Design and Analysis of Custom Serial to LAN Adapter

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***Abstract*— The current laboratory set-up for testing of routers and switches is an expensive affair. An equipment known as the terminal server is used to enable remote access to the DUT (Device Under Test). This terminal server adds majorly to the lab set-up cost. This paper develops a custom serial to LAN adapter that will eliminate the need for a terminal server. By the use of this custom adapter, remote access to a DUT will become simpler and need lesser cabling. A single chip-set solution using FTDI FT906L is illustrated in detail to achieve this. The Eclipse toolchain is used to develop the software application code to achieve the desired functionality. The resulting application code is compiled and ready to be flashed on to the evaluation board for testing.**

***Keywords*— Custom Adapter, Ethernet, USB, UART, Cisco, Remote lab access**

I. INTRODUCTION (*Heading 1*)

For many years, Cisco has been making products that form the backbone infrastructure of the internet. These include switches, routers, hubs, access points and much more. The Supply Chain Operations department of Cisco deals with innovating, planning, sourcing, manufacturing, testing and logistics of the components and the products as they move from the suppliers to the customer. One of the departments under supply chain operations is Product Operations. This department works closely with the engineering department to innovate new products and to develop tests to check for manufacturing errors. For this reason, many Cisco products have a serial diagnostic port, UART port. They also have a USB port for client diagnostics as well as a LAN port to network the device.

On the diagnostic side there is - a Terminal Server present to enable remote access to the device, an Ethernet Switch to network the device and a Server that stores and loads all the necessary scripts. Here it is important to note that the Terminal Server is an expensive piece of equipment. In order to reduce cost, both on the diagnostic side as well as the product side, the serial diagnostic port can be done away with thus eliminating the terminal server as well. This can be achieved through the development of a custom UART, USB to LAN adapter as is presented in this paper.

II. RELATED WORKS

Currently there is no adapter in the market that converts the UART and USB protocols to LAN. However, attempts have been made to develop remote labs for cost cuttings as mentioned in [1]. In this paper, Remote Network Labs (RNLs) are aimed at taking advantage of the expensive network equipment more effectively and decreasing the expense of building a test lab. In another work by French professors as mentioned in [3], they have developed remote access to engineering labs to aid in distance education. FPGA based eLabs have also been developed for the same purpose as issued in [4]. There have also been attempts to make the diagnostic system smart by implementing an SoC based Hardware-Software co-design as illustrated in [5]. There have been multiple patents filed [9-11] for novel design approaches in this field. A one-of-a- kind software flow to address console access to perform diagnostics is issued in [9]. A dedicated Operating System (OS) based approach for diagnostic needs is illustrated in [10].

III. PROPOSED WORK

Our proposed work is to develop a custom serial to LAN adapter to simplify console diagnostics for all Cisco products. We begin by understanding the key requirements of the adapter, which leads us to zero in on an MCU to implement our functionality. A block diagram is developed and schematic designs are made. Finally, the software application code is developed and ready to deploy onto the hardware.

A. Key Requirements

In the development of this custom adapter there were some key requirements that had to be met. These were decided upon through consultation with lead engineers of various product families at Cisco. The following are the key requirements to be met -

i. USB to LAN and UART to LAN bi-directional conversion.

ii. Desirably a small form factor for the adapter.

iii. Auto detection for UART or USB should be present.

iv. LAN Speed to be supported is - 10/100Mbps.

v. USB2.0 technology should be supported and compatible on the adapter.

B. Block Diagram

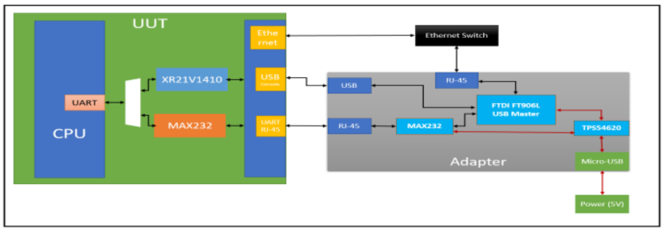

Fig. 1. Proposed Block Diagram

The Block Diagram as represented in Fig. 1 shows the various functional blocks, both on the adapter side as well as the DUT side. It also shows the interconnections between the two. This is the third iteration of the design. There have been multiple iterations on the design due to dependencies being discovered on testing certain interfaces.

C. Chip-set Selection

The most important and time-consuming step was the Chip-set selection. It was important to go through all the specifications of the Chip-set in depth by referring to all the literature available on it. The various development platforms i.e. IDEs (Integrated Development Environment), tool chains, evaluation boards, programmer modules and other specific resources had to be evaluated.

The FTDI FT906L chipset was finalized for the adapter. Some of the key features of FT906L are as follows -

- 32-bit RISC architecture
- 3.3V single supply operation
- USB2.0 device and host controller with Battery Charge Detection (BCD)

D. Schmatic Design

The next step in the design methodology was to come up with the Schematic for the adapter. The schematic was designed using the Cadence OrCAD Capture Tool. A new library was created for the FTDI FT906L chip-set. All the necessary pins were connected as advised in the data-sheet depending on whether it was being used or skipped. The schematic designed is as shown in Fig. 2.

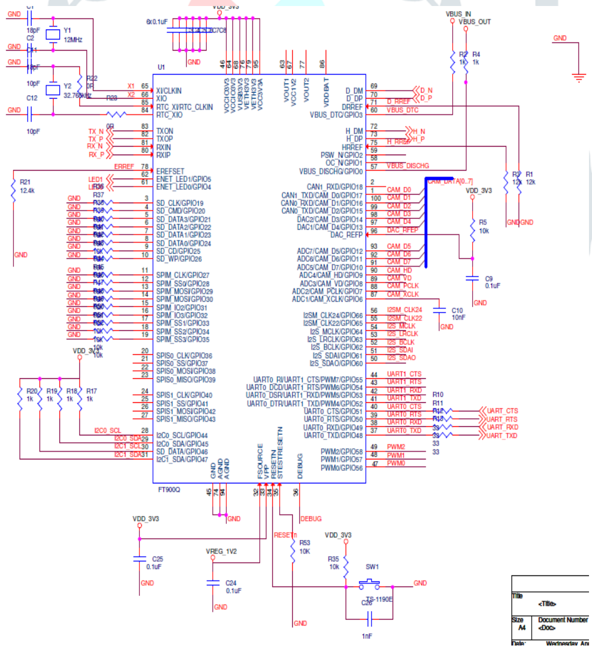

Fig. 2. Schematic Design

E. BOM

Next the BOM (Bill of Materials) is made from all the components present in the schematic. Here the CPNs (Cisco Part Number) for all the components had to be found and matched. The MPNs (Manufacturer Part Number) were also included. Along with this, cost and factory/manufacturer lead time were the other important parameters. The vendor, quantity being used, MOQ (Minimum Order Quantity) and PCB Footprint were also noted. It was important to keep the PCB Footprint as small as possible, keeping in mind the small form factor we're trying to achieve.

IV. Results

FTDI has it's own tool chain - Eclipse tool chain for development of the software code. The application code is written in embedded C. Along with the toolchain, FTDI has also provided some example codes for it various interfaces available in the FT90x family. The code has been compiled and is ready to be flashed onto the evaluation board. Fig. 3 shows the flow of the application code developed.

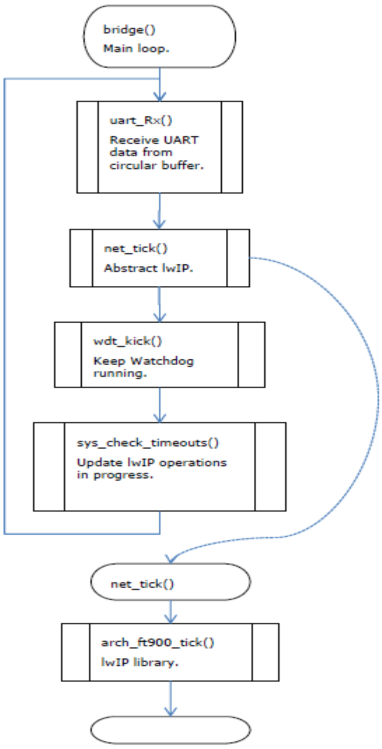

Fig. 3. Application Code Flow

V. Conclusion and Future Scope

The adapter design developed is most optimized and performs the functionality of converting UART and USB protocols to LAN. It is a cost effective solution that can be easily integrated into present lab settings. It will reduce the amount of cabling required to test a device. After PCB CAD design development, the custom adapter can be sent for fabrication and prototyping. Once a proto build is ready, it can be tested with switches and routers in the Cisco lab to validate it. This becomes the future scope of this paper.

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