SDIO: Bridging the gap of modular hardware design today

By: Ming Hoong Chong, Product Marketing Engineer, Cypress Semiconductor Corp.

It is a well known fact that mobile handset technology was and continues to be one of the fastest evolving technologies in current times. In parallel with all the popular features that accompany today's mobile handset, mobile handset design has also been continuously changing. This continuous change is due to the insatiable appetite of mobile consumers today who demand more and more features and wanted the features delivered yesterday. Design cycles that once took more than 2 years are now shortened to 6 months or less. This continuous demand for new designs and features delivered quickly has led to many changes in the mobile handset design practices. One of the most popular design practices today is the use of hardware modules. Instead of designing various different blocks in a handset, today's handset designer receives a specification on a particular handset and puts together a mosaic of various modules to create a complete handset solution.

Modular hardware design is such a popular design practice today because of the improved time to market that it provides. Previously, handset design requires the architecture to be planned, followed by schematics and the manufacture of an evaluation board that simulates the end product. This practice takes a lot of pre-study time before an evaluation board is made because a mistake or change in the specification will require a full re-manufacture of the board. This increases design time and cost. However, the modular hardware approach decreases the need for long planning cycles as expansion slots can be built on the evaluation board to accommodate changes in spec and feature sets. Designers now connect various modules to the core evaluation platform to achieve different desired results. With modular hardware design gaining traction, how are the various modules connected together?

Options for connecting modules

There are multiple ways for connecting chipsets and modules, some of the more popular ways are I2C, UART, SPI and SDIO.

I2C has the least number of logic signals and is the easiest to use among the various module connectivity solutions. However, with its minimal logic signals comes the sacrifice of performance. I2C is capable of a maximum of 3.4Mbps. However, the most prevalent I2C enabled devices are only capable of supporting data rates of between 400Kbps to 1Mbps.

Secondly, there is SPI. SPI is a 4 wire serial bus that has the capability of reaching transfer speeds of beyond 20Mbps. However, due to there being no uniform specification of SPI, there are multiple differences among SPI enabled devices. The differences can range from different word sizes to different commands used and handshake protocols. Thus, there is a high dependence on the types of modules used and the SPI capability of both the processor and modules. Due to the differing SPI interfaces, building a complex system made up of various SPI connected modules is a very challenging and time consuming task.

Another connection method among modules is UART. UART is capable of typical data rates of 1.5Mbps and High Speed UART supports speeds of up to 5Mbps. However, the UART interface most prevalent among chipsets is of the typical UART interface and not high speed.

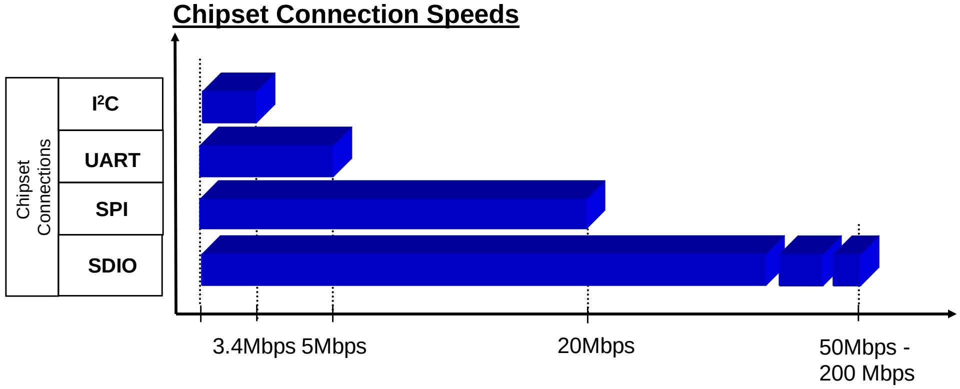
Connections	Typical Data rates	Disadvantage
I2C	400Kbps – 3.4Mbps	Low number of logic signals, slow
SPI	~20Mbps	No uniform spec, complicated
UART	1.5Mbps – 5Mbps	Slow

Due to all the shortcomings of previous chipset connections, a new chipset connection was introduced to enable easier and faster design cycles. This interface is known as SDIO and is based off the SD card spec. SDIO is the latest interface introduced for chipset connectivity that is standardized and is commonly found among today's handset processors and modules. The main benefits that SDIO brings are a standardized spec, performance, hot swap capability and end user expandability.

Secure Digital Input and Output (SDIO) was born from the SD spec that defined the criteria for SD cards used today. With the prevalence of SD cards in handsets, digital cameras and multiple other consumer electronic devices today, it is no wonder that its success in memory cards is now being emulated for modules. Similar to previous SD cards, SDIO enabled devices are capable of 1 or 4 bit modes. No matter what bit modes SDIO devices operate in, their timing is held to the SDIO spec and this makes using SDIO devices a breeze as there is no need to take into account special timing or handshake mechanisms.

SDIO v2.0 also calls for the capability of SDIO devices to operate at 50MHz. Thus depending on what bit mode the device operates in, SDIO devices can have data transfer rates that range from 50Mbps to 200Mbps. This performance capability is very important for today's latest features on mobile and consumer electronic devices including WiFi, SDHC cards, Digital TV and high performance RF modules. At the same time, the increased bandwidth is capable of providing the capability to support next generation data intensive devices like HD video camera modules, 802.11n WiFi devices and other new features. Thus, if a hardware platform already has multiple SDIO ports available for expansion, there will be no need for a total overhaul of designs as new features are added.

Chipset Connection Speeds



Another important capability of SDIO is the ability to hot swap. Picture the ability to swap in and out features of a handset similar to swapping in and out different brands and density SD cards, that is the feature that is making SDIO such an important interface for modular hardware design today. This is an extremely important feature for today's mobile and consumer electronic hardware designer due to the need to turn designs quickly and test different features on an evaluation board. Designers who have evaluation boards with SDIO slots on board have the ability to swap out various modules to provide different feature sets to their design while maintaining the same evaluation board. Thus this leads to one evaluation board with a fixed processor but almost infinite possibilities of end product and feature variations. Thus creating better differentiation in markets already congested with a multitude of similar looking devices.

The fourth benefit of designing with SDIO is seen in the end product in user expandability options. Similar to designers being able to swap in and out modules on their evaluation boards, the option of accessible SDIO ports on the mobile or consumer electronic device opens a whole new market segment. Now consumers can customize their latest and greatest gadgets with the newest SDIO device without having to be stuck with the features that come with a particular device. Picture the ability to change to the latest camera gadget on your mobile phone when it is available without having to purchase a new phone. How about changing the digital TV receiver depending on which country you are in to continuously watch TV on your mobile device? Sounds like what we've always been dreaming off doesn't it? Now instead of only customizing ringtones and screen profile designs, consumers have the option of customizing the features individually according to their needs and fancy.

Due to the benefits of SDIO, we see more and more SDIO enabled modules and devices in the market today. Some companies have entire business units dedicated to designing and manufacturing SDIO modules to be used by their design teams or for sale. Nevertheless, due to the slower change in processor and main chip interfaces, we see that many hardware designers today face an issue of a shortage of SDIO interfaces on their main processor to support all the different SDIO modules that they would like to have on their design. Therefore, this has created a strong demand by designers for IC's that enable SDIO expansion and a multitude of IC's have sprung up to satisfy the demand. They range from the simple ASIC to the advanced bridge chip.

Among ASIC chips there is the simple memory interface to single SDIO interface device and the more complicated multiple SDIO interface device that operates like an SDIO hub. These ASIC chips are to enable SDIO on processors that have no SDIO capabilities at all. However, what if designers need something a little better or to optimize the performance and capability of SDIO?

Many, if not all, then turn to bridge chips. Bridge chips provide more than just expansion capabilities but bring extra performance and extra features to enable state of the art devices to be built. These bridges not only include single but multiple SDIO ports. Furthermore, some bridge chips also provide a multitude of processor interfaces to connect to current and next generation processors. They even include other programmable and common features that mobile and consumer electronic devices today cannot live without, like Hi-Speed USB, MLC NAND support and others. Most ASIC chips that provide SDIO capabilities to the embedded processor only have simple SPI or I2C connections available for the processor to connect to. Therefore, even though the SDIO interface might be capable of supporting a much higher data rate, the data coming from the embedded processor is restricted. This issue is solved by advanced bridge chips that have a multitude of processor interfaces to choose from. These could include SRAM, Address Data Multiplex (A/D Mux) and even NAND interfaces, thus eliminating the bottleneck of data to and from the embedded processor.

With SDIO bringing so many benefits, it is inevitable that we will see a continuous uptake in the use of SDIO in modular hardware design and also more SDIO devices appearing in the various industries. Designers should take advantage of this new and improved feature in order to maintain competitiveness in the ever competitive landscape of mobile and consumer electronics hardware design. I sure look forward to that mobile device that allows me to customize its features with external SDIO ports.

Cypress Semiconductor
198 Champion Court
San Jose, CA 95134-1709
Phone: 408-943-2600
Fax: 408-943-4730
http://www.cypress.com