Netherlands OpenVMS Technical Update

Migrating to Integrity

Colin Butcher

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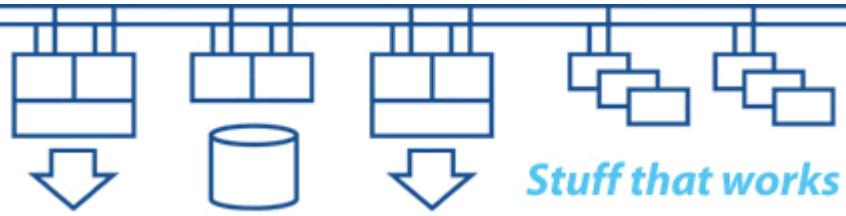

Topics

- Naming conventions
- Hardware platforms
- Console subsystems
- Blade systems
- Overall system design issues
- Software design and implementation issues
- Emulation and Binary Translation
- Migration and Porting guidelines

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OpenVMS and hardware naming

VAX and Alpha are used interchangeably to refer to system architectures (the instruction set), CPU / microprocessor implementations (eg: nVAX, EV7) and complete system platforms (eg: VAX 7000, AlphaServer GS1280):

- **VAX VMS was used up to V5.5-2H4**
- **OpenVMS VAX and OpenVMS Alpha are used from V6.0 onwards with the introduction of Alpha**

Intel implementations are different:

- **Itanium Architecture is the system architecture**
- **Itanium is the Intel microprocessor family (hence IPF)**
- **Integrity Server is the HP platform**
- **OpenVMS for AlphaServers and Integrity Servers is the HP operating system name**

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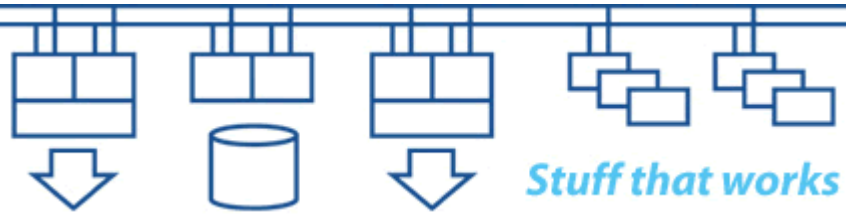

Hardware summary – Integrity (1)

- 64bit EPIC. Designed when memory is plentiful and cheap
- Itanium Processor Family architecture relies on compiler output to generate an efficient instruction and data flow through the CPU
- Instructions are packaged in “bundles” of up to three instructions per bundle – which are then processed entirely in parallel
- Needs synchronisation and serialisation issues to be carefully considered and coded
- Data alignment is important
- Floating point is IEEE format by default

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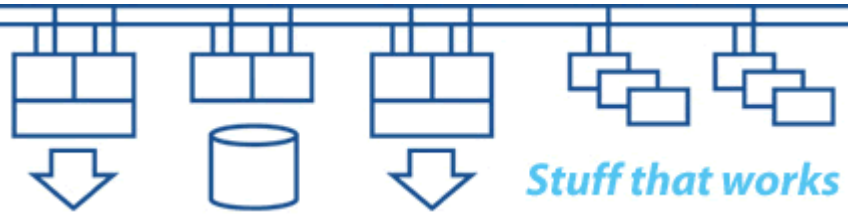

Hardware summary – Integrity (2)

- No “VAX like” or “Alpha like” console
- Has multiple consoles:
  - Management Processor (MP) and Baseboard (BMC)
  - Serial and Web (ILO) interfaces
  - Both attempt to be consistent across the entire range (only real difference is partitioned systems)
- Uses Extensible Firmware Interface (EFI) rather than BIOS
- PCI bus based (3.3volt only)
- PCI Express devices
- SAS (Serial Attached SCSI) devices
- Multi-core processors and HyperThreading

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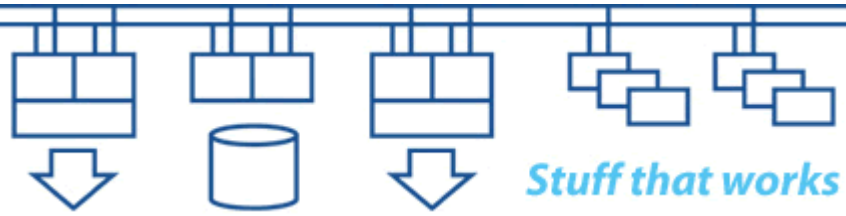

CPUs, Cores and Sockets

- What is Partitioning?
- What is a Cell?
- What is a Socket?
- What is a Core?
- What is HyperThreading?

- What does the operating system see?
- What are the performance implications?
- How is it licensed?

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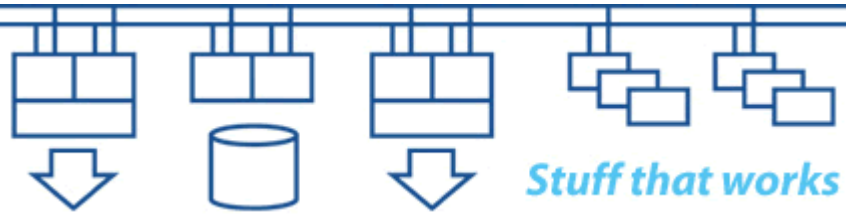

Memory subsystem

- **Used to be small, slow and expensive, so tried hard to minimise memory usage**
- **Now plentiful, fast and relatively cheap**
- **Can use memory to gain performance**
- **Caches and synchronisation**
- **Error detection and correction**
- **“Locality” to CPUs**
- **Memory interconnects to CPUs**

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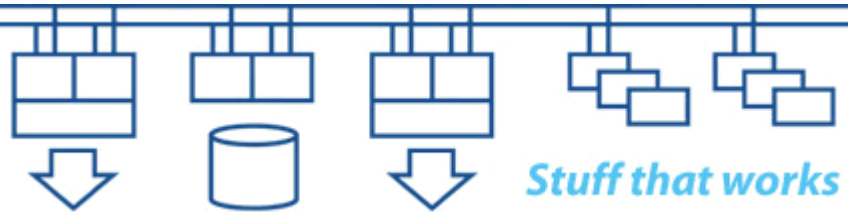

IO (Input / Output) subsystem

- **Provides interface with outside world (physical, electrical, logical …)**
- **Connects to storage subsystems**
- **Access times (memory, cache etc.)**
- **“Locality” to CPUs**
- **IO devices operation (interrupts, registers)**
- **IO interconnects to CPU and memory subsystems**
- **Disc subsystems (e.g.: EVA) depend on bandwidth in the fibrechannel path**

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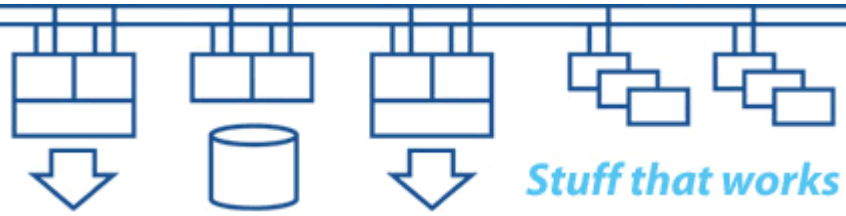

MP console – Integrity

- **MP serial console for "Management Processor"**
  - **Runs with base box level power, even with system off**
  - **Local, remote (modem) and network connectivity**
  - **Console configuration (terminal type, etc.)**
  - **<ctrl-H>, <ctrl-B>**
  - **Network configuration (hostname, IP address, etc.)**
  - **Multiple console sessions (one writer, many readers)**
  - **Provides ability to copy files over network with TFTP (firmware updates etc.)**
  - **Access to local USB devices for firmware updates**

Note: Set your terminal emulator up for delete / <ctrl-H> in VT100+ mode

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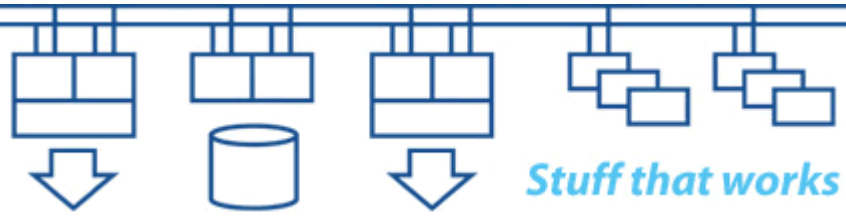

MP ILO (web) console interface

- **MP ILO (web) console for "Management Processor"**
  - **Runs with base box level power, even with system off**
  - **Access MP through web browser**
  - **Private MP LAN connection**
  - **Initial configuration of MP LAN via MP serial console ("LC" and "LS" commands at "CM" level)**
  - **VT terminal emulation**
  - **Redirects from HTTP to HTTPS**
  - **Currently not remotely accessible through a NAT firewall / router**

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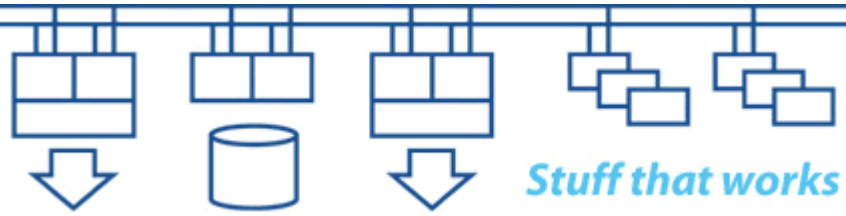

EFI – Integrity

- **EFI (extensible firmware interface):**
  - **Mini operating system**
  - **FAT formatted file system for EFI scripts and other files (eg: firmware updates)**
  - **OpenVMS currently presents a FAT16 partition to EFI**
  - **Boot menu and defaults**
  - **Environment variables are sticky (VMS_FLAGS etc.)**
  - **VMS_SHOW.EFI – shows device names in VMS format**
  - **VMS_LOADER.EFI - finds and loads IPB.EXE**
  - **Data passed to boot loader, eg: efi> vms_loader –fl 0,0**
  - **BOOT_OPTIONS.COM for FibreChannel devices on OpenVMS installation DVD**
- **IPB.EXE (boot loader) understands the OpenVMS file structure, EFI does not**

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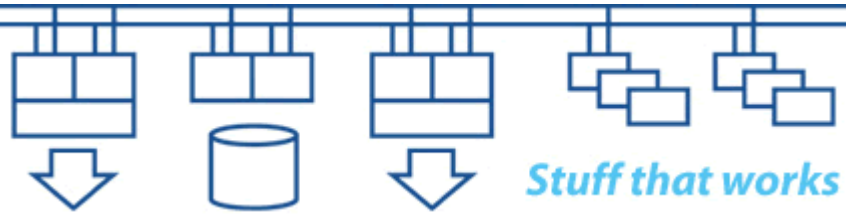

Boot process - Integrity

- EFI boot loader from FAT partition (hidden as a container file in the system disc file structure)
- Boot flags passed through environment variables
- Reads executive into memory
- Reads system parameters (SYSBOOT> if flags set) and initialises fixed data structures
- Passes control to executive
- Structures created with SET BOOTBLOCK command
- 2048 byte boot block for IDE/ATAPI optical media
- 512 byte boot block for SCSI optical media

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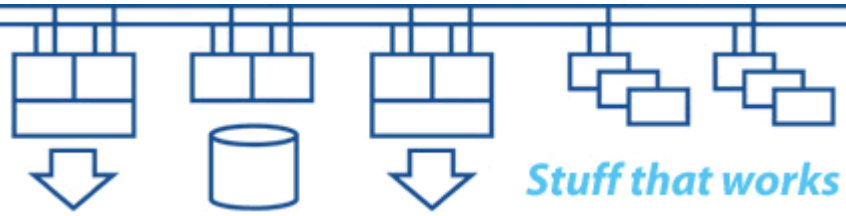

Device detection - Integrity

- **Itanium Processor Family architecture uses ACPI (Advanced Configuration and Power Interface) for device detection by firmware**
- **SYSMAN IO AUTO queries ACPI data to find devices and set up OpenVMS device drivers to communicate with the hardware**
- **Devices appear as a set of CSRs (Control and Status Registers) in physical memory - the IO space**
- **Devices have Interrupt Vectors which connect a device interrupt request to the device driver Interrupt Service Routine**

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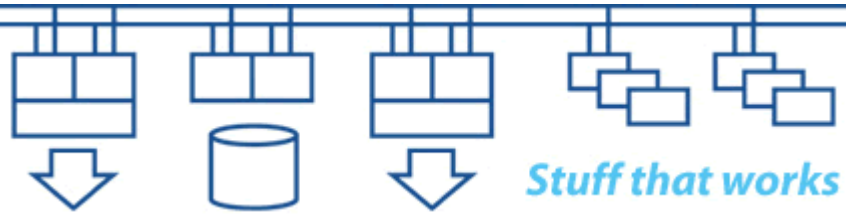

Blade systems - Integrity

- **Think DEChub900 for systems!**

- **Common chassis / backplane / power / cooling etc.**
- **Modular components for processors, storage and network switching**
- **Virtual interconnects capable of re-assignment**

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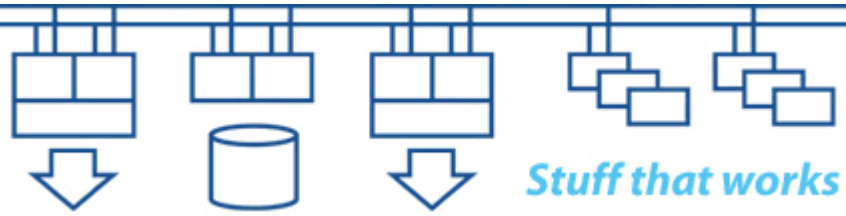

Current system classes - Integrity

- **“low end” DS15/25 equivalents e.g.: rx2660/rx3660**
- **“mid-range” GS80/ES47 equivalents: e.g.: rx6600/rx7640**
- **“high-end” GS1280 equivalents: e.g.: rx8640/SuperDome**

- **“blades” OpenVMS on the c-class (BL860C)**

- **Consistent console interface across all platforms (except no partitioning on low-end systems)**

- **See www.hp.com/go/integrity**

- **See Golden Eggs at http://goldeneggs.spyderbyte.com by Matti Patari**

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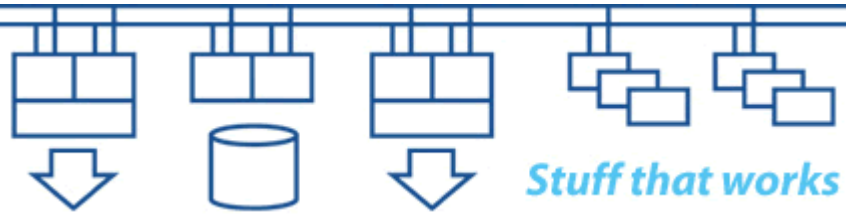

Software implementation issues

- Compilers are the key to performance
- Exception handling (LIB$SIGNAL etc.)
- Data alignment (unexpected alignment faults)
- Floating Point format (IEEE by default)
- Implicit assumptions
- Debugging
- ELF & DWARF formats
- Integrity calling standard and register usage

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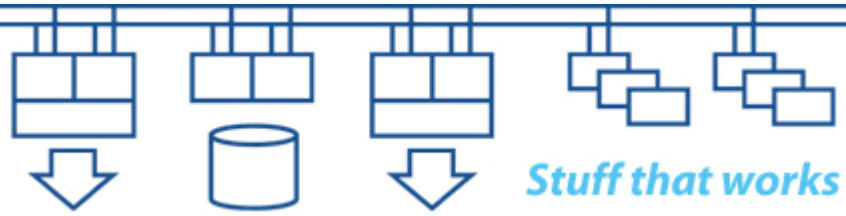

Compilers on OpenVMS Integrity

- **Currently a mixture of Intel standard compilers and GEM back-end compilers, depending on the language**
- **Defaults are likely to be different on Integrity, so explicitly set the command line switches to get the behaviour you need**
- **Check the SPDs for the compilers you need**

- **Test compile some of your code early on – get to the latest versions first if you can before you change platform**

- **DEC ADA'83 not available – use Gnat ADA Pro**
- **Standard C is Standard C**
- **Fortran DEC extensions are (mostly) supported**

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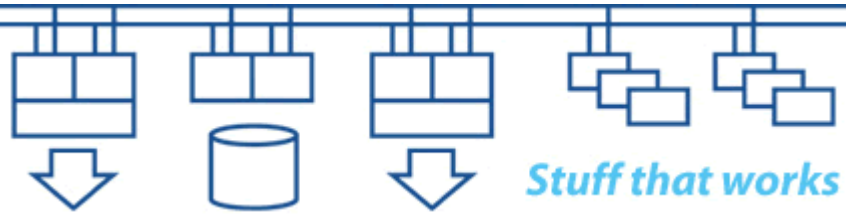

Alignment faults on OpenVMS Integrity

- **Unexpected alignment faults on Integrity are expensive and affect the entire system performance, so eliminate them if you can. Use the appropriate compiler switches.**
- **MONITOR ALIGN will show if you have issues**
- **Home in on the problem areas using the SDA extension:**
- **Alignment fault trace (with SDA)...**

  SDA> FLT START TRACE
  SDA> FLT SHOW TRACE /SUMMARY
  flt_summary.txt
- **Alignment fault trace (with SDA)...**

  SDA> FLT START TRACE [/CALL]
  SDA> FLT SHOW TRACE
  flt_trace.txt

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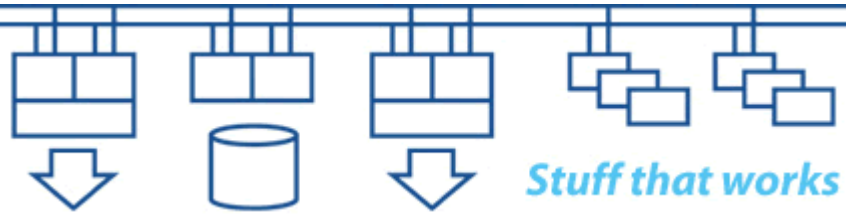

Exception handling on OpenVMS Integrity

- **Exception handling (LIB$SIGNAL etc.) is a more expensive mechanism than it was on Alpha**
- **Consider alternatives if your code makes extensive use of exception handling as part of it's normal flow of control**
- **Increase stack space when using threads**

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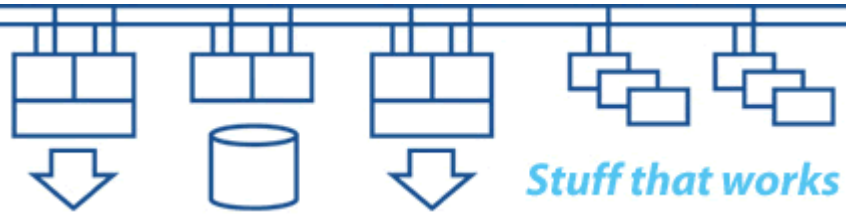

Floating point on OpenVMS Integrity

- **Integrity default floating point format is IEEE**
- **VAX floating point is handled by converting to IEEE format, doing the processing, then converting the result back from IEEE format to VAX format, hence a small performance penalty**
- **Alphas do both VAX and IEEE, but the default is VAX**
- **Results with IEEE are 'slightly different', not by much**
- **Consider testing for a small difference, not equal**

- **Beware LIB$WAIT(<real>)!**
- **Beware reading in data files / writing out data files and moving them between different systems**
- **What standard do you use for moving data?**

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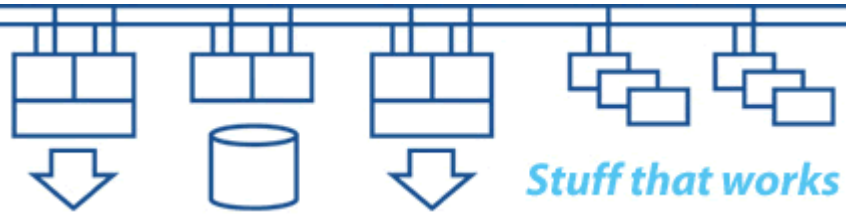

Beware implicit assumptions

- **Check for code making assumptions about hardware:**
  - **“if not Alpha” is definitely a problem!**
  - **“if not VAX” should be less of a problem**
  - **“if VAX” / “if Alpha” / “if IA64” is safe**

- **Check for code making assumptions about page sizes:**
  - **Memory page sizes are variable on Integrity (and Alpha)**
  - **VAX is 512 bytes (same as disc block size)**
  - **Alpha is 8192 bytes**
  - **Integrity is currently 8192 bytes**

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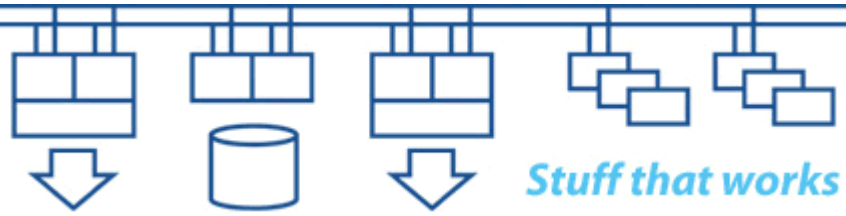

Uniprocessor to multi-processor

- **Check for code making assumptions that the system is a uniprocessor machine:**
  - **Flag bits controlling access to an entire global section**
  - **Loops polling for flag bit status changes (spinlocks)**
  - **Data structures not protected from operations that may happen in parallel instead of sequentially**
- **Use the lock manager to serialise and synchronise access to data structures**
- **Minimise wait states by having appropriate granularity of access to data structures**
- **Take null locks out, then simply convert them as needed**

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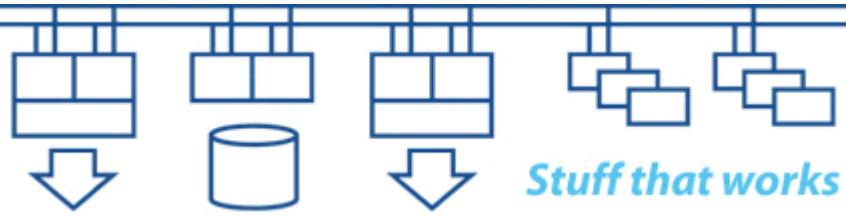

Other aspects of porting

- **Make a thorough audit and analysis of what you're doing at the moment**
- **Consider taking advantage of new features and new ways to do things**
- **There may be no direct equivalents**
- **Direct 'bug for bug' port or re-implement application?**
- **Are you going to have to continue to support non-migrated systems as well?**
- **System infrastructure implications – storage subsystems (eg: SANs) and network connectivity (eg: multiple NICs)**

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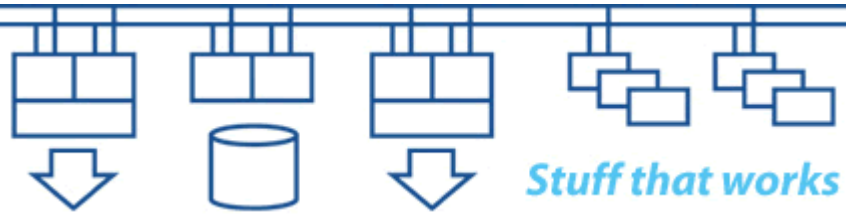

Emulation and Binary Translation

- **Emulators can let you run existing binary code on an emulated hardware platform hosted on a replacement system platform (typically a Windows PC)**
- **Emulators are entirely dependent on the underlying system platform for their overall behaviour**
- **Emulators require IO support to be created specifically**
- **Emulators can give you long-term complications – carefully consider the long-term cost of ownership and the implications for supporting critical applications over time**

- **Binary translators will convert executable images "on the fly" into an executable image for the target processor, even VAX to Alpha to Integrity**

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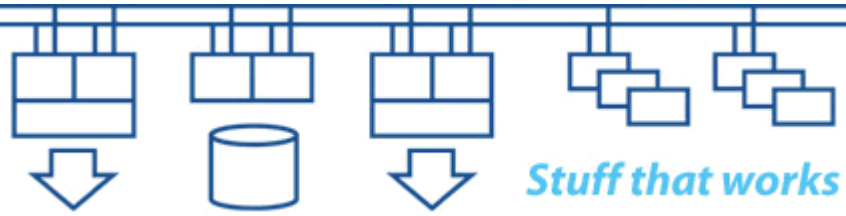

Starting on VAX

- **Hardware constraints, eg: real-time IO devices**
- **Software constraints, eg: tied to VAX hardware**
- **Operating system version constraints**
- **Layered product version constraints**
- **Network constraints, eg: X.25, PathWorks**
- **Performance constraints, eg: interrupt latency**
- **It may be surprisingly easy – recompile, relink, test thoroughly and then deploy**

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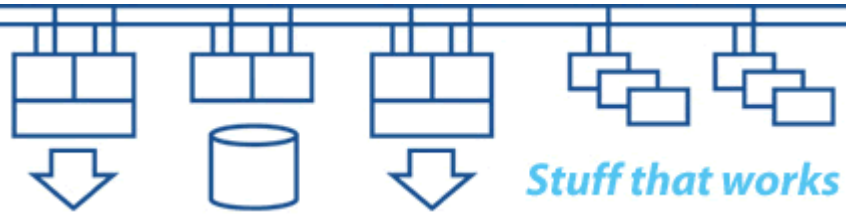

VAX to Integrity

- Tidy up application code (eg: synchronisation & serialisation, hard-coded values, run-time library calls, system service calls, implicit assumptions, etc. …)
- Think about data alignment
- Think about floating point data types
- DCL command files and systems management changes
- Convert from VMSINSTAL to PCSI?
- Either:
  - Move via Alpha as an intermediate step
- Or:
  - Move directly to Integrity

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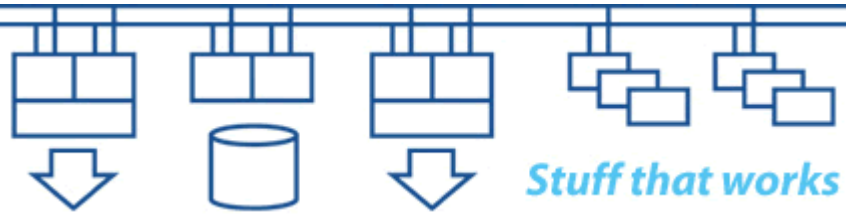

Starting on Alpha

- **Hardware constraints, eg: IO devices**
- **Software constraints, eg: tied to Alpha hardware**
- **Operating system version constraints**
- **Layered product version constraints**
- **Network constraints, eg: PathWorks**
- **Performance constraints, eg: big multiprocessor systems**
- **Functionality constraints, eg: Galaxy soft partitioning**
- **It may be surprisingly easy – recompile, relink, test thoroughly and then deploy**

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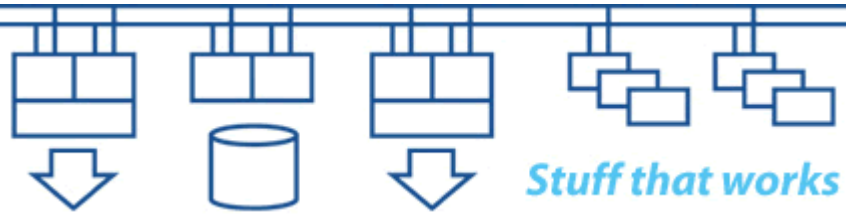

Alpha to Integrity

- **Tidy up application code (eg: synchronisation & serialisation, hard-coded values, run-time library calls, system service calls, implicit assumptions, etc. …)**
- **Think about data alignment**
- **Think about floating point data types**
- **DCL command files and systems management changes**
- **Convert from VMSINSTAL to PCSI?**
- **Move to Alpha current (eg: OpenVMS Alpha V8.3)**
- **Move from Alpha current to Integrity (eg: OpenVMS Alpha V8.3 to OpenVMS Integrity V8.3)**

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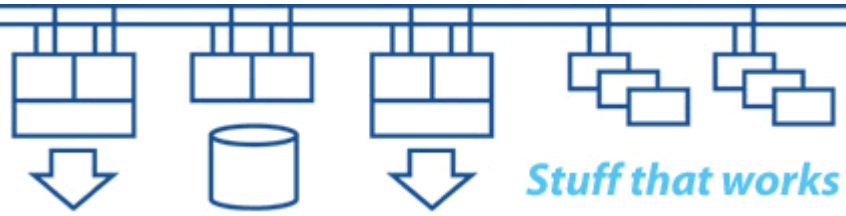

Further information

A lot of information is on the web:

- **Porting workshops**
- **HP DSPP (http://www.hp.com/dspp)**
- **OpenVMS Technical Journals**
- **OpenVMS documentation**
- **OpenVMS V8.3-1H1 Integrity Servers**
- **Transition tools:**
  http://h71000.www7.hp.com/openvms/ovmsproducts.html
- **White papers:**
  http://h71000.www7.hp.com/openvms/whitepapers/index.html
- **FAQ:**
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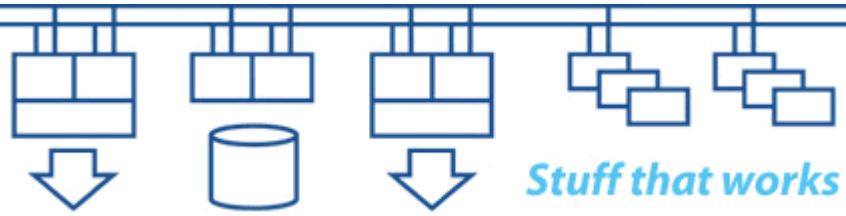

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Q & A

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