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Workshop Embedded systems

Linux Debug a New Paradigm

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Sept. 30 2005

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Embedded Linux

Hardware-Assisted Debugging Tools for Kernel, Process and Application Debug

- ARM Processors -

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Why Hardware-Assist ?

- Stable platform is NOT required
- Non-Intrusive, Real-Time Code Execution
- Does not Lose Context after System Reset
- Complete System Visibility to all ASIC or ASSP devices / registers

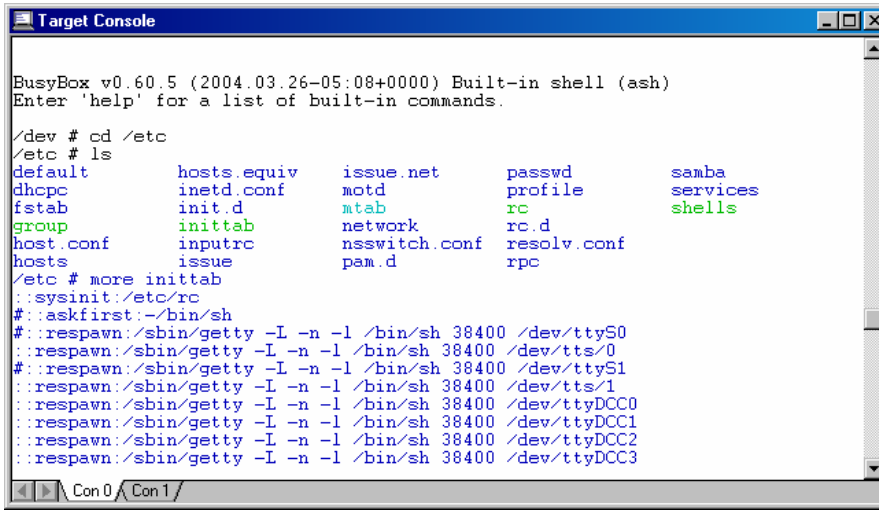
A new model for Linux debug

- **Virtual communication port via DCC**
  - Including Linux Console redirection
- **Source-level kernel debug**
- **Process Resource Lists**
- **Application Debugging**
- **All from within the same debugger**

Virtual Communication Port

- **Debug Communications Channel (DCC)**
  - Contained in the EmbeddedICE logic (CP14 register)
  - Allows target software to communicate with emulator / debugger
  - 32-bit data read register, 32-bit data write register
  - 6-bit communication control register for handshaking
  - XScale also uses this for debug message handling

- **Linux DCC driver**
  - Implements multiple tty devices in Linux OS
  - Typically built in with kernel code
  - Eliminates need for other communications ports (e.g. serial, TCP/IP, USB)



Linux Console output via JTAG

- **Output starts at boot**
- **No need to wait for initialization of peripheral communication**
- **All Linux command line messages and functionality available**

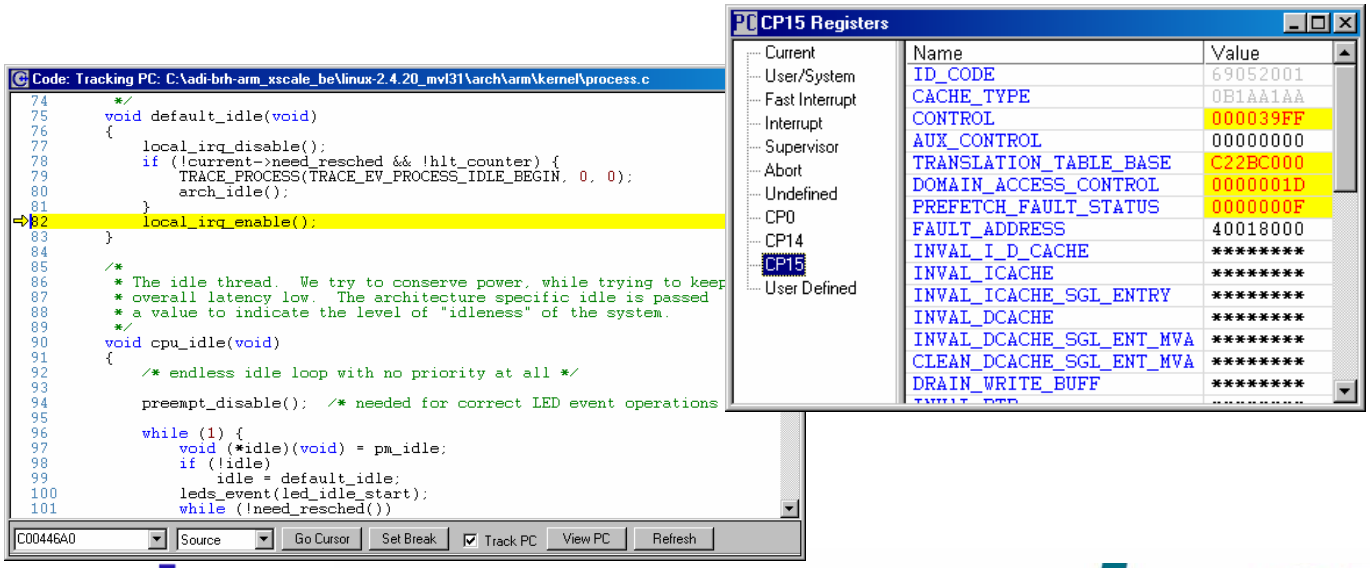
Target Console

```
Linux version 2.4.20_mvl31-brh (johno@AAIP061) (gcc version 3.3.1 (MontaVista
3.1-3.0.10.0300532 2003-12-23)) #14 Tue May 18 17:04:04 PDT 2004
CPU: XScale-80200 [69052001] revision 1 (ARMv5TE)
CPU: D undefined 5 cache
CPU: I cache: 32768 bytes, associativity 32, 32 byte lines, 32 sets
CPU: D cache: 32768 bytes, associativity 32, 32 byte lines, 32 sets
Machine: ADI BRH
On node 0 totalpages: 32768
zone(0): 32768 pages.
zone(1): 0 pages.
zone(2): 0 pages.
Kernel command line: root=/dev/ram initrd=0xc2000000,4000K
Calibrating delay loop... 104.65 BogoMIPS
Memory: 128MB = 128MB total
Memory: 123836KB available (1242K code, 315K data, 228K init)
XScale Cache/TLB Locking Copyright(c) 2001 MontaVista Software, Inc.
XScale cache_lock_init called
   Calling consistent alloc
   low_level_page initialized
   low_level_page @ 0xc8800000
      icache_lock_fn @ 0xc8800080
      dcache_lock_fn @ 0xc88000a0
      icache_unlock_fn @ 0xc8800098
      dcache_unlock_fn @ 0xc88000f0
Initializing TLB locking
TLB locking initialized
Dentry cache hash table entries: 16384 (order: 5, 131072 bytes)
```

Con 0 | Con 1

Source-Level Kernel Debug

- Use JTAG connection for communications
- Direct connect to processor core
- “Halt Mode” debug
- Static view of processor and code
- Tool facility to program flash with kernel boot code and root file system



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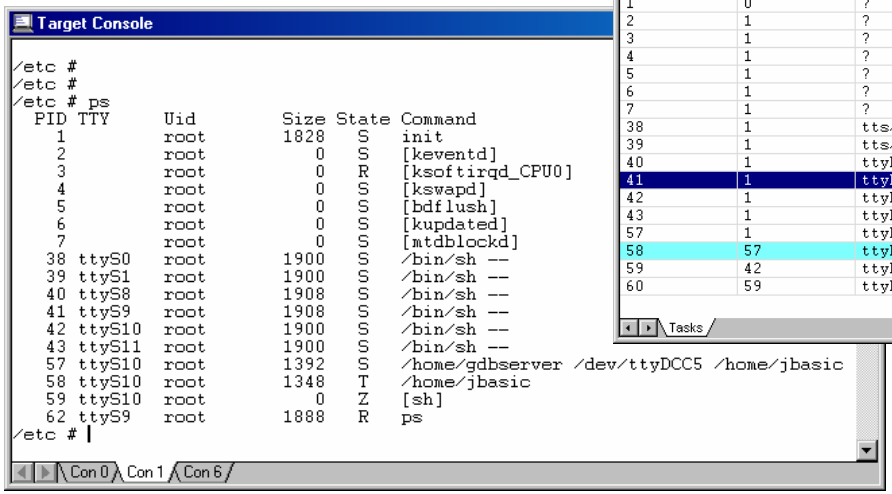
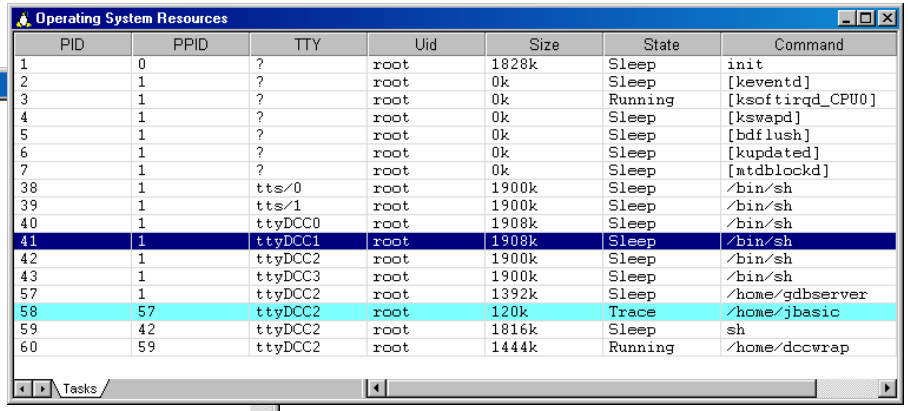
Application Debug

- **Linux applications are all mapped to the same address space**
- **Breakpoints can be set on dynamically located tasks**
- **"Run Mode" or "Task Mode" Debug**
  - Breakpoints stops the task, not the processor
- **Drill down from application level through the kernel to the board support package**
  - Combine Run mode with Halt mode debug

Linux Process/Application Representation

- Tasks are shown in Operating systems Resources
- Identical to “ps” output
- Attach / debug a running process
- Start and debug a new process
- Debug multiple applications simultaneously





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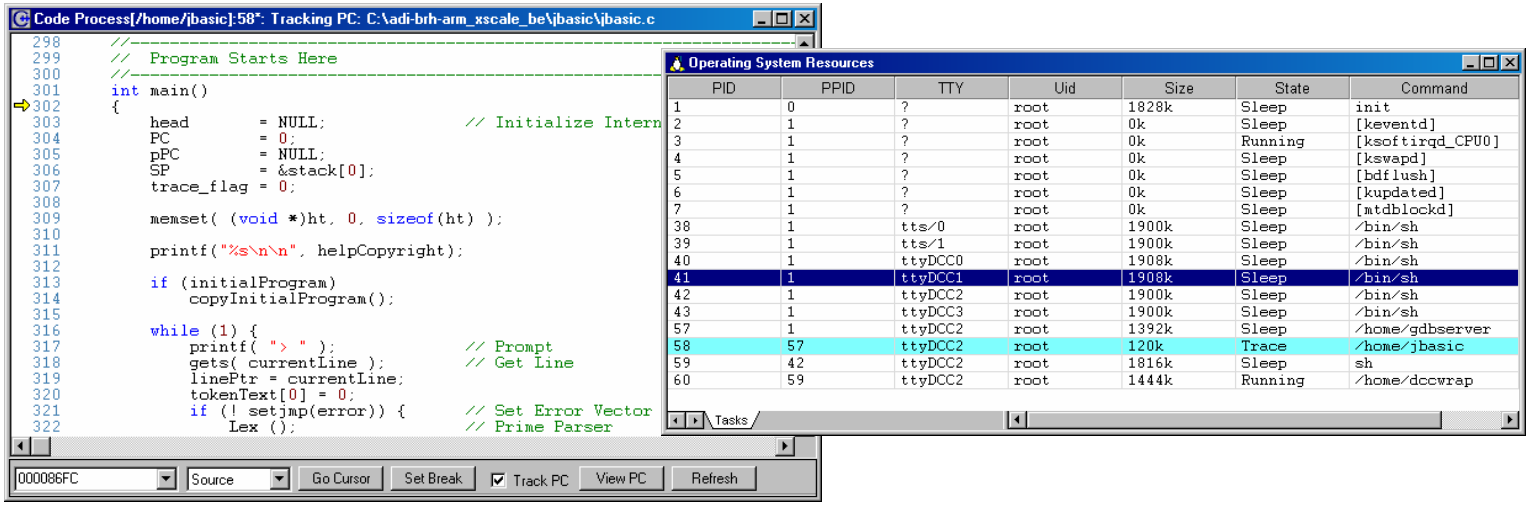
Linux Process Debugging

- Step through / set breakpoints in application code, kernel keeps running
- Examine / modify memory and process(or) registers
- Examine / modify application variables (global/local/stack)
- Full control of application code
- Highlighted Task List as the Focus Context
- Seamless transition in and out of kernel and process debug



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Practical use cases

- **"Headless" embedded systems**
  - no CRT, serial, ethernet or other console port available
    - DCC redirects console port over JTAG
- **No-stop debugging**
  - It is technically impossible or not desired to STOP the processor
    - Stop only the process you are debugging, keep your system running
- **Concurrent debug of kernel, processes and applications**
  - While debugging the application, you encounter a problem at the kernel
    - step down to kernel using the same debugger and session
- **Linux as development system**
  - Develop and debug your application from a linux host
    - Linux native version of the debugger available
- **Basically:**
  - Any Linux project on ARM / Xscale

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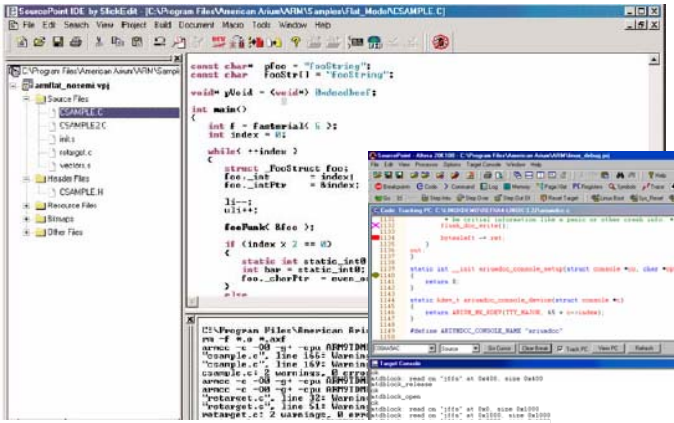
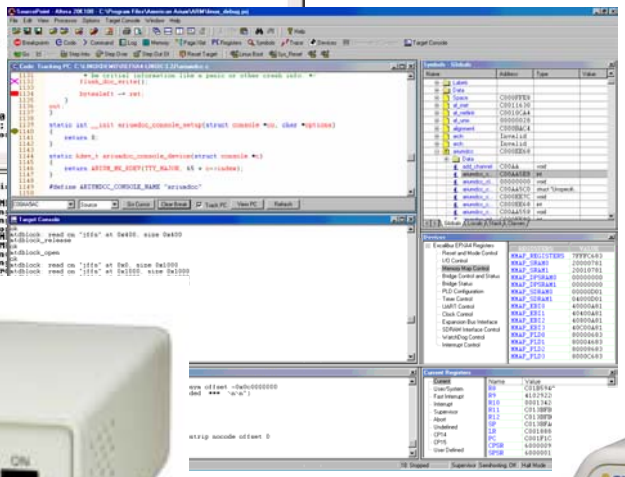
Products

IDE



Multi Core Source Level Debugger



Emulator with JTAG Run Control Features

Emulators with JTAG and ETM Trace features

Development Boards and Kits

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