Some hints and tips for simplifying the production of Bluetooth™ enabled products

CSR probably knows more than most about Bluetooth technology. We were, after all, the first company to market a fully integrated 2.4GHz radio, baseband and microcontroller Bluetooth solution on a single all-CMOS chip. So here are a few hints and tips to help you benefit from our experience and accelerate your delivery of Bluetooth enabled products!

Choosing a Bluetooth solution

As with any plan, having defined your goal you'll need to determine the route. Unless you're a manufacturer of Bluetooth modules, you have a choice. You can either obtain the necessary components from specialist suppliers and then handle all the integration issues yourself, or use a complete, pre-assembled Bluetooth module. Both routes have their pros and cons; the best one for you depends upon your circumstances.

Using individual components

- If you have the necessary expertise, the DIY approach can be less expensive over time, especially for products that are likely to move into high-volume production. But remember that incorporating sophisticated chip-level electronics demands considerable design skills – particularly with regard to software and RF integration – and that these skills do not come cheap, especially if you need to consider outsourcing.

- Individual components do not necessarily take up less space than a complete module, but if you are adding Bluetooth to space-critical products such as mobile phones and PDAs, you will gain placement flexibility that could be vital to the look, feel and ergonomics of your product, and might even improve its performance. Single-chip Bluetooth transceivers obviously take up less space that multiple-chip designs.

- Save valuable development time by using chips that are pre-approved to all the relevant Bluetooth radio, baseband and software standards. This way, you'll only need to secure regulatory type approval for your product before gaining a license to sell.

- An obvious tip is to check out which chips are used by your competitors for their Bluetooth-enabled products – and by the leading Bluetooth module manufacturers, who are the main high-volume users of Bluetooth chips today.

- Choose Bluetooth chips that are based on a standard, high-yield process such as CMOS, rather than on more esoteric fabrication technologies which carry a cost premium and sometimes pose long-term supply problems.

- Check that the Bluetooth chips you intend using are available in volume. It's no good basing your design on development samples and then discovering that the chips are due to enter volume production some time after your intended market launch date!

- Make sure that you understand all the cost-contributing factors of your chosen Bluetooth solution. Cost is critical in most consumer products, and you can gain or lose your competitive edge simply through your choice of components.

- On the hardware side, typical hidden costs include Bluetooth chips with complex multi-rail voltage requirements, or ones that demand a large number of additional components. Check out the tech specs carefully; some chips include things like voltage regulators, VCOs, RF/IF amplifiers and Tx/Rx switches – and some don't.

- Ideally, go for a solution that doesn't require any external active components at all, and try to avoid chips that need RF inductors, ceramic filters, screening cans or special mounting substrates. Choosing a radio chip that employs a near-zero IF is a good start, because you won't need any external channel filtering components at all. An all-digital demodulator is a great idea too, since it'll give you better co-channel rejection than its analog equivalent.

- By avoiding chips that demand external VCO circuitry, you'll also avoid another hidden cost: production set-up of the frequency control component. And if the chips that you use feature built-in self-test functions and auto-calibration, you might even be lucky enough to avoid RF testing altogether!

- On the software side, nearly all the hidden cost issues revolve around the Bluetooth protocol stack. Most importantly, you need to choose a stack that has been thoroughly qualified and shown to be fully compliant with the Bluetooth specification. And it's certainly worth checking how rigidly the stack software adheres to the Bluetooth profiles, so that you don't hit interoperability problems further down the line. As a guide, look for well-defined, event-driven interfaces to the stack's protocol layers, flexible stack partitioning schemes, and communications links that support features such as automatic error checking.

- Your choice of software development kit obviously depends upon the Bluetooth chips you select and your chosen computing platform (most people use PCs). But there's a strong case for turning this argument on its head, and letting your preferred choice of development system influence which chips you use. At the end of the day, you need to feel confident that you can generate and port the code quickly and easily. One of the key things to check out is how efficiently you can access the upper parts of the protocol stack (such as the L2CAP, RFCOMM and SDP layers), as well as, of course, the standard HCI layer. And don't forget to check the availability and cost of a source code licence and cross-compiler for your chosen target!

Using a pre-assembled Bluetooth module

Unless you have significant in-house electronics resources to call upon, you'll almost certainly be better off taking the Bluetooth module route. The disadvantage of higher bought-in costs is more than offset by the reduced risk of your product development schedule being delayed by unforeseen integration problems. With less time-critical elements to worry about, you gain better control of your development process – a vital consideration when time-to-market is everything.

- OK, from a design engineer's viewpoint, using a Bluetooth module isn't quite as exciting as developing your own all-singing, all-dancing, embedded solution. But if it's kudos *and* functionality you're after, don't be too quick to adopt the 'not designed here' cause!

- Pre-assembled modules provide a fast and relatively easy means of incorporating Bluetooth functionality in your product. They are the most cost-effective way of deploying the technology across low-volume products, and represent the only sensible way of adding Bluetooth communications capabilities to an existing product.

- Nearly all commercial Bluetooth modules on the market comply with the Bluetooth specification – it's one of the prerequisites of being able to use the logo. So in that respect, provided you choose a reputable supplier, you should be in safe hands. But as always, there are a number of factors you should consider before making your final choice.

- Perhaps one of the best tips is to check out the chipset used in the module. See if it meets some of the recommendations we've listed previously.

- Check that the module supplier will be able to satisfy all your production requirements, especially in terms of volume and delivery.

- Make sure you're aware of the level of software support that your chosen module supplier can provide. A considered approach here can save you a significant amount of work later, because virtually all the software you develop can be ported across to an embedded Bluetooth solution at a later date if necessary. It's a particularly good sign if the module supplier uses the same software development kit as the manufacturer of the chips that are used inside the module.

- It almost goes without saying that smaller modules are easier to integrate. But make sure that the mounting style fits with your fabrication process.

Top tip

Some Bluetooth modules feature a built-in antenna. But if your chosen model doesn't have an antenna, or you're taking the chip route, you'll need to consider this aspect very carefully. At the very least, there are likely to be stringent positioning needs which will have follow-on ramifications for your product's physical layout. And it's not just a question of optimising link performance – to obtain regulatory type approval you may need to demonstrate you've used an approved CAD system to design your 2.4GHz feed! We strongly recommend that you talk to one of the leading Bluetooth antenna suppliers at the very start of your design cycle.

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