Intel Itanium™ Porting Methodologies

Bill Chen

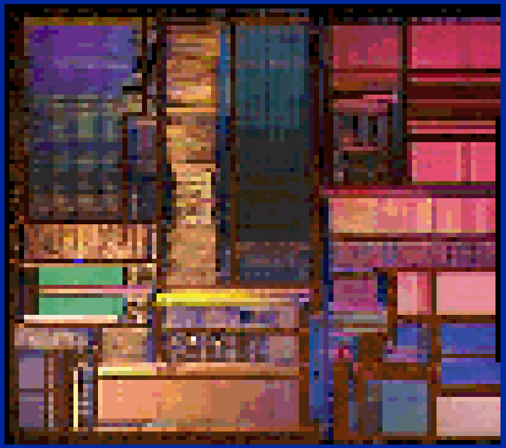
Intel China

Itanium™ Porting

- Why Port to Itanium™?
- Porting Process
- Porting Scenarios
- Porting Concerns
- Availability of porting tools by OS

Why Port to Itanium™?

- 64-bit virtual address space
- Addressing current architecture performance limitations
  - Inefficient parallelism
  - Branching
  - Procedure Calls
  - Memory latency



- Superior multimedia and FP performance

Intel Resources for Porting

- Application Engineer
  - Hands on technical assistance
- Training on SDV (Hardware and Software)
- Question and Answer Database (QuAD)
  - Web-based tech support by Intel experts

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- Application Solution Center (ASC)
  - Lab-based technical assistance

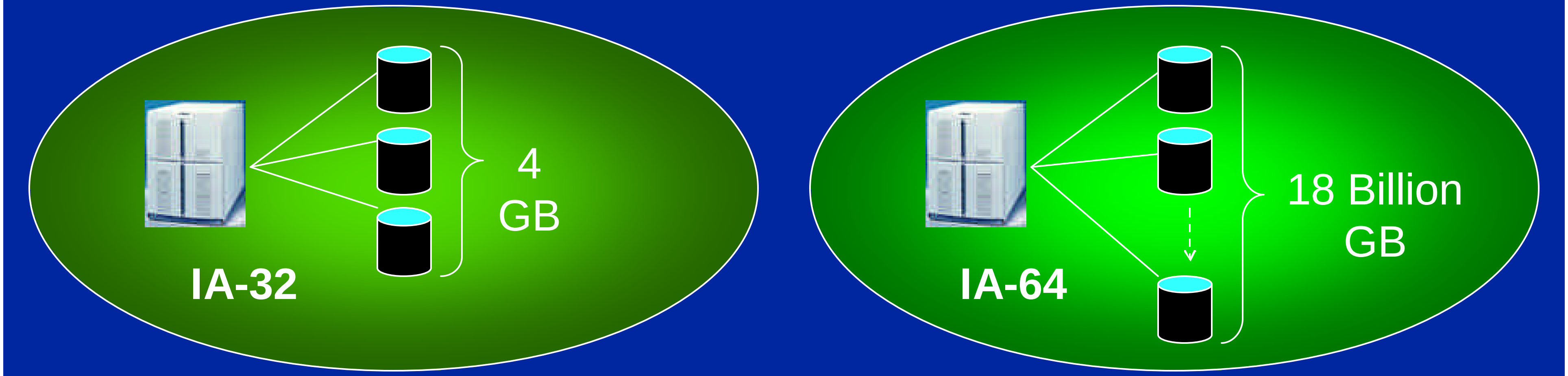
Itanium™ Porting Process

- Assess the Complexity of an Itanium™ Port
  - Identify dependencies
  - Analyze source code

- Develop a Porting Plan
  - Target platforms, training, resources
- Build Itanium™ executables
- Internal and External Testing

Porting Scenarios

- Full port with 64-bit pointers and 2^{64} address space
- Port with 64-bit pointers and <2 GB
- Unmodified IA-32 binaries



Complete full port for optimal performance on Itanium

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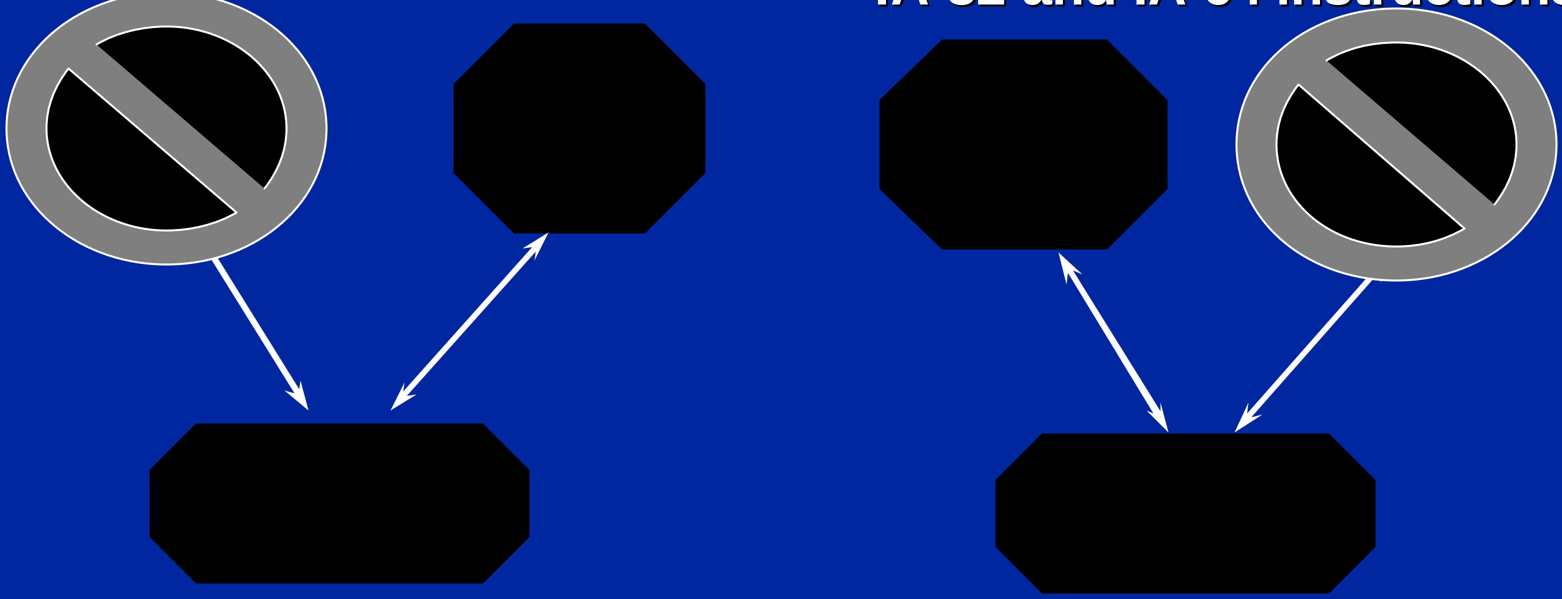
Dynamic Library Interaction

- IA-64 library port
  - The library is being used by both IA-64 32-bit and 64-bit apps, but not IA-32 applications.
- IA-32 library
  - The library can only be used by IA-32 apps.
  - OS does not allow mixing of IA-32 and IA-64 instructions.



Help us identify your 3rd party libraries early

i.e. DLL

Windows & UNIX have diverged

- The 32-bit world: one, happy “ILP32” family
  - `int`, `long`, `void *` (pointer): all 32 bits, UNIX *or* Windows
    - Same (base) types for UNIX and Windows
  - Both have named types derived from the base types
    - UNIX: `pid_t`, `size_t`, `time_t`, `off_t`, ...
    - Win32: `LONG`, `HANDLE`, `WPARAM`, `LPARAM`, ...
- The 64-bit world has differences

OS	Data Model	`int`	`long`	pointer
UNIX/64	I32,LP64	**32**	64	**64**
Windows (Win64)	IL32,P64	**32**	32	**64**

UNIX & Windows *both* tried hard to minimize changes needed in existing source code; different derived type models resulted in `long` being different

C Programming Data Models

- OS Implements the Data Models
- ILP32
  - int, long and ptr are 32 bits
  - Used by 32-bit OSs
- LP64
  - int is 32 bits
  - long and pointer are 64 bits
  - Used by 64-bit UNIX OSs
- P64 (or LLP64)
  - int and long are 32 bits; pointer is 64 bits
  - Used by Win64* and Modesto*

	ILP32 size (bits)	LP64 size (bits)	P64 size (bits)
int	32	32	32
long	32	64	32
pointer	32	64	64

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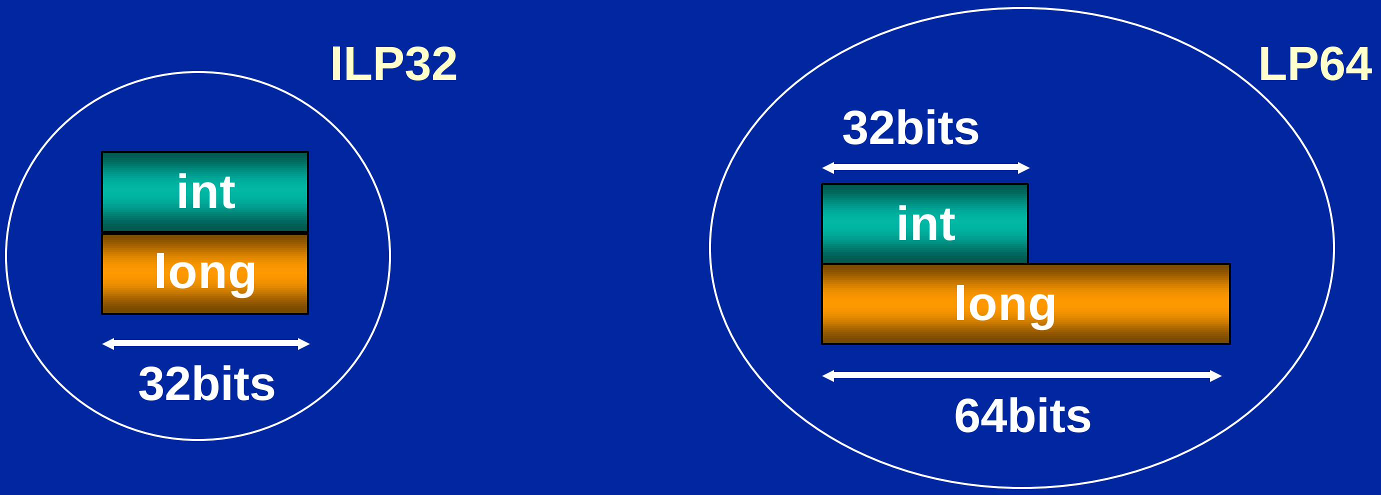
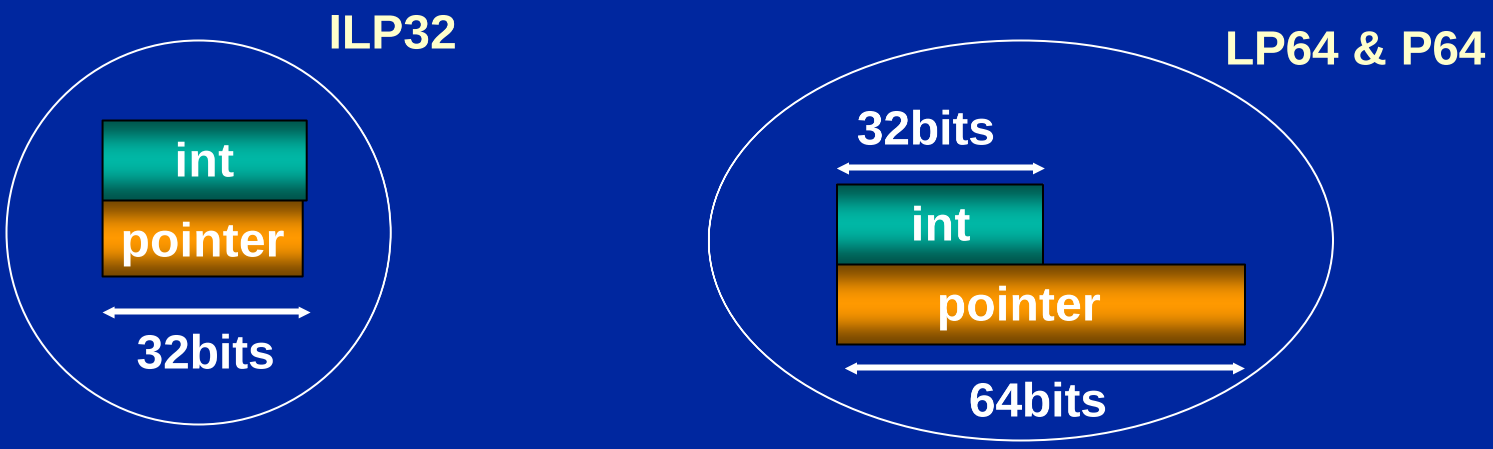
Porting Concerns (UNIX only)

- longs and ints are not the same size
  - Truncation of 64 bit value when assigned to a smaller type
  - Explicit cast improperly applied
  - A int pointer is not compatible with a long pointer
  - Lack of prototyped function declarations in scope of call statements
  - Untyped integral constants are int by default



Porting Concerns

- pointers and ints are not the same size
  - Truncation of a 64 bit pointer when converted to a smaller type
  - Assumption that pointers and int are same size in arithmetic context
  - Pointer return types in the absence of a function prototype



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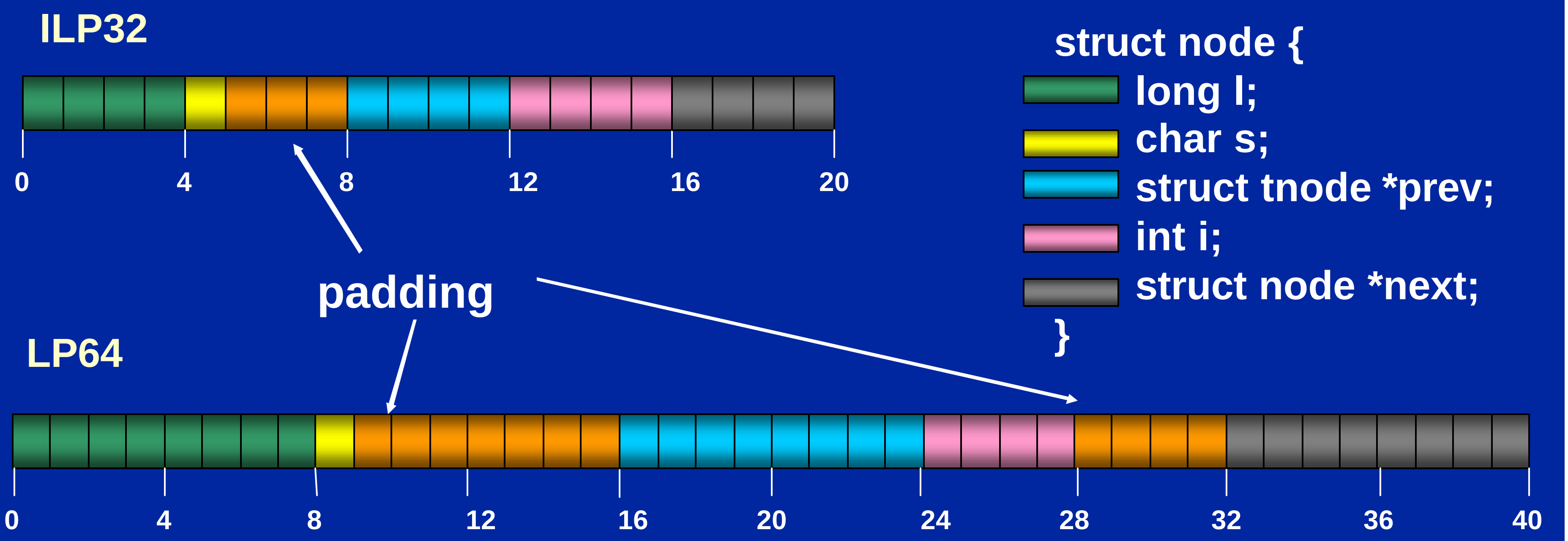
Porting Concerns

- Pointers/longs are 64 bits and 64-bits aligned
  - problems with data sharing because objects grow
  - data could be shared through IPC, network or disk



```
struct node {
🟩 long l;
🟨 char s;
🟦 struct tnode *prev;
🟪 int i;
⬛ struct node *next;
}
```

Porting Concerns

- Usage of undocumented/reserved bit fields
- Fix unguarded “#ifdefs" from defaulting to unwanted code generation
- Assembly code
- Self modifying code
- Portions of code utilizing data-packing

Examples

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Microsoft WinXP* 64-bit Edition

- Porting Tools
  - Windows 2000* Platform SDK
  - Intel and Microsoft* C++ compilers
  - Intel Fortran 90 compiler
  - Intel Enhanced Debugger
  - MigraTEC Migration Workbench

- Links
  - http://www.microsoft.com/windows2000/future/64bit/64bit.asp
  - http://msdn.microsoft.com/library/default.asp?URL=/library/psdk/buildapp/64bitwin_410z.htm

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Linux

- **Porting Tools**
  - HP/Intel: IA-64 Linux Simulator
  - VA Linux Systems: Sourceforge Itanium(tm) Processor Compile Farm
  - Red Hat: GNU tool chain
  - Red Hat Linux 7.1 for the Itanium^{TM} Processor
  - SGI: Pro64(tm) Compiler Development Tools
- **Links**
  - http://www.software.hp.com/ia64linux.htm
  - http://www.sourceforge.net/compilefarm
  - http://www.cygnus.com/ia64
  - http://www.linuxia64.org
  - http://www.redhat.com/products/software/linux/7-1_itanium.html
  - http://oss.sgi.com/projects/Pro64

HP-UX* 11i

- Refer to the other tracks at this event

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Call to Action

- Identify 3rd party dependencies
- Develop porting plan
  - Get your developers trained on Itanium based tools
  - Select porting scenario/model for each application
- Get Software Ready for the hardware

Backup

Examples: Use #if defined appropriately

```
#if defined(_WIN32)
… //  stuff related to Win32
#if !defined(_WIN64)
… //  Win32 without Win64 (regular Win32)
#else /* is _WIN64 also */
… //  Win64 variant of Win32
#endif /* _WIN64 ? */
#elif defined(__unix) || …
… //  various UNIXes
#else /* some other OS */
#error Unhandled OS;
#endif
```

Enhance portability, readability: account for all OSs

Back

Examples: Do not #define constants

```
#define mask 0x37FFC;
```

```
const int mask= 0x37FFC;
```

Problem(s):

- using a #define that the compiler can’t type check

Remedy:

- use ANSI C’s “const”
- use a specific data type
- you’ll get warned if any misuse is attempted

Let the compiler check declarations for you

Back

Examples: Watch for Hex constants

```
0xFFFFFFFF
    // 32-bits: -1, 64-bits: 4,294,967,295
0x100000000
    // 32-bits: 0, 64-bits: 4,294,967,296

const int all1s= 0xFFFFFFFF;
```

Problem(s):

- generating "all 1s" in hex
- using a #define that the compiler *can't* type check
- "-1" in 32-bit system, 4,294967,295 in a 64-bit system

Remedy:

- use ANSI C's "const"
- use a specific data type
  - signed/unsigned
- use type suffixes – "L", "UL"

Count the digits!

Back

Examples: Watch for Pointer truncation

```
mystruct *p;


unsigned int lowBits=
  (unsigned int)p;
  // truncation warning in Win64


unsigned int lowBits=
  PtrToInt(p);
  // truncation warning silenced


p= (mystruct *)lowBits;
```

- only do this if you *really* have to…

Problem(s):

- pointer truncations dirty your compilation listings

Remedy:

- Windows' `PtrToInt()` silences warnings
- see <`basetsd.h`>

Caution:

- Never, ever use data as pointer again; significant bits are *gone*

Be careful if you forcefully silence warnings

Back

Examples: Don’t cast Pointers to integer type

```
char *buf;
…
int i;
…
i= (int)buf;
```

```
uintptr_t ip;
…
ip= (uintptr_t)buf;
```

Problem(s):

- Pointers are bigger than ints in some architectures
- Using `long` won’t help in Win64
- Pointers *logically* unsigned

Remedy:

- Use `uintptr_t`; works on both UNIX and Windows

eliminate *all* cases of `(int)pointer casts`

Back

Examples: printf()format strings

```
long *Pl; // Win32 source
printf(“%08lX->%ld\n”,Pl,*Pl);

#ifdef _WIN64
#define FMTSZ3264 “I64”
#else /* Win32 or UNIX */
#define FMTSZ3264 “l”
#endif
```

Problem(s):

- “l” argument size specifier used with platform-scaled type
- don’t use “%X” for pointers
- “I64” does not scale – it is *not* polymorphic

Remedy:

- use “%p” to print a pointer
- use a macro and adjacent string catenation

```
__int3264 Pl;
printf(“%p->%” FMTSZ3264 “d\n”,Pl,*Pl);
```

Fix printing of pointers and “big” integers

Back

Examples: Don’t use `union`

```
union {
  long l;
  char bytes[4];
  };
...
for (i= 0; i<4; i++) …
```

```
union {
  __int3264 l; // chg w/ architecture
  char bytes[sizeof(__int3264)];
  };
...
for (i= 0; i<sizeof(bytes); i++) …
```

Problem(s):

- union for alternate access method incorrect for 64-bits

Remedy:

- 1st: avoid union if at all possible

else:

- fix primary data type size
- use C `sizeof( )` builtin for array

unions look ugly and cause lots of problems; don’t use them unless necessary

Back

Examples: Appropriate Field Indexing

```
struct S {
  void *pn;
  int ln;
};
S *Ps= new(S);
int i;
i= *(int *)((uintptr_t)Ps + 4);

i= *(int *)((uintptr_t)Ps +
  offsetof(S,ln));
```

padding varies with architecture

Problem(s):

- field offsets can vary across compilers
- any constant added to a pointer should be suspect
- natural alignment differs

Remedy:

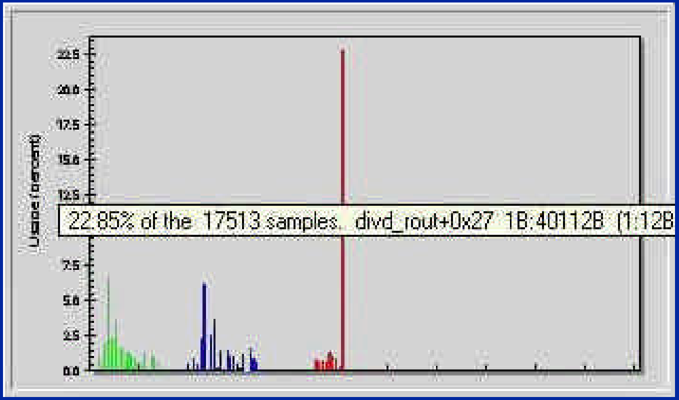
- use ANSI C `offsetof()` macro – ***not sizeof()***

Let the compiler calculate field offsets

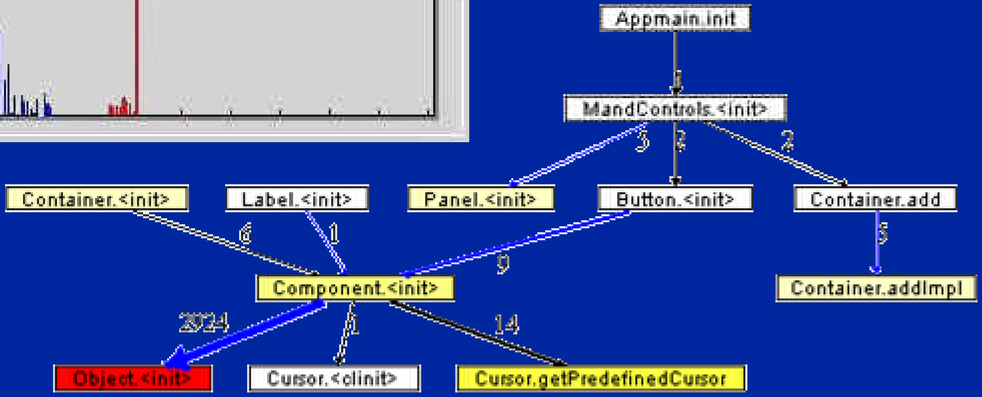
Back

ASC Performance analysis

- Runtime analysis gives an accurate picture
  - application “hotspots”, call graph
- Tools:
  - VTune
  - Quantify
  - APIMON
  - …



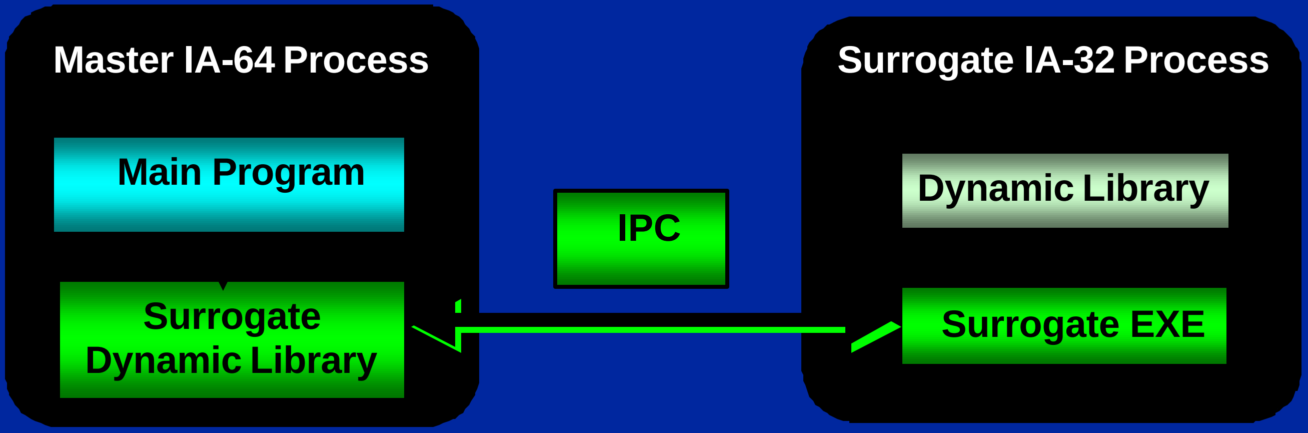
22.85% of the 17513 samples. divd_rout+0x27 1B:40112B (1:12B



Tools can help you pinpoint *best-benefit* spots

Dynamic Library Interaction

- 32-bit library access to 64-bit process through IPC
  - Surrogate binaries can be used to manage the IPC translation with no changes to existing code



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