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Health Management System: An Application of Recovery Oriented Computing (ROC) Targeted at HPEC Systems

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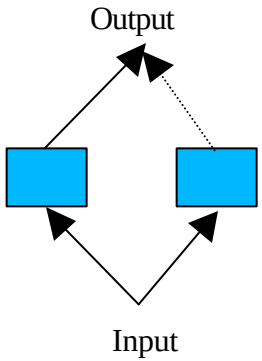
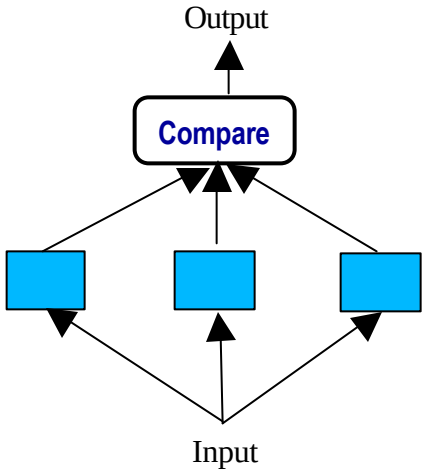
HA Approach: Redundancy

- Goal: Increase Mean Time To Failure
- Classes
  - Dual Redundancy (Hot Fail Over)
  - Triple Redundancy (Result Comparison)
- Redundancy at System/Component Level
- Drawbacks:
  - High Costs
  - Low Density
  - Additional Complexity





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SKY's HAA Approach: Recovery Oriented Computing

Two Basic Tenets:

- Failure Rates of Both Software and Hardware are Non-Negligible and Increasing
- Systems Cannot be Completely Modeled for Reliability Analysis (thus their failure modes cannot be predicted in advance)

Goal:

- Decrease Mean Time to Repair

ROC Mechanisms:

- Detection (Sensing and Diagnotics)
- Isolation
- Use of Excess Capacity (if available)
- Repair/Recovery

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Applying ROC to HPEC

Hardware:

- Quality Components
- Builtin Sensing of all Major Components
- Control of all Major Components (reset, etc.)
- Excess Capacity (where possible)

OS Middleware:

- Quality Components
- Builtin Sensing of all Major Components
- Control of all Major Components

Application:

- Quality Components
- Builtin Sensing of all Major Components
- Control of all Major Components
- Overall System Management (Sensing and Control)

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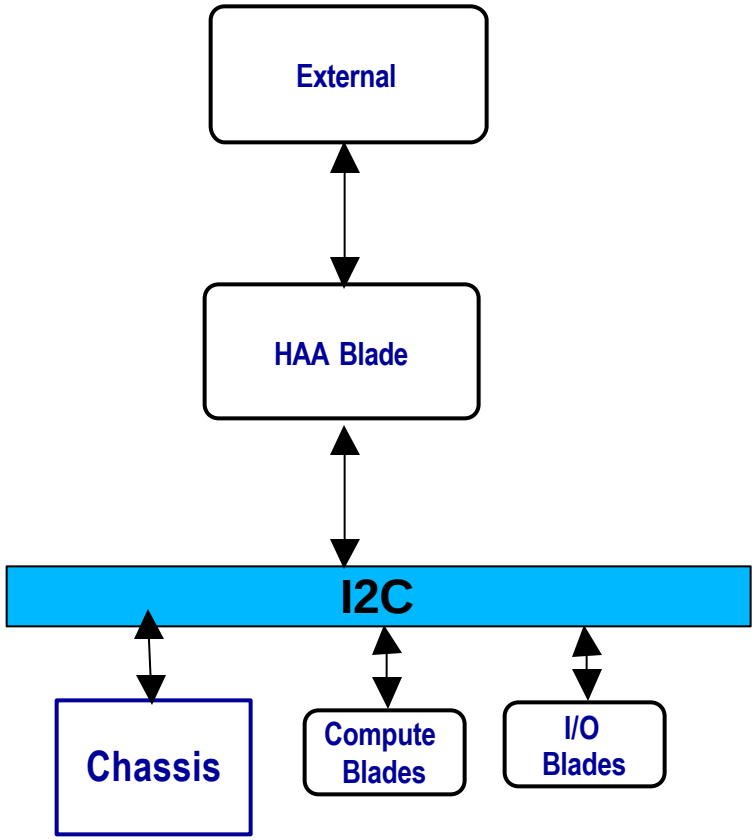
Hardware Support

- **HAA Support Blade**
  - Tini Management Processor (Java Processor)
  - I2C Integration
  - TCP/IP External Access
- **Compute/IO Blades**
  - Out-of-band Management Controller
  - Temperature Monitoring
  - Voltage Monitoring
  - Heart Beat Monitor
  - Power Control/Reset
  - I2C Integration
- **Chassis**
  - Fan Monitoring
  - Voltage Monitoring
  - Power Control/Reset



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Health Management System (HMS)

GOALS:

- Provide Capability to Instrument OS, Middleware, and Application (analogous to hardware instrumentation)
- Provide Uniform View of Entire System (hardware, OS, middleware, and application)
- Provide Integrated Diagnotics
- Provide Access Using Standard Interfaces
- Minimal Performance Impact
- Easily Extensible and Configurable (in order to meet individual application requirements)

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Health Management System (HMS)

- Server Objects: Sensors, Controllers, and Timers
  - Embedded within the hardware, OS, middleware, and application
  - Combined into a Resource Object
- Clients: Application, Management Tools, and Users
- Communication: Event Driven, Request Driven, and Timer Driven Messaging
- Lookup Services
- Extensible
  - Can support an arbitrary number of servers and clients
  - Application developers can add application specific servers
- Configurable
  - Which servers and clients are to run
  - When and where they are to run

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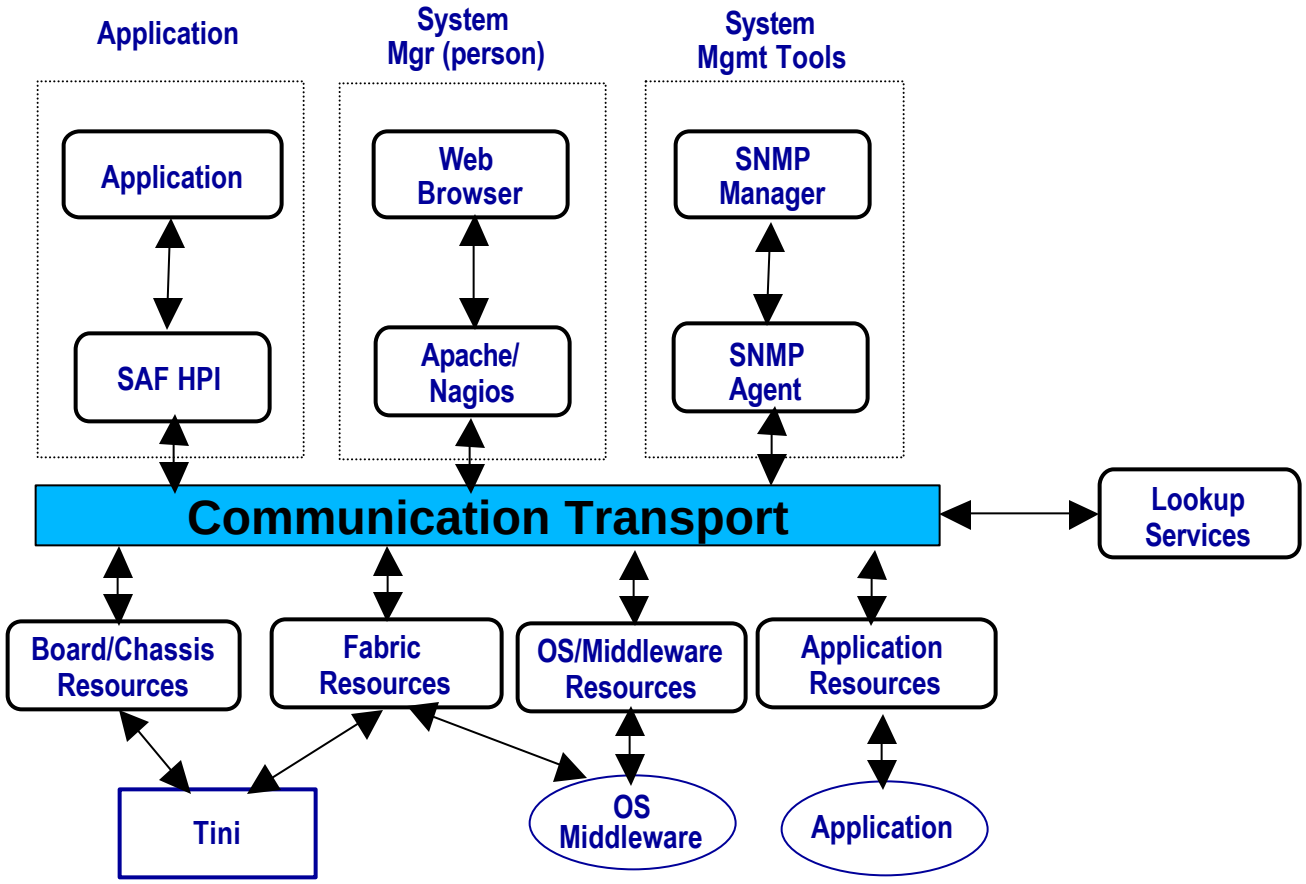
Example HMS Based System



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Health Management System

- Used to Monitor Resource Usage (Development and Runtime)
  - Hardware (temperature, voltage, etc)
  - OS/Middleware (processor load, data throughput, etc)
  - Application (queue lengths, wait times, etc)
- Used to Manage These Resources
- Used to Detect and Isolate Faults
- Used to Predict Possible Future Faults
- Used to Gather Statistics on Resource Usage and Performance
- Used to Determine the Health of Resources (Diagnotics)

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Future Directions

- Tight Integration with SKY Analysis Tools
- Tight Integration with SKY Development Tools
- Pattern-based Application Recovery Libraries
- Dynamic Insertion of Sensors/Controllers (Dynamic Probes)
- Support for Other Hardware Environments (Hot-Swap)