



We are  
**Delivering M2M**  
Around the World.

# ZigBee™ Make or Buy?



# Why ZigBee?

- **#1 - Low Cost**
  - Allows addition of wireless to any price product
- **#2 - Ease of Deployment**
  - Mesh networking overcomes line-of-sight fears
- **#3 - Multi-source Products**
  - Not betting on a single company
- **#4 - Battery Operation**
  - Allows products to be un-tethered from power cords

# ZigBee – Make or Buy?

- When a chipset costs less than \$10 for 1Ku, why pay \$20 for a module?



# ZigBee – Make or Buy?

- **Concerns about Buying:**
  - Cost
  - Flexibility
  - Control

# ZigBee – Make or Buy?

- **Agenda**

- Comparison of Development and Manufacturing Costs
- Comparison of Times to Market
- Impact of Volume on the Decision
- Flexibility – What can Modules Offer?
- Control – Making it Your Own
- Control – Intellectual Property
- Control – Leverage with Vendors
- Choosing a Module Vendor
- Conclusions

# ZigBee – Rolling Your Own

- **Evaluate/select chipset/stack vendor(s)**
- **Acquire Development Kit**
- **Attend Vendor Training**
- **Implement design**
  - Your own
  - Vendor's reference design
- **Integrate design into product**
- **PCB Layout with RF considerations**
- **Debug design**
- **Type acceptance tests – FCC, ETSI**

# ZigBee – Rolling Your Own

- **Join ZigBee Alliance**
- **ZigBee Tests if advertising ZigBee**
- **Release product into production**
- **Monitor production yields on RF characteristics**

# ZigBee – Off-the-Shelf

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# ZigBee – Evaluating/Selecting Vendor(s)

- Eval kits for chipsets or modules cost about the same ~ \$500
- Developer's Kits and Vendor training cost about \$10,000

	<u>Make</u>	<u>Buy</u>
Running Total:	\$12,000	\$2,000



RFM's ZMN2400HP Dev Kit - \$299 on Digi-Key

# ZigBee – Implementing a Design

- **Even simply implementing reference designs require special test equipment:**
  - Spectrum Analyzer
  - Signal Generator
  - Network Analyzer
- **Count on spending in excess of \$100,000 for test equipment**



	<u>Make</u>	<u>Buy</u>
<b>Running Total</b>	<b>\$112,000</b>	<b>\$2,000</b>

# ZigBee – Implementing a Design

- RF designs require an RF designer
- Count on spending \$150,000/year for an experienced RF designer. (You'll need to keep 'em on board through the life of the product.)

	<u>Make</u>	<u>Buy</u>
Running Total	\$262,000	\$2,000

# ZigBee – Layout with RF Considerations

- A single mistake on an RF layout can render the best design unusable
- Out-of-house layout services with RF expertise - \$5,000 for the initial layout

	<u>Make</u>	<u>Buy</u>
Running Total	\$267,000	\$2,000

# ZigBee – Type Acceptance

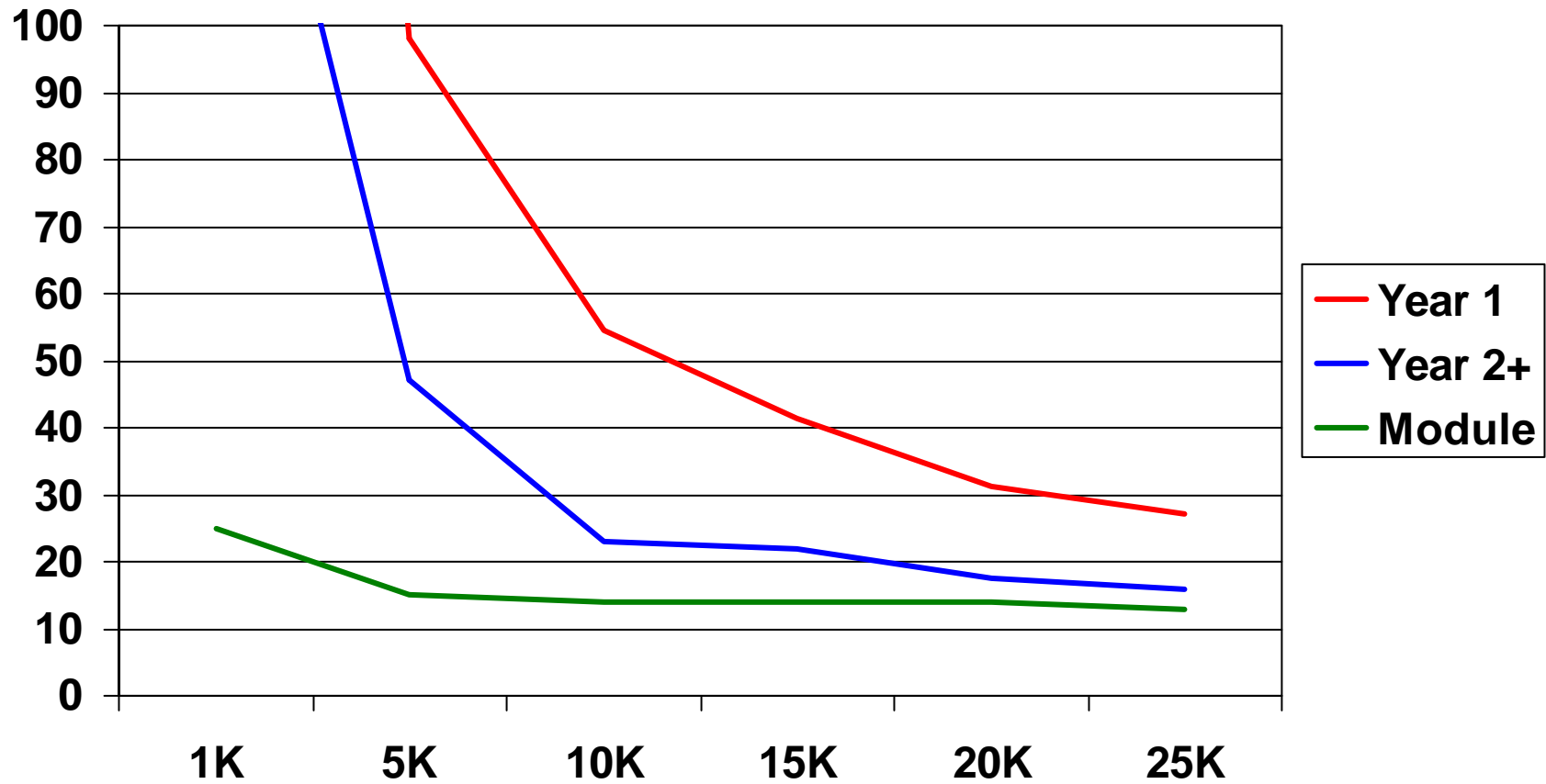
- **Test Lab and Filing Fee for FCC Type Acceptance \$5,000 if passes on first attempt. Add \$2,000 for each additional attempt**
- **Ditto for ETSI**

	<u>Make</u>	<u>Buy</u>
<b>Running Total</b>	<b>\$277,000</b>	<b>\$2,000</b>

# ZigBee – Incremental Indirect Costs

- **Development Costs** **\$275,000**
- **Ongoing Support Costs** **\$150,000/year**

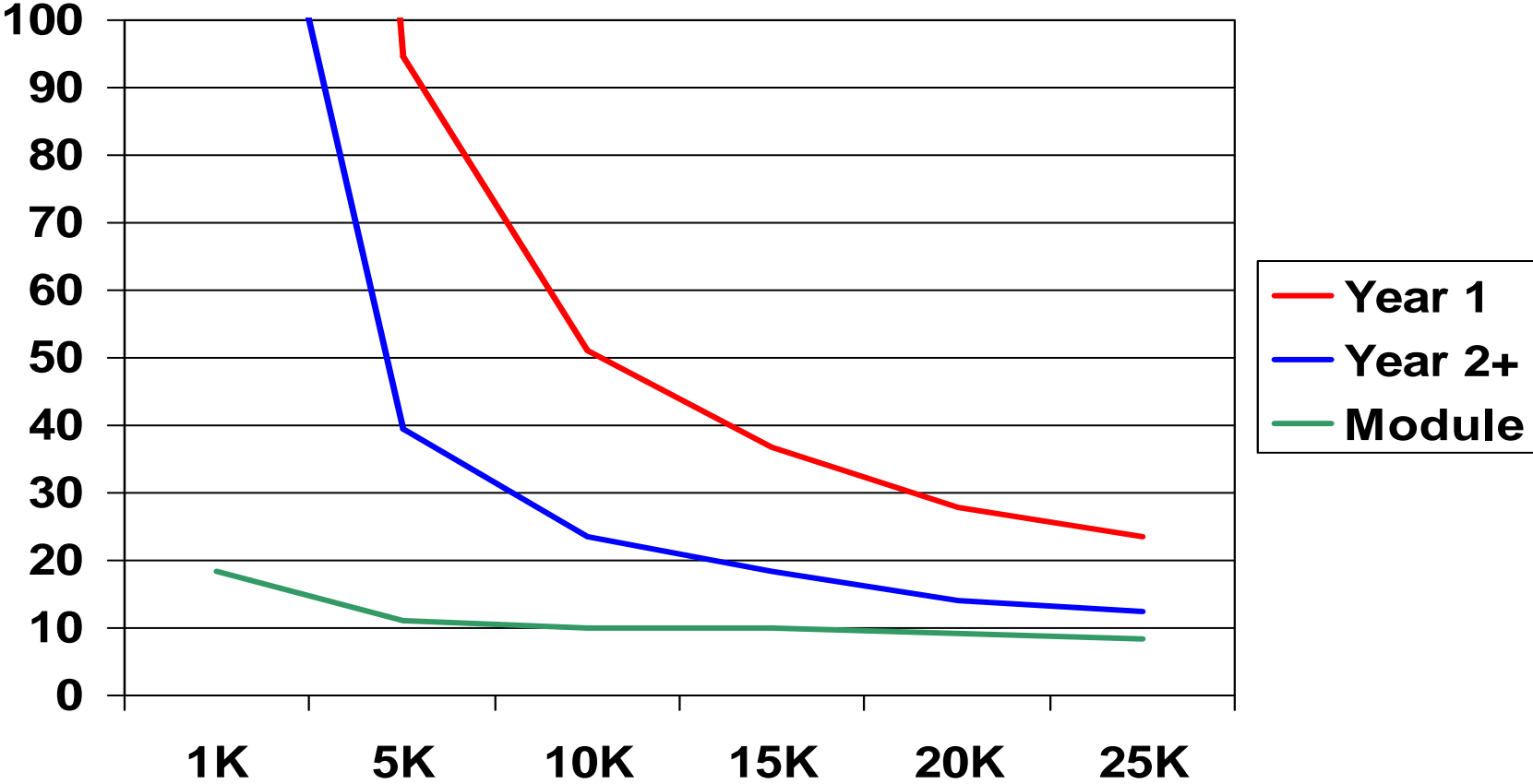
# ZigBee – Impact of Volume



# What About Single Chip Designs?

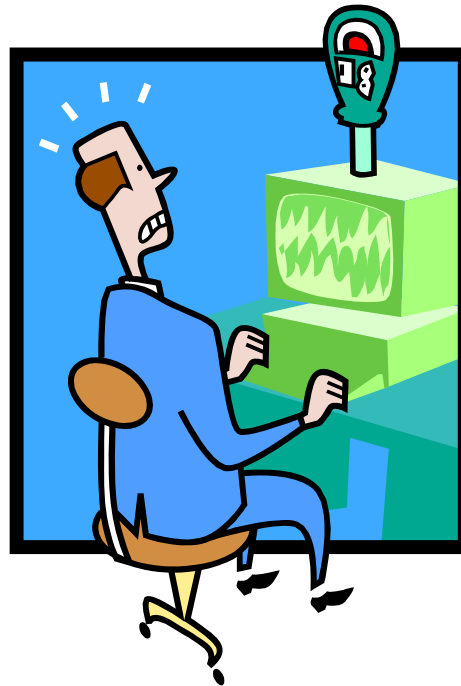
- **Two chip chipsets are replaced by single chip solution**
- **Cost savings that accrue to OEMs also accrue to module manufacturers**
- **Other BOM costs are the same**
- **Fixed costs don't change**
- **Single chip modules will cost less than two chip solutions**

# Impact of Volume – Single Chip Designs



# ZigBee – Manufacturing Yield

- “Anybody can build one of anything.”
- Consistent volume production without manual labor is key to keeping costs low.



# ZigBee – Manufacturing Yield

- **Yield issues due to component tolerances**
  - Can only be discovered through producing volumes of product
- **How much does it cost to rework your product?**

# ZigBee – Time to Market

- **Additional Development Time:**
  - RF Debugging 2 weeks
  - Type Acceptance Testing 2 weeks
  - Type Acceptance Grants 8 weeks
- **Time to Market Savings 12 weeks MINIMUM**

# ZigBee – Time to Market

- What is the value of time-to-market?



# ZigBee – Time to Market

- **Hypothetical Example**

- Limited selling window
- 10K annual quantities at \$400 ASP
- 3 Months of additional selling time = 2,500 additional units
- 2,500 units at \$400 ASP and 40% Gross Margins

**= \$400,000 incremental gross profit**

# ZigBee – Cost

- **The Economics are Compelling:**

**Unless you are planning on volumes well in excess of 25,000 pieces per year, third party modules are the most cost effective.**

# ZigBee – Flexibility

- **Using third party modules means working my design around what the module manufacturer thinks is important, right?**

**NO. There are a variety of third party modules available with a variety of features.**

# ZigBee – Flexibility

- **RFM Module I/O Options**

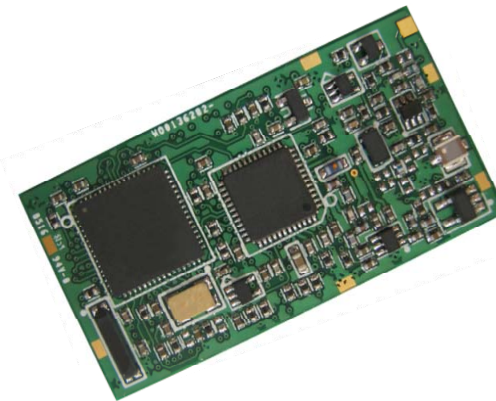
- UART Ports
- SPI Ports
- GPIO
- ADC Channels
- DAC Channels



ZMN2400 1mW  
Power Module \$22  
Single Piece

- **RFM Module Transmit Power Options**

- 1mW
- 10mW
- 100mW



ZMN2400 100mW  
Power Module \$36  
Single Piece

# ZigBee – Flexibility

- **Form Factor Options**
  - Various less than 1 square inch in area
  - Higher power modules a little larger
  - Variety of standard form factors announced

# ZigBee – Flexibility

- **Profiles**
  - Home Control and Lighting
  - Building Automation and Control
  - Industrial Plant Monitoring
  - Automatic Meter Reading
  - Other Public Profiles
  - Private Profiles
  - Custom Profiles

# ZigBee – Flexibility

- **RFM's CSM profile provides an API to the module, simplifying integration.**
  - Network Discovery
  - Send/Receive Serial Packet
  - Write/Read SPI Port
  - Read ADC Inputs
  - Write DAC Outputs
  - Read/Write GPIO
  - Module configuration
  - Sleep modes

# ZigBee – Flexibility

- **If I use a third party module, can I develop my own profile?**

**YES. It will be necessary to purchase the developer kit for the stack used on the module.**

# ZigBee – Flexibility

- **Can I get a custom profile developed by a third party?**

**YES. RFM offers this service as well as some stack/software companies.**

# ZigBee – Flexibility

- **Connection to an embedded microcontroller**
  - Connects directly to UART or SPI Port pins
  - 50 Ohm trace from module to antenna connector OR
  - Use module with chip antenna on board

# ZigBee – Flexibility

- **External Circuitry Needed for RS-232 Port**
  - Buffer/level shifter IC
  - Use UART Tx and Rx for transmit and receive data
  - Use GPIO pins for status and flow control lines

# ZigBee – Flexibility

- **External Circuitry Needed to Implement USB**
  - USB transceiver IC
  - Use UART Tx and Rx for transmit and receive data

# ZigBee – Flexibility

- **Integrating with a Sensor**
  - Connect Analog Sensor to ADC input
  - Use CSM commands to read the ADC input from the gateway

# ZigBee – Flexibility

- **Integrating with an Switch Closure**
  - Connect Switch to GPIO input
  - Use CSM commands to read the ADC input from the gateway
  - Use CSM to wake module on switch closure and send status to the coordinator

# ZigBee – Flexibility

- **Third party modules offer as much flexibility as in-house designs**
- **Given the variety of modules available, each end product's needs may be better met than with a single in-house design**

# ZigBee – Control

- **Making it My Own**
  - Creating barriers to entry for my competition
- **Intellectual Property**
  - Maintaining ownership of key intellectual property
- **Leverage with Vendors**
  - Not be at the mercy of a third party's product plans

# ZigBee – Control

- **Barriers to Entry for Competition**
  - Interoperability requires more than the same hardware platform
  - Availability of custom profiles or creating your own profile provides a mechanism for product differentiation
  - First to market is a competitive advantage

# ZigBee – Control

- **Ownership of Key Intellectual Property**
  - With chipsets from multiple vendors, the technology embodied in the module design is widely available
  - Key Intellectual Property is resident in the profile if in the wireless piece of the end product at all
  - Custom profiles performed as “Works for Hire” or in-house profile development allows ownership of key intellectual property when using a third party module

# ZigBee – Control

- **Leverage with and Independence from Vendors**

- Use of standards-based module brings same benefits as the use of standards-based chipsets
- From a hardware perspective, it is easier to change modules than it is to change chipsets
- There are more module vendors than there are chipset vendors creating more pressure for low costs

# ZigBee – Control

- **The use of third party modules does not mean less control than in-house designs and can offer long-lasting benefits through reduced time-to-market.**

# ZigBee – RF Truths

- With chipset vendors' reference designs, there's no design effort needed, right?



# ZigBee – RF Truths

- **There is a big difference between getting a design to work and getting it to work well.**



# ZigBee – RF Truths

- **Getting a design to work and getting a design to pass FCC and ETSI testing are two very different things**



# ZigBee – RF Truths

- **And if I do run into problems, my chip vendor will support me, won't they?**



# ZigBee – RF Truths

- **Chipset vendors do not have the resources to support a large number of developers. They target customers that will buy very high volumes of chipsets.**



# ZigBee – Choosing a Module Vendor

- RF hardware company
- Stable company with experienced management
- Profitable company with long track record
- Well-developed support
- Full line of products



ZG-2400E ZigBee  
Ethernet Gateway



ZG-241Z RS-232/485  
ZigBee Serial Modem

# Why RFM?

- **Customers need complete solutions – RFM ZigBee modules are complemented by other RFM ZigBee and non-ZigBee products**
- **RFM ZigBee modules can be used without modification**
- **RFM is a leader in the ZigBee market and the ZigBee Alliance working on several key working groups**
- **RFM has been in business for 18+ years and the acquisition by RFM further strengthens the company**
- **RFM is an RF company – all RFM does is RF, RF is not a sideline or secondary business**
- **RFM has a history of developing RF products that work where others can't**

# Conclusions – Caveat Designor

- **There is no one right answer for all companies**
- **Third party modules can provide cost-effective, flexible solutions while allowing the required control**
- **Each company should make their own decision based on their expected volumes, existing resources and corporate strategy**
- **The correct decision for one company may be the wrong decision for another company**
- **Making the correct decision but choosing the wrong vendor is as bad as making the wrong decision**

[www.RFM.com](http://www.RFM.com)