

The TornadoHD™

A Solid State Solution for Multi-Sensor Data Acquisition and Storage



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Presented at the THIC meeting at the Westcoast Silverdale
Hotel, Seattle, WA, October 9, 2001

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www.spec.com

Background/History



• **Founding**

- SPEC is a privately held corporation established in 1986

• **Profitability**

- SPEC has operated profitably since its inception

• **Growth**

- SPEC has grown an average of 50% annually for the past three years, and employees nearly 100 engineers, scientists and support personnel in its Austin, O'Fallon, Illinois, and Washington DC offices.

• **Partnering**

- SPEC has established collaborative relationships with more than 30 companies worldwide, several in the Fortune 500

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1998 Tibbetts Award Winner



The Need for Speed, Capacity, and Space

- ***High Resolution/High Frame-Rate Imagers***

- CCD, Hyperspectral
- 512 pixels X 512 pixels X 1000 fps @ 10 bits/pixel = 2.62Gbps
- 1,000,000 fps imagers on the horizon

- ***High Capacity Analog or Digital Sensors***

- Synthetic Aperture Radars, IR Sensors
- 100Gbyte - 1Tbyte capacities needed now
- Multi-Tbyte requirements on the horizon

- ***Limited Physical Space***

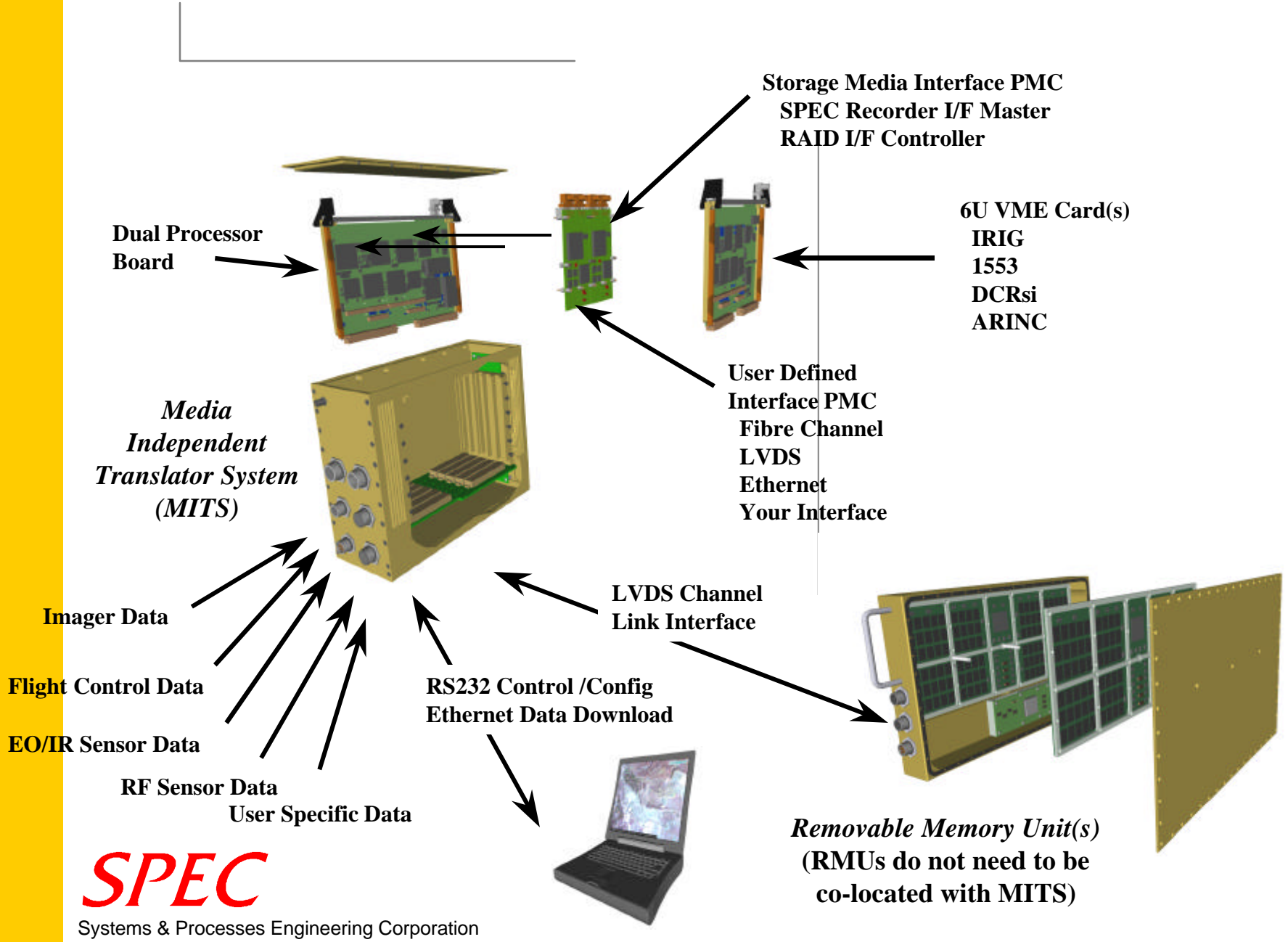
- Aircraft applications
- Space applications
- Autonomous missile applications

- ***Multi-sensor applications***

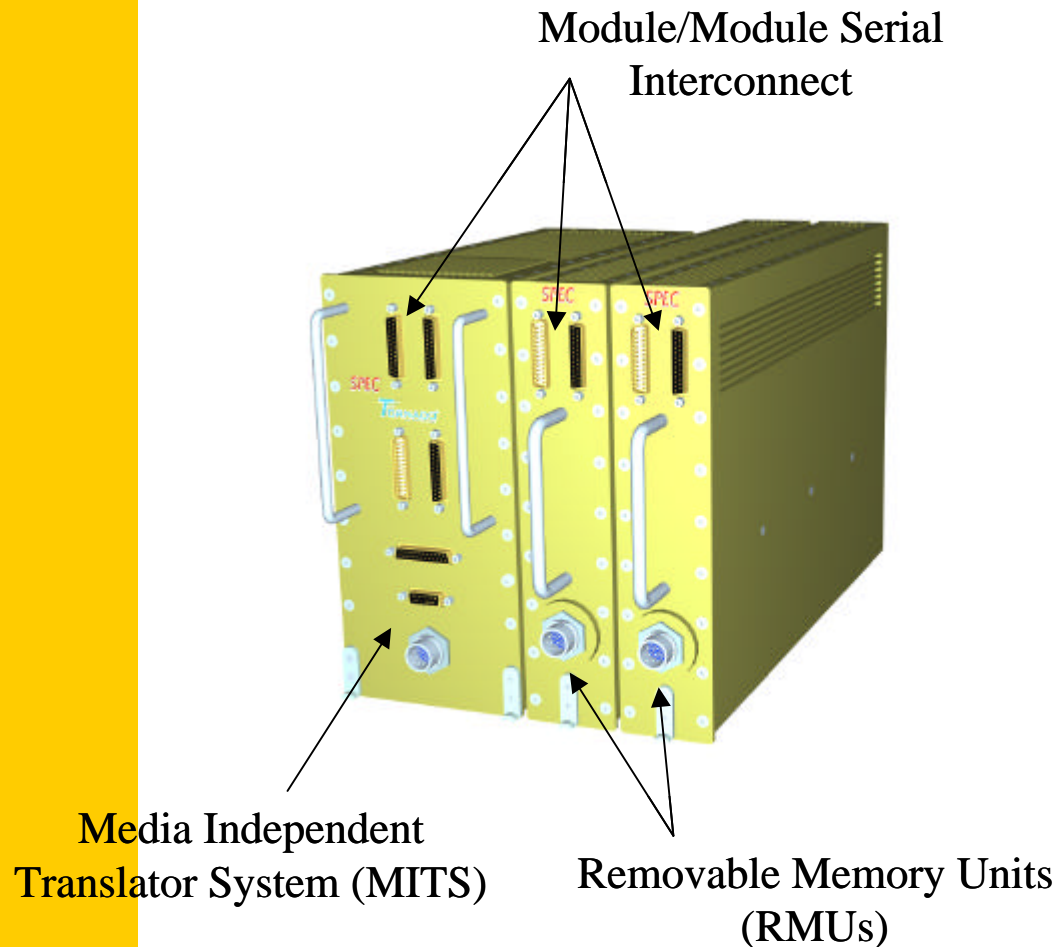
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SPEC Data Storage System Architecture



TornadoHD (Commercial Configuration)

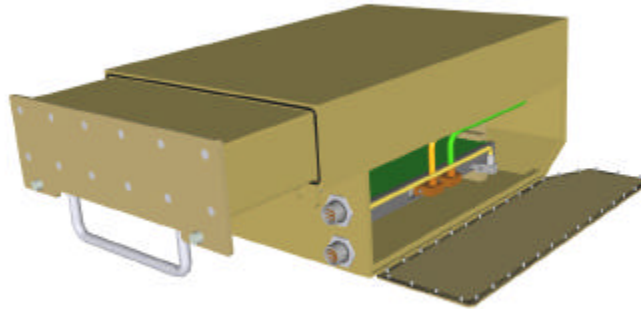


- Incorporates VMEbus architecture w/ RACEway switch fabric for interface flexibility
- Accommodates multiple sensor interfaces
- Memory capacities from 13.8GBytes to 221.2 GBytes per RMU (up to 16 RMUs)
- Compact design reduces size, weight, and power requirements
- Accommodates data rates in excess of 6 Gbits/sec

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Airborne Packaging Options



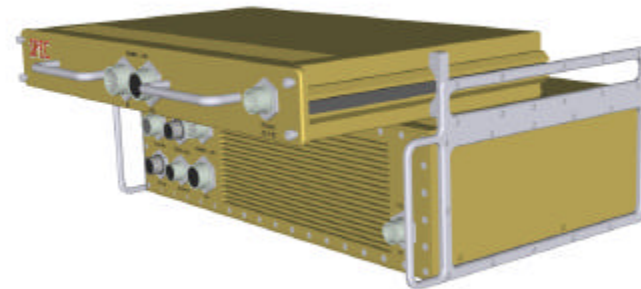
Integral RMU/MITS



Single Hard-Mounted Unit
(Raytheon Tucson Configuration)



ATR Configuration in
Eglin Flight Test Pod



Two Unit, Removable
Memory Configuration

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TornadoHD™ Design Overview

• *Media-Independent Translator System (MITS)*

- Accepts data from multiple wide-bandwidth sources (standard or custom)
- Coordinates recording of data to memory and memory playback
- Each channel consists of:
 - Interface Adapter PMC (Fibre Channel, LVDS, RS-170, custom, etc.)
 - Recorder Interface Master (RIM) PMC
 - VME-based dual PowerPC I/O controller
 - VME-based support cards (DCRsi™, Digital I/O, IRIG, etc.)

• *Removable Memory Unit (RMU)*

- Each RMU contains up to eight memory cards of 13.8GB each (221.2GB per RMU)
- Current configuration accommodates up to sixteen RMUs (3.6 TB)
- Design capacity limited only by customer space/power constraints

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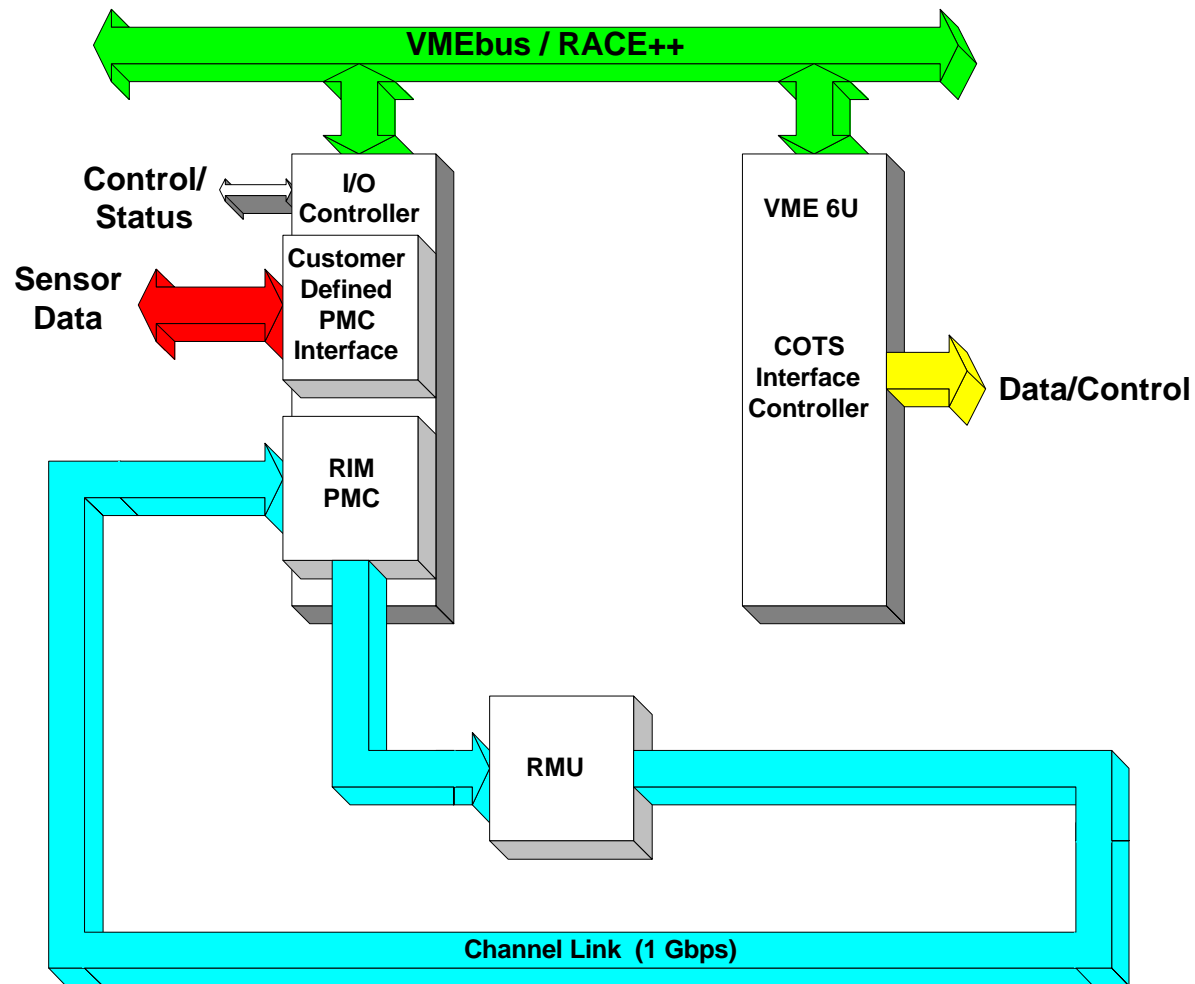
TornadoHD™ Features

- ***High-speed LVDS Channel Link for MITS/RMU communication***
 - 960Mbps sustained data rate per Channel Link
 - Increase throughput in approximately 1Gbps steps by adding parallel Channel Links
- ***VMEbus Open-Architecture MITS***
 - COTS I/O Controller with two independent PCI interfaces
 - Can accommodate multiple controllers
 - Can accommodate multiple 6U VME interface cards
- ***Removable Memory Unit (RMU)***
 - 960Mbps throughput capacity per RMU
 - Playback-while-Record (Read-while-Write) capability
 - Each RMU can be re-packaged with multiple Channel Links as the need for higher data rates arises

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TornadoHD™ Design Block Diagram (Single Link System)



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Media-Independent Translator System (MITS)

- ***Customer Specific PMC Interface Adapter***
- ***COTS I/O Controller***
 - Dual PowerPC processors
 - 250MHz PowerPC 603e core
 - Dedicated local PCIbus, RACEway bridge, & PMC slot for each processor
 - Fully-compliant VMEbus and RACE++ interfaces
 - On-board quad 64MB SDRAM Buffers
- ***Recorder Interface Master (RIM) PMC***
 - Full channel link command structure
 - Playback-while-record synchronization
 - 64KB FIFO buffer storage to/from PCIbus interface
 - Channel link synchronization & integrity BIT
 - Can be installed in PMC slot of any I/O Controller
 - Portable low-level software driver (VxWorks™ based)

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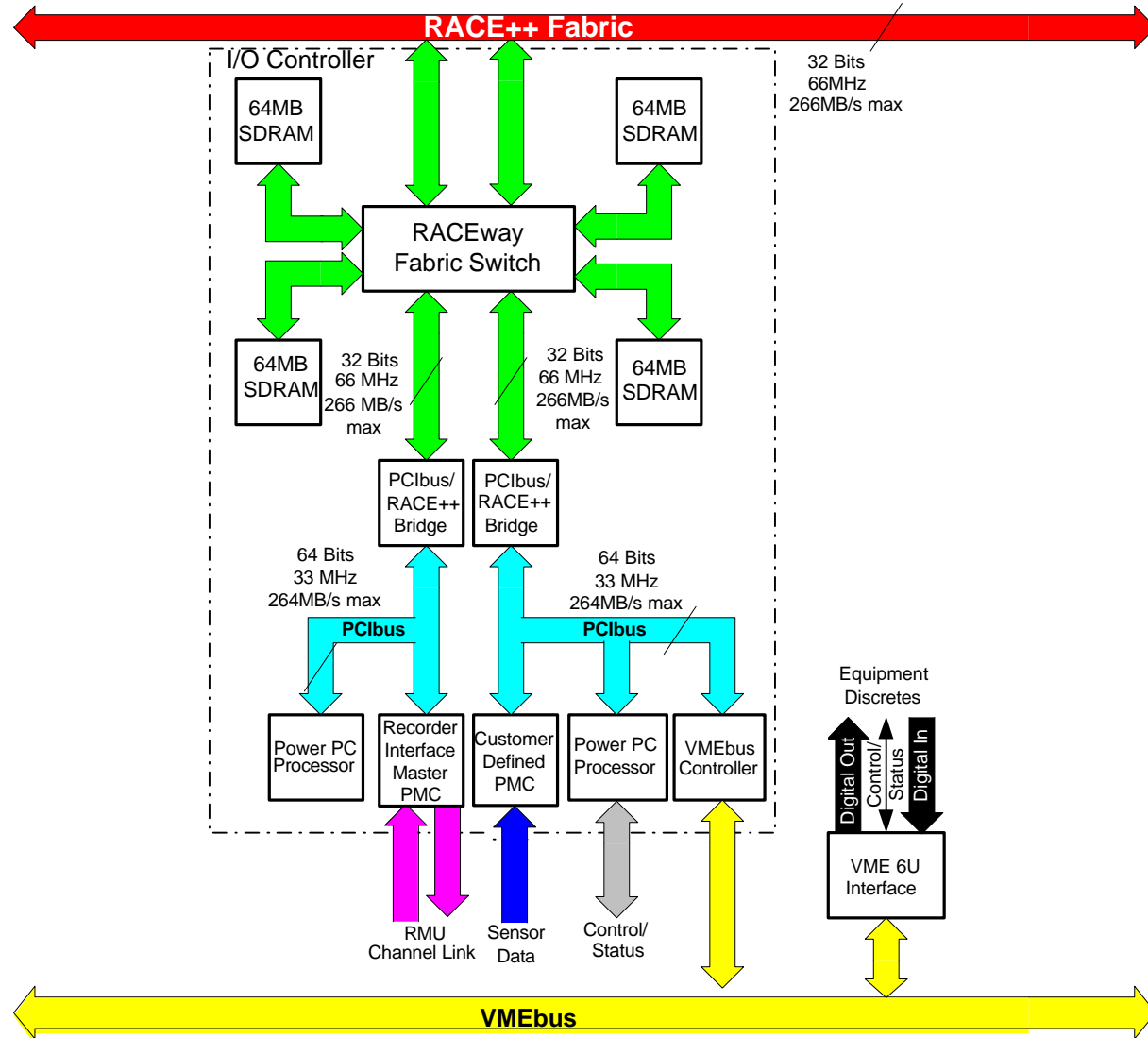
MITTS (Continued)

- *Additional COTS VME6U Interface Controllers as required by customer (1553, DCRsi, IRIG, ARINC)*
- *Installed in a 1/2 ATR tall, short VME avionics chassis*
- *RIM may be replaced with any COTS interface adapter to provide interface to any solid-state or disk-based storage media*

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Detailed MITS Block Diagram



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Removable Memory Unit (RMU)

- *ARINC 1/4 ATR form-factor, ATR Tall*
- *Conduction-cooled & ruggedized for harsh environments*
- *Contains up to eight Memory Matrix Modules for a storage capacity of 221.2GB*
- *Data rate of a single channel link is 960Mbps*
- *Modular design allows parallel channel links for faster data rates in parallel RMUs (or the same RMU)*
- *RMUs may be linked together to attain system storage capacity of up to 3.6TB per channel link*
- *Scalable storage density*

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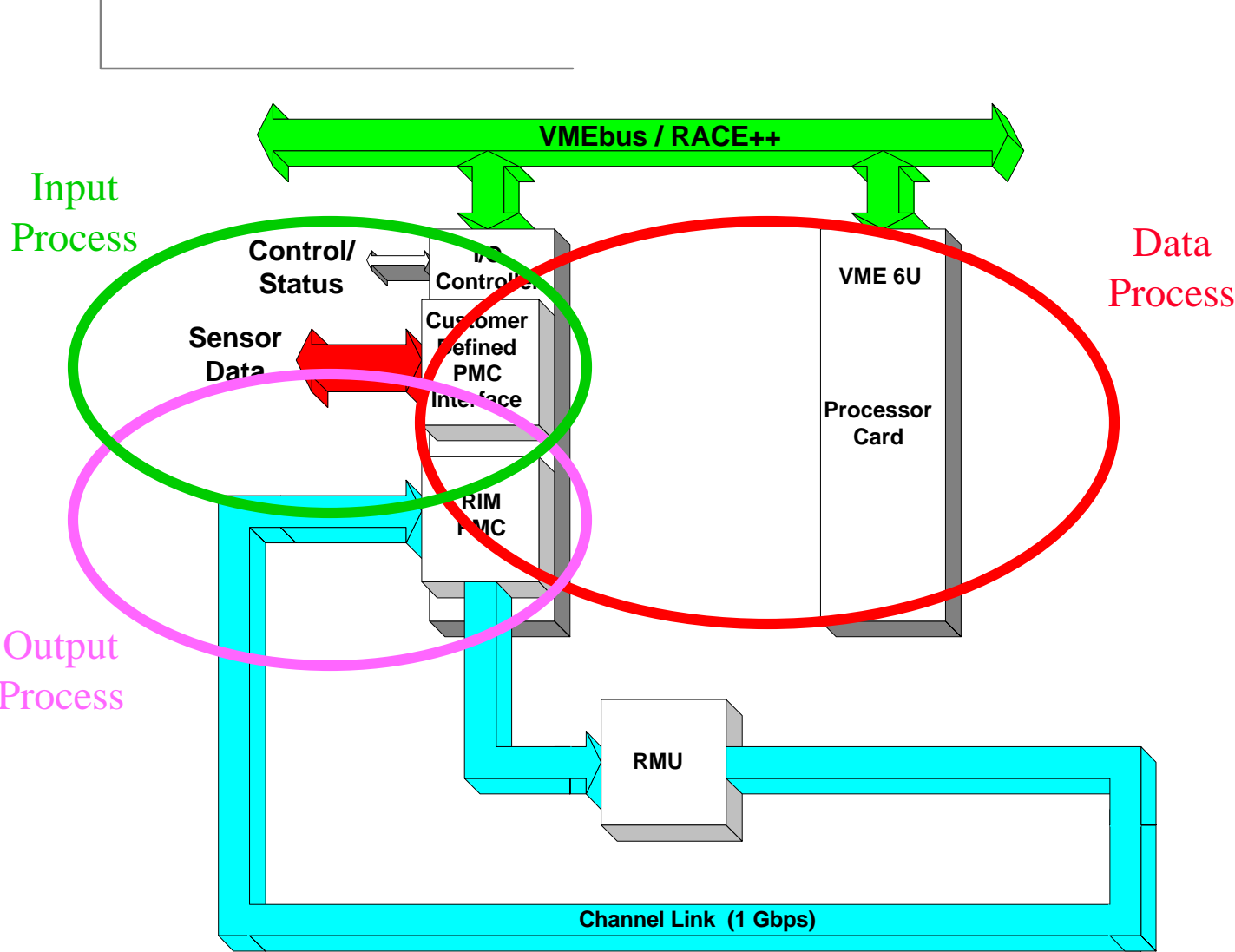
Memory Matrix Module

- **Total storage capacity 27.6GB per module**
- **Memory Array Controller (MAC) FPGA**
 - Complete bad block mapping (maps 100% of EEPROM blocks)
 - Channel link bypass/cell data transceiver/EEPROM control
 - Modular design allows easy reconfiguration of cell arrangement
- **Design is transparent to all EEPROMs with capacities of 128Mbits and above using SmartMedia™ format**
- **Unique cell structure allows concurrent data throughput and EEPROM commanding**
- **Burst playback design allows read-while-write**

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TornadoHD™ Software Architecture



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Software Architecture Features

• *Input Process*

- Fibre channel driver
- Analog and digital video
- EO/IR/RF
- User defined interface

• *Data Process*

- Image/Data compression
- RF processing (FFT/Filter)
- Error encoding

• *Output Process*

- Channel link to SPEC RMU
- RAID (SCSI)
- Etc.

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TornadoHD™ General Specifications

• ***Power (Front End plus one fully-loaded RMU)***

- 59 Watts maximum, record and/or playback

• ***Physical Properties***

• Front End:

- Dimensions: 10.6”H X 4.5”W X 12.5”D (ARINC 1/2 ATR Tall chassis)
- Weight: 15.9 lbs. Maximum

• RMU:

- Dimensions: 10.6”H x 2.25”W x 16.8” D (1/4 ATR Tall) or
7.7”H X 2.25”W X 19.6”D (1/4 ATR Long)
- Weight: 18 lbs. Maximum

• ***Solid State Reliability***

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Conclusions

- ***The recorder meets requirements for a ruggedized, medium to high-bandwidth, multi-channel solid-state data storage system***
- ***VMEbus-based MITS design provides data rate, interface, media, and data processing flexibility to meet future growth needs***
 - Multi-channel capability and increased data rates with additional processor/RIM PMC assembly
 - Interface flexibility using COTS PMC and VME cards
 - Compatible with other storage media
- ***The RMU was developed to be scalable in both memory depth and data rates***
 - Up to 16 RMUs may be linked (3.6 TB per channel link)
 - Increased data throughput provided by increasing number of parallel channel links
- ***Successful flight test series completed May 24, 2001***
- ***First production unit shipped in September 2001***
- ***In low rate initial production for follow on orders***

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