Abstract

Obsolescence affects all systems, today's bleeding edge technology will soon be a component of a legacy system. Whether legacy is a positive or pejorative term is of course a topic of current debate. The positive perspective of legacy systems is that they have real value in that they are validated and work, possess an implicit specification endorsed by their user community, provide a basis for incremental enhancement, and have well defined costs. The pejorative perspective perceives legacy systems as comprising ageing components with high support costs, which are based on arcane technologies and methodologies, supported by a dwindling band of high priests, and possessing the capability to undermine the mission at any time. Implicit in these perspectives are the evolutionary and big bang theories of system evolution. A balanced view is of course more nuanced: sometimes the system's match to mission needs provides an unequivocal answer, perhaps technology refresh is required to address supportability issues, alternatively perhaps reverse engineering and skilled documentation would enable effective maintenance, and of course proven software is worth much more than an executable requirements specification.

The presentation will review contemporary perspectives on obsolescence management and legacy systems. Using the re-implementation of a classic 1960's minicomputer on an FPGA as an exemplar, the implementation of powerful HCI capabilities on a host PC and the negligible infrastructure required to realise them will be described and demonstrated. Specifically, a diskless Digital PDP 8/E will be demonstrated as a system on a chip with a PC hosting a superset of the original blinkenlites and switches console.

Obsolescence / PDP−8 on an FPGA

- Obsolescence
  - Functional
  - Logistical
  - Social
  - Hardware
  - Software
- PDP-8 on an FPGA
  - Enabling technologies : FPGA, VHDL & VITAL, JTAG
  - Infrastructure; Architecture; User interfaces
- Conclusions
  - Where there's a will there's a way
  - PDP−8 on an FPGA
  - Emeritus Solutions' offerings

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DEC PDP−8/I : 1968 .. 1971

Photo © David Gesswein - www.pdp8.net

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Obsolescence : A Taxonomy

- Functional
  - It doesn't do what's required; It's time to move on
- Logistical
  - Can't buy the license; Downgrading licenses; A COTS issue
  - Dependence on 3rd party IP or knowledge; Can't access the IP
- Social
  - When people's knowledge lags technology
- Hardware
  - Components : The march of time, RoHS, …
  - PCAs : Lost the Gerbers, Incompatible components, …
- Software
  - Development strategy : Evolution or Big Bang ?
  - Legacy Systems; Incremental Change
  - Code Decay; Software Aging; Design for Maintenance

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BR Standard Class 5 73096 : Built 1955

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Is it Obsolete

- Steam Railway Locomotive
- Military Aircraft
  - B-52 : Dev 1946, IOC 1955, EOL 2040+ (94+ years)
  - K-135 : Dev 1954, IOC 1957, EOL 2040+ (86+ years)
  - C-130 : Dev 1951, IOC 1957, EOL 2030+ (79+ years)
  - F-15 : Dev 1969, IOC 1973, EOL 2021+ (51+ years)
- Sea Going Paddle Steamer
- HP Calculator
- DEC PDP−8 Mini Computer
- Xilinx Spartan 3 FPGA, x86, PPC AltiVec, …
- SCSI bus, GPIB bus, PCI, CAN bus, USB, …
- Your System

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PS Waverley : Built 1947

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HP Calculators : 1970's, 1980's, 1990's

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Obsolescence : Management Strategies

- Replace the (sub-)system
  - Big Bang approach – "Start with the Use Cases"
- Re-Implement or Emulate the (sub-)system
  - Evolutionary approach – "Ain't broke don't fix it"
  - Leverage from system knowledge and code base
  - Selecting the interfaces & scope of the re-implementation
    - External, standardised interfaces
    - Internal, proprietary interfaces
- Replace the defective entity
- Replace the failed component

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Hardware Obsolescence

- Silicon Chip Introduction Rate
  - (32 bit) processors : ~2years
  - FPGA : ~2 years (high and low end products in alternate years)
  - DSP : ~3 years
  - Memory : ~ 9 months
  - Logic, buffers : ~6 years
  - Linear, interface : ~8 years
- Obsolescence Mitigations
  - Life time buy
  - Component substitution
  - Aftermarket, component recovery, stores robbery, …
  - Re-design : “we have the VHDL source”

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Software Obsolescence : I

- “Legacy System” - Positive or Pejorative ?
  - Positive attributes
    - + is validated, works and is of real value to users
    - + possesses an implicit specification endorsed by users
    - + provides a basis for incremental enhancement
    - + has well defined costs
  - Pejorative attributes
    - − comprises aging components with high support costs
    - − is based on arcane technologies and methodologies
    - − is supported by a dwindling band of high priests
    - − is likely to prejudice mission success

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Software Obsolescence : II

- The Balanced View of “Legacy Systems” is more nuanced
  - does the system match mission needs ?
    - unequivocal answer ?
  - does the system have supportability problems ?
    - technology refresh ?
  - is maintenance ineffective ?
    - remediation of code and interfaces ?
    - reverse engineering and skilled documentation ?
  - values a proven system over a requirements specification

Software Obsolescence : In a Nutshell

- Code Decay / Software Aging
  - Comprehension (or software understanding) is critical
  - Collateral damage occurs during maintenance
  - Design for change and accrue long term savings
- Software Engineering Focus
  - First (next) Release or Long Term Health ?
- System Development
  - by Evolution
  - or Big Bang
- Incremental Change
  - Increasingly replaces the Waterfall Model paradigm
  - The Waterfall Model remains the normative methodology ?

PDP−8 on an FPGA : Old System, New Hardware

- Baseline : PDP−8/E
  - Mature family member with comprehensive functionality
  - Quality of (user) documentation is fair
  - Excellent (paper tape) diagnostics and exercisers
- Re-implementation
  - PDP−8/E logic embedded in Xilinx Spartan 3 FPGA
  - Blinkenlites console, virtual peripherals on PC
  - Physical peripherals, LED and switches console on FPGA PEC
  - All communication between PC and FPGA over JTAG
- Proofs of concept
  - JTAG provides an inexpensive customisable interface to FPGAs
  - VHDL, OVL for ABV, VITAL, ModelSim, Xilinx ISE work well
  - Verification by running the PDP−8/E paper tape diagnostics

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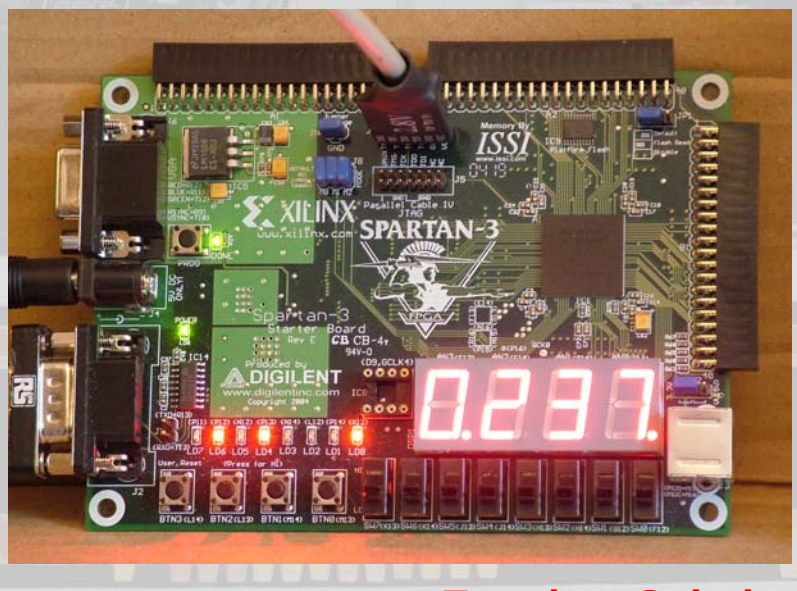
Xilinx Spartan 3



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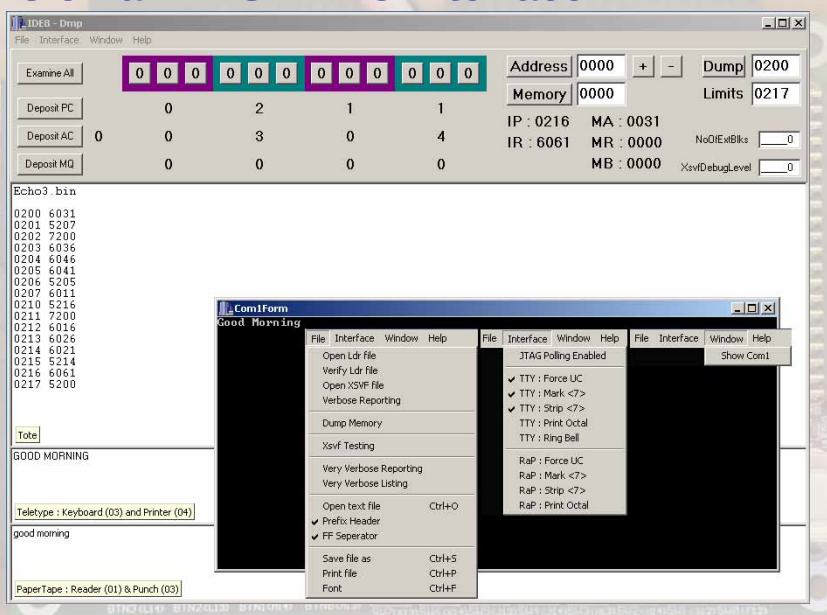
PDP−8 on an FPGA : PC Interface



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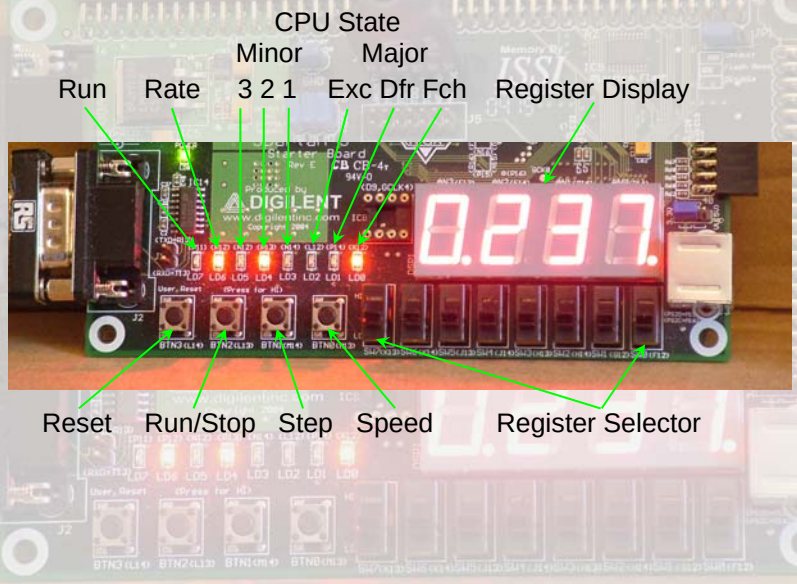
PDP−8 on an FPGA : Hardware Interface



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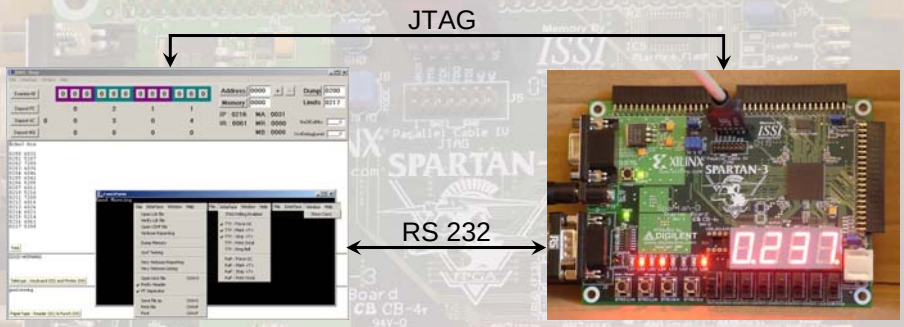
PDP8 on an FPGA : System Design



IDE running on Windows PC

- Paper Tapes and binary images
- Assembler, compilers, IDE

PDP8 running on FPGA

- Legacy code
- System on a chip ?

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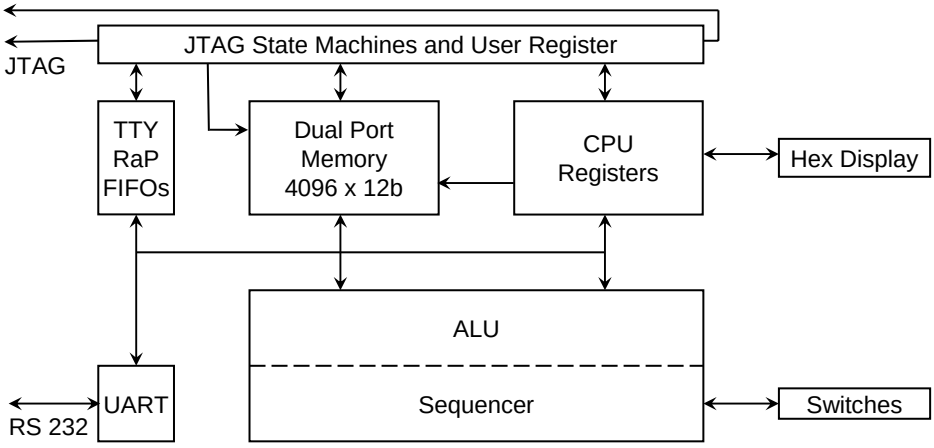
PDP8 on an FPGA : FPGA Logic



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Conclusions

- Where there's a will there's a way
  - Hardware obsolescence is the easy problem
  - Software obsolescence blurs with legacy system management
  - Incremental change eliminates software obsolescence ?
  - But, there is no free lunch : system's have to be maintained
- PDP−8 on an FPGA
  - Affordable reimplementation of a complex sub-system
  - Demonstrates powerful verification, diagnostic and HCI options
- Emeritus Solutions' Offerings
  - Technical Consultancy
  - System Development and Verification
  - Addressing your (obsolescence) problems

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