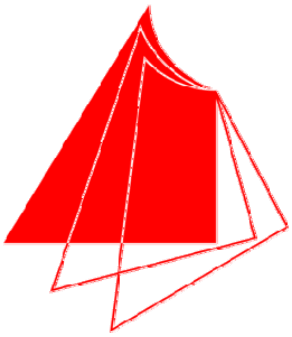

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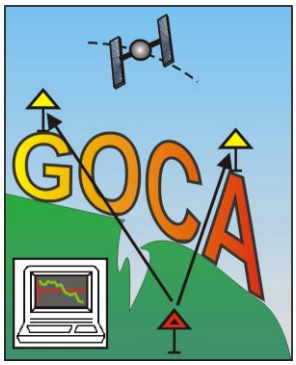
GOCA



GNSS/LPS/LS Based Online Control- and Alarm System
Version 5.0

GOCA

www goca.info

IAF
Institut für
Angewandte Forschung

GOCA Version 5.0

Authors: Reiner Jäger, Peter Spohn

Geo-Monitoring

With the worldwide use of newer and more efficient construction methods, the demand for geodetic supervision rises. In the past, buildings were constructed with the highest possible effort regarding safety and stability. Today, however, for the planning of constructions, new methods are introduced which are edging technical feasibility. These new methods require an increase of measurement accuracy and also a decrease of the epoch timespans, aiming to a continuous online geodetic monitoring of the building or construction. Otherwise, the security for man and building cannot be guaranteed.
Global climate changes, population growth and the successive expansion of general land-use area lead to a conflict between land use and prevention of natural hazards, such as slopes or thawing permafrost zones. This conflict can also be transferred to generally critical areas, like regions with volcano activities or earthquakes.
Geodetic geo-monitoring starts with the storage of original measurements and ends with reporting, - or in case of hazard mitigation projects with the step of alarming (fig. 1) of responsible persons. The complete automatation of the geo-monitoring chain can also reduces essentially the permanent costs. The deformation analysis software GOCA 5.0 fulfils all these requirements and is sucessfully tested in more than 40 installations worldwide.

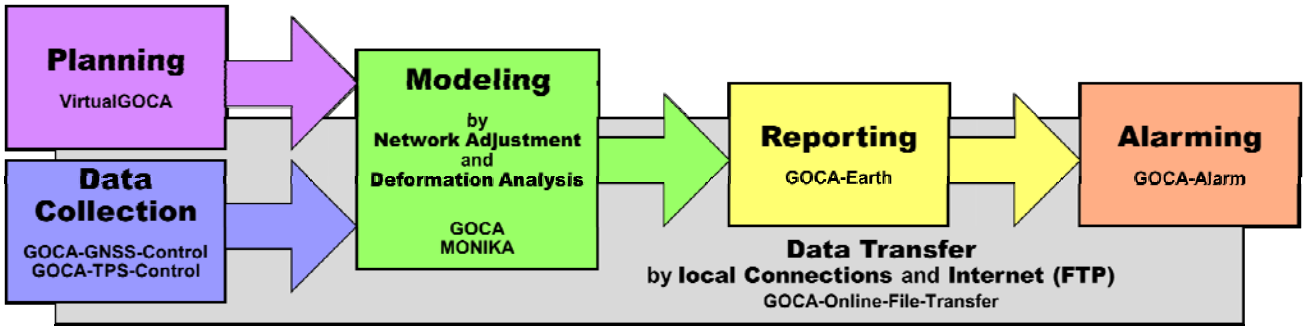


Figure 1: General scheme of an automatic geo-monitoring system

GOCA

The mobile or fixed installed multi-sensor-system GOCA 5.0 can be used as a rapid alarm system for natural disasters (landslides, volcanos) or it can be applied in the section of geotechnical facilities (mining, barrages, tunnels). The monitoring is based on geodetic network adjustment by use of GNSS (GPS/GLONASS/GALILEO) and terrestrial sensors (total stations, water level gauges, leveling instruments). The data of the sensors are send via the corresponding data-collecting and communication-software (fig. 1) within the open interface of the GKA-format to the GOCA-software. The GOCA-system can be used for online monitoring as well as for postprocessing. Through the realization of a classical deformation analysis based on a geodetic network adjustment there are no restrictions concerning the network design and the scale of the network in the GOCA system. So even GNSS base stations or total stations can be located in the object point area.

As a first step of the geodetic deformation analysis and as the GOCA adjustment step 1, the initialisation of the reference frame is calculated as a classical free network adjustment in the datum of the reference points. The object points are referenced on this reference-/ stablepoint-frame (fig.3). The following online monitoring (GOCA adjustment step 2, fig. 3) is a hierarchic adjustment, which takes the stochastic qualities of the reference points from step 1 into account. The final georeferencing of the object point coordinates is also possible in a user-defined system, independant from the geodetic datum of the reference points. These georeferenced object points with timestamps are saved as text-based FIN files, which can be used as an universal interface for other solutions or software (e.g. for FEM-software).

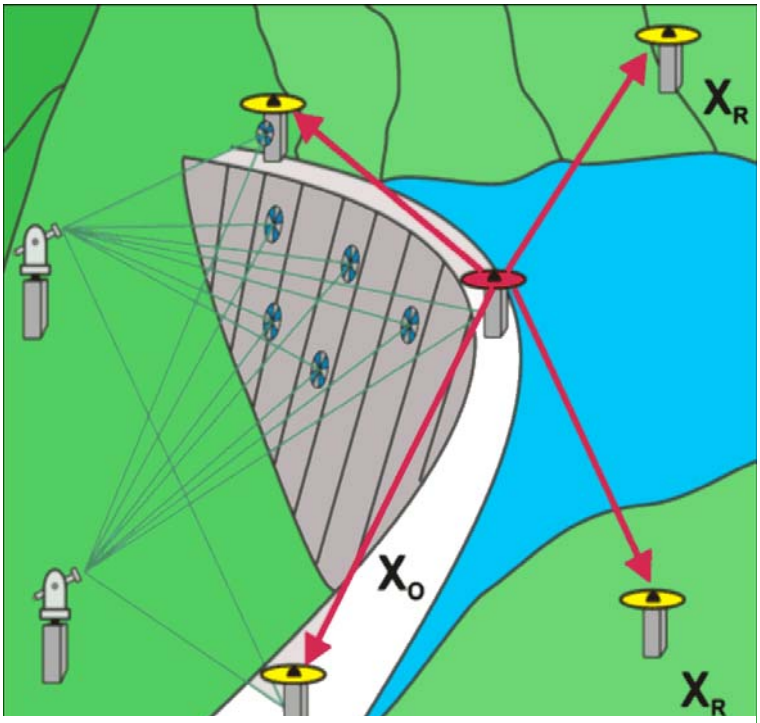


Figure 2: Typical network configuration modelled by GOCA

Simultaniously to the online monitoring (GOCA adjustment step 2) and based on the above mentioned FIN files, the geodetic deformation analysis can be executed (GOCA-adjustment step 3, fig. 3). There are three different mathematical models of the deformation analysis realised in the GOCA software: Displacement estimation, moving average and Kalman filtering (displacement, velocity and acceleration). Based on the Kalman-filtering a prediction of the displacement of the object points and a following early warning can be made. Additionally to the standard least-squares estimation (L2-Norm), robust estimation (L1-Norm, Huber) is implementented in all analysis filters. Critical situations are tested automatically with user defined critical deformations or with significant deformations detected in statistical tests, or both. The alarm settings for the individual state estimation of the object points are configurable. All state variables, the variances and the statistical significance tests of above-mentioned deformation analysis estimations are available in open data interfaces (MVE, SHT, KAL, VHS) for reporting (fig. 1) and further processing, too.

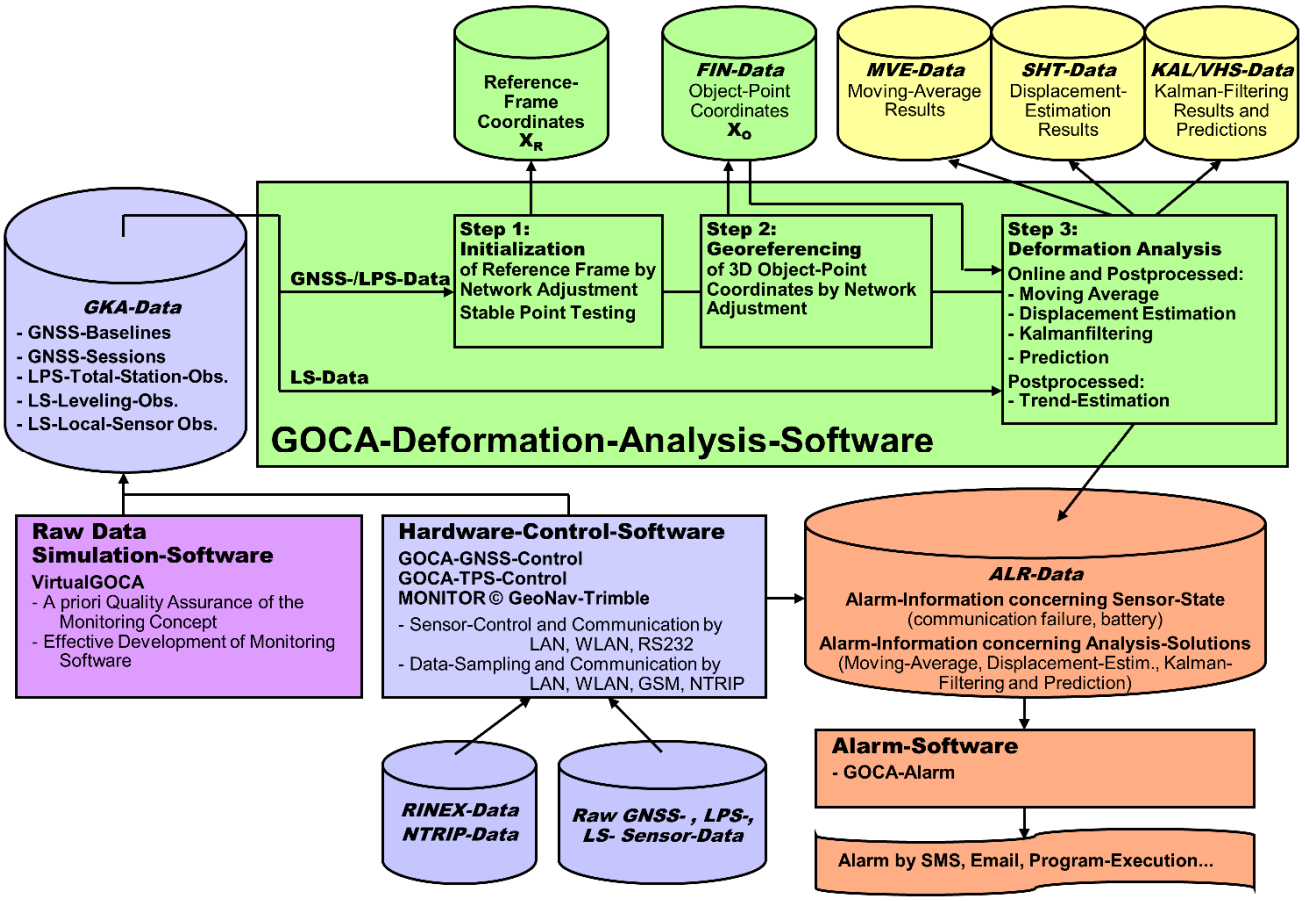


Figure 3: Procedure of a deformation analysis in GOCA

For visualisation of the deformation state estimations (3D displacements, velocities, accelerations) and forecasting for early warning, different kind of time series diagrams are available in the GOCA software in addition to the visualisation by GOCA-Earth (fig. 1). These time series diagrams are all updated continuously during an online monitoring project and can also be individually adjusted for every point. The same is true for the visualisation in the user defined array grafic.

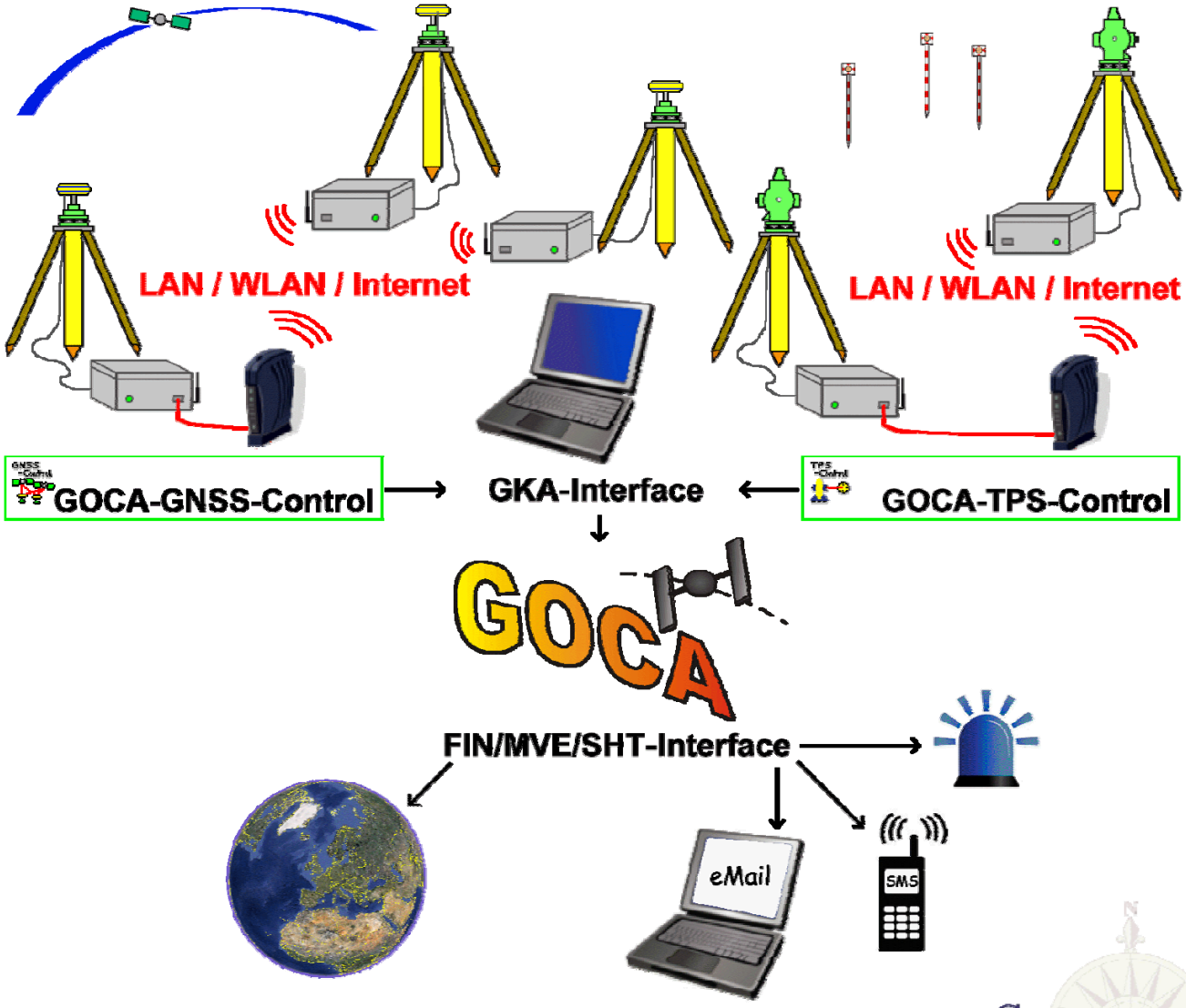


Figure 4: Geo-monitoring-chain in GOCA

Supported manufactors:

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