



# Embedded Ethernet Solutions

Gautam Kotwal

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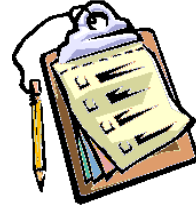
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Slide 1

Hello and welcome to today's Ethernet Webinar. My name is Gautam Kotwal, product marketing manager for Microchip Technology. Today our discussion will focus on embedded Ethernet solutions from Microchip Technology.

## Agenda

- **Why Ethernet**
- **Networking with Ethernet**
- **Markets**
- **Ethernet Portfolio**
- **Software Library – TCP/IP stack**
- **Development Tools**
- **Summary**



The agenda for today's presentation, I will discuss the needs of Ethernet, networking with Ethernet, potential markets, Microchip's Ethernet portfolio, software library and development tools.

## Why Ethernet?

- Ethernet is the most widely deployed network in offices and industrial buildings
- Ethernet's infrastructure, interoperability and scalability ensure ease of development
- Once equipment is connected to a Ethernet network, it can be monitored or controlled through the Internet
- Low Latency – “Real Time” Remote Delivery

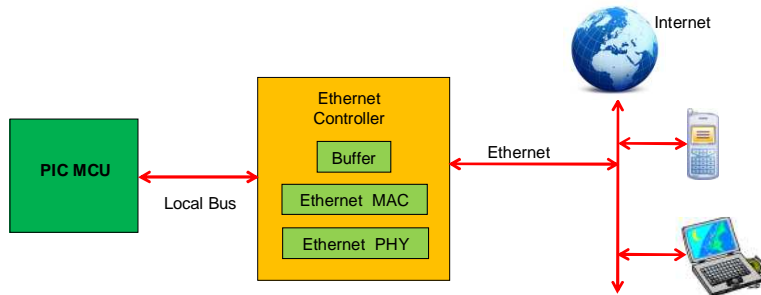


So why would you want to choose Ethernet?

1. Ethernet is the most widely deployed network in offices and industrial buildings. Thus Ethernet is **ubiquitous**.
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 removing any distance barrier that may have inhibited remote communication previously.

## Networking with Ethernet

- Monitor, control or access devices over internet using Ethernet Controllers




Thus with our Ethernet portfolio we can cater to the market needs of embedded Ethernet. As we see from the block diagram PIC MCU and Ethernet controller can make any device connected to the world wide web.

Based on its ease of use, low cost, high bandwidth, stability, security, and compatibility across devices, Ethernet has become the de facto standard of network access for 32-, 16- and even 8-bit microcontrollers.

Thus it helps in monitor, control or access devices over internet.


Today's embedded systems designers and developers are increasingly asked to incorporate Ethernet connectivity into their systems. Ethernet's ubiquity and longevity in connecting to a network makes it an attractive networking choice for embedded systems. The key advantage to connecting over Ethernet lies in the overall savings in software development. If system designers use standard software protocols over Ethernet, they could take advantage of a plethora of software that's already installed on many of today's computers and handheld devices, without worrying about compatibility between multiple operating systems.


As learnt from previous slide that stand alone Ethernet controllers with MAC and PHY can communicate with any PIC microcontroller to provide single port network capability. Thus this solution is suitable for:


  
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## Markets


**Communications**


 Video / IP Phone


 VoIP ATA

 Wireless Router

 Printer Scanner

 IP Camera

 Disk Array

 NAS

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OA/Communication segment devices like IP phones, printers, N/W attached storage etc.

## Markets

### Communications



Video / IP Phone



VoIP ATA



Wireless Router



Printer Scanner



IP Camera



Disk Array



NAS

### Automation/Control



Test Equipment



POS Terminal



Kiosks



UPS



Vending Machines



Surveillance System



LED Display Board









Security System  
Light Control  
HVAC Control

Automation / Control segment devices like HVAC control systems, POS terminals, safety equipments etc.









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## Markets





### Communications

 Video / IP Phone  
  VoIP ATA  
  Wireless Router  
  Printer Scanner  
  IP Camera  
  Disk Array  
  NAS

### Automation/Control

 Test Equipment  
  POS Terminal  
  Kiosks  
  UPS  
  Vending Machines  
  Surveillance System  
  LED Display Board  
  Security System  
Light Control  
HVAC Control

### Entertainment

 IPTV  
  IP STB  
Cab/Sat STB  
  Net DVD  
DVR-R/HDD  
  Internet Radio

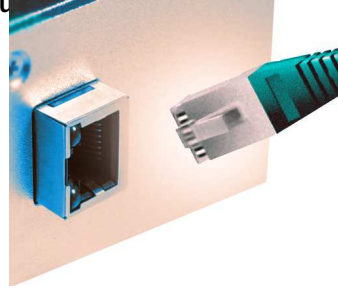
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Entertainment segment devices like IPTV, IPSTB, internet radio etc.



## Embedded Applications - Network Speeds

- **10 BaseT (10 Mbps)**
  - Target applications – low bandwidth
  - Embedded applications behind switch or router
- **100 BaseT (100 Mbps)**
  - Low latency – “real time” delivery
  - High bandwidth needs
    - Voice over Ethernet
    - Remote secure monitoring



The embedded Ethernet solutions are offered with 10 Base-T and 100 Base-T PHYs.

In 10Base-T the target applications only need to send a few bytes and don't require high bandwidth.

Also Embedded applications with Ethernet will typically be on a sub-network behind a router. This prevents degrading the performance of the rest of the network.

Additionally, 100Base-T helps to reduce the latency associated with data packet transmission and draw closer to real time delivery. Some example of high bandwidth embedded applications that require 100Base-T bandwidth include VoIP Intercoms and remote monitoring.

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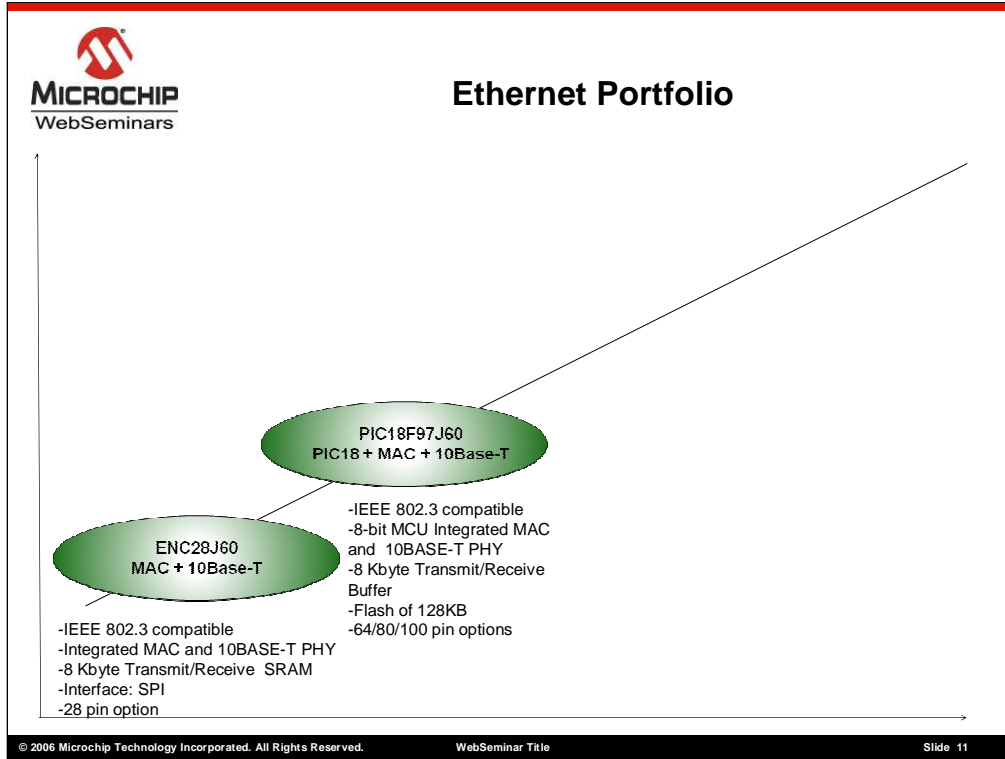
## Ethernet Portfolio

ENC28J60  
MAC + 10Base-T

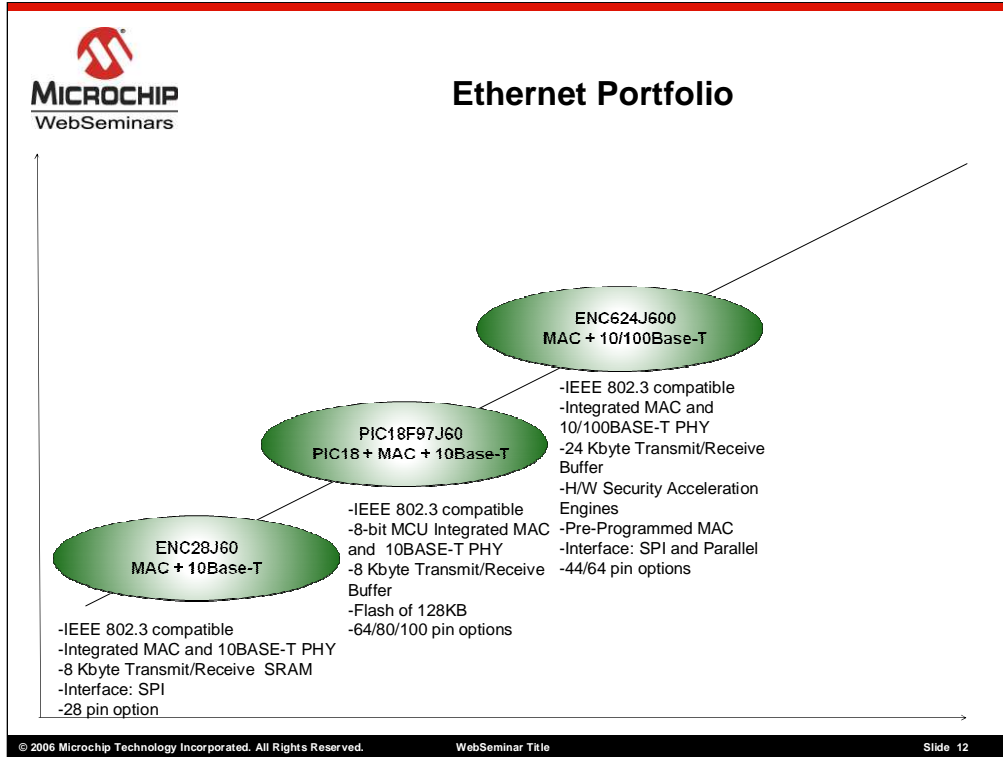
- IEEE 802.3 compatible
- Integrated MAC and 10BASE-T PHY
- 8 Kbyte Transmit/Receive SRAM
- Interface: SPI
- 28 pin option

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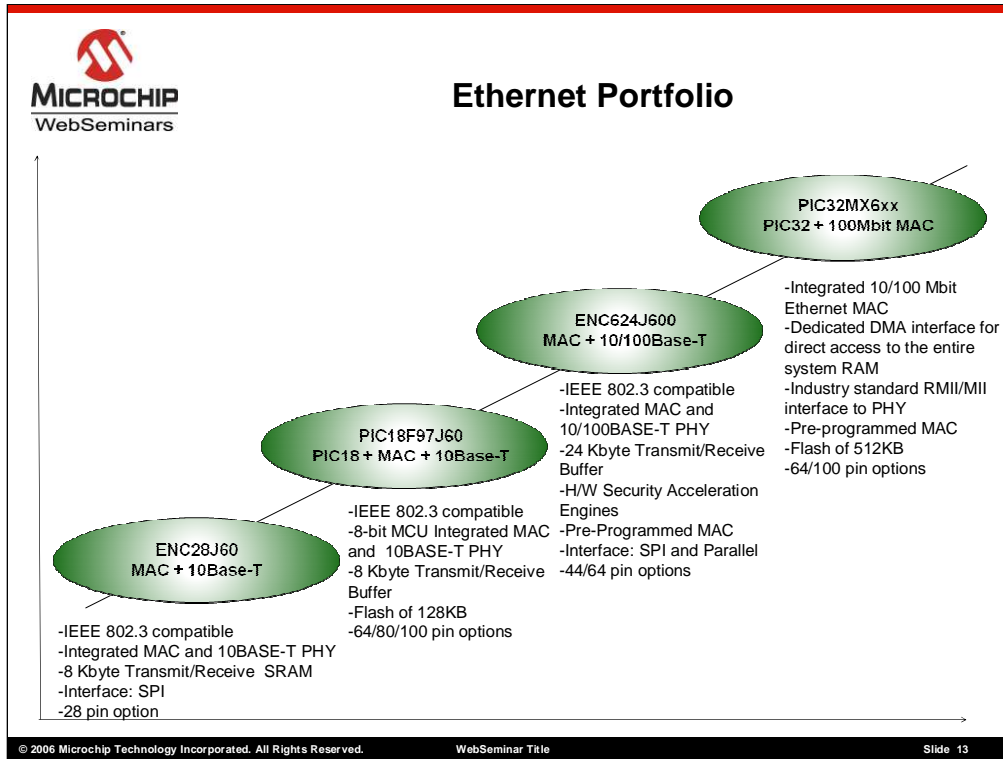
ENC28J60 is a stand alone Ethernet controller with MAC and 10 Base-T PHY. It has 8KB of configurable transmit / receive buffer with SPI interface. It is world's smallest Ethernet controller being offered in 28 pins.



PIC18F97J60 is 8-bit MCU with integrated MAC and 10 Base-T PHY. The family has 9 variants with different flash sizes and IOs.



ENC624J600 is a stand alone Ethernet controller with pre programmed MAC and 10/100 Base-T PHY. It has 24KB of configurable transmit / receive buffer with SPI and flexible parallel interface. The H/W security acceleration engines in the family differentiates itself from other solutions.



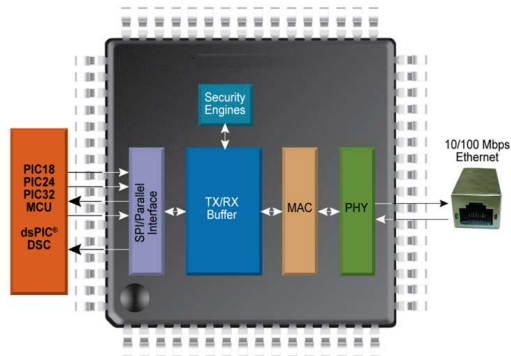
The PIC32MX6xx is the latest entrant in the embedded Ethernet solutions portfolio. It offers integrated 10/100 Mbit Ethernet MAC in 32-bit microcontrollers.

## Comparison with Peers

	ENC624J600	ENC28J60	PIC18F97J60	PIC32MX6xx
<b>PIC + Ethernet</b>	-	-	Yes	Yes
<b>Integrated MAC</b>	Yes (Factory Pre-Programmed)	Yes	Yes	Yes
<b>Integrated PHY</b>	10/100Base-T	10Base-T	10Base-T	-
<b>Tx/Rx Buffer (KB)</b>	24	8	8	Configurable from SRAM
<b>Compliance (IEEE802.3)</b>	Yes	Yes	Yes	Yes
<b>Interface</b>	SPI/Parallel	SPI	-	-
<b>H/W security</b>	Yes	-	-	-
<b>Pin / Package</b>	44 – TQFP, QFN 64 - TQFP	28 - SPDIP, SSOP, SOIC, QFN	64 – TQFP 80- TQFP 100 - TQFP	64 – QFN, TQFP 100 - TQFP

This slide shows some of the key features available within the embedded Ethernet solutions.

## ENC624J600



- Interface to PIC18, PIC24, PIC32, and dsPIC MCUs
- Serial and parallel interfaces
- Free Microchip TCP/IP stack
- Hardware development tools

The device comes with an on-chip 100 Mbps Ethernet Physical Layer (PHY) and Medium Access Controller (MAC), providing reliable packet-data transmission/reception based on an industry-standard Ethernet protocol.

A total of 24 kilobytes of buffer is present on the device. The microcontroller can configure how much of the 24KB is allocated to the receive hardware. The unallocated space remains useful as a transmit buffer. This buffer memory provides a flexible, reliable data-management system.

To reduce the processing requirements of the host controller, ENC624J600 devices incorporate different cryptographic security engines. These security engines perform the types of encryptions, decryptions and mathematical computations that are most commonly used for network security functions. They accelerate the computation of public/private key pair negotiations, message hash authentication and bulk data encryption.

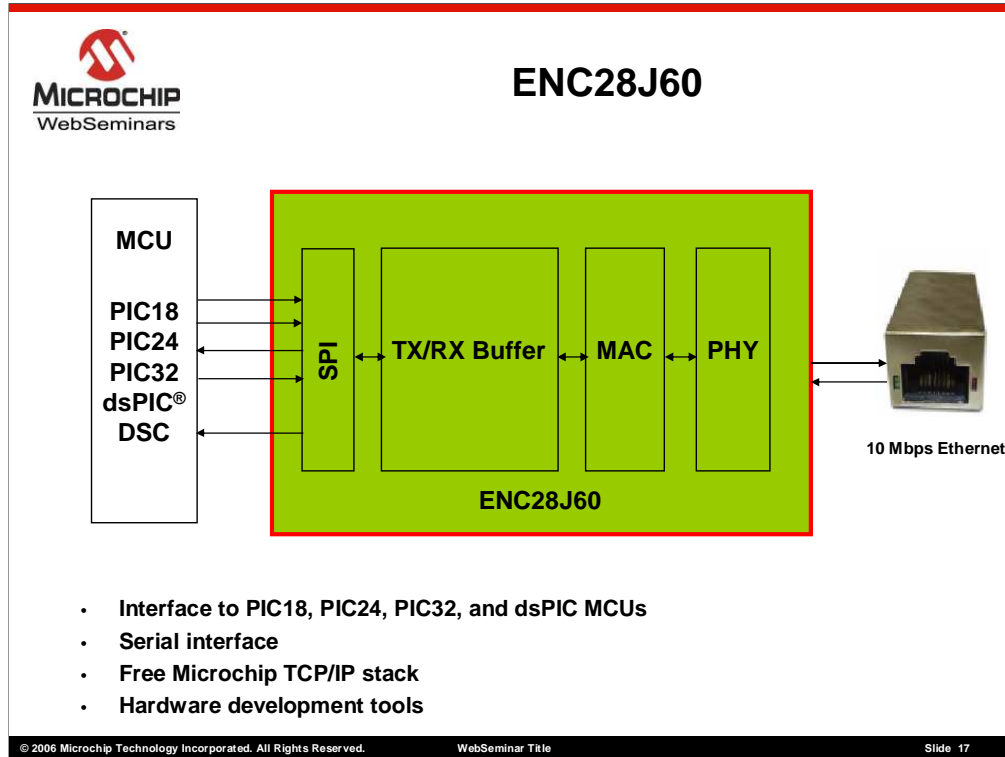
One of the quite unique features for this Ethernet controller is that it interfaces to the host MCU with either SPI or flexible parallel interfaces.

## ENC624J600

- Operational Features
- Operating voltage 3.0 to 3.6V
- 24 KB Ethernet Buffer
- Flexible 8- or 16-bit Parallel Interface
- Package options
  - 44-pin TQFP and QFN
  - 64-pin TQFP
- Hardware Security Engines
- RSA® and Diffie-Hellman Key Exchange Algorithms
- AES Encrypt/Decrypt with up to 256 bit key
- Fast MD5 hash computations
- Fast SHA-1 hash computations
- Ethernet Controller Features
- IEEE 802.3 complaint
- Integrated MAC and single port 10/100 Base-T PHY
- SPI interface with clock speeds up to 20Mbps
- MAC
  - Supports unicast, multicast and broadcast packets
  - Programmable receive packet filtering
- PHY
  - Loopback mode
  - Energy Detect power down mode

ENC624J600 standalone, IEEE 802.3™ compliant, 100 Mbps are Ethernet interface controllers. These Ethernet controllers combine a 10/100Base-TX physical interface (PHY) and a Media Access Controller (MAC) with a hardware cryptographic security engine, and can connect to any PIC® microcontroller via an industry-standard Serial Peripheral Interface (SPI) or a flexible parallel interface. Additionally, each device has a unique, factory-preprogrammed MAC address and 24 Kbytes of configurable SRAM for packet transmit/receive buffering and data storage. This combination of speed, flexibility and features enables designers to create fast, secure network- and Internet-connected embedded applications with minimized board space, cost and complexity.





•The device comes with an on-chip 10 Mbps Ethernet Physical Layer Device (PHY) and Medium Access Controller (MAC), providing reliable packet-data transmission/reception based on an industry-standard Ethernet protocol. The PHY contains analog circuitry to encode and decode the data on the twisted pair interface while the MAC contains digital circuitry to control when to transmit, handle automatic retransmission when a collision occurs, and do other necessary tasks.

•A total of 8 kilobytes of RAM is present on the device. The microcontroller can configure how much of the 8KB is allocated to the receive hardware. The unallocated space remains useful as a transmit buffer offering flexible, reliable data-management system.

It interfaces to the host MCU over an Serial peripheral interface. Thus with only 4 wires, a MCU can be network enabled.

## ENC28J60

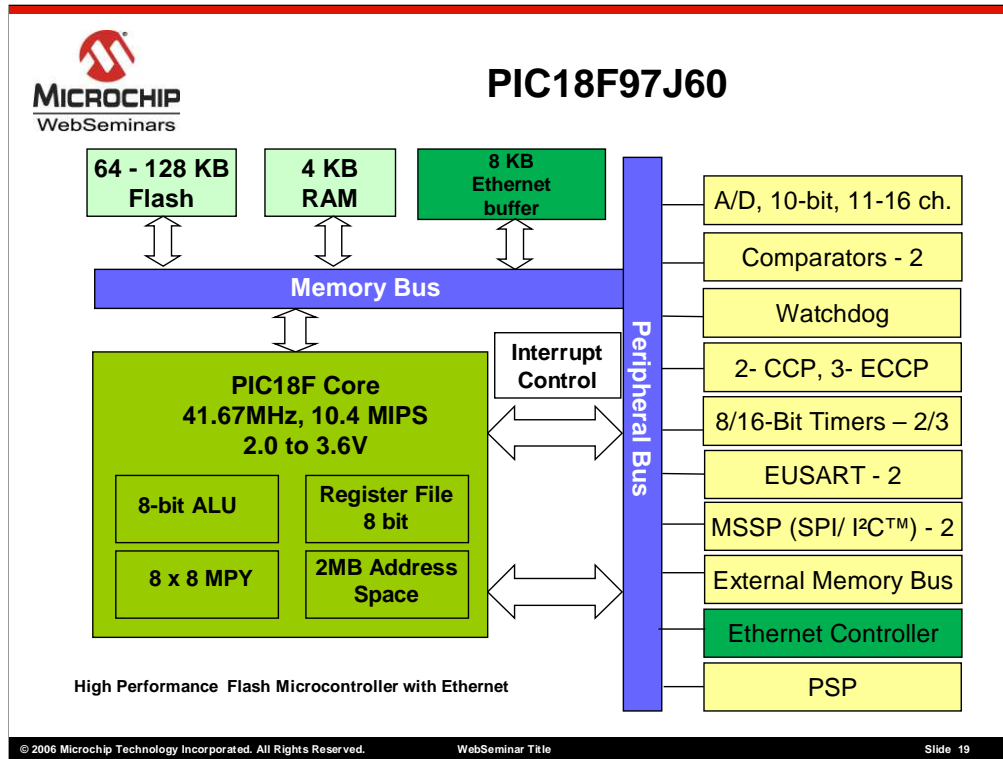
- Operational Features
- Operating voltage 3.1 to 3.6V
  - 5V tolerant inputs
- 8 KB Ethernet Buffer
- Package options
  - 28-pin SPDIP, SSOP, SOIC and QFN
- 25 MHz Clock input requirement
- Clock out pin with programmable prescaler
- Ethernet Controller Features
- IEEE 802.3 complaint
- Integrated MAC and 10 Base-T (10 Mbps) PHY
- SPI interface with clock speeds up to 20MHz
- MAC
  - Supports unicast, multicast and broadcast packets
  - Programmable receive packet filtering
- PHY
  - Loopback mode
  - Two programmable LEDs for link, TX/RX activity, collision and half/full duplex status

-IEEE 802.3 compatible Ethernet Controller

-Integrated MAC and 10BASE-T PHY

-8 Kbyte Transmit/Receive Packet Buffer SRAM

-Supports One 10Base-T Port with Automatic Polarity Detection and Correction



The single chip solution features 8-bit microcontroller and Ethernet MAC and PHY on a single 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 packets on twisted pairs have to be considered.

## PIC18F97J60

- Features
- Operating voltage 2.35 to 3.6V
  - 3.1V to 3.6 V for the Ethernet module
  - 2.5V on-chip regulator
- Flash Program Memory
  - 64, 96 and 128 KB
- 4 KB SRAM
- 8 KB Ethernet Buffer
- 10.4 MIPS, 41.67 MHz performance
- Package options
  - 64-, 80- and 100-pin TQFP
- Peripherals
- 2 x CCP and 3 x ECCP
- MSSP (SPI/I<sup>2</sup>C™) - 2
- 1 to 2 x EUSART
- Up to 16 ch. x 10-bit A/D
- 2 x 8-bit, 3 x 16-bit timers
- On-chip IEEE 802.3 compatible Ethernet controller
  - Integrated MAC and 10-Base T PHY
- PSP
- External memory bus (100 pin devices only)
  - Up to 2 MB
  - 8-, 16- and 20- bit addressing modes
- 2 x comparators with input multiplexing

-IEEE 802.3 compatible Ethernet Controller

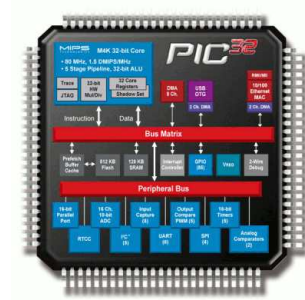
-Integrated MAC and 10BASE-T PHY

-8 Kbyte Transmit/Receive Packet Buffer SRAM

-Supports One 10Base-T Port with Automatic Polarity Detection and Correction

## PIC32 Ethernet MAC Controllers

- 10/100 802.3 Ethernet MAC
  - Full and Half Duplex operation
  - Configurable packet filtering
  - Configurable interrupts
  - Manual and Automatic flow control
  - Packet payload checksum
- Integrated DMA channels for Tx and Rx
- RX Filter (RXF)
- Industry standard MII or RMIi Interface to external PHY
- Uses main SRAM for buffers



PIC32MX6 and MX7 series of microcontrollers supports 10/100 Ethernet MAC. The Ethernet controller is a bus master module that interfaces with off chip Physical Layer (PHY) to implement a complete Ethernet node in a system.

The industry standard MII and RMIi interfaces enables seamless connection to commodity PHYs. Dedicated 2 channel DMA controller supports packet scatter/gather for outstanding low-CPU-overhead performance at full 100Mbps.

## TCP/IP Stack

- C source code provided
  - Free; No-fee license agreement
  - Separate driver available for Standalone Controllers
  - Download: [www.microchip.com/tcpip](http://www.microchip.com/tcpip)
- Can be implemented on any PIC MCU - PIC18, PIC24, PIC32, and dsPIC DSC
- Suite of files
  - 'C' source code
  - PC based utilities
  - Example projects
- Standard Microchip technical support
- Useful for Wired and Wireless solutions

Communication over the Internet is accomplished by implementing the TCP/IP protocol. Microchip offers a free TCP/IP software stack that is optimized for the 8-, 16-, 32-bit MCU and dsPIC device families. The stack is a suite of programs that provide services to all TCP/IP based applications. Users do not need to know all the intricacies of the TCP/IP specifications in order to use the stack. The stack is proven in the industry, and can be downloaded from Microchip's website.

## Development Tools – Daughter Boards



### Fast 100Mbps Ethernet PICtail Plus Daughter Board (AC164132)

- RJ-45 Ethernet Connector
- ENC624J600 10/100 Base-T Ethernet
- Connects with Explorer 16 and PIC18 Explorer boards



### PICtail Ethernet Board (AC164121)

- RJ-45 Ethernet Connector
- ENC28J60 10 Base-T Ethernet
- Connects with PIC18 Explorer board



### Ethernet PICtail Plus Daughter Board (AC164123)

- RJ-45 Ethernet Connector
- ENC28J60 10 Base-T Ethernet
- Connects with Explorer 16 board

### Fast 100Mbps Ethernet PICtail Plus Daughter Board

The Fast 100 Mbps Ethernet PICtail™ Plus Daughter Board (AC164132) is an Ethernet demonstration board for evaluating Microchip Technology's ENC624J600 and ENC424J600 stand-alone 10/100 Base-T Ethernet controllers. It is an expansion board compatible with many PICtail and PICtail Plus host boards, including the Explorer 16, PIC32 I/O Expansion Board, PICDEM.net™ 2 and PIC18 Explorer development boards.

### PICtail Ethernet Board

The Ethernet PICtail™ Daughter Board is an Ethernet demonstration board for evaluating Microchip Technology's ENC28J60 stand-alone 10 Base-T Ethernet controller. It is an expansion board compatible with a number of PICDEM™ demonstration boards. A complete list of compatible PICDEM demonstration boards is available on Microchip's web site.

### Ethernet PICtail Plus Daughter Board

The Ethernet PICtail™ Plus Daughter Board is an Ethernet demonstration board for evaluating Microchip Technology's ENC28J60 stand-alone 10Base-T Ethernet controller. It is an expansion board compatible with the Explorer 16 development board.

## Development Tools – Ethernet Development Boards



### **PICDEM.net 2 Development Board (DM163024)**

- Internet / Ethernet development board
- Supports ENC28J60 and PIC18F97J60
- Preprogrammed firmware



### **PIC32 Ethernet Starter Kit (DM320004)**

- Supports PIC32MX795F512L 32-bit microcontroller
- On-board programmer/debugger
- RJ-45 Ethernet port

Using PICDEM.net 2 Development Board and Microchip's free TCP/IP source code, developers can experiment with the preprogrammed Microchip TCP/IP demo application and learn how to integrate connectivity into their applications. The preprogrammed firmware allows users to begin evaluating the board right out of the box with no additional programming or configuration.

The PIC32 Ethernet Starter Kit contains everything needed to begin Ethernet networking applications using the high performance PIC32 microcontroller family. It provides the easiest and lowest cost method to experience 10/100 Ethernet development with PIC32. Combined with Microchip's free TCP/IP software, the project will run in no time. The PIC32 also has peripherals available as CAN2.0b and USB host/device/OTG.





## Additional Information

[www.microchip.com/Ethernet](http://www.microchip.com/Ethernet)

Offers information on Ethernet products, development tools, app notes, FAQs, etc.

[www.microchip.com/TCPIP](http://www.microchip.com/TCPIP)

Provides information on TCP/IP stack download and support

[www.microchip.com/RTC](http://www.microchip.com/RTC)

Regional Training Centers offers training facilities to our customers on Microchip's products, tools and applications

- COM 4201: Designing Embedded TCP/IP Monitor and Control

[www.microchip.com/Support](http://www.microchip.com/Support)

Offers help to customers on 24x7 basis

One can visit the following links to get more information on Microchip's Ethernet portfolio, TCPIP stack, Regional training centers and to get 24x7 customer support.

## Summary

- **Microchip offers wide range of embedded Ethernet solutions**
  - 10 Base-T PHY with MAC
  - 8-bit microcontroller with integrated 10 Base-T PHY and MAC
  - 10/100 Base-T PHY with pre-programmed MAC
  - 100 Mbit Ethernet MAC
- **License free, zero cost software library – TCP/IP stack**
  - Can be ported on any PIC or dsPIC controllers only
- **Customer support**
  - 24x7 customer support
  - Regional training classes for new professionals



Microchip offers wide range of embedded Ethernet solutions that meet the requirements of embedded design engineers.

MCHP offers license free TCP/IP stack to help accelerate your time to market.

24x7 customer support and regional training centers are available to assist customers in their design.

**Thank You**