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Embedded Ethernet Made Easy

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Microchip Technology

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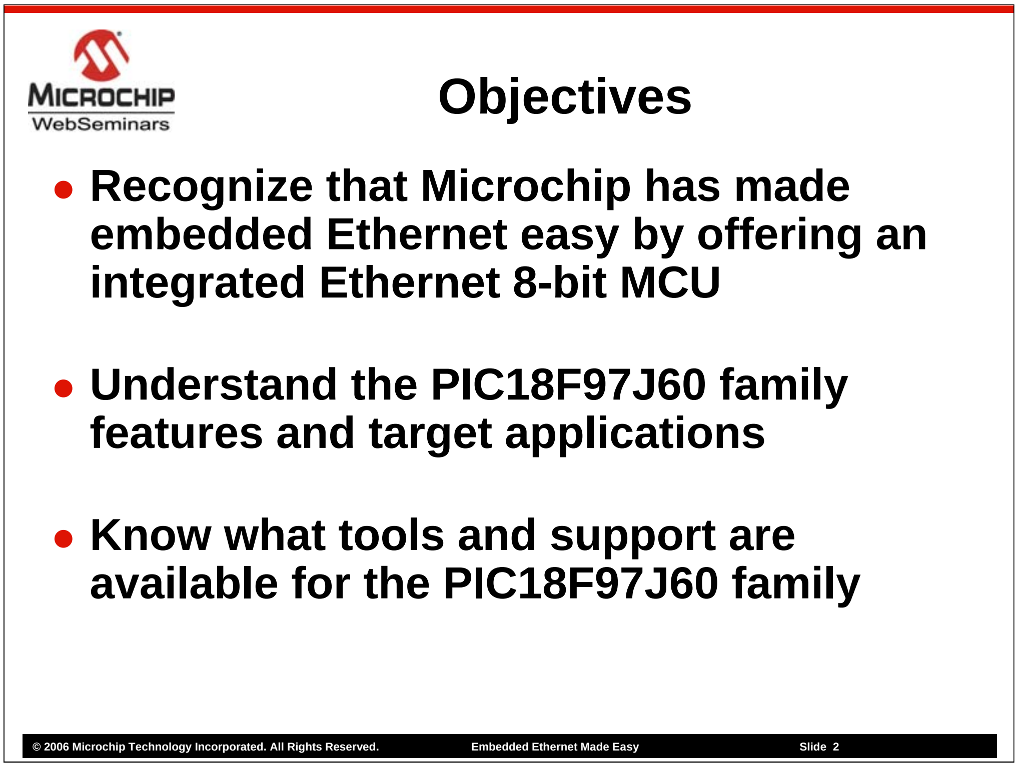
 Embedded Ethernet Made Easy Slide 1

Welcome to today's webinar. My name is Nathan Smith, product marketing manager for Microchip Technology. Today our discussion will feature Considerations for Adding Ethernet Embedded Designs.



Microchip has recently announced its Ethernet Microcontroller family, PIC18F97J60. Approaches to adding Ethernet to embedded designs in the past have been costly and complex. Microchip has removed these barriers by developing a single chip solution to make Embedded Ethernet Easy.

This webinar will help you to become familiar with how the PIC18F97J60 family fits into the rest of Microchip's controller portfolio. You will also learn the basic features and target applications for the Ethernet microcontrollers. Finally, you will learn which development tools and additional support are available to get your designs to market quickly.

Agenda

- Ethernet Overview
- PIC18F97J60 positioning and features
- Supporting Development Tools
- Example Application
- Conclusion

 Embedded Ethernet Made Easy Slide 3

Here is our agenda for today's webinar. First, I will briefly present an introduction and overview of Ethernet and why it is a compelling consideration for embedded applications. Next, I'll discuss the hardware approaches which prove the benefits of the new PIC18F97J60 family. This will be followed with a discussion on the new families positioning and features. Next I will explain the supporting development tools for the family followed by an example application that takes advantage of Ethernet. Finally I will wrap up with a and few concluding comments.

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Agenda

- Ethernet Overview
- PIC18F97J60 positioning and features
- Supporting Development Tools
- Example Application
- Conclusion

 Embedded Ethernet Made Easy Slide 4

Lets get started with a brief overview on Ethernet.

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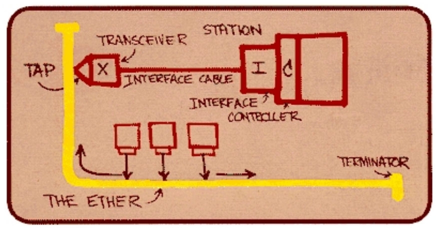
Why Ethernet?

- Ubiquity
- Interoperable
- Scalability
- No Distance Barrier



Bob Metcalf

 Embedded Ethernet Made Easy Slide 5

When Bob Metcalf originally conceived what would become known as Ethernet networking, I am quite sure he didn't realize that Ethernet would someday become a target for Embedded applications. There are 4 key reasons for why Ethernet is compelling for embedded applications:

1 Ethernet is **ubiquitous.** Ethernet is the most widely deployed network. It is already installed in many offices and industrial buildings

2. Ethernet is based on standards (IEEE802.3) that ensure reliability of network connections and data transmission. This ensures **interoperability.**

3. Ethernet networks are **scalable** from the simplest to most complex networks or up to 2^{48} network nodes

4. Once equipment is connected to a Ethernet network, it can be monitored or controlled through the Internet. While the Ethernet maximum cable length is 100 meters, communication over the Internet removes any previous distance barrier. Remote monitoring, control, diagnostics, data collection, and data sharing are all benefits from using Ethernet in embedded applications.

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Network Speed

- **10Base-T**
  - **Target applications - low bandwidth**
  - **Embedded applications typically configured as a sub-network behind a switch or router.**
- **100Base-T**
  - **Network performance**
  - **Low latency – real time delivery**
  - **High bandwidth applications**
    - **VoIP Intercoms, Automotive navigational systems**

 Embedded Ethernet Made Easy Slide 6

In considering Ethernet, it is important to discuss data packet traffic speed. The first speed that gained momentum in the PC industry was 10Base-T or 10Mbps. Other speeds that are more common today are 100Base-T and gigabit Ethernet. However, 10Base-T is more than sufficient for the applications that would be served in the embedded market. The typical requirements communication requirements for remote monitoring and control require only small bursts of data sent infrequently.

Occasionally there are those who are concerned about the network compatibility and performance when a 10Base-T node is connected to a faster speed network. If the network administrator takes care to configure the 10Base-T nodes as a sub-network behind a switch or router, the speeds are auto negotiated and therefore do not degrade the performance of the network.

In the embedded space the actual need for 100Base-T is less prevalent. The need comes from those that desire to maintain 100Mbps connections across the network. Additionally, 100Base-T helps to reduce the latency associated with data packet transmission and draw closer to real time delivery. Although real time delivery can not totally be over come with CSCD/MA based characteristics, the recommendation is to implement IEEE1588 or QoS protocols at the network system level. Finally, some example high bandwidth embedded applications that require 100Base-T bandwidth include VoIP Intercoms and automotive navigational systems.

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Traditional 8-bit MCU Limitations

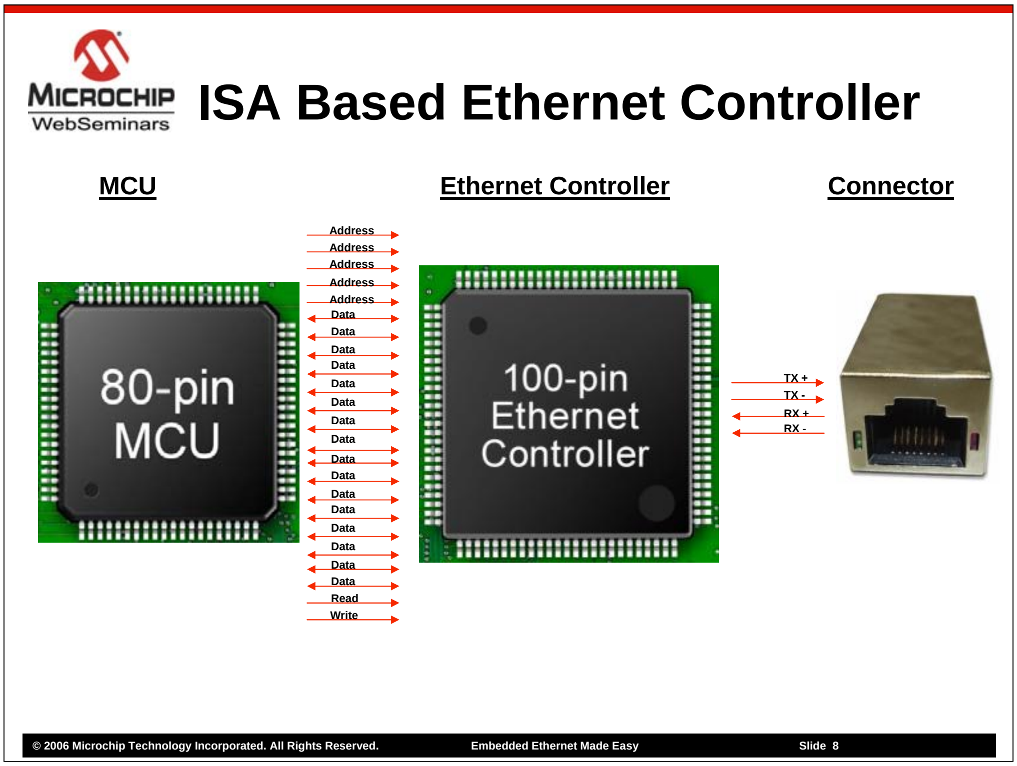
- **Interface**
  - **Adding Ethernet Expensive**
  - **Board Space and Complexity**
  - **Insufficient I/O**
- **Insufficient Program Memory**
  - **TCP/IP Stack Code space**

 Embedded Ethernet Made Easy Slide 7

Traditionally, 8-bit microcontrollers were challenged by the interface and program memory such that adding Ethernet for communication to the application was not feasible. There were two main reasons:

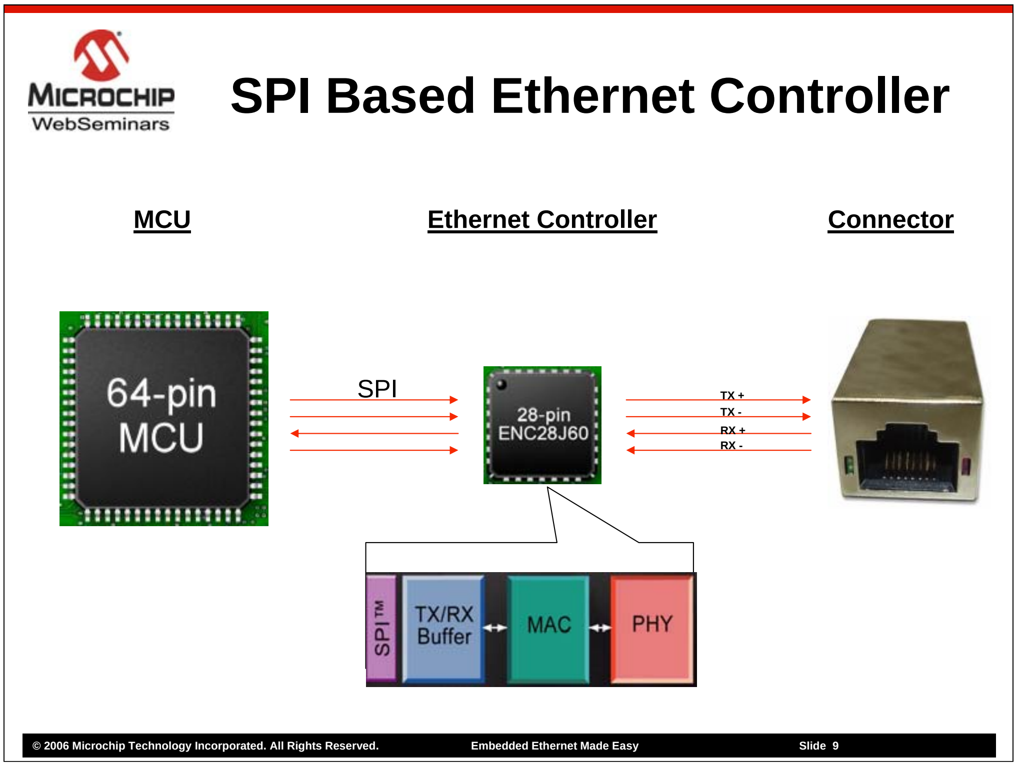
First, adding Ethernet could be expensive. Integrated, single chip alternatives were not available. 2nd, Ethernet controller chips were designed originally for the PC industry and used a foreign interface increasing design complexity and consuming occupied board space. Finally, due to the required number of I/O required to interface to the Ethernet controller, the number of available I/O for other control functions were severely limited.

Another challenge was the program memory. Given that a few years ago, 8-bit microcontrollers were limited to 14-16Kbytes of program memory, TCP/IP stack footprints were simply too large for the available code space on the MCU.

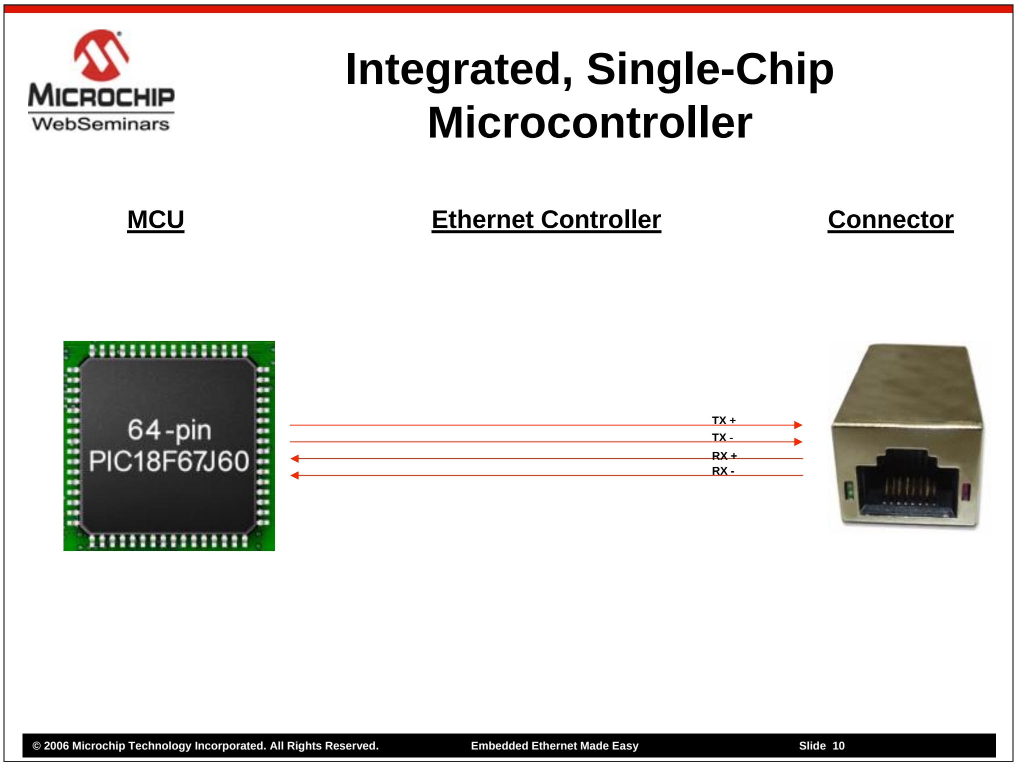


This next series of slides will walk through the approaches for adding Ethernet into embedded designs and how original challenges have been over come. Available Ethernet controllers were large in pin count. Controllers originally designed for PC networks included 100 pin count devices from Realtek, SMSC, or Cirrus Logic. The ISA interface required by these controllers included 16 data lines, 5 address lines and 2 lines for read and write functions. Not only did this design increase the design complexity and occupied board space, in order to have reasonable functionality including analog for sensing or PWM channels etc, a large I/O, 80 pin host microcontroller was necessary.

Now at this point it must be mentioned that the connection to Ethernet through the RJ-45 connector requires the standard twisted pair for transmission or the TX+/TX- and also the twisted pair for RX+ and RX-. This interface will remain constant through the next few slides.



In the last year, an innovative approach was taken to reduce the number of I/O required to interface to the Ethernet Controller.   Using a standard 4-wire SPI interface Ethernet controller, similar features could be accomplished when adding Ethernet to the design. Due to the less number of I/O required to the host microcontroller, now a 64-pin device could be considered while maintaining the same features discussed on the previous slide. In this design implementation, the advantages associated with the interface and board space are compared with the previously discussed implementation.



New to the 8-bit world are integrated, single chip solutions that feature the Ethernet MAC and PHY on chip. This eliminates the need for a separate interface controller which, as previously mentioned can be complex and costly. So with this solution, only the interface for the transmit and receive twisted pairs have to be considered.

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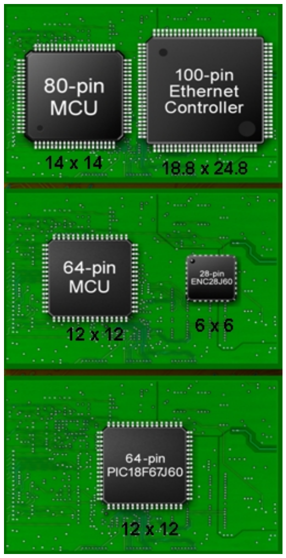
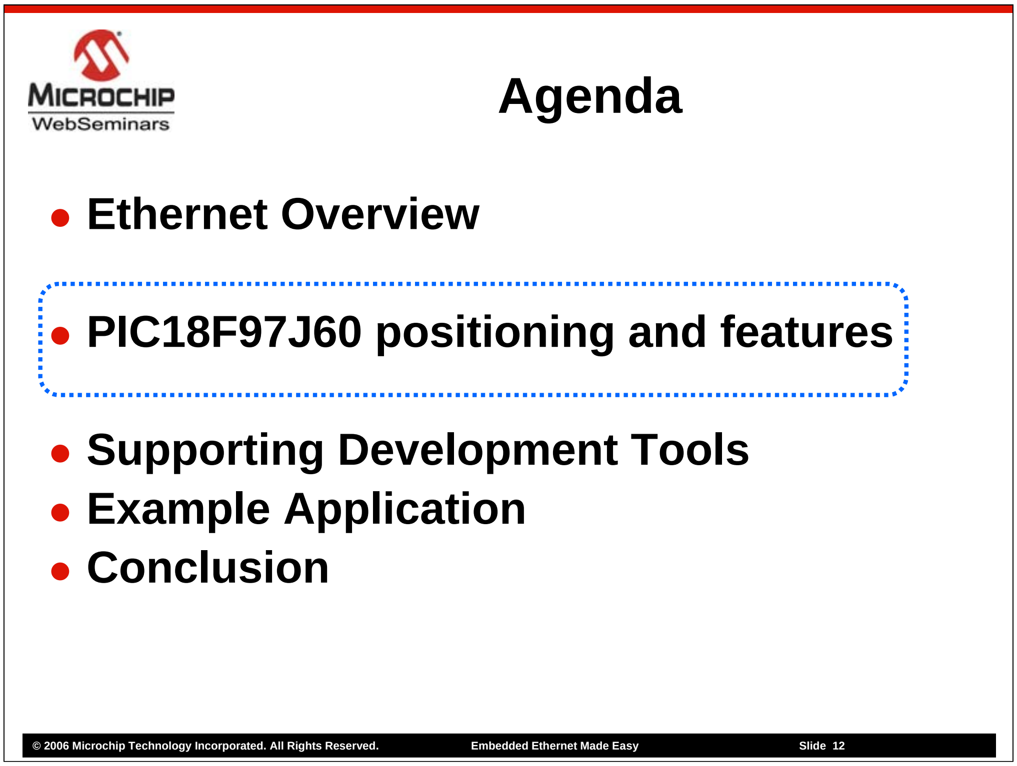
Space Comparison



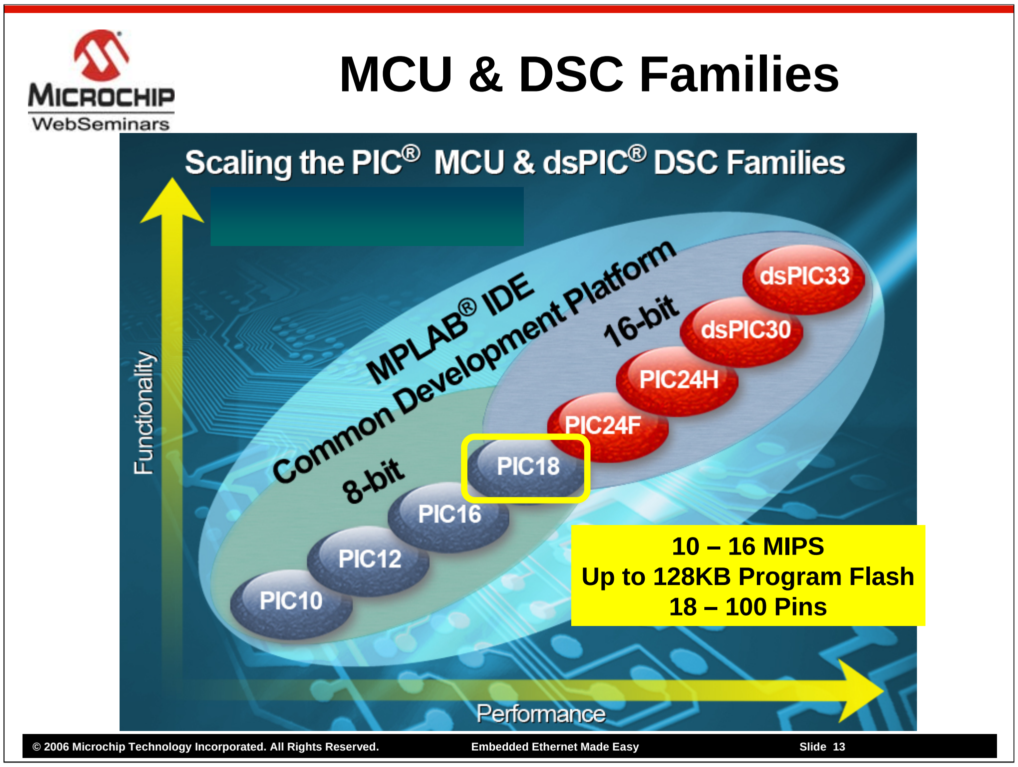
Space Reduction	~Cost Reduction
52%	34%
68%	51%

 Embedded Ethernet Made Easy Slide 11

Taking the previous 3 slides into account, the panels shown here highlight the compelling space saving and associated cost savings of the solutions high lighted. Compared to the original ISA interface implementation, the space savings using an SPI interface controller in comparison is 52% with an associated cost reduction of 34%. Compared with to the Single-chip, integrated solution, the space savings is 68% and the approximate cost reduction is 51%.

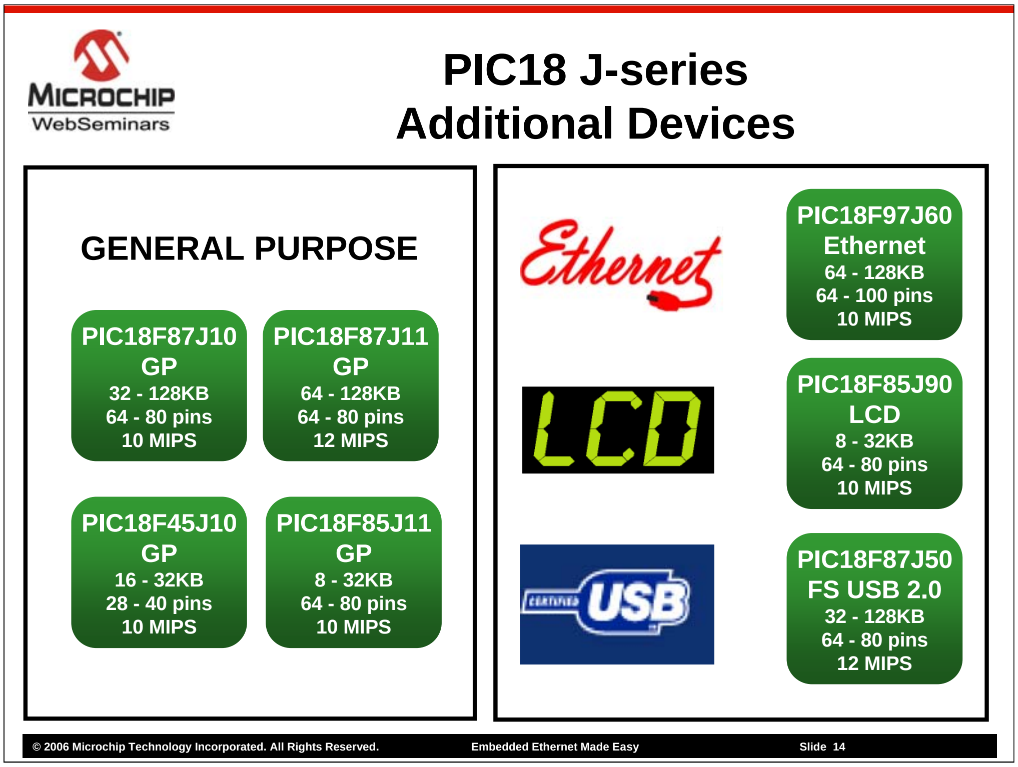


We have just discussed why Ethernet is compelling for embedded applications and the benefits of an integrated Ethernet microcontroller. Now let's drill down on a little more detail on the positioning and features of the new PIC18F97J60 family.



Microchip offers a complete range of 8-bit and 16-bit microcontroller and digital signal controller families ranging from very small low-cost PIC10 devices, to sophisticated dsPIC products with digital signal processing. The PIC18 family is an 8-bit MCU which is at the high end of our 8-bit MCUs, with 10-16 MIPS performance (40 – 64MHz). In addition to performance, the PIC18 family has a range of program flash up to 128KB and packages ranging from 18 to 100 pins.

The PIC18 devices use Microchip's high performance 8-bit architecture with a 16-bit instruction word and 8-bit data. Nearly all instructions execute in a single cycle making this RISC architecture extremely efficient. The PIC18 family has a rich set of integrated communication and connectivity peripherals to reduce application system cost and many of the PIC18 devices include nanoWatt technology for power management. Like all of Microchip's microcontrollers, these products offer socket, software and peripheral compatibility for easy migration and scalability.



Over the last year, Microchip has introduced its PIC18 J-series general purpose MCUs providing a low cost point/performance ration while providing more I/O on-chip. Other devices targeted for Ethernet, LCD, and USB markets are also part of this family. Each of these devices are supported by design centers with application notes, free software and drivers.

Today our discussion focuses on the PIC18F97J60 embedded Ethernet controller for remote monitoring and control. The PIC18F97J60 family is compliant with the industry standard for 10BASE-T (10 Mbps) Ethernet. The family comes with an integrated, on-board MAC and PHY, making Ethernet communications possible. The superset device, PIC18F97J60, is a 100-pin part with 128 Kbytes Flash, 3 Kbytes of data SRAM and 8 Kbytes of dedicated buffer RAM.

Over the next few months, Microchip will also release the PIC18F85J90 which includes LCD drive for segmented displays and the PIC18F87J50 which includes full-speed USB 2.0 support in 64/80 pins.

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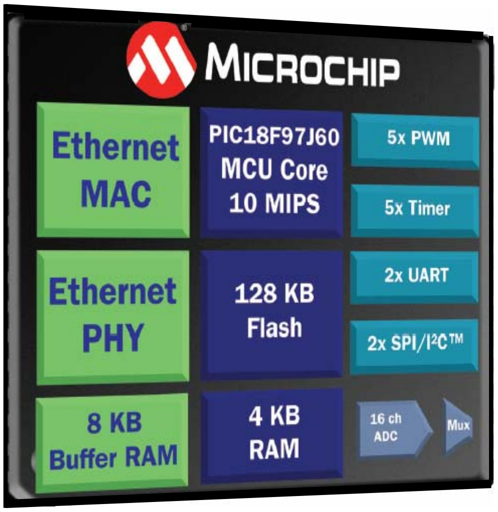
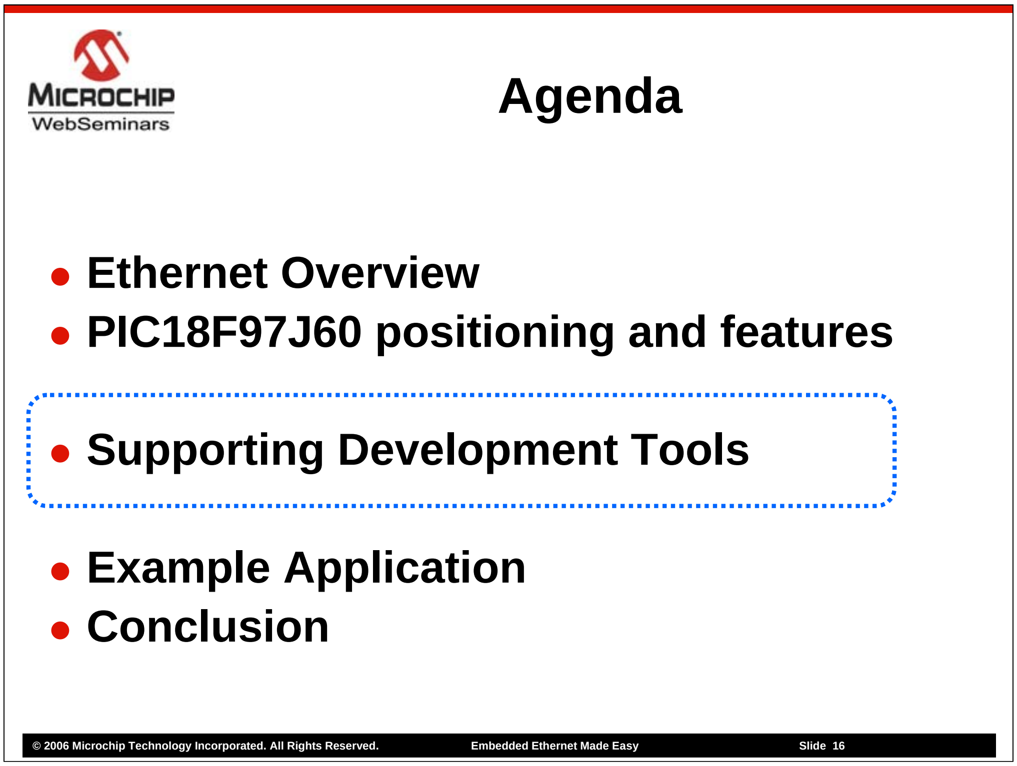
PIC18F97J60



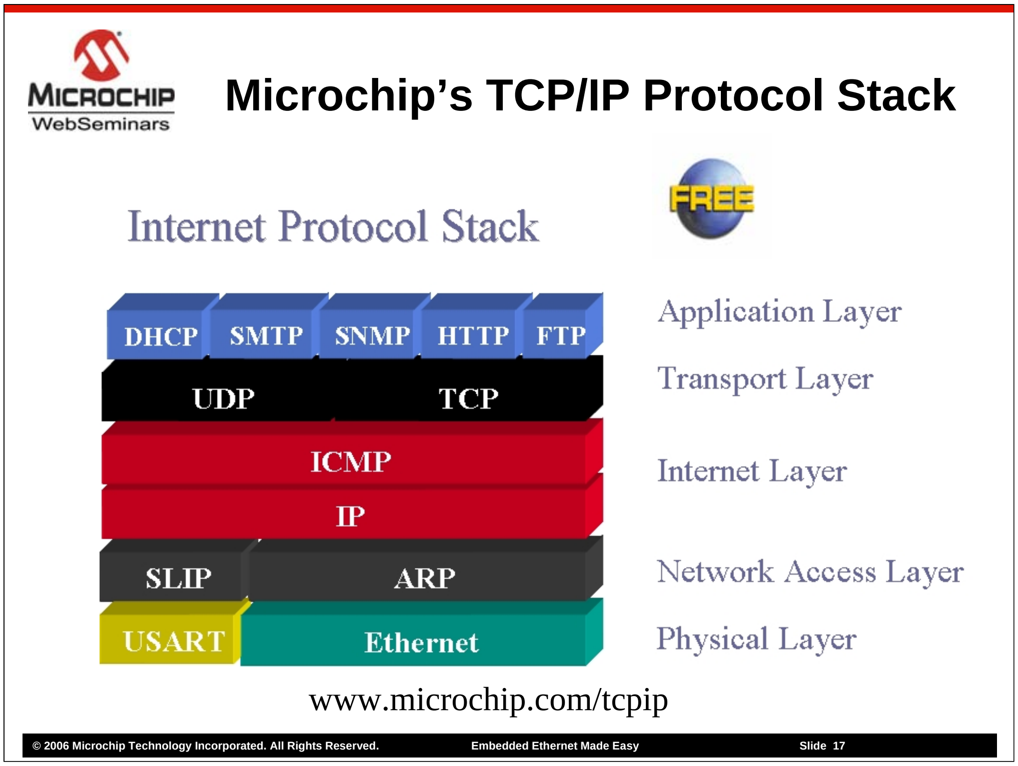
- **10 MIPS/40 MHz at 3V**
- **10 Base-T Ethernet MAC and PHY**
- **8 KB Dedicated Buffer**
- **64 – 128KB Program Flash**
  - **1k retention**
  - **20 years retention**
  - **self write**
- **Feature set optimized for embedded control**
- **64, 80 & 100 Pins**
- **10k price starting at $4.14 for PIC18F66J60**

The PIC18F97J60 is the superset device in our 64/80/100 pin Ethernet MCU family. With 10 MIPS performance at 3V, this family offers a 10 Base-T Ethernet MAC and PHY on chip with 8 KB of buffer RAM dedicated for Ethernet communication providing a full state machine so as to prevent overloading the core when sending or receiving packet data.

With a feature set optimized for embedded control, the family comes with up to 128KB of flash with self write capability, 5x PWMs, 5x timers, 2 UARTs, 2 SPI/I2C and a 16ch 10bit ADC.   Pricing for this family starts at $4.14 for 10K unit volumes.



Having talked about the PIC18F97J60 family positioning and features, now lets move on to the supporting development tools including software and hardware.



At the heart of Ethernet communications is the TCP/IP protocol. The TCP/IP stack allows total location independence and interoperability to any embedded application. The software stack shown includes the key blocks associated with the network OSI reference model based on IEEE standards. Rather than taking extensive time to review the definitions of each of the protocol blocks, I simply refer you to webopedia.com for a review if need be. A typical TCP/IP stack requires ~25K bytes of code space depending on the protocols included.

With the 128Kb of code space available on the PIC18F97J60 family, a TCP/IP stack can easily be accommodated while leaving plenty of program memory for the application.

Microchip offers a free TCP/IP stack that can downloaded for free from www.microchip.com/tcpip. This stack is royalty and license free can has been in production for some 5+ years. It is supported for all PIC18, PIC24 and disPIC product families and the source code is made available to the programmer.

PIC18 J-series Development Tools

- **MPLAB® IDE**
  - **Free download**
- **MPLAB® C18 Compiler**
  - **#SW006011 free evaluation**

- **MPLAB® ICD 2 In-Circuit Debugger**
  - **#DV164005**
- **MPLAB® PM3 Device Programmer**
  - **#DV007004**

- **MPLAB® REAL ICE™ Emulation**
  - **#DV244005**

Microchip's PIC microcontrollers are supported by the MPLAB IDE which is used to integrate the development, debug and software utilities available when developing code for a product. MPLAB is the only platform you will need to develop for all of Microchip's MCUs and DSCs and it can be downloaded for free on our website. Language tools are available from Microchip in the form of an Assembler (MPASM), a linker (MPLINK) and a C compiler. The C compiler for the PIC18 family is called MPLAB C18 and a free student version can be downloaded from our website.

MPLAB IDE is designed to work with all of Microchip's standard hardware tools such as ICD 2 and PM3 programmer. ICD 2 is a flash upgradeable in-circuit debugger which is connected to and powered by the USB connection on the host PC. It will enable in-circuit debugging via either single step or break points for each and cost-effective debugging.

The only hardware tools that are not supported with the PIC18 J-series and thus the PIC18F97J60 family, are the ICE 2000 and ICE 4000 emulators. Instead, Microchip's new MPLAB REAL ICE supports the entire PIC18 J-series. It is a low cost emulation system ($499) with high speed USB connection for full emulation speed and includes logic probes, device adapters, high-speed connectivity, debug & programming with capture and I/O port trace.

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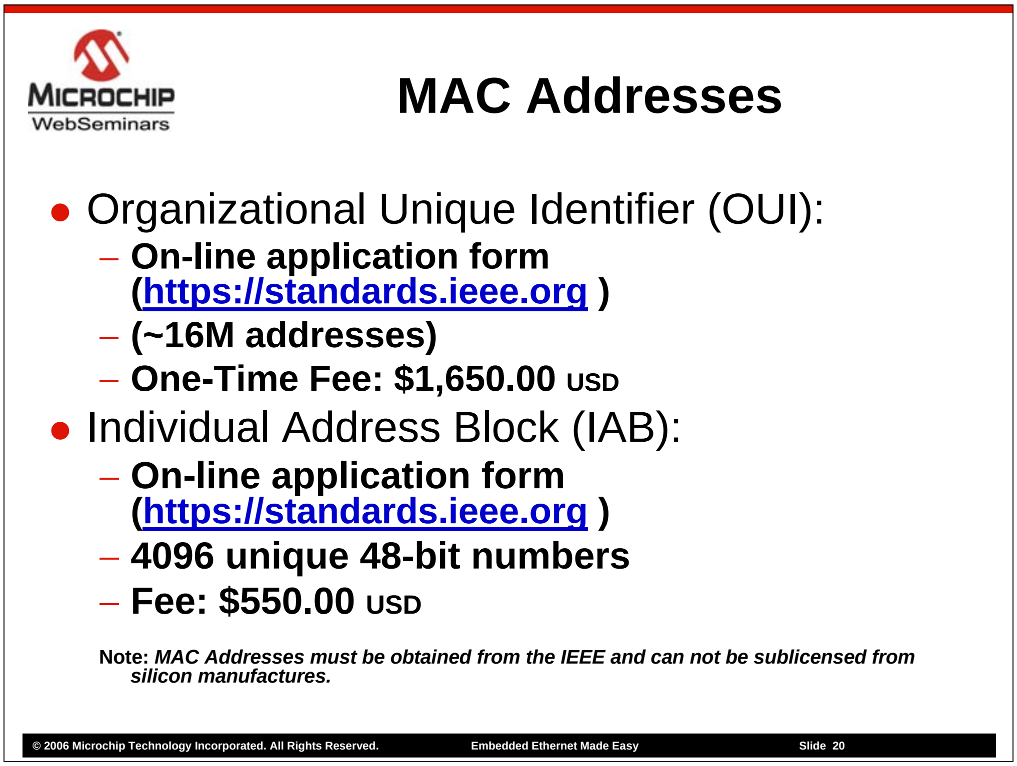
PICDEM.net™ 2 Demonstration Board (DM163024)

- **Features**
  - Populated with PIC18F97J60
  - PICtail™ connector for future expansion boards
  - Alpha-numeric LCD Display
  - Programmable buttons/LEDS
  - Ethernet Connectors
    - Evaluate PIC18F97J60 & ENC28J60 on same board
  - Temp Sensor
  - USART
  - ICSP™ Programming
  - Real-Time Clock

$165 USD Retail

 Embedded Ethernet Made Easy Slide 19

For evaluation purposes, Microchip offers the PICDEM.net 2 Demonstration board. This board comes populated with PIC18F97J60, has a PICtail™ connector for future expansion boards, an Alpha-numeric LCD Display, Programmable buttons/LEDS, two Ethernet Connectors for Evaluating the PIC18F97J60 & the stand alone Ethernet controller, ENC28J60 on same board, a Temp Sensor. A USART, ICSP™ Programming and a Real-Time Clock. Priced at $165, this board is available to quick start the design process and accelerate time to market.

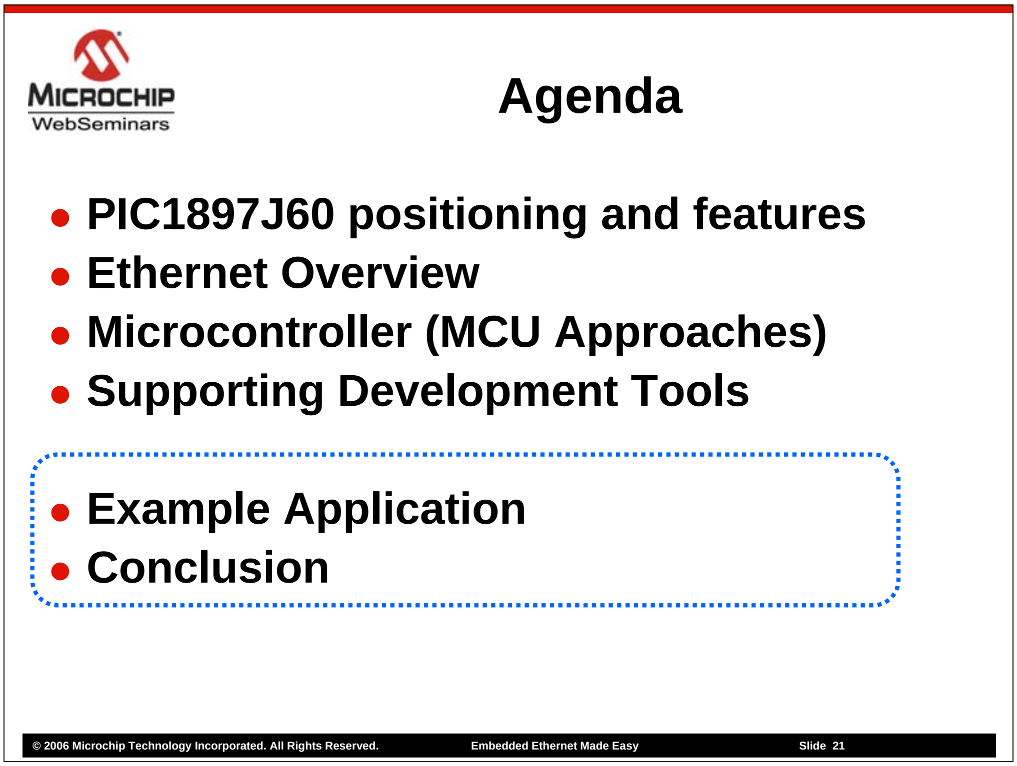


In networking a Media Access Control address (MAC address) is a unique identifier attached to most network adapters. It is a number that acts like a name for a particular network adapter or node. Each node on the network must have its own unique identifier or MAC address.

MAC address are sourced from the IEEE organization. There are two types that can be purchased including Organizational Unique Identifiers and Individual Address Blocks. Each require an on-line application that can be downloaded from standards.ieee.org.

The **OUI address blocks** are for large volume requirements and can purchased for $1,650.

IAB address blocks, on the other hand**:** are for people who need less than 4096 unique 48-bit numbers (EUI-48) and thus find it hard to justify buying their own OUI. Customers can purchase an Individual Address Block for $550 and this gives them a block of 4,097 MAC addresses



Now lets consider an example application and wrap up with a conclusion.

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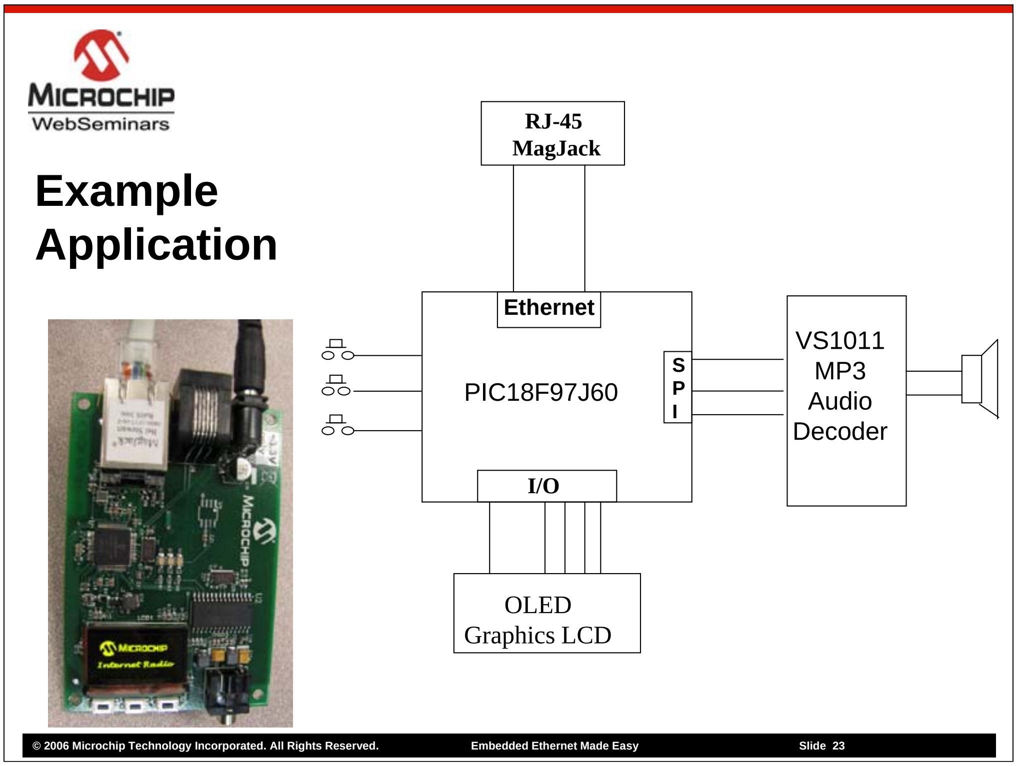
Target Applications

- **Industrial Automation**
  - Industrial Control
  - Power-Supply Monitoring
  - Network/Server Monitoring
  - Environmental Monitoring
- **Building Automation**
  - Fire & Safety
  - Access Control
  - Security Panels
  - Lighting Control
  - VoIP Intercom
- **Home Control**
  - Security
  - Networked Appliances

- **Commercial Control**
  - Kitchen Appliances
  - Drink Dispensers
  - Hotel Minibars
  - POS Terminals

 Embedded Ethernet Made Easy Slide 22

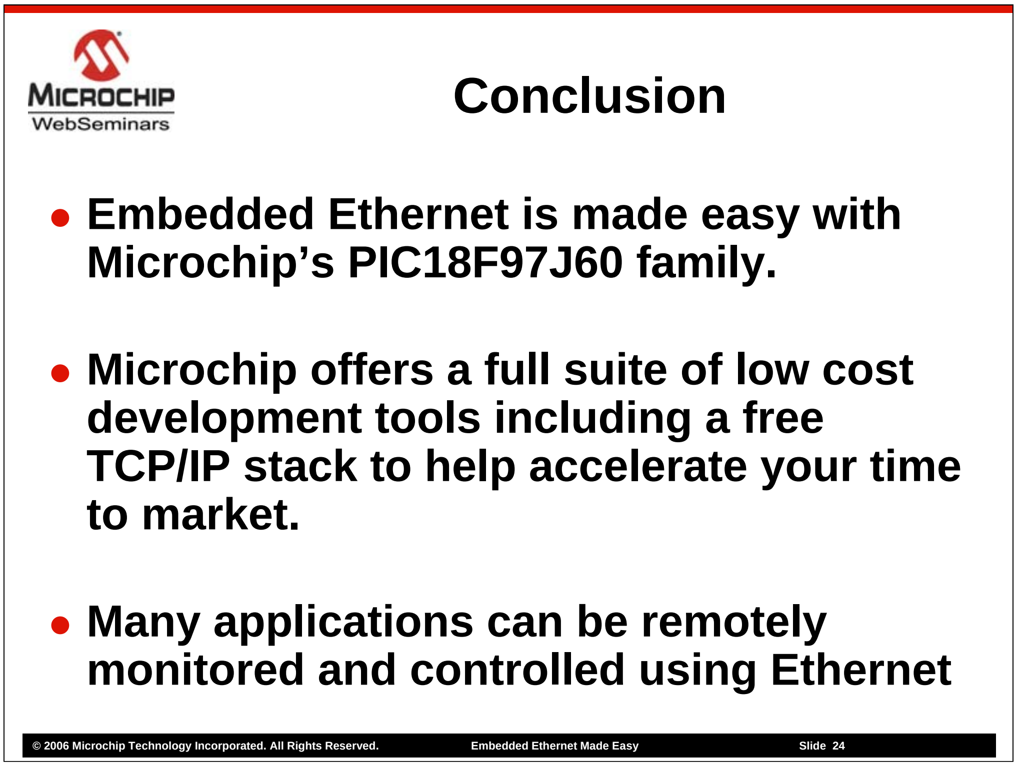
Target applications for the PIC18F97J60 family are shown on this slide, ranging from Industrial to Home control to Commercial. Within each of these microcontroller application areas, there are applications that can take advantage of remote monitoring and control. The PIC18F97J60 family can easily accomplish remote communications over Ethernet as well as carry out the typical functions associated with embedded control.



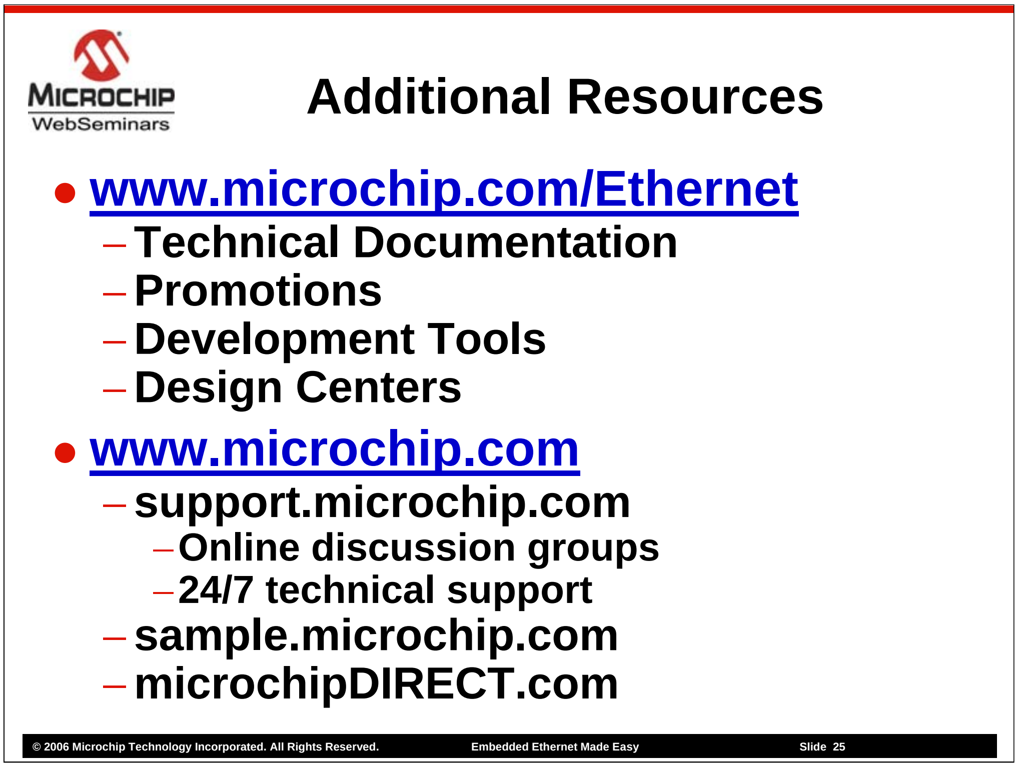
There are many example applications that can make use of a Ethernet communication. Here I highlight one interesting example, an internet radio. The obvious benefits of the Internet radio compared to legacy radios is location independence. So if for instance, I am traveling and out of reception range for my home town radio station, over the Internet I can still listen to my favorite radio programs.

On the left side of the slide I show the demonstration board. On the right a block diagram of the system. Using its Ethernet on-chip peripheral, the PIC18F97J60 interfaces to the RJ-45 MagJack Ethernet cable connector. Having the TCP/IP stack from Microchip programmed on the PIC18F97J60 microcontroller, communication over the internet is made possible. Using the I/O of this Ethernet Microcontroller the Interface to the OLED graphics LCD display allows for displaying IP addresses, mode of operation and other important information to be displayed. Finally, using the SPI interface, the PIC18F97J60 interfaces to the VLSI VS1011 MP3 Audio decoder. With the URL for a multiple station listing pre-programmed on the system, push buttons will allow the user to scroll through the radio stations and select the station desired.

This is just one example of an application that can be designed with an 8-bit Ethernet microcontroller.



To bring this webinar all together, just a few parting comments. First, an embedded design requiring Ethernet is made easy with Microchip's PIC18F97J60 family. Second, Microchip offers a full suite of low cost development tools including a free TCP/IP stack to help accelerate your time to market. And finally, Many applications can be remotely monitored and controlled using Ethernet.



Now that you know more about the PIC18F97J60 family I wish to reference you to a few places where you can obtain more information. There is a dedicated website at www.microchip.com/ethernet where you will find additional information and resources related to our Ethernet offerings and our free TCP/IP stack. There is also a webpage at www.microchip.com/PIC18 which highlights all of our PIC18 devices. On Microchip's homepage, you will find support links to 24/7 tech support as well as online discussion groups. To order free samples, go to sample.microchip.com. You can purchase development tools directly from Microchip via microchipDIRECT.

That brings this webinar to its conclusion. Thank your for your time today and remember, Microchip makes embedded Ethernet Easy!