IwGame Game Engine SDK Programming v0.34

Developed and maintained by Mat Hopwood of Pocketeers Limited (http://www.pocketeers.co.uk).
For support please visit http://www.drmop.com

Table of Contents

1.0 IwGame.....
1.1 What is IwGame?.....
1.2 Games Created with IwGame.....
1.2.1 cOnnectiCons.....
1.2 Installing IwGame.....
1.3 Usage Rights and Warranties.....
1.4 Brief How To on Using IwGame.....
1.5 IwGame Concepts.....
1.5.1 Standard Class Definitions.....
1.5.2 Getters and Setters.....
1.5.3 Init / Release.....
1.5.4 Singletons.....
1.5.5 Event Notification.....
1.5.6 XOML Mark-up Language.....
1.5.7 Local and Global Resources.....
1.6 Example Code and Tutorials.....
1.7 Known Issues.....
2.0 CIwGame Object – The Eye in the Sky.....
2.1 Introduction.....
2.2 Implementing our own CIwGame.....
3.0 CIwGameScene Object – A Place for Actors to Play.....
3.1 Introduction.....
3.2 Creating a Scene.....
3.3 Virtual Canvas.....
3.4 Scene Object Management.....
3.5 Scene Extents and Clipping.....
3.6 Scene Camera.....
3.7 Potential Colliders and Collision Handling.....
3.8 Current Scene Concept.....
3.9 Actor Management.....
3.10 Scene Naming and Finding Scenes.....
3.11 Scene Layers.....
3.12 Scene Origin.....
3.13 Scene Visibility and Active State.....
3.14 Scene Transitions.....
3.15 Creating a Scene from XOML.....
3.16 Animating Scene Components.....
3.17 Creating a Custom Scene.....
3.18 Creating Custom Actions.....
3.19 Augmenting Scenes.....
4.0 CIwGameActor Object – Sprites With Brains.....
4.1 Introduction.....
4.2 Creating Actors.....
4.3 Creating a CIwGameActorImage.....
4.4 Text Based Actors.....
4.5 Particle System Actors.....

4.6 Actor Lifetimes.....
4.7 Actor Naming and Finding Actors.....
4.8 Actor Types.....
4.9 Moving, Rotating and Spinning Actors.....
4.10 Attaching a Visual and an Animation Timeline.....
4.11 Changing an Actors Colour.....
4.12 Obeying Scene Extents.....
4.13 Actor Layering.....
4.14 Scene Visibility and Active State.....
4.15 Resetting Actors.....
4.16 Collision Checking.....
4.17 Creating an Actor from XOML.....
4.18 Animating Actor Components.....
4.19 Creating a Custom Actor.....
5.0 CIwGameString – String Building Without Fragmentation.....
5.1 Introduction.....
5.2 Basic String Building.....
5.3 Comparing Strings.....
5.4 Stream Style Searching.....
5.5 Getting Strings Values.....
5.5 Other Useful String Tools.....
6.0 CIwGameFile – File System Access.....
6.1 Introduction.....
6.2 Loading a Local File.....
6.3 Saving a Local File .....
6.4 Loading a Memory Based File.....
6.5 Loading a Remote File.....
6.6 Other Useful File Tools.....
7.0 CIwGameInput – I Need Input.....
7.1 Introduction.....
7.2 Checking Availability.....
7.3. Single and Multi-touch Touches.....
7.4 Working with Touches.....
7.5 Checking Key / Button States.....
7.6 On Screen Keyboard.....
7.7 Accelerometer Input.....
7.8 Compass Input.....
7.9 Input and the Marmalade Emulator.....
7.10 Other Useful Utility Methods.....
8.0 CIwGameTimer – Time and Timers.....
8.1 Introduction.....
8.2 Getting the Current Time.....
8.3 Creating and Using Timers.....
9.0 IwGameHttp – Playing Outside the Box.....
9.1 Introduction.....
9.2 The HTTP Manager CIwGameHttpManager.....
9.3 IP Addresses and User-Agents.....
9.4 POST and GET.....

9.5 Setting Up Headers.....
9.6 Performing a GET.....
9.7 Performing a POST.....
10.0 CIwGameAudio – Say No To Silent Movies.....
10.1 Introduction.....
10.2 The Audio Manager CIwGameAudio .....
10.3 Adding Audio Resources.....
10.3.1 Adding Sound Effects.....
10.3.2 Creating a Resource Group.....
10.4 Playing and Modifying Sound Effects.....
10.5 Playing Streamed Music.....
11.0 CIwGameImage – The Art of Game.....
11.1 Introduction.....
11.2 Creating an Image from a Resource.....
11.2.1 Adding Images.....
11.2.2 Creating a Resource Group.....
11.3 Creating an Image from Memory.....
11.4 Creating an Image from a Web Resource.....
11.5 Creating Images from XOML.....
12.0 CIwGameSprite – A Sprite for Life.....
12.1 Introduction.....
12.2 Sprite Manager.....
12.3 Creating a Bitmapped Sprite.....
12.4 Creating a Text Sprite.....
12.4 Creating our own Custom Sprites.....
13.0 CIwGameAnim – Life and Soul of the Party.....
13.1 Introduction.....
13.2 Animation Frame Data.....
13.3 Animations and the Resource Manager.....
13.4 Animation Instances.....
13.5 Animation Targets and Target properties.....
13.6 Animation Timeline's.....
13.7 Resource Manager and Timelines.....
13.8 Working with Animations.....
13.9 Creating a Basic Animation in Code.....
13.9 Creating a Basic Animation in XOML.....
13.10 Creating an Image Animation.....
15.0 CIwGameAds – Wanna Make Some Money?.....
15.1 Introduction.....
15.2 Setting up and Updating IwGameAds.....
15.3 Ad Types.....
15.4 Requesting Ads.....
15.5 Working with CIwGameAdsView.....
15.6 Ad Animators.....
15.7 CIwGameAdsMediator – The Art of Ad Mediation.....
15.8 Supported Ad Providers.....
15.9 OpenGL Considerations.....
16.0 CIwGameXml – Cross Platform Data.....

16.1 Introduction.....
16.2 Setting the Memory Pooling.....
16.2 Loading an XML file.....
16.3 Working with Nodes.....
16.4 Node and Attribute Iteration.....
16.5 Attribute Query.....
16.6 Creating an XML file.....
17.0 CIwGameDataIO – Stream Style Access to Memory.....
17.1 Introduction.....
17.2 Input Streams.....
17.3 Output Streams.....
18.0 CIwGameResource – Getting a Handle on the Beast.....
18.1 Introduction.....
18.2 Creating a Resource Group.....
18.3 Resource Management.....
18.4 Global Resources.....
19.0 CIwGameXOML – Welcome to the Easy Life.....
19.1 Introduction.....
19.2 Loading a XOML file.....
19.3 Types of XOML Data.....
19.3.1 Resource Groups.....
19.3.2 Images.....
19.3.3 Animations.....
19.3.4 Timeline.....
19.3.5 Actors.....
19.3.6 Scenes.....
19.3.7 Shapes.....
19.3.8 Box2dMaterials.....
19.3.9 Styles.....
19.3.10 Variables.....
19.3.11 Actions.....
19.3.12 LoadXOML.....
19.3.13 Templates.....
19.3.14 Fonts.....
19.3.15 Cameras.....
19.3.16 Data Binding.....
19.3.17 Conditional Variables and Actions.....
19.3.18 Modifiers.....
19.3.19 Brushes.....
19.3.20 Joints.....
19.4 XOML Workflow.....
19.5 XOML's future.....
20.0 Box2D Physics – Lets Bounce.....
20.1 Introduction.....
20.2 Box2dMaterial's.....
20.3 Box2D World.....
20.4 Box2D Bodies.....
20.5 Box2D Collision.....

20.6 Box2D Joints.....
21.0 CIwGameRender2d – Better Control Over Rendering.....
21.1 Introduction.....
22.0 CIGameFacebook – Lets be Social.....
22.1 Introduction.....
22.2 Create a Facebook App.....
22.3 Posting Information to the Users Wall.....
22.4 MKB Changes.....
23.0 In-App Purchasing - IwGameMarket.....
23.1 Introduction.....
23.2 Setting up IwGameMarket.....
23.3 Adding Products.....
23.4 Making a Purchase.....
23.5 iOS In-App Purchase Testing.....
23.6 Android In-App Purchase Testing.....
24.0 Modifiers – Building from Blocks.....
24.1 Introduction.....
24.2 Creating a Modifier.....
24.3 CIwGameMods and Modifier Creators.....
25.0 IwGame Extensions.....
25.1 Extension Scenes.....
25.2 Extension Actors.....
25.2.1 CIwGameActorConnector.....
25.3 Extension Modifiers.....
CIwGameModFollowHeading.....
25.4 Extension Actions.....

1.0 IwGame

1.1 What is IwGame?

IwGame is a little more than what one would class as a traditional game engine, it also includes (or will soon include) much support for none game related functionality such as reading the camera, compass, sending / receiving data between web servers and requesting / showing ads etc.. IwGame is more of an object orientated extension of the Marmalade SDK designed and built to lessen the learning curve and to provide a lot of out-of-the-box functionality that is great for game development. The main aim of IwGame is to allow game developers to get started on a game immediately without having to worry about things such how to read the camera or perform gets and posts to send and retrieve data from web servers.

IwGame is an evolving open source SDK that enables developers to create games using tried and tested industry standard game programming techniques that are widely used across the industry today.

IwGame is built upon the incredibly powerful cross platform Marmalade SDK, enabling unparalleled “native” peddle to the metal game and application development across a wide range of platforms including Apple iPhone, iPad, Google Android (Phone and Tablet), Samsung Bada, Blackberry Playbook, Symbian, Palm WebOS, LG-TV, Windows and Mac OS.

In order to use IwGame you will need a copy of the the Marmalade SDK which you can download from http://www.madewithmarmalade.com

IwGame is currently maintained at http://www.drmop.com/index.php/iwgame-engine/

Whilst Pocketeers Limited does provide limited free support via www.drmop.com and www.pocketeers.co.uk, we can provide 24/7 dedicated paid support via email, telephone and Skype.

IwGames current feature set includes:

- Native and cross platform
- Free and open source
- Fully documented
- Support for multiple platforms (iPhone, iPad, Android, Bada, BBX, Symbian, Windows Mobile, mobile Linux, LG-TV, Windows and Mac OS)
- In-purchasing support for iOS and Android plaforms
- Layered sprites / sprite management (CIwGameSprite) including 3D depth with centre of projection
- Support for text and fonts. Also support for text based sprites and text based game actors
- Extensible actor / scene / camera system for organising game and game objects. Also

supports multi-part actors with independent animation time lines per part and automatic hit testing.

- Box2D integration into the scene and actor system as well as XOM. Physical objects, materials and shapes can be defined declaratively.
- Advanced extensible animation system based on time lines with smooth key frame interpolation, easing (linear, quadratic, cubic and quartic in and out), delta / absolute animations. Also supports start, end and repeat events and actions
- Multi-channel audio and music playback
- Touch and multi-touch support
- Button, keyboard, accelerometer and compass support
- Powerful extensible XML based mark-up system (XOML) – Enables definition of IwGame objects from XML script such as Scenes, Actors, Images, Animations, Timelines, Shapes, Physical materials, ResourceGroups, Cameras, Modifiers, Actions, Events, Variables, Conditional variables, Styles, Bindings and Templates.
- Queued POST / GET http communications
- Global and scene local resources, including automated clean-up
- Support for resource groups
- Support for particle system actors
- Auto handles resizing to any size / aspect ratio display using virtual canvasses
- Auto handles frame rate variations to produce smooth animation
- IwGameAd engine which mediates ad collection, display and click processing across multiple ad providers (12 providers supported to date). Ad system uses an animation system that is producing 3%-8% CTR
- Support for streamed IO style access to memory
- Support for simple, fast and memory efficient XML serialisation using memory pooling
- On demand GIF, PNG and JPEG image loading over HTTP
- PNG image format saving
- String builder support reducing memory fragmentation when dealing with strings
- Platform agnostic File I/O
- Timers and other utilities
- Supports ultra smooth animation via sub-pixel rendering
- Supports batch rendering for optimised image rendering
- Full commercial game provided as an example including all code and scripts

Future planned features include:

- Web streamed resources (allowing you to change and upgrade your game without having to resubmit it to app stores)
- Video playback wrapper (IwGameVideo)
- User interface system (IwGameUI) including support for Native UI
- Location services integration (IwGameLocation)
- Camera and image reel access (CIwGameImaging)
- Social services integration (Facebook, Twitter, IwGameSocial)
- Analytics integration (IwGameAnalyitics)
- Support for 3D based scenes and actors
- Web based game editor

1.2 Games Created with IwGame

1.2.1 cOnnectiCons

We put together a full game using the IwGame engine called "cOnnecticOns", full source available with this archive (To see the game in action take a look at http://www.youtube.com/watch?v=sVa8TWYQEsQ). The game took just under 36 man hours to create including all art work running very snmoothly and without issue on iPhone, iPad, Andriod, Blackberry Playbook and amsung Bada with no additional changes made for any of those platforms.

This game is driven mainly by XOML. All UI and levels are fully defined in XOML, including resources, layouts, animations, events and actions. The only major code written for this game was the basic counter game logic..

Development was split into approximately the following times:

- Level design and level XOML creation – 12 hours
- Art production – 12 hours
- Other XOML writing – 6 hours
- Coding – 8 hours

1.2 Installing IwGame

Firstly, download the latest version of the IwGame SDK from
http://www.drmop.com/index.php/iwgame-engine/

If you haven't already installed the Marmalade SDK then grab a copy from
http://www.madewithmarmalade.com

IwGame is currently provided as a Marmalade library project and test bed project giving examples of how it should be used.

The IwGame zip archive that you downloaded contains the following important folders:

```
IwGame
      Docs - Contains documentation
      h - Contains IwGame engine headers
      Libs - Contains IwGame dependencies such as zlib and libpng
      Source - The full source to IwGame
      Examples - Contains example apps
      TestBed - A test bed app that shows IwGame usage and integration
```

To open up the test bed app go to IwGame\TestBed and open the IwGame_TestBed.mkb Marmalade project file, this will open up the test bed project in Visual Studio / XCode.

If you take a look at the solution explorer you will see a IwGame filter / folder. If you drill down you will be able to see the source files and the Marmalade project file that make up the engine.

Now lets take a look at the IwGame_TestBed.mkb project file to find out how to integrate IwGame into your project.

From the MKB we can see that we only need to add two commands to integrate IwGame into our project:

```
options
{
      module_path="../IwGame"
}

subprojects
{
      IwGame
}
```

These commands will tell Marmalade where to locate the project.

Once you have updated your project MKB with the above changes, run your MKB file again to regenerate your project. You can of course place the IwGame engine anywhere you like, just remember to change the module path.

Note that if you already have something in module_path then you can quite easily tag IwGame into the path like this:

```
module_path=”module_path="$MARMALADE_ROOT/modules/third_party;../IwGame"
```

1.3 Usage Rights and Warranties

IwGame and associated classes and components are provided “as is” and “without” any form of warranty. Yours, your employers, your companies, company employees, your clients use of IwGame is completely at your own risk. We are not obligated to provide any kind of support in any shape or form.

You are free to use IwGame in your projects in part or in whole as long as the header comments remain in-tact. Whilst you are not obliged to mention your usage of IwGame in your products it would be great and beneficial to let us know as we can publicise your product on our blog and other web sites / services (Our blog receives over 200,000 hits per month) However, if you use any part of the IwGame extensions system, which includes extension actors, extension scenes or extension modifiers then we ask that you mention usage of the IwGame Engine in your product.

You may not claim the IwGame engine or its documentation as your own work or package it up and include it in any kind of middleware product without express prior written notice from an executive of Pocketeers Limited with the correct authority to grant authorisation. You may not publicly host any source code that is part of the IwGame Engine, the source will be hosted at http://www.drmop.com/index.php/iwgame-engine/

Also note that IwGame utilises zlib, libpng and Box2D, so please take note of those licenses.

Our aim is to promote IwGame as a viable cross platform game engine built on top of the Marmalade SDK, so any publicity will serve to not only help increase public awareness of IwGame in the development community but also increase awareness of the Marmalade SDK, who made this all possible.

If you would like to let us know that you are using IwGame in your products then please get in touch with us at admin@pocketeers.co.uk. We also appreciate any comments or feedback.

If you would like us to develop your product using the IwGame engine then please get in touch at admin@pocketeers.co.uk

All code, scripts and assets that accompany the game cOnnecticOns / Puzzle Friends are protected under copyright by Pocketeers Limited @2012 and may not be re-used in your existing products. You may use the code base for cOnnecticOns as a reference / learning tool only. If you have any queries about what you can and cannot use then please get in touch with us.

1.4 Brief How To on Using IwGame

At this stage I think its important for you to have a basic understanding of how to use IwGame as this will help you to better understand the rest of this material.

The basic purpose of IwGame is to enable developers to get a game up and running quickly, with IwGame taking care of all the basic and mundane tasks.

Initially you would create you own game class derived from CIwGame then implement your own initialisation and clean-up routines in YourGame::Init() and YourGame::Release()

Once you have a basic game class up and running you begin adding scenes to your game. You can think of scenes as different views / environments with their own purpose. For example, you may have a scene that contains your main game area and another scene that contains your in-game overlays / HUD. You may also have a number of scenes that make up your user interface (options screen, menu, in-app purchases, ad display etc..). You can then add separate entities to each scene using actors. You can think of actors as smart sprites, they contain logical and visual components. Actors can be anything from simple in-game objects and effects to something more complex such as user interface button

As of v0.27 a new mark-up language was added to allow developers to create scenes, actors, images, animations, animation time lines etc.. using a very simple human readable XML style language. XOML is similar in style and function to Microsoft's XAML and Adobe's MXML mark-up languages, so if you are familiar with these then you have a good head start.

1.5 IwGame Concepts

It will make explaining how to use IwGame much easier if we explain a few concepts that relate to IwGame's development up front.

1.5.1 Standard Class Definitions

We like to write neat and tidy code and have come up with a standard system to make classes nice and readable. A class is usually split into 5 sections:

- Section 1 – Public enums, typedefs and static data
- Section 2 – Properties provide public access to class private data via getters and setters. A property can be thought of as a private class variable that you want to allow the outside world to change but in a safe manner.
- Section 3 – Private / protected types, class data and methods (used by the class internally only)
- Section 4 – Construction / destruction and initialisation.
- Section 5 – Public access class functionality

1.5.2 Getters and Setters

A long time ago I used to have many classes with lots of public variables and as you would guess many odd and difficult to track bugs to go along with that style of software development. Eventually I came across the idea of hiding all of my variables away (even those that I wanted to be public) and used methods to access them instead. These methods are called getters and setters and we use them extensively throughout IwGame

1.5.3 Init / Release

I personally took the decision a long time ago to not use constructors and destructor's much because they discourage object re-use. Instead I like to move all class initialisation code out of the constructor and place it into my class Init() method, same goes for the destructor and the Release() method. This allows me to re-initialise and tear down a class without having to actually new or delete it. This can prove very useful in many situations such as object pooling to reduce memory fragmentation, where the idea is to preserve the classes memory and re-use it.

1.5.4 Singletons

We use singletons extensively throughout IwGame because a) they provide global access to a particular system b) they ensure that only one instance of that system can be created at runtime reducing the chances of conflict and c) They are convenient and easy to use

We use the CDEFINE_SINGLETON(class_name) in our header file to define a class as a singleton and CDECLARE_SINGLETON(class_name) to declare the singleton methods. You will also note that we use a macro such as:

```
#define      GAME   Game::getInstance()
```

This macros allows us access the singleton using a more readable shorthand, for example:

GAME->Init();

Which looks better and more readable than:

Game::getInstance()->Init();

1.5.5 Event Notification

We use two primary methods of handling event notification:

- C style callbacks - Many of IwGames classes allow the user to be notified of specific events occurring or to allow the user to tag in their own specific functionality when certain events occur. For example, when an animation is started, stopped or has looped the user can be notified by setting the appropriate handler for the animation
- C++ virtual methods – Where we find it appropriate / convenient (generally when we expect the user to derive their own class from one of our base classes) we provide virtual and in some cases pure virtual event methods that the user should implement in their own derived version of the class. For example, IwGameScene implements a number of virtual event notification methods NotifySuspending(), NotifyResuming(), NotifyLostFocus() and NotifyGainedFocus() which should be implemented by the derived scene class

1.5.6 XOML Mark-up Language

XOML (Xml Object Modelling Language) is an XML style language designed and developed specifically by Pocketeers Limited to allow developers to design and layout IwGame scenes, set up actors, build complex animations, load resource group's, tie up events / actions and variables etc.. XOML was chosen as it is an easy to understand human readable cross platform text based format

1.5.7 Local and Global Resources

Resources can be anything from images and animations to Marmalade resource collections. Resources can be local to a scene or global. Local resouerces are only accessible to objects within a scene and will be destroyed with the scene when it gets destroyed. Global resources are global to the game object and are accessible to all scenes and objects contained within those scenes. Global objects are destroyed when the game is is destroyed. The distiction is important when taking into account resource names. Two resources of the same type should not share the same name within the same scene.

1.6 Example Code and Tutorials

The current IwGame distribution comes with a number of an example application that shows many of the features of IwGame. Below is a list of the current available examples:

- Hello World – Shows how to set up a basic game and draw some text
- Hello World XOML – Shows how to set up a basic game and draw some text using XOML
- TestBed – A generic test bed that shows many of the different features of the engine
- cOnnecticOns – A Complete game showing how to use code and XOML to create a full game that can be deployed across all platforms

Also keep an eye out for additional sample projects as well as tutorials on our blog at www.drmop.com

1.7 Known Issues

There is currently a conflict with Visual Studio 2008 and the PNGLIB. We are not sure how this is happening so if you happen to come across upon a solution then please let us know.

2.0 CIwGame Object – The Eye in the Sky

2.1 Introduction

CIwGame is basically the kind of eye-in-the-sky controller of the game engine and can be thought of as the main loop of the game engine. CIwGame takes care of many things including:

- Initialisation, processing and cleanup of many systems including graphics, input, resource manager and audio etc..
- Managing and updating scenes
- Sorting scenes by layer order
- Notifying the user of scene change events
- Rendering scenes
- Tracking frame speed
- Processing events such as tapped, touch begin / end
- Processing scene modifiers

You never actually create an instance of CIwGame, instead you derive you own version of the class from CIwGame like this:

```
#define       GAME   Game::getInstance()

class Game : public CIwGame
{
       CDEFINE_SINGLETON(Game)
public:
protected:
       //// Properties
public:
       //// Properties end
protected:
public:
       void                Init(bool enable_http = true, bool enable_extensions = true);
       void                Release();
       bool                Update();
       void                Draw();
       void                PostDraw();
       void                Save();
       void                Load();
};
```

You then implement Init(), Release(), Update() and Draw() methods to provide your own initialisation, clean-up, per frame update and per frame rendering code. You can also override PostDraw() to apply post rendering.

Note that the games Init() method takes two parameter called enable_http and enable_extensions. If you plan on using anything relating to the HTTP manager, such as ads, web file / image access then

you will need to pass true to the game object during initialisation. If you plan on usni any of the extension actors, extension scenes or extension modifiers then you need to pass true to enable_extensions.

2.2 Implementing our own CIwGame

Lets now take a quick look at a bare bones implementation of the above methods:

```
CDECLARE_SINGLETON(Game)

void Game::Init(bool enable_http, bool enable_extensions = true)
{
	CiwGame::Init(enable_http, enable_extensions);

	// TODO: Insert your own initialisation here
}

void Game::Release()
{
	// TODO: Insert your own cleanup here

	CIwGame::Release();
}

bool Game::Update()
{
	if (!CIwGame::Update())
		return false;

	// TODO: Insert your own custom game update functionality here

	return true;
}

void Game::Draw()
{
	CIwGame::Draw();

	// TODO: Insert your own custom game rendering functionality here
}

void Game::Save()
{
	// TODO: Insert your own game save functionality
}

void Game::Load()
{
	// TODO: Insert your own game load functionality
}
```

Note that if you utilise IwGames systems then it is very unlikely that you will need to add additional rendering code to Game::Draw().

At its heart, CIwGame contains a collection of game scenes (CIwGameScene's) that in turn drive actors and cameras to provide your games functionality (more on these classes later).

CIwGame enables you to add, remove and search for scenes within the game as well as set the currently active scene using the following methods:

```
void                    addScene(CIwGameScene *scene, bool bring_to_front = true);
void                    removeScene(CIwGameScene* scene);
void                    removeScene(unsigned int name_hash);
void                    removeAllScenes(CIwGameScene* exclude_scene);
void                    removeAllScenes(unsigned int exclude_name_hash);
CIwGameScene*           findScene(unsigned int name_hash);
CIwGameScene*           findScene(const char* name);
CIwGameScene*           findScene(int type);
CIwGameScene*           getScene(int index);
void                    clearScenes();
void                    changeScene(CIwGameScene *new_scene);
bool                    changeScene(unsigned int name_hash);
CIwGameScene*           getCurrentScene()
void                    BringSceneToFront(CIwGameScene* scene);
```

Note that all visible scenes will be rendered every game frame and usually only the current scene will be updated.

The CIwGame class also provides a few additional methods that are very useful:

```
void            setTouchFocus(CIwGameActor* focus)
CIwGameActor*   getTouchFocus()
void            SetBackgroundColour(uint8 r, uint8 g, uint8 b, uint8 a);
void            DisableFocus();
void            SetAllTimelines(CIwGameAnimTimeline* timeline);
```

setTouchFocus – Changes the actor that has the touch focus
getTouchFocus – Returns the actor that has the current touch focus
SetBackgroundColour – Change the background colour of the game
DisableFocus – Prevents all scenes from receiving focus
SetAllTimelines – Sets the timelines of all scenes

3.0 CIwGameScene Object – A Place for Actors to Play

3.1 Introduction

Its easier to think about game development if we think in terms of the movie business, we all watch movies and programmes on the TV which makes it easy to relate to.

A movie usually consists of a number of scenes that contains the environment, actors and cameras. At the moment, IwGame only supports actors and cameras (environments may be added at a later date).

A CIwGameScene is responsible for the following functionality:

- Setup and handling of the virtual canvas
- Managing, updating and cleaning up actors
- Managing, updating, rendering and cleaning up sprites
- Managing and clean up of animation data
- Managing and clean up of animation timelines
- Managing and clean up of Marmalade resource groups
- Managing and clean up of images
- Managing and clean up of physics materials and shapes
- Clipping sprites against the scenes visible extents
- Updating the camera
- Tracking actors that can potentially collide
- Transitions between scenes
- Updating the scenes animation timeline
- Instantiating itself from XOML
- Managing and clean up of XOML variables
- Updating physics

Its also worth a major note at this point that any actors that live inside a scene will be transformed by the same transform as the scene, so if you move, scale or spin the scene then the contained actors will also move, scale and spin with it. The same can also be said about the base colour of the scene

3.2 Creating a Scene

Creating a scene is very simple, as the following code shows:

```
	CIwGameScene* game_scene = new CIwGameScene();
	game_scene->Init();
	game_scene->setName("GameScene");
	game_scene->setVirtualTransform(VIRTUAL_SCREEN_WIDTH, VIRTUAL_SCREEN_HEIGHT, 0, true,
false);
	changeScene(game_scene);
```

In the above code snippet we allocate a new CIwGameScene object and called its Init() method to set up scene internals. We give the scene a name so we can find it later then set the virtual transform (see next section for explanation of the virtual canvas). Finally we ask the game to change the current scene to our newly created scene (CIwGame::ChangeScene())

You can create as many scenes as you like and add them to the game, just remember only one can be the active scene, but all visible scenes will be rendered.

I would like to add some additional information regarding CIwGameScene::Init(), its prototype looks like this:

```
int		Init(int max_collidables = 128, int max_layers = 10);
```

As you can see, the method actually takes two parameters (defaults are applied so you can go with the defaults if you like). The two additional parameters are defined as:

- max_collidables – This the maximum size of the collidable objects list and should be as large as the maximum number of objects that can possibly collide in your scene. For example, if you have 100 objects that are marked as collidable then you can set this value to 100
- max_layers – Scenes support object layering, the default number of layers is set to 10, but you can change this value here

If you would like to prevent the internal Box2D physics engine update then set the scenes WorldScale to 0:

```
	game_scene->getBox2dWorld()->setWorldScale(0, 0);
```

This stops the internal Box2D physics update. It can be re-enabled by changing WorldScale to a valid value.

3.3 Virtual Canvas

Targeting a large selection of different phones, tablets and other devices with a variety of screen sizes and aspect ratios is a bit of a nightmare when it comes to game development. Luckily the CIwGameScene class takes care of this for us. A scene is quite a clever object in that it can render itself to any sized / configuration display using the virtual canvas concept. A virtual canvas is basically our own ideal screen size that we want to render to. The scene will scale and translate int visuals to fit our canvas onto the devices display allowing us to get on with developing our game using a static resolution. Lets take a look at the prototype for setting a scenes virtual canvas:

```
	void	CIwGameScene::setVirtualTransform(int required_width, int required_height,
float angle, bool fix_aspect = false, bool lock_width = false);
```

And an explanation of its parameters:

- required_width – The width of the virtual canvas
- required_height – The height of the virtual canvas
- angle – Angle of the virtual canvas
- fix_aspect – Forces the rendered canvas to lock to the devices aspect ratio (you may see letter boxing or clipping)
- lock_width –Calculates scale based on screen_width / required_width if set true, otherwise scale based on screen_height / required_height.

3.4 Scene Object Management

When it comes to coding I am quite bone idle and hate having to track things such as allocating actors, images / memory for animations etc,. I want something that will let me allocate these types of objects, assign them then forget about them. CIwGameScene contains a SpriteManager, and a ResourceManager (will cover these in detail later) that takes care of the things that I don't want bothering with during development. In addition, if I remove a scene from the game CIwGameScene will clean the lot up for me when it gets destroyed.

This automated clean-up does come at a very small price however, if you want to add a resource group to the scene then you will need to do that through the scene itself. Here's an example:

```
	// Create and load a resource group
	CIwGameResourceGroup* level1_group = new CIwGameResourceGroup();
	level1_group->setGroupName("Level1");
	level1_group->setGroupFilename("Level1.group");
	level1_group->Load();
	// Add the resource group to the scenes resource manager
	game_scene->getResourceManager()->addResource(level1_group);
```

As you can see we need a reference to the scene so that we can get to the resource manager. Not too painful, but thought it best to make you aware of this small caveat.

3.5 Scene Extents and Clipping

Scenes have an extents area that can be defined which defines the area in which actors can be, actors that are outside of the scenes extents are wrapped around to the other side of the scene. This behaviour can be enabled / disabled on a per actor basis. You can set the scenes extents by calling:

```
void CIwGameScene::setExtents(int x, int y, int w, int h);
```

Scenes also allow you to define a visible clipping area, pixels from the scene that fall outside that area will not be drawn. You can set the clipping area of a scene by calling:

```
void CIwGameScene::setClippingArea(int x, int y, int w, int h);
```

The default behaviour is for the clipping area to move with the scenes camera, but this can be disabled by enabling the scenes ClipStatic state. When ClipStatic is true, the scenes clipping rectangle will remain static on screen, whilst the contents move around inside the clipping area.

3.6 Scene Camera

A scene has a camera associated with it that allows the user to pan around the scene as well as rotate and scale the view. All actors within the scene will move / rotate and scale in relation to the camera. It is possible to switch cameras within a scene, although you will need to manage the lifetime of these cameras, the scene will only manage the currently attached camera (so do not delete it a camera if it is assigned to the scene. You can assign a camera to the scene using:

```
void CIwGameScene::setCamera(CIwGameCamera* camera);
```

3.7 Potential Colliders and Collision Handling

As a scene processes actors it will build a list of references to all actors that are marked as possibly colliders, once all actors have been processed the scene will walk the list of potential colliders and call their ResolveCollisions() method to give each actor a chance to handle its own collisions. Note that the scene does NOT handle collision detection and response, actors themselves should take care of that.

Note that actors that have a physics material attached are under the control of the Box2D physics engine and collision is handled separately (more on this in the actors section)

3.8 Current Scene Concept

Because the game consists of multiple scenes and only one scene can have the focus at any one time we use the concept of the current scene. Whilst all scenes are visible (unless made hidden) and rendered they are not all processed. By default the only scene that is processed is the current scene. It is however possible to force a scene to be processed even when it does not have the focus by calling CIwGameScene::setAllowSuspend(false). This will prevent the scene from being suspended when another scene is made the current scene.

Scenes can exist in two states, suspended or operational (resumed). Suspending scenes are not processed but are still rendered. When a new scene is switched to using CIwGame::changeScene(CIwGameScene* new_scene) the old scene will be put into a suspended state and the new scene will be resumed. IwGame will notify you when either of these events occur via the following methods:

```
virtual void  NotifySuspending(CIwGameScene* new_scene)    // This event is called when this
scene is being suspended
virtual void  NotifyResuming(CIwGameScene* old_scene)      // This event is called when this
scene is being resumed
virtual void  NotifyLostFocus(CIwGameScene* new_scene)     // This event is called when this
scene has just lost focus
virtual void  NotifyGainedFocus(CIwGameScene* old_scene)   // This event is called when this
scene has just gained focus
```

In order to receive these events you should implement them in your derived scene class, e.g.:

```
void   MyGameScene::NotifySuspending(CIwGameScene* new_scene)
{
      // Add code to handle the scene being suspended
}
```

Note that you do not need to derive your own scene class from CIwGameScene as long as you are happy with the generic functionality that it ptovides, however you will not have access to the suspend / resume functionality as C style callbacks are not used in this instance.

You can tie into these events in XOML by implementing the OnSuspend /OnResume events, e.g.:

```
<Scene Name="GameScene3" OnSuspend="SuspendActions">
    <Actions Name="SuspendActions">
        <Action Method="ChangeScene" Param1="GameScene2" />
        <Action Method="PlayTimeline" Param1="GameScene3Anim" />
        <Action Method="PlaySound" Param1="Explosion" />
    </Actions>
</Scene>
```

When the scene is suspended, the actions set SuspendedActions will be executed.

3.9 Actor Management

The main reason that scenes exist is to facilitate actors. Once an actor is created and added to a scene the scene handles their update, rendering and clean up. CIwGameScene contains the following methods for adding, removing and searching for actors within a scene:

```
void                    addActor(CIwGameActor *actor);
void                    removeActor(CIwGameActor* actor);
void                    removeActor(unsigned int name_hash);
CIwGameActor*           findActor(const char* name);
CIwGameActor*           findActor(unsigned int name_hash);
CIwGameActor*           findActor(int type);
void                    clearActors();
```

3.10 Scene Naming and Finding Scenes

IwGame is designed to prevent what I like to call “unreliable references”. To me an unreliable reference is a reference to an another object that can disappear at any moment without the object that references it knowing about it, this can lead to some pretty nasty bugs that are incredibly difficult to track down. So instead of simply keeping a reference to an object we keep a name.

IwGame uses object naming quite extensively for major system such as actors and scenes. The idea is that if we want to speak to a scene from somewhere outside that scenes instance we simply find it by name using CIwGame::findScene(). Once found we can grab a pointer to it and access it. The wonderful thing about this system is that if the scene has disappeared when we call findScene() a NULL pointer will be returned signifying that it no longer exists, allowing our calling code to determine what to do about it (as opposed to simply crashing or doing something even worse such as writing all over memory that its not supposed to).

The naming system does add a little overhead to our game but not a great deal as searches are done using string hashes instead of string comparisons. The tiny overhead is definitely worth the buckets of tears that you can potentially save from days of tracking down hard to find bugs.

3.11 Scene Layers

Actors within a scene can be depth sorted using layers. Each actor has its own layer number which decides where it will appear within the scenes depth tree. Actors on higher layers will appear over actors on lower layers. Actors on the same layer will be drawn in the order in which they were added to the layer, so later actors will be drawn on top of earlier added actors.

Note that the layering system is not strictly part of the scene engine, instead it is handled by the sprite manager contained within a scene, but for the purpose of easy access is accessible through the scene.

3.12 Scene Origin

A scenes origin is set at 0, 0, which is the centre of the virtual canvas (usually centre of screen) for the default transform.

3.13 Scene Visibility and Active State

Scenes can be made visible or invisible by calling CIwGameScene::setVisible(). You can also query the visibility of a scene using CIwGameScene::isVisible(). When a scene is invisible it is not rendered.

Scenes can also be made active or inactive by calling CIwGameScene::setActive(). You can also query the active state of a scene by calling CIwGameScene::isActive(). When a scene is active it is processed.

Note that a scenes active and visibility states are independent, an inactive scene will still be rendered and an invisible scene that is active will still be processed.

3.14 Scene Transitions

Scene transitions are taken care of by the timeline system. A quick scroll scene transition is shown below:

```
    <Animation Name="SceneTransition1" Type="vec2" Duration="2" >
        <Frame Value="0, 0"    Time="0.0" />
        <Frame Value="480, 0"  Time="2.0" />
    </Animation>

    <Scene Name="GameScene" …..... OnSuspend="SuspendActions">
        <Actions Name="SuspendActions">
            <Action Method="SetTimeline" Param1="SceneTransition1" />
        </Actions>
        <Timeline Name="SceneTransition1" AutoPlay="true">
            <Animation Anim="SceneTransition1" Target="Position" Repeat="1"
StartAtTime="0"/>
        </Timeline>
    </Scene>
```

In the above XOML we create a scene and attach the SuspendActions collection to the OnSuspend scene event. Note that the timeline was defined inside the scene because it is not requested until some actor actually suspends the scene. Here's an example showing an actor that raises the scene suspended event when it is tapped:

```
    <TestActor Name="Player4" ..... OnTapped="SuspendScene3">
        <Actions Name="SuspendScene3">
           <Action Method="SuspendScene" Param1="GameScene3" />
        </Actions>
    </TestActor>
```

3.15 Creating a Scene from XOML

Scenes can be created declaratively using XOML mark-up, making scene creation much easier and more readable. Below shows an example of a scene declared using XOML:

```
    <Scene Name="GameScene" CanvasSize="320, 480" FixAspect="true" LockWidth="false"
Colour="0, 0, 255, 255" AllowSuspend="false">
    </Scene>
```

The scene tag supports many different attributes that determine how a scene is created and how it behaves. A description of these tags are listed below:

- Name – Name of the scene (string)
- Type – Type of scene (integer)
- CanvasSize – The virtual canvas size of the screen (x, y 2d vector)
- FixAspect – Forces virtual canvas aspect ratio to be fixed (boolean)
- LockWidth – Forces virtual canvas to lock to with if true, height if false (boolean)
- Extents – A rectangular area that describes the extents of the scenes world (x, y, w, h rect)
- AllowSuspend – Determines if the scene can be suspended when other scenes are activated (boolean)
- Clipping – A rectangular area that represents the visible area of the scene (x, y, w, h rect)
- Active – Initial scene active state (boolean)
- Visible – Initial scene visible state (boolean)
- Layers – The number of visible layers that the scene should use (integer)
- Layer – The visual layer that this scene should be rendered on (integer)
- Colliders – The maximum number of colliders that the scene should support (integer)
- Current - If true then the scene is made the current scene (boolean)
- Colour / Color – The initial colour of the scene (r, g, b, a colour)
- Timeline – The time line that should be used to animate the scene
- Camera – Current camera
- OnSuspend – Provides an actions group that is called when the scene is suspended
- OnResume – Provides an actions group that is called when the scene is resumed
- OnCreate - Provides an actions group that is called when the scene is created
- OnDestroy - Provides an actions group that is called when the scene is destroyed
- OnKeyBack - Provides an actions group that is called when the user presses the back key
- OnKeyMenu - Provides an actions group that is called when the user presses the menu key
- Gravity – Box2D directional world gravity (x, y 2d vector)
- WorldScale – Box2D world scale (x, y 2d vector)
- Batch – Tells the system to batch sprites for optimised rendering (boolean)
- AllowFocus – If set to true then this scene will receive input focus events that the current scene would usually receive exclusively. This is useful if you have a HUD overlay that has functionality but it cannot be the current scene as the game scene is currently the current scene1Anim

- DoSleep – If set to true then actors that utilise physics will eb allowed to sleep when they are not moving / interacting

3.16 Animating Scene Components

Scenes allow an animation time line to be attached to them that animates various properties of the scene. The following properties are currently supported:

- Camera Position – Cameras current position
- Camera Angle– Cameras current angle
- Camera Scale– Cameras current scale
- Colour – Scenes current colour
- Clipping – Scenes current clipping extents
- Visible – Scenes current visible state
- Timeline – The currently playing timeline
- Camera – change current camera

Any of these properties can be set as an animation target

3.17 Creating a Custom Scene

Whilst CIwGameScene can suffice for most tasks, you may find that you need to create your own type of scene that has functionality specific to your game or app. You begin the creation of a custom scene by deriving your own scene class from CIwGameScene then overloading the following methods to provide implementation:

```
virtual int  Init(int max_collidables = 128, int max_layers = 10);
virtual void Update(float dt);
virtual void Draw();
```

Here's a quick example:

```
class MyGameScene : public CIwGameScene
{
public:
	MyGameScene() : CIwGameScene() {}
	virtual ~MyGameScene();

	virtual int		Init(int max_collidables = 128, int max_layers = 10)
	{
		CIwGameScene::Init(max_collidables, max_layers);
	}
	virtual void Update(float dt)
	{
		CIwGameScene::Update(dt);
	}
	virtual void Draw()
	{
		CIwGameScene::Draw();
	}
};
```

We have provided a very basic implementation of Init(), Update() and Draw() which call the base CIwGameScene class methods so we keep its functionality in-tact.

You can take the implementation one step further (or maybe two) by implementing both the IIwGameXomlResource and IIwGameAnimTarget interfaces to allow instantiation of your custom class from XOML and to allow your class to be a target for animation time lines.

Firstly lets take a look at XOML enabling your custom scene class. To get IwGame to recognise your class whilst parsing XOML files you need to do a few things:

- Derive your class from IiwGameXomlResource and implement the LoadFromXoml method
- Create a class creator that creates an instance of your class then add this to the XOML engine

Lets start by taking a look at step 1.

Because we have derived our class from CIwGameScene we already have the support for step 1. However we would like to insert our own custom attribute tags so we need to make a few changes.

Lets take a look at our new class with those changes:

```
class MyGameScene : public CIwGameScene
{
public:
	// Properties
protected:
	float		Gravity;
public:
	void		setGravity(float gravity)  { Gravity = gravity; }
	float		getGravity() const				{ return Gravity; }
	// Properties End
public:
	MyGameScene() : CIwGameScene(), Gravity(10.0f) {}
	virtual ~MyGameScene();

	virtual int		Init(int max_collidables = 128, int max_layers = 10)
	{
		CIwGameScene::Init(max_collidables, max_layers);
	}
	virtual void	Update(float dt)
	{
		CIwGameScene::Update(dt);
	}
	virtual void	Draw()
	{
		CIwGameScene::Draw();
	}

	// Implementation of IIwGameXomlResource interface
	bool				LoadFromXoml(IIwGameXomlResource* parent, bool load_children,
CIwGameXmlNode* node)
	{
		if (!CIwGameScene::LoadFromXoml(parent, load_children, node))
			return false;

		// Add our own custom attribute parsing
		for (CIwGameXmlNode::_AttribIterator it = node->attribs_begin(); it != node-
>attribs_end(); it++)
		{
			unsigned int name_hash = (*it)->getName().getHash();

			if (name_hash == CIwGameString::CalculateHash("Gravity"))
			{
				setGravity((*it)->GetValueAsFloat());
			}
		}

		return true;
	}
};
```

Our new class now basically supports a Gravity attribute that we will eventually be able to set in XOML using something like:

```
    <MyGameScene Name="GameScene" Gravity="9.8">
    </MyGameScene>
```

However, before we can do that we need to let the XOML system know about our new type of class (MyGameScene), so it can be instantiated when the XOM parser comes across it. To do this we need to create a creator:

```
class MyGameSceneCreator : public IIwGameXomlClassCreator
{
public:
	MyGameSceneCreator()
	{
		setClassName("MyGameScene");
	}
	IIwGameXomlResource* CreateInstance(IIwGameXomlResource* parent) { return new
MyGameScene(); }
};
```

The creator basically defines the tag name "MyGameScene" and returns an instance of the MyGameScene class when CreateInstance() is called.

To get the XOML system to recognise our creator we need to add it to the XOML parsing system using:

```
	// Add custom MyGameScene to XOML system
	IW_GAME_XOML->addClass(new MyGameSceneCreator());
```

Now XOML integration is out of the way, lets take a quick look at enabling our class as an animation target.

To enable a class as an animation target we derive it from IIwGameAnimTarget and implement the UpdateFromAnimation() method. Luckily we derived our MyGameScene class from the CIwGameScene class which already provides this functionality. Lets take a quick look at how we extend the animation update method to account for animating our gravity variable.

```
	bool		UpdateFromAnimation(CIwGameAnimInstance *animation)
	{
		if (CIwGameScene::UpdateFromAnimation(animation))
			return true;

		// Add our own custom animating property
		unsigned int element_name = animation->getTargetPropertyHash();

		if (element_name == CIwGameString::CalculateHash("Gravity"))
		{
			CIwGameAnimFrameFloat* frame = (CIwGameAnimFrameFloat*)animation-
>getCurrentData();
			setGravity(frame->data);
			return true;
		}

		return false;
	}
```

We added the above code to our MyGameScene class definition. We begin by calling the base UpdateFromAnimation() method so we can keep the existing animation properties of the scene. We then add our own custom check for the Gravity variable. If the animation property matches Gravity then we set the gravity to the provided interpolated value.

3.18 Creating Custom Actions

XOML's event / action system is very powerful, allowing you to tie certain events to collections of actions without writing any code. Lets take a quick look at an example:

```
        <!-- Create back button -->
        <InertActor Name="Back" Position="-120, 10" Size="200, 90" SrcRect="600, 333, 200,
90" Image="sprites2" OnTapped="BackAction" OnBeginTouch="BackBeginTouch"
OnEndTouch="BackEndTouch">
            <Actions Name="BackAction">
                <Action Method="SetTimeline" Param1="fly_out_back" Param2="PauseMenu" />
            </Actions>
            <Actions Name="BackBeginTouch">
                <Action Method="SetTimeline" Param1="buttonin_anim1" />
                <Action Method="PlaySound" Param1="ui_tap" />
            </Actions>
            <Actions Name="BackEndTouch">
                <Action Method="SetTimeline" Param1="buttonout_anim1" />
            </Actions>
        </InertActor>
```

In the above XOML our actor handles the events OnEndTouch, OnTapped and OnBeginTouch. Each of these events calls an actions list when the event occurs on that object. Below the actor definition we have three action lists defined that correspond to the actions that are specified in our events:

```
            <Actions Name="BackAction">
                <Action Method="SetTimeline" Param1="fly_out_back" Param2="PauseMenu" />
            </Actions>

            <Actions Name="BackBeginTouch">
                <Action Method="SetTimeline" Param1="buttonin_anim1" />
                <Action Method="PlaySound" Param1="ui_tap" />
            </Actions>

            <Actions Name="BackEndTouch">
                <Action Method="SetTimeline" Param1="buttonout_anim1" />
            </Actions>
```

The first action collection “BackAction” is called when a user performs a tap action on “Back” actor. This collection contains a single action which contains a method called “SetTimeline” and two parameters “fly_out_back” and “PauseMenu”.

This action actually changes the time line of the PauseMenu object to the fly_out_back animation time line (defined elsewhere in XOML). However, how does the system know how to do this and more importantly how do we define our own actions that we can call from XOML events?

Well firstly it depends on where the action is being called as certain object types have their own list of actions. In addition, there is also a global list of actions carried by the global resource manager.

Here we will take a look at adding our own custom action to the global resource manager.

The first thing we need to do is derive a class from IIwGameXomlAction and implement the Execute() method like this:

```
class CustomXomlAction_Global : public IIwGameXomlAction
{
public:
	CustomXomlAction_Global() {}
	{
		// Set out action name
		setActionName("customaction1");
	}
	void Execute(IIwGameXomlResource* source, CIwGameAction* action)
	{
		CIwGame* game = NULL;
		CIwGameScene* scene = NULL;
		CIwGameActor* actor = NULL;

		// Determine the scene, game and possibly actor that called the action
		if (source->getClassTypeHash() == CIwGameXomlNames::Scene_Hash)
		{
			scene = (CIwGameScene*)source;
			game = scene->getParent();
		}
		else
		if (source->getClassTypeHash() == CIwGameXomlNames::Actor_Hash)
		{
			actor = (CIwGameActor*)source;
			scene = actor->getScene();
			game = scene->getParent();
		}

		// TODO: Do something with the action here (Param1 and Param2 contain
parameters

	}
};
```

Now that we have an action object we need to tell the XOML system that its available using:

```
IW_GAME_XOML->addAction(new CustomXomlAction_Global());
```

We would place this call somewhere in our main boot up so it gets called before any XOML parsing that contains this action begins.

Now lets take a look at a bit of XOML that shows the use of our new action:

```
    <Actions Name="BackAction">
        <Action Method="CustomeAction1" Param1="Hello World!" Param2="Im an action!" />
    </Actions>
```

3.19 Augmenting Scenes

A scene once declared in XOML can later be updated / augmented with additional XOML code elsewhere. For example, lets say that you declare some common scene that contai9ns a basic background and some other elements that are common across a number of screens. You can later load the scene and then augment it by declaring the scene again then supplying the additional elements inside the newly declared scene:

```
<Scene Name="CommonScene" ..... >
    <Original_Element1 />
    <Original_Element2 />
    <Original_Element3 />
</Scene>
```

Now declare a 2nd scene with the same name:

```
<Scene Name="CommonScene">
    <Extra_Element1 />
    <Extra_Element2 />
    <Extra_Element3 />
</Scene>
```

In memory the scene now looks like this:

```
<Scene Name="CommonScene" ..... >
    <Original_Element1 />
    <Original_Element2 />
    <Original_Element3 />
    <Extra_Element1 />
    <Extra_Element2 />
    <Extra_Element3 />
</Scene>
```

4.0 CIwGameActor Object – Sprites With Brains

4.1 Introduction

Whilst our title comparison suggests that actors are simply sprites with brains they have the potential to be much more.

Going back to comparison in the scene introduction section, actors play a pivotal role in our scenes, each actor having its own unique role and visual appearance. Actors are the building block of the game, they provide the actual unique functionality and visuals that make up the game as a whole. They can provide any type of functionality from a simple bullet fleeting across the screen to something as complex as a dynamic machine that modifies its behaviour and appearance based upon data streamed from a web server.

A CIwGameActor is a very generic object that provides quite a lot of functionality out of the box. The idea is for developers to create their own actor types from the base CIwGameActor class then implement their own custom functionality within its Update() method. The basic functionality provided by CIwGameActor includes:

- Support for actor pooling to help reduce memory fragmentation
- Unique names so they can be searched
- Actor types
- Position, Depth, Origin, velocity and velocity damping
- Angle, angular velocity and angular velocity damping
- Scale and Colour
- Layers
- Active and visible states
- A visual that represents it on screen
- Animation timeline that can be attached to the visual
- Collision size / rectangle
- Wrapping at scenes extents
- Instantiation itself from XOML
- Animation timline update
- Other actor linkage (used to connect actors in a child / parent style system)
- A Box2D physical body consisting of a material and shape
- Box2D collision category, mask and group

Note that any changes made to the actor will automatically be applied to the actors visual.

As IwGame progresses more actor types with additional functionality will be created to create more out of the box style game objects (plug-in actors if you will). For the moment the following actors have been created for you:

- CIwGameActorImage – This object represents a basic image based actor which has an associated image and animation. (ActorImage in XOML)
- CIwGameActorText – This object represents a basic text based actor which has an associated font and animation. (ActorText in XOML)
- CIwGameActorParticles – This object represents a complex particle based actor system consists of manypatricles that move independently and have varying life spans. (ActorParticles in XOML)

A word of warning, do not forget to call the based classes Init(), Reset(), Update(), UpdateVisual() methods from your own derived classes or the underlying functionality will not be provided.

4.2 Creating Actors

Creating an actor is very simple as the following code shows:

```
// Create player actor
MyActor* actor = new MyActor();
if (actor == NULL)
	return NULL;

actor->Init();
actor->setName("Player1");
actor->setPosition(x, y);

// Add player actor to the scene
scene->addActor(actor);
```

In the above code we create a a basic MyActor object, which is a class that I created derived from CIwGameActor giving us the base CIwGameActor functionality. However, adding this code into a game wouldn't actually see anything as we have not assigned a visual element to the actor. CIwGameActor does not handle the creation of a visual for you, instead it handles the rendering and update of a visual and its animations.

To get developers started with actors we included the CIwGameActorImage that will create a basic image based actor that supports animation.

If you require your actor to support Box2D physics then you should either define the Box2DMaterial and Shape in XOML or if creating manually then call:

```
InitBody(Scene, shape, material, &Position, Angle, com.x, com.y);
```

This can be called before or after CIwGameActor::Init()

4.3 Creating a CIwGameActorImage

Creating an image based actor is a little more complicated, lets take a look at some example code:

```
// Create a new instance
ActorPlayer* actor = new ActorPlayer();
if (actor == NULL)
	return NULL;

// Create player actor
actor->setScene(scene);
actor->Init(image, 36, 40);
actor->setPosition(x, y);

// Add player actor to the scene
scene->addActor(actor);
```

Creation is very similar to creating a basic CIwGameActor with the additional complication of having to pass an image to the actors Init() method.

Looking at the above code we create an ActorPlayer, which is a class that I created derived from CIwGameActorImage as we want some basic image functionality.

We then call the actors its Init() method to set up actor internals. We give the actor a name so that we can find it later then set its world position to the centre of the scene. Finally we add the actor to the scene.

You will notice that ActorPlayer's Init() method has quite a a few parameters. When we call Init(....) we are actually calling CIwGameActorImage::Init(....) and passing along all the details shown in the code above which includes an image that will represent our actor (or more usually an image atlas), and the width and height of the visual on screen (in virtual canvas coordinates). Internally CIwGameActorImage will create a sprite to display our actor.

The end product of the above code is an actor that can be seen, moved around, scaled, rotated etc..

Now lets take a look at a slightly more complicated ezmple that creates an image based actor that uses an animation time line (more details on time line's later):

```
	// Create a new instance
	ActorPlayer* actor = new ActorPlayer();
	if (actor == NULL)
		return NULL;

	// Create an animation timeline to hold our image animation
	CIwGameAnimTimeline* timeline = new CIwGameAnimTimeline();

	// Create and set up our face animation
	CIwGameAnimInstance* face_anim = new CIwGameAnimInstance();
	face_anim->setAnimation(anim);
	face_anim->setTarget(actor, "SrcRect");
	timeline->addAnimation(face_anim);
	timeline->play();

	// Create player actor
	actor->setScene(scene);
	actor->Init(image, 36, 40);
	actor->setTimeline(timeline);
	actor->setPosition(x, y);

	// Add player actor to the scene
	scene->addActor(actor);
```

I have marked the changes from the previous example.

The first set of changes deals with creating a time line object then creating the instance of an animation and adding that to the time line. This process allows the actor to track and update its own animations

In the last change we simply assign the time line to the actor, the actor will now take care of playing the animation and updating the actors visual with animation changes.

4.4 Text Based Actors

Text based actors enable you to instantiate text into the scene with very little effort from code or more easily from XOML. Thse text objects can be use very much in the same way as image based actors in that they can be moved around, scaled, rotated, hit tested or even have physics and collision applied to them.

Lets firstly take a look at creating a text based actor in code:

```
	// Find our preloaded font
	CIwGameFont* font = (CIwGameFont*)IW_GAME_GLOBAL_RESOURCES->getResourceManager()-
>findResource("font1", CIwGameXomlNames::Font_Hash);

	// Create a text actor
	CIwGameActorText* text_actor = new CIwGameActorText();
	text_actor->Init(font);
	text_actor->setText("Hello World!");
	text_actor->setRect(CIwRect(-100, -100, 200, 200));
	text_actor->setColour(0, 0, 0, 255);
	text_actor->setPosition(0, 0);
	text_actor->setAngle(45);

	// Add to the scene
	CIwGameScene* scene = findScene("Scene1");
	scene->addActor(text_actor);
```

In the above code we firstly locate our font (which we have already preloaded into the resource system) then we create a text based actor from CIwGameActorText initialising it with the font. We then set the text, rect and some other parameters.

We now search for the scene we want to place the actor in and it to the scene.

Now lets take a look at how to instantiate a text based actor in XOML:

```
<ActorText Position="0, 0" Rect="-100, -100, 200, 200" Angle="45" Font="font1" Text="Hello
World!" Colour="0, 0, 0, 255" />
```

As you can see the XOML definition is much more compact and readable.

4.5 Particle System Actors

From v.030 of IwGame the new particle system based actor is available. This actor is special in that it is optimised for creating, displaying and updating a complete system of sprites (kind of like its own sprite manager). The advantage of this actor is that it does not have to deal with each particle as a separate actor object. The CIwGameActorParticles actor supports both manual and auto generation of particles. Auto generation can be controlled using a number of a control parameters.

Particles have a number of properties that can be adjusted:

- Visual
- Position
- Velocity
- Velocity Damping
- Gravity
- Scale
- Scale Velocity
- Scale Velocity Damping
- Angle
- Angle Velocity
- Angle Velocity Damping
- Colour
- Colour Velocity
- Colour Velocity Damping
- Depth
- Depth Velocity
- Depth Velocity Damping
- Active state
- Visible state
- Lifespan – Duration of particle in seconds
- SpawnDelay – The amount of time to wait before spawning for the first time
- Lives – Number of times the particle will re-spawn (-1 for infinite)

The CIwGameActorParticles class contains two methods for generating random particles:

```
void GenerateRandomParticles(int count, CIwRect& src_rect, CIwFVec4& colour, CIwFVec4&
colour_velocity, float duration, int repeat_count, float spawn_delay_change, float gravity)
void GenerateRandomParticles(int count, CIwGameActorParticle* particle, CIwRect& src_rect,
float duration, int repeat_count, float spawn_delay_change)
```

Both of these methods will generate a number of particles based on a set of limits.

To determine which particle parameters are generated randomly the CIwGameActorParticles class supports the following methods:

```
void   setPositionMode(eParticleMode mode)
void   setAngleMode(eParticleMode mode)
void   setScaleMode(eParticleMode mode)
void   setVelocityMode(eParticleMode mode)
void   setAngVelocityMode(eParticleMode mode)
void   setScaleVelocityMode(eParticleMode mode)
void   setDepthMode(eParticleMode mode)
void   setDepthVelocityMode(eParticleMode mode)
```

By setting the mode to PAM_Random the specified parameters will be generated randomly.

When parameters are generated the following methods specify limits to the random formulas used to generate the parameters:

```
void   setPositionRange(CIwFVec2& range)
void   setAngleRange(CIwFVec2& range)
void   setScaleRange(CIwFVec2& range)
void   setDepthRange(CIwFVec2& range)
void   setVelocityRange(CIwFVec4& range)
void   setAngVelocityRange(CIwFVec2& range)
void   setScaleVelocityRange(CIwFVec2& range)
void   setDepthVelocityRange(CIwFVec2& range)
```

Lets take a look at some code that generates an explosion type particle system:

```
CIwGameActorParticles* GameScene::AddExplosion(int num_particles, float x, float y, float
scale, float depth, int layer, float gravity)
{
	// Create explosion particle actor
	CIwGameActorParticles* actor = new CIwGameActorParticles();
	addActor(actor);
	actor->Init(num_particles);
	actor->setImage((CIwGameImage*)ResourceManager->findResource("sprites1",
CIwGameXomlNames::Image_Hash));
	actor->setPosition(x, y);

	// Set random paramaters
	actor->setScaleMode(CIwGameActorParticles::PAM_Random);
	actor->setAngVelocityMode(CIwGameActorParticles::PAM_Random);
	actor->setVelocityMode(CIwGameActorParticles::PAM_Random);

	// Set paramater limits
	CIwFVec2 scale_range(scale, scale + scale / 2);
	actor->setScaleRange(scale_range);
	CIwFVec2 angle_range(-5, 5);
	actor->setAngleRange(angle_range);
	CIwFVec4 vel_range(-5, 5, -5, 5);
	actor->setVelocityRange(vel_range);
	CIwRect src_rect(908, 440, 100, 100);
	CIwFVec4 colour(255, 255, 255, 255);
	CIwFVec4 colour_vel(0, 0, 0, -5);
```

```
	// Gnnerate the particles
	actor->GenerateRandomParticles(num_particles, src_rect, colour, colour_vel, 2, 1, 0,
gravity);

	return actor;
}
```

Here we create a particle actor, set up the which parameters should be randomised then set the random limits. Finally we tell the actor to generate random particles

Now lets take a quick look at generating particles manually in code:

```
CIwGameActorParticles* GameScene::AddStream(int num_particles, float x, float y, float
scale, float depth, int layer, float gravity)
{
	// Create stream particle actor
	CIwGameActorParticles* actor = new CIwGameActorParticles();
	addActor(actor);
	actor->Init(num_particles);
	actor->setImage((CIwGameImage*)ResourceManager->findResource("sprites1",
CIwGameXomlNames::Image_Hash));
	actor->setPosition(x, y);
	CIwRect src_rect(800, 291, 68, 65);
	CIwFVec4 colour(255, 255, 255, 128);
	CIwFVec4 colour_vel(0, 0, 0, -3);

	// CReate and add particles
	float spawn_delay = 0;
	for (int t = 0; t < num_particles; t++)
	{
		CIwGameActorParticle* p = new CIwGameActorParticle();
		p->LifeSpan = 1;
		p->Lives = -1;
		p->SpawnDelay = spawn_delay;
		p->Gravity = gravity;
		p->Colour = colour;
		p->ColourVelocity = colour_vel;
		p->DepthVelocity = -0.01f;

		actor->addParticle(p, src_rect);
		spawn_delay += (float)1.0f / num_particles;
	}

	return actor;
}
```

This method creates a particle actor then manually creates a stream of particles that spawn at slightly different times to create a stream type particle system.

Particle actors can also be created in XOML. Lets take a quick look at an example:

```
<ActorParticles Name="StreamParticles" Image="sprites1" Position="0, 0" Scale="1.0"
          Depth="1.0" Layer="1" VelAngMode="random" VelMode="random" AngMode="random"
          ScaleMode="random" PositionRange="100, 100" AngleRange="0, 360"
          AngVelRange="-5, 5" ScaleRange="0.25, 0.5" DepthRange="0.5, 1.0"
          VelRange="-2, 2, -2, 2" ScaleVelRange="0, -0.1" DepthVelRange="0, 0">
    <Particle Count="10" Position="0, 0" VelocityDamping="0.95, 0.95"
          SrcRect="908, 440, 100, 100" ColourVelocity="0, 0, 0, -4" Duration="2"
          Repeat="-1" SpawnDelay="0" />
    <Particle Position="0, 0" VelocityDamping="0.95, 0.95" SrcRect="908, 440, 100, 100"
          ColourVelocity="0, 0, 0, -4" Duration="2" Repeat="-1" SpawnDelay="0" />
    <Particle Position="0, 0" VelocityDamping="0.95, 0.95" SrcRect="908, 440, 100, 100"
          ColourVelocity="0, 0, 0, -4" Duration="2" Repeat="-1" SpawnDelay="0.4" />
    <Particle Position="0, 0" VelocityDamping="0.95, 0.95" SrcRect="908, 440, 100, 100"
          ColourVelocity="0, 0, 0, -4" Duration="2" Repeat="-1" SpawnDelay="0.8" />
    <Particle Position="0, 0" VelocityDamping="0.95, 0.95" SrcRect="908, 440, 100, 100"
          ColourVelocity="0, 0, 0, -4" Duration="2" Repeat="-1" SpawnDelay="1.2" />
    <Particle Position="0, 0" VelocityDamping="0.95, 0.95" SrcRect="908, 440, 100, 100"
          ColourVelocity="0, 0, 0, -4" Duration="2" Repeat="-1" SpawnDelay="1.6" />
</ActorParticles>
```

The above XOML firstly generates 10 random particles at time 0, followed by 4 additional particles at times 0.4, 0.8, 1.2 and 1.6 seconds.

If you would like finer grained control over particle actors then you can simply derive your own version from CIwGameActorParticles

4.6 Actor Lifetimes

Actors will persist within the scene until a) the scene is deleted b) you explicitly remove them or the recommended method c) they remove themselves. An actor can easily remove and delete itself from the scene by returning false from its Update() method. Here's an example:

```
bool ActorPlayer::Update(float dt)
{
	// If fade timer has timed out then delete this actor
	if (FadeTimer.HasTimedOut())
	{
		return false; // returning false tells the scene that we no need to be removed
	}

	// Calculate our opacity from time left on fade timer
	int opacity = FadeTimer.GetTimeLeft() / 2;
	if (opacity > 255) opacity = 255;
	Colour.a = opacity;

	return CIwGameActorImage::Update(dt);
}
```

4.7 Actor Naming and Finding Actors

As mention previously for scenes, actors also named objects, each instance of an object that you wish to query should have its own unique name (per scene) so that it can be located and modified at a later date.

You can find an actor in a particular scene using:

```
	CIwGameActor* actor = scene->findActor("Player1");
	if (actor != NULL)
	{
		// Do somethinig with the actor
	}
```

There are three ways to locate actors within a scene:

```
	CIwGameActor*		findActor(const char* name);
	CIwGameActor*		findActor(unsigned int name_hash);
	CIwGameActor*		findActor(int type);
```

These allow you to search for actor by string, hash or type. Note that searching by type will return the first and only the first instance of that particular actor type. This is very useful if you want to find a unique actor type, for example the player.

4.8 Actor Types

When developing games I find it incredibly useful to assign different types of actors different type ID's, this allows me to optimise many area of my code such as collision checks. Carrying a type ID for each actor also comes in handy when you want to know the types of actor that you are interacting with.

You can set and get the actors type ID using:

```
void          setType(int type)
int           getType() const
```

4.9 Moving, Rotating and Spinning Actors

Actors come with a very basic physics system that allows movement via velocity and angular velocity, actors can also be scaled. CIwGameActor provides the following basic functionality to handle these features:

```
void                    setPosition(float x, float y)
CIwFVec2                getPosition()
void                    setAngle(float angle)
float                   getAngle()
void                    setVelocity(float x, float y)
CIwFVec2                getVelocity()
void                    setVelocityDamping(float x, float y)
void                    setAngularVelocity(float velocity)
float                   getAngularVelocity() const
void                    setAngularVelocityDamping(float damping)
void                    setScale(float scale)
float                   getScale() const
```

Note that velocity and angular velocity damping is a reduction factor that is applied each game frame to slow down objects linear and angular velocities. Their default values are 1.0f which provides no damping, setting this value to less than 1.0f will dampen velocity whilst setting it to a value greater than 1.0f will enhance velocity.

Also note that changing position or angle will not effect velocity.

If the actor was created with Box2D physics enabled then you can also use the supplied force application methods.

4.10 Attaching a Visual and an Animation Timeline

For our actor to become visible on screen we need to assign it a visual component. If you are rolling your own actor and don't go the CIwGameActorImage route then you will need to create and assign your own visual component to the actor.

To assign a visual to an actor you would call:

```
void          setVisual(CIwGameSprite* visual)
```

Now when the scene renders the actor it will attenot to render the visual. I want to mention at this pont that as far as IwGame is concerned a visual is an object type that derived from a CIwGameSprite (we will cover this later), but for now we wil just say that a sprite as far as IwGame is concerned is anything that can be displayed, be it a simple image or a complex piece of SVG.

And where you find visuals you will usually find some kind of animation. The actor class supports attachment of CIwGameAnimTimeline which is basically a collection of animations (we will cover this in more depth later). To assign a time line we call:

```
void          setTimeline(CIwGameAnimTimeline* timeline) { Timeline = timeline; }
```

4.11 Changing an Actors Colour

Each actor has its own independent colour (including opacity). All actors are set to a default colour of white and full opacity. To change the colour of an actor you can call:

```
void          setColour(CIwColour& colour)
```

Note that an actors colour will be combined with its parents base colour.

4.12 Obeying Scene Extents

By default an actor would merrily travel across the game scene and beyond its extents into oblivion and out of range coordinates, this can cause a bit of a mess for the underlying math and rendering routines. To prevent actors from going off into oblivion we can tell them to wrap around to the other side of the scene if they hit its extents boundary. To force actors to wrap around at the boundaries of the scene we call setWrapPosition(true):

```
void          setWrapPosition(bool enable)
bool          getWrapPosition() const                              {
```

4.13 Actor Layering

We touched on layering earlier when we talking about layering in scenes. All actors within a scene exist (visually) on a layer. The layer determines the order in which the actors are rendered with lower layers appearing below higher layers. The maximum layer that an actor can exist on is determined by the scene that it lives in. To change the layer that an actor appears on and to retrieve its current layer we use:

```
void          setLayer(int layer)
int           getLayer() const
```

4.14 Scene Visibility and Active State

You can query an actors visibility state and set its visibility state using:

```
void          setVisible(bool visible)
bool          isVisible() const
```

You can query an actors active state and set its active state using:

```
void          setActive(bool active)
bool          isActive() const
```

Note that when an actor is made inactive it will also become invisible. However making an actor invisible will not make it inactive.

4.15 Resetting Actors

Because actors can be part of an object pooling system and may not get re-initialised when re-used, we provide the functionality to reset them to a default state. This allows developers to re-use objects and not worry about the previous state of the object. Just remember to call the underlying CIwGameActor::Reset() method from your own Reset() method to ensure that the actor is completely reset.

4.16 Collision Checking

Right now IwGame does not carry out collision checks for you, instead it calls back each actor in the scene after the scene has been updated to give each possible colliding object a chance to check and respond to collisions. To take advantage of this functionality you need to implement the following handler in your derived actor class:

```
	virtual void ResolveCollisions() = 0;
```

A basic actor to actor collision method is included in CIwGameActor to allow actors to test for overlap based on the size set by setCollisionRect();

When a collision does take place, actors can notify each other by calling:

```
	virtual void NotifyCollision(CIwGameActor* other) = 0;
```

Here's a quick example showing how to use the system:

```
void ActorPlayer::ResolveCollisions()
{
	// Walk the scenes actors
	for (CIwGameScene::_Iterator it = Scene->begin(); it != Scene->end(); ++it)
	{
		// Only test collision against ball type actors
		if ((*it)->getType() == ActorType_Ball)
		{
			// Check for physical collision
			if (CheckCollision(*it))
			{
				// Norify ourselves that we collided with ball actor
				NotifyCollision(*it);
				// Notify ball actor that we collided with it
				(*it)->NotifyCollision(this);
			}
		}
	}
}
```

Note that if you are using integrated Box2D then you safely bypass this collision check system.

4.17 Creating an Actor from XOML

Actors can be created declaratively using XOML mark-up, making actor creation much easier and more intuitive. Below shows an example of an actor declared using XOML:

```
        <MyActor Name="Player1" Position="0, 0" Size="100, 100" Angle="45" SrcRect="0, 0,
36, 40" Image="Sprites" Timeline="Player1Intro2" />
```

The basic actor tag supports many different attributes that determine how an actor is created and how it behaves. A description of these tags are listed below:

- Name – Name of the scene (string)
- Style – Style that should be applied to this actor. If a properties that exists in the style is added to the definition then it replaces the property found in the style
- Type – A numerical type that can be used to identify the type of this actor (integer)
- Position– Position in the scene (x, y 2d vector)
- Origin– Origin in the scene, moves the point around which the actor will rotate and scale (x, y 2d vector)
- Depth – Depth of the actor in 3D (float – larger values move the sprite further away)
- Velocity – Initial velocity of the actor (x, y 2d vector)
- VelocityDamping – The amount to dampen velocity each frame (x, y 2d vector)
- Angle – The orientation of the actor (float)
- AngularVelocity – The rate at which the orientation of the actor changes (float)
- AngularVelocityDamping – The amount of rotational velocity damping to apply each frame (float)
- Scale, ScaleX, ScaleY – The scale of the actor (float)
- Colour – The initial colour of the actor (r, g, b, a colour)
- Layer – The scenes visible layer that the actor should appear on (integer)
- Active – Initial actor active state (boolean)
- Visible – Initial actor visible state (boolean)
- HitTest – If true then this actor will receive touch events
- Collidable – Collidable state of actor (boolean)
- CollisionSize – The circular size of the actor (float)
- CollisionRect – The rectangular collision area that the actor covers (x, y, w, h rect)
- WrapPosition – If true then the actor will wrap at the edges of the canvas (boolean)
- Timeline – The time line that should be used to animate the actor
- Box2dMaterial – Sets the physical material type used by the Box2D actor
- Shape – Box2D fixture shape for the Box2D actor
- COM – Centre of mass of Box2D body (x, y 2d vector)
- Sensor – Can be used to set the Box2D actor as a sensor (boolean)
- CollisionFlags – The Box2D body collision flags (category, mask and group)
- OnTapped – Tapped event handler
- OnBeginTouch – Event handler that specifies an actions list to call when the user begins to

touch the actor
- OnEndTouch – Event handler that specifies an actions list to call when the user stops to touching the actor
- OnTapped – Event handler that specifies an actions list to call when the user taps the actor
- OnCreate – Event handler that specifies an actions list to call when this actor is created
- OnDestroy – Event handler that specifies an actions list to call when this actor is destroyed
- LinkedTo – Name of actor that this actor links to (string)

For actors that are derived from CIwGameActorImage we have the following additional properties:

- Image – The image that is to be used as the actors visual (string)
- Size – The on screen visible size of the actor (x, y 2d vector)
- SrcRect – The position and source of the source rectangle in the image atlas (x, y, w, h rect). Used for panning the portion of a sprite atlas shown allowing frame based animation.
- FlipX – Horizontal flipped state (boolean)
- FlipY – Vertical flipped state (boolean)

For actors that are derived from CIwGameActorText we have the following additional properties:

- Font – Name of font to use to draw the text (string)
- Rect – The area thuat the text should be drawn inside of (x, y, w, h rect)
- Text – String to display (string)
- AlignH – Horizontal alignment (centre, left and right)
- AlignV – Verticalalignment (middle, top and bottom)
- Wrap – If true then text is wrapped onto next line if to long (boolean)

Note that unlike scenes you cannot create an Actor or ActorImage directly as their corresponding CIwGameActor and CIwGameActorImage classes are abstract, so you must derive your own actor class. More on this later.

In addition, actors must be declared inside a scene tag element as they must have a parent scene and cannot be declared as resources.

4.18 Animating Actor Components

Actors allow an animation time line to be attached to them that animates various properties of the actor. The following properties are currently supported:

- Position – Actors current position
- Depth – Actors 3D depth
- Origin – Actors transform origin
- Velocity – Actors current velocity
- Angle – Actors current angle
- AngularVelocity – Actors current angular velocity
- Scale, ScaleX, ScaleY – Actors current scale
- Colour / Color – Scenes current colour
- Layer – Actors current visible layer
- Visible – Actors current visible state
- HitTest – Determines if the actor can be tapped
- Timeline – The currently playing timeline

For actors that are derived from CIwGameActorImage we have the following additional properties:

- SrcRect – Actors currebt bitmapped visual source rectangle
- Size – Actors visible size on screen

Any of these properties can be set as an animation target

4.19 Creating a Custom Actor

Whilst CIwGameScene can be instantiated and used as-is, CIwGameActor and CIwGameActorImage are abstract and cannot. The actor system is designed this way as the developer is meant to create their own custom actor types that provide bespoke functionality that is specific to their game.

You begin the creation of a custom actor by deriving your own actor class from either CIwGameActor or CIwGameActorImage then overloading the following methods to provide implementation:

```
	virtual void		Init();
	virtual bool		Update(float dt);
	virtual bool		UpdateVisual();
	virtual void		ResolveCollisions() = 0;
	virtual void		NotifyCollision(CIwGameActor* other) = 0;
```

Here's a quick example:

```
class MyActor : public CIwGameActor
{
public:
	MyActor() : CIwGameActor() {}
	~MyActor() {}

	void		Init()
	{
		CIwGameActor::Init();
	}

	bool		Update(float dt)
	{
		if (!CIwGameActor::Update(dt))
			return false;

		// Here we put our actor specific implementation

		return true;
	}

	bool		UpdateVisual()
	{
		if (!CIwGameActor::UpdateVisual())
			return false;

		// Here we put our actor specific rendering code (if any is needed)

		return true;
	}


	void		ResolveCollisions() {}
	void		NotifyCollision(CIwGameActor* other) {}
```

```
};
```

We have provided a very basic implementation of Init(), Update() and UpdateVisual() which call the base CIwGameActor class methods so we keep its functionality in-tact.

We also provide a none functional implementation of ResolveCollisions() and NotifyCollision() as these are required methods

You can take the implementation one step further by implementing both the IIwGameXomlResource and IIwGameAnimTarget interfaces to allow instantiation of your custom actor class from XOML and to allow your class to be a target for animation time lines.

Firstly lets take a look at XOML enabling your custom actor class. To get IwGame to recognise your class whilst parsing XOML files you need to do a few things:

- Derive your class from IIwGameXomlResource and implement the LoadFromXoml method
- Create a class creator that creates an instance of your class then add this to the XOML engine

Lets start by taking a look at step 1.

Because we have derived our class from CIwGameActor we already have the support for step 1. However we would like to insert our own custom attribute tags so we need to make a few changes.

Lets take a look at our new class with thiose changes:

```
class MyActor : public CIwGameActor
{
public:
	// Properties
protected:
	int			NumberOfEyes;
public:
	void		setNumberOfEyes(int num_eyes)	{ NumberOfEyes = num_eyes; }
	float		getNumberOfEyes() const			{ return NumberOfEyes; }
	// Properties End
public:
	MyActor() : CIwGameActor() {}
	~MyActor() {}

	void		Init()
	{
		CIwGameActor::Init();
	}

	bool		Update(float dt)
	{
		if (!CIwGameActor::Update(dt))
			return false;
```

```
		// Here we put our actor specific implementation

		return true;
	}

	bool		UpdateVisual()
	{
		if (!CIwGameActor::UpdateVisual())
			return false;

		// Here we put our actor specific rendering code (if any is needed)

		return true;
	}

	void		ResolveCollisions() {}
	void		NotifyCollision(CIwGameActor* other) {}

	// Implementation of IIwGameXomlResource interface
	bool		LoadFromXoml(IIwGameXomlResource* parent, bool load_children,
CIwGameXmlNode* node)
	{
		if (!CIwGameActor::LoadFromXoml(parent, load_children, node))
			return false;

		// Add our own custom attribute parsing
		for (CIwGameXmlNode::_AttribIterator it = node->attribs_begin(); it != node-
>attribs_end(); it++)
		{
			unsigned int name_hash = (*it)->getName().getHash();

			if (name_hash == CIwGameString::CalculateHash("NumberOfEyes"))
			{
				setNumberOfEyes((*it)->GetValueAsInt());
			}
		}

		return true;
	}
};
```

Our new class now basically supports a new NumberOfEyes attribute that we will eventually be able to set in XOML using something like:

```
<MyActor Name="AlienCritter" Position="100, 100" Size="100, 100" NumberOfYes="3" />
```

However, before we can do that we need to let the XOML system know about our new type of class (MyActor), so it can be instantiated when the XOML parser comes across it. To do this we need to create a XOML class creator:

```
class MyActorCreator : public IIwGameXomlClassCreator
{
public:
	MyActorCreator()
	{
		setClassName("MyActor");
	}
	IIwGameXomlResource* CreateInstance(IIwGameXomlResource* parent) { return new
MyActor();	}
};
```

The creator basically defines the tag name "MyActor" and returns an instance of the MyActor class when CreateInstance() is called.

To get the XOML system to recognise our new creator we need to add it to the XOML parsing system using:

```
	// Add custom MyActor to XOML system
	IW_GAME_XOML->addClass(new MyActorCreator());
```

Now XOML integration is out of the way, lets take a quick look at enabling our class as an animation target.

To enable a class as an animation target we derive it from IIwGameAnimTarget and implement the UpdateFromAnimation() method. Luckily we derived our MyActor class from the CIwGameActor class which already provides this functionality. Lets take a quick look at how we extend the animation update method to account for animating our NumberOfEyes variable.

```
	bool		UpdateFromAnimation(CIwGameAnimInstance *animation)
	{
		if (CIwGameActor::UpdateFromAnimation(animation))
			return true;

		// Add our own custom animating property
		unsigned int element_name = animation->getTargetPropertyHash();

		if (element_name == CIwGameString::CalculateHash("NumberOfEyes"))
		{
			CIwGameAnimFrameFloat* frame = (CIwGameAnimFrameFloat*)animation-
>getCurrentData();
			setNumberOfEyes((int)frame->data);
			return true;
		}

		return false;
	}
```

We added the above code to our MyActor class definition. We begin by calling the base UpdateFromAnimation() method so we can keep the existing animation properties of the actor. We then add our own custom check for the NumberOfEyes variable. If the animation property matches NumberOfEyes then we set the number of eyes to the provided interpolated value.

5.0 CIwGameString – String Building Without Fragmentation

5.1 Introduction

Strings are used extensively throughout game development, making it an incredibly important subject. We use strings for everything from naming objects to presenting interactive text to the player.

String building can be a nightmare for memory managers as constantly rebuilding strings causes many memory allocations and deallocations fragmenting the available memory into small hard to use units.

A string builder is a class that allows you to build a string using a predefined sized buffer or at the very least a buffer than can be resized. CIwGameString supports the following features:

- String builder functionality
- Named strings
- String concetanation and resizing
- String building from integers, floats and boolean types
- String comparison
- Stream style string searching
- Find strings between markers
- Character replacement
- HTML decoding
- URL encoding / decoding
- Change of case

5.2 Basic String Building

Strings can be created from raw text, integers, floats and boolean variables as shown below:

```
CIwGameString string("Hello");          // Creation from raw text
CIwGameString int_string(1234);         // Creation from an integer
CIwGameString int_string(100.234f);     // Creation from a float
CIwGameString int_string(true);         // Creation from a boolean
```

Strings can also be concatenated:

```
CIwGameString string("Hello");
string += ". How you doing";
```

If you are creating a string and you know that it will require quite a number of concatenations then you should set its initial size to prevent memory resizing, here's an example:

```
CIwGameString string;
string.allocString(1024);  // here we preallocate 1024 bytes of memory for the string
string += "Hello!";
string += " How you doing.";
string += " I'm great thanks, how are you?";
string += " Fantastico!";
```

5.3 Comparing Strings

There are 5 ways to compare a string or part of a string:

```
bool                operator==    (const CIwGameString& op);
bool                operator==    (const char* op);
bool                operator==    (unsigned int hash);
bool                Compare(const char* pString, int len) const;
bool                Compare(int start, const char* pString, int len) const;
```

The most optimal way to compare two strings is to compare two CIwGameString objects with auto hashing enabled on both, this will involve only a basic check of both strings hashes to see if they match. You do however need to enable auto hashing on both strings before you compare them, e.g.:

```
	CIwGameString string1("String1");
	CIwGameString string2("String1");

	string1.setAutoHash(true);
	string2.setAutoHash(true);
	if (string1 == string2)
	{
	}
```

If a string is set to auto hashing then the new hash value will be recalculated every time the string is changed. For performance it is best to disable auto hashing then enable it when the string has finished building.

5.4 Stream Style Searching

CIwGameString is set up to allow stream like searching whereby your last searched position will be saved, allowing you to carry out additional searches from where the last search left off. This type of string searching is incredibly useful when it comes to parsing areas of memory. The following methods can be used:

```
	int	Find(const char* string);		// Simple string search
	int	FindNext(const char* string, int len);	// Searches from last find position
for test string
	int	FindNext(const char* string);		// Searches from last find position
for test string
	void	FindReset();				// Resets the find position to start
of string
	int	StepFindIndex(int amount);		// Adjust the find position by the
specified
	int	getFindIndex()				// Gets the current find index
	int	GetNextMarkedString(char start_mark, char end_mark, int &offset);	// Returns
a string marked by start and end marker characters
```

5.5 Getting Strings Values

CIwGameString provides some useful methods for converting from strings to certain other types:

```
int    GetAsInt();
bool   GetAsBool();
float  GetAsFloat();
int    GetAsListOfInt(int *int_pool);
int    GetAsListOfFloat(float* float_pool);
```

- GetAsInt() - Returns the integer value of the string
- GetAsBool() - Returns the boolean value of the string. Valid values include true and 1, all other values are classed as false
- GetAsFloat() - Returns the floating point value of the string
- GetAsListOfInt() - Returns a list of integers (string should contain comma separated values)
- GetAsListOfFloat() - Returns a list of floats (string should contain comma separated values)

5.5 Other Useful String Tools

CIwGameStribng contains a few additional utility methods to help make various tasks easier:

```
void          Replace(char chr, char with);
int           Contains(char c) const;
void          ReplaceHTMLCodes();
void          URLEncode(const char* str);
void          URLDecode();
void          ToUpper();
void          ToLower();
bool          SplitFilename(CIwGameString& filename, CIwGameString& ext);
bool          GetFilenameExt(CIwGameString& ext);
```

- Replace() - Replaces all occurrences of char “chr” with char “with” in a string
- Contains() – Returns true if a string contains the specified character
- ReplaceHTMLCodes() – Replaces HTML style codes such as & with their ACII equivalents
- URLEncode() – Encodes a string as URL encoded
- URLDecode() – Decodes a URL encoded string
- ToLower() – Converts a string to all lower case
- ToUpper() – Converts a string to all upper case
- SplitFileName() - Splits a string into file name and extension strings
- GetFilenameExt() - Extracts a file names extension as a string

6.0 CIwGameFile – File System Access

6.1 Introduction

Veering off course a little, I'm not going to cover some of the more lower level features of IwGame as many of them are required to gain a complete understanding on how IwGame works.

IwGame encapsulates Marmalade's file system neatly into a single class called CIwGameFile. This class enables the following features:

- Auto file closing when the file object goes out of scope
- Reading and writing of local files
- Reading and writing of memory based files
- Blocking and none blocking reading of files from an external source such as a web site / server
- File name splitting
- File type retrieval

6.2 Loading a Local File

Loading a local file is very simple, as is shown in the following example:

```
// Here we declare a string, open a file then read some data into it
CIwGameString data;
CIwGameFile file;
if (file.Open("\\my_data.txt", "rb"))
{
	int len = file.getFileSize();
	data.allocString(len);
	data.setLength(len);
	file.Read((void*)data.c_str(), len);
}
```

6.3 Saving a Local File

Saving a local file is also a very simple, as is shown in the following example:

```
// Here we declare a string, open a file then write the string to it
CIwGameString data("Hello storage, how you doing?");
CIwGameFile file;
if (file.Open("\\my_data.txt", "wb"))
{
	file.Write((void*)data.c_str(), data.GetLength());
}
```

6.4 Loading a Memory Based File

Loading a memory file is just as easy as opening a local file, as is shown in the following example:

```
// Here we declare a string, open a file then read some data into it from memory
CIwGameString data;
CIwGameFile file;
if (file.Open(my_data_in_memory, my_data_length))
{
	int len = file.getFileSize();
	data.allocString(len);
	data.setLength(len);
	file.Read((void*)data.c_str(), len);
}
```

6.5 Loading a Remote File

The format of loading a file for remote is the same as local file loading

```
	// Here we declare a string, open a remote file then read some data into it
	CIwGameString data;
	CIwGameFile file;
	if (file.Open("http://www.myserver.com/my_data.txt", NULL, true))
	{
		int len = file.getFileSize();
		data.allocString(len);
		data.setLength(len);
		file.Read((void*)data.c_str(), len);
	}
```

With a few differences. The first differenece is the very noticable filename change to that of a web address. The second more subtle difference is the inlusion of a 3rd parameter to Open() which tells the method to block until the complete file has been downoaded or an error occurs.

With modern games the user expects action on the screen most of the time, so sitting loading your assets from a server with no viusal update would not be a great idea, ruling blocking remote file loading out for anything more than a few files. A better alternative is to use asynchonrous file downloading that is none blocking, allowing the game loop to proceed whilst your assets load.

Loading a remote file using a none blocking method can be achieved as shown below:

```
int32 WebFileRetrievedCallback(void* caller, void* data)
{
	CIwGameFile* file = (CIwGameFile*)caller;

	// file->getContent() and file->getContentLength() contain the data and data size

	delete file;

	return 0;
}
	// Initiate a none blocking file  download
	CIwGameFile* image_file = new CIwGameFile();
	image_file->setFileAvailableCallback(WebFileRetrievedCallback, NULL);
	image_file->Open("http://www.battleballz.com/bb_icon.gif", NULL, false);
```

Examining the above code we can see that we set up a callback so that we get notified when our file has been downloaded. Next we initiate the file download but this time passing "false" as our blocking parameter to ensure that the download does not block the main thread.

If you don't fancy setting up a callback, you can poll the CIwGameFile instead to see if the file has been retrieved using:

```
	bool		CIwGameFile::isFileAvailable()
```

6.6 Other Useful File Tools

CIwGameFile also contains a few additional useful tool type methods:

```
	static void	GetComponents(const char* file_path, CIwGameFilePathComponents&
components);
	static bool	GetFileType(const char* file_path, CIwGameString& type);
	static bool	isHttp(const char* file_path, int path_len);
```

- GetComponents() – Splits a path into its separate drive, path, name and extension components
- GetFileType() – Returns the file type of the supplied file name
- isHttp() – Checks a file name to see if it uses the http protocol

7.0 CIwGameInput – I Need Input

7.1 Introduction

A game wouldn't really be much of a game if the user could not interact with it. IwGame provides the CIwGameInput singleton class to manage all game input. CIwGameInput manages the following types of input:

- Single and multi-touch input
- Button and key states
- On screen keyboard input
- Acceleromter
- Compass

Access to input methods are provided via the IW_GAME_INPUT macro, for example:

```
if (IW_GAME_INPUT->getTouchCount() > 0)
{
}
```

If you are using CIwGame then you do not need to worry about initialising, updating or cleaning up the input system, however if you are rolling your own solution then you will need to take care of these steps yourself, here's a quick example showing how to do this:

```
// Initialise the input system
CIwGameInput::Create();
IW_GAME_INPUT->Init();

// Main loop
while (1)
{
	// Update input system
	IW_GAME_INPUT->Update();
}

// Shut down the input system
IW_GAME_INPUT->Release();
CIwGameInput::Destroy();
```

7.2 Checking Availability

As IwGame is designed to work across multiple platforms you should check to ensure that a particular input system is available before you use it. Here's a quick example showing how to check that the pointer input is available:

```
// Check to see that the pointer is available
if (IW_GAME_INPUT->isPointerAvailable())
{
	// Check to see if any touches have been made
	int num_touches = IW_GAME_INPUT->getTouchCount();
}
```

IwGame provides a number of methods to check for particular input systems availability:

```
bool	isPointerAvailable()		// Returns availability of the pointer
bool	isKeysAvailable()		// Returns availability of keys
bool	isOSKeyboardAvailable()		// Returns availability of on screen keyboard
bool	isAccelerometerAvailable()	// Returns availability of accelerometer
bool	isCompassAvailable()		// Returns true if compass is available
```

7.3. Single and Multi-touch Touches

CIwGameInput supports single and multi-touch events, allowing you to check for multiple simultaneous touches. However many devices do not support multi-touch events so a method has been provided to determine multi-touch support:

```
bool	isMultiTouch()			// Returns multitouch capability
```

If you are developing a game or app that relies on multi-touch then you should implement a fall back method that will work with single touch devices. Touch modes is a good solution that can help mirror multi-touch functionality by putting the pointer into different modes, such as move, scale, rotate etc.. and allow the user to switch between them.

No matter if you are using single or multi-touch functionality retrieving touches is done in very much the same way.

7.4 Working with Touches

CIwGameInput provides methods that enable you to detect and collect touch data. The usual process is to determine if any touches have been made by calling IW_GAME_INPUT->getTouchCount() and then take a look at the touches list to see what touch events occurred. Here's an example:

```
	// Check to make sure that the pointer is available
	if (IW_GAME_INPUT->isPointerAvailable())
	{
		// Get the total number of current touches
		int num_touches = IW_GAME_INPUT->getTouchCount();
		if (num_touches != 0)
		{
			// Check list of touches to see which are active
			for (int t = 0; t < MAX_TOUCHES; t++)
			{
				// Get the touch data
				CIwGameTouch* touch = IW_GAME_INPUT->getTouch(t);
				if (touch->active)
				{
					// Do something with the touch
				}
			}
		}
	}
```

Note that getTouch() returns the CIwGameTouch struct for the touch at te specified index. CIwGameTouch looks like this:

```
struct CIwGameTouch
{
public:
    int       x, y;         // Touch position
    bool      active;       // Touch active state
    int       id;           // ID of touch - The system tracks multiple touches by assigning
each one a unique ID
};
```

If you want to track a touch to monitor its status then you should store its ID and use CIwGameInput::getTouchByID(id) to find it again later.

7.5 Checking Key / Button States

As you expand your list of supported devices for your products you will discover that devices come in all sorts of different configurations, some will even have hard keyboards / keypads and buttons. For example, the Samsung Galaxy pro has a full QWERTY keyboard and almost all Android devices have hardware buttons for menu, home and back.

To query the state of a a key / button (buttons are mapped to keys) you call the following methods of CIwGameInput:

```
bool          isKeyDown(s3eKey key)             // Tests if a key is down
bool          isKeyUp(s3eKey key)               // Tests if a key is up
bool          wasKeyPressed(s3eKey key)         // Tests if a key was pressed
bool          wasKeyReleased(s3eKey key)        // Tests if a key was released
```

Each method takes an s3eKey as input, a full list of possible keys can be found in s3eKeyboard.h.

Note that to detect the back and menu buttons you should check both s3eKeyBack / s3eKeyAbsBSK and s3eKeyMenu / s3eKeyAbsASK respectively.

7.6 On Screen Keyboard

As most devices do not have hardware keyboards an on screen keyboard is the only method of inputting text into the device. IwGameInput provides access to this functionality via the showOnScreenKeyboard():

```
const char* showOnScreenKeyboard(const char* prompt, int flags = 0, const char* default_text
= NULL);
```

Calling this method will display a modal on screen keyboard with the provided prompt text and using the supplied default text (pass NULL if you do not require default text). Flags provides a hint to the system to let it know what type of keyboard you want to display to the user, possible values are:

- S3E_OSREADSTRING_FLAG_PASSWORD - A Password entry keyboard
- S3E_OSREADSTRING_FLAG_EMAIL - An email address entry keyboard
- S3E_OSREADSTRING_FLAG_URL - A web URL entry keyboard
- S3E_OSREADSTRING_FLAG_NUMBER - A Numeric entry keyboard

Passing 0 for flags will use the default keyboard.

Once the on screen keyboard has been dismissed the entered text will be returned as a string.

7.7 Accelerometer Input

An accelerometer is a device usually found inside phones and tablets that measures acceleration. This is great for gaming as you can use the actual angle or speed at which the user tilts their device to affect game play. For example, you could for example use the accelerometer to allow the player to navigate a ball around a maze or maybe determine how hard the player wants to hit a ball. However the accelerometer does have limitations. If the users phone is perpendicular to the floor then changes in reading may not be registered.

Accelerometer hardware is usually quite power hungry so in order ot use it you need to start it using:

```
IW_GAME_INPUT->startAccelerometer();
```

And when not in use you can turn it off using:

```
IW_GAME_INPUT->stopAccelerometer();
```

Per frame update of the accelerometer is automatically taken care of by CIwGameInput.

To read the current position of the accelerometer you call:

```
CIwVec3 accelerometer_pos = IW_GAME_INPUT->getAccelerometerPosition();
```

Because the user can potentially start a game with the phone held at any angle, reading accelerometer readings are best made from a frame of reference. This is usually the initial position that the user is holding the device at when they start the game. To set the reference point for the accelerometer call:

```
IW_GAME_INPUT->setAccelerometerReference();
```

This will set the reference point for offset reads to the current position of the users phone. You may want to display a short instructions screen at this point that informs the user how to hold the phone.

To read the accelerometer position with respect to the reference point call:

```
IW_GAME_INPUT->getAccelerometerOffset();
```

7.8 Compass Input

The digital compass is a device that uses the Earth's ambient magnetic field to determine the orientation of the users phone. This allows you to measure the angle of the device and the direction in which its pointing.

Like the accelerometer hardware the compass is usually quite power hungry so in order to use it you need to start it using:

```
IW_GAME_INPUT->startCompass();
```

And when not in use you can turn it off using:

```
IW_GAME_INPUT->stopCompass();
```

Per frame update of the compass is automatically taken care of by CIwGameInput.

To read the current orientation and heading of the compass you call:

```
CIwVec3 compass_heading = IW_GAME_INPUT->getCompassHeading();
int compass_directiom = IW_GAME_INPUT->getCompassDirection();
```

7.9 Input and the Marmalade Emulator

The Marmalade SDK simulator will allow you to simulate multi-touch functionality in your application but you firstly need to enable it. To enable this functionality you need to:

- Go to the simulator menu and select Configuration Pointer
- Tick “Report multi-touch available” and “enable multi-touch simulation mode”

  Now that you have enabled multi-touch simulation you can use the middle mouse button to place touches. You can move the touches around by holding the middle mouse button down over the placed touch and move it. To remove a multi-touch touch, simply click the middle mouse button over the touch again.

The PC keyboard provides more than adequate emulation of a real device keyboard. In addition certain keyboard keys act as buttons, for example the F1 key will simulate the menu button press on Android and F3 will simulate the back button.

7.10 Other Useful Utility Methods

The CIwGameInput class provides some additional utility functionality that can speed up development:

```
bool          hasTapped()
bool          isTouching()
bool          isDragging()
CIwVec2       getTouchedPos()
CiwGameTouch* getFirstTouch()
CIwVec2       getDragDelta()
bool          isBackPressed()
void          resetBackPressed()
bool          isMenuPressed()
void          resetMenuPressed()
```

- hasTapped() - Returns true the user has tapped on the display
- isTouching() - Returns true if the user is touching the display
- isDragging() - Returns true if the user is moving their finger on the display
- getTouchedPos() - Returns the position on the display that the user is touching
- getFistTouch() - Returns the first touch made
- getDragDelta() - Returns the number of pixels the user last moved their finger across the display
- isBackPressed() - Returns true if the user is pressing the back button
- resetBackPressed() - Resets the back button pressed status
- isMenuPressed() - Returns true if the user is pressing the menu button
- resetMenuPressed() - Resets the menu button pressed status

8.0 CIwGameTimer – Time and Timers

8.1 Introduction

Time plays a very important role in app and game development. Time allows us to perform useful tasks such as time events, fire off events at regular intervals and stabilise animations etc..

CIwGameTimer provides a software based timer mechanism for timing events as well a static method for retrieving the current time in milliseconds. Timers will not automatically fire off events when they expire, instead they have to be polled.

Timers provide additional functionality for calculating how much time is left on the timer as well as how much time has expired since the timer was started.

Timers don't really have much of an overhead so you can create as many as you like.

8.2 Getting the Current Time

To retrieve the current time in milliseconds CIwGameTimer provides a static method:

```
uint64 GetCurrentTimeMs()
```

8.3 Creating and Using Timers

Creating a timer is a simple case of declaring or allocating a CIwGameTimer then setting it off going. To check the timer you then poll it to check to see if it has timed out. Here's an example:

```
// Create a timer that expires after 10 seconds
CIwGameTimer BusyTimer;
BusyTimer.setDuration(10000);

// Check to see if the timer has timed out
if (BusyTimer.HasTimedOut())
{
}
```

Timers can be reset, stopped and started using Reset(), Stop() and Start().

A few additional utility methods are also included in the CIwGameTimer class:

```
bool          hasStarted()
bool          hasStopped()
void          setAutoReset(bool auto_reset)
uint64        GetElapsedTime()
uint64        GetTimeDiff(uint64 this_time)
uint64        GetTimeDiff()
uint64        GetTimeLeft()
```

- hasStarted() - Returns true if the timer was started
- hasStopped() - Returns true if the timer has stopped
- setAutoReset() - If true the timer will automatically restart itself when it runs out
- GetElapsedTime() - Returns the amount of time elapsed since the timer was started
- GetTimeDiff(time_diff) - Returns the time difference between the supplied time and the start of the timer
- GetElapsedTime() - Returns the amount of time left on the timer

9.0 IwGameHttp – Playing Outside the Box

9.1 Introduction

Modern apps and games are no longer limited to the confines of their local memory, they now have the power to play outside their limited box and interact with other external systems such as web sites and web services. For example, posting the players latest achievements to Facebook and Twitter feeds or playing an interactive game with friends on different devices running different operating systems.

IwGame provides access to the outside world via IwGameHttp. IwGameHttp provides the following functionality:

- Queues requests between your game and a web server
- Supports POST and GET requests
- Calculates user-agent based on platform / device and obtains IP address
- Error handling and reporting

IwGameHttp consists of a number of classes:

- CIwGamHttpHeader – Specifies headers that can be sent with POST and GET requests
- CIwGameHttpPostData – Specifies data that can be sent with a POST request
- CIwGameHttpRequest – Represents an HTTP request
- CIwGameHttpManager – The main HTTP manager that queues requests between the game and a web server

9.2 The HTTP Manager CIwGameHttpManager

CIwGameHttpManager is a singleton class that acts as the mediator between your game and an external web service. All requests sent to the HTTP manager are queued and processed in the order in which they are created. Requests are sent out one at a time, the next request will wait until the previous request returns or times out.

Access to the HTTP manager methods are provided via the IW_GAME_HTTP macro, for example:

```
IW_GAME_HTTP_MANAGER->AddRequest(&AdRequest);
```

Because not all games will have a need for HTTP communications, CIwGameHttpManager will not automatically be created and updated for you unless you request it when creating the main IwGame object.

You can also handle this yourself as shown below:

```
// Initialise the http manager
CIwGameHttpManager::Create();
IW_GAME_HTTP_MANAGER->Init();
```

the HTTP manager will need to be updated every game frame inside your main loop as shown below:

```
while (game_running)
{
	// Do game related stuff

	// Update http manager
	IW_GAME_HTTP_MANAGER->Update();
}
```

And finally the HTTP manager must be cleaned up on app exit

```
// Clean up http manager
IW_GAME_HTTP_MANAGER->Release();
CIwGameHttpManager::Destroy();
```

9.3 IP Addresses and User-Agents

Many web services require some method of identifying the mobile device that is accessing them. Identification usually comes in the form of the user-agent and IP address.

The user-agent is a header that browsers send to web server when they request data from it. From the user-agent the web server can determine what type of device and operating system the device has as well as what language the user is using

Some web services also require the users IP address. An IP address is a unique address that identifies the users mobile device on the internet. IP addresses can be local (to the network they are on, such as a home or office network) or remote. If your device is connected to the net over Wi-Fi then it will very likely be assigned a local IP address. If the devices is connected via the carrier then your device will have a remote IP address assigned to it by your carrier. This is a very important distinction to take note of as some services will not or cannot serve content to devices with local IP addresses.

Once you have initialised the CIwGameHttpManager you can retrieve the user-agent and IP address by calling:

```
CIwGameString&      getUserAgent()      // Returns current user-agent
CIwGameString&      getIPAddress()      // returns current IP address
```

If you would like to supply your own custom user-agent and / or IP address then you can do that also using:

```
void          setUserAgent(const char* user_agent)
void          setIPAddress(const char* ip_address)
```

9.4 POST and GET

POST and GET are two methods of communicating with a web server over HTTP. A POST is used to send data to the server whilst a GET is usually used to retrieve data from a server. You can actually think of POST and GET as commands that are sent to a server, with POST implying that you want to modify the state of the server in some way by sending data to it, whilst GET implies that you want to simply retrieve data and not modify it.

However, most web services support both GET and POST, allowing GET to modify the state of the server as data “can” be passed to the server as part of the URL. You have probably seen many long URL's of the form http://www.someserver.com/add_this.php?name=mat&socks=3&trousers=10&method=update (don't click the URL it means nothing). Notice how we are passing the items socks=3, trousers=10,method=update to the server. One major problem with using GET where POST should be used is data caching. Many servers now employ data caching techniques to reduce server load (they no longer have to go to the back end database and perform expensive SQL queries, instead they cache the web page or some data relating to the web page). So no matter what parameters you pass you could be returned cached data!

GET is however very convenient to use, you simply append all of your variables and values separated by ampersands onto the end of the URL.

Performing a POST on the other hand is only slightly more complicated. Instead of appending all your data onto the URL you package the data up into a string and set the data as the HTTP requests POST body. You then tell the server what type of data it is going to get by setting the Content-Type header and then tell it the size of the data by setting the Content-Length header.

IwGame supports both headers and post data via the CIwGameHttpHeader and CIwGameHttpPostData classes. More on these classes later.

No matter which method you choose POST or GET, both will return a response from the web server, which can be read by calling CIwGameHttpRequest::getContent();

9.5 Setting Up Headers

In the world of HTTP communications, headers play a very important role, they carry around information that tells the web server and the device lots of important information, such as the user-agent used, the accepted types of data (MIME types), cookies, the size of the POST body etc. in fact, you can pass anything you like. A good summary of the standard header types can be found at http://en.wikipedia.org/wiki/List_of_HTTP_header_fields .

9.6 Performing a GET

To perform a GET you simply create a CIwGameHttpRequest and fill it in as shown below:

```
// Our GET completed callback
int32 GetCompletdCallback(void* caller, void *data)
{
	CIwGameHttpRequest* request = (CIwGameHttpRequest*)caller;

	// request->getContent() and request->getContentLength() contains the
	// request data and data length

	IW_GAME_HTTP_MANAGER->RemoveRequest(request);  // Remove request from http manager
queue
	delete request;	// Delete the request

	return 0;
}


	CIwGameHttpRequest* Request = new CIwGameHttpRequest();
	Request->setGET();  // Tell the manager that we want to do a GET
	// Set the GET URL
	Request->setURI("http://www.someserver.com/add_this.php?
name=mat&socks=3&trousers=10&method=update");
	// Set a callback so we know when the request completes
	Request->setContentAvailableCallback(&GetCompletdCallback, NULL);
	// Set the user-agent header
	Request->SetHeader("User-Agent", UserAgent.c_str());
	// Queue our request
	IW_GAME_HTTP_MANAGER->AddRequest(Request);
```

The callback GetCompletedCallback() is called when the HTTP manager retrieves the data, you can use getContent() to read the retrieved data. Note that you must also remove the request from the http manager queue to prevent the queue from becoming cluttered with previously processed requests.

9.7 Performing a POST

Performing a POST is strikingly similar with only a few additional changes.

To perform a POST you simply create a CIwGameHttpRequest and fill it in as shown below:

```
// Our POST completed callback
int32 PostCompletdCallback(void* caller, void *data)
{
	CIwGameHttpRequest* request = (CIwGameHttpRequest*)caller;

	// request->getContent() and request->getContentLength() contains the
	// request data and data length

	IW_GAME_HTTP_MANAGER->RemoveRequest(request);  // Remove request from http manager
queue
	delete request;	// Delete the request

	return 0;
}

	CIwGameHttpRequest* Request = new CIwGameHttpRequest();
	Request->setPOST(); // Tell the manager that we want to do a POST
	// Set the POST URL
	Request->setURI("http://www.someserver.com/add_this.php");
	// Set a callback so we know when the request completes
	Request->setContentAvailableCallback(&PostCompletdCallback, NULL);
	// set the POST body
	Request->setBody("name=mat&socks=3&trousers=10&method=update");
	// Set the user-agent header
	Request->SetHeader("User-Agent", UserAgent.c_str());
	// Set the POST body content MIME type as application/x-www-form-urlencoded
	Request->SetHeader("Content-Type", "application/x-www-form-urlencoded");
	// Set the body content length as a string
	Request->SetHeader("Content-Length", CIwGameString(Request-
>getBody().GetLength()).c_str());
	// Queue our request
	IW_GAME_HTTP_MANAGER->AddRequest(Request);
```

The callback PostCompletedCallback() is called when the HTTP manager retrieves the data, you can use getContent() to read the retrieved data. Note that you must also remove the request from the http manager queue to prevent the queue from becoming cluttered with previously processed requests.

10.0 CIwGameAudio – Say No To Silent Movies

10.1 Introduction

Games would be pretty boring if they had no sound effects or music. Audio has always played an important role in games since they first games appears many years ago. IwGame provides access to sound effect and streamed music playback via the CIwGameAudio singleton.

CIwGameAudio has the following features:

- Compressed WAV software sound effect playback
- MP3 playback via the devices media engine
- Support for multiple simultaneous sound effects
- Control over volume and pitch

IwGame contains a number of classes for dealing with audio playback:

- CIwGameSound – Represents a sound effect
- CIwGameSoundCollection – Represents a collection of sound effect
- CIwGameAudio – The game audio manager

If you are using CIwGame then you do not need to worry about initialising, updating or cleaning up the audio system, however if you are rolling your own solution then you will need to take care of these steps yourself, here's a quick example showing how to do this:

```
// Initialise audio system
CIwGameAudio::Create();
IW_GAME_AUDIO->Init();

// Main loop
while (1)
{
	// Update audio
	IW_GAME_AUDIO->Update();
}

// Shut down audio
IW_GAME_AUDIO->Release();
CIwGameAudio::Destroy();
```

Sound effects are compressed using 8 and 16 bit ADPCM IMA (not Microsoft's version).

10.2 The Audio Manager CIwGameAudio

CIwGameAudio is a singleton class that is responsible for playing sound effects and streamed music

Access to the audio manager methods are provided via the IW_GAME_AUDIO macro, for example:

```
	IW_GAME_AUDIO->PlaySound("explosion");
```

CIwGameAudio provides the following methods:

```
	CIwGameSound* PlaySound(const char* name);
	CIwGameSound* PlaySound(unsigned int name_hash);
	void          StopSound(const char* name);
	void          StopSound(unsigned int name_hash);
	void          StopAllSounds();
	void          PauseAllSounds();
	void          ResumeAllSounds();

	bool          PlayMusic(const char* name, int repeat_count = 0); // Plays music from
a local file
	bool          PlayMusic(void* buffer, uint32 buffer_length, uint32 repeat_count); //
Plays music from a memory buffer
	void          StopMusic();
	void          PauseMusic();
	void          ResumeMusic();
	bool          isMusicPlaying();
```

Sound effects are played by name whilst music is played by file name or via a memory buffer (for pre-loaded audio).

CIwGameAudio contains a sound collection that stores all of the sound specs for all sound effects within the game. A sound collection is populated from a Marmalade resource group (more on this later)

10.3 Adding Audio Resources

10.3.1 Adding Sound Effects

Sound effects are loaded and tracked by the Marmalade resource system. To give our audio manager access to them we need to load the group containing the audio and assign it to the CIwGameAudio's sound collection. Here's an example showing the process:

```
	// Load audio resource group into the resource manager
	IwGetResManager()->LoadGroup("Audio.group");

	// Set up audio
	CIwResGroup* AudioGroup = IwGetResManager()->GetGroupNamed("Audio");
	IW_GAME_AUDIO->setGroup(AudioGroup);
```

Our sound effects are now available and ready to be played.

Note that when you change the current audio resource group being used by CIwGameAudio, all sound effects will be stopped and all previous sound effects will be deleted and replaced with the new set.

10.3.2 Creating a Resource Group

Marmalade supports a resource grouping system via a resource manager called IwResManager(). This manager loads groups of resources in the using .group files. A typical resource group for our sound effects would like this:

```
CIwResGroup
{
	name "Audio"

	// Sound sample WAV files
	"./explosion.wav"

	// Create sound specs (can be thought of as sound materials)
	CIwSoundSpec
	{
		name		"explosion"		# The name we want to use to refer to this
sound effect in out code
		data		"explosion"		# The WAv file name (without .wav
		vol		0.7			# Default volume to be played at
		loop		false			# Do we want this sound effect to play
forever?
	}

	// Create a sound group to contain all of our sound specs
	CIwSoundGroup
	{
		name		"sound_effects"	# Name of our sound group
		maxPolyphony 8			# Maximum sounds that can be played
simultaneously
```

```
            killOldest    false               # Tell system not to stop the oldest sound
effects frmo playing if we run out of channels
            addSpec       "explosion"         # Add the explosion sound spec to our sound
group
      }

}
```

The above resource group script basically creates a resource group named “Audio”, which we later access in our code by name via:

```
      // Set up audio
      CIwResGroup* AudioGroup = IwGetResManager()->GetGroupNamed("Audio");
```

It then creates a sound specification for our explosion sound effect. Finally we create a new sub group called “sound_effects” that contains all of our sound specifications.

If you want to learn more about Marmalade's resource management system then take a look at our blog on the object at http://www.drmop.com/index.php/2011/10/01/marmalade-sdk-tutorial-marmalades-resource-management-system/

We also have an additional blog directly related to creating audio resource groups at

http://www.drmop.com/index.php/2011/10/07/quick-and-easy-audio-and-music-using-s3eaudio-and-iwsound/

Once a resource group has been created you need to add it to the assets section of your mkb project file like so:

```
assets
{
      (data-ram/data-gles1, data)
      audio.group.bin
}
```

Note that audio,group.bin gets built from our Audio.group file when the x86 Debug build of our game is ran. So remember to run the game on the emulator before deploying to a device to ensure that the latest version of this file is created.

10.4 Playing and Modifying Sound Effects

Once a group of sound effects are assigned to the audio managers using IW_GAME_AUDIO-->setGroup(), all sound effects within the resource group will be created and added to the audio managers internal sound collection, at this point in time each sound effect will be instantiated as a CIwGameSound.

When we play a sound effect using the following code:

```
CIwGameSound* sound = IW_GAME_AUDIO->PlaySound("explosion");
```

A CIwGameSound object is returned from PlaySound(). This object allows us to control the sound after it has been started.

If we take a quick look at CIwGameSound functionality we see that it has a number of methods available to modify and check the status of the sound being played:

```
void          Play()
void          Stop()
void          SetVolume(float vol)
void          SetPitch(float pitch)
bool          isPlaying()
```

These methods peform the following function:

- Play – Plays the sound effect
- Stop() - Stops the sound effect from playing
- SetVolume() - Sets the volume of the sound effect. A value of 1.0f represents full volume
- SetPitch() - Sets the pitch of the sound effect. A value of 1.0f represents normal playback pitch
- isPlaying() - Returns true if the sound is currently playing

Sound effects can be stopped, paused and resumed en-mass using the following CIwGameAudio methods:

```
void          StopAllSounds();
void          PauseAllSounds();
void          ResumeAllSounds();
```

You also also set / get the master sound and music volumes using the following CIwGameAudio methods:

```
void          setSoundVolume(float vol);
float         getSoundVolume();
void          setMusicVolume(float vol);
float         getMusicVolume()
```

10.5 Playing Streamed Music

Streamed audio playback is usually used to play music that sits in the background of the game to give it atmosphere. IwGame utilises the media player on the device to playback audio from either storage or a pre-loaded memory buffer.

However, before music can be played back, we must firstly check that the device supports the codec that we used to encode the music we are attempting to play. Here is a quick examle showing how to check and play an MP3 file using CIwGameAudio:

```
// Check to see if MP3 codec is supported
if (IW_GAME_AUDIO->isMusicCodecSupported(S3E_AUDIO_CODEC_MP3))
{
       // Play some music
       IW_GAME_AUDIO->PlayMusic("music.mp3");
}
```

Below is a list of all possible codecs:

```
S3E_AUDIO_CODEC_MIDI          // MIDI files
S3E_AUDIO_CODEC_MP3           // MP3 files
S3E_AUDIO_CODEC_AAC           // Raw AAC files
S3E_AUDIO_CODEC_AACPLUS       // AAC plus files
S3E_AUDIO_CODEC_QCP           // QCP files
S3E_AUDIO_CODEC_PCM           // PCM files
S3E_AUDIO_CODEC_SPF           // SPF files
S3E_AUDIO_CODEC_AMR           // AMR files
S3E_AUDIO_CODEC_MP4           // MP4 or M4A files with AAC audio
```

Please note that these codecs may change with future versions of the Marmalade SDK and hence the IwGame engine so please consult the s3eAudioCodec enum located in s3eAudio.h for a full and up to date list.

Streamed music can also be stopped, paused and resumed. You can also check to see if music is playing using the following methods of CIwGameAudio:

```
void               StopMusic();
void               PauseMusic();
void               ResumeMusic();
bool               isMusicPlaying();
```

11.0 CIwGameImage – The Art of Game

11.1 Introduction

Lets face it, its possible to play a game without audio, we've all played a game with the audio turned down and it was still playable, in fact some games have truly awful audio and sound better with the audio switched off. However, try playing a game with all the graphics switched off, hmm, don't think that is going to work.

The brunt of any game is bore by the graphics engine, its usually where most of the games processing is taking place. Images are pivotal to any game engine (2D game engines at least), even vector graphic based games cache their vector based offering as images to increase performance.

IwGame provides a class specifically for loading and dealing with images called CIwGameImage.

CIwGameImage and associated classes are simple yet powerful supporting the following features:

- Image loading (PNG, GIF and JPEG) from Marmalade resource groups
- Image loading (PNG, GIF and JPEG) from a memory buffer
- Image loading (PNG, GIF and JPEG) from a file located locally or on the web (blocking and none blocking)
- Creation of PNG's from image data that can be saved or sent to a web server
- Management of collections of images using CIwGameResourceManager
- Instantiation from XOML

11.2 Creating an Image from a Resource

11.2.1 Adding Images

Images are loaded and tracked by the Marmalade resource system. When we create an image we assign it a name and a resource group. Here's an example showing the process:

```
// Load our graphics resource group into the resource manager
CIwResGroup* group = IwGetResManager()->LoadGroup("Graphics.group");
CIwGameImage* image = new CIwGameImage();
image->Init("sprites", group);

// Add the image to global resource manager
IW_GAME_GLOBAL_RESOURCES->getResourceManager()->addResource(image);
```

Note that if you are using scenes then you can use the scenes resource manager instead of creating and managing your own. e.g.

```
	// Add an image to the scenes resource manager
	game_scene->getResourceManager()->addResource(image);
```

Either way, our image is now available and ready to use, well, almost.

The underlying 2D image will not actually be created until it has been loaded / uploaded to video RAM. There are two ways to accomplish this:

- You can call CIwGameImage::Load() on the image to force it to be loaded / uploaded.
- Load on demand – The image will be loaded / uploaded when it is first accessed (for example when the sprite manager attempts to draw a sprite that uses the image)

11.2.2 Creating a Resource Group

Marmalade supports a resource grouping system via a resource manager called IwResManager(). This manager loads groups of resources in the using .group files. A typical resource group for our graphics would like this:

```
CIwResGroup
{
	name "Graphics"

	// Graphics
	"./sprites.png"
}
```

The above resource group script basically creates a resource group named “Graphics”, which we later access in our code by name via:

```
	// Add an image to image manager
	CIwResGroup* group = IwGetResManager()->LoadGroup("Graphics.group");
```

The resource group contains our sprites.png image file.

If you want to learn more about Marmalade's resource management system then take a look at our blog on the object at http://www.drmop.com/index.php/2011/10/01/marmalade-sdk-tutorial-marmalades-resource-management-system/

Once a resource group has been created you need to add it to the assets section of your mkb project file like so:

```
assets
{
	(data-ram/data-gles1, data)
	graphics.group.bin
}
```

Note that graphics,group.bin gets built from our Graphics.group file when the x86 Debug build of our game is ran. So remember to run the game on the emulator before deploying to a device to ensure that the latest version of this file is created.

11.3 Creating an Image from Memory

We can create an image from a file in memory using the following method CIwGameImage:

```
	bool	Init(void* memory_file, int memory_file_size);
```

This method of image creation gives you the option to create images from local files or images that you have downloaded from an external source such as a web server. Here is an example showing how to create an image from a memory buffer:

```
	// Download an image file from the web
	CIwGameFile* image_file = new CIwGameFile();
	image_file->Open("http://www.battleballz.com/test_image.jpg", NULL, true);

	if (image_file->isFileAvailable() && image_file->getError() ==
CIwGameFile::ErrorNone)
	{
		// Create an image from the downloaded JPEG file
		CIwGameImage* image = new CIwGameImage();

		// Initialise the image with the image file data in memory
		image->setName("test_image");
		image->Init(image_file->getContent(), image_file->getContentLength());
	}
	delete image_file;
```

Note that when creating an image from a memory buffer the image is automatically loaded so Load() does not need to be called.

11.4 Creating an Image from a Web Resource

We can create an image from a file located externally on a web server using:

```
    void                Init(const char* filename);
```

This method of image creation gives you the option to create images from local files or images that you have downloaded from an external source such as a web server. The image will not be loaded until Load(bool blocking) has been called. If you load an image using none blocking then you will need to check its loaded status by calling:

```
    if (Image->getState() == CIwGameImage::CIwGameImage_State_Loaded)
```

11.5 Creating Images from XOML

IwGame allows you to create An image using XOML mark-up language. Here's a quick example:

```
   <Image Name="Buddy" Location="http://www.battleballz.com/bb_icon.gif" Preload="true"
Blocking="false" />
```

This creates an image named buddy from a GIF file located on the the web. Note that it is preloaded but will not block the main loop whilst loading. Instead the sprite that is rendering the image will not appear on screen until the image has been fully downloaded. Images can be loaded locally using this method also.

We can also declare images that are located in Marmalade resource group files. Here is an example:

```
   <ResourceGroup Name="Level1" GroupFile="Level1.group" Preload="true" />
   <Image Name="Sprites" Location="Level1" Preload="true" />
```

Here we create a resource group called level1 then create an image called Sprites, passing the group name of the group that contains the “Sprites” image. Note that the image name and the name of the Marmalade resource must match or the resource may not be found.

Please note that images created inside a scene will be local to the scene and will be deleted when the scene is destroyed.

12.0 CIwGameSprite – A Sprite for Life

12.1 Introduction

Images wouldn't be much use unless we could move them around the screen, rotate, them, flash them and perform a whole host of other cool effects on them. A sprite in a visual element that can be moved around the display and rotated, scaled etc.. For the purpose of this document a sprite is not just an image based visual, it could be any kind of visual including a line or even a complex piece of vector graphics.

As explained in our actor discussion earlier, an actor is made of two parts a) a logical component and b) a visual component. The visual part of an actor is basically a sprite.

If you decided to use the predefined CIwGameActorImage class to derive your actors from then you will have had an image based sprite created for you automatically. If not then we have some extra work to do.

At the moment we have two types of sprite:

- CIwGameSprite – A basic generic sprite type that you can use to create your own types of sprites. It offers no rendering functionality and you are required to implement the base Draw() method to provide the custom rendering functionality.
- CIwGameBitmapSprite – A generic bitmapped based sprite that provides functionality for rendering an image based sprite
- CIwGameTextSprite – A generic text based sprite that provides functionality for rendering a text based sprite

Sprites have the following properties than can be dynamically changed:

- Width and height – Visual width and height on screen
- Position – A position on the screen, relative to the parent sprite manager
- Depth – 3D position (larger values go into the screen)
- Origin – Transform origin
- Angle – Orientation in degrees (IW_ANGLE_2PI == 360 degrees)
- ScaleX – Horizontal sale of sprite (IW_GEOM_ONE == 1.0f)
- ScaleY – Vertical sale of sprite (IW_GEOM_ONE == 1.0f)
- Colour – Colour and opacity of the sprite
- Visible – Visibility
- Pooled – Determines if the sprite is part of a sprite pool
- Layer – Visible layer that the sprite lives on
- LinkedTo – Used to linl sprites together. A sprite that is linked to another sprite will use its transform as well as its own

A CIwGameBitmapSprite sprite supports the following additional properties:

- SrcX, SrcY, SrcWidth, SrcHeight – Specifies a sub area of a large image to draw instead of the whole image
- ImageTransform – Marmalade image transform that flip the sprites image on the x and y axis

Note that bitmapped sprites that are created in code can set the colour of each vertex of the sprite using

```
    void         setColour(int index, CIwColour& colour)
```

A CIwGameTextSprite sprite supports the following additional properties:

- Text – The string to draw
- Rect – A rectangular area that the string should eb drawn in (relative to the sprites position)
- Font – The font to use to draw the text
- Flags – Marmalade font flags to be applied to the rendered text
- AlignH, AlignV – Marmalade alignment flags used to align the text

During rendering a sprites visual transform is built based upon the sprites position, angle and scale as well as its parent sprite managers transform. To optimise sprite rendering a sprites visual transform is only updated if either the position, rotation or scale changes. It will also be updated if the parent sprite managers transform is modified.

12.2 Sprite Manager

The sprite manager (CIwGameSpriteManager) is the system that takes care of tracking and rendering sprites. When sprites are created they are added to a sprite manager. The sprite managers geometric transform will be used as the base of the sprites transform, so any translation, rotation or scaling that is applied to the sprite managers transform will also be applied to all sprites that it is managing.

The sprite manager handles layers of sprites to allow sprites to be rendered using visible depth layering. Sprites on lower layers appear below sprites on higher layers. You can define the total number of layers available to the sprite manager upon its creation using:

```
    void                Init(int max_layers = 10);
```

The default number of layers is set to 10, although you can change this to any value within reason. Note that if you are using the sprite manager that is created and maintained by a scene then the scene will determine the number of layers that a sprite manager has. The scene will also be in charge of updating and rendering the sprite manager.

The sprite manager automatically batch renders sprites to improve performance in scenes that consists of many sprites. However the font rendering system does not use batch rendering and if switched on, sprites that exist on the same layer as the text will not be depth sorted correctly. To sort properly the sprite manager needs to have batching disabled.

The sprite manager also supports a centre of projection for 3D depth rendered sprites (sprites with a depth value of something other than 1.0). Moving the centre of projection will shift the projection origin.

12.3 Creating a Bitmapped Sprite

A bitmapped sprite is a basic image based sprite with support for image atlases using a source rectangular area that defines which portion of the assigned image is rendered; an image atlas is a large image that contains sub images.

A bitmapped sprite can render just a small portion of the large image allowing repositioning of the source rectangle within the image to create frame based animations.

Creating a bitmapped sprite is very simple as can be seen from the following example:

```
// Allocate a sprite
CIwGameBitmapSprite* sprite = new CIwGameBitmapSprite();

// Set its image
sprite->setImage(image);

// Set its display size
sprite->setDestSize(width, height);

// Add sprite to the sprite manager so it can be managed and drawn
Scene->getSpriteManager()->addSprite(sprite);
```

The variable “image” shown in the above code is a CIwGameImage that you would have previously created. The “Scene” variable is a scene that you will have already previously created. If you do not add a sprite via the scenes sprite manager then you must create and manage your own.

12.4 Creating a Text Sprite

A text sprite is a basic text based sprite with support for rendering a string to the display.

Creating a text sprite is very simple as can be seen from the following example:

```
// Allocate a sprite
CIwGameTextSprite* sprite = new CIwGameTextSprite();

// Set font
sprite->setFont(font);

// Set rectangular that text sprite will appear in
sprite->setRect(rect);

// Set the text to display
sprite->setText("Hello World!");

// Add sprite to the sprite manager so it can be managed and drawn
Scene->getSpriteManager()->addSprite(sprite);
```

The variable “font” shown in the above code is a CIwGameFont that you would have previously created. The “Scene” variable is a scene that you will have already previously created. If you do not add a sprite via the scenes sprite manager then you must create and manage your own.

12.4 Creating our own Custom Sprites

IwGame's sprite system is powerful in the sense that its extensible. You can create a multitude of different custom sprite types and the sprite manager will update and render them for you (obviously you will need to provide the rendering functionality in your own derived sprite class). Lets take a quick look at how we would create our own sprite class by taking a look at the implementation of CIwGameSpriteImage:

Firstly lets look at our class layout:

```
class CIwGameBitmapSprite : public CIwGameSprite
{
	// Properties
protected:
	CIwGameImage* Image;			// Bitmapped image that represents this sprite
	int			SrcX, SrcY;		// Top left position in source texture
	int			SrcWidth, SrcHeight;// Width and height of sprite in
source texture
public:
	void		setImage(CIwGameImage* image)
	{
		Image = image;
	}
	CIwGameImage* getImage()			{ return Image; }
	void		setSrcRect(int x, int y, int width, int height)
	{
		SrcX = x;
		SrcY = y;
		SrcWidth = width;
		SrcHeight = height;
	}
	void		setSrcRect(CIwGameAnimImageFrame* src)
	{
		SrcX = src->x;
		SrcY = src->y;
		SrcWidth = src->w;
		SrcHeight = src->h;
	}
	int			getSrcWidth() const		{ return SrcWidth; }
	int			getSrcHeight() const		{ return SrcHeight; }
	// Properties End
public:

	CIwGameBitmapSprite() : CIwGameSprite(), Image(NULL), SrcX(0), SrcY(0), SrcWidth(0),
SrcHeight(0) {}
	virtual ~CIwGameBitmapSprite() {}

	void	Draw();
};
```

Here we add properties to define the visual appearance of our sprite such as an image and a source rectangular area within that image that defines whidch portion of the image we want to display. We added a few setters and getters to access our new data.
Note how in the constructor we call the base CIwGameSprite constructor and set some default values for or class variable.

Next we will take a look at the Draw() method, only major method that we need to implement:

```
void CIwGameBitmapSprite::Draw()
{
	// Do not render if not visible or no image assigned
	if (Image == NULL || !Visible || Colour.a == 0)
		return;

	// If transform has changed then rebuild it
	if (TransformDirty)
		RebuildTransform();

	// Set this transform as the active transform for Iw2D
	Iw2DSetTransformMatrix(Transform);

	// Set colour of sprite
	Iw2DSetColour(Colour);

	// Render the sprite (centered)
	int x = -(Width / 2);
	int y = -(Height / 2);
	Iw2DDrawImageRegion(Image->getImage2D(), CIwSVec2(x, y), CIwSVec2(Width, Height),
CIwSVec2(SrcX, SrcY), CIwSVec2(SrcWidth, SrcHeight));
}
```

Again, quite simple straight forward code. Firstly we perform a little error checking then rebuild the visual transform if it has changed. Next we set the Iw2D transform so that anything we render will be transformed by our sprites transform. Finally we render the sprite using its centre point as its origin using Iw2D (We use the centre point as the origin to allow the sprite to rotate and scale around its centre).

13.0 CIwGameAnim – Life and Soul of the Party

13.1 Introduction

There are plenty of great games out there that do not feature any form of animation. However, most modern games do feature animations to enhance their look and feel. Lets take “Angry Birds” as an example, Angry Birds uses animations all over the place, such as the animating birds and pigs, even the menus contain flashing and sweeping animations.

When we initially decided to implement an animation system we decided that it had to be very flexible and support any type of animation, be it animating the position of an actor, animating the graphical frames of an actor or even animating a list of commands for an actor. From IwGame's point of view, animation refers to any variable or set of variables that can change over time.

IwGameAnim currently supports the following features:

- Time based frame and interpolated named animations
- Delayed and looped animations
- Support for boolean, float, vectors (2d, 3d and 4d), rect (for image frames), string and custom frame data types
- Resource manager that tracks and manages sets of animations (scene local and global)
- Animation data re-use using animation instances
- Animation time lines to support multiple simultaneous animations that can target object specific properties such as the colour of a scene or the position of an actor
- Time line manager that tracks and manages sets of animation time lines
- Callback notifications for animation instance started, stopped and looped events
- Animations and animation time lines can be defined and attached to actors and scenes using XOML
- Support for OnStart, OnEnd and OnRepeat events in code and in XOML
- Linear, quadratic, quartic and cubic in and out easing

The animation is split into the following classes:

- CIwGameAnimFrame – Base animation frame class
- IIwGameAnimTarget – Interface for classes that act as an animtion target
- CIwGameAnim – A basic animation
- CIwGameAnimCreator – Class used to instsntiate an animation from XOML
- CIwGameAnimManager – Manages a collection of animations
- CIwGameAnimInstance – An instantiated running animation
- CIwGameAnimTimeline – A collection of running animation instances
- CIwGameAnimTimelineCreator – Class used to instantiate a collection of running animations frfm XOML
- CIwGameAnimTimelineManager – Manages a collection of timelines

13.2 Animation Frame Data

Animation frame data is the backbone of all animations, it represents the actual discrete state of a variable at a given point in time (called a key frame). An animation frame consists of two components:

- Frame data – Frame data is the value or values of a specific variable at a specific point in time
- Frame time – The time at which the frame has its value (in seconds)

The base class for all animation frame data types is the CIwGameFrameData. This class provides a means for the developer to implement their own custom animation frame data types. The following animation frame data types are already implemented:

- CIwGameAnimFrameBool – Boolean variables such as actor visbility
- CIwGameAnimFrameFloat – Floating point variables such as angle and scale
- CIwGameAnimFrameVec2 – Floating point 2 parameter variables such as 2D position and velocity
- CIwGameAnimFrameVec3 – Floating point 2 parameter variables such as 3D position and velocity
- CIwGameAnimFrameVec4 – Floating point 4 parameter variables such as colour
- CIwGameAnimFrameRect – Integer 4 parameter variables such as image source rectangles
- CIwGameAnimFrameString – String based parameters such as narrative text, commands or even other timeline's

13.3 Animations and the Resource Manager

The resource manager is used to manage a group of resources (animations and animation time lines included). The idea is that you create a group of animations and time lines then add them to the resource manager and then forget about them. The resource manager will take care of cleaning them up when the scene or game is destroyed. The main game object contains its own global resource manager whilst all scenes contain their own local resource manager.

Note that when animations are created via XOML mark-up they are added to the resource manager. Animations that are created inside a scene will be added to the scenes resource manager, whilst animations created outside of the scene will be added to the global resource manager.

To find an animation within a scenes resource manager you would use could such as:

```
CIwGameAnim* anim = (CiwGameAnim*)scene->getResourceManager()->findResource("Player1Anim",
CIwGameXomlNames::Animation_Hash);
```

Note that if the animation is not found within the scene then the system will automatically search the global resource manager for the animation. You can prevent this global search by passing false

as the third parameter to findResource().

13.4 Animation Instances

You do not play a CIwGameAnim directly, instead you create an instance of it using CIwGameAnimInstance:

```
// Create and set up an animation
CIwGameAnimInstance* face_anim = new CIwGameAnimInstance();
face_anim->setAnimation(anim);
face_anim->setTarget(actor, "SrcRect");
```

Note the following line of code:

```
face_anim->setTarget(actor, "SrcRect");
```

This line of code tells the animation to modify the “SrcRect” (the actors image atlas position) property of the actor object, causing the image to change.

Animation instances can be played, paused, resumed, stopped and restarted. You can also tell an animation to delay playing for a finite period of time. Methods of CIwGameAnimInstance are shown below:

```
int           getRepeatCount()
void          setRepeatCount(int repeat_count)
float         getCurrentTime()
bool          isFinished()
CIwGameAnimFrame*    getCurrentData()
float         getDelay()
void          setDelay(float delay)
bool          isPlaying()
bool          isPaused()
bool          isDelayed()
void          restart()
void          play()
void          stop()
void          pause()
void          setStartedCallback(CIwGameCallback callback)
void          setStoppedCallback(CIwGameCallback callback)
void          setLoopedCallback(CIwGameCallback callback)
```

13.5 Animation Targets and Target properties

IwGameAnim uses the concept of animation targets and animation target properties. An animation target is basically a class that contains a variable or group of variables that can be targeted for modification by an animation. The actual variable or variables that are targeted are called target properties. An example target would be an actor and example target property would be the actors position. When you create an instance of an animation you set the target and target property that the animation will modify using code similar to that shown below:

```
	face_anim->setTarget(actor, "SrcRect");
```

Any class can be used as a target for animation as long as it derives from the IIwGameAnimTarget interface and implements the the following pure virtual method:

```
	virtual bool  UpdateFromAnimation(CIwGameAnimInstance *animation) = 0;
```

When the animation updates it will call back this method passing in its data asking the method to update the state of the object. Both scene and actor classes already have this functionality implemented.

Lets take a quick look at how the CIwGameScene class has implemented this method:

```
bool CIwGameScene::UpdateFromAnimation(CIwGameAnimInstance *animation)
{
	unsigned int element_name = animation->getTargetPropertyHash();

	if (Camera != NULL)
	{
		if (element_name == CIwGameXomlNames::Position_Hash)
		{
			CIwGameAnimFrameVec2* frame = (CIwGameAnimFrameVec2*)animation-
>getCurrentData();
			Camera->setPosition(frame->data.x, frame->data.y);
			return true;
		}
		else
		if (element_name == CIwGameXomlNames::Angle_Hash)
		{
			CIwGameAnimFrameFloat* frame = (CIwGameAnimFrameFloat*)animation-
>getCurrentData();
			Camera->setAngle(frame->data);
			return true;
		}
		else
		if (element_name == CIwGameXomlNames::Scale_Hash)
		{
			CIwGameAnimFrameFloat* frame = (CIwGameAnimFrameFloat*)animation-
>getCurrentData();
			Camera->setScale(frame->data);
			return true;
```

```
		}
	}
	if (element_name == CIwGameXomlNames::Colour_Hash)
	{
		CIwGameAnimFrameVec4* frame = (CIwGameAnimFrameVec4*)animation-
>getCurrentData();
		Colour.r = (uint8)frame->data.x;
		Colour.g = (uint8)frame->data.y;
		Colour.b = (uint8)frame->data.z;
		Colour.a = (uint8)frame->data.w;
		return true;
	}
	else
	if (element_name == CIwGameXomlNames::Clipping_Hash)
	{
		CIwGameAnimFrameRect* frame = (CIwGameAnimFrameRect*)animation-
>getCurrentData();
		ClippingArea.x = (uint8)frame->data.x;
		ClippingArea.y = (uint8)frame->data.y;
		ClippingArea.w = (uint8)frame->data.w;
		ClippingArea.h = (uint8)frame->data.h;
		return true;
	}
	else
	if (element_name == CIwGameXomlNames::Visible_Hash)
	{
		CIwGameAnimFrameBool* frame = (CIwGameAnimFrameBool*)animation-
>getCurrentData();
		IsVisible = frame->data;
		return true;
	}

	return false;
}
```

The logic is quite simple, we check the name of the property that was passed in by the animation instance then check that against known property names of the class. If it matches then we move the animation data from the animation instance into our classes local variable.

As you can see implementing your own custom animation targets is a simple case of:

- Deriving your class from IIwGameAnimTarget
- Implement the UpdateFromAnimation(CIwGameAnimInstance *animation) method

13.6 Animation Timeline's

An animation time line is basically a way to group together multiple animation instances and play, pause, stop and resume them all together. The general idea is that you create an animation time line then create animation instances and add them to the time line. You then attach the time line to your destination object, be that a scene or an actor. The animation system will then take care of the rest for you. Here is an example showing how to create and use a time line:

```
	// Find our face animation
	CIwGameAnim* face_anim = (CIwGameAnim*)scene->getResourceManager()-
>findResource("FaceAnim", CiwGameXomlNames::Animation_Hash);

	// Create and set up our animation instance
	CIwGameAnimInstance* instance = new CIwGameAnimInstance();
	instance->setAnimation(face_anim);
	instance->setTarget(actor, "SrcRect");
	timeline->addAnimation(instance);
	timeline->play();

	// Create an animation timeline to hold our image animation
	CIwGameAnimTimeline* timeline = new CIwGameAnimTimeline();
	timeline->addAnimation(instance);

	// Attach timeline to the actor
	actor->setTimeline(timeline);
```

Defining and attaching animations is much easier and more intuitive if done declaratively using XOML mark-up. More on this this later

Note that when you attach an animation time line to a scene or an actor, the scene / actor will automatically take over updating it for you.

Time lines can be played, paused, resumed and stopped. All animation instances within the animation time line will be affected. Methods of CIwGameAnimTimeline are shown below:

```
	void                setName(const char* name)
	unsigned int        getNameHash()
	void                addAnimation(CIwGameAnimInstance* anim)
	void                removeAnimation(CIwGameAnimInstance* anim)
	CIwGameAnimInstance* findAnimation(const char* name)
	CIwGameAnimInstance* findAnimation(unsigned int name_hash)
	void                play()
	void                stop()
	void                pause()
	void                restart()
	int                 getAnimationCount()
	void                setTargetElement(IIwGameAnimTarget* target)
```

13.7 Resource Manager and Timelines

The resource manager is generally responsible for managing the lifetimes of animation time lines, in particular those created from XOML mark-up.

Each scene has its own local resource manager and the global game class also contains a global resource manager.

13.8 Working with Animations

The general work flow when working with the animation system has two potential paths:

- Manual definition – You manually create all of the animation frames, animation classes, instances, timelines etc
- XOML definition – You load a XOMl file that contains the definictions, find the time lines and attach

The firtst method is more difficult as it does require creatng abnd setting up animation classes yourself. Heres the basic flow for manual animation setup:

- Create a CIwGameAnim object and give it a meaningful name
- Create and set-up animation frames
- Add animation frames to the CIwGameAnim object
- Add the CIwGameAnim object to the scene or global CIwGameAnimManager
- Later when you need to create an instance of the animation, search the animation manager for the animation by name
- Create a CIwGameAnimTimeline object
- Create a CIwGameAnimInstance object and attach the CIwGameAnim object
- Set up any additional paramaters for the time line object
- Add the time line object to the scene or global time line manager (not essentuial as scenes and actors can clean them up for you)
- Set the actor or scenes time line using setTimeline()
- Call the time line's play() method to start the time line playing

The second method using XML is much simpler:

- Create a XOML file
- Add Animation and Timeline definitions
- If your scene / actor is also defined in XOML then you simply set the Timeline property to the name of the timline and you are done. If not then continue onto the next step
- Search the scenes timelines for our named time line
- Set the actor or scenes time line using setTimeline()
- Call the time line's play() method to start the time line playing

13.9 Creating a Basic Animation in Code

IwGame supports a number of different types of animation as previously explained. In our example we are going to create a basic floating point animation that animates the rotation of an actor object.

```
// Create an animation
CIwGameAnim* anim = new CIwGameAnim();
anim->setName("TestAnim");
anim->setDuration(3);
anim->setType(CIwGameAnimFrame::FT_Float);

// Create and add frames
CIwGameAnimFrameFloat* frame = new CIwGameAnimFrameFloat();
frame->Time = 0;
frame->data = 0;
anim->addFrame(frame);
frame = new CIwGameAnimFrameFloat();
frame->Time = 1;
frame->data = 45;
anim->addFrame(frame);
frame = new CIwGameAnimFrameFloat();
frame->Time = 2;
frame->data = 90;
anim->addFrame(frame);

// Create animation instance
CIwGameAnimInstance* instance = new CIwGameAnimInstance();
instance->setAnimation(anim);
instance->setDelay(0);
instance->setRepeatCount(0);
instance->setTarget(actor, "Angle");

// Creata a time line
CIwGameAnimTimeline* timeline = new CIwGameAnimTimeline();
timeline->setName("Timeline1");
timeline->addAnimation(instance);

// Play the timeline
timeline->play();

// Attach timeline to actor
actor->setTimeline(timeline);
```

As you can see it is a little verbose, which is why we recommend using XOML mark-up for defining animations in particular.

13.9 Creating a Basic Animation in XOML

XOML is IwGame's mark-up language that can be used to define and set-up actors, ecenes, resource, animations and other game elements. Here is an example showing how to set up the previous example using XOML syntax:

```
<xml>
    <Animation Name="TestAnim" Type="float" Duration="3" >
        <Frame Value="0"   Time="0.0" />
        <Frame Value="45"  Time="1.0" />
        <Frame Value="90"  Time="2.0" />
    </Animation>
    <Timeline Name="Timeline1" AutoPlay="true">
        <Animation Anim="TestAnim" Target="Angle" Repeat="0" StartAtTime="0"/>
    </Timeline>
</xml>
```

As you can see it is incredibly easy to set up animations and time line's using XOML syntax.

13.10 Creating an Image Animation

We are now going to take a look at creating an image based animation that we can attach to an actor:

```
    // Create an animation
    CIwGameAnim* anim = new CIwGameAnim();
    anim->setName("TestAnim");
    anim->setDuration(0.8f);
    anim->GenerateAtlasFrames(8, 36, 40, 0, 0, 512, 40, 512, 0.1f);

    // Create animation instance
    CIwGameAnimInstance* instance = new CIwGameAnimInstance();
    instance->setAnimation(anim);
    instance->setDelay(0);
    instance->setRepeatCount(0);
    instance->setTarget(actor, "SrcRect");

    // Creata a time line
    CIwGameAnimTimeline* timeline = new CIwGameAnimTimeline();
    timeline->setName("Timeline1");
    timeline->addAnimation(instance);

    // Play the timeline
    timeline->play();

    // Attach timeline to actor
    actor->setTimeline(timeline);
```

Setting up an image based animation is a little simpler because the CIwGameAnim::GenerateAtlasFrames() method() automates the generation of frames for us.

However in XOML will still need to list all frames:

```
<Animation Name="TestAnim" Type="rect" Duration="0.8" >
    <Frame Value="0, 0,   36, 40" Time="0.0" />
    <Frame Value="0, 40,  36, 40" Time="0.1" />
    <Frame Value="0, 80,  36, 40" Time="0.2" />
    <Frame Value="0, 120, 36, 40" Time="0.3" />
    <Frame Value="0, 160, 36, 40" Time="0.4" />
    <Frame Value="0, 200, 36, 40" Time="0.5" />
    <Frame Value="0, 240, 36, 40" Time="0.6" />
    <Frame Value="0, 280, 36, 40" Time="0.7" />
</Animation>
<Timeline Name="Timeline1" AutoPlay="true">
    <Animation Anim="TestAnim" Target="SrcRect" Repeat="0" StartAtTime="0"/>
</Timeline>
```

Helper tags will be added at a future date to automate the creation of atlas image animations and frames that follow patterns.

15.0 CIwGameAds – Wanna Make Some Money?

15.1 Introduction

On certain platforms, trying to get users to part with “the cost of less than a cup of coffee” for all your hard work is seemingly impossible. A popular alternative to paid apps are free ad supported apps, where the app is given away for free and revenue is generated by users clicking on ads displayed within the app. Before we get into the coding side of things there are a few important things you need to know about ads and the ad industry in general.

An ad's potential to make you money is measured in CPC (cost per click) or eCPM (cost per 1000 impressions). I prefer to deal in CPC as its a much clearer measuring stick to determine the value of particular ads and ad providers. Unfortunately the industry hides behind eCPM because it is vague and easy to mask, however its all we have to measure ad performance so we will speak in terms of eCPM.

eCPM is calculated based on how much you have or will have earned based on an average 1000 ads shown to users. Values can vary from as low as $0.10 to as high as $5.00. So as you can see it is going to take a LOT of impressions to make any decent money, but it is better than your app sat on some app store making nothing because users don't even know its there. Free apps tend to get much more exposure and users are much more likely to download them because they are free.

The next term you need to become familiar with is CTR (click through rate). This is the ratio of ads served to your app and the number of people that have actually clicked on your ads. So for example, lets say you get 10,000 ads served to your app in one day and 500 users click on ads, this will make you CTR (500 * 100) / 10,000 = 5%. Click through rates can typically range from 0.1% to 10.0%, with the average being around 1%. At the moment ads running using IwGame's animating ads system are getting the following CTR's:

- Android – 3.2%
- iPhone – 8%
- iPad – 3%
- Samsung Bada - 4%

As you can see by adding some style to your ads you can vastly exceed the standard 1% CTR rate that most static ads obtain.

The last term that you should need to become familiar with is fill rate. This is the ratio of ad requests (termed requests) made from your app to ads actually sent back (termed impressions) to the user from their ad network. This varies based on the device running your app, the country and language of the user and the ad providers size and popularity. To calculate fill rate you divide the number of impressions by the number of requests. So for example, lets say you get 10,000 ad requests in one day but only 5,000 impressions then you fill rate is (5000 * 100) / 10,000 = 50%. Average fill rates vary massively across platform, provider and country. iPhone and Android platforms tend to have very high fill rates (typically 90%+) because they are popular and everyone

wants to advertise their wares on these platforms. Platforms such as Samsung Bada and Blackberry Playbook experience much lower fill rates. Bada fill rates (can be as low as 20%,) simply because they aren't quite as popular.

One way to combat low fill rates is to use multiple ad providers. If one ad provider does not return an ad for your platform then request an ad from the next provider. (usually referred to as ad mediation) You may need to integrate 4-5 ad providers to ensure a 100% fill rate and maximise your apps earning potential on some platforms.

Ok, now that we have that out the way, lets take a look at IwGameAds.

IwGameAds is a cross platform unified ad API that allows you to make requests from a number of ad providers. It also goes one step further and provides a view that can display retrieved banner based ads and register clicks. IwGameAds provides the following functionality:

- Asynchronously request text, image and html based ads from a variety of ad providers
- Automatic extraction of ad data, such as image url, click url and text
- Provision for targetted ads by age, gender, location etc..
- Integrated ads view that can display animating ads to the user as well as detect clicks and launch the external URL / app that deals with the click destination
- Cache and display multiple ads from multiple providers
- Ad mediation using the priority based IwGameAdsMediator class

IwGameAds currently supports Inner-active, AdFonic, VServ, Mojiva, Millennial Media and AdModa ad providers. More will be added as they are confirmed as working.

CIwGameAds and CIwGameAdsView are both singletons that provide easy global access from anywhere in your game. CIwGameAds is not dependent upon CIwGameAdsView so can roll your own ad view system if you want to.

15.2 Setting up and Updating IwGameAds

If you are going to use the provided ads view then the process is setting up and updating IwGameAds is very simple as the view will take care of initialising and updating the ads system:

```
// Create ad view
CIwGameAdsView::Create();

// Initialise with Application ID (you get this from your ad provider)
IW_GAME_ADS_VIEW->Init("Your App ID");

// Set ad request interval in seconds
IW_GAME_ADS_VIEW->setNewAdInterval(30);

// Set ad provider (if you want ads to be automaticall collected at an interval)
IW_GAME_ADS_VIEW->setAdProvider(CIwGameAds::InnerActive);

// Set total number of ads visible in the ads view
IW_GAME_ADS_VIEW->setNumAdsVisible(1);
```

If you not want ads to be requested automatically at a set interval then you should not use setNewAdInterval(). Calling setAdInterval(0) will disable auto collection of ads.

And updating the view in your main loop would look like this:

```
// Update the ads view
IW_GAME_ADS_VIEW->Update(1.0f);
// draw the ads view
IW_GAME_ADS_VIEW->Draw();
```

Note that if you would like the ads view to scale to fit your scenes transform then you can pass the scene as a parameter to Draw().

Finally cleaning up the ads view is done like this:

```
// Clean up the ads view
IW_GAME_ADS_VIEW->Release();
CIwGameAdsView::Destroy();
```

As you can see its a very simple 3 stage integration. If however you have decided to roll your own ads view then you will need to set up CIwGameAds yourself:

To initialise the ads system you should implement the following:

```
// Create ad view
CIwGameAds::Create();
IW_GAME_ADS->Init();
// Set the Application ID (you get this from your ad provider)
IW_GAME_ADS->setApplicationID(id);
```

You need to update the ads system each game loop using:

```
// Update the ads system
IW_GAME_ADS->Update();
```

And finally clean up the ad system when done with it using:

```
IW_GAME_ADS->Release();
CIwGameAds::Destroy();
```

15.3 Ad Types

CIwGameAdsView currently supports the rendering of image based banner ads only. It will not render text or html based ads. However you tell the ads system which types of ad you are willing to accept. You can tell the ad system to return these types of ads using:

```
void                setTextAds(bool text_ads)
void                setHtmlAds(bool html_ads)
```

Note that not all ad providers may offer this functionality so the system uses it more as a hint.

15.4 Requesting Ads

Requesting an ad using CIwGameAdsView is very simple as the following piece of code will show:

```
// Request an Inner-active ad
IW_GAME_ADS_VIEW->RequestNewAd(CIwGameAds::InnerActive);
```

Once the ad is available the ads view will display it to the user.

If you are rolling your own ad view then requesting ads looks very much the same.

```
// Request an Inner-active ad
IW_GAME_ADS->RequestAd(CIwGameAds::InnerActive);
```

The slightly more complicated process is detecting when the ad has arrived. The code below shows how to detect the arrival of a new ad and how to get at the ad information:

```
// Check to see if new ad has arrived
if (IW_GAME_ADS->isAdAvailable())
{
	CIwGameAds::eIwGameAdsError error = IW_GAME_ADS->getError();
	if (IW_GAME_ADS->getError() <= MinError)
	{
		// No error - You can now acess the ads information
		CIwGameAd& ad = IW_GAME_ADS->getAd();
	}
	else
	{
		// Error occuured - error contains an error
	}

	// Allow the next ad request
	IW_GAME_ADS->setAdAvailable(false);
}
```

Your own implementation will also need to take care of displaying ads and responding to clicks.

15.5 Working with CIwGameAdsView

CIwGameAdsView is a convenient ad view that will retrieve ads, display them using animations and monitor and respond to ad clicks. We've already explained how to create an update an ads view, but we haven't yet covered some of the cooler features of the view. Here is a list of features:

- Can display multiple ads
- Can display ads anywhere on screen
- Can rotate and scale ads
- Can change the colour and opacity of ads
- Can hide and show ads
- Can animate ads

When you create the CIwGameAdsView you can set how many ads you would like the view to display using:

```
    void                setNumAdsVisible(int count)
```

You can also set the position, scale, rotation, colour and visibility of each separate ad as well add animators using the following methods:

```
    void                setVisible(int index, bool visible)
    void                setPosition(int index, int x, int y)
    void                setScale(int index, float scale)
    void                setAngle(int index, float angle)
    void                setColour(int index, int r, int g, int b, int a)
    void                addAnimator(int index, CIwGameAdsViewAnimator* animator)
```

Using the above methods you can provide a whole range of animations to your ads

15.6 Ad Animators

To test out our animating ads idea we created a basic class called CIwGameAdsViewAnimator. This class provides an easy way to quickly get ads animating. This class is provided mainly as an example showing how to animate ads yourself.

The ad view animator assumes that the ad is going to be in one of 4 states:

- AnimIn – The ad is coming into view
- AnimOut – The ads is going out of view
- AnimStay – The ad is at rest but visible to the user
- AnimDone – The ad is finished

The ad view will allow you to add animations for the in, out and stay phases.

Hers an example that shows a typical sweep in over one second, stay on screen for seven seconds and then sweep back out over one second.

```
// Create and attach an animator that fades the ad in over 1 second, pauses for 7
// seconds and then fades the ad back out
CIwGameAdsViewAnimator* anim = new CIwGameAdsViewAnimator();
anim->Init();
anim->setAdViewDataIndex(0);
anim->setCanvasSize(width, height);
anim->setInAnim(CIwGameAdsViewAnimator::AnimFadeIn, 1000);
anim->setOutAnim(CIwGameAdsViewAnimator::AnimFadeOut, 1000);
anim->setStayDuration(7000);
IW_GAME_ADS_VIEW->addAnimator(0, anim);
```

You can add multiple animations to the same ad as shown in the following example:

```
// Create and attach an animator that sweeps the ad in from the right the over 1.2
// seconds, pauses for 7 seconds and then sweeps back out
anim = new CIwGameAdsViewAnimator();
anim->Init();
anim->setAdViewDataIndex(0);
anim->setCanvasSize(width, height);
anim->setRestingPosition(0, -height / 8);
anim->setInAnim(CIwGameAdsViewAnimator::AnimRightSweepIn, 1200);
anim->setOutAnim(CIwGameAdsViewAnimator::AnimRightSweepOut, 1200);
anim->setStayDuration(7000);
IW_GAME_ADS_VIEW->addAnimator(0, anim);

// Create and attach an animator that scales the ad in over 1.5 seconds, pauses for 7
// seconds and then scales back out
anim = new CIwGameAdsViewAnimator();
anim->Init();
anim->setAdViewDataIndex(0);
anim->setCanvasSize(width, height);
anim->setInAnim(CIwGameAdsViewAnimator::AnimScaleIn, 1500);
anim->setOutAnim(CIwGameAdsViewAnimator::AnimScaleOut, 1500);
anim->setStayDuration(7000);
IW_GAME_ADS_VIEW->addAnimator(0, anim);

// Create and attach an animator that rotates the ad in over 1 second, pauses for 7
// seconds and then rotates back out
anim = new CIwGameAdsViewAnimator();
anim->Init();
anim->setAdViewDataIndex(0);
anim->setCanvasSize(width, height);
anim->setInAnim(CIwGameAdsViewAnimator::AnimSpinIn, 1000);
anim->setOutAnim(CIwGameAdsViewAnimator::AnimSpinOut, 1000);
anim->setStayDuration(7000);
IW_GAME_ADS_VIEW->addAnimator(0, anim);
```

By combining animators you can produce some interesting effects.

15.7 CIwGameAdsMediator – The Art of Ad Mediation

Integrating a single ad provider into your product is not a great idea if you want to maximise your products earning potential. When ad providers give fill rate figures of over 90%, they leave out the fact that the fill rate they advertise is based upon their best performing platforms and countries. An ad provider will based eCPM on how many ads were delivering to your app and not how many ad requests were made from your app, which can be VERY misleading. Some platforms such as Bada have fill rates as low as 20%, whilst some countries such as China have even lower fill rates.

To get around this problem you need to use ad mediation. This is the process of going through a list of prioritised ad providers requesting an ad, if the ad provider does not provide an ad then request an ad from the next provider. Keep doing this until you get an ad that you can use.

IwGame provides automated ad mediation using the CIwGameAdsMediator. To use the mediator you create a CIwGameAdsmediator, populate it with ad party's then attach it to the CIwGameAds object as shown below:

```
// Create ad mediator and attach it to the main ad object
CIwGameAdsMediator* ad_mediator = new CIwGameAdsMediator();
IW_GAME_ADS->setMediator(ad_mediator);

// Create Inner-active ad party and add to the mediator
CIwGameAdsParty* party = new CIwGameAdsParty();
party->ApplicationID = "Your inner-active App ID";
party->Provider = CIwGameAds::InnerActive;
ad_mediator->addAdParty(party);

// Create AdModa ad party and add to the mediator
party = new CIwGameAdsParty();
party->ApplicationID = "You AdModa App ID";
party->Provider = CIwGameAds::AdModa;
ad_mediator->addAdParty(party);

// Create AdFonic ad party and add to the mediator
party = new CIwGameAdsParty();
party->ApplicationID = "Your AdFonic App ID";
party->Provider = CIwGameAds::AdFonic;
ad_mediator->addAdParty(party);
```

As you can see, incredibly simple. The process of attaching the ad mediator will ensure that the ad object will attempt to collect ads from all ad parties should previous parties fail to collect an ad. You do not need to make any changes to the ad view, the system is completely automated.

15.8 Supported Ad Providers

The following ad providers are currently supported:

- Inner-active
- AdFonic
- Vserv – Also provides support for InMobi, BuzzCity, JumpTap, ZestAdz / Komli Mobile and Inner-active
- Mojiva
- Millennial Media – Also provides support for AdMob, Amobee, JumpTap and Mojiva
- AdModa

We have plans on adding support for the following ad providers:

- MobFox
- InMobi
- Madvertise

If you know of any additional ad providers that support a REST based API then please let us know at admin@pocketeers.co.uk

15.9 OpenGL Considerations

If you are using raw OpenGL functions in your rendering pipeline then you may experience a conflict between Iw2D and OpenGL. The problem is that Iw2D can change certain GL states that are not put back to their original setting when Iw2D has finished rendering. For example, Iw2D can change the texture matrix or the shading model state (amongst other states). To combat this issues you should ensure that you reset any features that you plan to use after displaying the ads view. A couple of examples include:

To switch back to smooth shading use:

```
glShadeModel(GL_SMOOTH);
```

To repair the texture matrix add the following before you render your GL content:

```
glMatrixMode(GL_TEXTURE);
glPushMatrix();
glLoadIdentity();
```

After your GL rendering is finished restore the GL texture matrix:

```
glMatrixMode(GL_TEXTURE);
glPopMatrix();
```

16.0 CIwGameXml – Cross Platform Data

16.1 Introduction

IwGame comes with a basic XML parser that has the following features:

- Load and save XML files
- Very small code footprint
- Very quick parser
- Uses memory pooling for tags, attributes and values, reducing memory fragmentation

CIwGameXml does however have limitations such as no support for XML schemas and will allow you to do some things that normal XML parsers will not allow you to do.

The XML engine is split into the following classes:

- CIwGameXmlAttribute – A nodes named attribute and value
- CIwGameXmlNode – A named node containing a collection of attributes
- CIwGameXmlParser – The main parser object that loads and parsers the XML file

16.2 Setting the Memory Pooling

Before you can use the Xml parser you must set-up the Xml parser memory pools. These pools pre-allocate space for a group of nodes, attributes and tags before parsing a file. Once the pools are set-up they can be re-used by all future parse calls. Below is an example showing how to set up the initial XML parser pools:

```
CIwGameXmlParser::PoolsInit();
```

This will allocate 2048 nodes, 2048 tags and 4096 attributes.

- Nodes – Represents actual XML nodes found in the document
- Tags – Represent the total number of actual XML tags found in document. The tag pool is used to pre-parse the XML document and speed up parsing
- Attributes – Represents the total number of actual XML node attributes found in the document

So if you have an XML document that contains 1000 total nodes and each node contains at most 2 attributes then you could pass the following values to PoolsInit():

```
CIwGameXmlParser::PoolsInit(1000, 1000, 2000);
```

16.2 Loading an XML file

To load an XML file, create an instance of CIwGameXmlParser and call Parse() to parse the data, like shown below:

```
// Reset XML parser pools memory
CIwGameXmlParser::PoolsReset();

// Load the xml file
CIwGameXmlParser*    xml = new CIwGameXmlParser();
if (xml->Parse("./Scene1.xml") == eXMLParserError_None)
{
	// Save the xml file back out
	xml->GetRoot()->Save("test1.xml");
}
```

We firstly reset the XML parser pool memory, if we did not reset this then we would soon run out of pool memory space.

Next we create an instance of the XML parser object then call Parse() passing in the name of the XML file. If there was no parsing errors then we save the file back out to check that it worked.

Three versions of Parse() are available:

```
eXMLParserError            Parse(const char* filename);
eXMLParserError            Parse(CIwGameFile *file);
eXMLParserError            Parse(CIwGameDataInput* data);
```

These allowing parsing of a named file, an IwGame file and a data input stream.

16.3 Working with Nodes

The parser provides a number of useful methods that you can use to get nodes from the parsed data:

```
CIwGameXmlNode*     GetRoot()
CIwGameXmlNode*     GetFirstNamedNode(CIwGameXmlNode *parent, const char* node_name)
CIwGameXmlNodeList* GetNamedNodes(CIwGameXmlNode *parent, const char* node_name)
```

- GetRoot – Returns the root node of the loaded XML data
- GetFirstNamedNode – Searches the complete XML node structure from the specified parent node and returns the first node who's name matches the supplied node name
- GettNamedNodes – Searches the complete XML node structure from the specified node and returns all nodes who's names match the supplied node name

Once you have a node you can begin querying the nodes value and attributes. To get the nodes value you can use the following methods:

```
const CIwGameString&            GetValue()
int                             GetValueAsInt() const;
float                           GetValueAsFloat() const;
bool                            GetValueAsBool() const;
```

For debug purposes you can also print the nodes attributes and complete hierarchy using the following methods:

```
void                            PrintAttributes();
void                            PrintTree();
```

You can search a nodes child nodes using the following methods:

```
CIwGameXmlNode*     GetFirstNode();
CIwGameXmlNode*     GetFirstNamedNode(const char* nodeName, unsigned int name_hash);
void                GetNamedNodes(const char* nodeName, unsigned int name_hash,
CIwGameXmlNodeList* nodes);
```

Note that these methods take a hashed string value as node names instead of a string.

CIwGameXmlNode also provides methods for saving its structure to a file:

```
int                 SaveAttributes(CIwGameFile* file);
int                 SaveTree(CIwGameFile* file);
int                 Save(const char* filename);
```

Querying attributes can be done using the following methods:

```
int                         GetAttributeCount();
CIwGameXmlAttribute*        GetAttribute(const char* name);
CIwGameXmlAttribute*        GetAttribute(int index);
```

The string version of GetAttribute() will return the named attribute whilst the integer version returns the attribute at the specified index (0 index based)

And finally methods have been provided for building nodes:

```
void                SetName(const char* name, int len)
void                SetValue(const char* value, int len)
void                AddChild(CIwGameXmlNode* node)
void                AddAttribute(CIwGameXmlAttribute *attribute)
void                AddAttribute(CIwGameString& name, CIwGameString& value)
void                AddAttribute(CIwGameString& name, const char* value)
```

16.4 Node and Attribute Iteration

CIwGameXmlNode provides iterator based access to both child nodes and attributes:

```
	typedef CIwList<CIwGameXmlNode*>::iterator		_Iterator;
	typedef CIwList<CIwGameXmlAttribute*>::iterator	_AttribIterator;
	_Iterator			begin()
	_Iterator			end()
	_AttribIterator		attribs_begin()
	_AttribIterator		attribs_end()
```

These types and methods allow you to easily walk the nodes child nodes and attributes. Below is an example showing how to walk a nodes child nodes and each nodes attributes:

```
	// Walk the child nodes
	for (CIwGameXmlNode::_Iterator nodes = node->begin(); nodes != node->end(); ++nodes)
	{
		// Walk the nodes attrobutes
		for (CIwGameXmlNode::_AttribIterator attribs = (*nodes)->attribs_begin();
attribs != (*nodes)->attribs_end(); ++attribs)
		{
		}
	}
```

16.5 Attribute Query

CIwGameXmlAttribute provides an extensive set of methods for querying attribute values and converting the data to different formats. Below is a list of all methods:

```
	CIwGameString&			GetValue() { return Value; }
	int						GetValueAsInt() const;
	float					GetValueAsFloat() const;
	bool					GetValueAsBool() const;
	bool					GetValueAsPoint(CIwFVec2 &point);
	bool					GetValueAsPoint3(CIwFVec3 &point);
	bool					GetValueAsPoint4(CIwFVec4 &point);
	bool					GetValueAsColour(CIwColour &colour);
	bool					GetValueAsRect(CIwRect &rect);

	CIwGameXmlStringList*	GetValueAsList();
	int						GetValueAsListOfInt();
	int						GetValueAsListOfFloat();
	int						GetValueAsListOfBool();
```

The list value retrieval methods use a pooled memory system to reduce constant allocation and deallocation of memory, so please ensure that you store off the values retrieved into the pool buffers

before calling the list methods again or data will be written over. To see how the list pool buffers are used lets take a quick look at at GetValueAsRect():

```
bool CIwGameXmlAttribute::GetValueAsRect(CIwRect& rect)
{
	if (Value.GetAsListOfInt() != 4)
	{
		return false;
	}
	rect.x = g_IntListPool[0];
	rect.y = g_IntListPool[1];
	rect.w = g_IntListPool[2];
	rect.h = g_IntListPool[3];

	return true;
}
```

As you can see, when we call GetAsListOfInt() a global buffer called g_IntListPool is filled with the values that are returned.

Global data is messy and we don't like it however so this will change in the future, but the implementation will remain the same.

16.6 Creating an XML file

XML is very useful when it comes to representing data in a platform independent manner. It's also very useful when it comes to serialising game state and other data to storage as it can be saved in a good structured format.

To create an XML file you need to create a root XML node then add further named child nodes that contain values and attributes that contain your data. Below shows a quick example:

```
	// Reset XML pool data
	CIwGameXmlParser::PoolsReset();

	// Create root XML node
	CIwGameXmlNode* root = CIwGameXmlParser::AllocNode();
	root->SetName("xml");

	// Create and add a settings child node to the root
	CIwGameXmlNode* settings_node = CIwGameXmlParser::AllocNode();
	settings_node->SetName("Settings");
	root->AddChild(settings_node);

	// Create and add a FullVersion node to the settings node
	CIwGameXmlNode*	value_node = CIwGameXmlParser::AllocNode();
	value_node->SetName("FullVersion");
	value_node->SetValue("true");
	settings_node->AddChild(value_node);

	// Save the XML file
	settings_node->Save("./Settings.xml");
```

The above code will generate the following XML file:

```
<?xml version="1.0"?>
<Settings>
	<FullVersion>true</FullVersion>
</Settings>
```

Note that the above code also uses the XML memory pooling system so you do not need to worry about cleaning up after you are done creating the node structure.

17.0 CIwGameDataIO – Stream Style Access to Memory

17.1 Introduction

From the perspective of IwGame a stream is data that can be read from or written to. When data is read from a stream, the position at which we read the next lot of data moves to the end of the previously read data. Streams have a stream pointer / position which marks the place where new data will be read or written.

IwGame provides two simple classes that allow you to treat memory as though it was a stream. This can come in very useful when serialising binary data or parsing data located in a memory buffer.

Two classes are provided which provide support for input and output:

- CIwGameDataInput – Input stream access to a a memory buffer
- CIwGameDataOutput– Output stream access to a a memory buffer

17.2 Input Streams

To create an input stream we create a CIwGameDataInput object, initialise it then load some data into it:

```
// Create and initialise an input stream of 1024 bytes
CIwGameDataInput *stream  = new CIwGameDataInput();
stream->Init(1024);

// Read some data into the stream
if (!file->Read(stream->getData(), size))
      return -1;

// Do something with the data
....
```

You can now access the stream using the following methods:

```
int          Skip(int nNumBytes);
int          SetPos(int nPos);
int          GetPos() const
int          GetLength() const
bool         IsEOF() const
int          Remaining() const
char         GetByte();
float        GetByteAsFloat();
char         GetUByte();
int          GetUByteAsInt();
float        GetUByteAsFloat();
```

```
        int             GetBytes(char* pData, int nCount);
        int             GetBytes(short* pData, int nCount);
        int             GetBytes(int* pData, int nCount);
        int             GetBytes(float* pData, int nCount);
        int             GetUBytes(char* pData, int nCount);
        int             GetUBytes(int* pData, int nCount);
        int             GetUBytes(float* pData, int nCount);
        int             GetChars(char* pData, int nCount);
        short           GetShort();
        short           GetShortSwab();
        float           GetShortAsFloat();
        int             GetUShort();
        float           GetUShortAsFloat();
        int             GetShorts(short* pData, int nCount);
        int             GetShorts(int* pData, int nCount);
        int             GetShorts(float* pData, int nCount);
        int             GetUShorts(short* pData, int nCount);
        int             GetUShorts(int* pData, int nCount);
        int             GetUShorts(float* pData, int nCount);
        int             GetInt();
        int             GetIntSwab();
        int             GetInts(int* pData, int nCount);
        int             GetInts(float* pData, int nCount);
        float           GetFloat();
        int             GetNextString(CIwGameString *pString);
        int             GetNextString(char *pString, int max_len);
        int             GetNextQuotedStringAsint(int *pNum);
        bool            GetNextQuotedString(CIwGameString *pString);
        bool            GetNextQuotedString(char *pString, int max_len);
        bool            GetNextOccuranceOf(char find);
        int             GetNextTag(char tag_start_char, char tag_end_char, int range, int
&start_pos);
        int             GetNextTagOrValue(char tag_start_char, char tag_end_char, int range,
int &start_pos);
        int             FindString(char* pString, int str_len) const;
        int             SkipToWhitespaceInTag();
        int             SkipToNoneWhitespaceInTag();
        int             SkipToCharInTag(char chr);
        int             GetLineNumber(int pos) const;
        int             CalculateCheckSum();
        int             StripXMLComments();
```

As you can see there are a lot of methods for accessing streams, some of the less obvious methods are described below:

- Skip – Moves the stream data pointer
- SetPos / GetPos – Move / get the current stream pointer position
- IsEOF – Return true of the end of the stream was reached
- Remaining – Returns the total number of bytes remaining in the stream
- GetLineNumber – Counts the the number of carriage returns to determine the approximate text line number of the current stream position

For an example of CIwGameDataInput usage, take a look at the source for CIwGameXml as this class uses streams extensively for parsing XML data.

17.3 Output Streams

To create an output stream we create a CIwGameDataOutput object, initialise it then write some data into it:

```
// Create and initialise an input stream of 1024 bytes
CIwGameDataOutput *stream  = new CIwGameDataOutput();
stream->Init(1024);

// Write some data into the stream
stream->Set(10);           // Write an integer
stream->Set(1.2f);         // Write a floating point value
stream->Set("Hello", 5);   // Write some text
```

You can now access the stream using the following methods:

```
int          Skip(int nNumBytes);
int          SetPos(int nPos);
int          GetPos() const
int          GetLength() const
bool         IsEOF() const
int          Remaining() const
void         Set(char data);
void         Set(short data);
void         Set(int data);
void         Set(float data);
void         Set(char* pData, int nCount);
void         Set(short* pData, int nCount);
void         Set(int* pData, int nCount);
void         Set(float* pData, int nCount);
void         Set(CIwGameString* pString);
int          CalculateCheckSum();
```

- Set – Writes data to the stream
- CalculateChecksum – Calculates a simple checksum for the entire stream (up to the current stream position)

18.0 CIwGameResource – Getting a Handle on the Beast

18.1 Introduction

The Marmalade SDK groups collections of resources into groups (CIwResGroup). You can find out more details about Marmalade resource groups and their creation at http://www.drmop.com/index.php/2011/10/01/marmalade-sdk-tutorial-marmalades-resource-management-system/ .

IwGame provides a basic wrapper around a Marmalade resource group called CIwGameResourceGroup which allows groups to be loaded and destroyed when IwGame groups are insantiated and deleted. CIwGameResourceGroup also allows integration of groups into the XOML mark-up system.

CIwGameResource consists of a number of classes:

- CIwGameResourceGroup – A basic resource group
- CIwGameResourceGroupCreator – Class uses to instantiate a resource group from XOML
- CIwGameGlobalResources – A global resource manager, managing resource groups, animations, images and timelines on an application level

18.2 Creating a Resource Group

IwGame has two ways to create a resource group:

- Manually create a CIwGameXomlResourceGroup and assign it a name and filename then attach it to either the global CIwResourceManager or a scenes CIwGameXomlResourceManager
- Declare a ResourceGroup in XOML

To create a resource group manually:

```
// Create a resource group
CIwGameResourceGroup* group = new CIwGameResourceGroup();
group->setGroupName("Level1");
group->setGroupFilename("Level1.group");

// Add the resource group to the global resource manager
IW_GAME_GLOBAL_RESOURCES->getResourceManager()->addResource(group);
```

Note that at this point the resource group is only created and has not been loaded. You can call CIwGameResourceGroup::Load() to load the group into the Marmalade resource group manager system. Alternatively you can allow the group to be loaded on first access to the group. That is when the first call to CIwGameResourceGroup::getResourceGroup() is called.

To create a resource group from XOML we would declare the following:

```
<ResourceGroup Name="Level1" GroupFile="Level1.group" Preload="true" />
```

As you can see its much easier to declare resource groups using XOML. In addition, if you declare the resource group within scene tags then the resource group will become local to that scene, which will allow the resource group to be cleaned up when the scene is destroyed.

The CIwGameResourceGroupCreator class is responsible for instantiating a CIwGameResourceGroup from XOML.

18.3 Resource Management

Life is much easier when we leave the management of various classes to someone else. In this case we use the CIwGameXomlResourceManager to manage a collection of resource groups. Each scene that is created contains its own resource manager and the global resource system also contains one.

Any type of IIwGameXomlResource derived resource can be added to the resource manager, including Marmalade resource groups, images, animations, timelines, shapes, Box2dMaetrials and custom resources.

To create your own resource type you should:

- Derive your class from IiwGameXomlResource
- Implement LoadFromXoml(IIwGameXomlResource* parent, bool load_children, CIwGameXmlNode* node);
- In your classes constructor set the class type name using setClassType() for example setClassType("ResourceGroup"); - Generally this represents the common base class for all objects of this type.
- Create a class creator derived from IIwGameXomlClassCreator

The resource manager supports the following methods:

```
	void		addResource(IIwGameXomlResource* resource);
	void		removeResource(IIwGameXomlResource* resource);
	void		removeResource(unsigned int name_hash, unsigned int type_hash);
	IIwGameXomlResource* findResource(unsigned int name_hash, unsigned int type_hash, bool
global_search = true);
	IIwGameXomlResource* findResource(const char* name, unsigned int type_hash, bool
global_search = true);
	IIwGameXomlResource* findResource(const char* name, const char* type, bool
global_search = true);
	void		clearResources();
```

The resource type name is the name that you assigned to your class with setClassType()

18.4 Global Resources

CIwGameGlobalResources represents a collection of resources that are meant to be accessible across the entire game and for the life time of the game. A CIwGameGlobalResources contains a CiwGameXomlResourceManager which a list of resources of varying types.

These types of resources are used across the whole game engine and are globally available.

The CIwGameGlobalResources class is a singleton that is available via the IW_GAME_GLOBAL_RESOURCES macros.

To get to the contained resources you should call one of the following methods to gain access to its manager:

```
CIwGameXomlResourceManager*             getResourceManager()
```

19.0 CIwGameXOML – Welcome to the Easy Life

19.1 Introduction

I like to make code that is extensible but I also like to make life easier for myself without sacrificing too much versatility, so my coding style constantly strives towards balancing ease of use to extensibility. I've done a lot of Silverlight / WPF coding in the passed which is where I came across Microsoft's XAML mark-up language. I later came across Adobe Flex's MXML mark-u language and decided that mark-up language was the way to go with game and app development. Being able to define my whole UI, game scenes, animations and even game logic using simple readable XML seemed like the best way to go.

IwGame adds some of the great functionality found in XAML / MXML allowing you to declare much of what will appear in your game using XOML (XML Object Modelling Language).

The major advantages of using XOML include:

- Saves a whole bunch of typing
- Design and layout scenes and actors using mark-up
- Design resource groups and images using mark-up
- Use templates to create many instances of massively complex objects
- Create styled actors
- Design complex animations and time line animations
- Link up events and actions
- No recompiling required to test changes
- Add new content without resubmitting to the app stores
- Add content that is streamed from a server

As you can see, we have some pretty neat advantages to switching over to using a mark-up language

Lets take a quick look at an example XOML file:

```
<?xml version="1.0"?>
<xml>
    <ResourceGroup Name="Audio" GroupFile="Audio.group" Preload="true" />
    <ResourceGroup Name="Level1" GroupFile="Level1.group" Preload="true" />
    <Image Name="Sprites" Location="Level1" Preload="true" />
    <Image Name="Buddy" Location="http://www.battleballz.com/bb_icon.gif" Preload="true"
Blocking="false" />
    <Animation Name="PlayerImageAnim" Type="rect" Duration="0.8" >
        <Frame Value="0, 0,   36, 40" Time="0.0" />
        <Frame Value="0, 40,  36, 40" Time="0.1" />
        <Frame Value="0, 80,  36, 40" Time="0.2" />
        <Frame Value="0, 120, 36, 40" Time="0.3" />
        <Frame Value="0, 160, 36, 40" Time="0.4" />
```

```
        <Frame Value="0, 200, 36, 40" Time="0.5" />
        <Frame Value="0, 240, 36, 40" Time="0.6" />
        <Frame Value="0, 280, 36, 40" Time="0.7" />
    </Animation>
    <Animation Name="SpinAnim1" Type="float" Duration="8" >
        <Frame Value="0"   Time="0.0" />
        <Frame Value="90"  Time="2.0" />
        <Frame Value="180" Time="4.0" />
        <Frame Value="270" Time="6.0" />
        <Frame Value="360" Time="8.0" />
    </Animation>
    <Animation Name="ScaleAnim1" Type="float" Duration="4" >
        <Frame Value="0.1"  Time="0.0" />
        <Frame Value="1.0"  Time="1.0" />
        <Frame Value="1.5"  Time="2.0" />
        <Frame Value="1.6"  Time="3.0" />
        <Frame Value="1.65" Time="4.0" />
    </Animation>
    <Animation Name="ColourAnim1" Type="vec4" Duration="4" >
        <Frame Value="255, 255, 255, 0"    Time="0.0" />
        <Frame Value="255, 255, 255, 200"  Time="1.0" />
        <Frame Value="255, 255, 255, 255"  Time="2.0" />
        <Frame Value="255, 255, 255, 200"  Time="3.0" />
        <Frame Value="255, 255, 255, 0"    Time="4.0" />
    </Animation>
    <Animation Name="PlayerStates" Type="string">
            <Frame Value="State1" Time="0" />
            <Frame Value="State2" Time="0.5" />
            <Frame Value="State3" Time="1.0" />
            <Frame Value="State4" Time="1.5" />
    </Animation>
    <Timeline Name="Scene1Anim" AutoPlay="true">
        <Animation Anim="SpinAnim1" Target="Angle" Repeat="1" StartAtTime="0"/>
        <Animation Anim="ScaleAnim1" Target="Scale" Repeat="1" StartAtTime="0"/>
    </Timeline>

    <Scene Name="GameScene" CanvasSize="320, 480" FixAspect="true" LockWidth="false"
Current="true" Colour="128, 128, 128, 255" Timeline="Scene1Anim">
        <Timeline Name="Player1Intro" AutoPlay="true">
            <Animation Anim="PlayerImageAnim" Target="SrcRect" Repeat="0" StartAtTime="0"/>
            <Animation Anim="SpinAnim1" Target="Angle" Repeat="4" StartAtTime="10"/>
            <Animation Anim="ColourAnim1" Target="Colour" Repeat="10" StartAtTime="2"/>
        </Timeline>
        <TestActor Name="Player1" Position="-100, 0" Size="100, 100" Angle="45" SrcRect="0,
0, 36, 40" Image="Sprites" Timeline="Player1Intro" />
        <TestActor Name="Player2" Position="0, 0" Size="100, 100" Angle="-45" SrcRect="0, 0,
36, 40" Image="Sprites" />
        <TestActor Name="Player3" Position="0, 100" Size="100, 100" Angle="0" SrcRect="0, 0,
64, 64" Image="Buddy" />
    </Scene>

    <Scene Name="GameScene2" CanvasSize="320, 480" FixAspect="true" LockWidth="false"
Colour="0, 0, 255, 255" AllowSuspend="false">
        <Timeline Name="Player1Intro2" AutoPlay="true">
            <Animation Anim="PlayerImageAnim" Target="SrcRect" Repeat="0" StartAtTime="1"/>
            <Animation Anim="SpinAnim1" Target="Angle" Repeat="4" StartAtTime="10"/>
        </Timeline>
        <TestActor Name="Player1" Position="0, 0" Size="100, 100" Angle="45" SrcRect="0, 0,
36, 40" Image="Sprites" Timeline="Player1Intro2" />
        <TestActor Name="Player2" Position="100, 0" Size="100, 100" Angle="-45" SrcRect="0,
```

```
0, 36, 40" Image="Sprites" />
        <TestActor Name="Player3" Position="100, 100" Size="100, 100" Angle="0" SrcRect="0,
0, 64, 64" Image="Buddy" />
    </Scene>
</xml>
```

It may look like quite a bit of XML but the above would take many hundreds of lines of code to instantiate all of these classes and set up their data.

XOML is also extensible in that you can provide your own custom tags.

19.2 Loading a XOML file

Loading a XOML file is incredibly simple:

```
    // Load a test XONL file
    IW_GAME_XOML->Process(this, "Scene1.xml");
```

The first parameter to the Process() method represents the parent class that you want to load all of the XOML data into. For example, if you load a XOML file that contains scenes then you should pass the CIwGame derived game object so that the created scenes will be added to the main game object. On the other hand if the XOML file contains a simple list of global resources then you can pass NULL. This kind of versatility allows you to split your game definitions across multiple files.

Its worth noting at this point that you need to ensure that IwGame::Init() has been called before using the XOML system as IwGame::Init() sets up important systems that are used by the XOML system.

19.3 Types of XOML Data

19.3.1 Resource Groups

Resource groups provide grouped resources to the game engine. A resource group is basically a Marmalade resource group with a unique name that the engine can use to identify it. Here are a few example of declaring a resource group in XOML:

```
<ResourceGroup Name="Audio" GroupFile="Audio.group" Preload="true" />
<ResourceGroup Name="Level1" GroupFile="Level1.group" Preload="true" />
```

Valid attributes:

- Name – The name of the resource group
- GroupFile – The name of the resource group file
- Preload – If true then the resource group will be loaded into the Marmalade resource manager as soon as it is declared. If false then the resource group will be loaded on first access.
- Tag – Group tag

A resource group can be declared inside a scene or outside a scene. Scene declared resources will be local to the scene and objects within that scene.

19.3.2 Images

In order to use an image (even if stored inside a resource group) we must first declare it in XOML:

```
    <Image Name="Sprites" Location="Level1" Preload="true" />
```

Or for a web based image:

```
    <Image Name="Buddy" Location="http://www.battleballz.com/bb_icon.gif" Preload="true"
Blocking="false" />
```

Valid attributes:

- Name – Image name
- Location – The web address of the image for web based images, local file name for local images or the group name that contains the image
- Preload – If true then the image is loaded as soon as it is instantiated, otherwise it is loaded on first access
- Blocking – If true then the image will be loaded and main loop processing will stop until the image is loaded. If false then the image will be loaded asynchronously. Sprites that use unloaded image will not be displayed until the image has been fully loaded.
- Tag – Group tag

Images can be declared inside a scene or outside a scene. Scene declared images will be local to the scene and objects within that scene.

19.3.3 Animations

IwGame's animation system is very powerful but simple to use when couple with XOML. An example some of the types of animation that you can create declaratively is shown below:

```
<Animation Name="PlayerImageAnim" Type="rect" Duration="0.8" >
    <Frame Value="0, 0,   36, 40" Time="0.0" />
    <Frame Value="0, 40,  36, 40" Time="0.1" />
    <Frame Value="0, 80,  36, 40" Time="0.2" />
    <Frame Value="0, 120, 36, 40" Time="0.3" />
    <Frame Value="0, 160, 36, 40" Time="0.4" />
    <Frame Value="0, 200, 36, 40" Time="0.5" />
    <Frame Value="0, 240, 36, 40" Time="0.6" />
    <Frame Value="0, 280, 36, 40" Time="0.7" />
</Animation>
<Animation Name="SpinAnim1" Type="float" Duration="8" >
    <Frame Value="0"   Time="0.0" />
    <Frame Value="90"  Time="2.0" />
    <Frame Value="180" Time="4.0" />
    <Frame Value="270" Time="6.0" />
    <Frame Value="360" Time="8.0" />
</Animation>
<Animation Name="ColourAnim1" Type="vec4" Duration="4" >
    <Frame Value="255, 255, 255, 0"    Time="0.0" />
    <Frame Value="255, 255, 255, 200"  Time="1.0" />
    <Frame Value="255, 255, 255, 255"  Time="2.0" />
    <Frame Value="255, 255, 255, 200"  Time="3.0" />
    <Frame Value="255, 255, 255, 0"    Time="4.0" />
</Animation>
<Animation Name="PlayerStates" Type="string">
    <Frame Value="State1" Time="0" />
    <Frame Value="State2" Time="0.5" />
    <Frame Value="State3" Time="1.0" />
    <Frame Value="State4" Time="1.5" />
</Animation>
```

To create an animation we open an Animation tag, set the animations attributes then add Frame tags that declare the actual animation frames that make up the animation.

Valid Animation attributes:

- Name – The name of the animation
- Type – The type of animation data, currently supports:
    - bool - Boolean
    - float - Floating point
    - vec2 - 2D vectors
    - vec3 - 3D Vectors
    - vec4 - 4D vectors
    - rect - Rectangles (no interpolation between frames and used mainly by the image animation system for atlas frame based animations)
    - string - Strings

- Duration – The length of the animation in seconds (floating point)
- Tag – Group tag

Animations can be declared inside a scene or outside a scene. Scene declared animations will be local to the scene and objects within that scene.

Easing is also supported on a per frame basis using the “Ease” attribute of the frame tag. Valid values of ease include:

- linear – No easing
- quadin / quadout – Quardatic in / out easing
- cubicin / cubicout – Cubic in / out easing
- quarticin / quarticout – Quartic in / out easing

A special tag has been included that enables the generation of sprite atlas aimation frames using a single command, see the example below:

```
    <Animation Name="PlayerImageAnim" Type="rect" Duration="0.8" >
        <Atlas Count="8" Size="36, 40" Position="0, 0" Pitch="1024, 40" Width="1024"
Duration="0.1"/>
    </Animation>
```

The new atlas tag has the following properties:

- Count – Number of frames ot generate
- Size – The size of each geerated frame
- Position – Start position on the sprite atlas
- Pitch – The amount to step across and down the image the image each frame
- Width – Width of the atlas image
- Duration – The duration of each frame

19.3.4 Timeline

Time lines are IwGame's way of grouping together many different types of animations into a time line, then applying them to specific properties of specific objects, providing a robust and powerful animating scenes and actors. An example time line is shown below:

```
<Timeline Name="Player1Intro" AutoPlay="true">
    <Animation Anim="PlayerImageAnim" Target="SrcRect" Repeat="0" StartAtTime="0" />
    <Animation Anim="SpinAnim1" Target="Angle" Repeat="4" StartAtTime="10" />
    <Animation Anim="ColourAnim1" Target="Colour" Repeat="10" StartAtTime="2" />
</Timeline>
```

To create a time line we open an Timeline tag, set the time line's attributes then add Animation tags that declare the actual animations that make up your time line.

Once declared a time line can be attached to any object that supports time line's (a scene or actor for example)

Valid timeline attributes:

- Name – The name of the timeline
- AutoPlay – If true then the animation will start playing as soon as it is loaded. If false then you must set the time line playing manually
- Tag – Group tag

Valid child animation attributes:

- Anim – The name of the previously declared animation
- Target – The target element that the animation will modify such as Position, Angle, Velocity etc..
- Repeat – The total number of times to repeat the animation (0 represents play forever)
- StartAtTime – Allows the animation to be delayed, value provided is in seconds (floating point)
- Delta – True if this animation will update the target paramater as oposed to overwriting it. This allows you to for examlpe move something by x amount each frame instead of setting its absolute position
- OnStart – Defines an action that is called when this animation starts
- OnEnd – Defines an action that is called when this animation ends
- OnRepeat – Defines an action that is called when this animation repeats

Note that a time line can be assigned to as many objects you like but the time line will be played back the same on all objects. This is very useful if you have a group of actors that need to run the same animations synchronously.

19.3.5 Actors

Actors are the back bone of the IwGame engine so it seems fitting that they should be included in the XOML system. There is a small caveat when it comes to declaring actors in XOML and that is that you cannot directly declare an actor or image actor because they abstract class types and cannot be instantiated. Instead you create your own actor derived from one of the actor classes then add it to the XOML system so you can declare it in XOML. Lets say for example that you have already added two types of actors to the XOML system, you can then declare instances of those actors inside a scene like this:

```
    <Scene Name="GameScene">
        <PlayerActor Name="Player1" Position="-100, 0" Size="100, 100" Angle="45"
SrcRect="0, 0, 36, 40" Image="Sprites" Timeline="Player1Intro" />
        <AlienActor Name="Baddy1" Position="0, 0" Size="100, 100" Angle="-45" SrcRect="0, 0,
36, 40" Image="Sprites" />
        <AlienActor Name="Badedy" Position="0, 100" Size="100, 100" Angle="0" SrcRect="0, 0,
64, 64" Image="Buddy" />
    </Scene>
```

In the above XOML we declared a basic scene then declared 3 actors, one PlayerActor and two AlienActors. See section 4.17 for a walk-through on how to create a custom Actor that you can declare using XOML.

Valid CIwGameActor derived attributes:

- Name – Name of the scene (string)
- Style – Provides a style that this scene should use to style its properties (string)
- Type – A numerical type that can be used to identify the type of this actor (integer)
- Position– Position in the scene (x, y 2d vector)
- Origin– Origin in the scene, moves the point around which the actor will rotate and scale (x,y 2d vector)
- Depth – Depth of the actor in 3D (float – larger values move the sprite further away)
- Velocity – Initial velocity of the actor (x, y 2d vector)
- VelocityDamping – The amount to dampen velocity each frame (x, y 2d vector)
- Angle – The orientation of the actor (float)
- AngularVelocity – The rate at which the orientation of the actor changes (float)
- AngularVelocityDamping – The amount of rotational velocity damping to apply each frame (float)
- Scale, ScaleX, ScaleY – The scale of the actor (float)
- Colour – The initial colour of the actor (r, g, b, a colour)
- Layer – The scenes visible layer that the actor should appear on (integer)
- Active – Initial actor active state (boolean)
- Visible – Initial actor visible state (boolean)
- HitTest – If true then this actor will receive touch events
- Collidable – Collidable state of actor (boolean)
- CollisionSize – The circular size of the actor (float)
- CollisionRect – The rectangular collision area that the actor covers (x, y, w, h rect)

- WrapPosition – Of truethen the actor will wrap at the edges of the canvas (boolean)
- Draggable – When set to true the user can drag the actor around the world with their finger (boolean)
- Timeline – The time line that should be used to animate the actor
- Box2dMaterial – Sets the physical material type used by the Box2D actor
- Shape – Box2D fixture shape for the Box2D actor
- COM – Centre of mass of Box2D body (x, y 2d vector)
- Sensor – Can be used to set the Box2D actor as a sensor (boolean)
- CollisionFlags – The Box2D body collision flags (category, mask and group)
- OnBeginTouch – Event handler that specifies an actions list to call when the user begins to touch the actor
- OnEndTouch – Event handler that specifies an actions list to call when the user stops to touching the actor
- OnTapped – Event handler that specifies an actions list to call when the user taps the actor
- OnCreate – Event handler that specifies an actions list to call when this actor is created
- OnDestroy – Event handler that specifies an actions list to call when this actor is destroyed
- LinkedTo – Name of actor that this actor links to (string)
- Bindings – Name of the bindings set that will be bound to this actor

Additional attributes available to actors derived from CIwGameActorImage:

- Brush – Specifies a brush that is used to define the image and source rectangle (string)
- Image – The image that is to be used as the actors visual (string)
- Size – The on screen visible size of the actor (x, y 2d vector)
- SrcRect – The position and source of the source rectangle in the image atlas (x, y, w, h rect). Used for panning the portion of a sprite atlas shown allowing frame based animation.
- FlipX – Horizontal flipped state (boolean)
- FlipY – Vertical flipped state (boolean)

Additional attributes available to actors derived from CIwGameActorText:

- Font – Name of font to use to draw the text (string)
- Rect – The area thuat the text should be drawn inside of (x, y, w, h rect)
- Text – String to display (string)
- AlignH – Horizontal alignment (centre, left and right)
- AlignV – Verticalalignment (middle, top and bottom)
- Wrap – If true then text is wrapped onto next line if to long (boolean)

Note that text and particle generator actors can be instantiated directly from XOML using the ActorText and ActorParticles tags.

Actors can be created within other actors to form a parent / child relationship. Inner actors will be linked back to their containing actor forcing them to be transformed by their parent actors. This system allows you to create a very powerful intuitive multi-part actor system complete with animations per actor part. Note that all positions, depths etc will be relative to the container actor, so for example, if the parent actor has a Depth value of 1.0f and the child actor has a Depth value of

1.0f then the child's effective Depth will be 2.0f. Here's an example showing parent / child actors:

```
<InertActor Name="Level1" Style="LevelButtonStyle" Position="$pos$"
OnBeginTouch="BeginTouch11" OnTapped="StartLevel1" >
    <ActorText Name="Record1" Style="LevelButtonTextStyle" Colour="255, 80, 80, 255"
Position="0, 0" Text="0" Depth="0" />
    <ActorText Style="LevelButtonTextStyle" Position="0, 60" Text="Round 1" Depth="0" />
    <InertActor Name="LevelComplete1" Size="74, 67" Image="sprites2" SrcRect="582, 423, 148,
134" Position="60, -20" HitTest="false" Depth="0" Timeline="tick_scale_anim" />
</InertActor>
```

In the above XOML the parent actor level1 contains three children actors that will all follow the Level1 actors visual transform.

19.3.6 Scenes

XOML is very powerful system to the point that you can declare and instantiate complete scenes from XOML including all of their resources and actors without even writing a single line of code. Below is an example showing declaration of a couple of scenes using XOML:

```
    <Scene Name="GameScene" CanvasSize="320, 480" FixAspect="true" LockWidth="false"
Current="true" Colour="128, 128, 128, 255" Timeline="Scene1Anim">
        <Timeline Name="Player1Intro" AutoPlay="true">
            <Animation Anim="PlayerImageAnim" Target="SrcRect" Repeat="0" StartAtTime="0"/>
        </Timeline>
        <PlayerActor Name="Player1" Position="-100, 0" Size="100, 100" Angle="45"
SrcRect="0, 0, 36, 40" Image="Sprites" Timeline="Player1Intro" />
        <AlienActor Name="Baddy1" Position="0, 0" Size="100, 100" Angle="-45" SrcRect="0, 0,
36, 40" Image="Sprites" />
        <AlienActor Name="Badedy" Position="0, 100" Size="100, 100" Angle="0" SrcRect="0, 0,
64, 64" Image="Buddy" />
    </Scene>

    <Scene Name="GameScene2" CanvasSize="320, 480" FixAspect="true" LockWidth="false"
Colour="0, 0, 255, 255" AllowSuspend="false">
        <Timeline Name="Player1Intro2" AutoPlay="true">
            <Animation Anim="PlayerImageAnim" Target="SrcRect" Repeat="0" StartAtTime="1"/>
            <Animation Anim="SpinAnim1" Target="Angle" Repeat="4" StartAtTime="10"/>
        </Timeline>
        <TestActor Name="Player1" Position="0, 0" Size="100, 100" Angle="45" SrcRect="0, 0,
36, 40" Image="Sprites" Timeline="Player1Intro2" />
        <TestActor Name="Player2" Position="100, 0" Size="100, 100" Angle="-45" SrcRect="0,
0, 36, 40" Image="Sprites" />
        <TestActor Name="Player3" Position="100, 100" Size="100, 100" Angle="0" SrcRect="0,
0, 64, 64" Image="Buddy" />
        <MyActor Name="Player3" Position="100, 100" Size="100, 100" NumberOfYes="3" />
    </Scene>
```

Valid scene attributes:

- Name – Name of the scene (string)
- Type – An integer that defines the type of scene
- Style – Provides a style that this scene should use to style its properties (string)
- CanvasSize – The virtual canvas size of the screen (x, y 2d vector)
- FixAspect – Forces virtual canvas aspect ratio to be fixed (boolean)
- LockWidth – Forces virtual canvas to lock to with if true, height if false (boolean)
- Extents – A rectangular area that describes the extents of the scenes world (x, y, w, h rect)
- AllowSuspend – Determines if the scene can be suspended when other scenes are activated (boolean)
- Clipping – A rectangular area that represents the visible area of the scene (x, y, w, h rect)
- ClipStatic – Determines if clipping is fixed or moves with the scene (boolean)
- Active – Initial scene active state (boolean)
- Visible – Initial scene visible state (boolean)
- Layers – The number of visible layers that the scene should use (integer)
- Layer – The visual layer that this scene should be rendered on (integer)

- Colliders – The maximum number of colliders that the scene should support (integer)
- Current - If true then the scene is made the current scene (boolean)
- Colour – The initial colour of the scene (r, g, b, a colour)
- Timeline – The time line that should be used to animate the scene
- Gravity – Box2D directional world gravity (x, y 2d vector)
- WorldScale – Box2D world scale (x, y 2d vector)
- DoSleep – if set to true can improve performance by not simulating inactive bodies (boolean)
- Camera – Current camera
- OnSuspend – Provides an actions group that is called when the scene is suspended
- OnResume – Provides an actions group that is called when the scene is resumed
- OnCreate - Provides an actions group that is called when the scene is created
- OnDestroy - Provides an actions group that is called when the scene is destroyed
- Batch – Tells the system to batch sprites for optimised rendering (boolean)
- AllowFocus – if set to true then this scene will receive input focus events that the current scene would usually receive exclusively. This is useful if you have a HUD overlay that has functionality but it cannot be the current scene as the game scene is currently the current scene1Anim
- Bindings – Name of the bindings set that will be bound to this scene

19.3.7 Shapes

XOML provides the ability to create shapes of a variety of types, below are some examples:

Below shows an example of creating a box shape called floor with a width of 320 and a height of 20:

```
<Shape Name="Floor" Type="box" width="320" height="20" />
```

Below shows an example of creating a circle shape called Alien with a radius of 100 units:

```
<Shape Name="Alien" Type="circle" radius="100" />
```

Below shows an example of creating an arbitrary shaped polygon called Platform1 that consists of 5 points:

```
<Shape Name="Platform1" Type="polygon">
    <Point Value="-100, -100" />
    <Point Value="-100, -200" />
    <Point Value="100, -100" />
    <Point Value="100, 100" />
    <Point Value="-100, 100" />
</Shape>
```

Shapes can be used for any purpose but mainly for providing body shapes to actors that use the Box2D physics engine.

A shape can also have a group tag that enables it to be tagged as part of a collection of common resources

19.3.8 Box2dMaterials

Box2dMaterial's allow you to specify the physical properties of an actor that is under control of the Box2D physics engine. Below shows a few examples:

```
    <Box2DMaterial Name="Floor" Type="static" Density="1.0" Friction="1.0" Restitution="0.5"
/>
    <Box2DMaterial Name="BounceyBall" Type="dynamic" Density="1.0" Friction="0.9"
Restitution="0.1" />
```

Supported attributes include:

- Name – Name of the physics material
- Type – Type of physics material (values can be static, dynamic and kinematic)
- Density – The objects density (default is 1.0)
- Friction – The coefficient of friction (default is 1.0)
- Restitution - The coefficient of restitution (default is 0.1)
- IsBullet – If set to true, will force the object that this material is attached to to be treat as a high speed moving object (required more processing so use wisely) (default is false)
- FixedRotation – If set to true then the object that this material attaches to will not be allowed to rotate (default is false)
- GravityScale – This is the amount to scale the affect of gravity on objects that this material is attached to (default is 1.0)
- Tag – Group tag

19.3.9 Styles

XOML provides a mechanism to allow styling of objects using XOML styles. A style is basically a group of pre-defined attributes that are common and can be applied to a number of objects. e.g:

```
<Style Name="BasicActorStyle">
    <Set Property="Size" Value="60, 60" />
    <Set Property="Angle" Value="0" />
    <Set Property="SrcRect" Value="0, 0, 36, 40" />
    <Set Property="Image" Value="Sprites" />
    <Set Property="Timeline" Value="Player1Intro1" />
    <Set Property="Shape" Value="PlayerShape" />
    <Set Property="Box2dMaterial" Value="BounceyBall" />
    <Set Property="CollisionFlags" Value="1, 1, 1" />
</Style>

<TestActor Name="Player2" Style="BasicActorStyle" Position="0, -150" />
```

Supported attributes include:

- Name – Name of the style
- Property – Property name to target
- Value – The value to apply to the target property
- Tag – Group tag

The above XOML creates an actor called Player2 that contains all of the attributes provided by the style BasicActorStyle, saving us a lot of typing and making our code much more readable.

Note that any attributes provided along with the style will override any style attributes, e.g:

```
<TestActor Name="Player2" Style="BasicActorStyle" Position="0, -150" Angle="45" />
```

In the above XOML code the Angle attribute will override the Angle value provided by the style.

Styles can currently be applied to scenes and actors. Support for additional types will be included in the future.

19.3.10 Variables

XOML provides the facility for creating variables via XOML that can be accessed from your in-game code. Here are a few examples:

```
<Variable Name="PlayerName" Type="string" Value="Player One" />
<Variable Name="PlayerScore" Type="int" Value="0" />
<Variable Name="PlayColour" Type="vec4" Value="255, 128, 64, 8" />
```

Supported attributes include:

- Name – Name of the variable
- Type - Type of variable. Variables can be of type int, bool, float, vec2, vec3, vec4, string and condition
- Value – The initial value of the variable
- Tag – Group tag

Each scene as well as the global resource manager carries a list of variables that are managed by a CIwGameXomlVariableManager. On the code side, you can request a variable by calling findVariable() which returns a CIwGameXomlVariable derived structure depending upon the type of variables:

- CIwGameXomlVariable - String variable
- CIwGameXomlVariableBool – Boolean variable
- CIwGameXomlVariableFloat – Floating point variable
- CIwGameXomlVariableInt – Integer variable
- CIwGameXomlVariableVec2 – 2 component vector variable
- CIwGameXomlVariableVec3 – 3 component vector variable
- CIwGameXomlVariableVec4 - 4 component vector variable
- CIwGameXomlVariableCondition – A string variable that contains a set of conditions

You can retrieve the actual native variable data by examining the NativeValue member of the structure, with exception to the string type as its native value is already a string. In addition, you can check the Modified flag to see if the data has changed. If you rely on the Modified flag to determine when the variables has actually changed then you should reset the Modified flag after reading it.

You can check to see if a variable is true by calling the isTrue() method regardless of variable type. Usually if the variable equates to 0 or empty then it is classed as false. Variables also support the checkCondition() method which enables you to run a variety of comparisons against the variable. Currently supported conditions include:

- Equal (==)
- Not equal (!=)
- Greater than (GT)
- Greater than or equal (GTE)
- Less than (LT)
- Less than or equal (LTE)
- Bitise AND (AND)

The value parameter supplied to checkCondition() is provided in string format and is converted to the variables native format to carry out the condition check. Note that if the variable type is a string then <, <=, >, >= tests are carried out on the length of the string, whilst the AND operator will do a string search to test if a sub-string is found within the string. Also note that if the variable is a vector then <, <=, >, >= tests are carried out on the length of the vector.

Variables can also be updated from XOML via the SetVar action.

Variables defined outside a scene will be assigned to the global variables table, whilst variables defined inside a scene will be assigned to the scenes variable table.

19.3.11 Actions

XOML actions are basically commands that can be executed from XOML mark-up, usually in response to some kind of event occurring, such as a scene being suspended or an actor being tapped by the user. Actions are created in groups. Here's an example:

```
<Scene Name="GameScene3" Style="GenericSceneStyle" OnSuspend="SuspendActions">
    <Actions Name="SuspendActions">
        <Action Method="SetTimeline" Param1="SceneTransition1" />
        <Action Method="PlaySound" Param1="explosion" />
    </Actions>
</Scene>
```

In the above example we define a scene that contains an actions group tag called Actions. Within this tag we have two actions defined. The first action sets the scenes time line to SceneTransition1 and plays the time line, whilst the second action tells the system to play the explosion sound effect.

The action tag provides a number of attributes:

- Method – The name of the pre-defined method the action should call
- Param1 – First parameter
- Param2 – Second parameter
- Param3 – Third parameter
- Param4 – Fourth parameter
- Condition – A condition variable that must equate to true for the action to take place. Also supported by the action group Actions tag
- Tag – Group tag

If you also take a look at the scene tag, there is an attribute called “OnSuspend”. This attribute is an event handler that tells the scene that when it receives a suspend event that it should run the SuspendActions actions collection.

This type of event / actions system allows you to develop some very powerful interactive content.

The following actions are currently supported:

- ChangeScene – Changes the currently focused scene to the specified scene (Param1="new scene name")
- SuspendScene – Suspends the specified scene (Param1="target scene", uses container scene if no Param1)
- ResumeScene– Resumes the specified scene (Param1="target scene", uses container scene if no Param1)
- HideScene– Hides the specified scene (Param1="target scene", uses container scene if no Param1)
- ShowScene– Shows the specified scene (Param1="target scene", uses container scene if no Param1)
- ActivateScene – Activates the specified scene (Param1="target scene", uses container scene if no Param1)

- DeactivateScene – Deactivates the specified scene (Param1="target scene", uses container scene if no Param1)
- KillScene – Destroys and removes the specified scene from the game, all contained resources amd actors will be also be destroyed (Param1="target scene", uses container scene if no Param1)
- KillAllScenes – Destroys and removes all scenes except the scene specified by Param1
- CallActions – Calls the actions group specified by Param1 in scene Param2
- SetAllSceneTimelines – Sets the timelines of all active scenes to the scene specific by Param1
- HideActor – Hides the specified actor (Param1="target actor", uses container actor if no Param1)
- ShowActor – Shows the specified actor (Param1="target actor", uses container actor if no Param1)
- ActivateActor – Activates the specified actor (Param1="target actor", uses container actor if no Param1)
- DeactivateActor – Deactivates the specified actor (Param1="target actor", uses container actor if no Param1)
- KillActor – Kills and removes the specified actor (Param1="target actor", uses container actor if no Param1)
- PlayTimeline – Plays the specified timeline. If no timeline is supplied then the current actor / scenes timeline will be restarted (depends on where the action was defined) (Param1="name of timeline" Param2="Target scene or actor")
- StopTimeline – Stops the specified timeline. If no timeline is supplied then the current timeline will be stopped. (depends on where the action was defined) (Param1="name of timeline" Param2="Target scene or actor")
- SetTimeline – Changes to the specified timeline. If no timeline is supplied then the current timeline will changed and restarted. (depends on where the action was defined) (Param1="name of timeline" Param2="Target scene or actor")
- PlaySound – Starts playing a sound effect (Param1="sound effect name")
- PlayMusic – Starts the playing specified music file (Param1="music file name", Param2="number of times to repeat, 0 for infinite")
- StopMusic – Stops the music player playing
- LoadXOML – Loads a XOML file into scene or globally. If a scene is provided then the XOML will be loaded into that scene (Param1="XOMl file name", Param2="Target scene to load XOML data into, if not supplied then target is the main game class IwGame (deafault)")
- SetVar – Sets the value of a variable (Param1="variable name", Param2="variable value", Param3="Scene where variable lives" (optional))
- Launch – Launches an external URL (string) (Param1="URL to launch")
- setBGColour – ets the current background colour (Param1="Background colour in r, g, b, a format")
- SetCurrentScene – Sets the currently active scene, bringing it to the front of the scene stack (Param1="target scene")
- BringSceneToFront – Brings the scene to the front of the scene stack (Param1="target scene")
- AddVar – Adds an amount onto a XOML variable and capping the variable to an optionally

specified limit (Param1="variable to update", Param2="amount to add", Param3="limit")
- EnterValue – Brings up the devices keyboard and allows the user to enter a value which is placed into the destination variable (Param1="message to show user", Param2="variable to place entered text into", Param3="default text, if you want to replace the variables value as the default text that is shown to the user")
- UpdateText – Updates the target text actor with the value of the specified variable (Param1="Target text actor name", Param2="variable to write to the actor", Param3="scene where target actor lives")
- Exit – Requests that the app exits
- RemoveResource – Removes the name (Param1) resource from the global resource manager
- RemoveResources – Removes all resources tagged with Param1 from the global resource manager
- AddModifier – Adds a modifier (Param1) to a scene or actor. Param2 is passed as the first paremeter to the modifier, Param3 can be used to specifiy a specific actor to add the modifier to. Param4 can be used to specify which scene the actor lives in. If Param3 is not supplied the scene specified by Param4 will be the target of the modifier
- ChangeModifier – Changes an existing modifier (Param1) in a scene or actor. Param2 specified how the modifier is to be changed (activate, deactivate, toggle and remove), Param3 can be used to specifiy a specific actor that contains the modifier. Param4 can be used to specify which scene the actor lives in. If Param3 is not supplied the scene specified by Param4 will be the target of the modifier changes
- SetProperty – Sets the property of an actor directly. Param1 = "actor property", Param2 = "property value", Param3 = "Specific actor (if ommitted then actor that the action is called from will be used)", Param4 = "Scene wher ethe specific actro lives"
- AddProperty – Adds a value onto the property of an actor. Param1 = "actor property", Param2 = "property value", Param3 = "Specific actor (if ommitted then actor that the action is called from will be used)", Param4 = "Scene wher ethe specific actro lives". If the target value is a boolean then it will be toggled

Currently supported events include:

Scenes:
- OnSuspend
- OnResume
- OnLostFocus
- OnGainedFocus
- OnCreate
- OnDestroy
- OnKeyBack
- OnKeyMenu

Actors:
- OnTapped
- OnBeginTouch
- OnEndTouch
- OnCreate
- OnDestroy

Timelines:

- OnStart
- OnEnd
- OnRepeat

Additional events and action methods will be added over time, although it is possible to add your own custom events and action methods

19.3.12 LoadXOML

XOML allows you to load other XOML files into your existing XOML app. Here is an example that shows how to load a number of additional XOML files:

```
<LoadXOML File="Common.xml" />
<LoadXOML File="scene2.xml" />
<LoadXOML File="Scene3.xml" />
```

Note that you should class any loaded XOML files as part of the same XOML source, so watch out for duplicating object names and such. Also, be careful not to allow cyclic includes as there are no include guards in-place. For example, file1 includes file2 and file2 includes file 1.

XOML files can also be loaded via an action that was fired by some event, e.g:

```
<Scene Name="GameScene3" Style="GenericSceneStyle" OnSuspend="SuspendActions">
    <Actions Name="SuspendActions">
        <Action Method="LoadXOML" Param1="Scene3.xml" />
    </Actions>
</Scene>
```

19.3.13 Templates

Ok, if you thought styles were cool for saving on typing then templates will ball you over. Templates allow you to create large sections of XOML as templates then instantiate those large pieces of XOML somewhere else using custom parameters that you pass to the template when you instantiate it. Lets take a quick look at a super simple example:

```
    <Template Name="ActorTemplate">
        <InertActor Name="Explosion$name$" Image="$image" Position="$pos$" Scale="$scale$"
Depth="$depth$" Layer="1" AngularVelocity="0" />
    </Template>
```

Here we define a template called ActorTemplate that contains a basic InertActor definition. You may notice some strange markers in there surrounded by double dollars signs ($name$, $image$, pos, $scale$ and $depth$).

Now when we instantiate this template somewhere we would use:

```
    <FromTemplate Template="ActorTemplate" name="actor1" scale="1.0" pos="300, 150"
depth="1.0" image="sprites1" />
```

The above XOML command will instantiate whatever is in the ActorTemplate template passing all of its parameters, replacing the double dollar definitions inside the template (Hmm, sounds very much like calling a function? Which I guess in some ways it is)

Want to see something cool? Well take a look at this template:

```
        <!-- Create a template that defines an actor, its timelines and actions -->
        <Template Name="Temp1">
            <Timeline Name="scale_in$level$" AutoPlay="true">
                <Animation Anim="scale_in" Target="scale" Repeat="1" StartAtTime="0" />
            </Timeline>
            <InertActor Name="Level$level$" Style="LevelButtonStyle" Position="$pos$"
OnBeginTouch="BeginTouch1$level$" OnTapped="StartLevel$level$" >
                <ActorText Style="LevelButtonTextStyle" Position="0, -50" Text="Best:" Depth="0" />
                <ActorText Name="Record$level$" Style="LevelButtonTextStyle" Colour="255, 80, 80, 255"
Position="0, 0" Text="0" Depth="0" />
                <ActorText Style="LevelButtonTextStyle" Position="0, 60" Text="Round $level$" Depth="0" />
                <InertActor Name="LevelComplete$level$" Size="74, 67" Image="sprites2" SrcRect="582, 423,
148, 134" Position="60, -20" HitTest="false" Depth="0" Timeline="tick_scale_anim" />
                <Actions Name="StartLevel$level$">
                    <Action Method="SetTimeline" Param1="scene_fade_out" Param2="ButtonsScene" />
                    <Action Method="SetTimeline" Param1="scene_fade_out" Param2="BackgroundScene" />
                    <Action Method="SetTimeline" Param1="button_chosen" />
                    <Action Method="SetVar" Param1="StartRound" Param2="$level$" />
                </Actions>
                <Actions Name="BeginTouch1$level$">
                    <Action Method="SetTimeline" Param1="scale_in$level$"/>
                    <Action Method="PlaySound" Param1="ui_tap" />
                </Actions>
            </InertActor>
        </Template>
```

This is the template for one of the level select buttons used in cOnnecticOns. As you can see we define a multi-part actor complete with time line and a bunch of actions etc.. And here we instantiate 10 of them:

```
        <!-- Create level select button actors-->
        <FromTemplate Template="Temp1" pos="0, 0" level="1" />
        <FromTemplate Template="Temp1" pos="300, 0" level="2" />
        <FromTemplate Template="Temp1" pos="600, 0" level="3" />
        <FromTemplate Template="Temp1" pos="900, 0" level="4" />
        <FromTemplate Template="Temp1" pos="1200, 0" level="5" />
        <FromTemplate Template="Temp1" pos="1500, 0" level="6" />
        <FromTemplate Template="Temp1" pos="1800, 0" level="7" />
        <FromTemplate Template="Temp1" pos="2100, 0" level="8" />
        <FromTemplate Template="Temp1" pos="2400, 0" level="9" />
        <FromTemplate Template="Temp1" pos="2700, 0" level="10" />
```

Now that saved some serious typing. Imagine if I had defined them all separately in XOML then decided that I needed to change the layout (gulp!)

The template system offers a VERY powerful versatile system for making life easy for yourself.

Its possible to instantiate a template from code as well as XOML. Lets take a quick look at how to do this in the following code:

```
void CounterActor::Spawn(int counter_num, int pos_x, int pos_y)
{
	// Find game scene that contains our counter player template
	GameScene* scene = (GameScene*)GAME->findScene("GameScene");
	if (scene != NULL)
	{
		// Find our counter or counter player tremplate
		CIwGameTemplate* temp = (CIwGameTemplate*)scene->getResourceManager()-
>findResource("CounterTemp", "template");
		if (temp != NULL)
		{
			// Create a set of XML attributes that will replace the template
parameters
			CIwGameXmlNode* replacements = new CIwGameXmlNode();
			replacements->Managed = false;
			CIwGameXmlAttribute* attrib;

			// Set base template paramater
			attrib = new CIwGameXmlAttribute();
			attrib->Managed = false;
			attrib->setName("base");
			attrib->setValue(CIwGameString(counter_num).c_str());
			replacements->AddAttribute(attrib);

			// Set position template paramater
			attrib = new CIwGameXmlAttribute();
			attrib->Managed = false;
			attrib->setName("pos");
			CIwGameString pos = pos_x;
```

```
                    pos += ", ";
                    pos += pos_y;
                    attrib->setValue(pos.c_str());
                    replacements->AddAttribute(attrib);

                    // Set depth template paramater
                    attrib = new CIwGameXmlAttribute();
                    attrib->Managed = false;
                    attrib->setName("depth");
                    attrib->setValue("1.0");
                    replacements->AddAttribute(attrib);

                    replacements->AddAttribute(attrib);

                    // Instantiate the template
                    temp->Instantiate(scene, replacements);

                    // Clean up replacement attributes
                    delete replacements;
                }
            }
}
```

In the above method we find the template called CounterTemp in the scenes resources. We then create an XML node and add our name, value pairs that represent the attributes we want replaced and the values we want replacing with then instantiate the template using CiwGameTemplate::Instantiate()

A template can also have a group tag that enables it to be tagged as part of a collection of common resources

19.3.14 Fonts

XOML supports the definition of fonts that can be used for the rendering text. Below is an example of creating a font in XOML:

```
    <Font Name="trebuchet_12" Location="Common" />
```

Font attributes are defined as follows:

- Location – The name of the Marmalade resource group that contains the fnot
- Name – The name of the font within the resource group
- Tag – Group tag

19.3.15 Cameras

XOML supports camera definition and attachment to scenes. Cameras can also be animated by the scene using time lines that target the scene that the camera is attached to. In addition, cameras can be made to track the users finger enabling drag panning right in XOML. Lets take a quick look at a camera definition in XOML:

```
<Camera Name="SelectCam" Position="0, 0" Angle="0" Scale="1.0" TouchPanX="true"
VelocityDamping="0.92, 0.92" />
```

Cameras support the following attributes:

- Name – Cameras name
- Position – Start world position of the camera
- Angle – Rotation of the camera
- Scale – Scale of the camera (can be used for zoom effects)
- TouchPanX / TouchPanY – Setting true causes the camera move around when the user drags their finger on the screen using veloicty obtained from the speed of the users drag. Separate X and Y axis panning can be enabled / disabled.
- VelocityDamping – Amount of damping to apply to the cameras velocity each frame
- Tag – Group tag

19.3.16 Data Binding

As of version 0.32, IwGame now supports data binding in XOML. Data binding is the ability to map properties of objects to XOML variables. Changes to those variables will be immediately reflected in all properties of all objects that are bound. Lets take a look at a quick example:

We declare a global variable that holds a profile name:

```
<Variable Name="ProfileName" Type="string" Value="None" />
```

Next we create a bindings set that contains a single property called “Text” that is bound to the “ProfileName” variable that we just defined:

```
<Bindings Name="SC_ProfileBindings">
    <Binding Property="Text" Variable="ProfileName" />
</Bindings>
```

We now attach our bindings list "SC_ProfileBindings" to a text actor:

```
<ActorText Name="NameLabel" ......... Bindings="SC_ProfileBindings" />
```

Now if we change the ProfileName variable in XOML or in code, our NameLabel actor's Text property will be automatically updated.

We opted to use independent binding lists (as opposed to in-line bindings as used in XAML / MXML) because they are re-usable, the same bindings list can be used across many objects. They are also much more readable as bindings are not intermingled with normal property values.

Note that if you also have a timeline animation that updates the same property then the timeline is given priority and the timeline will write over the binding value.

Binding lists can be attached to scenes and actors. The following properties can be bound:

CIwGameScene:
- Position
- Angle
- Scale
- Colour
- Clipping
- Timeline
- Binding
- Camera
- Type
- Active
- Visible
- AllowSuspend
- AllowResume

CIwGameActor:
- Position
- Depth
- Origin
- Angle
- Scale, ScaleX and ScaleY
- Colour
- Velocity
- Angular Velocity
- Timeline
- Binding
- Type
- Active
- Visible
- Collidable
- Draggable
- HitTest

CIwGameActorImage (in addition to those present in CIwGameActor):

- Size
- SrcRect
- Image

CiwGameActorText (in addition to those present in CIwGameActor):

- Text
- Rect

Binding sets that are defined outside a scene will be assigned to the global resource manager, whilst bindings defined inside a scene will be assigned to the scenes resource manager.

Data bindings offer a way to create complex scenes and user interfaces without having to manually update the properties of the individual elements

19.3.17 Conditional Variables and Actions

As of version 0.32 of the IwGame engine, XOML supports a new variable type called a condition variable. A condition variable is a variable that contains an expression that is defined by a list of variables, operators and values. Lets take a look at a quick example:

```
<!--Create a bog standard int variable that contains the current level /-->
<Variable Name="current_level" Type="int" Value="1" />

<!--Create a condition variable that tests the current level is between 1 and 9 /-->
<Variable Name="low_level_extras" Type="condition" Value="current_level GTE 1 AND
          current_level LT 10" />
```

We create an integer variable called current_level and assign it the value of 1. Next we create a new variable called “low_level_extras” that is of type “condition”. The most interesting part of our condition variables is the value, which is:

```
current_level GTE 1 AND current_level LT 10
```

Unlike normal variables which contain constant values of some kind, condition variables contain dynamic expressions that are evaluated at run-time. The end result of a condition variable is always either true or false. The above expression in terms of C code would read like this:

```
bool low_level_extras = (current_level >= 1 && current_level < 10);
```

Condition variables aren't much use on their own and are usually used in conjunction with actions to provide conditional action functionality whereby an action or actions group will only be executed if a certain set of conditions are met. Lets take a look at a quick example:

```
<Actions Name="NextScene">
   <Action Method="LoadXOML" Param1="MainScene.xml" />
   <Action Method="LoadXOML" Param1="LowLevelExtras.xml" Condition="low_level_extras" />
   <Action Method="KillScene" />
</Actions>
```

The above actions group is called when we click a button to start a game. The actions group starts by loading the MainScene XOML file which creates the main game scene. Next the condition variable “low_level_extras” is checked to see if It is true, if current_level is between 1 and 9 then the variable will return true and the additional XOML file “LowLevelExtras” will be loaded. If however the current_level variable is <1 or > 9 then the additional XOML file will not be loaded.

This is just a very simple example showing how conditional actions can be used to re-use and extend XOML code.

19.3.18 Modifiers

As of 0.34 IwGame now supports modifiers using the IwGameModfier system. Modifiers can be thought of as small functional building blocks that can be stacked in an actor or scene to extend the functionality of that actor or scene. For example, a typical modifier for a scene could be one that tracks the players scores / hi-scores, change day / night settings or detects special gestures. An actor modifier example could be a modifier that allows the actor move around using heading and speed or even a modifier with functionality specific to your game such as make a baddy that walks left and right on a platform. The idea is to allow developers to build games and apps up from smaller re-usable building blocks and be able to add them using code or XOML. Below is a quick example showing how to attach a modifiers list to an actor in XOML:

```
<ActorImage Name="Baddy1" …..... >
    <Modifiers>
        <Modifier Name="WalkLeftRight" Active="true" Param1="1" />
        <Modifier Name="ShootPlayerWhenClose" Active="true" Param1="1" />
    </Modifiers>
</ActorImage>
```

Modifiers support the following attributes:

- Name – Modifier name (string)
- Active – Active state of the modifier (boolean)
- Param1, Param2, Param3, Param4 – Parameters that get passed to the modifier (string)

19.3.19 Brushes

A brush is an image and rectangular area within that image combination. They can be used to provide common visual styling for a whole group of actors. Using brushes saves you a lot of time as you do not have to specify the Image and SrcRect of each individual actor. It also makes making changes to common sprites very easy as you simply change the brushes paramaters.

A brush can be defined in XOML as follows:

```
<Brush Name="Crate" Type="image" Image="frog" SrcRect="0, 241, 168, 152" />
```

Brush supports the following properties:

- Name – The name of the brush (string)
- Type – Can be solid, gradient or image (image is currently the only type used) (string)
- Image – The image that represents the brush (string)
- SrcRect – The sub area of the image that represents the brush (rect)
- Tag – A resource tag name (string)

19.3.20 Joints

Joints allow you to specify a physical connection between two actor that are under control of the Box2D physics engine. Below shows an example:

```
        <ActorImage Name="Crate1" ..... />
        <ActorImage Name="Crate2" ..... >
            <Joints>
                <Joint type="distance" ActorB="Crate1" OffsetA="0, 50" OffsetB="0, -50"
Frequency="10" Damping="0" SelfCollide="true" />
            </Joints>
        </ActorImage>
```

Note that Joints should be declared inside the actor that represents BodyA.

The following attributes are supported:

Common:

- Type – Type of joint (distance, revolute, prismatic, pulley and wheel)
- AnchorA – Anchor point on body A (vec2)
- AnchorB – Anchor point on body B (vec2)
- Body B – The other body that the joint is attached to (string)

Distance Joint:

- Length – The max length between the two bodies (float) – This is calculated if not supplied
- Frequency – Oscillation frequency in Hz (float)
- Damping – Oscillation damping ratio (float)

Revolute Joint:

- ReferenceAngle – The initial angle between the two bodies (float) – This is calculated if not supplied
- LimitJoint – When set to true will limit joint rotation (boolean)
- UpperLimit – Upper angle limit in degrees (float)
- LowerLimit – Lower angle limit in degrees (float)
- MotorEnabled – When set to true the joint motor is enabled (boolean)
- MotorSpeed – Speed of the motor (float)
- MaxMotorTorque – Maximum torque that the motor will apply (float)

Prismatic Joint:

- ReferenceAngle – The initial angle between the two bodies (float) – This is calculated if not supplied
- Axis – Axis of movement (vec2)
- LimitJoint – When set to true will limit joint translation (boolean)
- UpperLimit – Upper translation limit (float)
- LowerLimit – Lower translation limit (float)
- MotorEnabled – When set to true the joint motor is enabled (boolean)
- MotorSpeed – Speed of the motor (float)
- MaxMotorForce – Maximum force that the motor will apply (float)

Pulley Joint:

- GroundAnchorA – Anchor point where pulley point for Body A is situated (vec2)
- GroundAnchorB – Anchor point where pulley point for Body B is situated (vec2)
- LengthA – Distance between BodyA and Ground Anchor A - This is calculated if not supplied (float)
- LengthB – Distance between BodyB and Ground Anchor B - This is calculated if not supplied (float)
- Ratio – The ratio of side A to side B (float)

Wheel Joint:

- Axis – Axis of movement (vec2)
- MotorEnabled – When set to true the joint motor is enabled (boolean)
- MotorSpeed – Speed of the motor (float)
- MaxMotorTorque – Maximum torque that the motor will apply (float)
- Frequency – Oscillation frequency in Hz (float)
- Damping – Oscillation damping ratio (float)

Note that all coordinates are specified relative to the relevant body (local)

19.4 XOML Workflow

How is XOML meant to be used? Well that's up to you, I'm pretty sure you already have hundreds of cool ideas bouncing around your mind right now. That said we do have some recommended usage and work flow ideas.

The idea is to define all of your different types of actors and / or scenes derived from IwGame base scenes and actors then add the creators to the XOML system. This allows you to declare them in XOML.

You should have very few if not a single global resource XOML file that contains all of your global resources. This gets loaded first when you boot the game.

You then create separate XOML files that contain either single scenes or scenes grouped by functionality.

Try to keep scene specific resources within scenes so they can be freed up when the scene is no longer needed, but try to balance resource group loading times with resource re-use.

The animation system provided by XOML is very powerful so try to use it wherever appropriate.

Use events and actions to link up actors and animations / audio as well as loading XOML files in on the fly.

Use variables to pass data from XOML to your code and from your code back to XOML. Use bindings to hook actors up to internal data, this allows them to be automatically be updated when the variables the bindings are bound to are changed.

Use styles, templates and bindings to reduce XOML code size and make it more re-usable and readbale.

Start looking at your game as being driven by XOML rather than XOML being a simple data format.

19.5 XOML's future

XOML was initially designed to simplify the mundane and time consuming tasks involved in creating scene layouts and animations etc, but luckily it turned into something much more. Over time XOML will evolve into even more with future with plans for the following addictions:

- Declaration of user interfaces
- More IwGame class support such as support for video, data files, camera streaming, audio time lines and more..

20.0 Box2D Physics – Lets Bounce

20.1 Introduction

I need to admit that physics is fun. Didn't quite think like that at school, but games that use physics simulation to control game objects and the environment seem to have that cool factor that almost always wow gamers. Take a look at the likes of Angry Birds to see how adding a little physics can really bring a game to life. I would hazard a guess that without Box2D style physics, games such as Angry Birds would be not have been anywhere near as popular.

As of v0.28 IwGame supports Box2D physics. Actors that are set up with a collision shape and physics material will be put under control of the scenes Box2D world controller.

Actors support a number of physical attributes including:

- Physical shape (defined by a CIwGameShape)
- Physical material (defined by a CIwGameBox2dMaterial)

Scenes currently support:

- World scale – This is the world to pixel scaling factor required by Box2D as Box2D does not work in pixel coordinates
- Gravity – Direction and speed of gravity

Generally you will declare a scene in XOML, set the Gravity and WorldScale attributes then add shapes and Box2dMaterial's that define the shape and physical properties of your game actors. Finally you will add actors to the scene that reference the shapes and materials declared earlier. Example XOML is shown below:

```
    <Scene Name="GameScene3" CanvasSize="320, 480" FixAspect="true" LockWidth="false" Colour="255, 255, 255, 255"
AllowSuspend="false">
        <Box2DMaterial Name="Solid" Type="static" Density="1.0" Friction="1.0" Restitution="0.1" />
        <Box2DMaterial Name="BounceyBall" Type="dynamic" Density="1.0" Friction="0.9" Restitution="0.6" />
        <Shape Name="PlayerShape" Type="box" width="60" height="60" />
        <Shape Name="Wall" Type="box" width="20" height="320" />
        <Shape Name="Floor" Type="box" width="320" height="20" />
        <Timeline Name="Player1Intro1" AutoPlay="true">
            <Animation Anim="PlayerImageAnim" Target="SrcRect" Repeat="0" StartAtTime="1"/>
        </Timeline>
        <TestActor Name="Floor" Position="0, 200" Size="320, 20" Angle="0" SrcRect="0, 0, 32, 32" Image="Block" Shape="Floor"
Box2dMaterial="Solid" CollisionFlags="1, 1, 1" />
        <TestActor Name="LeftWall" Position="-140, 0" Size="20, 480" Angle="0" SrcRect="0, 0, 32, 32" Image="Block"
Shape="Wall" Box2dMaterial="Solid" CollisionFlags="1, 1, 1" />
        <TestActor Name="RightWall" Position="140, 0" Size="20, 480" Angle="0" SrcRect="0, 0, 32, 32" Image="Block"
Shape="Wall" Box2dMaterial="Solid" CollisionFlags="1, 1, 1" />
        <TestActor Name="Player1" Position="-50, -200" Size="60, 60" Angle="0" SrcRect="0, 0, 36, 40" Image="Sprites"
Timeline="Player1Intro1" Shape="PlayerShape" Box2dMaterial="BounceyBall" CollisionFlags="1, 1, 1" />
        <TestActor Name="Player2" Position="0, -150" Size="60, 60" Angle="0" SrcRect="0, 0, 36, 40" Image="Sprites"
Timeline="Player1Intro1" Shape="PlayerShape" Box2dMaterial="BounceyBall" CollisionFlags="1, 1, 1" />
        <TestActor Name="Player3" Position="50, -200" Size="60, 60" Angle="0" SrcRect="0, 0, 36, 40" Image="Sprites"
Timeline="Player1Intro1" Shape="PlayerShape" Box2dMaterial="BounceyBall" CollisionFlags="1, 1, 1" />
        <TestActor Name="Player4" Position="0, -1000" Size="60, 60" Angle="0" SrcRect="0, 0, 36, 40" Image="Sprites"
Timeline="Player1Intro1" Shape="PlayerShape" Box2dMaterial="BounceyBall" CollisionFlags="1, 1, 1" />
    </Scene>
```

In the above scene we declare two materials, one for our solid environment pieces (floor and walls) and then another for our bouncy players.

Next we define a shape for our player, a shape for our floor and s shape for our walls.

Lastly, we create actors that represent our floor, left wall, right wall and 4 player actors, assigning the correct shapes and materials.

20.2 Box2dMaterial's

Box2dMaterial's allow you to specify the physical properties of an actors body that is under control of the Box2D physics engine. A Box2D material is represented by the CiwGameBox2dMaterial class and supports the following methods:

```
void                    setBodyType(b2BodyType type)
b2BodyType              getBodyType()
void                    setDensity(float density)
float                   getDensity()
void                    setFriction(float friction)
float                   getFriction()
void                    setRestitution(float restitution)
float                   getRestitution()
void                    setBullet(bool bullet)
bool                    isBullet()
void                    setFixedRotation(bool fixed)
bool                    isFixedRotation()
void                    setGravityScale(float scale)
float                   getGravityScale() const
```

These methods allow you to set the type of physical body, density and coefficients of friction and restitution

20.3 Box2D World

All objects that are under control of the Box2D physics system require attachment to the Box2D world. The Box2D world is represented by the CiwGameBox2dWorld class.

This class contains the actual Box2D b2World object as well as a few additional useful properties:

```
	b2World*	World;			// Physical world
	CIwFVec2	WorldScale;		// Scaling between physical and viusal
worlds (set to 0, 0 to disable physics update)
	int		VelocityIterations;	// Number of internal iterations used when
computing velocities
	int		PositionIterations;	// Number of internal iterations used when
computing positions
	CIwFVec2	Gravity;		// Scene gravity
```

These properties can be modified and queried using the following methods:

```
	void		setWorldScale(float x, float y)
	CIwFVec2	getWorldScale()
	b2World*	getWorld()
	void		setVelocityIterations(int count)
	int		getVelocityIterations()
	void		setPositionIterations(int count)
	int		getPositionIterations()
	void		setGravity(float x, float y);
	CIwFVec2	getGravity()
```

In addition methods are provided for converting between Box2D world and IwGame scene canvas pixel coordinates:

```
	float		WorldToPixelX(float x)
	float		WorldToPixelY(float y)
	float		PixelToWorldX(float x)
	float		PixelToWorldY(float y)
```

To initialise a Box2D world you call InitWorld() and to update the Box2D world each frame you call UpdateWorld().

20.4 Box2D Bodies

A Box2D body is a basically the physical representation of an object in the Box2D world. Bodies contain fixtures of various shapes and sizes that have particular attributes such as friction, density and restitution.

A Box2D body is defined by the CIwGameBox2dBody class which contains the b2Body object, a single fixture (multiple fixtures will be supported at a later date) a material and a shape.

To create a body you call the InitBody() method:

```
	void	InitBody(CIwGameBox2dWorld* world, CIwGameShape* body_shape,
CIwGameBox2dMaterial* body_mat, CIwFVec2* pos, float angle, float com_x, float com_y);
```

- world – The box2d world
- body_shape – The shape of the body
- body_mat – The material of the body
- pos – Position of the body in the Box2D world
- angle – Rotation of the body in the Box2D world
- com_x – Centre of mass x value
- com_y – Centre of mass y value

All co-ordinates are in pixels

A number of additional functions are included that allow you to apply various forces to the body:

```
	void		ApplyForce(float force_x, float force_y, float world_pos_x, float
world_pos_y);
	void		ApplyForceToCenter(float force_x, float force_y);
	void		ApplyTorque(float torque);
	void		ApplyLinearImpulse(float impulse_x, float impulse_y, float world_pos_x,
float world_pos_y);
	void		ApplyAngularImpulse(float impulse);
```

All values are in Box2D world coordinates

20.5 Box2D Collision

The CIwGameBox2dCollidable class manages collision begin and end events and tracks a list of all other Box2D objects that are currently in contact with the object.

Objects that implement CIwGameBox2dBody will automatically get this collision handling functionality as CIwGameBox2dBody is derived from a CIwGameBox2dCollidable which enables it to receive begin and end collision contact events.

When a collision occurs between two objects the Box2D collision system will call addCollisionStarted() adding each of the objects to each others collision started array. When a collision stops the system will call addCollisionEnded() which will remove the corresponding objects from each others collision started arrays and add each of the objects to each others colision ended array.

Below is an example showing how to implement an actors colision using Box2D collision:

```
void CounterActor::ResolveCollisions()
{
	if (IsDying || Box2dBody == NULL)
		return;

	// Check begin contacts
	CIwGameSlotArray<CIwGameBox2dCollidable*>& started = Box2dBody-
>getCollisionsStarted();

	for (int t = 0; t < started.getSize(); t++)
	{
		CIwGameBox2dCollidable* collision = started.element_at(t);
		if (collision != NULL)
		{
			CIwGameActor* actor = (CIwGameActor*)collision->getUserData();
			if (actor != NULL)
			{
				actor->NotifyCollision(this);
			}
		}
	}
}
```

In the above code we check the objects array of “started collision” events. If any are present then we call that objects NotifyCollision() to let those objects know that we collided with it.

Below is an example NotifyCollision() handler:

```
void CounterActor::NotifyCollision(CIwGameActor* other)
{
	CounterActor* counter = (CounterActor*)other;

	IW_GAME_AUDIO->PlaySound("collide");
	if (counter->getCounterColour() == CounterColour)
	{
		counter->Kill(this);
	}
}
```

Basically in the above code we check to see if the two counters share the same colour and if they do we destroy the counter.

20.6 Box2D Joints

From version 0.34 of the IwGame Engine support has been added for Box2D physics joints in code and in XOML. Physics joints enable you to connect physical bodies together in a variety of ways. The following types of physical joints are currently supported:

- Distance – A distance joint limits the distance of two bodies and attempts to keep them the same distance apart, damping can also be applied
- Revolute – A revolute joint forces two bodies to share a common anchor point. It has a single degree of freedom and the angle between the two bodies can be limited. In addition a motor can also be applied to the joint
- Prismatic – A prismatic joint limits movement between the two bodies by translation (rotation is prevented). The translational distance between the two joints can be limited. In addition a motor can also be applied to the joint
- Pulley Joint – A pulley joint can be used to create a pulley system between two bodies so that when one body rises the other will fall.
- Wheel Joint – A wheel joint restricts one body to the line on another body and can be used to create suspension springs. A motor can also be applied to the joint

All joints share the same base class IIwGameBox2dJoint

Joints can be created in code and attached to a body using CiwGameBox2dBody::addJoint(). Joints can later be removed using removeJoint(). You can also search for existing joints using getJoint() and findJoint()

```
        <ActorImage Name="Crate1" ..... />
        <ActorImage Name="Crate2" ..... >
            <Joints>
                <Joint type="distance" ActorB="Crate1" OffsetA="0, 50" OffsetB="0, -50"
Frequency="10" Damping="0" SelfCollide="true" />
            </Joints>
        </ActorImage>
```

The easiest way to create and attach joints is using XOML. Below is an example showing how to create and attach a distance joint between two crates:

21.0 CIwGameRender2d – Better Control Over Rendering

21.1 Introduction

Up until version 0.29 of the IwGame Engine we used Marmalade's Iw2D engine as the rendering core. As of v0.30 we have switched to Marmalade's IwGx rendering system as it offers much more versatility as well as brings the engine into the realms of 3D rendering, which is where we will eventually be steering the engine.

To facilitate this change over and to keep the game engine code nice and readable, all rendering has been abstracted away into a nice simple class called CIwGameRender2d. CiwGameRender2d is and will in future be the centre point for all rendering that takes place within IwGame.

At the moment CiwGameRender2d offers:

- Batch and none batch sprite rendering of quad based polygons
- Rendering of prepared text from the Marmalade IwGxFont system

In the near future we will be adding support for various other types of primitives, 3d models and hopefully our own custom shaders etc..

22.0 CIGameFacebook – Lets be Social

22.1 Introduction

It cannot be denied that the modern way of letting people know something en-mass is to via social networking. Cool and interesting news will propogate quite quickly across the planet once picked up by the likes Twitter, Facebook and Google+.

A great way to increase a games visibility is to integrate social sevices into the game. Here are a few examples fo social integration:

- Sharing scores and achievements (posted directly to the users facebook stream for example)
- Sharing game levels (A feature that will be coming to cOnnecticOns very soon)
- Integrating friends directly into the game play, such as friend leaderboards, exchanging virtual gifts and helping one another

CIwGameFacebook is a wrapper around the Marmalade Facebook extension that allows users to log into their Facebook no device and post wall updates using a snigle method call.

The CIwGameFacebook class is a singleton so you only need to create a single version of it during the games lifetime. The code below shows how to create and initialise the Facebook class:

```
CIwGameFacebook::Create();
IW_GAME_FACEBOOK->Init();
IW_GAME_FACEBOOK->setAppID("20597290572907520");      // Put your Facebook apps API_KEY here
```

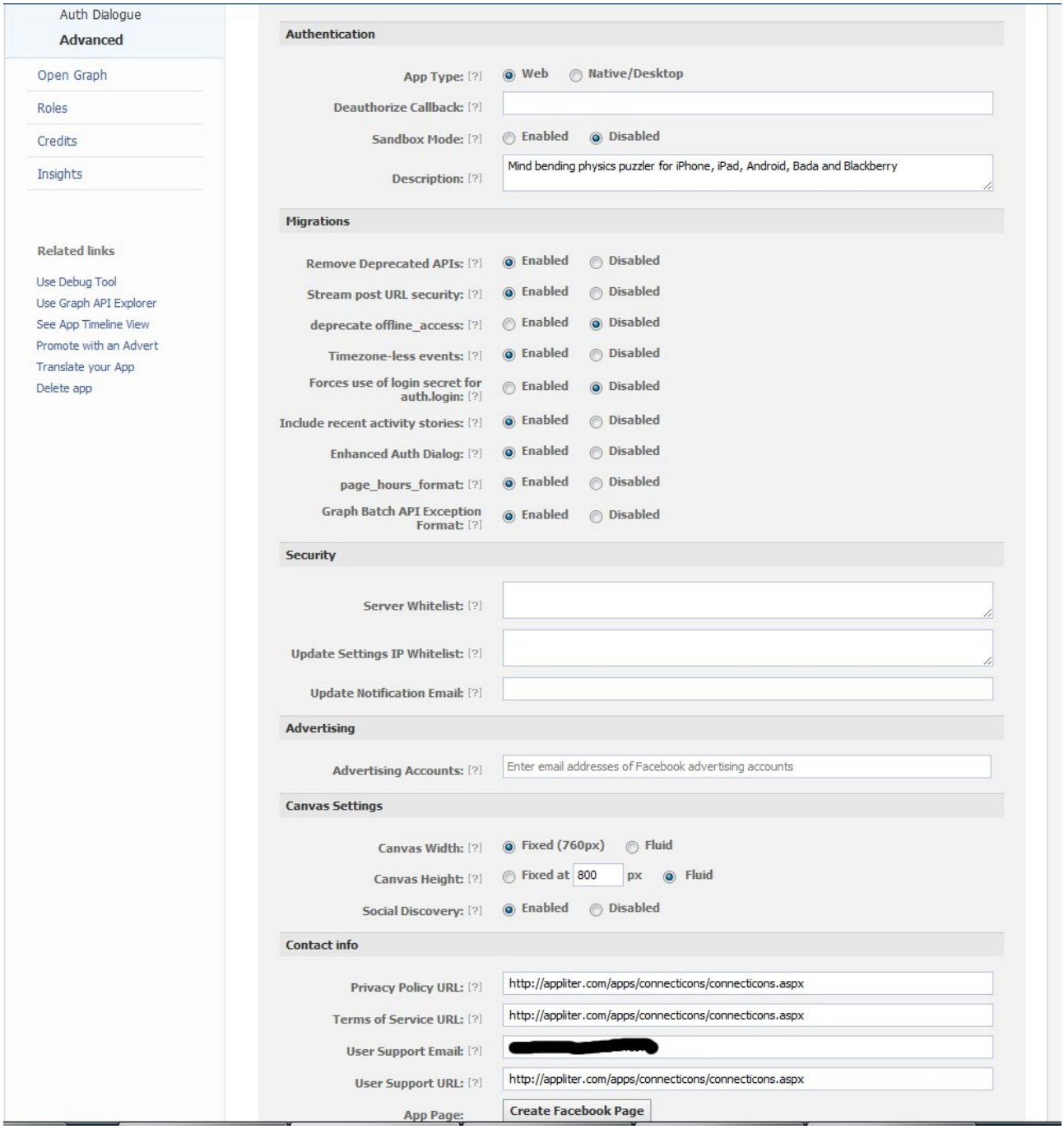
And later on before you exit the app you should clean-up the Facebook class using:

```
if (IW_GAME_FACEBOOK != NULL)
{
	IW_GAME_FACEBOOK->Release();
	CIwGameFacebook::Destroy();
}
```

22.2 Create a Facebook App

Before you can begin interacting with your users Facebook account you need to create a Facebook app. To start creating a Facebook app go to https://developers.facebook.com/apps

For cOnnecticOns we created a simple web site app (not a native mobile app). Here are the settings we use:



Note that you will need to copy the API KEY that Facebook generates for your app as you are going to need to provide that to the CIwGameFacebook class during initialisation. You should also need to

note down your API SECRET as this is required for performing certain actions with te Facebook API. Not currently supported by CIwGameFacebook however.

22.3 Posting Information to the Users Wall

CIwGameFacebook provides a simple method that allows you to post information directly to a users Facebook wall:

```
	bool	PostWall(const char* message, const char* link_uri, const char* image_uri,
const char* name, const char* description);
```

message – Message to display to the users wall visitors
link_uri – URL that the user will visit when clicking on the wall post link
image_uri – URL of an image that you would like to be displayed along with the post
name – The title of the post
description – Description of the post (displayed in weaker font beneath title)

You can see an example of a Facebook post made by cOnnecticOns below:

22.4 MKB Changes

For the Facebook extnsion to operate correctly on newwer iOS devices you will ned to ensure that the followni info is added to the deployment section of your MKB file:

```
deployment
{
      iphone-bundle-url-name="com.companyname.appname"
      iphone-bundle-url-schemes="fbFACEBOOK_APP_ID"
}
```

Enter your company name i/app name nto company / app name string and replace FACEBOOK_APP_ID with your facebook App ID.

23.0 In-App Purchasing - IwGameMarket

23.1 Introduction

Its an incredibly tough job to get noticed in the app stores these days with approaching half a million apps available in the larger stores (insane competition), its an even tougher job persuading Joe public to part with their money for your app. Many developers are turning to developing freemium titles as a means to increase visibility (app users are much more likely to download a free app) and earn money by offering the app in a limited form then allowing users to purchase additional content and game features. As of IwGame v0.33, basic in-app purchasing is now available for iOS and Android using a wrapper around Marmalade's EDK in-app purchase extensions called IIwGameMarket.

IIwGameMarket is a not a concrete class however so you cannot just create one and use it. Instead it provides a basic interface for creating the platform specific market class as well as access to common functionality. At the moment the following marker classes are available:

- CIwGameMarketiOS – Uses iOS in-app purchasing
- CIwGameMarketAndroid – Uses Android market billing
- CIwGameMarketTest – This version is a test class that you can use to simulate purchases / errors etc in the simulator.

IwGameMarket is designed to allow you to initialise and set-up and use in-app purchasing in a platform agnostic fashion, allowing you to query / purchase content very easily.

IwGameMarket works using a product list system, where you create and add CIwGameMarketProduct products to the IwGameMarket. Each CIwGameMarketProduct represents a single consumable / none consumable product that can be purchased.

Note that if you are running your app on the Marmalade simulator then you need to update the test market each game frame using:

```
IIwGameMarket::getMarket()->Update();
```

23.2 Setting up IwGameMarket

Setting up the IwGameMarket is very simple, you simply call IIwGameMarket::Create() which initialises the correct market for the platform that your game or app is running on then set-up a few handlers, depending upon which messages you want to handle. Below shows a quick example:

```
IiwGameMarket::Create("Your android public key");
IIwGameMarket::getMarket()->setReceiptAvailableHandler(PurchaseComplete, NULL);
IIwGameMarket::getMarket()->setErrorHandler(PurchaseError, NULL);
IIwGameMarket::getMarket()->setRefundHandler(Refunded, NULL);    // Android only
```

Note that if you are releasing for iOS only then you do not need to supply your Android Market public key, simply pass no parameters to Create().

In this example, we have told IwGameMarket that we want to be notified when a purchase receipt is available, when an error occurs or when a transaction refund has happened.

When done with the market don't forget to clean it up using:

```
    IIwGameMarket::Destroy();
```

23.3 Adding Products

Now that the market is set-up we need to add products, below shows a quick example:

```
// Which OS are we running
int os = s3eDeviceGetInt(S3E_DEVICE_OS);

// Create product 1
CIwGameMarketProduct* product = new CIwGameMarketProduct();
product->Consumable = true;
product->ID = 1;
product->Name = "10 Coins";
if (os == S3E_OS_ID_IPHONE)
	product->ExternalID = "com.companyname.gamename.coinsx10";
else
	product->ExternalID = "coinsx10";
product->Purchased = false;
IIwGameMarket::getMarket()->addProduct(product);

// Create product 2
product = new CIwGameMarketProduct();
product->Consumable = true;
product->ID = 2;
product->Name = "50 Coins";
if (os == S3E_OS_ID_IPHONE)
	product->ExternalID = "com.companyname.gamename.coinsx50";
else
	product->ExternalID = "coinsx50";
product->Purchased = false;
IIwGameMarket::getMarket()->addProduct(product);
```

In this example, we create 2 products, our first represents 10 in-game coins, whilst the second represents 50 in-game coins. The ExternalID property is the product ID as defined in the in-app purchase section of your app in iTunes Connect for iOS or the product id of the in-app purchase in the in-app purchase section of your Android Market product control panel for Android. ID can be anything you like but will need to be unique.

23.4 Making a Purchase

Now that the system and product set-up are out the way, lets take a look at how to purchase a product. Firstly you need to call PurchaseProduct() passing in the ID defined in the CIwGameMarketProduct that you added earlier:

```
if (IiwGameMarket::getMarket()->PurchaseProduct(product_id))
{
}
```

You then need to add code to the callbacks that we added in our set-up:

```
int32 MarketScene::PurchaseComplete(void* caller, void* data)
{
	int type = IIwGameMarket::getMarket()->getLastPurchaseID();
	if (type == 1)	// 10 coins
	{
		GAME->AddCoins(10);
	}
	else
	if (type == 2)	// 50 coins
	{
		GAME->AddCoins(50);
	}

	return 1;
}

int32 MarketScene::PurchaseError(void* caller, void* data)
{
	// Display an error to the user

	return 1;
}

int32 MarketScene::Refunded(void* caller, void* data)
{
	// Only available on th Andriod platform
	CIwGameString id = IW_GAME_MARKET_ANDROID->getRefundedID();

	// Player was refunded so take back the items(s)

	return 1;
}
```

23.5 iOS In-App Purchase Testing

Testing in-app purchasing is not an easy task, but to ease the pain a basic walk-through for iOS has been laid out in this section.

1. Create your app in iTunes Connect (do not put into waiting for upload state)
2. Click the "Manage In-App Purchases" button
3. Create your in-app purchases but leave them in the "Waiting for screenshot" state
4. If you dont have one already then create a test user account
5. Log into the test user account on your iOS device
6. Test your in-app purchases
7. When finished testing ensure that you upload your in-app purchase screenshots before you upload your binary for approval

23.6 Android In-App Purchase Testing

Testing in-app purchasing is not an easy task, but to ease the pain a basic walk-through for Android has been laid out in this section.

1. Create and save your app in the Android market control panel (do NOT publish it)
2. Click in "In-app Products" link below your app name in the Android market control panel
3. Create and "publish" your in-app purchases
4. If you dont have one already then create a 2nd gmail user account
5. Edit your Android market profile and add the 2nd user gmail to the "Test Users" field then save
6. Log into the 2nd user gmail account on your test device and make it the primary user (note that older devices will not allow you to change the primary user, so you have to factory reset the device and then add the 2nd user from scratch)
7. Test your in app purchases
8. Note that the s3eAndroidMarketBilling extension only works with Android 2.2 and above, although we did figure out a workaround, if you need to support older devices (<2.1 represents around 10-15% of Android devices) http://www.madewithmarmalade.com/devnet/forum/7780
9. When finished testing upload your app to the Android market

24.0 Modifiers – Building from Blocks

24.1 Introduction

As of 0.34 IwGame supports modifiers using the IwGameModfier system. Modifiers can be thought of as small functional building blocks that can be stacked in an actor or scene to extend the functionality of that actor or scene. For example, a typical modifier for a scene could be one that tracks the players scores / hi-scores, change day / night settings or detects special gestures. An actor modifier example could be a modifier that allows the actor move around using heading and speed or even a modifier with functionality specific to your game such as make a baddy that walks left and right on a platform. The idea is to allow developers to build games and apps up from smaller re-usable building blocks and be able to add them using code or XOML. Below is a quick example showing how to attach a modifiers list to an actor in XOML:

```
<ActorImage Name="Baddy1" …..... >
    <Modifiers>
        <Modifier Name="AddThrustMod" Active="true" Param1="1" />
        <Modifier Name="ShootPlayerWhenClose" Active="true" Param1="1" />
    </Modifiers>
</ActorImage>
```

Here we have added two modifiers to the Baddy1 actor which modify its behaviour. Note that up to 4 parameters can be passed to the modifier

Modifiers can also be attached in code like this:

```
// Find the modifiers creator
IIwGameModifierCreator* creator = IW_GAME_MODS->findCreator("addthrustmod");
if (creator != NULL)
{
	// Create an instance of the modifier
	IIwGameModifier* mod = creator->CreateInstance();
	if (mod != NULL)
	{
		// Set up the instance
		mod->setName("WalkLeftRight");
		mod->setActive(true);
		mod->setParameter(0, "1");

		// Add the modifier to the actor
		actor->getModifiers()->addModifier(mod);
	}
}
```

Its a little more verbose than XOML.

24.2 Creating a Modifier

To create a modifier you must derive your modifier class from IIwGameModifier and implement the following three pure virtual methods:

```
	virtual void		InitModfier(IIwGameXomlResource* target) = 0;
	virtual void		ReleaseModfier(IIwGameXomlResource* target) = 0;
	virtual bool		UpdateModfier(IIwGameXomlResource* target, float dt) = 0;
```

For example:

```
class AddThrustMod : public IIwGameModifier
{
public:
	void InitModfier(IIwGameXomlResource* target)
	{
		CIwGameError::LogError("AddThrustMod::Init()");
	}
	void ReleaseModfier(IIwGameXomlResource* target)
	{
	}
	bool UpdateModfier(IIwGameXomlResource* target, float dt)
	{
		CIwGameActor* actor = (CIwGameActor*)target;
		actor->setVelocity(-10, 0);

		return true;
	}
};
```

This class provides the functionality for the modifier and will be utilised by all actors that have this modifier attached.

However to let the Modifier system know that this modifier is available we must first notify the modifier system that our modifer is available for use.

24.3 CIwGameMods and Modifier Creators

The CIwGameMods class is a singleton class that provides global access to the IwGame modifier system. It is accessed via IW_GAME_MODS and is automatically created and cleaned up for you by the main IwGame class. In order for the modifier system to know that your modifiers exist you must add a class that can create them to the IwGameMods system. To create a modifier creator you derive your own class from IIwGameModifierCreator and implement the following method:

```
virtual IIwGameModifier* CreateInstance() = 0;
```

Here is an example showing how to create a modifier creator for the AddThrustMod class:

```
class AddThrustModCreator : public IIwGameModifierCreator
{
public:
	AddThrustModCreator()
	{
		setClassName("addthrustmod");
	}
	IIwGameModifier* CreateInstance() { return new AddThrustMod(); }
};
```

Note that the lower case “addthrustmod” (case does not matter in XOML but it does in code) name is the name that must be used when searching for the modifier or when attaching the modifier to actors or scenes in XOML.

25.0 IwGame Extensions

From v0.24 of IwGame a new optional extensions system has been added. The extensions system is basically a collection of actors, scenes, actions, modifiers and other elements that are not part of the base IwGame engine. The extensions system provides support for game specific objects and other functionality that can be used to make creating specific types of games much easier.

The following extension objects are currently available:

25.1 Extension Scenes

None currently available

25.2 Extension Actors

25.2.1 CIwGameActorConnector

The connector actor is an image based actor that can connect together two points within the world muwch like a string. Those points can come from static world positions or dynamic actor positions. CIwGameActroConnector supports the following properties:

```
CIwGameActor*           TargetA;        // Target actor A
CIwGameActor*           TargetB;        // Target actor B
CIwFVec2                OffsetA;        // Target A offset
CIwFVec2                OffsetB;        // Target B offset
```

- TargetA – Actor whos position will be used for one end of the actor
- TargetB – Actor whos position will be used for one end of the actor
- OffsetA – An amount to offset the connection point on Actor A. If TargetA actor is not specified then this will be classed as a static world position
- OffsetB – An amount to offset the connection point on Actor B. If TargetB actor is not specified then this will be classed as a static world position

Lets take a quick look at a XOML example:

```
<ActorConnector Size="100, 20" Brush="Rope" TargetA="Crate21" TargetB="Crate22" />
```

In this example we create a connector actor that connects two crates together using a rope. The Size

property behaves slightly differently to a normal actor in that the x size is actually a percentage and the y size is the width of the connector. The percentage value specifies how much of the space between the connectors end points should be filled with the actor. A value of 100 will ensure that the full space netween them is filled.

25.3 Extension Modifiers

CIwGameModFollowHeading

This modifier when attached to an actor will allow the actor to be controlled via heading and speed instead of linear velocity. To use this modified create a copy of it and attachit to an actors modifier list. To use this modifier in XOML see the example below:

```
<ActorImage Name="Car" ........ >
    <Modifiers>
        <Modifier Name="iw_followheading" Active="false" Param1="45" Param2="10" />
    </Modifiers>
</ActorImage>
```

Param1 represents the initial angle of the actor whilst Param2 represents the initial speed.

25.4 Extension Actions

None currently available