

# A new elevation data set—from conception to fruition

Thomas Knudsen

Danish Geodata Agency

EuroSDR workshop, Tønsberg, Norway, 2016-01-12

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Agency for  
Data Supply and  
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# Outline

Acknowledgement

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Historical background, 1880–2011

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Conclusion, 2016

CD bonus track: A Semantic Patch Platform of LAS files

# Acknowledgement

This is a presentation on behalf of the **entire** DK-DEM QC/Production team

- ▶ Gitte Rosenkranz
- ▶ Peter Bartels Petersen
- ▶ Simon Lyngby Kokkendorff
- ▶ Thomas Knudsen
- ▶ Kristian Evers
- ▶ Thorbjørn Kjærshøj Nielsen
- ▶ Andrew Flatman

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Fruition, 2015

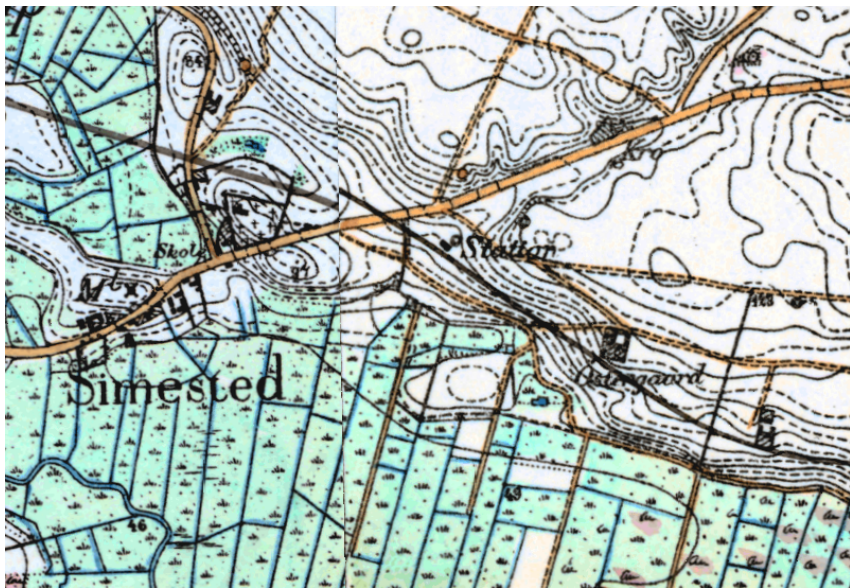
Conclusion, 2016

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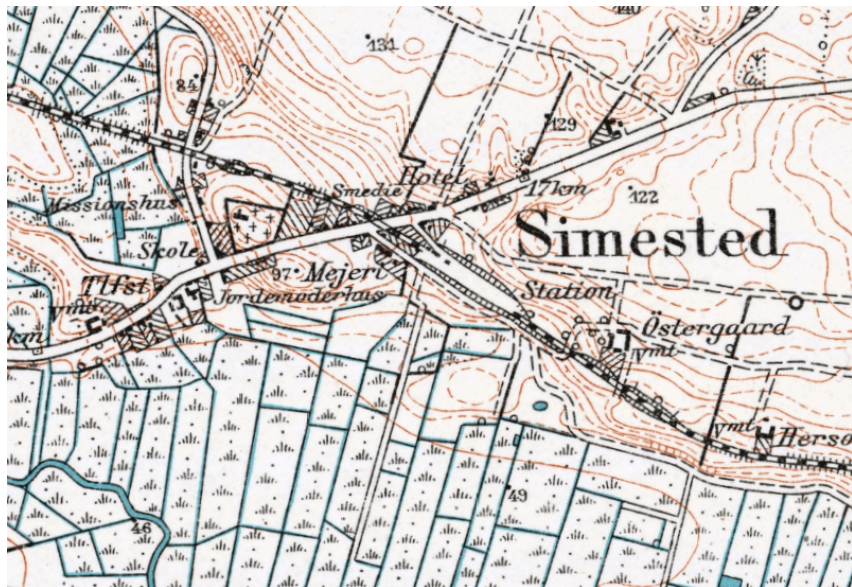
## Once upon a time (1880–1910)



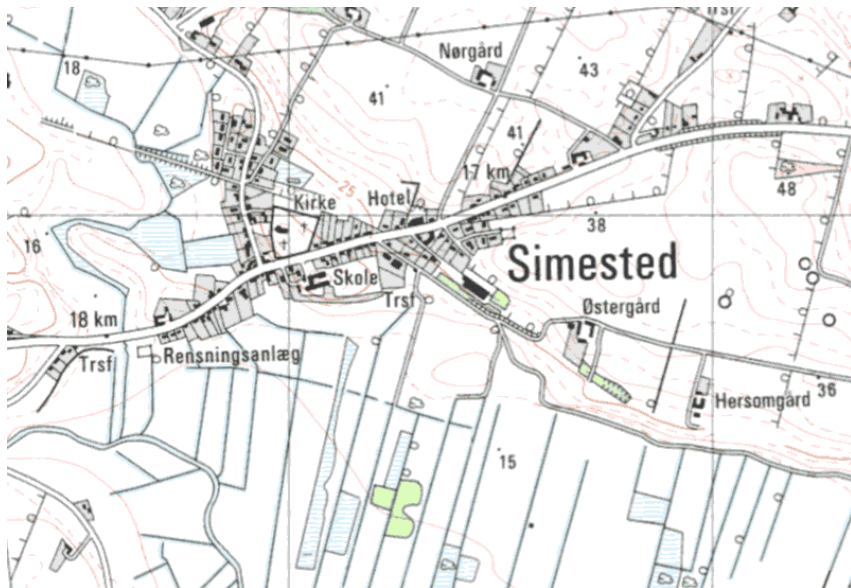
## 1890 – a horse-powered army



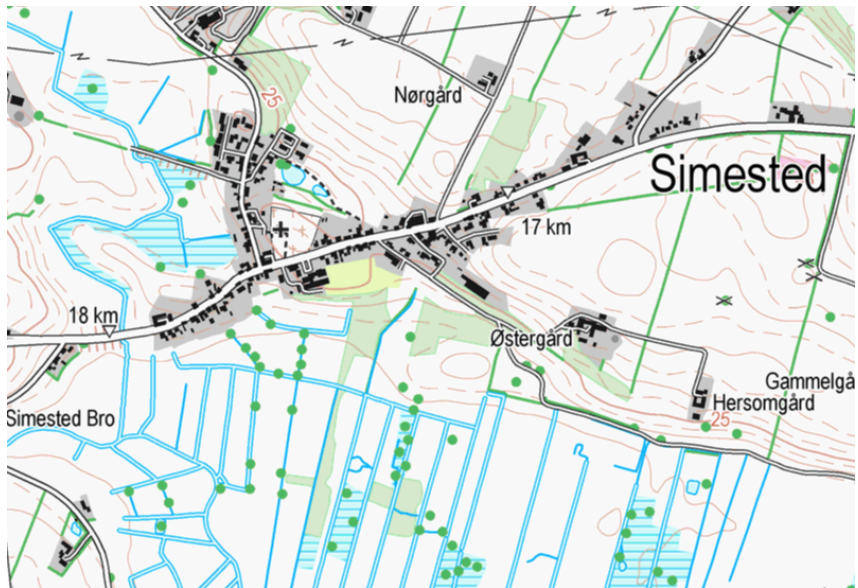
## 1920 – diesel takes over



2000 – still same contours



## 2010 – DK-DEM (DHM, Danmarks Højdemodel)



## What happened?

1890 data OK for more than 110 years—why suddenly this urge for new data?

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© 2011 by Dorthie Lemke

# What was done, what was learned?

Done:

- ▶ 2007: Tender for a new gridded elevation model for public sector use

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# What was done, what was learned?

## Done:

- ▶ 2007: Tender for a new gridded elevation model for public sector use
- ▶ Based on LiDAR data collected 2005–2007
- ▶ Delivery and QA/QC process running in 2007–2008

## Learned:

- ▶ An amazing success!!!
- ▶ Many new users and uses
- ▶ Limitations (no point cloud, public sector only) were a real problem

# What happened next?

**TED** Watch Discover Attend Participate About

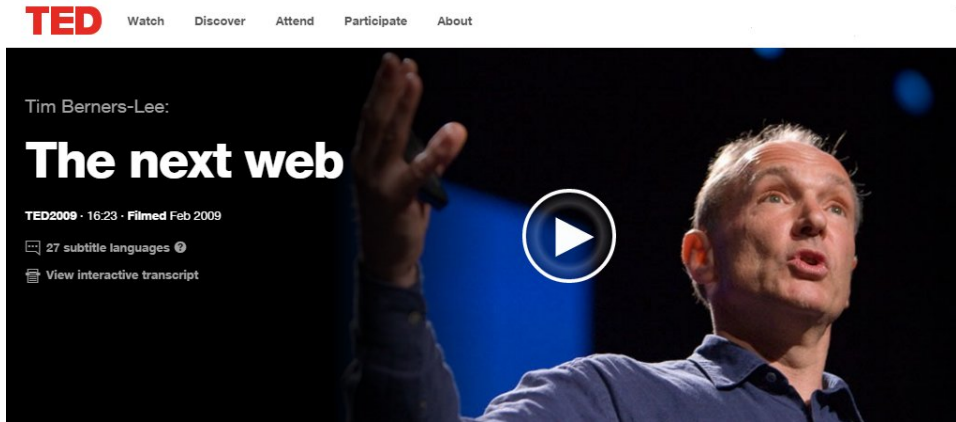
Tim Berners-Lee:

## The next web

TED2009 · 16:23 · Filmed Feb 2009

27 subtitle languages ?

View interactive transcript



## What happened next?



EUROPEAN COMMISSION

Brussels, 12.12.2011  
COM(2011) 882 final

**COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN  
PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL  
COMMITTEE AND THE COMMITTEE OF THE REGIONS**

**Open data**  
**An engine for innovation, growth and transparent governance**

Acknowledgement

Historical background, 1880–2011

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The time was ripe!



## “Basic Data”...

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- ▶ Used as common reference across geographic and administrative boundaries

Meaning:

- ▶ Update of DK-DEM urgently needed
- ▶ Funding allocated—not just for immediate update, but for continuous future updates!
- ▶ Get going—reduce the update cycle for DK-DEM from 110 years to 5 years!

## A beauty contest

With funding allocated specifically for DK-DEM, we could issue a tender inviting for a race to the **top of quality**, rather than a race to the **bottom of price** (and quality).

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- ▶ Colour information from concurrently recorded images for all day time flights

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- ▶ Full Waveform information

Acknowledgement

Historical background, 1880–2011

Conception, 2011–2013

**Data Capture and Production, 2014–2015**

Fruition, 2015

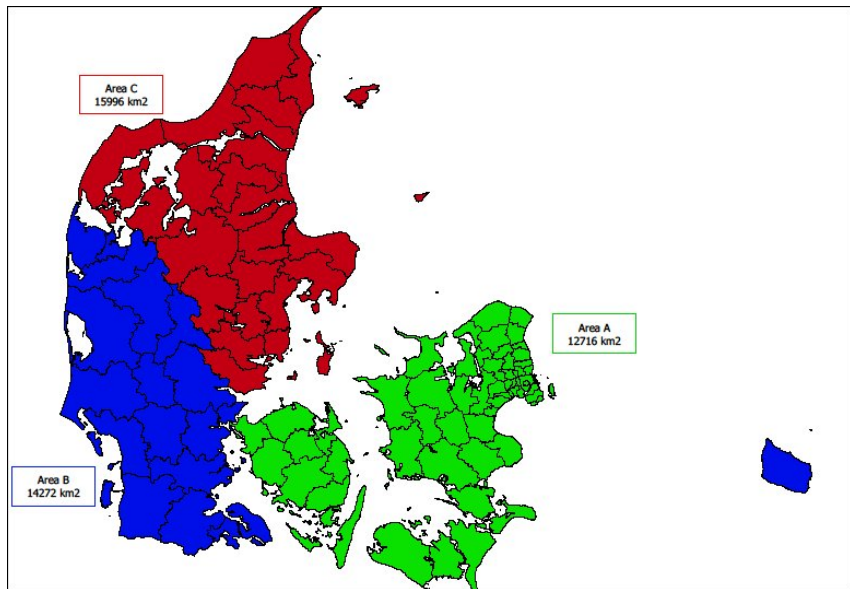
Conclusion, 2016

CD bonus track: A Semantic Patch Platform of LAS files

Contract signed December 2013



3 flight seasons. Project ends December 2015



# Specification philosophy

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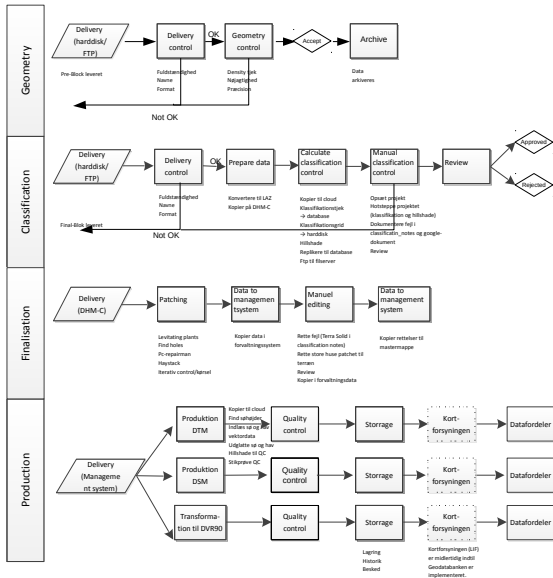
## Specification philosophy

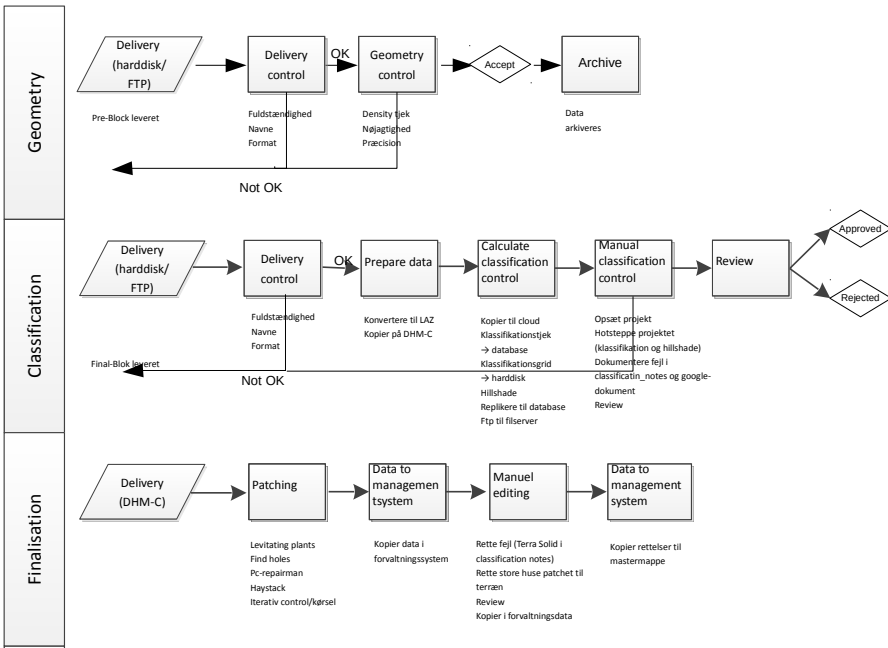
- ▶ Do not specify anything that cannot be checked
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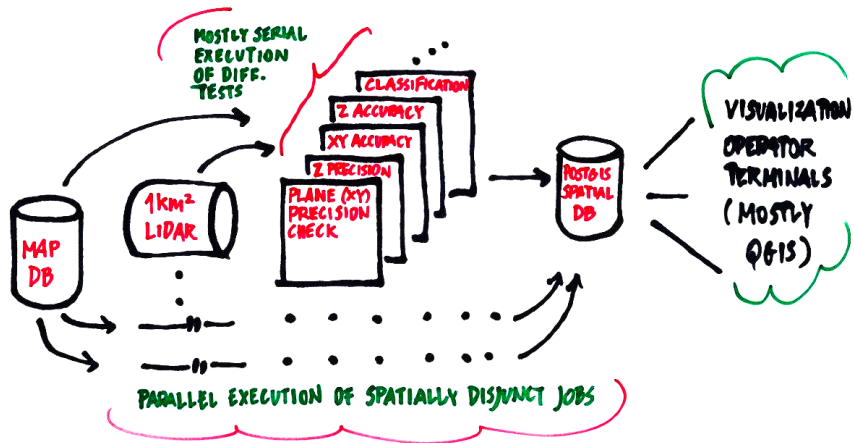
- ▶ Do not specify anything that cannot be checked
- ▶ Check everything specified
- ▶ ... and not just by spot checks (CPU clock cycles are cheap)
- ▶ We're the National Mapping Authority—take advantage of existing photogrammetrically derived geodata
- ▶ ... and get a better overall feel for the accuracy and precision of the **entire geodata stack**

# QC and Production system—architecture



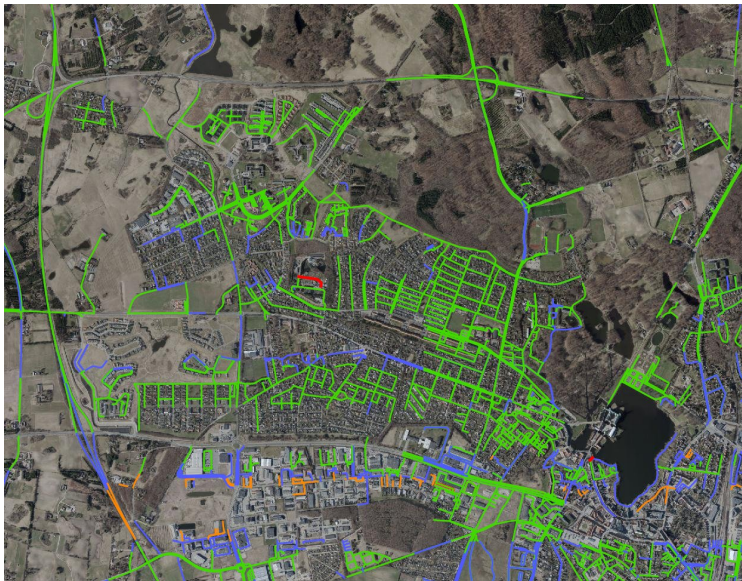


## QC details

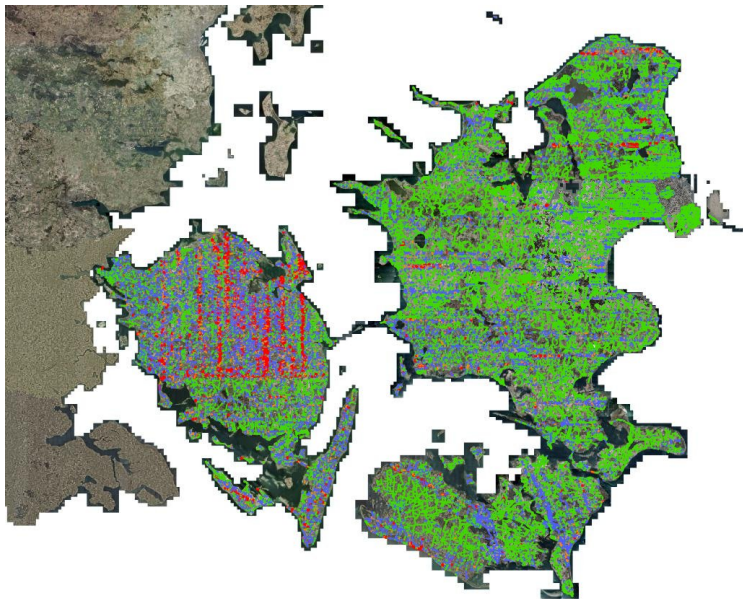


**Data delivery:** Blocks of up to 40 km x 40 km. **Checks:** Run in parallel on 1 km x 1 km tiles

## QC: Vertical precision—detail

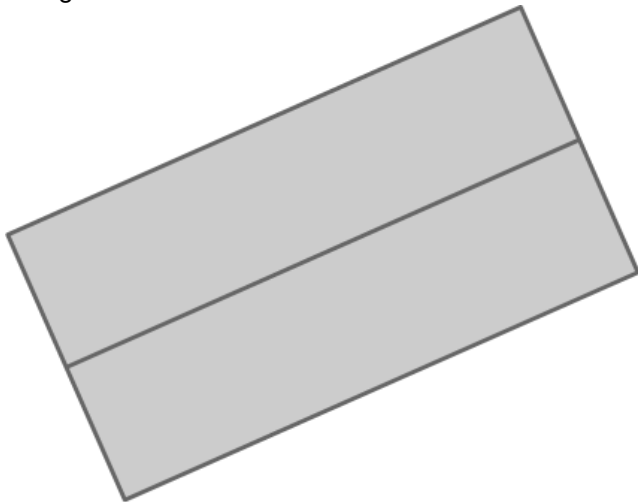


## QC: Vertical precision—first flight season



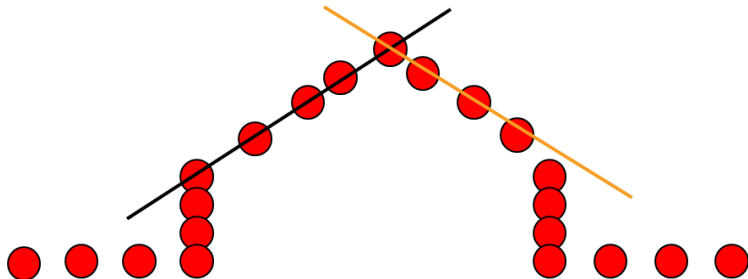
## QC: Horizontal accuracy—How?

- ▶ Take advantage of a highly symmetric subset of building registrations.
- ▶ Assume roof ridge is at the exact center.

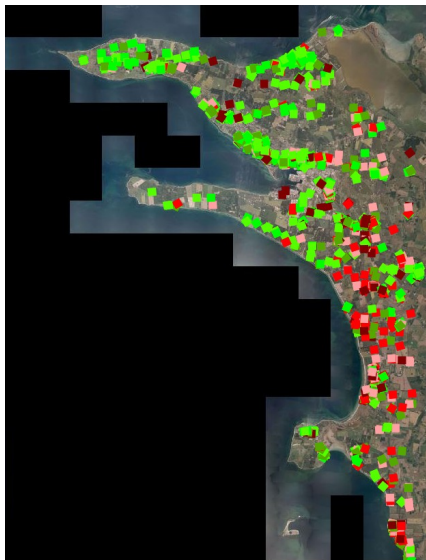


## QC: Horizontal accuracy—How?

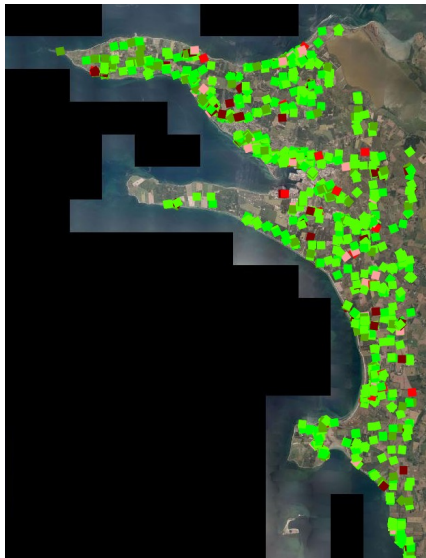
- ▶ Extract point cloud patch for building outline
- ▶ Do 3D Hough transform
- ▶ Find intersection of 2 first Hough components



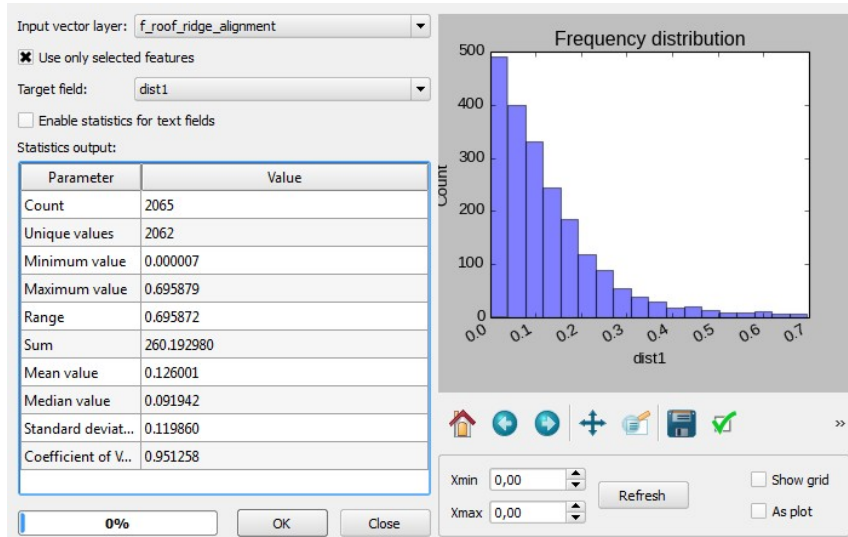
## QC: Horizontal accuracy—Example (first delivery)



## QC: Horizontal accuracy—Example (second delivery)



## QC: Horizontal accuracy—Example (statistics)



## QC: Classification

We're avid users of the

**S.R.A.F.A.P.**

method

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► **S**tudents

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- ▶ **P**ossible

## QC: Classification

But they need something to **run** with: Grids indicating suspicious situations

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But they need something to **run** with: Grids indicating suspicious situations

- ▶ Registered buildings with no points classified as building
- ▶ Vegetation where buildings (or roads) are expected
- ▶ ... and a few more

Acknowledgement

Historical background, 1880–2011

Conception, 2011–2013

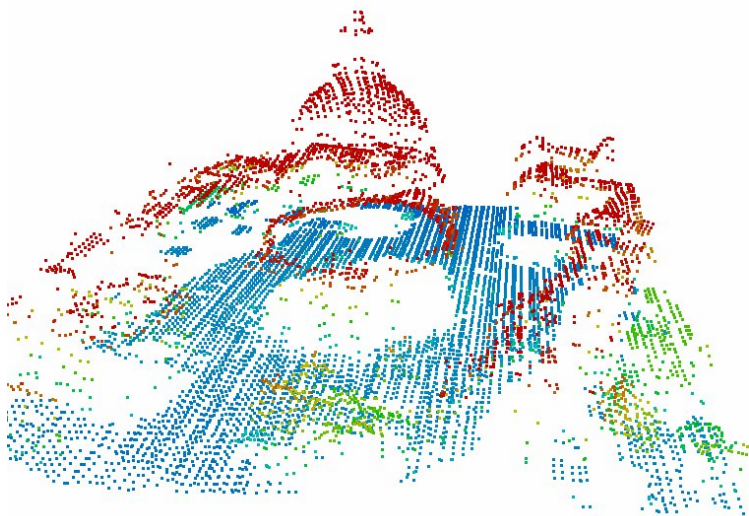
Data Capture and Production, 2014–2015

**Fruition, 2015**

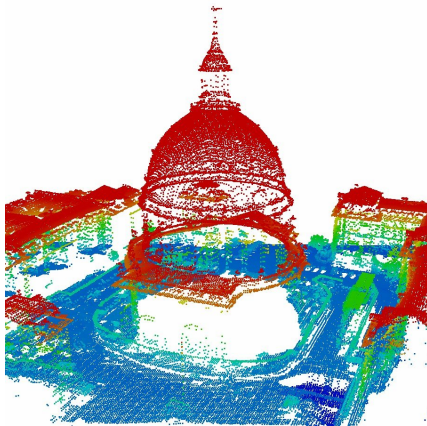
Conclusion, 2016

CD bonus track: A Semantic Patch Platform of LAS files

## Example: Frederik's Church, 2007



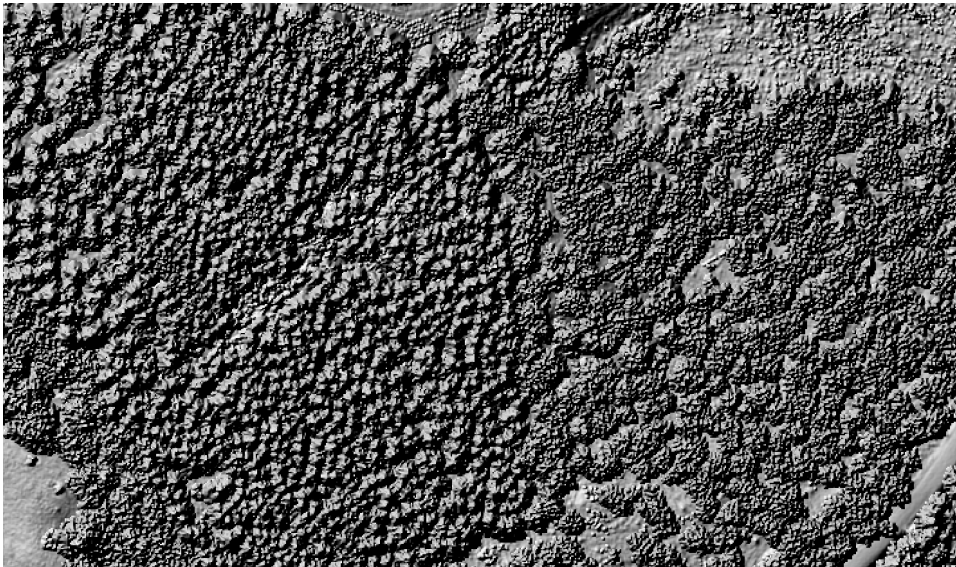
## Example: Frederik's Church, 2014



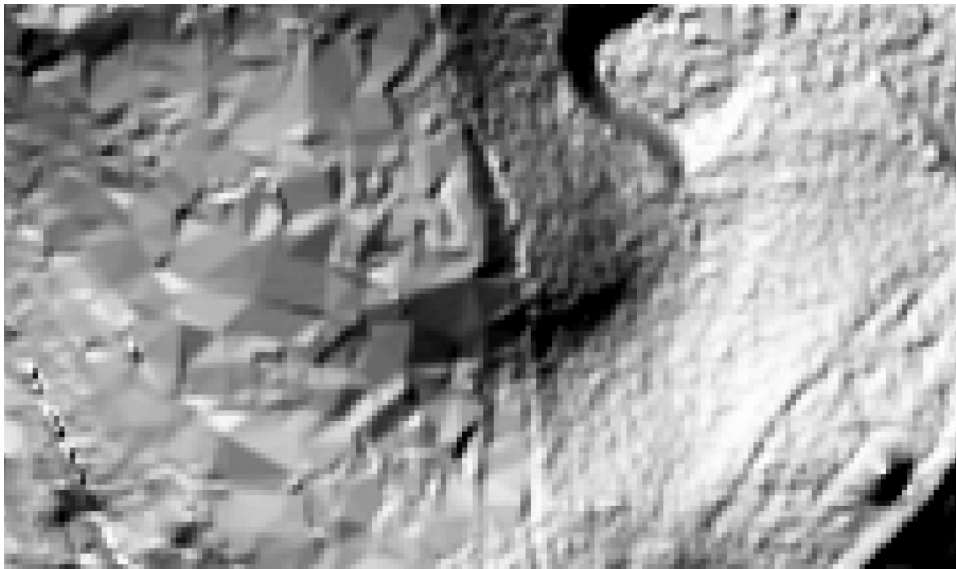
## Example: Deciduous vs. Coniferous, 2007 vs. 2014



## Example: Deciduous vs. Coniferous, DSM 2014



## Example: Deciduous vs. Coniferous, DTM 2007



## Example: Deciduous vs. Coniferous, DTM 2014

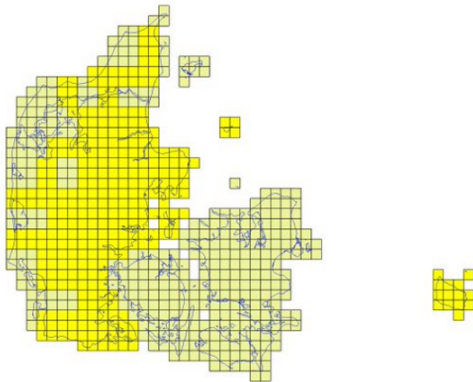


## Fruition—all done with one day to spare

PIP

Kortforsyningen PIP @Kortforsyningen · 30. dec. 2015

Download: DHM opdatering - DHM er landsdækkende. Datasættene DTM, DSM og punktsky kan downloades som 10 km. blokke.



# Try it yourself

The screenshot shows a web browser window with the Bitbucket interface. The address bar shows the URL `https://bitbucket.org/GSTudvikler/gstdhmqc`. The page title is "Overview". The repository is named "gstudvikler/gstdhmqc". The page displays various statistics and options:

- Last updated:** 2015-12-22
- Language:** Python
- Access level:** Admin (revoke)
- 2 Branches**
- 2 Tags**
- 0 Forks**
- 4 Watchers**

There is a button to "Edit README" and a section for "Build instructions..." which includes the command:

```
- change directory to src/build
```

On the right side, there is a section for "Recent activity" showing two entries for "sanitize Issue #1" by "Thorbjorn".

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Historical background, 1880–2011

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**Conclusion, 2016**

CD bonus track: A Semantic Patch Platform of LAS files

## (un)Conclusion

Well—we did it. We (and AeroData) finished the project in time, building the tracks (i.e. the QC/Production system) while driving the train.

I'll let some users conclude. . .

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Martin Keller (German Aerospace Center, DLR): The DEM looks really great. I don't think that I ever had a DEM in this quality, wow!

Lene Fischer (lecturer in GIS, University of Copenhagen): A fantastic data set. Teaching GIS has suddenly become *much* more fun.

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Historical background, 1880–2011

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**CD bonus track: A Semantic Patch Platform of LAS files**

## Patching text files mechanically

```
153 153      if g_warp is not None:
154 154          g.grid[M]-=g_warp[M] #warp to dvr90
155      - g.grid=g.grid.astype(np.float32)
155      + g.grid=g.grid.astype(np.float32)
156 156      t.grid=t.grid.astype(np.float32)
157 157      if doround:
158 158          print("Warning: experimental rounding to mm level")
```

# Patching binary files semantically

Converting las file heights from ellipsoidal to orthometric in 3 lines of code

```
#include "sspplash.h"
HEADER {automatic;}
RECORD {O.rec.z = I.rec.z - N (I.rec.x, I.rec.y); automatic;}
```

Where traditional patch scripts describe the **mechanics** of what to do, semantic patch scripts describe the **semantics**.

Hence, the patch platform need to understand quite a bit of the input data format it processes.