

The Xilinx EDK Toolset: Xilinx Platform Studio (XPS)

Building a Base System Platform

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What is Xilinx EDK?

- EDK = **E**mbded **D**evelopment **K**it.
- It is a set of tools used to build embedded processing systems.
 - i.e. Systems-On-Chip (SoCs).
 - Processors (MicroBlaze, PowerPC).
 - Interconnect (PLB, OPB, FSL, Custom, etc.).
 - Memories (BRAM, DDR).
 - Peripherals (UART, GPIO, Ethernet, Custom, etc.).
- Provides a single environment for...
 - Simulation
 - Synthesis.
 - Compilation.

How Do I Use Xilinx EDK?

- Xilinx Platform Studio (XPS) - the actual tool.
 - Design flow...
 - First, create the hardware platform.
 - Select all of the peripherals.
 - Connect all of the peripherals.
 - Second, create the software for the platform.
 - Write SW to “make things work”.
 - Iterate if needed.
 - The FPGA has a malleable fabric...
 - So both SW and HW are flexible and can be changed...
 - At “compile-time”.
 - At “run-time” (dynamic reconfiguration).

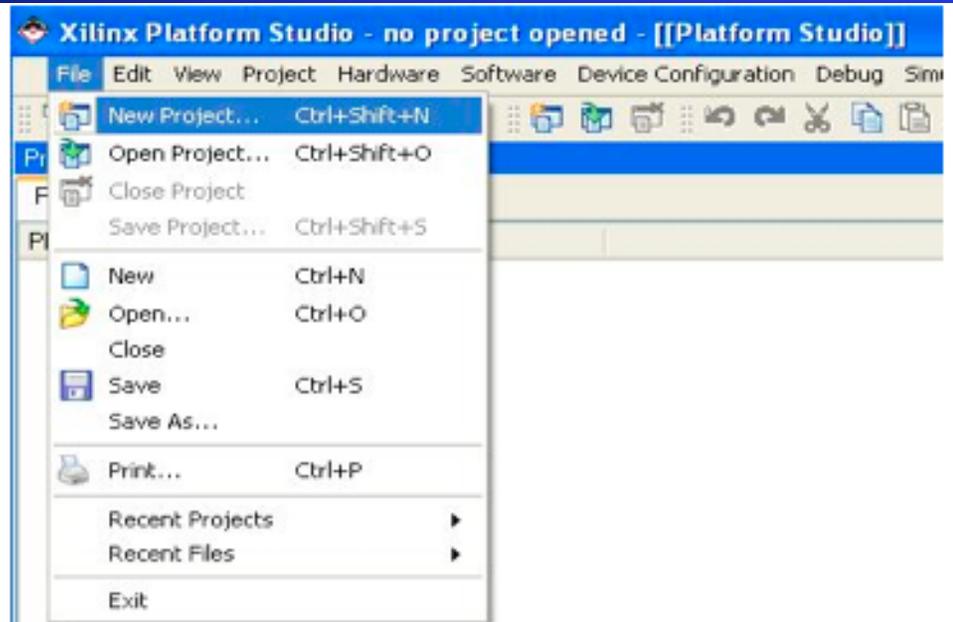
Important EDK Files

- MHS File:
 - Describes all components and connections in a system.
- MSS File:
 - Describes all SW drivers associated with components of a system.
- UCF File:
 - Describes the connections of all top-level ports.
 - All top-level ports have connections to specific physical pins on the FPGA.

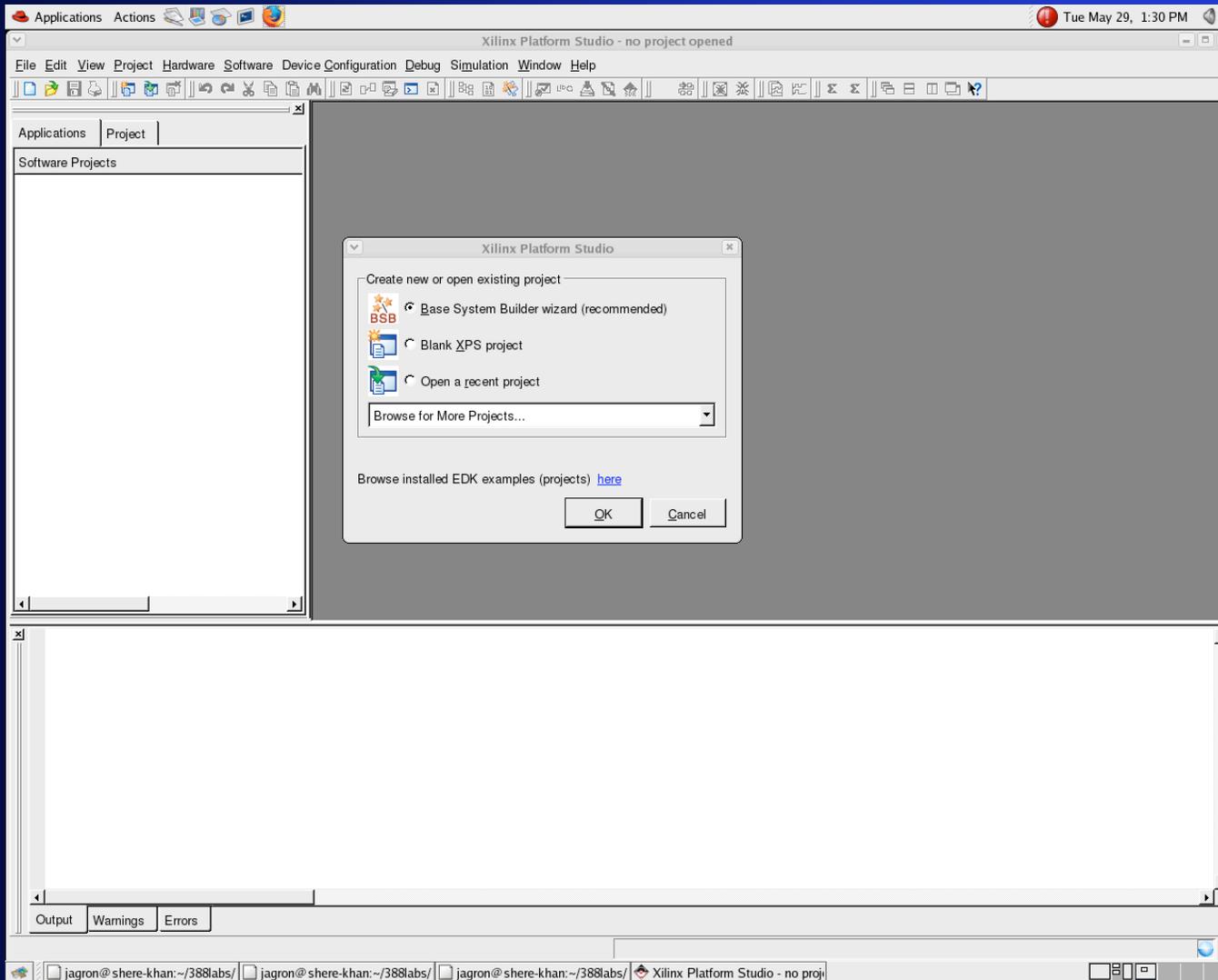
How To Get Started

- Open up XPS.
- Create a new project.
 - Select “File”, “New Project”
 - Select “Base System Builder...”
 - Provides a wizard to help get basic system established.
 - Click OK.

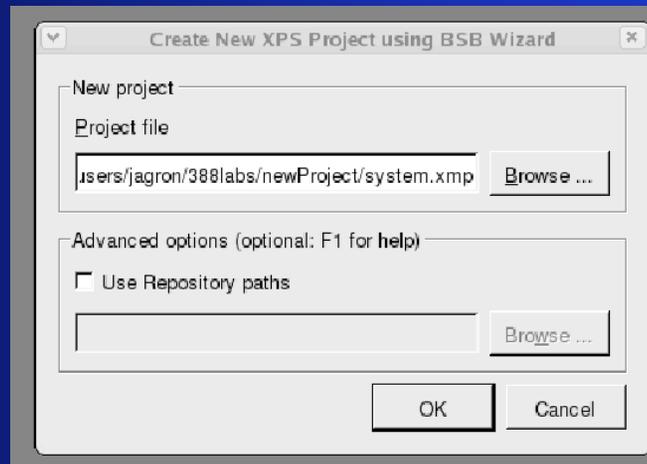
XPS - Getting Started



XPS - New Project Creation



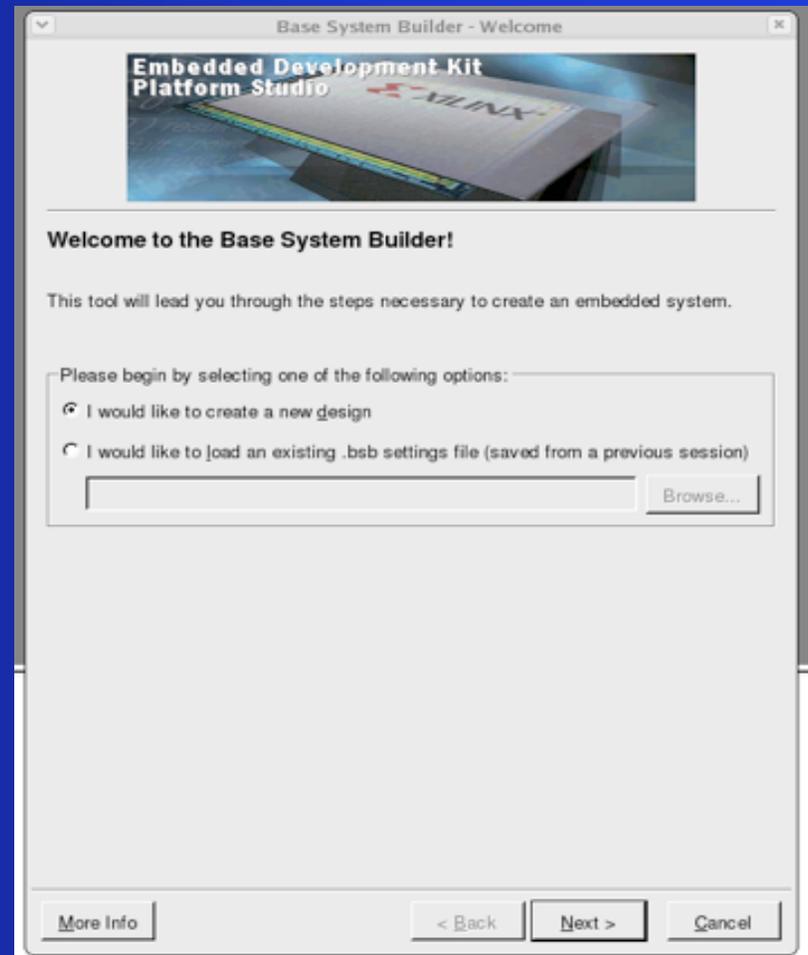
XPS - Creating The Base System



- Now, create a directory for this EDK project.
 - Saved as a .xmp file.
- **IMPORTANT NOTE!!!!**
 - Make sure that the absolute path contains no spaces!!!!

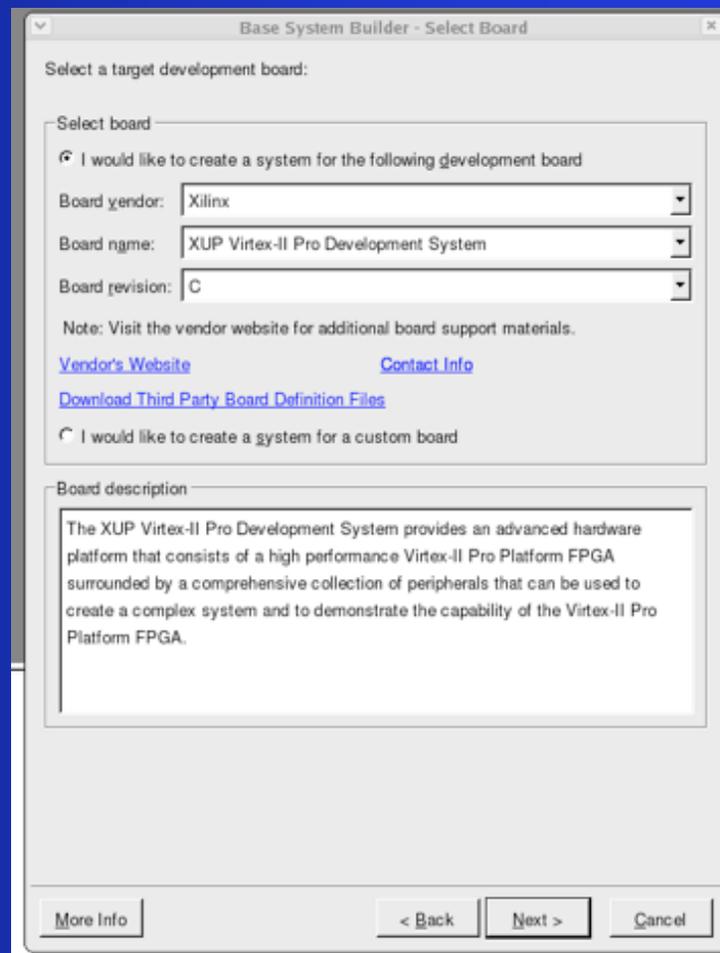
XPS - Base System Builder

- The Base System Builder window will open.
- Select “Create a New Design...”.
- Now we can select the base components of our custom SoC.



XPS - Board Selection

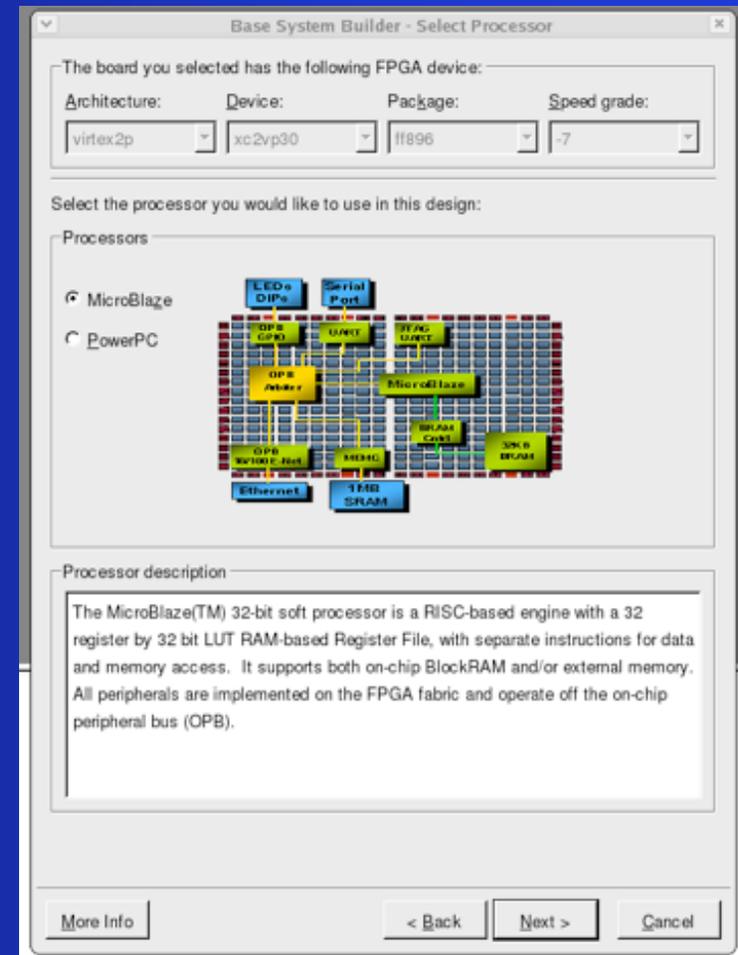
- We must select the platform we wish to use.
- In our case it is...
 - Vendor = Xilinx.
 - Board = XUP.
 - Rev # = C



The screenshot shows a dialog box titled "Base System Builder - Select Board". The main instruction is "Select a target development board:". Under the "Select board" section, the radio button "I would like to create a system for the following development board" is selected. Below this are three dropdown menus: "Board vendor" set to "Xilinx", "Board name" set to "XUP Virtex-II Pro Development System", and "Board revision" set to "C". There is a note: "Note: Visit the vendor website for additional board support materials." with three hyperlinks: "Vendor's Website", "Contact Info", and "Download Third Party Board Definition Files". The second radio button, "I would like to create a system for a custom board", is unselected. The "Board description" section contains a text box with the following text: "The XUP Virtex-II Pro Development System provides an advanced hardware platform that consists of a high performance Virtex-II Pro Platform FPGA surrounded by a comprehensive collection of peripherals that can be used to create a complex system and to demonstrate the capability of the Virtex-II Pro Platform FPGA." At the bottom, there are four buttons: "More Info", "< Back", "Next >", and "Cancel".

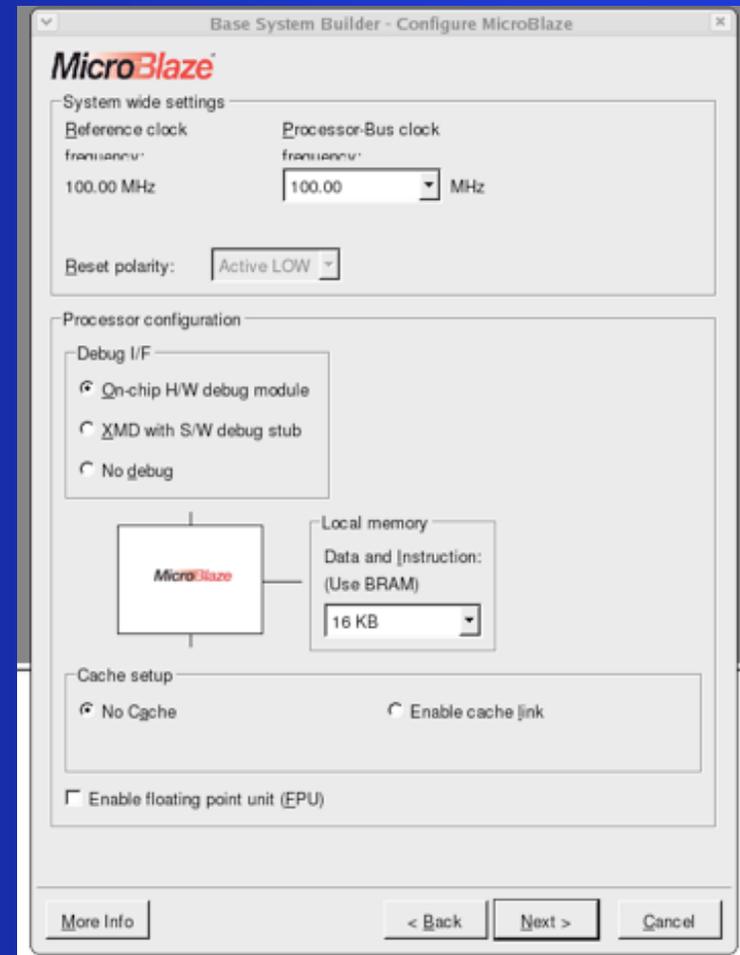
XPS - Processor Selection

- Choice as to which processor to use in our SoC.
- PowerPC:
 - PPC405 Hard Core.
 - Physical CPU embedded within FPGA fabric.
- MicroBlaze:
 - Soft core.
 - Must be synthesized (implemented using the FPGA fabric).
- We will use the MicroBlaze.



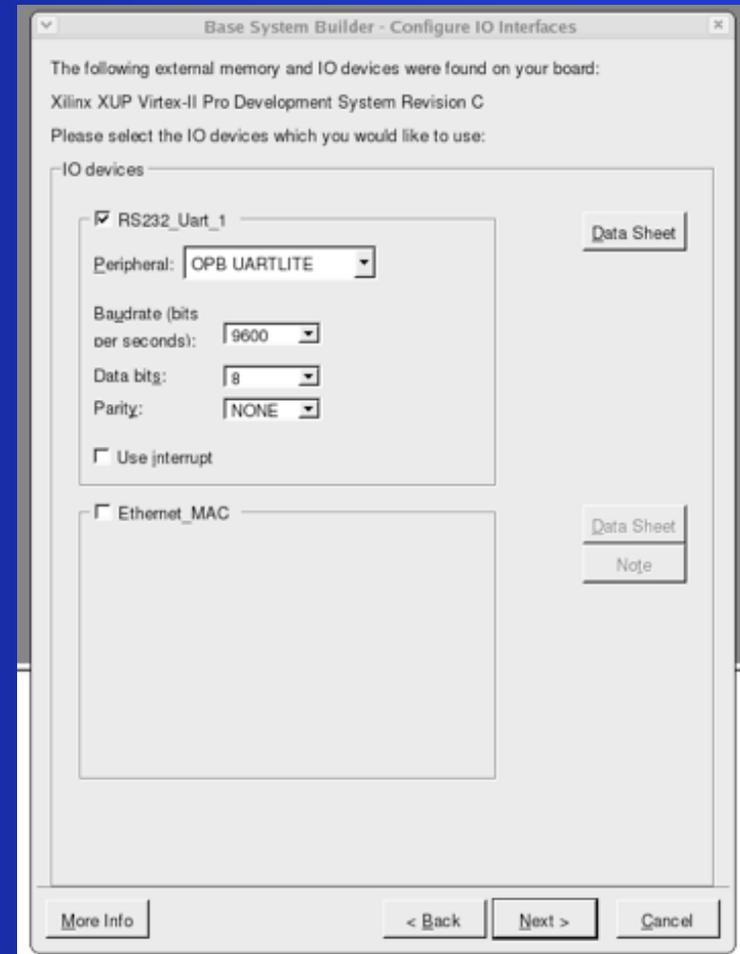
XPS - Processor Configuration

- Choose customizable CPU settings.
- In our case...
 - Bus freq. = 100 MHz.
 - Debug I/F = On-chip.
 - Local mem. = 16 KB.
 - No cache.
 - Disabled FPU.
- Simple, but highly effective.



XPS - I/O Interface Configuration

- Choose from available I/O interfaces.
- Ethernet.
 - allows boards to be networked.
- RS232 UART.
 - Serial protocol I/O for the board.
- In our case...
 - No Ethernet.
 - RS232 + UARTLite.
 - 9600 Baud. No parity
 - 8 Data bits.



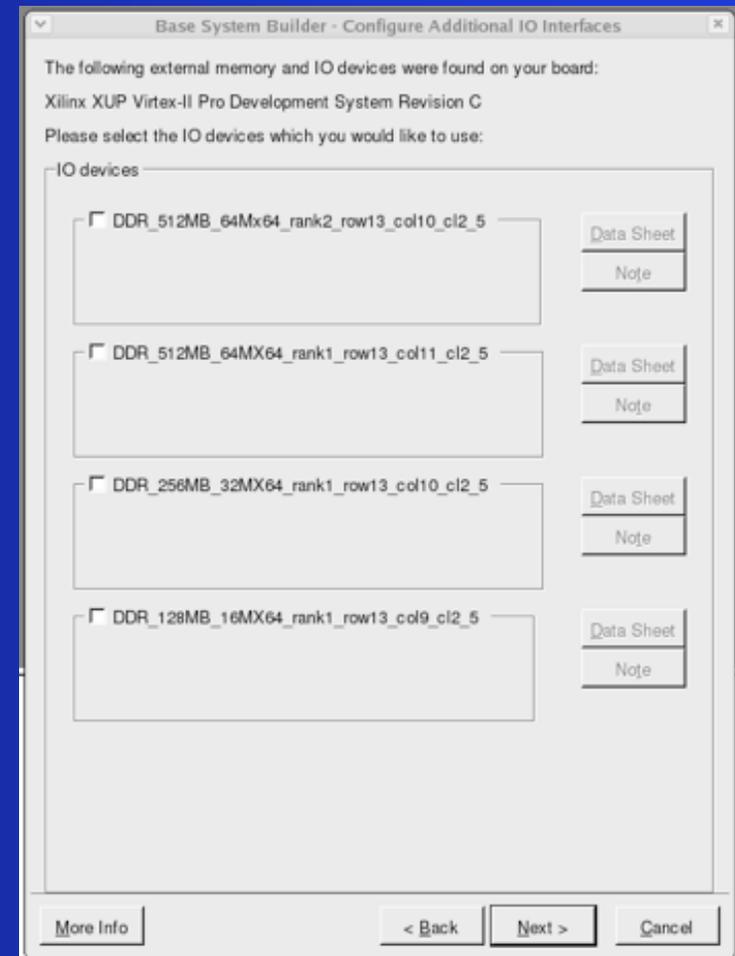
XPS - I/O Interface Configuration

- Configure additional I/O interfaces.
- SysACE.
 - Allows for file storage.
- General Purpose I/O.
 - GPIO.
 - Used for LEDs, switches, and push buttons.
- In our case...
 - Only use the GPIOs for LEDs, DIPSWs, and PushButtons (No SysACE).



XPS - I/O Interface Configuration

- Configure additional memory interfaces.
- Different types of external memory.
- Often times DDR.
 - Large amount of storage.
 - Cheap.
 - Fast.
- For this system...
 - No external memory.



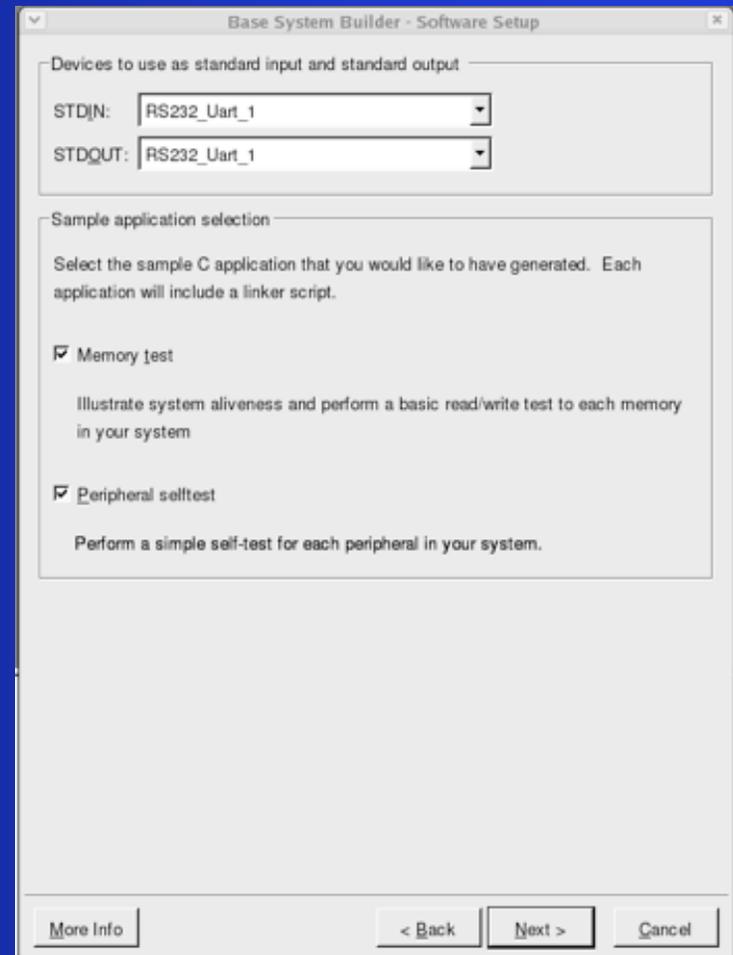
XPS - Add Internal Peripherals

- Xilinx provides a large library of peripherals:
 - I/O
 - Debug
 - Busses
 - Memory
 - Timers
 - Interrupts
 - A/D
- In our case...
 - We will add internal peripherals at a later time.



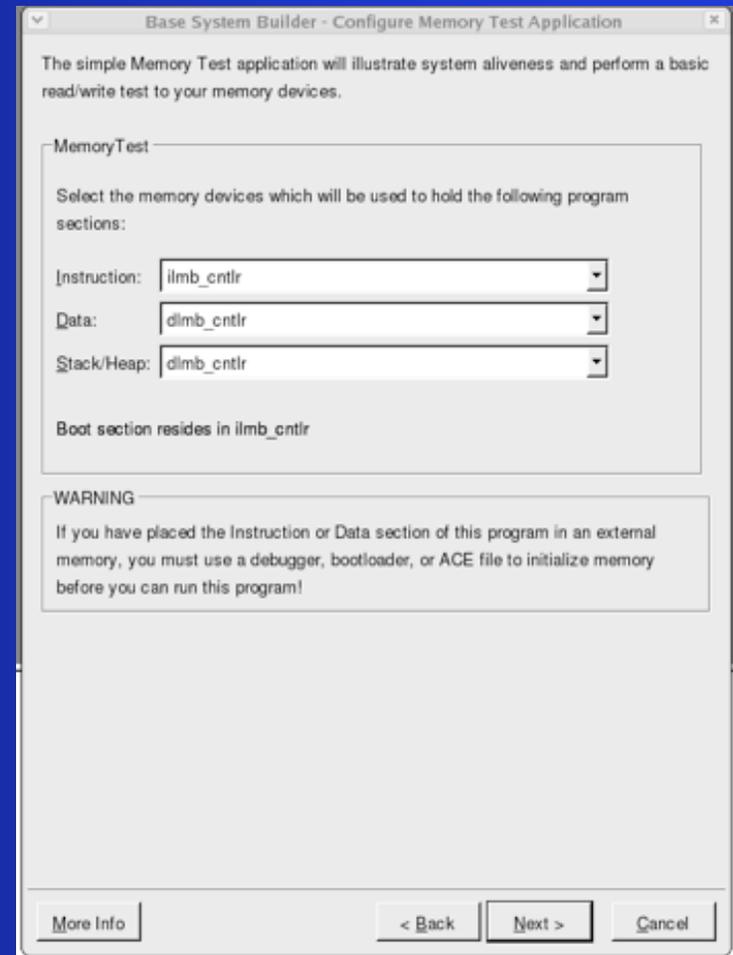
XPS - Software Setup

- Configuration of software-related properties of the system.
- I/O Configuration:
 - STDIN = UART.
 - STDOUT = UART.
- Include sample applications:
 - Memory test.
 - Peripheral self-test.
- In our case...
 - Use the defaults.



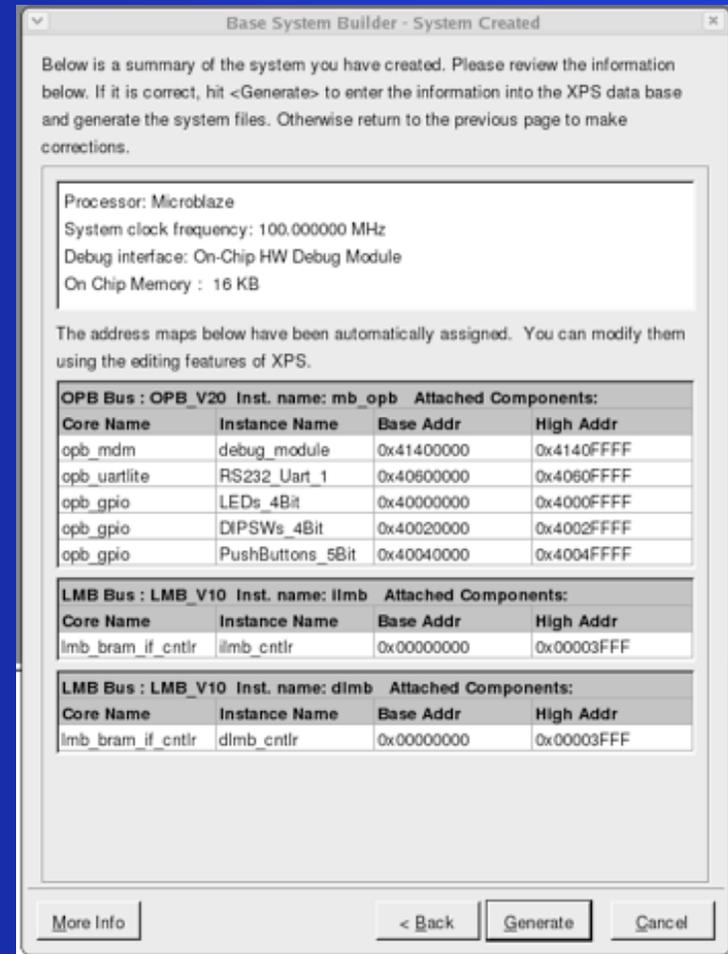
XPS - Application Configuration

- Configuration of application-related properties of the system.
- Choose where instructions and data are stored in the system.
- In our case...
 - Our system is simple a single memory for instructions and a single memory for data.
 - Use the defaults.



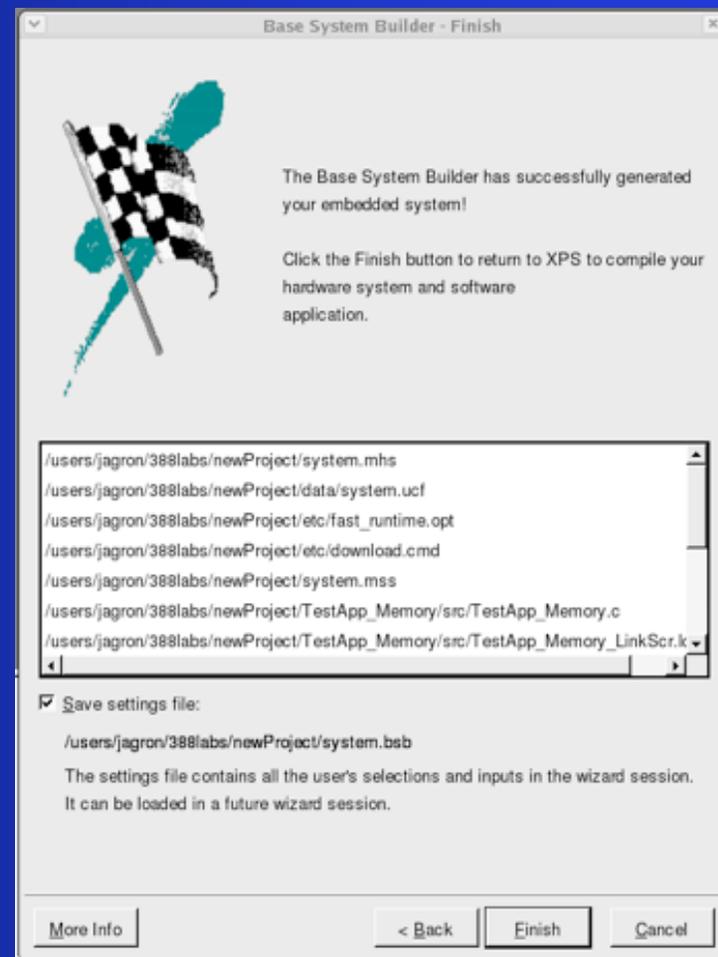
XPS - System Created

- System configuration is complete.
- Displays all of the included components and their associated address spaces.
- What are *address spaces*?
- Why is knowing the address space of a device useful?
- Click “Generate”...



XPS - BSB Complete

- Congratulations!!!!
 - You have just created a custom SoC!
- Now click on “Finish”, and you can begin...
 - Using the system.
 - Developing custom HW and SW for the system.
- BSB has just generated a .mhs file for your system.
 - A file that lists all components and how they are configured and connected.
 - This file can be translated directly to VHDL or Verilog, and synthesized to the FPGA.



XPS - Project Tab

The screenshot displays the Xilinx Platform Studio (XPS) interface in the System Assembly View. The window title is "Xilinx Platform Studio - /users/jagron/388labs/newProject/system.xmp - [System Assembly View]". The menu bar includes File, Edit, View, Project, Hardware, Software, Device Configuration, Debug, Simulation, and Window Help. The toolbar contains various icons for file operations and project management.

The left-hand pane shows the Project Files and Project Options sections:

- Project Files:**
 - MHS File: system.mhs
 - MSS File: system.mss
 - UCF File: data/system.ucf
 - iMPACT Command File: etc/download.cmd
 - Implementation Options File: etc/fast_runtime
 - Bitgen Options File: etc/bitgen.ut
- Project Options:**
 - Device: xc2vp30ff896-7
 - Netlist: TopLevel
 - Implementation: XPS
 - HDL: VHDL
 - Sim Model: BEHAVIORAL
- Reference Files:**
 - Log Files
 - Synthesis Report Files

The central diagram area shows a system assembly view with components connected by lines. The components are listed in the right-hand pane:

Name	Bus Connection	IP Type	IP Version
microblaze_0		microblaze	5.00.c
mb_opb		opb_v20	1.10.c
lmb		lmb_v10	1.00.a
dlmb		lmb_v10	1.00.a
debug_module		opb_mdm	2.00.a
dlmb_cntlr		lmb_bram_if_cntlr	2.00.a
lmb_cntlr		lmb_bram_if_cntlr	2.00.a
RS232_Uart_1		opb_uartlite	1.00.b
LEDs_4Bit		opb_gpio	3.01.b
DIPSWs_4Bit		opb_gpio	3.01.b
PushButtons_5Bit		opb_gpio	3.01.b
lmb_bram		bram_block	1.00.a
dcm_0		dcm_module	1.00.a

The bottom of the window shows the Output, Warnings, and Errors panes, which are currently empty. The taskbar at the bottom indicates the user is jagron@shere-khan and the application is Xilinx Platform Studio.

XPS - IP Catalog Tab

The screenshot displays the Xilinx Platform Studio (XPS) interface. The main window is titled "Xilinx Platform Studio - /users/jagron/388labs/newProject/system.xmp - [System Assembly View1]". The top menu bar includes "File", "Edit", "View", "Project", "Hardware", "Software", "Device Configuration", "Debug", "Simulation", "Window", and "Help". The top toolbar contains various icons for file operations and project management.

The interface is divided into several panes:

- Left Pane (IP Catalog):** Shows a tree view of IP categories. The "IP Catalog" tab is selected. The categories listed are: Analog, Bus, Bus Bridge, Clock Control, Communication High-Speed, Communication Low-Speed, DMA, Debug, FPGA Reconfiguration, General Purpose IO, Interrupt Control, Memory Block, Memory Controller, PCI, Peripheral Controller, Processor, Reset Control, and Timer.
- Center Pane (System Assembly View):** Displays a schematic diagram of the system assembly. It shows a central bus structure with various IP blocks connected to it. The blocks are color-coded and labeled with their names.
- Right Pane (Filters):** Shows a table of IP blocks with columns for Name, Bus Connection, IP Type, and IP Version. The table is filtered to show only the blocks present in the assembly view.

Name	Bus Connection	IP Type	IP Version
microblaze_0		microblaze	5.00.c
mb_opb		opb_v20	1.10.c
lmb		lmb_v10	1.00.a
dlmb		lmb_v10	1.00.a
debug_module		opb_mdm	2.00.a
dlmb_cntlr		lmb_bram_if_cntlr	2.00.a
lmb_cntlr		lmb_bram_if_cntlr	2.00.a
RS232_Uart_1		opb_uartlite	1.00.b
LEDs_4Bit		opb_gpio	3.01.b
DIPSWs_4Bit		opb_gpio	3.01.b
PushButtons_5Bit		opb_gpio	3.01.b
lmb_bram		bram_block	1.00.a
dcm_0		dcm_module	1.00.a

The bottom of the window features a status bar with tabs for "Output", "Warnings", and "Errors". The taskbar at the very bottom shows the user's name "jagron@shere-khan" and the application "Xilinx Platform Studio - /users/jagron/388la".

XPS - Applications Tab

The screenshot displays the Xilinx Platform Studio (XPS) interface in the Applications tab. The main window shows a System Assembly View with a table of components. The table has columns for Name, Bus Connection, IP Type, and IP Version. The components listed are:

Name	Bus Connection	IP Type	IP Version
microblaze_0		microblaze	5.00.c
mb_opb		opb_v20	1.10.c
lmb		lmb_v10	1.00.a
dlmb		lmb_v10	1.00.a
debug_module		opb_mdm	2.00.a
dlmb_cntlr		lmb_bram_if_cntlr	2.00.a
lmb_cntlr		lmb_bram_if_cntlr	2.00.a
RS232_Uart_1		opb_uartlite	1.00.b
LEDs_4Bit		opb_gpio	3.01.b
DIPSWs_4Bit		opb_gpio	3.01.b
PushButtons_5Bit		opb_gpio	3.01.b
lmb_bram		bram_block	1.00.a
dcm_0		dcm_module	1.00.a

The interface also shows a left-hand pane with Software Projects, including 'Project: TestApp_Memory' and 'Project: TestApp_Peripheral'. The bottom status bar indicates the user is 'jagron@shere-khan:~/388labs/basicMB' and the application is 'Xilinx Platform Studio - /users/jagron/388la'.

XPS Interface

- System Assembly View:
 - Graphical view of system.
 - Can edit configurations, port connections, bus connections, and memory spaces for all components.
- Tabs:
 - Project Tab.
 - Project info (.mhs, logs, etc.).
 - IP Catalog Tab.
 - Available peripherals that can be added to the system.
 - Application Tab.
 - Available SW projects that can be run on the system.

How To Run An Application

- Select the application of choice.
 - Compile the sources for the application.
 - Right-click and select “Build Application”.
- Execute the test on the base system platform.
 - This requires the following to be combined...
 - Hardware bitstream (.bit)
 - Software executable (.elf)
 - This is done by selecting “Device Configuration”.
 - “Update Bitstream” - combines HW/SW (.bit + .elf).
 - “Download Bitstream” - downloads the configuration to the board.
 - Over the USB-based JTAG connection.

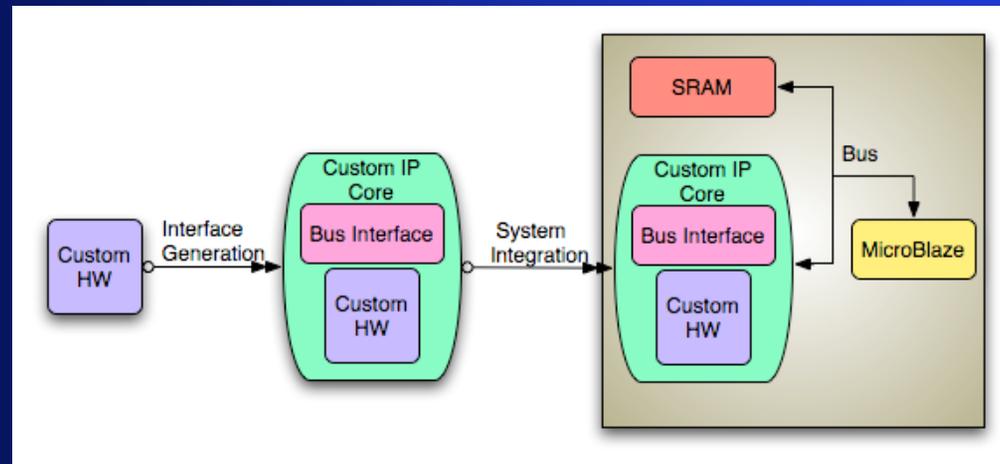
Monitoring Software Execution On The FPGA

- How do you see what is happening on the FPGA?
 - Normally in software you use print() statements.
 - The output goes to the screen.
- In this system, STDIN/STDOUT are routed to the serial port.
 - We must monitor the serial port from an external host to see what is happening.
- In order to “see” what is executing...
 - Open up a terminal windows.
 - Minicom (Linux) or Hyperterminal (Windows).
 - Setup the correct communication parameters
 - Baud rate = 9600.

Creating New SW Applications

- Select “Software”...
 - Click on “Add Software Application Project”.
- Enter the new project name.
 - Also choose which CPU to run the application on.
- Now a new application tab entry will appear.
 - You can now add/edit sources for this application.
- In order to run this new application...
 - Right-click on it.
 - Select “Mark to initialize BRAMs”.
 - Instructs the tool that this application is to be “combined” with the bitstream.
 - Now, when updating the bitstream, this application will be used.

Integration of IP Cores



- EDK allows one to add IP cores to a system.
 - Pre-built cores from Xilinx.
 - Custom cores.
- Additionally, there is a Create/Import Core Wizard that...
 - Allows one to quickly create bus interfaces for custom IP cores.
 - PLB, OPB, FSL interfaces.
 - Imports cores into an EDK repository.
 - So that the IP cores can be added into a system.

How to Create/Import Cores

- Select “Hardware”...
 - Click on “Create/Import Peripheral”.
- Creating a new peripheral...
 - Peripheral name.
 - Bus interface type (PLB, OPB, FSL).
 - Interface features:
 - Master/Slave.
 - Interrupts and Resets.
 - Registers.
 - Accessible Signals.
- Importing a peripheral...
 - Not recommended, much easier to do via cut/copy from the command line.

Initial Assignment

- Create a new SW project...
 - Make it do the following...
 - Print “Hello <yourName>!”
- Run the SW on the board and demonstrate that it works correctly.
- This may not seem like much, but...
 - You just created a SoC (System-On-Chip).
 - You just cross-compiled a program to run on “bare-metal” (no OS).

Questions

- 1) What is an FPGA?
- 2) What is an SoC? Why is it different from your desktop computer system?
- 3) What does soft-core IP mean?
- 4) What is an MHS, MSS, and UCF file?
- 5) What does cross-compile mean?
- 6) Why does it take so long to build the HW portion of your system?
- 7) How does the desktop computer program the FPGA, how does it monitor the FPGA?