SIXTH FRAMEWORK PROGRAMME
PRIORITY [Aero_3.e]—ACTIVITY AERONAUTICS & SPACE
SPECIFIC TARGETED RESEARCH INNOVATION PROJECT (STREP)

Improvement for Landing on Small-Medium Airports Using Future, Aircraft-Autonomous Guidance Aids

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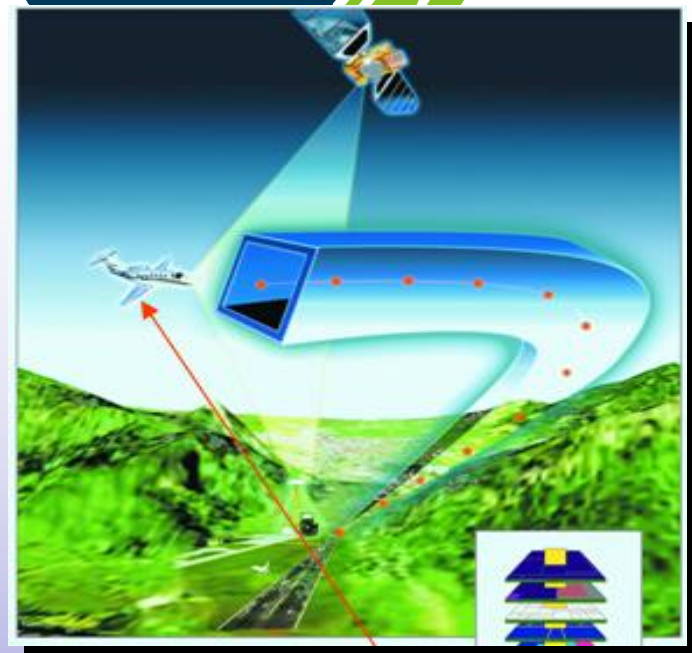
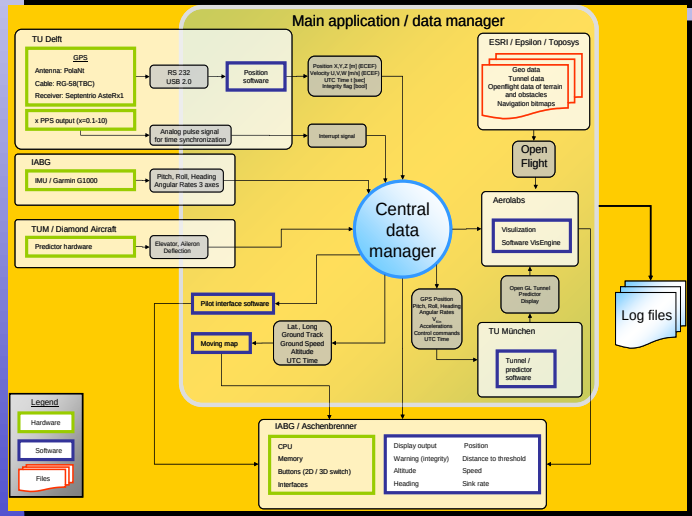
ESRI Geoinformatik GmbH, PBS

FSD Institute of Flight System Dynamics

26th ICAS Congress
Anchorage, Alaska, USA, 14 - 19 Sept. 2008

LANDING Partners





- Partner—Development Phase
- EPSILON GIS Technologies SA (GR)
- ESRI Geoinformatik GmbH (DE)
- IABG GmbH, Aeronautical Sevices(DE)
- Toposys GmbH LIDAR Technology(DE)
- Aschenbrenner Elektronik GmbH
- Aerolabs AG Software Systems
- Delft University of Technology (NL)
- TUM:Technical University of Munich (DE)
- User—Test- & Validation Phase
- Diamond Aircraft Industries GmbH (AT)
- AeroServices SA (GR)
- Airport Authority Lugano (CH)
- Airport Authority Bolzano (IT)
- Airport Authority Skiathos (GR)

Landing System Components
EGNOS Positioning

Georeferencing Stations in Europe

The European Geo-stationary Navigation Overlay Service (EGNOS) offers improved position accuracy and integrity, based on GPS and in future also Galileo.
EGNOS provides positions in the ITRF2000 (its tracking stations, the Ranging and Integrity Monitoring Stations (RIMS) all across Europe, and the satellite position corrections pertain to ITRF2000). Hence, LANDING will use the WGS84/ITRF2000 as a reference frame to express three-dimensional receiver position coordinates (XYZ) on, or above the Earth.

Source:

TU Delft
Technische Universiteit Delft

FSD Institute of Flight System Dynamics

GNSS Antenna
PolaNT High precision

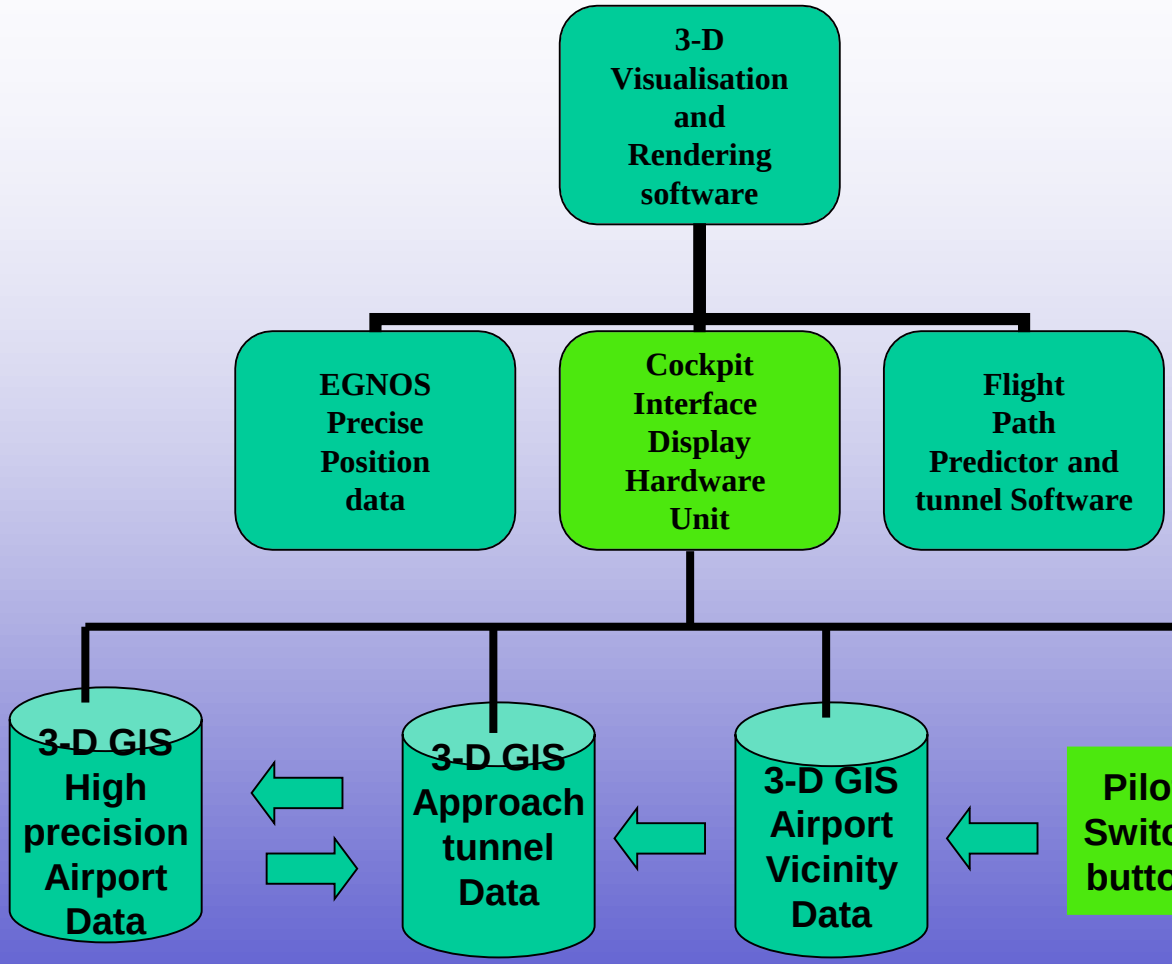
Aste Rx1 Receiver
GPS-Galileo

ESRI Geoinformatik GmbH

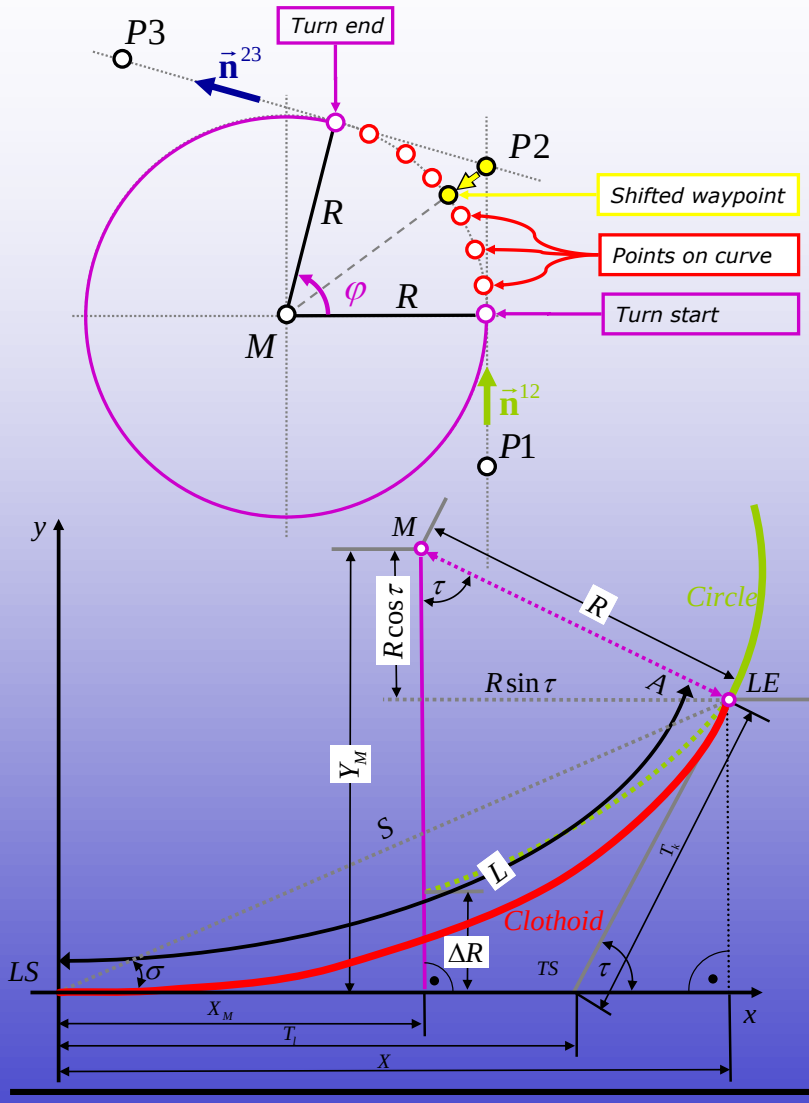
General Project Goals

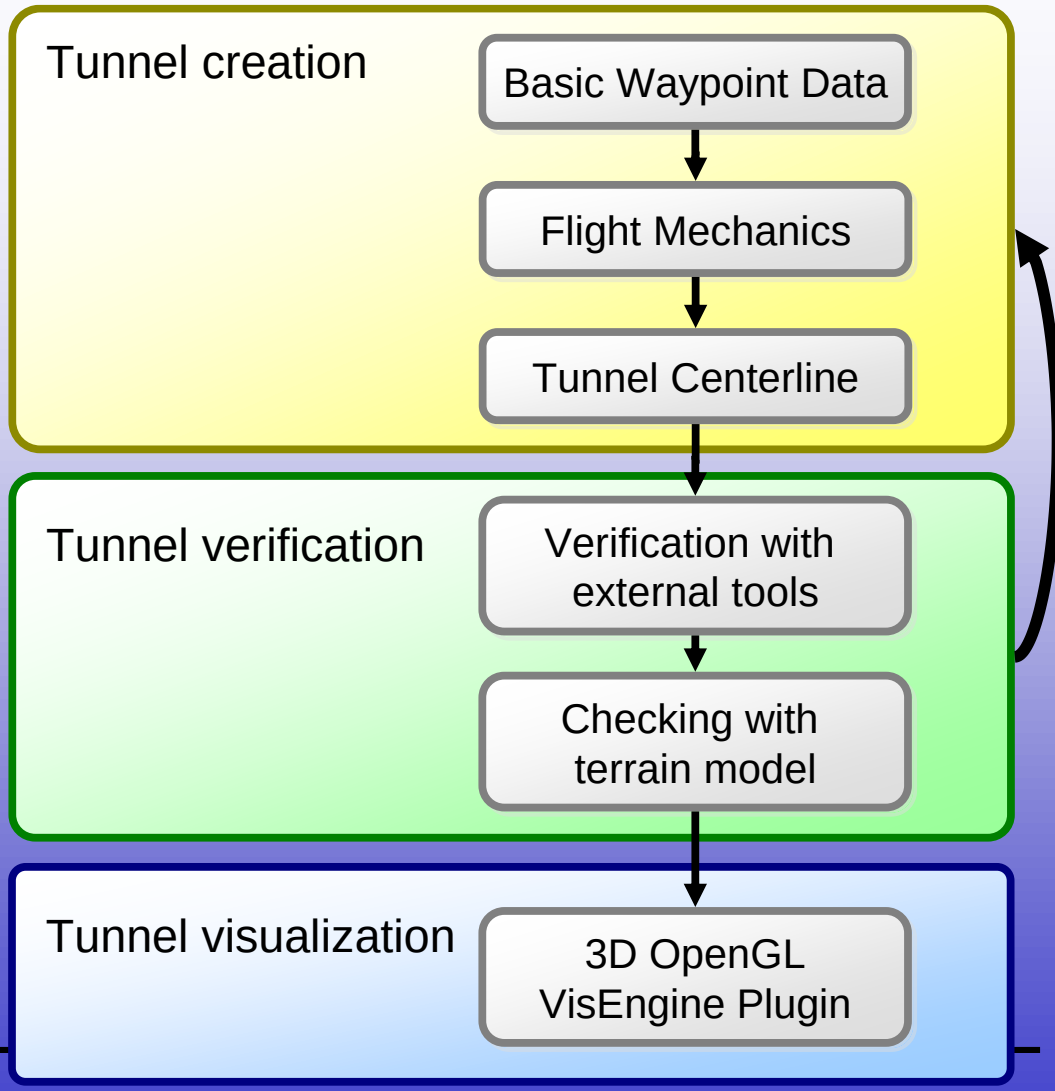
- Autonomous 3-D guiding system for smaller aircrafts and smaller airfields
- Additional navigational aid for situational awareness
- Undependend from ground based systems
- Low cost hardware and software with COTS and ISO standards
- Easy to install and to maintain
- Providing low cost 2-D and 3-D GIS databases with high resolution and accuracy depending of the distance to the airfield
- Developing a software for automatic tunnel creation
- Development of a predictor software
- Integration of existing 2-D moving map technology
- Creation and testing of a pre- industrial prototype
- Preparation of a certification procedure for a final product

Landing Data and Software Integration



Software -Tunnel approach

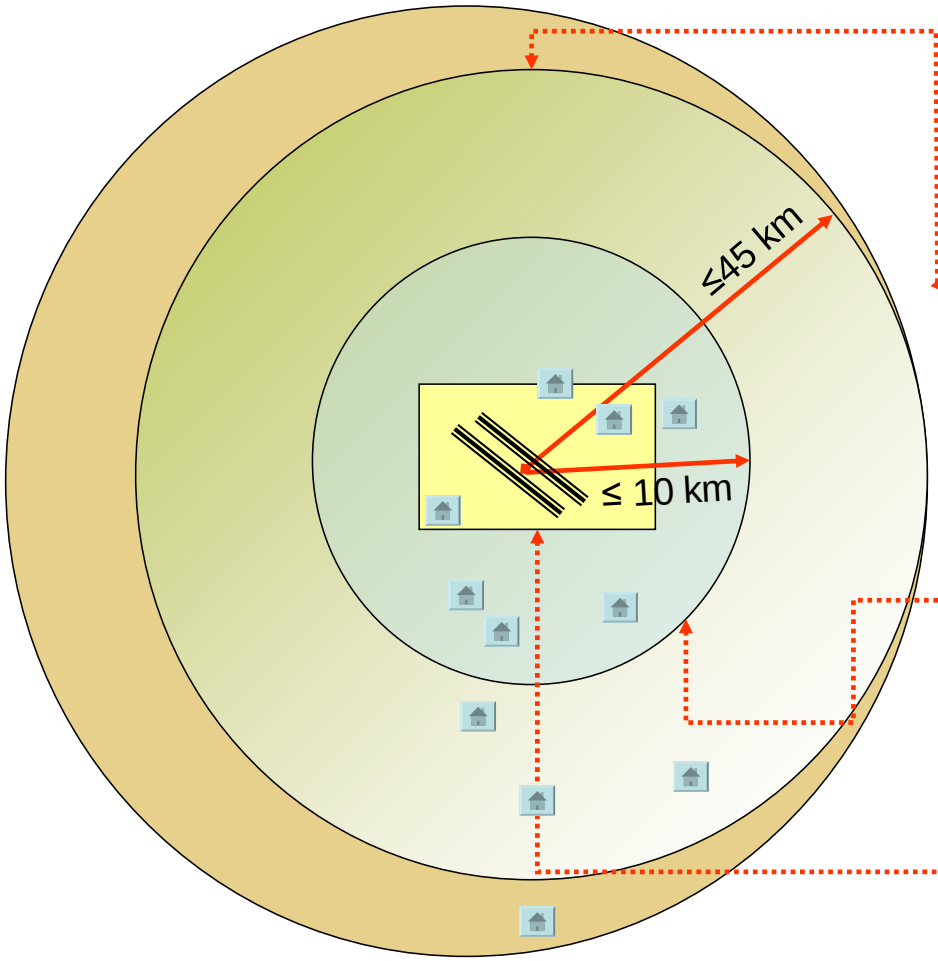




LANDING Geodatabase

Key Points:

- **All information for Visualisation is stored in the LANDING Geodatabase.**
- **The Geodatabase contains aeronautical topographical and DSM and technical features and according validation rules.**
- **The cockpit display software can access and display the data.**
- **Presentation rules set the appearance of the data display inflight**



Regional Terrain (Area 1)
- TerraSarX data
- Spot 2,5 ortho/colour

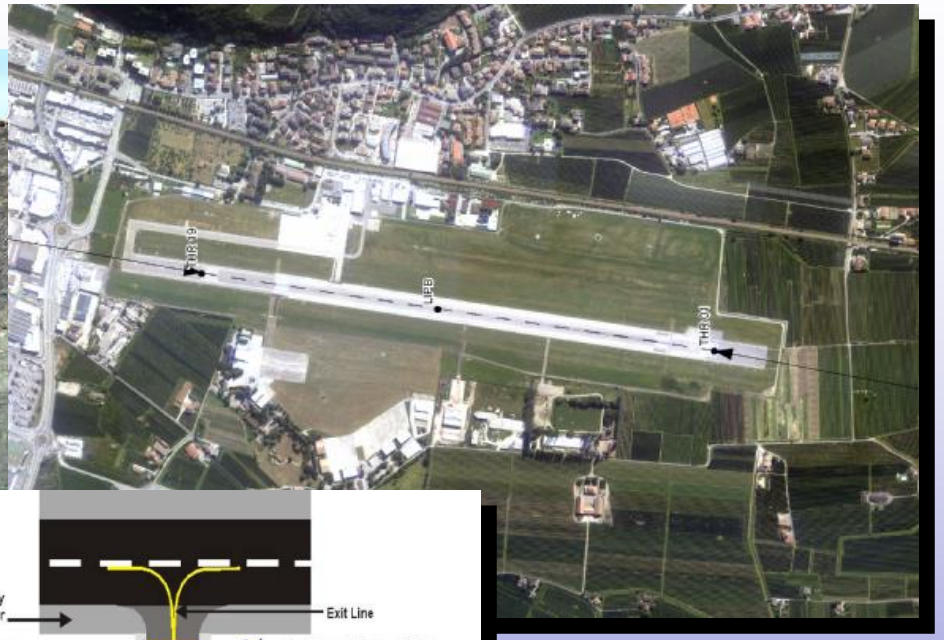
Approaching Region (Area 2)
- TerraSarX data
- Intermap data
- Jeppesen approach map

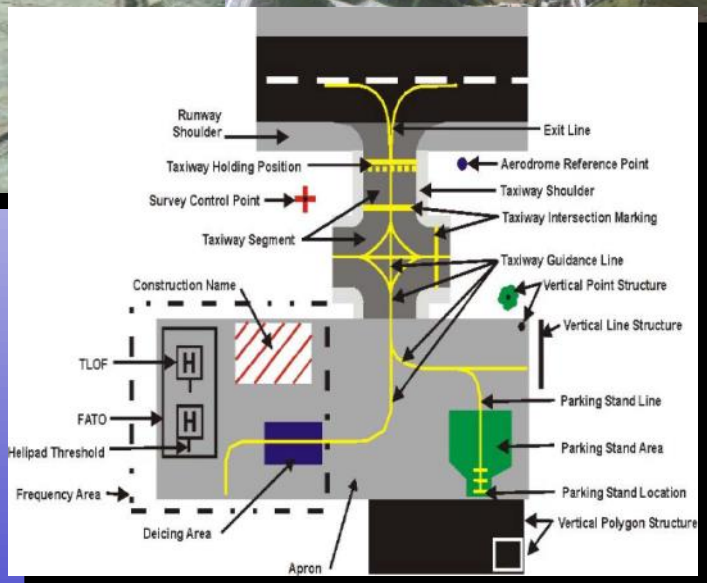
Tunneling Path (Area 3)
- Intermap data
- Lidar data
- Ikonos data
- Jeppesen approach plate

Aerodrome & Landing Path
- Lidar data
- CAD + other data

Areas with Different Distances to Airport and GIS Data Sources

GIS Data Sources- and Model

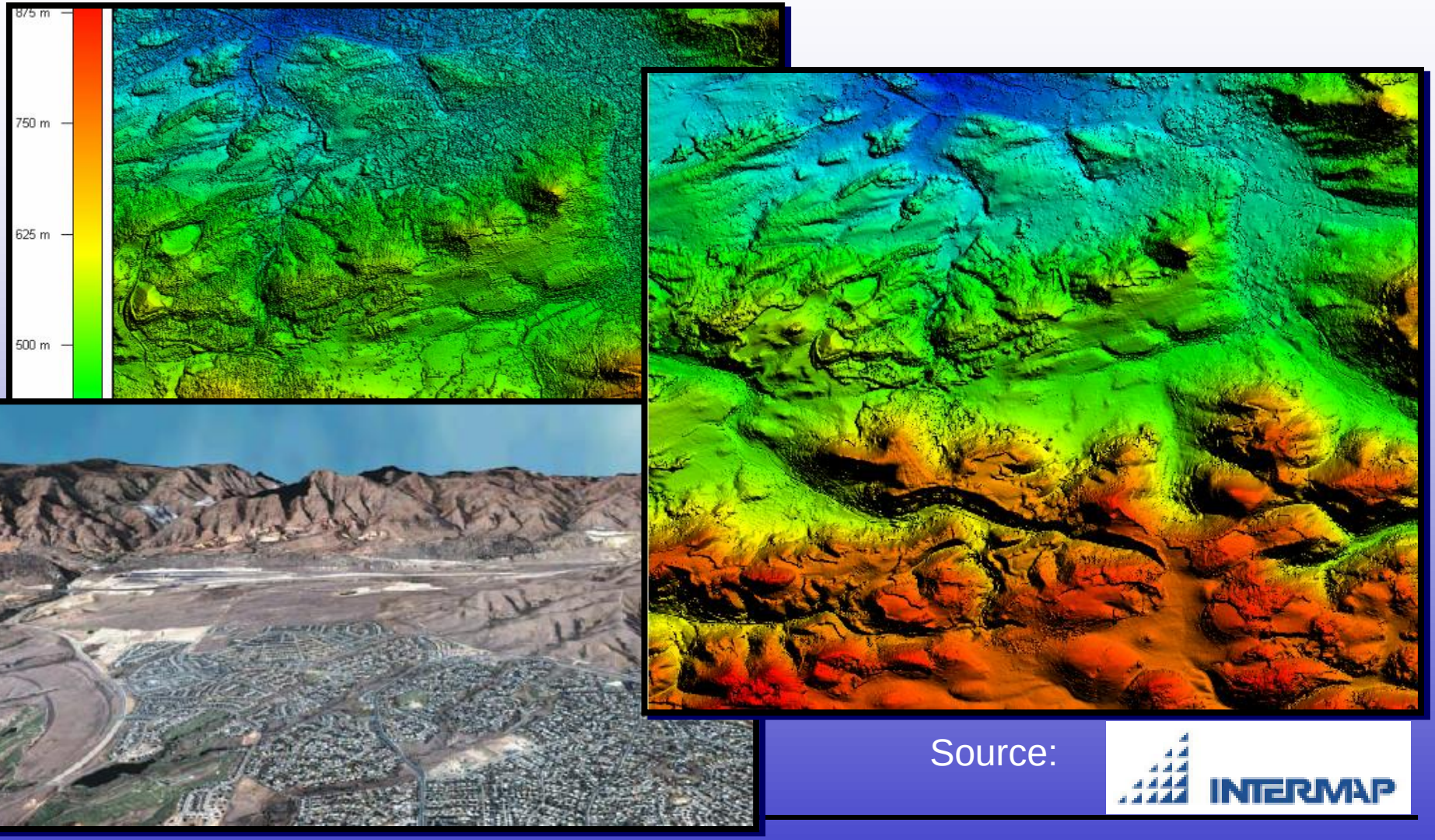




- Selection of remote sensing sensor
- Image and CAD acquisition
- Image digitizing
- Orthorectifying, georeferencing
- Vectorizing and adding of attributes
- Data verification etc.

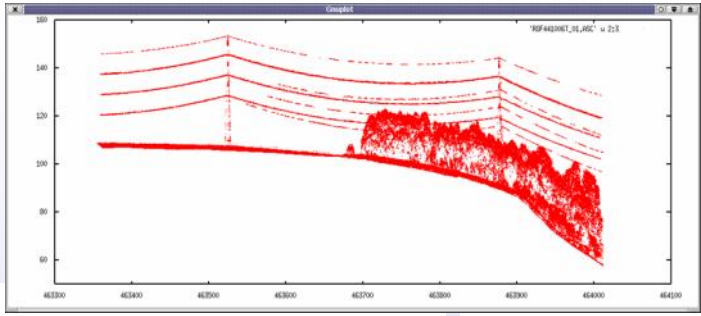
Sources: Toposys, Geosystems GmbH, ESRI GmbH Aleksandar Pavlovic, ICAO Steve Young, NASA Lima 2007

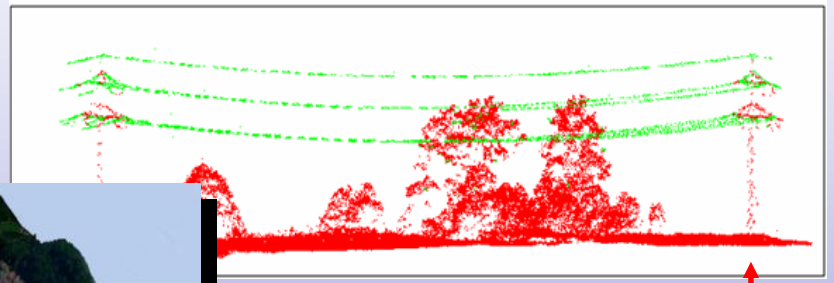
3-D Visualization Data sources airborne radar DSM and DTM

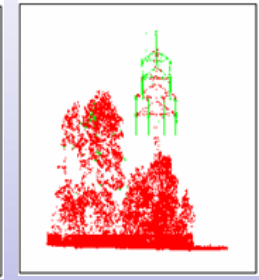


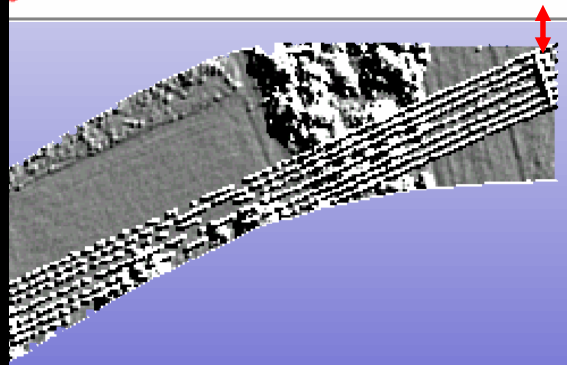
Source: INTERMAP

LIDAR DTM/DSM





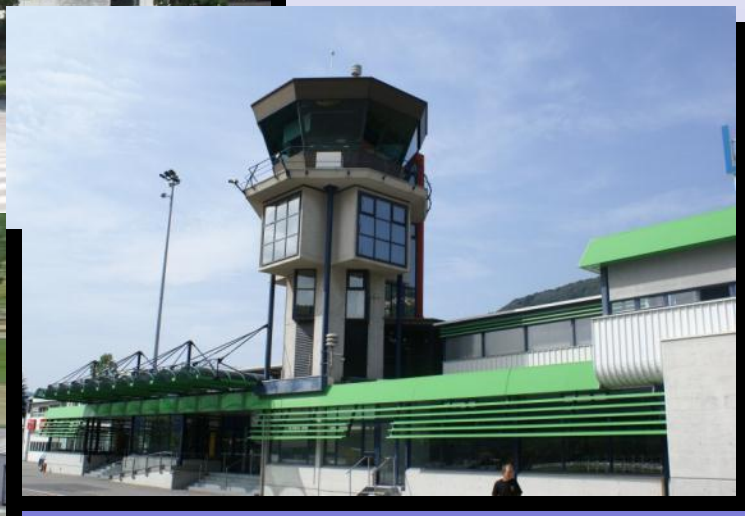




Source: TopoSys®

CAD and Image Sources

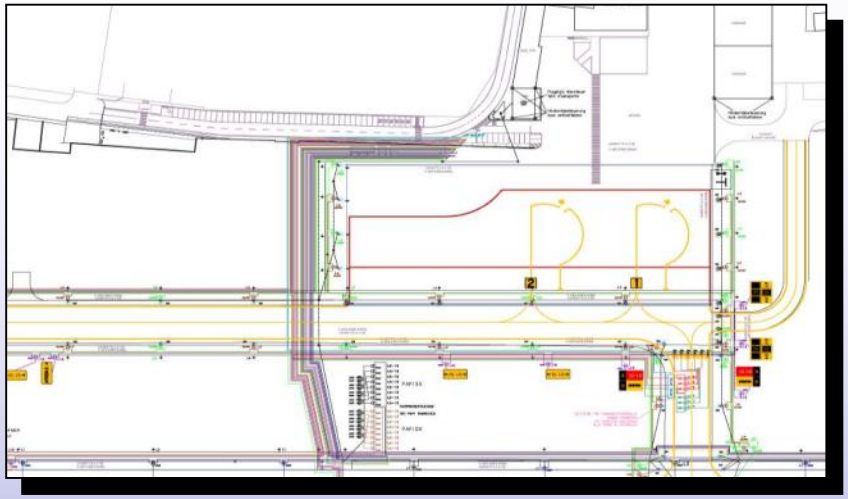
Bolzano

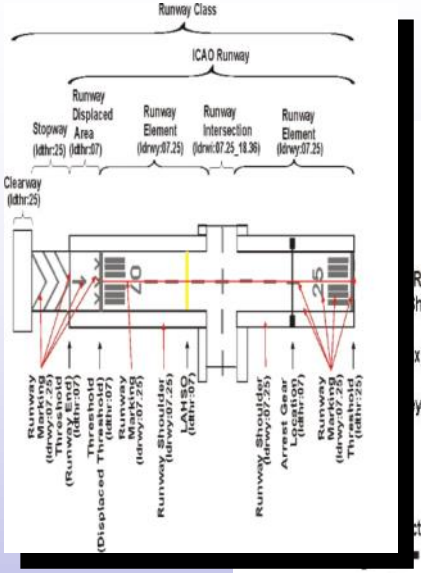


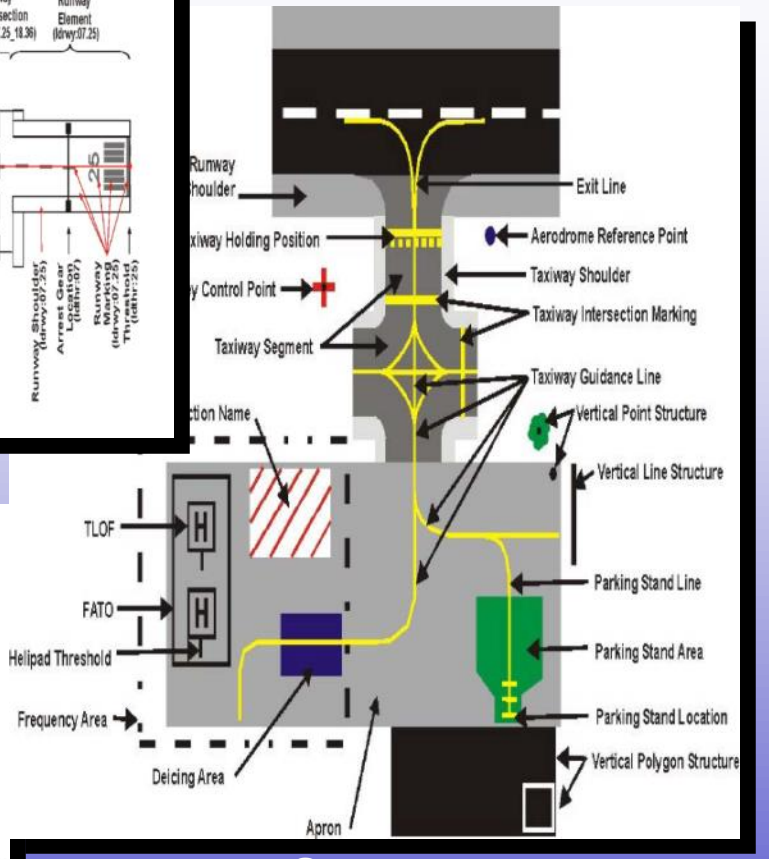
Lugano

Source:
ESRI, Triangraphics GmbH

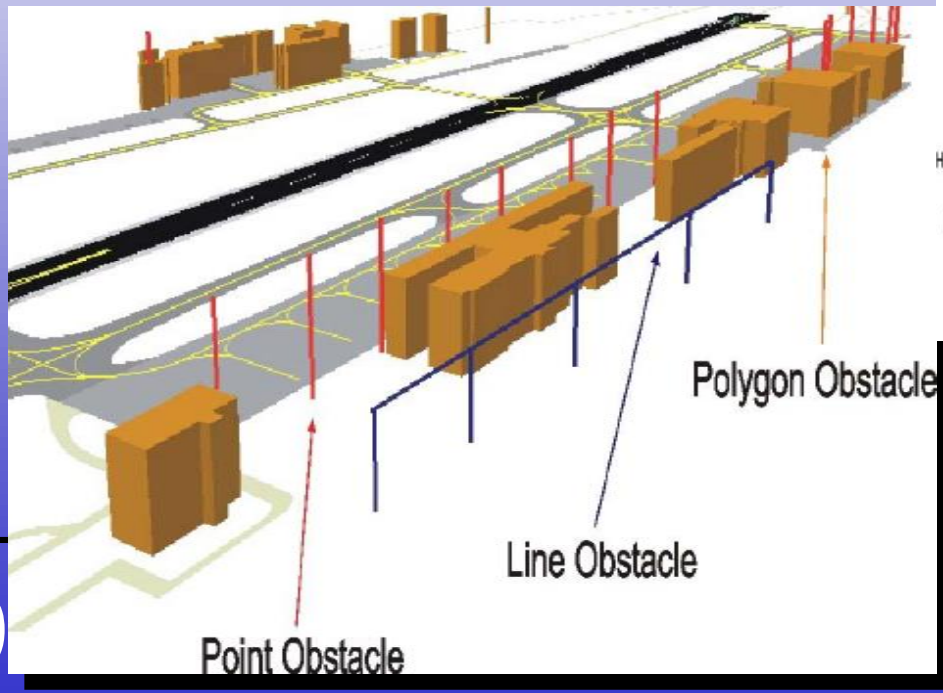
CAD Data Integration







Source:
Airport
Bolzano

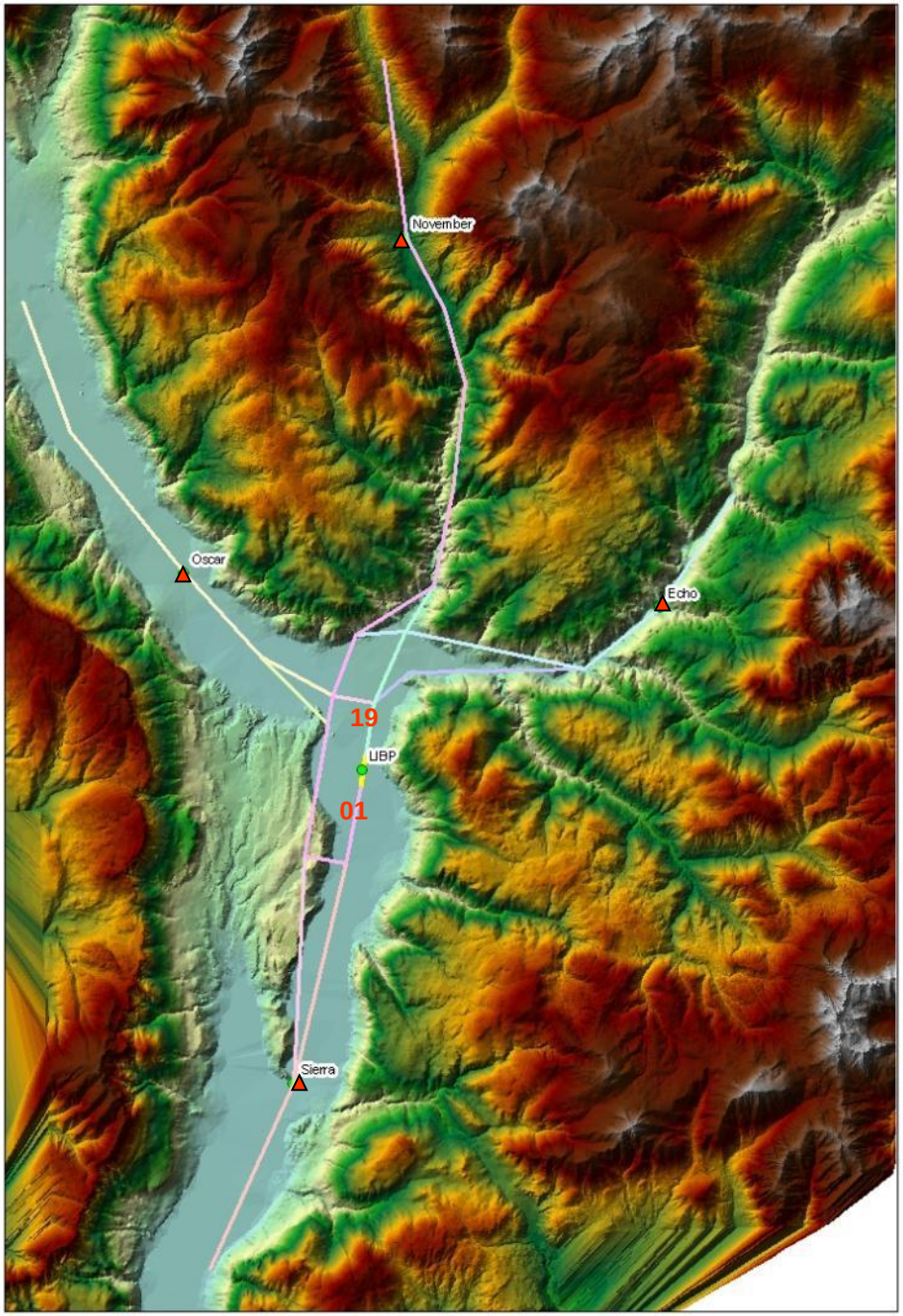


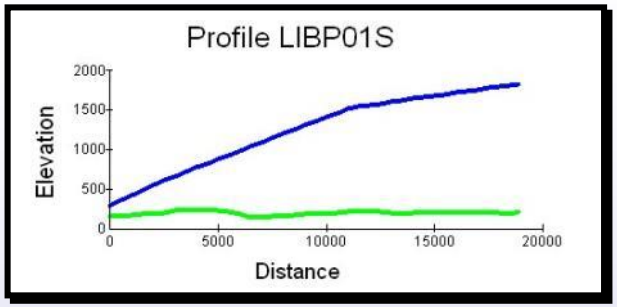
Source:
Aleksandar Pavlovic, ICAO
Steve Young, NASA
Lima 2007

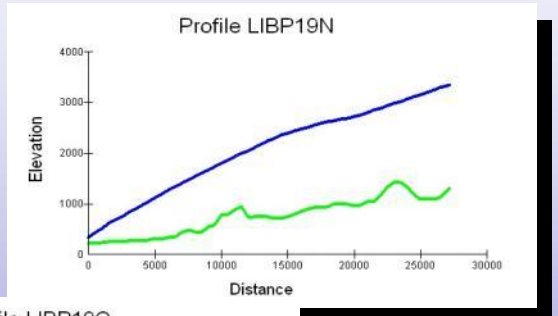
FSD

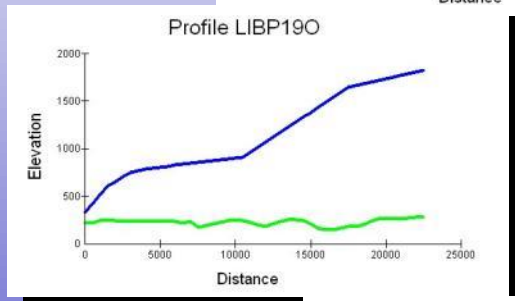
ESRI Geoinformatik GmbH

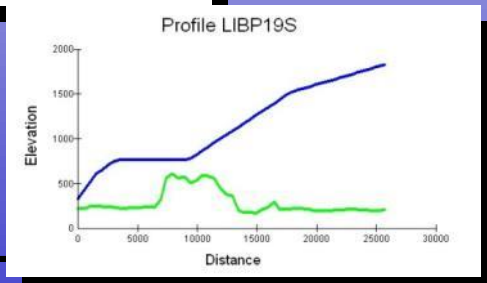
Tunnel Design LIBP





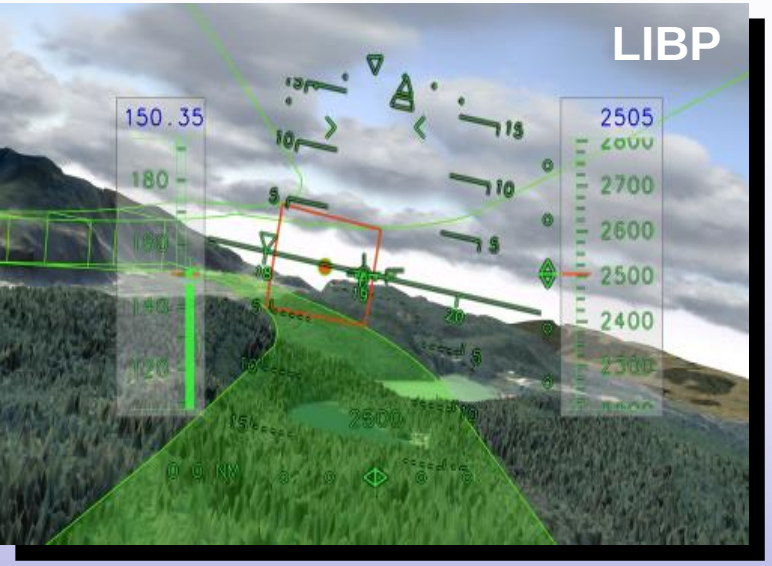


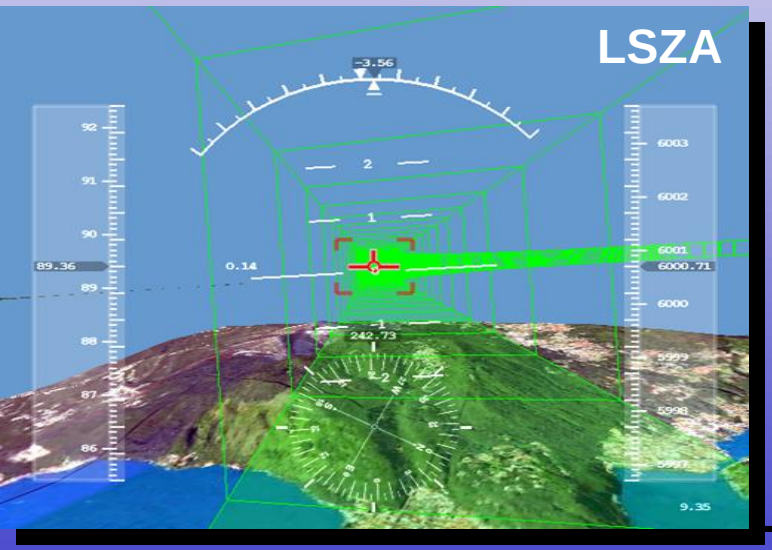




ESRI Geoinformatik GmbH

3-D Visualisation Software





Real time rendering and visualization of the airport vicinity

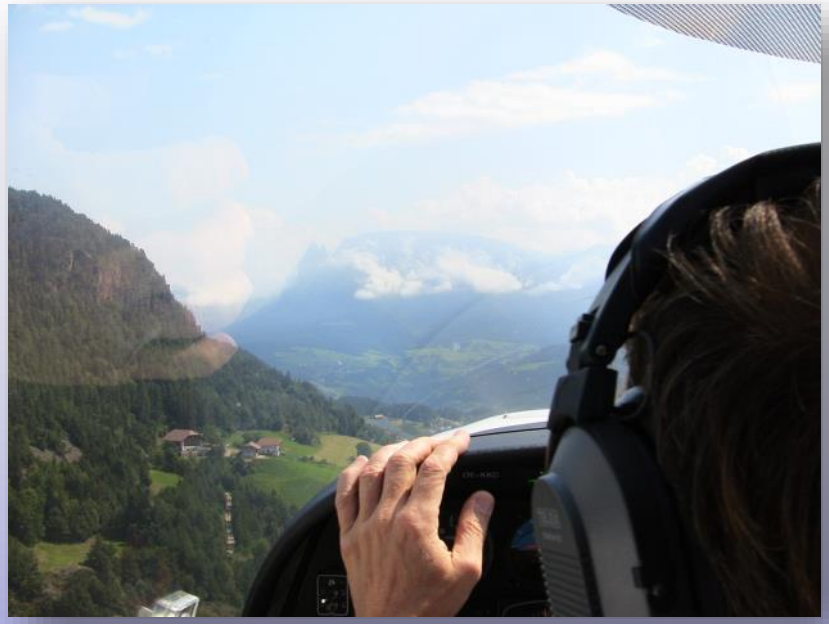
The AeroLabs *VisEngine* image generator is a software package that can be used to interactively visualize 3D terrains and scenery In the TUM simulator and inflight

Source: aerolabs™

The ESRI *ArcGlobe* Software image renderer has also been successfully tested for the real time visualization of high resolution terrain and scenery data on COTS HW

Source: ESRI GmbH

Flight tests Bolzano – DA 40



Pilot Interface Hardware

Buttons are placed on the display
Multiple assignments reduce the number of buttons necessary.

The following functions are provided:

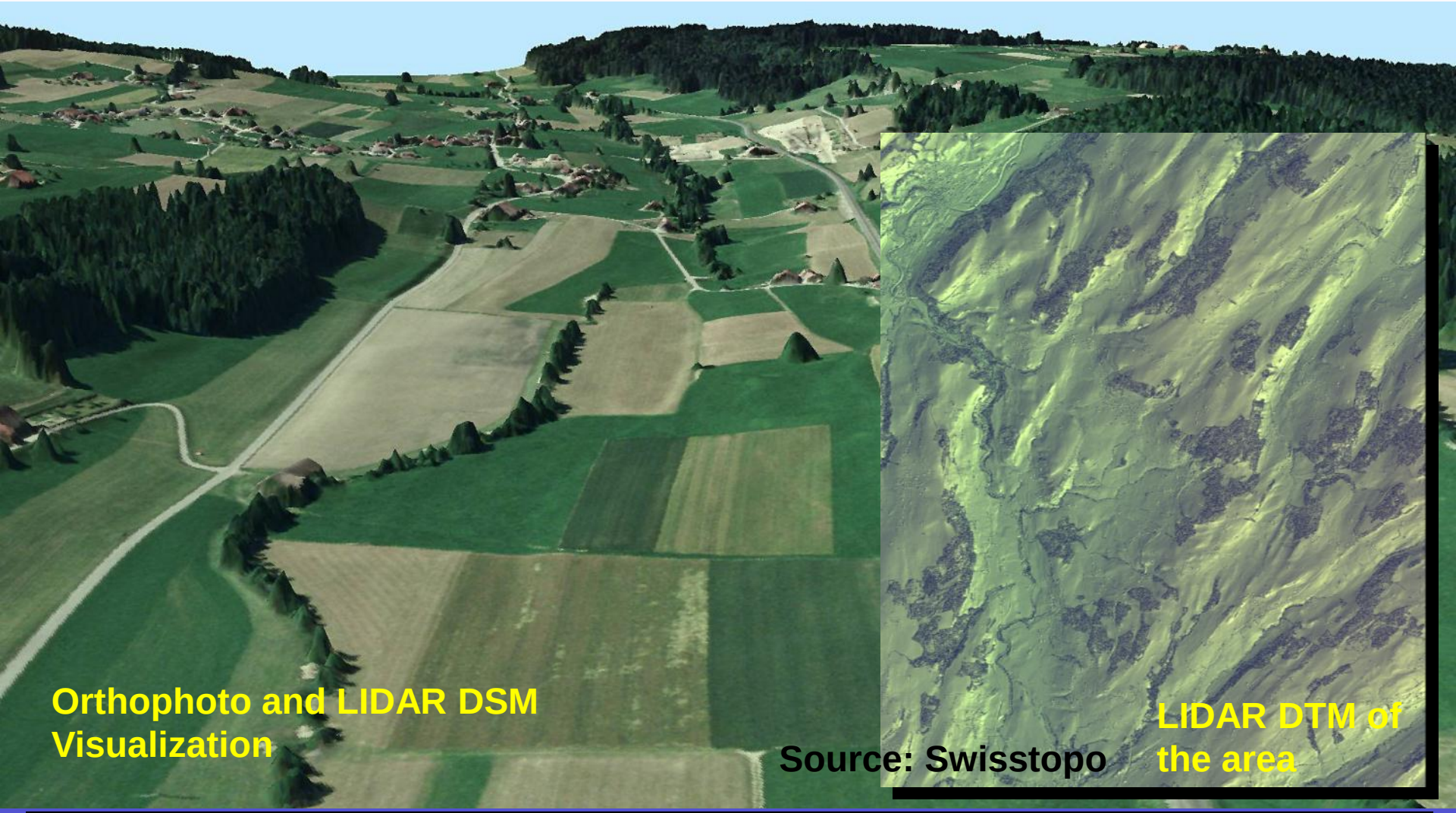
- **Mode Switch (2D, 3D Mode)**
- **Zoom In/Out**
- **Map Selection Next / Prev.**
- **Track Overlay On/Off**
- **Brightness Control**
- **Tunnel Selection**

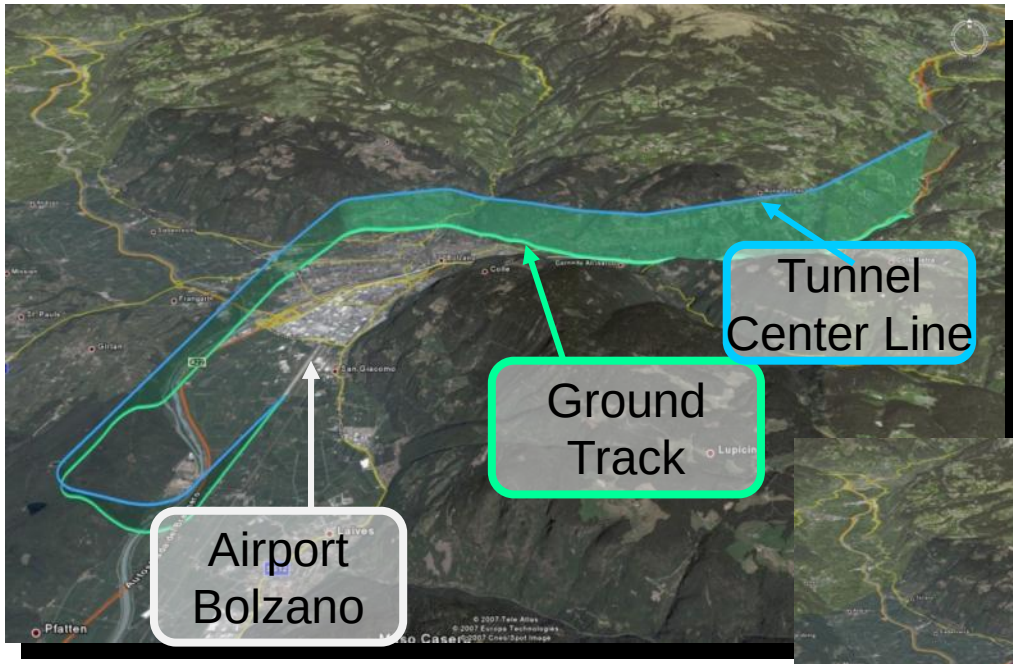
A 6.5 “transreflective TFT” with a resolution of 1024 x 768 pixels is used. Brightness control over a wide range (night, sunlight) is possible.

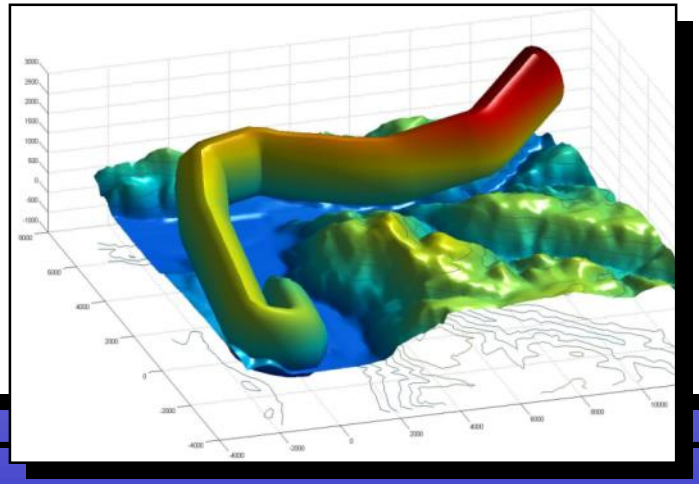
aschenbrenner elektronik gmbh

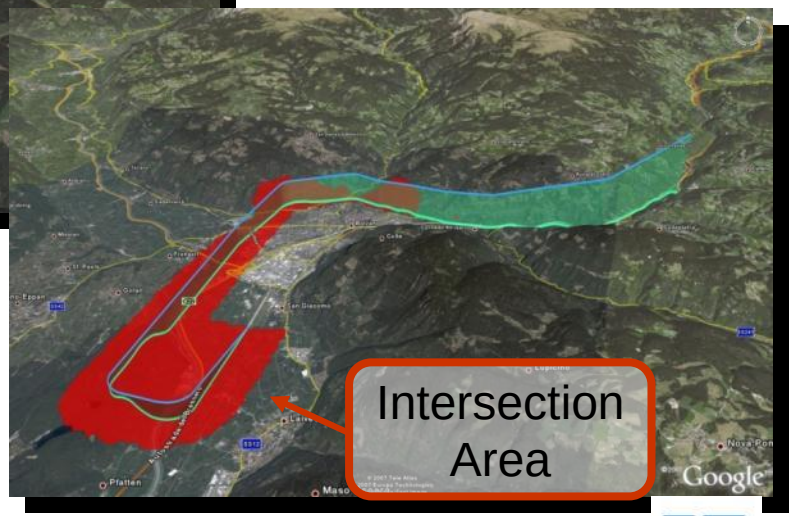
iABG

3-D Visualization Data sources
Swiss Topo LIDAR DSM and RGB Orthofoto



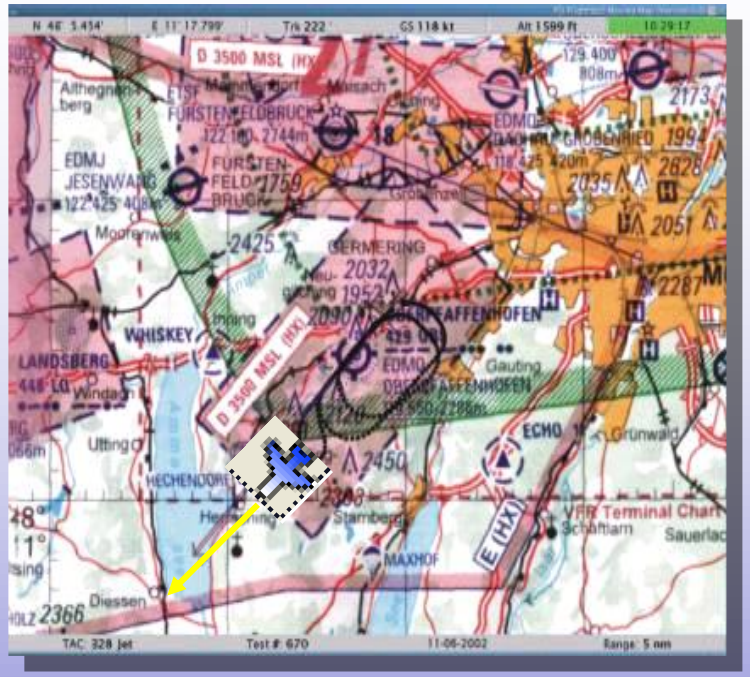

Tunnel
Center Line
Ground
Track
Airport
Bolzano




Intersection
Area
Google

Source:

Moving Map Software:

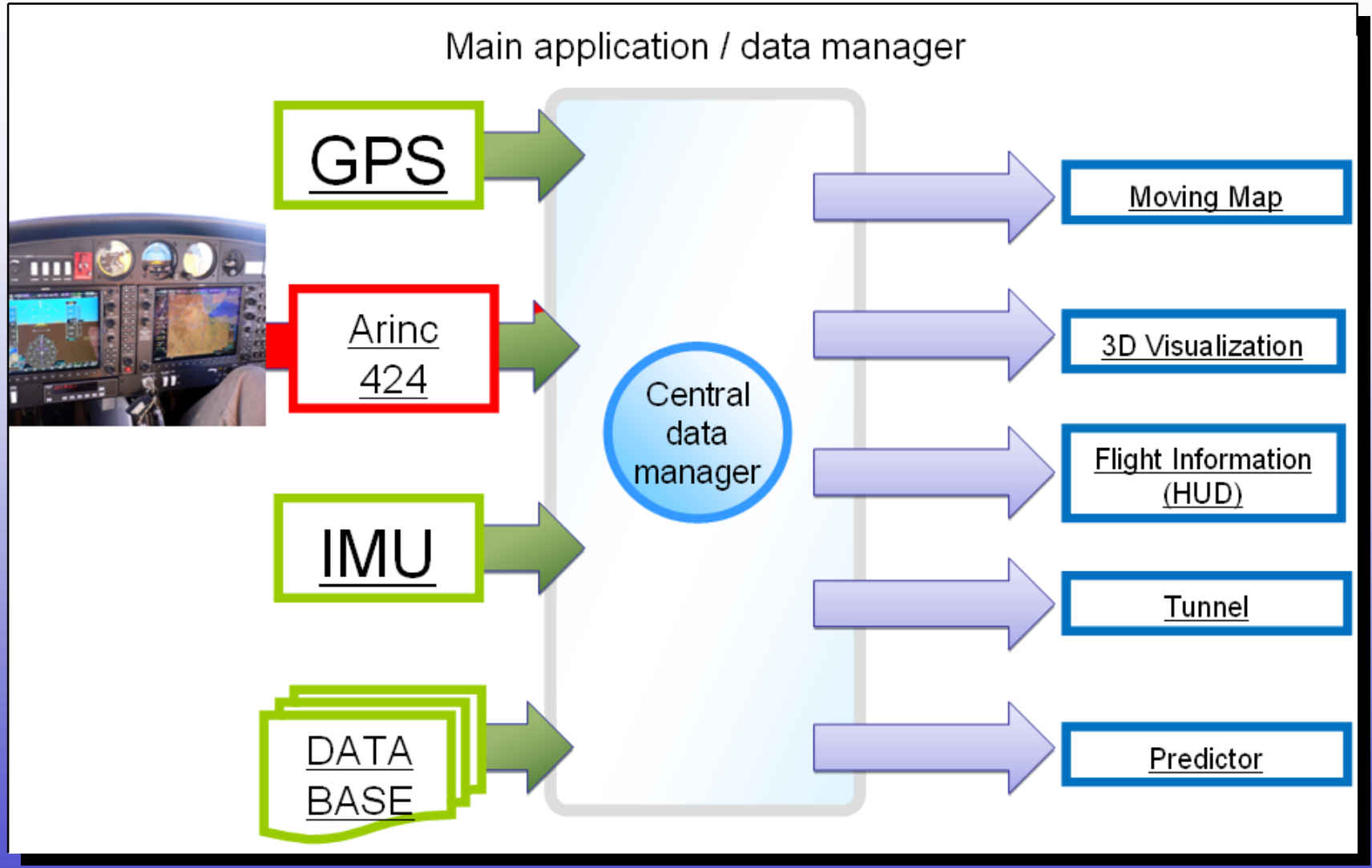


A moving map provides information on the position of the aircraft and can be shown together or seperately on the LANDING pilot's display in the cockpit

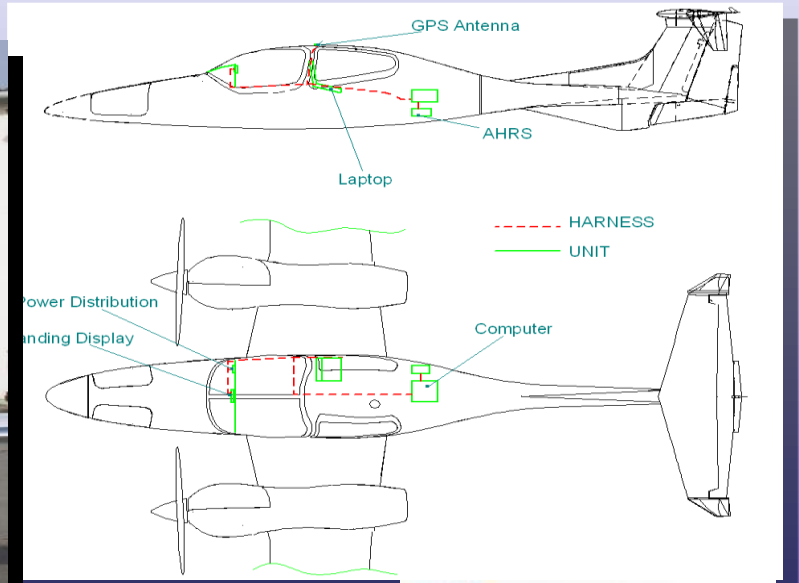
The moving map software displays the georeferenced raster background map in the desired scale selected by pilots selection. On top of the raster map an aircraft symbol is displayed and moves real time along the used flight path. Beside this the software has the following functions:

- **Selection of map window**
- **Selection of map scale**
- **Variable map zoom in - zoom out**
- **Numeric display of navigation data (position, ground speed, time, distance and time to waypoint, altitude etc.**
- **Overlay display of airspace information (TRA's, Danger areas etc …)**
- **Flight path vector incl. position prediction (time related)**
- **Map display mag. North up or heading**

Source:

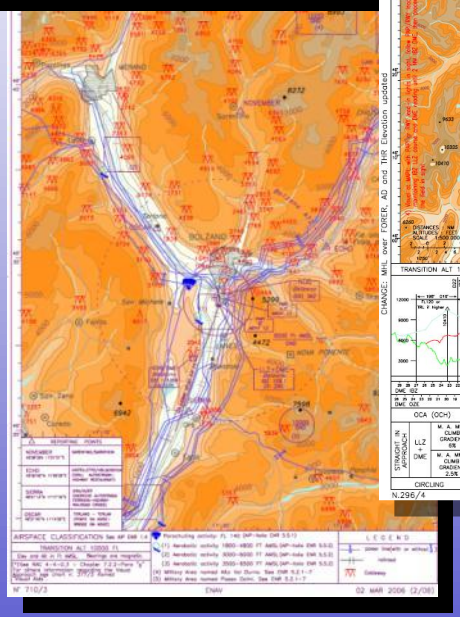

Main application / data manager
GPS
Arinc 424
IMU
DATA BASE
Central data manager
Moving Map
3D Visualization
Flight Information (HUD)
Tunnel
Predictor

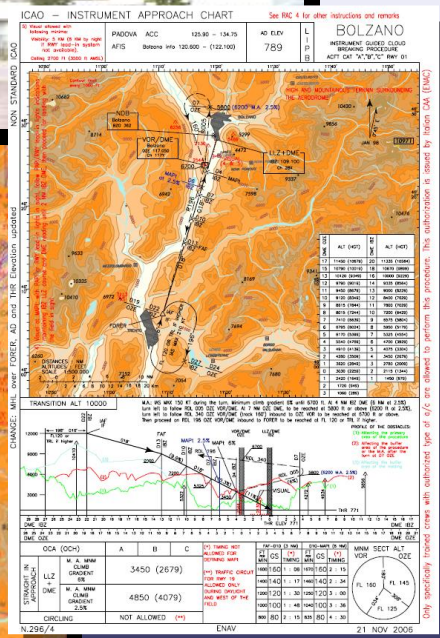
The DA 42 Test Platform:

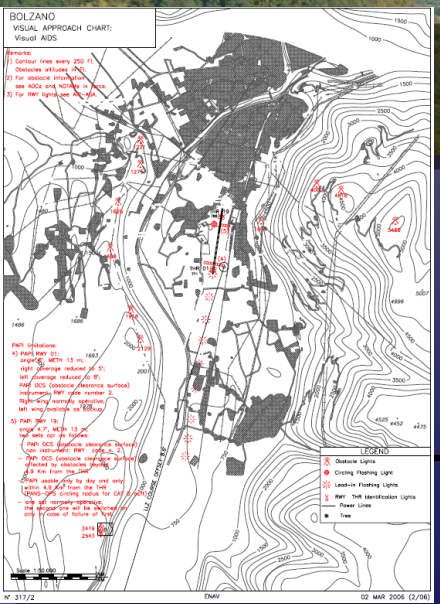


Source: Diamond AIRCRAFT

Landing Validation Airport LIBP Bolzano (Italy):







Aeronautical features

- Airspace „G“ Visual approach
- IFR procedure inbound RWY01 based on VOR/DME instruments
- IFR operations only for specifically authorized crews (special training) and types of A/C (steep aproach supplmt)
- IFR visibilty limitations

Source:

LANDING contract partner

Supervision and authorizations

100% Land Südtirol

STA Südtiroler Transportstrukturen AG

ENAC

97%

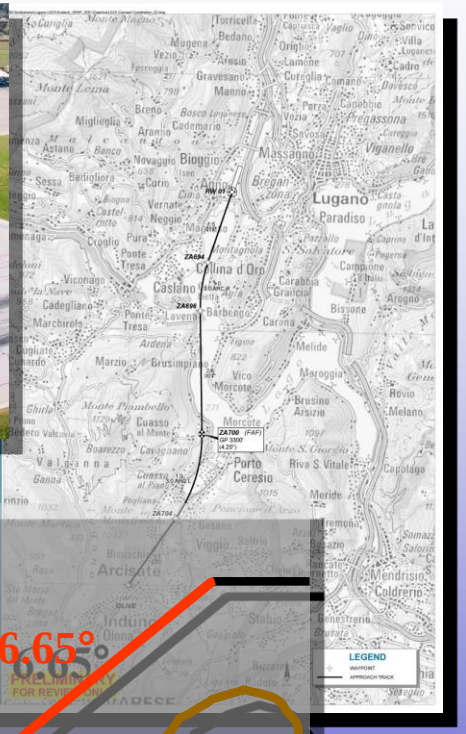
ABD Airport Bolzano

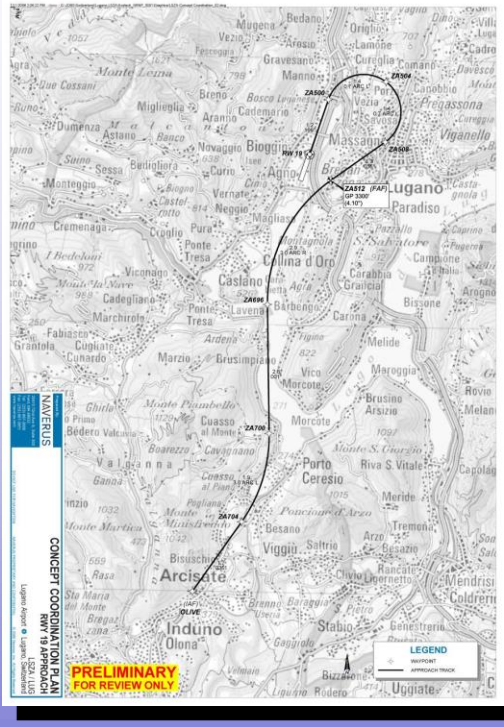
LANDING

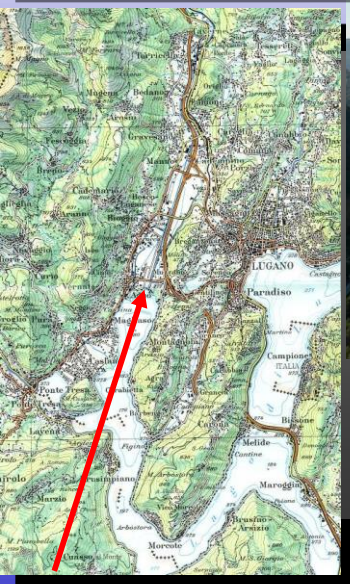
(Airport operator)

ESRI Geoinformatik GmbH

Landing Validation Airport LSZA Lugano (Switzerland):





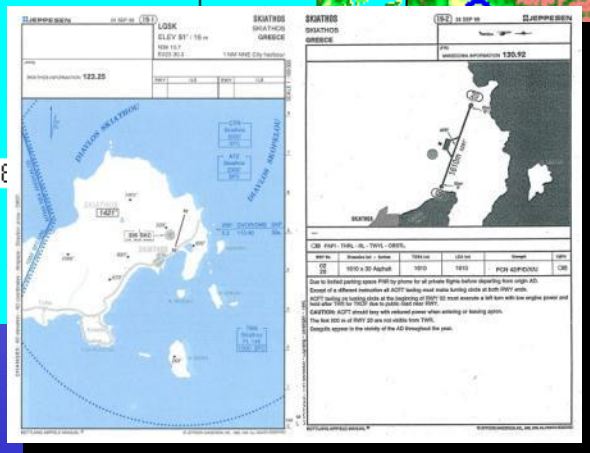


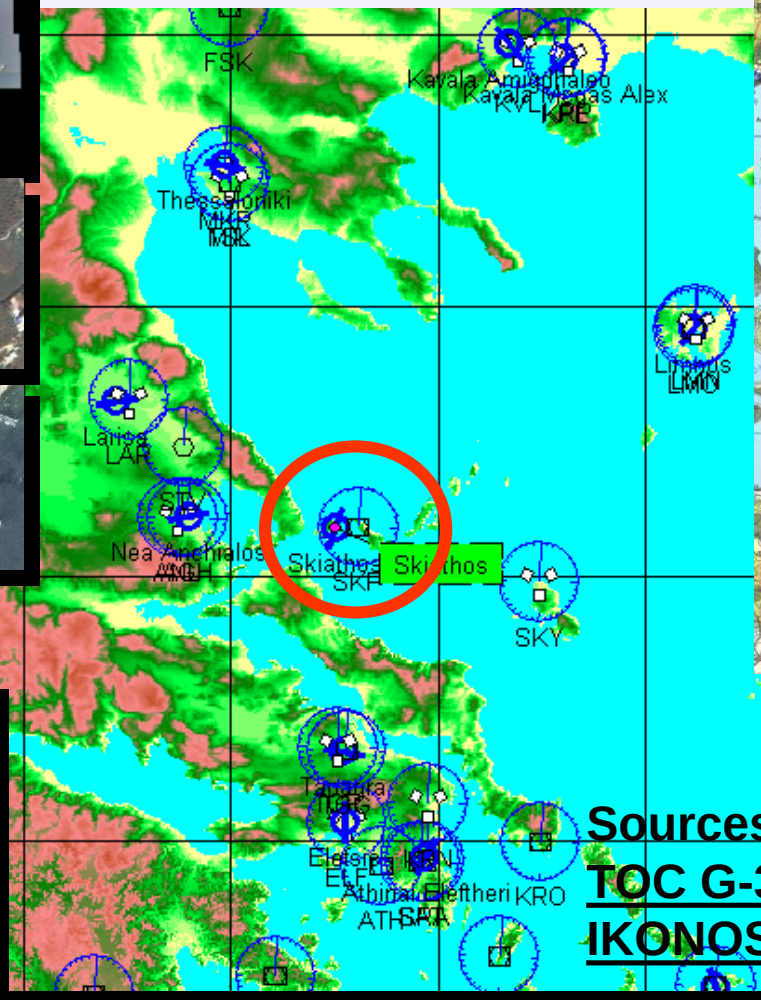
Conceptional flight pathes for possible tunnelling approaches from the south to the field.

M. Pianbello

Source:

Landing Validation Airport LGSK Skiathos (Greece):





Sources: Jeppeson, Bottlang
TOC G-3A US Government 1995
IKONOS SAT Data

ESRI
ESRI Geoinformatik GmbH

Live Demo of Bolzano and Lugano Testflights

Conclusions

- **On-Board Guidance Aid**
  - Predictor-tunnel display
  - Integrated presentation of terrain image, resolution dependent on distance from airport
- **Tunnel Generation**
  - Accounting for flight mechanics considerations (easy to fly command trajectory in difficult terrain environment), safety issues (safety corridor), etc.
- **System Testing**
  - Pilot-in-the-loop simulation
  - Flight tests
- **Development of an pre - industrial prototype**