Connectors have played a role in automotive development since the beginning of the industry. As technology, in general, has evolved throughout the decades, so too have automotive electronics. In the primitive days of the automotive industry, connectors primarily served as simple power linkages for the battery, alternator, and generator, in addition to carrying electrical signals linking switches to the headlights, windshield wipers, climate controls, and basic instruments like speedometers. Once-simple mechanical controls for door locks, trunk latches, and for adjusting the seats and windows now essentially all rely on electronic connections. While the basic mechanical systems of an automobile have remained constant, the electronics have progressed in response to the consumer’s demands for better performance, efficiency, safety, and functionality as infotainment systems and ADAS (Advanced
Driver Assistance Systems) become standard in new vehicles and as autonomous vehicles become a near-future reality.

"Through the gradual electrification of virtually every system in the automobile, electronics have steadily become a more integral part of the automotive system."

Through the gradual electrification of virtually every system in the automobile, electronics have steadily become a more integral part of the automotive system. Simple connections have progressed into more complex networks. Not long ago, engine control computers, power brakes and steering units, transmission monitoring, and advanced safety systems (i.e. antilock braking systems, traction controls, airbags, engine diagnostics, electronic stability programs, and tire pressure monitoring systems) were new technological concepts that initiated the use of specialized two-way ultra-reliable connectivity. With the increasing involvement of the interconnections between the vehicle systems, the Controller Area Network (CAN) standard was devised to facilitate the increase in communications between the systems by providing assured, non-conflicting, speedy connections to enable a broader range of automotive safety, economy, and convenience features.

CAN Bus Shortcomings Lead to New Applications for Ethernet

For many years, the traditional CAN bus has been an automotive standard and has played a key role in the reliable connectivity of automotive electronics. Eliminating the need for traditional hard-wired connections by shifting to a software-based network, the CAN bus affords valuable space-, weight-, and cost-savings. The CAN bus continues to prove its economical and effective benefits for small networks, but the introduction and standardization of infotainment systems – a combination of hardware and software to provide the driver and passengers with user-friendly audio and visual multimedia entertainment, including: GPS navigation, mobile communication connectivity, keyless entry/car alarm, tracking systems, etc. – has increased the need for a network that can support a larger bandwidth.
Originally a popular high-speed interface in homes and offices, Ethernet has proven itself among automotive manufacturers to be a reputable alternative to CAN bus in its ability to support the rapid growth in the data transfer demands of new infotainment systems and sensor communications. While Automotive Ethernet comprises a similar packetized, bidirectional system as CAN bus, this new communications protocol is better equipped to support the increasing connection complexities faced by future automotive systems by supporting higher data transportation speeds – up to 100x faster than the CAN bus.

Computer Technology Expands Automotive Electronics Capabilities

In addition to requiring a network to support higher bandwidths, infotainment systems have also commanded new developments in connector specification and applications. Akin to Automotive Ethernet, connectors originally intended for computers and data networking applications (i.e. USB 2.0, HDMI ports, and SD card connectors) are being incorporated into infotainment interfaces, in addition to memory- and data storage-type connectors to support new Wi-Fi® capabilities in the latest generation of automotive systems.

These recent innovations were never previously envisioned for onboard communications. In the near future, the extensive integration of shielded flex circuit connectors to improve EMI and EMC characteristics is highly probable, as well as the introduction of the latest generation of computer connector. This USB 3.1 Type C devices offer a higher current rating (5 A), increased speed (<10 Gbps), and user-friendly reversible plugs.

Increased Safety Controls Target Connector Performance and Reliability

The standardization of infotainment systems is paralleled by innovative ADAS technology, which is rapidly becoming mandated by safety regulations in many cases. ADAS technology alerts drivers to potential problems on the road and implements safeguards – such as taking over control of the vehicle – to avoid collisions. Other safety features include blind spot detection, automatic braking, GPS and traffic alerts, and rearview cameras. High reliability, rugged connectors have been used effectively thus far to ensure a dependable connection in harsh automotive environments. The advancement in safety-focused human machine interface of ADAS technology has not only set new expectations for connector performance and reliability but has also facilitated in the advancement of tomorrow’s autonomous vehicles.
Connectors Play a Critical Role in Advancing Autonomous Vehicles

The autonomous vehicle, or “self-driving car,” has proven to be one of the biggest innovations in the history of the automotive industry. Autonomous vehicles have the ability to sense the world around them, navigate without driver input, and increase driver safety further than ADAS. Connectors will prove to be crucial to the overall performance of the vehicle, as every system and sensor become an integrated web of connectivity. In order to provide optimal performance and handle larger bandwidth loads at the higher speeds needed for these new advanced safety systems, connector technology will need to meet several critical requirements. Standard bandwidth in vehicles has increased from 1 MB to 1 GB. However, in order to handle the new extended bandwidth requirements of autonomous vehicles, connectors will need to be able to handle signals at 6 GB and even 12 GB. Rapid data transfer speeds are needed to enable two-way transfer of the complex signals the vehicle receives from its sensors to both monitors as well as direct the vehicle’s reaction.

Sensor functions have begun influencing connector design. Still in its preliminary phase, one new connector design involves integrating the sensors into the actual connector body. This combination reduces component count, reduces weight and volume, and helps to eliminate inductance and time delays that could potentially interfere with the operation of safety systems.

“However, in order to handle the new extended bandwidth requirements of autonomous vehicles, connectors will need to be able to handle signals at 6 GB and even 12 GB.”

Automotive connectors have always needed protection against shock and vibration, but this is especially imperative in safety-critical systems. Employing a locking mechanism prevents most automotive connectors from accidental disconnect or damage caused by vibrations. Autonomous vehicles require a new level of reliability, as catastrophic problems could arise from a damaged connector.

As automotive technology continues to evolve, connectors find new purpose and new applications. Automotive electronics have borrowed from existing computer networking technology to increase bandwidth for infotainment and sensor systems with the introduction of Automotive Ethernet and new computer connectors. All of the recent upgrades to automotive connectivity and increased safety measures have enabled the progression of the development of autonomous vehicles.
Thomas Scannell

Tom Scannell is currently an Automotive Business Development Lead in the Americas for the Amphenol Information, Communication and Commercial (AICC) group. With over 20 years in the industry, Mr. Scannell began his career at Amphenol FCI and advanced his way through the organization and held various management roles such as Global Account Manager, Global EMS Sales, Americas Distribution Sales Director and Director of Industrial Business Development. Prior to his time at Amphenol FCI Scannell held management roles at Wang Laboratories (Boston, MA) and Thomas & Betts (Bridgewater, NJ).