Mobile 4th Generation Intel® Core™ Processor, Modular Board Design (MBD) Based on the Intel® ISX Platform

Hardware Reference Design to Accelerate Time-to-Market
White Paper

February 2016

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Revision History

Date	Revision	Description
February 2016	002	• Changed to new white paper format. • Revised document for clarity.
November 2014	001	Initial release.

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1.0 Executive Summary

Internet of Things (IoT) sales opportunities for the Intel® Architecture are great within the Industrial PC, Point-Of-Sale, Digital Signage, Digital Security Surveillance, and broad market segments.

The typical board design cycle for an IoT application that uses the Intel® Architecture (IA) takes about four to five months. This is due to the small form factors for the boards and challenging signal integrity requirements for ever increasing, and higher signal speeds.

The Modular Board Design (MBD) for IA Core™ Platforms introduced in this white paper gives board designers and project managers a great new option to speed up the overall design cycle when faced with limited resources, by providing:

- A small, conveniently portable form factor for IoT specific applications that also adheres to the Layout Design Guidelines
- Editable schematic and layout files (for copy-exact or customized Input/Output (I/O) interfaces)
- Complete bundle of industry-standard manufacturing-ready Tape-Out files such as Gerber file, board stack-up data, and so on

The Intel® Embedded Design Center (EDC) provides qualified developers with web-based access to technical resources. Access Intel® Confidential design materials, step-by step guidance, application reference solutions, training, Intel's tool loaner program, and connect with an e-help desk and the embedded community.

Design Fast. *Design Smart*. *Get started today*, at:

http://www.intel.com/content/www/us/en/intelligent-systems/intelligent-system-extended-modular-board-design.html

The following sections are idea **topics** that can be used for content in a whitepaper. Alternately, you can use any topic that is appropriate for your situation/discussion.

Use the section formatting samples presented at the link above.

1.1 Terminology

Table 1. Terminology

Term	Description
EDC	Embedded Design Center
DRAM	Dynamic Random Access Memory
GPIO	General Purpose Input Output
I/O	Input/Output
IA	Intel® Architecture (IA)
IMVP	Intel Mobile Voltage Positioning
IoT	Internet of Things
LVDS	Low Voltage Differential Signal
MBD	Modular Board Design
mDP	Mini Display Port
MMR	Memory Module Routing
MXM	Mobile PCI Express* Module
ODM	Original Design Manufacturers
OPS	Open Pluggable Specification
PCB	Printed Circuit Board
PCH	Platform Controller Hub
SIO	Serial Data Input Output
TTM	Time-to-Market
VR	Voltage Regulator

1.2 Reference Documents

Table 2. Reference Documents

Document	Document No./Location
None	N/A

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2.0 Background and History

Intel has been in the embedded business for a long time and has set the standard, pushing the embedded industry forward, decade after decade.

However, there is no standard motherboard form factor produced for the embedded design market, or widely used in it.

This is a major difference between the embedded market and the desktop market. In the desktop market there is a standard motherboard form factor, one that has existed for some time.

In the embedded design space, the focus is the customization for various types of usage models, and in recent years, some board vendors have developed and released a standard board form factor that caters to embedded niche segments: Mini-ITX*, 5.25", u-ATX, and so forth.

Intel has more than 3,000 customers in the embedded market who design with Intel processors and chipsets. This huge customer base is represented by companies with a wide variety of unique design prospects and board form factors.

System designs vary in terms of board size. But ever increasing signal speeds bring with them challenging signal integrity requirements, for all of these designs.

It is a time-consuming, labor-intensive work effort and a technical challenge for the Intel support team to sustain and service such a huge customer based.

For some of Intel's newer customers (especially the ones who are not very familiar with the IA), they may end up spending three to five months on board development, and thus completely miss the time-to-market opportunity to sell products to their customers and end-users.

Intel's customers can be exposed to high-speed signal routing issues, when a small form factor is in use. This can be a memory data signals routing violation that produces signal integrity deterioration due to crosstalk, electrical noise, bad return path, and so forth. In a case like this, memory signals routing and rectification becomes the most time consuming part of the layout design process.

In schematic design, errors often occur when the designer makes mistakes in the termination design, with the number of decoupling caps, or with pin strapping. Any of these can make the board un-bootable.

During layout design, designer error can be caused by non-compliance with traces design rules and component placing. These lead to signal integrity issues. When these human errors occur, a customer may end up spending more than five months on the design cycle.

There is also another big challenge: Optimizing hardware design to accommodate maximum feature capability on the board, while at the same time being able to ensure flexibility for form factors and I/O customization.

The Modular Board Design (MBD) concept introduces the flexibility not only for board customization, but also for accelerating the time-to-market.

This technical content in this white paper that follows is divided into the following main topic sections:

- The Modular Board Design (MBD) Solution
- Intel® Architecture Modular Board Design: Six Key Advantages
- Board Design Usage: Integrating MBD into the Design Lifecycle
- The MBD Super Set: MBD Enhancement

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3.0 The Modular Board Design (MBD) Solution

The typical board design cycle for an embedded application that uses the Intel® Architecture (IA) is about three to five months. This is the time required to accomplish the following (chronologically):

- Schematics Design
- Board Tape-Out File development
- Debugging and validation

Adopting the MBD simplifies the development effort and shortens the Time-To-Market (TTM). The board level and also system level have been validated together with a regulatory compliance pre-scan test.

By using the MBD, a design-house customer can have a production ready board and system as a quick reference. They can also choose either to fully deploy the complete solution, or to instead customize the system based on their own product requirements.

Modular Board Design (MBD) ensures flexibility for board customization, while at the same time, accelerating TTM for Intel customers.

The Modular Board Design (MBD) for IA Core™ Platforms introduced in this white paper gives board designers and project managers a great design package for IoT specific applications that provides all of the following:

- Small (conveniently portable) form factor
- Editable schematic and layout files (for copy-exact or customized Input/Output (I/O) interfaces)
- Comprehensive bundle of industry-standard manufacturing ready Tape-Out files such as Gerber file, board stack-up data, and so on.

Figure 1 and Figure 2 show the MBD Block Diagram and Board Layout.

Figure 1 Block Diagram: 4th Generation Intel® Core™ Processor (Code name: Haswell) Based on Intel® Intelligent System Extended (Intel®ISX) Platform, Using Modular Board Design

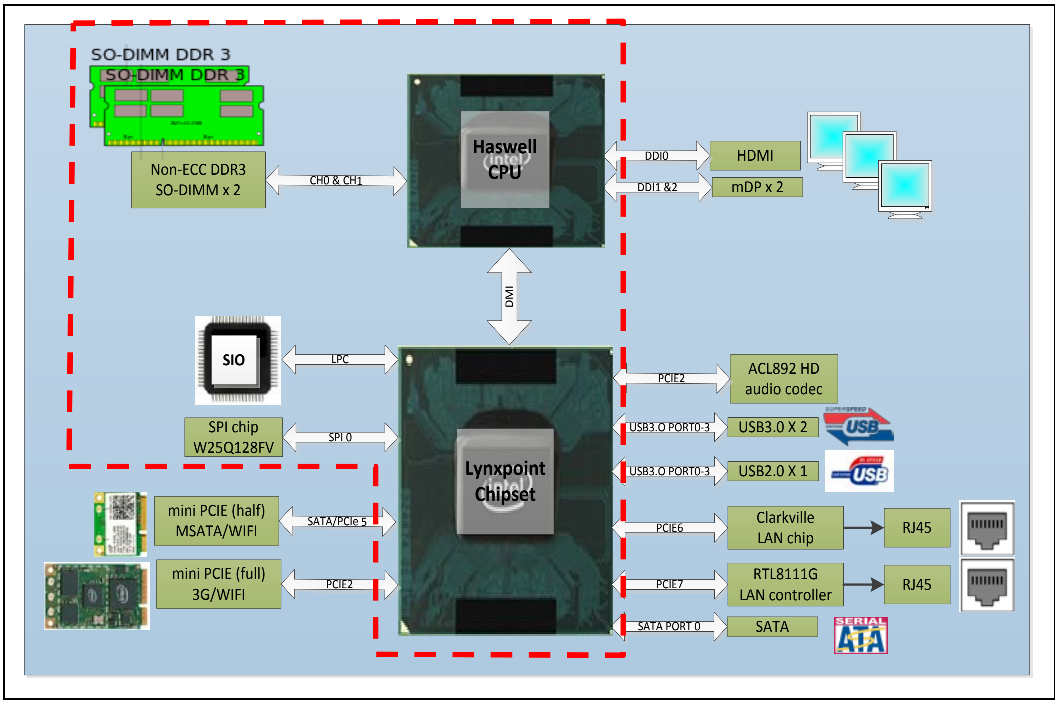
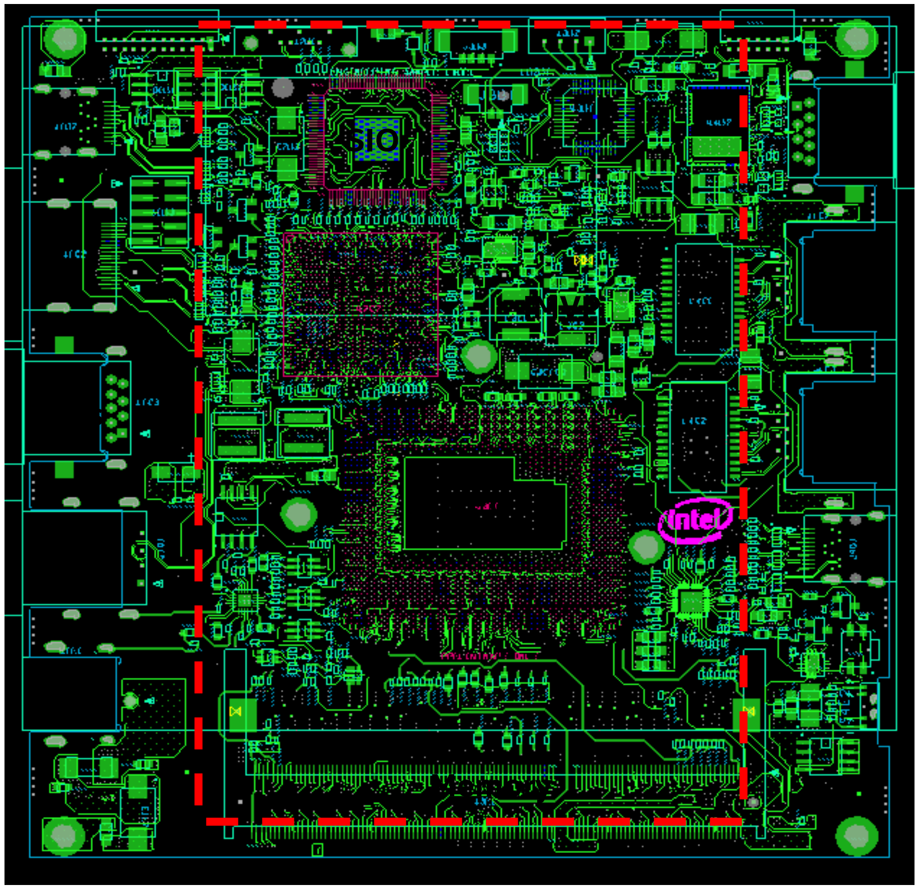


Figure 2 Board Layout: 4th Generation Intel® Core™ Processor (Code name: Haswell) Based on Intel® ISX Platform, Using Modular Board Design



MBD is comprised of complete schematic and routing between the most critical components (70% of Board Design time is spent on the following):

- Processor
- Chipset
- Memory
- Controller (SIO/EC)
- Voltage Regulators (VR), including:
  - Core VR: Intel Mobile Voltage Positioning (IMVP)

The remainder of the board design time is dedicated to Input Output (I/O) and display interface customization.

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4.0 Intel® Architecture Modular Board Design: Six Key Advantages

The MBD Reference Design File Package contains:

- The main routing traces for Intel® Architecture Silicon
- Associate source files, including:
  - The full schematics file (.cpm/.dsn),
  - Board files (.brd)
  - Manufacturing Tape-Out File (Gerber, board stack up, and so forth)

The MBD source file is Cadence* and OrCAD* Design Tool based. No concern is necessary by the designer regarding the component symbols for the Cadence* and OrCAD* Design Tool.

This is because the entire MBD Archive Library is included together with the schematic archive file. Board designers are able to modify designs directly with the MBD source file.

Or, they can add in their own customer's symbols into the MBD. Either way, designers are able to edit the required interfaces, and complete the schematic and layout files to fit into any of embedded form factor, without having to start from scratch with an entire new board design.

The MBD Reference Files have been validated via a regulatory compliance pre-scan test.

Thus, customers can complete all board design activities (from amongst the very large selection of different sized boards and form factors) in a very tight time frame, with fewer debugging issues related to Power Supply delivery and Signal Integrity for High-Speed Signals.

Customers can thus achieve speedy time-to-market by cutting total design time and eliminating debug time sinks and delays.

Using MBD can streamline the customer design cycle through the following six strengths, as described in the following sections of this document.

4.1 Shortens the Design Cycle

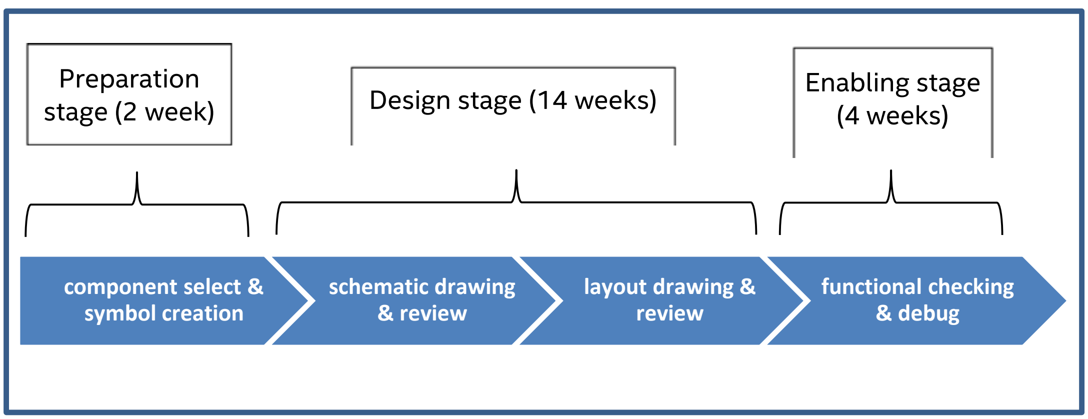
By using MBD design files customers do not have to start from scratch when designing a board that is based on newly released or unfamiliar IA platform. Customers can leverage the MBD design file and focus solely on I/O design and connection routing.

Generally, Memory Module Routing (MMR), VRs, and power sequencing design are the most difficult design tasks and consume the most time in the design phases. Additionally, board designers are also required to make extra efforts and take extra time to review all circuitry to make sure signals are properly connected.

Because MBD makes up 70% of a complete board design, the MBD solution provides significant design cycle time savings, possibly equating to a 50% reduction in a customer's overall design efforts. Designers are able to shorten the design cycle of their new products and majorly reduce overall time-to-market.

Figure 3 and Figure 4 show the typical design timeline, without MBD and with MBD. As shown in the figures, MBD can help shorten customer board design cycle from approximately four to five months to one to two months. At the same time, MBD allows for a reduction in the resources required for board design.

Figure 3 Without MBD Design Cycle



Without using MBD (Figure 3), designers must start a design with a new symbol footprint, especially for the VR, controller ICs, and active components. Designers also need some time to study components in order to lessen the Bill of Materials (BOM) cost, by researching part availability on the market.

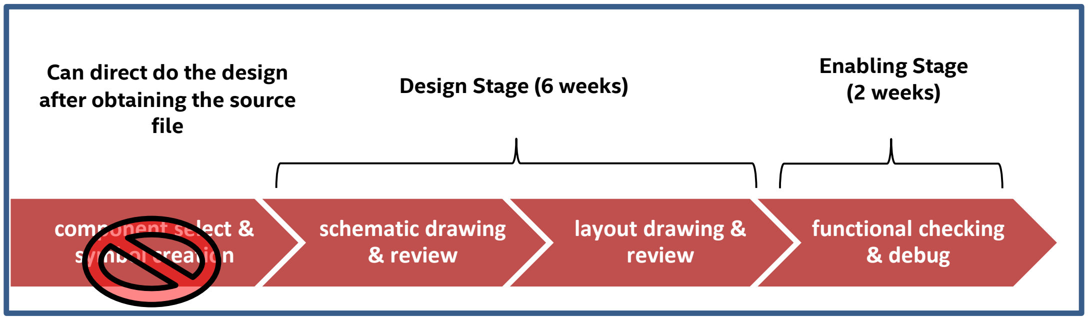
During the schematic design phase, a designer needs to make sure that all circuits between the CPU, Platform Controller Hub (PCH), and VRs are connected correctly. The Designer also needs to be careful with the power sequence design, in regards to the correct setting on the timing delay.

In the Layout Design part of board design, the designer needs to study component placement and routing, with MMR taking the most time.

The design lifecycle, start to finish, normally takes an Intel customer an average of about 14 weeks:

- 5 weeks for Schematic Design
- 8 weeks for Layout Design
- 1 week for the Design Review

Figure 4 With MBD Design Cycle



Using MBD, (as depicted in Figure 4), the designer can simply use the MBD symbol libraries. These libraries include the main VRs and Controller. The designer doesn't need to create a new symbol footprint in the main design, and can also utilize I/O symbols that already have their own library.

The MBD includes MMR, inclusion of which provides significant design time savings: A reduction from approximately 14 weeks down to just 6 weeks.

As the MBD is pre-validated by Intel to make sure there is proper functioning, it creates a low-risk design environment for the following major steps:

- Power Sequence
- Power Delivery
- Memory

Because of this, during the Enabling Stage, there is a much greater chance that the system will boot up.

Because of this, functional testing and software integration can begin much more quickly. This "sling shot" leap right into the major design work instantly, "jump starts" the important design phases of testing and integration.

MBD makes it possible for a < 50% reduction in the time spent on System Enabling.

4.2 Familiarizes New Customers with the Intel® Architecture

For new Intel customers who are not yet familiar with the Intel® Architecture (IA), MBD is a great way to design products using an Intel processor. These new customers are able design with very little IA knowledge. This makes it so there is little to no risk of design time delays due to learning the IA.

MBD covers 70% of all Board Design activities, including the most time-consuming, complex IA board design elements like: Memory Signals routing, Power Delivery, Power Sequencing, and General Purpose Input Output (GPIO) Strapping. Thus, new customers are able to keep at a minimum any time spent—without worry—on these IA design items, and concentrate instead just on the design of their own I/Os and other design blocks like application software development, and so forth.

4.3 Complies with the Intel® Design Guide

In general these are the Design Quality issues that are the largest when designing a new IA platform:

- Noise: includes crosstalk, mutual inductance, and substrate coupling
- Signal Integrity: affects all levels of electrical design for high speed signals and packaging

To prevent these design quality issues, MBD design makes sure it is complying with the Intel Simulation and Design Guide for interconnection between the CPU and memory, involving the Printed Circuit Board (PCB) DRAM package and DRAM I/O driver.

Also, the Intel System Integration Team has inspected the MBD Design so that any customer layout issue, when using the MBD, can be avoided altogether.

However, customers are required to simulate and validate their own I/O routing for their customized board designs.

4.4 Reduces Platform Design Error

In schematic design, most design errors are caused by wrong pin to pin connection, CPU/PCH strapping, termination, discrete component value, number of decoupling caps required to meet the specification, and so forth.

The Intel® Architecture is complex. Having the awareness about these schematic design errors could, sometimes, not be part of the mentality of board designers, especially at a company that is a new Intel customer, or at a company where the designers don't know the IA very well at all.

Board designers might not be aware of, for example, a key Intel design spec created by the Product Development Group or one that is available from the Intel® Embedded Design Center (EDC). An Intel document like this could be 500 pages long, or more. It could very possibly provide detailed design help and instructions that could prevent error occurrences.

IA design errors and VRs can be reduced when board designers adopt MBD. Overall, human errors will be greatly reduced.

Also, when designers start a new design using MBD, they will not need to go through the large number of requirements that are listed in a Platform Design Guide (PDG) or in an External Design Specification (EDS) or datasheet that make it necessary to get a hold of and set up necessary design parts.

4.5 Scales with a Wide Variety of Small Form Factors

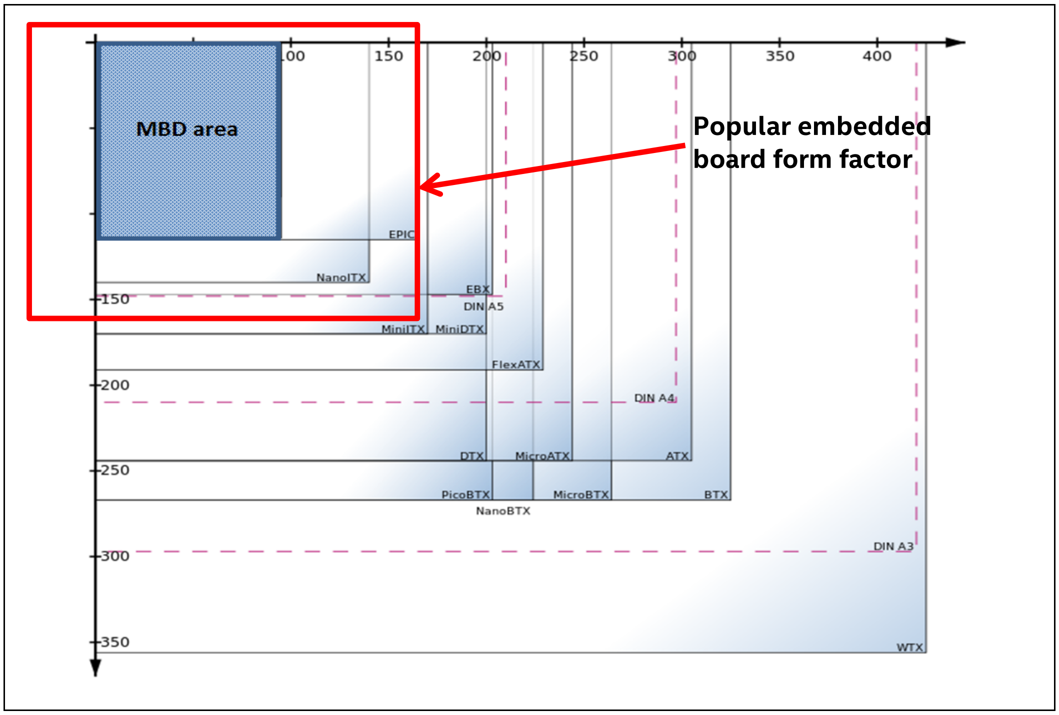
As the size of the MBD is small, any customer can use MBD with many different kinds of form factors and platforms, just by extending the I/O routing traces.

The average MBD area for the 4th Generation Intel® Core™ Processor based on the Intel® Intelligent System Extended (Intel® ISX) Platform is 71 mm x 114 mm; 3” x 4”.

MBD is best for any board that is within the following size range:

- From a nano-ITX (120 mm x 120 mm; 4.7” x 4.7”) form factor; up to:
- A standard ATX form factor (305 mm x 244 mm; 12” x 9.6”)

Figure 5 Design Area: MBD Size vs Average Standard Board Size on the Market



4.6 Scales with Future Platforms

MBD can increase and maintain customer design in "stickiness," across Intel® Processors' Tock-Tick generations.

By standardizing the placement of I/Os on the board, board designers can simply reuse I/Os from previous boards and upgrade to the most recent IA MBD when designing the new board.

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5.0 Board Design Usage: Integrating MBD into the Design Lifecycle

The Intel MBD comes in a package that contains (available from the EDC):

- MBD design schematic source file: Cadence.cpm
- MBD design layout file: Cadence* Allegro* PCB.brd

This chapter provides help for board designers on how to start a new board design using the MBD reference files. It contains the following instructions:

- Starting from MBD design schematic source file
- Starting from MBD design layout source file

5.1 Starting Design in MBD Mode: Using the Cadence* Design Systems* Schematic Source File

The MBD reference files include the entire Cadence* schematic source file (.cpm) archive. This includes the symbols library for CPU, PCH, VRs, Serial Data Input Output (SIO) memory socket, and other components that go on the MBD form factor.

Board designers can use the MBD source file directly, when starting schematic design for a new board. This makes using the components symbol no longer required in any way.

Also, board designers can add their own symbols library (especially for I/O ports or connectors) simply by linking to a library using Cadence SPB 16.5* software.

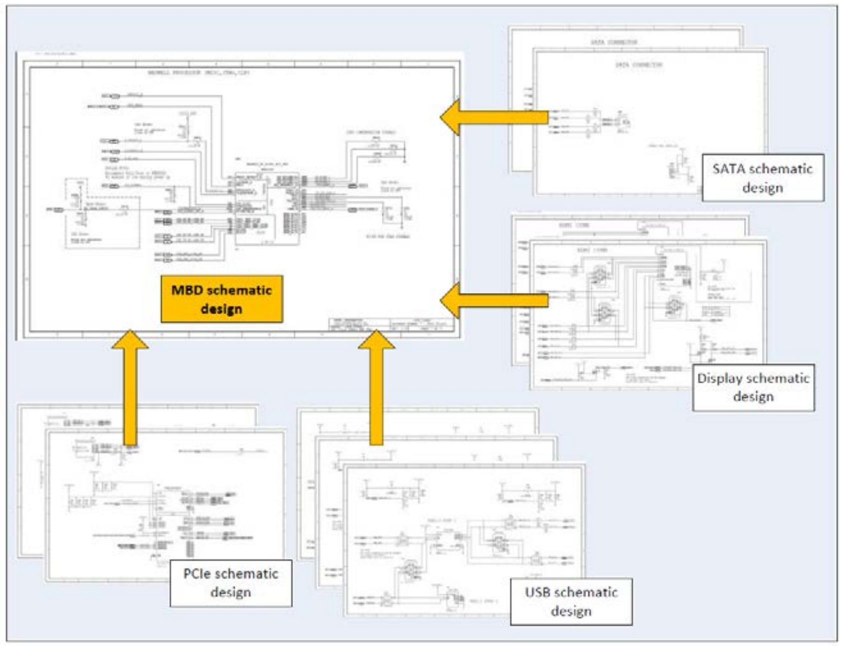
In addition, board designers can re-use their own I/O design simply by doing a "copy and paste" into the MBD archive file, compiling the entire schematic design.

As shown in **Figure 6**, board designers can merge their own SATA, display, Peripheral Component Interconnect Express (PCIe*), and USB design with the MBD design, and compile it as a complete system schematic design file.

The designer needs only to make sure the net name on the I/O connector is the same as the net name in the MBD design.

Once the schematic design is finished, the designer can quickly create the BOM List using Cadence*, as the MBD also already contains all of the source file information.

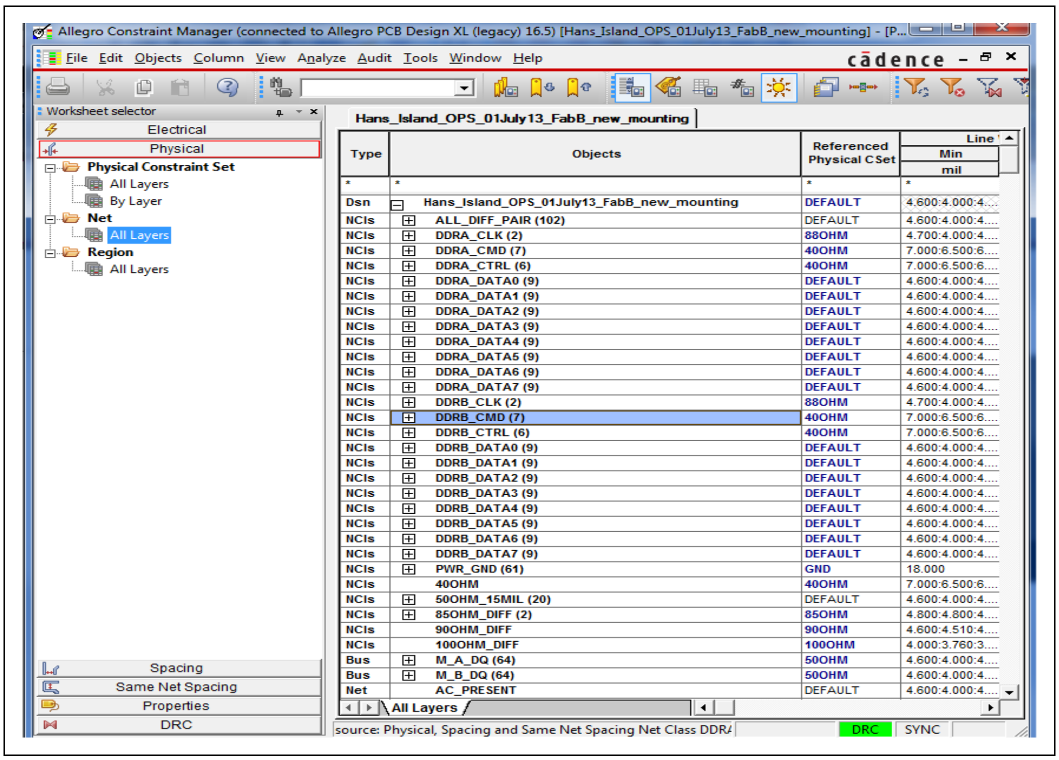
Figure 6 MBD Additions through I/O Schematic Design



5.2 Starting Design in MBD Mode: Using the Cadence* Allegro* Layout Source File

The MBD reference files also contain a complete Cadence* layout file (.brd). This includes all constraint manager routing settings (see Figure 7). Thus, the designer no longer needs to reinsert all of the traces routing settings like spacing, trace length, impedances, and spend time being delayed with insertions of high-speed signals like memory and PCIe*.

Figure 7 Constraint Manager Setting for MBD



After importing the updated schematic file Board, designers can simply open the layout file using the Cadence* Allegro* PCB Editor and continue I/O routing.

Figure 8, Figure 9, and Figure 10 show how a board designer can add an I/O connector to the design, using the MBD layout.

Basically, the board designer needs to complete about 80% of the schematic design before starting the layout design.

In the first layout design step, the board designer needs to open the provided MBD layout file, and then import the entire logical symbol from the updated schematic. All other components automatically appear on the layout, and the designer can begin putting components on top of the MBD layout.

The MBD design consists of a small form factor (71 mm x 114 mm), so a small number of I/Os can be routed out.

If the board designer plans to extend the board with MBD recommended I/Os, the designer can continue routing, without touching the MBD portion design.

Or, if the board designer wants to add more I/Os than those supported by the MBD, it is recommended to add more PCB layer counts to enable the existence of additional I/O traces routing.

Figure 8 Adding and Inserting an mDP Connector into the MBD Layout

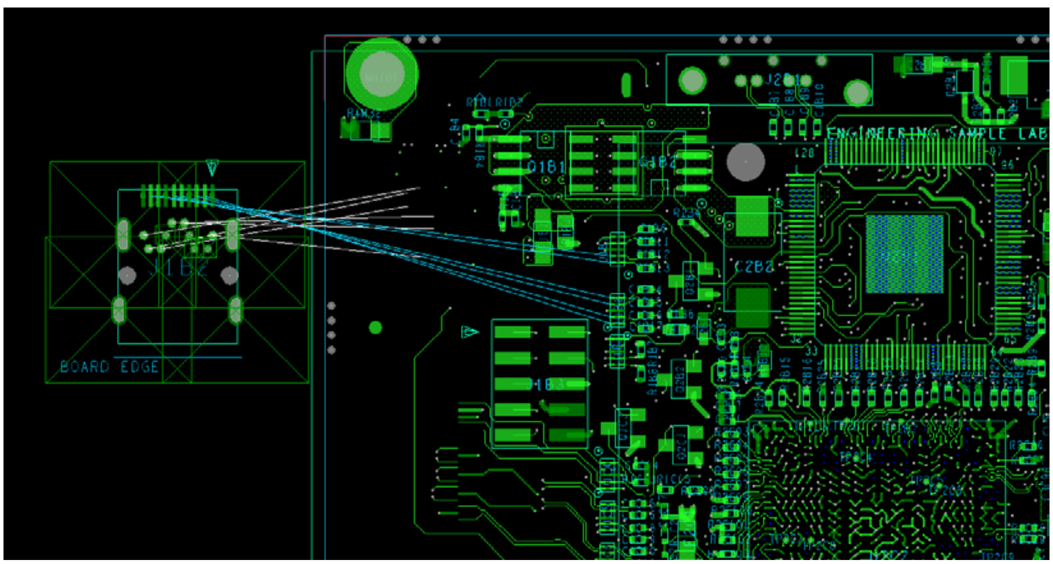


Figure 9 Using MBD to Continue to Route the Mini Display Port (mDP) Signals

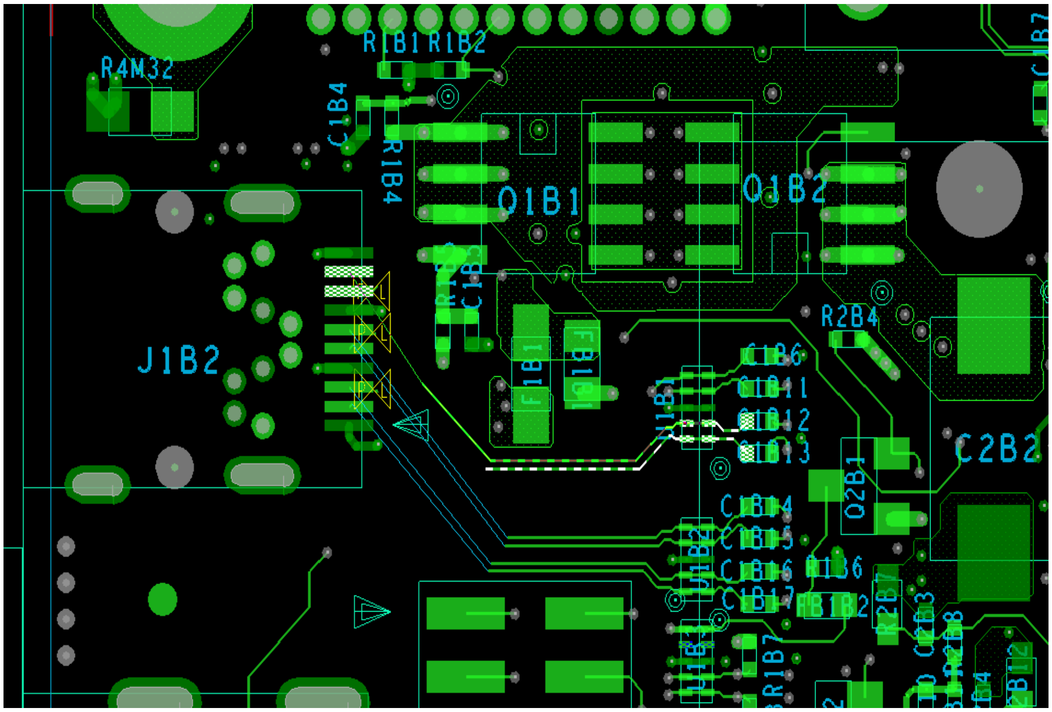
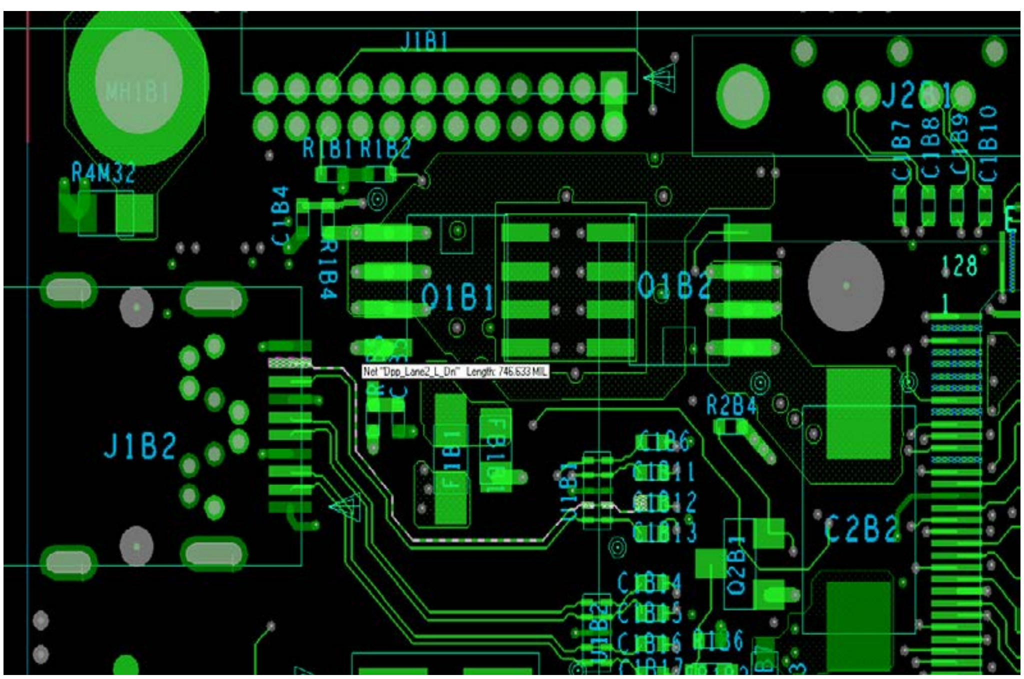


Figure 10 Complete Routing for mDP Signals



5.3 Using MBD to Modify an Additional Motherboard Form Factor

With the MBD reference files, board designers can change the board design to include or tweak additional I/Os such as:

- Audio
- VGA
- Low Voltage Differential Signal (LVDS)
- Standard PCIe* slot

Figure 11 shows the MBD modified board for the 4th Generation Intel® Core™ Processor based on Intel® ISX Platform, with the corresponding MBD portion of the board highlighted.

Board designers can add I/Os by extending the board size through the use of a different form factor like mini-ITX. Or, a designer can remove some I/Os to produce a smaller size board.

Figure 11 MBD Enhanced Motherboard: 4th Generation Intel® Core™ Processor Based on Intel® ISX Platform

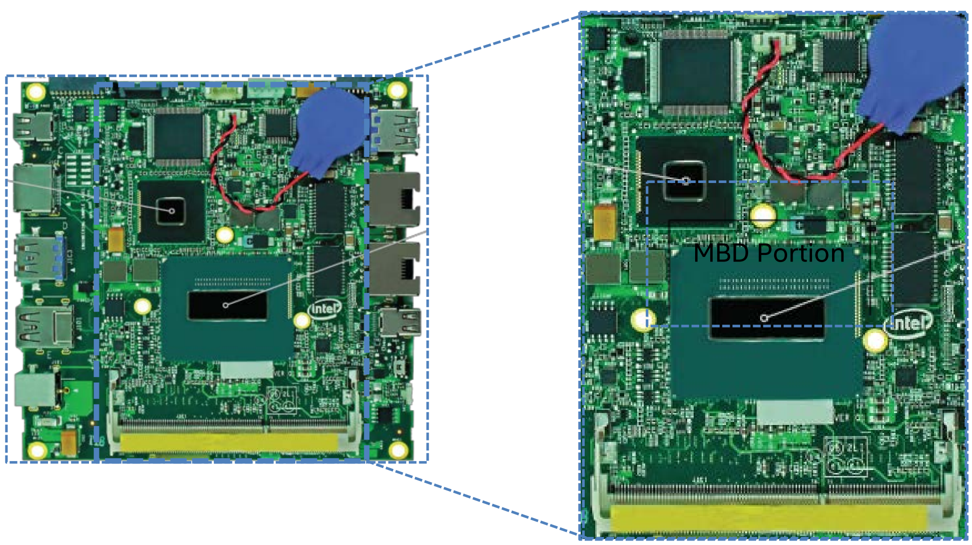


Figure 12 and Figure 13 show a customized board made using the Mobile 4th Generation Intel® Core™ Processor based on Intel® ISX Platform MBD, but with more feature sets.

The derivative board size is extended, with the following extra I/Os added:

- Local Area Network (LAN) port
- Standard Display Port (DP) connector
- SIM card slot
- Audio port

This derivative board design, utilizing MBD, was able to be completed (tape out ready) in less than 6 weeks. This could take 20 weeks if one starts from scratch, as is typical in current design practices.

Figure 12 Comparison between 4th Generation Intel® Core™ Processor Based on Intel® ISX Platform and Derivative Board (Top view)

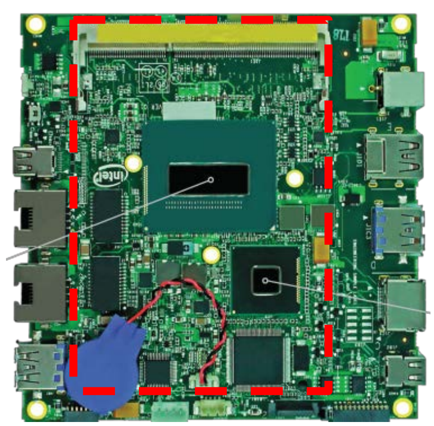
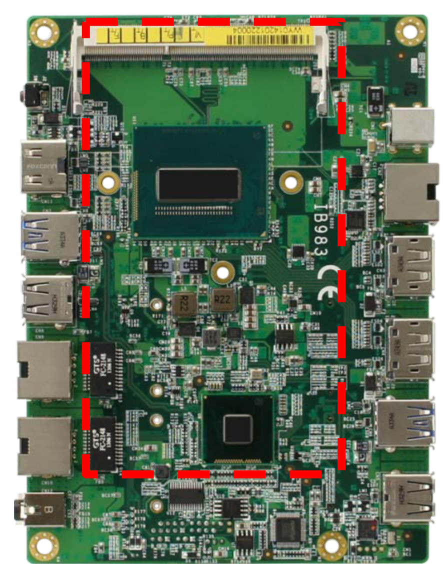
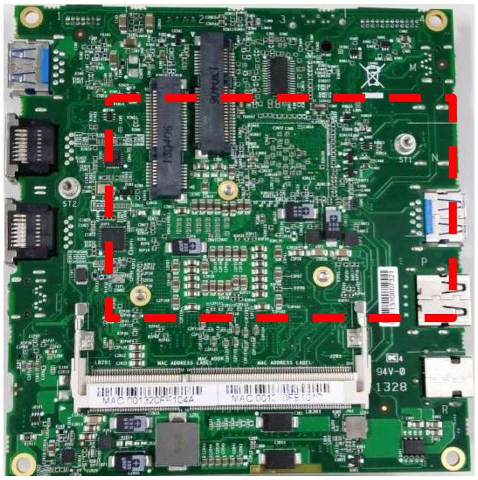
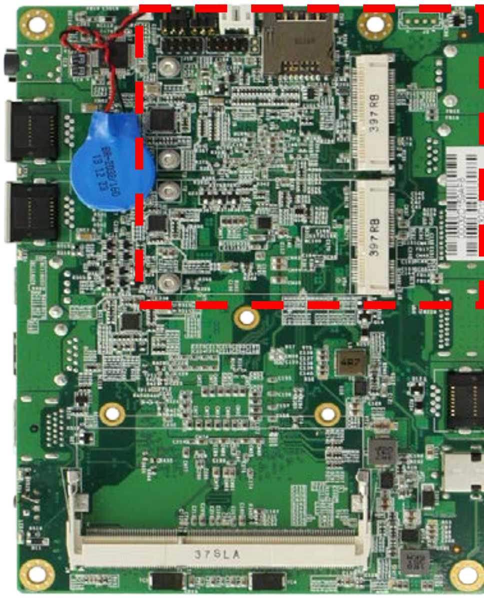
	
Intel® ISX Platform	**Derivative Board**

Figure 13 Comparison between 4th Generation Intel® Core™ Processor Based on Intel® ISX Platform and Derivative Board (Bottom view)

	
Intel® ISX Platform	**Derivative Board**

The same MBD files for one product (as proven in this document, and in the use case design proof of concept example that it has showcased) can be used to customize other products that have different form factors and features sets.

This usage can reduce design time in a huge way, compared to designs that begin from scratch.

This saves money on engineering labor costs and on overall total development money spent, especially for broad market customers who don't have many designers and who also have small design budgets and pockets.

The ultimate goal of using a MBD is to shorten the time to market for customers. MBD also makes sure that Intel and the Intel® Architecture provide designers with the most product design wins.

5.4 MBD Modification with a Computer Module Card

If wanted, MBD can also be used in a re-design, by using a daughter card or an external module. Customers can just plug it in to the connector of a base board. The following types of connectors can be used:

- Computer-On Module Express* (COM Express*)
- Mobile PCI Express* Module (MXM)
- Open Pluggable Specification (OPS)

This sub-section of the document describes how to use these connectors.

5.4.1 COM Express* Connector

COM Express* is a computer-on-module (COM) form factor. This standard was released by the PCI Industrial Computer Manufacturers Group (PICMG) in 2005. It was created to give standardized module interfaces for several different target applications.

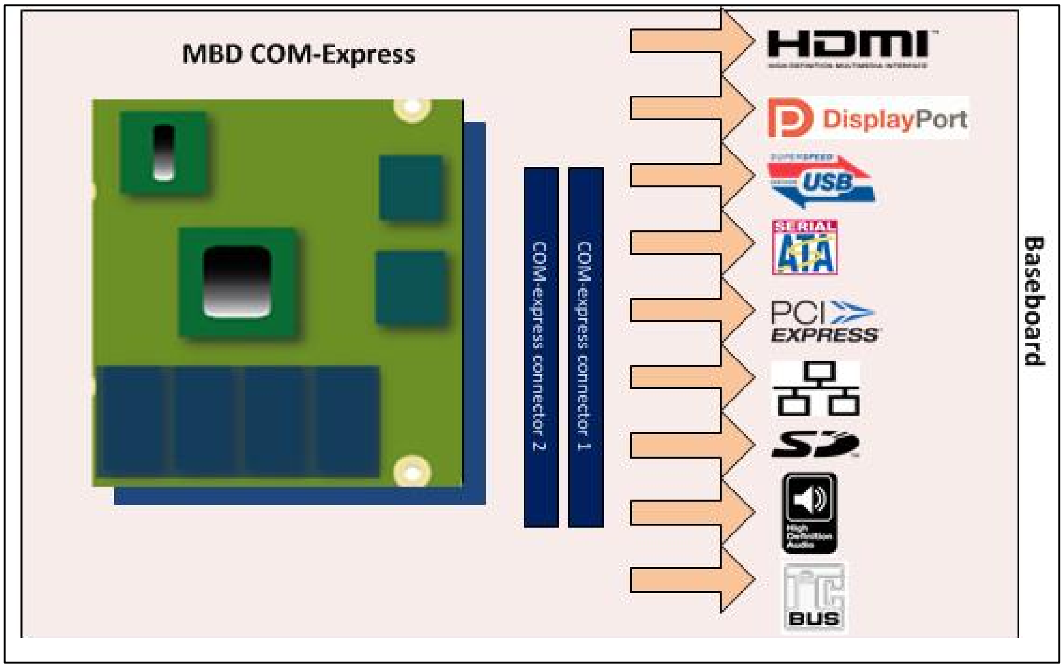
COM Express* is a highly integrated and compact PC card that can be used in a design application, much like an integrated circuit component. Like MBD, it integrates the core CPU, controller, and memory functionality.

All COM Express* I/O signals are mapped to two high-density, low-profile connectors on the bottom side of the module.

COM Express* defines five types of different pin out configurations and feature sets, on one or two 220-pin connectors. Exact pin usage depends on the I/O configuration a board designer requires. COM Express* allows flexibility to better serve the end application, while at the same time maintaining compatibility within each module.

As COM Express* is widely used by embedded Original Design Manufacturers (ODM), and the COM Express* I/Os are well defined (refer to **Figure 14**), MBD can follow the COM Express* connector pin out configuration in a re-design of an MBD COM Express* Compliance Daughter Card. The main challenge, however, is in assessing the power definition: To ensure sufficient power from base board to the main module.

Figure 14 Modular Board Design Using COM Express* - Layout Map



5.4.2 MXM Connector

Mobile PCI Express* Module (MXM) is an interconnect standard for Graphics Processing Units (GPU) in laptops (MXM Graphics Modules).

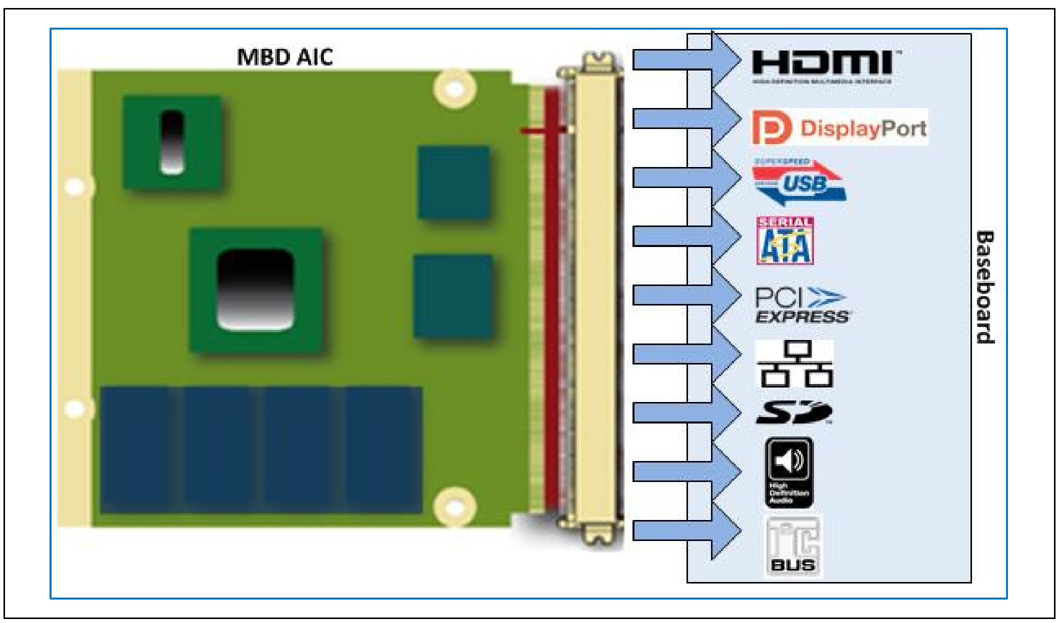
A big difference between an MXM connector and a COM Express* connector, it that an MXM connector only needs a female connector on base board: The Module acts as a card rather than as a module with a male connector.

Creation of the MXM Standard was to make sure that there is widespread use of a non-proprietary, industry standard socket, so that one can easily upgrade the graphics processor in a laptop, without having to buy a whole new system, or having to rely on a proprietary vendor upgrade. With MXM, as with MBD, the goal is enable the ability to scale to a future Intel® Architecture designs and chipset generations. With MXM, board designers can reuse the base board (that already includes the I/Os) and utilize MBD from generation to generation of the Intel® Architecture.

As MXM is suitable for use with high speed signals, it is suitable for MBD usage as well (refer to Figure 15).

The main challenge is to re-define I/O routing and pin out definitions on the card gold finger. This may involve signal integrity simulation to ensure the signal quality on connector edge.

Figure 15 Modular Board Design Using MXM - Layout Map



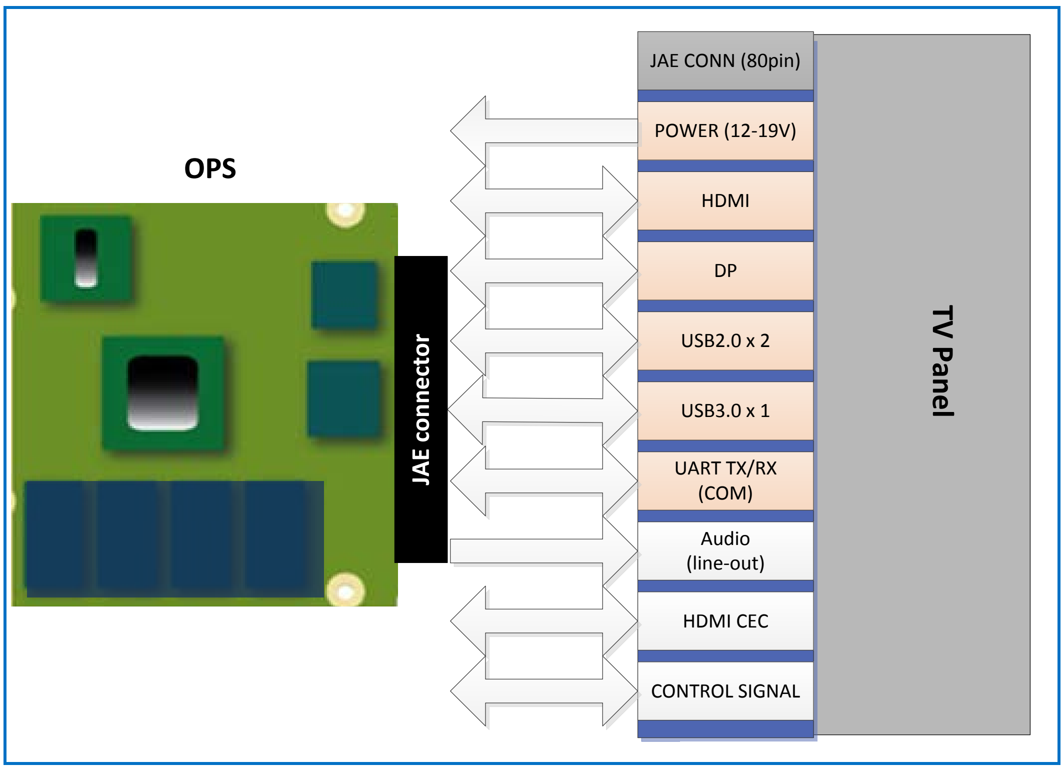
5.4.3 OPS Connector

The Open Pluggable Specification (OPS) is an Intel developed specification designed to simplify device installation and upgrade activities and to maintain digital signage infrastructure. OPS standardizes the design and development of digital signage devices and pluggable media players using an 80-pin Java Application Environment (JAE) Connector that supports commonly used interfaces such as display port, HDMI, and USB*, among others. OPS is Intel® Architecture based.

OPS assists implementation of scalable digital signage applications that can easily network with other equipment. This simplifies interoperability and application upgrades that are designed to meet the digital signage requirements of individual customers, and simultaneously helps future-proof technology investments.

Compatible with MBD, OPS can be defined as a computer on a module that's plug enabled, for installation on a display/TV panel. MBD is suitable for implementation as an OPS application, as illustrated in Figure 16.

Figure 16 Modular Board Design using OPS - Layout Map



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6.0 The MBD Super Set: MBD Enhancement

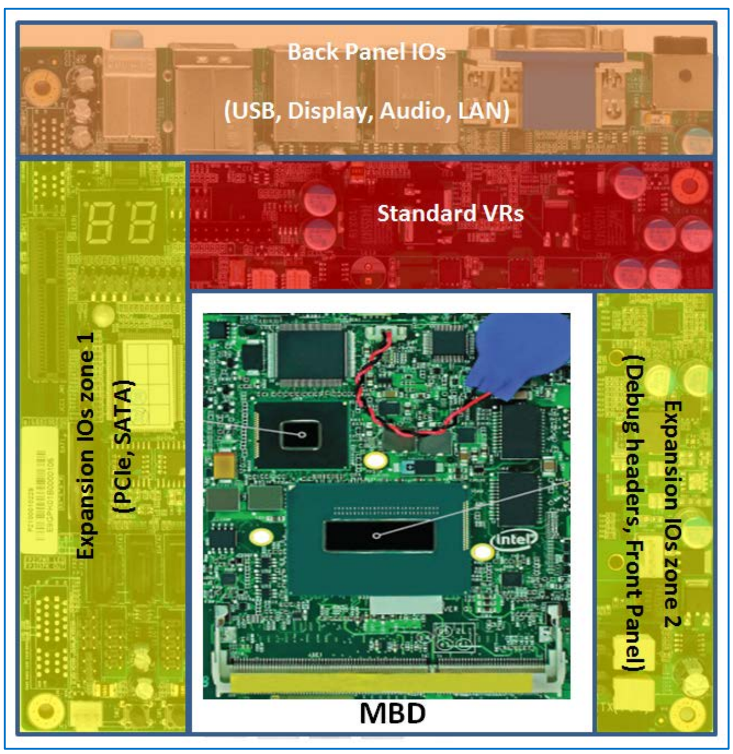
6.1 MBD Super Set Source File

For robust enhancement abilities and extendable design flexibility, the MBD Super Set Reference Source File package supports all types of platforms, in every tech market segment, from Mobile all the way on up to Server.

The extendable design ability enabled by the super set is made possible by inclusion of design variables that interface with all popular I/Os, and connect to all I/O routing locations. This combination is extremely user-friendly. The MBD Super Set Reference Files enable board designers to re-use the I/O layout placement from a previous platform and directly replace the MBD layout portion with the newest generation of IA.

Figure 17 shows how the MBD can connect Back Panel I/Os (display, audio, USB* and LAN signals) with PCIe* and SATA* in Expansion I/Os Zone 1, and to the low speed signals in Expansion I/Os zone 2.

Figure 17 MBD Super Set: Standard Components Placement on the MINI-ITX Motherboard



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7.0 Conclusion

Intel has more than 3,000 customers in embedded market design with Intel processors and chipsets. These customers are legion, with a dizzying array and multitude of design prospects and board form factors.

Customer system designs vary in terms of board size. But ever increasing signal speeds necessarily bring with them challenging signal integrity requirements for all of the designs.

It is a time-consuming, labor-intensive work effort and technical challenge for the Intel support team to sustain and service such a huge customer based.

The typical board design cycle for an embedded application that uses the Intel® Architecture is about four to five months.

For some of Intel's newer customers (especially the ones who are not well familiarized yet with the Intel® Architecture), they may end up spending three to five months on board development, and thus completely miss the time-to-market opportunity to sell products to their customers and end-users.

The Modular Board Design (MBD) for IA Core™ Platforms introduced in this white paper equips board designers and project managers with comprehensive and sufficient design files that are comprised of:

- Small (conveniently portable) form factors
- Editable board schematics (flexibility enhancing)
- Comprehensive layout reference file set

By using MBD design files, customers do not have to start from scratch when creating a design that is based on a newly released IA design or an IA design that is new to them. Customers can use the MBD design file and focus solely on I/O design and connection routing.

MBD covers 70% of all Board Design activities, including the most time-consuming, complex IA board design elements like: Memory Signals Routing, Power Delivery, Power Sequencing, and GPIO Strapping.

Thus, new customers are able to keep at a minimum any time spent (and concern about) on these IA design elements, and concentrate solely on the design of their own I/Os and other design blocks like application software development, and so forth.

As MBD comprises 70% of a complete board design, MBD usage will provide significant design cycle time savings and generally enable more than a 50% reduction in a customer's overall implementation efforts. Designers are able to shorten the design cycle of their new products and significantly curtail overall time-to-market.

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