Configurability is Key to Delivering Custom ATR Solutions

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High-powered embedded computing equipment utilizing the Air Transport Rack (ATR) form factor is playing an ever-larger role in extreme, mission-critical applications in air, land, and sea environments. This compact, rugged, and light form factor has been around for nearly 70 years, and has proved to be both durable and flexible. Its small size meets the tight space constraints of the current generation of military grade equipment, and its flexibility, coupled with the proliferation of commercial off-the-shelf (COTS) components, allows ATR-based systems to meet cost and upgradeability goals for both legacy and emerging systems.

ATRs are used in aircraft, wheeled and tracked vehicles, and increasingly in shipborne applications. Each application is subject to its own array of harsh environmental factors—including shock, vibration, temperature, moisture and salt—that need to be taken into consideration. The ATR has been introduced into applications never before imagined, including surveillance, data collection and storage, and weapons control, all made possible by advances in open computing technology.

As computing power has increased, however, and ATRs are used in more strenuous avionic and military applications, performance requirements for ATR designs have steadily increased as well. This creates a challenge for systems designers working within the COTS framework. Each new application brings additional requirements that, if developed as custom solutions, would lead to unacceptably long development times. These requirements include variations in size and weight, exterior and aesthetic features, I/O and cabling, power supply and performance characteristics, and thermal management.

After considering these points, it's clear that customization is no longer the exception, but rather the norm, and measures must be taken to ensure that customers receive a solution that meets their unique needs in a timely manner.

The problem of mass customization

Manufacturing firms in many industries are experiencing a growing need for so-called 'mass customization', sometimes referred to as the long tail. This concept has primarily been used to understand the evolution of consumer markets. The idea is that while a product with a single configuration of features may satisfy a large part of the market, market growth is to be found in the long tail of the demand curve, which is usually composed of a collection of micromarkets with specific needs.

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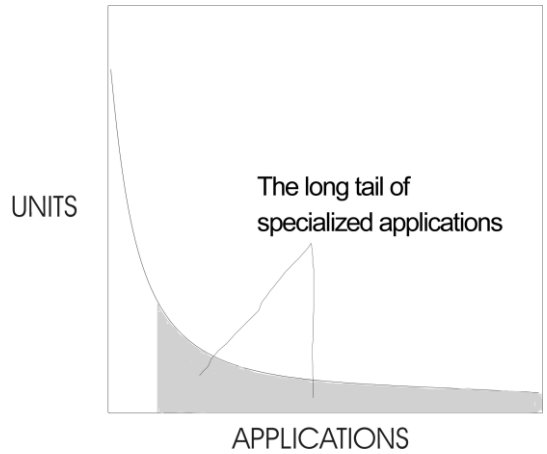
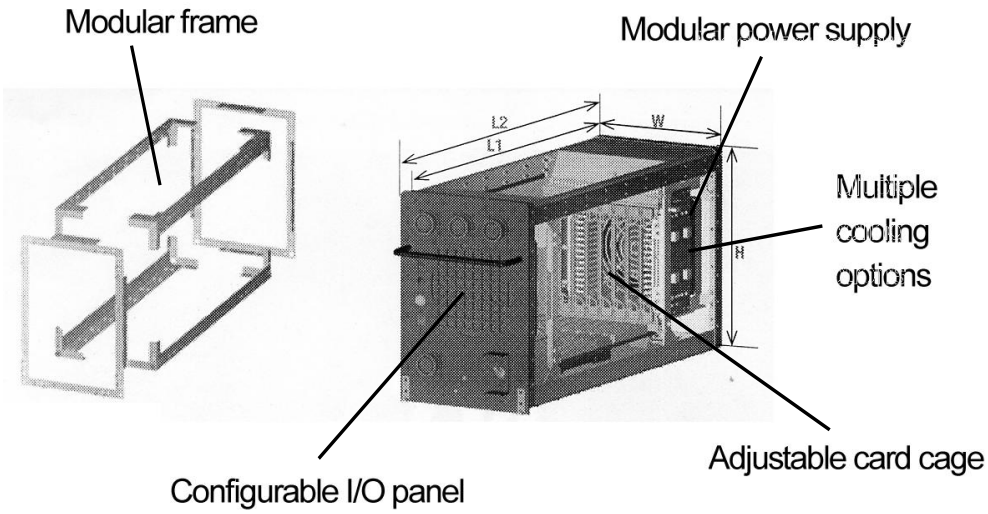


In fact, as the understanding of these sub-markets grows, manufacturers are discovering that they can better meet the needs of all their customers by offering multiple options, so customers have to accept fewer compromises.
The top suppliers of ATR enclosures, operating in a market where compromise is not an option and where customers demand fast turnaround on both initial shipments and reorders, have met this challenge through a strategy of configurability rather than customization.

Flexible platform

The key to achieving the goals of custom requirements, fast turnaround times, and rigorous standards begins with platform architecture. The core platform has to be designed from the outset to meet a variety of uses, even if those uses are not yet known.
Products developed in this way can be configured to meet multiple emerging and future standards as well as requirements for flexibility and scalability. The leading ATR enclosure manufacturers have designed their products to be configurable in the following dimensions:

- Modular power supply using AC or DC inputs
- Adjustable card cage
- Multiple form factors meeting ARINC 404A specifications
- Multiple cooling schemes, including convection and conduction, high-altitude configurations, and cold start-up heaters
- Modular frame
- Configurable I/O panels



These capabilities must be engineered into the core platform design of the ATR enclosure, so that customization is a matter of assembly and testing rather than ground-up redesign.

It is important to remember that, as specialized needs and the expectation of rapid delivery times increase, the requirements for reliability and performance remain high. In addition to the configurable components listed above, the core enclosure design features a rugged aluminum frame with solid rivet technology and is reinforced with aluminum outer panels, allowing the unit to meet strict specifications in the areas of:

- Operating temperature, from -40 degrees Celsius to +70 degrees Celsius
- High humidity and altitudes up to 50,000 feet
- Structural integrity using aircraft-grade construction to withstand the abuse of combat conditions
- Electromagnetic Compatibility (EMC), which requires that systems/equipment be able to tolerate a specified degree of interference and not generate more than a specified amount of interference to surrounding equipment

Thermal management as an example of configurability

Perhaps the most difficult challenge of ATR design is thermal management. At the same time that form factors are getting smaller, computing hardware is getting more powerful, increasing heat dissipation requirements. In addition, COTS boards have greater cooling requirements than customized boards. Conventional systems can use forced-air convection-cooled designs. Harsh and caustic environments (chemical, salt, sand and dust) require conduction cooling, which is less efficient and often requires creative solutions. To accommodate different cooling strategies for different environments, manufacturers such as SIE Computing Solutions have designed innovative solutions to meet a wide range of situations.

SIE addresses the heat dissipation problem in the conduction and air-over conduction ATR's by using state-of-the-art thermal simulation techniques to optimize the size and location of our innovative heat spreaders, which are responsible for conducting heat away from the chassis' power supply and card cage area. The resulting designs are then realized using a dip brazing fabrication process or modular conducting frames, which both completely seal the enclosure and aid in its natural convection to quickly cool the unit.

SIE also uses an innovative panel-over-frame design that both lowers weight and provides flexibility in meeting a wide range of deployable configurations. The use of the panel-over-frame design is similar in concept to the fabrication techniques used in aircraft where the combination of frame and exterior panels produce a rugged overall assembly. Our experience deploying equipment in many environments makes us uniquely positioned to address any new applications coming down the pike.

Positioned to meet future needs

The ATR has been proven again and again, and will continue to be utilized as designers adapt it to new situations. Enclosure manufacturers will respond with new materials, designs and technologies such as liquid cooling systems. Those manufacturers who have embraced the design philosophy of modularity and configurability over customization, and who leverage their experience to anticipate future needs, will be the best positioned to deliver in time and on spec. This approach supports the rapid deployment of COTS boards and other cutting edge components, to ensure that the latest and greatest technology is available to pilots, soldiers, and the many other users of mobile computing systems.

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