



S.7 Trailers, Bodies & Material Handling Study Group Position Paper: 2023-1

Design Recommendations for Next Generation Trailer Electrical Architecture

Developed by the Technology & Maintenance Council's (TMC)
S.7 Study Group Next Generation Trailer Electrical Architecture Task Force

ABSTRACT

This Position Paper was developed by the S.7 Trailers, Bodies & Material Handling Study Group of ATA's Technology & Maintenance Council (TMC). TMC recommends that the smart trailer expectations outlined in this document be considered by trailer manufacturers to guide development of current and future technologies and by fleets to assess the robustness and applicability of suppliers' offerings. In providing this information, TMC seeks to help ensure that tomorrow's products are backward compatible and forward looking to enable better safe and efficient commercial vehicle transportation.

INTRODUCTION

This Position Paper was developed by the S.7 Trailers, Bodies & Material Handling Study Group of ATA's Technology & Maintenance Council (TMC). TMC recommends that the smart trailer expectations outlined in this document be considered by trailer manufacturers to guide development of current and future technologies and by fleets to assess the robustness and applicability of suppliers' offerings. In providing this information, TMC seeks to help ensure that tomorrow's products are backward compatible and forward looking to enable better safe and efficient commercial vehicle transportation.

S.7's Next Generation Trailer Electrical Architecture Task Force, through which this work was developed, used the following baseline principles in its research:

- The current electrical architecture for trailers is inadequate for the future.
- Trailer tracking is now well accepted in the industry and expanding to include multiple sensors for wheel ends, temperature, door lock, load, and more.
- Electric-powered refrigeration may require off-board charging of trailers.
- Safer vehicles being pursued by tractor original equipment manufacturers

Technology & Maintenance Council (TMC)
80 M St., SE, Suite 800 • Washington, DC 20003 • Ph: (703) 838-1763
tmc@trucking.org • <http://tmconnect.trucking.org/tmc>



(OEMs) ranging from SAE International Level 2 to fully autonomous Level 5 operation require additional information and control of trailer-mounted items.

- Several companies have proposed new architectures for trailers.
- TMC previously addressed a similar issue in the mid-1980s with the establishment of tractor data networks.
- Fleet input is critical to provide a future-proof, reliable, and easily maintained electrical and information network on trailers.
- Collaboration is anticipated with other TMC Study Groups and outside organizations. For example, a related task force in TMC's S.1 Electrical Study Group will work on the requirements for the tractor-trailer interface.

Given this, the Task Force set for itself the following objectives:

- Obtain input from tractor OEMs on future needs for trailer information and control for safer vehicles.
- Obtain input from fleet/equipment users on their expectations for future electrical wiring.
- Review proposals from manufacturers on electrical and information networks.
- Develop initial expectations for an anticipated TMC recommend engineering practice to guide future OEM designs.

BACKGROUND

In March 2019, a presentation on future trailers was made at the Truckload Carriers Association (TCA) Annual Meeting. In September 2019, two related task forces were approved by TMC's S.1 Electrical and S.7 Trailers, Bodies & Material Handling Study Groups respectively to address the future electrical and information needs of the trailer and the impact that would have on the tractor-trailer interface. Throughout 2020, TMC gave suppliers of advanced trailer technology an opportunity to outline their thoughts on the future tractor-trailer interface.

The **References** section at the end of this paper includes links to many of those presentations.

In the fall of 2020, a proposed set of expectations were published for discussion. Throughout 2021 and into 2022, additional industry presentations were made at various SAE and TMC meetings.

In coordination, TMC's S.1 Next Generation Tractor-Trailer Interface Task Force has been developing its own position paper on the tractor-trailer interface and studying various design concept proposals.

SMART TRAILER EXPECTATIONS

Just as the number of electronics and sensors increased significantly on truck-tractors from the mid-1980s until today, trailers will gain more electronic controls and sensors during the next several decades. Approximately 250,000 trailers are produced annually in North America to supply a base of six million trailers with a service life range of 12-25 years. Common guidelines for the tractor helped the trucking industry achieve significant improvements in fuel economy, cost, air quality, and serviceability. Common guidelines for next generation smart trailers are needed to achieve similar results. Recognizing the need for recommended practices to continue improving the safety, efficiency, and reliability of freight transport, TMC proposes industry consideration of the following 13 guidelines and principles for new trailer designs:

1. Right to Repair Is a Must for Users—

The 2015 Memorandum of Understanding for National Commercial Vehicle Service Information should be reviewed and revised to include smart trailers. (https://www.etoools.org/Resources/Documents/RTR_National_Commercial_Vehicle_Service_Information_MOU_executed_MOU.pdf) TMC's Technical Policy Advisory TMC TPA2017-1, *V2V Communications*, should be considered as well. To maintain compatibility with service equipment

deployed throughout the industry, digital service information should be made available in accordance with SAE J1939's published diagnostic codes and suppliers should avoid proprietary diagnostic codes that are not available to fleets under some license agreement. The California Air Resources Board (CARB) and International Organization for Standardization (ISO) should support the continued use of SAE J1939 diagnostic trouble codes (DTCs) for North American heavy-duty combination vehicles.

- 2. Patent-Free Solutions Are Preferred by Industry Groups**—TMC, ATA and SAE, as the groups which deal with setting guidelines, recommended practices, and advocating for regulations, prefer industry solutions that are open and free from patent protection. Some groups can accept patented solutions if there is a method for widely and reasonably licensing the solution to others. Strictly proprietary solutions that are tightly controlled and unique to specific suppliers are discouraged. Fleets always deal with equipment from multiple suppliers through acquisition strategies, the result of mergers and acquisitions, and for rental/lease of equipment as may be needed.
- 3. Global Non-Proprietary Solutions Are Preferred**—Truck and/or truck-tractor manufacturers all operate globally today, whether across North America, North and South America, or other continents. By this definition, some fleets operate globally. Trailer manufacturers are likely to operate globally in the next decade. Global regulations, standards, and guidelines help to reduce costs and improve reliability/durability/safety of products for both manufacturers and fleet operators. Non-proprietary solutions may be useful to fleet operators as they manage the mix of equipment from different manufacturers and to optimize their service network globally.

- 4. Forward/Backward Compatibility Must Be Considered**—Due to the installed base of millions of trailers with useful lives of 20-25 years, it is necessary for industry to consider forward/backward compatibility for new features and functions of smart trailers. Fleets are likely to prefer a single electrical cord whether connecting to a new or old trailer. For tracking and tracing purposes, when connecting, trailers and tractors should securely exchange identification information on the equipment and, possibly, on the load. Autonomous vehicles require special consideration. Automated coupling with a new connector is under consideration in some global markets. Some autonomous operations may benefit from the tractor being able to identify the level of safety features on the trailer and adapt to the operation of the combination vehicle securely and appropriately. Adapter cables and retrofit options may be needed to introduce smart trailers with higher safety features to the market.
- 5. Safety Is a Must**—The safety of smart trailers is of paramount importance, especially for autonomous operation. All new features and functions are expected to meet the requirements of ISO 26262, *International standard for functional safety of electrical and/or electronic systems in production automobiles*. Power to the brake system controllers and other electronics must be ensured to the maximum reasonable extent possible, including preventing ground voltage shifts. Lamps and electronic signaling for antilock braking systems (ABS) and other features are expected to be reliable. Batteries, where used, should consider the life range of the trailers and minimize replacement over the life of the trailer.
- 6. A Single Telematics Device When Untethered Should Be the Standard**—Multiple telematics devices on a trailer create additional costs, make combining

information from multiple sources more complex, and decrease reliability. When untethered, it would be preferred if the trailer telematics device would provide 60-90 days of operation. When tethered, consideration should be given to solutions which use one telematics device and account, such as that of the tractor, if available. Smart trailer solutions should allow field upgradability from 4G LTE and US global positioning satellite (GPS) to future cellular systems and global tracking systems.

- 7. Doubles and Triples Support Should be Provided**—Doubles and triples improve efficiency of freight movement, help alleviate driver shortages, and can be coupled with safety improvements of smart trailers to make them more acceptable to the public and for use in autonomous vehicle operation. Therefore, technical and commercial solutions should account for these configurations.
- 8. Software Should Be Upgradable and Compatible**—Software for smart trailers must be easily and reliably upgradable in the field using secure over-the-air (OTA) programming methods. Due to units from multiple suppliers, ideally, compatibility with other units would be ensured by the purchaser/lessee; in advance, with careful validation and verification processes.
- 9. Data Ownership and Electronic Documentation Should Be Shared Fairly**—Smart trailers will produce a significant amount of information interesting to suppliers, fleets, shippers, consignees, and government entities. Trailers may be owned by the carrier, another company, or a leasing/rental company. The load is under the control of the carrier during transport but may be under the control of the consignee once dropped or the shipper during loading. TMC recommends that all of the data will be shared fairly among the parties needing the information. A separate agreement may

be created among the parties involved to address this issue. Efforts to improve efficiency and tracking of product from source-to-factory-to-home, and from farm-to-table will create a move toward more electronic documentation and the use of distributed ledgers for security. Therefore, TMC recommends that suppliers participate in the development of logistics information standards including trailer identification, load identification and other items needed to advance technology, enabling greater efficiency and safety while subject to the privacy expectations of the parties involved.

- 10. Smart Trailers Require High-Speed Connections**—Smart trailers will likely need to support multiple, including high speed, connections to the tractor and the cloud for such items as cameras, braking systems, vehicle-to-vehicle safety features, emergency vehicle priority, higher levels of autonomous operation, highway tolling, and weigh stations. The electronic communications for this need to follow agreed, global standards that employ secure communications. Connectors are expected to follow industry norms related to durability and reliability. New connectors and connections (wireless) must be agreed upon and are expected to meet the requirements of the industry, this position paper, and applicable government regulations. All of this depends upon the availability of published standards sufficiently prior to the date of manufacture so that manufacturers have sufficient lead time to design for and incorporate the standard connectors and connections and protocols.
- 11. Cybersecurity Is a Key Concern**—Since smart trailers will produce so much information on the equipment, components, and the load, the need for secure communications and operation require careful attention to cybersecurity. Issues of confidentiality, integrity, availability,

and privacy must be considered. The National Motor Freight Traffic Association (NMFTA) *Cybersecurity Requirements for Telematics Systems* provides important guidance ([https://biz.nmfta.org/documents/ctsrp/NMFTA Cybersecurity Requirements for Telematics Systems v1.5.pdf](https://biz.nmfta.org/documents/ctsrp/NMFTA%20Cybersecurity%20Requirements%20for%20Telematics%20Systems%20v1.5.pdf)). See the **Additional Cybersecurity Considerations** section or more information on NMFTA's trailer cybersecurity expectations. Cybersecurity can only be achieved when all parties work together from component suppliers to fleets to shippers and consignees and third parties such as freight matching services. Additional information secure communications for trailers can be found in U.S. Department of Homeland Security, Cybersecurity and Infrastructure Security Agency (CISA) advisories ICSA-20-219-01 and ICSA-22-063-01 where it is asserted that the SAE J2497 databus is susceptible to being compromised in certain trailer configurations. Software for smart trailers must take all the above into account as well as considering CISA BOD 20-10, SAE J3061 Appendix A, UN-ECE-WP.29 R155, and ISO 21434:2021.

- 12. Future Power Connections Should Be Considered**—Future power needs should be considered. Product developments and concepts include electric transportation refrigeration units, powered lift-gates, electrified axles, and other items that can increase the voltage and/or current requirements for the trailer and its connections to the tractor and to infrastructure.
- 13 Installation, Maintenance, and Inspection Must Be Considered**—Vehicle OEMs and fleets require consideration for installation in factories and in the aftermarket. They expect easy and quick installation as well as equipment and procedures for assuring proper installation and operation. Government agencies will need equipment and processes for

inspecting equipment in operation on highways.

ADDITIONAL CONSIDERATIONS FOR CYBERSECURITY

As part of the cybersecurity requirements and considerations of the Trailer Interface Memorandum of Understanding (MOU), NMFTA requested inclusion of a recommendation that equipment manufacturers include a threat modeling process in their design and development of information systems for trailers. To inform that process, NMFTA also requested that the following information security goals for trailer information systems be made available in or with the MOU.

Users of trailers, (e.g. motor freight carriers), expect certain security properties to be maintained by the equipment throughout the lifetime of its operation. These properties are categorized one or more of confidentiality, availability, integrity, and anonymity. They are examined in more detail below. Threat modeling of trailer equipment should set as objectives.

A. Confidentiality of Trailer Contents

Users of trailers have an expectation of confidentiality of the trailer contents. The expectation of confidentiality applies by logical extension also to 'side channels' which can yield inference of trailer contents — e.g. air weigh axles and tire pressure monitoring systems. The expectation of confidentiality applies directly to trailer canvassing and HVAC systems. Where trailers are leased, the user leasing the trailer expects the contents to be confidential during that use. Where trailers are 'traded' between motor freight carriers: trailer contents are not expected to be confidential to either of the motor freight carriers involved in the sharing for the duration of the exchange. However, confidentiality of previous and future trailer contents is expected.

An exception to the above confidentiality of contents are materials requiring visible display

of hazards on the outside of the trailer. Users expect that this property of the contents is clearly communicated and hence have no expectation of confidentiality of that information.

B. Availability of Trailers and Tractors and Information Technology Systems

Users of trailers expect trailer safety features to be available. If this seems obvious, it is nonetheless important in discussing objectives for security design. For example, trailer equipment cybersecurity should be designed to ensure that trailer safety is unaffected by malicious actions. Users of trailers expect trailer functionality (e.g., rolling, deploying landing gear, opening doors) to be available. Users of trailers expect tractor safety availability independent of the trailer. That is, trailer equipment should be designed to not contribute to denial of availability of tractor safety. Users of trailers expect Information Technology (IT) systems technology (e.g., distribution center and back-end systems and also telematics) availability independent of the trailer. That is, trailer equipment should be designed to not contribute to denial of availability of any IT systems in the user's tractor or other connected parts of the business.

C. Integrity of Trailers, Tractors and Other Business Information

Users of trailers expect that information in storage and in transit on trailer equipment is 'integral' (not tampered with). Similarly to availability above, users expect information integrity in tractor functionality, safety and other connected parts of the business are not affected by trailer equipment.

D. Anonymity of Trailers

There is no expectation of anonymity of trailers from a local scope. For example, trailers already carry identifying marks on their exterior which can uniquely identify them. At larger scales, however; this fact ceases to obviate the need for privacy and users of trailers have an expectation of anonymity of trailer units. For

example, parties other than the equipment user cannot uniquely identify trailers in telematics datasets, public or otherwise. In contrast to confidentiality of contents, when trailers are leased both the owner and the leasing party expect to be able to uniquely identify trailers in telematics datasets. However, the expected ability to identify a trailer being leased presently does not imply that the leasing party can identify that trailer before or after the present lease. Similarly to leasing, where trailers are 'traded' between motor freight carriers, the parties involved in the trade don't expect any anonymity of that trailer in any datasets but anonymity of that trailer is expected in datasets for any times other than the present trade.

CONCLUSIONS

The years from 2000-2020 have seen trailers go from simple electrical devices to electronics to control brakes, refrigeration, tire pressure, and telematics. The future holds even more technology for the trailer as new government regulations for food safety, CO₂ emissions, and general safety take effect. Insurance companies are likely to require some electronic devices for coverage. Electric vehicles and autonomous vehicles will drive more electronics and more communications among the devices on the trailer, the tractor, and the infrastructure. This position paper provides a framework to ensure fleet needs for operation and maintenance are considered in new designs.

REFERENCES

From July 2020 through August 2022 a number of presentations were made and recorded in support of this topic. This is a partial listing:

1. July 2020 Truck Trailer Manufacturers' Association (TTMA) meeting. <https://www2.slideshare.net/PaulMenig/ttma-next-generation-trailer>
2. September 2020 SAE International COMVEC Meeting. <https://vimeo.com/482428314>
3. March 3, 2021 Peterson Manufacturing presentation to TMC. <https://ata.webex>.

- com/recording-service/sites/ata/recording/play/827d4bd4f7764b248777058489e2d00b*
4. April 7, 2021 Phillips Connect Technologies presentation to TMC. <https://ata.webex.com/recording-service/sites/ata/recording/99b777b85ab6422b8f33771ff7390cef>
 5. April 14, 2021 Truck-Lite presentation to TMC. <https://ata.webex.com/recording-service/sites/ata/recording/play/195da4f16f6241db90958daf8ee16f44>
 6. May 5, 2021 WABCO presentation to TMC. <https://ata.webex.com/recording-service/sites/ata/recording/545a21a22ace4185b166217cb8f2f3e2>
 7. May 26, 2021 Haldex presentation to TMC. <https://ata.webex.com/ata/lsr.php?RCID=5122eaec8c8359351836570e88053a95>
 8. June 2, 2021 DröV Technologies presentation to TMC. <https://ata.webex.com/ata/lsr.php?RCID=ff2e3fbc4872484f8b8285c7144c9054>
 9. June 16, 2021 Bendix/Knorr-Bremse presentation to TMC. <https://ata.webex.com/ata/lsr.php?RCID=87abb1d7e4e0427c9a4961137ba7aaa3>
 10. June 24, 2021 — TMC's Virtual Vehicle Electrical/Electronic Architecture & Fleet Benchmarking Conference. <https://ata.webex.com/ata/lsr.php?RCID=27b46c51d3c548159b6391c832bccb60>
 11. June 30, 2021 Go Power presentation to TMC. <https://ata.webex.com/ata/lidr.php?RCID=27b46c51d3c548159b6391c832bccb60>
 12. August 12, 2021 SKF presentation to TMC. <https://ata.webex.com/ata/lsr.php?RCID=a4d59554356d4b82a52eb37cd9febe18>
 13. January 13, 2022 vHub presentation to TMC. <https://ata.webex.com/ata/lsr.php?RCID=9f0090ae48e74e34815ec1e6ca69171c>
 14. January 26, 2022 ZF presentation to TMC. <https://ata.webex.com/ata/lsr.php?RCID=8202937f368849b7906f8656d314156b>
 15. February 17, 2022 Canadian Transport Equipment Association (CTEA) Meeting. <https://vimeo.com/516477436>
 16. Ninety-minute version made in June 2020 that does not include all the information presented since then. <https://vimeo.com/433438674> Password is: Tech!M2020TMC.
 17. TMC IR-2021-1, *North American Trailer Rental/Lease Company Survey Report: Next Generation Trailer Expectations*. <https://www.atabusinesssolutions.com/Shopping/Product/viewproduct/7042007>
 18. TMC IR-2022-1, *North American Refrigerated Trailer Survey Report: Next Generation Trailer Expectations*. <https://www.atabusinesssolutions.com/Shopping/Product/viewproduct/8514288/TMC%20IR20221%20North%20American%20Refrigerated%20Trailer%20Survey%20Report%20Next%20Generation%20Trailer%20Expectations>
 18. <https://www.acumenresearchandconsulting.com/semi-trailer-market>
 19. <https://www.marketsandmarkets.com/Market-Reports/semi-trailer-market-136867745.html>
 20. <https://www.mordorintelligence.com/industry-reports/semi-trailer-market>
 21. <https://www.globenewswire.com/news-release/2020/06/12/2047312/0/en/Truck-Trailer-Market-in-the-United-States-Analysis-Forecast-and-Company-Profiles-2020-2025.html>
 22. [https://samples.mordorintelligence.com/51283/Sample%20-%20Semi-Trailer%20Market%20\(2020%20-%202025\)%20-%20Mordor%20Intelligence.pdf](https://samples.mordorintelligence.com/51283/Sample%20-%20Semi-Trailer%20Market%20(2020%20-%202025)%20-%20Mordor%20Intelligence.pdf)
 23. <https://issuu.com/primecreativemedia-2016/stacks/7bd06124d32c459885a3c2154f521eb5>
 24. <http://www.globaltraileromag.com/magazine/> 