CS-360
GUI & Windows Programming

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Computer Science Department
SUNY Binghamton
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MWF, 10:50-11:50 A.M.
S2-337

Course Information

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- Email: reckert@binghamton.edu
- http://www.cs.binghamton.edu/~reckert/
  - CS-360 link for syllabus, notes, programs, assignments, etc.
- Class Listserv:
  - cs360-L@listserv.binghamton.edu
- TA Information: TBA

Course Prerequisites

- CS-220, Computer Organization and Assembling Language Programming
- CS-240, Data Structures
- Some knowledge of C or C++ helpful
  - Not essential

Text Book Information

- Required:
  - Deitel, et.a., "C# for Experienced Programmers, PH/Pearson, ISBN 0-13-046133-4
- Recommended:
  - Kate Gregory, "Special Edition Visual C++ 6 .NET" Que, 2002, ISBN 0-7887-2466-9
- Many Books on Reserve

Evaluation

Programming Assignments	45%
Term Examinations (2)	40%
Final Project	15%

Policies

- Assignments
  - Individual
  - Due on due date, but can be turned in to CS-360 drop drawer outside CS Department any time that day or night
  - 5% off for every day late
    - Weekends and holidays not included
  - No assignments accepted more than one week late
- Originality
  - Any work found to be copied will be grounds for an F in the course

Course Schedule (weekly)

1. Intro to GUIs & Windows Programming
2. Using Visual Studio,Win32 API Programming
3. MFC Programming: App/Window &Doc/View Approaches
4. Visual Studio .NET & C#, Windows Forms, Events, Essential Structures
5. Graphics, Animation, Timers, DateTime
6. Mouse, Images, Bitmaps
7. Text, Fonts, Keyboard, Printing
8. Pages & Transformations, Menus

Course Schedule (continued)

9. Controls: Buttons, Labels, TestBoxes, Scrollbars, Listboxes
10. Dialog Boxes, Common Dialog Boxes, File/Stream I/O
11. Clipboard, Multimedia
12. Network Programming, TCP/IP Sockets
13. Data Bases and ADO.NET, Web Matrix
14. XML, Web Forms, Web Controls, ASP.NET
15. ASP.NET Web Services
16. The X Window System

Introduction To GUIs and Windows Programming

User Interfaces

- Connection between the computer and the user
- Two types:
  - Command Line
  - GUI--Graphical (Visual)

Command Line Interfaces

- User types commands ==> must remember
- Results Scroll by
- Text-based
- “Interactive” but hard to use
- No direct interaction between user and screen

Visual (Graphical) Interfaces

- Show Graphical Objects on screen
  - e.g., images, icons, buttons, scroll bars
- User interacts using pointing device
- Intuitive
  - Objects can be dragged, buttons pushed, etc....
- Better way of using screen space
  - Panes can overlap
  - Underlying panes can be brought to forefront
  - Desktop metaphor (like papers on a desk)
    - Well, not exactly!

Graphical Interfaces, Continued

- Use graphics to organize user workspace
- Environment allows many tasks to be performed simultaneously
- Different tasks share screen space
- Visually rich way of conveying information
- WYSIWYG display of documents

Main Feature of GUIs:

- THE WINDOW
  - Rectangular area of screen onto which a program draws text and graphics.
  - User interacts with program using pointer device to select objects inside.
  - Some window components:
    - border, title bar, client area, menu bar, tool bars, scroll bars, max/min/close buttons, etc.

Brief History of GUIs

- 1968: ARPA-funded Stanford Research Center (Doug Engelbart)
- First windows (screen sliced up into overlapping panes)
- Only textual information
- Underlying windows could be popped to the top
- Selection done with light pen
- Invented the mouse

Xerox PARC--Alto Computer

- 1970s
- First GUI
- Cursor tracked position of mouse
- WYSIWYG
- Windows with precise text
- Displayed more than just text
- First interactive painting program
- Technology "acquired" by Apple

Recent History (PCs)

- 1977: Radio Shack TRS-80, Commodore Pet, Apple II
- 1981: IBM PC, DOS
- 1983: Apple Lisa (failure)
- 1984: Apple Macintosh--standard for GUIs
- 1985: Microsoft releases Windows 1.0
  - Difficult to program
  - Prone to crashing
  - Needed hardware not yet available
- 1987: Windows 2.0
- 1988: Windows/386 (Virtual 86 mode on 386==>multiple DOS sessions in windows)

Recent History (Microsoft)

- 1990: Windows 3.0
  - 80x86 protected mode, up to 16 Meg memory, cooperative multitasking
- 1992: Windows 3.1, Windows for Workgroups 3.11
  - TrueType fonts, multimedia, protected mode only; Networking
- 1993: Windows NT
  - 32-bit flat memory space, 16 MB, thread-based pre-emptive multitasking, separate from DOS, multi-platform, networking, secure)

Recent History (Microsoft)

- 1995: Windows 95
  - Runs on 4 Meg, long file names, plug and play, new controls, new desktop/window style
  - Hybrid 16/32 bit OS, depends on DOS, lacks security of NT
- 1998: Windows 98
  - Integrated Web functionality
- 2000-01: Windows 2000, ME, XP
  - Upgrades of 95-98-NT
  - 95->98->Me->XP Home: for home use
  - NT->2000->XP Professional: for businesses
  - XP:
    - fancier user interface; latest multimedia (DVD); upgraded web capabilities; improved help (remote); improved performance & security

Recent History (Microsoft)

- 2000: The Microsoft .NET Initiative
  - A new paradigm for Windows distributed applications
  - Independence from specific language or platform
    - Applications developed in any .NET compatible language
      - Visual Basic .NET, Visual C++ .NET, C# and more
    - Programmers can contribute to applications using the language in which they are most competent
  - Architecture capable of existing on multiple platforms
  - New program development process
    - Provides increased productivity
    - Vision for embracing the Internet in software development
  - New way of designing & creating applications that share work between components (local and distributed over the internet)

Other GUI-Windowing Systems

- IBM OS/2: Presentation Manager
- Sun Microsystems: Java
  - AWT
  - Swing
  - Platform independent
  - JDK is free
- The X Window System
  - Developed at MIT, late 1980s
  - Networked graphics programming interface
  - Independent of machine architecture/OS (but most used under UNIX)

Course Content

- Microsoft Windows Visual Studio .NET
  - Using Microsoft Developer Studio (Visual Studio .NET)
  - Win32 API Programming and MFC Programming using Visual C++
  - The .NET Framework: Programming Windows Forms, Web Applications, Web Services, and Data Base Applications using C#
  - Introduction to X-Windows Programming
  - Example programs and notes online at:
    - http://www.cs.binghamton.edu/~reckert/
    - "CS-360" link

Windowing Systems Features

- Consistent user interface
  - Display within a window
  - Menus to initiate program functions
  - Make use of child window "controls":
    - predefined windows used with main program window
    - examples: buttons, scroll bars, edit controls, list boxes, drop-down list boxes, combo boxes
    - Dialog box--popup window containing several controls

Consistent User Interface, continued

- Programs have same look and feel
- Same built-in logic to:
  - draw text/graphics
  - display menus
  - receive user input
    - controls, dialog boxes, use of mouse

Multitasking

- Every program acts like a RAM-resident popup
- Programs run "simultaneously"
- Each program occupies its own window
  - User interacts with program in its window
- User can switch between programs

Windows Multitasking Features

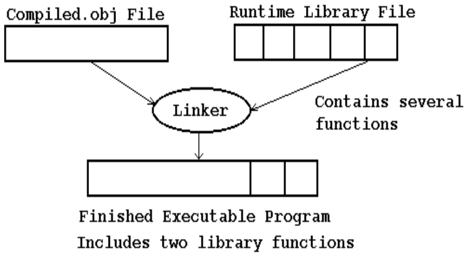
- Cooperative (Windows 3.xx)
  - Programs give up control so others can run
  - Programs coexist with other programs
- Preemptive (Windows NT, 95, 98, XP)
  - Thread-based: System timer allocates time slices to running program threads
- Under both systems, code is moved or swapped into and out of memory as needed

Windows Memory Management

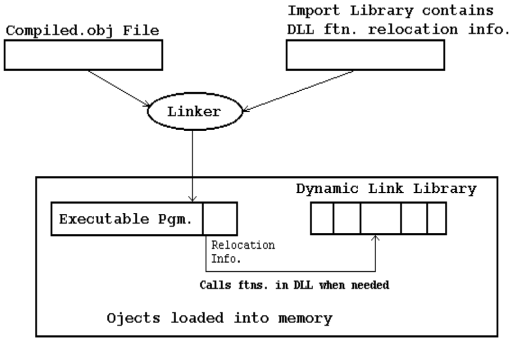
- Older versions: 16-bit, segmented memory
  - Dictated by processor architecture
  - Hard to program
- Newer versions: 32-bit, flat memory model
  - Easier to program
- As old programs terminate, new ones start
  - Code swapped into and out of memory
  - Windows does this automatically
- Programs can share code located in other files (Dynamic linking)

Static vs. Dynamic Linking

- Static Linking
  - code incorporated into executable at link time
- Dynamic Linking
  - Code is put into separate modules
    - These are loaded at run time
  - Linker generates relocation information
    - Only that is put into executable
    - Smaller programs
  - DLL loaded when needed
  - Relocation info used to get DLL function code as needed


Compiled.obj File
Runtime Library File
Linker
Contains several functions
Finished Executable Program
Includes two library functions

Static Linking


Compiled.obj File
Import Library contains DLL ftn. relocation info.
Linker
Dynamic Link Library
Executable Pgm.
Relocation Info.
Calls ftns. in DLL when needed
Ojects loaded into memory

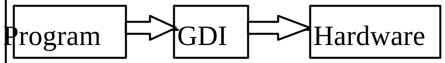
Dynamic Linking

Pros/Cons of Dynamic Linking

- Smaller programs (code is not in program)
- DLL can be used by many programs with no memory penalty
  - Only loaded once!
- Disadvantage--DLL must be present at run time ==> no standalone programs
- Most of the Windows OS is implemented in DLLs

Device Independent Graphics

- Windows programs don’t access hardware devices directly
- Make calls to generic functions within the Windows ‘Graphics Device Interface’ (GDI)
- The GDI translates these into HW commands



Windows API

- The interface between an application and Windows
- A library of functions Windows programs can call
- Several versions
  - Win16 (16 bit apps for Windows 3.xx)
  - Win32 (32 bit apps for Windows NT/95/XP)
  - Win32s (patches Win16 to create 32 bit apps that run under Windows 3.xx)

Classical Win32 API Windows programming

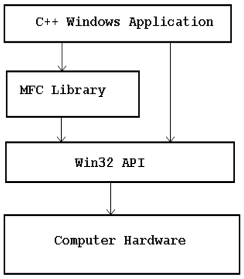
- Use C to access raw API functions directly
- No C++ class library wrappers to hide API
- Hard way to go, but most basic
- Faster executables
- Provides understanding of how Windows and application program interact
- Establishes a firm foundation for MFC and .NET programming

Class-based Windows Programming

- Microsoft Foundation Class Library (MFC)
- Microsoft .NET Framework Class Library (FCL)
- Borland’s OWL Library
- Characteristics:
  - Encapsulate the API functions into classes
  - Provide a logical framework for building Windows applications
  - Object Orientation means reusable code

MFC Library

- Microsoft’s C++ Interface to Win32 API
- O-O Approach to Windows Programming
- Some 200 classes
- API functions encapsulated in the MFC
- Classes derived from MFC do grunt work
- Just add data/functions to customize app
- Provides a uniform application framework



The Relationship between Windows MFC and Win32 API Programming

Microsoft Visual Studio

- Developer Studio IDE (Interactive Designer)
- 3 Windows application development systems
  - C/C++ programs using Win32 API
  - C++ programs using MFC
  - Multilanguage program development using .NET Framework Class Library & the CLR
- Some Developer Studio IDE Components
  - Text/Resource Editors
  - C, C++, C#, Visual Basic, J#, etc. Language Compilers
  - Resource Compilers
  - Linker
  - Debugger
  - Wizards
  - On-line Help

Microsoft .NET

- What is it?
  - A platform to run code on
  - A class library of code that can be used from any language (FCL)
  - New programming interactive development environment
  - A set of server products
  - New way of designing & creating applications that share work between components (local and distributed over the internet)
- You can get it free from the Watson School Microsoft Academic Alliance
  - It's huge!

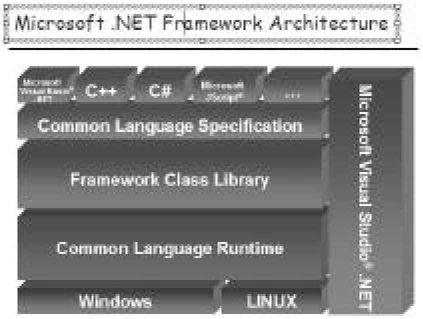
.NET Framework

- Platform for developing distributed applications for the Internet
- Design Goals:
  - Provide high degree of language interoperability
  - Provide a managed runtime environment
  - Provide simple software deployment & versioning
  - Provide high-level code security through code access security & strong type checking
  - Provide consistent object-oriented programming model
  - Facilitate application communication by using industry standards such as SOAP & XML
  - Simplify Web application development with ASP .NET
  - Facilitate Data Base access with ADO .NET
  - Provide high performance and easy scalability

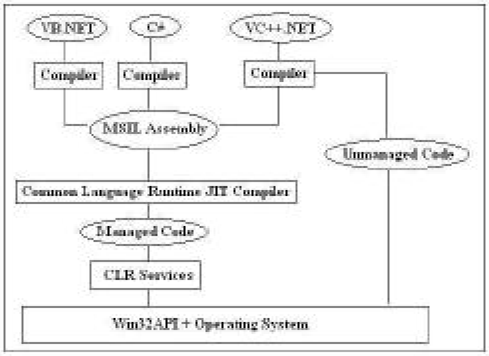
Components of .NET

- The .NET Framework Class Library (FCL)
  - Organized into namespaces (like packages in Java)
  - Handle things like: Data, IO (simple & file), Windows Forms, Web Forms, Windows Controls, User Interfaces, Drawing, Threading, Exceptions, Networking, Web Services, Data Bases (ADO), XML, ASP, Security, Collections, … lots of others
- Common Type System (CTS)
- Common Language Specification (CLS)
- Common Language Runtime (CLR)

.NET Architecture


Microsoft .NET Framework Architecture
Microsoft Visual Basic® .NET
C++
C#
Microsoft JScript®
...
Common Language Specification
Framework Class Library
Common Language Runtime
Windows
LINUX
Microsoft Visual Studio® .NET

Compilation in the .NET Framework



.NET Framework and the Common Language Runtime

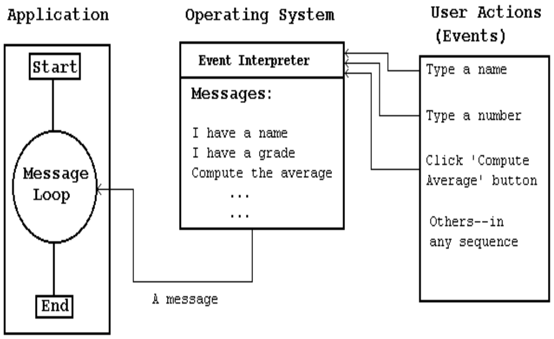
- Why two compilations?
  - Platform independence
    - .NET Framework can be installed on different platforms
    - Execute .NET programs without any modifications to code
  - Language independence
    - .NET programs not tied to particular language
    - Programs may consist of several .NET-compliant languages
    - Old and new components can be integrated
- Other advantages of CLR
  - Execution-management features
    - Manages memory, security and other features
      - Relieves programmer of many responsibilities
      - More concentration on program logic

Sequential Programming (Console Applications)

- Standard programming--program solicits input (polling loop)
- Approach follows a structured sequence of events
- Example--averaging grades:
  - Input name
  - Input first grade
  - Input second grade
  - Input third grade, etc.
  - Calculate average
  - Output average

Event-Driven Programming

- Designed to avoid limitations of sequential, procedure-driven methodologies
- Process user actions (events) as they happen: non-sequential
- Program doesn't solicit input
- OS detects an event has happened (e.g.., there's input) and sends a message to the program
- Program then acts on the message
- Messages can occur in any order



The Event-Driven Programming Paradigm

Sequential vs. Event-Driven Programming

- Standard Sequential programming:
  - Program does something & user responds
  - Program controls user (the tail wags the dog)
- Event-Driven Programming:
  - Used by Windows
  - User does something and program responds
  - User can act at any time
  - User controls program
    - the dog wags the tail
  - OS really is in control (coordinates message flow to different applications)
  - Good for apps with lots of user intervention