

# How the Microchip Ecosystem is Supporting Superior Embedded System Development

Mark Patrick, Mouser Electronics

There are an array of pressures on today's embedded systems developers. Through coding, they must be in a position to write and test ideas quickly while still taking into account the features and capabilities of the underlying hardware. In addition, they need to be able to look inside the target processor and specified memory resource to see what is happening in real time as the platform handles interrupts and other events – because of the complex interactions that can take place between the hardware and software layers. Each requirement needs to be reflected in the tools portfolio available for the target, which is frequently some form of microcontroller (MCU) platform.

Vendors must work hard to ensure that reliable and efficient toolchains support their products. In the case of Microchip, that support has to encompass the PIC®, dsPIC®, AVR® and ARM architectures. As the AVR MCU family acts a core part of the Arduino development environment, engineers can also work within the easy-to-use, open-source framework and gain access to the many code modules that users have posted online. A design assembled in the Arduino environment can provide a rapid proof of concept, along with scope for further custom development and the possibility of greater optimization via the Microchip ecosystem.

At the core of the toolchain is the MPLAB® integrated development environment (IDE). The latest incarnation of this popular IDE, MPLAB X, supports PIC, dsPIC and AVR MCU architectures and can be hosted on Windows, Linux and OS X operating systems. Based on the NetBeans environment provided by Oracle, the IDE can incorporate tools from Microchip and third parties seamlessly. MPLAB X IDE does not just give the developer access to an editor, C compiler, make tools or software debug front ends. The IDE has functions that support complete project management and advanced code analysis through visual call graphs. These graphs show a clear trace of dependencies through the tree of function calls that an application can make. Working in conjunction with a suitable hardware-assisted debugger, the IDE provides configurable watch windows that make it easy to see how variables change in real time. To help get users up to speed on language features and save time typing, the feature-rich editor includes code completion and hyperlink navigation.

A key aspect of embedded development is aligning code with the target device, and as a leading supplier, Microchip has many MCU variants. This makes it easy for the product designer to choose hardware that

fits neatly with their memory and I/O requirements. If during software development it becomes apparent that the application needs more program or data, it is often easy to move up to a larger variant. Conversely, if at the end of the project it turns out there are unused peripherals or spare memory capacity, the decision might be taken to scale down to an MCU with a smaller cost and I/O footprint. Traditionally, such changes would take a long time to make because embedded software development has relied on detailed modification to the header files and boot code used to set up the MCU.

Many of the Microchip MCUs allow different functions to be mapped to the I/O pins, an approach that offers a high degree of flexibility to the system designer. Tracking those changes using conventional tools is a time-consuming and error-prone process. Supplied as part of the MPLAB X IDE, the MPLAB Code Configurator (MCC) dramatically simplifies the process of setting up an MCU for software-controlled applications. It presents the user with graphical views of the target's configuration and the options that are available for the target MCU. The tool shows which functions are mapped to each of the pins and generates warnings if a register setting means two or more peripherals are assigned to the same pin. Once the configuration is fixed, the MCC generates bootloaders and other support files ready for application development to proceed using the C toolchain within MPLAB X IDE. For MCUs with complex peripherals, such as USB and network interfaces, the MCC can create not just configuration files and bootloaders but communication stacks that allow high-level access to packet handling.

Alongside the core toolchain of the C compiler, editing and make environment within MPLAB X IDE, a key element is the debugger. Microchip's ecosystem comprises a wide range of debugger options that provide developers with access to information on the internal state of the target, and the ability to perform the fine-grained run controls required to identify problems in real-time control code. The simplest option is the MPLAB Snap, a highly affordable USB-based debug probe for PIC or AVR MCU and dsPIC digital signal controller targets. This delivers both simple hardware breakpoints and support for more complex software breakpoints that can be used to stop execution when the code reaches a particular stage or accesses a programmed memory location. Several debuggers, such as the Atmel ICE and Power Debugger, offer access to the on-chip instrumentation found on many AVR and SAM MCUs. Some MCU implementations can make breakpoints function as watchpoints – so the developer can see in real time how memory locations are being updated by control code, without having to stop and start the target. The Atmel ICE and Power Debugger also provide access to real-time program trace.

For the PIC, dsPIC and ARM architectures, the MPLAB ICD 4 in-circuit debugger/programmer offers a mixture of features that will suit many debugging requirements that include complex hardware breakpoints. The MPLAB REAL ICE in-circuit emulator goes further – offering advanced features, such as data capture, logic trigger and higher-speed debugging. The MPLAB REAL ICE and MPLAB ICD 4 support transfer rates high enough to also be used as programmers in a production environment. A debug facility is also a critical attribute of the Xplained series of evaluation and prototyping boards. With

boards such as these, the Microchip ecosystem does not just help with inserting code into the MCU but provides a wide range of support hardware to streamline the process of taking a design from concept to release for production. Traditionally, embedded systems designers would have to lay out and send prototypes to a manufacturing house for fabrication before testing of code took place. That added a long wait time to the project. Evaluation and prototyping boards eliminate that initial delay from the equation.

The [Xplained series of boards](#) support a dual role. Each one is built around a representative member of the AVR and ARM-based MCUs from the Microchip portfolio and is designed to act as a low-cost, easy-to-use evaluation kit that can demonstrate the features and capabilities of the platform. Developers can quickly move from evaluation to prototyping for specific applications by adding expansion boards explicitly created for the Xplained format. One example of this is the ATBNO0550-XPRO, which includes a nine-axis orientation sensor made by Bosch together with an RGB LED that can be used to provide visual feedback of software activity. For instance, as a user tilts the module, the software can change the color of the LED to indicate how the system perceives the change in orientation.



Figure 1: Microchip's SAMA5D4 Xplained Ultra evaluation board.

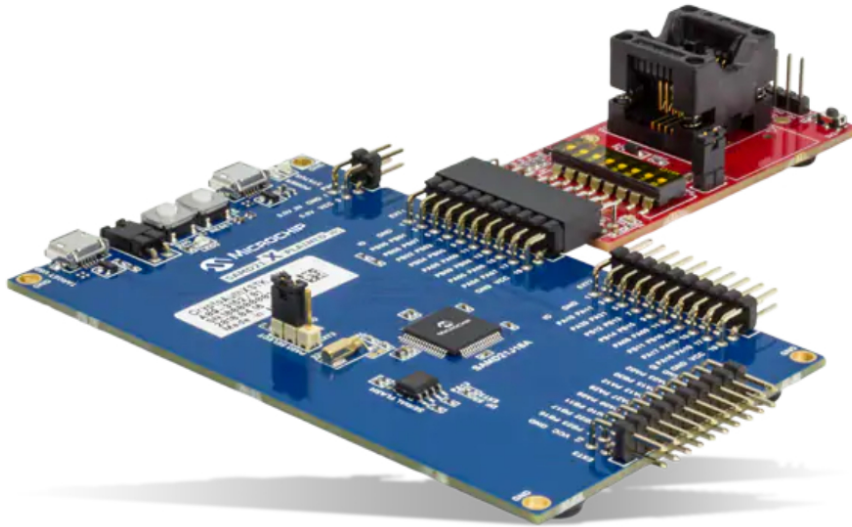


Figure 2: The CryptoAuthentication XPRO kit from Microchip.

To enable work on systems that need security, the [CryptoAuthentication XPRO kit](#) provides access to the crypto-controller functionality of the ATECC108A and similar devices in the Microchip range. These devices make it possible to ensure that other accessories and systems that the module communicates with have not been cloned or tampered with. Functions such as cryptography and networking, which can be tested using Wi-Fi and Ethernet kits in the Microchip portfolio, are often complex – so each Xplained board is supplied with a rich selection of sample projects and code drivers.

A key advantage of the MPLAB X IDE is that, whatever the level of access provided by the hardware-assisted debugger, the developer has the same simple one-button procedure to try out each code change. Hitting the Run, Program or Debug Run buttons will automatically start the relevant make process for the target. That process checks for changes to source files and recompiles and links any that have changed before transferring the resulting binary image to the target. Once the code is in place on the target, MPLAB X IDE initiates either a debug session or direct execution of the programmed image.

For developers working on projects aimed at the Internet of Things (IoT), the Microchip ecosystem includes the Curiosity family of development boards, which are designed around Microchip's PIC MCUs. Each board supplies a different set of built-in peripherals that range from cryptography support to USB 2.0 OTG interfaces. Further expansion is possible through the use of [MikroElektronika's CLICK boards](#). More than 300 different I/O modules employ the CLICK format, providing access to Bluetooth and other wireless network interfaces, as well as 3D motion sensors, motor controllers and high-resolution analog I/Os. This format also enables easy prototyping of custom I/O modules: the pins on the MikroBus connector are at a pitch that is compatible with standard 100mil-pitch breadboards.

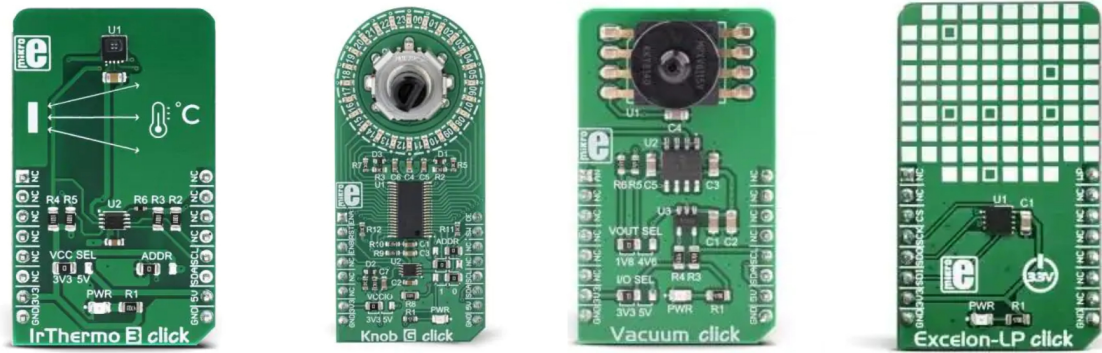


Figure 3: The MikroElektronika CLICK boards.

In addition to the Curiosity and Xplained families, the Microchip ecosystem includes a number of application-focused development boards, many of which support the PICtail or MikroBus daughterboard connectors. One example is the DM240312, which provides an easy way to start work with the PIC24FJ256DA210 MCU and build graphics and touch-input functionality into the target system. The MCU includes functionality to control a color pixel-addressable LCD and will connect to a variety of off-the-shelf display modules. To support user input, the board includes touch pads and a PICtail Plus connector for daughtercards as well as a USB port.

From the start of evaluation through prototyping to release for volume production, the expansive ecosystem discussed in this article provides engineers with a comprehensive set of tools. By using them, the development process can be significantly accelerated, and better embedded system designs will be derived as a result.