WHITE PAPER
DEFENSE

INTEGRATED MISSION COMPUTERS

The COTS alternative to custom systems and blade-based computing

Integrated Mission Computing represents a new approach to developing and implementing rugged computing systems. It gives system integrators a new tool for their system-design tool kit. By taking a COTS, pre-qualified rugged computing platform and adjusting it to their specific mission requirements, integrators can now bring their systems to market more quickly and with lower overall development costs. As a leading worldwide embedded computer manufacturer with a strong track-record in meeting the demands of the Defense sector, Kontron is well-positioned to support systems integrators with its proven range of Integrated Mission Computing solutions.

CONTENTS

EXECUTIVE SUMMARY

Since the commercial off-the-shelf (COTS) revolution largely ended most 100 % custom defense computing platforms some 25 years ago, there have essentially been two approaches to designing new systems; one designed with a full custom assembly using a mixture of COTS and custom components; the other leveraging COTS blade-style computing components with a custom backplane in a customized chassis.

There were standards to rely on such as classic 19-inch racks, the half- or full-ATR chassis standard captured by ARINC 404/600 and the various blade-computing standards including VME, Compact PCI, or VPX. However, integrators were still forced to do a great deal of system and mechanical engineering to bring their systems to a point where their application could be loaded and run, let alone ready for environmental testing and, ultimately, deployment.

Today, however, there is an alternative with the emergence of Integrated Mission Computers. In this whitepaper we will examine how these systems are designed and tested, and how they can be customized to meet specific mission requirements.

INTRODUCTION

With the emergence of multi-core processing, small-form-factor standards-based computing modules and very small form factor peripheral devices (also standards-based), it is now possible to design and bring to market very compact but configurable mission computing platforms, pre-qualified for the demanding environmental conditions required by defense systems.

We call these platforms Integrated Mission Computers. By leveraging these COTS platforms and modifying them to meet the needs of the mission at hand, system integrators can take months off the engineering effort involved in a development project and reduce overall project risk. While further environmental and emissions/susceptibility testing may still be necessary due to the customizations applied, having a system that has already undergone and passed such testing gives the integrator some confidence that their new custom system will also pass testing.

INTEGRATED MISSION COMPUTING: WHAT MAKES IT DIFFERENT?

Defense system integrators are increasingly turning to integrated mission computers as starting points for their rugged defense systems. By leveraging COTS or modified COTS systems that have previously undergone rugged environmental qualification testing, integrators not only have a platform ready to integrate their application without a lengthy up-front design and fabrication effort, but they also gain early confidence that their final system will be deployment-ready with little or no additional environmental qualification testing.

Integrated Mission Computers are typically relatively small, physically enclosed, rugged computing platform with standards-based I/O using mil-circular connectors. These systems often leverage COTS computing modules such as COM Express® or VNX and are essentially rugged equivalents of a typical PC – although often enhanced with specialized functionality or I/O. Most often these systems bolt down to a mounting surface (as opposed to the traditional rack-mount approach) and are often fanless, using natural air convection across finned surfaces for cooling, although fans or cold-plates are sometimes used.

By deploying multiple common or specialized units tied together with an Ethernet-based network backbone (such as found in VICTORY systems – see www.victory-standards.org/ for details), a systems integrator can quickly build a system-of-systems using COTS or modified COTS components. Later, when a unit needs a service or upgrade, the computer can be easily swapped-out using common tools without disturbing the rest of the system, minimizing mean-time-to repair/replace and, thus, platform down time.

Defense platforms using Integrated Mission Computers are thus not unlike systems leveraging the Industrial Internet-of-Things (IIoT) - small, often physically distributed boxes, each performing their particular function but tied together through a network backbone. Thus they enjoy many of the same benefits of IIoT systems.

INTEGRATED MISSION COMPUTERS: CHARACTERISTICS

A COTS Integrated Mission Computer can generally be characterized as follows:

- A physically small, sealed box with MIL-circular power and I/O connectors
- Usually fanless/passive-convection-cooled, but fans and other cooling methods may be used on more powerful units
- Typically based on a single-board computer, or COTS module (like COM Express®) with a carrier – therefore often a single-CPU solution (but certainly not always)
- Includes internal expansion capability for customization
- Usually DC powered, with 28 V being most common, but voltages between 9 V and 48 V are also occasionally used, and often a wide range of input power is supported

The I/O found in an Integrated Mission Computer can naturally vary depending on the approach taken by the supplier. However, one can generally find those I/Os typically found on a modern computer including:

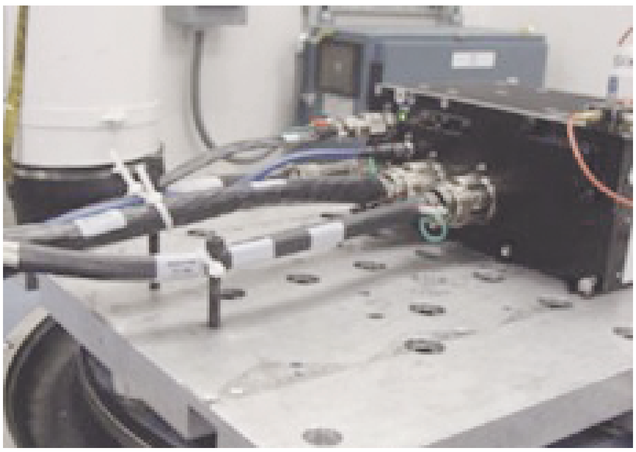
- Serial links (RS-232, RS-422/485)
- USB 2, and occasionally USB3
- Ethernet (of various speeds)
- Video (VGA, HDMI or Display Port)
- General purpose I/O (for discrete I/O signals)
- Audio (in, out)

From this point specialized I/O might be added. If the Integrated Mission Computer is designed for Avionics applications, it might include one or more MIL-STD-1553 or ARINC 429 interfaces. For automotive or other ground vehicle applications, it may include CANbus. For surveillance or media service applications, an Ethernet switch with multiple Gigabit Ethernet ports could be included. The list of potential options is nearly endless.

In the following example, we break down a typical Integrated Mission Computer. In this case, we find that inside the metal enclosure is a sandwich of circuit boards. A carrier card forms the center of this assembly. It provides connectors and mechanical mounting points for a COM Express® computing module, connectivity for the front panel Signal Interface Board (SIB) along with one or more expansion slots and connectors for storage or other peripheral devices. This assembly is securely mounted inside the enclosure with critical components attached to the enclosure top, or to an accessory/thermal plate under the assembly to provide a path for heat to escape to the outside of the unit. In this example, removable drive bays, the power supply, some additional front-panel I/O, and the bottom plate round out the system assembly.

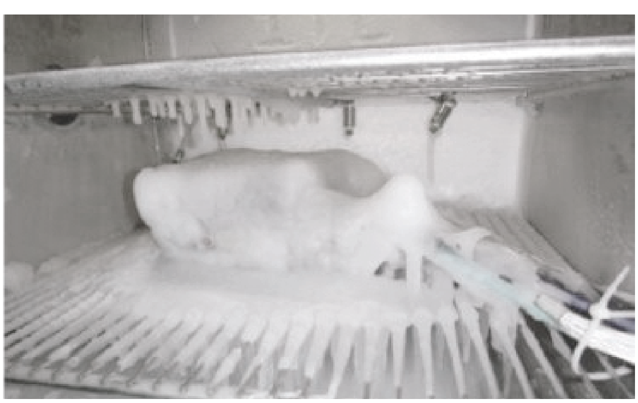
// Components of a typical Integrated Mission Computer. The carrier card (1) hosts the COM Express®-based computing module and heat spreader, along with the front-panel Signal Interface Board (or, SIB). This arrangement permits a range of onboard and front-panel customization options.

Very often, a baseline version of an Integrated Mission Computer undergoes stringent MIL-STD or DO-160 qualification testing for environmental conditions, emissions and susceptibility, and power and electrical conformance. By pre-qualifying a baseline unit, both the supplier and the system integrator gain confidence that a customized variant will also pass most, if not all, of the same testing.



// Shock and vibration testing

Depending on the nature of the customization, testing may be limited or indeed, completely waived; where, for example, the customization involves adding a specialized interface such as MIL-STD-1553 with no connector changes, and the chosen add-on board has itself undergone rugged qualification testing. In this case, the integrator may decide that the only testing necessary is emissions and susceptibility in relation to the new MIL-STD-1553 interface, simply accepting the remainder of the qualification data by reference or analysis. This reduced testing requirement can bring huge savings in both money and project time.



// Ice and Freezing Rain

The latest generation of Integrated Mission Computers pushes the definition of Small Form Factor embedded computing. By incorporating high-core-count CPUs, MXM-based expansion slots for high-performance GPU or FPGA computing modules, and higher-speed I/Os such as 2.5G or 10G Ethernet, and by offering fan or liquid-cooled kits as assembly options, these compact and powerful systems are attractive solutions for many tough problems. They provide I/O and processing performance rivaling much larger blade-based computing platforms, making them well suited to demanding applications including autonomous vehicle sensor processing, deep learning-based automatic target recognition, and vehicle self-protection systems.

INTEGRATED MISSION COMPUTERS: WHEN DO THEY MAKE SENSE?

There are certain types of design challenges where an Integrated Mission Computer-based solution makes good sense and others where they are not such a good fit. While processing performance is the critical criterion, almost all defense computing application choices tend to be driven by space, weight, and power considerations (SWaP).

- Smaller is always better, although there is generally a relationship between the size of the unit and the amount of computing power that the unit can provide. Weight is also often directly linked to the unit's size.
- Power can vary widely, and is directly related to processing performance. The smallest units may draw only a few Watts, while higher-performance systems may draw several hundred. However, once the accumulated power demand of all the components needed for an application reaches the 200+ Watt range, it may be better to consider a blade-based solution like VPX provided it fits within the space constraints concerned.

Thus, a balance of processing performance and features, power, and environmental requirements tend to drive system selection. Some of the most critical decision-making criteria will include:

- The type of processing – both CPU-based and using attached computing resources such as GPUs, FPGAs, or even the newest deep-learning silicon
- The front-panel I/O – clearly this will drive unit size, and costs if very high-speed links are required
- Specialized I/O or other functionality. Should an application require a specialized function or I/O that is not found on COTS Integrated Mission Computer variants, then additional engineering effort will be necessary. The more unusual or extensive the feature, the more costly it will be in both time and money. Some features may simply be impractical to add to a small Integrated Mission Computer, or perhaps less costly to integrate using blade-based solutions
- Storage needs, and whether it is fixed or removable

KONTRON'S APPROACH TO INTEGRATED MISSION COMPUTING

Kontron entered the Integrated Mission Computing market several years ago with the COBALT™ line of systems. After a number of generations and with sizable deployments across multiple defense, avionics and industrial vehicle applications, the current COBALT™ 901 | 400 series is a 30-55 W class of Integrated Mission Computer.

// COBALT™ 901 Integrated Mission Computer

The COBALT™ 901 is based on the Kontron COMe-bSL6 which uses the Intel® Quad-Core™ E3-1505L (formerly Sky Lake) running at 1.7 GHz. This Xeon®-class processor is ideal for mission computing as it provides both AVX256 floating-point vector units and an Intel® HD Graphics P530 engine.

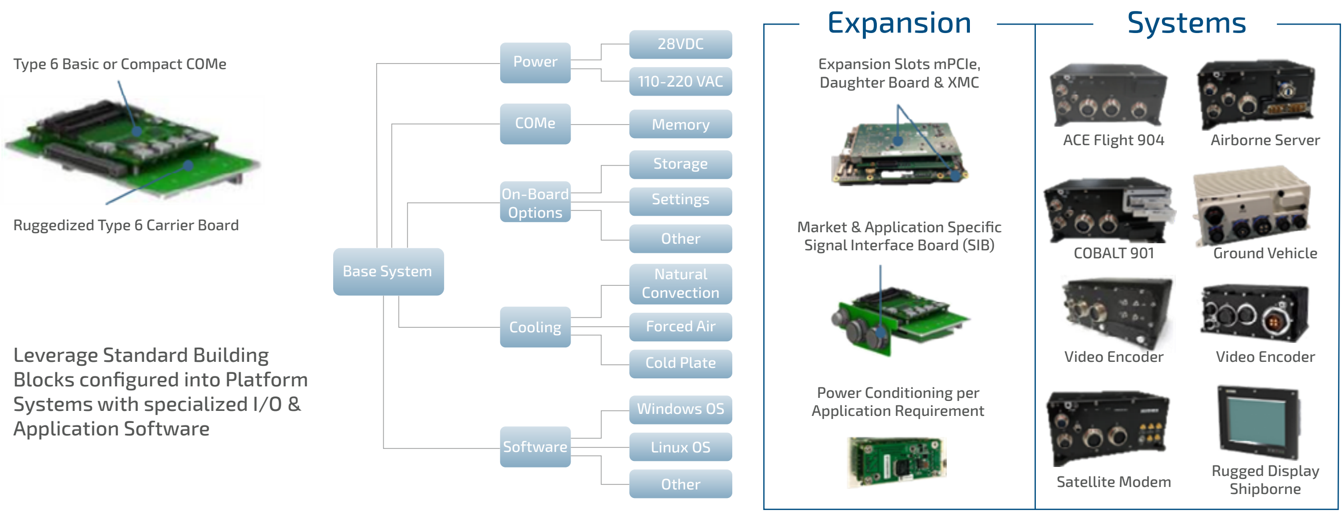
It is offered in four COTS variants available, each with dual removable solid-state drive bays:

- Base COBALT™ 901 | 400
- COBALT™ 901 | 400 Media Server
- COBALT™ 901 | 400 with MIL-STD-1553
- COBALT™ 901 | 400 with CANBus

COBALT™ 901 meets a broad range of applications, even without further customization. However, multiple methods of customization are available:

- Adjusting or tailoring the population of the mini-PCIe/mSATA slots
- Adding (or removing) a Gigabit Ethernet switch (two switch models are available)
- Adding an XMC for more specialized I/O

COMe – Carrier – Expansion – System

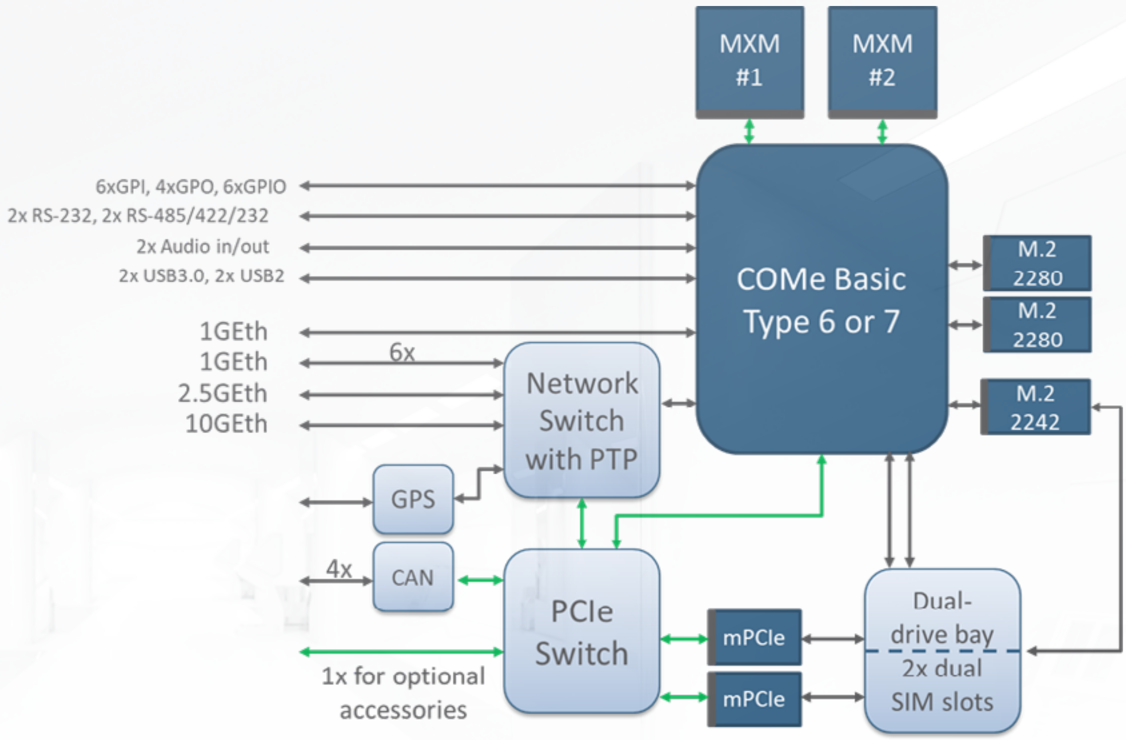


// COBALT 901: Common Integrated Mission Computing Platform can be easily adapted and customized to meet specific mission requirements.

By providing a carrier/COM Express® "stack" with flexible expansion sites, the COBALT™ 901 forms a flexible, expandable, and adaptable architecture for an integrated mission computing platform. By using a common "Signal Interface Board" along with space for additional custom connectors, the COBALT™ 901 enables rapid customization to meet specific mission requirements.

// COBALT™ S1901: High-performance Integrated Mission Computer

The new COBALT™ S1901 platform builds on this same architectural approach, but targets systems in the 50 to 250 watts in power. The COBALT™ S1901 uses the same carrier/COM Express® module approach as the COBALT™ 901, but the new S1901 carrier offers significantly more I/O and expansion, including two MXM sites (for graphics processors, FPGAs or other high-performance computing), three M.2 sites, two mPCI sites, and an on-board Ethernet switch with 1G, 2.5G, and 10G Ethernet ports.



// COBALT™ S1901 Carrier Block Diagram

The COBALT™ S1901 also offers superior thermal capabilities to support higher-power COM Express® modules with one or two MXM-based graphics processing unit (GPU) modules. The baseline unit can support up to 150 W of power across the whole -40 °C to 71 °C operating range with its fanless convection-cooled design, and up to 250 W with the addition of an optional IP67-rated fan kit. A liquid-cooled jacket is even in the works to address those high-performance systems that cannot utilize a fan-based cooling mechanism.

Like the COBALT™ 901, the COBALT™ S1901 is offered both in COTS and customized variants. The COTS COBALT™ S1901 is based on the more powerful COMe-bBD7 using the Intel® Xeon® D-1539 8-core processor running at 1.6 GHz, along with an NVidia T1000 GPU. Other processor and GPU options are available for customized variants, along with a host of I/O options.

The COBALT™ 901 and S1901 platforms represent a continuous spectrum of integrated mission computing solutions from 35 to 250 Watts. By building on the pre-qualified COTS 901 and S1901 variants, Kontron can quickly create customized solutions to meet mission requirements, and customers benefit not only from this rapid development, but also from the comfort that the baseline system from which their solution was derived has already undergone rugged environmental, power, and emissions qualification testing.

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About Kontron – Member of the S&T Group

Kontron is a global leader in IoT/Embedded Computing Technology (ECT). As part of the S&T technology group, Kontron offers individual solutions in the areas of Internet of Things (IoT) and Industry 4.0 through a combined portfolio of hardware, software and services. With its standard and customized products based on highly reliable state-of-the-art technologies, Kontron provides secure and innovative applications for a wide variety of industries. As a result, customers benefit from accelerated time-to-market, lower total cost of ownership, extended product lifecycles and the best fully integrated applications.

For more information, please visit: **www.kontron.com**

About the Intel® Partner Alliance

From modular components to market-ready systems, Intel and the over 1,000 global member companies of the Intel® Partner Alliance provide scalable, interoperable solutions that accelerate deployment of intelligent devices and end-to-end analytics. Close collaboration with Intel and each other enables Alliance members to innovate with the latest IoT technologies, helping developers deliver first-in-market solutions.

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