Building Well-Performing Autodesk® AutoCAD® Applications

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Agenda

- ## Designing for performance
  - AutoCAD's interaction with Windows and user
  - AutoCAD's interaction with your code
  - Using threads, asynchrony
  - Deciding between C++/.NET/VBA/Lisp/JavaScript
- ## Measure, measure, measure
  - Profilers
  - Using Windows Performance Toolkit
  - Using AutoCAD events
  - Adding your own custom events
  - AutoCAD Performance Reporting Tool

Designing for performance

AutoCAD's interaction with Windows

- ## AutoCAD is like any other Windows application:
  - It has a UI thread with a _message queue_.
  - It has a _message loop_.
  - Each window has a _window procedure (message handler)_ implemented by
    - AutoCAD

  or
    - your code directly.

AutoCAD's interaction with your code

- Window procedures of AutoCAD call your code
  - Enter key event → your command handler
  - Mouse move → drag sample, input point monitor
  - Some built in command → 1. virtual functions on custom object
                                              2. reactor events
                                              3. overrules
  - Your code has a time "budget"
    - It isn't always easy to determine how much budget you have
    - Windows will mark a window "(Not Responding)" after about 5s.
    - Understanding the contexts in which your code is called is critical

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Understanding the context of your code

What frequency does your code get called?

- Once per document?
- Once per command? Is your code a command?
- Once per each object in the selection?
- Once per each drawing object?
- Once for each frame?
- Once per mouse move?

- Can you narrow the scope when you hook events?
  - The code that is not engaged is the fastest

Understanding your code

- What is the complexity of your code?
    - Constant?
    - Linear with the number of objects? Quadratic? Worse?
    - Can it be parallelized?

Threading, asynchrony

- AutoCAD API can only be accessed from the UI thread
- You can still use threads
  - Make sure that you don't call into AutoCAD APIs
  - Return to the main thread via the message loop: post a message when you want the main thread to do something
- Using multiple processes is often the right answer
  - You can build your own RealDWG host app
  - You can use AcCoreConsole.exe
  - You can use acad.exe

Choosing the right implementation

- ## Different development environment have different performance potential
    - C++ - fastest
    - .NET – faster
    - VBA - good
    - Lisp - good
    - Out of process COM – slow, but runs in separate thread, process
    - JavaScript – slow, but runs in separate thread, process

Measure, measure, measure

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Profilers

- Profilers are tools that help measure software performance
- They record events
- A record usually contains
  - Timestamp
  - Name
  - Call stack
  - Other parameters

Popular profilers, profiler types

- ## Sampling profiler
  - ### Visual Studio
- ## Instrumenting profiler
  - ### Visual Studio
- ## CPU event profiler
  - ### Intel Vtune
- ## OS event profiler
  - ### Windows performance Toolkit

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Sampling profiler

- Records the callstack at a certain frequency
- Lot of samples with the same callstack → the CPU spent lot of time there
- Drawbacks:
  - When a thread is blocked you get no samples → sampling profiler is not useful for scenarios that are not CPU bound
  - Call count of a function is unknown
- Visual Studio provides a sampling profiler

Instrumenting profiler

- Records callstack every time a function is entered/exited → functions with high call count or long duration are easy to identify
- Drawbacks:
  - The instrumentation can skew the profile
  - Requires a modified program
- Visual Studio provides a instrumenting profiler

Demo

CPU event profiler

- Records CPU events (cache misses, branch mispredictions etc.) →provides insight why a function is slow
- Drawbacks:
  - Requires detailed knowledge of the modern CPU
- Intel Vtune gives you everything you want to know

OS event profiler

- Records events in the OS and applications → provides global picture
- Drawbacks:
  - Massive amount of data, requires sophisticated tool to make sense of it
- Windows Performance Toolkit is the profiler to optimize Windows apps.

Windows Performance Toolkit

- Provides tools to record and visualize events
  - To record: xperf.exe, wpr.exe, wprui.exe
  - To visualize: wpa.exe
- Built on Event Tracing for Windows (ETW)
- Every major subsystem in Windows provides events:
  - Time-based samples
  - Thread context switch, ready-thread
  - Disk I/O, File I/O
  - Network activity
- Applications can add their own events

AutoCAD event provider

- AutoCAD offers events since AutoCAD 2012
- They are undocumented because they may change from release to release
  - The most useful ones will be highlighted here
- The event manifest is installed with AutoCAD
  - See acad-etw.man

AutoCAD events

- Command start/end
- LoadModule start/end
- AcGiDrawable-viewportDraw start/end
- AcGiDrawable-worldDraw start/end
- AcDbImpObject-objectRecordIn start/end
  - The time it takes to create an object
  - Read its data from disk
  - And call AcDbObject::dwgInFields (overridden by derived class)

AutoCAD events (continued)

- ## Doc start/setCurrent/onActivate/Activated/end
  - ### Tracks creation, destruction
  - ### Tracks when a document is made current or active
- ## SysvarList
  - ### Lists all the sysvars and their values
- ## AcRxClassLifetime
  - ### Tracks the construction/destruction of AcRxClass objects
  - ### Useful to figure out the class in AcGiDrawable events

Demo

Custom events

- You can add your own events
  - Timestamp
  - Callstack
  - Whatever data you want
- .NET: System.Diagnostics.Tracing.EventSource
- C++: EventWrite function
- They are correlated with all the other OS and AutoCAD events

Custom event parser

- Useful when the wpa.exe falls short
- [.NET library](#) to parse events

AutoCAD Performance Reporting Tool

- https://beta.autodesk.com/callout/?callid=C5C0C22717284DB98EFC275106F7D572
- Works with AutoCAD 2014 and later
- It collects events from Windows and AutoCAD
- Uploads the ETL file
- We are looking at these reports to figure out where to invest

Q & A