



XBee

XBee - 802.15.4

XBee – Znet 2.5

Xbee – ZB



XBee Key Features

- Price-to-Performance Value
- Low Power Consumption
- Receiver Sensitivity
- Industrial Temperature Rating
- Worldwide Acceptance
- Small Form Factor

WHEN
RELIABILITY
MATTERS™



XBee “Standard” Series comparison

802.15.4

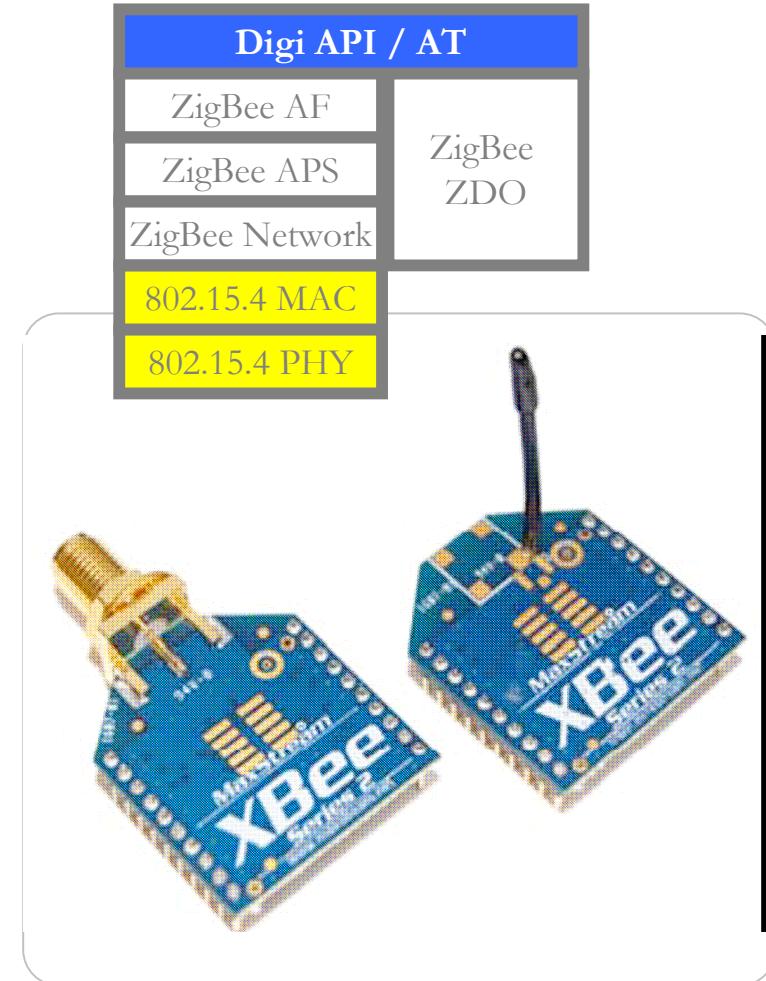
Znet 2.5 / ZB

Indoor/Urban Range	up to 30 m	up to 40 m
Outdoor RF line-of-sight Range	up to 100 m	up to 120 m
Transmit Power Output	1 mW (0 dBm)	2 mW (+3 dBm)
RF Data Rate	250,000 bps	Same
Receiver Sensitivity	-92 dBm (1% PER)	-95 dBm (1% PER)
Supply Voltage	2.8 – 3.4 V	2.8 - 3.3 V
Transmit Current (typical)	45 mA (@ 3.3 V)	40 mA
Idle / Receive Current (typical)	50 mA (@ 3.3 V)	40 mA
Power-down Current	< 10 µA	< 1 µA
Frequency	ISM 2.4 GHz	Same
Dimensions	0.960" x 1.087"	Same
Operating Temperature	-40 to 85° C	Same
Antenna Options	Chip, Integrated Whip, U.fl	Chip, Integrated Whip, U.fl, RPSMA
Supported Network Topologies	P2P, P2M, and PP	P2P, P2M, and MESH
Number of Channels	16 Direct Sequence Channels	Same
Filtration Options	PAN ID, Channel & Source/Destination	Same
Zigbee	NA	2006+ / 2007
FCC Part 15.247	OUR-XBEE	OUR-XBEE2/ TBD
Industry Canada (IC)	4214A-XBEE	4214A-XBEE2 / TBD
Europe (CE)	ETSI	ETSI



XBee Module

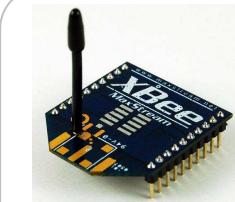
- Thin API or AT interface application layer to 802.15.4 or EmberZNet stack
- Powerful feature set includes:
 - Remote configuration
 - Low power end devices
 - IO line set/read capabilities
 - 8+1 GPIO (1 PWM)
 - 4 A/D inputs
 - Network diagnostics
- 4 Antenna Options: Whip, Chip, U.FL, RPSMA
- No RF HW development risk
- Fully approved !!!





Transparent / AT Firmware

- Transparent operation works “out of the box”
- Serial cable replacement
- 3 Command Characters to enter Command mode ('+++’ default)
- Simple configuration of network, addressing, and other advanced features



Coordinator



Router



Router



End Device



API Firmware

- Commands and data sent to the module through a simple API (Application Programming Interface)
- API frames expose simple and advanced ZigBee capabilities



Coordinator



Router



Router



End Device



API Firmware

- ZigBee API Frames
 - Transmit and Receive Frames
 - Simple Transmit and receive frames require only module addresses
 - Advanced transmit and receive frames expose ZigBee cluster IDs, endpoints
 - Transmit status frames indicate the delivery status of the transmission
 - Receive frames indicate the sender's address
 - Status Frames
 - Indicate device and network-level behavior including join indications, reset notifications, etc.



AT versus API mode

- Advantages
 - Simple
 - Transparent
 - Streaming performance

- Disadvantage
 - Slow for commands
 - Not optimized for embedded systems

- Advantages
 - Quick commands
 - Additional information
 - Over the air configuration
- Disadvantages
 - Complex
 - Not transparent



XBee - IO features

- UART Data Input (3.3V)
- 4 ADC's
- 8+1 DIO lines
- PWM (RSSI) output



XBee - ADC

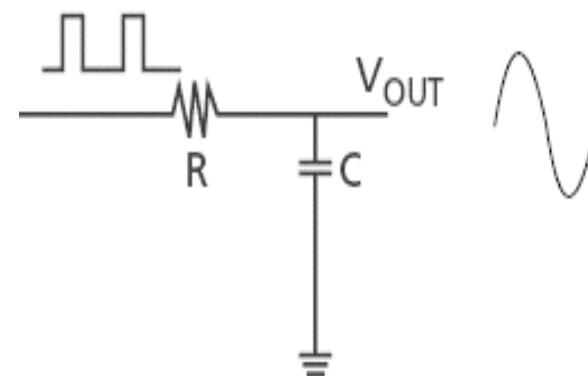
- Analog to Digital Conversion
- XBee has 4 ADC's
- 10 bit resolution
- 1KHz MAX sample rate
- The XBee does not have DAC's
 - Output can be read from the UART
 - Also can build a LPF for the PWM output



XBee - DAC

DAC

- PWM Pulse Width Modulation
- LPF





XBee - DIO line passing

- Digital Input / Output lines
- XBee has 8+1 DIO lines
- User configurable for
 - Timed sampling
 - Default states
 - Change Detect
 - Pass-through mode
 - Internal Pull-up enable/disable



Xbee – Over the Air

- Using API mode it is possible
 - To change configuration over the air
 - Set/Reset and read IO lines
 - Read A/D values
- XBee also can send you automatic low battery warning (voltage threshold)



ZNet 2.5 & ZB (Zigbee PRO)

- Separate Platforms (part no)
- In Common:
 - Full Function Mesh (Coord/Routers, RFD)
 - Reliable Transmission
 - Network Join/Route Discovery
 - AES Encryption
 - Adapter Support/Commissioning Button
 - API Support



ZNet 2.5 & ZB (Zigbee PRO)

- ZigBee Alliance
 - ZNet 2.5: Designed for ZigBee
 - ZB: ZigBee Certified (pending)
- Unicast Timeout (Hop Maximum)
 - ZNet 2.5: Fixed Unicast Timeout
 - ZB: Adjustable Unicast Timeout (12 sec.)
- Over-the-air firmware updates
 - ZNet 2.5: not possible
 - ZB: available



ZNet 2.5 & ZigBee PRO

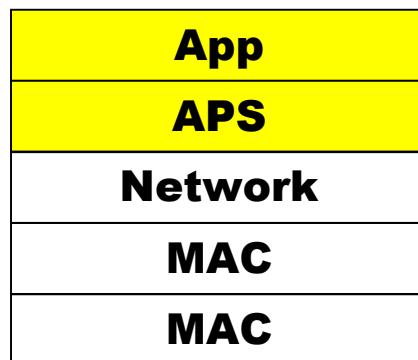
- PAN ID
 - ZNet 2.5: 16-bit PAN ID
 - ZB: 16-bit & 64-bit PAN ID
- ZigBee Pro Adds Improved Frequency Agility
- Interoperability
 - ZNet 2.5: Other EM250/ZNet 2.5 Devices
 - ZB: Full Interoperability with Public Profiles (using API)



ZNet 2.5 & ZB (Zigbee PRO)

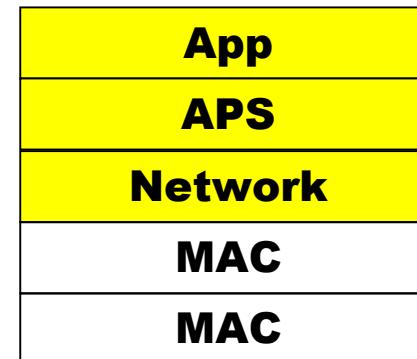
ZNet 2.5

- Single encryption key for entire network

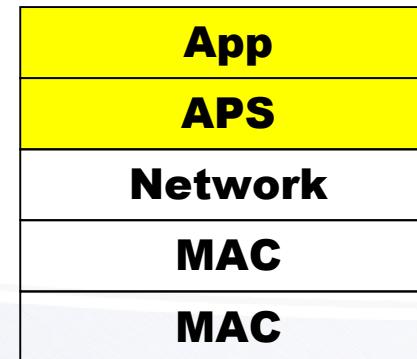


ZB (Zigbee PRO)

- Network Key



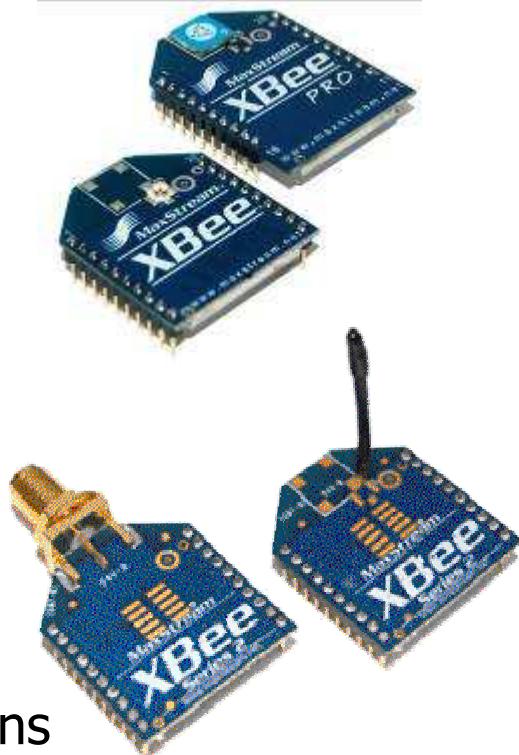
- Link Key





XBee Series

- XBee 802.15.4
 - FreeScale Chipset
 - Ideal for 802.15.4 applications
 - 4 Antenna Options
- XBee Znet 2.5
 - Ember EM250 Chipset
 - Ideal for ZigBee Applications
 - 4 Antenna Options
- Xbee ZB*
 - Ember EM250 Chipset
 - Ideal for Zigbee Cross-Compliant Applications
 - 4 Antenna Options





Decision factors

- XBee 802.15.4 (Freescale based)
 - 802.15.4 (point to multipoint)
 - Slightly lower price than Series 2
 - Lower more predictable latency
 - More predictable battery life
- XBee Znet 2.5 / ZB (Ember based)
 - **Mesh support**
 - Automatic route discovery
 - Self-healing
 - Extended range – through mesh



Xbee modules – sneak preview

- So what's next ?
 - XBee Zigbee 868 ?
 - No, because 802.15.4 – 868 is 1ch, 20kbs
 - So: XBee DigiMesh 868
 - But also: XBee DigiMesh 2.4 and 900
 - AND also: XBee 802.11



Digi RF roadmap

Hardware

XBee-PRO ZNet 2.5

U.fl, Wire, Chip

- 2.4 GHz
- Designed for ZigBee
- Mesh topology
- 1 mile (1.6 km) RF LOS Range
- Tx: +17 dBm
- Rx: -102 dB

February 2008



March 2008



April 2008



May 2008



July 2008



Q4 2008



XBee-PRO ZNet 2.5

RPSMA

- 2.4 GHz
- Designed for ZigBee
- Mesh topology
- 1 mile (1.6 km) RF LOS Range
- Tx: +17 dBm
- Rx: -102 dB

XBee-PRO XSC

- 900 MHz
- XStream Compatible
- Multipoint topology
- 15 miles (24 km) RF LOS Range
- Tx: +20 dBm
- Rx: -106 dB

XBee-PRO 868

- 868 MHz
- Multipoint
- 20+ mile (32+ km) RF LOS Range
- Tx: Greater than +20 dBm
- Rx: -110 dB (spec)
- Data Preliminary

Planned

Released

Definition



Digi RF Roadmap

Firmware (stand-alone products)

XBee & XBee-PRO ZB (2007)

- 2.4 GHz
- ZNet 2.5 Hardware
- Will be "ZigBee Certified"
- ZigBee-PRO Stack Mesh

XBee & XBee-PRO

DigiMesh 2.4

- 2.4 GHz
- 802.15.4 hardware
- DigiMesh & Sleeping Routers

May 2008

June 2008

August 2008

Q1 2009

XBee-PRO DigiMesh 900

- 900 MHz
- XBee-PRO 900 Hardware
- DigiMesh & Sleeping Routers

XBee-PRO DigiMesh 868

- 868 MHz
 - XBee-PRO 868 hardware
 - DigiMesh & Sleeping Routers
- *Feasibility not known

Planned

Released

Definition



XBee Platform Comparison

Platform	Hardware	Shared?	Protocol	Positioning
802.15.4	Freescale	DigiMesh 2.4	802.15.4	Low-Cost Multipoint
ZNet 2.5	Ember	ZB	ZNet 2.5	Low-Cost Mesh
XSC	Proprietary	No	Proprietary	Long-Range Multipoint
ZB	Ember	ZNet 2.5	ZigBee-PRO	ZigBee-PRO FS
900	Proprietary	DigiMesh 900	Proprietary	High-Speed Multipoint
DigiMesh 900	Proprietary	900	DigiMesh	Sleeping Routers
DigiMesh 2.4	Freescale	802.15.4	DigiMesh	Sleeping Routers
868	Proprietary	No	Proprietary	Long-Range Multipoint
868 MHz	900 MHz	2.4 GHz		Not Released



AT Command Mode Demo

The image shows two side-by-side terminal windows from the X-CTU software, demonstrating an AT command exchange between a Coordinator and a Router.

Left Terminal (Coordinator):

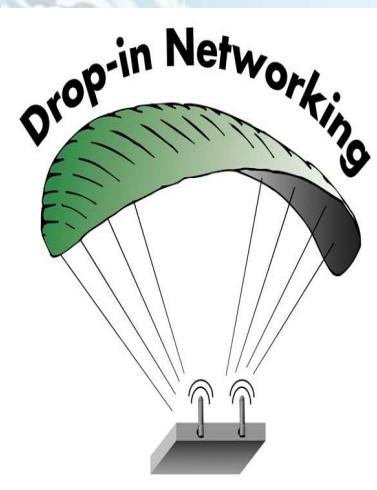
- Port: X-CTU [COM1]
- Line Status: CTS (green), CD (green), DSR (green)
- Configuration Buttons: Assert (DTR checked, RTS checked, Break unchecked), Close Com Port, Assemble Packet, Clear Screen, Show Hex
- Text Log:
 - +++OK
 - atid
 - 234
 - atch
 - 11
 - atmy
 - 2AC9
 - atsh
 - D6F00
 - atsl
 - 68959
 - atcn
 - OK
 - Transmitting sample data packet from Coordinator to Router
- Status Bar: COM1 | 9600 8-N-1 FLOW:NONE | Rx: 88 bytes

Right Terminal (Router):

- Port: X-CTU [COM4]
- Line Status: CTS (green), CD (green), DSR (green)
- Configuration Buttons: Assert (DTR checked, RTS checked, Break unchecked), Close Com Port, Assemble Packet, Clear Screen, Show Hex
- Text Log:
 - +++OK
 - atid
 - 234
 - atch
 - 11
 - atmy
 - 0
 - atdhd6f00
 - OK
 - atd168959
 - OK
 - atpl4
 - OK
 - atcn
 - OK
 - Transmitting sample data packet from Coordinator to Router
- Status Bar: COM4 | 9600 8-N-1 FLOW:NONE | Rx: 24 bytes



Digi added advantage: Drop in Networking



WHEN
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End-to-End Wireless networks

Central Systems

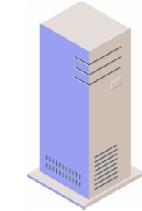
WAN

Gateways

Zigbee PAN

Sensors

Connectware

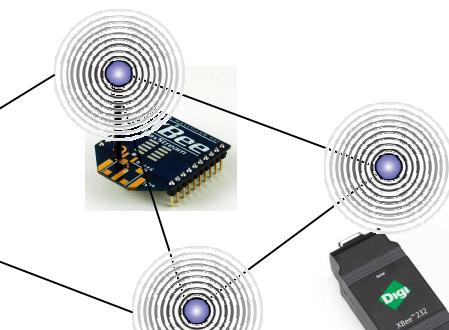


WAN

Ethernet

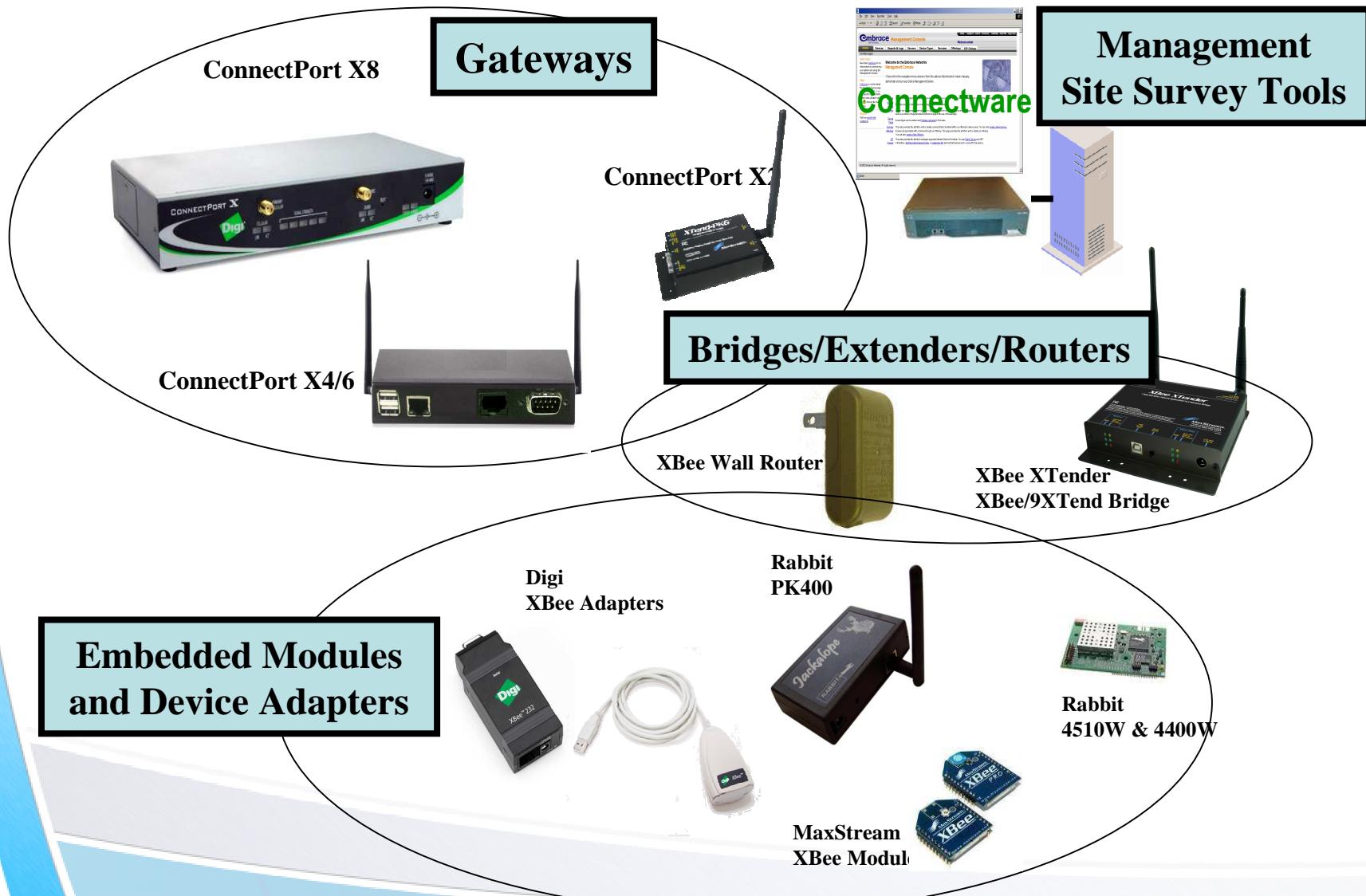


Local Access





Drop-in Network Architecture





XBee Adapters (SP-style)



- Battery (N-cell), externally powered, or both for redundancy
- Supports all XBee formats with PRO level range
- Versions - Now
 - XBee 232 – DB9
 - XBee 485 – Terminal Block
 - XBee 1-Wire – RJ45
- Next Versions
 - XBee Digital I/O – Terminal Block
 - XBee Analog I/O – Terminal Block (0-10 volts, 12 bit)



XBee Adapters (EP-style)



- Small form factor
 - Digi EdgePort/1 Size
- Value connectivity
- XBee USB
 - USB Host Connected
 - Quick connect to a PC
 - Drivers compatible with other MaxStream USB products
 - Supports all XBee formats at a PRO level
- XBee 232PH
 - Parasitically powered
 - Simple serial connectivity
 - RS232 only
 - Ember 2.5 and Zigbee PRO compatibility



XBee USB & 232PH

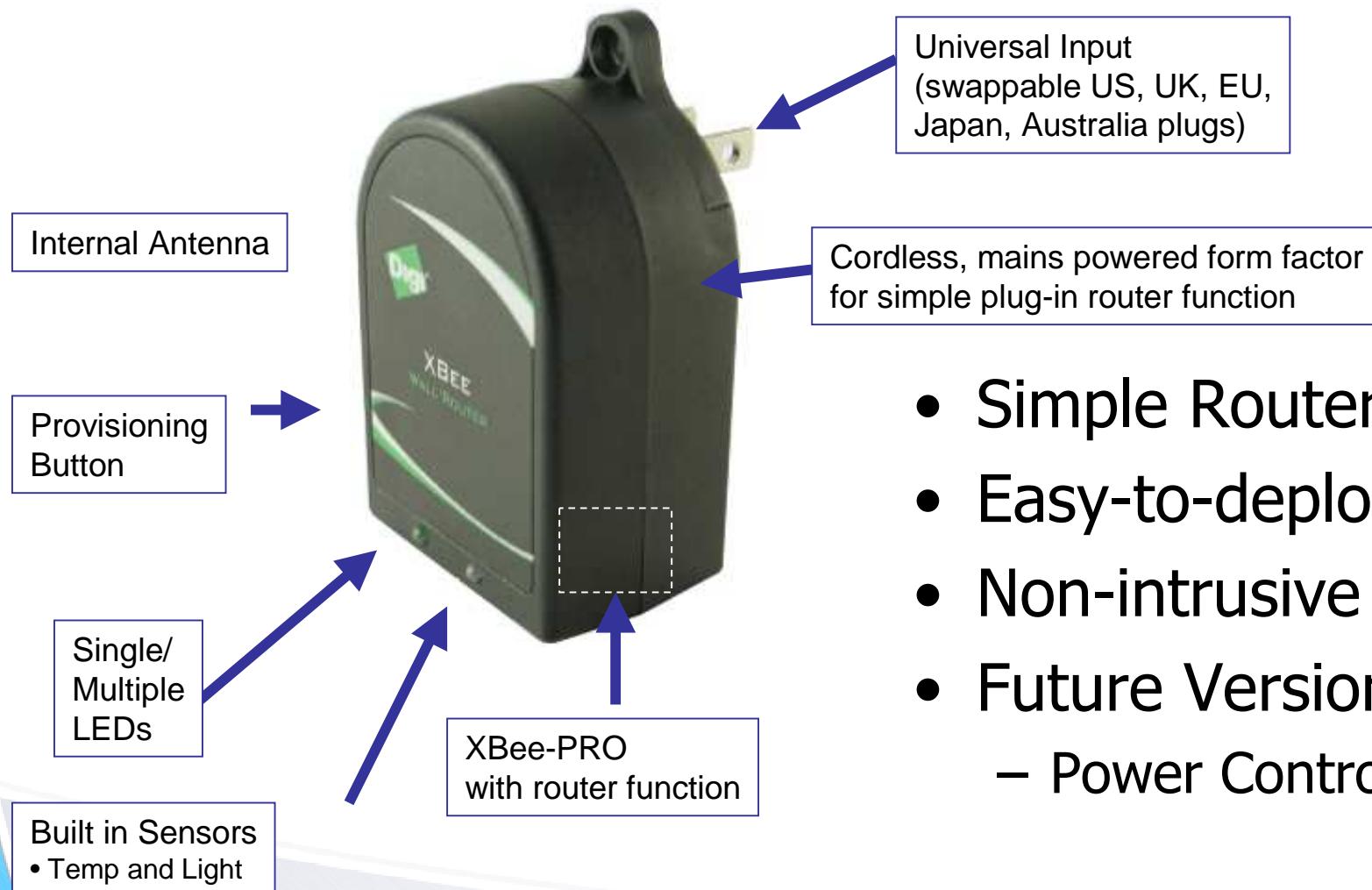
New PIC
Coming



- Low power, low cost simple ZigBee adapter
 - Targeted at Point of Sale, Transaction Processing and simple Terminal server applications
 - Powered from Serial Port with small rechargeable batteries
 - May also be added to current Digi DS, TS and Cellular products
- Supports MaxStream APIs
 - Currently compatible with only Ember 2.5 and ZigBee PRO stacks



XBee Wall Router





Introducing: ConnectPort X Gateways





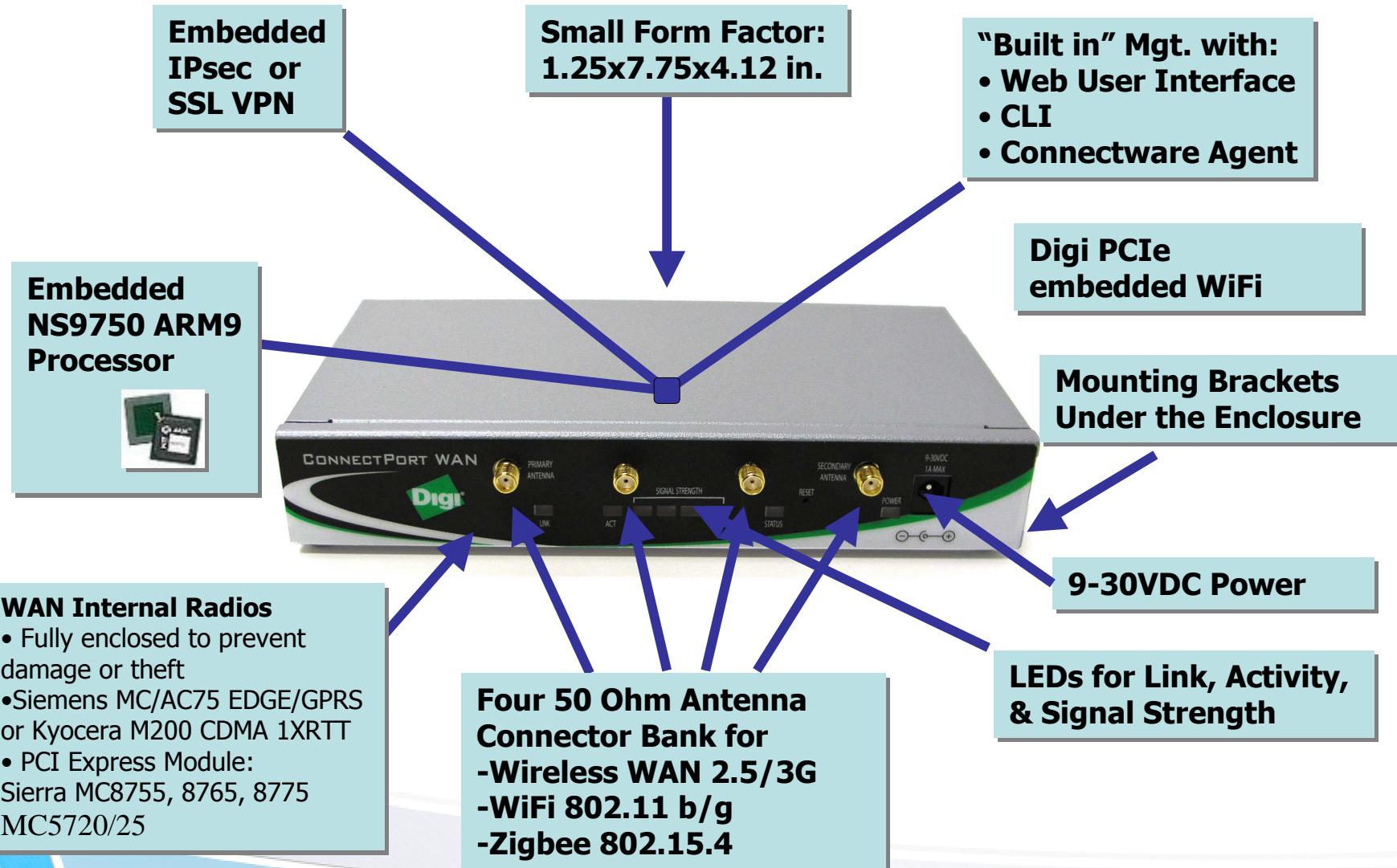
ConnectPort X features

- Digi Cellular / Ethernet /Zigbee Gateway Routers
 - Transparent Gateway operation
 - Remote configuration and monitoring of ZigBee networks





ConnectPort X8





ConnectPort X Gateways

Feature	X2	X4	X8
Positioning	Single Function ZigBee to Ethernet or WiFi	Low Cost ZigBee to Cellular	High-End Multifunction Gateway; most versatility and flexibility
Processor	NS7520 ARM7	NS9360 ARM9	NS9750 ARM9
Programming Environment	Python	Python	Python
Dimensions	4.5" x 2.75" x 1.125" 11.43 cm x 6.99cm x 2.86cm	5.25" x 3.35" x .97" 13.34cm x 8.51cm x 2.47cm	8.7" x 4.11" x 1.3" 22.1cm x 10.4cm x 3.3cm
RAM	8MB	16MB	16MB
FLASH	4MB	8MB	8MB
PCIe Slots	No	1	2
Cellular	No	2G or 2.5G	3G
GPS	No	External	Yes PCIe or External
Wi-Fi	Yes w/o Ethernet	Yes via PCIe	Yes via PCIe
Ethernet (RJ-45)	Yes w/o Wi-Fi	1	1
Serial (DB-9)	No	1	1
USB	No	1	2
Storage Module (1GB PCIe)	No	Ethernet version only	Yes via PCIe
Sensor Port (RJ-45)	No	No	1
Availability	Now	Now	Now



ConnectPort X8

- **Network Flexibility**

- 3G EVDO or HSDPA for Wireless WAN
- 2.5G EDGE/GPRS and 1xRTT Wireless WAN
(1xRTT option via Sierra EV-DO PCIe module)
- Ethernet for WAN or LAN
- 802.11.b&g for WAN or LAN



- **Mesh Zigbee**

- MaxStream Freescale 802.15.4
- MaxStream Ember 2.5 stack, 3.0 when available
- MaxStream Freescale ZigBee available upon release

- **Security**

- IPSEC/SSL Tunneling on WAN Connections with DES, 3DES or AES Encryption
- 128 bit encryption on the Zigbee/802.15.4 Network

- **Commercial/Industrial Grade**

- Enclosed card/module to reduce breakage/theft
- External antennas with standard connectors
- Extended operating temperature, -20° to +60°C
- Hardened enclosure with built-in mounting flanges
- Real-time clock

- **Connectware Enterprise Management**

- **PCIe Options coming**

- Internal GPS
- 2GB Storage



- Dynamic, object-oriented language
- Extensive libraries
- Works well with other languages
- True “Open Source”-> no royalties
- Runs on a wide range of operating systems- Windows, Linux/Unix, Mac OS X, OS/2, Amiga, Palm Handhelds, and Nokia mobile phones. Python has also been ported to the Java and .NET virtual machines
- Used by Google, Yahoo, uTube, NASA, Honeywell, Disney, IBM, National Weather Service
- Supporting Rel 2.5 downloadable from
<http://www.python.org/>



Drop-In Networking

DEMO

WHEN
RELIABILITY
MATTERS™



Digi XBee - Fastest Time From Zero to ZigBee

- The quickest way to enable ZigBee mesh networking
- FCC and ETSI approval
- Robust RF test fixture certifies reliable hardware operation
- Multiple antenna options available
- Free RF-XPert Technical Support
- Development kits available
- Contact Digi/MaxStream or your distributor for more information

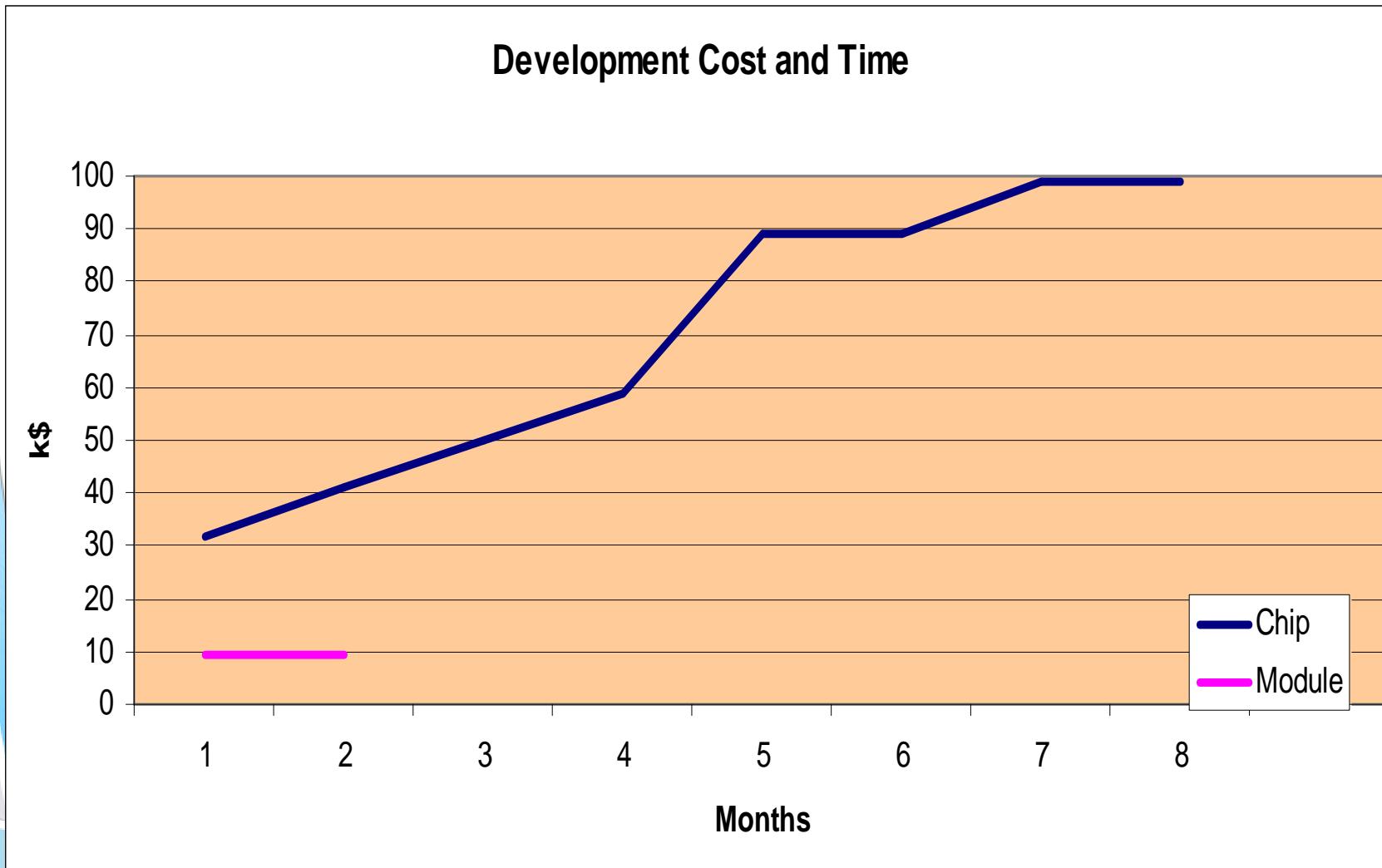


Chip design vs. Module

- **Chip design (Cost, Time, and Quality)**
 - Cost \$ 96k
 - To design ~\$35k (one general purpose engineer 4 months)
 - Test Equipment ~\$21k (Spec An -11k, Sig Gen -10k, Network Analyzer 20k)
 - Software Tools- \$2k
 - International Compliance ~\$10k (FCC, IC, ETSI, etc.)
 - Manufacturing test fixture ~\$30k (above test equipment + PC DAQ board, etc)
 - **The cost of missed opportunities?**
 - Time 8 Months
 - 4 Months (software and hardware design)
 - 2 Months (test fixture design and setup)
 - 2 Months (International Compliance)
 - Quality
 - Manufacturing process definitions
 - Test fixture design and upgrades

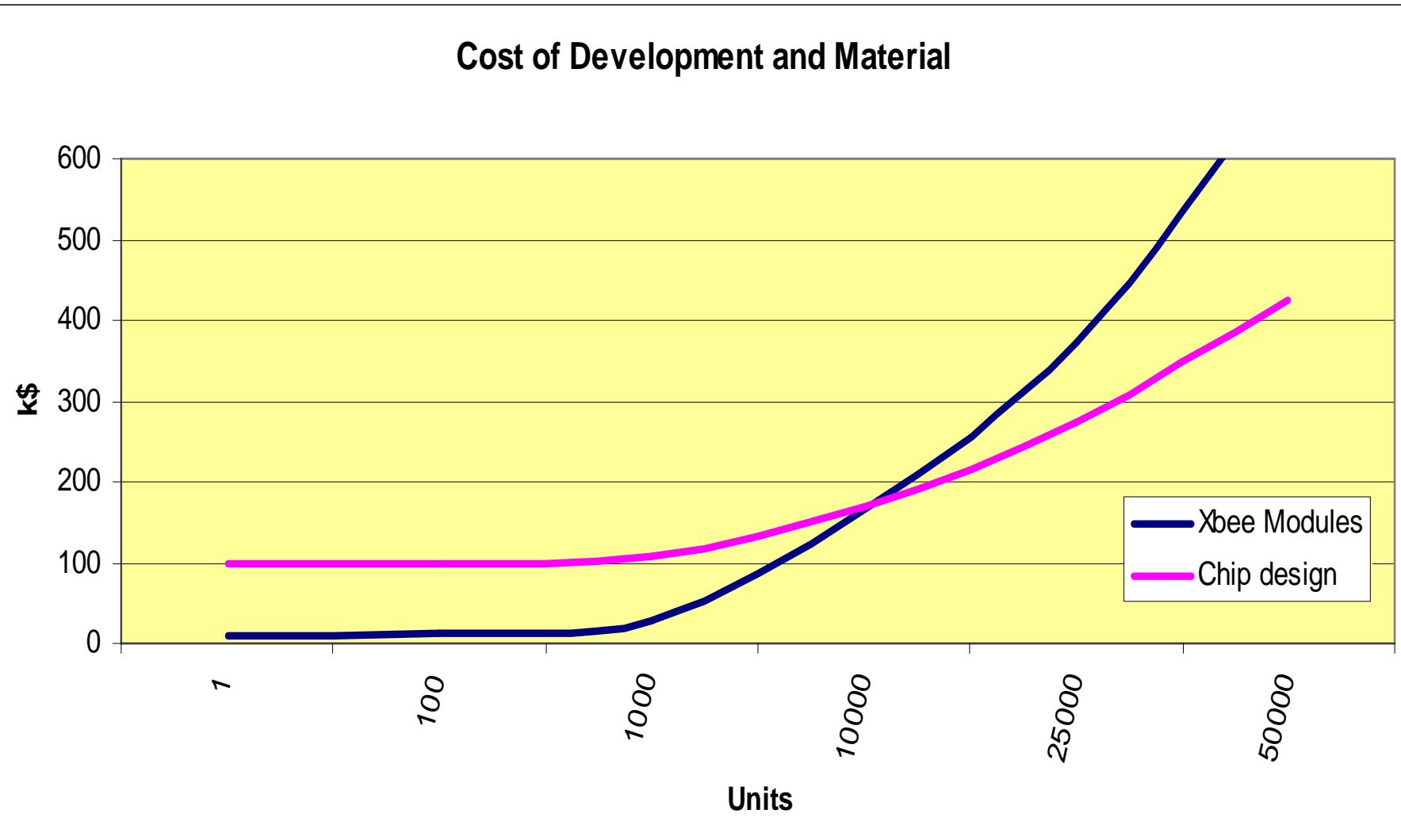


Chip vs. Module - TTM



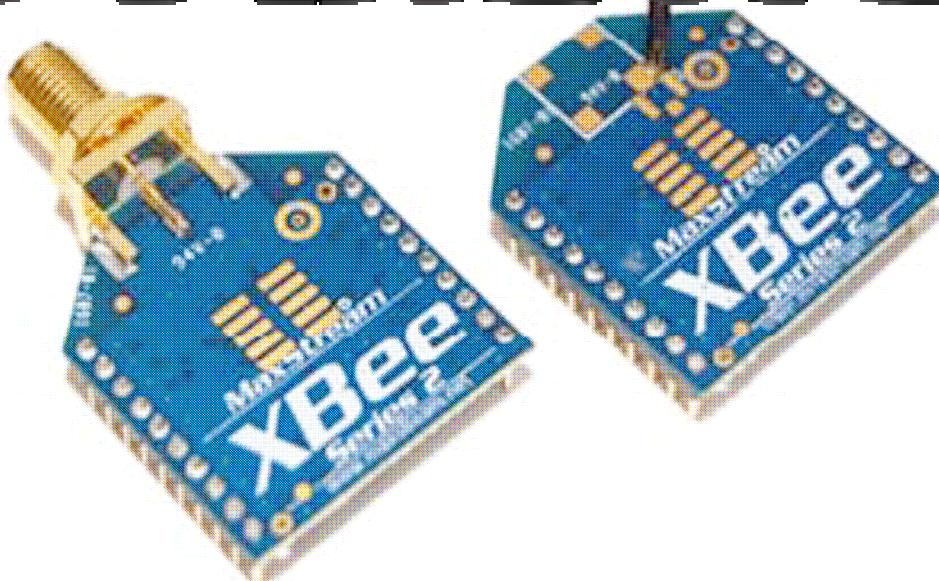


Chip vs Module...cost





Questions & Answers



www.digi.com