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AN ALGORITHM FOR REMOTE ACCESS TOOL FOR THE INTEL REFERENCE VALIDATION PLATFORMS

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ABSTRACT. Remote Access control is important and a precondition for an efficient production within an organization. At the organizational level, to verify or track the status of a hardware platform present at a distant location, the engineer must be physically present at that location, this circumstance must be improvised because it is impractical to be present at the location as and when the requirement arises. In this paper we have proposed an architecture of a remote access tool that will allow the user at remote end to control, monitor and validate the Intel Reference Validation Platforms (IRVP) from remote end. The tool consists of an add-in card which will be connected to the RVP, a program that will be installed on the microcontroller in the add-in card and duplication of the host machine using ethernet or cloud connectivity. This tool aims to develop the connection between the Reference Validation Platforms (RVP) and the remote-positioned host computer, by the means of this connection we are able to retrieve the register information from the RVP and perform operations like switching RVP on and off, resetting it, accessing its I2C buses and controlling the General Purpose Input Output (GPIO) pins. In this paper we have discussed algorithm and commands of the firmware developed using Keil tool. This code is used to communicate with the host. The onsite host can be then accessed by the user from remote location and hence the RVP can be operated remotely as well.

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1. INTRODUCTION

Industrial Internet of Things (IIoT) is a system of machine to machine and industrial communication technology. It is an automation framework that gives a clearer picture of the validation process and contributes to effective and sustainable production [1]. The implication of the IIoT technology is the interaction between various devices and hence the reduction of manual interference to enhance efficiency and economic benefits in many technical aspects. This project is carried out to provide a scheme for the automation of the Remote Access Tool. The remote access tool proves to be very useful in situations where testers/engineers find it difficult to access platforms on the physical site; this tool serves the requirement that enables engineers to resolve the constraint of not having platforms on their physical sites. It is accomplished with a combination of software, hardware and network connectivity.

The RVP is a hardware which is used to validate the platforms developed for laptops, computers and various other electronic devices. Since RVP is a bulky hardware and organization-specific board, it is non portable. The add-in card is a palm sized Printed Circuit Board (PCB) which is connected to RVP. This add-in card is responsible for establishing the connectivity between host and RVP to transfer the data to and from the RVP. In the 'Proposed Methodology' an in-depth explanation of hardware design has been provided. In 'Experiment And Result' section the implementation of this tool has been explained. A flexible firmware platform which allows the fast access to the RVP and acquires data from it has been developed. The platform relies on various components and a microcontroller, which act as a bridge between the different devices of the system and the host. By means of a dedicated serial link, the software application, which has been implemented with, uVision Keil, directly controls each microcontroller communication interface (such as SPI, I2C or UART), and sends low-level commands to the system devices. With this approach, the firmware is the same for all the microcontrollers, it is independent of the final application, and it can be adapted to the hardware architecture of the system with a slight customization of a C header file [2]. Result section deals with the commands developed in order to communicate with the RVP which are listed in the form of a table. In January 2000, Philips Semiconductors introduced the I2C (Inter Integrated Circuit) protocol to permit devices to communicate with each other over a serial data bus without data loss, as well as to help faster devices to communicate with slower ones. Since then there have been I2C enabled microcontroller families such as Atmel's PIC18F452 and Texas Instruments' TMS470. A model of I2C bus controller has been presented in [3]. Technical description of the I2C bus and how it operates, previous limitations / solutions, comparison with SMBus, analysis of the various available I2C tools and patent / realty information has been described in [4] and [5]. Project specifies and checks the UART (Universal Asynchronous Receiver Transmitter) receiver data with error free and baud rate generation at different frequencies using Xilinx ISE 14.2 suite software [6]. Designing a UART which is implemented with Verilog HDL (Hardware Description Language) can be easily integrated onto FPGA (Field Programmable Gate Arrays) to achieve more reliable and error free data transmission has been presented in [7]. The hardware implementation of UART using Verilog HDL on FPGA: EP2C20F484C7, family of Altera cyclone II is also discussed. Simulation is done by Quartus II simulator which is fully compatible with UART. The GPIO pins of STM32 microcontroller offer several ways of interfacing with external circuits within an application context. The application note [8] offers basic details about GPIO configurations, as well as guidance for developers of hardware and software to improve their power output.

The rest of the paper is organized as follows. Proposed Remote access tool algorithm is explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

2. Proposed Algorithm

2.1 Remote Access Tool Development

By embedding the firmware into the add-in card, the remote access tool is designed, which provides the hardware setup. The USB (Universal Serial Bus) link from add-in card to nearby host launches communication through open source terminal emulator program called Tera Term [9]. In the section 2.1, the architecture and connectivity of the add-in card is discussed and in section 2.2 the firmware algorithm for the remote access tool is discussed. Figure 1 depicts the complete connectivity of the remote access tool graphically. The add-in card is a palm sized PCB which is shown in figure 2. The code is embedded into the microcontroller of this add-in card and this add-in card is connected to the RVP.

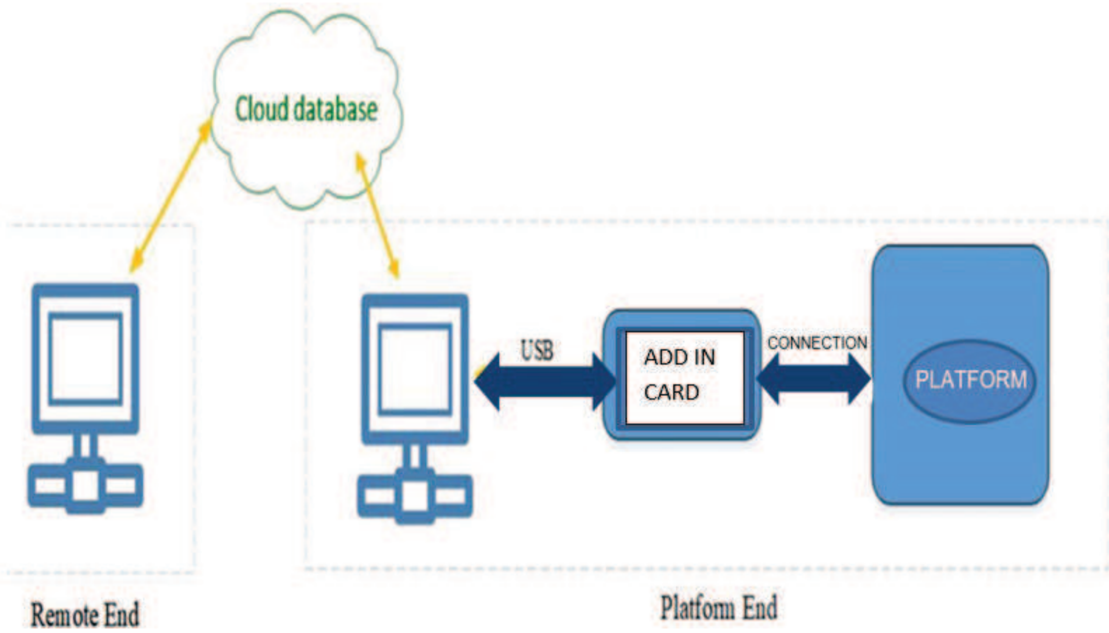

FIGURE 1. Connectivity of Remote Access Tool

For schematic design of add-in card, the PCB Cadence Concept HDL tool was used. The layout was prepared in a production environment provided by the Allegro PCB designer. The 4-layer stack-up was chosen for PCB fabrication with a thickness of 0.8mm ± 10The main component in add-in card is the micro controller STM32F070RB [10], which is chosen based on the validation customer requirements. The microcontroller runs on 3.3 V and has 32KB of flash memory and frequency up to 48 MHz, two Inter integrated circuit interfaces and four USARTs supporting master synchronous SPI (Serial Peripheral Interface) and modem control and SWD. The voltage supplied through USB is 5V, which is level translated to 3.3V using a level translator.

2.2. Development of Remote Debug Algorithm

The remote debug algorithm consists of a firmware developed in Keil IDE (Integrated Development Environment) [11] using embedded C, this firmware is flashed into the microcontroller STM32F070RB. This microcontroller is embedded inside the add-in card which is connected to a 40-pin header present on the RVP. Through Tera Term, which is installed in the host machine or laptop, the contact is established between the microcontroller (RVP) and the user at remote

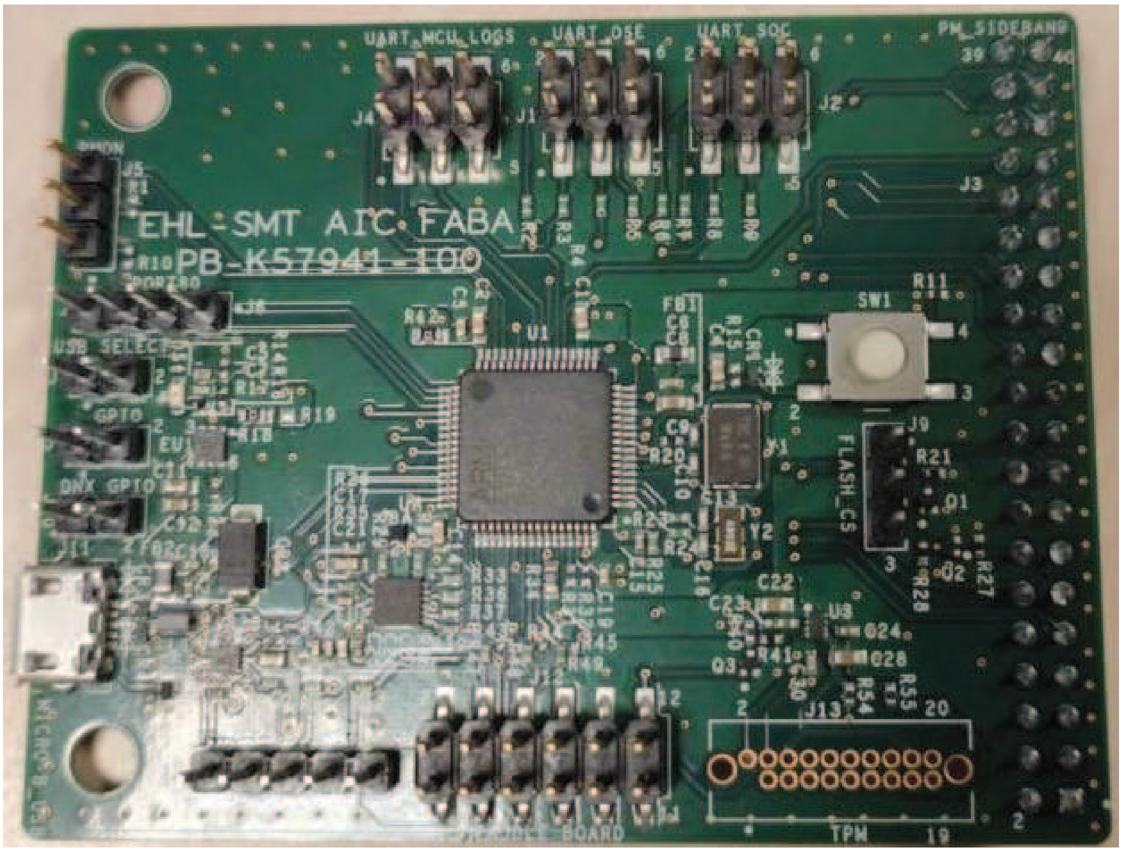

FIGURE 2. Add-in card

location. Figure 3 shows a flow of algorithm between microcontroller and Tera Term (host). The code communicates with the RVP using some standard serial communication protocols like UART, I2C and SPI. Figure 4 depicts the flowchart for the remote access tool. RVP SELECT SIGNAL, which is an input to the microcontroller from RVP, is used detect to which RVP the add-in card is connected. Once the RVP is known, its respective input output configuration is set for execution of the commands to perform operations on GPIOs, I2C buses, reset and power buttons. A fixed format for the commands has been developed, where the initial 6 characters define the function user wants to do and followed by a blank space character followed by details such as port number, pin number, slave addresses, register address and data, as shown in detail in table 1. The in-built functions from the HAL (Hardware Abstraction Layer) library have been

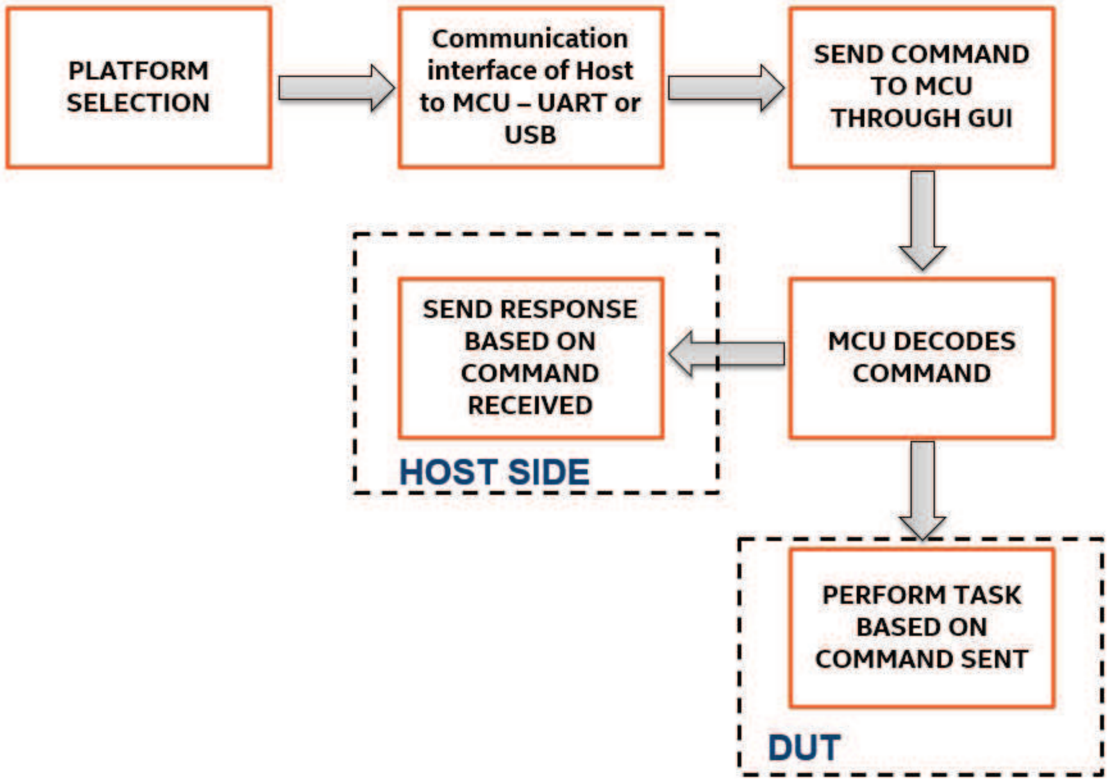

FIGURE 3. Algorithm for the firmware

used to develop these commands. The 4 in-built function used are stated below are referred from [12]:

(1) HAL_GPIO_ReadPin(GPIO_TypeDef* GPIOx, uint16_t GPIO_Pin)
(2) HAL_GPIO_WritePin(GPIO_TypeDef*GPIOx,uint16_tGPIO_Pin,GPIO_PinState PinState)
(3) _I2C_Master_Receive(I2C_HandleTypeDef *hi2c, uint16_t DevAddress, uint8_t *pData, uint16_t Size, uint32_t Timeout).
(4) HAL_I2C_Master_Transmit(I2C_HandleTypeDef *hi2c, uint16_t DevAddress, uint8_t *pData, uint16_t Size, uint32_t Timeout).

Depending on which command has been entered, the output is displayed on the Tera Term screen.

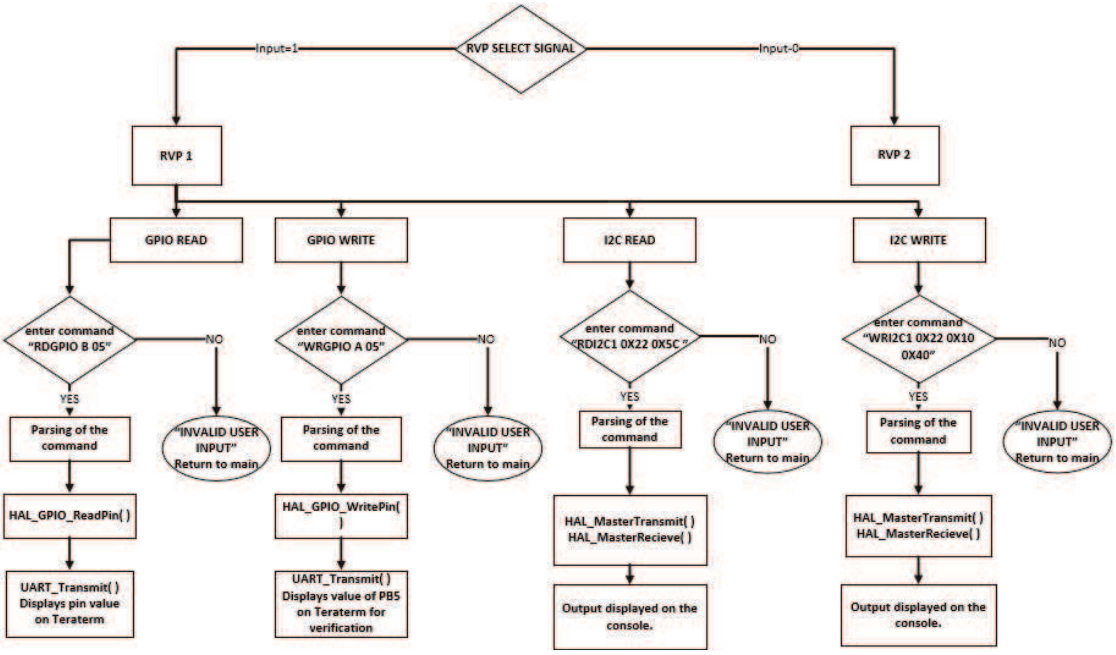

FIGURE 4. Flowchart of remote access tool

3. EXPERIMENT AND RESULT

The developed code is flashed into the micro controller and the remote access is achieved, connection is established between Tera term and RVP, the data can be retrieved from the RVP at the baud rate of 115200 bytes per second, by entering the developed commands in the on-site host connected to the setup. A user sitting in the remote location can then access on-site host using ethernet or Wi-Fi to communicate with the RVP. In table 1, a few examples of the command are shown. The command for reading GPIO, reads pin 07 of port C of the microcontroller. This command returns the value in that pin (high or low). The second command is to write "LOW" onto pin 02 pin of port A on the microcontroller. I2C read command is to read a register value of a slave on I2C1 bus of microcontroller; where, 0x40 is 1 bit left shifted in 7-bit slave address 0x20; 0x01 is register address in I2C slave. This returns the value of the above register.I2C write command is to write into a register of a slave on I2C1 bus on microcontroller where, 0x40 is 1 bit left shifted in 7-bit slave address 0x20; 0x0A is register address in I2C slave; 0x10 is value to be written in register.

TABLE 1. Tera Term commands

COMMANDS SUPPORTED BY TERA TERM	COMMAND SYNTAX	EXAMPLE
Read GPIO	RDGPIO <MCU Port> <pin>	RDGPIO C 07
Write GPIO	WRGPIO <MCU Port> <pin> <Value>	WRGPIO A 02 0
I2C Read	RDI2C1 <8-bit Slave address> <Register Address in Slave>	RDI2C1 0x40 0x01
I2C Write	WRI2C1 <8-bit Slave address> <Register Address in Slave> <Value>	WRI2C1 0x40 0x0A 0x10

4. CONCLUSION

In IIoT machines there is a need to be able to securely link and communicate in real time to create a connected industrial framework that allows for faster communication, increased performance and reduced costs. Within the Remote Access Tool for the RVP, the developed firmware achieves these benefits, the remote link is created and users sitting away from the RVP are now able to control, monitor and test the RVP. With the emergence of this tool a huge collection of use cases gets allowed. In order to make validation / testing easier, more features can be added on the tool such as rebooting, flashing of RVP. The provision for an alarm in case of occurrence of catastrophic error. The tool can be connected to cloud and all the data retrieved can be stored for future analysis. A GUI (Graphical User Interface) can be developed which could not only retrieve data from RVP but also analyze it for the user by producing graphs, charts, tables and calculations beneficial for the user and organization.

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