

## L-3 Communications Finds That Expedition Enterprise Grows as their Needs Grow

*L-3 Communications is the sixth largest military contractor in the United States, providing products for Command, Control, and Communications, Intelligence, Surveillance, and Reconnaissance (C3ISR), Aircraft Modernization and Maintenance, and others. They are also a major provider of homeland defense products and services.*

It's no surprise that military contractors often work with the very leading edge of technology, pushing previous boundaries, and moving into the unknown. When L-3 Communications recently took on a very complex design in a limited-size footprint, they indeed pushed boundaries into the unknown, but printed circuit board success was ensured by L-3's use of Mentor Graphics Expedition Enterprise and its capability to grow as the customer's needs grow.

### **Fast Signals, Dense Routing, and Small Form Factor: A Big Challenge**

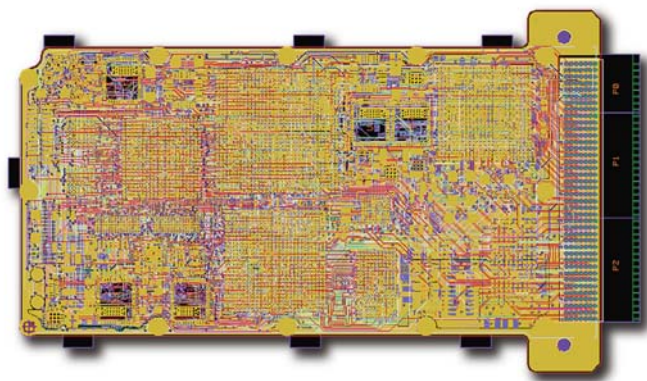
Working together, electrical engineer Michael Talbot and printed circuit board designer Jayson Harames at L-3 Communication's office in Salt Lake City, Utah, have used Expedition Enterprise for a number of designs. They have established a standard workflow around Expedition.

"We start off in design capture and then use the constraint editor to input our design constraints. We simulate the board using HyperLynx and then use the Expedition flow to layout the board," described Talbot.

Talbot and Harames were given a project that would push the designers' knowledge and skills, but Expedition would be there with the tools they needed. They knew they were in for a challenging design when they were presented the schematic and the requirement that it be contained on a 3U-size board. The small form factor was one thing, but heaped on top of this was the fact that the onboard processor would be running at 1+ GHz, there was 512 MB of DDR memory, a large FPGA, and a serial RapidIO switch. The final layout of the board is shown in the figure below.

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*"Using the Expedition Enterprise flow, we were able to analyze what needed to be done with high speed constraints, understand the final product and what it needed to look like, and apply the tools to deliver a reliable board."*

Jayson Harames  
Printed Circuit Board Designer  
L-3 Communications

## Mentor Supports the Customer

They had been using Expedition Enterprise awhile to produce a number of challenging layouts, but this would require technology that they had not used extensively and education about the technology as well.

High Density Interconnect (HDI) printed circuit board technology was introduced to L-3 shortly before this project. However, this team had only limited experience with HDI. While they had designed other boards with perhaps a couple hundred microvias, this would be their first with multiple-thousands.

With HDI technology introduced into our company, we had to learn a lot; we weren't experts," acknowledged Harames. The amount of time needed to become fully up-to-speed was considerably beyond what the project could make available.

"We quickly understood we needed more education," said Harames. "We teamed up with Mentor to use their consultants to educate us in HDI."

Mentor's consultants, with considerable expertise in HDI, provided the needed support to accelerate the L-3 team's learning curve. As their knowledge grew, Expedition was there with the technology in place to let them take maximum advantage of HDI technology.

## Entering Constraints

With knowledge in hand and a mentor from Mentor, the L-3 team moved into constraint entry. The

design called for several serial RapidIO busses as well as PCI Express busses...all operating at multi-gigabit-per-second rates. With Expedition's constraint editor, the extremely tight tolerances required to match differential pairs were straight forward.

"The constraint editor helped because it looks at the entire net; it doesn't differentiate between pieces of the net. It also allowed us to pre-skew signals at a large connector to account for the differential skewing the connector produced," said Talbot. "The most useful feature was entering the complex equations for our DDR2 constraints. It made it a lot simpler, and made it much easier to route the board successfully...we met the real DDR2 constraints as opposed to the rule of thumb 'match everything.'"

## Pre-Layout Simulation

Another challenge of the board was the proliferation of multi-gigabit-per-second signals. With switching speeds in this range, signal integrity (SI), as well as power integrity (PI) become critical factors to ensuring a properly working PC board.

"We used HyperLynx to establish the basic ground rules for routing high-density lines," said Talbot. "A lot of time was spent simulating to establish a set of rules to route our multi-gigabit lines. We used parallelism to make them easier to route."

With military communications, signal integrity is absolutely critical. "Signal integrity is critical to our designs. Understanding the total

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Michael Talbot,  
Electrical Engineer, L-3  
Communications

impact of SI is one of the driving factors of what we do," emphasizes Harames. Although more critical than some applications, Harames acknowledges that "our SI and PI problems are probably the same problems that everyone has. Signal edges are faster; density is tighter, higher pin counts cause us to put signals closer together than we'd like."

In the past, boards had been designed using "rules of thumb." Moving into the world of HDI and extremely fast signals means there is no longer the luxury of rules of thumb. Luxury? Actually, yes: rules of thumb generally provide very conservative constraints to ensure that every design works. When density increases, this luxury of space no longer exists and the rules of thumb have to be violated just to get the board routed. With HyperLynx simulation, routing can be simulated and tolerances reduced based on the actual signals present in the traces, rather than rules of thumb.

## Layout and Routing

If it seems that constraint entry and simulation are treated with extreme care at L-3, there is a reason: L-3 does not produce prototype boards. So, as Harames observes “getting it right the first time is critical to what we do!” Of course, that carries through into layout and routing as well. They found that Expedition handled the HDI technology as smoothly and accurately as their previous (non-HDI) designs.

Mentor tools have a reputation of being easy to learn and quick to apply to new problems. “Handling HDI within Expedition was relatively straight forward,” said Harames. “I was able to use the tool the way I was accustomed to.”

“We did some post route analysis to determine what the autorouter did with the constraints we entered and make sure they were correct and make necessary adjustments. The end result was that we were able to produce the fabrication files using technology new to us, and still meet our schedule.”

## Project Debriefing

Both Talbot and Harames agreed that they were very pleased at how well Expedition Enterprise handled moving into technologies with which they had little previous experience, as well as Mentor’s consulting support to ensure their success. Despite the fact that they had to educate themselves in a new technology, their schedules were met. In fact, the layout schedule originally called for 12 weeks of time, but had to be reduced to just six; nevertheless the new schedule was achieved.

There are also forward-looking benefits to this particular project and the educational process that accompanied it. “We’re going to benefit from the success of this project,” said Talbot. “We have already started to incorporate HDI interconnect in more of our boards.”

As with any venture into the unknown, there were some surprises as well. Used to dealing with impedance mismatches and reflections resulting from through-hole vias, HDI

microvia technology provided the surprise for Harames: “We found that the total SI improved using microvias even though the nets were tighter packed and there was more opportunity for crosstalk.”

Harames summed up the entire project this way:

“With high speed design the total quality of the board is extremely important. Using the Expedition Enterprise flow, we were able to analyze what needed to be done with high speed constraints, understand the final product and what it needed to look like, and apply the tools to deliver reliable board; meet all the high speed constraints; ensure that the bus structures work properly; and that signal integrity was properly maintained.

“The whole spectrum of the tool helped us accomplish these purposes.”

**For more information, contact 1-800-547-3000 (503-685-8000)  
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