The AHN2 3D web viewer and download tool

Massive Point Clouds for eSciences

http://pointclouds.nl

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Management of massive point cloud data: wet and dry (2)

8 December 2015, 10-17 hours, TU Delft

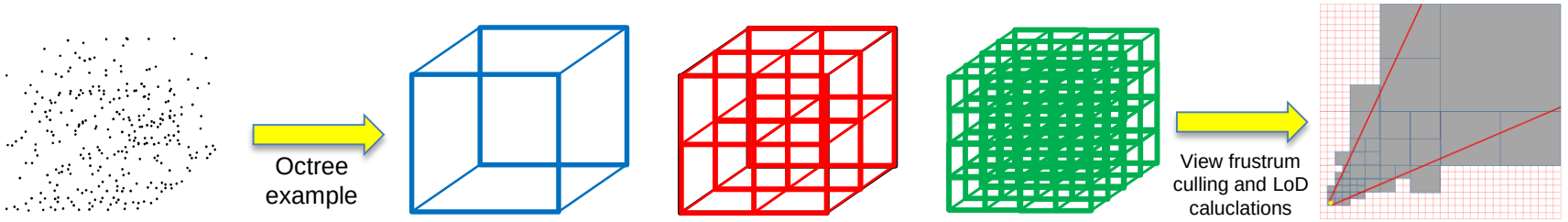
netherlands eScience center
by SURF & NWO

TU Delft
Delft University of Technology

Potree.org
webGL point cloud visualization

Point cloud visualization

- Existing **PCDMS's*** aim at **analytic** purposes
- Existing **PCDMS's* not** efficient **LoD** support
- **Visualization solutions**:
  - **Small** point clouds → **"Any system"** can do it
  - **> Small** → **Specific** data management solutions for **visualization (efficient LoD)**
    - **Large** point clouds → **Multi-resolution data structures** (quadtree, octree, kd-tree, etc.)



  - Many **desktop-based** solutions (and some really cool and efficient)
  - WebGL → **new point cloud web renderers (FOSS: Potree and Plasio)**
  - **Massive** point clouds → **Bottleneck**: expensive creation multi-resolution data structures

* Oracle, PostgreSQL, MonetDB, LAStools, PDAL, Sqlite, etc.

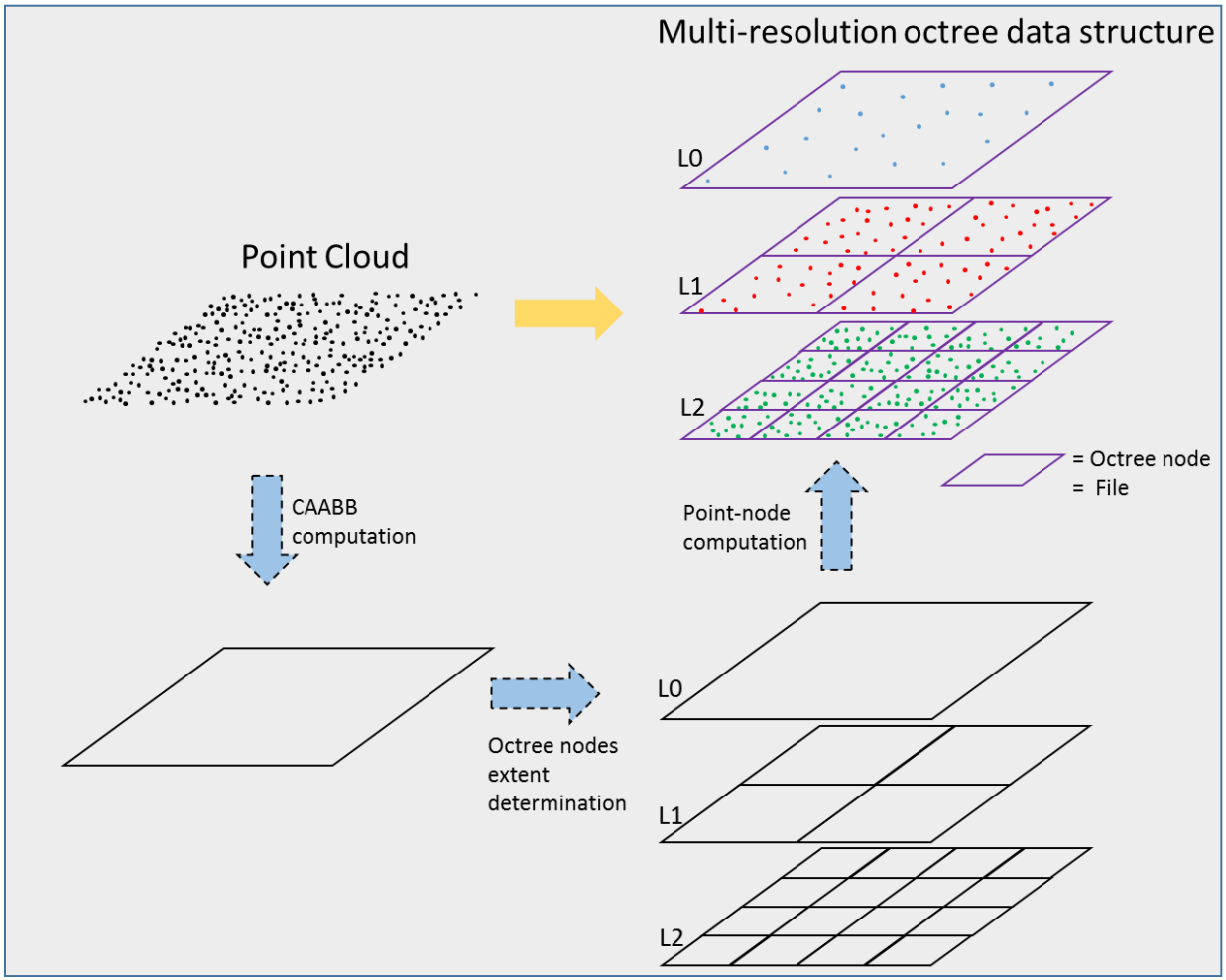
Potree (http://potree.org)

- Developed by **Markus Schütz**
- **Web renderer** for large point clouds (**WebGL** / three.js)
- **Modern web browsers** (no plugins required): Chrome, Firefox, Safari, Edge
- **Client-side** application (**server** “only” hosts **files)**
- Requires data re-organization: **PotreeConverter (LAZ, LAS or BINARY)**
- **Do not load full data**: Low-resolution data when far and gradually higher resolution data when closer
- **Color** on RGB, classification, elevation, etc.
- 4 **point rendering modes**: squares, circles, interpolation and splats
- 3 **point sizes modes**: fixed, attenuated and adaptive
- Eye-Dome-Lighting (**EDL**): illuminate point clouds without normal
- **Measurements** toolkit (distances, areas, height profiling)
- **FOSS**
- Based on **InstantPoints** (SCANOPY). Now under **Harvest4D**

TU WIEN TECHNISCHE UNIVERSITÄT WIEN

HARVEST 4D HARVESTING DYNAMIC 3D WORLDS FROM COMMODITY SENSOR CLOUDS

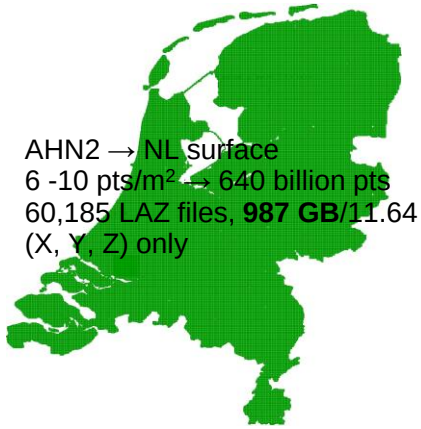
PotreeConverter (2D simplification)



User-configurable parameters:

- *spacing*: distance points root (L0)
- *levels*: number of levels
- *aabb*: Cubic axis-aligned bounding box

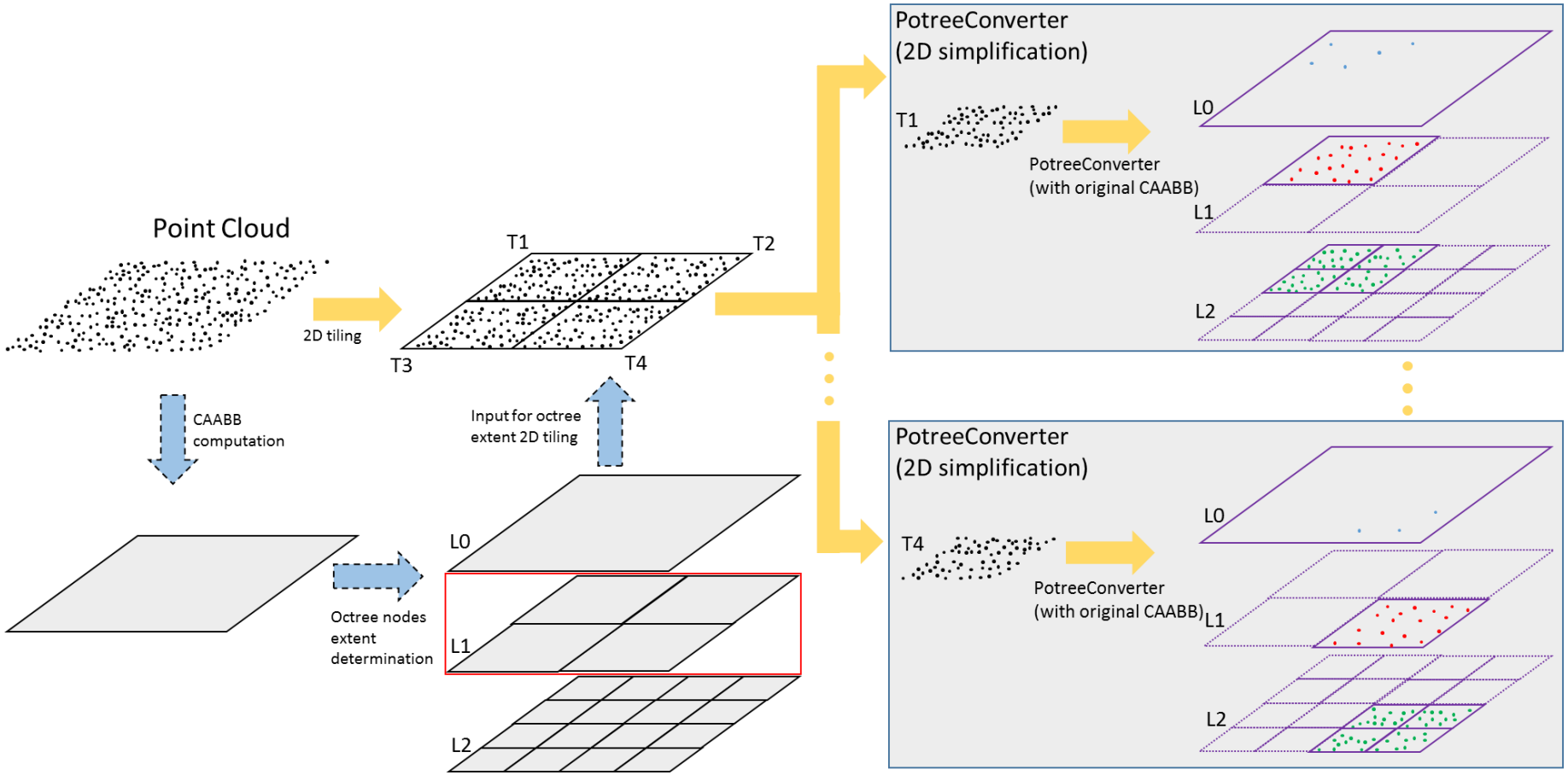
Massive point clouds



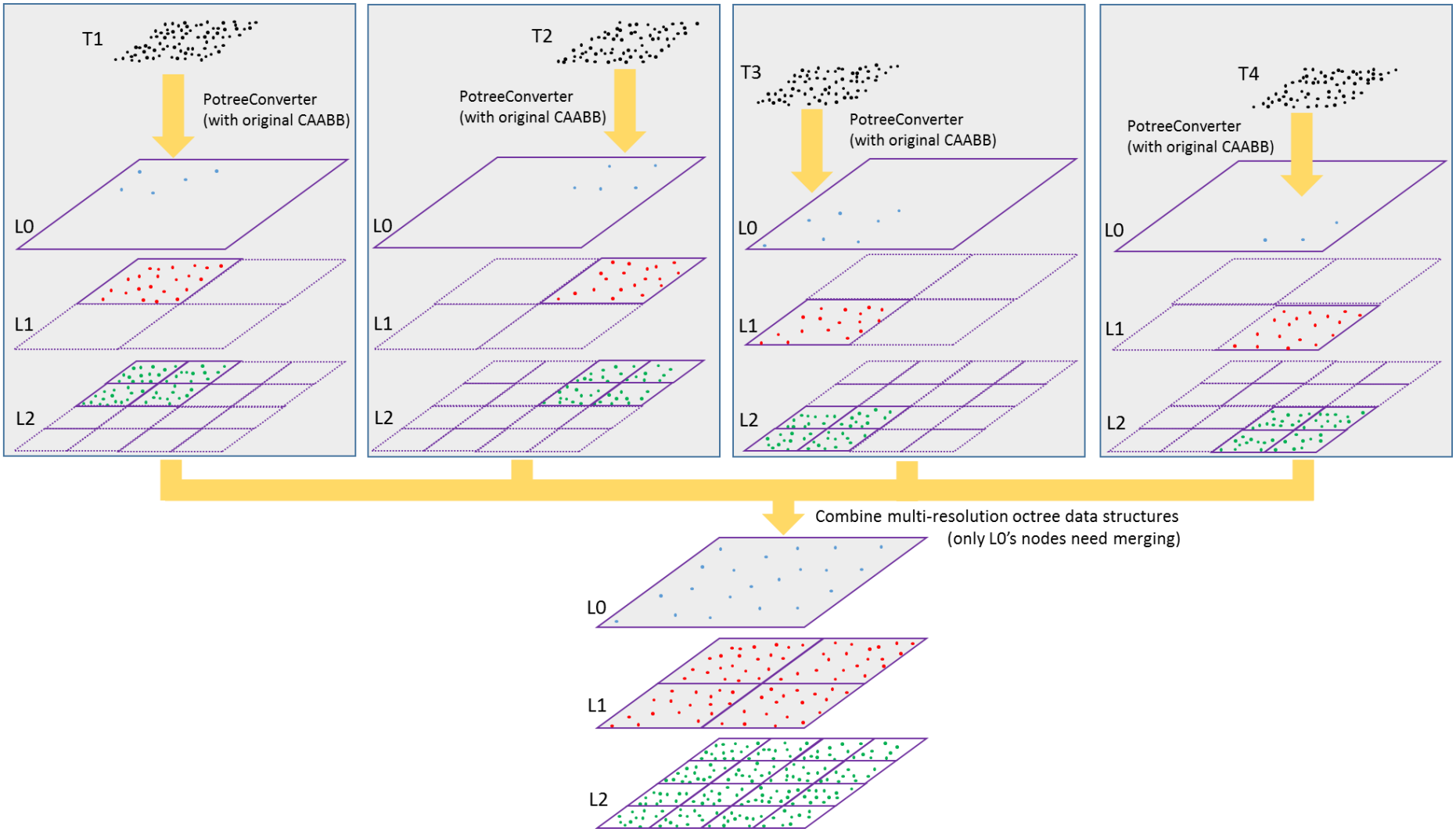
- **AHN2** use case (NL, **640 billion** points)
- PotreeConverter performance*: 250 million points / hour
  → **AHN2 estimate: 100 days**
  - PotreeConverter is **single-process**
  - **IO-bonded**
- Our solution: **Massive-PotreeConverter**
  - Divide and conquer generic algorithm, specific implementation for Potree octree
  - Exploits knowledge of spatial extents of octree nodes (also usable for other trees where nodes extent is independent of points)
  - Divides creation of massive octree into multiple independent tasks (creation of small octrees)
  - Tasks can run in multiple systems and cores
  - Small octrees are merged into massive octree
  - FOSS
  - https://github.com/NLeSC/Massive-PotreeConverter

*HP DL380p Gen8 server with 128 GB RAM and 2 x 8 Intel Xeon processors E5-2690 at 2.9 GHz, 2 x 41 TB SATA 7200 rpm in RAID 5 configuration

Massive-PotreeConverter (2D simpl.)



Massive-PotreeConverter (2D simpl.)



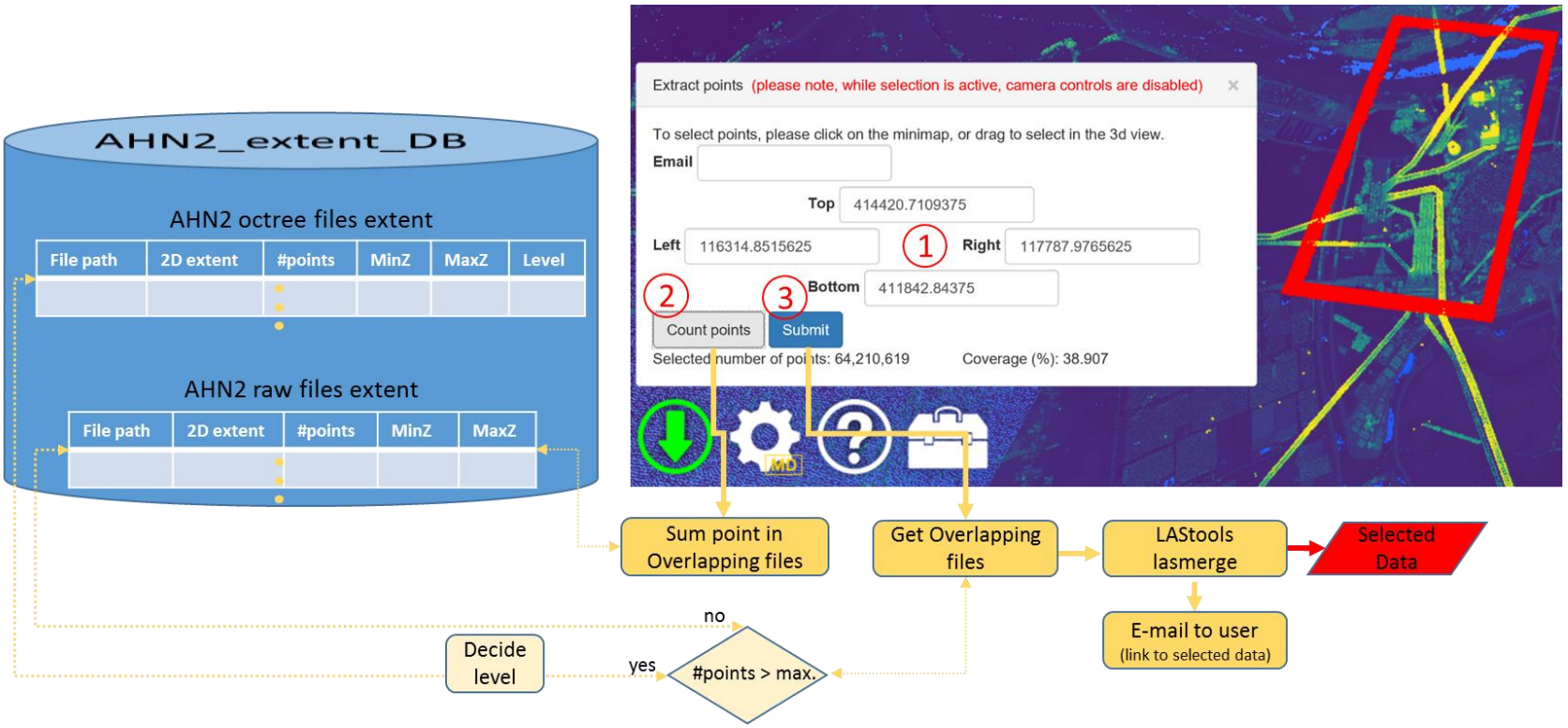
AHN2 web viewer and download tool

http://ahn2.pointclouds.nl

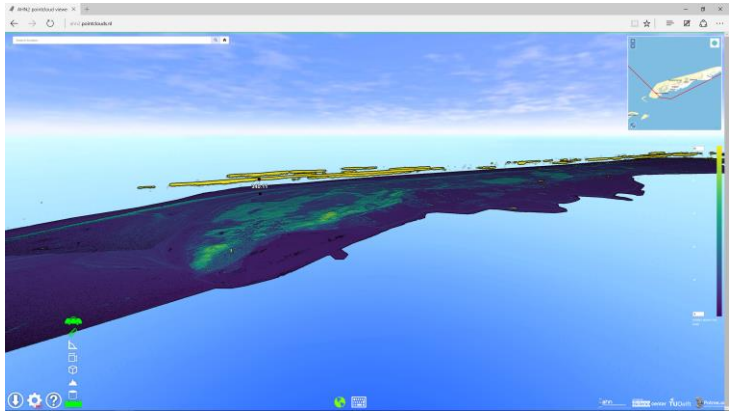
AHN2 web viewer and download tool

- **4 quality options: low, standard, high and ultra**
- 2 navigation modes: GoogleEarth-like and keyboard interaction
- Geographic name **search bar** (Bing Geocoding service converts names to coordinates)
- 2D orientation **minimap** (3D field-of-view depiction)
- **Height coloring** configuration
- **Demo mode** (download/upload demo paths)
- **Speed control**
- **Potree features**: Measurement toolkit, color by other attributes, etc.
- **Multi-resolution download tool**

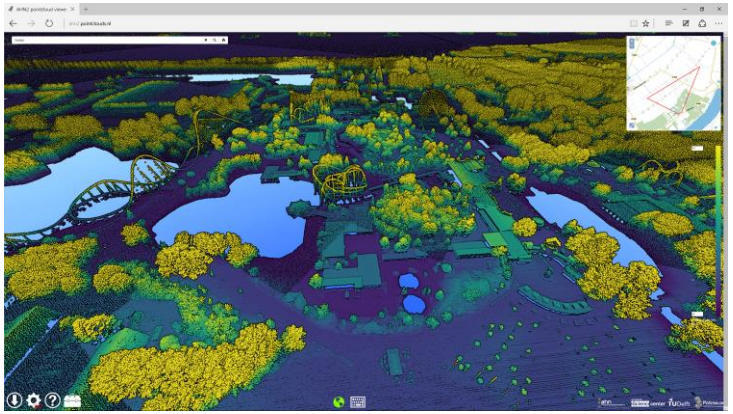
Multi-resolution download tool



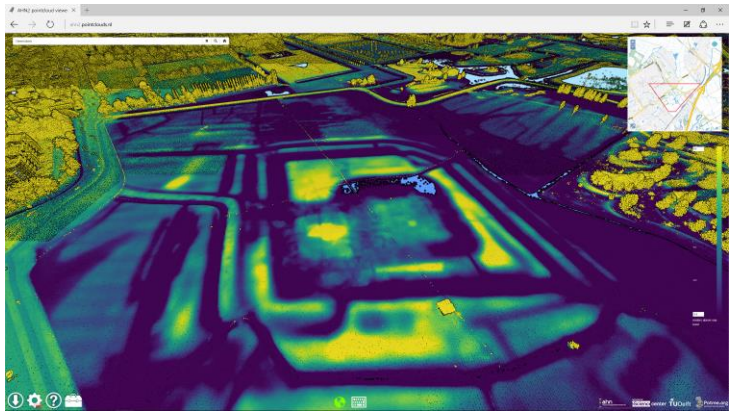
Demos



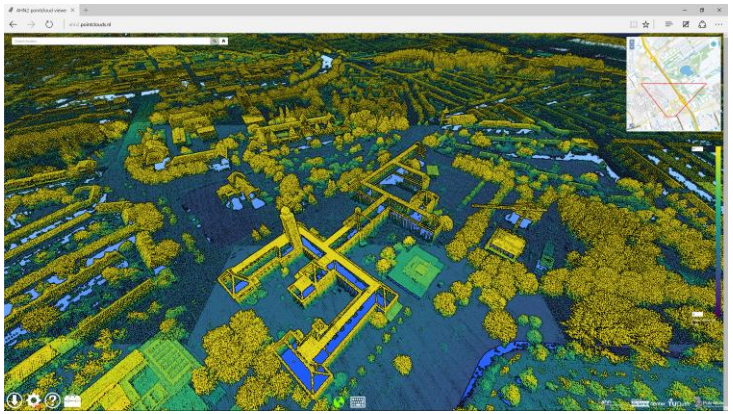
“The autoscanned plane”



“The imagine-this-with-rasters”



“The lost castle”



“The quest for home”

Conclusions and future work

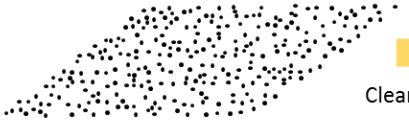
- **D&C algorithm** for creating massive multi-resolution data structures suitable for visualization
- **FOSS** implementation for Potree/PotreeConverter (octree)
  → **Massive-PotreeConverter**
- Used for **AHN2** → public web service (**http://ahn2.pointclouds.nl**)
- **Proof-of-Principle** massive point clouds can be web-visualized with FOSS
- Future work:
  - Massive-PotreeConverter tasks distribution and merging still “too manual”
  - Add different point cloud **time** snapshots (AHN2-AHN3)
  - Mix with **imagery** tiles to get color (beta)
  - Trees with **all points** (**SOLVED!**)
  - Handle **millions** octree nodes/**files** (key-value stores, HTTP Range Retrieval Requests, etc.)
  - ***OpenPointCloudMap***: More countries → all planet, flexible to add/update point clouds
    - *Synchronize efforts with **standardization** (OGC-PC-DWG,OSGEO PointDown)*
    - ***Integration** Potree with PDAL/Plasio/Entwine/Greyhound. **Common streaming API***
    - *Centralized infrastructure VS. **distributed infrastructure with common API/protocol** (next talk by M. Kodde)*
  - ***nD-PointCloud** (submitted H2020 FET Open): http://nd-pc.org*

Thank you for your attention

More information:

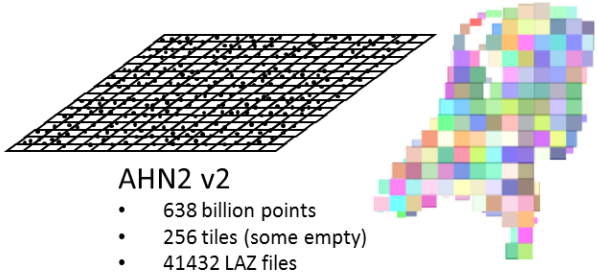
- Taming the beast: Free and open-source massive point cloud web visualization. Capturing Reality 2015 paper proceedings
  - https://www.researchgate.net/publication/284617106_Taming_the_beast_Free_and_open-source_massive_point_cloud_web_visualization
- https://www.youtube.com/watch?v=odLSB2rExHQ
- https://github.com/NLeSC/Massive-PotreeConverter
- https://github.com/NLeSC/ahn-pointcloud-viewer
- https://github.com/NLeSC/ahn-pointcloud-viewer-ws

AHN2 conversion



Cleaning

2D tiling level 4 (PDAL)



AHN2 v0

- 640 billion points
- 60185 LAZ files
- "Dirty"
- Separated in objects and terrain
- 1 TB (529 GB terrain, 459 GB objects)

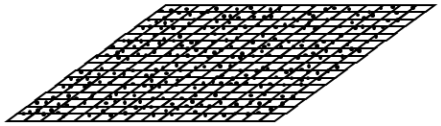
AHN2 v1

- 638 billion points
- 37588 LAZ files
- No errors / duplicates
- No objects/terrain separation
- 2.2 TB

AHN2 v2

- 638 billion points
- 256 tiles (some empty)
- 41432 LAZ files
- No errors / duplicates
- No objects/terrain separation
- 2.2 TB

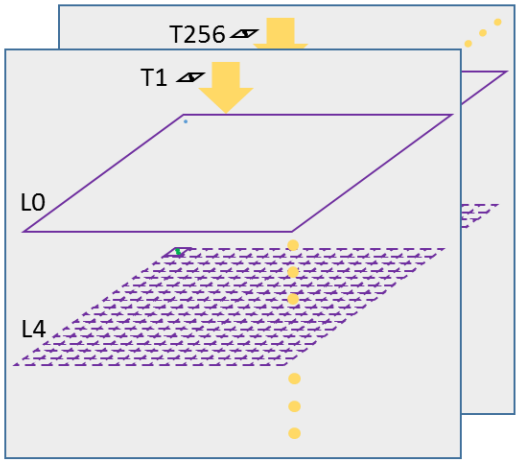
Sort/Index



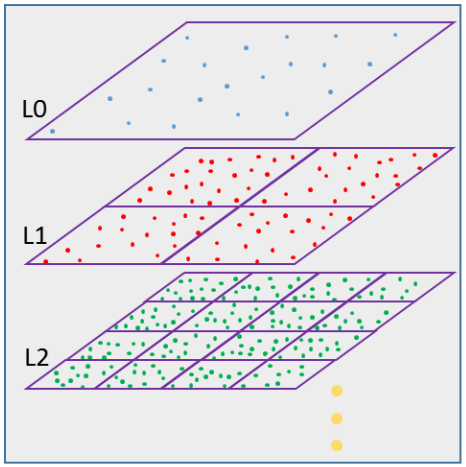
Distributed PotreeConverters

AHN2 v3

- 638 billion points
- 256 tiles (some empty)
- Sorted/Indexed (LAStools)
- 41432 LAZ files
- 41432 LAX files
- No errors / duplicates
- No objects/terrain separation
- 1.6 TB



Merging process



AHN2 v4

- 597 billion points
- 256 octrees (some empty)
- 14 levels per octree
- 38285863 LAZ files
- No errors / duplicates
- No objects/terrain separation
- 1.6 TB

AHN2 v5

- 597 billion points
- 1 octree
- 14 levels
- 38233895 LAZ files
- No errors / duplicates
- No objects/terrain separation
- 1.6 TB

AHN2 conversion

level	#files	files_fact	#points	points_fact
0	1		34,045	
1	4	4,00	134,786	3,96
2	14	3,50	541,973	4,02
3	41	2,93	2,205,484	4,07
4	143	3,49	8,833,283	4,01
5	499	3,49	36,081,908	4,08
6	1,804	3,62	155,411,383	4,31
7	6,767	3,75	668,597,511	4,30
8	25,939	3,83	2,834,989,373	4,24
9	101,057	3,90	11,355,433,955	4,01
10	398,423	3,94	39,911,483,676	3,51
11	1,584,598	3,98	112,993,998,398	2,83
12	6,671,815	4,21	259,014,500,658	2,29
13	29,442,790	4,41	170,207,571,211	0,66
Total	38,233,895		597,189,817,644	