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# **Impact of Satellite Positioning Services on State Survey Control Networks**

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# Overview



## German State of Lower Saxony

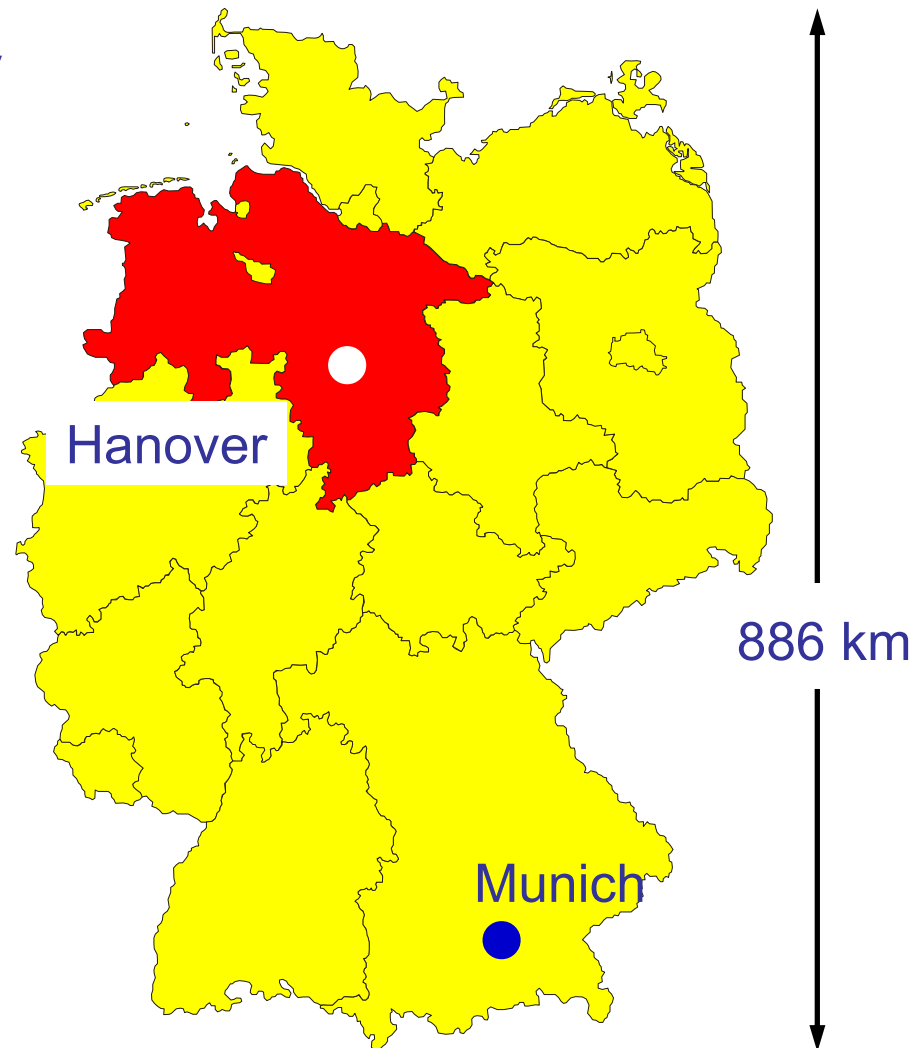
- 47.620 km<sup>2</sup> (2nd)
- 8 Mill. inhabitants (4th)

## Geodetic infrastructure:

- 41 SAPOS stations
- 120.000 control points
- 1.600 base network points



Landesvermessung und  
Geobasisinformation  
Niedersachsen



# Contents

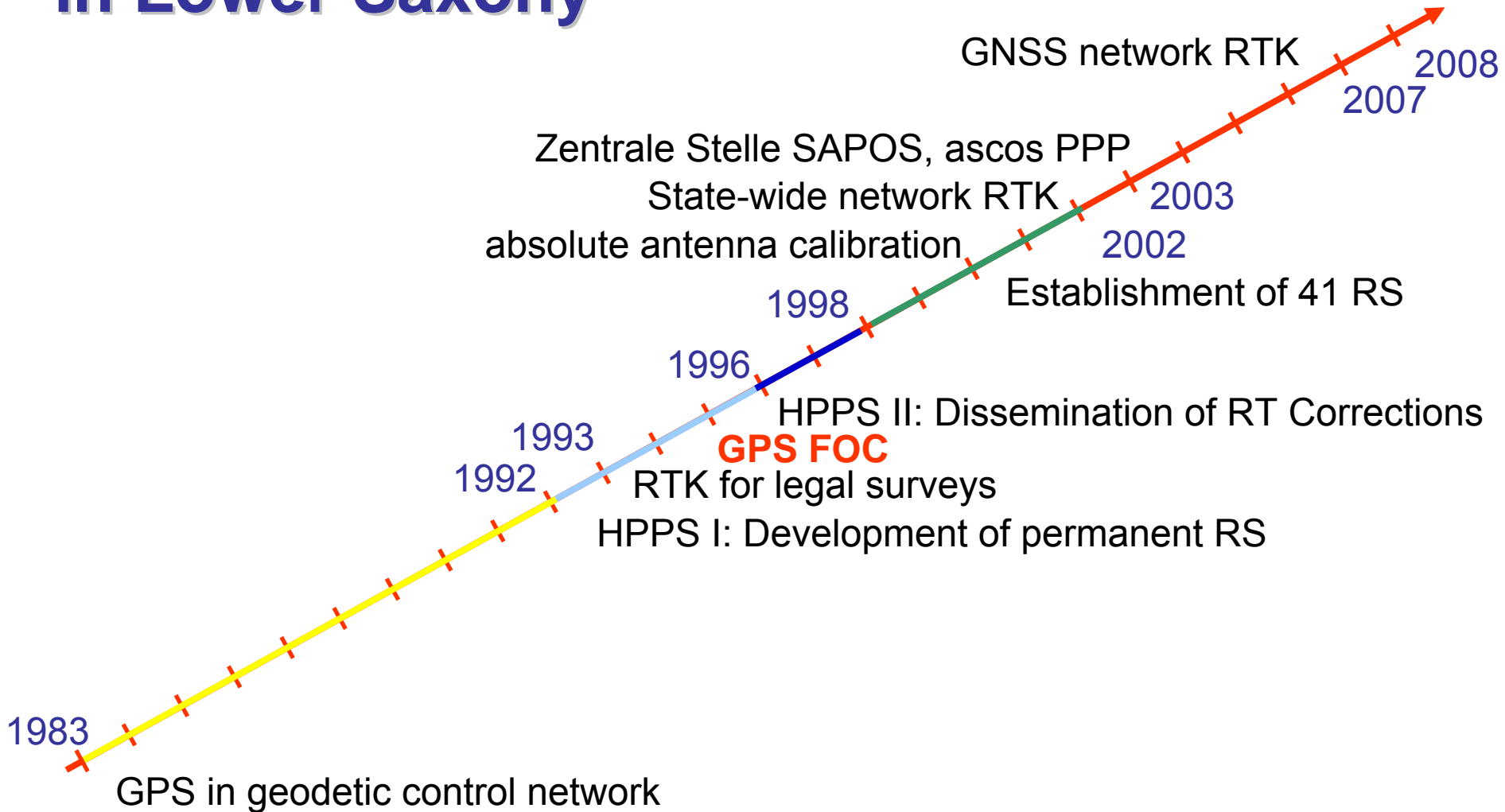
- 1) Classical Geodetic Control Networks (GCN)
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- 5) The future of GCN and CORS
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**Disclaimer:**  
The following are personal observations  
and do not represent any official view

# Classical Geodetic Control Networks (GCN)

- Monumented (pillar, pipe, slab) control points
- Different networks for position (2D, 3D), heights, gravity
- Independent observations at different points/epochs
- Legal survey markers hierarchically linked into GCN
- State-wide availability (big expense, low revenue)
- Access almost exclusively by State Survey Authority and surveying experts
- No research objectives (except crustal dynamics)
  - terrestrial measurements replaced by GPS

# Evolution from GCN to GNSS network RTK in Lower Saxony



# Motivation for CORS

- Vaníček et al. 1983: „The Future of Geodetic Networks ...“  
Augath 1994
- Providing direct access to reference frame in global datum, using Continuously Operating Reference stations (CORS)
  - for post processing and differential real time positioning
  - for different precision levels
  - for different applications
- Inconsistencies and deficiencies need to be resolved:
  - skipping hierarchical network structure (distortions, deformations)
  - undefined relationship between classical GCN and CORS
  - incompatibility to official local datum, e.g. DHDN90
  - complex infrastructure (station design, hard-/software, communication)

# From CORS to Positioning Services

- HPPS (1992-1998), SAPOS (since 1998)
    - State Survey Authority provides CORS infrastructure for multiple applications and users
  - Competing CORS operators
    - energy, telecommunication, ...
    - continental and global services (SBAS, StarFire)
  - Competing providers
    - e.g. ascos (PPP contracts with State Survey Authorities via Zentrale Stelle SAPOS)
    - Ordnance Survey Net, UK: Leica, Trimble
- Economically questionable,  
administrative and technical challenges

# Administrative Challenges

- Set-up and operation of network RTK services is expensive
- CORS infrastructure is rapidly evolving (ahead: GALILEO)
- Cooperation across CORS networks required (data exchange, data processing)
- Relationship between NMA and competing operators/providers needs clarification
  - Relation between GCN and CORS needs standardization
  - CORS should be tied to ITRF, but must consider dependency on legal aspects of cadastre
  - Coordination of CORS activities (NMA, eurogeographics, FIG, IAG, IGS)?
    - insufficient political representation, e.g. regarding GALILEO
    - involving commercial operators/providers



# Technical Challenges

- precise GNSS RT positioning model requires more research:
  - antenna and station calibration
  - multipath error, esp. near-field effects
  - troposphere errors and heights (geoid model)
  - Validation of ambiguity resolution
  - Network RTK approaches (state space modelling)
- Research towards analysis and monitoring of CORS (definition of quality measures)
- Precise 3D positioning (heighting) requires quality improvements of CORS components and real time processing as well as proper field procedures

# The Future of GCN plus CORS

- Geodetic control networks maintained for over 150 years, ownership of land to be guaranteed for another 100 years
- Less than 10 years experience with positioning services
- Availability of GPS guaranteed till 2030 (FRNP)
  
- High measurement accuracies enable observation of ground subsidence and regional geodynamic effects
- Changing earth surface requires appropriate spacing of GCN
  
- CORS need to be integrated into modern monumented base network, materializing the reference frame simultaneously for position, height, and gravity
  - will be established in Germany within DHHN campaign 2007-2011
  
- Ensuring long-term stability of reference frame independent of current measuring system

# Conclusions

- CORS and RTK networks
  - have proven their technical reliability
  - concepts are widely spread and highly accepted
  - technology (GNSS, communication) is rapidly evolving
  - impact the tasks, procedures, and conception of State Survey Authorities
  - entice to minimize efforts for GCN which are by no means obsolete
- Deficiencies of CORS
  - no sufficient long-term experiences
  - unknowns in GNSS error model
  - changes of earth surface
  - legal aspects of cadastre
- Modern monumented geodetic base networks are indispensable

**Shaping the Change**