NXP ARM Microcontroller Solutions: *More Than Moore*** !!!

Ashok Chandak, Sr Director- NXP India
15 Nov 2010
The Complete ARM MCU portfolio

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NXP Semiconductors

- **Headquarters**: Eindhoven, The Netherlands
- **Employee base**: about 28,000 employees working in more than 25 countries
- **Net sales**: $3.8 billion in 2009
- **Patents**: ~14,000 issued and pending
- **R&D**: Over $600 million investment per year
- **Innovation track record dating 50+ years**

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NXP is a leader in ARM Flash MCUs

- Clear strategy: 100% focus on ARM
- Top performance through leading technology & architecture
- Design flexibility through pin- and software-compatible solutions
  - Scalable memory sizes
  - Widest range of peripherals
- Unlimited choice through complete families for multiple cores

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NXP changing the industry MCU landscape

Breaking through traditional boundaries of 8b, 16b, 32b and DSP

- 8-bit
- 16-bit
- 32-bit
- DSP

Very low-end 8b
Eg 6-8 pin not planned

Cortex-M0
Cortex-M3
Cortex-M4

High-end DSP/MPU not planned

Binary and tool compatible

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Changing the MCU Landscape

LPC213x (2003)
LPC210x (2005)
LPC24xx (2007)
LPC17xx (2009)

The Hot 100 products of 2005

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NXP Microcontrollers
The leading ARM MCU supplier

• **Design flexibility** through pin- and software-compatible solutions
  - Scaleable memory sizes
  - Widest range of peripherals to select in line with application needs

• **Top performance** through leading technology & architecture
  - Highest bandwidth for CPU and communication peripherals
  - Low power operation

• **Unlimited choice** through complete families for multiple cores
  - Perfect fit for various applications
  - Commitment to continuously broaden ARM portfolio

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LPC1100
Low Power
Easy to Use
Features to Be Announced

LPC1300
Cortex-M0

LPC2000 + LH7
Cortex-M3

LPC2000
ARM7 TDMI-S

LPC1700
Cortex-M3

LPC2900
ARM968E-S

LPC3000 + LH7A
ARM926EJ-S

Cortex-M0

LPC1300
50 MHz
128 KB Flash
32 KB SRAM
USB
CAN
I2S
+ Analog system

LPC2000 + LH7
72 MHz
512 KB Flash
100 KB SRAM
LCD controller
Ethernet
USB
CAN
I2S
+ Lower power revision2 core

LPC1700
100 MHz
512 KB Flash
64 KB SRAM
Ethernet
USB
CAN
I2S

LPC2900
125 MHz
768 KB Flash
48 KB SRAM
EEPROM
TCM
USB
CAN
LIN
+ Motor control subsystem

LPC3000 + LH7A
266 MHz
VFP co-processor
MMU
256 KB RAM
TCM
LCD controller
Touch screen int.
Ethernet
USB
I2S
+ LPC3130 (HS USB)

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All MCUs are not created /Born equal

- ARM vendors start with the same ARM IP
  - Cores, Internal Bus, Interrupt Controllers, etc
  - But the end result is not the same!

- Architectural choices, implementation, processing optimization, and power management make a big difference
  - MCU supplier implementation impacts performance, power consumption and ease of use

- Examples:
  - Flash memory performance
  - Peripheral consistency
  - Integration
  - Debugging capabilities

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Family Overview

- **80C51**
  - LPC900/LPC700
  - 8-bit Families
  - (Up to 18 MHz)

- **Cortex**
  - LPC1000
  - Low Power / Mixed Signal
  - (Up to 100 MHz)
  - Cortex-M0
  - Cortex-M3

- **ARM7**
  - LPC2000
  - Mid-Range
  - (Up to 84 MHz)
  - ARM7TDMI-S
  - ARM720T (LH7)

- **ARM9**
  - LPC3000
  - Application Processors
  - (Up to 270 MHz)
  - ARM926EJ-S
  - ARM922T (LH7A)
  - ARM968 (LPC2900)

**Focus Applications**

- Industrial
- Consumer
- Medical
- Automotive
- Sensors
- e-Metering
- 16-bit Applications
- Battery Applications
- Connectivity
- Industrial
- Smart Control
- White goods
- Connectivity
- Industrial
- Consumer
- Medical
NXP’s Peripheral Strengths

- USB: >45 options
- LCD: >10 options
- Motor Control: >15 options
- ETHERNET: >20 options

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Cortex-M0 : The Low Power Option
Easy to use

- **An ideal C target**
  - Interrupt service routines can be coded in C
  - ISR nesting, priority, stacking is automatic

- **Simple to program**
  - Only one mode (Privileged mode only)
  - 8, 16 or 32-bit data transfers achieved in one instruction
  - Supported by popular tool-chains (Keil, IAR, GNU)
  - Only 60 assembler instructions

- **32-bit complexity removed**
  - All instructions and interrupts are deterministic
  - No AHB buffering
  - No Burst transaction
  - No merging or re-ordering of accesses
LPC111x Key Features

- **Memory:**
  - Up to 32 KB on-chip Flash
  - Up to 8 KB SRAM

- **Peripherals:**
  - One UART, 1-2 SPI/SSP, One I2C
  - Four general purpose counter/timers with PWM
  - 10-bit 8-channel ADC
  - Programmable Watch Dog Timer (WDT)
  - 12 MHz internal RC oscillator trimmed to 1% accuracy
  - Programmable watchdog oscillator

- Unique device serial number

- Single 3.3 V power supply (1.8 V to 3.6 V)

- LQFP48 and HVQFN33 packages

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LPC11C1x

Total CAN solution!!
- C_CAN 2.0B controller
- Plug and Play with on-chip CAN & CANopen drivers
- Flash updates over CAN

CAN & CANopen drivers
- Up to 8KB Extra Flash Memory for your Product's Firmware
- Tested & Validated CANopen Drivers
- Reduces Product Development Risks

Upcoming New family members will also include CAN transceiver…

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Superior Code Density

- Why superior code density?
  - In Cortex-M0 all instructions (except BL) are 16-bit wide instructions.
  - 8- and 16- processors with Over 64KB of address space have to introduce paging leading to extra overhead in code.
  - Efficiency of the Cortex-M0 instruction set.
Bridging Two Great Families

*Cortex-M0 & Cortex-M3*

LPC1300

Cortex-M3

LPC1100

Cortex-M0

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Powerful Cortex-M instruction set

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LPC1100L Cortex-M0: Summary
Re-defining 32-bit migration

- 2-10x higher performance than 8/16-bit MCUs
- 40-50% smaller code size than 8/16-bit MCUs
- Very low active power 130uA/MHz
- Pricing
- Pin compatible options from M0 to M3
Tool Support

Fully Featured Development Tools
Customers committed to industry standard third party tool platforms

Online Rapid Prototyping Tool
For anyone… non embedded engineers also

NXP’s Low cost Development Tool Platform
Specifically targeted for 8/16-bit users
Customers need low cost production tools
Competitive with other 32-b architectures
LPCXpresso supporting NXP microcontrollers

- Already more than 15,000 board on the LPCXpresso forum
- LPC1768 boards are now shipp board support across the Cortex
- LPCXpresso Linux now availabl
Cortex-M3 : Highest Performance

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ARM Cortex™-M3 based parts

“Industry-leading 32-bit processor for highly deterministic real-time applications … specifically developed for high-performance and low-cost.”

- NXP’s Cortex-M3
  - Highest performing Cortex-M3 at 150MHz
  - Rich set of peripherals including USB, Ethernet, Motor Control PWM, etc.
  - Pin compatible options from M0 to M3, and M3 to M4
LPC1700 & LPC1800 Series

- Based on the ARM Cortex - M3 Revision 2 Core

- About Cortex - M3 Core
  - Harvard architecture with separate local instruction and data buses
  - 3-stage pipeline w/ limited branch prediction
  - Thumb®-2 and Thumb® instructions
  - ALU with support for H/W divide and single cycle multiply
  - Built-in Nested Vectored Interrupt Controller (NVIC) with Wakeup interrupt controller (WIC)
  - Automatic state save and restore for interrupts
  - Bus matrix
  - Advanced debug components
  - Integrated low power modes
  - Memory Protection Unit (MPU)
EEMBC Benchmark Results – Same Clock

LPC1768 executes benchmark code 35% faster than competitive M3
LPC176x Block Diagram

- Up to 64 KB SRAM
- Up to 512 KB FLASH
- Cortex-M3 Core
- Nested VIC
- Brown Out Detect
- MPU
- Power On Reset
- Ethernet MAC
- USB Host/OTG/Device
- GP DMA
- 3 x I²C
- 3 x SSP/SPI
- i²S
- 4 x UARTs RS486/IrDA/Modem
- 2 x CAN 2.0B
- 12-bit/8-ch DAC
- 10-bit DAC
- 4 x 32-bit Timers
- Motor Control PWM
- Quad Encoder Interface
Cortex-M4 : Digital Signal Control
ARM Cortex™-M4 based parts

“Specifically developed to address digital signal control markets. A easy-to-use blend of control and signal processing capabilities."

- NXP’s Cortex M4 leverages NXP’s extensive ARM microcontroller knowledge
  - Adds unique set of innovative peripherals
  - Pin compatible options from M3 to M4
Why is NXP adopting Cortex-M4?

- Enables us to address new markets requiring DSC
  - Digital Signal (Processor + Micro) Controller
  - An intelligent blend of MCU and DSP features demanded
    - High performance mixed signal peripherals demand much more signal processing
    - Upper limits of bandwidth challenged in general purpose MCUs
    - Hard to learn/program technology in many licensable DSP cores

- Extend the Cortex-M portfolio to cover new markets
  - Cortex-M0 for mixed signal devices and state machine replacements
  - Cortex-M3 for mainstream 32-bit MCUs
  - Opportunity: High end MCUs and DSC market

- Introduce ARM strengths to DSC market
  - Very high energy efficiency- more processing in less milliwatts
  - Strong s/w ecosystem- easy to program and use
Cortex-M4 Core

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Powerful Cortex-M instruction set

Cortex-M0/M1

Cortex-M3

Cortex-M4

Cortex-M4F

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Development Boards

NXP Cortex-M4 Eval board

Third Party Boards are in development

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DSP Libraries for Cortex™-M3 and M4

- A free C Library of Optimized DSP Algorithms will be available including:
  - FFT
    - Supports both 32 and 16 bit data lengths
    - Block sizes of 64, 256 and 1024
  - FIR and IIR filters
    - 16-bit single stage Biquad
    - 32-bit single stage Biquad
  - PID controller
  - Resonator function
  - Random number generator
  - Dot Product
  - Cross product of vectors
mbed success growing further!

- Already more than 10,000 boards shipped!

- More and more boards keep popping up!

- Design competition
  - Worldwide coverage
  - 5000 free boards available
  - Launched September 2010

- [http://www.circuitcellar.com/nxpmbeddesignchallenge/](http://www.circuitcellar.com/nxpmbeddesignchallenge/)
LPC17xx Application Notes

- AN10943 Decoding DTMF tones using M3 DSP library FFT function V1 with software
- AN10934 Using M3 DSP library filter functions V1 with software
- AN10918 NXP LPC Cortex-M3 IEC60335 Class B library V1 with software
- AN10917 Memory to DAC data transfers using the LPC1700's DMA V1 with software
- AN10916 FAT library EFSL and FatFs port on NXP LPC1700 V2 with software
- AN10915 Using the LPC1700 power modes V1 with software
- AN10913 DSP library for LPC1700 and LPC1300 V3 with software V2.0.0
- AN10908 Wakeup from Deep Sleep using the CANActivity interrupt V1 with software
- AN10898 BLDC motor control with LPC1700 V1 with software
- AN10878 Migrating to the LPC1700 series V1
- AN10875 IEC 60601-1-8 audible alert generator using the LPC1700 V1 with software V1.1
- AN10866 LPC1700 secondary USB bootloader V1 with software
- AN10859 LPC1700 Ethernet MII Management (MDIO) via software V1 with software
- AN10851 Using Code Read Protection in LPC1700 V1 with software
- AN10850 LPC1700 timer-triggered memory-to-GPIO data transfer V1 with software
- AN10849 LPC1700 RTC hardware auto calibration V1 with software
- AN10845 Porting uIP1.0 to LPC1700 V1 with software

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New uC/OS-III Book and Handbook Library

- Micrium has a new book on uC/OS-III with LPC1768
  - Includes a range of examples, providing a hands-on experience, and leading to a faster understanding of the concepts presented in the book
  - $60 - $90, based on quantity

- New Handbook Library on ICS website
- 31 book previews available
  - Includes Table of Contents and Introduction
  - English, Polish and Chinese books
Customer-focused passion to win

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