Design Whitepapers from F9 Systems and North East Systems Associates

ATCA - Design Considerations
August 2007

Greetings!

This is our inaugural communication to the design community. We will be periodically contacting you with interesting technical information and articles having to do with high-performance design. Let us know what your interests are too - send email to breda@nesa.com or kbreda@f9-systems.com. Thank you!

Multi-Gigabit ATCA Design Architectures and Features

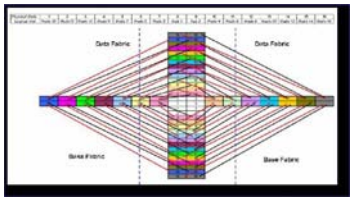
ATCA based systems are standardized, multi-gigabit platforms designed specifically for telecom infrastructures. They permit the deployment of "best-in-class" telecom systems, all with common system interfaces and platforms.

The ATCA system interconnect architecture specification has been written in terms of logical slot connections. The most popular configurations are the centralized 14-slot switch and 5-slot full mesh architectures, also known as centralized Switch Architecture.

The designer is free to map the logical architecture onto the physical architecture of chassis and backplane which suits their reliability and performance requirements. Different combinations of logical and physical configurations lead to dramatically different architectures such as non-centralized redundant switches, also known as dual star and isolated switch architectures.

There are design benefits and drawbacks for each type of architecture. The following is a quick overview of features for architectures used in ATCA system designs.

Centralized Switch Architecture: A Quick List...



- The Centralized Switch Architecture is the most common design used.
- The architecture is the simplest and least expensive to layout and route.
- The architecture has the shortest overall trace lengths. FR-4 material is probably viable up to 5 Gbps. Lower loss material is recommended for higher data rates.
- There are three thermal zones, so six to nine 5 1/4 inch fans are recommended to cover 14-slot the area.
- There is a single zone of thermal failure above the highest power boards.
- A N+1 redundant fan cooling design is probably not possible.

Dual Star Switch Architecture: A Quick List...

F9 Systems Test Fixtures

Cost Efficient Lab & Design Tools

ThermalBlade:

ATCA compatible design offers the flexibility to verify the power and thermal characteristics of your Advanced TCA chassis, logic cards and backplane designs.

Inventory Sale Price:

$ 649.00

RTM ThermalBlade:

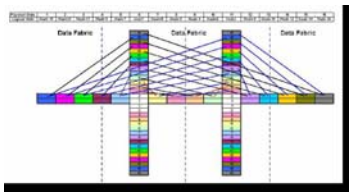
Used in conjunction with the ThermalBlade, the RTM emulates a typical rear mounted logic card of an ATCA system.

Inventory Sale Price:

$ 549.00

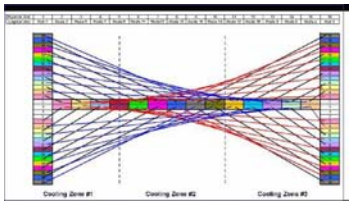
Tx/Rx SignalBlade:

This ATCA compatible test card offers the flexibility to verify the performance of Advanced TCA fabric and base channels. The set of four transmit pairs and four receive pairs allows access to a full channel's eight pairs for backplane path characterization. Perform skew, connectivity, signal impedance and probe, observe and measure eye-openings.



- There is no single point of thermal failure above the highest power boards.
- There are up to four independent thermal zones rather than just three. Smaller diameter high capacity fans can provide some redundancy for N+1 reliable designs, but costs of fan tray solutions may rise.
- Due to balanced thermal zones there is a low potential for flow choke.
- This architecture has medium overall trace lengths, which may make FR-4 usable to 5 Gbps.
- This architecture is a bit more complicated to layout and route than a centralized switch due to crossovers.
- This is not a common physical architecture in the telecom industry.

Isolated Switch Architecture: A Quick List...



- This is a highly fault tolerant architecture, where there is no single point of thermal failure with respect to the highest power boards.
- There are up to four independent thermal zones.
- The balanced thermal zones offer a low potential for flow choke.
- This architecture has the longest overall trace lengths, which may make FR-4 usable only up to 3.125 Gbps.
- The architecture is complex to layout and route and requires higher layer count due to crossovers.
- This is a high reliability physical architecture for the telecom industry where 5-9's reliability is required.

The data fabric signal fidelity and eye-diagram performance is key to taking advantage of the multi-gigabit performance offered by ATCA. All approved protocols, serial Gigabit Ethernet, PCI-E, Serial Rapid IO, Fibre Channel and Infiniband require definitive and validated eye-opening performance. The signal density and data rates make it impractical to probe the backplane or logic cards by conventional means.

Validated performance can only be achieved by the use fixturing that offers a low distortion full channel interface to Gigabit scopes and BERT testers. Such fixturing must have superior impedance control and low losses to achieve the specified eye-diagram performance goals.

ATCA Tx/Rx fixturing is now available off-the-shelf from F9 Systems for signal sampling directly at the logic card interface, at the backplane signal terminus locations or for the injection of test signals to the logic cards or ATCA backplane.

Although ATCA is a design standard, there are still many design detail decisions that engineers need to make about a system's operation before their product

Price: $1,995.00

Tx/Rx BenchBlade:

This ATCA compatible test card offers the flexibility to verify the performance of Advanced TCA fabric and base channels. The set of four transmit pairs and four receive pairs allows access to a full channel's eight pairs for logic card characterization. Perform skew, connectivity, signal impedance and probe, observe and measure eye-openings.

Price: $1,995.00

Tx/Rx CALBlade:
The CalBlade backplane calibration fixture is designed to permit accurate and convenient impedance and transmission measurements of a HM-Zd backplane. The CalBlade is used to calibrate the logic card connector interface to the backplane rather than to the usual far-end of the coaxial measurement cables. Very accurate impedance, skew and propagation delay measurements are possible since parasitic fixturing effects are removed. This board is specifically designed for Agilent measurement products

Price: $349.00

Quick Links

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specification can be finalized. Resources and test fixture tools from North East Systems Associates and F9 Systems can help ferret out the answers to thermal, power, redundancy and signal-type design trade-offs.

Eliminate ATCA Thermal Failures - Validate Early & Often

As companies vie to develop new products to meet changing ATCA market needs, a tradeoff between the time and cost of innovative design versus the need for verified quality and reliability continues to be a problem. ATCA card developers and integrators depend on the enclosure meeting the system level requirement of 200 watts per slot to some altitude level and/or temperature rise standard. But, it is unlikely that the chassis supplier understands the many possible configurations and combinations of components and fault conditions of your boards. At the end of day however, each ATCA board supplier is responsible for their own board operation no matter what the other boards are doing in the system or what air flow conditions exist.

The Engineering Dilemma

The age-old answer has been Computational Fluid Dynamics (CFD) validation followed by thermal performance measurements of the system with the actual logic cards. Unless it has been incorporated into the original development schedule, this methodology is time and dollar consuming and redirects engineering resources from the primary goal of getting the product completed and released. Although CFD and validation has their place, it isn't in the day-to-day "what-if" and problem solving analysis performed in the lab.

Engineering Phase Thermal Evaluations

An innovative alternative approach exists. Engineers can conduct thermal experiments using power load cards, such as those designed by F9 Systems, to mimic logic cards installed in a standard ATCA chassis. This is best done early in the logic engineering cycle because the placement of various parts and blockages, e.g. uATCA mezzanine cards, can be evaluated well before prototype fabrication. This methodology is also very useful to analyze changes in logic card placements and power or chassis-type configurations in "what-if" type of analyses.

Power and Fan System Verification

Don't forget about verification of the backplane power delivery. The power demands for specialized ATCA blades such as advanced switch and computational cards will rise above 200 watts/slot. New chassis designs can easily be required to support 5KW or more when higher power boards are implemented and the resulting power conversion inefficiencies and fan power requirements are added to the logic dissipation. Backplane currents can easily exceed 150 Amps under low voltage conditions! The verification of the backplane power delivery including the redundant backplane primary connectors is a mandatory issue for integrators and OEMs. The key is to test early and often to avoid costly operating problems later.

Summary

The use of controlled thermal and power testing provides board level ATCA suppliers with the benefits of better floor planning for high power parts, early design verification of the placement as well as the advantage of "what-if" analyses. The focus on key design parameters, such as thermal load, blockages and failure modes as discussed above, enables engineers to make thoughtful concise design decisions and revisions in a timely market driven environment without the damaging effects to parts, budget and schedule of conventional analysis and full system testing.

ATCA logic card architects and designers can feel a lot more comfortable with their choice of ATCA platform and

logic card designs when the system thermal and power performance can be validated early on and throughout the engineering development cycle.

F9 Systems designs and sells test fixture products for engineers designing ATCA systems. North East Systems Associates, Inc. (NESA) provides high performance engineering design and analysis services. NESA has been providing these services for 34 years. F9 Systems and NESA are teamed to provide off the shelf or custom engineering test solutions for your system designs.

If you would like more information please send email to kbreda@f9-systems.com or breda@nesa.com or call +1 781-248-9155 or +1 781-837-9088.

Thank you!