Bluetooth Interface and Application on a PXA 270 Based Embedded Platform

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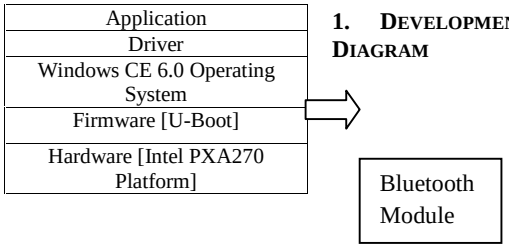
***Abstract*— Decrease in the cost of Bluetooth technology has allowed an increasing number of mobile embedded devices to have access to a large bandwidth wireless network connection. This technology finds application in mobile point of sale terminals, handheld terminals, industrial data loggers, microfinance terminals and cash registers. This work uses PXA270 Intel Xscale architecture spark development platform to interface the Bluetooth stack. Win CE operating system image is created using Microsoft platform builder and porting of the operating system image to the hardware platform is performed. Device drivers are developed to control the UARTs ports. Applications are developed for mobile point of sale terminal, handheld terminals, industrial data loggers, microfinance terminals and cash registers using visual C++. This project is used to communicate between the developed system and surrounding device like mobile or any PC.**

***Keywords*— Bluetooth, PXA270, Win CE.**

1. INTRODUCTION

Bluetooth wireless technology has become a global specification for short-range wireless communication between portable devices, mobile communicators and desktop machines and peripherals. It enables users to exchange, transfer and synchronize data without having to cable devices together, merely by having the devices come within range of each other. The wireless link can have a range up to 100 meters allowing users to have mobility than ever before. The Bluetooth transceivers operate in the globally available unlicensed ISM (Industrial, Scientific and Medical) radio frequency band of 2.4 GHz, which do not require an operator's license from a regulatory board. Bluetooth wireless technology has been greeted with unparallel enthusiasm throughout the computer and communications industries.

The demand of Bluetooth solutions will be driven by the key success factors of low cost, low power consumption, small Integrated Circuit packaging form factor, feasibility of volume production and guaranteed interoperability.



1. DEVELOPMENT STACK DIAGRAM

Fig.1. Development Sack Diagram.

This project explores the different hardware possibilities and interface required components for this hardware. Complete software has been developed for the Embedded System.

2. HARDWARE MODULE

The Intel PXA27x hardware development kit was chosen because of it's capabilities to run Microsoft Windows CE, and Microsoft Visual C++. The HDK combines a PXA270 processor, networking capability, USB and other output ports, and a fully integrated touch screen. After doing a comparative study of all the available processors, PXA 270 processor was found to be the best suited.

3.1. COMPARATIVE STUDY

3.1.1. Selection of Processor

The project requires a processor that provides the following features. High seed processing, I/O ports, Communication capabilities Graphics or display capabilities Minimum mathematical computational features

3.1.2. Comparative Chart for Processor selection

The below chart reveals that the best suited processor is Intel XSCALE this decision is based on: Supported Operating Systems,

Low voltage requirements, Available internal memory and Development platforms available

Fig 3: Block Diagram of PXA 270 Platform Interfaced with Peripheral Devices.

3.2. Hardware- PXA270 Architecture

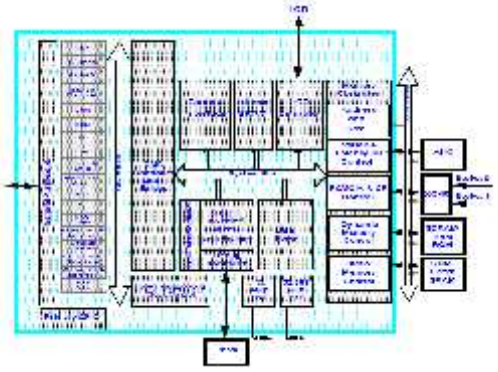


Fig.2: Intel PXA270 Processor Architecture.

3.3. Block Diagram

Spark kit platform is designed Intel PXA270 processor running at 520MHz and is powered by Win CE 6.0., with PC and includes a range of I/O and expansion slot including SD/MMC slots, USB host and client,10/100 Ethernet, Bluetooth, audio line in/out and UARTs. For storage the platform consists of 512MB of NAND flash and provides file system support on the same on Win CE 6.0. Among other things the platform has an expansion bus connector through which customer specific application modules can be plugged in.

Spark kit being modular in design and tested thoroughly leads to reduction of the time-to-market for any of the new product idea, tailored around this Reference Platform and can be used for any of the handheld applications such as Handheld data logging terminals, Streaming Media players, Point-of-Sale terminals, Industrial PDA designs, Video Conferencing Terminals, Informative Kiosks etc.

3.4. Peripheral Features

The PXA 270 processor supports rich set of peripherals it has 7 Stage pipeline, rich serial peripheral set, three high-speed UARTs, hardware debug features — IEEE JTAG interface with boundary scan, real-time clock, operating-system timers, LCD Controller, four low-power modes, dynamic voltage and frequency management, high-performance memory controller, compact Flash, CPU clock from 104 to 624 MHz. It also has additional peripherals for system connectivity like SD Card Controller, two I2C controllers, four pulse-width modulators (PWMs), keypad interface with both direct and matrix keys support

3.5. Electrical Specifications

Absolute maximum Ratings
Supply Voltage: 12V Supply Current 2Amps.
Operating Ratings
Supply Voltage: 9 - 12V Supply Current 1Amps.

3.6. Mechanical Specifications

Board Length: 114mm

Board Width: 65.023mm
PCB Thickness: 1.6 mm

3.7. BLUETOOTH 2.0V – SPECIFICATIONS

Bluetooth radios operate in the unlicensed ISM band at 2.4 Gigahertz using 79 channels between 2.402 GHz to 2.480 GHz (23 channels in some countries). The range for Bluetooth communication is 0-30 feet (10 meters) with a power consumption of 0dBm (1mW). This distance can be increased to 100 meters by amplifying the power to 20dBm. The Bluetooth radio system is optimized for mobility. Bluetooth supports two kinds of links: Asynchronous Connectionless (ACL) links for data transmission and Synchronous Connection oriented (SCO) links for audio/voice transmission. The gross Bluetooth data rate is 1 Mbps while the maximum effective rate on an asymmetric ACL link is 721 Kbps in either direction and 57.6 Kbps in the return direction. A symmetric ACL link allows data rates of 432.6 Kbps. Bluetooth also supports up to three 64 Kbps SCO channels per device. These channels are guaranteed bandwidth for transmission.

- Allows up to 8 devices to communicate in a local network called a Piconet, also known as a PersonalArea Network or PAN
- Because of its low power consumption, its range is limited to 10 m.

However, range can be increased to 100 m by employing a scatternet topology or a higher powered antenna.

Three classes of Bluetooth devices

- Class 1 – 100 m ≤ 20 dBm power
- Class 2 – 10m ≤ 4 dBm power
- Class 3 – 10 cm at 0 dBm power

Taking in to above characteristics the class 1 of Bluetooth 2.0 version is best suit for the project.

3. SOFTWARE MODULE DESIGN

4.1. Selection of Operating System

The Intel XSCALE processor supports the following operating systems:

•Windows CE 6.0 Features:

- Large Memory footprint (32MB – recompilable as Tiny Kernel ~1MB).
- Excellent availability of programming tools – Visual Studio 2005.
- Supports most development boards.
- Customization of kernel available through WinCE platform builder.

•Palm OS : Features

- Small Memory footprint (< 4MB)
- Programming tools available
- No customization of kernel
- Supports only selected development boards

•Symbian OS Features:

- Large Memory footprint (> 4MB)
- Programming tools available
- No kernel customization
- Supports only selected development boards

•Montavista HardHat Linux Features:

- Small memory footprint (< 4 MB)
- Programming tools available
- Kernel customization possible
- Supports most development boards

•Other OS (like eCOS, ARM Linux) Features:

- Limited programming tools available
- No or limited development board support for XSCALE processor

The selection of operating system must consider the memory foot print, support for development boards and the kernel customization. Based on these considerations Windows CE 6.0 suit the project needs.

4.2. Windows Compact Edition (Win CE) version 6.0:

4.2.1. Specification and Development Tools:

- Windows CE v6.0 has support for ARM v4.1+ and Intel XSCALE
- Proprietary platform of Microsoft (requires license for distribution)
- Kernel with all requirements met with additional C support ~ 1 MB
- Visual studio 2005 (already available in institute labs)
- Emulation through Win CE platform emulator, but requires custom x86 Emulator kernel.

4.3. The hardware and software requirement for the software module design:

4.3.1.Hardware requirement:

Any personal computer or Laptop available in the market with the standard features.

4.3.2.Software requirement:

- Visual studio Service pack 2005.
- Windows Embedded CE 6.0.
- e-con Regulus SDK.
- Microsoft Service Pack1
- BSP (Board Support Package)
- Active sync

4.4.Image Creation Flow Chart

The flow chart for the operating system image creation is as shown.The first step towards image creation is the project creation phase after the successful creation of the project-creation-phase the

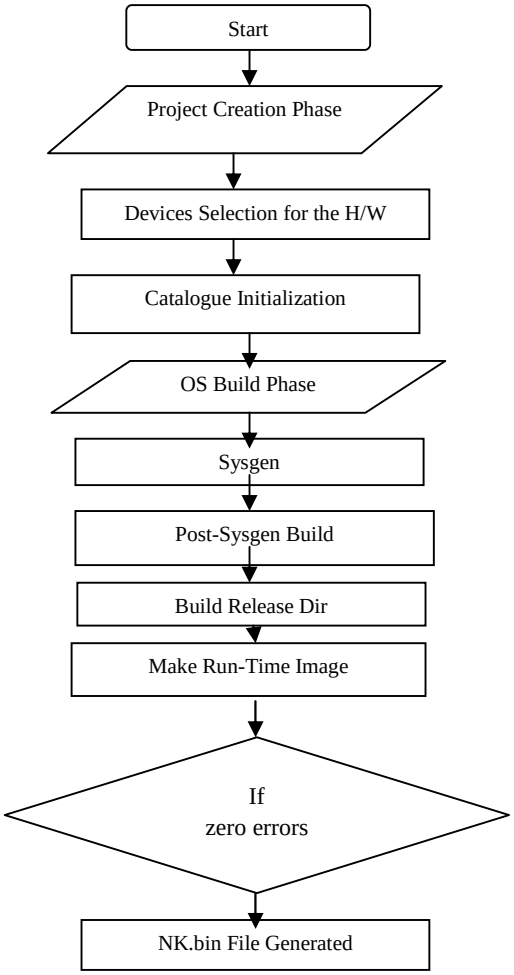
next stage is the device selection phase here the devices connected to the hard ware is selected next stage is the catalogue initialization phase in this phase the different peripheral devices connected to the hardware is included.

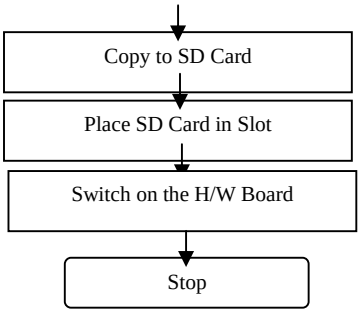
The next stage is the build phase

The build phase consist of

- Sysgen
- Post-Sysgen Build
- Build Release Dir
- Make Run-Time Image phases

After completion of these stages the build image is successful if image as zero errors and a NK.BIN is created in the target directory. This NK.BIN file is copied to the SD card and this card is placed in the slot given on the board.The board is now switched on for the operating system to run for the first time.





5. APPLICATION

VC++ is used for developing the application's. Two program codes are developed.

- A GUI code for displaying the longitude, latitude, number of satellites, quality of the signal and time.
- A code for creating an interface between the bluetooth module and the hardware.

6. TESTING AND RESULTS:

6.1. TESTING SETUP:

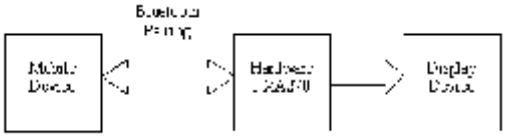


Fig.4.The project module interacting with the other Bluetooth device.

Two Bluetooth devices agree to communicate with each other and establish a connection called Bluetooth pairing.The project was tested in real time with a surrounding mobile devices paired with the project Bluetooth 2.0 module.

Tests were carried out taking in to considerations bandwidth, connection times, acceptable range and the results are obtained.

6.2. RESULTS:

- The amount of data in bytes to move from the mobile device to Hardware PXA270 acceptance time taken in seconds.

Mobile Device Data in bytes	PXA270 Acceptance time taken in seconds
1.04 MB	4
5MB	5
10MB	7
15MB	8
20MB	9
40MB	10
80MB	11

- The amount of data in bytes to move from the PXA270 device to mobile device acceptance time taken.

PXA270 Data in bytes	Mobile device Acceptance time taken in seconds
1.04 MB	4
5MB	5
10MB	7
15MB	8
20MB	9
40MB	10
80MB	11

7. CONCLUSION:

Over all project was success. Porting Win CE operating system and firmware on to the hardware board was a success. Working on Bluetooth device was new experience and knowledge gain was invaluable.

8. REFERENCES:

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