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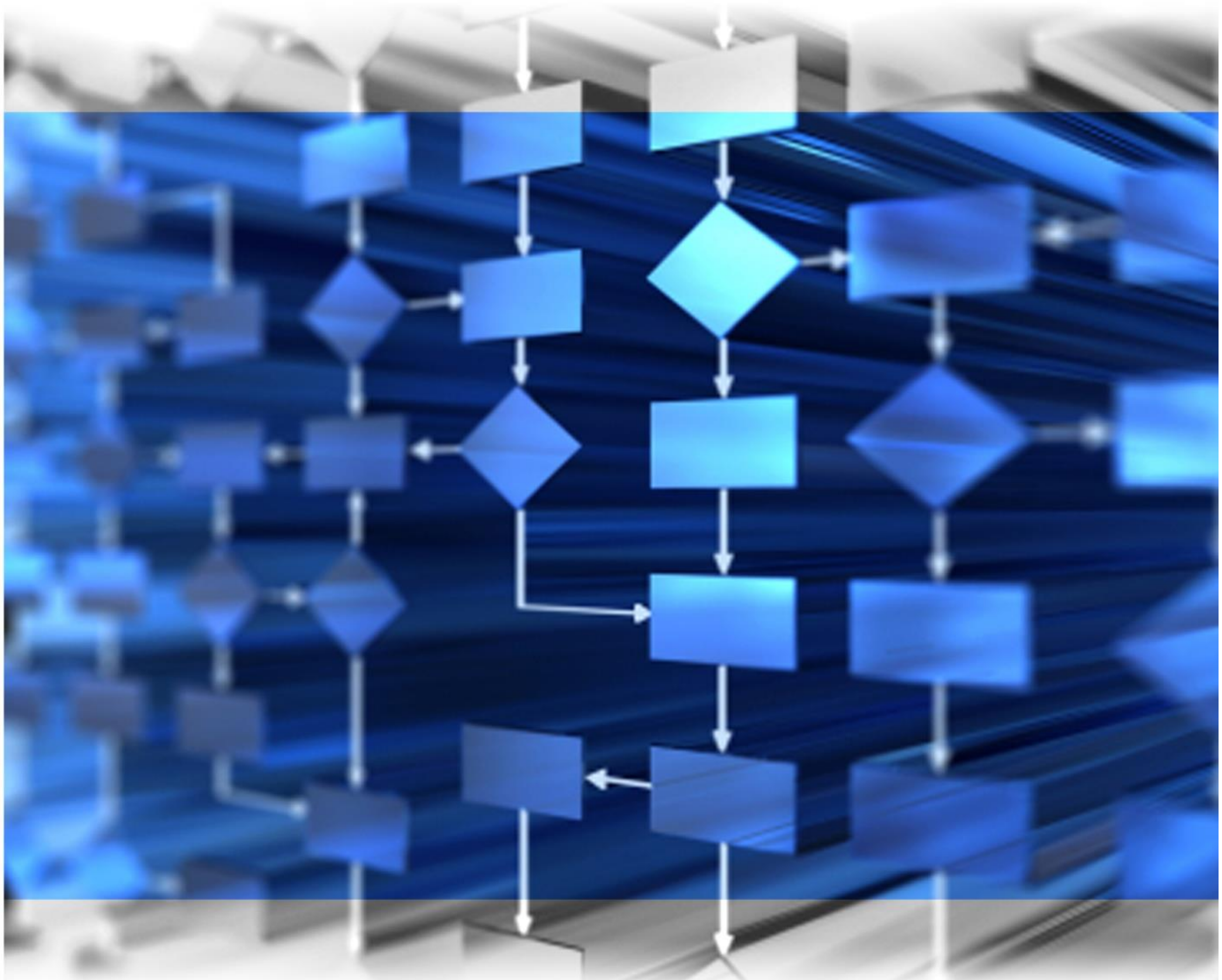

CAN Bus For Weapon Internal Communications

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FORWARD

Lone Star provides systems engineering and systems support for clients using and developing complex systems. The drive for open architectures in many markets requires a digital backbone that supports open systems.

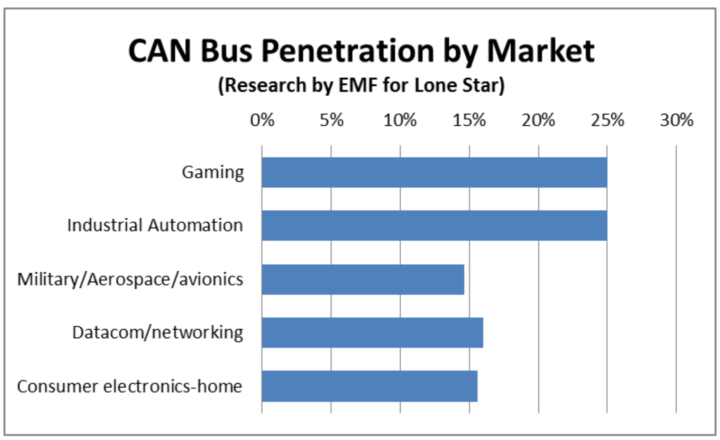
This paper is an example of Lone Star's systems architecture work. Lone Star is frequently asked to provide independent assessments, support, or design reviews. One approach is to look at the systems and components used in other markets. That approach was used in this study.

Open Architecture for Precision Guided Weapons

One of the least "open" class of systems in production are guided weapons. This paper addresses that challenge: *Lone Star's research suggests most weapon internal communications could use the CAN Data Bus based on an open COTS standard.*

What is CAN?

The "Controller Area Network" bus (CAN bus) is a rugged serial bus, introduced in 1986 for in-vehicle networks in cars. Billions of devices have been used in automotive applications. But CAN use is widespread in other markets. As shown in the Figure1, it is used in myriad applications including high reliability medical applications, aircraft and aerospace as well as in cars, trucks and buses.



[1] Embedded Market Forecasters, EMF is a preeminent technology research firm. Lone Star has a long standing teaming relationship with EMF for systems architecture and technology research, using EMF's data base. Lone Star's approach to systems architecture and analysis is data driven. As such, the EMF data has been critical for Lone Star clients who need to look across markets for benchmarking.

CAN is cheap enough to be used in consumer game applications, and robust enough to be used in more demanding applications.

It replaces wiring harnesses with a two-wire differential pair, using broadcast methods.

Because it broadcasts information, CAN lowers the cost of changing configurations. Network devices do not have to specify an address, so information used by many subsystems can be sent only once.

In automobiles, this means turning on the headlight switch may also trigger other events, which may be options and not installed in all models. For example, secondary lights are programmed to respond to the headlight message on the CAN bus. The headlight switch may not need to “know” all the subsystems which respond to the “on” message.

This puts software integration emphasis on the new device, not on the host vehicle in most cases, greatly reducing the cost of platform software, and the cost of integration.

CAN also provides fault-tolerant transmission over one wire if a short occurs. The architecture is inherently fault tolerant in other ways, as well.

It is common to design a vehicle with multiple CAN busses, which may operate at different rates. CAN is a fully open architecture, and since 1995, CANopen has provided a high-level application layer protocol.

An Open Standard

Development of the Controller Area Network began at Robert Bosch GmbH, a major electronics vendor to the European automotive industry. The protocol was officially released in 1986 at the Society of Automotive Engineers (SAE) congress. The first CAN controller chips, produced by Intel and Philips, came on the market in 1987. CAN has been multiple sourced and open from its inception. Today, more than 50 semiconductor firms produce CAN devices.

The CAN performance and features have grown, in the context of open, competitive standards.   CAN 2.0 was specified in 1991.   The history of improvements have continued, with ongoing refinements and improvements to extend ISO 11898 and other CAN-related standards.

OpenCAN, General Motors, ARNIC, and other groups have specified versions of CAN. A defense related standard is MilCAN. This deterministic protocol version of CAN defined by an interest group of companies and government bodies targeted at, manufacture and test of military vehicles. MilCAN may not be the best version of CAN for all military applications, and should not be confused as being “the MIL-SPEC CAN”.

CAN specifications cover all of the layers of the OSI model.[2] This means CAN supports “open standards” at all levels of systems design and architecture.

Lower Costs Four Ways

CAN was also devised to lower the total cost of interconnection. The wiring (and weight) in automotive applications has been greatly reduced by CAN. Today’s feature rich automobiles might not be feasible without an interconnection architecture like CAN. Today, it lowers cost four ways.

Recurring Costs

The volume of devices produced for the CAN market is staggering. Market researchers estimate the current market at roughly 800 million CAN controllers sold per year. CAN is one of the world’s most used real-time communication technologies, comparable to telecom and other high volume consumer protocols. Semiconductor volumes of this scale drive component prices down.

Prices seem poised to remain low. Because the applications of electronics in vehicles are growing, and because the application of CAN in non-automobile markets is growing, the CAN market is expanding at impressive rates: In 2015, some market researchers expect annual sales figures of 2 billion CAN chips. About 400 Million nodes will be used in a wide range of non-automotive applications such as medical equipment, heavy vehicles, trains, door control systems and industrial automation.

Development Costs

Development costs can be lower with CAN because of the wide variety of reference designs, open source software, and off the shelf standard elements. Because all types of CAN devices are produced in very high volumes, and most are offered by multiple sources, both developers’ kits, and reference designs are remarkably inexpensive.

Integration Costs

CAN’s unique attributes were chosen to greatly lower the cost of vehicle integration. CAN’s strategy is inherently plug and play, and puts integration burden on the new devices, not on the host vehicle in most cases. For the original applications (the automotive market) this was a critical element of quickly offering new options and features in a rapidly changing consumer driven market.

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[2] The Open Systems Interconnection (OSI) model (ISO/IEC 7498-1) characterizes and standardizes the internal functions of a communication system by partitioning it into abstraction layers. The model is a product of the Open Systems Interconnection project at the International Organization for Standardization (ISO). The ‘layers” defined by the OSI model deal with all of the ways networked elements interact, thus creating a disciplined framework for managing open systems, and for preventing closed, proprietary solutions from creating barriers.

As CAN has matured, a wide array of interface adapters have emerged. This means that during integration, the CAN bus can be monitored by nearly any type of digital device, connected by all of the most common interface formats.

Testing Costs

An incredible number of CAN testing devices exist for hundreds of purposes, testing everything from the physical layer to all other OSI layers of CAN functionally.

These testing systems range from very simple test and monitoring devices, to very sophisticated monitoring and test generation systems.

These testers lower testing costs by their ease of use, and by the low cost of the testers.

Recommendations

Lone Star recommends most architectures and designers should conduct trade studies for other internal communication methods, but we recommend all point of departure baselines use CAN, as an element of low flyaway and total ownership costs.

In other words, guided weapon architectures should begin design trades assuming internal communication will be conducted via CAN. In some cases, CAN will not be the best choice, but it should be seen as the best default place to start a precision guided weapons trade study.

About Lone Star: Lone Star provides business and technical analysis and advisory services addressing our clients’ most complex, mission critical challenges. Lone Star has a reputation for insightful analysis, advice and support.

Our work leads to improved performance, monetary savings and risk reduction. Lone Star’s roots lie in the development, fielding and support of complex technologies and programs for defense and commercial enterprises including telecommunications, energy, and technology markets.

