Choosing the Right High-Speed SerDes Technology for ADAS and Infotainment Systems

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Abstract

As infotainment and advanced driver assistance systems (ADAS) become increasingly sophisticated, accurate and real-time data processing has become more critical for vehicles. The only technology that can manage the explosion of video, audio, and communications data fueling these applications are high-speed serial links. High bandwidth, performance, and reliability of these serial links will continue to be key requirements as the automotive industry advances toward fully autonomous cars. In this paper, we will examine how high-speed serial links enable next-generation vehicles.

Introduction

The Road to Self-Driving Cars is Paved with High-Speed Serial Links

Bandwidth requirements in cars to increase by a factor of 25 by 2020

In the not-too-distant future, our cars may become our workstations as we commute to our offices. Or an entertainment center during a long road trip, with some passengers playing video games, others posting to their social media accounts, and still others watching movies on an ultra-high-definition (UHD) display. Traveling from point A to point B will also become safer and more efficient. This is the promise of autonomous vehicles. And as car buyers become more interested in ADAS applications, OEMs and suppliers are recognizing that these applications could help differentiate their vehicles and their brands.

While we're not quite there yet with self-driving cars, we are on the road to more advanced ADAS and infotainment systems that are transforming the driving experience. Cars have evolved from having single-function, low-resolution displays to boasting rear-facing cameras and high-resolution displays. On the horizon are vehicles that will commonly have more than a dozen cameras, several high-definition displays, and multiple serial links to transport all of this data. Strategy Analytics anticipates that bandwidth requirements will increase by a factor of roughly 25 from this year to 2020. Moreover, a move to higher frame rates and resolutions will further increase automotive bandwidth requirements. The steep increase in bandwidth requirements is essential to support an explosion of

data that video conferencing, streamed videos, social media and email access, and other online activities portend to bring to vehicles.

Not all serial link technology, however, is equipped to meet emerging challenges around high bandwidth, interconnect complexity, and data integrity. Given the harsh operating environment of a vehicle, particularly where electronic components are concerned, serial link technology must deliver the speed, reliability, and low latency to push voluminous amounts of data through to trigger real-time responses. Let's take a closer look at the different automotive applications that rely on high-speed serial links, along with their unique bandwidth requirements. In this paper, we will also compare the capabilities of the underlying serial link technology required to transport all of this data.

Figure 1. Autonomous driving capabilities will require faster data rates and more bandwidth.

ADAS: Delivering a Safer Ride

According to Autoblog, "In just one model year, advanced driver assists have gone from being offered in a minority of new vehicles to being sold in the majority. Some experts believe ADAS technologies are becoming the next competitive area, a place for an automaker to differentiate its vehicles from another's."[1] Safety functions that are already available or under further refinement run the gamut, from pedestrian and traffic sign detection to lane departure warning, driver drowsiness detection, and collision avoidance. Some of these applications are being driven by regulatory pushes toward increased safety. For example, the U.S. and the European Union are both mandating that all vehicles have autonomous emergency braking systems and forward-collision warning systems by 2020.

ADAS applications rely on the input of a variety of sensors, including radar, lidar, and cameras. Data from these sensors must be collected and processed in real time by sophisticated software algorithms running in a microcontroller unit (MCU) or electronic control unit (ECU). The resulting output triggers the vehicle to take some corresponding action or alert the driver to do so. Vehicular camera systems, in particular, have very high data rates. For example, in a surround-view system, each camera typically boasts a video stream with 1280 x 800 pixel resolution and a frame refresh rate of 30 f/s.[2] What's more, every IC on a camera module must be able to withstand stringent temperature ranges and different environmental conditions, providing the durability to perform reliability for the life of the vehicle. Limited

Figure 2. Rear-view cameras will among the roughly one dozen cameras that future cars will have to enable applications such as ADAS and infotainment.

space is another important consideration – while the number of in-vehicle camera systems is on the rise, vehicles themselves aren't increasing in size to accommodate the additional components. So, there's a push to make these systems more compact and also lower cost.

Infotainment: Enriching the In-Vehicle Experience

While ADAS is focused on safety and convenience, infotainment systems enrich the driver and passenger experiences with multimedia content, navigation, communications, and the convenience of touchscreens and even voice control. Infotainment systems are complex and distributed, accessing functionality from different in-vehicle control units and processing the information from these varied sources in parallel. A variety of established bus systems can now be found inside cars, transferring data between components. For example, the MOST protocol links the components that make up the infotainment system with different audio amplifiers, tuners, and CD/DVD changers. CAN buses perform

Surround-view cameras boast frame refresh rates of 30f/s

Emerging V2V and V2X systems rely on high bandwidth and data integrity

the communications needed for comfort and convenience functions. Encrypted as well as unencrypted transmission of uncompressed video data call for additional point-to-point connections in cars; this usually involves serializers and deserializers. Previously common, simple high-speed video transmission has evolved into technology that supports video and audio signals along with control channels.[3]

Vehicle-to-Vehicle and Vehicle-to-Everything Communications: Increasing Safety and Efficiency

As the internet of things (IoT) brings intelligence and connectivity to a host of products, vehicles are not exempt from this movement. Wireless vehicle-to-vehicle (V2V) and vehicle-to-everything (V2X) communications enables cars to talk to each other and to static objects on the road, such as traffic signals. Equipped with this communications capability, vehicles can broadcast to one another their position, speed, brake status, and other useful data. Such technologies not only offer the promise of increased safety, but also efficiency benefits in areas like fleet management, fuel usage, traffic flows, and even parking. During a week in the spring of 2016, about a dozen mostly autonomous trucks, connected via Wi-Fi, drove themselves across Europe as part of the European Truck Platooning Challenge. Truck platooning—where the vehicles follow one another at less than one second apart—is promoted as a way to improve traffic safety and traffic flow, lower fuel consumption, and reduce CO_2 emissions

by participating vehicles. Researchers at TNO (the Netherlands Organization for applied scientific research) estimate that platooning will yield average fuel consumption reductions of 10% and overcome human-induced accidents (more than 90% of all traffic accidents stem from human error)[4]. V2V and V2X systems play major roles in the underlying technology for platooning. Like ADAS and infotainment systems, V2V and V2X systems will also require high levels of bandwidth and data integrity.

High-Speed Serial Links for Tomorrow's Car

High-speed serializer/deserializer (SerDes) line drivers and receivers transport the data streams that make in-vehicle video, audio, and communications possible. Given the volumes of multi-type data involved, high bandwidth, performance, and reliability of these high-speed links is critical. In today's cars, it's fairly common to find an Ethernet backbone, so many OEMs opt to tap into this existing backbone when they need to add, say, new cameras to their next design. A bidirectional and packetized system, Ethernet can transport data over a link 100x faster than a CAN bus. This data rate makes Ethernet useful for mid-level bandwidth communications in applications like navigation systems and control. Ethernet has also been applied to support backup cameras and entertainment systems; however, the video feed must be compressed at the source and then decompressed at the destination. Lower bandwidth communications is where the CAN bus comes into play, as it operates at speeds under 1Mbps. Applications that

can utilize the CAN bus also include those with a limited amount of data, such as communications about the transmission, windows, power steering, braking, and other mechanical systems.

However, automakers are increasingly seeking high-speed links that can transport megapixel resolution images inside a vehicle. Since they're also integrating more electronics into vehicle head units, they also want to be able to free up space and decrease the power budget currently used by head units. Many of the serial link technologies available simply don't meet these demands.

GMSL: Faster Data Rates at Lower Costs

Maxim, which has shipped more than one billion automotive ICs, offers high-speed links that are ideal to support multiple data types with the high bandwidth needed to enable a variety of in-vehicle communications applications. Its Gigabit Multimedia Serial Link (GMSL) SerDes technology simultaneously transports HD video, audio, control information, aggregated sensor data, and Gigabit Ethernet over 15m of a single coaxial cable or 10m to 15m of shielded-twisted pair cabling, all while meeting stringent automotive electromagnetic compatibility (EMC) specifications. The use of coaxial and shielded-twisted pair cables mitigates what would otherwise be a complex interconnect backbone, supporting video multi-streaming at lower system cost. Compared to Ethernet technology, GMSL technology can transport multi-megapixel images without compression. As such, GMSL can support the machine vision technology that is becoming essential for safety features such as object and pedestrian detection. (Compression results in artifacts and lost information, making it impossible to support machine vision.)

Ethernet isn't fast enough for tomorrow's cars

Comparing Data Rates

Technology	Current GMSL	Next-Generation GMSL
Camera Resolution	2MP, 30fps	8MP, 30fps
Display Resolution	HD	4K

Table 1: This table shows how camera and display resolution have continued to improve from current to next-generation GMSL technology.

GMSL SerDes technology paves the way for 4K video, sensor data aggregation, Gigabit Ethernet, and audio

Each GMSL SerDes IC features a built-in spread-spectrum capability, which reduces electromagnetic interference (EMI) of the link. The power-over-coaxial architecture of the ICs eliminates the need for additional power or ground wires, addressing vehicle weight challenges. With an integrated bidirectional control channel, a single microcontroller can program the serializer, deserializer, and all of the connected peripherals. For typical applications, this architecture eliminates a remote-side microcontroller and its support components, simplifying the design and reducing cost, size, and power consumption. Also lowering system costs as well as reducing design time is the ability to daisy-chain multiple camera modules over GMSL. Data integrity is enhanced from the technology's built-in diagnostic capabilities. As shown in Figure 3, GMSL technology allows video aggregation and splitting.

An example of how GMSL technology can simplify an automotive design while saving space and power is Maxim's new radio tuner solution chipset, which includes a 14-bit GMSL serializer and a 14-bit GMSL deserializer. The resulting architecture simplifies the design of the head unit while also yielding better radio signal quality and lower cost, weight, and power consumption compared to other available approaches. Today's high-end vehicles need to support up to six radio receivers, creating design, layout, and heat dissipation challenges in the limited head-unit space. By serializing the output of the tuners with GMSL links, this architecture reduces the amount of cables needed.
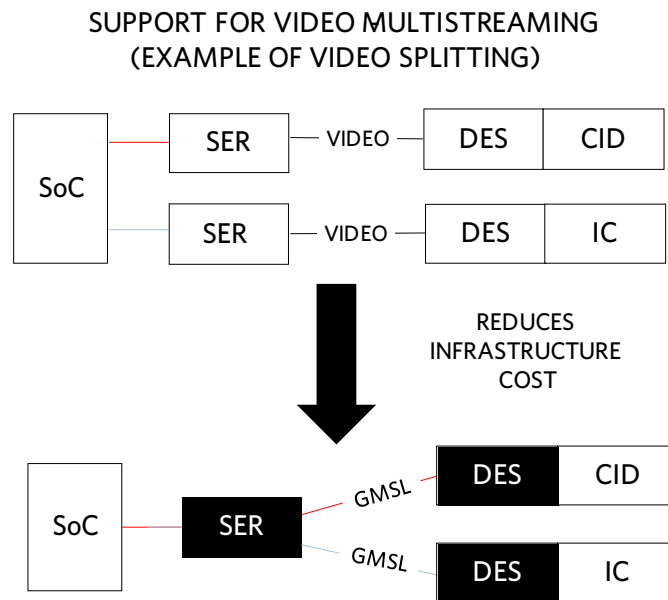
SUPPORT FOR VIDEO MULTISTREAMING
(EXAMPLE OF VIDEO SPLITTING)

Figure 3. GMSL SerDes technology allows video aggregation and splitting.

Summary

From traditional automakers to technology companies like Google and Apple, the race is on to develop self-driving vehicles. Before fully autonomous cars hit the road, however, there's plenty of development underway for cars with autonomous capabilities. These capabilities are driven by enormous volumes of data that are, in turn, putting pressure on the high-speed serial links that serve as the freeways for all of this data traffic. Next-generation cars require high-bandwidth and reliability along with low latency to fuel data-hungry ADAS, infotainment, V2V, and V2X applications.

As GMSL technology continues to evolve, it is poised to be the high-speed data path for a variety of next-generation automotive communications applications. Major automakers are already designing the technology into their next-generation cars. Meantime, Maxim's engineers are continuing to push the bandwidth envelope in the forward direction and on the back channel to enable support of higher camera and display resolutions, as well as more data streams from multiple sources with less latency.

For More Information

Learn more about Maxim's GMSL technology:

https://www.maximintegrated.com/en/products/interface/high-speed-signaling/gmsl.html

Sources

[1] http://www.autoblog.com/driver-assist-technology/

[2] https://www.maximintegrated.com/en/design/blog/camera-interfaces-critical-adas-sys-design.html

[3] https://www.maximintegrated.com/en/app-notes/index.mvp/id/5810