What is Digital FX!32?

An end-user utility for \textit{Fast} transparent \textit{ execution of Win32} applications on Alpha NT

- \textbf{Transparency}:
  - Apps install & launch \textit{just like x86}.

- \textbf{Correctness}:
  - Apps \textit{just work}.

- \textbf{Performance}:
  - Target is 70\% of native Alpha.
  - On 500 MHZ Alpha: approx. P6 (200)
Step 1. User executes app...

- NT invokes FX!32 Runtime via transparency agent
- Runtime:
  - ñ loads the x86 .exe and associated x86 .dllís
  - ñ queries Database for translated images
- Seeing none, Runtime uses Emulator to run the application, producing:
  - ñ correct application behavior
  - ñ execution profiles
Step 2. In the background...

- FX!32 Server:
  - sees new profile data
  - evaluates whether to optimize
  - invokes Translator

- Translator processes application, producing:
  - translated image in a native Alpha .dll

- FX!32 Server manages execution profiles and translated images:
  - merging, purging, etc.
Step 3. User executes app again

- NT invokes FX!32 Runtime via transparency agent
- The Runtime:
  - ñ loads the x86 .exe and associated x86 .dllís
  - ñ queries Database for translated images
- Seeing some, Runtime:
  - ñ loads translated .dllís
  - ñ uses optimized Alpha code when available
  - ñ uses Emulator otherwise
New Features

- A new style of user interface (No commands)
- A long term profile data base (Per user per program kept automatically and out of sight)
- A translator that converts important parts of a program to native code (in the background)
- It's not a JIT
- It's a JAC (Just After Compiling)
Transparency Agent

- Provides transparent execution of 86 applications
- No user commands required
- Present in all Alpha processes
- Invokes FX!32 Runtime to execute x86 images
- Acts like an extension to the OS, but it's user level code
FX!32 Agent

- Enables processes - starting with login shells and servers
- Loops through all the images in the process into which it is loaded and hooks APIs.
  - `CreateProcess`
  - `LoadLibrary`
  - `FreeLibrary`
  - `LoadModule`
  - `WinExec`
  - `GetProcAddress`
  - `GetPrivateProfileString`
FX!32 Agent

- CreateProcess
  - Determines if x86 image by looking at image header
  - If not x86 image, creates the process and injects self if image is "injectable"
  - If x86 image, starts FX!32 to run image
FX!32 Agent

- GetProcAddress
  - ñ Hooks APIs accessed by GetProcAddress
- FreeLibrary/LoadLibrary
  - ñ For x86 images calls FX!32 FreeLibrary
- GetPrivateProfileStringA
  - ñ Returns original shell when called with parameters `ìBOOTî, `ìShellî.`
Emulator

- Interprets x86 code
- Allows calls to translated routines and jackets
- Collects profile data
- Written in Alpha assembler - Icache aware
- x86 state maintained in Alpha registers
- Caches used for profiling
- x86 registers (also in Alpha registers)
- Condition code state (also in registers)
- FP status and control words
Run Time Jackets

- If a native version of a library routine exists, a jacket routine is used to convert arguments and make the native call.
- FX!32 jackets 40 DLLS, 12,000 WIN32 call APIs.
- An application that makes a lot of GUI calls can spend half of its time in native code.
- Most jackets are generated automatically from header files. Some are hand built, some are generated on the fly.
Generation of Profiles

Profiles contain information about addresses
- Call targets
- Targets of indirect control transfers
- Unaligned memory accesses
FX!32 Server

- Implemented as a regular NT service
- Merges run profiles into cumulative profile
- Runs translator when needed
- Maintains profiles & translated images
- Can share translation results
FX!32 Translator

- Need to find routines (based on profile)
- Only translates routines that were executed
- Translates most heavily executed code first
- No type information
- Uses profile data to determine alignment
- Cannot count on any call argument rules (or much else)
  e.g., programs can reach up into parent's stack and change something
Whatís Running Today

| 4nt | Adobe Photoshop 3.05 | MicroRim Rbase 5.1 |
| Arm2 | Arm2 | Microsoft Access 7.0 |
| Boggle | Boggle | Microsoft Excel 7.0 |
| Borland Paradox 7.0 | Borland Paradox 7.0 | Microsoft FrontPage 1.0a |
| CodeWright 4.0 | CodeWright 4.0 | Microsoft Office95 Pro |
| CorelDraw 6.0 | CorelDraw 6.0 | Microsoft Powerpoint 7.0 |
| CRT 1.1 | CRT 1.1 | Microsoft Publisher 3.0 |
| Dispalc | Dispalc | Microsoft Schedule95 7.0 |
| Drag and file 2.0 | Drag and file 2.0 | Microsoft Visual Basic 4.0 |
| Drag and View 1.22c | Drag and View 1.22c | Microsoft Word 6.0 |
| Drag and zip 1.14a | Drag and zip 1.14a | Microsoft Word 7.0 |
| Fury 3.0 | Fury 3.0 | Netscape Navigator 2.01 |
| Hangman | Hangman | O'Reilly Website |
| Harvard Graphics 4.0 | Harvard Graphics 4.0 | Persuasion |
| KAI Power Tools | KAI Power Tools | Pixfot32 |
| Klotz | Klotz | Polyview |
| Live Markup | Live Markup | Solitaire |
| Lotus Notes 4.0 client | Lotus Notes 4.0 client | Stonehenge |
| Mathcad 6.0 | Mathcad 6.0 | TinyCAD |
| Mazelord | Mazelord | Visio Technical 4.0 |
| MicroEmacs | MicroEmacs | Visual Reality 2.0 |
| MicroGrafix ABC Flowcharter 6.0 | MicroGrafix ABC Flowcharter 6.0 | Visual Slick Edit |
| MicroGrafix ABC Graphics 6.0 | MicroGrafix ABC Graphics 6.0 | WinVN 0.99.7 |
| MicroGrafix Design | MicroGrafix Design | WinZip 6.1 |
| Corel Xara | Corel Xara | Adobe Acrobat |
| CU-SeeMe | CU-SeeMe | Corel Xara |
| DacEasy Accounting Payroll | DacEasy Accounting Payroll | Corel Xara |
| DeltaGraph Pro 3.5 | DeltaGraph Pro 3.5 | Corel Xara |
| Frame FrameMaker | Frame FrameMaker | Corel Xara |
| LiveView Pro | LiveView Pro | Corel Xara |
| Macromedia Freehand | Macromedia Freehand | Corel Xara |
| Microsoft Money95 | Microsoft Money95 | Corel Xara |
| Microsoft Works | Microsoft Works | Corel Xara |
| Mosaic V2 | Mosaic V2 | Corel Xara |
| Novell WordPerfect 6.1 | Novell WordPerfect 6.1 | Corel Xara |
| Street Atlas USA 3.0 | Street Atlas USA 3.0 | Corel Xara |
| Visual FoxPro | Visual FoxPro | Corel Xara |
| Adobe PageMaker 6.0 | Adobe PageMaker 6.0 | Corel Xara |
| Microsoft Encarta Encyclopedia | Microsoft Encarta Encyclopedia | Corel Xara |
| Microsoft Golf95 | Microsoft Golf95 | Corel Xara |
| Ray Dream Designer 4.0 | Ray Dream Designer 4.0 | Corel Xara |
| RoboHelp95 3.7 | RoboHelp95 3.7 | Corel Xara |
| Tcl/Tk | Tcl/Tk | Corel Xara |
| ThumbsPlus32 | ThumbsPlus32 | Corel Xara |
| Trispectives | Trispectives | Corel Xara |
| Visual Software Instant 3D | Visual Software Instant 3D | Corel Xara |

...and many more
Digital FX!32: Canít Do It All

- Win16 unsupported
- Drivers unsupported
- Debug API unsupported
Licensing Issues

- None with Digital FX!32!
- **CANNOT** run application on Alpha without original x86 code
  - Digital FX!32 enforces same software license as the original application
  - Translated code can be moved around freely, but useless without original application
- Vendors can rest easy that their intellectual property is safe