



# ARM<sup>®</sup> 2013 TechCon™

*Where Intelligence Connects*



**The Developer Summit at ARM<sup>®</sup> TechCon™ 2013**



# Webkit Rasterization

Matt Spencer

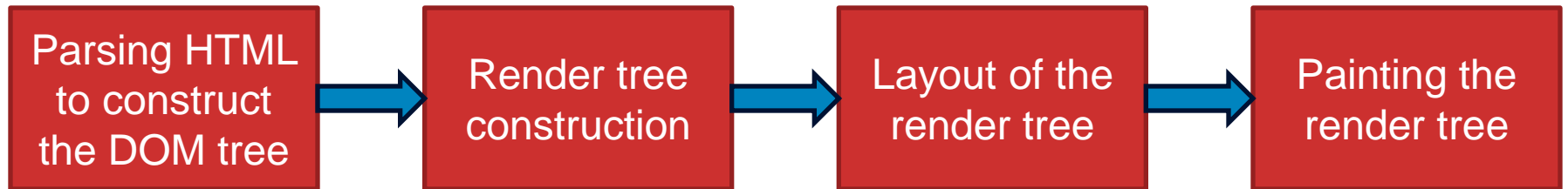
**ARM**<sup>®</sup>

The Developer Summit at ARM<sup>®</sup> TechCon™ 2013



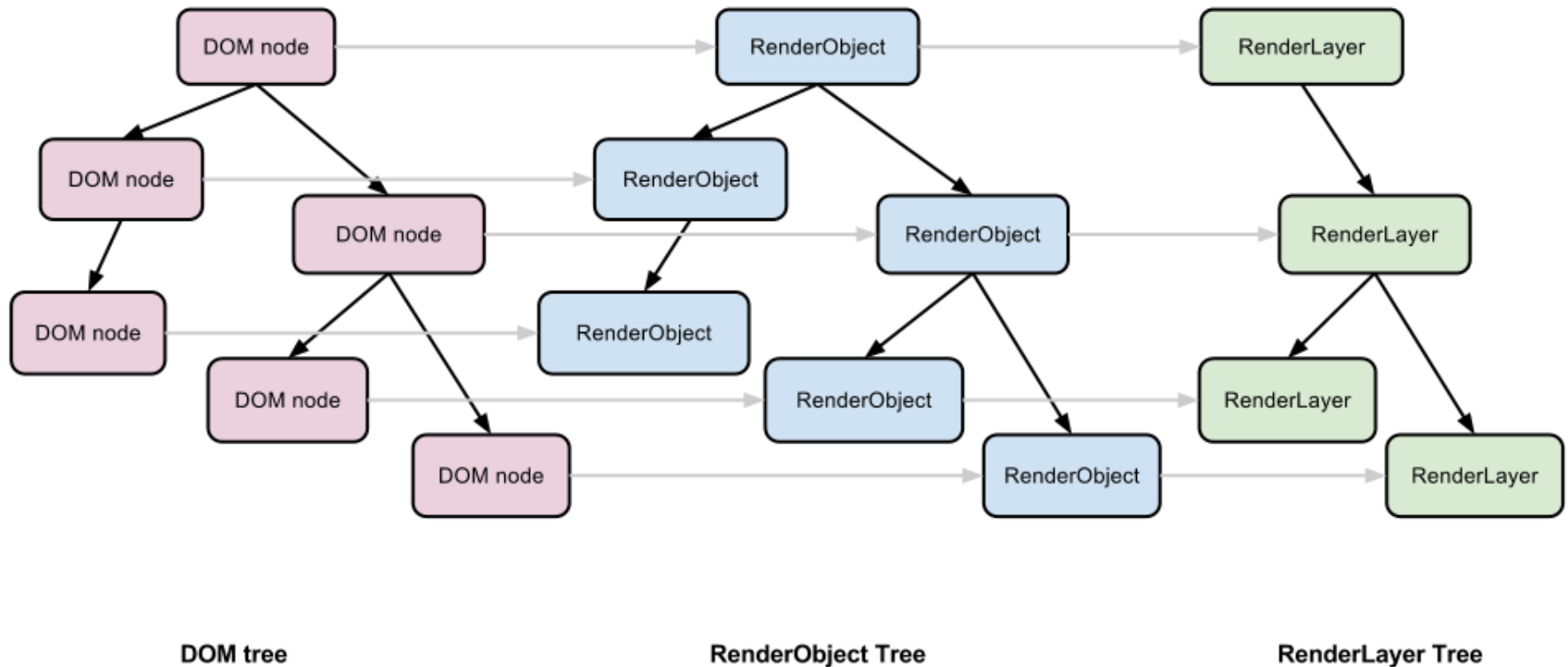
Where Intelligence Connects

# How WebKit Works



<http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/>

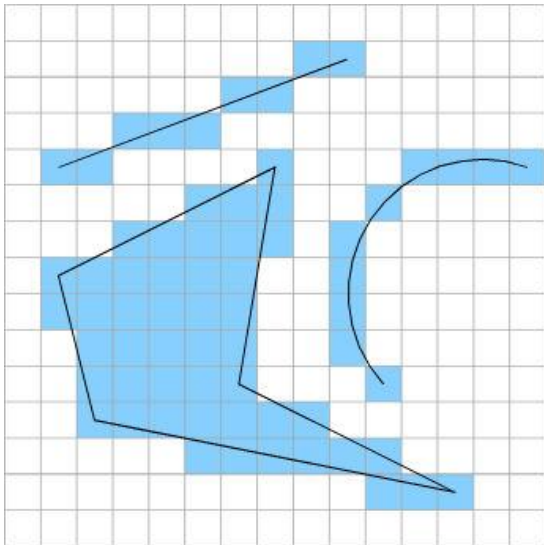
# How WebKit Works (2)



<http://www.chromium.org/developers/design-documents/gpu-accelerated-compositing-in-chrome>

# Rasterization vs Composition

**Rasterization** is the task of taking an image described in a vector graphics format and converting it into a raster image for output on a video display



**Compositing** is the combining of visual elements from separate sources into single images, often to create the illusion that all those elements are parts of the same scene

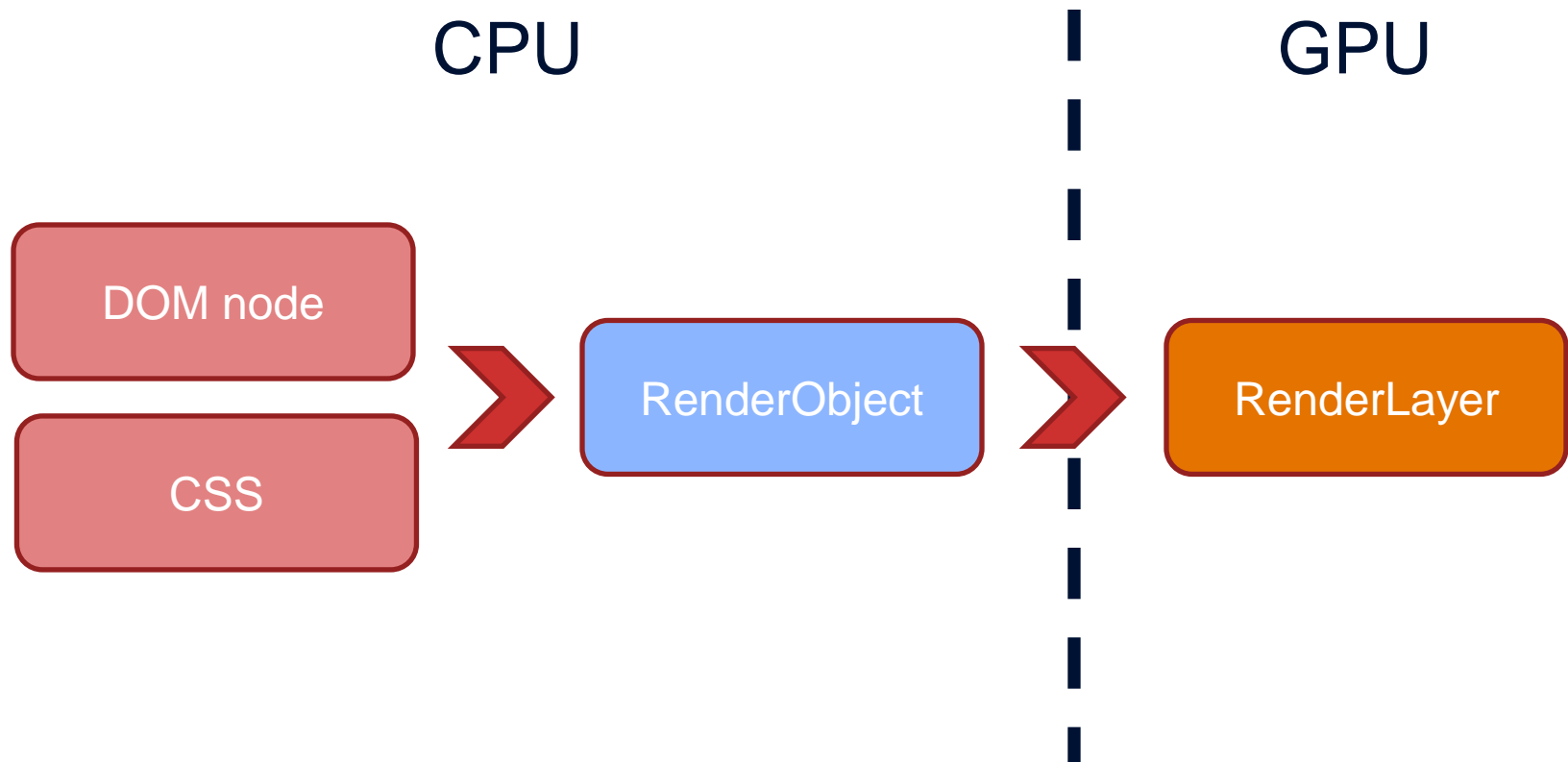
# Rasterization?

# What is Rasterization

## Recap

**Rasterization** is the task of taking an image described in a vector graphics format and converting it into a raster image for output on a video display

# Current State





# Problems with Current State

- Pixel data transfer from CPU to GPU is slow
- Not making efficient use of GPU
- CPU blocked by rasterization process
  - Cannot process JavaScript
  - This would be a good time to trigger Garbage Collection

# GPU Rasterization

The Developer Summit at ARM® TechCon™ 2013

# GPU Rasterization

- GPU works with two types of data
  - 2D/3D Vector data
  - 2D Bitmap data
- Vector data can be in the following forms
  - Triangles, Triangle strips/fans, Points and Lines
- GPU rasterizes Vector data to bitmaps for display

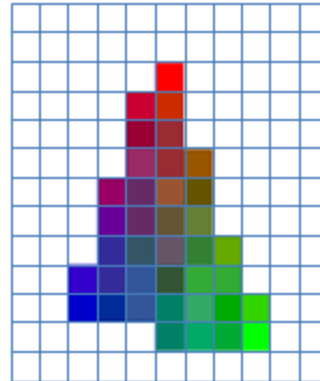
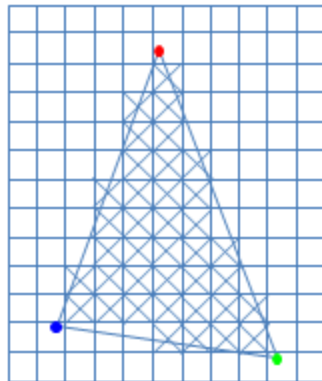


Image source: <http://www.lighthouse3d.com/tutorials/glsl-core-tutorial/glsl-core-tutorial-rasterization-and-interpolation/>

# GPU Rasterization (cont)

- To render a webpage GPU needs to work with paths because
  - WebKit creates paths for rendering rectangles etc.
  - All fonts are represented using paths.

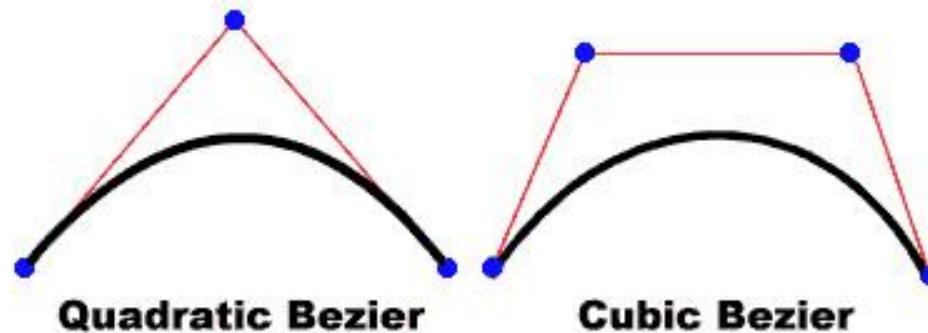
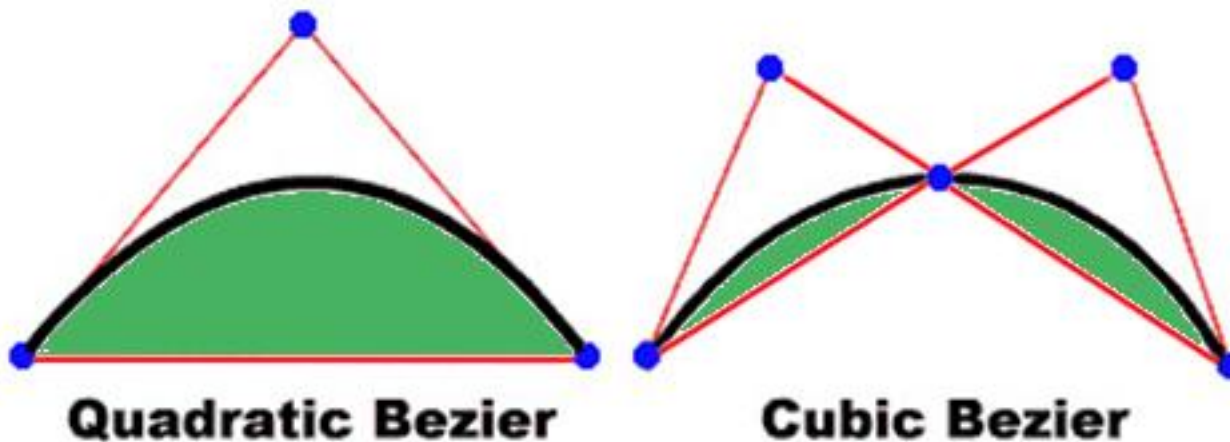


Image source: <http://www.paultondeur.com/2008/03/09/drawing-a-cubic-bezier-curve-using-actionscript-3/>

# Problems with GPU Rasterization

- Most GPUs only support OpenGL / ES.
- OpenGL ES does not have any support for path Rasterization.
- Paths must be converted to triangles or distance fields before rendered on the GPU.



# WebKit1 vs WebKit2

- WebKit1 is single process based so creating a rendering engine for WebKit1 is easy.
- WebKit2 has multi-process architecture so synchronization between different processes using OpenGL ES API is not trivial.
- Existing solutions are X11 specific.
- ~~Single vs Multithreaded paint engine – problems of GPU synchronization...~~

# Current State

- We have created Text rendering demos using GPUs and we see huge performance improvement.
- We have started an OpenGL ES 2.0 port to WebKit called GL2D.
- We have a shader based path rasterizer in GL2D.

# Font Rasterization



# Investigations

- Overview of the investigations undertaken
  - Texture Atlas
  - Vector
  - Signed Distance Field
  - Vector Texture Maps

# Text rendering method (resolution dependent)

Texture atlas  
created  
from font file



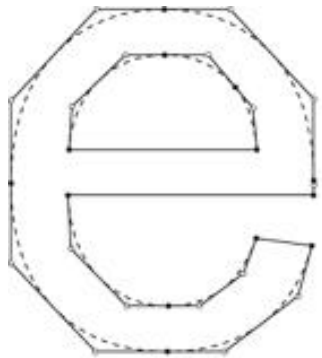
A quad (2-triangles)  
are created for each  
glyph

division in Ireland. Re  
ary over the Jacobites

Roman Catho

Roman Catho

# Text rendering method (resolution independent)



(a)



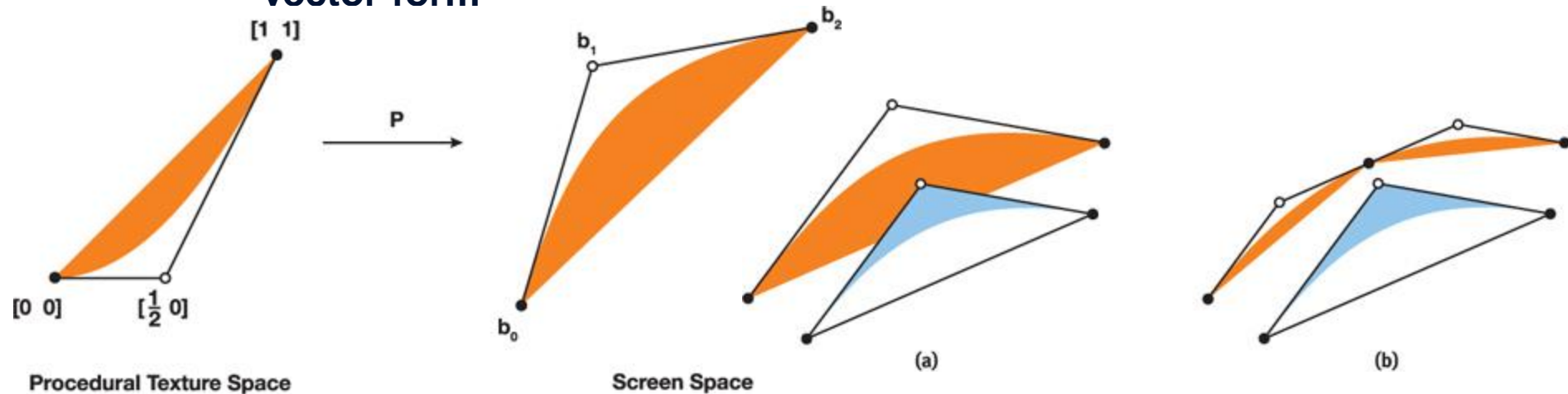
(b)



(c)

3 sets of triangles  
are rendered for  
Inside triangles and  
Inner and outer  
Bezier curves

Glyphs are separately loaded in  
vector form



[http://http.developer.nvidia.com/GPUGems3/gpugems3\\_ch25.html](http://http.developer.nvidia.com/GPUGems3/gpugems3_ch25.html)

# Text rendering method (resolution independent)

! " # \$ % & ' ( ) \* + , - . /  
0 1 2 3 4 5 6 7 8 9 : ; < = > ?  
@ A B C D E F G H I J K L M N O  
P Q R S T U V W X Y Z [ \ ] ^ \_  
' a b c d e f g h i j k l m n o  
p q r s t u v w x y z { | } ~

Glyphs are  
separately loaded in  
texture atlases in  
Signed distance  
form (SDF)



division in Ireland. Re  
ary over the Jacobites

~~Roman Catho~~

Roman Catho

A Quad (2-triangles)  
are drawn for each  
glyph

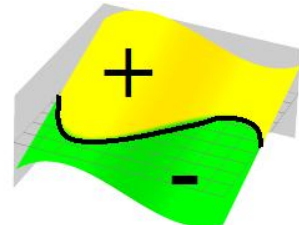
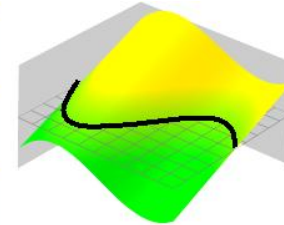
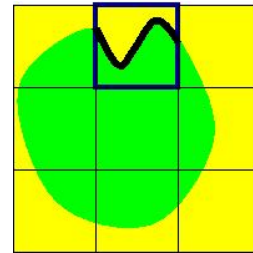
# Text rendering method<sub>(resolution independent\*)</sub>

- This approach is based on Vector Texture Maps (VTM)
- Discontinuities are completely represented at the fragment level
- Curved discontinuities and sharp turns can be represented

division in Ireland. Re  
ary over the Jacobites

~~Roman Catho~~

Roman Catho



A Quad (2-triangles)  
are drawn for each  
glyph

\* Under development

# Benefits

- ~~Higher number of Glyphs per second~~
- ~~Lower power consumption~~
- Up to 6 times performance improvement
- We haven't done any power measurements yet

# Conclusions

- WebKit still uses CPUs heavily for rasterization
- GPUs are much better suited for rasterization
- CPU implementation don't scale with resolution
  - CPU rasterization at 4k resolution could cripple performance
  - GPU rasterization at 4k makes much more efficient use of resources
- WebKit requires a GPU based backend

# What Next

The Developer Summit at ARM® TechCon™ 2013



# WebKit + Blink

- Landscape became more complicated
- Two engines to support – but which first?
- Current investigations based on WebKit-nix
  - Simplified dependency tree
  - Good starting point for a pure POSIX based engine
- Partners interested in Blink
  - Need to see how the rendering engines diverge
  - Need to investigate desire in Blink community for GL2D based rasterization

# Conclusions...

- Initial work is showing good results
- Still need to validate Power benefits
  - Require a more complete implementation for like-to-like comparison



# Matt Spencer

UI & Browser Marketing Manager

[matt.spencer@arm.com](mailto:matt.spencer@arm.com)

**ARM**<sup>®</sup>

The Developer Summit at ARM<sup>®</sup> TechCon™ 2013





# ARM<sup>®</sup> 2013 TechCon<sup>™</sup>

*Where Intelligence Connects*



**The Developer Summit at ARM<sup>®</sup> TechCon<sup>™</sup> 2013**

