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00B-0248

Standards: *Bridging the Generation Gap between Linux® and UNIX® Systems*

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This talk covers

- Why Standards Matter…
- The Standards
  - A review of the latest open systems standards
  - How Linux shapes up to them
- Their use…
  - POSIX
  - The Single UNIX Specification
  - The Linux Standard Base (LSB)
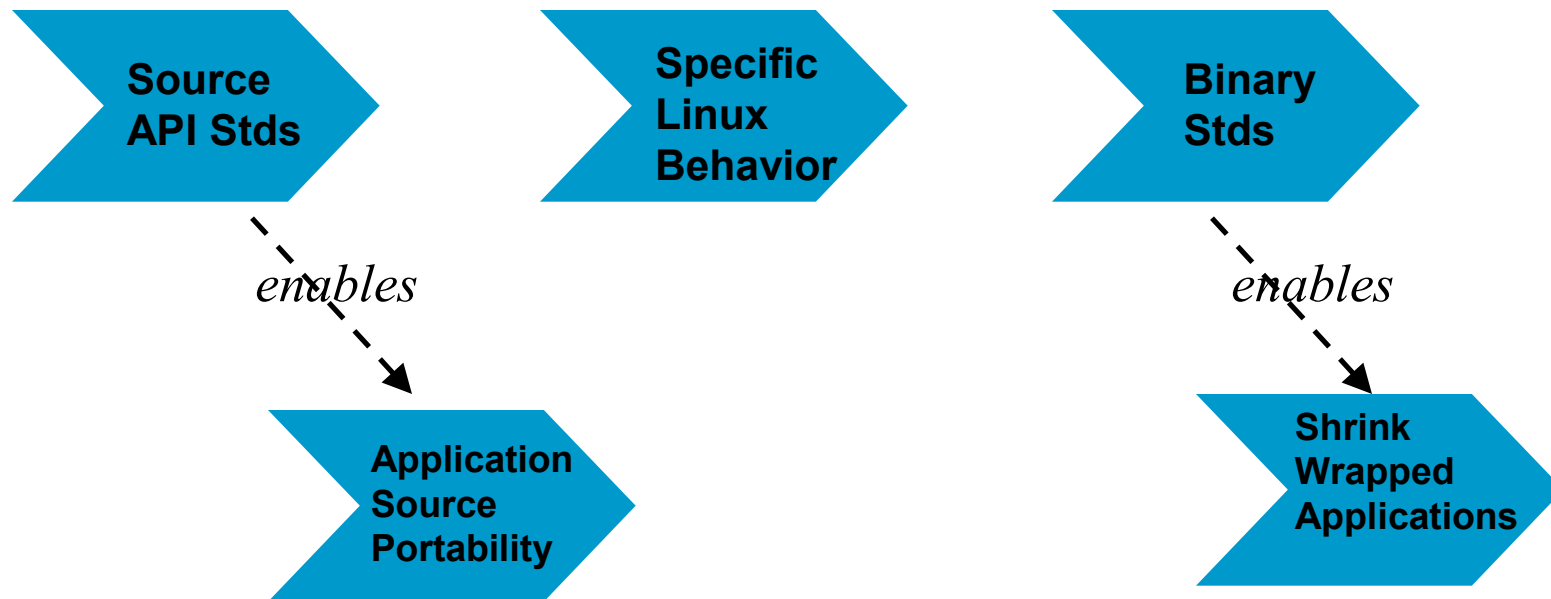
Why you should care…

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"Despite their well earned reputation as a source of confusion, standards are one of the enabling factors behind the success of Linux. If it weren't for the adoption of the right standards by Linus Torvalds and other developers, Linux would likely be a small footnote in the history of operating systems."

\- Dan Quinlan, Free Standards Group Chairman

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The Free Market

- The key to the growth of the Linux market is the free–market demands placed upon suppliers by customers
  - Open Standards
- These systems ultimately compete on quality and added value features to retain customers
- Dissatisfied customers can move on to another supplier

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Background: Source Standards versus Binary Standards

Source API Stds

Specific Linux Behavior

Binary Stds

enables

enables

Application Source Portability

Shrink Wrapped Applications

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What is an API?

- Application Program Interface

- A written contract between system developers and application developers

- It is not a piece of code, it is a piece of paper defining what the two sets of developers are guaranteed to receive and are in turn responsible for providing

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POSIX® /pahz‑icks/

- *POSIX , pronounced pahz‑icks as in positive, not poh‑six, or other variations*

- POSIX is a registered trademark of the IEEE

- An acronym for *Portable Operating System Interface*

- The basic objective is portability
  - Both programmers and application source code
  - Portability of the OS kernel itself and/or application binary code are <u>not</u> objectives

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The Success of POSIX

- ❑ The majority of UNIX system suppliers today support POSIX

- ❑ A core component of Linux

- ❑ Many other systems also now claim support for POSIX, for example VMS, MVS, MPE and even Microsoft Windows NT

- ❑ It is now so successful that it has lost its role as a *market differentiator*, it is required infrastructure

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POSIX Deliverables

- *POSIX.1 – 1990 System Interfaces (C language binding)*
- POSIX.2 – 1992 Shell & Utilities
- POSIX.5 – 1992 Ada bindings
- POSIX.1b – 1993 Realtime Extension
- POSIX.1c – 1995 Threads Extension
- POSIX.5b – 1996 Ada Realtime Extension
- POSIX 1003.13 – 1998 Realtime Profiles

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POSIX *Latest* Deliverable

- *POSIX.1 – 2001*
    - *Approved December 6th 2001*
- Developed by the *Austin Group (see later)*
- Supersedes POSIX.1-1990 and its amendments and POSIX.2-1992 and its amendments .
- A combined system interfaces and utilities specification as a single 4000 page standard

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POSIX.1-1990,.1b-1993 and Linux

❑ Linux mostly compatible at the source level with IEEE POSIX 1003.1–1990

❑ An early version was certified for FIPS 151–2 compliance (from Open Linux Ltd.)

❑ Linux AIO presently has problems

❑ Test suites are freely available to measure compliance (VSX-PCTS,LSB-OS):

  ▪ *http://www.opengroup.org/testing/downloads.html*

  ▪ *http://www.linuxbase.org/*

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POSIX.1c-1995 and Linux

❑ Linux has a partial *pthreads* implementation
- Most of the APIs are present
- Some semantic differences
- Several emerging Threads implementations (the latest in glibc) shows a solution possible
- The *gLSB* includes a section giving advice to the programmer on how to work around the differences.

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POSIX.2-1992 and Linux

❑ Recent distributions are getting closer to POSIX.2 and provide most of the required utilities

❑ Usually differences hidden by POSIXLY_CORRECT environment variable

❑ The *gLSB* includes a set of man pages for the commands and utilities listing the differences when applicable

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Agenda

❑ **Standards Projects**

   ▪ **POSIX**

   ➢ **The Single UNIX Specification**

   ▪ **The Linux Standard Base**

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The Single UNIX Specification

- ❑ A single set of APIs supported by every UNIX system

- ❑ Shifted the focus from incompatible UNIX system product implementations to compliance to a single set of APIs

- ❑ If an OS meets the specification and commonly available applications run on it, then it is open.

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POSIX UNIX LSB Synergy

- ❏ The Single UNIX Specification builds on the foundation of POSIX and ISO C

- ❏ The LSB specification builds on the foundation of the Single UNIX Specification Version 2

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Interface Counts

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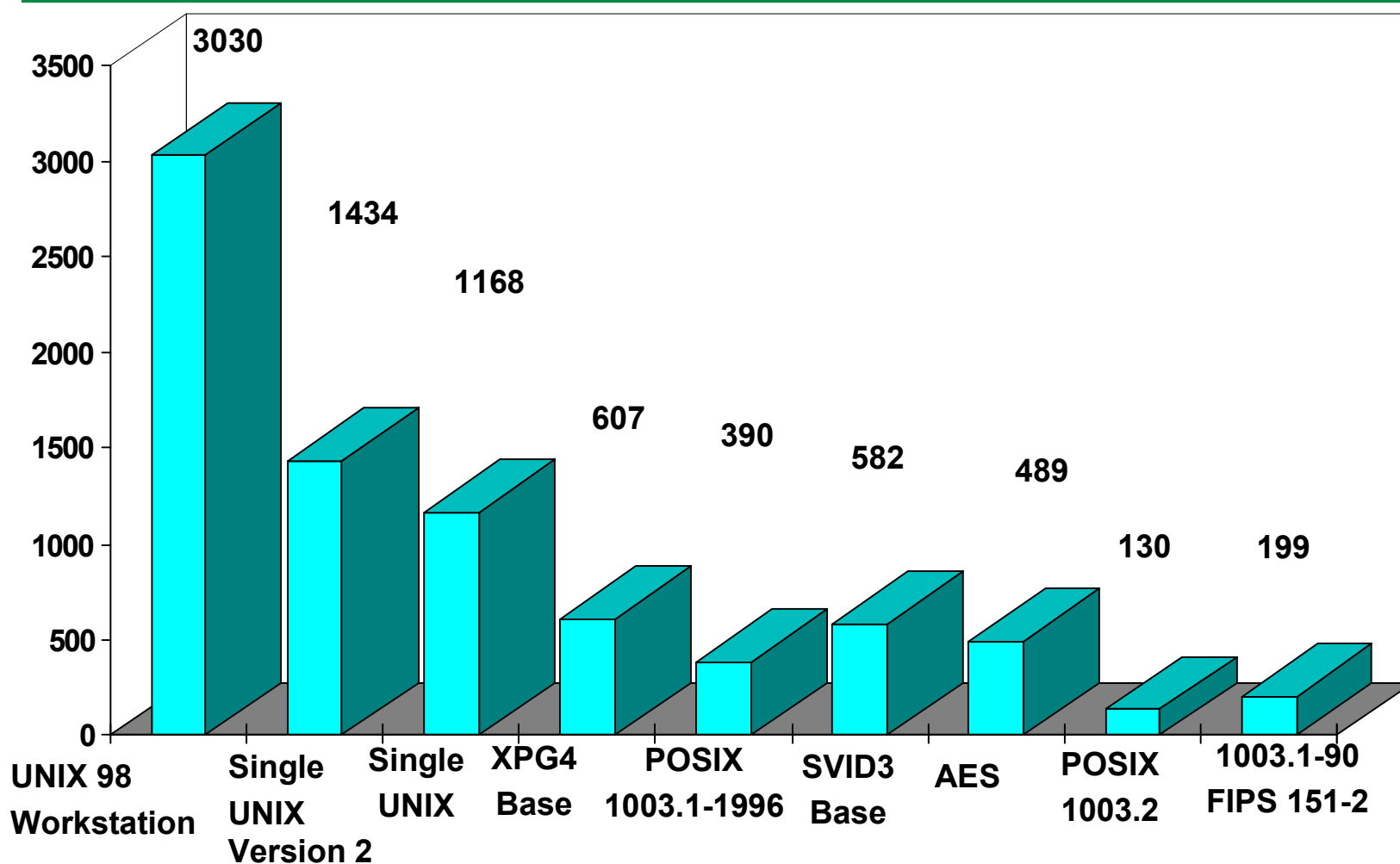
Linux Status

- Recent versions of glibc have been getting closer to full coverage of the *Single UNIX Specification Version 2*

- Closer still to the *Single UNIX Specification Version 3*

- The LSB test program shares core common test suites which have been a catalyst to some of this

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Linux Status (Cont'd)

❑ Some features from Version 2 of the Single UNIX Specification not implemented:

  ▪ STREAMS (isastream, getmsg, putmsg, etc.)

  ▪ XTI (t_alloc, etc)

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Linux Status

❑ Some features partially implemented :

- Wide characters (complete support in glibc 2.2 and later)

- Pthreads

- Large file semantics

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Linux Utilities

❑ Some differences

❑ Mainly due to the standards being aligned with System V historical definitions

- notably the shell (sh)

- Some efforts made with *bash* to align with POSIX as a result of the LSB test efforts (see the *VSC-lite* test suite which contains tests for the utilities and shell)

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Linux Utilities (Cont'd)

- In general, where Linux provides an alternative functionality to that in the Single UNIX Specification, the standard version has not been provided

  - Compress/uncompress vs gzip/gunzip
  - SCCS utilities vs RCS

- As per *POSIX.2;* see the *gLSB specification* for details of the differences

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The Single UNIX Specification Version 3

- ❑ Developed by the Austin Common Standards Revision Group

- ❑ An open industry initiative to revise the core *POSIX standard* and the *Single UNIX Specification*; standards that lie at the heart of the Linux operating system

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About the *Austin Group*

- Over 600 participants

- Wide industry support:
  - *AT&T, Compaq, Fujitsu, HP, IBM, Lucent, Microsoft, Red Hat, SGI, Siemens, Sun*
  - *DoD, USENIX, Canada Customs and Revenue Agency*

- Participation in the *Austin Group* from the Open Source community included:
  - *The Linux Standard Base, NetBSD, FreeBSD, and many others*

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Scope of the revision

❑ Production of a single document to be adopted by multiple parties

❑ Minimize the number of changes required to implementations of earlier versions of the Base documents for the revision

❑ Limit new work items to those related to integration and consistency, resolving any conflicts
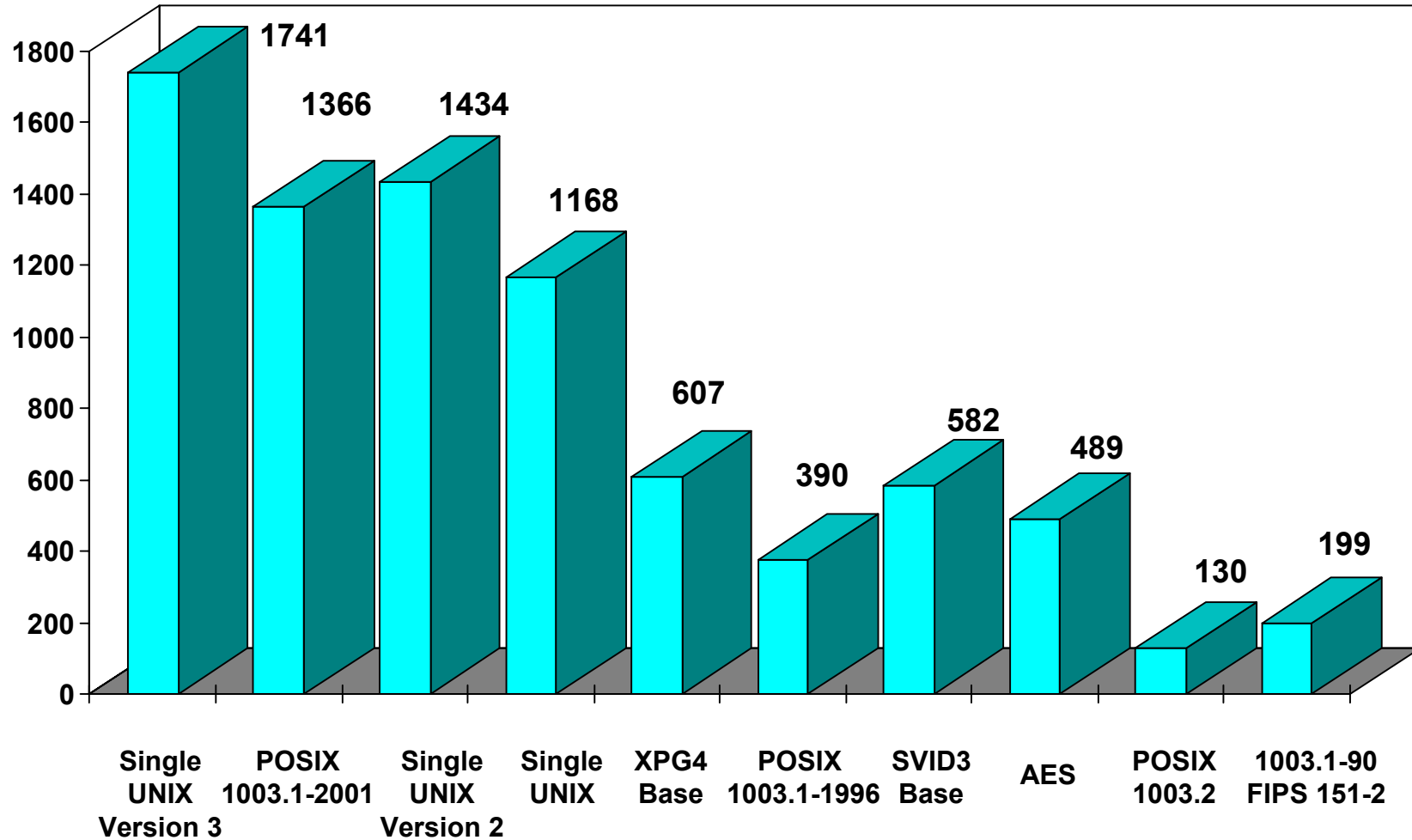
❑ Alignment with the ISO C 1999 standard

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Approvals Status

- The Open Group September 12th 2001
- IEEE December 6th 2001
- ISO/IEC 9945:2002 Parts 1 thru 4, November 2002
- Published in hardcopy (3700 pages, 9kg!!), electronic and CDROM

Portability Functions

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Formal Standards Alignment

- IEEE Std 1003.1-2001 (POSIX.1)
    - The Base Specifications Issue 6 and ISO/IEC 9945:2002 are technically identical to POSIX.1, they are all the same document (*word for word, a single publication*)
- ISO/IEC 9899:1999, Programming Languages − C (ISO C)

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Options

- ❑ Encryption
- ❑ Realtime
- ❑ Realtime Threads
- ❑ Advanced Realtime
- ❑ Advanced Realtime Threads
- ❑ Tracing
- ❑ XSI STREAMS
- ❑ Legacy

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Key Changes

- ❑ Legacy and obsolescent features dropped
  - ▪ Much of this was to compromise between System V and BSD
- ❑ Job control and certain options in POSIX.1 mandated (FIPS 151-2 alignment)
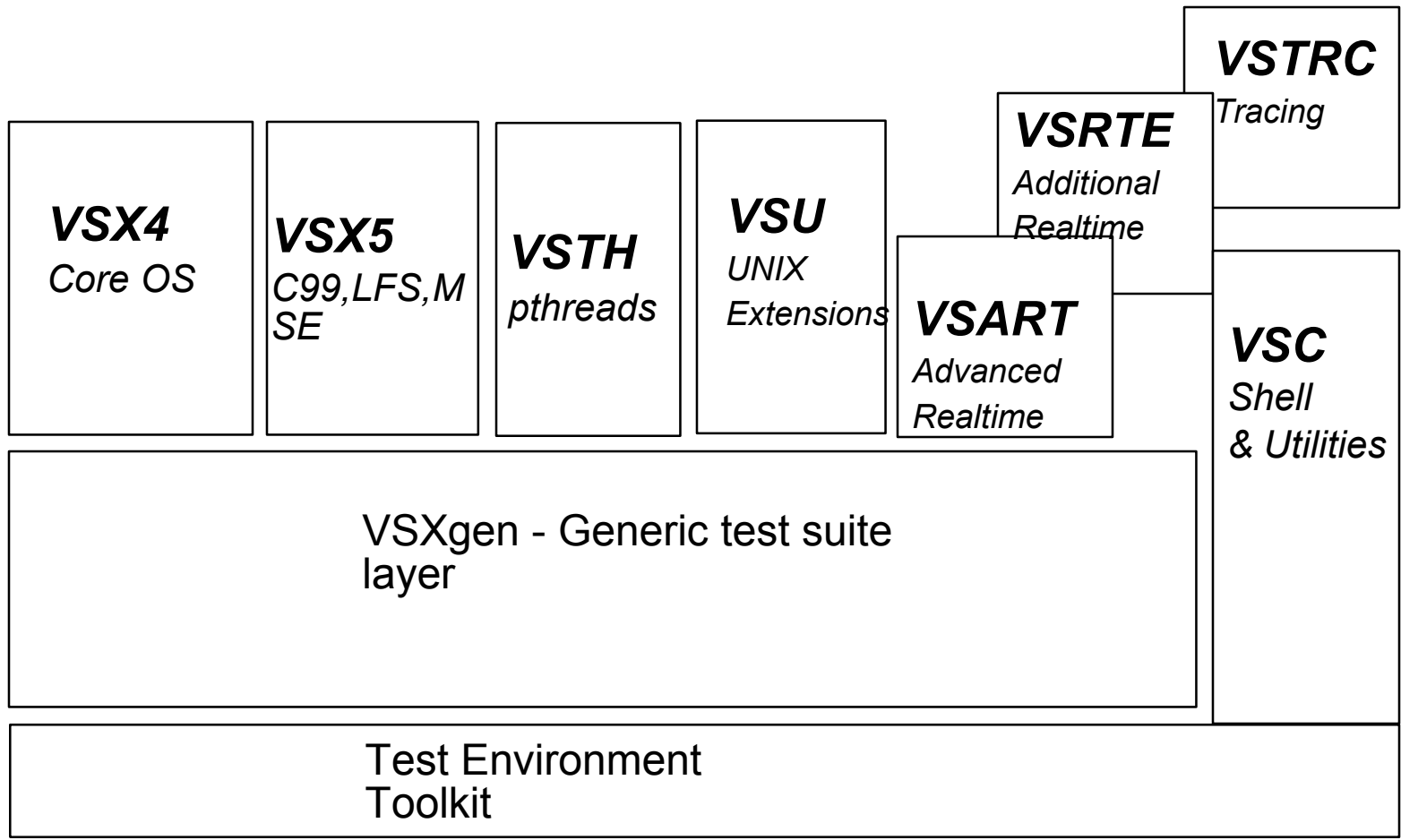 - ▪ ditto
- ❑ Corrigenda incorporated

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Key Changes (Cont'd)

❑ XTI dropped

- Is retained as a separate specification but not required for POSIX or UNIX conformance

❑ STREAMS optional

- An optional feature group for those systems that wish to support the functionality

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Where to Obtain the Specification?

- ❑ The html version is online at
  - ▪ http://www.UNIX-systems.org/version3/
- ❑ PDF either electronically or on CDROM can be ordered from
  http://www.opengroup.org/pubs/catalog/un.htm
    - ▪ The PDF is free to members of The Open Group
- ❑ Available also on CDROM with *The Authorized Guide to the Single UNIX Specification Version 3*

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UNIX 03 Test Suites

VSTRC
Tracing

VSRTE
Additional
Realtime

VSX4
Core OS

VSX5
C99,LFS,M
SE

VSTH
pthreads

VSU
UNIX
Extensions

VSART
Advanced
Realtime

VSC
Shell
& Utilities

VSXgen - Generic test suite
layer

Test Environment
Toolkit

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Linux Status

❑ Latest versions of *glibc* have implemented much of the Austin Group specification

- C99 Alignment
  - Some differences in the I18N behavior
  - See http://gcc.gnu.org/c99status.html for the latest status

- Concentrated on the XSI mandatory parts of the XSH document

- Remaining differences due to underlying kernel

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Agenda

- **Standards Projects**
  - **POSIX**
  - **The Single UNIX Specification**
  - **The Linux Standard Base**

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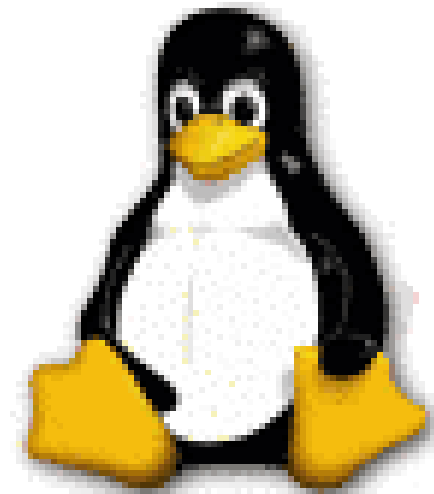
LSB Overview

- Mission & Goals

- Why is the LSB needed?

- Organization

- What LSB does NOT attempt to do & why

- Architectural Overview - How will it work?

- Current LSB Roadmap

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Mission

- The LSB develops and promotes a set of standards that increases compatibility among Linux runtime environments and enables software applications to run on any compliant Linux system.

- In addition, the LSB helps coordinate efforts to recruit software vendors to port and write products for Linux.

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Goals

❑ To preserve backwards compatibility without locking out future progress

❑ To allow runtime environments to still be unique (and provide added value) by only standardizing the base

❑ To avoid fragmentation of the base functionality

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Why is the LSB Needed?

- Allows ISVs to:
  - Minimize issues in porting code from another Linux platform
  - Allows a package to perform the same way regardless of the Linux runtime environment or emulation of such

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Organization

- Steering Committee Chair - George Kraft IV
    - FSG liaisons -Scott McNeil, Dan Quinlan
    - Technical Sub-Committees
        - Written Spec - Technical Lead - Stuart Anderson
        - Test Suites - Technical Lead - Andrew Josey
        - Sample Implementation - Technical Lead - Ralf Flaxa
        - Build Environment – Technical Lead – Chris Yeoh
        - LSB Futures – Technical Lead – Matt Taggart
    - *Plus many volunteers*

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What is not covered?

- It does not mean there will only be one "Linux"
  - One port - multiple platform choices
- It does not specify the kernel level
  - The kernel can be any version that provides conforming interfaces
- It does not cover languages other than C
  - Other languages will be covered over time
  - Possible to statically link libraries for other language bindings or include interpreter

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What is not covered?

- ❑ It does not specify a desktop environment
  - ■ Desktop integration is a work in progress
  - ■ Use desktop independent toolkits (Qt, Gtk)
- ❑ It does not fully cover system administration
  - ■ Settled areas are specified - Others will be added

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LSB Specification

- A *generic, processor-independent* specification
    - The Generic LSB Specification known as the *gLSB*
- One or more processor *architecture-specific* supplemental specifications that build upon the *gLSB* to provide a complete binary specification
    - Known as *archLSB specifications*
    - IA32, IA64, PPC32

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LSB Specification

- Object file formats
- Dynamic linking
- Base libraries
- Utility libraries
- Graphics Libraries
- Packaging

- Commands and Utilities
- Standard Shell
- Users and Groups
- Filesystem Hierarchy
- System Initialization

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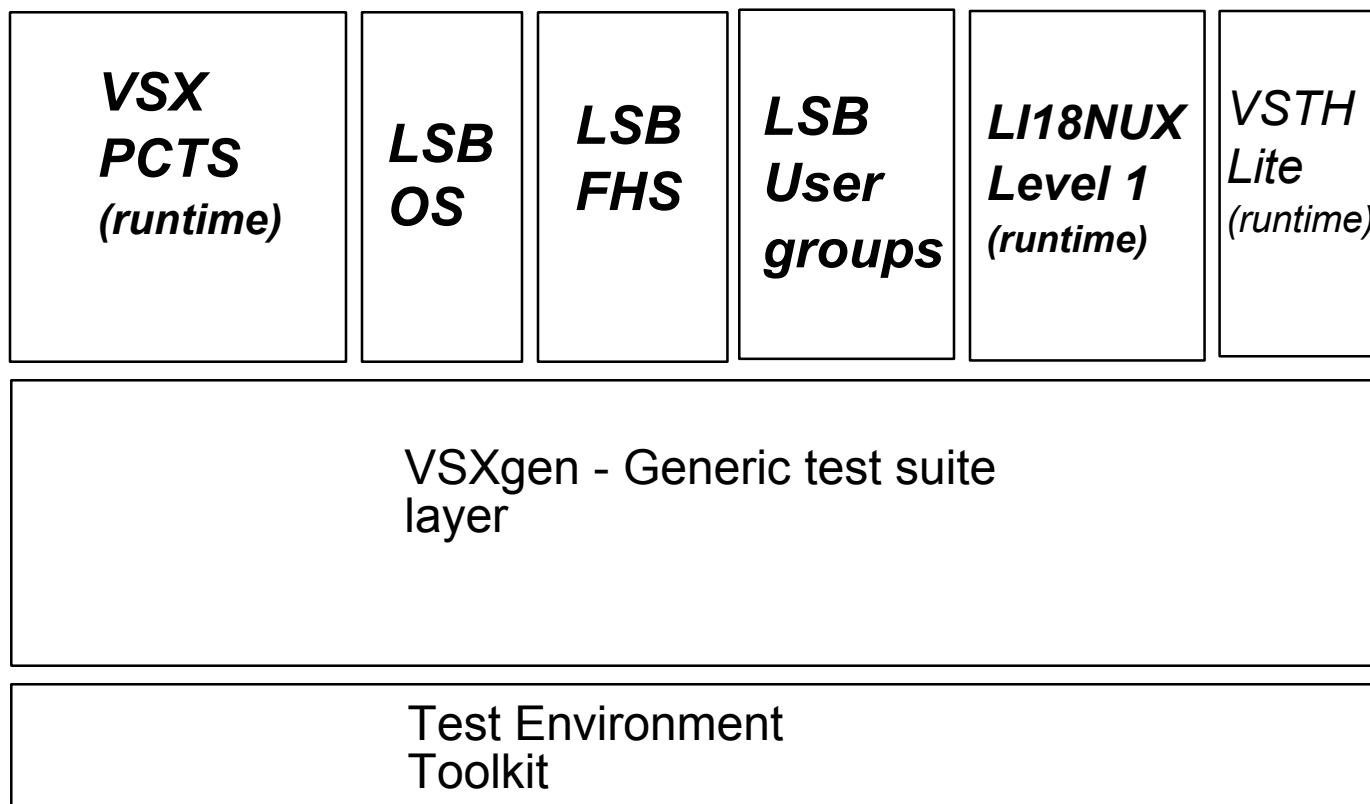
Standards Alignment

❑ **Aligns with industry standards**

- ▪ IEEE Std POSIX 1003.1-1996 (POSIX.1)

- ▪ IEEE Std POSIX 1003.2-1992 (POSIX.2)

- ▪ The Open Group Single UNIX Specification Version 2 (*aka* UNIX 98)

- ▪ AT&T (Caldera/SCO) SVID, Issue 3 1989-2001 (SVID.3)

- ▪ See www.linuxbase.org/spec/gLSB/gLSB/rstandards.html

   36 Specifications referenced at this time

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LSB Milestones

- *gLSB 1.0* Specification published June 2001
- Pilot Beta test program launched August 2001
- *gLSB* 1.1 Specification published December 31 2001
- *archLSB* for IA32 published December 31 2001
- archLSB for IA64 published 2002
- gLSB 1.2 Specification published July 2002
- archLSB for IA32, PPC32, published July 2002
- LSB Certification launched July 2002
- LSB 1.3 Specification Published Jan 2003
- LSB 1.3 Certification Launched Jan 2003

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LSB 1.3 Runtime Tests

VSX PCTS (runtime)	LSB OS	LSB FHS	LSB User groups	LI18NUX Level 1 (runtime)	VSTH Lite (runtime)

VSXgen - Generic test suite layer

Test Environment Toolkit

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The Free Standards Group LSB Certification Program

- ❑ A voluntary program.
- ❑ Open to any product meeting the conformance requirements
- ❑ Not restricted to Linux-based systems or Linux-based applications.
- ❑ Once a supplier has achieved certification for a product, they are permitted to use the LSB trademark in connection with that product.

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Understanding LSB Certification

❑ To become familiar with the LSB Certification program, you should read the following program documents:

  ▪ The *LSB Certification Policy*
  ▪ The *LSB Product Standards*

❑ http://www.freestandards.org/certification/

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The LSB Certification Policy

- ❑ The foundation of the program.
- ❑ Defines the types of products that can be certified.
- ❑ Defines what it means to be certified.
- ❑ Defines what is required to certify a product .
- ❑ Defines how to make sure that a product remains certified.

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LSB Product Standards

❏ The detailed conformance requirements against which a product can be certified.

- A mapping between certification, the LSB specifications and the test suites needed to demonstrate conformance.

- An *LSB Product Standard* for each type of product that can be certified.

❏ Current Product Standards :

- *LSB Application for IA32/PPC32/IA64*

- *LSB Runtime Environment for IA32/PPC32/IA64*

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LSB Certification

- Product Types that can be (currently) certified
  - LSB Runtime Environment Certification
    - For platforms providing services that conform to the LSB specifications.
  - LSB Application Certification
    - For applications conforming to the LSB specifications.
    - LSB applications are the consumers of the services provided by LSB Runtime Environments.

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LSB Application Certification:Test Campaign

❑ The application must execute correctly on the two selected LSB runtime environments and the LSB Sample Implementation

❑ Completion of an LSB Application Conformance Statement

❑ Test Journal output from the LSB Application Checker tool (*lsbappchk*)

❑ For the test journal, any FAIL, UNRESOLVED, UNREPORTED or UNINITIATED results need to be resolved

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LSB Runtime Environment Certification:Test Campaign

❑ Completion of the LSB Runtime Environment Conformance Statement

❑ Test Journal output from the LSB runtime environment test suite

❑ Test Journal output from the LSB Library Checker tool (*lsblibchk*)

❑ For the test journal output, any FAIL, UNRESOLVED, UNREPORTED or UNINITIATED results need to be resolved

❑ For the test journal output, any FIP results need to be manually resolved

❑ A list of the set of binary applications from the LSB Application battery that the applicant warrants works correctly
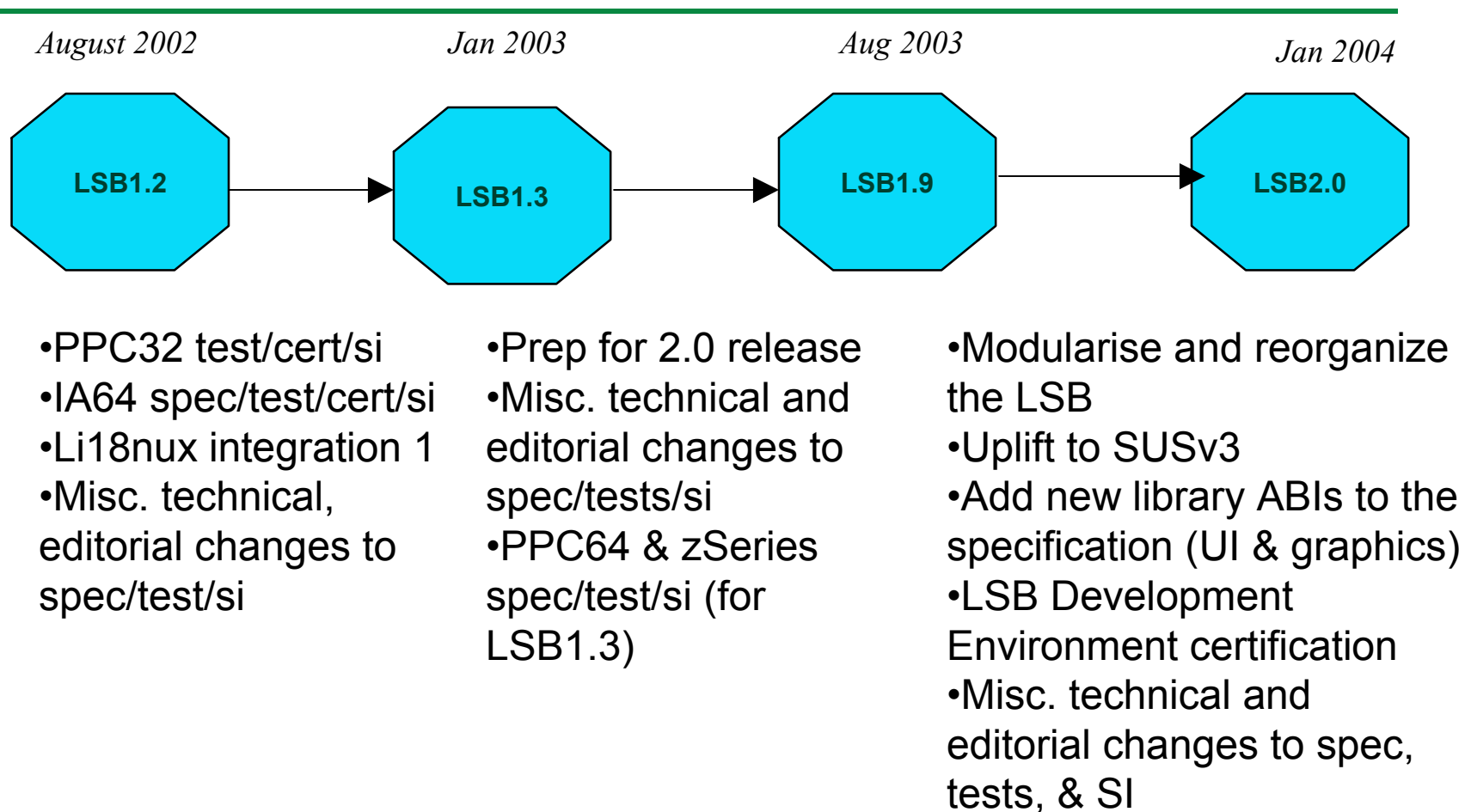
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LSB Certification Status

- 15 Certified Systems
- 8 Suppliers

15 runtime environments
Zero applications

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LSB Roadmap

August 2002 | *Jan 2003* | *Aug 2003* | *Jan 2004*

LSB1.2 → **LSB1.3** → **LSB1.9** → **LSB2.0**

•PPC32 test/cert/si
•IA64 spec/test/cert/si
•Li18nux integration 1
•Misc. technical, editorial changes to spec/test/si

•Prep for 2.0 release
•Misc. technical and editorial changes to spec/tests/si
•PPC64 & zSeries spec/test/si (for LSB1.3)

•Modularise and reorganize the LSB
•Uplift to SUSv3
•Add new library ABIs to the specification (UI & graphics)
•LSB Development Environment certification
•Misc. technical and editorial changes to spec, tests, & SI

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LSB Resources

❑ LSB main site – *www.linuxbase.org*

❑ Free Standards Group – *www.freestandards.org/*

❑ The LSB Specification -*www.linuxbase.org/spec/*

❑ LSB Test

   ▪ *www.linuxbase.org/test/*

❑ LSB Sample Implementation

   ▪ *www.linuxbase.org/impl/*

❑ LSB Futures

   ▪ *www.linuxbase.org/futures*

❑ LSB Certification

   ▪ *www.opengroup.org/lsb/cert/*

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Summary

- ❏ **Standards activities**
  - ▪ alive and ongoing
  - ▪ free to participate in
- ❏ **Significant cross-fertilization of projects**
- ❏ **Significant opportunities to grow the market and prevent fragmentation**

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Further Information

- ❑ *The Linux Standard Base*
  - ▪ *www.linuxbase.org*

- ❑ The Austin Group
  - ▪ *www.opengroup.org/austin*

- ❑ *The Single UNIX Specification*
  - ▪ *www.UNIX-systems.org*

- ❑ *These slides*
  - ▪ *www.UNIX-systems.org/slides.html*

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How You Can Help?

- To participate in the *Austin Group*, join the mailing list by visiting the web site at:
    - *www.opengroup.org/austin*
- To participate in the Linux Standard Base visit:
    - www.linuxbase.org
- To join the Free Standards Group, visit:
    - www.freestandards.org

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