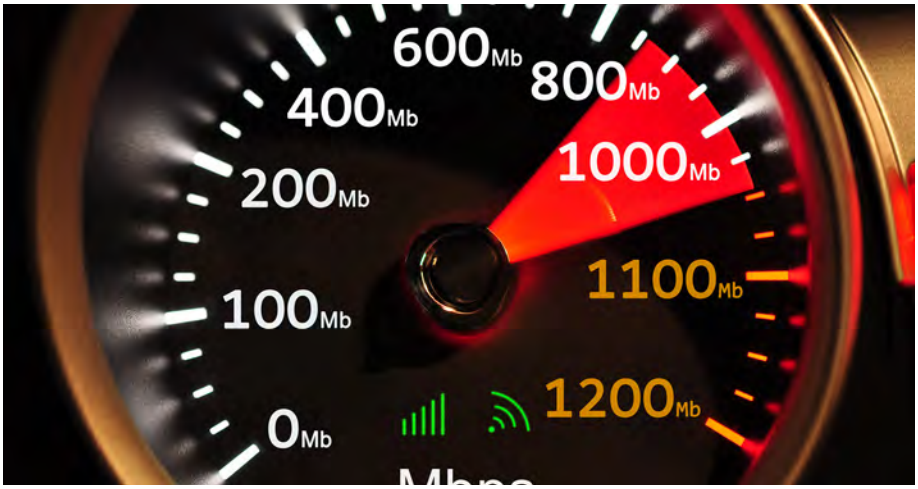
With robotic telesurgery, a surgeon manipulates a console connected remotely to a robot that performs the actual surgery. 5G introduces the ability to create distance between surgeon and patient. The patient may be in a clean room in the same building to prevent infection, or in a battlefield hospital half a world away. The potential benefits of telesurgery include improved precision, lower invasiveness, reduced trauma, faster recovery times, and in the long term, lower healthcare costs.

5G Speed

The speed of 5G is expected to make 4G seem slow by comparison. During testing in 2016, AT&T achieved speeds of 14 Gbps over a wireless connection with less than 3 ms latency. Also in 2016, Verizon achieved 10 Gbps. (Source: FierceWireless.com, Verizon's 5G tests hit 10-Gig speeds, commercial deployment in 2017 possible.)

In real-world U.S. trials, AT&T achieved 5G speeds of 1.2Gbps with 9 ms to 12 ms latency. (Source: cnet.com, AT&T shows how fast US 5G could be.) Similarly,

Verizon has achieved around 1 Gbps with less than 10 ms latency. (Source: idropnews, Verizon Plans to offer 5G Residential Broadband Next Year.)



The Race is On

The United States is expected to be one of the first countries to launch 5G commercial services. (Source: The 5G Era in the US, GSMA Intelligence.) Others in the running include South Korea, China, and Japan.

Beginning in late 2018, and continuing through 2019, U.S. service providers will begin a limited rollout of 5G residential fixed-wireless service. 5G-capable phones will follow in 2019 and are expected from 18 global device manufacturers. (Source: CNET.com, all the proof you need that 5G phones are coming in 2019.)

Initially, both 4G and 5G networks will exist simultaneously, with a full transition to 5G occurring in time and bringing opportunities for innovation, economic growth, and disruptive change. 5G networks will be used for mission-critical applications that require high reliability and low latency, while 4G networks will support non-critical roles until 5G networks are fully implemented.

5G is so important to global technology leadership that the U.S. government blocked a takeover of San Diego-based Qualcomm on the basis that its lead in 5G development is a critical national asset. Reuters estimates that Qualcomm owns 15 percent of 5G-essential patents, which is more than Nokia (11 %) or all telecoms in China (10%).

The U.S. government blocked a takeover of U.S.-based Qualcomm because its lead in 5G is considered a critical asset to U.S. national security.

According to the McKinsey Global Institute, IoT has the potential to deliver more than four trillion dollars in global economic impact a year by 2025.

IoT

According to the McKinsey Global Institute, IoT has the potential to deliver more than four trillion dollars in global economic impact a year by 2025. Leading contributors are factories and cities; consumer, retail, and logistics; connected autos and autonomous driving; workplace operations and maintenance; and connected homes and offices. Although consumer IoT will deliver many benefits and gain much of the attention initially, B2B and industrial applications are expected to account for nearly 70 percent of the value.

Machine-to-Machine communications will enable factory systems to "talk" to each other, share massive streams of real-time data, and make decisions largely on their own.

Industrial and Commercial IoT Applications

Robotic Manufacturing and Smart Factories

Industrial IoT (IIoT) refers to IoT applications that are not consumer related. It includes smart factories that use machine learning, artificial intelligence, robots, connected sensors, and real-time data and analysis to improve the manufacturing process.

M2M communication will enable factory systems to "talk" to each other, share massive real-time data streams, and make decisions and adjustments largely on their own. Subsequently, data can be analyzed by humans to gain additional insight and discern how to further improve operations, increase quality, reduce production time, or lower costs.

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In a smart factory, cameras and sensors will be used to monitor and adjust manufacturing in real time. Costs can be reduced via lower error rates and less rework. Efficiency can be increased with improved throughput and less human intervention, leading to increased consistency and higher quality. (Source: Developers Alliance, Internet of Things, Manufacturing IoT From the Factory Floor.)

As IIoT evolves, multiple systems, factories, and logistics providers will be connected to a centralized IT system that provides total visibility to all manufacturing and supply chain events. Radio Frequency Identification (RFID) tags can track products as they move, improving accuracy and quality, and informing managers about issues that need adjustment or resolution.

Today, companies use IIoT largely for predictive maintenance and to improve safety. For example, sensors are used to deactivate a machine if humans inadvertently cross a predetermined safety zone. Although IIoT is in its infancy today, it is expected to be the largest growth category by 2023, when it will overtake consumer IoT. (Source: The Mobile Economy 2018, GSMA Intelligence.)

Smart Cities

Have our city centers have become too large, complex, and fast-paced for humans to manage effectively? The smart cities of tomorrow will use a variety of IoT-connected devices and sensors to better match resources with demand, monitor fleet reliability, improve infrastructure and operations, reduce human intervention, and increase safety, service, quality, and efficiency.

Some examples include smart traffic management systems; smart parking, lighting, water, and public transportation systems; and automated waste management systems. By leveraging sensor data—as well as real-time information from vehicles, pedestrians, and infrastructure—city managers will be better able to reduce congestion, improve resource, and increase energy conservation.

By leveraging information from a variety of sensors across the city, managers can better allocate resources to improve safety, service, quality, and efficiency.

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Smart City Experimentation

Leading cities are already experimenting with smart systems. Tokyo is testing autonomous robot taxis that are expected to debut during the 2020 Tokyo Olympic Games to demonstrate that Japan remains a world leader in technology.

Robot Taxi (www.dena-automotive.com) is a joint venture between mobile internet provider DeNA and robotics firm ZMP. According to Robot Taxi CEO Hiroshi Nakajima (via translator), "When you look at manned taxis, 70% of the cost is actually related to labor costs. If we can replace that with [artificial intelligence], I think we'll be able to provide a very attractive price point." (Source: Quartz.com, Japan is building a "Robot Taxi" service, with thousands planned for the
2020 Olympics.)

Separately, Nissan and DeNa are collaborating to pilot a self-driving taxi service in 2018 and commercialize it in 2020. Initially, autonomous Nissan Leafs will be available within a geofenced 4.5 km route around Nissan global headquarters and a local shopping center. A safety driver will be behind the wheel in the event of an unusual situation or emergency. (Source: The Verge, Nissan plans to launch its own self-driving taxi service in Japan.)

Tokyo is also testing Panasonic autonomous wheelchairs at Haneda Airport that use sensors to navigate around pedestrians, luggage, and other obstacles. Disabled visitors use a smartphone to arrange for pickup and drop-off, and after the journey is completed, the wheelchair automatically returns to its docking station or continues to its next destination. The fleet will debut at the 2020 Olympics, possibly to transport Paralympians. (Source: Smithsonian.com, What Will the Automated City of the Future Look Like?)

At Haneda airport in Tokyo, Panasonic autonomous wheelchairs are being tested and may be used to transport Paralympians at the Olympic Games in 2020.

With enough data from across the 30-mile wide island, Singapore can create highly accurate models to conduct virtual simulations and modeling for a wide variety of scenarios.

In Singapore, self-driving cars and buses have been testing since 2013. More recently, autonomous taxis have also been tested. By using a variety of sensors to track bus fleets, Singapore has been able to identify problems areas where more buses are needed to reduce congestion and wait times. As the island is only 30 miles across, it is an ideal testbed for IoT technologies. Its Smart Nation initiative aims to propel it to a leadership position among smart cities. (Source: bbc.com, Tomorrow's Cities: Singapore's plans for a smart nation.)

Called "autonomous air taxi" (AAT) by the Dubai government, the aspirational goal is to have 25 percent of passenger journeys served by AATs by 2030.

Due in 2020, a government-mandated satellite-navigation system will be required on all vehicles in Singapore to enable optimization of traffic flow, assess road taxes, and inform better road design. With sensor data from around the city—from buildings, roads, buses, taxis, personal vehicles, and the infrastructure—a highly accurate computer model can be built to enable virtual simulation and modeling. Singaporeans can already access traffic and parking data, security cameras, and other public data online. (Source: engadget.com, Singapore is striving to be the world's first 'smart city'.)

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In September 2017, testing of an unmanned, aerial two-seat drone or flying air taxi, began in Dubai. With the goal of becoming the world's first autonomous flying taxi service, the 18-rotor Volocopter can fly for 30 minutes with a range of 17 miles. (Source: Newatlas.com, Volocopter flying taxis takes unmanned flight over Dubai.) Called "autonomous air taxi" (AAT) by the Dubai government, the aspirational goal is to have 25 percent of passenger journeys served by AATs by 2030.

The Autonomous Flying Air Taxi of Dubai

Although experimental, the autonomous flying air taxi is intriguing. Essentially a highly sophisticated, two-seat drone, the Volocopter aspires to be an integral part of future cities ten years from now. In 2017, the company partnered with the Dubai transit authority to test air taxis over a period of five years with a goal of implementing a commercial pilot program around 2020.

Smart Traffic Management

The FHWA estimates that more than 10 percent of all delays and congestion are related to inefficient signal timing, which leads to increased fuel consumption and vehicle emissions, higher fuel and labor costs, and lower productivity and efficiency. Therefore, real-time smart traffic management systems are being used to optimize signal timing and traffic flow in cities around the country.

Cities like Los Angeles use real-time monitoring at nearly 4,600 signal intersections to reduce travel times 12% and increase vehicle speeds 16%. (Source: LADOT, www.trafficinfo.lacity.org/about-atsac.php.) Areas like New York City, Miami-Dade in Florida, and Ann Arbor, Michigan have also reported similar gains.

A new advanced traffic management system in Ann Arbor measures how many vehicles are waiting at a light, which lane they are in, and how many cars coming down the road are expected to arrive at the intersection. (Source: FutureCar, Michigan Fighting Traffic with Smart Traffic Systems.)

In the future, smart parking systems will be used to save gas and reduce emissions by alerting users to space availability in real time. Smart public transportation will offer real-time tracking and traffic projections for metro lines, buses, and train systems.

Smart Resource Management

Smart grid management will improve operations, maintenance, planning, and resource allocation within cities. For example, internet-connected trash cans can signal when waste collection and removal is required via an automated collection fleet, thereby improving sanitation and reducing costs. Similarly, oil and gas delivery or utility service and repair could also be automated. Smart water sensors can monitor and adjust the quality of drinking water, while smart lighting sensors can dim street lights when no pedestrians or traffic are present.

As city systems evolve, real-time connections among vehicles, people, and infrastructure could decrease congestion, improve traffic flow, and reduce emissions. Connecting vehicles to each other (V2V), to the infrastructure (V2I), and eventually to everything (V2X) would enable further advances in safety, convenience, and efficiency. In a V2X scenario, vehicles could share information about road conditions with other devices—including traffic signals, sensors, emergency roadside warnings, and hazard systems—and with pedestrians and sensors embedded in road systems.

In a vehicle-to-everything (V2X) scenario, vehicles could share information on road conditions with other devices and with pedestrians and sensors embedded in road systems.

Smart Buildings

Smart buildings use IoT-connected devices to optimize energy use by matching resource allocation to occupancy patterns. Such systems can increase occupant comfort and convenience, predict equipment problems before they occur, and monitor building security.

Consumer IoT Applications

Consumer IoT – The Smart Home

Smart homes use IoT-connected devices and a gateway/router to monitor and access home-control devices via smartphone. The number of smart home connections is expected to increase threefold to more than 5 billion by 2025 (Source: GSMA Mobile Economy 2018.) Globally, this market grew 95% (Q2 2016 to Q2 2017) to $3.3 billion, with the United States representing $1.6 billion of that total. (Source: IoT Analytics GmbH.)

5G enables widespread use of 4K, 8K, 3D video, and 360-degree video, which combined are expected to account for 75% of mobile data traffic worldwide by 2023—up from 55% in 2017.

The largest smart home categories include gateways, speakers, security systems, and appliances. Others include thermostats, lighting, switches, and detectors. For example, temperature sensors that continually adjust between efficiency and comfort, sensors that can turn off lights in unoccupied rooms, and window sensors that can sense when windows or doors are open to reduce HVAC usage. Other applications include appliance control (i.e., washers, dryers, refrigerators/freezers, ovens/microwaves), security systems

(i.e., motion sensors, cameras, lock control), and entertainment devices (i.e., Bluetooth enabled speakers for music, smart speakers/voice controlled assistants).

In home entertainment, the increased bandwidth of 5G will enable widespread sharing of 4K, 8K, 3D video, and 360-degree video, all of which combined are expected to account for 75% of mobile data traffic worldwide by 2023—up from 55% in 2017 (Source: Ericsson Mobility Report, November 2017.) 5G will also bring improvements in cloud gaming as well as augmented and virtual reality applications for training, education, marketing, sales, and entertainment.

Automotive IoT Applications

The Connected Car

A connected car is a vehicle with internet access, and many are already on the road today. Connectivity enables numerous safety, convenience, and entertainment features. Safety and security options include automatic crash notification, road hazard warning, emergency breakdown notification, and vehicle recovery services. Real-time traffic and navigation, remote vehicle diagnostics, service reminders, and remote lock and unlock functions add convenience. In the realm of in-car work and entertainment, connectivity brings streaming music and video, in-car hotspots, and mobile office functionality.

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Self-Driving Vehicles

The Waymo self-driving fleet, which is Level 4 autonomy, is currently being tested in a geofenced area in Chandler, Arizona, interacting with other real-world vehicles, pedestrians, and road users. Waymo has accumulated a great deal of experience in self-driving technology, accumulating far more miles than all other automakers or suppliers combined, giving them potential first-mover advantage.

In California, automakers are required to submit reports to the DMV to test self-driving vehicles (www.dmv.ca.gov). Waymo has reported 635,868 miles in self-driving vehicles in 2016 (up from 424,331 in 2015). No other automaker or supplier is close. The next-highest is General Motors, which logged 10,015 miles (June 2015 to November 2016).

Waymo has reported 635,868 miles in self-driving vehicles in 2016 (up from 424,331 in 2015).

LEVEL	DESCRIPTION	ADDITIONAL DETAILS
Level 0	No Automation	
Level 1	Driver Assistance	car can manage either steering or speed, under certain conditions (i.e., adaptive cruise control)
Level 2	Partial Automation	car can steer, accelerate and brake, in certain circumstances (i.e., Cadillac Super Cruise)
Level 3	Conditional Automation	car can manage most aspects of driving, driver must be ready to take control when alerted (i.e, Audi Traffic Jam Pilot)
Level 4	High Automation	car can drive itself under certain conditions, such as freeways only or predetermined geofenced areas only
Level 5	Full Automation	the car can drive itself under any condition, steering wheel and pedals are no longer needed

In addition to self-driving miles logged, another key metric that is reported to the State of California the number of times the system disengages from autonomous mode, which indicates how often human intervention was required. Disengagement can occur for a variety of reasons. Some are related to software, such as camera or sensory perception issues, inability to properly predict traffic patterns, or unwanted vehicle maneuvers. Others include external conditions, such as weather, improper driving from other vehicles, road construction, or roadway debris.

Waymo has shown that driverless cars can work in ideal conditions on real roads. They have also conducted hot weather testing in Death Valley, California and plan additional winter testing in Michigan to gain experience in snow, sleet, and ice. They are working to show that their vehicles can perform in all environments under any conditions and reach Level 5 autonomy.

The Future of Automated Driving

Today, several automakers offer vehicles with Level 2 autonomy, where partial assistance is provided under certain conditions (Cadillac, Tesla, Volvo, Mercedes-Benz). One (Audi) has announced its intention to offer Level 3 autonomy on a 2019 model—pending regulatory approval in several states.

However, only experimental vehicles such as Waymo (Google self-driving car project) have achieved Level 4 autonomy. Although the technology is available to support fully autonomous vehicles today, it is expensive. Over time and with scale, however, the full cost of hardware, software, and associated systems and sensors will decline. Even so, market acceptance and introduction may be at least a decade away. (Source: plasticstoday.com, Here's Why Level 5 Autonomous Cars May Still be a Decade Away.)

Consumer acceptance is just one issue. Liability and state regulations are others. In March 2017, AAA indicated that 75% of U.S. drivers feel "afraid to ride in a self-driving car". Interestingly however, 59% of Americans were interested in having some autonomous features on their next vehicle. (Source: AAA, Americans Feel Unsafe Sharing the Road with Fully Self-Driving Cars.) More recently, an Accenture online survey revealed that 54 percent of online consumers are willing to be a passenger in a self-driving vehicle. (Source: Accenture.com.) So, while it appears that consumers are comfortable with some aspects of self-driving technology, they don't appear ready for full autonomy.

While 75% of drivers were reluctant to embrace a self-driving car, a majority were interested in having some autonomous features on their next vehicle. (Source: AAA)

Although the technology is available to support fully autonomous vehicles today, market acceptance and introduction may be at least a decade away.

Legal liability issues also remain. The good news is that although regulations tend to lag the pace of technology development, state and local governments have generally welcomed technologies they believe will bring overall economic benefit, including autonomous vehicles.

With 5G, automakers will be able to gather over-the-air data from experimental fleets to create more powerful simulations, which then, in turn, can become part of the vehicle reference database.

With 5G, automakers will be able to gather over-the-air data from experimental fleets to create more powerful simulations, which then, in turn, can become part of the vehicle reference database. Because Level 5 autonomy must cover all situations all the time without driver assistance, automakers will likely focus on Level 4 autonomy for now, where routes are restricted to certain geographic areas. Several automakers intend to have Level 4 vehicles available by 2020/2021.

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Conclusion

From automated manufacturing and self-driving vehicles to smart homes, buildings, and factories, the interconnectedness of society is set to increase exponentially with the introduction of 5G technology. Virtually unlimited bandwidth, superfast speeds, and near-real-time connections will become commonplace.

A multitude of connections—via IoT devices, vehicles, cities, infrastructure, and industrial entities—will enable new innovations, new technologies, and new business models. Some will offer more efficient and more productive ways of doing business for legacy industries; others are completely unknown and have yet to be discovered. One thing is certain, though. Disruption and change will be key components to the future fabric of our society, leading to new discoveries, transformation, and improvement.

Electro Rent test solutions and expertise help leading companies accelerate time-to-market and reduce testing costs. Electro Rent is enabling a successful transition to 5G, delivering customers with first-to-market solutions at every stage of the test lifecycle.

One thing is certain, though. Disruption and change will be key components to the future fabric of our society, leading to new discoveries, transformation, and improvement.

We proudly offer 5G test solutions from Rohde & Schwarz and Keysight, world leaders in RF and test and measurement. Let us help you on your journey to a 5G future.

About

Electro Rent is a leading global provider of test and technology solutions that enable customers to accelerate innovation and optimize asset investments. Our rental, lease, sales, and asset management solutions serve innovators in communications, aerospace and defense, automotive, energy, education, and electronics industries, and we have been doing so since 1965.

Why Electro Rent?

Electro Rent is enabling a successful transition to 5G by offering first-to-market solutions at every stage of the test lifecycle. We provide semiconductor, network, equipment, and device manufacturers with efficient solutions that can reduce testing and measurement costs.

- Our large inventory ensures that you get the equipment you need, when you need it.
- We stand behind our products with support and service; our calibration facilities are world class.
- If there's anything you don't like, just let us know and we'll do our best to resolve it to your satisfaction.
- Our advisors recommend a variety of easy-to-start rental and financing programs to fit your situation.

We proudly offer 5G test solutions from Rohde & Schwarz and Keysight, world leaders in RF test and measurement.

Let us help you on your journey to a 5G future.

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Rohde & Schwarz SMW200A Vector Signal Generator, 100kHz to 40GHz

Electro Rent Part No. RS-SMW200A-40

The SMW200A is the vector signal generator for the most demanding 5G applications. It offers flexibility, performance, and intuitive operation for generating complex, digitally-modulated signals of high quality for 5G LTE Advanced to 2G applications.

Applications

- Pre-5G NR Signal Generation
- Antenna Array Testing - Conducted and Over-the-Air
- 5G Waveform Candidates

Features

- Single side band phase noise typ. -135dBc @1GHz, 20kHz carrier offset
- High output power up to +18dBm (PEP)
- Analog and digital modulation
- Cellular modulations

Keysight M9383A PXIe Microwave Signal Generator, 1 MHz to 44 GHz

Electro Rent Part No. KT-M9383A-F44

The M9383A is a modular microwave signal generator test solution for design validation. It can be efficiently leveraged into a manufacturing environment with the flexibility to solve today's pre-5G LTE Advanced requirements and can be upgraded to your future test needs.

Applications

- Modular test solution for design validation that can be efficiently leveraged into manufacturing
- Flexibility to solve your immediate test needs, but upgradable for what comes next – whether that's more frequency coverage or a rapid shift to high volume production.
- Pre-5G signal confidence you need with 1% EVM @ 28 GHz, 800 MHz bandwidth

Features

- Single side band phase noise typ. -137dBc @1GHz, 20kHz carrier offset
- High output power @1GHz, -90 to +19dBm
- Analog and digital modulation
- Cellular modulation formats from 2G to Pre-5G LTE Advanced

Keysight E8267D PSG Vector Signal Generator, 100kHz to 44GHz

Electro Rent Part No. KT-E8267D-544

The E8267D vector signal generator is used to test advanced receivers, with realistic wideband radar, EV, Satcom, and 5G applications. It offers up to 2GHz of bandwidth (with external AWG), allowing you to simulate complex electromagnetic environments and reduce complex signal creation times.

Applications

- Waveform playback and real-time
- Antenna Array Testing - Conducted and Over-the-Air
- 5G Waveform Creation with signal studio application
- Signal optimizer with K3101A

Features

- Single-side-band phase noise typ. -143dBc @1GHz, 20kHz carrier offset
- High output power @1GHz, -130 to +21dBm
- Analog and digital modulation
- Cellular modulation formats from 2G to Pre-5G LTE Advanced

Rohde & Schwarz FSW43 Signal and Spectrum Analyzer, 2Hz to 43.5GHz

Electro Rent Part No. RS-FSW43

The FSW43 Signal and spectrum analyzer is designed with 5G measurement analysis in mind. It offers low phase noise, wide analysis bandwidth (2GHz) for complex LTE Advanced applications, with an easy to use GUI.

Applications

- Used in aerospace and defense applications (ASD)
- Wideband communication systems for military and commercial use
- 5G Waveform analysis
- Development of oscillators for radar systems and complex LTE Advanced applications

Features

- Analysis bandwidth – 10MHz standard, upgradable to 2GHz
- Displayed average noise level (DANL) +154dBm at 2GHz (1Hz resolution)
- SSB phase noise at 10kHz offset -134dBc
- Cellular modulation analysis from 2G to Pre-5G LTE Advanced

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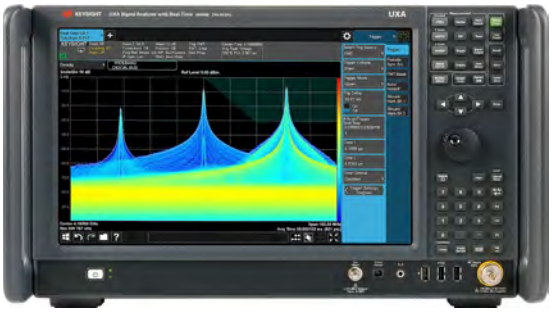
Keysight N9040B UXA Signal Analyzer, Multi-touch, 2 Hz to 50 GHz



Electro Rent Part No. KT-N9040B-550

The N9040B Signal analyzer offers real-time spectrum performance analysis up to 1GHz for deeper views of complex and challenging 5G signals. Clean spectral purity with leading phase noise measurements. Extendable frequency range to 110GHz with external smart mixers.

Applications

- Utilize application measurements that range from parametric to wireless measurements including 5G LTE Advanced, WCDMA, phase noise, noise figure, analog demodulations
- 5G Waveform analysis and vector analysis with VSA software 89601B
- Satellite, radar, EW, fast-hopping signal analysis

Features

- Analysis bandwidth – 25MHz standard, upgradable to 1GHz
- Real-time bandwidth optional to 510MHz
- Displayed average noise level (DANL) +174dBm at 1GHz (1Hz resolution)
- SSB phase noise at 10kHz offset -136dBc
- Cellular modulation analysis from 2G to Pre-5G LTE Advanced
- 5G NR (new radio) with N9085EMOE application software

8511 Fallbrook Ave, Suite 200
West Hills, CA 91405

O: 818-787-2100
F: 818-786-4354
electrorent.com

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