Implement Off-Screen MSAA

Revision	Author	Date	Reviewer	Approver	Disapproval	Changelog	JIRA Story
"rev 0.1"	Zhang, Mingming	30 Jun 2022				Implement the off-screen MSAA	**TASDK-24600** - Investigate and Implement the MSAA on Atlas engine CODE REVIEW

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Introduction

As a user, I would like to see smooth, non-aliased elements on the map (roads, buildings, etc) so that I can have a delightful experience when exploring the map.

Currently, the buildings and roads have an aliasing effect, we need to try different anti-alias technology to reduce it. even we've used FSAA, but its effect is not perfect.

Multisample anti-aliasing (MSAA) is a type of spatial anti-aliasing, a technique used in computer graphics to remove jaggies.

Here introduces it into Atlas engine as an option to improve picture quality and we could set 4x, 8x by configure.

Requirements

ANDROID-3010 Anti-aliasing using the MSAA technique

We've used FXAA for buildings on C++, and tried multiple other hack-fixes to try and hide the aliasing effects on the roads, but with no huge impact:

- https://jira.telenav.com:8443/browse/TASDK-21062
- https://jira.telenav.com:8443/browse/TASDK-21949

On Android, anti-aliasing could be better achieved using multi-sample anti-aliasing.

We need to start researching this option and decide what our course of action will be.

Acceptance Criteria

AC should focus on below 4 major aspects:

- *non-aliased elements on the map (Road, polygon, building, landmark, just the same scope of the current FXAA.*
- *Multiple samples should be configurable*
  It should be 4, 8, 16, when larger than the GPU maximum samples just using maximum GPU samples.
- *no obvious performance degradation.*
- Support to open FXAA and MSAA at the same time

Design

~~Solution 1~~

Using **texelFetch + glTexStorage2DMultisample**

Advantage support to design your own sampling algorithm in shader, it will be more programmable.
Disadvantageuse GLES **3.1** new feature glTexStorage2DMultisample https://docs.gl/es3/glTexStorage2DMultisample, but most of our client just support ES 3.0, in long term perspective, we should also support this.

Solution 2

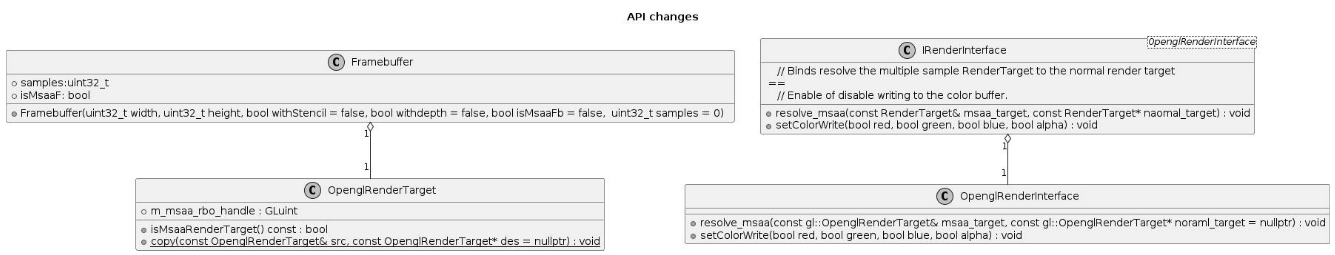
Using **glBlitFramebuffer**

Advantage: glBlitFramebuffer need GLES 3.0 https://docs.gl/es3/glBlitFramebuffer, meet the most client's GL version, no shader changes, code is simple.

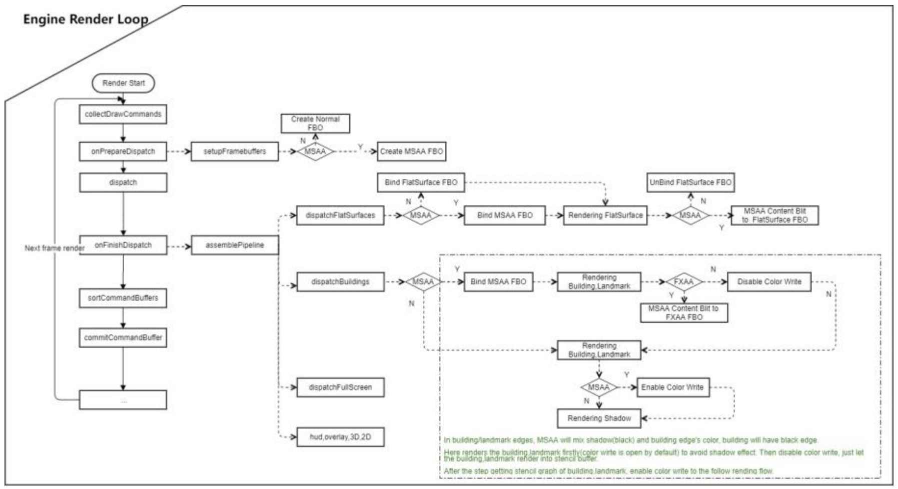
Disadvantagethe processed texture can't be used(binded) directly, need to use "blit" to the target frame buffer; the sampling algorithm is fixed (OpenGL defined), not be programmable.

Conside that most of our client just support ES 3.0, currently, Implement the **solution 2** for atlas engine.

Class Diagram


API changes
Framebuffer
samples:uint32_t
isMsaaF: bool
Framebuffer(uint32_t width, uint32_t height, bool withStencil = false, bool withdepth = false, bool isMsaaFb = false, uint32_t samples = 0)
1
1
OpenglRenderTarget
m_msaa_rbo_handle : GLuint
isMsaaRenderTarget() const : bool
copy(const OpenglRenderTarget& src, const OpenglRenderTarget* des = nullptr) : void
IRenderInterface
OpenglRenderInterface
// Binds resolve the multiple sample RenderTarget to the normal render target
==
// Enable of disable writing to the color buffer.
resolve_msaa(const RenderTarget& msaa_target, const RenderTarget* naomal_target) : void
setColorWrite(bool red, bool green, bool blue, bool alpha) : void
1
1
OpenglRenderInterface
resolve_msaa(const gl::OpenglRenderTarget& msaa_target, const gl::OpenglRenderTarget* noraml_target = nullptr) : void
setColorWrite(bool red, bool green, bool blue, bool alpha) : void

MSAA Rendeing Pipeline



In building/landmark edges, MSAA will mix shadow(black) and building edge's color, building will have black edge.

Here renders the building,landmark firstly(color wirte is open by default) to avoid shadow effect. Then disable color write, just let the building,landmark render into stencil buffer.

After the step getting stencil graph of building,landmark, enable color write to the follow rending flow.

User Interfaces

Configuration

Add msaa option in view_settings of "default.info"

```
view_settings
{

   msaa
   {
      enabled      false
      samples      4
   }

}
```

Change Impact

Performance and Memory Impact

Test steps of Atlas performance: https://spaces.telenav.com:8443/x/FYspDQ

Environment: HP, win10, Intel(R) UHD Graphics 620

Data: NA20Q2

Test data xlsx: in the attachment of TASDK-24600 **- Investigate and Implement the MSAA on Atlas engine** CODE REVIEW named **benchmark.7z.**

Get avg from all xlsx files and calculate by hand

5s fps avg	msaa off, with 3D buiding	msaa off, without 3D buidling	msaa on 4x, with 3D buiding	msaa on 8x, with 3D buiding	msaa on 16x, with 3D buiding
	441.80	478.2226	277,90	206.17	127.25
	478.31	592.8634	263.51	206.70	144.55
	510.33	618.9639	287.84	209.16	135.13
AVG	476.8133	563.35	275.675	207.3433	135.6433
%	100%	118.15%	57.81%	43.48%	28.448%
	0	+18.15%	-42.18%	-56.51%	-71.55%

MSAA 4x performance degradation **-42.18%**

MSAA 8x performance degradation **-56.51%**

MSAA 16x performance degradation **-71.55%**

Test reprot print by running the python script : https://bitbucket.telenav.com/projects/NAV/repos/tasdk-nav-core/browse/mapdisplay2/tools/benchmark/process_kpi.py

https://jira.telenav.com:8443/secure/attachment/762865/report.txt

	msaa off, with 3D buiding	msaa off, without 3D buidling	msaa on 4x, with 3D buiding	msaa on 8x, with 3D buiding	msaa on 16x, with 3D buiding
	379.650449	395.802080	293.585133	227.297507	149.894765
	403.024532	464.147817	275.051712	227.297507	158.841303
	407.566800	493.294706	278.868493	218.580432	153.795156
AVG	396.7473	451.0815	282.5018	224.3918	154.1771
%	100%	113.695%	71.204%	56.558%	38.86%
	0	+13.695%	-28.795%	-43.442%	-61.14%

MSAA 4x performance degradation **-28.795**%

MSAA 8x performance degradation **-43.442**%

MSAA 16x performance degradation **-61.14%**

Generally, the MSAA is expensive anti-aliasing method, suggest to use 4x, then 8x, not use 16x.

Test Images

Origin

MSAA x4

origin VS MSAA x4
left is origin, right the MSAA

MSAA x8

origin VS MSAA x8
left is origin, right the MSAA

FXAA + MSAA x8

FXAA

Backward Compatibility Impact

No impact on the backward compatibility, it's a new configure, no public API change.

Others (FAQ, References, ...)