



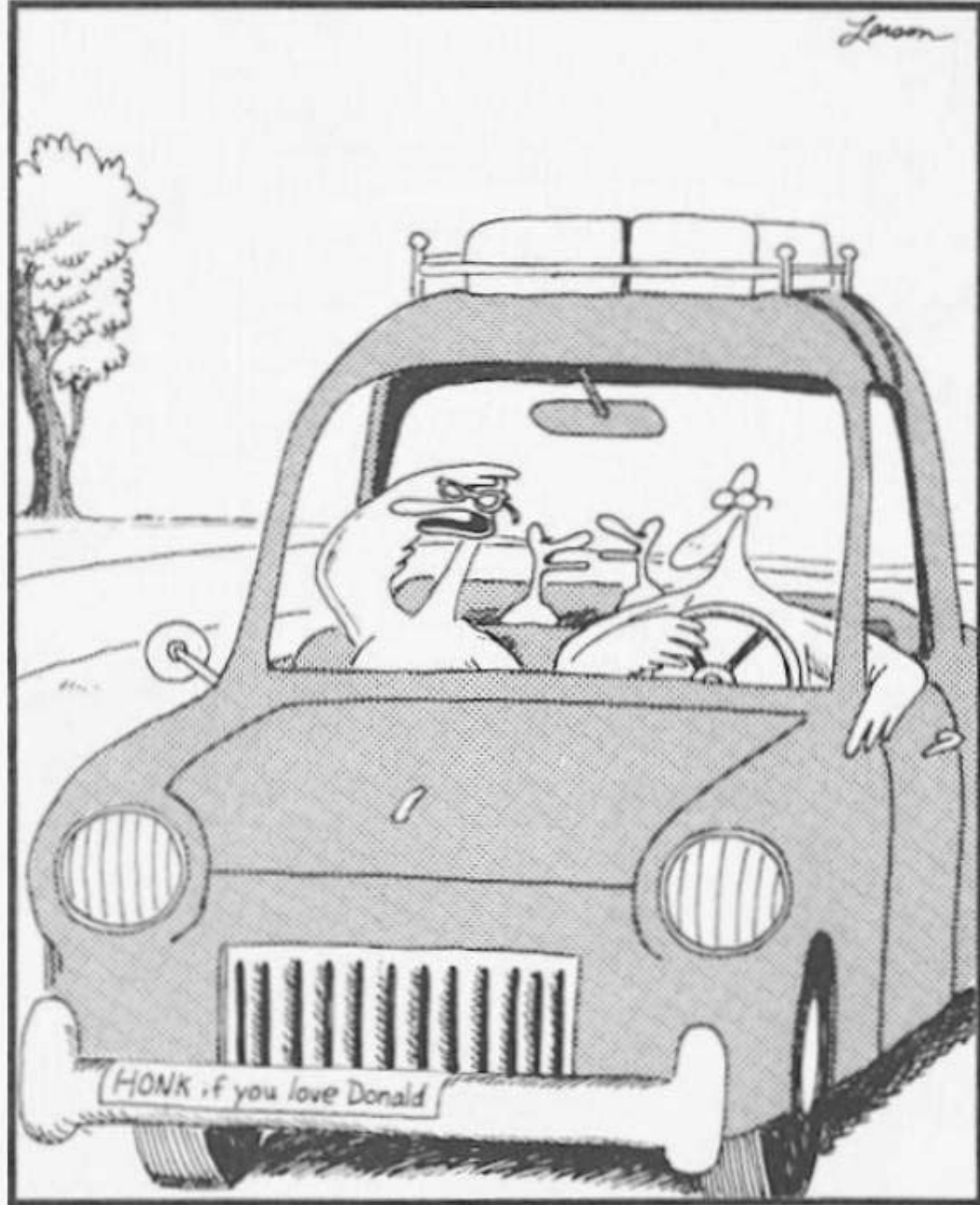
Porting Applications from Tru64 UNIX[®] to HP-UX 11i

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"Oh God, George! Stop! ... Stop the car! I've got another migration headache!"

Agenda



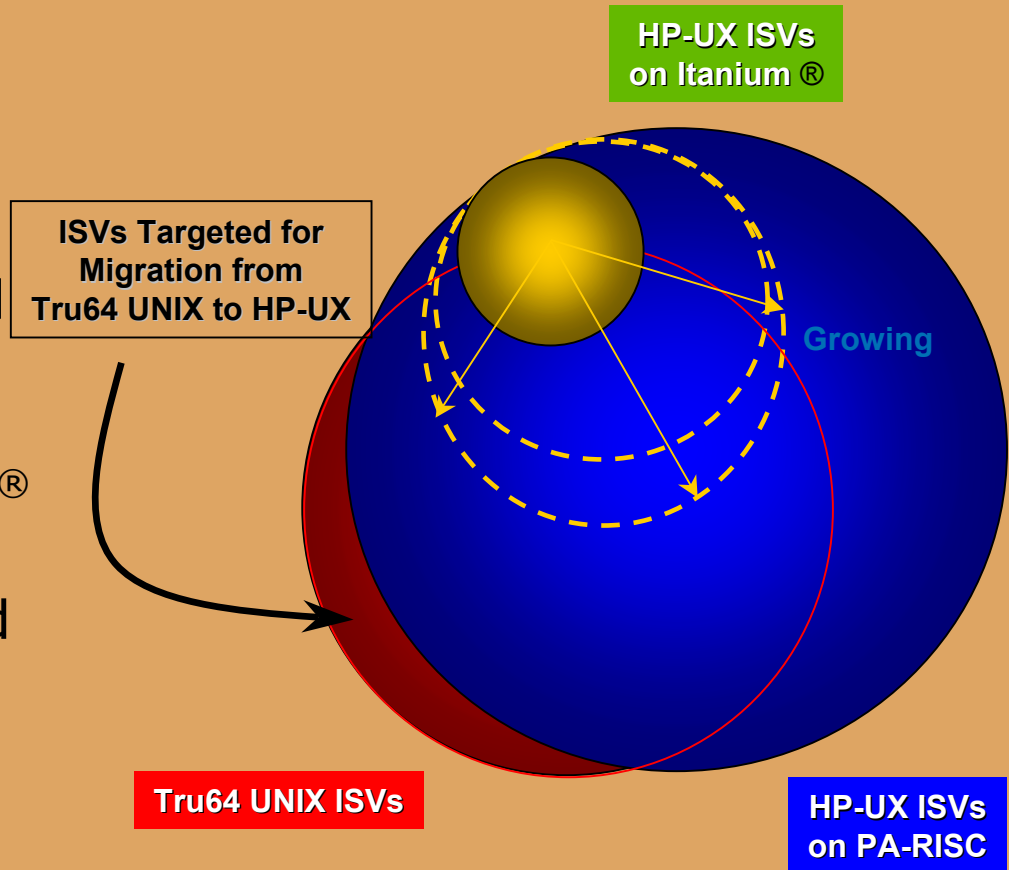
- Tru64 UNIX and HP-UX 11i Migration Scenario and Roadmaps
- Comparison of Tru64 UNIX and HP-UX Development Environments
- Transition Tools and Resources

UNIX® ISV Migration Scenario

Large overlap of applications on Tru64 UNIX® on AlphaServer and HP-UX on PA-RISC today

Ports to HP-UX on Itanium® are in process. Portfolio is growing, and HP is focused on Itanium® application availability

ISVs that are only on AlphaServer are in vertical segments, and HP is committed to migration with these partners



Tru64 UNIX[®] V5.1B and its updates



V5.1B, with its enhancements, will be supported for at least 5 years beyond last sale date of AlphaServer systems

V5.1B-1 "Vail" 2003

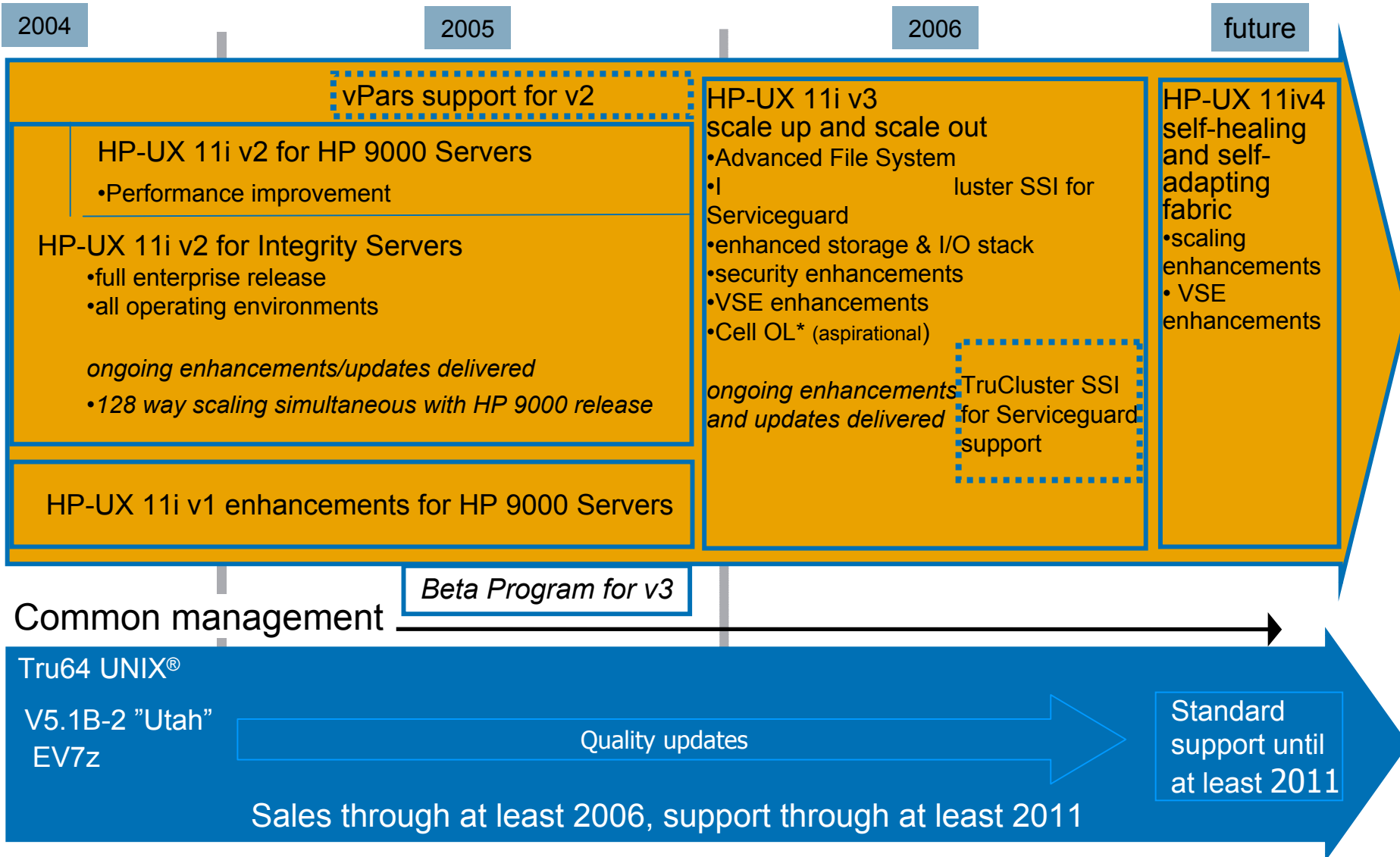
- Scaling to 64 CPUs
- Continued leadership storage SAN support
- Resiliency enhancements
- Enhanced availability and disaster tolerance
- Migration tools availability

V5.1B-2 "Utah" 2004

- Support EV7z AlphaServers
- Improved storage management and new storage options
- Resiliency enhancements
- HP-UX 11i compatibility tools

Maintain binary compatibility,
Continue focus on quality and stability.

HP-UX 11i and Tru64 UNIX® roadmap



Tru64 UNIX and HP-UX Comparison

- HP-UX is based on System V with features from 4.x BSD
- Tru64 UNIX environment is based on 4.x BSD with features from System V
- HP-UX and Tru64 UNIX conform to multiple common standards

Standards Conformance



Standard	Tru64 UNIX	HP-UX
IEEE POSIX 1001.3c Kernel threads	√	√
IEEE POSIX 1003.1-1996 System calls	√	√
IEEE POSIX 1003.1b Real-time APIs	√	√
IEEE POSIX 1003.2 Commands and Utilities	√	√
X/Open Portability Guide (XPG3, XPG4)	√	√
Single UNIX Specification V1 (UNIX 95)	√	√
Single UNIX Specification V2 (UNIX 98)	√	Almost!

Standards Conformance (cont)

Standard	Tru64 UNIX	HP-UX
System V Interface Definition (SVID3)	√	√
X11 Window System, Font Server and Clients	R6.5	R6.2
OSF/Motif 2.1	√	√
FIPS 151-2	√	√
FIPS 189	√	√
LP64	√	√

Development Environment Comparison



- Compilers
- Linkers
- Debuggers
- Make
- Threads
- Libraries and APIs
- Floating Point Exception Handling
- Data Alignment
- Endianism
- Security

Compilers

- C, C++, Fortran, Java and assembler are covered in porting guide
- Includes tables mapping Tru64 UNIX compiler options to HP-UX compiler options
- Tru64 UNIX Migration Environment for HP-UX includes a cc driver to map Compaq C compiler options to the equivalent options for HP C
- **NOTE:**
 - HP-UX compilers generate 32-bit objects by default
 - Use +DD64 option to generate 64-bit image.

C Compilers

- Both Compaq and HP C compilers support ANSI C
- Strictly conformant code will compile and run without change
- Turn on strict ANSI checking (-std1 option) to find non-compliant code
- HP ANSI C compiler for Itanium[®] platforms does not support K&R mode

Language Mode Options

Compaq C	HP C	Description
-std (V5.x default)	-Ae (default)	ANSI C mode w/ extensions
-std0 (V4.x default)	-Ac (PA-RISC only)	K&R C
-std1	-Aa	Strict ANSI C

Namespaces



Tru64 UNIX	HP-UX	Standard
-D_OSF_SOURCE (Default)	-D_HPUX_SOURCE (Default for -Ae)	Proprietary interfaces
-D_XOPEN_SOURCE=500	-D_XOPEN_SOURCE=500 or -DUNIX_STD=98	UNIX 98
-D_XOPEN_SOURCE_EXTENDED	-D_XOPEN_SOURCE_EXTENDED	UNIX 95
-D_XOPEN_SOURCE (Default)	-D_XOPEN_SOURCE	XPG4
-D_POSIX_SOURCE	-D_POSIX_SOURCE	POSIX
-D_ANSI_C_SOURCE	Default for -Aa and c89	ANSI C

Example: Define Namespace when using -Aa on HP-UX



```
/* open.c */
#include <fcntl.h>
#include <stdio.h>
main( int argc, char *argv[] ) {
int fd1;
fd1 = open( "testfile", O_CREAT|O_RDWR, 0666 );
if( fd1 < 0 ) { perror("open testfile"); exit( 1);}
printf( "file descriptor %d opened\n", fd1);
}
```

% cc -Aa open.c

Error 172: "open.c", line 9 # Undeclared variable 'O_CREAT'

% cc -Aa -D_POSIX_SOURCE open.c

Porting C Code Without Prototypes

- Functions w/o prototypes assumed to return type int
- Tru64 UNIX compilers return a 64-bit value
- HP-UX compilers return a 32-bit value, resulting in truncation of upper 32 bits for routines intended to return a 64-bit long or pointer
- Use `-warnprotos` option with Compaq C to detect function calls w/o prototypes
- Use `+tru64` option with HP C A.05.50 or higher to obtain Tru64 UNIX behavior
- Recommended solution: use prototypes!

Example: Calling Functions w/o Prototypes on HP-UX



```
/* noproto.c */  
#include <stdio.h>  
int main() {  
    long a;  
    a = foo();  
    printf ("The returned value is:  
0x%lx\n", a);  
    return 0; }
```

```
% cc +DD64 noproto.c foo.c
```

```
% ./a.out
```

The returned value is:

0x55667788

```
/* foo.c */  
long foo()  
{ return 0x1122334455667788L;  
}
```

```
% cc +tru64 +DD64 noproto.c  
foo.c
```

```
% ./a.out
```

The returned value is:

0x1122334455667788

C++ Compilers

- Both Compaq and HP C++ compilers support ANSI C++
- Default for Compaq C++ is `-std ansi`, which supports commonly used extensions.
- Use `-std strict_ansi` option for Compaq C++ to flag any nonstandard code
- Use `-Aa` option with HP aC++ to enable ANSI C++ Standard features like standard scoping rules for variables declared in conditional statements like for loops.

Scoping Rules for Variables in a for loop

```
/* forloop.C */  
int main() {  
int sum = 0;  
for (int k = 0; k!=100; ++k) /* line 3 */  
    sum += k;  
for (int k = 100; k!=0; k--) /* line 5 */  
    sum += k;  
}
```

% aCC forloop.C

Error 173:"forloop.C", line 5 # Redefined symbol 'k';
previously defined at ["forloop.C" line 3].

% aCC -Wc,-ansi_for_scope,on forloop.C

C++ Options to Select iostreams Library

- Default iostreams library is different on Itanium[®] than Alpha or PA-RISC
- **NOTE:** -AA and -AP options are mutually exclusive. All objects and libraries for an executable must be consistently built with one or the other.

iostreams library	Compaq C++	HP aC++
Pre-standard	-D_NO_USE_STD_IO_STREAM (default)	-AP (PA-RISC default)
Standard	-D_USE_STD_Iostream Or -std strict_ansi[_errors]	-AA (Itanium [®] default)

Functionality in ANSI/ISO C++ standard not yet supported by HP aC++:



- Support for universal character sequences (`\uxxxx`)
- Template features:
 - Separation model for template compilation (*export* keyword)
 - Template template parameters
 - Omission of template parameter names
- Compaq C++ supports all but *export* keyword

Fortran

- Both Compaq and HP Fortran compilers conform to Fortran 90 and Fortran 95 standards
- Both support a full OpenMP implementation
- Compaq Fortran highly compatible w/ FORTRAN 77. HP Fortran does not support FORTRAN 77 nonstandard extensions
- See HP Fortran Programmer's Guide for info on migrating to Fortran 90:

<http://docs.hp.com/hpux/dev/index.html#Fortran>

Linkers



- Library Search Order
- Uninitialized Global Data

Library Search Order

- Library search order differs between Tru64 UNIX and HP-UX linkers:
 - Tru64 UNIX searches all directories in the search path for shared libraries and then makes a second pass to search for archives.
 - HP-UX linker makes one pass of all directories, looking for shared libraries then archives in each one (like `–oldstyle_liblookup` on Tru64 UNIX)
- May need to explicitly specify library names or change order of directory specifications on link line

Example: Library Search Order

Libraries L1/libA.a

L2/libA.so

L2/libB.so

Tru64 UNIX

```
% cc -LL1 -LL2 main.c -IA -IB -rpath L1:L2
% ldd a.out
/usr/bin/ldd a.out
Main => a.out
libA.so => L2/libA.so
libB.so => L2/libB.so
libc.so => /usr/shlib/libc.so
```

HP-UX

```
% cc -LL1 -LL2 main.c -IA -IB
-Wl,+vtype,files
Loading main.o:
Loading L1/libA.a[a.o]:
Loading L2/libB.so:
Loading /usr/lib/hpux32/libc.so:
Loading /usr/lib/hpux32/libdl.so.1:
```

Uninitialized Global Data

- Resolution of uninitialized global data differs between HP-UX and Tru64 UNIX:
 - On Tru64 UNIX, external definition is used if available, otherwise, uninitialized element used for symbol resolution
 - On HP-UX, uninitialized global data references are implicitly initialized to zero, and data references are resolved by first definition encountered rather than continuing to search for an initialized data object.

Example – Uninitialized Global Data

% cat a.c

```
int object; /* Uninitialized global symbol */
```

```
void a()
```

```
{ printf("\tA object is %d\n", object); }
```

% cat b.c

```
int object=1; /* Initialized global symbol */
```

```
void b()
```

```
{ }
```

% cat main.c

```
int main(int argc, char* argv[])
```

```
{ a(); }
```

Example – Uninitialized Data (continued)



Tru64 UNIX	HP-UX
<pre>% cc -c main.c % cc -shared a.c -o libA.so % cc -shared b.c -o libB.so % cc main.o -L. -rpath . -IA -IB -o test % ./test object is 1</pre>	<pre>% cc +DD64 -c main.c % cc +DD64 -b a.c -o libA.so % cc +DD64 -b b.c -o libB.so % cc +DD64 main.o -L. - WI,+b,. -IA -IB -o test2 % ./test2 object is 0 NOTE: result is link order dependent!</pre>

- Resolution: Declare object as extern in a.c:
extern int object;

Debuggers

- See Guide to Using HP WDB for Ladebug Users (available in the Tru64 UNIX to HP-UX STK)
- Use +noobjdebug linker option on Itanium[®] to put debug info in executable (to match Tru64 UNIX behavior)
- Debugging shared libraries requires use of the chatr(1) command on Itanium[®], or pxdB on PA-RISC, if attaching to a running process:

On Itanium[®]:

```
% chatr +debug enable a.out
```

On PA-RISC:

```
% /usr/ccs/bin/pxdb -s on a.out
```

Make

- Tru64 UNIX provides three versions of make
- `/usr/bin/posix/make` is most like the HP-UX System V make
- The default make on Tru64 UNIX (`/usr/bin/make`) has been ported to HP-UX (available in the Migration Environment)
- `cc` and `ld` drivers in Migration Environment may be used to help port make files

Threads

- POSIX threads implementation on both Tru64 UNIX and HP-UX (Itanium[®] only) are based on two level scheduling and an MxN model.
- Use of any nonportable threads APIs (with `_np` suffix) will have to be replaced. See porting guide for mapping of some `_np` APIs to existing HP-UX threads APIs.
- Some `_np` APIs available in Migration Environment
- See porting guide and “Guide to HP WDB for Ladebug Users” for mapping of Ladebug threads commands to WDB commands

Compiling Threaded Programs

- Tru64 UNIX:

```
% cc myprog.c -pthread
```

- HP-UX:

```
% cc +DD64 -mt myprog.c    (Itanium® only)
```

OR

```
% cc +DD64 -D_POSIX_C_SOURCE=199506L myprog.c -lpthread
```

- **NOTE:** omitting `-lpthread` will not generate a compile-time error!
- Use `-mt` option for HP aC++/ANSI C to compile threaded C and C++ programs on Itanium[®]-based systems
- Use `-D_THREAD_SAFE` to select thread-safe versions of I/O routines if using `iostream.h` (set by `-mt` option)

Libraries and APIs

- Engineering work currently underway to:
 - enrich HP-UX with Tru64 UNIX-unique functions
 - resolve or document conflicts
 - Migration Environment provides some Tru64 UNIX APIs on HP-UX, including **selected**:
 - Math routines
 - Pthread routines
 - Arena malloc routines
 - Secure temp file routines
 - Networking routines
 - Signal routines

Examples – API Differences

- malloc()
 - The return value of malloc() when passed a zero is undefined by standards. Tru64 UNIX returns null, while HP-UX returns a valid pointer
- String routines
 - Passing null pointer generates SEGV on Tru64 UNIX
 - Use `-z` linker option on HP-UX to allow run-time detection of null pointers
 - Exception: `strcmp()` on HP-UX never triggers SEGV when passed null pointer

Floating-Point Exception Handling

- Default handling mode for floating-point exceptions is different between Tru64 UNIX and HP-UX:
 - HP-UX suppresses all exceptions by default (IEEE behavior); Tru64 UNIX does not
 - Tru64 UNIX ignores underflow and inexact exceptions, but overflow, divide-by-zero, and invalid operations will generate a trap. Also, denormalized values are flushed to zero (fast underflow) by default.
- Tru64 UNIX default behavior can be obtained on HP-UX by using the **+FPOVZD** compiler option:
`% cc +FPOVZD foo.c`

Data Alignment

- Alpha, PA-RISC and Itanium[®] processors require data to be aligned on natural boundaries.
- Tru64 UNIX provides support for handling unaligned data accesses, either by silently correcting or issuing message
- HP-UX does not perform unaligned access fixups. SIGBUS signal is raised, allowing application to handle or fatally exit.
- Unaligned data access fixup on Alpha causes performance hit. On HP-UX, a fatal error occurs.

Compiler Support for Accessing Unaligned Data



- Tru64 UNIX compilers provide **__unaligned** keyword to generate code for unaligned loads and stores
 - More expensive than aligned data access, but faster than generating alignment faults
- HP C and C++ compilers on Itanium[®], and C++ compiler on PA-RISC provide **UNALIGN** pragma which affects the next typedef declaration:

```
#pragma UNALIGN 1
```

```
typedef int ua_int; // ua_int has 1 byte alignment
```

```
typedef int a_int; // a_int has natural alignment
```

Handling Data Storage in Endian Neutral Formats



- Store data in defined endian format
 - e.g. network data and Java traditionally use big endian
- Add additional data to indicate format
 - Fortran allows endianness control based on OPEN statement
- Store data in endian neutral format such as ASCII strings
 - e.g. XML data

Security



- Tru64 UNIX and HP-UX use two different security facilities:
 - Security Integration Architecture (SIA) on Tru64 UNIX
 - Pluggable Authentication Modules (PAM) on HP-UX
- See porting guide for a comparison and mapping of SIA APIs to PAM APIs.

Additional Topics in Porting Guide

- Run-Time Environment
- Multiprocessor Environments
- Clustering
- Hardware
- Graphics
- Networking
- Internationalization
- Kernel and Driver Interfaces
- Freeware
- System Tuning

Transition Tools

- Appscan
 - Utility to list all dependencies (shared libraries and symbols) of an executable and the disposition on HP-UX of each API

<http://www.hp.com/go/tru64appmigration>
- Tru64 UNIX to HP-UX Software Transition Kit
 - Identifies compatibility issues between Tru64 UNIX and HP-UX

<http://devresource.hp.com/STKT>
- Tru64 UNIX Migration Environment for HP-UX
 - Software compatibility layer on HP-UX for select Tru64 UNIX APIs, tools and commands

<http://www.hp.com/go/tru64appmigration>

Resources

Tru64 UNIX to HP-UX 11i Porting Guide

<http://www.hp.com/go/tru64appmigration> >> porting guide

Application Migration Website

<http://www.hp.com/go/tru64appmigration>

From Tru64 UNIX® to HP-UX

<http://www.hp.com/go/tru64transition/>

Alpha Retain Trust Program

http://www.hp.com/products1/evolution/alpha_retaintrust/

HP Developer and Solution Partner Portal

<http://www.hp.com/dspp/>

HP Test Drive Program

<http://www.testdrive.hp.com>



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