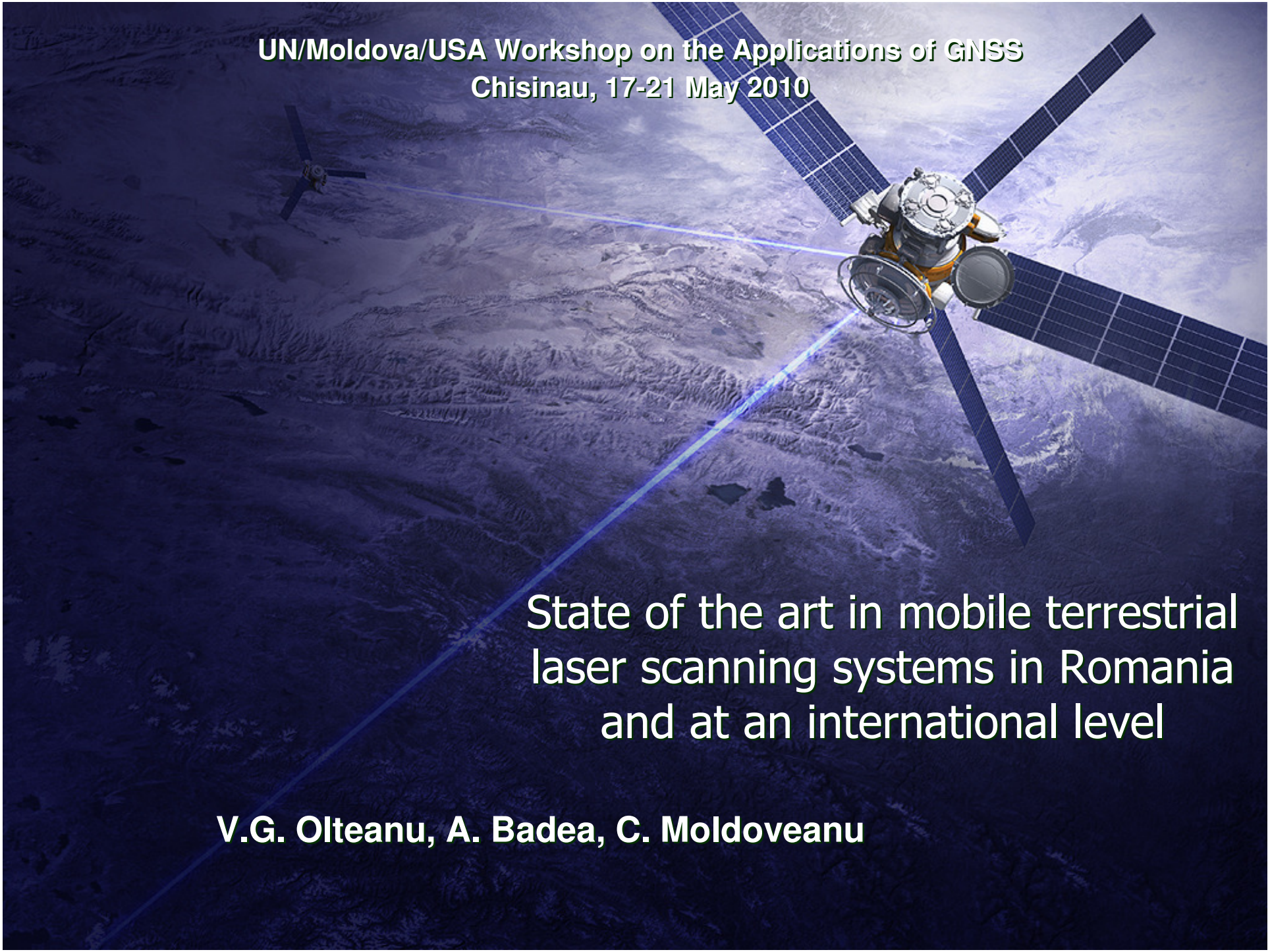


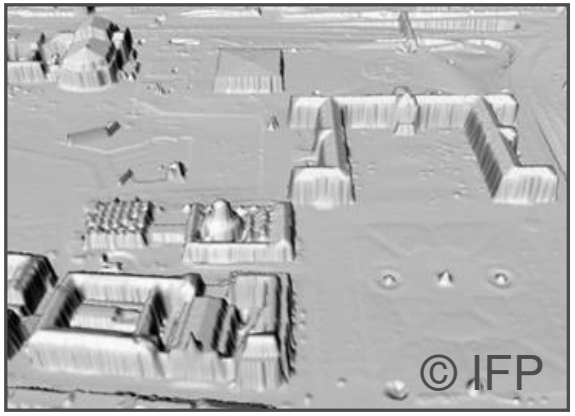
UN/Moldova/USA Workshop on the Applications of GNSS
Chisinau, 17-21 May 2010

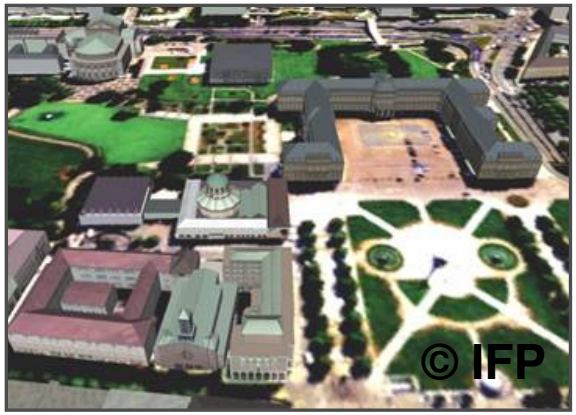
State of the art in mobile terrestrial laser scanning systems in Romania and at an international level

V.G. Olteanu, A. Badea, C. Moldoveanu

Introduction

- **An accurate, detailed and up to date Digital Surface Model – key demand in many of the engineering tasks in several domains:** geodesy, architecture, hydrotechnics, land reclamation, civil or industrial engineering, etc.
- **The necessary data in order to obtain the DSM may be collected by different methods, techniques and technologies :**
  - *Classic topo-geodetic surveying*
  - *Surveying by means of GNSS technologies*
  - *Photogrammetric/Remote Sensing Methods*
  - *SAR Technologies*
  - *LiDAR Technologies (airborne or terrestrial)*
- **Mobile terrestrial laser scannings represent nowdays the most efficient way of collecting the necessary data to obtain the DSM.**





Historic development – laser scanning systems

- The first laser scanning systems used on airborne platforms emerged in the 70's but due to the fact that there were no direct georeferencing solutions at that moment they had limited use and their applications regarded the atmosphere, the oceans, the glaciers, etc.
- After the development of the Global Navigation Satellite Systems, of the Inertial Navigation Systems and of a mathematical model which combines the data (Kalman Filter), using the airborne laser scanners for terrain modeling became possible
- During the same period, terrestrial laser scanning systems were developed for topographic and industrial applications, but were used as well in other domains such as architecture, archaeology, etc. Their applicability was, until recently, a static one, by that meaning the system is not moving during a scanning session.
- Mobile terrestrial laser scanning systems were developed in the early 2000s.

A first look in the development of mobile terrestrial laser scanning

- The first efforts in this domain were undertaken in 2003-2004 in different parts of the world primarly in research institutes.

- Regularly, the created systems are modular platforms, as they can be easily and continuously upgraded.

- Until now, there are no companies which produce all the components of such systems. Usually, companies like Riegl or Topcon which sell mobile terrestrial laser scanning systems, use some of their own components together with other companies' components (e.g. Sick, Applanix).

- The number of applications in which these systems are or may be used is very large and they vary from simple scannings for façade modelling to modelling the zones where accidents occurred.

Mobile terrestrial laser scanning systems developed at international level

1) Geomobil – Institut Cartografic de Catalunya

- The first mobile terrestrial laser scanning platform – developed in the frame of a research project
- Was initially equipped with videocameras for stereoscopic images acquisition.
- Starting with the year 2003, the platform was improved by integrating a Riegl LMS Z-210 laser scanner, capable of collecting up to 10000 points/per second.
- The platform containes several subsystems: the power subsystem, the data acquisition subsystem, the synchronization subsystem. The positioning system belongs to Applanix (POS LV 420)

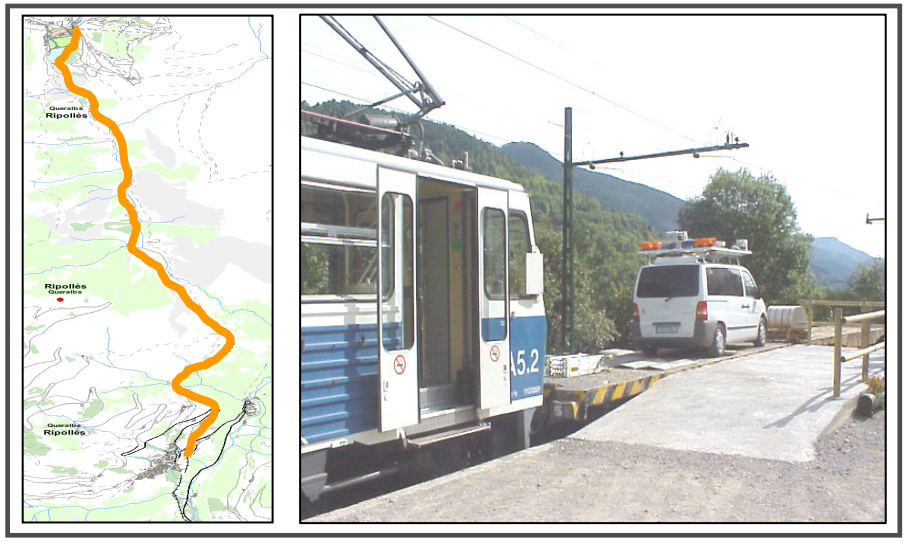
Geomobil – with the courtesy of *Institut Cartografic de Catalunya*

Geomobil – Institut Cartografic de Catalunya
~ Applications ~

– From its realisation and up to the present days, ICC used the mobile terrestrial laser scanning platform in several applications from which we present two:

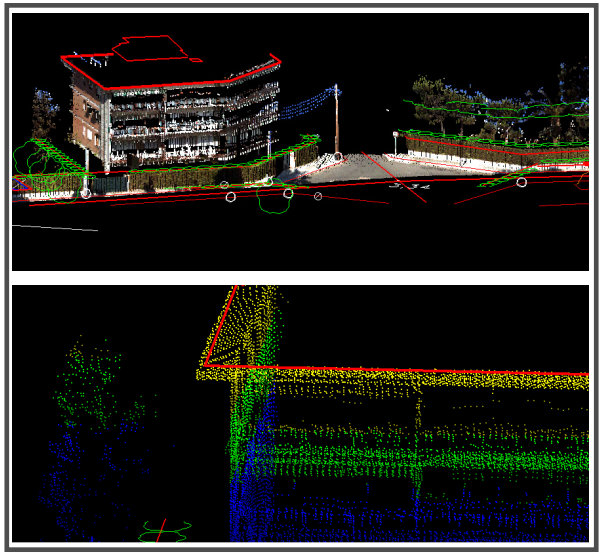
➢ Using ***Geomobil*** in modelling the mountainous area between Ribes de Freser and Santuario de Nuria in the Pyrenees.

➢ Using ***Geomobil*** in urban modelling – modelling the facades in Sitges (Spain).



*Application 1 – Modelling the mountainous area between Ribes de Freser and Santuario de Nuria © **ICC***

*Aplicatia 2 – Control point in scanning the city center of Sitges (Spain) © **ICC***



Mobile terrestrial laser scanning systems developed at international level

2) StreetMapper – 3D Laser Mapping & IGI mbH

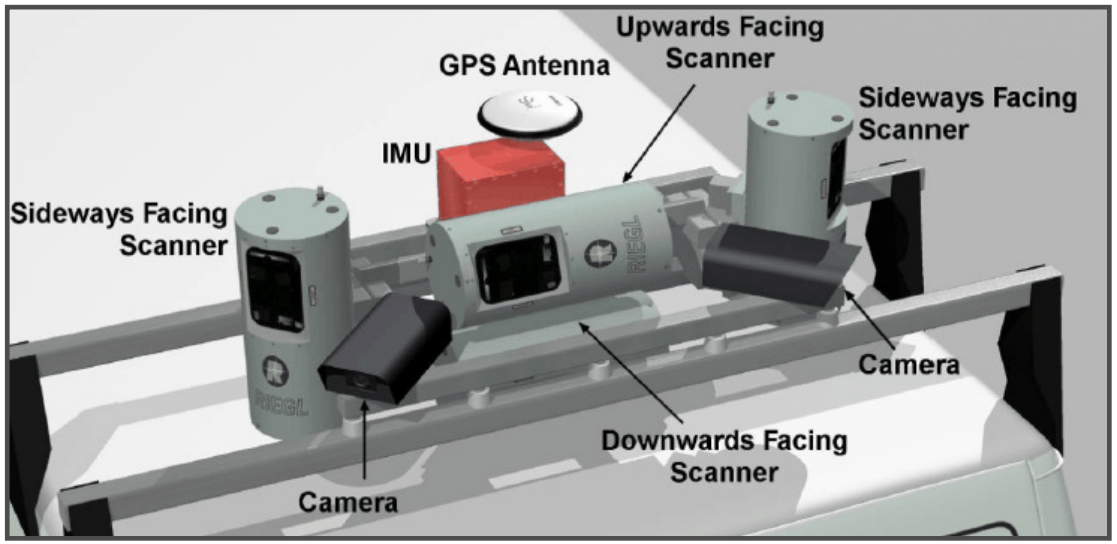
- The system developed by 3DLM and IGI is the first commercial mobile terrestrial laser scanning system.
- The first system was developed in 2005 and had a 6 months test period.
- It's the first mobile terrestrial laser scanning system with a 360^0 field of scan; this is realised by integrating multiple laser scanners.
- Last year, 3DLM and IGI developed a portable version of the system. This platform may be installed on almost every terrain vehicle or boat.

StreetMapper **© 3DLM**

StreetMapper – 3D Laser Mapping & IGI mbH

The StreetMapper components:

- Inertial systemTERRAControl developed by IGI and composed of:
  - IMU developed by IGI
  - GNSS NovAtel OEMV-3 (GPS/GLONASS/DGNSS) reciever
  - Aditional distance measurement sensor used to improve the positioning accuracy in case of missing satellite signal.
  - TERRAControl Computer
- Up to 4 Riegl LMS – Q120 laser scanners for a 360^0 field of scan
- Video cameras for a better data interpretation.



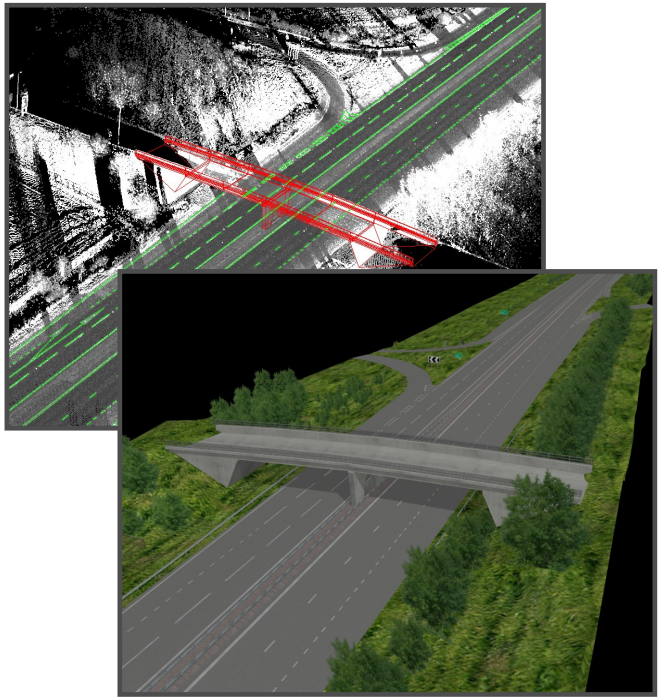
StreetMapper platform components © **3DLM**

StreetMapper – 3D Laser Mapping & IGI mbH
~ Aplications ~

– The system developed by 3DLM and IGI being a commercial one was used in numerous applications from many domains. In the following sections only the most relevant applications are presented:

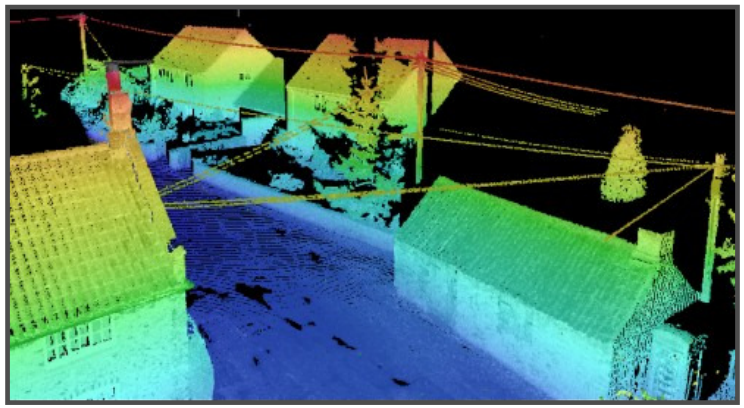
➢ Using ***StreetMapper*** in modelling the areas were car accidents occurred or may occur in order to better understand the causes that lead to the incident.

➢ Utilizarea ***StreetMapper*** in determining the position of wires above the ground.



Application 1 – Point cloud, CAD model and 3D model of an area where accidents occur frequently

Application 2 – Determining the position of cables above the ground



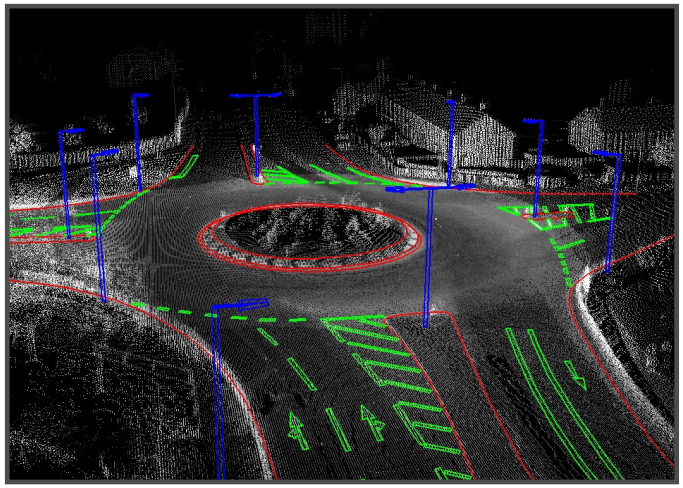
StreetMapper – 3D Laser Mapping & IGI mbH
~ Aplications ~

- Using ***StreetMapper*** in modeling the coastal areas in order to monitor certain phenomena (erosion, sediments and other extreme phfenomena)

*Application 3 –***StreetMapper***; Point cloud obtained in Felixstowe*

StreetMapper – 3D Laser Mapping & IGI mbH
~ Aplications ~

- Using ***StreetMapper*** for Indivisible Abnormal Load (IAL) routes planning. Although, the main part of the routes is generally known, like highways or European roads, which are monitored and often used for such transports, the final leg of the journey from the highway until the destination needs surveying in order to choose the optimum route. The StreetMapper was used in this type of application at the request of an UK power utility company to survey an area in Staffordshire to ensure the route was suitable for transporting a large transformer.



Application 4 – Point cloud and CAD model for an intersection; 3D model used in the route study ***© 3DLM***

Mobile terrestrial laser scanning systems developed at international level

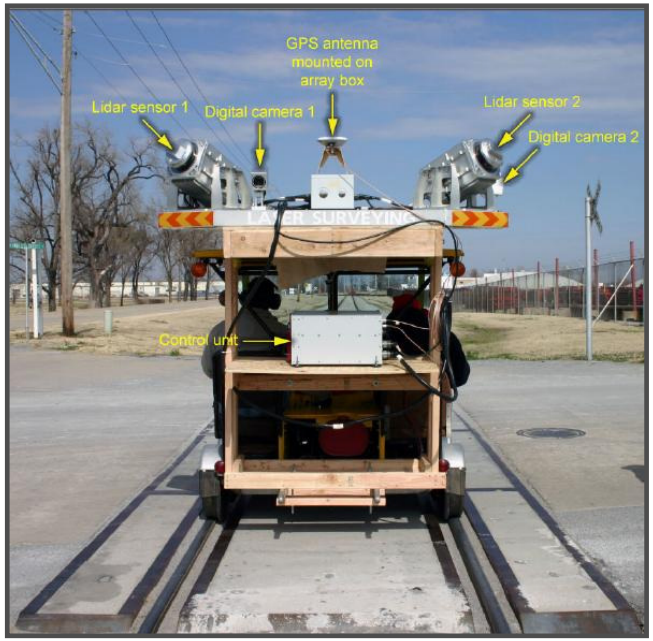
3) LYNX Mobile Mapper™ – Optech Inc.

- ***LYNX Mobile Mapper*** is one of the newest mobile terrestrial scanning platforms. The system's architecture is similar to the ones presented before; only the type of instruments used is different.
- Similar to ***StreetMapper,*** the system developed by Optech Inc. is able to provide a 360^0 field of scan by incorporating up to 4 laser scanners designed by themselves.
- The positioning system was designed by Applanix (POS LV 420) and the GNSS recievers belong to Trimble.

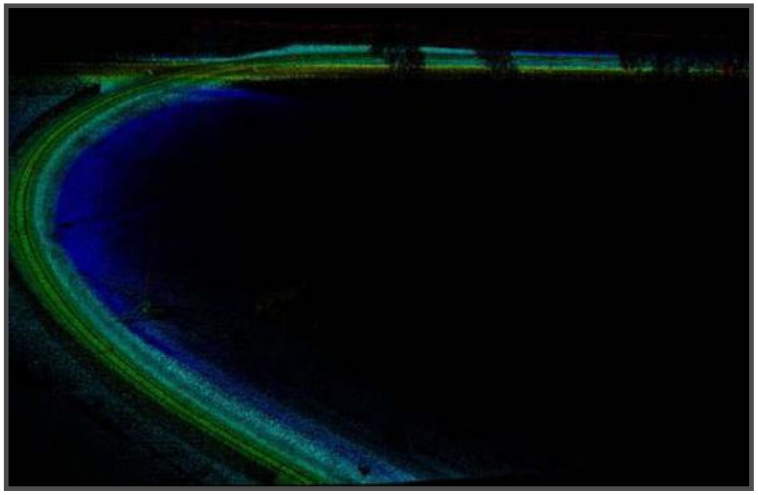
LYNX Mobile Mapper™ © Optech Inc.

LYNX Mobile Mapper™ – Optech Inc.
~ Applications ~

- Like ***StreetMapper***, LYNX Mobile Mapper is a commercial system and was used in numerous applications from which we will present two of the most relevant.
- Using ***LYNX Mobile Mapper*** in surveying the railway infrastructure. This application was done at the request of Aerial Data Service, Tulsa, Oklahoma who wanted to test the Optech's system in such situations.



a)



b)

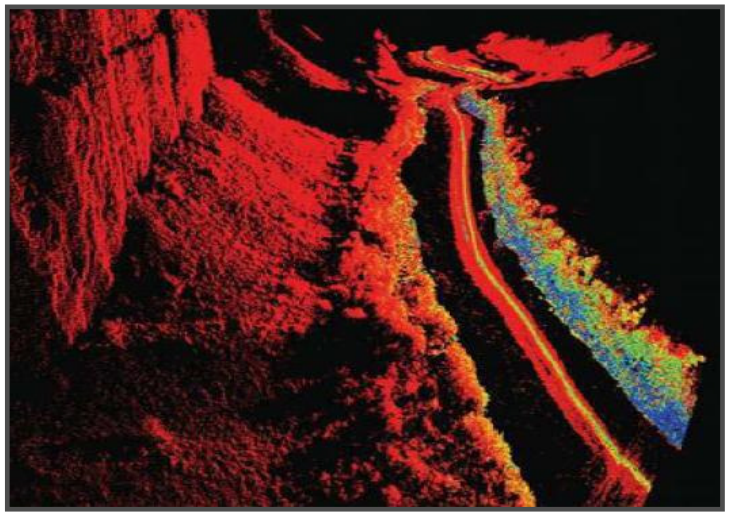
Application 1 – Using LYNX Mobile Mapper in railway surveying

a) Mounting the system on a "Speeder". b) Point cloud

LYNX Mobile Mapper™ – Optech Inc.
~ Aplications ~

- Mounting the ***LYNX Mobile Mapper*** on a speedboat in order to scan the inaccesible steep areas on the river bank.
- Other application which worths mentioning is: scanning the road infdastructure in Greece (2008) – Scanning the highway between Athena and Corinth

a)



b)

Application 2 – Using LYNX Mobile Mapper in modeling the inaccesible steep areas on the river bank

a) Mounting LYNX on a speedboat b) Point cloud

Mobile terrestrial laser scanning systems developed at international level

~ *Other mobile terrestrial laser scanning systems*~

- The systems presented above, represent only the first platforms developed in this field. Besides them, in the recent years other mobile terrestrial laser scanning systems were developed by certain companies. From them we mention:
  - ***Riegl – VMX 250***– Commercial system developed by Riegl.
  - ***IP-S2*** – Commercial system developed by Topcon – the positioning system and the GNSS recievers were developed by Topcon and the laser scanners were developed by SICK.

RIEGL – VMX 250 (© Riegl) and ***TOPCON – IP-S2 (© Topcon)***

Mobile terrestrial laser scanning systems developed in Romania

- In Romania there is only one such system known to pe developed or used. It was developed based on a research project, financed in the frame of PNCDI II.
- The platform developed by S.C. C-TECH S.R.L. (Constanta) differs from the ones developed at international level only through the type of instruments used. These are represented by:
  - Riegl LMS Z420i laser scanner – having a capability of measuring distances up to 1000m.

Riegl LMS Z420i laser scanner used by S.C. C-TECH S.R.L.

Mobile terrestrial laser scanning systems developed in Romania

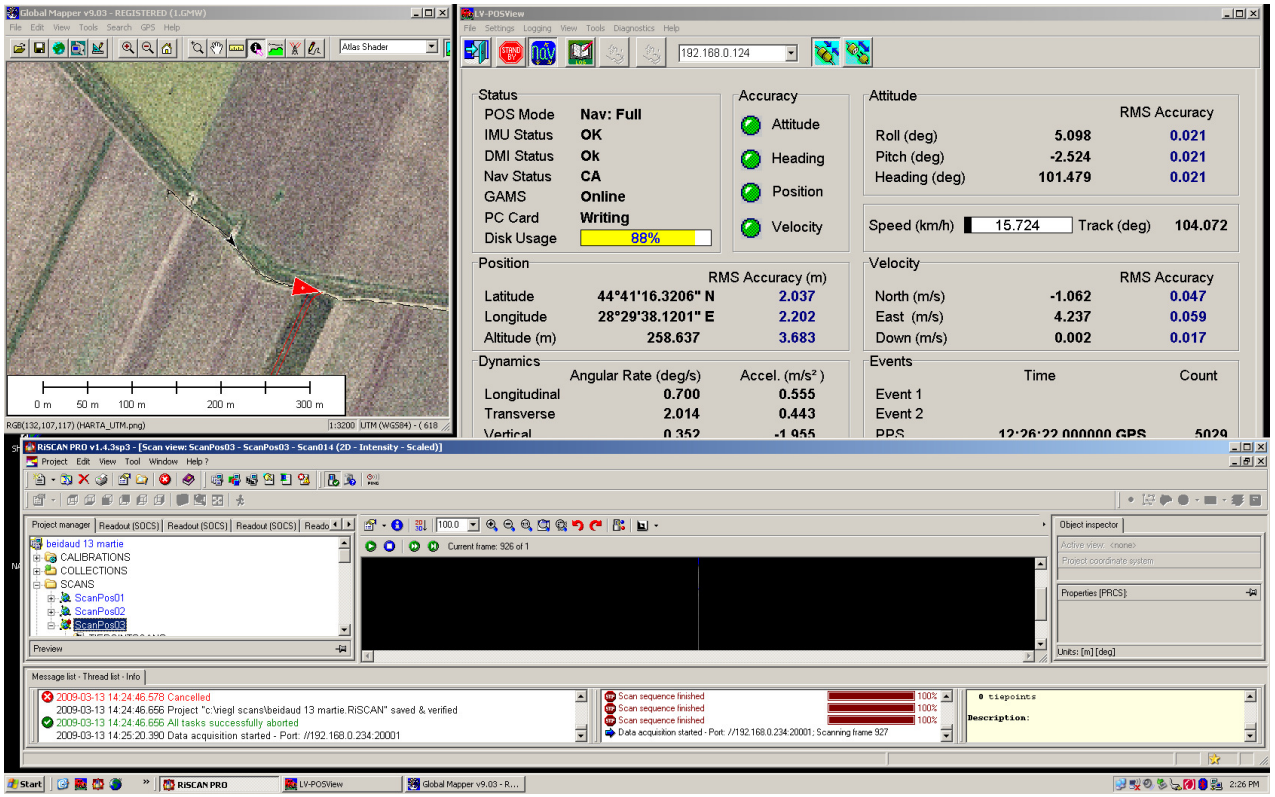
- GPS Trimble R8 recievers
- Applanix IMU
- Positioning system Applanix POS LV
- Additional distance measurement unit (DMI).

Applanix IMU and positioning system

The platform developed by S.C. C-TECH S.R.L.

Mobile terrestrial laser scanning systems developed in Romania

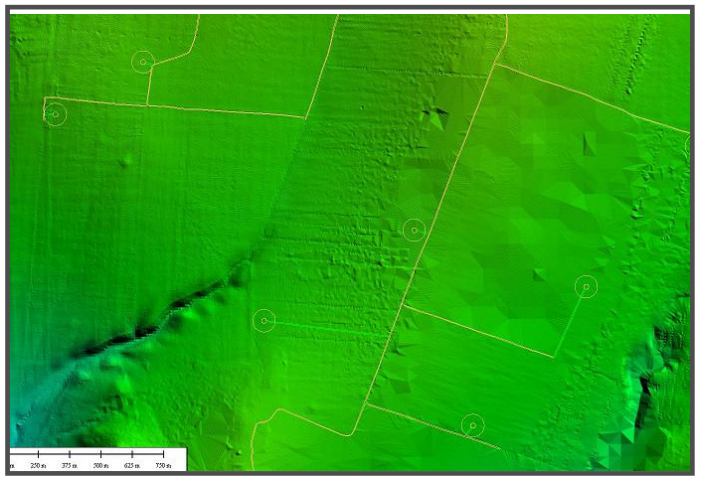
- The system may be monitorized during the scanning by using the postioning system's software (POS View) and the scanners's software (RiScan Pro).
- We can monitor in this way certain parameters like: the system's position (N,E,H) and their standard deviations, the way the solution is obtained (GNSS/INS or INS) , GPS Time, memory, velocities (N,E,D) and their standard deviations, roll, pitch and heading



Mobile terrestrial laser scanning systems developed in Romania

~ Applications ~

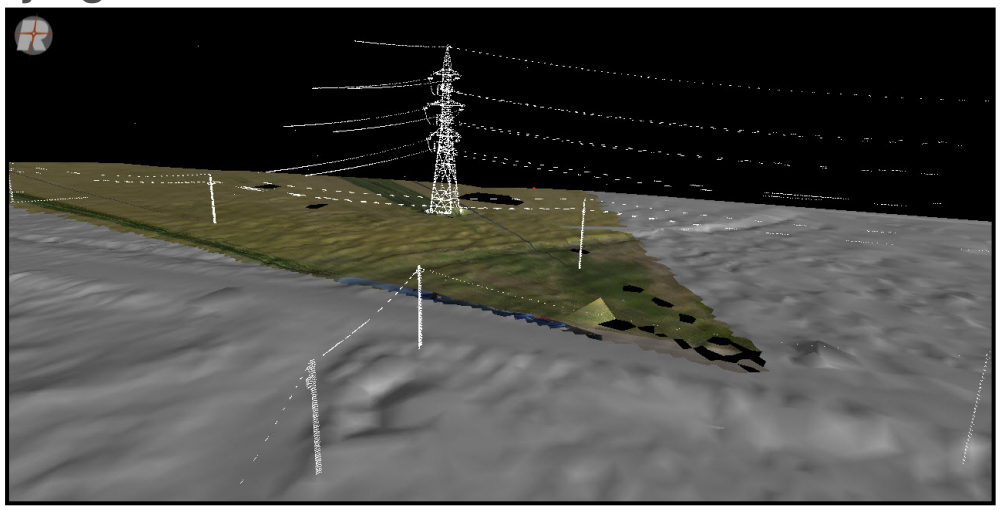
- From its development (2008) and up to now, the platform designed by C-TECH was used in different applications from which we mention here:
  - **Generating the Digital Terrain Model and the Digital Surface Model for certain areas.**
  - **Road and highway monitoring**
  - **Risk studies**



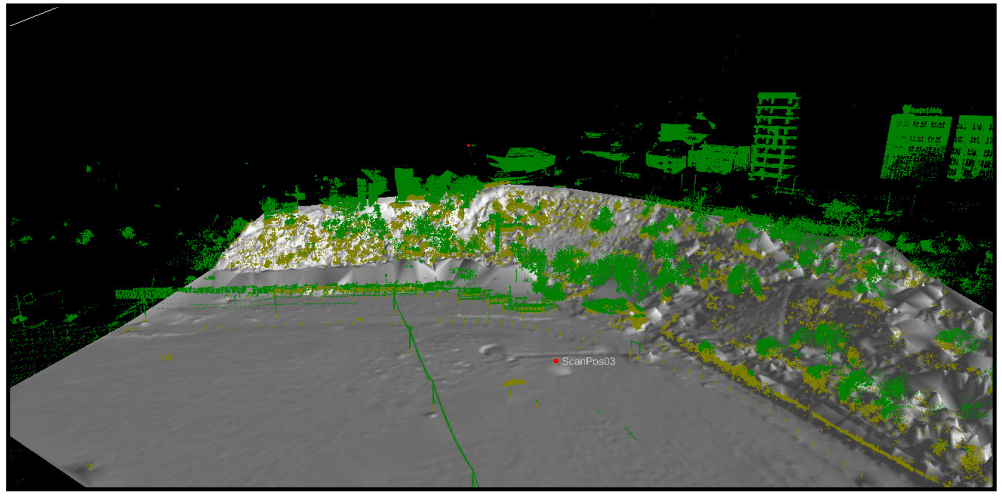
DTM in the vicinities of Beidaud and Baia, Tulcea

Mobile terrestrial laser scanning systems developed in Romania

- Identifying electrical networks



- Updating the geospatial database necessary to evaluate the level of erosion in coastal regions, at the seaside, for rivers or for the Danube



Conclusions

- The development of mobile terrestrial laser scanning systems enhanced the geospatial data collection necessary in order to obtain the DSM or other similar products
- A shortcoming of these equipments is represented by their high development / aquisitioning costs
- Developing such systems still represents a field of research at Romania's level but at international level as well.
- The research is oriented on:
  - Improving the positioning accuracy
  - Reducing the system's size
  - Portability
  - Improving the algorithms used in the post-processing of the point cloud since there is no dedicated software and the existing ones are extremely time consuming.
- It should be studied the impact of future global satellite systems on the position accuracy.

Thank you!