



Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland

## Radical change to a modern general control network

by  
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## Radical change to a modern general control network

### Outline

- The technical changes and effects in surveying and mapping
- The situation in the Federal Republic of Germany
  - Federal strategy for the future general control network
  - Function of the fundamental geodetic points
- The example of the State of Baden-Württemberg
  - Future general control network
  - Reduction of points and saving of costs
- A theoretical concept for the general control network of a state
- The effects on the real estate cadastre
- Summary

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## The example of the State of Baden-Württemberg

- Reduction of the personal expenditure -

	1975	2005
Number of employed workers	128	24
Personal expenditure (present cost-output evaluation)	4,96 Mio Euro	0,96 Mio Euro
Annual savings	80,7% = 4,0 Mio Euro	

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## The technical changes in surveying and mapping

- A look back over the last 20 years -

- Worldwide international Global Navigation Satellite-Systems (GNSS)
  - GPS, GLONASS, Galileo
- On the basis of GNSS-technology a new type of surveying has been developed in connection with extensive hard- and software
- National GNSS based reference station networks have been set up
  - SAPOS®, swipos, APOS,
- Standardization for the international terrestrial reference system
- Replacing of the traditional national spatial reference systems DHDN
  - ETRS89
- GNSS-based surveying online without identical points
- Reduction of the survey standards in the official surveying and mapping

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## The technical changes in surveying and mapping

- The effects of the technical changes -

- Reference station networks realize the spatial reference system as a whole
- In future we will work only with general control networks which are thinned out
  - Position
  - Height
  - Gravity
- The previous 1d- rather 2d-general control networks will be replaced by 3d- to 5d-general control networks
- Through the combination of levelling and GPS-derived heights we are in a position to create a new type of height surveyance

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## The situation in the Federal Republic of Germany

- Decision of the Adv in the year 2004-

### Homogenous federal general control networks (duty)

- SAPOS® reference stations of the system ETRS89
- High general control network of 1. order in the system DHHN92
- General gravity points of the DHSN 1. order in the system DHSN96
- Geodetic control points
  - 3d-station monumenting
  - 3d-coordinates in the system ETRS89/UTM
  - Heights in the system DHHN92
  - Gravity in the system DHSN96

### State specific general control networks (option)

- Position general control networks 1. to 4. order in the system of GK
- Height general control networks 2. and 3. order in the system DHHN92
- Gravity general control networks 2. and 3. order in the system DHSN96

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## The situation in the Federal Republic of Germany

- Decision of the AdV in the year 2004-

**Homogenous federal general control networks (duty)**

- SAPOS<sup>®</sup> reference stations of the system ETRS89
- Height general control network of 1. order in the system DHHN92
- General gravity points of the DHSN 1. order in the system DHSN96
- Geodetic control points
  - 3d-station monumenting
  - 3d-coordinates in the system ETRS89/UTM
  - Heights in the system DHHN92
  - Gravity in the system DHSN96

**State specific general control networks (option)**

- Position general control networks 1. to 4. order in the system of GK
- Height general control networks 2. and 3. order in the system DHHN92
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## The situation in the Federal Republic of Germany

- Function of the geodetic control point -

- Geodetic control point represents a 5d-point
  - 3d (coordinates x,y,z in the system ETRS89 / UTM)
  - 1d (height in the system DHHN92)
  - 1d (gravity in the system DHSN96)
- Geodetic control points serve
  - for a short time
    - link of position, height and gravity concisely in one point
    - additional group of points
  - in the long run
    - realization of the total spatial reference

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## The example of the State of Baden-Württemberg

- Reduction of points -

	Now	Future
<b>Homogenous federal general control networks (duty)</b>		
● SAPOS <sup>®</sup> reference stations of the system ETRS89	-	16
● Height general control points of 1. order in the system DHHN92	9 000	9 000
● General gravity points of the DHSN 1. order in the system DHSN96	36	36
● Geodetic control points <ul style="list-style-type: none"> <li>- 3d-station monumenting</li> <li>- 3d-coordinates in the system ETRS89/UTM</li> <li>- Heights in the system DHHN92</li> <li>- Gravity in the system DHSN96</li> </ul>	-	180
<b>State specific general control networks (option)</b>		
● Position general control networks 1. to 4. order i.t.s.o. Gauss-Krüger	61 000	-
● Height general control networks 2. and 3. order i.t.s.o. DHHN92	52 000	14 000
● Gravity general control networks 2. and 3. order i.t.s.o. DHSN96	6 000	-
<b>Total</b>	<b>ca. 128 000</b>	<b>24 000</b>

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## The situation in the Federal Republic of Germany

- Reason for the reduction of the general control network -

<b>Position</b> 3d	<ul style="list-style-type: none"> <li>● Accuracy of the points : +/- 2 cm</li> <li>● SAPOS reference stations in connection with software for networking</li> <li>● Reduction: up to now: 1...2 points per 1 km<sup>2</sup> in future: 1 point per 2000...2500 km<sup>2</sup></li> </ul>
<b>Height</b>	<ul style="list-style-type: none"> <li>● Clear separation between the scientific network and the survey network</li> <li>● Use network has to accept a reduction of the survey standard</li> <li>● Networks of the 2...3. order will be dropped</li> </ul>
<b>Gravity</b>	<ul style="list-style-type: none"> <li>● Frame network as a scientific network will be required</li> <li>● Non-marked out general gravity control network of 2. and 3. order for the determination of the highly accurate Quasigeoid</li> </ul>

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## The situation in the Federal Republic of Germany

- Reason for the reduction of the general control network -

**Important assumptions**

- In the long run we have to give up the existing control networks
- We have to accept, that GNSS-technology is the technology of the future
- GNSS-technology is no additional technology to the existing technology

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## The situation in the Federal Republic of Germany

- The future general control network for a state -

- Setup of an own Satellite Positioning Service
  - Accuracy of +/- 2 cm for the fixing of a point
  - 1 reference station per 2 500 km<sup>2</sup>
  - All reference stations have to be connected by software for networking
- Geodetic control point
  - Fairly identical to the points of the Satellite Positioning Service
  - Fairly identical to the levelling network of 1. order
  - Absolute measurement of gravity should be carried out
- Levelling network
  - Levelling network 1. order has to be seen as a scientific network
  - Use network has less accuracy (+/- 2 cm)
  - Recovered through a highly accurate Geoid (better +/- 1 cm)

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### The future general control network for a state

- Theoretical thoughts of an outsider -

	State X	Federal Republic of Germany	State of Baden - Württemberg
Area	x 000 km <sup>2</sup>	357 023 km <sup>2</sup>	35 500 km <sup>2</sup>
GNSS-reference-stations	0,45x points	260 points	16 points
Geodetic control points	0,45x points	260 points	16 points
Levelling network	200,00x points	55 000 points	7 100 points
Gravity network, marked not marked	200,00x points 200,00x points	55 000 points 16 500 points	7 100 points 7 100 points
Total, marked not marked	200,45x points 200,00x points	55 260 points 16 500 points	7 016 points 7 100 points
All together	<b>400,45x points</b>	<b>71 760 points</b>	<b>14 116 points</b>

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### The future general control network for a state

- Reality -

	State X	Federal Republic of Germany	State of Baden - Württemberg
Area	x 000 km <sup>2</sup>	357 023 km <sup>2</sup>	35 500 km <sup>2</sup>
GNSS-reference-stations	0,45x points	160	260 points
Geodetic control points	0,45x points	160	(260+x) points
Levelling network	200,00x points	71 400	55 000 points
Gravity network, marked not marked	200,00x points 200,00x points	71 400 71 400	55 000 points 70 000 points
Total, marked not marked	200,45x points 200,00x points	71 560 71 400	55 260 points 70 000 points
All together	<b>400,45x points</b>	<b>142 960</b>	<b>125 260 + x</b>

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### The effects on the real estate cadastre

**Condition:** Spatial reference of cadastre is identical to the spatial reference of the general control network

- Measurements of cadastre through SAPOS® reference stations automatically show the coordinates of the target system
- Usual fitting into surrounding cadastre field can be left out
- Reference stations will directly show the spatial reference
- Expenditure of the surveying of the real estate will be reduced by factor 3 to 5
- Expense and personal expenditure will fall accordingly

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### Radical change to a modern general control network

#### Summary

1. Technical changes and their results in surveying and mapping
2. Situation in the Federal Republic of Germany
  - German strategy for the future general control network
  - Function of the fundamental geodetic points
3. Example of the State of Baden-Württemberg
  - General control network of the future
  - Potential forecast saving
4. Theoretical concept for a future general control network of a state
5. How modern new general control network affect the real estate cadastre?

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### The example of the State of Baden-Württemberg

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