molex®

A LEVEL APPROACH TO AUTOMOTIVE CONNECTIVITY

BY Mike Gardner | MOLEX INCORPORATED

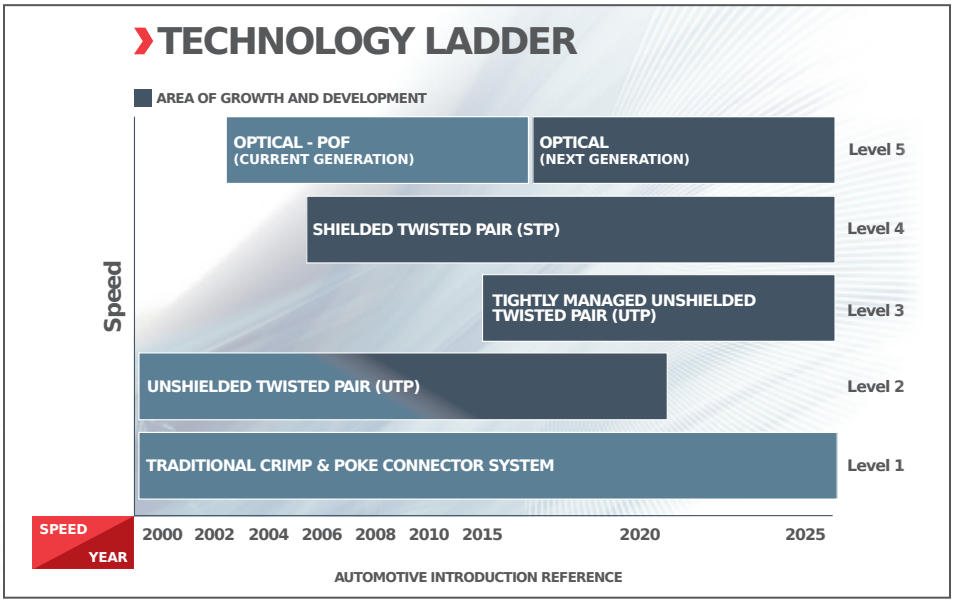
Bandwidth and cost are giving rise to the complexity and definition of automotive connector requirements. The increasing need for bandwidth, driven by the growing functionality and popularity of electronic systems within the vehicle, is pushing connector and cable development to new levels. It is no longer an automotive traditional approach of terminal, wire, crimp, poke, seals, and wire harnessing assembly boards yielding endless miles of winding and curving bundles of copper that will deliver luxury to your driveway. Instead, consumer demand and the insatiable desire to bring our 24/7 connected lives into our vehicles have automakers scrambling to distinguish their products—and the connector and cabling industry looking at product offerings in new ways.

As an industry leader in automotive connectivity, Molex is taking the perspective of multi-levels of cost and complexity. Each level brings different challenges and disruptions to the more traditional automotive connector systems of generations past.

Level 1 is widely recognized as the foundation of decades of automotive connector development and advancements. The traditional "Crimp and Poke" approach, as it is commonly known, offers a range of terminals meeting OEM preferences and application demands. Terminal post sizes are noted as 2.8mm, 1.5mm, 1.2mm, 0.64mm, and the newest addition of 0.50mm. Connector bodies with circuit size variations and a mixture of terminal types bring together family trade names that often become a part of the daily automotive cable and connector lexicon. Sealed and unsealed solutions support signal or power, while plastic features provide keying, terminal position assurance (TPA) and connector position assurance (CPA) with secondary latching innovations. These features combine to meet the specifications of the 'best of the best' connector engineers.

Existing bandwidth demands brought forward technologies such as CAN, FlexRay or MOST Bus, which have introduced complexities for existing connector and wiring harness investment and infrastructure handling due to twisted pair wires. These technologies have advanced their presence and challenged the wire harness manufacturing processes over the past decade to deliver ever improving twist methods. Industry first introduced processes as simple as twisting post terminated wires, with nothing more than what looks like an industrialized version of a home power drill, to now highly automated pieces of equipment delivering very precise twisting and placement of splice connections along the cable run—a true marvel of accomplishment that demonstrates what any engineer with enough motivation and desire can deliver. However, the twisted wire approach has only taken the technology up one level of performance into level 2, which essentially advanced wire manufacturing processes and demand for twisted pair wire technologies in the same cable and connector systems in level 1.

At this point it is best to skip to level 4, in order to clarify some of the challenges of level 3. Level 4 introduced shielding of cables. Most notable in this category, coax cable has increasing demands from when it was first introduced for AM/FM antenna applications. In more recent times, the challenge of shielded differential twisted pair (STP) was thrust on the scene with the introduction of USB. The gateway of electronic devices interacting with vehicles, USB was no longer just needed to recharge devices, but to actually enable the data paths needed to deliver stored digital music, audio books and other

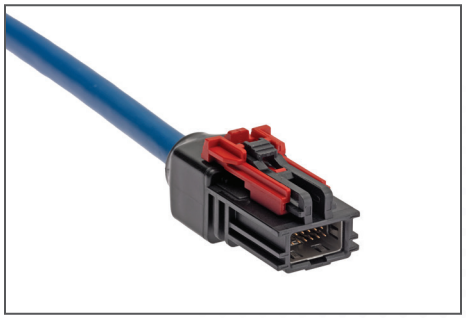


***Technology Ladder**: Each level provides a clear separation into five distinct automotive connector trends*

Originally published in DesignNews October 2014

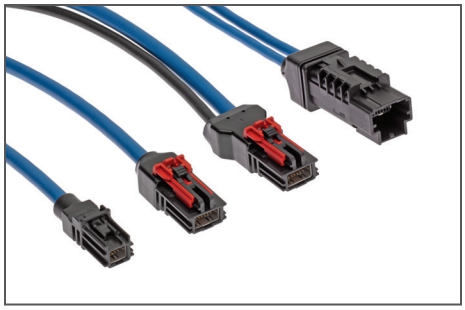
forms of entertainment to drivers and their passengers during daily commutes and cross country travel. The introduction of USB represented the fastest data bus vehicles had yet encountered. Delivering 480Mb/s of data, USB demanded shielding traditional level 1 connectors could no longer provide—although many tried and fell short despite noble efforts.

Nearly simultaneously (in automotive terms), SerDes (Serializer / Deserializer) technology, so often deployed by the PC and consumer world, came thrusting onto the automotive scene. The consolidation of the rainbow (Red, Green, Blue-RGB) arrived just in the nick of time to drive rear seat entertainment displays and enhanced center console displays for built-in GPS mapping capabilities. Added demand surged for shielded twisted pair connection systems to enable higher resolutions center stack displays, backup cameras, digital instrument clusters, heads-up displays (information projected onto the driver side windshield) and to expand customer convenience port (CCP) access through digital media hubs.



The sturdy shielded and newest offering from Molex, HSAutoLink™ II components economically and reliability meets stringent automotive mechanical requirements as offered in 6- and 12-pin option, with additional options for sealed and unsealed applications. Multiple cable configuration and keyed headers allow various packaging options and easy integration.

Growing demand for higher bandwidth in-vehicle consumer devices is driving up the need for more capability or greater screen resolution. Increased lanes of shielded twisted pairs push up the circuit count of the latest automotive connectors on the market and introduce application space for better solutions featuring greater shielding and additional pin count, such as the HSAutoLink™ II.



But at some point copper and shielding costs, as well as the complexities of managing shielding opens the door to level 5 optical fiber cabling systems. Some automakers and technology approaches favored the introduction of Plastic Optical Fiber (POF), which boosts costs and complexity. However, POF effectively bridged the traditional foundation of copper products known throughout the automotive industry. Only a few brave souls are yet willing to go the distance to make that leap to a new transport medium. The upshot is that future technologies can build off POF when market dynamics reach that tipping point. In terms of performance and cost, optical advancements are offering new paths of development options that will likely surpasses the current limitations of POF and may lead into other forms of optical fiber construction and optical transceiver (the electrical-to-optical converters) performance exceeding the current 150 Mb/s application it is currently serving. Potential for 1, 3 and 5 Gb/s is within reach and represents real promise.

Market dynamics and application demands never rest. Automakers demand more for their customers and product offerings at lower costs. This driving demand opens up opportunity for a new level. An undefined level 3—highly managed twisted pair suggests that prior methods are no longer sufficient to meet the needs of higher performing link segments. Post twisted wires introduce unbalanced and inconsistent twists that can no longer be tolerated by systems noted in level 2. The inherent improvements of pre-twisted wires with cable shielding introduced by systems in level 4, drive costs and complexity higher for automotive connection systems.

Challenges now surface to find balance between these two extremes. A simple illustration can be offered in the form of an air filled balloon. Pressing on the balloon at one end pushes the air to the other side, but only volume displacement has taken place. The issue is the same for the connector and cabling system. The physics of the link can be pushed around but the problem remains constant with cost being the variable directly impacted. When looking at it from an “End-to-End” solution including silicon, cable, connector - if a blended balance is achieved in all areas of the problem, it is possible to maintain performance that can eliminate the costly shielding. The industry is currently engaged in such an effort through one public forum, IEEE, the world’s largest professional association driving Ethernet Standards and dedicated to the advancement of the technology.

As efforts of industry developers’ work pushing for balance of these physical and electrical requirements to deliver an Ethernet based solution, automotive cable and connector solutions will begin to surface and evolve as boundary conditions are refined. New cable constructions, connectors, terminations, and automation solutions will begin to appear from Molex and industry in this level 3 category.

While we often think of technology advancements pushing at the outer limits, the requirements in this case will be the introduction of an entirely new space that sits in the middle of the extremes and looking for that perfect balance of performance and cost, while delivering bandwidth to fuel the needs of automotive manufacturers and the insatiable consumer demand for improved functionality and a feature-rich driving experience in our connected world.

Order No. 987651-1953 Printed in USA/GF/2014.12