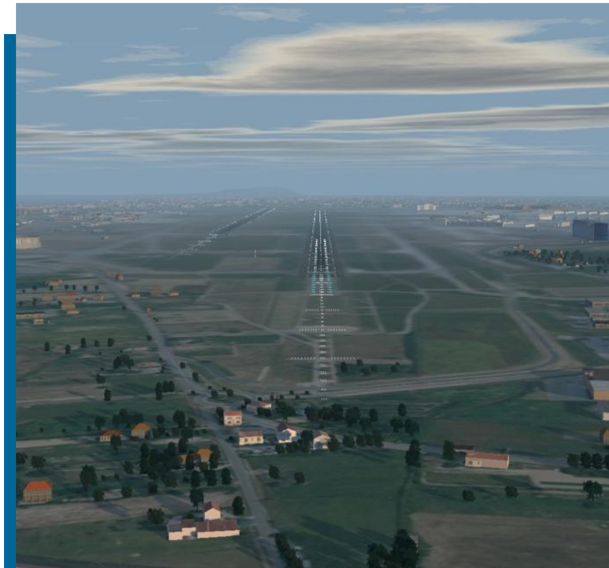
OKTAL-SE

procedural DB creation and rendering

a real interoperability challenge



SC24 2017

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Outlines

- New needs for 3D DB modelling and rendering
- Solution: procedural approach
  - what is procedural?
  - general advantages
- Additional solution: use of patches
  - what are patches?
  - general advantages
- Additional solution: use physical classification
  - what is classification?
  - general advantages
- Global OKTAL-SE solution: WTS
  - what is WTS
  - fighting non determinist and implicit behaviour
  - fighting monotony
- What about interoperability?

Needs

- Long distance observation (watch and survey) and high altitude observation (satellite) with very strong zoom factors
  ➲ Large areas with a lot of details: more than 500 km x 500 km with a density of details up to the grass blade...

- Animations
  - Wind related animations
  - Animation related to mobile parts (helicopters rotor wash)
  - Evolution of the time of day
  - Evolution of the weather conditions
  - Clouds animations
  - Traffic
  - Crowd animations
  - Effects on IR rendering (vehicles traces, convection, ...)
  - Effects on RF rendering (Doppler effect, ...)
  - Dynamic terrain (shooting effects, ...)

- Real time

Needs

- Reduced production deadline and cost
- Geometrical and texturing reliability (no room for human error)
- Physical attributes reliability

➲ One relevant solution is to use
procedural + patches + classification

- **Procedural**: dynamic procedural terrain generation
- **Patches** # Legos, for example geo-typical building blocks
- **Classification**: material based attribution, material identification

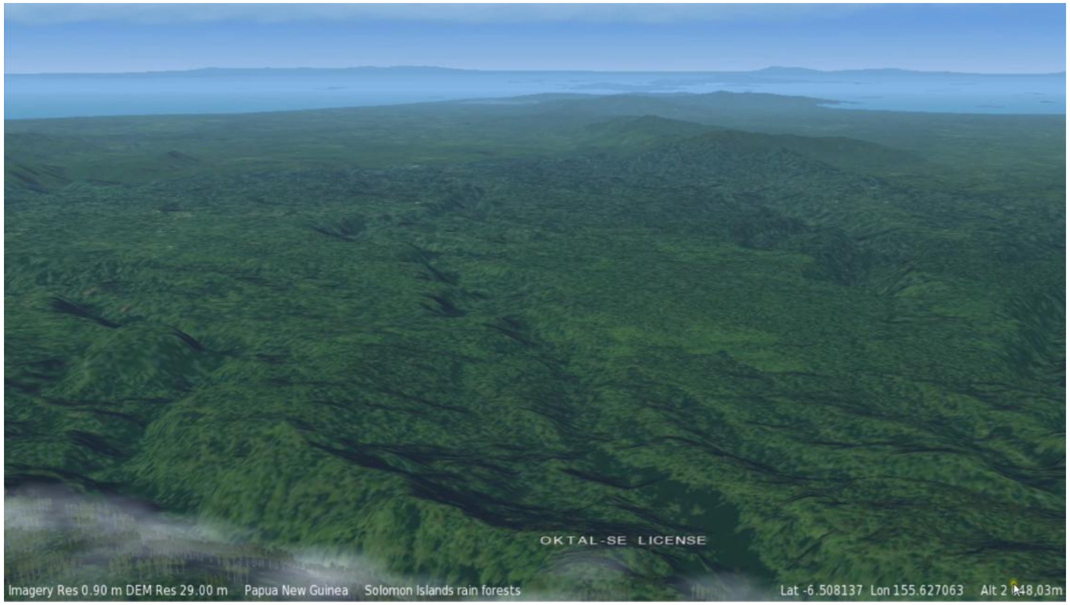
Procedural: What is procedural?

Classical approach (static)

- 3D database: the polygons are stored on the disk after modelling
- Rendering: GPU rasterising

Procedural approach

- 3D database: only “rules”, “instances” and “seeds” are stored on the disk
- Rendering: the polygons, textures and associated physical information are created “on fly”



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Procedural: General advantages

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Advantages:

- No database size limit (we store the rules, not the results)
- Continuous Levels Of Details, computed at pixel level
- Computation load adaptive to the CPU/GPU ⇨ real time
- Adapted to the automated classification
- Simplifies the modelling of the 3D database
- Animations are generalised to any entity

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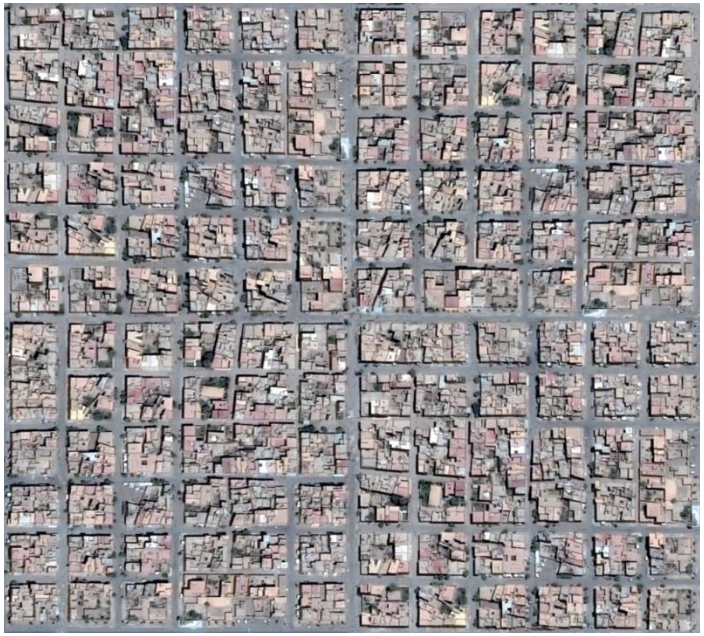
Patches: What are patches?

Example of the SE-OASIS 3D database:

- In addition to the specific individual buildings, several SE-AGETIM-BUILDING “templates” are specially created for SE-OASIS database, representing houses of this desert geographic area
- Using these building templates, individual objects, vegetation samples and a satellite image, a generic town area is created as a mini SE-AGETIM map



Patches: What are patches?

Example of the SE-OASIS 3D database:

- This generic town sample is made of a set of building blocks occupying an area of 600 m x 600 m:

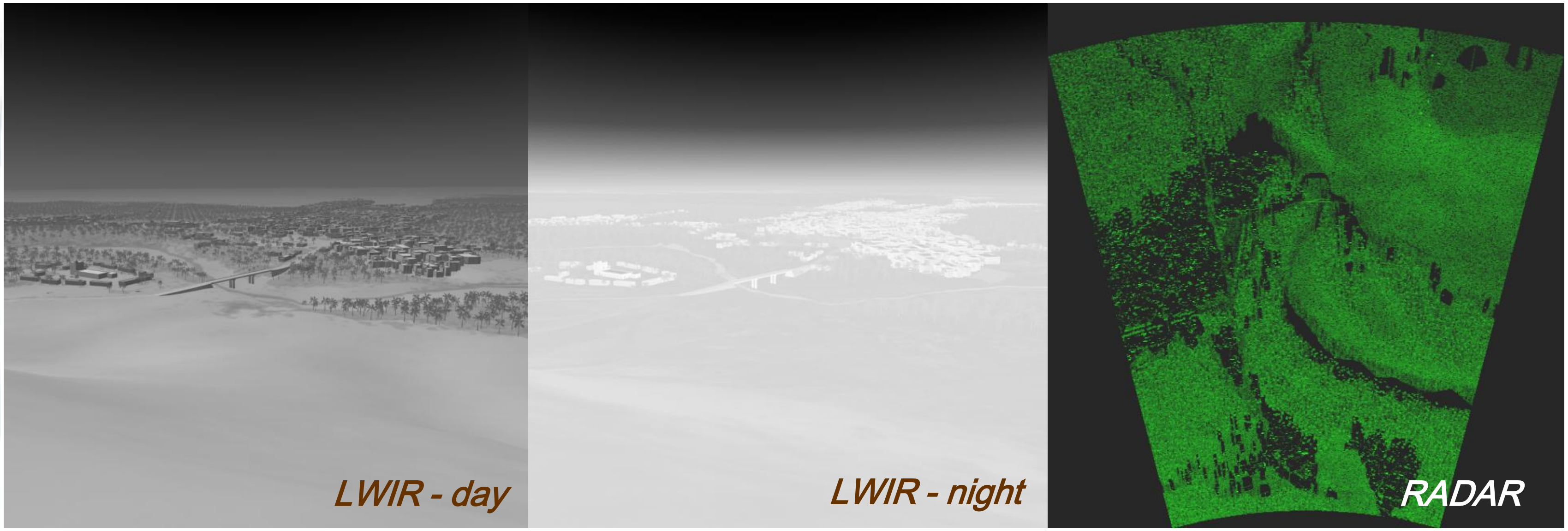
Patches: What are patches?

Example of the SE-OASIS 3D database:

- This generic area has been “painted” on the whole database urban areas, using the patch as a “motif”, providing rich and realistic urban zones:

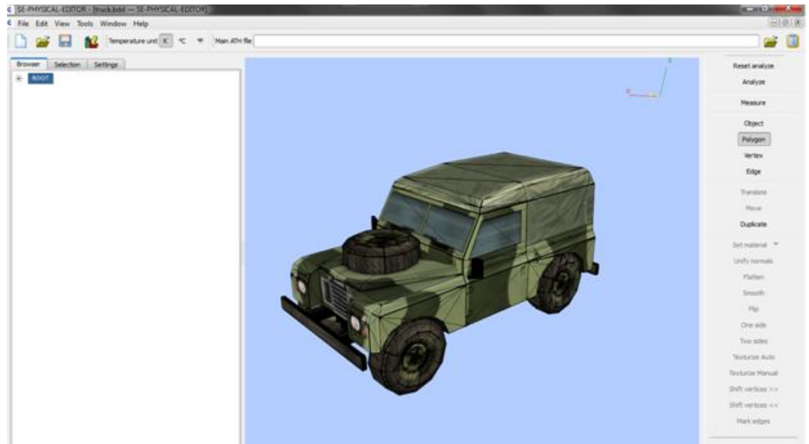
Patches: General advantages

- No geometrical error in the whole scene, provided the patch has been checked
- No radiometric error in the whole scene, provided the patch classification is OK

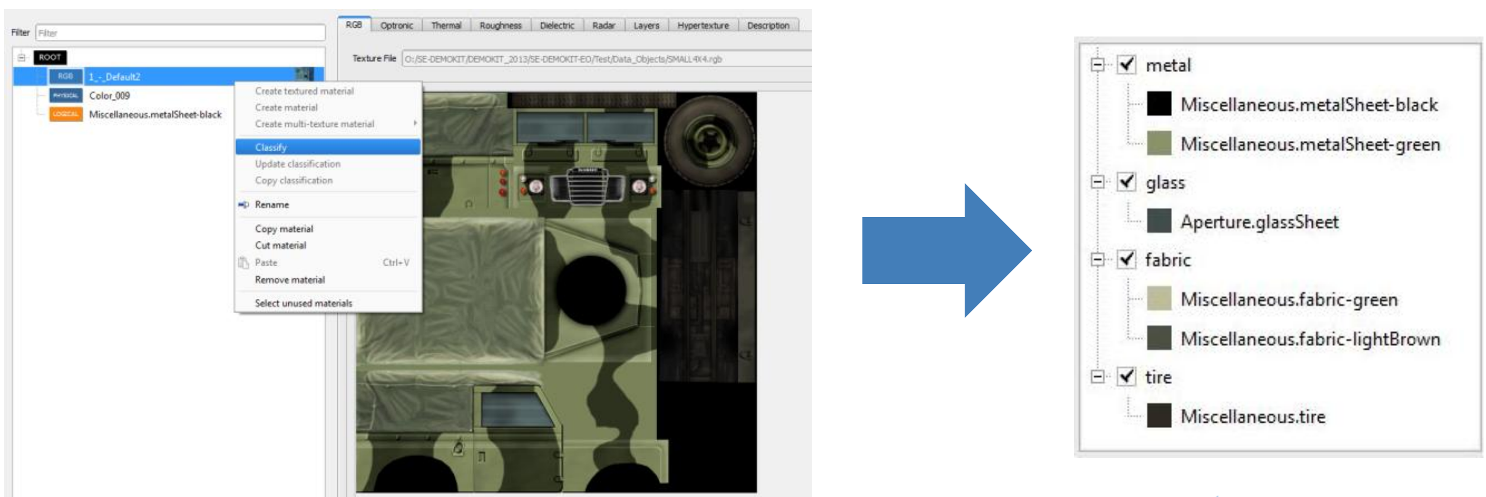


Classification: What is classification?

Starting with the “visible” textures of an object

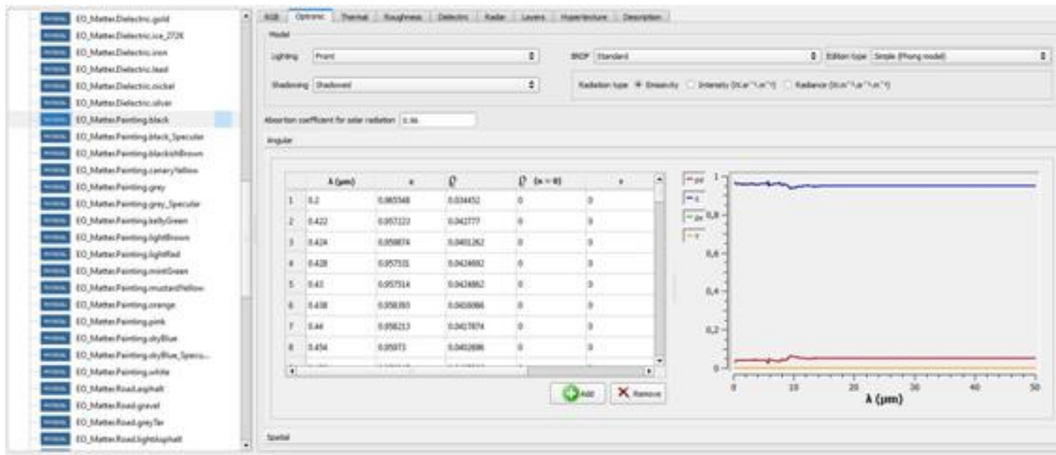


Using layers, the expert user is able to affect material information

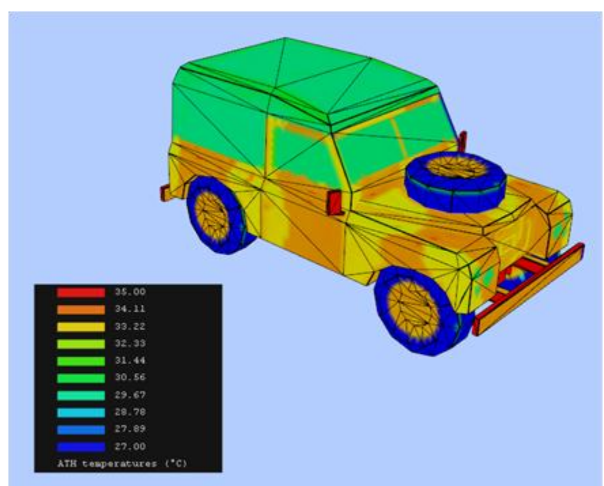


Classification: What is classification?

Those materials contain complete physical information



Allowing “physical”, sensor rendering:



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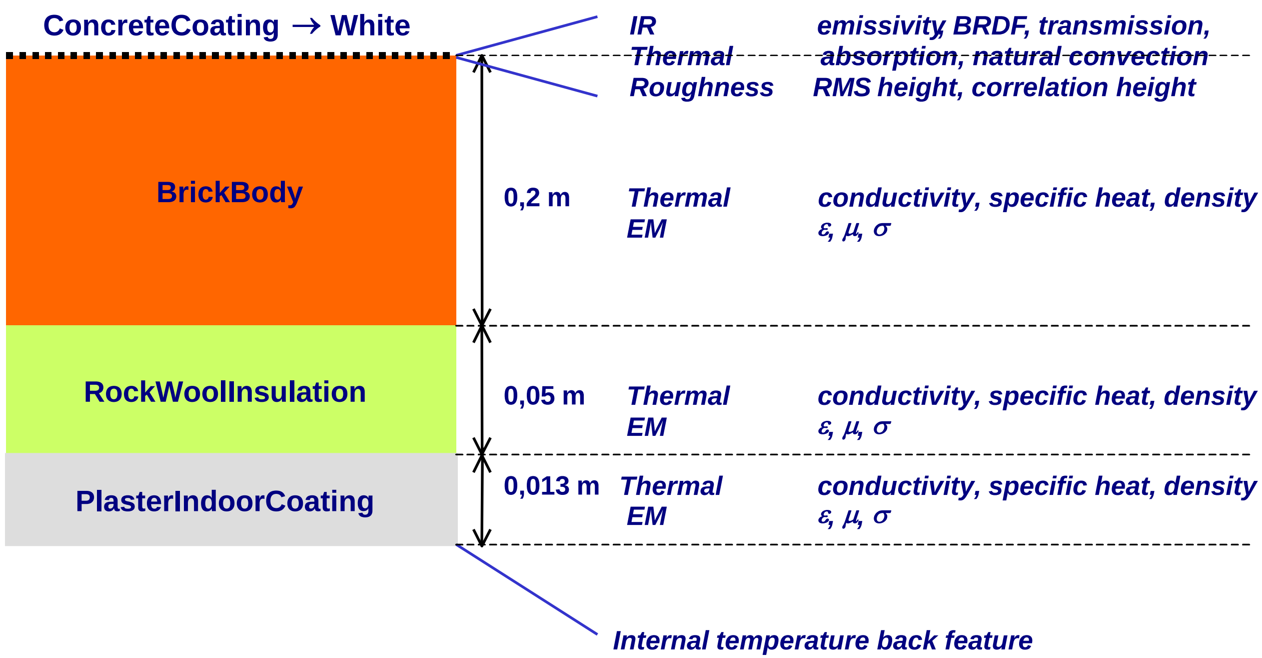
Classification: What is classification?

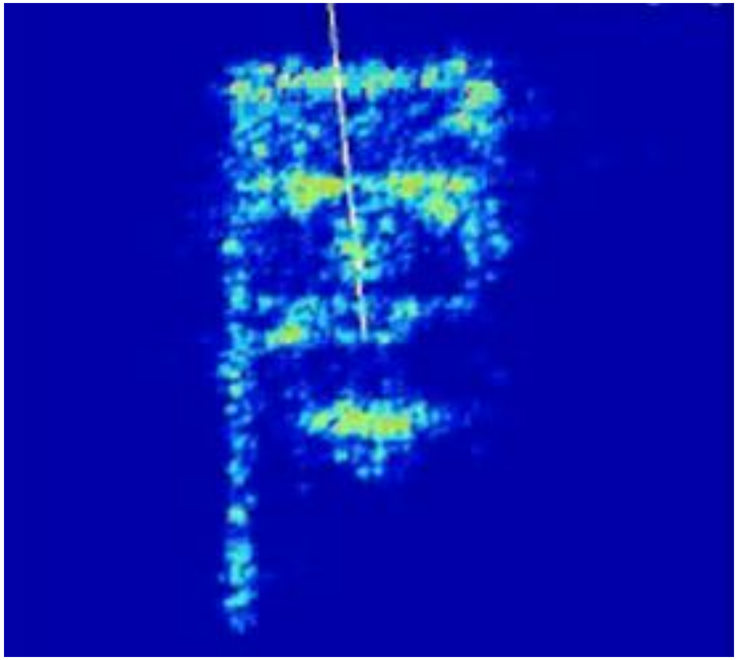
Example of a "wall" material

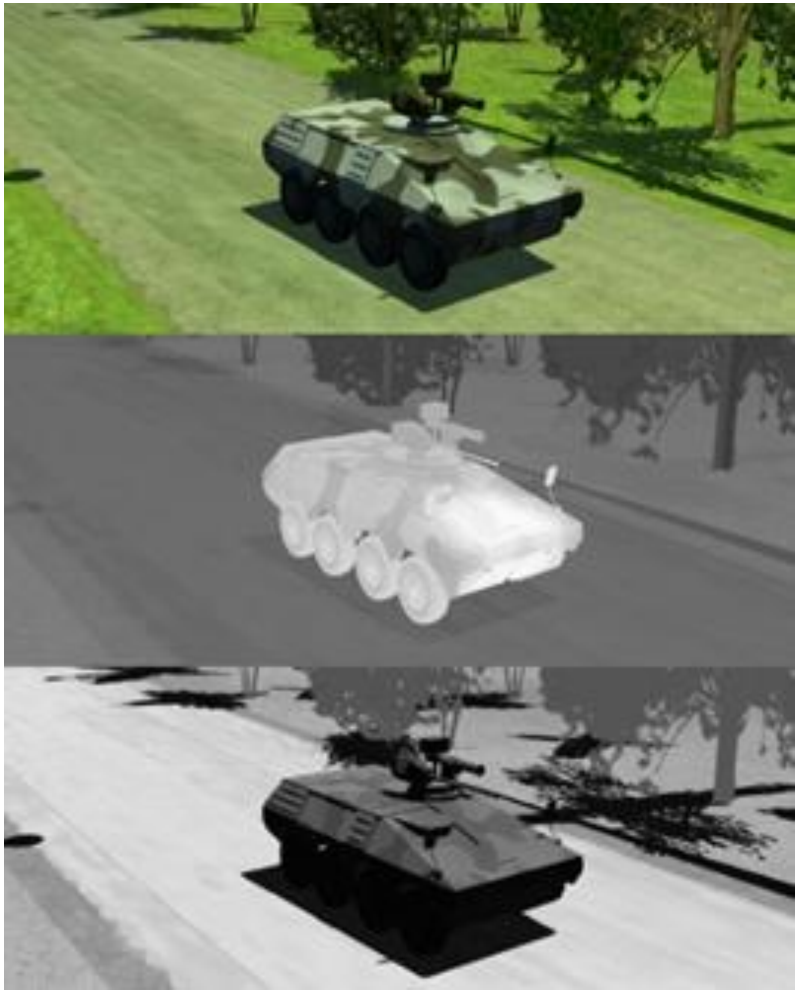
- Hierarchical definition of the fact that it is a building, then the building type, then the building part, then the coating, then the color, then the body structure and finally the insulation system
- Building → Industrial → Wall → ConcreteCoating → White → BrickBody → RockWoolInsulation → PlasterIndoorCoating



Classification: General advantages

- Polymorphism: multi spectral
- Explicit: physical attributes can be set for every pixel
- Deterministic: no random, same conditions, same results





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WTS: What is WTS?

Procedural + patches + classification
⇨ WTS
A 3D Earth viewer
for multi-sensors simulation

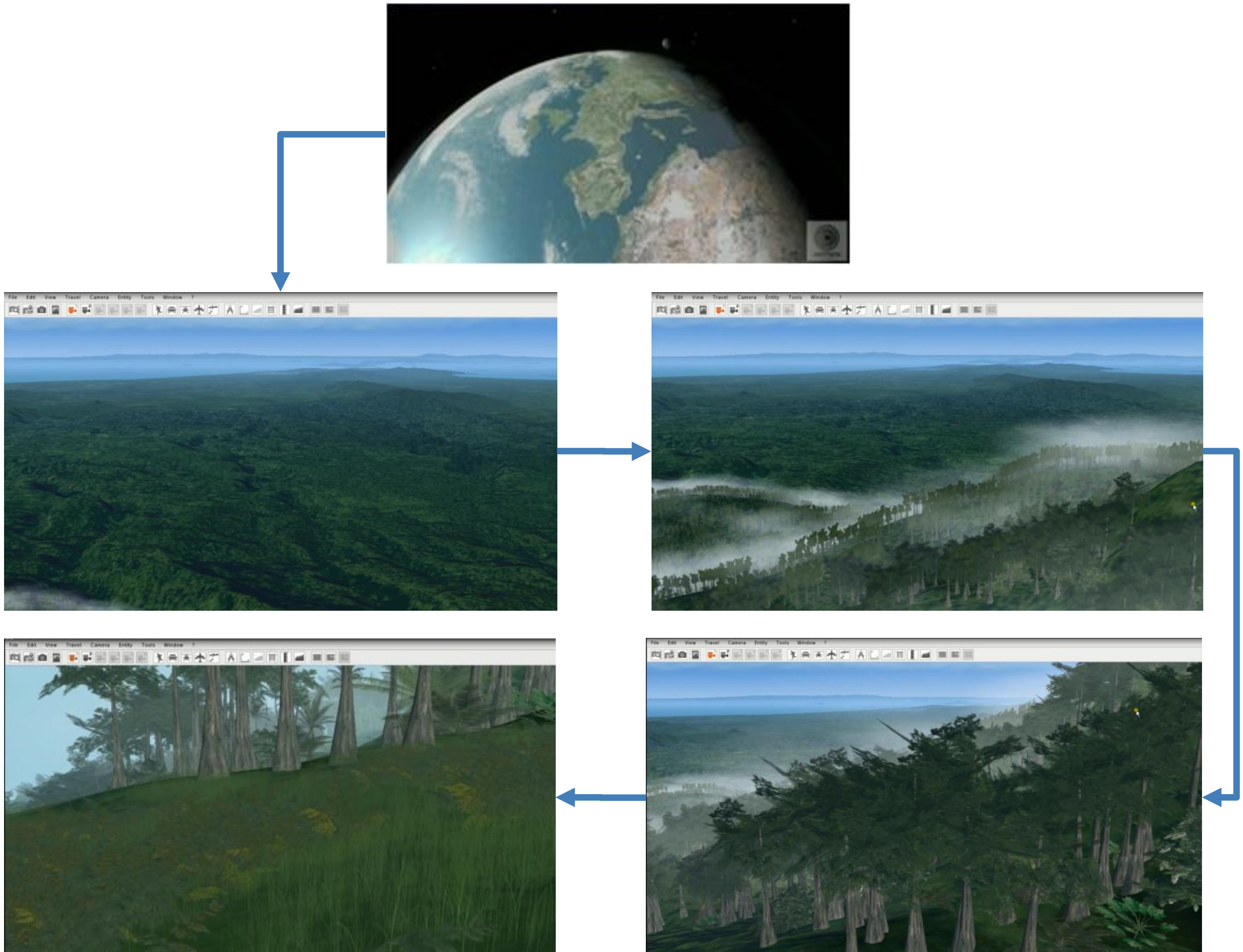
vieWTerra Sensors

WTS: What is WTS?

Geo-typical representation of the entire Earth

Geo-typical representation of micro details

WTS: What is WTS?



WTS: What is WTS?

Technical approach:

- WTS is based on **“material cover”** procedural generation
- A land cover is a raster or vector file that gives the nature of the terrain
  Example: Corine LandCover

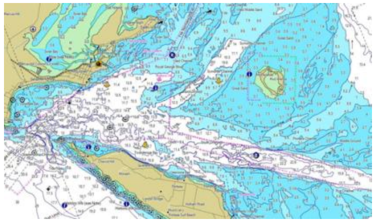
Lake
Forest
Field
Meadow
Urban
…

WTS: What is WTS?

Technical approach:

- Use of world wide available Land Covers and eco-regions files using combination and fusion

- Complementary layers
  - ortho-images (LandSAT…)
  - planimetry files (Shapefiles…)
  - maps of the Earth's Night Lights
  - nautical charts (coast contours…)

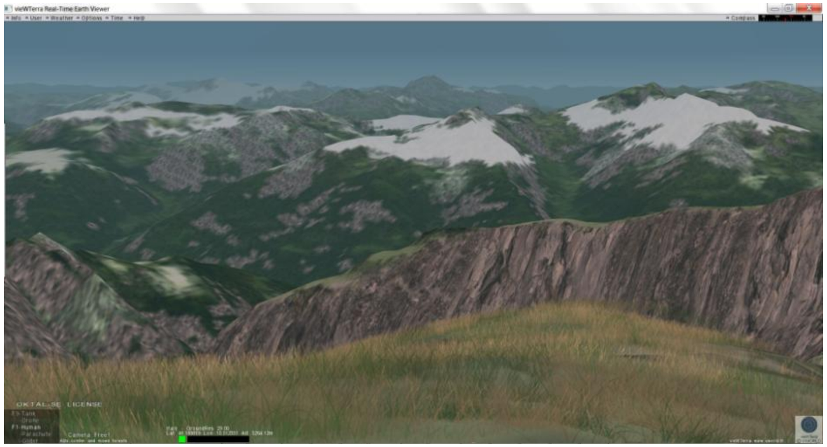


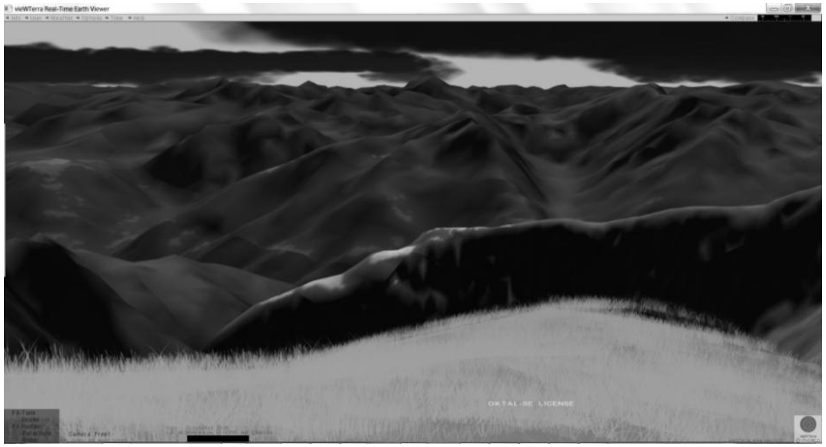
- Invention of new geometrical detail (in real time)
  - using fractalisation
  - using 3D details instancing

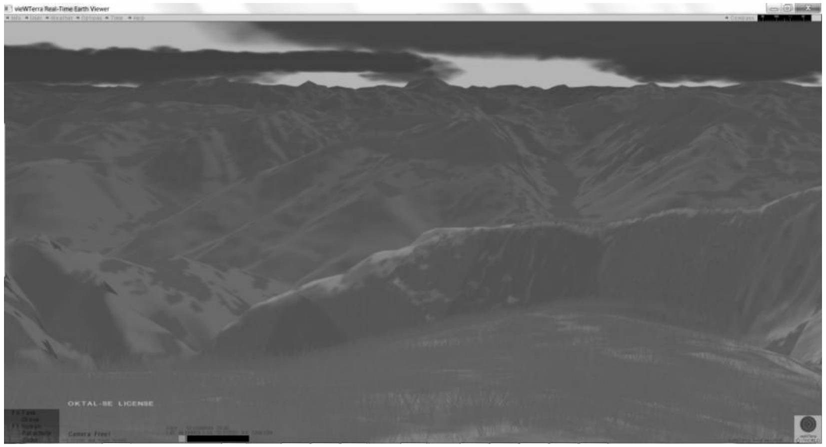
- Invention of new geometrical detail (in real time)
  - using texture synthesis

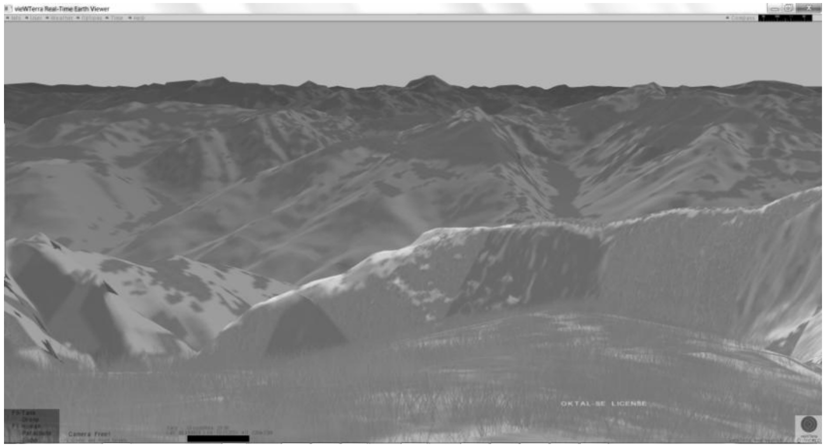
WTS original algorithm:
refining in real time the "material cover" grid with regard to**:**
- **geometry**
- **physical radiative & thermal attributes** through texture classification

WTS: What is WTS?





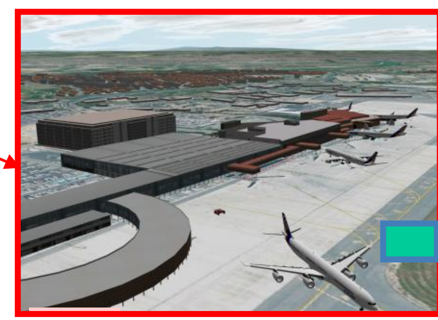




WTS: Proving deterministic and explicit behaviours while using procedural approach

1. **Geo-typical** representation of the entire Earth

2. Inclusion of static **geo-specific** areas (inserts)



3. **Geo-typical** representation of micro details within static areas

Application for 2000 airports all over the world!

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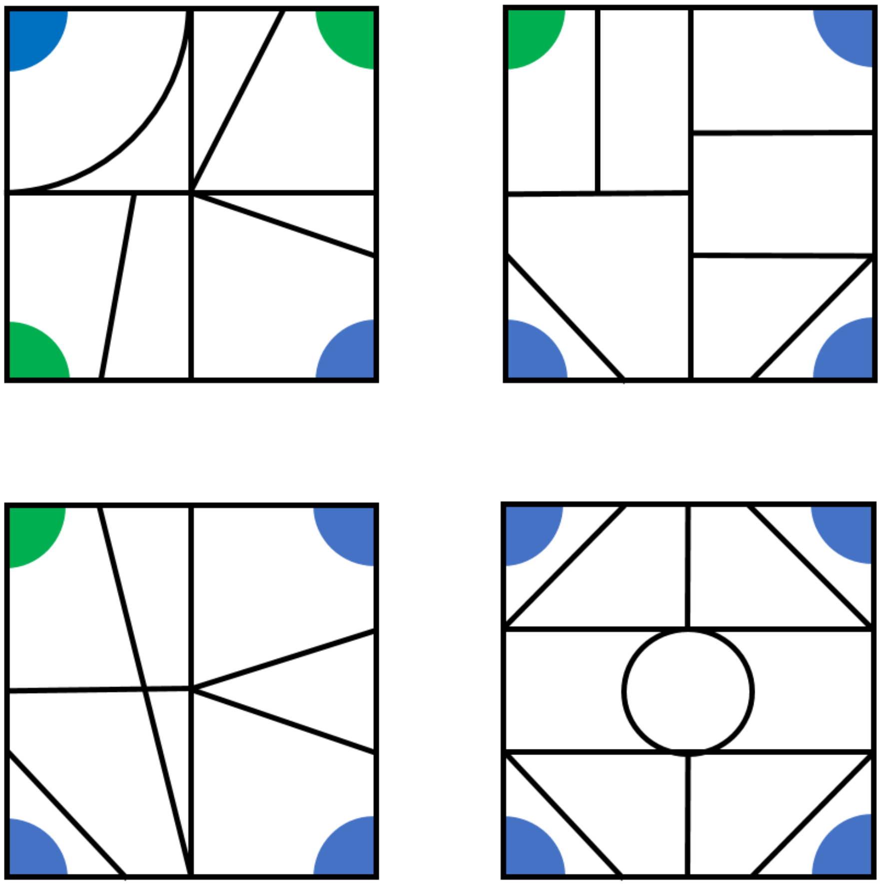
Synthetic Environment

WTS: Proving deterministic and explicit behaviours while using procedural approach

WTS: Fighting monotony: Wang Tiling

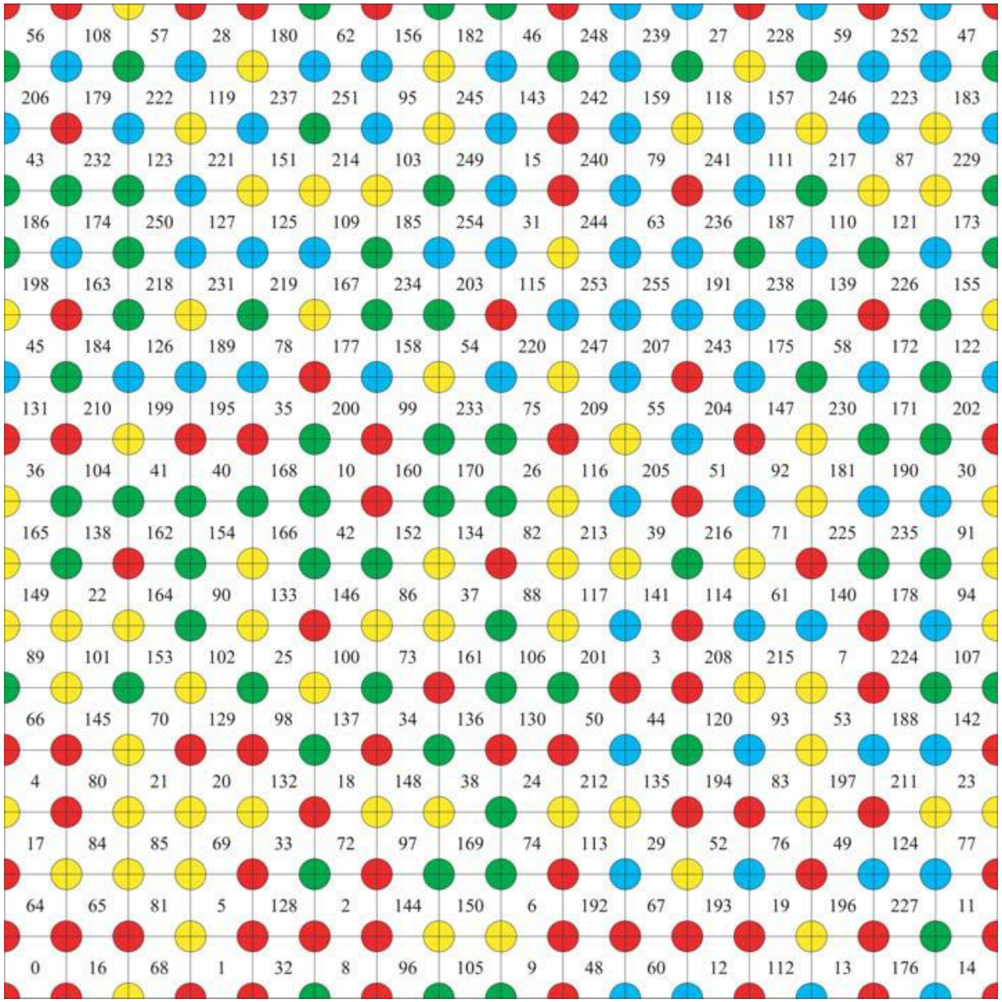
- The method implemented by OKTAL-SE is based on corner colour Wang Tiling

Example of 4 tiles from a set of corner coloured Wang Tiles using green and blue “colours”



WTS: Fighting monotony: Wang Tiling

- With respect of the corner colours with 4 colours => 4^4 => 256 = 16x16



The corner tile Problem:

Permutation of 256
⇨ 256!
⇨ 10^507 combinations
⇨ Pre-computation

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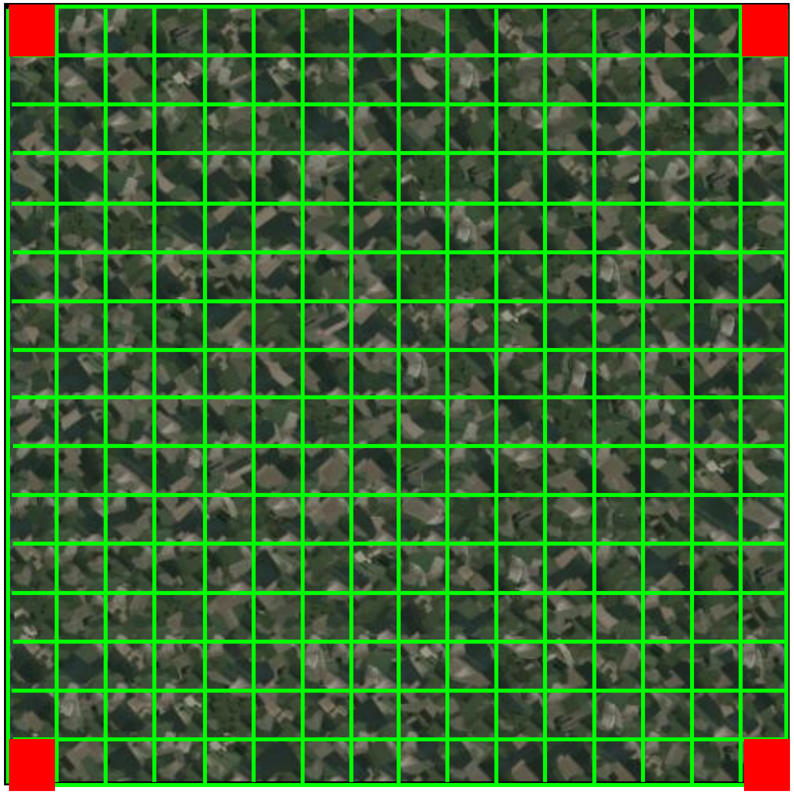
WTS: Fighting monotony: Wang Tiling

- Source image 512 x 512

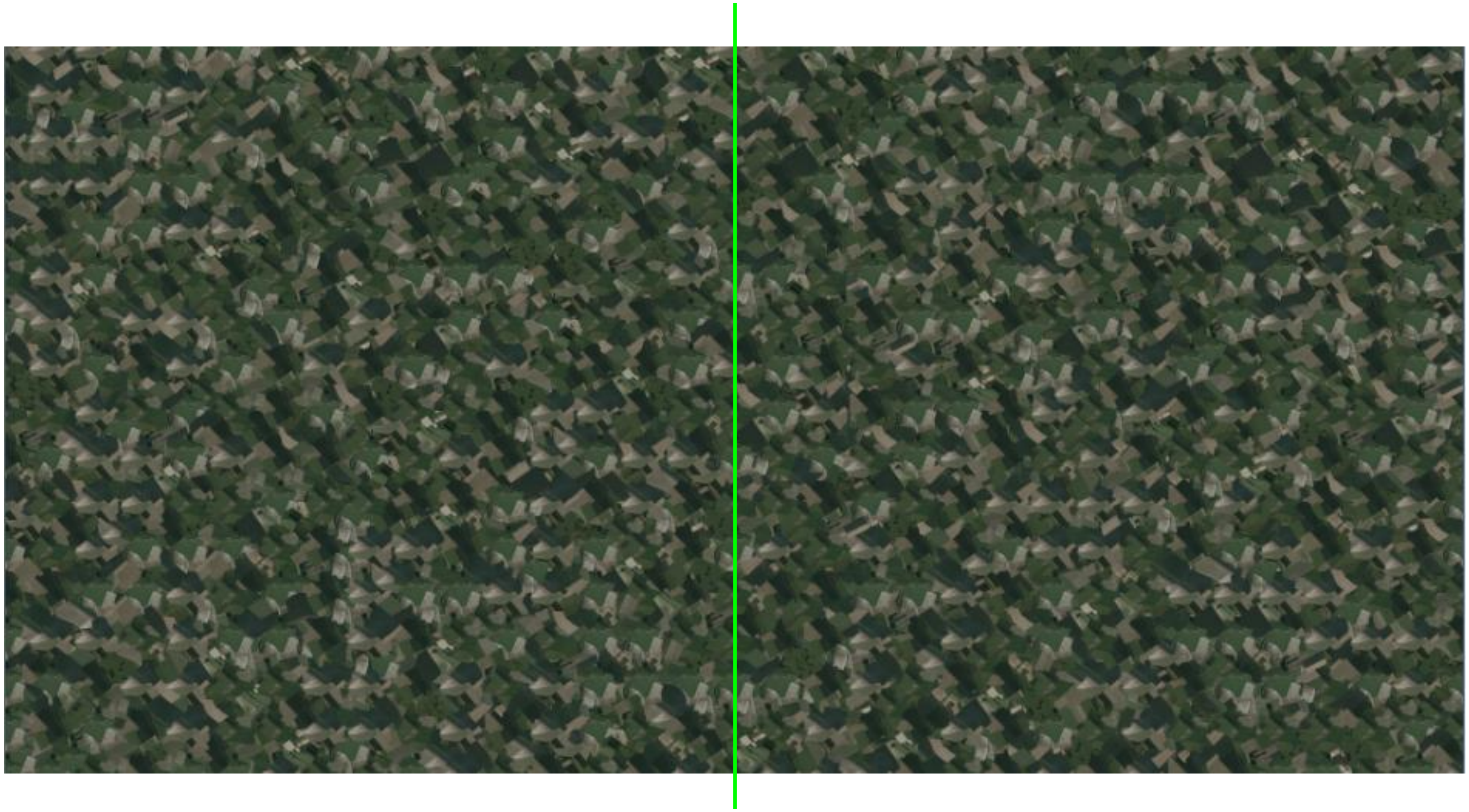
- Creation of 256 random tiles made periodic
- Correct corner "colour"



Same "colour" corner

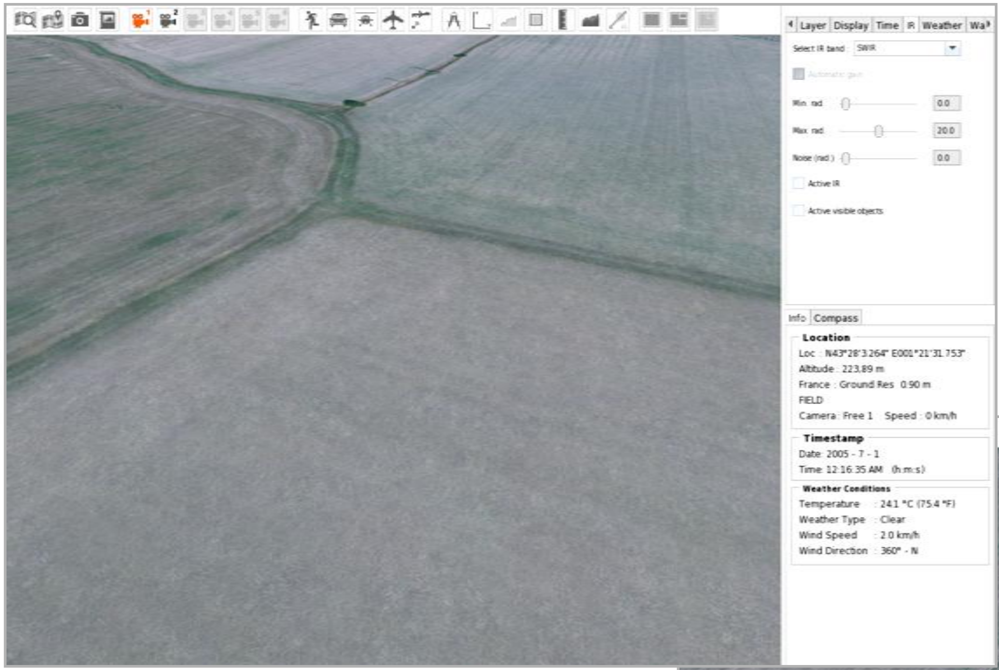
WTS: Fighting monotony: Wang Tiling

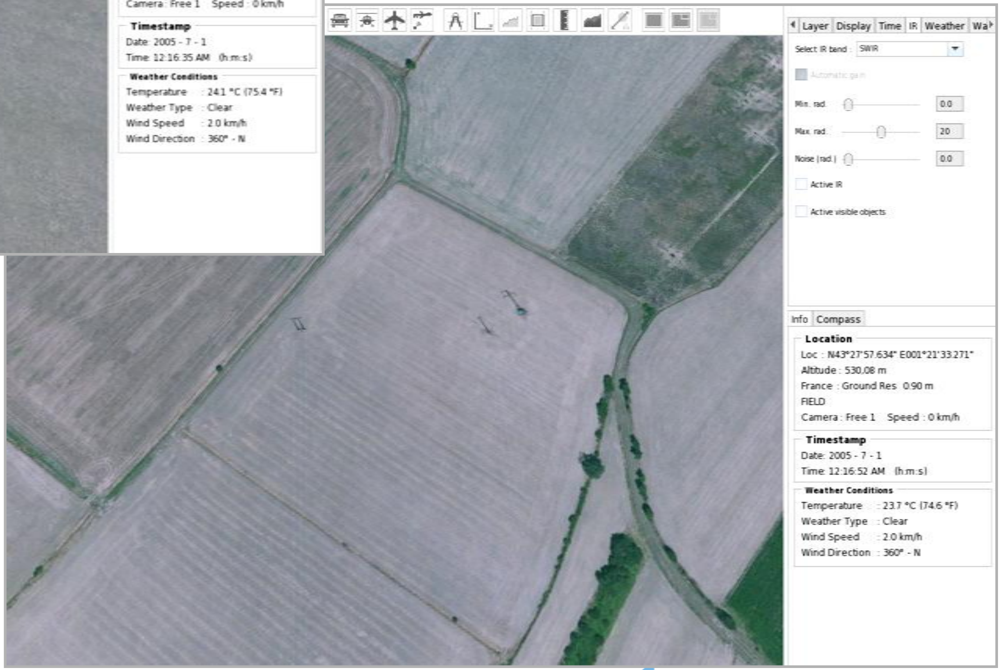
- Duplication of the last tile using other assembly combination
- respect of the corner colours ⇨ non discontinuity in the central line



WTS: Fighting monotony: Wang Tiling example

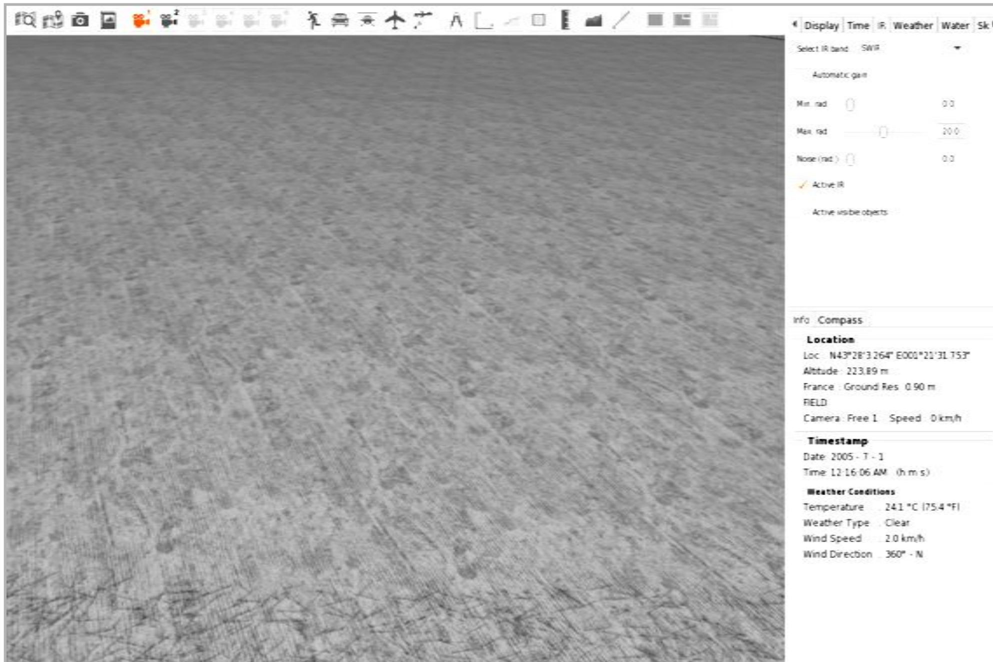
- In visible domain

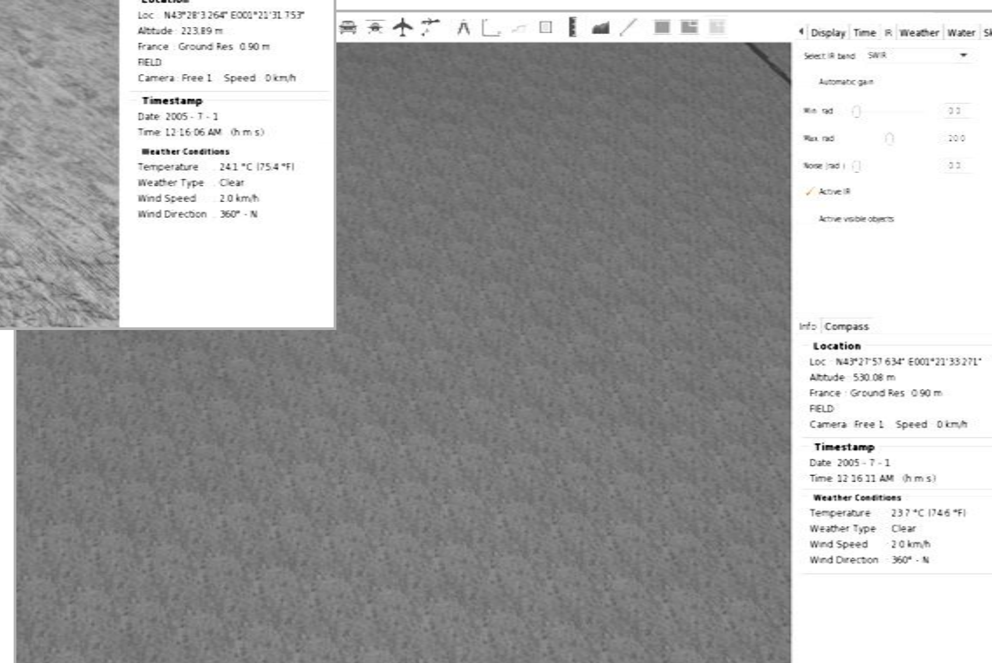




WTS: Fighting monotony: Wang Tiling example

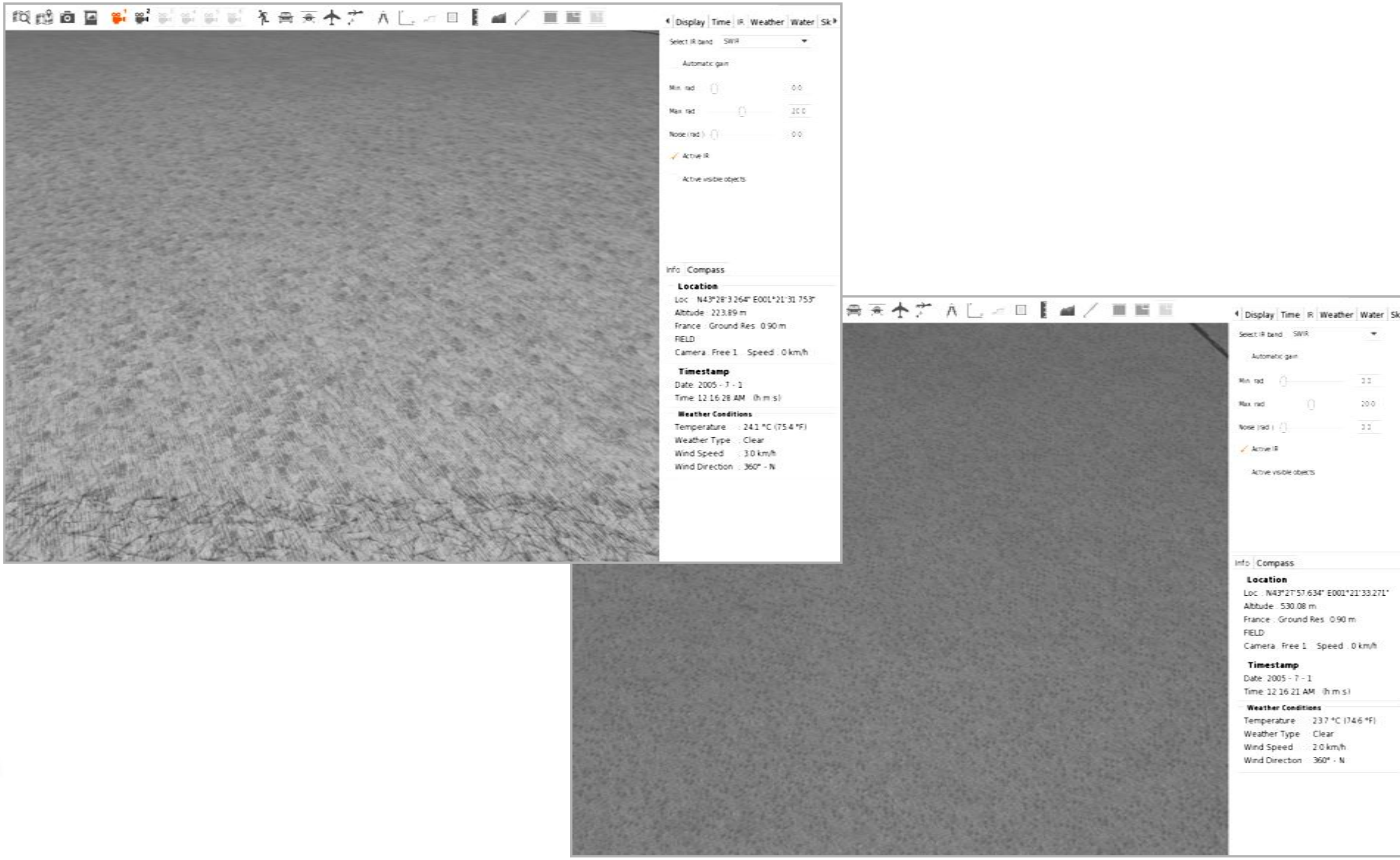
- In IR domain **without** Wang Tiling ⇨ repetition “ravioli” effect





WTS: Fighting monotony: Wang Tiling example

- In IR domain **with** Wang Tiling ⇨ no repetition, “ravioli” effect **not** perceptible



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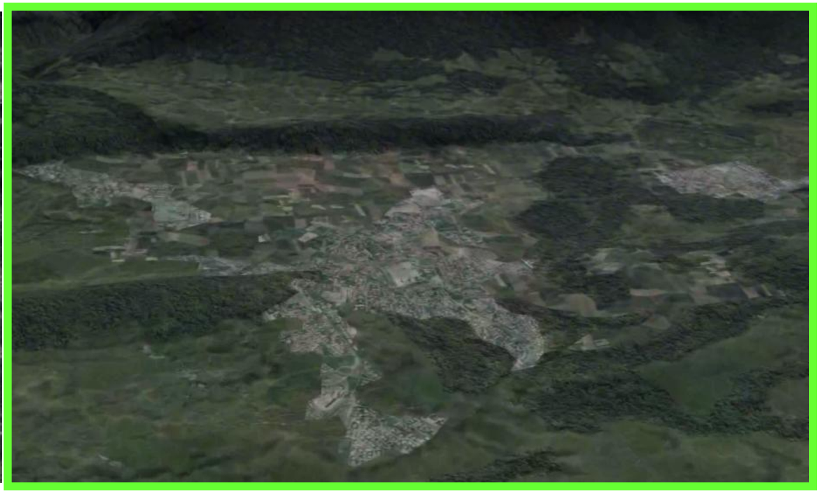
WTS: Fighting monotony: Wang Tiling use

Wang Tiling can be used for both static and procedural 3D database for:

- Geo-typical areas: in this case, Wang Tiling is everywhere
- Geo-specific areas: in this case, it is used as detailed texture: from a long observation distance, only the ortho-image is visible, the closer we get to the ground, the more it is mixed with a generic texture of grass or field, etc.



What about interoperability?

Synthetic Environment Interchange (**SEDRIS**...) ⟷ Scenario, communication (**HLA**...)

Synthetic Environment Interchange:

- At target data level ⇨ file conversion (OFLT...)
  ➲ No problem with SEDRIS
- At source data level (at various levels of semantics) ⇨ file conversion (DTED, Shapefile...)
  ➲ No problem with SEDRIS
- What about the terrain modeller work data level?
  ➲ A study was conducted by OKTAL-SE in France during the DGA PROVIDENS project - with some evolution of the standard, it is feasible

What about interoperability?

Synthetic Environment Interchange:

- What about procedural level?

  - Geometry + texture + physics "invented" at rendering
  - Each editor implements his own rules without any coordination

SEDRIS could easily store rules and parameters even if the rendering algorithms remain proprietary. But then how to ensure that every user has the same database ?

⇨ **Being able to do off-line everything that is done on-line in a procedural rendering**

⇨ **We should be able to invoque the procedural motor on a given area so it creates a static declination of its procedural rendering**

⇨ **SEDRIS is the solution**

What about interoperability?

Synthetic Environment Interchange:

- SEDRIS DRM and EDCS are the only standards that support representing such data and expressing the semantics of parameters, attributes, and rules.
- New EDCS entries would need to be registered to define and specify the parameters and attributes used in procedural generation of content.
- Possible modifications to the DRM may be needed, if the current DRM classes cannot support all the rules and representations of procedurally generated content.

What about interoperability?

Synthetic Environment Interchange:

- Even with use of standards for data sharing, not all tools can use, process, or even understand parameters, attributes, or rules used for procedural generation of content.
- **Recommendation**: Begin work in standardizing the concepts, attributes, parameters, and rules for procedural generation of environmental data.

Bonus: videos

We provide some videos showing WTS capabilities:

- “WTS.wmv” is a general presentation of the WTS product
- “procedural.wmv” shows the level of detail that can be reached when zooming on the terrain: from forests to individual trees to grass blades
- “launch.wmv” shows how a rocket can be launched and how a sensor can follow it, with a coherent background at any moment
- “Spacecraft.wmv” shows a spacecraft taking off in a desert area
- “spain_mwir.wmv”, “Colorado_mwir.wmv” and “Fuji_mwir.wmv” show rendering of those particular areas in the Middle Wave InfraRed spectrum