White Paper

Wireless Transceivers—Make or Buy?

OVERVIEW

The question of whether to make or buy a component has been around as long as engineering departments. The answer is rarely obvious, as there are many factors to consider. Nor is there a wrong decision; one path may be better than another, but it is unusual for one decision to lead to a dead end. The case of adding spread spectrum wireless capability to a product is no different, and the associated regulatory compliance issues introduce additional considerations.

One reason often cited in favor of custom designed solutions is control—of the design, of the timing and of the cost. In terms of the design, this may be a valid argument. The in-house design can be exactly what is needed, with no compromises or extra features. But even this argument is somewhat weakened by the ready availability of custom designs by outside suppliers.

Arguments for timing and cost control are not as clear. The lead time for a standard module from an outside supplier has a higher degree of certainty than the availability of an in-house design. In addition, when overall cost is considered, buying a wireless module will very often be the more cost-effective route. This paper examines the relative merits of each approach and provides a guide for product managers, engineers, and others considering adding wireless data communications capability to new or existing products.

QUALITATIVE CONSIDERATIONS

While cost is often the first factor that comes to mind, the appropriate first consideration should be the capabilities of the engineering staff. Does wireless expertise currently exist within the engineering department? If it does not, is it in keeping with strategic corporate goals to develop that expertise? The answer to these questions may well be affirmative, but it must also be understood that wireless design is a highly specialized discipline requiring full-time attention. To assign wireless design as a secondary function to an engineer whose main responsibility is digital design is unfair to both the engineer and the project.

Moreover, it's important to determine whether wireless capability be a key product differentiator, or if a specific wireless characteristic is to make it unique. If it is the latter, a custom design may be required. If it is the former, a standard design will suffice. At issue then is whether a company should dedicate resources to developing expertise in an area that is not key to differentiating its products. More likely is that those resources are better spent on building and maintaining the areas of expertise that are critical in differentiating the company's products.

COST FACTORS

The question that is often heard is, "Why should I pay someone several hundred dollars for a module when I can buy a $35 chip set?" To understand the answer, Cirronet developed costs for the Harris Semiconductor PRISM™ reference design found on their web site. We costed the bill of materials (BOM) at 1,000 and 5,000 pieces. The costs to build that design are presented below in Table 1. (Details of the BOM and assembly and test costs are presented in Appendix A.)

Quantity	Cost
1,000	$217.54
5,000	$200.94

Table 1: Manufacturing costs, including parts, assembly, and testing.

These costs include assembly and test labor. Clearly, the cost is substantially more than $35. But BOM and assembly costs are not the only costs that must be borne by the product. In order to develop, test, and verify the design, a significant investment in prototyping tools and test equipment must be made. The following tables list typical prototyping costs and the minimum necessary equipment and their associated costs.

Description	Qty	Cost
Prototype tooling NRE		$1,500
First run PCBs	1 panel	$1,000
Second run PCBs	1 panel	$1,000
Pilot run PCBs	1 panel	$1,000
Total		**$4,500**

Table 2: Prototyping, tooling, and PCB costs.

Equipment	Cost
Spectrum Analyzer	$11,000
Signal Source	$10,000
Assorted Meters	$4,000
Total	**$25,000**

Table 3: Minimum test equipment costs.

Once the design has been built and its operation verified, it's now time to submit it for DCC compliance, so costs for the test lab and certification fees also go into the equation. Typical test lab fees run about $3,000, and FCC filing charges run about $1,000. A typical total to secure FCC compliance is therefore $4,000. If the device is to be used internationally, costs for additional compliance testing should also be considered.

Next are personnel costs. In most cases, personnel represents incremental costs. That is, if the wireless design is not performed in-house, personnel costs need not be considered. In other situations, it is possible that existing engineering personnel will be assigned to become wireless experts. In this situation, the cost involved is the opportunity cost of not doing something else. Because this will be different for every situation, we will assume that new personnel will be brought on to do the wireless design.

Ignoring any changes to the reference design, 2 man months of engineering is a reasonable amount to implement the reference design. Using an engineer being paid a $60,000 salary with an additional 20% for benefits, etc., the 2 man months will cost $12,000. Bear in mind that in addition to an RF engineer, an accomplished digital engineer will also need to be involved to design the circuitry that controls the wireless radio. This may be an engineer currently on staff.

Other costs will vary from company to company and can only be talked about in general terms. One is the cost to support the design. This includes everything from bug fixes to feature additions. Another is the cost of carrying inventory. While there are inventory costs associated with purchased wireless modules, blanket orders allow the buyer to receive volume pricing, with deliveries scheduled out over a period of time, up to one year. There is also the issue of design changes making some parts inventory obsolete. These costs can be quite substantial or relatively modest, but they are not negligible.

The following table summarizes the costs quantified above. Costs discussed but not enumerated have not been included. Equipment cost was spread out over the associated number of units.

Item	Cost	Per unit cost at 1,000 units	Per unit cost at 5,000 units
Parts, assembly & test		$217.54	$200.94
Prototyping	$4,500	$4.50	$0.90
FCC testing & certification	$4,000	$4.00	$0.80
Equipment	$25,000	$25.00	$5.00
Personnel	$12,000	$12.00	$2.40
Totals		**$263.04**	**$210.04**

Table 4: Total Cost to Manufacture Reference Design

The best case scenario shows the in-house reference design comes in at $263.04 in 1,000 unit quantities. This compares with a purchased wireless module price of $275 in 1,000 piece quantities. At the 5,000 unit quantity, the cost drops to less than $210.04 versus a purchased price of $215.

How can manufacturers of wireless modules sell products at costs so close to the reference design cost? Based on their experience and expertise, wireless radio manufacturers have improved their designs over time. In addition, their designs have only what is required for the particular radio. Chip set designs, because they must attain high volume sales, often times will have additional circuitry which may or may not be needed. Experienced wireless designers are not wedded to chip set solutions and thus can design for lower cost. Plus, the wireless modem OEMs have the advantage of high volume as they build at the combined quantities of their customers. These factors allow the wireless manufacturers to sell at a price in line with the cost of an in-house design and still make a reasonable profit.

THE TIME FACTOR

Another key decision variable is time. In the above example, it will take two man months of engineering to implement the reference design. We will assume that the two man months of work can be completed in two months—though typical prototyping and layout delays can extend this time considerably.

The next phase—the FCC testing and grant process—will take a minimum of three months, typically at least four months. So the minimum time to get a product to market is six months, assuming all goes according to a very aggressive schedule, successful type testing, and that the reference design is indeed implemented *and* integrated into the product during the initial two-month engineering phase. That's a significant delay in getting the product to market.

Obviously, some time can be saved by addressing engineering issues concurrently with FCC testing, but only minimal changes may be applied to the design without forcing it to be re-submitted. Any meaningful change to the reference design will add substantial cost and time to the project. The engineering requirements will increase dramatically and the time to market will increase by months. Do not assume that changes to the reference design can be made without significantly impacting the scope of the project.

Compare that scenario with the incorporation of purchased wireless data modules. Already FCC type certified, "off-the-shelf" or OEM modules offer significant advantages. They can be integrated into new or existing product designs without having to submit the overall design to FCC type re-certification. This means that the component for which the least in-house expertise exists is removed from the time-to-market path. When it comes to time considerations, an OEM wireless data module is clearly the better approach.

CONCLUSION

So, is there a right answer? In some cases it will be better to make the wireless radio in-house, while in other cases, embedding an OEM module is clearly the better decision. All factors must be considered on a case-by-case basis to determine the right approach.

With respect to cost, all associated costs must be considered, not just module's purchase price versus line items in a bill of materials. Based on the information presented above, it is unclear that in-house designs have any cost advantage at quantities below 5,000 units—in fact, this may be the more expensive route.

Buying a ready-made wireless data module—particularly one that already meets FCC and/or European standards—offers clear timing advantages. It also offers the manufacturer significant economies and removes the wireless design from the critical path.

Ultimately, each design team will have to outline its own cost and timing criteria for each wireless data communications application. As long as the factors discussed above are thoroughly evaluated, designers and manufacturers will make the right decision.

APPENDIX

MFR	PART NUMBER	QTY	PRICE		TOTAL	
			1K	5K	1K	5K
Harris	HFA3925IA96	1	10.22	9.62	10.22	9.62
Siemens	BBY51-E6327	1	0.35	0.32	0.35	0.32
Voltronics	JZ060 Trimmer Cap	1	0.53	0.45	0.53	0.45
Dialight	597-3311-407	1	0.18	0.18	0.18	0.18
Dialight	597-3401-407	1	0.18	0.18	0.18	0.18
Dialight	597-3111-407	1	0.18	0.18	0.18	0.18
Murata	LFJ30-03B2442BO84	2	0.82	0.76	1.64	1.52
NIC	NCB1206B320TR	7	0.04	0.04	0.28	0.28
AVX	L0603100GFWTR	1	0.24	0.24	0.24	0.24
AVX	L0603120GFWTR	1	0.27	0.27	0.27	0.27
PHILLIPS	BFR505	1	0.17	0.17	0.17	0.17
Motorola	MMBT2222ALT1	2	0.034	0.025	0.068	0.05
Motorola	MMBT2907ALT1	1	0.027	0.027	0.027	0.027
Harris	HFA3724IN	1	24.14	22.66	24.14	22.66
AMD	AM29F010-55EC	1	2.15	2.00	2.15	2.00
AMD	AM79C930	1	22.15	21.12	22.15	21.12
Harris	HFA3624IA96	1	10.49	9.95	10.49	9.95
Harris	ICL7660SIBA-T	1	0.87	0.83	0.87	0.83
Toyocom	TQS-432E-7R	2	2.74	2.10	5.48	4.20
Harris	HSP3824VI	1	24.70	24.70	24.70	24.70
Mitsubishi	M5M5256CVP-55LL	1	1.50	1.40	1.50	1.40
Harris	RF1K4909396	2	0.65	0.50	1.30	1.00
Statek	CXO-M-10N-40MHZ	1	8.15	5.41	8.15	5.41
Statek	CX-6V-SM2-32.768K-C/I	1	2.39	2.25	2.39	2.25
EF Johnson	142-0701-235	1	2.03	2.03	2.03	2.03
Z-Communications	SMV2100L	1	15.95	10.00	15.95	10.00
Harris	HFA3424IB96	1	4.17	3.89	4.17	3.89
Fox Crystal	F4106	2	1.40	1.24	2.80	2.48
Harris	HFA3524IA96	1	11.08	10.56	11.08	10.56
Toko	TDF2A-2450T-10	2	1.77	1.77	3.54	3.54
AVX	Capacitors-Various				5.92	5.92
Panasonic	Resistors/ Pots Various				1.49	1.49
Toko	Inductors-Various	10	0.18	0.18	1.80	1.80
	PCMCIA Connector	1	3.50	3.50	3.50	3.50
Toko	TK11235AMTL	3	0.50	0.50	1.50	1.50
TOTAL					**171.44**	**155.72**