Disruptive Technologies Threatening NMCA's Centralized Mapping

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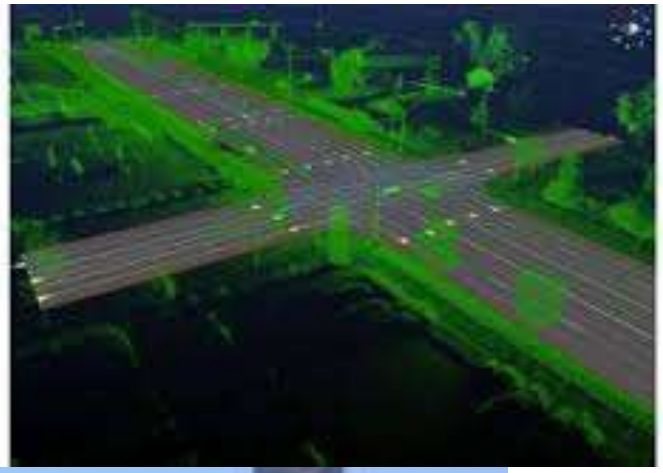
CoE-LaSR Vision

- “**Laser scanning is omnipresent and affecting positively the life of every citizen in modern information society by early 2020s**”
- In the next two decades, new mobile laser scanning systems are making laser scanning more ubiquitous in the same sense as the first personal computing was followed by ubiquitous computing. Even autonomous robots using point-cloud-generating perception sensors may be added to the ecosystem during this timeframe. **What can be said for certain is that during the 2020s and 2030s, there will be a great number of laser scanners omnipresent in everyday life. Mobile Laser Scanning is also one of the main techniques to create local virtual reality**.
- **We are in the middle of disruptive technologies, multidisciplinary work**

HERE & Google



Objective merging virtual and physical worlds

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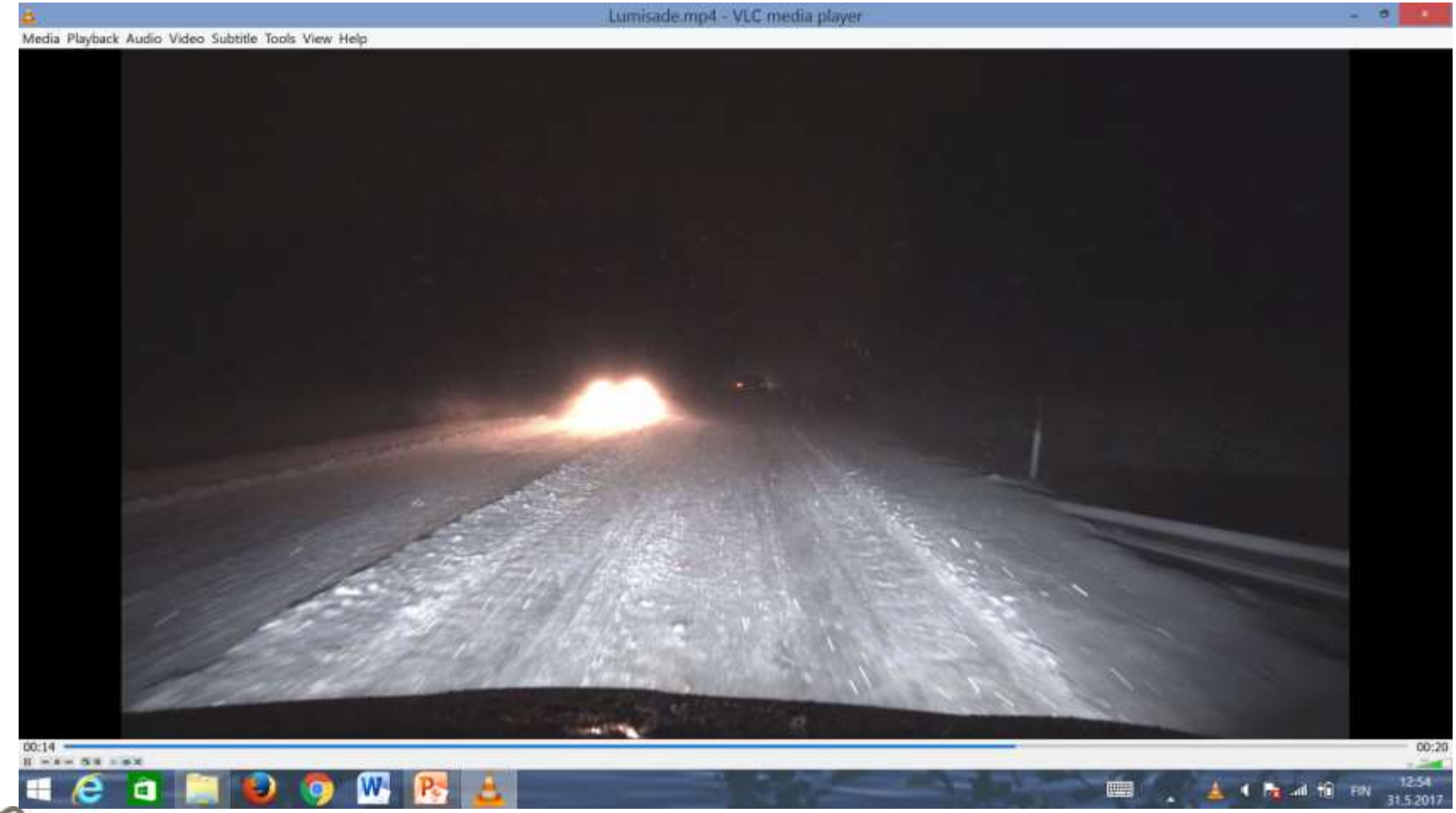
Industry revolution

- You are in a middle of the disruptive technologies
- **NMCAs (National Mapping and Cadastre Agencies) shoud stimulate the process, but can hardly adapt to situation**
- Mapping is done by major global ICT companies
- Tiny SMEs have technically the same capacity as NMCAs, but are more innovative
- Nokia acquired Navteq with 8B$ in 2007: Similar technology is in 2030 in 15% of all new cars (15-20M units)
- Intel acquired Mobileye for 15.3 B€ (turnover 71M$)

Industry will solve real-time, fully automated mapping in these conditions, how about you ?



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27 May 2014 Last updated at 23:52 GMT

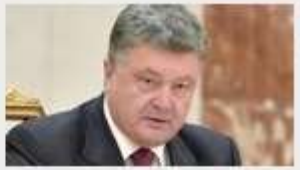
Tree-mapping drone start-up has sky-high ambitions

By Mark Bosworth
BBC World Service, Helsinki

Tero Heinonen (right) launched Sharper Shaper almost a year ago

Mapping the trees in Finland's forests sounds like a Herculean

Top Stories



'Russian t
deployed'

IS 'kills dozens of Syrian soldiers'

Ebola spreads to Nigeria oil hub

Missing plane search area refined

France urges special Libya suppo

Features & Analysis

Vanishing po

Dear NMCA Leaders

There is at least one person saying this to many of you!

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Small examples of the technological developments

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DEM automated by ALS

Almost 90% reduction in error

Costs 50% savings

Significant reduction in personnel needed

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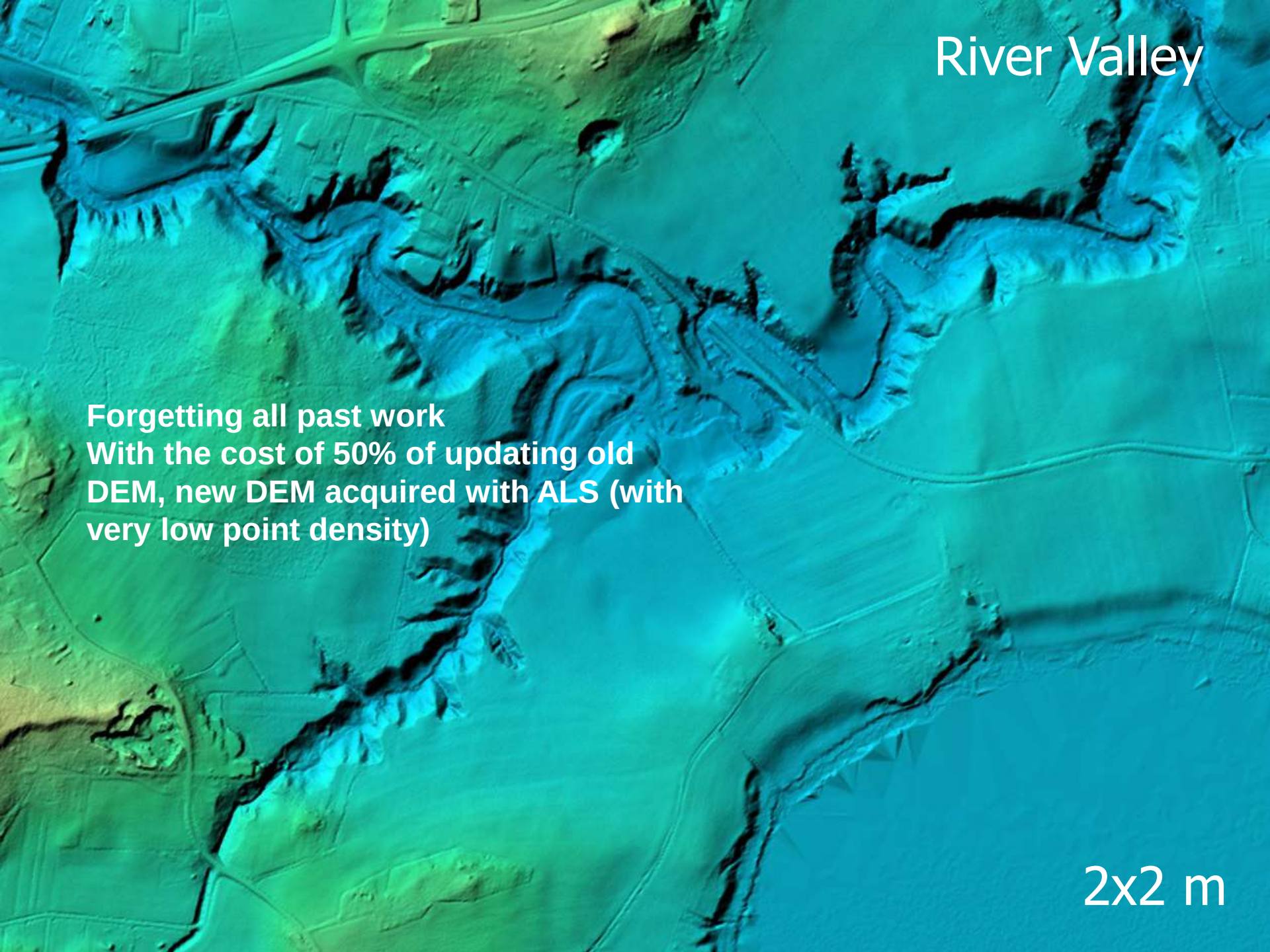
National elevation models

Quality of National DEMs after several hundred years of work

25x25 m


River Valley
Forgetting all past work
With the cost of 50% of updating old DEM, new DEM acquired with ALS (with very low point density)
2x2 m

Forest Inventory automated by LS

National savings in Finland 20 M€ annually

Accuracy improved

Precision forestry allow more than 100M€ saving through electronic wood sale

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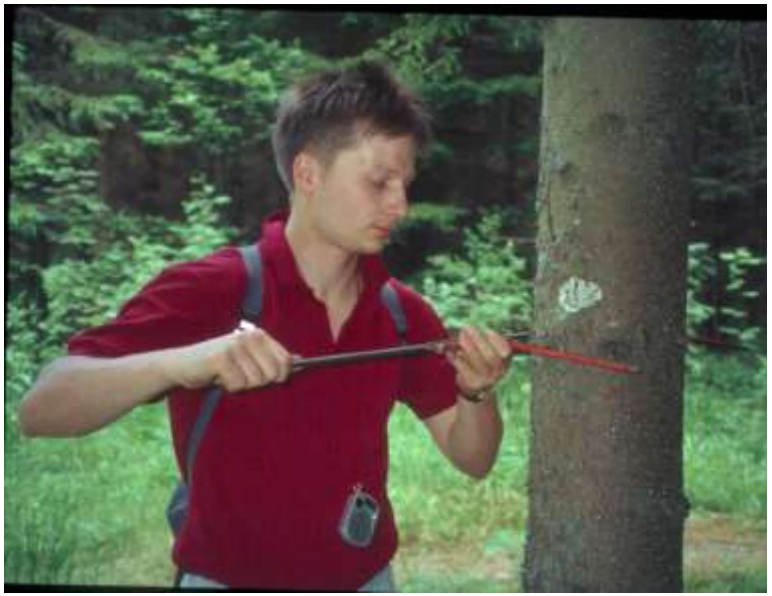
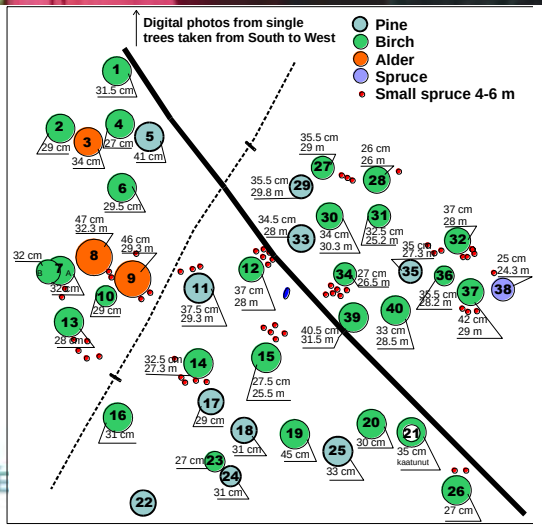
This is how forest are traditionally measured

10-20 €/ha costs for standwise inventory; several hundreds € for plots (few hundred m^2)





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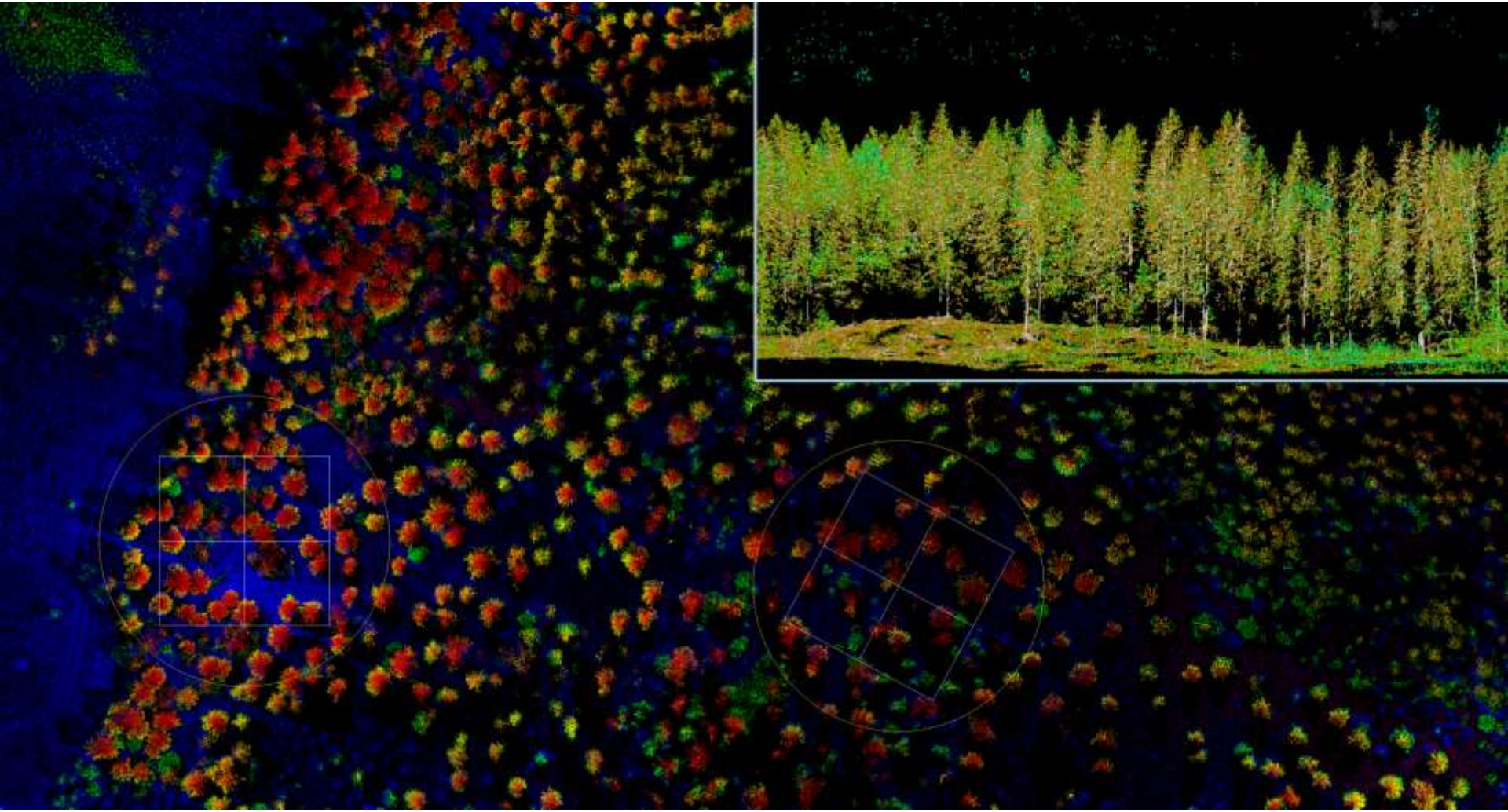
Boreal forest data



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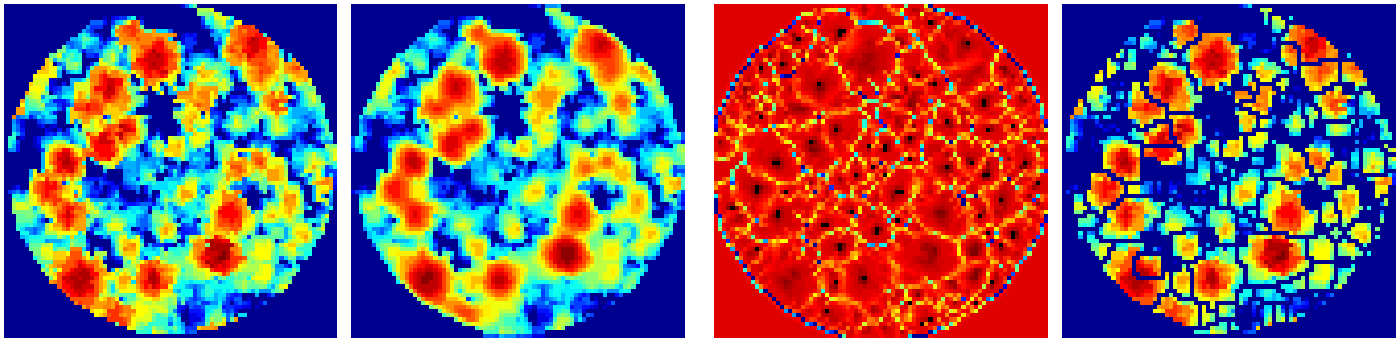
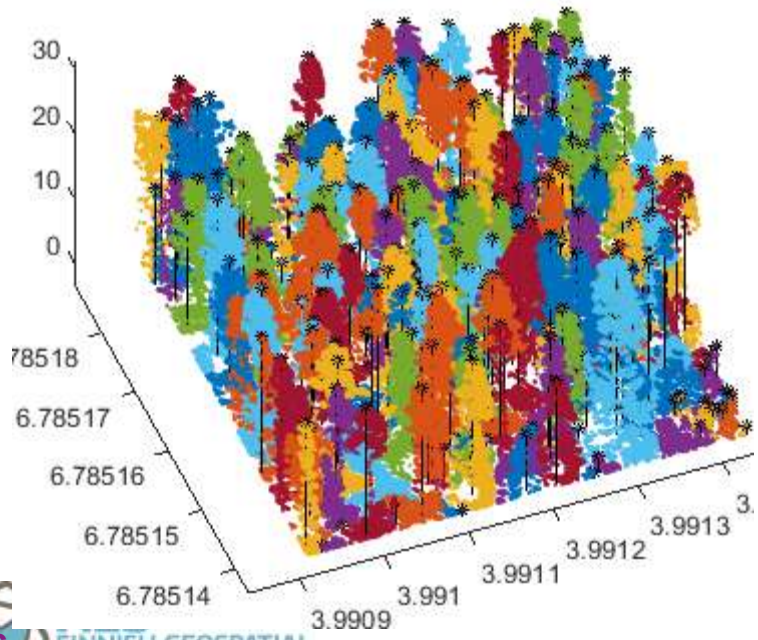
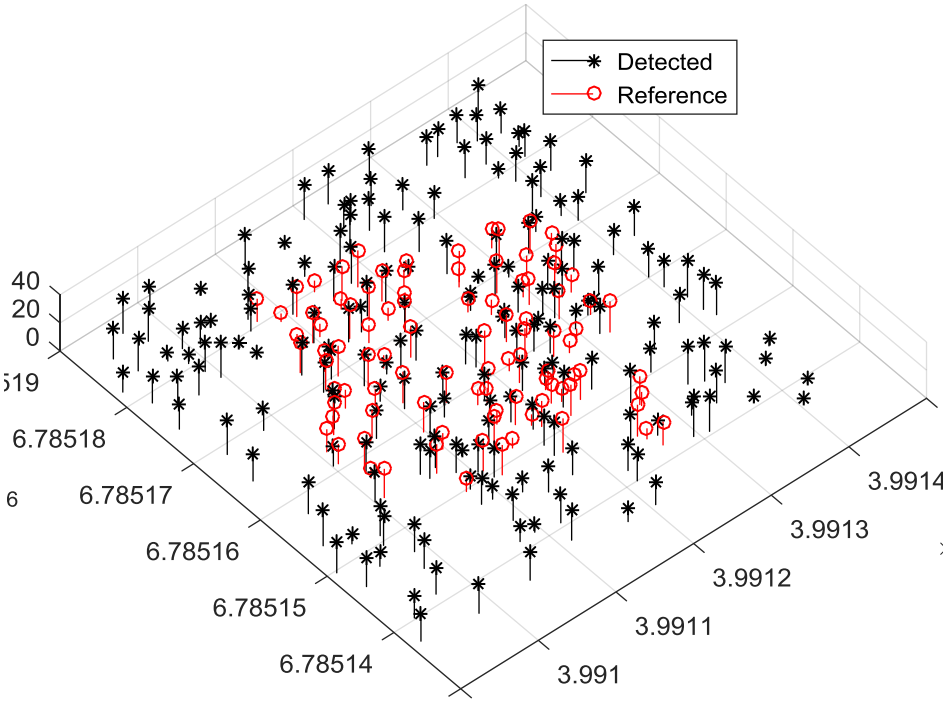
Individual Tree Detection







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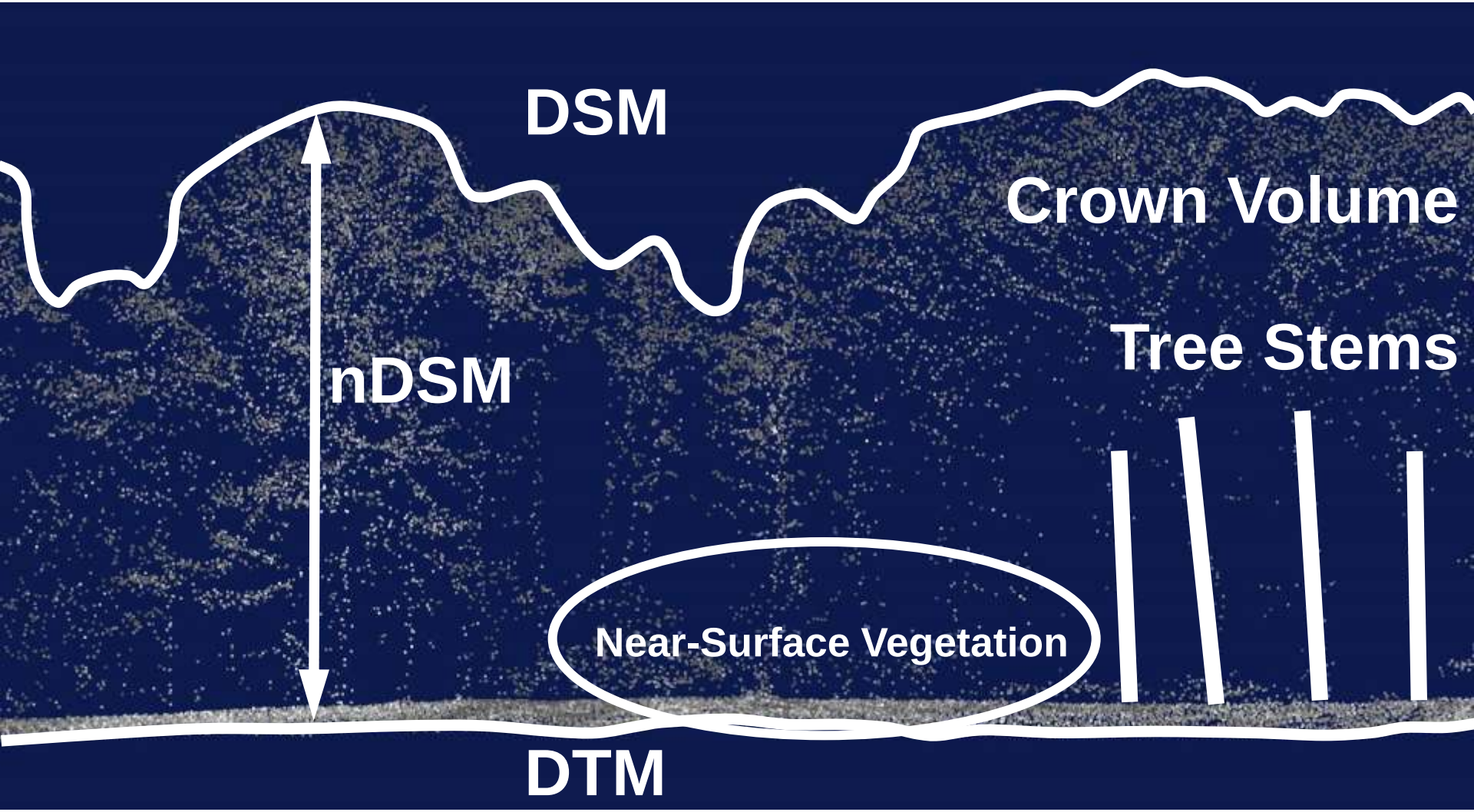
Huge savings due to ALS



Electronic wood sale – several 100M€/year

Next steps in forestry and powerline monitoring

Automated plot level inventory

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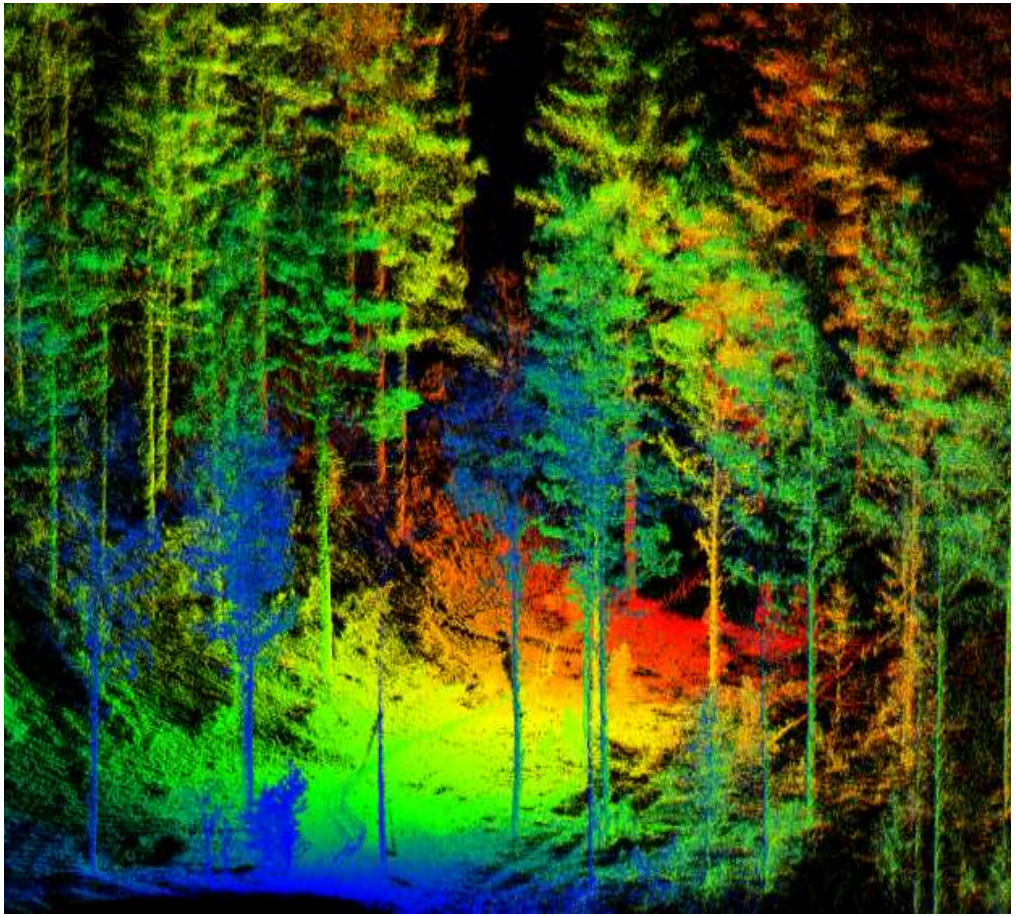
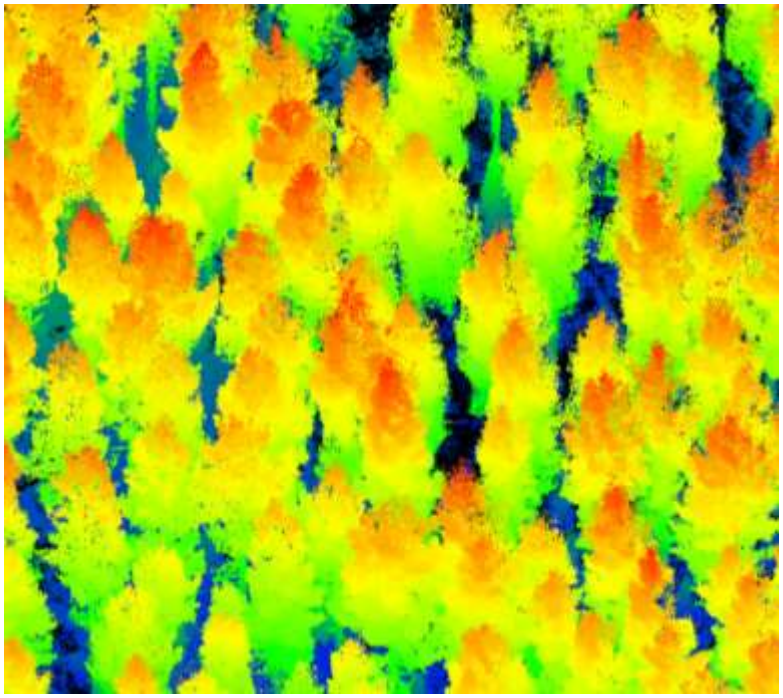
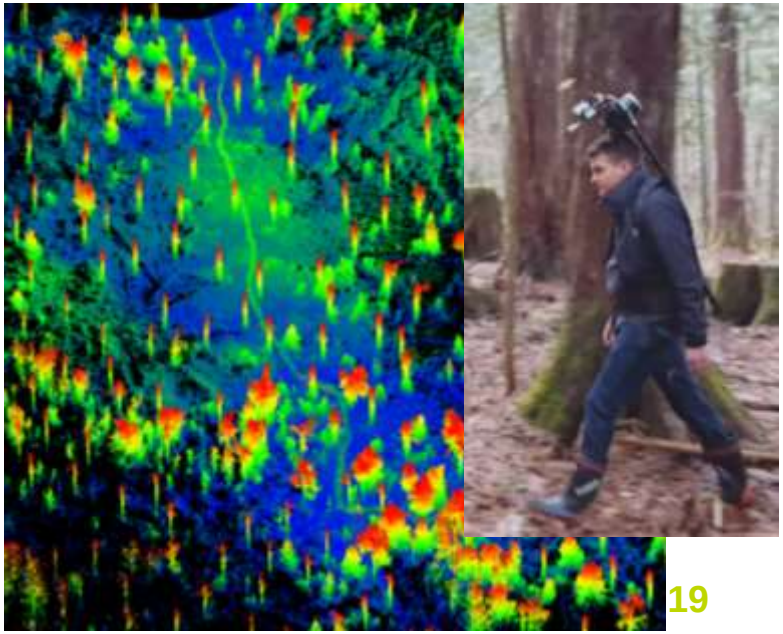
Low-cost Backpack for Forestry







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UAV breakthrough

- Velodyne VLP-16
  - PRF 300 kHz
  - Dual Return
  - SF 5-20 Hz
  - Range 100 m
  - 16 profiles
  - FOV ±15°, 360°
- NovAtel IGM-S1
  - 125 Hz Trajectory

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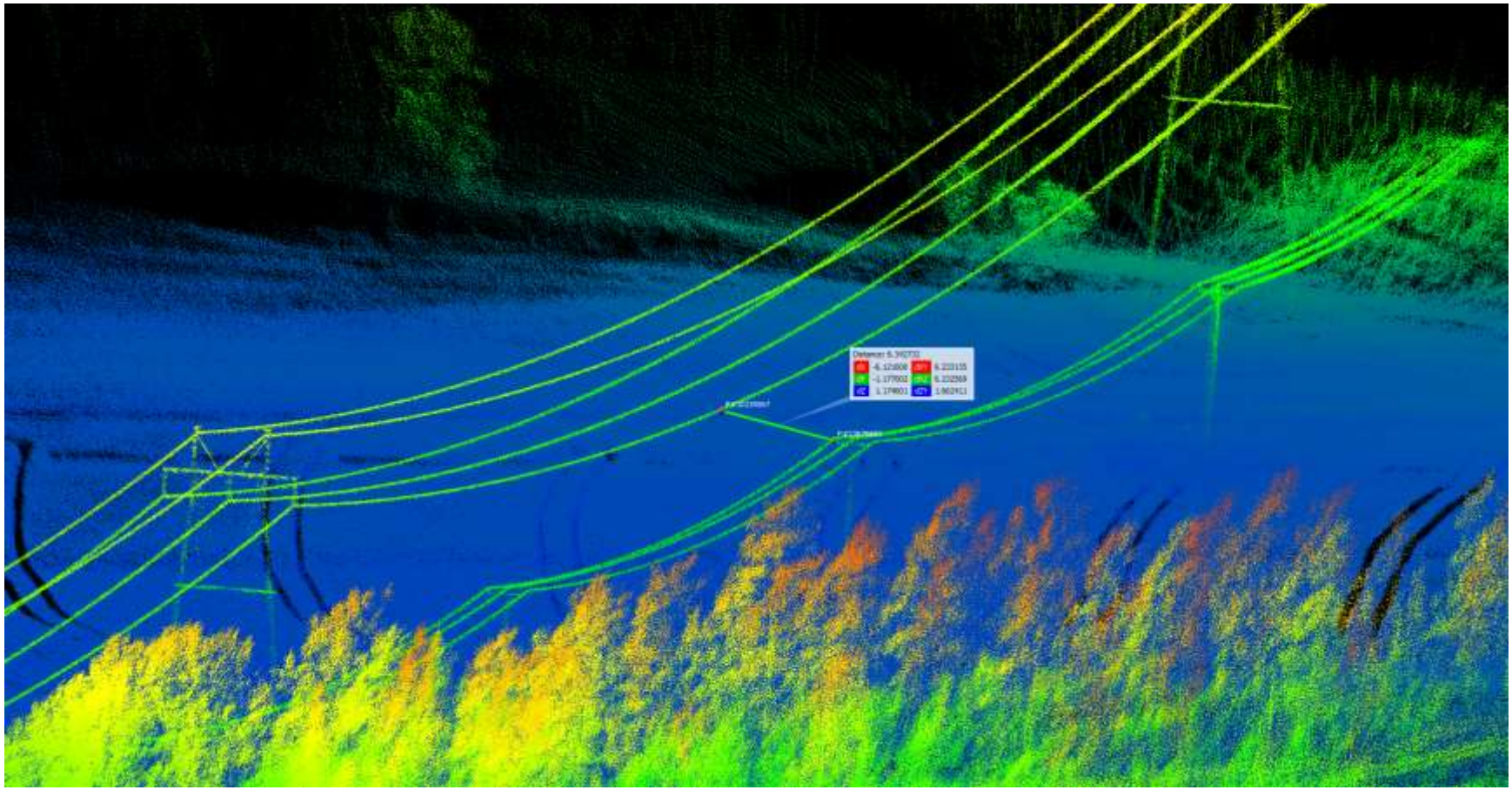
Mini-UAV-LS operational corridor mapping, Sept 2014



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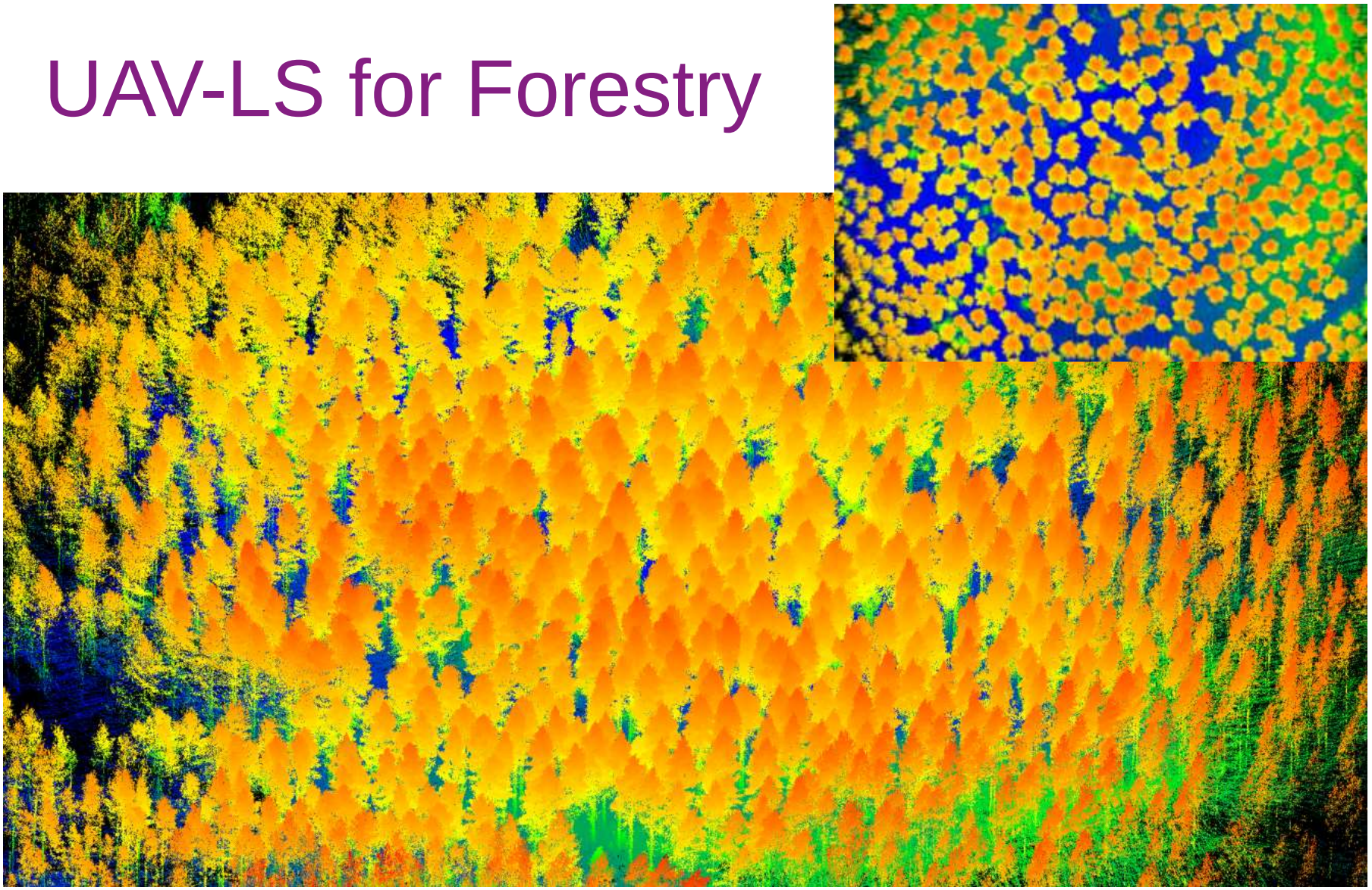
UAV-LS for Forestry



Virtual forests

Automated map updating

Multispectral ALS allow near-automated map updating

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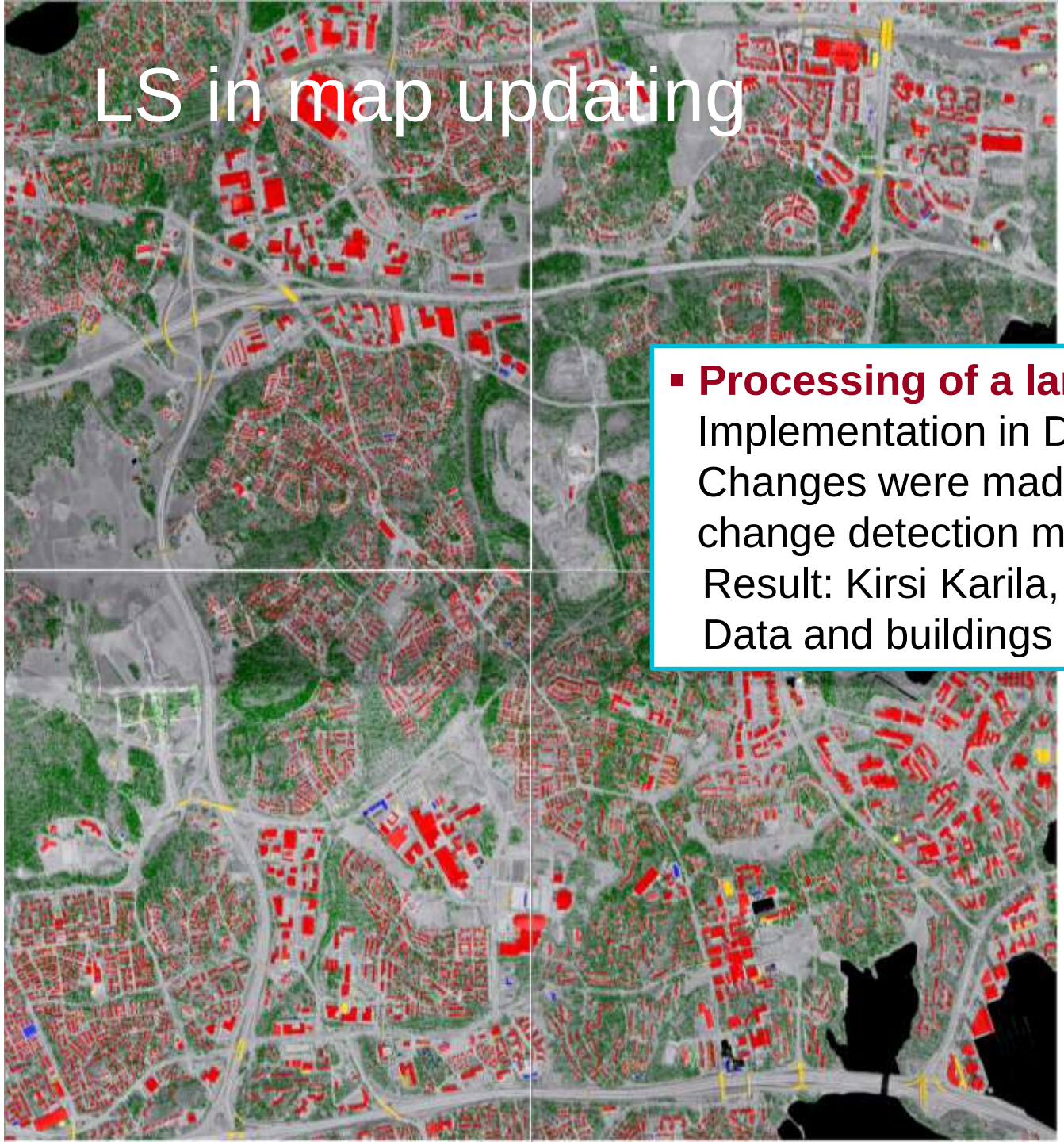
Virtual Reality and gaming

LS in map updating



- **Processing of a large area** (6 km x 6 km)
  Implementation in Definiens software.
  Changes were made especially in the change detection method.
  Result: Kirsi Karila, FGI
  Data and buildings of the map: NLSF

OK

New

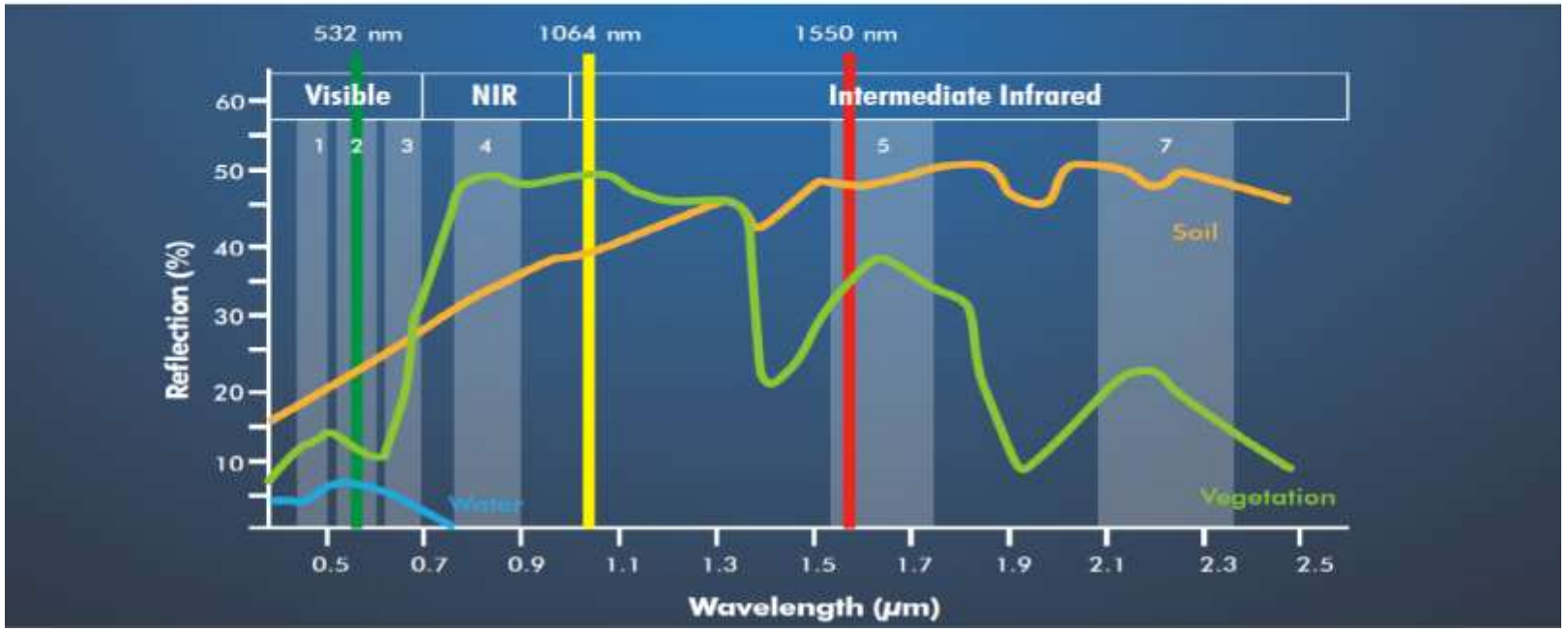
Not found

Classified as tree

Multispectral Airborne LS

TITAN – Wavelength Sensitivities

- Vegetation is strongly reflective in NIR, and slightly so in visible green spectrum
- Vegetation can be easily distinguished from soil and water (i.e. vegetation versus non-vegetation)
- Water is best penetrated using green wavelengths



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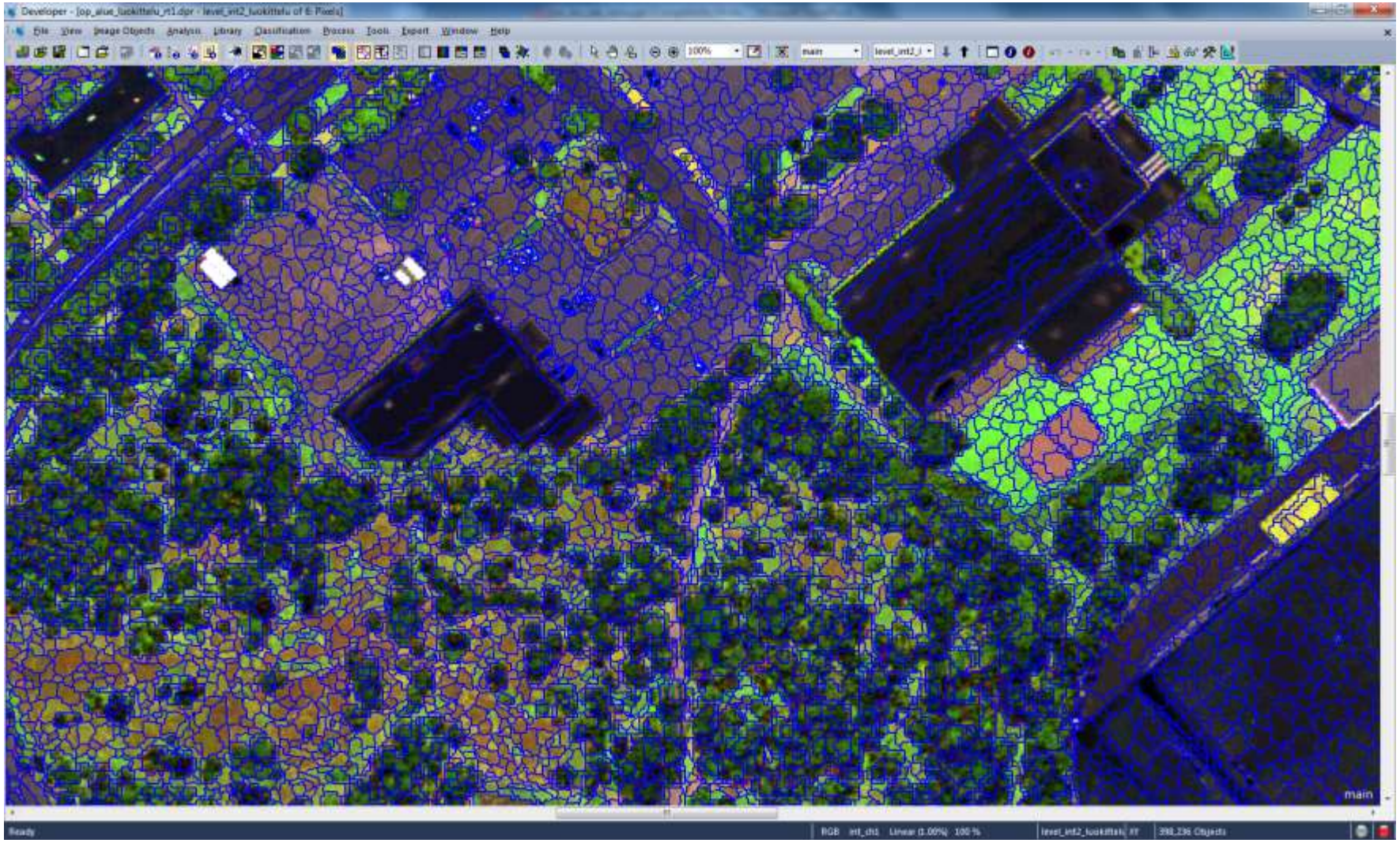
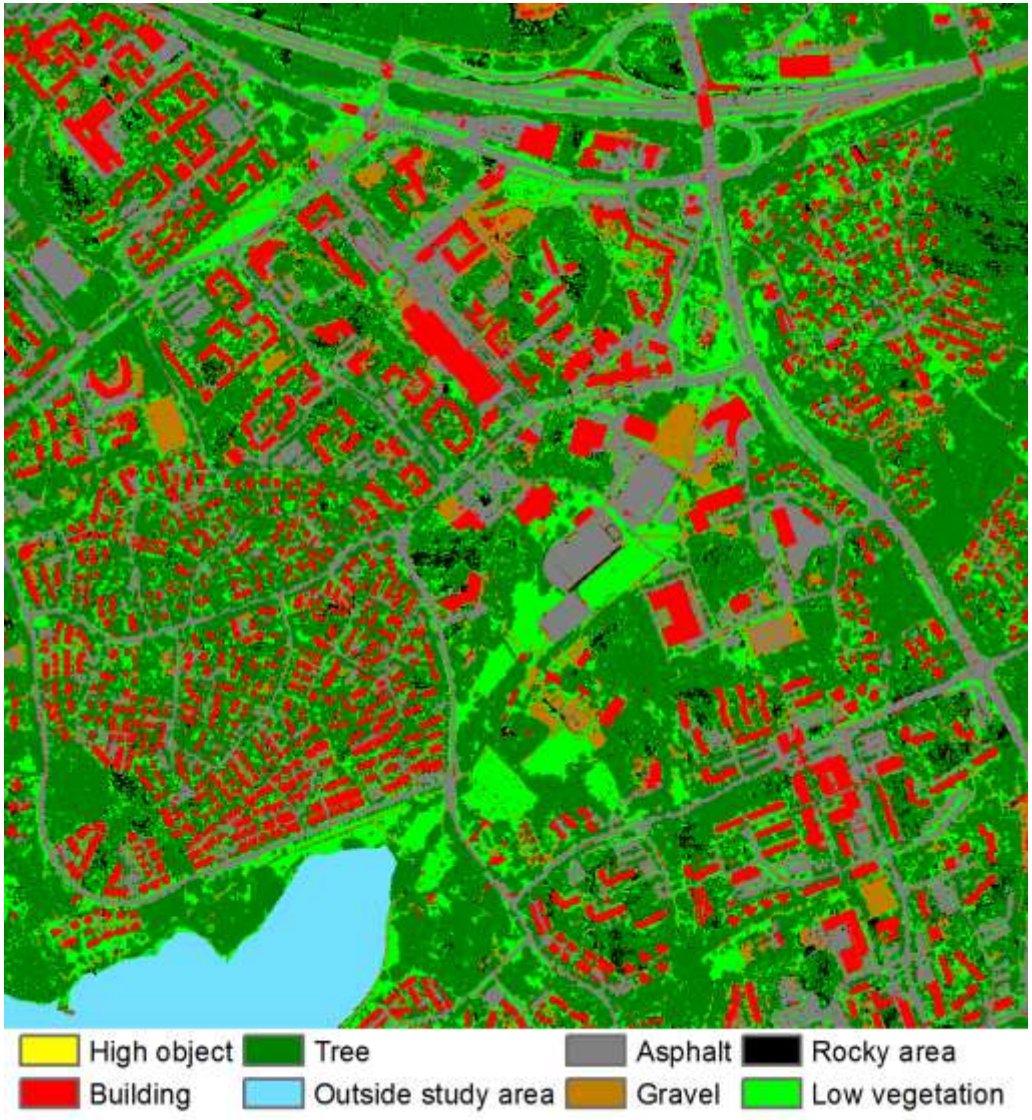
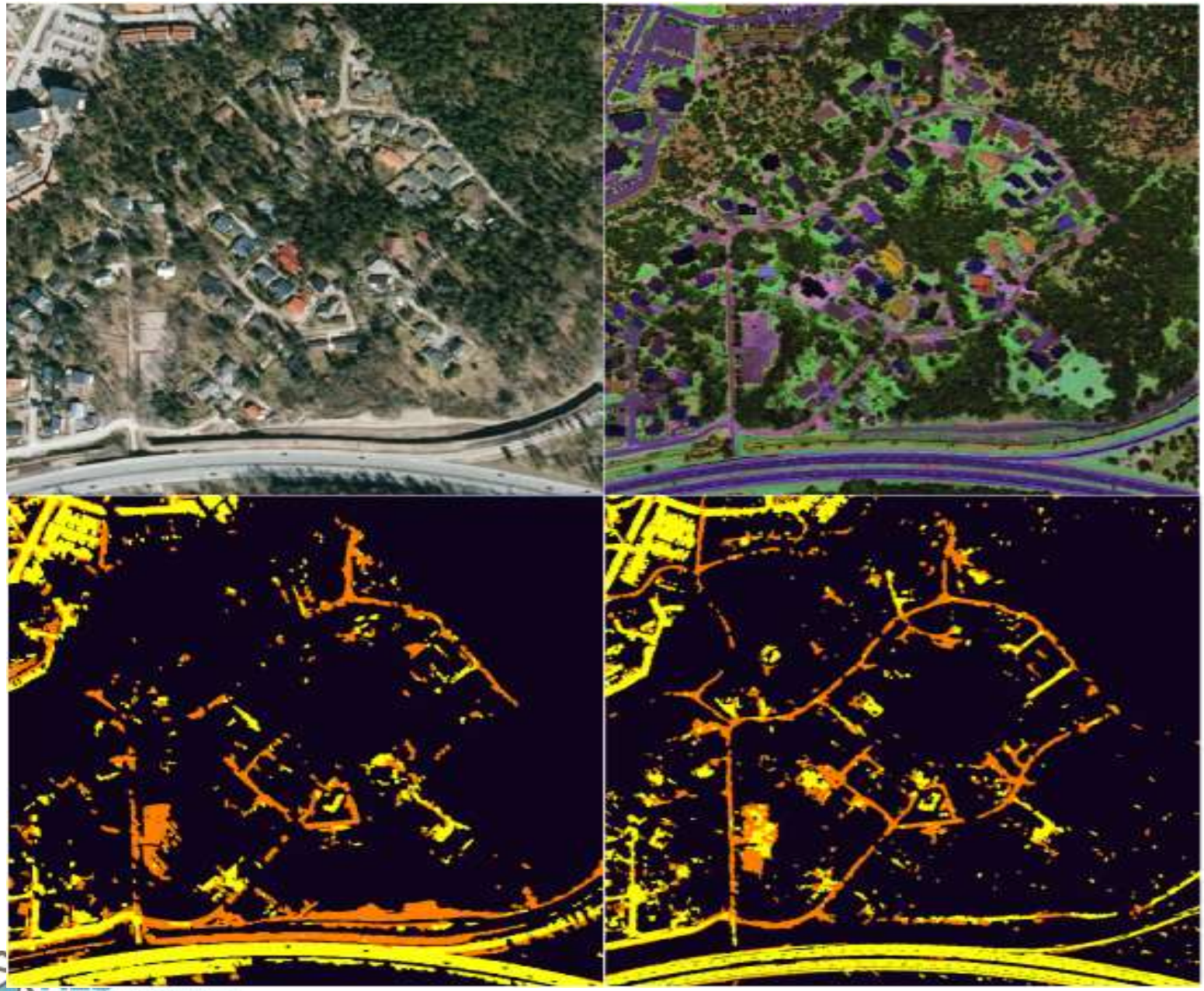
Object-based analysis



Land cover classification





Road mapping

Accuracy:

- 81% of topographic database road centre lines classified as road
- 93% of road surface classified correctly into asphalt or gravel

Figure and results: Kirsi Karila

Solves many basic problems

Confusion matrix based on intensity features

		Predicted			producer
		Pine	Spruce	Birch	
Reference	Pine	623	12	16	95.70
	Spruce	32	180	27	75.31
	Birch	47	18	197	75.19
user		88.75	85.71	82.08	Overall = 86.81%

Confusion matrix based on point cloud and intensity features

		Predicted			producer
		Pine	Spruce	Birch	
Reference	Pine	622	14	15	95,55
	Spruce	18	201	20	84,10
	Birch	46	21	195	74,43
user		90.67	85.17	84.78	Overall = 88.36%

Change based national mapping: LS every 2-5 years

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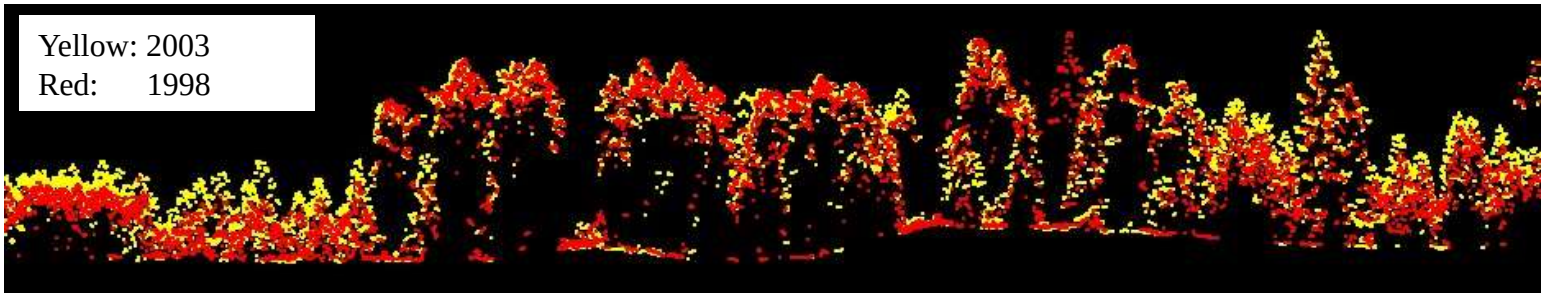
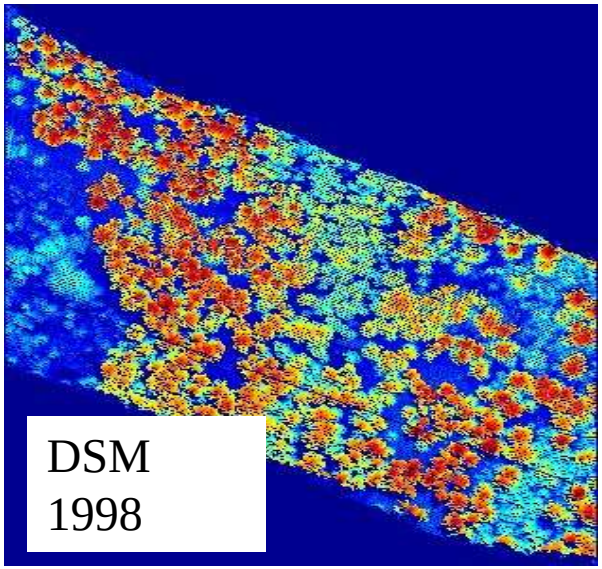
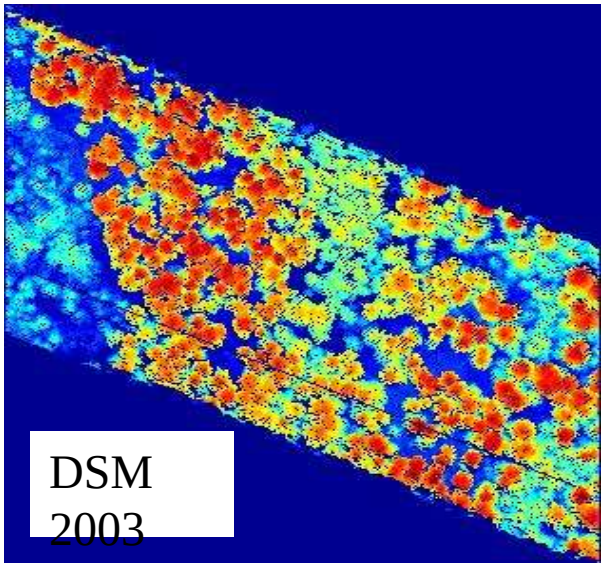
Change Based Mapping







Hyyppä, J., Yu, X., Rönnholm, P., Kaartinen, H., and H. Hyyppä, 2003. Factors affecting laser-derived object-oriented forest height growth estimation, *The Photogrammetric Journal of Finland,* Vol. 18(2), 16-31.

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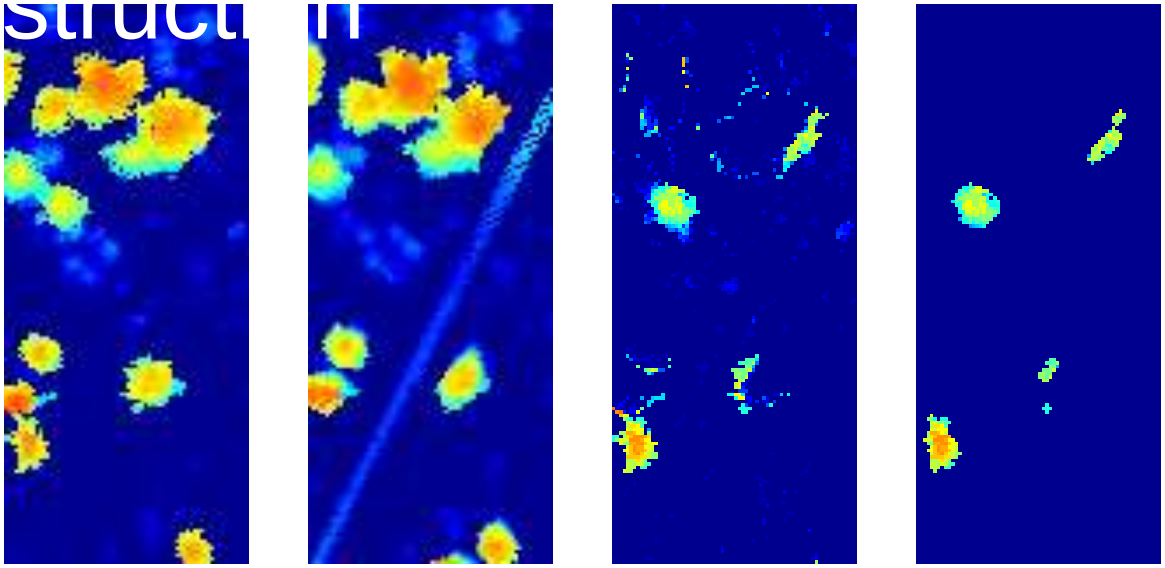
Courtesy to Xiaowei Yu, FGI

This change monitoring capacity would cost in Finland 1€/person per year



Yu, X., Hyyppä, J., Kaartinen, H., and M. Maltamo, 2004. Automatic detection of harvested trees and determination of forest growth using airborne laser scanning. *Remote Sensing of Environment*, Vol. 90, 451-462

Indoors and GNSS denied environments

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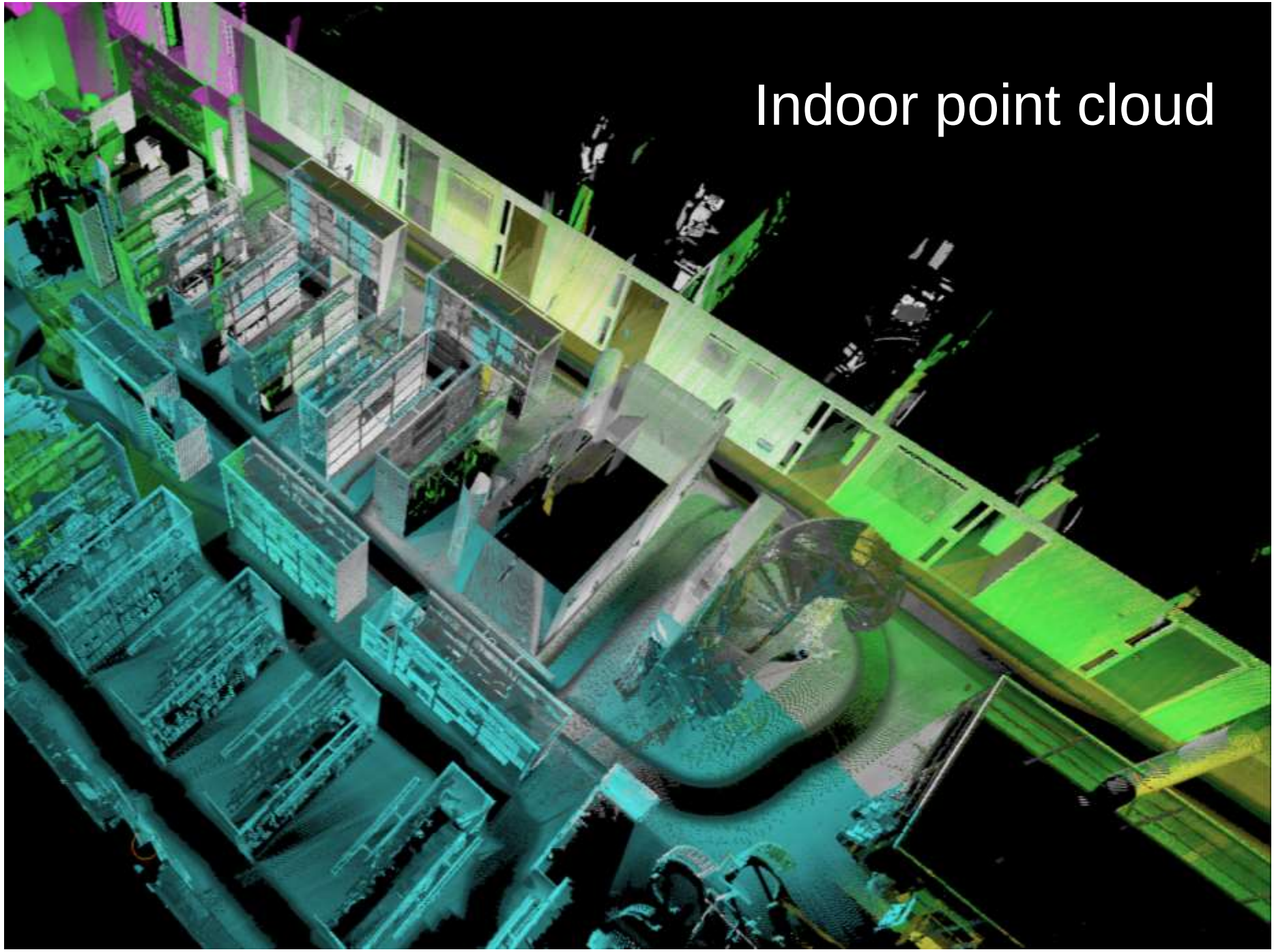
Indoor point cloud

Combination of PLS and Indoor TLS for seamless modeling

Citizens and small SMEs can have NMCA capacity

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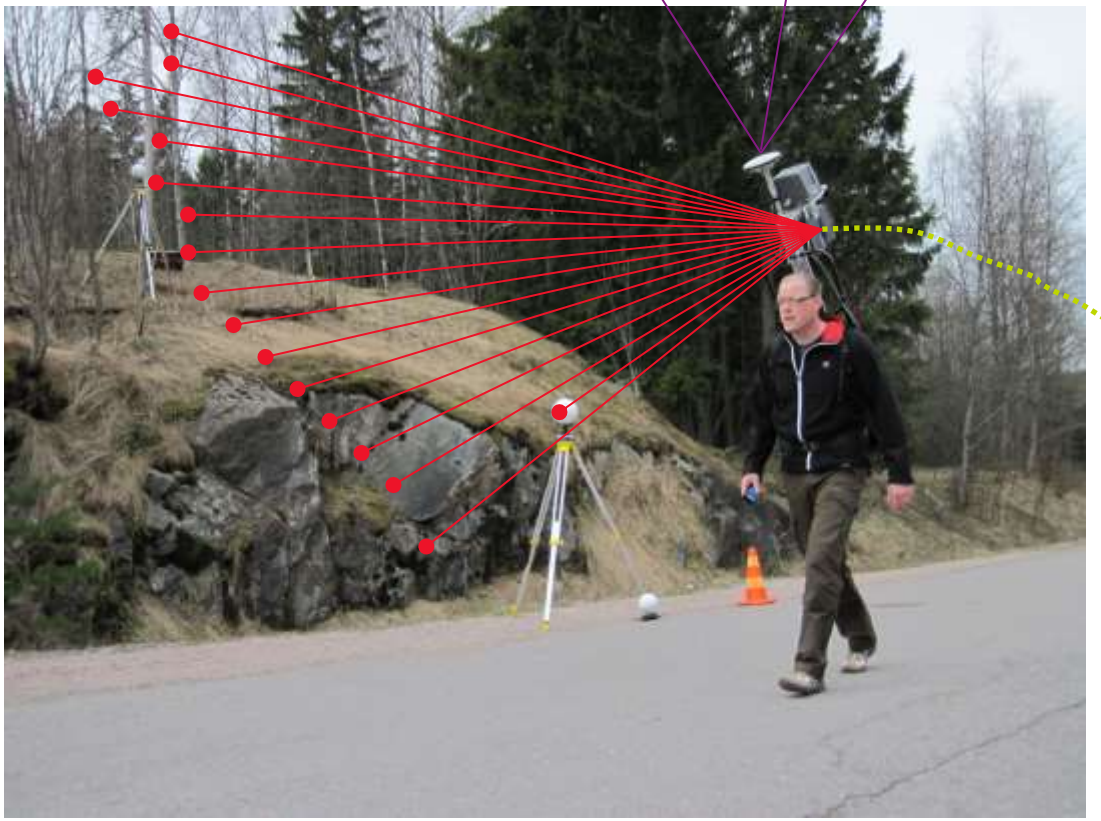
Phone-based mapping

Figure 1. RGB image (left) and range image (right) taken by Kinect sensor. Markers pinned on the trunk can be visually identified from the RGB image.

Personal laser scanning system

- Specialized application of MLS
- GNSS-INS Positioning
- Ultra high speed laser scanner
- Mobility

- Suitability for many new applications



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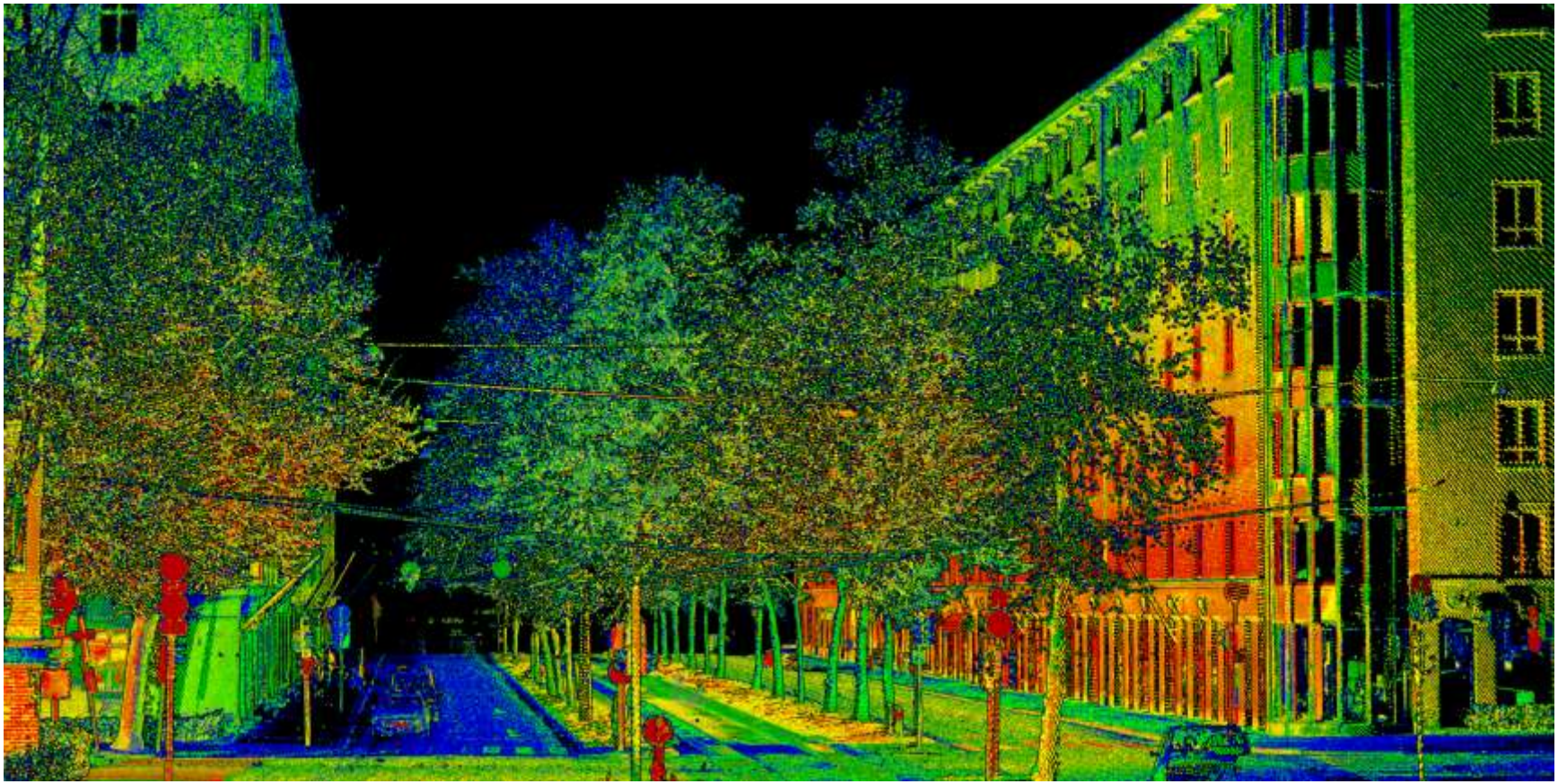
Point Cloud



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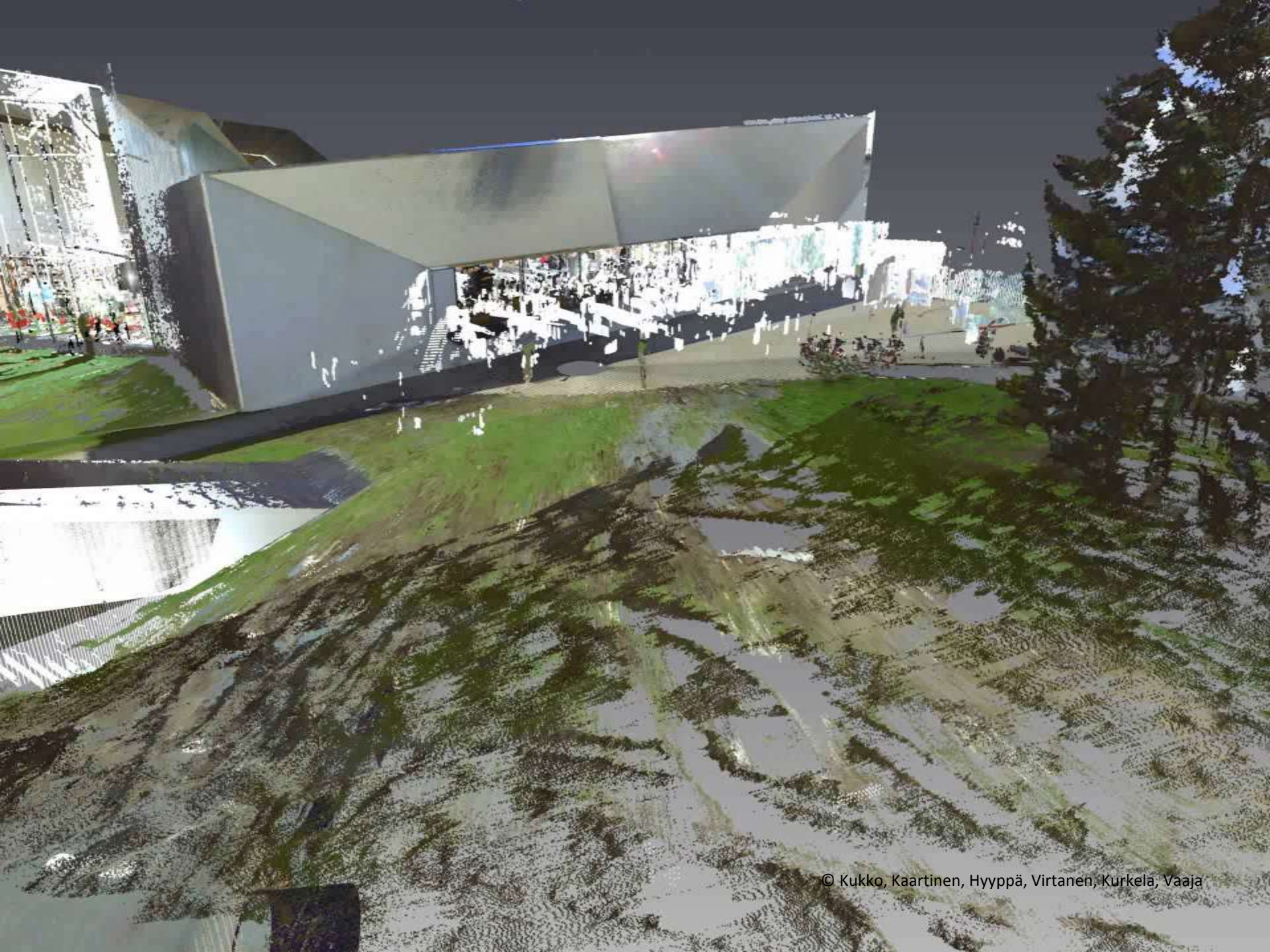
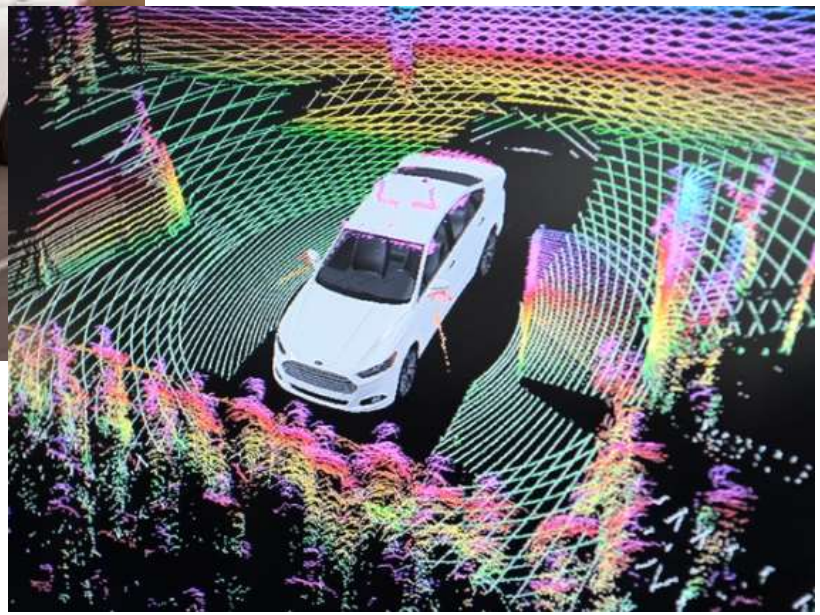
Point cloud as topographic data base


© Kukko, Kaartinen, Hyyppä, Virtanen, Kurkela, Vaaja

Autonomous Driving



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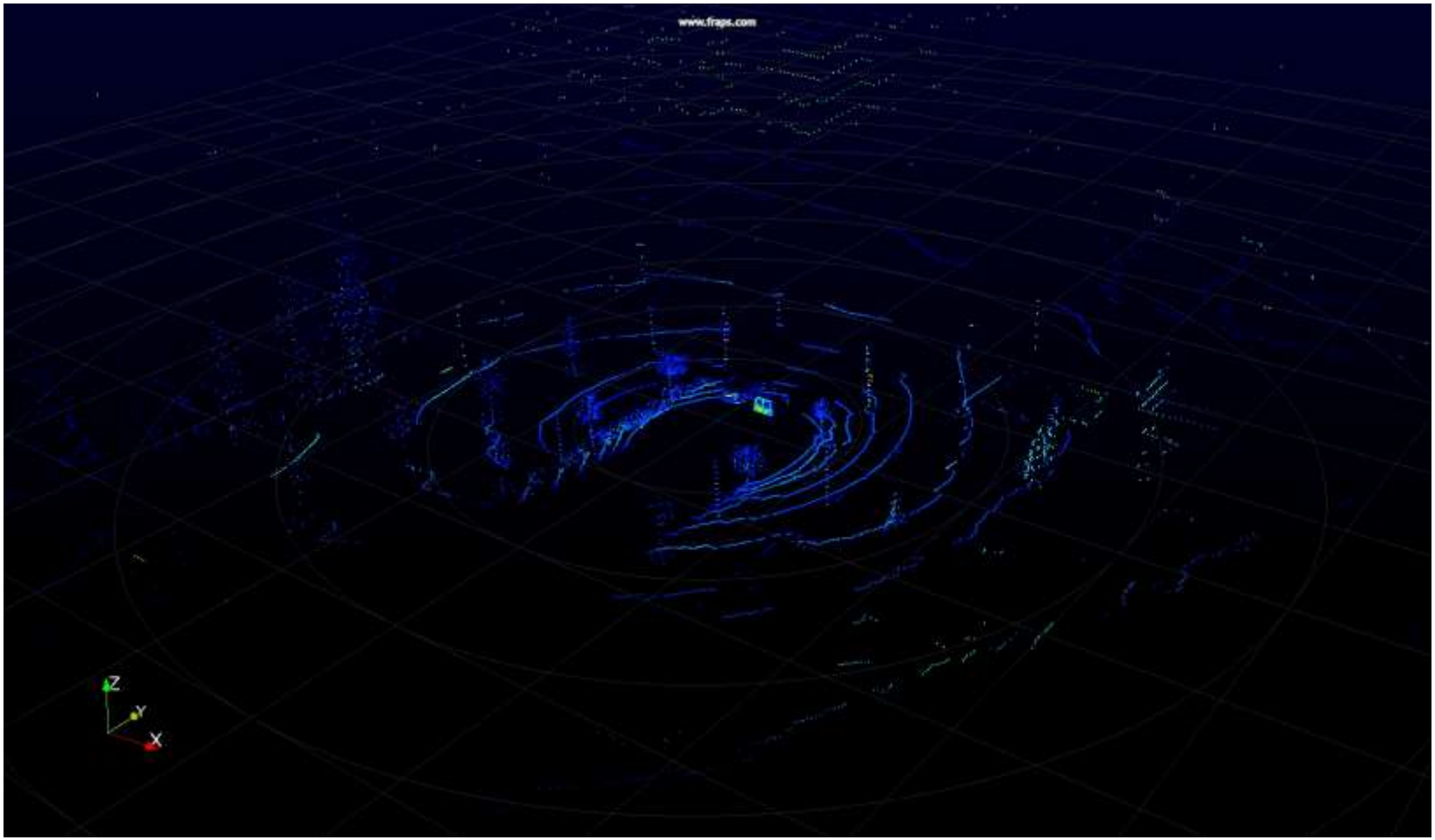
Real-time data



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Autonomous driving

Autonomous Driving

Google's modified Toyota Prius uses an array of sensors to navigate public roads without a human driver. Other components, not shown, include a GPS receiver and an inertial motion sensor.

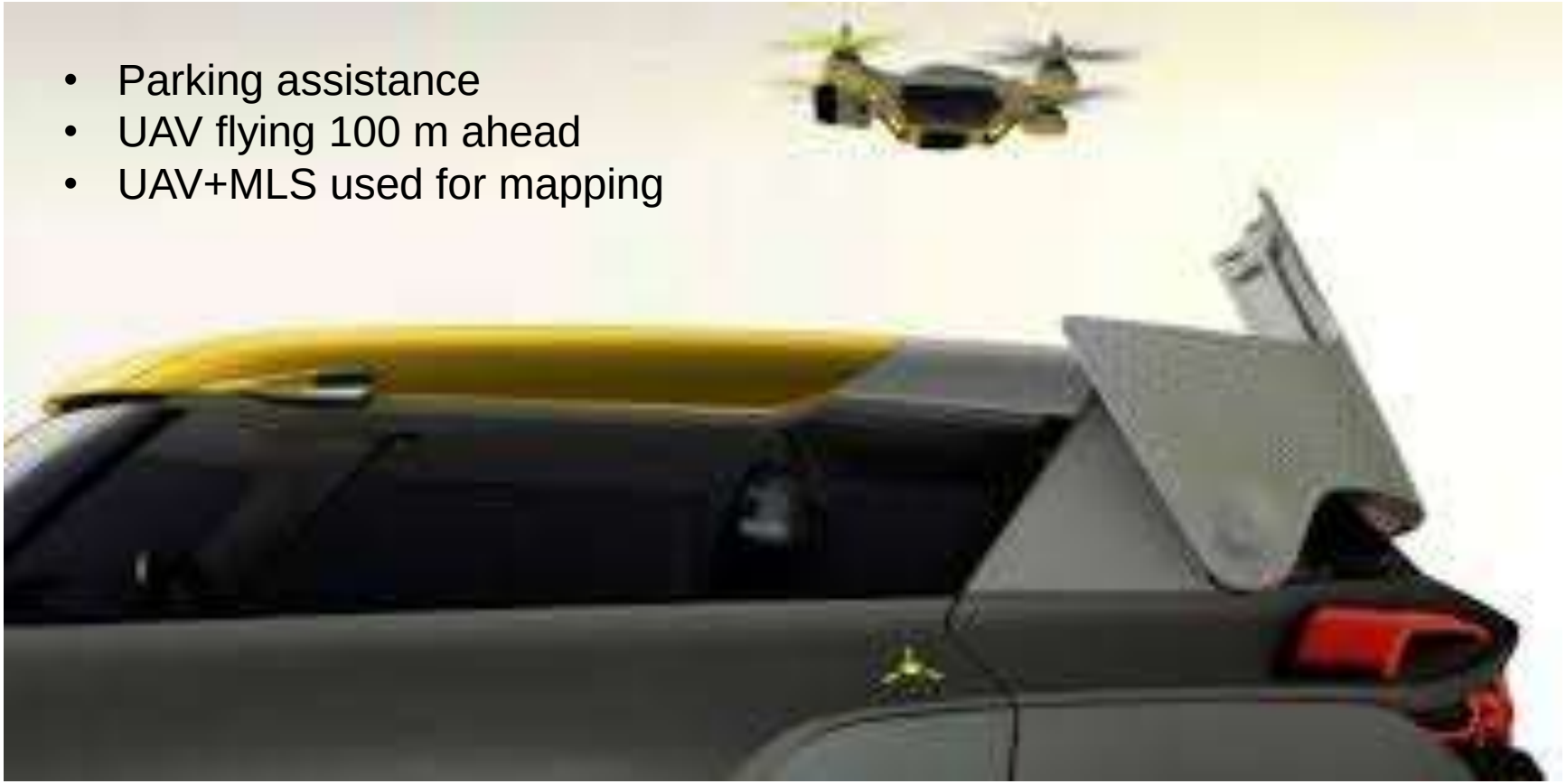
LIDAR
A rotating sensor on the roof scans more than 200 feet in all directions to generate a precise three-dimensional map of the car's surroundings.

POSITION ESTIMATOR
A sensor mounted on the left rear wheel measures small movements made by the car and helps to accurately locate its position on the map.

VIDEO CAMERA
A camera mounted near the rear-view mirror detects traffic lights and helps the car's onboard computers recognize moving obstacles like pedestrians and bicyclists.

RADAR
Four standard automotive radar sensors, three in front and one in the rear, help determine the positions of distant objects.

UAV and MLS linkage



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Robotbus project stack
COE, SOHJOA, COMBAT

National Decision Makers

Trafi Board
(@Anna_Jokela)

Minister Kai Mykkänen
(@HarriSantamala)

Peter Vesterbacka
(@pvesterbacka)

HKI, Pekka Sauri
(@satu_helsinki)

Zeit Online

The Guardian

International Decision Makers

Xinhua News

TechCrunch

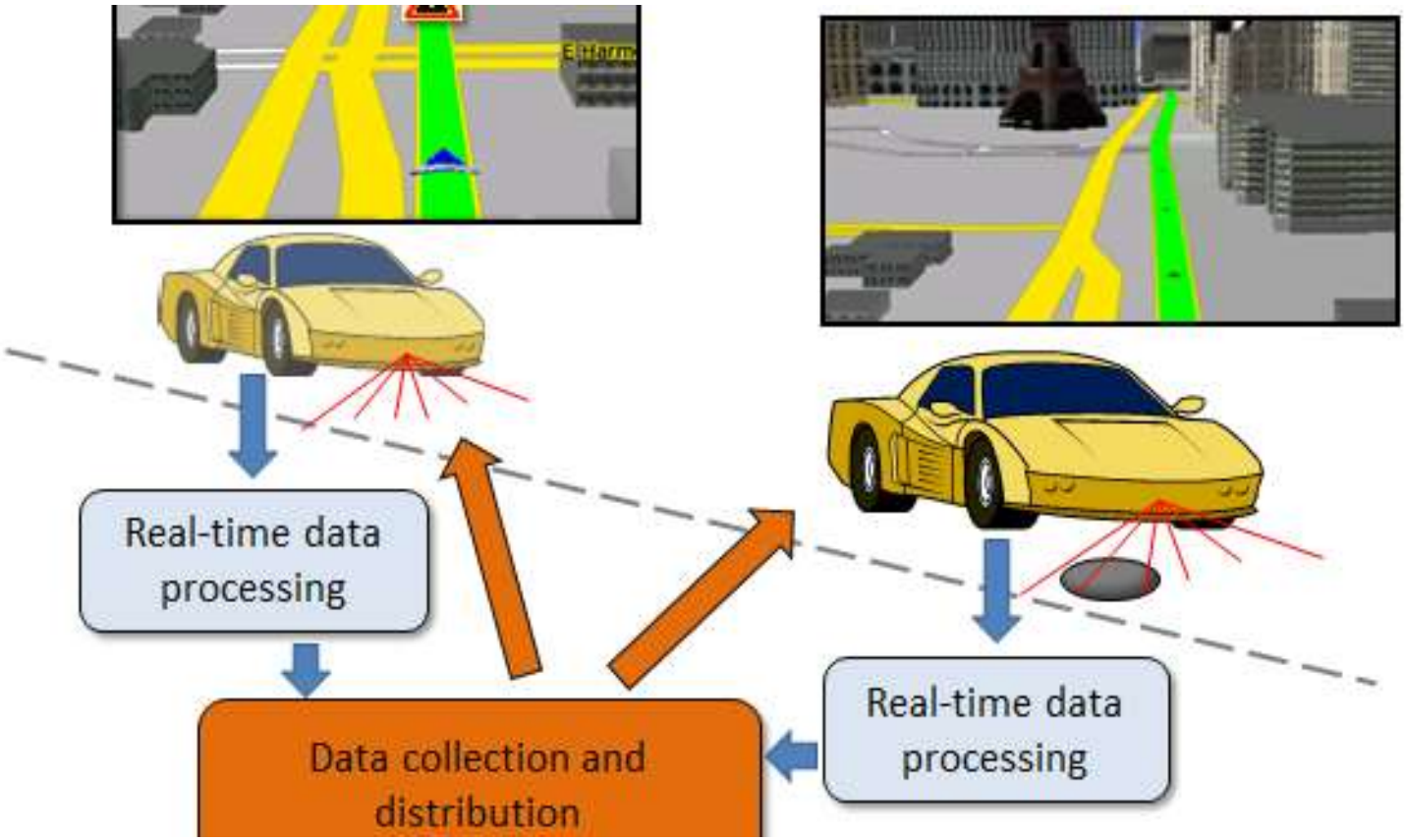
CNN Money

President of Lithuania
Dalia Grybauskaitė
(@hannuhyyppa)

Selected International Media

We have the biggest robotics research group in Finland

Data used as Big Data?



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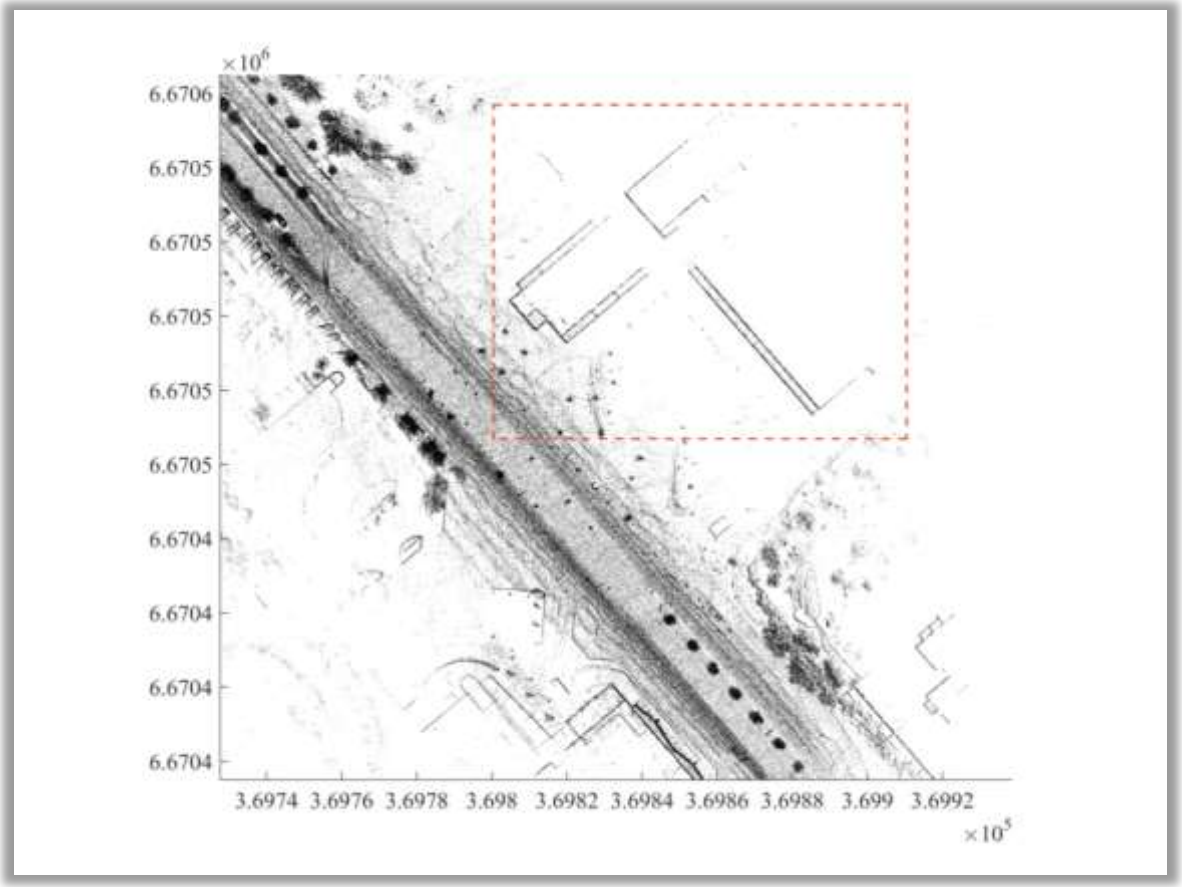
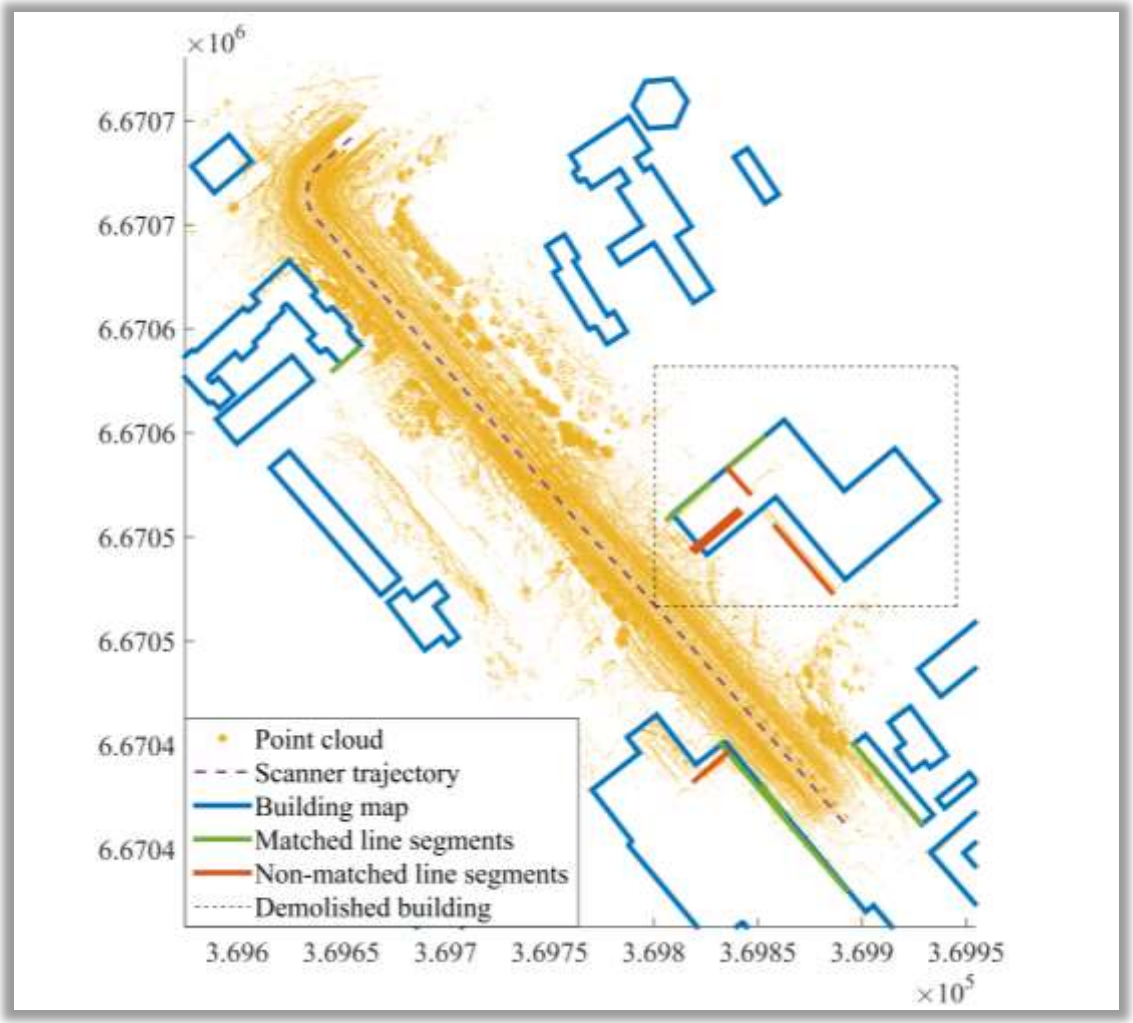


Automated map updating

The area inside the rectangle (red dashed line) contains the new buildings that were not presented in the old building map.



Old Building Map and Extracted Lines

The extracted lines (red and green) have been compared with the old building map (blue lines). Red lines correspond to extracted walls that do not match with the old building map: They indicate new buildings.

Car parkings

Figure. a) Part of the street Espoonlahdenkatu as recorded on the reference video during data acquisition Drive 1. b) Raster representation of the car-based laser scanner data. The pixel value of each 0.3 m × 0.3 m cell corresponds to the number of laser points inside the cell. Parked cars appear as L shaped clusters of bright pixels.

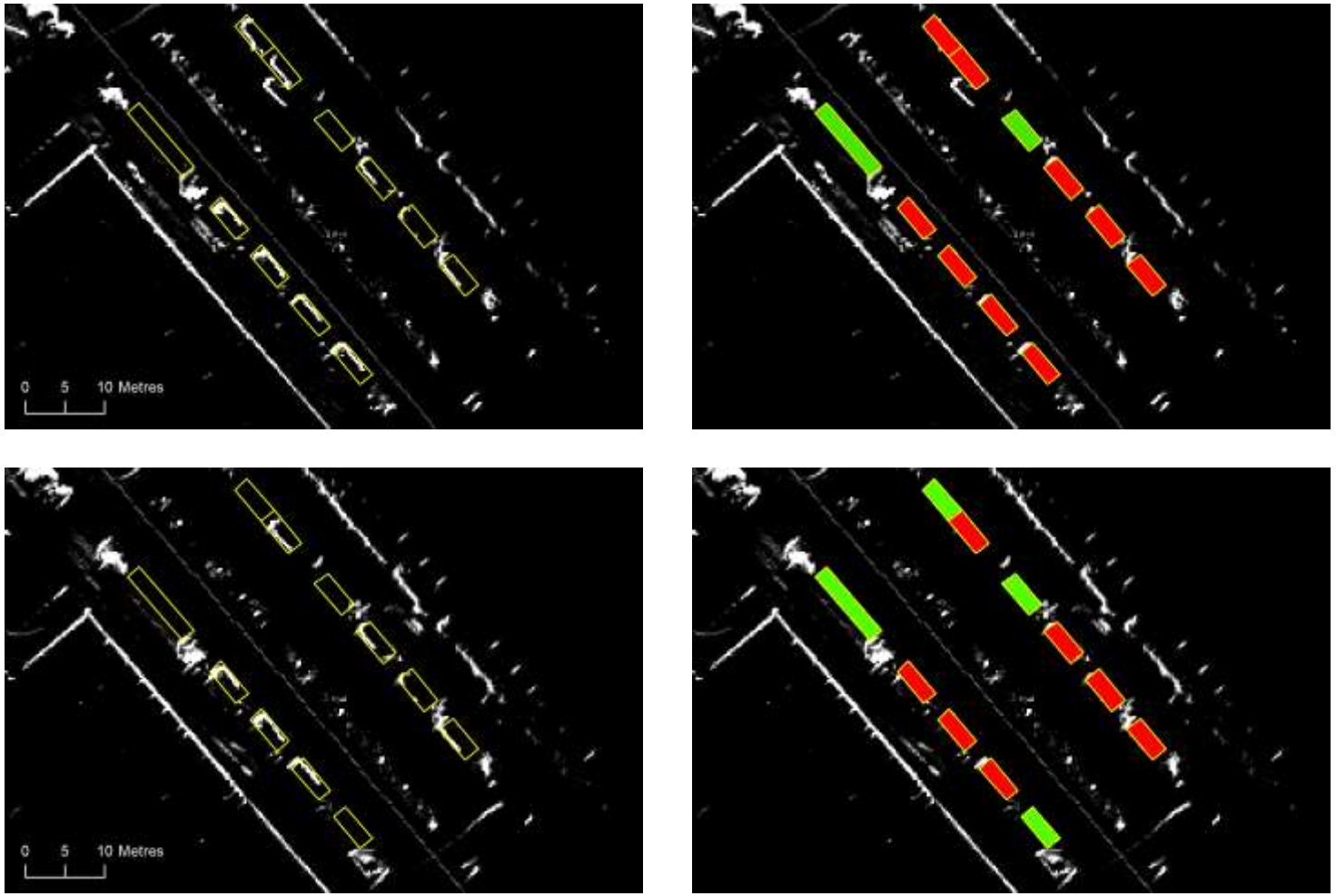


Figure x. Data (left) and classification results (right) for Drives 1 (upper row) and 2 (lower row). Parking places classified as free are shown in green and parking places classified as occupied are shown in red. Digitized boundaries of the parking places are shown in yellow.

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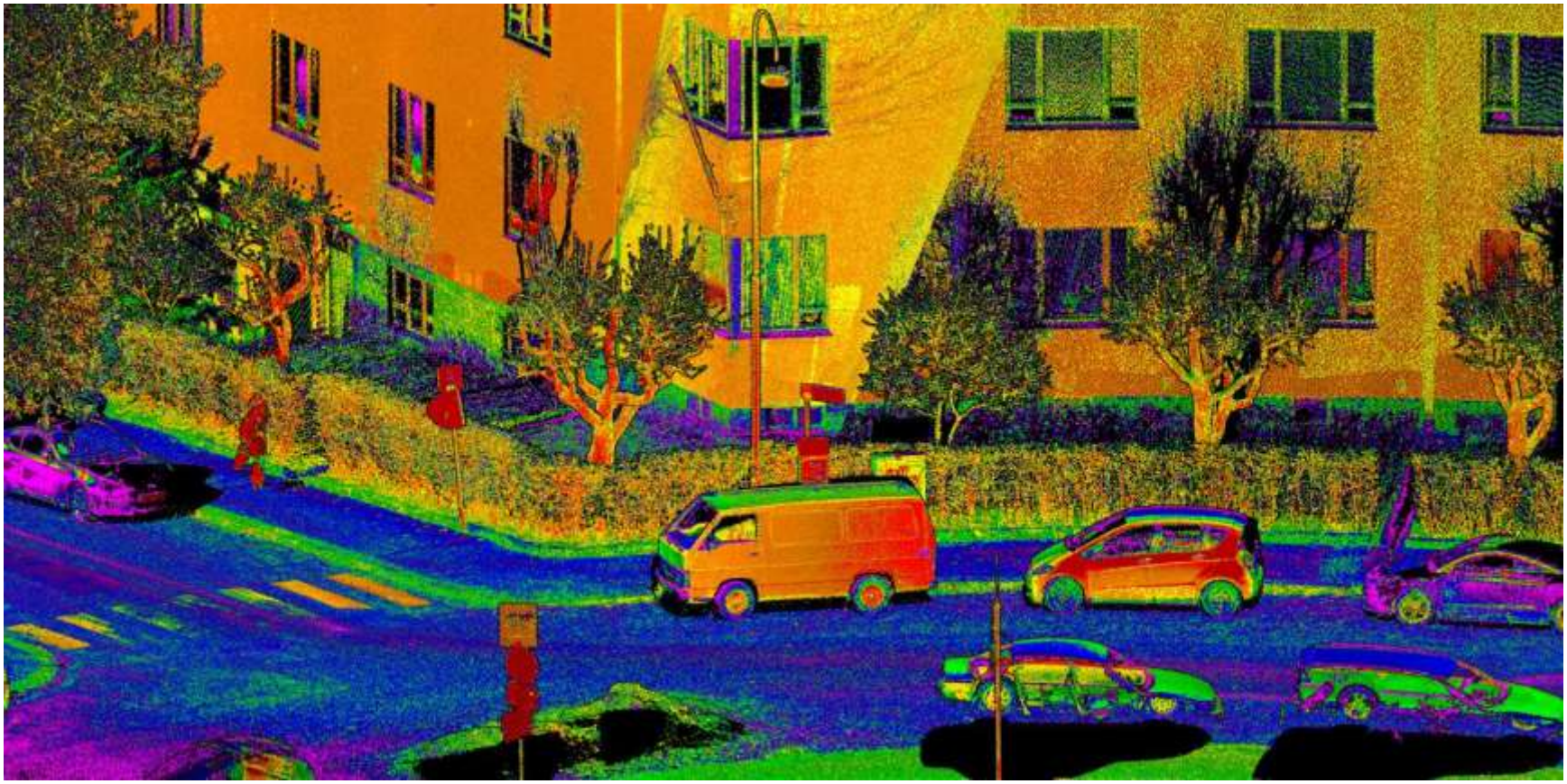
Level 5 autonomous car data



What should NMCA do?

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Action items

- Main issue from collaboration with companies
  - **Reasonable amount of current money allocated smartly to R&D of innovative SMEs capable to export will pay it back to the society with increased employment and taxes paid**. With the current technology disruption this may even generate a new value adding service sector.
- National collaboration at ministry level may be needed
  - **National data acquisition programmes solving national problems** (environment, built, traffic etc)
- Provide National Core Datasets
  - **Industry provides as subcontract, NMCA specifies**
  - Huge savings when large areas collected at the same time
  - **Open data or near-open data** serving all citizens and Value-adding companies
- What about if National Topographic database = High-quality Point Cloud + Images (and basic products done with 95% automation)


CHANGE
OR DIE.