

3D Vision Based Mobile Mapping and Cloud-Based Geoinformation Services

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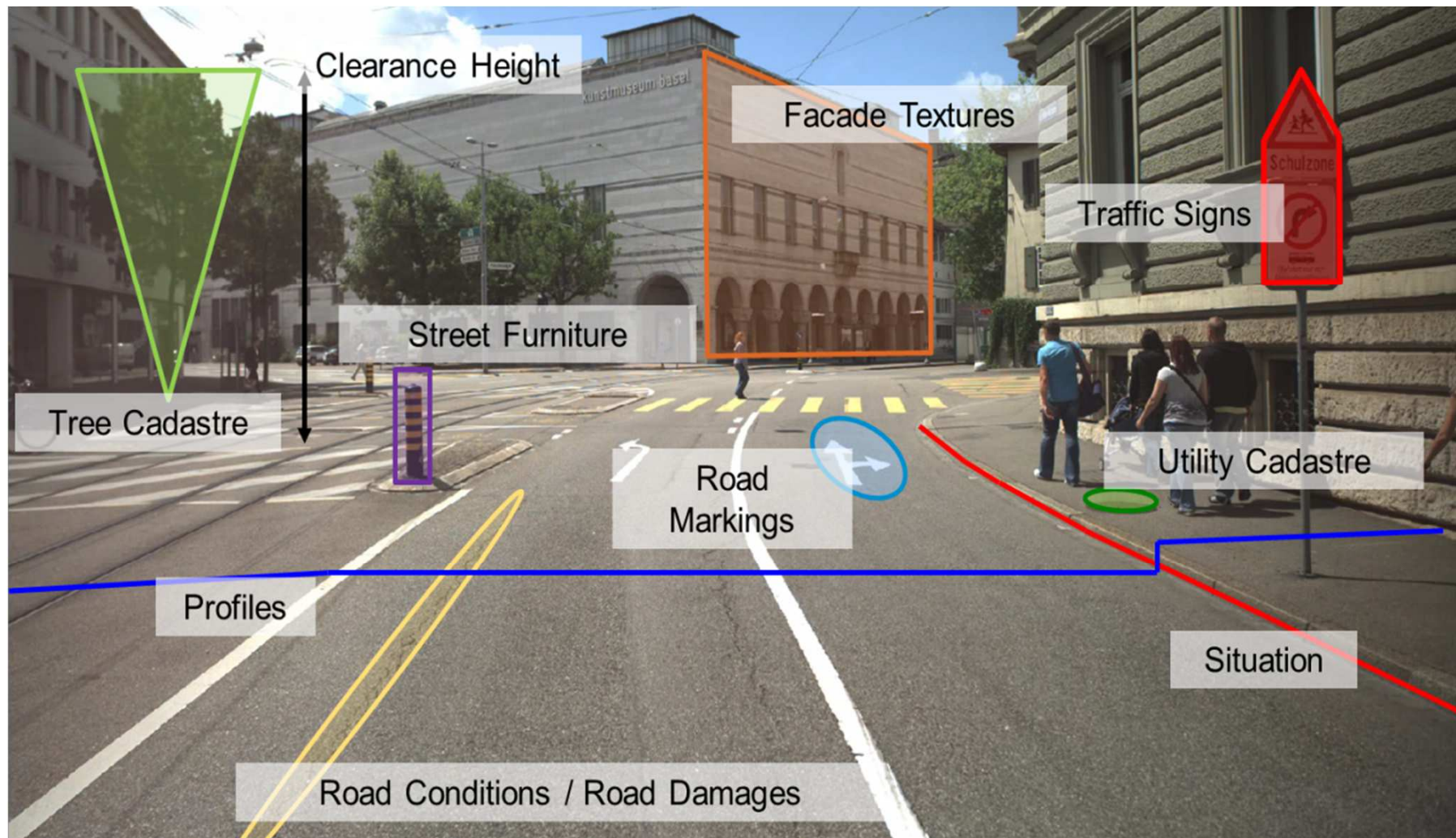
Beyond Limits – Developments in Cadastral Domain

Joint Workshop organized by C+LR KEN of EuroGeographics in
cooperation with Swiss Think Tank "Dimension Cadastre"

Zurich, Switzerland, 19-20 March 2015

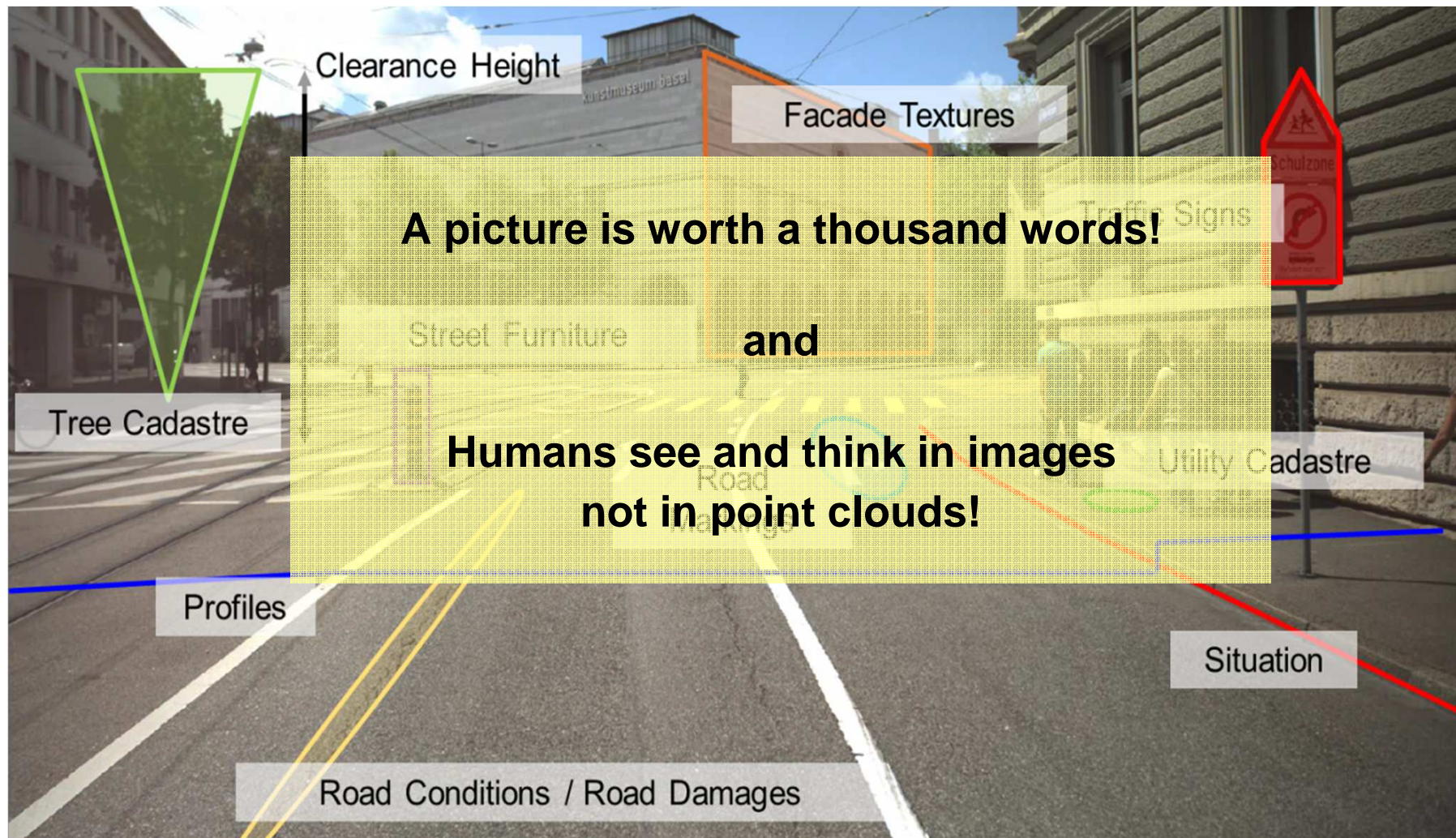
The vast majority of Mobile Mapping relies on Laserscanning

So why Imagery and why 3D Image-based Mobile Mapping?



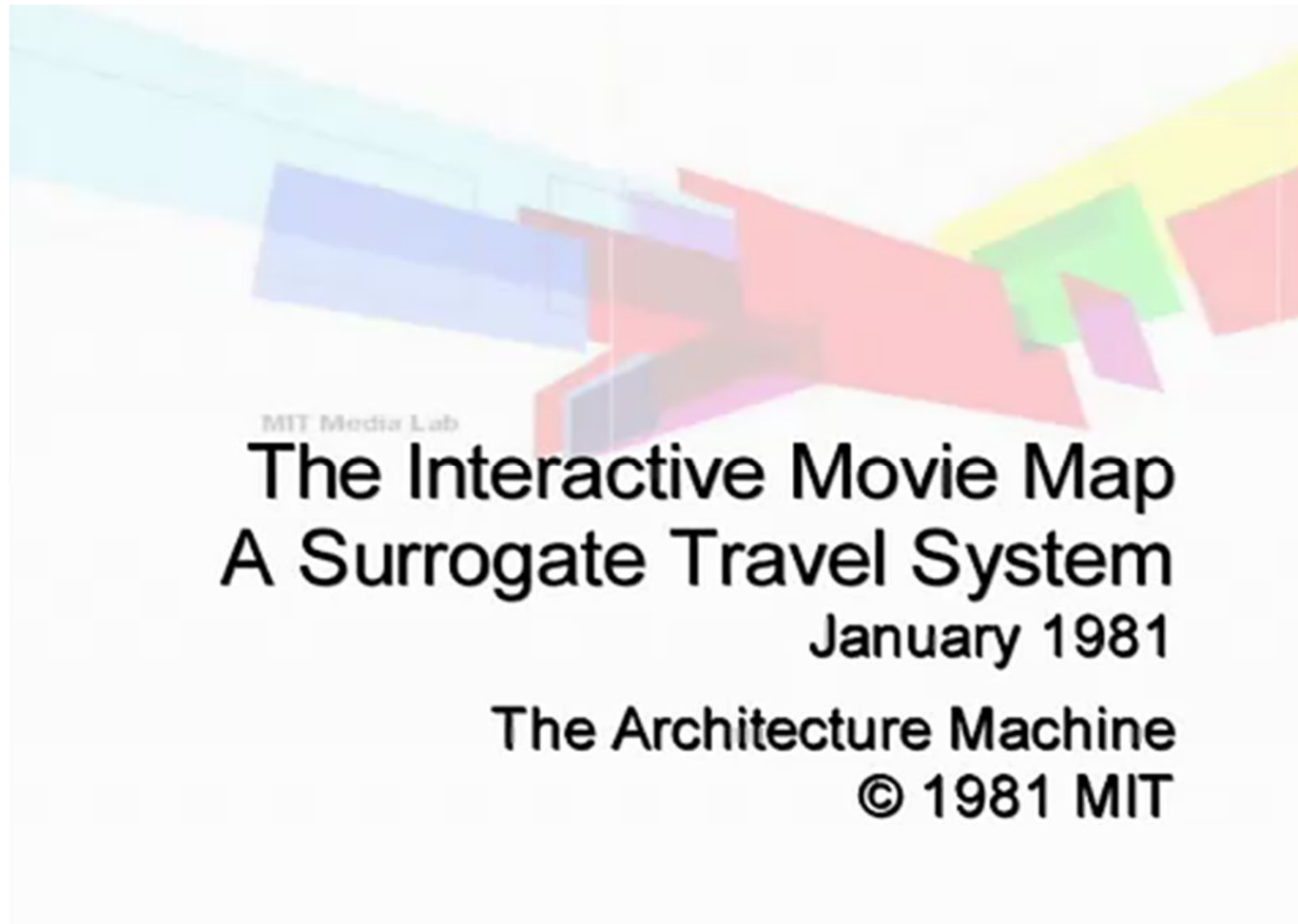
An estimated 90% of Mobile Mapping relies on Laserscanning

So why Imagery and why 3D Image-based Mobile Mapping?





Aspen Movie Map – An Early Street View Vision



Visionary Features

- Interactive navigation
- Linking of video with 2D map
- Multi-temporale imagery contents
- Multimedia contents (Images, sound, video)
- Augmented display
- Touch interface
- Voice output

Lippman, A., 1980. Movie-maps: An application of the optical videodisc to computer graphics. ACM SIGGRAPH Computer Graphics 14(3): 32-42.

Background

The Street View Idea

- There was life before Google (Street View) ...

Why not successful in the 1980es – why now?

Recent tremendous progress in ...

- Digital cameras
- Storage capacity and performance
- Network bandwidths
- Cloud computing (massive / on-demand computing and storage capacities)
- New Web technologies (web programming language / plug-in free solutions)

Outline

Introduction / Motivation

Vision

Technology

Applications

Conclusion and Outlook

Vision

The 3D Geoinformation Loop

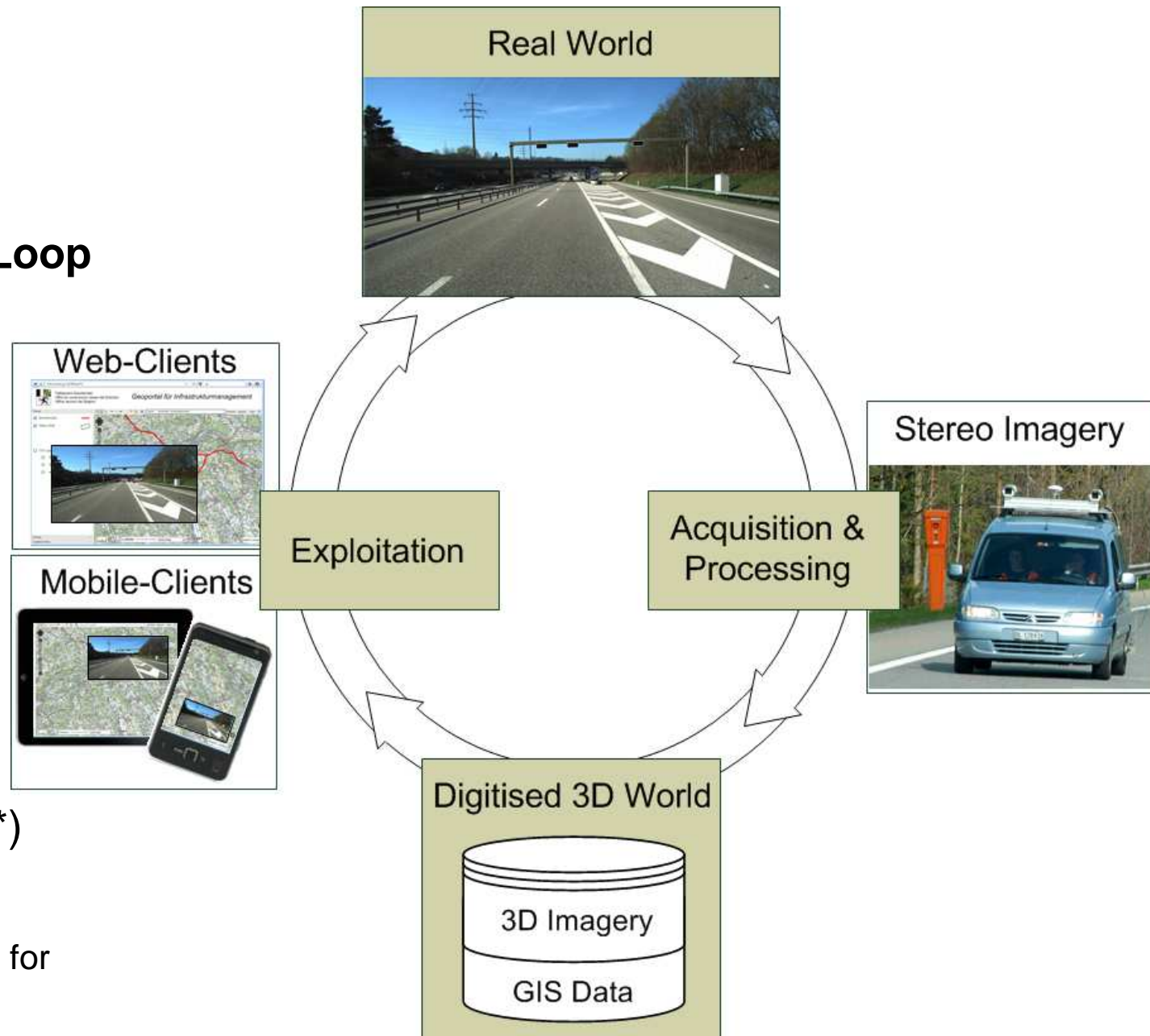
based on

Intelligent 3D Image Spaces

Research Projects

- SmartMobileMapping (*)
- infraVIS (*)

(*) supported by the Commission for
Technology and Innovation CTI



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3D Vision Mobile Mapping – Acquisition Systems

Mobile Platform

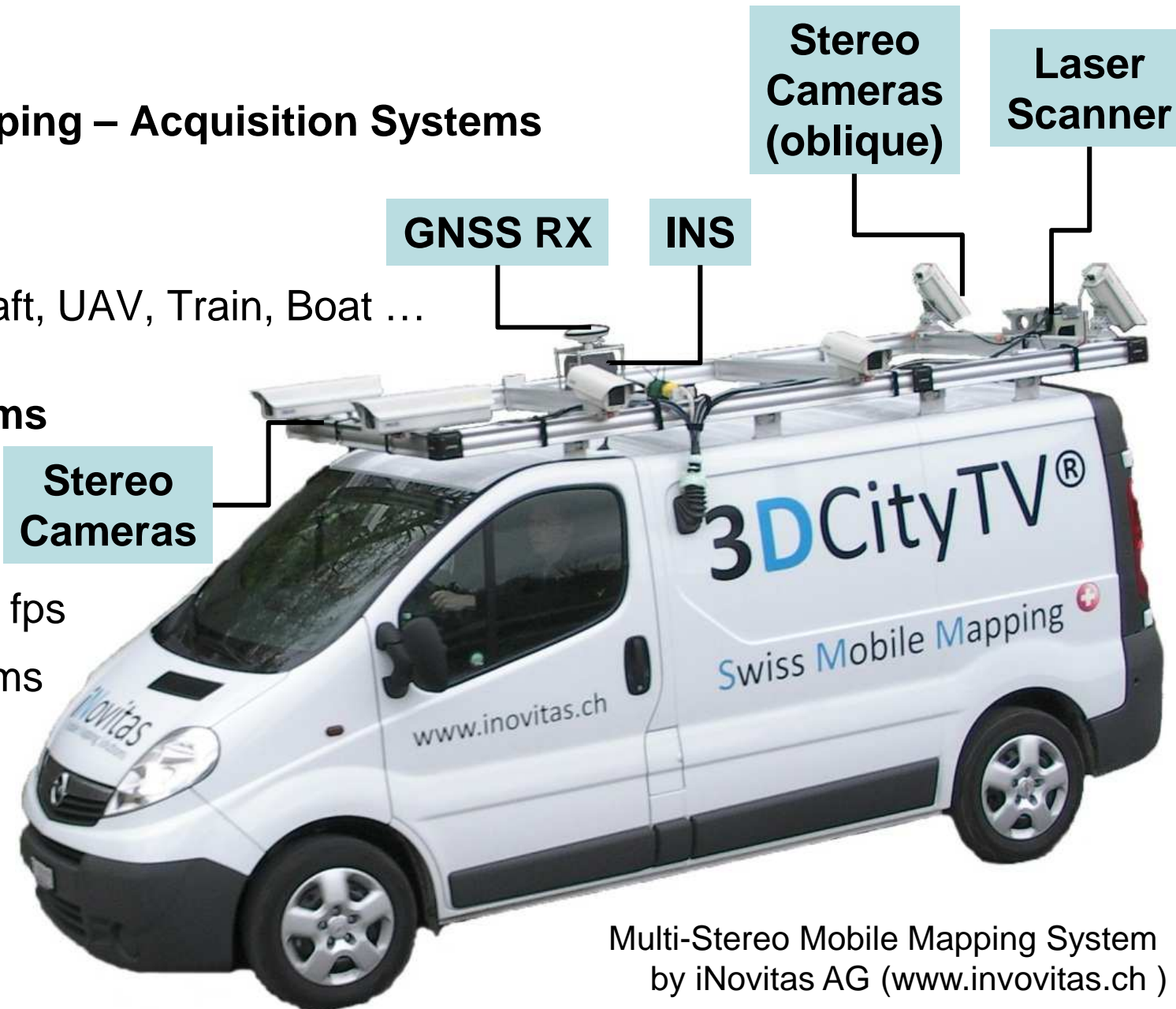
- Motor Vehicle, Aircraft, UAV, Train, Boat ...

Multiple Stereo Systems

- high-performance industry cameras
- up to 11 MP, 5 to 30 fps
- up to 5 stereo systems (i.e. 10 cameras)

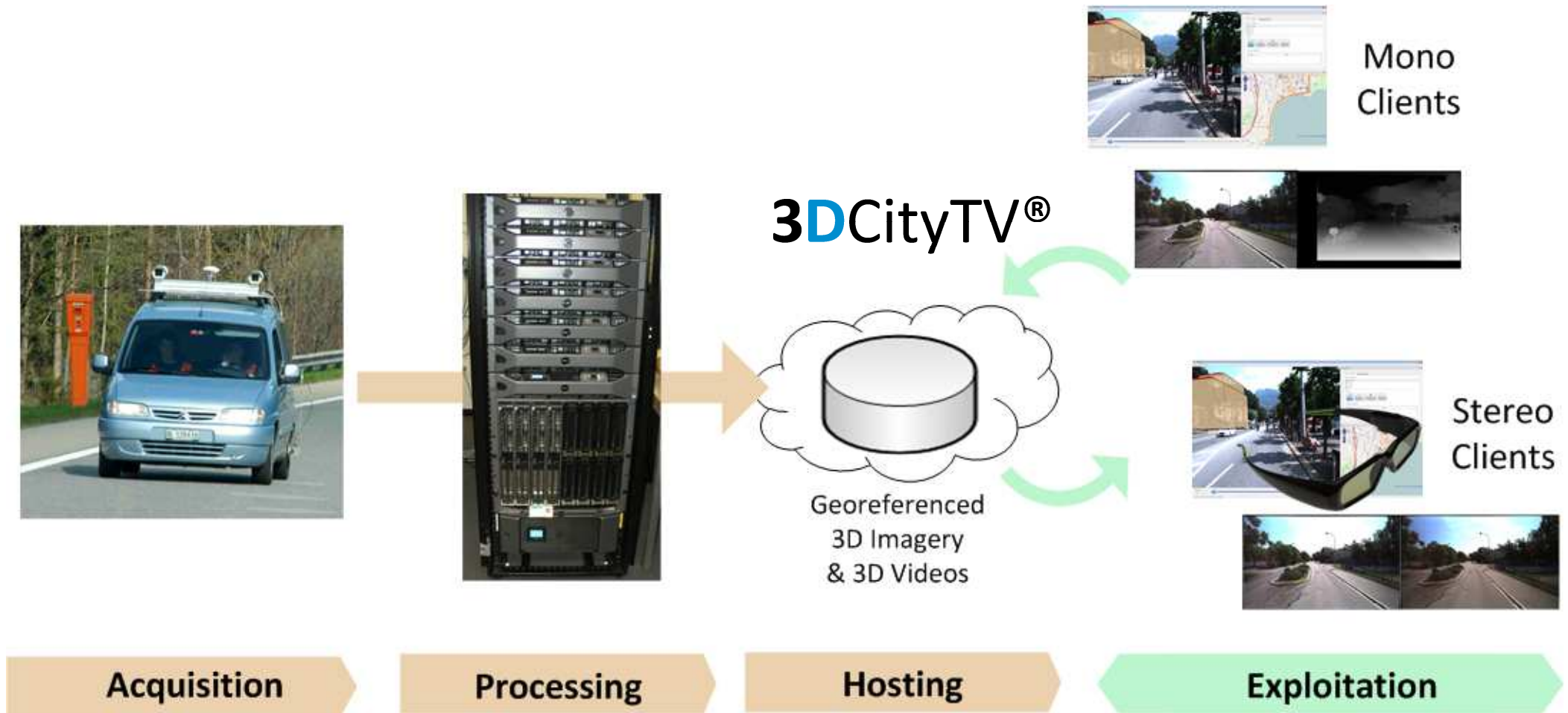
Onboard data storage

- highly parallel
- 1-2 TB per hour



Multi-Stereo Mobile Mapping System
by iNovitas AG (www.inovitas.ch)

3D Vision Mobile Mapping – Components and Workflow



infra3D Technology – Processing

System calibration

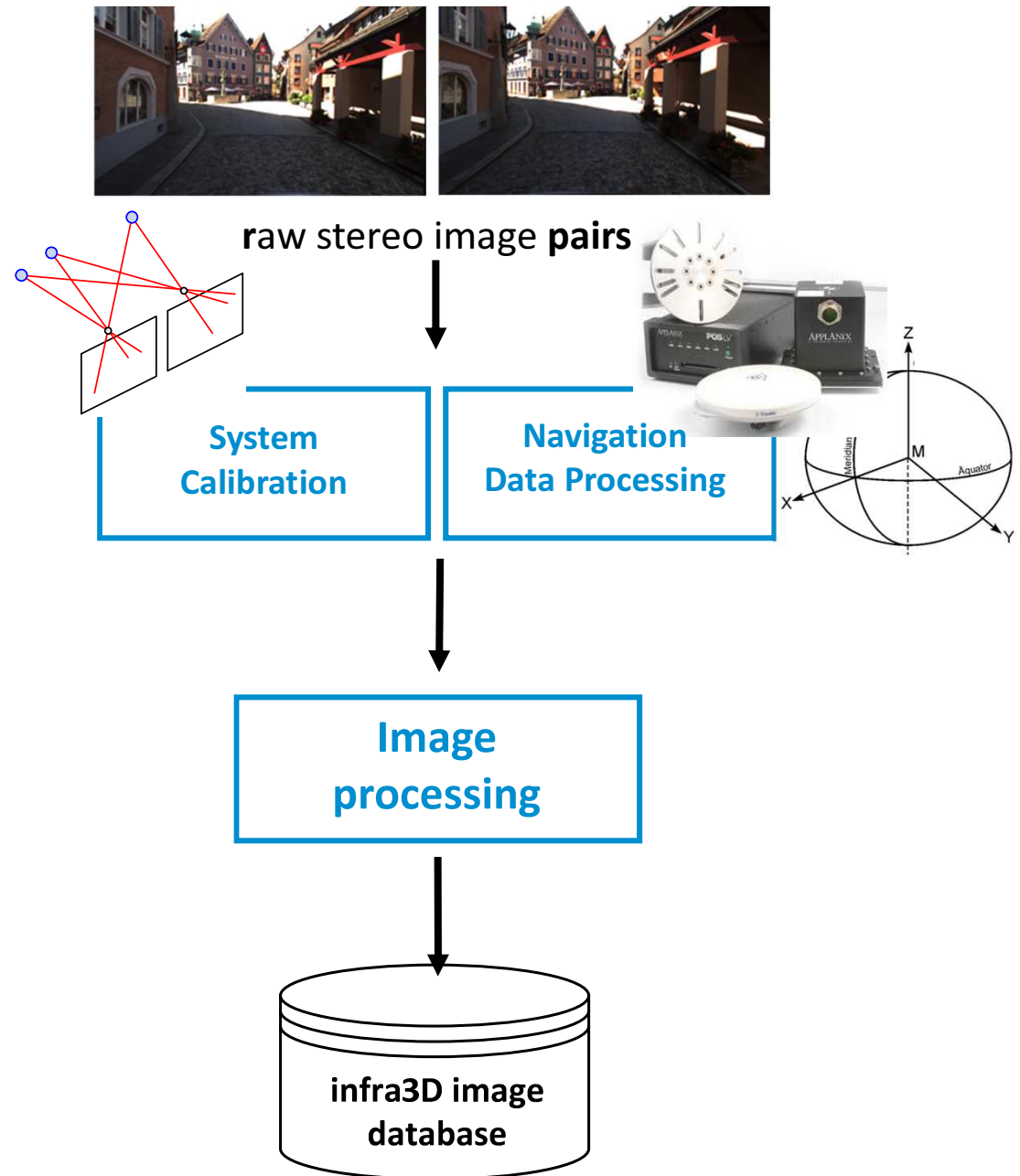
INS/GNSS navigation data processing

- Direct sensor orientation –
DSO (Standard)
- Integrated sensor orientation –
ISO (if required)

Stereo image normalisation

3D image generation

3D image database population



3D Image Generation by Dense Image Matching

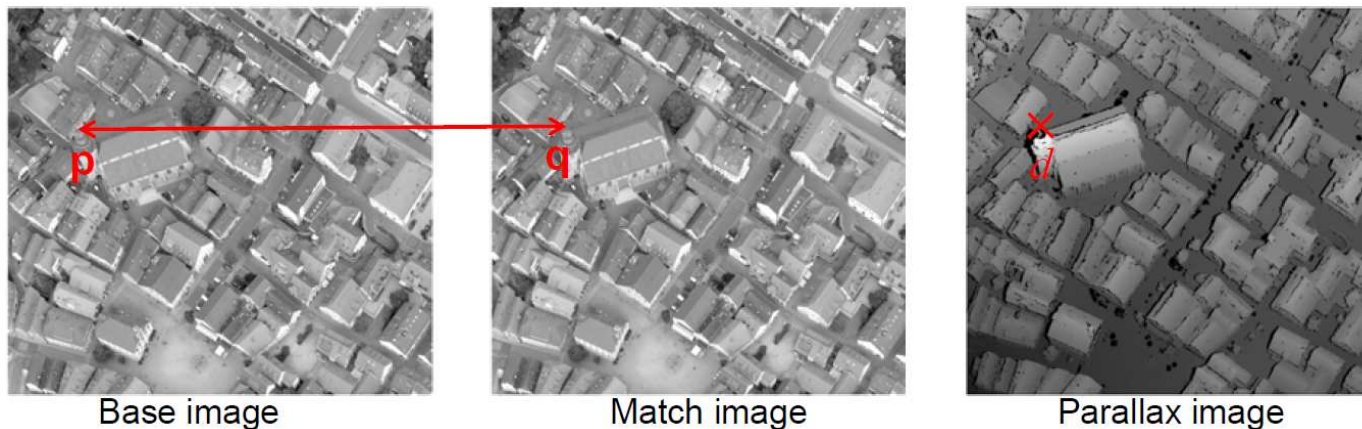
Goal: depth / distance computation for each pixel

Semi-Global Matching (SGM)

Hirschmüller, H., 2008. Stereo processing by semiglobal matching and mutual information. IEEE transactions on pattern analysis and machine intelligence, 30(2), pp.328–41.

Dense matching of aerial stereo image pair and resulting disparity map

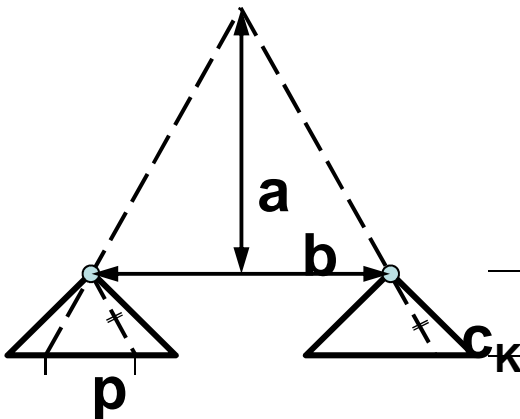
Haala, N., 2011. Multiray Photogrammetry and Dense Image Matching.



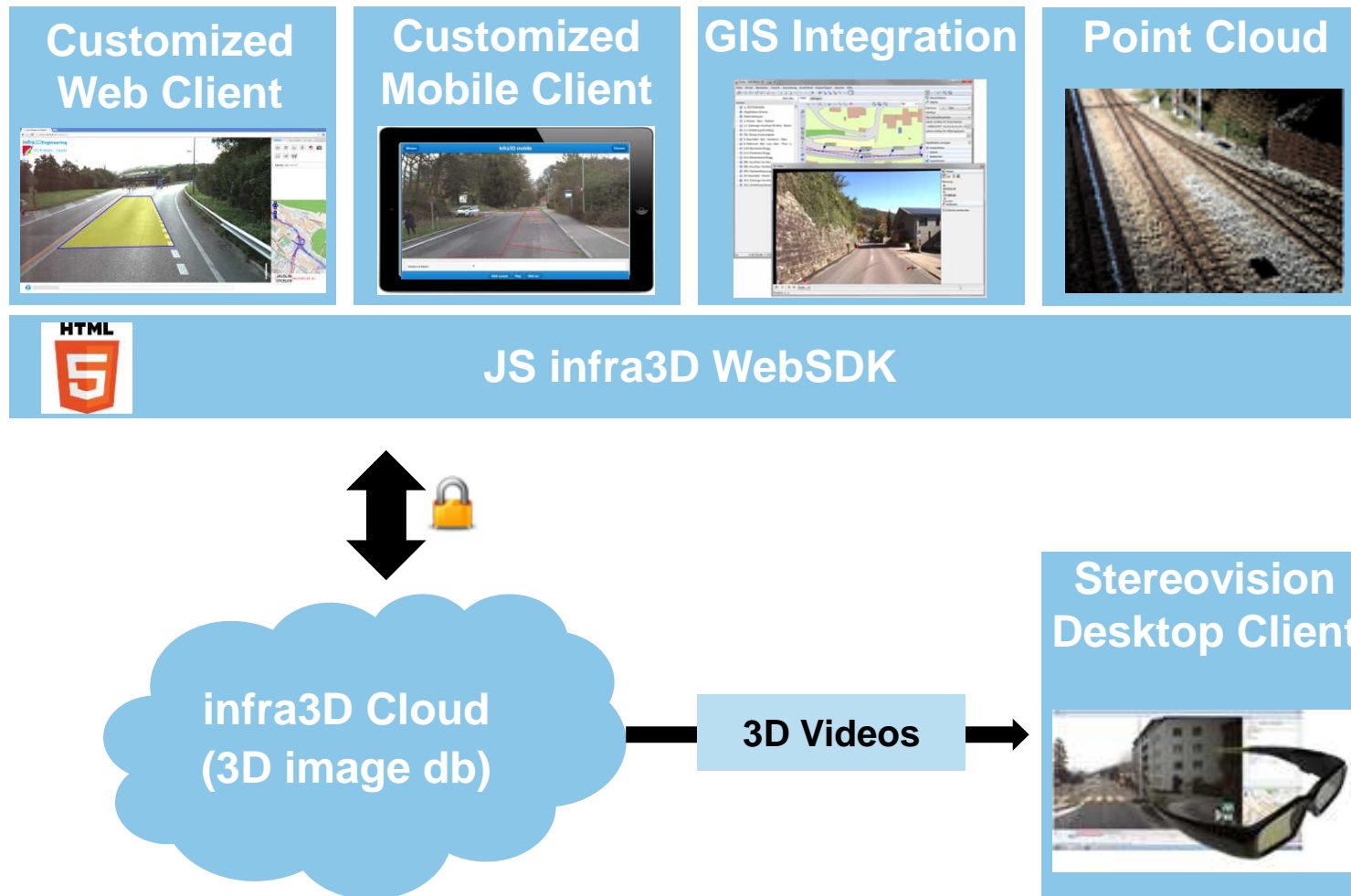
Mobile Mapping Stereo Scene and Depth Maps from Dense Image Matching

Top: stereo scene
acquired with IVGI
Stereovision MMS

Bottom: disparity
maps extracted
using SURE dense
matching software



infra3D Technology - Exploitation



3D Point Coordinate Determination Accuracy

(MSc Project Cavegn, 2010; Bachelor Thesis Arnold, 2011)

Empirical Standard Deviations of Coordinate Differences

- stereovision mobile mapping vs. tachymetry (reference)
- approx. 50 check points

	Position	Height	3D
Absolute	3-4 cm	2 cm	4 cm
	3D Distance		
Relative	< 1 cm		

- With ground control points & integrated sensor orientation
 - 1-2 cm absolute 3D accuracy (even in tunnels)



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infra3D – ASTRA / FEDRO Swiss Federal Roads Office

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

3D
Date: 24.9.2011, iNovitas AG / FHNW

Axis: CH:N1:-
Sector: 94A
-0.31km

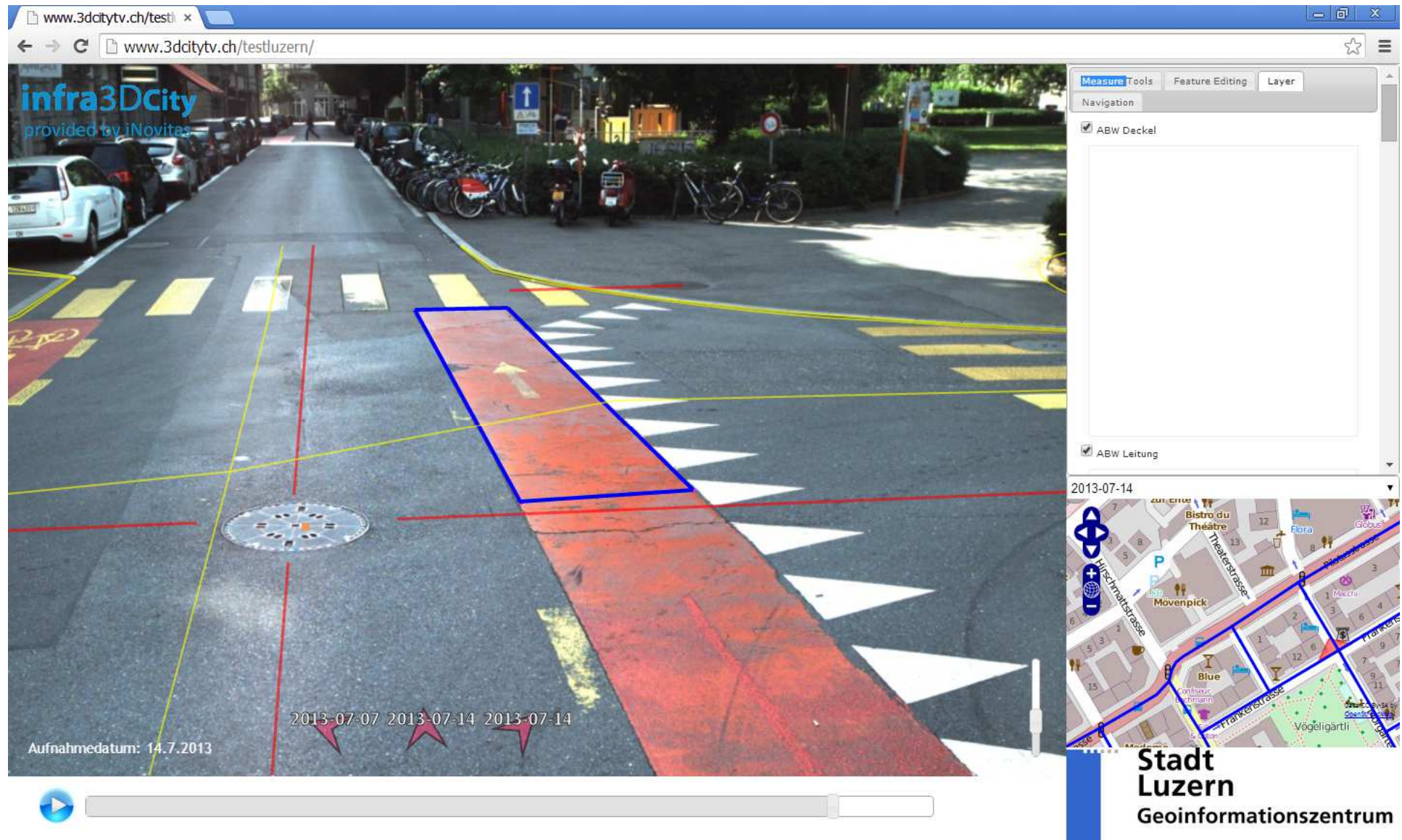
Playback Rate: 10

Campaign	Date	Axis	Direction
iNovitas AG / FHNW	19.7.2012	N1	plus
iNovitas AG / FHNW	19.7.2012	N1	minus
iNovitas AG / FHNW	19.7.2012	N1	minus
iNovitas AG / FHNW	24.9.2011	N1	plus
iNovitas AG / FHNW	24.9.2011	N1	minus
iNovitas AG / FHNW	24.9.2011	N1	minus
iNovitas AG / FHNW	24.9.2011	N1_BAD	<--
Filiale Zofingen, RMSdata	28.7.2011	N1	plus

Grid spacing: 1.00 m

Map Legend

infra3DCity – Lucerne, Switzerland



infra3DRail – Appenzeller Bahnen

infra3D-Client

www.infra3d.ch/client/live/

infra3DRail
provided by iNovitas

Fläche [m²]: 11.2

3D 20.11.2014

Fläche: 11.2 m²

Bildposition: 739563.08 247612.17 806 CH1903 / LV03

Achse geladen!

Calendar... Inbox - S... Mindjet... W... infra3D... Unterlag... 5050.1c... 2015031...

21:57
14.03.2015

infra3DLocal – City of Rüti with Integration of Cadastral Data

The screenshot displays the **infra3D-Client** software interface. The main window shows a 3D perspective view of a street in Rüti, Switzerland, with buildings and a car. A red and yellow wireframe overlay indicates the integration of cadastral data. The interface includes a sidebar on the left with a 'Themen' (Themes) list, a top toolbar with various navigation and editing tools, and a right-hand panel showing a 2D map view. The bottom status bar displays the date '3D: 7.4.2014', the image position 'Bildposition: 706630.48 235071.90 472', and the coordinates 'CH1903 / LV03'.

Themen (Themes) List:

- infra3D Demo ☒
- Punkt ☒
- Linie ☒
- Polygon ☒
- AV Daten ☒
- Gebäude ☒
- Gebäude Umrisse ☒

Map View Data Table:

Datum	Adresse / Achse	Richtung
07.04.2014	Rapperswilerstrasse	←
07.04.2014	Rapperswilerstrasse	→

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A (Mobile) 3D Vision for Cadastre

Interactive and semi-automatic verification and updating of cadstral data

- road network, buildings, landcover in general, DSM / DTM

Automatic conversion of 2D to 3D cadastres

- e.g. gullies / underground utilities

Mobile Augmented Reality Clients

- in-field inspection / verification
- measurements
- staking-out ?
- etc.



Source: http://labs.blogs.com/its_alive_in_the_lab/2012/09/check-out-this-simulated-augmented-reality-with-autodesk-infrastructure-modeler.html

Thank you! Questions / discussion ?

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