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CHASSIS MANAGEMENT

Monitoring Chassis Health in Military Systems Using OpenVPX or SOSA Aligned Boards

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Monitoring the health, power, and cooling of VPX boards used in all military applications, including radar, electronic warfare (EW), communications, sensor processing, etc., is just as important as keeping an eye on the performance and capability of the end system. Chassis Managers – as defined in VITA 46.11 – now enable the system designer to find faults before any defects negatively impact the individual board or the entire system; correctly implemented, the Chassis Manager also can help maintain power levels and reduce overall downtime.

The Chassis Manager directly benefits the warfighter by providing reconfigurability for faster redeployment and health monitoring in the event that elements of the chassis start to fail. This health-monitoring capability and flexibility becomes even more important as open standards initiatives – such as the Sensor Open Systems Architecture (SOSA) Technical Standard – are making Chassis Managers a requirement, as more commonality is designed into radar, EW, and communications systems.

Chassis Management: Benefits

Chassis Managers are akin to early-warning systems for operators of radar and EW signal-processing systems. They monitor the health of the chassis and its installed boards and will send out alerts for any health faults, using a Chassis Manager GUI as an easy user interface to the Chassis Manager. Chassis Management also improves reset sequencing; it should be noted that the specific VPX boards in a system, and their compatibility with VITA 46.11, will determine the level at which the Chassis Manager can diagnose and respond to system events.

The reconfiguration capability provided by the Chassis Manager enables faster deployment, giving system integrators the ability to utilize known components in a new system with reliability testing already complete. Development time is also reduced by having all software tools already in place and understood by the team.

Module vendors benefit as well, as they can avoid source-code changes for every new module and can even reduce SKUs of the same device, because the customer can handle the reconfiguration.

The Chassis Manager will create a sensor log for all the devices within the chassis and will monitor these sensors, but the Chassis Manager itself cannot make changes to these sensors. Only an operator with Admin privileges could make changes to these sensors by creating and installing a new SDR (Sensor Data Record) file. A list of all sensors connected to each intelligent FRU in the system, along with any threshold or limits, is maintained via the Chassis Manager. Logs in general will provide a history of all events – such as an over-temperature

condition or an under-voltage condition – and are configurable. You can configure the Chassis Manager to overwrite the log once it is full, or you can configure the Chassis Manager to maintain the log and only erase it with an operators command.

Other benefits of a Chassis Manager include monitoring of system cooling, inventory management, and an ability to restart and gracefully reboot.

The Days Before Chassis Management

Prior to the release of VITA 46.11 "System Management on VPX," VITA 46.0 "VPX" designers relied upon front-panel light-emitting diode (LED) alerts to notify them of thermal or power errors and built-in-test (BIT) functions to monitor interruptions. Only backplane voltages – and sometimes the fan speed (or a fan-fail signal) or the chassis temperature – were monitored. Nothing existed to properly monitor systems faults and provide real-time alerts.

Without using elaborate middleware, no central location existed where a developer could consistently monitor critical parameters such as board temperature and health, backplane voltages, chassis temperature, or fan speed. With EW and radar system requirements steadily getting more stringent and complex, a better and more robust monitoring system was needed.

Chassis Management Origins: from PICMG to VITA 46.11

To tackle this problem, the VITA Standards Organization (VSO) released – in 2015 – the VITA 46.11 specification, also known as the System Management of VPX specification. VITA 46.11 is a modified version of the PICMG shelf-management specification, originally developed for CompactPCI, modified and expanded in AdvancedTCA (ATCA), a PICMG-developed open modular platform.
The shelf manager was initially developed for CompactPCI systems by PICMG in 2000 for servers. Since its inception, the original shelf-management specification (PICMG 2.9 R1.0 System Management Specification) has been considerably refined for use in AdvancedTCA systems and later for MicroTCA systems. PICMG authorized VITA to leverage the hardware-management portion of the ATCA specification, a move that massively reduced the typical development time for the specification.

Differences from PICMG Version

The PICMG shelf manager and the VITA 46.11 chassis manager are not twin specifications. There are several differences – a major one being that PICMG requires all boards to have IPMCs (Intelligent Platform Management Interface [IPMI] controllers); however, IPMCs are optional for VITA 46.11 boards.

A standard VPX system does not require system management to function and hot-swapping is not implemented. Since the Chassis Manager does not provide power management and not all boards will have IPMCs, electronic keying (E-Keying) cannot be used for the VPX systems. VITA 46.11 adds some features such as mandatory sensors for voltage, temperature, and overall health.

The VITA 46.11 Chassis Management subsystem uses 3.3V_AUX power so the Chassis Manager is still active when a VITA 62.0 (or equivalent) power supply is inhibited. It can be used to monitor and control managed FRUs (field-replaceable units), even when their payload power is off.
See FIGURE 1:

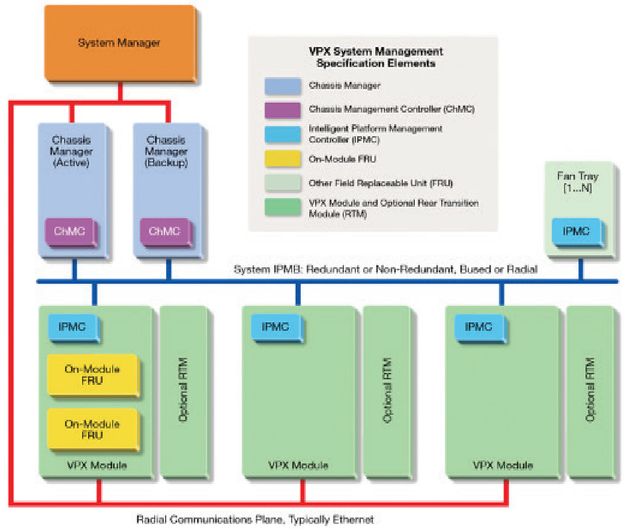
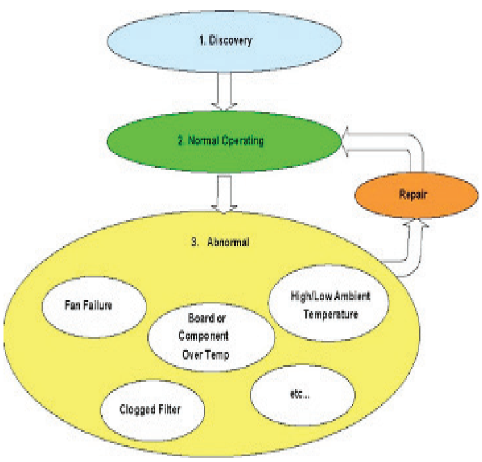


FIGURE 1: VITA 46.11 TOPOLOGY -- THE BASE TECHNOLOGY



Primary Functions

A Chassis Manager's primary function is to: discover all FRUs (IPMCs) in the chassis; monitor the sensors for each FRU; report any abnormal or failed sensors; report fan failures or clogged filters; adjust the fan speed for over-/under-temperature conditions; and report or shut down due to over-/under-voltage/current conditions. See FIGURE 2:

FIGURE 2: CHASSIS MANAGER FUNCTIONALITY

VITA 46.11 layers

The three VITA 46.11 Chassis Manager layers are the Intelligent Platform Management Controller (IPMC), chassis manager, and system manager. These management layers are hierarchical in nature, where the IPMC (integrated into each VPX module and representing that module to the Chassis Manager) communicates with the chassis manager, which, in turn, reports to the system manager. The system-management layer monitors multiple chassis.

The basic components are the BMC (Baseboard Management Controller), the Intelligent Platform Management Bus (IPMB), and the IPMC (Intelligent Platform Management Controller). The IPMB is an enhanced I²C bus and the IPMI is the messaging protocol that communicates across the IPMB.

The lower logical layer of management would be the IPMCs, which are required on all intelligent FRUs, such as front-loading VPX plug-in modules, fan trays, power supplies, and the like. The IPMC, which is in effect a slave to the Chassis Manager, provides the status of each board in the chassis; it can also be customized for the end user. The board manufacturer determines what is important to monitor, defines what the particular failures can be within a board, then tweaks it per end-user requirements.

An IPMI controller for boards or intelligent FRUs is used to monitor the health of the board or FRU, voltages, temperature, device ID, serial numbers, part numbers, and software versions. The Sensor Data Recorder (SDR) repository will provide a full list of all the sensors on a particular board or FRU.

VITA 46.11 defines two tiers of functionality for the Chassis Manager and the IPMC to enable implementation flexibility. Tier 1 is the easiest to implement while Tier 2 provides the highest functionality.

The minimum capabilities of a Tier-1 Chassis Manager include:

- Maintain an FRU population table containing information for each FRU in the chassis, whether a plug-in module or another type of chassis FRU
- Bridge between the System Manager logical layer and the IPMC logical layer
- Maintain IPMC state information for each IPMC in the chassis

The Tier-2 Chassis Manager adds functionality, but also complexity with capabilities that include:

- Tier 2 is a superset of Tier 1
- Supporting the discovery of each FRU in the chassis
- Supporting management of chassis infrastructure (power supplies, fans, etc.) including temperature, voltage, and intrusion sensors as well as power and thermal management
- Participating in event generation and reception
- Supporting event logging
- Supporting dynamic sensor devices
- Supporting FRU recovery, including FRU reset and power cycling
- FRU payload control – power, reset, graceful reboot, and initiating diagnostics

The minimum capabilities of the Tier-1 IPMC include:

- Responsibility for system IPMB start-up and fault handling
- Supporting the discovery of the FRU it controls
- Supporting access to the management information for the FRU it controls

The Tier-2 IPMC adds additional capabilities that include:

- Participating in event generation and reception
- Supporting dynamic sensor device

Intelligent power supplies

Thanks to contributions from the Sensor Open Systems Architecture (SOSA) Consortium to the VITA 62 standard, Chassis Managers now have the capability to monitor power supplies within a chassis. In its development of the SOSA Technical Standard, Consortium members worked together to introduce VITA 46.11 to power-supply modules, as SOSA requires monitoring of the power supplies for reporting and control. SOSA was pushing for power supplies to support 46.11, but VITA 62.0 is where this is actually implemented.

Now power supplies can accept commands from the Chassis Manager; moreover, a smart board is now added inside VPX power supplies, such as those designed by Behlman Electronics, for example. The power supply now interfaces with the Chassis Manager via the IPMB.

Ecosystem Testing and Interoperability

The VITA and OpenVPX ecosystems are relatively small when compared to those the SOSA initiative is targeting. The June 2019 signing of the Tri-Service memo by every branch of the U.S. military service was a very important milestone, as it directs the defense agencies to consider open architectures and specifically the SOSA architecture. The signing of this accord was particularly important for the VITA community. Along came SOSA and with it, huge numbers of interested parties were brought into the process – especially from the end-user side. Having the end user driving and requesting changes makes so many things possible that were simply impossible before. SOSA also has crossover with the Hardware Open Systems

Technologies (HOST) initiative. HOST is a standards framework that applies open architectures to high-performance embedded computing. These standards support a Modular Open Systems Approach (MOSA) to implementing systems based on commercial off-the-shelf (COTS) components for embedded computing on U.S. defense platform open systems.

To prove out the SOSA/HOST/VITA specifications, five vendors agreed to participate in live demos at the Tri-Service Interoperability Demonstration (TSOA-ID), hosted by Georgia Tech Research Institute (GTRI) in Atlanta, GA in early 2020. The demo also showcased the capabilities of Elma's Chassis Manager. The vendors contributed hardware and engineers to support the demo in a 3U 12-slot OpenVPX backplane. See FIGURE 3.

The demo system slot profiles are aligned to SOSA Snapshot 3. The slot breakdown is:

- 4 Payload and 4 SBC slots
- 2 Network switch slots, 1 RF Switch slot
- 1 Timing, 2 Power slots

Vendors and their contributions include the following board set (see Figure 3):

- Elma's CMOSS/SOSA backplane and Chassis Manager
- Elma's 3U VPX IPMC carrier air-cooled test card, which looks like a payload card to the Chassis Manager
- Concurrent Technologies single board computer, TR-E5X/3sd-RCx. It uses a GUI to show cards as icons running Windows and scanning for the identifiable plug-in cards
- Behlman Electronics SMART VITA 62 power supply, VPXtra 700M-IQI, with 700 Watts DC and a dual bus IPMB-A, IPMB-B
- Crossfield Technologies m.2 Storage Module and Altera Stratix FPGA Module

The objective of the demo was to use the current SOSA and HOST standards to prove the success of plug-in cards built to those standards. VITA 46.11 Tier II was a requirement, as was HOST alignment. The goal was to show interoperability of plug-in cards with Chassis Management components.

Going forward

Following the successful demo, work within the SOSA Consortium continues to make steady progress leading up to the release of the SOSA Technical Standard 1.0 in 2021.

FIGURE 3: PICTURED IS THE EQUIPMENT FROM ELMA, CONCURRENT, BEHLMAN AND CROSSFIELD USED IN A SOSA ALIGNED CHASSIS MANAGEMENT INTEROP DEMO.

SOSA Reference Architecture, Snapshot 3, released earlier in 2020, provided further specification of the System Management layer. Within the VITA Standards Organization, work is being done to standardize IPMI messages for power supply parameters in VITA 62.

Industry developments include an IPMC solution developed under a contract from NAVAIR. The Crossfield IPMC is easily modifiable as it can be configured via an IPMC generator; this capability enables quick personalization of the controller. Moreover, the Chassis Manager solution can be adapted to different environments. Initial implementation has already been done with a SmartFusion2 SOC FPGA.

Along those lines, reconfiguration of VPX plug-in cards via the IPMC is also being pursued, which will enable a system manager to reconfigure a plug-in card to fit different mission requirements. This feature is critically important to supporting reduced cost and rapid deployment of systems to the warfighter.

The Chassis Manager's reconfigurability and effective health monitoring translates to faster deployments of technology, quick redeployments of chassis to meet changing mission requirements, and reduced downtime, which translate into lower long-term life cycle costs. As a result, systems, designers, and end users gain the necessary agility when navigating complex environments and countering complex threats from adversaries.

For more information on the Chassis Manager, visit www.elma.com.

For more information on the open standards organizations:
SOSA www.opengroup.org/sosa VITA www.vita.com

For more detailed descriptions of the acronyms used here and beyond as well as links to defense organizations, please reference DoD Alphabet Soup.