CONNECTED LIFE: WHEN EVERY CONNECTION COUNTS

From home to work, on and off road, and in the air, connectivity is transforming our lives. The experiences we undertake and the products we use all rely on shared data, adding rich communications to every interaction. More information, shared by more devices, informs better decisions on everything from how to keep your home at a comfortable temperature to how to fly an airplane in a fuel-efficient manner.

Connectivity has the power to entertain and add comfort to our lives — but it also makes our lives safer and the planet greener. Connected cars and aircraft operate safely and reduce harmful emissions. Connected factories are more efficient and allow workers to create innovative new products and solve problems faster. Connected trucks and industrial vehicles get crops harvested and buildings built in less time, even under harsh operating conditions.

To meet the high expectations for connected devices, manufacturers need hardware that is completely reliable and cannot fail; is small, light, and multifunctional; and offers affordability at high volume. In response, solution providers are increasingly looking across many industries for knowledge to help innovate and solve problems in their market as connectivity needs and end-user expectations continue to converge. In this paper, you'll learn more about the critical role that such technology plays in the creation of the connected life — and how sensors, connectors and other components are making every connection count.

TE connectivity

Connected Home: A Hub of Activity

Whether you call it the connected home, smart home, or home automation, homes are now a hub of activity for connectivity and sensor solutions. While mainstream adoption may still be years away, this market is poised for growth. It represents an important opportunity for consumer product manufacturers in sectors such as appliances, security and lighting to deliver products that are differentiated with new functionality and connectivity.

However, today's market is fragmented, and standards differ. The killer application does not yet exist. Vendors are competing for mindshare with their own version of walled gardens or individual platform standards. What's clear is that there is no one approach or obvious leader today. The migration towards home automation is based on do-it-yourself product solutions versus an integrated whole home solution. All of the products in this market are competing for a bigger share of mind and control in the home.

Smart connectivity is just a starting point. The possible applications range from basic diagnostics to automation and remote management. As artificial intelligence matures and proliferates, devices will leverage complicated analysis in the cloud to deliver actionable insights back to users and systems within the connected home. Automation will eventually make routine tasks or chores easier, and perhaps invisible. This process will drive a cycle of increased demand for leading products, resulting in greater adoption and improved data on behavior and efficiencies. These improved results create a better experience for consumers, who then demand more products.

In response, companies are beginning to offer points of collaboration. Samsung has long supported the developer community, and specifically supports developers of connected home products via its SmartThings platform. Even Apple is recognizing the importance of common technologies. At its 2016 Worldwide Developers Conference, the company announced it is releasing the Home app for the iOS platform, which will act as a central control point for HomeKit-compatible smart home devices. In addition, Apple has opened up Siri to third-party developers, just as Amazon opened up its Alexa platform. This will allow app developers to use Siri to act as a product's voice control.

In addition to technology and standards, the connected home market is also affected by the consumer adoption mindset. Early adopters are intrigued by new products and functionalities and will start purchasing, testing, and talking about them. Mainstream adoption may be years away, yet the fact remains that people are testing the waters. We can expect to see adoption curves differ depending on the product focus, geography, and pain points. However, the benefits of automation, remote management and servicing, and other customer-friendly features will encourage appliance manufactures to differentiate in order to compete. They may be the drivers of adoption, as OEMs bring products that offer new levels of functionality to the market sooner than later.

Homes:
When EVERY CONNECTION COUNTS
TE Connectivity is uniquely positioned to help customers succeed in the connected home market. From material components such as relays and connectors, to smart components such as sensors and antennas, TE offers all of the internal elements that make end products smart and connected.

Visit te.com/connected-home to learn more.

Commercial Buildings: Connected Systems for Efficiency and Comfort

The need for connectivity, powered by sensors and connectors, is even more important in commercial buildings. Building managers need to know who is accessing buildings and at what time, how much energy is being used and where, what areas of the buildings are occupied, and how efficiently the physical plant is being run. In addition to sensors, there are far more actuators in a commercial building. A centralized control system may take readings from multiple airflow sensors in a building, and dynamically adjust airflow dampers to ensure equalized airflow and comfort throughout the building.

The future will see buildings more heavily instrumented than ever before, with an increasing focus on environmental quality (including air, comfort and light) to maximize the efficiency and comfort of building inhabitants. Similar to trends in the home automation market, there will be significant miniaturization and intelligence in commercial building devices.

Visit te.com/commercial-buildings to learn more.

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Connected Car: Safer, Greener and More Enjoyable Driving

Just as consumers want a connected life when they're at home, they want it while they're on the road as well. With data connectivity, drivers can do more than just point the car where they want it to go: data can help them get places faster, spend less money on gas, and travel in greater comfort.

Car manufacturers and government regulators also see value in connected cars, but for different reasons: connectivity promises to improve safety and reduce polluting emissions. However, to meet the demands of both consumers and regulators, automakers must equip cars with internet connectivity and sensor capabilities that can share information from many sources inside and outside the vehicle. This means manufacturers must develop the quality connectors and sensors that make connectivity possible, so that information can be exchanged both inside and outside the vehicle.

Here's how the automotive market is using connectivity to respond to trends in safety, the environment, and consumer lifestyle preferences.
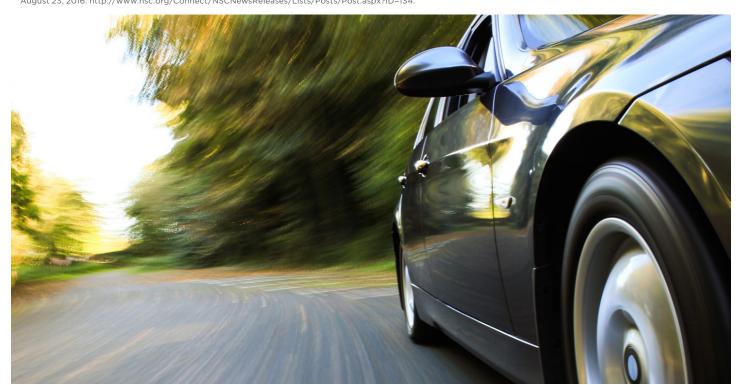
Auto Safety

More than one million people die every year in automotive accidents globally; car accidents are the most common killer of people ages 10-24.[1] In addition, the number of motor vehicle deaths in the first half of 2016 is nine percent higher than the same period in 2015.[2]

To make cars safer, manufacturers and regulators are focusing on smart, connected technologies that can reduce traffic fatalities and injuries, such as advanced driver assistance systems (ADAS), which can help drivers avoid collisions. Providing the desired safety levels requires more networking of all onboard systems and sensors, as well as high data speeds. Connected car systems must be capable of transmitting a full gigabyte of information per second under high-vibration conditions if they are to be considered reliable.

To contribute to safety, connected cars must also share supplementary information from WLAN or mobile telecommunication channels between the onboard electronic devices and the infrastructure (V2I) or other vehicles in the vicinity (V2V), which will boost the decision confidence level of the ADAS.

[1] Association for Safe International Road Travel: http://asirt.org/Initiatives/Informing-Road-Users/Road-Safety-Facts/Road-Crash-Statistics.
[2] "Motor Vehicle Fatalities Up 9%; No Sign of a Decrease in 2016, says National Safety Council," National Safety Council, August 23, 2016: http://www.nsc.org/Connect/NSCNewsReleases/Lists/Posts/Post.aspx?ID=134.

Environmental Concerns

Automakers and government regulators have made great strides in reducing polluting emissions from cars. However, inefficient driving habits and traffic congestion hinder efforts to make cars more environmentally friendly. Traffic delays and congestion increase carbon dioxide (CO_2) emissions and drive up costs, causing more money to be spent combating pollution.

When cars are more connected, including to infrastructure, they use less fuel (and pollute less) because there will be less time waiting in traffic (or even non-traffic). For example, technology can aid route optimization to avoid traffic delays and idling. Also, since it's estimated that 25 percent of city driving involves simply searching for parking spaces, navigation systems equipped with parking availability data can help drivers park and turn off cars faster. A vehicle's weight can be reduced by using lighter or miniaturized components, improving fuel efficiency and reducing CO_2 emissions.

Driver and Passenger Preferences

Consumers who are used to connectivity everywhere they go — at cafes, hotels, home or office — are reluctant to give up this information access when they are on the road and in their cars. Access to information can help people drive more efficiently and avoid hazards — for example, avoiding traffic congestion or choosing safer routes when the weather is bad.

To bring car owners features that improve driver comfort, navigation and guidance, automakers must work with technology vendors to create in-dashboard applications that supply drivers and passengers with cloud-connected information and services. These *telematics* systems provide two-way communications — to the vehicle and from the vehicle.

Solutions Needed for Connected Cars

Building cars that are safer, greener, and consumer-friendly requires a complex combination of hardware, software, and connectivity and sensor solutions:

- Robust and reliable connectivity and sensor technologies
- Core connectivity — essential, seamless power signal and data
- Reliable performance in harsh environments, such as extreme temperature variations, and vibrations in rugged terrain
- Miniaturization — ever smaller, lighter, and modular components
- Effective, safe, and efficient power management
- Faster data transmission, which consumers have come to expect in their connected homes
- Sensing for improved performance and monitoring

Cars:
When EVERY CONNECTION COUNTS

TE products connect almost every electrical function in cars — from alternative power systems to infotainment and sensor technologies. TE is committed to offering connectivity and sensor solutions that allow OEMs to bring innovation to the connected car universe: products that are smaller and lighter, and offer high reliability and performance in increasingly harsh environments. **Visit te.com/connected-car to learn more** about our broad product portfolio that is making connected cars a reality, such as our MATEnet modular and scalable connectors for high-speed Ethernet, MATE-AX miniaturized automotive coax connector system as well as other key products.

TE connectivity

Connected Trucks and Off-Highway Vehicles: Overcoming Rigors of Harsh Environments

The connectivity that's become ubiquitous in passenger vehicles has come to industrial and commercial transportation — technology like GPS and entertainment systems, as well as safety features such as rear-view cameras. There's a difference, however: the harsh environments under which industrial vehicles operate call for far more rugged connected systems. Sensors, connectors and relays must withstand dirt, moisture, salt and vibration endemic to industrial sites and long-haul operation.

At the same time, there is demand for high reliability, as well as systems that can improve efficiency and safety, in order to address these concerns:

• **Environment.** Like passenger cars, commercial vehicles are subject to increasingly stringent emission controls. To meet emissions standards, manufacturers seek ways to improve fuel efficiency, using connected systems that help reduce exhaust toxicity, provide more precise fuel metering, and manage engine performance.

• **Safety.** Rear-view cameras have become commonplace on semi-trucks, construction equipment, tractors, and snow plows to reduce accident risk — thereby increasing demand by manufacturers for infotainment connectors and harsh environment power and signal connectors. In addition, trucks are equipped with smart card readers that can record driving times for a commercial vehicle operator as a way to reduce fatigue-related accidents.

• **Productivity.** Farm vehicles equipped with GPS systems can increase crop yields and reduce waste involved in tasks such as fertilizing crops — for example, measuring a field to determine the most efficient driving path, and accurately assessing the amount of chemicals or pesticides needed.

• **Uptime.** By preventing connectivity failures in commercial vehicles, manufacturers can protect the value of time-sensitive construction or agricultural projects — like pouring foundations, or harvesting crops when weather is optimal.

Manufacturers of industrial and commercial vehicles need to work closely with suppliers of sensor and connector solutions in order to find the precise connectivity products for tasks and project environments. In many cases, these connectivity solutions must be developed from the ground up, tapping into engineering knowledge of materials and technologies that can meet durability requirements.

Trucks and Off-Highway Vehicles:
When EVERY CONNECTION COUNTS

TE's portfolio of rugged sensors, terminals, connectors, relays, and hybrid and electric mobility solutions withstand the rigors of the road and water — helping them operate smarter, safer, greener, and more connected. TE collaborates with engineers to redefine what's possible using intelligent, efficient and high-performing products and solutions proven in harsh environments. Some TE solutions include the new smart card reader, AEF connector, and the SmartSeal connector.

Visit te.com/connected-harsh-environment to learn more.

Connected Factory: Accelerating Productivity, Reducing Inefficiency

As connectivity comes to factories, both consumers and manufacturers stand to gain. Consumers will benefit from innovative products that come to market faster. And manufacturers will benefit from increased efficiency and greater control over production quality, maintenance, and the supply chain.

The Factory 4.0 will operate much differently from its predecessors in order to react quickly to changes in markets. Increasingly, industrial demand is changing from mass production to customized manufacturing – for example, custom-printed footwear that's molded according to the precise cushioning needs of an athlete's foot, from manufacturers such as Adidas.

To accommodate this change, the structure of the factory has to change as well: Instead of a production line, factories will rely on individual production steps, all managed by systems that talk to each other. One machine can alert another with a message such as "I need maintenance in two weeks" — and the machine on the receiving end of the message can initiate a maintenance request, all without human intervention. Or, one machine can send a message about ambient temperature to the climate-control system: "Since it's hot in the factory today, please regulate temperature so that we don't overheat."

It's a much less hierarchical process than what was common in traditional factories of the past, where machines would communicate instructions to the level below them, and so on. In Factory 4.0, thanks to intelligent data-sharing, machines can operate more independently. In effect, these subsystems can make their own decisions and improve factory efficiency.

How the Internet of Things Accelerates the Connected Factory

The trend toward the Internet of Things, or IoT — in which machines and processes are connected by electronics, software, and sensors — is making Factory 4.0 a reality. Because machines are connected to each other, they build intelligence into manufacturing floors and production lines where it didn't exist before. These connected systems create greater value and service by capturing and exchanging data with other connected devices — building more and better products, faster. When systems are connected, valuable data within a manufacturing line can boost uptime and efficiency, or be used to customize goods. IoT therefore has the potential to create what's often called the fourth industrial revolution.

TE connectivity

The Benefits of the Connected Factory

Factories equipped with machines that can communicate with each other will see gains in productivity and efficiency. For example, intelligent systems can collaborate with global suppliers and customers across the supply chain. Here are other benefits on the horizon for connected factories:

Predictive maintenance. With sensor-equipped machines, factory leaders can shrink the time it takes to detect problems or determine when maintenance is needed. Since managers have timely, accurate data at hand, they can decide proactively when to intervene to solve a quality or production issue, and reduce equipment downtime — instead of reacting after the damage is done.

People-centered decision-making. In previous industrial revolutions, mass production reduced the need for workers. However, the connected factory sees workers as a vital link in the decision-making process. Equipped with data, workers can quickly respond to changing market demands and suggest new products or manufacturing approaches.

Transparency. Data-sharing doesn't have to stop at the factory walls. Data on quality inspections, for example, can be more easily shared up and down the supply chain for greater and faster visibility. Operational managers and engineers working at corporate headquarters can view a broader range of data, and suggest systems changes that boost efficiency. Inventory managers can change orders based on what's happening in the production environment.

The Must-Haves for the Connected Factory

The connected factory needs technologies that meet the demand for reliable, flexible communications and connectivity:

- Ruggedized for harsh environments. Devices such as sensors need to perform even when undergoing extreme temperature changes, vibration, and shock.
- Can't-fail reliability. The reliance on end-point connectivity as a way to drive value means that connectivity cannot fail.
- Smaller size and weight. Connected factory systems need lighter weight electronics, such as contactless power and data transmission capabilities, that use space efficiently.

Factories: When EVERY CONNECTION COUNTS

TE is transforming the concept of the smart factory into operational reality by introducing high-performance information and communication technologies – products that connect computers, information systems, sensors, relays, robotics, tools, building facilities, materials and products to each other.

Visit te.com/connected-factory to learn more.

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connectivity

Connected Aircraft: Efficient, Safe, and Enjoyable Air Travel

Airlines and aircraft manufacturers are continually searching for ways to make commercial flight safer and more efficient — and to offer a superior customer experience that attracts loyal flyers. Passengers want Wi-Fi connections and entertainment choices that mirror what they're used to at home. Pilots and ground crews need more information, faster, to manage increasingly complex aircraft systems. Airlines want planes with self-diagnostics that are easier to maintain and fly to maximize their investments.

Toward this end, today's aircraft are more connected than ever before. Aircraft are being enabled to capture and share inflight data about the management, health, and maintenance of critical aircraft systems. In a bid for greater reliability and efficiency, manufacturers are replacing traditional hydraulics and pneumatics with electrical systems — in fact, electronic content in airplanes has grown from about 10 percent of the value of the aircraft in the 1980s to 40 percent today. Connected electronic systems also allow manufacturers to reap the benefits of smaller, lighter-weight components that can improve fuel economy and free up space for more cargo and passengers.

To meet the demand for connected systems and more electronification, manufacturers need sensors, connectors, relays, and fiber-optic systems that are up to the task to work reliably in the airplanes in harsh environments, such as temperature extremes and exposure to high vibrations. Five key areas are found in commercial aircraft showing how today's aviation industry is meeting the new demands, and new challenges, of connectivity.

1) In-flight Entertainment (IFE)
Aircraft and IFE systems manufacturers need connectivity partners that can respond quickly to technology innovations, to create technology solutions that can evolve at the pace required by an increasingly connected flying public. The drive is to increase information speeds and bandwidth adapted to the challenges of Wi-Fi and entertainment services while in flight. Passengers, especially on long-haul flights, have high expectations that the entertainment and online services they access at home will be just as reliable during their trip. In turn, airlines want to meet this demand, since Wi-Fi and entertainment services are a source of revenue.

2) Avionics
As avionics systems exchange more data, greater bandwidth is required to deliver high-speed data transfers. Global airline flight traffic is expected to double over the next 20 years, and fast data transfer will be critical as new aircraft navigation and communication systems will evolve to support navigation in congested commercial airspace. In addition, air traffic control systems will be upgraded, creating more demand for improved connectivity. Data collection and sharing are critical components of these systems — for example, information about an airplane's position.

TE connectivity

3) Flight Controls and Landing Gear

Sensors and sealed harness assemblies attached to landing gear are exposed to water and chemicals, not to mention extreme temperature fluctuations of +50°C while on the ground on the hot tarmac to –60°C while in flight at high altitude just a few minutes after takeoff. Aircraft and systems manufacturers must work together to design interconnected solutions that can perform effectively under these conditions.

Systems that control engine speed and wing position, like other aircraft functions, continue to shift toward electronic systems and away from hydraulics and pneumatics. These systems are controlled by fly-by-wire and embedded computing components that require high reliability, particularly in the harsh environment of flight.

4) Engines and Power Distribution

Power-switching systems can improve efficiency and load balancing, thereby improving how an aircraft uses available power. For example, manufacturers have embedded sensors and added electrical monitoring equipment that can detect when maintenance is needed, ensuring that engine health is managed efficiently. Today's aircraft use five times as much electrical power as they did 30 years ago. So, smart power-switching systems are more critical now that electrical systems are commonplace in aircraft, and particularly as the industry moves to hybrid electrical-fuel systems in the future that can supply power to engines.

5) Grounding Systems

The new generation of composite material airframes made from carbon-fiber-reinforced polymer (CFRP) reduce weight, and therefore improve fuel efficiency and load capacity, but they can't dissipate lightning strikes and electrostatic discharges the same way a metal airframe can. Therefore, these planes need highly sophisticated grounding systems that provide sufficient conductivity, safely. These composite structures use new dedicated grounding paths with a combination of traditional metallic elements to maintain a low-resistance pathway for grounding and lightning strike dissipation purposes.

Aircraft:
When EVERY CONNECTION COUNTS

TE Connectivity's solutions help solve the aviation industry's space, weight, reliability and efficiency challenges. For example, TE is working with the ARINC Incorporated industry standard group on the Mini Modular Rack Principle (MiniMRP) distributed avionics system that creates flexible capabilities in a smaller, lighter package – so manufacturers can deploy them anywhere they need design flexibility. Similarly, TE's grounding system solutions can be tailored to virtually any commercial aircraft.

Visit te.com/connected-aircraft to learn more.

TE: Creating the Connected Life

As a world leader in connectivity and sensor solutions, TE understands the challenges and demands for rapid and reliable connectivity. TE's engineers leverage the power of the company's expertise across many industries, bringing knowledge gained in one market to solve problems in another market. This intra-collaboration — what we call The Power of TE — speeds solutions and drives even greater innovation and value for our customers.

TE's global reach, and daily collaborations with customers in more than 150 countries, provide true evolution and innovation for manufacturers driven by connectivity. **Learn more about TE solutions at te.com.**