# Smartphone Docking Systems to Unlock Smartphone Potential and Drive Standardization of Interfaces

*By: Vanessa Lee and Stephen Harris, Product Marketing Engineer, Cypress Semiconductor*

The smartphone era has revolutionized the way in which people communicate, conduct business and browse the internet. There is little doubt that smartphones are here to stay however with the recent introduction of netbooks and tablets, the smartphone market may find itself infringed upon by more intuitive devices in the coming years.

In a few years time, your average smartphone will be capable of processing the tasks you typically use your laptop for now. Mobile computing speed and capability has been advancing at an exponential rate in the last five years. Multimedia and interconnectivity has been a theme among smartphones released in the 2009 and 2010 time period. Users, now more than ever, are looking for new ways to unlock their smartphones entertainment potential. This evolution will eventually change the way users incorporate smartphone technology into their daily lives and expect the same from complimentary devices such as mobile accessories.

Mobile phone accessories have, for the most part, always aimed to provide users with more convenient and intuitive ways to use their mobile devices. In the next decade, the mobile accessories market will be looking to provide smartphone users better ways to access their smartphones whether it be audiovisual content, document manipulation or data storage.

As evident in phones already in the market as of 2010, there is already a movement towards increasing user interface to allow users to take advantage of smartphones high processing power. The key to translate this computing power into improved user experience is leveraging the mobile accessories market to product products which improve user interface and overall utility of the smartphone. This challenge of how to enable users to take full advantage of our mobile devices may always plague phone manufacturers as users concept of mobile computing grows.

## What are Current Smartphones Lacking?

An important requirement of any dock peripheral is port expansion. Smartphones today have a very limited number of ports. Although this is not necessarily consistent with future devices, the number of ports and the size of those ports will most likely remain small to preserve mobility and durability.  This limits the number of devices users can connect to their smartphones. For example, smartphones are not able to display to a monitor and connect to a keyboard simultaneously for document manipulation.

Different peripherals exchange data through different interfaces. Manufacturers are hesitant to incorporate all of these interfaces on a smartphone because of design obligations such as maintaining hardware durability and a small footprint. Many monitors today, for example, only accept HDMI or VGA signals. In instances such as this, users are required to grab a converter in order to connect their devices, something which is not ideal when trying to connect to several peripherals all at once. Even though the smartphone has begun incorporating more interfaces into devices, support for legacy devices is low.

The growing popularity of applications and online media stores such as iTunes and the App Store mean users are storing more purchased content on their phones. Flurry reported a 15% increase in Apple App Store purchases in Q4 of 2009 alone [2].  Because users are purchasing more content on their smartphones, they are more inclined to backup their valued content more routinely. Backup processes are lengthy, inconveniencing users who download new content daily. A quicker and more convenient method for storage is required.

## What is in a Smartphone Dock?

A smartphone dock simply expands the user interface and functionality of a given smartphone. Most of the intelligence and processing power is still executed within the phone with some clever interfacing and processing blocks located within the dock. Features may include charging, multimedia output to a monitor or television, LAN connection, Bluetooth connection and connecting other HID devices and additional memory. Ideas have been formulating in the past five years for these devices but some limitations in interface standardization have slowed development.

## Smartphone to Dock Connectivity

The first design discussion revolves around smartphone and dock connectivity. Choosing an interface which is both robust and well-adopted are important criteria for this type of an application.

Because USB connections are so popular amongst peripheral and memory connections, it is the most practical digital connection interface for connecting smartphones with flash drives, monitors, keyboards and other HID devices. Of course there are many other existing interfaces which allow for higher throughput however USB remains the most popular and versatile in terms of peripheral and memory connections, the two main focuses of this discussion.

The inherent properties of USB hubs and bridges require very little tweaking to satisfy dock requirements. The single master-multi slave architecture of hubs available today provides an ideal method of communication to memory and peripherals. However, phones will need to be equipped with either a host interface or a USB On-The-Go (USB OTG) interface before they can be capable of hosting a hub. Luckily, OTG interfaces are already widely adopted in the smartphone industry which makes the USB solution even more attractive. Hubs can be used to expand the minimal number of ports on smartphones to enable more device connections in the smartphone docking station.

As mentioned previously, a primary goal of the smartphone dock is to provide a larger user interface for smartphones. This can include the addition of monitors, keyboards, speakers and other HID devices. This trend is already apparent in some phones in the market today which contain either an HDMI port or an analog-video port. Currently, this type of interfacing technology requires controller or interface logic blocks within the device. For legacy devices however, the only way to send display data is through existing USB ports. This presents a significant issue in how to send a VGA signal or HDMI signal for example, over the phone's existing USB port. Decoding this data will require dedicated software and hardware. Although USB has begun to take over many peripheral digital connections, there still exist some interfaces which require interface conversion in order to be USB compliant. There is also the issue if managing data flow in which case hubs may need to be customized to specific interfaces.

Bridge chipsets can be used to expand the number of ports and interfaces of smartphones to allow for more peripheral connection options. In traditional laptop architecture, north and south bridges are used to control the data flow from the CPU to memory and peripheral devices. Similar architecture can be applied to the smartphone dock. These types of devices provide signal conversion and allow for a wider range of peripheral connection. Referring to the above example, a USB signal can then be translated to an HDMI signal for monitor or television consumption, without requiring any hardware from the device. As more bridge and interconnection ships are developed, users will be able to expand their mobile accessories devices to suit their specific needs.

## Role of Memory Storage

With a dedicated memory controller, moving content into a memory reservoir within the docking station will provide a much faster backup solution than traditional computer connections. An example of a memory controller which is capable of completing these tasks is Cypress's West Bridge product. This setup optimizes the time it takes to back up valuable purchased content from a user's smartphone.

The mobile smartphone dock provides a convenient and safe location for backing up content on mobile smart phones. To achieve this, the dock requires a memory controller to ensure proper data movement, error correction and wear leveling. Drives such as this are widely available and easy to adopt making memory addition an easy feature to include in the docking station.

To summarize, the greatest hurdle for smartphone dock development comes from interfacing between the phone's existing USB connection and the interfaces of different peripheral systems. Memory connections are not as difficult given that many memory controllers already accept USB data.

## Smartphone Dock Conceptualization

Combining the use of hubs, interface chips and additional memory will provide a high level view of what is possible given today's smartphones and connection technology. Many of these technologies exist today and could be put together to form a solution for this type of a product. The figure below presents a block diagram of a possible smartphone dock system using interface blocks available today.
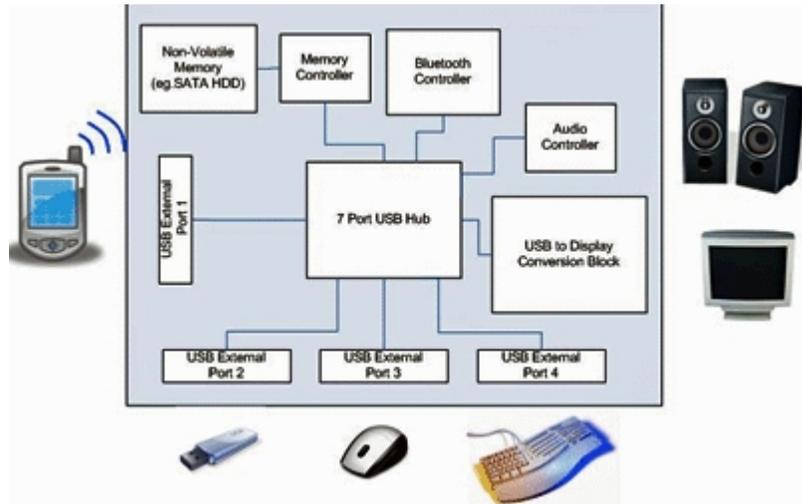
**Figure 1 – Example of Current Implementation**

To support legacy smartphones, USB and possibly Bluetooth act as the primary connection point(s). The dock shown here provides users an expanded interface, a memory bank as well as enough additional USB ports to allow for expanded memory and other peripherals. Any connected flash memory could also be used to increase the devices RAM given the proper software was installed on the device.

## Possible Smartphone Dock Evolution

For future devices, proprietary interfaces can be incorporated to enable more dock configurations. The block diagram below is a high level example of how additional CPU cores, RAM memories and network connections can be added to the dock given a proprietary interface is included in the smartphone.
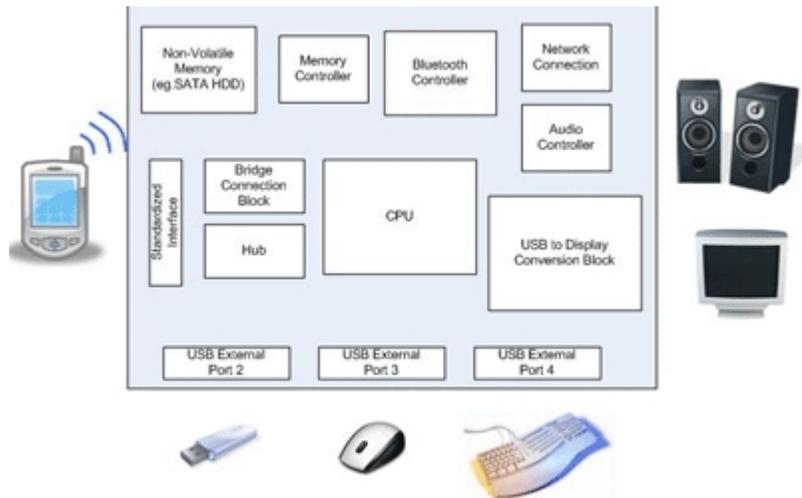


**Figure 2 – Future Dock Implementation**

Having an additional CPU allows for any additional drivers to be stored in the dock device. The docks internal CPU can then be used to execute these drivers to prevent unnecessary driver storage on the smartphones limited memory. Given the large number of peripherals, this is a significant amount of memory saved and allows for faster dock/smartphone operation.

Although it is possible to create a smartphone dock using legacy interfaces, the more exciting opportunities come when more powerful interfaces are standardized for the purpose of dock connection.

Having a phone with a single port for each interface is not ideal which makes interface consolidation and standards development important. Consolidating these interfaces into a proprietary connection benefits both the smartphone design as well as the docking station. Smartphones are required to be robust. Having too many ports makes the phone vulnerable to water damage and other environmental factors. Also, having a proprietary interface makes it easier to connect more obscure blocks, such as that connecting to the phones CPU and LAN connection, much easier. In the most ideal case, all phones would share a new, very powerful and interconnected universal connection as USB was when it was first released.

Many sources have said that the mobile phone will become our new go-to computing device by the end of the next five years. It cannot be expected that current mobile accessories will be suitable for such powerful devices. Providing users with the option of expanding their user interface and make better use of the multimedia capabilities of their smartphones will be at the forefront of mobile accessories.

With the use of hubs and interconnection chips, it is definitely a possible technology which can unlock a lot of computing potential for smartphone users. Being able to display video, documents and games on a full sized monitor while having additional backup storage are just a couple of benefits of the smartphone dock. Some challenges the mobile accessories group will face include port expansion, interconnecting different interfaces and interface consolidation. However, future developments in interface standards will play a key role in relieving these issues.

With the introduction of netbooks and tablets, there promises to be exciting developments in mobile computing in the next five years. Smartphone products were the first to introduce true mobility to its users and, with its rapid growth, seem unmoved by these new products. However, given the larger and more intuitive interfaces provided by the tablet and netbook, it seems the smartphone no longer satisfies all of the mobile computing needs of today's users. Dock development will help to bring expanded utility to smartphones which will secure and possibly expand smartphones already ubiquitous role in our daily lives.

1) http://www.sd.polyu.edu.hk/iasdr/proceeding/papers/The%20mechanisms%20of%20product%20form%20classification.pdf
2) http://www.mobilecrunch.com/2009/12/28/flurry-app-store-sees-record-breaking-christmas-50-growth-from-november-to-december/