ECE4893A/CS4803MPG: Multicore and GPU Programming for Video Games

Walkthrough of an XNA 2D Game

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2D games

- Using "Sprites"
  - All textures
  - Simple to make or obtain
- Early games before the 3D revolution
  - Space Invaders, Lode Runner, Donkey Kong, Pac-Man
- Do not require high performance accelerators
- Simple enough for your grandparents to enjoy

- Easy to do using XNA framework
- No "effect" (.fx) used

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Prof. Lee's game: DawgShower

- Shoot the bad dawgs!
- Consist of four main objects
  - The shooter (ship.cs)
  - The bad dawgs (meteros.cs)
  - The missile (missile.cs)
  - Music (AudioComponent.cs)

- The moving objects are all made of sprites

Adapted from Chapter 3 of A. Lobao, B. Evangelista, and J.A. Leal de Farias, "XNA 2.0 Game Programming: From Novice to Professional"

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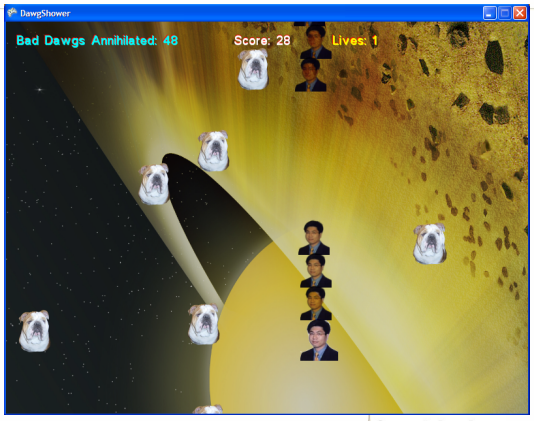
Screenshot



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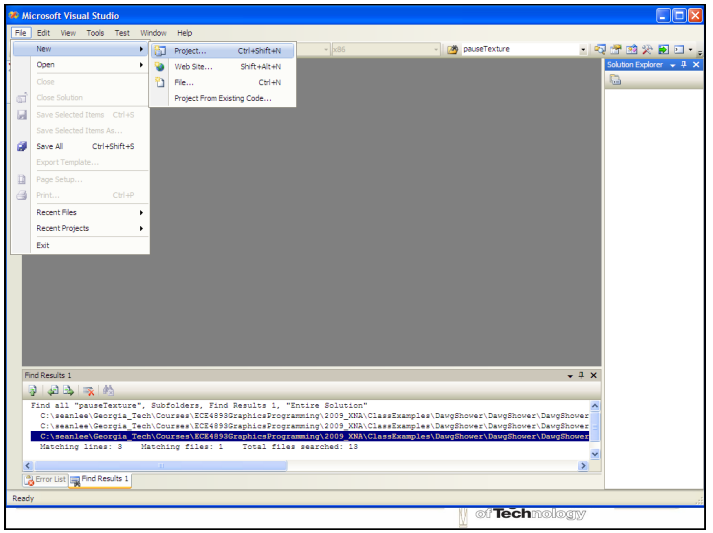
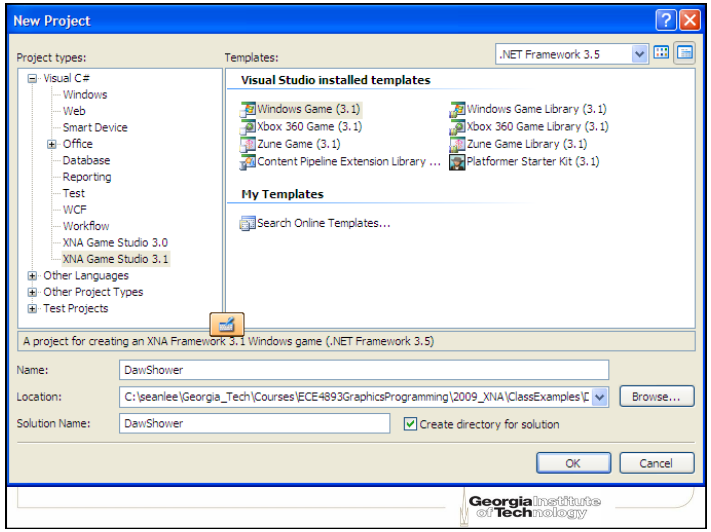
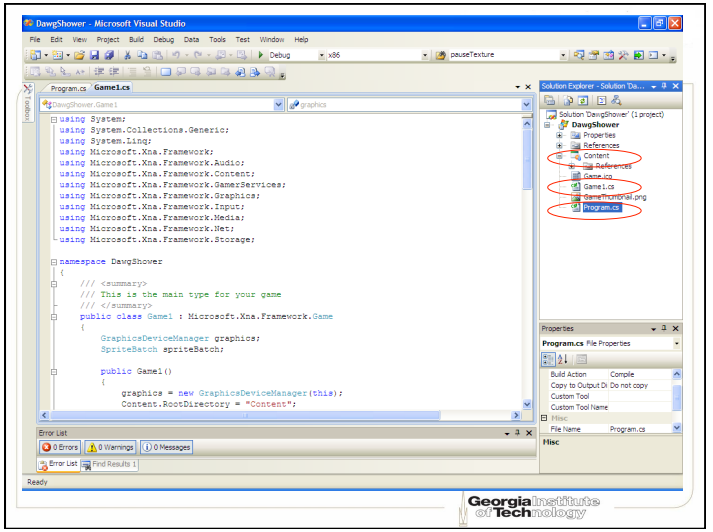
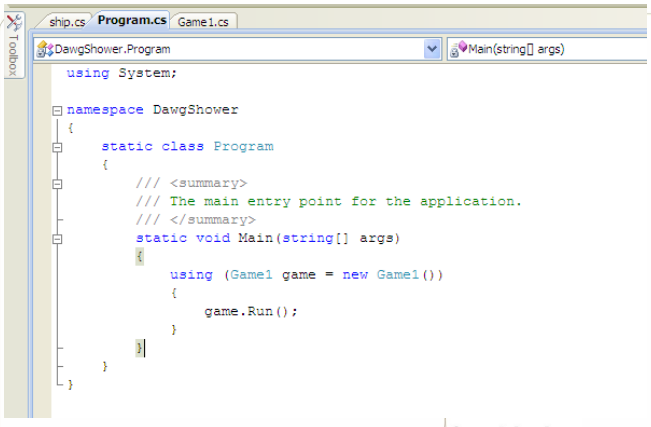
Demo DawgShower Game Example



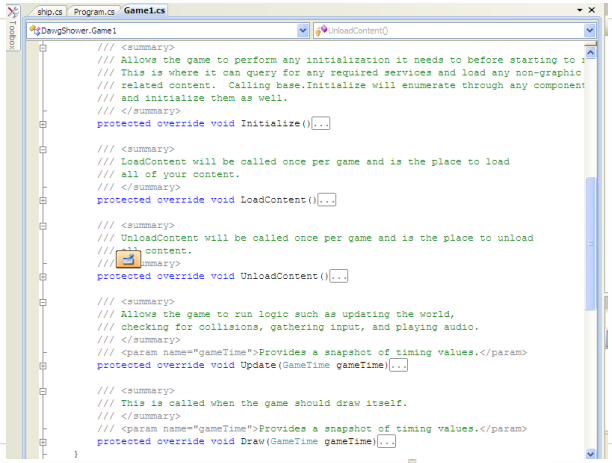




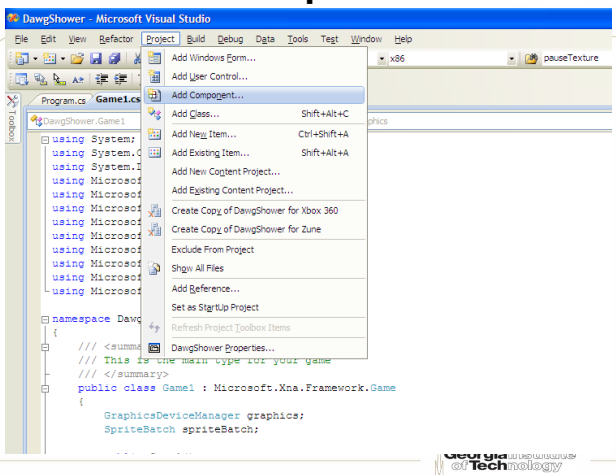
Top level program (Program.cs)



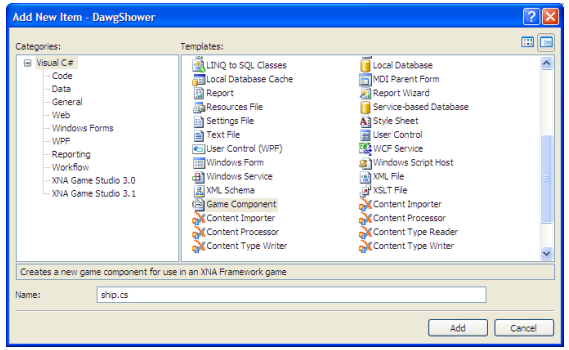
Main game loop (Game1.cs)



Add Game Component

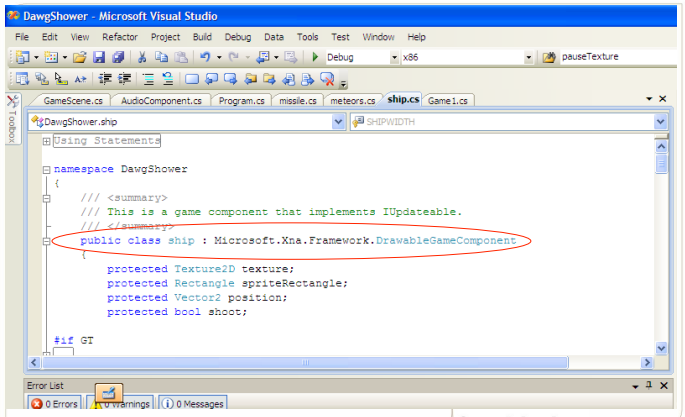


Adding Game Component (C# src file)



- Adding new DrawableGameComponent class of objects in the game
  - This class loads and draws graphics content
- Project → Add Components

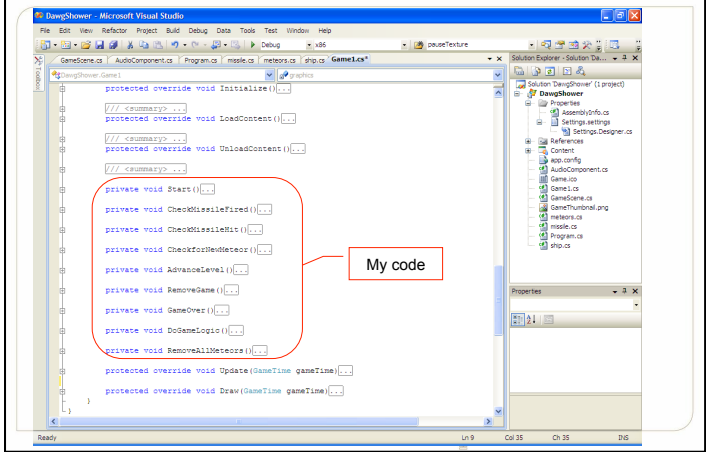
DrawableGameComponent class (1)



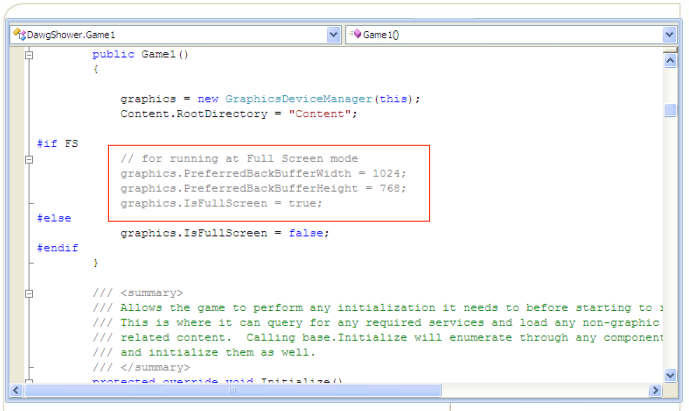
DrawableGameComponent class (2)

- Inherits:
  - GameComponent.Initialize
  - GameComponent.Update
  - DrawableGameComponent.Draw
- Base.draw() method will go through all DrawableGameComponents to execute their respective draw() call

Main program in Game1.cs



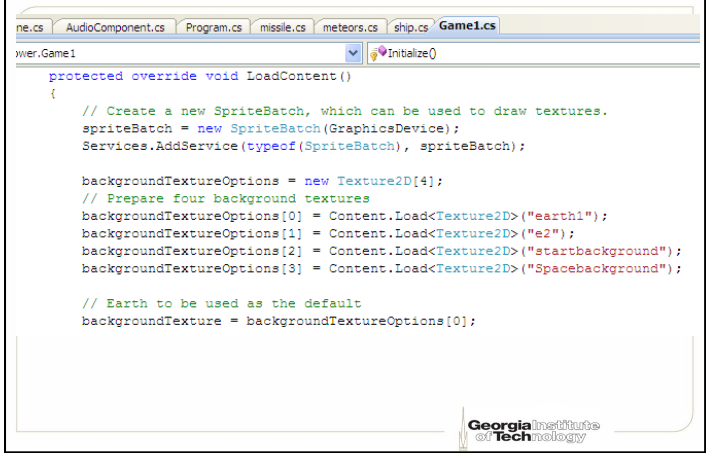
Full screen mode



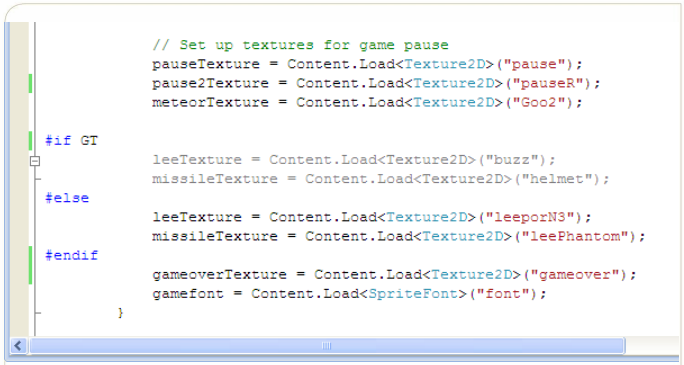
Drawing sprites using XNA

- Use “textures”
- Store with XNA’s `Texture2D` class
- Include new texture images into the Content Pipeline
- Use “Content.Load” to associate texture variables

Big sprites for the background



Small sprites for game assets



Game Services

- Game services maintain loose coupling between objects that need to interact with each other
- Register a “global” SpriteBatch for drawing all sprites
- Draw() method will look for an active SpriteBatch in GameServices
- All GameComponents will use this SpriteBatch

Game Services – setup & use

```
// Create a new SpriteBatch, which can be used to draw textures.
spriteBatch = new SpriteBatch(GraphicsDevice);

Services.AddService(typeof(SpriteBatch), spriteBatch);
```

Registering a Game Service in LoadContent()

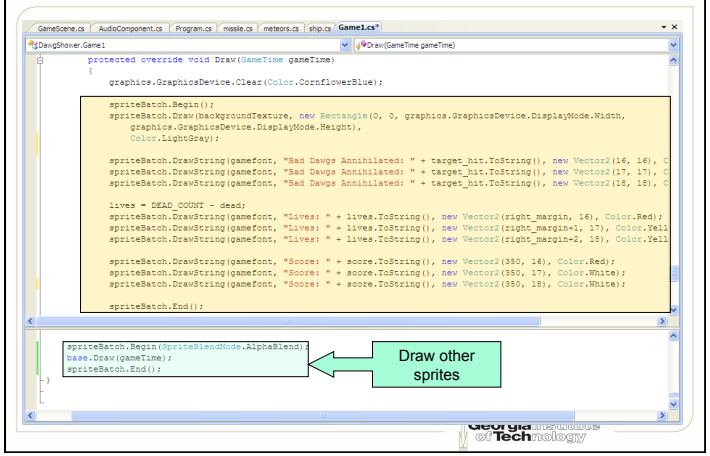
```
public override void Draw(GameTime gameTime)
{
    SpriteBatch sBatch =
        (SpriteBatch)Game.Services.GetService(typeof(SpriteBatch));

    sBatch.Draw(texture, position, spriteRectangle, Color.White);

    base.Draw(gameTime);
}
```

Use GetService to acquire service for each DrawableGameComponent

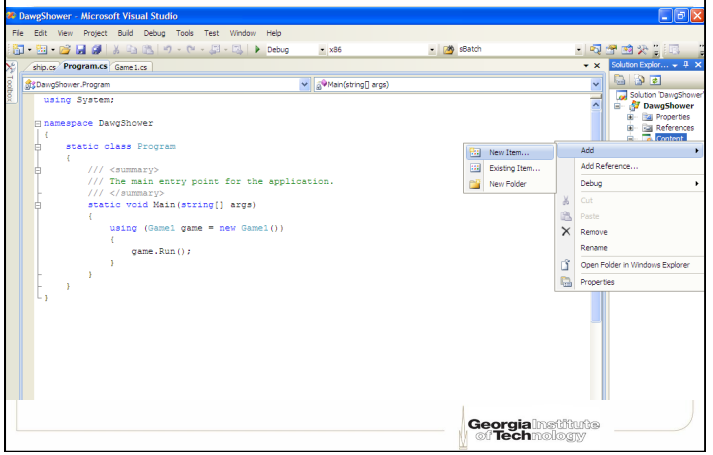
Drawing the background



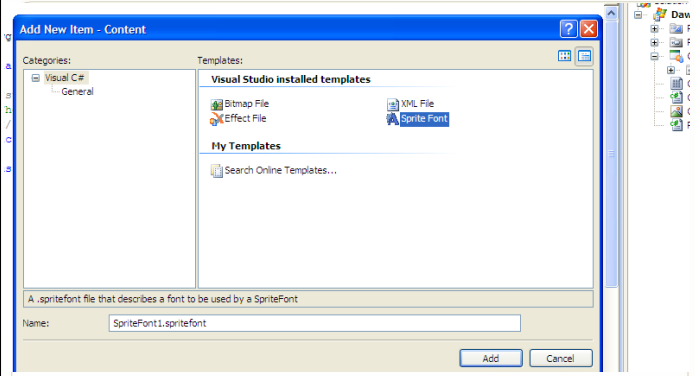
Printing text

- Draw using SpriteBatch
- Create a “font sprite”
- Based on available Fonts in the system
- Add font in LoadContent()

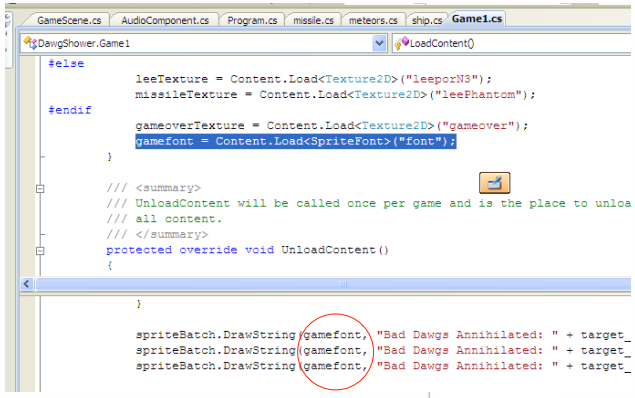
Create a SpriteFont (1)



Create a SpriteFont (2)



DrawString



Manage components

- Components: member of GameComponentCollection (i.e., Microsoft.XNA.Framework.Game)
- Use Components.Add() to add a new component to the list
- Components.RemoveAt(j) removes j^{th} component

Add sound and the player's ship

```
protected override void Initialize()
{
    audioComponent = new AudioComponent(this);
    Components.Add(audioComponent);
```

```
private void Start()
{
    if (player == null)
    {
        player = new ship(this, ref leeTexture);
        Components.Add(player);
```

Add missiles, remove meteors

```
private void CheckMissileFired()
{
    // add component is SPACE bar was hit
    if (player.shootMissile())
    {
        audioComponent.PlayCue("shoot");
        Components.Add(new missile(this, ref missileTexture, player.GetPosition()));
        player.resetShoot();
    }
```

```
if (Components[j] is meteors)
{
    bool hasCollision = false;
    hasCollision = ((meteors)Components[j]).CheckCollision(((missile)Components[i]).GetBounds());
    if (hasCollision)
    {
        audioComponent.PlayCue("explosion");
        // remove collided meteros (BadDawgs)
        score++;
        Components.RemoveAt(j);
```


Game logic

- Embedded inside Update() function

```
private void DoGameLogic()
{
    bool hasCollision = false;
    Rectangle shipRectangle = player.GetBounds();
    foreach (GameComponent gc in Components)
    {
        if (gc is meteors)
        {
            hasCollision = ((meteors)gc).CheckCollision(shipRectangle);
            if (hasCollision)
            {
                audioComponent.PlayCue("missile");
                score -= PENALTY;
                dead++;
                RemoveAllMeteors();
                Start();
                break;
            }
        }
    }

    CheckforNewMeteor();
    CheckMissileFired();
    CheckMissileHit();
    AdvanceLevel();

}
```

Pause the game

```
if (!pause && keyboard.IsKeyDown(Keys.P))
{
    pause = true;
}
else if (pause && keyboard.IsKeyDown(Keys.Tab))
{
    pause = false;
}

// Check if Game is over
GameOver();

if (pause == false && ![illegible]ver)
{
    DoGameLogic();
    base.Update(gameTime);
}
```

Built-in test for collision detection

- Test bounding boxes of given rectangular sprites
- Return a Boolean result

Missile's position

```
public bool CheckCollision(Rectangle rect)
{
    Rectangle spriterect = new Rectangle((int)position.X, (int)position.Y,
                                         MISSILEWIDTH, MISSILEHEIGHT);
    return spriterect.Intersects(rect);
}
```

BoundingSphere

- Alternative method (more often used for 3-D games)

```
public BoundingSphere (
        Vector3 center,
        float radius
)
```

```
public bool Intersects (
        BoundingSphere sphere
)
```

Sound – simple, easy way (1)

- Can use .wav, .mp3, and .wma
- SoundEffect Class
  - Quick vocalizations, door knocks, etc.
- Song Class
  - Background music
- MediaPlayer Class
  - Can pause, resume, skip around, change volume, etc.
  - Access user's music library on WMP, Xbox 360, and Zune

Sound – simple, easy way (2)

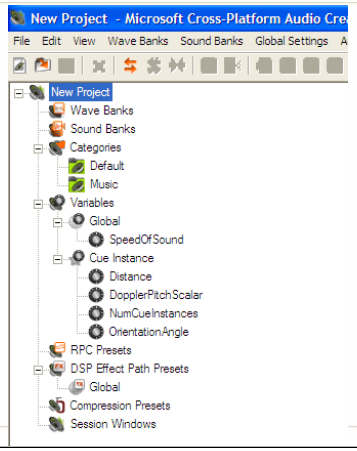
- Drag sound files into Content folder
- Load through Content Pipeline

```
SoundEffect soundEffect =
  Content.Load<SoundEffect>(@"Content\Audio\LaserShot");

soundEffect.Play();
```

Example from http://xna-uk.net/blogs/offbyone/archive/2010/01/21/sound-in-xna-3-1-part-i.aspx

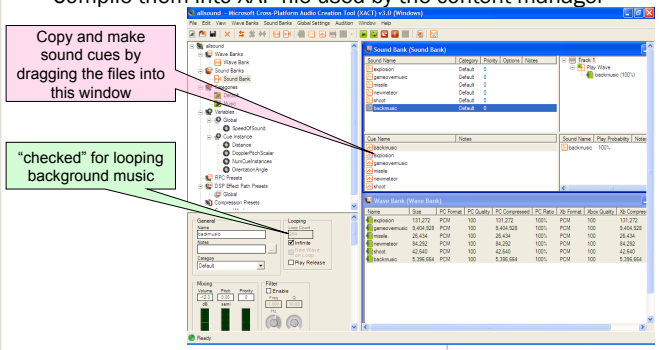
Sound – powerful, complex way



- XACT: Microsoft Cross-Platform Audio Creation Tool
- Only way to do sound before XNA 3.0!

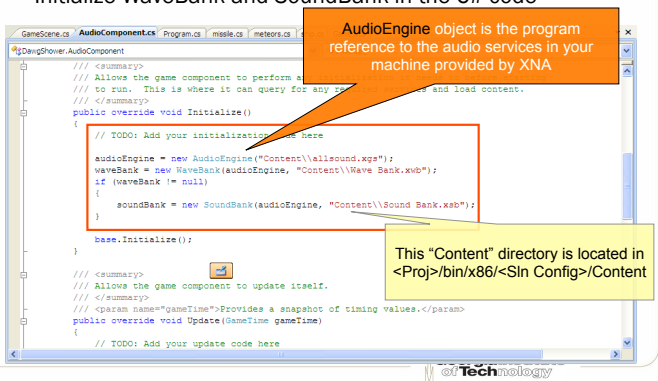
Using XACT

- Create wave banks and sound banks
- Compile them into XAP file used by the content manager



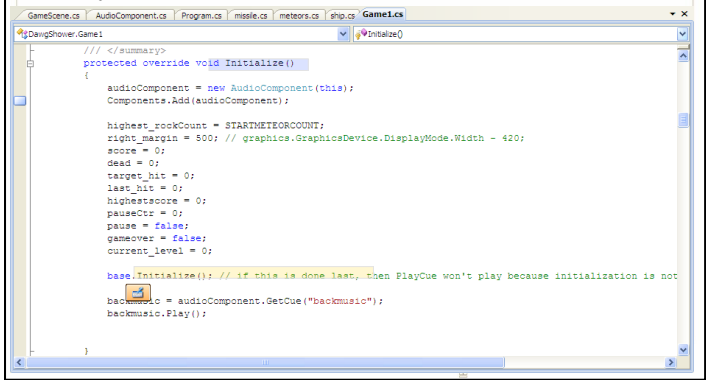
Using files created by XACT in XNA

- Create a new GameComponent for audio
- Initialize WaveBank and SoundBank in the C# code



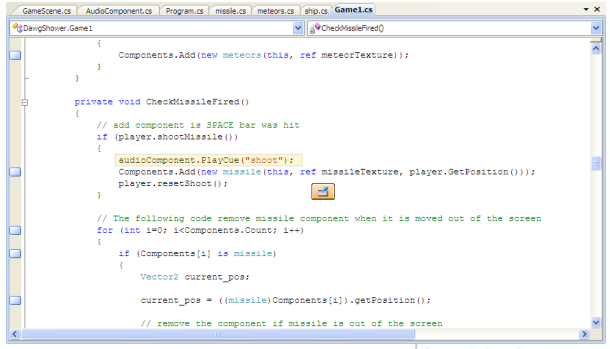
XACT – background looping music

- Add in Initialize code of the Game
- PlayCue is a method of SoundBank



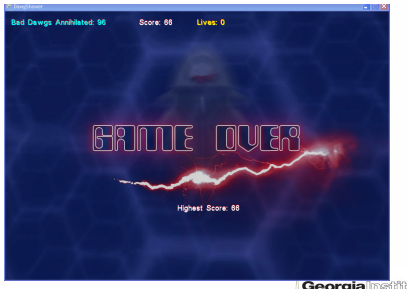
XACT – play sound on event

- Shoot.wav in SoundBank was not set to "infinite", thus will only be played once



Game Over

- Remove all components
- Replace background canvas
- Pause the music



Game Over - Code

```
private void RemoveGame()
{
    for (int i = 0; i < Components.Count; i++)
    {
            Components.RemoveAt(i);
            i--;
    }
}

private void GameOver()
{
    if (dead >= DEAD_COUNT)
    {
        if (highestscore < score)
            highestscore = score;

        RemoveGame();
        backgroundTexture = gameoverTexture;
        gameover = true;
        player = null;
        backmusic.Pause();

    }
```


Organized game structure