Overview of MIL-STD-3071 – Tactical Microgrid Standard

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Abstract

MIL-STD-3071, or the Tactical Microgrid Standard (TMS), is a data and communication standard for power devices to maximize interoperability between power solutions from various vendors. The TMS implements a data model for each type of power device that allows participants on the microgrid to know the type of device and associated capabilities. TMS also implements the role of Microgrid Controllers (MC) and Microgrid Dashboard (MD). The MC collects the real time data from the various power devices and acts as a supervisory controller to optimize the power devices in terms of fuel efficiency or resiliency. The MD provides the ability to display all the real time data to the user in one location.

The TMS will open the possibility for the latest and greatest power technologies to integrate with existing power technologies and create more efficient, adaptable, and resilient power.

As of January 2023, the TMS has been approved as a Military Standard, MIL-STD-3071. The TMS was developed by U.S. Army Combat Capabilities Development Command C5ISR Center, U.S. Army Corps of Engineers Engineer Research and Development Center (ERDC), MIT Lincoln Labs, and is owned and maintained by U.S. Army PEO Combat Support and Combat Service Support (CS & CSS). Future procurement of power devices may require TMS compliance to ensure interoperability.

C5ISR Center is developing a suite of tools to assist in the development of TMS complaint devices to include a TMS Topic Monitor and TMS Simulator.

This paper will present a high-level overview of the standard, what tactical power solutions it may enable, and what tools are being developed to assist TMS developers.

Keywords

Tactical Microgrid Standard; TMS; Microgrid; Military Standard; Military; MIL-STD-3071; Communication; Control; Interoperability;

TMS Overview

The Tactical Microgrid Standard (TMS) supports robust power for the Warfighter by standardizing the communications and controls architecture across mobile electric power systems. TMS enables monitoring and management of tactical power devices through the establishment of communication protocols, messaging patterns, and data models and in turn can provide more resilient, adaptable, and efficient power for the Warfighter. Additionally, the TMS allows for an opens systems approach to microgrids, providing a diverse and open ecosystem to enable future power systems to easily integrate into existing microgrids.

The TMS was developed by U.S. Army Combat Capabilities Development Command C5ISR Center, U.S. Army Corps of Engineers Engineer Research and Development Center (ERDC), MIT Lincoln Labs, and is owned and maintained by U.S. Army PEO Combat Support and Combat Service Support (CS & CSS).

The TMS was ratified and approved by the Defense Standardization Program in January 2023 as MIL-STD-3071 and is now an official standard to be used in Department of Defense acquisitions.

Although developed for the tactical space, the TMS has applications for all services and in all environments to include air crafts, ships, unmanned vehicles, space assets, and installations. Additionally, the TMS has applications outside of the Military for commercial and other state and federal applications. Efforts to utilize the TMS are already undergoing in many of these areas.

Where to find the standard

The TMS, MIL-STD-3071, can be found online on the Acquisition Streamlining and Standardizing Information System (ASSIST) at quicksearch.dla.mil and searching for document number 3071.

What TMS is and what it is not

At its core, TMS is a document that defines the communication and control interface requirements between power components and enables the development of Tactical Microgrids. Ultimately, the intent for the TMS is to provide a framework for power system vendors to develop the intelligent control of microgrids to allow for optimization for resiliency,

efficiency, adaptability, and to ensure adequate power quality and electrical stability.

For instance, although the TMS does standardize the communications and data model for a Microgrid Controller (MC), the standard does not provide an actual implementation of an MC, nor does it provide control theory or specific electrical performance requirements that a microgrid needs to meet. Instead, a controls vendor would utilize their expertise in power physics and control theory and develop a MC that complies with the TMS. The combination of the vendors expertise and the standard would result in a TMS compliant MC that can control and optimize power devices.

Benefits of TMS

The main benefit of the TMS is that it enables interoperability for power systems, allowing for vendor agnostic and plug and play solutions. The TMS provides an ecosystem where power systems from any vendor can communicate and optimize This interoperability that is enabled by TMS will allow ease of procurement for the defense acquisition community.

Secondary benefits from the application of the TMS are that it will provide resilient, adaptable, and efficient power networks.

Resilient: Enabling TMS microgrids allows for redundancy of power assets so in the case of equipment failure there are other resources to immediately provide power and more available to come online.

Adaptable: Microgrids can be setup and reconfigured based on mission needs. Units operating their own microgrid can come together to further optimize their power systems and separate when needed.

Efficient: TMS Microgrids can enable the resiliency required while reducing the number of running generators to reduce fuel usage. Additionally, TMS Microgrids can utilize energy storage and alternative energy sources to further increase the energy efficiency.

The addition of resilient, adaptable, and efficient microgrids will have profound impacts on Warfighting applications and allow the Warfighters to increase mobility and adaptability while decreasing reliance on the logistics trail.

Technical Overview

To create a standard set of data, the data is structured as a “topic”. A topic defines a group of closely related data and is published and subscribed to by different devices on the microgrid based on the Device Role (further described below). Each topic has one or more data type that specifies the data to transfer and what how the data should be structured. Additionally, each topic has timing specified for when the data is transferred. The timing at which the topics are published is based on the variability of the data. Highly variable data such as power measurements are included in topics that are updated up to 100ms, while other data that changes infrequently or not at all are included in topics that are published on change or at discovery.

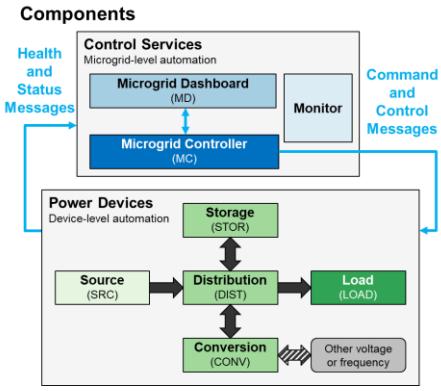

Figure 1. TMS Device Roles

Figure 1 shows the various device roles that are established in the TMS. The TMS established five Power Device Roles:

- Source (SRC) - a device that provides power to the microgrid (generator, solar panels, wind turbines).
- Distribution (DIST) – a device that connects other power devices together and may have metering and switching capabilities.
- Load (LOAD) - a device that consumes power.
- Conversion (CONV) - a device that modifies power to a different frequency or voltage (inverters, rectifiers, transformers).
- Storage (STOR) - a device to store energy and provide it back to microgrid when needed (batteries, flywheels).

Additionally, the TMS establishes three Control Device Roles:

- Microgrid Controller (MC) - a device which coordinates and dispatches power devices across the microgrid.
- Microgrid Dashboard (MD) - a device that provides a user interface and depicts the health and status of the microgrid, while also allowing the user to provide control requests.
- Monitor (MON) - a device used for passive monitoring of the microgrid.

The TMS specified which topics each Power and Control Device needs to publish and subscribe to. A power device will publish topics related to its capabilities and its real time power metrics while subscribing to various control topics to allow for instructions to adjust its performance. A MC will subscribe to most topics and utilize the data to determine an optimization strategy and publish control request topics.

The TMS makes use of the Object Model Group Data Distribution Service (OMG DDS) standard to provide the communication middleware which includes the network logic and creates the publisher and subscriber architecture. OMG DDS also provide a cyber security plug in, DDS Security, that allows for end-to-end encryption of the data and certified participants. In the future, additional requirements may be included in the TMS standard for additional cyber protections.

Compliance

Procurements of military power systems will likely need to comply with the TMS, MIL-STD-3071. Efforts are currently under way to stand up a testing capability that will allow the government to verify compliance and should be completed at the end of 2023. Additionally, a subset of the capability may be released to government contractors which will allow initial checks for compliance via a software tool called the Compliance Checker.

A separate compliance document has been written that outline the test procedures that need to be performed to verify compliance to the standard. That document can be made available to government contractors.

Tools

Developer Tools have been and are being developed to assist with the development of TMS compliant devices.

TMS Monitor - This tool provides several basic functions needed for verifying interoperability and communication patterns with TMS devices. It can be used for: 1) Verifying connectivity to a specific set of TMS devices; 2) Displaying published data in both tabular and graphical formats; 3) Record captured data to disk in JSON format; 4) Visually inspect message content. The topic monitor is similar in nature to a network packet inspector, such as Wireshark, and is just one tool that can be used for data capture, analysis, or monitoring purposes.

TMS Simulator – This tool can simulate any TMS device role to include a microgrid controller. This tool can provide insight to a developer by allowing them to see the data flows for a fully implemented TMS device. Additionally, the tool can be used to send requests from an MC to a real implemented TMS device to perform end to end testing of that device.

TMS Compliance Checker – This tool can be used to perform initial checks for validation and verification of a TMS device. The tool is not intended to be an authoritative source for compliance but instead provide a general indication that the TMS implementation in on the right track. The tool only covers a subset of the tests prescribed in the compliance document.

Governance and Industry Participation

PEO CS&CSS is standing up a governance process for the TMS for long term support of the standard. It is clear that the standard will need to be a living document and be updated as issues or limitations are identified, and as new technologies are developed that require new capabilities. The updating process will allow for government and industry participation in the development of the proposed updates to ensure that any updates to the standard are properly prepared and reviewed before inclusion in the official standard.

Conclusion

The TMS, MIL-STD-3071, is officially approved and is ready to usher in a new ecosystem that is required for innovation for tactical power solutions. The interoperability between power components from different vendors facilitate streamlined procurement and will bring resiliency, adaptability, and efficiency to tactical, air, sea, space, installation, and commercial microgrids alike.

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