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Embedded System for USB WiFi Bridge

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ABSTRACT
Data transfer between two devices, one with USB port but no WiFi connectivity and another device with WiFi connectivity but no USB port, is not possible as two devices cannot be connected directly. Our aim is to transfer data from the USB device to the WiFi device or vice-versa. To overcome this shortcoming, we program an embedded system such that it acts as a bridge between the two devices enabling the transmission of data between the two.
Keywords - **ARM9 processor, Real Time System, Wireless networking, Optimized transmission, Interconnection of two different technologies**

1. INTRODUCTION
Many times we feel a need to transfer data from one device to another which have different connection mechanisms, making them incompatible. It seems to be impossible to transfer data between two non-compatible devices. Like a device has a WiFi interface but not the USB interface, and another device has USB but not WiFi. So how will you transmit data between these two devices?

The data could be transmitted through a third device (like laptop) which has both WiFi as well as USB connectivity. But the task becomes lengthy, as you first have to copy data from USB to your laptop and then transfer if to the other device through WiFi.

For latest development in the direction of embedded system and wireless network, this technology proposes a new idea in which data can be transferred from a USB device to a WiFi enabled device through an embedded kit. Hence a 3-step process is optimized to a 1-step process. Due to the USB device having no WiFi connectivity and WiFi device having no USB port, the embedded system is used to bridge the devices and transfer the data between the two. The Linux operating system can load the drivers of WiFi and USB. Based on this model, we can implement this USB WiFi Bridge.

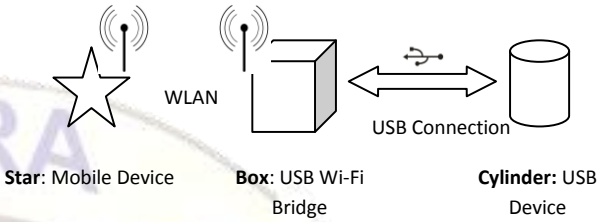

Figure1. overview of the technology

The above figure illustrates:

Star: A mobile device that is capable of WLan communications only.
Ex.: An iPod, iPad, Android cell phone, a NetBook or any hardware device that may need to connect wirelessly for that matter
Box: The USB to Wi-Fi Bridge. This is the unit which is the subject of development.
Cylinder: A sample USB device connected on USB port to Box.
Ex.: A camera, Pen drives etc.

The basic objective of the system is to allow wireless connections from Star to Cylinder.

Due to the limitation of Star (only wireless connections possible) and Cylinder (only USB connections possible), Box would be required to bridge the connections and transform data packets to and from Star and Cylinder to compatible formats.

Since many wireless devices may also be capable of TCP/IP connections through internet and LAN, the system may also provide normal TCP/IP connections over internet for remote handling of the USB device (cylinder) from mobile device (star).

2. LITERATURE SURVEY
Huo and Liu have proposed the system for wireless image transmission based on the embedded system in [1]. The system is using the wireless network card with the transmission rate of 54Mbps that will greatly increase the access capacity of the embedded system and make the system more competitive. system is divided into the embedded system and the PC connected wireless card. Hardware development

board connects external USB wireless card and USB camera through the USB Hub. USB camera captures images and USB wireless card sends images. The other side is the PC which is responsible for receiving images under the Redhat9.0 operating system. As they have used UDP, it abolishes the rechecking and re-sending process. Hence, there will be some dropped frames. And the use of TCP will slow down the transmission.

Ni and Liu have proposed a system for Image acquirement in embedded Linux. The file is transmitted between embedded Linux platform and Bluetooth mobile phone by Bluetooth OBEX protocol and Object PUSH service [2]. They have made use of the Bluetooth. The Bluetooth has its limitations like, range of transmission, speed of transmission, etc.

The comparison of the various wireless transmission technologies are shown below [3].

A. Comparison of wireless technologies

Protocol	Zigbee	Bluetooth	Wi-Fi
IEEE Standard	802.15.4	802.15.1	802.11a/b/g
Frequency Band	2.4 GHz, 915 MHz 868 MHz	2.4 GHz	2.4 GHz; 5 GHz
Data Rate	20/40/250 Kb/s	1 Mb/s	54 Mb/s
Communication Range(m)	10-100	10	100
Error Control/ Reliability	16-bit CRC,ACK, CSMA-CA	16 -bit CRC	32-bit CRC

Thus, all the above techniques were based on different approaches of transfer of images on Embedded System. But they all have their own limitations. In this proposed work the main focus is on transfer of any type of file on an embedded system and the technology used here is Wi-Fi as it has an upper hand over the other technologies.

3. EMBEDDED SYSTEM FOR USB WI-FI BRIDGE

3.1 IEEE 802.11g 2003

IEEE 802.11g-2003 or 802.11g is an amendment to the IEEE 802.11 specification that extended throughput to up to 54 Mbit/s using the same 2.4 GHz band as 802.11b. This specification under the marketing name of Wi-Fi has been implemented all over the world. The 802.11g protocol is now Clause 19 of the published IEEE 802.11-2007 standard.

3.2 Proposed System

This USB-to-wireless bridge transfers USB data wirelessly back and forth, and it can enable the wireless communication of the WiFi device and the embedded kit. This application is based on ARM9 processor, a product that provides a full/low-speed USB OTG module.

The basic idea of the product is to transfer the data between a USB device and a WiFi device (the devices are not compatible) through the embedded kit. This will reduce a 3 step process in 1 step process. Thereby, reducing the efforts for data transfer and making the transmission between two non-compatible devices possible.

As per the proposed system, the connections are established. The list of the files available for transmission is displayed on the receiving end. The GUI is designed using java. The user is provided with the option of the selection of the file based on extension and size. Let us consider the case of transmission from the USB device to the Wi-Fi device. After the selection of the file, the file is transmitted from the usb device to the internal buffer through the usb driver. The file is then transferred from the buffer to the wifi device through the wifi driver. The terminal don't feel the presence of the intermediate device, as there is no need to operate on the intermediate device.

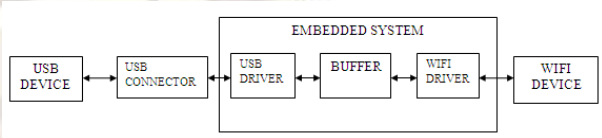

Figure 2. block diagram of the proposed system

3.3 Hardware Description

The proposed system is to be implemented on a Single Board Computer (SBC) having the features like WiFi adapter and USB ports like Technologic systems' TS-7553board. Along with it, we will need a ARM9 CPU for embedding the drivers which we are coding, on the SBC.

The TS-7553 features a 250MHz Cavium ARM9 CPU and a 5000 LUT Lattice FPGA. With 64MB RAM and a bootable 256MB on-board flash drive with our new XNAND technology, the TS-7553 is a powerful and extremely reliable embedded solution. External devices can connect to the TS-7553 via Ethernet, 802.11g WiFi, XBee radio socket (point to point), USB host, USB device, or I2C ports, as well as DIO, UARTs, CAN Bus, DMX, and SPI which are implemented in the standard FPGA load.

ARM is a 32-bit reduced instruction set computer (RISC) instruction set architecture (ISA) developed by ARM Holdings. It was known as the Advanced RISC Machine. ARM9 is an ARM architecture 32-bit RISC CPU family. With this design generation, ARM moved from a von Neumann architecture (Princeton architecture) to a Harvard architecture with separate instruction and data buses (and caches), significantly increasing its potential speed. Most silicon chips integrating these cores will package them as modified Harvard architecture chips, combining the two address buses on the other side of separated CPU caches and tightly coupled memories.

3.4 Software Description

The entire system is composed in three parts. First is, we will need a software to extract data from the USB device at the USB end. This will mount the USB device onto the board, get the files and pass the reference to the next software. When the connection establishment and files to be transmitted has completed, the same software will transfer the files to the buffer memory for the Wi-Fi driver to pick up the data. Secondly, inside the bridge, at the Wi-Fi device end, the driver will take the data from buffer and will send it to the destination device after verifying the Wi-Fi device is present and connection is established. On the receiving end device, a User Interface is present which will actually initialize the connection and prompt user to select the files to be transmitted. This transmission is from USB to Wi-Fi end. Similarly transmission in opposite direction will take place, each entity playing its role in reverse order. After the transmission of a file, an acknowledgement will be sent prompting the driver to empty the buffer for next transmission.

4. CONCLUSION

There are various methods to transfer the information between two different independent connections like USB and Wi-Fi. However, all these methods are indirect. For example, data has to be transferred manually through a PC or any other device that supports both connections. But here, we are developing a system that can convert this manual function into a simple 1 step procedure. Moreover, the idea of making it portable makes it handy to use outdoors. Such a system will be beneficial for different purposes and future research.

Because the system adopts high- powered ARM9 processor and Linux operation system, it has expansibility. Besides, according to different practice application and hardware platform, users may tailor Linux core to satisfy different needs. The system has characteristics such as strong function, high reliability, good stability and expansibility.

The device is built using embedded arm processor and single board computer for initial deployment. However for mass production the entire kit can be replaced by hardware developed solely for this purpose. This will increase the portability and efficiency of the device.

For advancement of the technology we propose to add more data security like checking the files before transmitting. If the file is corrupt (by any source like viruses, Trojans) then the file must be repaired. This will ensure transmission of safe data and will protect the target/receiving device even if it does not have security measures like antivirus, firewall, etc.

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