A Real Time Embedded Gateway System for Industrial Auotmation Applications

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ABSTRACT - The demand for industrial networking in this era has rapidly increased which interconnects various devices attached to different platforms. Every network has distinct architecture and separate protocols. Communication in a heterogeneous environment is a challenging field. ARM Processor with Embedded Linux which acts as a gateway is used which repackages the information to match with the destination system. The computers attached to different platforms communicate through the gateway. The aim is to develop a system that is going to act as a gateway between three networks one in RS485 protocol, one in Bluetooth and other using Ethernet. In this article the current state of art for networking is presented. Furthermore, the addressing problems that arrive when the proper end-to-end communication to be assured in today's heterogeneous environment.. Thus gateway is formed using a suitable method and code is written in Embedded C to accomplish this.

KEYWORDS: Embedded, Gateway, ARM Processor, Industrial, Networking, Wired and Witreless Communications, heterogeneous.

I. INTRODUCTION

Embedded gateway is a system that has computer intelligence and is dedicated to performing a single task, or a group of related tasks.[1] Communication between different architectures and protocols is made possible by gateways. The data is repackaged and converted from one network to another so that it can understand the other application data. Gateways repackage information to match the requirements of the destination system [2].

A gateway connects two systems that may not share the same communication protocols and data formatting standards [3]. A gateway is a network device that acts as an entrance point to different network. Gateways are considered to be access mediators to be managed and controlled including privacy, security, message routing, message screening, message parameter screening, bridging and and protocol conversion, performance monitoring and protection, error handling.[4]

This paper aims at building a system which is going to act as a gateway between three networks one in RS485 protocol, one in Bluetooth and other using Ethernet to which devices are attached. It is used also to determine network traffic patterns, usage patterns. The system developed is an embedded system, which has computer intelligence and is dedicated to perform a single task, or a group of related tasks. They're called embedded systems because the program code is an integral part of, or embedded in, the devices.

The system uses ARM Processor, which implements a low power, high performance 32 bit RISC architecture. The first part, is to analyze the features of ARM Processor which involves application peripherals, standard interfaces, debug features. This part focuses on applications and implementation. Next goal is to see how these features can be made use of to accomplish the required task. This involves selection of Embedded Operating System, configuring it and porting on to the processor.

Finally C Language is used to write a code for the implementation of the Embedded System which is a gateway for different devices in a wired cum wireless heterogeneous networks.

II. EMBEDDED GATEWAY

Gateways facilitate communication between different protocols and architectures. Repackaging and converting data from one network to another allows it to understand the other's application data according to the destination system's specifications. A gateway links two

systems that might not use the same Communication protocols and data formatting structures.

A gateway is an element of a network that acts as an entry point to another network. Gateways are considered to be access mediators to be managed and controlled including privacy, security, message routing, message screening, message parameter screening, bridging and protocol conversion, performance monitoring and protection, error handling, and billing. The goal of access mediation is to enable the interconnection of individual networks.
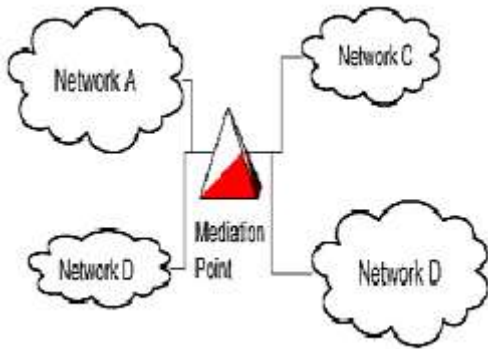

Fig 1. Access Mediation in a Conceptual Network

Fig. 1 shows the generalized way of gateway representation. It emphasizes interconnection of different wired cum wireless network

An overview of different communication technology which includes

1) Socket Communication for Ethernet technology
2) Bluetooth Communication and
3) RS-485 Serial Communication

The system which is going to act as a gateway between three networks one in RS485 protocol, one in Bluetooth and other using Ethernet uses separate and distinct set of protocols for specific application. Some of the protocols that are used are:

1) TCP/IP for Ethernet Technology

2) LAN Protocols for industrial networking

3) Logical Link Control and Adaptation Protocol (L2CAP) for Bluetooth Communication

4) RS485 Serial Communication Protocol

When two devices try to interchange the data over a network, there are certain components/features that must be in accodance before the actual communication be intiated to send and receive. To have a communication the physical hardware must exist which is typically either a Network Interface Card (NIC) or a serial communications port for dial-up networking connections. Beyond this, the

physical connection however computers/devices also need to use a standard protocol that defines the parametersor specifications of the communication between the devices.
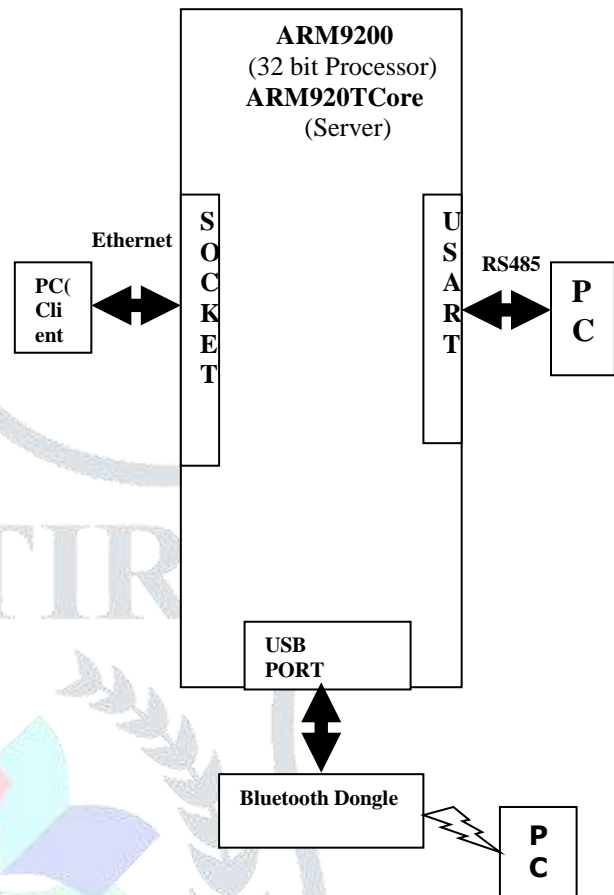
III. Description of Block Diagram

Fig 2. Block diagram of embedded gateways

The block diagram of embedded gateway for industrial networking is as shown in Fig 2. . The overall purpose of this is to communicate data from one pc to other attached to different platforms. The pc connected through RS-485 and Bluetooth device differs in network architecture and protocols AT91RM9200 (32- bit processor) acts as a gateway to facilitate this. Industrial networking means to say that the pc can be of any number connected through LAN at the client side. Also many pc's can be connected to RS-485 and Bluetooth devices. The client machine communicates data to the server machine through Ethernet, which can be sent either through RS-485 and Bluetooth device. Socket is a structure to be created using software to facilitate this.

AT91RM9200 is a 32-bit ARM processor with Embedded Linux has computer intelligence acts as server forms the gateway to other pc's or devices. It receives data from client machine through Ethernet, repackages it and sends it to the destination system.

Bluetooth devices are connected to server as well as the pc meant for Bluetooth communication. Data communication takes place between the two Bluetooth devices. Bluetooth soleil is software to be installed initially in the destination pc. RS485 is a specialized interface that would not be considered standard equipment on today's home PC but is very common in the data acquisition world. RS232 is the most common interface used to communicate serially but it has its limitations. While a multi-drop "type" application has many desirable advantages, RS422, RS232 etc., devices cannot be used to construct a truly multi-point network. A true multi-point network consists of multiple drivers and receivers connected on a single bus, where any node can transmit or receive data.

This system acts as a gateway between three networks one in RS485 protocol, one in Bluetooth and other using Ethernet.

IV. IMPLEMENTATION & RESULTS

ARM development board is used to build a gateway for different devices connected to different networks. ARM with Embedded Linux has computer intelligence to perform networking in heterogeneous wired cum wireless networks. The process of implementation involves the following steps

1) Connecting ARM Board to the PC via Serial Port
2) Kernel Configuration
3) Root File System Creation
4) Down loading into ARM Board
5) Data transfer verification

The AT91RM9200 Development Board enables real-time code development and evaluation. It supports the AT91RM9200 ARM9-based 32-bit RISC microcontroller. ARM Development Board with its features and embedded Linux acts like a server, takes data from the client machine (PC).

A code is written in C Language for this first followed by code for transfer of data to wire cum wireless network (Here RS-485 and Bluetooth). All these , are accomplished using a code written in C Language under Linux Operating System.
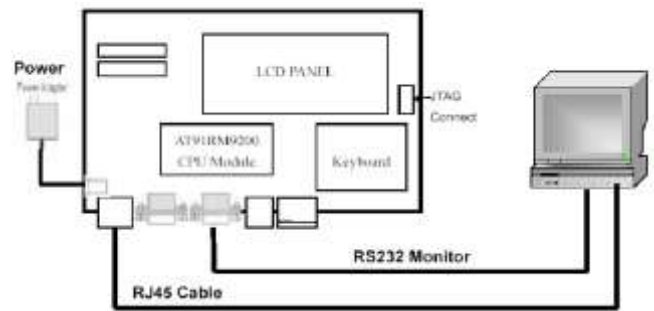
Connecting ARM board to PC

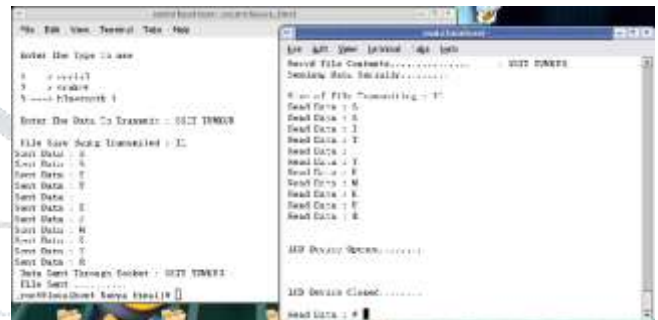**Fig 3:** Implementation setup for ARM Processor

Results

Fig 4: The snapshot showing the display of message by client communicating to destination through serial communication (using RS232 Protocol)
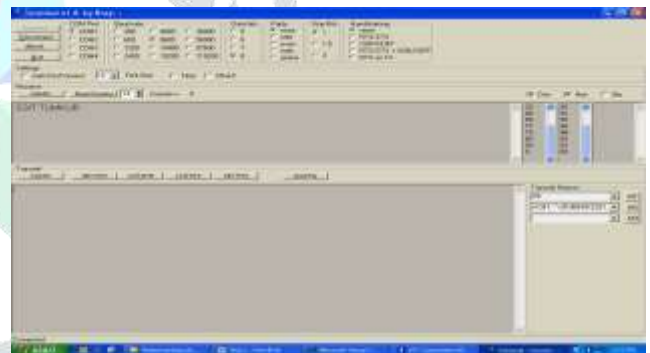

Fig 5: The snapshot showing the display of message by client to destination through serial communication (using RS232 Protocol)
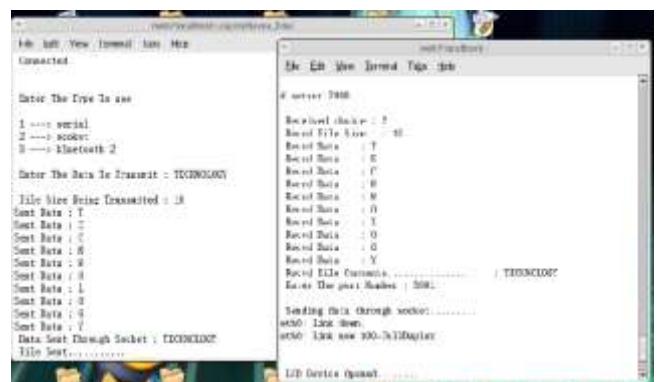

Fig 6: The snapshot showing the display of message by client communicating to destination through Bluetooth communication (using L2CAP Protocol)
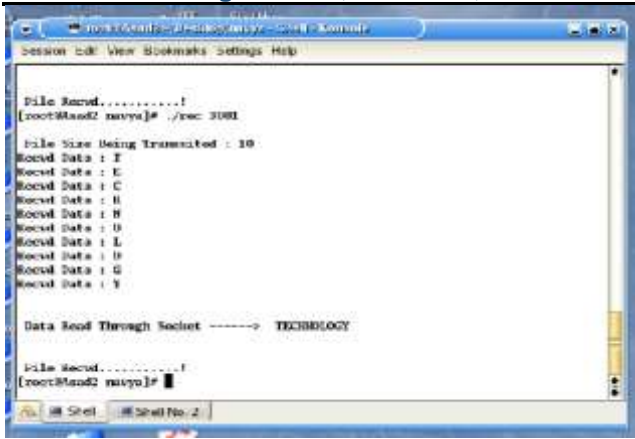
Fig 7: The snapshot showing the display of message by client communicating to destination through socket communication (using TCP/IP Protocol)
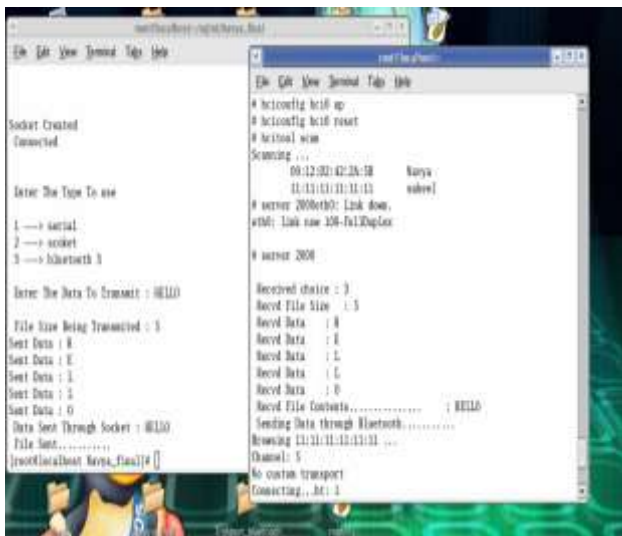

Fig 8: The snapshot showing the display of message client communicating to destination through Bluetooth communication (using L2CAP Protocol)

Fig 9. Display of message on AT91RM9200

V. CONCLUSION AND FTURE SCOPE

Conclusion

ARM Linux is developed and installed. The operating system kernel is configured and Root File System is created. They are downloaded on to ARM Processor to make it as a Gateway for different devices using different protocols and networks (wired cum wireless).

With kernel configuration and Root file system creation we are creating an executables such as Ram Disk AND Z Image. Since the kernel is the only software allowed to deal with hardware, the choice of what parts ought to be included and what parts ought to be discarded. Root file system is selection of commands. Ram Disk has Root file system creation.

Embedded Gateways are developed to implement interconnection of various devices using different protocols and networks (wired cum wireless).Thus, the Gateway is developed and implemented.

Scope for Future work

Embedded Gateway offers some attractive features such as interconnecting many devices using a particular network to other devices using separate network. The devices can be connected without any wire, which is going to be very helpful for industrial networking. This can be incorporated in the future. The client side consists of more than one PC and these PCs are connected using a wired LAN (local area network) standard .In future IEEE 802.11 a leading standard for Wireless LAN can be deployed so that wireless users can access real time and internet services virtually anytime, while enjoying the flexibility of mobility and guaranteed connectivity.

Mobility and Resource management are the issues that are challenges for wireless networks can be dealt in the future to achieve fast and guaranteed connectivity for various applications.Thus,Gateway is implemented using a special 32-bit processor and 'C' Language under Linux operating system.

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