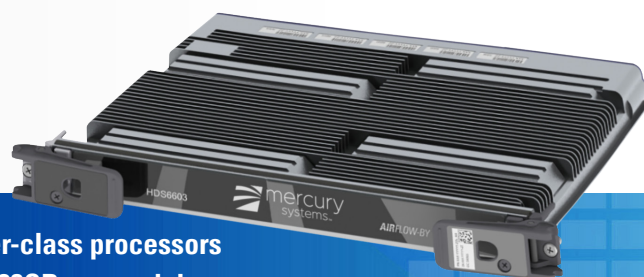*Ensemble*Series™ **HDS6603**

6U OpenVPX dual Xeon (Haswell) processing blade

- **Dual Intel® 1.8GHz 12-core Xeon® (with Haswell architecture) server-class processors**
- **Up to 64 GB DDR4-2133 SDRAM (per processor) for a total of up to 128GB per module**
- **40Gb/s Ethernet or InfiniBand high switch fabrics**
- **Gen3 PCIe co-processing and I/O expansion plane communications**
- **Optional MOTS+ rugged packaging for extreme environmental protection**
- **SOSA compatible profiles**

The EnsembleSeries™ HDS6603 is Mercury's fourth generation Intel Xeon server-class, OpenVPXTM processing blade to deliver the first single slot blade to break the 1 TFLOP general processing benchmark. Dual Intel Xeon E5-2648L v3 x86 processors, each with 12 cores, Haswell architecture and Wellsburg Bridge (collectively called Grantley) and the support of unrestricted 40Gb/s Ethernet and FDR10 fabric bandwidth deliver scalable general processing power. Mechanical ruggedness and the efficient cooling technology ensure high MTBFs even under full throttle, continuous processing conditions.

Optional MOTS+

The EnsembleSeries HDS6603 family of blades are OpenVPX compliant and have options for modified off the shelf plus (MOTS+) manufacturing and packaging for extreme durability. MOTS+ configurations leverage enhanced commercial components, board fabrication rules, and subsystem design techniques for extra durability and withstand extreme temperature cycles better than other rugged designs. Please contact Mercury directly for MOTS+ configurations.

The HDS6603 is part of Mercury's Xeon server-class ecosystem of OpenVPX building blocks that includes other Intel Haswell and Xeon processor solutions, 40 Gb/s Ethernet/InfiniBand switches and intelligent mezzanine carrier boards. These may be quickly configured and developed in the lab using concurrent engineering disciplines and Mercury's 6 and 16 slot development chassis. Supporting Mercury's Xeon server-class ecosystem is Mellanox's Connect-X3 40Gb/s enabled fabrics and tuned signal channels for unrestricted 40Gb/s and faster fabrics.

Mercury's Xeon server-class OpenVPX ecosystem is the most powerful open system architecture (OSA) available for embedded general processing applications, enabling true on-platform cloud processing capability at the tactical edge. Eminently suited to radar, electro-optical/infrared (EO/IR) and complex image intelligence (IMINT), artificial intelligence (AI) and converged sensor applications, this standard 1-inch, 6U OpenVPX blade enables compute capabilities that were never previously possible adding new functionality and autonomy to modern missions.

SOSA profiles

EnsembleSeries HDS6603 blades are optionally available in Sensor Open Systems Architecture (SOSA) compatible configurations.

Mercury Systems is a leading commercial provider of secure sensor and safety-critical processing subsystems. Optimized for customer and mission success, Mercury's solutions power a wide variety of critical defense and intelligence programs.

ACQUIRE DIGITIZE PROCESS STORAGE EXPLOIT DISSEMINATE

Xeon Server-Class Ecosystem

The EnsembleSeries HDS6603 features two Intel 64-bit Xeon (E5-2648L v3) 12-core processors. The EnsembleSeries HDS6603 is Mercury's fourth generation of Xeon server-class technology and demonstrates a high technology readiness level (TRL). Each HDS6603 blade utilizes robust packaging technologies to support two instances of high-pin-count land grid array (LGA) processors in a rugged, embedded form-factor. The dual 12-core processors are linked via two high-speed, low-latency quick path interconnect (QPI) interfaces, each providing 38 GB/s (bi-directional) data transfer rate, for a total of 76 GB/s of bandwidth between processors. This interconnected processor architecture is optimized for the data movement needed by high performance processing algorithms, such as all-to-all corner turn operations and AI applications. From a software perspective, this QPI architecture enables each HDS6603 blade to be configured with a single kernel NUMA-aware operating system running across both processor devices.

Each processor is capable of delivering 0.69 TFLOPS (peak), with four high-speed, 15 GB/s DDR4-2133 memory channels raw bandwidth each, for a total peak of 1.38 TFLOPS and 120 GB/s total raw memory bandwidth. The EnsembleSeries HDS6603 refines the rugged standing memory fabrication approach first seen on the HDS6600, HDS6601 and HDS6602 to support up to 128 GB of on-board DRAM. Native Gen3 PCIe support is also featured on this processor, linking the processing resources directly to the I/O sources on the blade. The HDS6603 also makes use of the Wellsburg platform controller hub (PCH) chipset, which provides additional I/O bridging between the Intel processor and external devices.

Each Intel E5-2648L v3 processor includes a large 30 MB cache, shared between the cores, allowing many high performance calculations to remain cache resident. This accelerates processing by eliminating the potential latency required to access DRAM to fetch upcoming data. The Haswell Bridge family of processors also supports the proven AVX2 instruction set, delivering a revolutionary increase in floating-point algorithm performance that is portable to future Intel architectures. Each core provides the AVX2-capable fused, multiple-add (FMA) vector engine, which is especially valuable for radar processing applications that routinely requires the summing of vast arrays of multiplied numbers. The inclusion of FMA support enables complex radar and similar operations to be performed approximately twice as quickly as before. Fast Fourier transformations (FFTs) and other matrix manipulations are handled more efficiently with Intel's server-class memory and processing optimizations in the Xeon E5 processor family.

High Speed Fabric Interfaces

The EnsembleSeries HDS6603 compliments Mercury's other OpenVPX modules that feature Mellanox's ConnectX-3 host adaptors for data plane communications. Bridging between the native Gen3 PCIe interfaces on the Intel processors and the OpenVPX data plane, the ConnectX-3 can be configured to support InfiniBand (DDR, QDR or FDR10) or 10/40 Gigabit Ethernet as the data protocol. This advancement scales the data plane bandwidth to up to a peak theoretical rate of up to 5 GB/s per port, or 20 GB/s aggregate across the entire four-port OpenVPX data plane. By scaling the data plane bandwidth to match the increase in processing performance, the HDS6603 architecture ensures that the processor is never starved for data.

The HDS6603 blade is compliant to the VITA 65 module profile MOD6-PAY-4F1Q2U2T-12.2.1-n, where n can vary based on ConnectX-3 configuration. The HDS6603 is supported in chassis slots compliant with VITA 65 slot profile SLT6-PAY-4F1Q2U2T-10.2.1.

PCIe Architecture

The EnsembleSeries HDS6603 provides high-end Gen3 PCIe backplane interfaces via the native PCIe resources on the E5-2648L v3 processor. In addition to supporting the processor's interface to the ConnectX-3 bridges described above, an additional x16 Gen3 PCIe interface is provided to the OpenVPX expansion plane interface on both the P2 and P5 VPX connectors. These interfaces enable the HDS6603's compatibility with Mercury's GPU, FPGA, or mezzanine carrier modules. The interfaces are user configurable to lower port widths, and can support non-transparent (NT) bridge functionality at run time. These configuration options support the construction of complex PCIe trees with many other PCIe-capable devices.

Module I/O	
	Backplane
InfiniBand	DDR/QDR/FDR10
Or Ethernet	4 x XAUI (10Gb per lane)
USB 3.0	1
USB 2.0	2
Gen 3 PCIe (8x)	32 - Dual full x16 or dual x8
1000BASE-T Gigabit Ethernet	1
1000BASE-BX SERDES Ethernet	2
SATA	2
RS232/RS422	2 x RS-422/2 x RS-232 or 4 x RS-232

System Management Plane

Each HDS6603 blade implements the advanced system management functionality architected in the OpenVPX standard to enable remote monitoring, alarm management, and hardware revision and health status.

Using the standard I2C bus, intelligent platform management controller (IPMC), and IPMI protocol, the on board system-management block implementation is designed to comply with VITA 46.11.

This allows each EnsembleSeries HDS6603 blade to:

- Read sensor values

- Read and write sensor thresholds allow an application to react to thermal, voltage, or current variations that exceed those thresholds

- Reset the entire blade

- Power up/down the entire blade

- Retrieve blade field replaceable unit (FRU) information

- Be managed remotely by a chassis management controller at the system level

Additional Features

The EnsembleSeries HDS6603 blade provides all the features typically found on a single-board computer. In addition to the sophisticated management subsystem and fabric interconnect, each HDS6603 blade provides users with a toolkit enabling many different application features including:

- Thermal and voltage sensors integrated on-board

- Real-time clock with accuracy better than 10ppm<1second per day

- General purpose timers

- Global clock synchronization capabilities via the OpenVPX utility plane clock signals

- Watchdog timer to support interrupt or reset

- Multiple boot paths, include netboot, USB boot, boot from SATA, or from the on-board 8GB flash device

Open Software Environment

Mercury leverages over 35 years of multicomputing software expertise, including recent multicore processor expertise, across its many platforms. This strategy is fully applied to the HDS6603 blade. The same Linux® development and run-time environment is implemented on the HDS6603 blade as on other Intel based Mercury OpenVPX modules across the Ensemble 3000 and 6000 Series. Off-the-shelf open software such as OFED and OpenMPI are fully supported by the Mellanox ConnectX-3 data plane.

Mercury's OpenVPX Ecosystem

Sensor processing chain awareness, building blocks and ecosystem Sensor chain awareness is having the technical expertise and resources to design and build capable, compatible solutions along the whole sensor processor chain. From RF, digital/analog signal manipulation to dense, SWaP optimized processing resources to actionable intelligence

dissemination; Mercury's rugged processing subassemblies leverage the best commercial-item technology, enabling prime contractors to win more business.

Modern sensor processing subassemblies are customized assemblies of interoperable building blocks built to open standard architectures. Mercury's hardware and software portfolio of building blocks are physically and electrically interoperable as defined by international industrial standards, including OpenVPX.

System Bandwidth – The Effect of Interconnect Performance

Bandwidth is critical and especially applicable to switched fabric resources that dictate the responsiveness of the entire subsystem. All modular solutions, including OpenVPX are to some degree, interconnect-bound; they are restricted by the limitations of the best industry interconnect technology. To address this, Mercury fabricates system interconnections with innovative technology, which mitigates insertion-loss and cross-talk while maintaining full VITA/ OpenVPX compliance. The resulting system performance boost enables the latest fabrics to run at full, unencumbered speed.

Module Packaging

VPX-REDI

The VPX (VITA 46) standard defines 6U and 3U board formats with high performance interconnects capable of supporting today's high-speed fabric interfaces. VPX may be paired with the ruggedized enhanced design implementation standard — REDI (VITA 48). HDS6603 blades when implemented as conduction-cooled or Air Flow-By™ are VPX-REDI compatible. Air-cooled equivalents conform to the same OpenVPX form factor and are suitable for less challenging environments. Targeted for harsh embedded environments, VPX-REDI supports higher functional density and two-level maintenance (2LM). 2LM allows relatively unskilled maintenance personnel to replace a failed module.

Rugged Air Flow-By

Air- and conduction-cooled subsystems rely on filtration to remove contaminants from their cooling air streams. Mercury's Air Flow-By technology eliminates filtration with the most elegant cooling solution available within a sealed and rugged package. Fully compliant to the VITA 48.7 standard, Air Flow-By maintains OpenVPX's 1-inch pitch requirement, is highly resilient to liquid and particle contamination, boosts SWaP, reduces operating temperature, extends MTBF by an order of magnitude and enables embedded deployment of the most powerful and reliable processing solutions. HDS6603 blades are available as air-cooled (various levels of ruggedness), and rugged Air Flow-By and conduction-cooled variants.
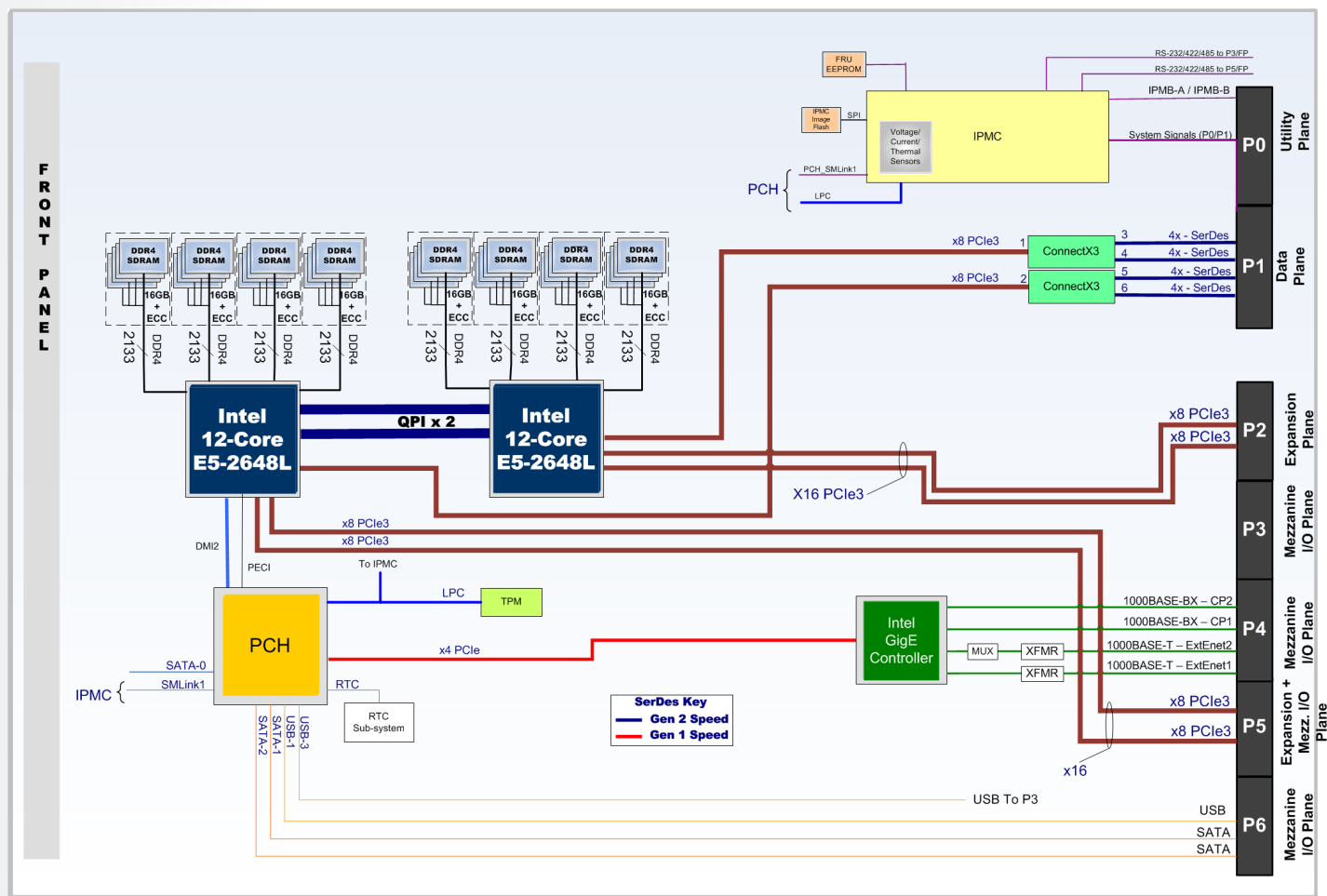
Figure 1. *HDS6603 functional block diagram*

Specifications

Processors

Dual Intel 1.8GHz 12-core E5-2648L v3 (Wellsburg Bridge) server-class processors

Peak performance   1.38 TFLOPS per module

Threads per core   2

QPI interface between processors   2 x 9.6 GT/s (or 38 GB/s per processor, per direction, 76 GB/s total) peak performance

Dual Integrated x16 Gen3 PCIe interface

Memory

Up to 128 GB DDR4-2133 with ECC

Raw memory bandwidth: 60 GB/s per processor

BIOS

SPI flash: Dual 8 MB partitions

NAND flash: 16 GB, SATA interface

Data Plane PCIe to Switched Fabric Bridge

Mellanox ConnectX-3 VPI host adapter

Support DDR/QDR/FDR10 InfiniBand or 40 Gigabit Ethernet protocols

Ethernet Connections

Ethernet functions supported by the chipset include:

UDP, TCP, SCTP, ARP, IPv4, IPv6, IEEE1588, flow control, 802.1P (priority) and 802.1Q (VLAN)

IPMI (Intelligent Platform Management Interface)

On-board IPMI controller

Voltage and temperature monitor

Geographical address monitor

Power/reset control

FRU and on-board EEPROM interfaces

FPGA, CPU, and CPLD interfaces

OpenVPX Multi-Plane Architecture

System Management via IPMB-A and IPMB-B link on P0 management plane

InfiniBand or 40 Gigabit Ethernet interfaces on data plane

Dual full x16 or dual x8 PCIe Gen3 expansion plane

Mechanical

6U OpenVPX

1.0" slot pitch for all packages except some Air Flow-Through configurations

OpenVPX and VPX REDI

Power consumption:

~75W per processor

~200W per blade

Standard Compliance

OpenVPX System Standard (VITA 65) encompasses:

VITA 46.0, 46.3, 46.4, 46.6, 46.11, and VITA 48.1, 48.2 (REDI)

VITA 65 module profile MOD6-PAY-4F1Q2U2T-12.2.1-n (where n can vary based on ConnectX-3 configuration)

Dual 1000BASE-KX Ethernet control plane

OpenVPX Profiles

SLT6-PAY-4F1Q2U2T-10.2.1 (SOSA compatible)

SLT6-PAY-4F1Q2U2T-10.2.6 (SOSA compatible)

SLT6-PAY-4F2Q2U2T-10.2.7 (SOSA compatible)

Please refer to Mercury publication "Environmental Protections for Operation at the Tactical Edge" for specific ruggedness levels and cooling options.

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