



Arbeitsgemeinschaft der Vermessungsverwaltungen  
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# Germany: Integrated Geodetic Spatial Reference 4.0

## EUREF Symposium 2019 Session 3 - Techniques: GNSS, Levelling, Combination

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# Integrated Geodetic Spatial Reference

*integrated surveys: „mix of methods“*

provision

ETRS89/  
DREF91  
(Realisation 2016)

DHHN2016

DHSN2016

GCG2016

components of the  
Spatial Reference 2016

1. order - leveling (30.000 km)

GNSS campaign  
(250 GGP)

absol. gravimetry  
(100/250 GGP)

relativ.gravimetry  
(>x.000 points)

AFIS (DB of points)

SAPOS (RTK-GNSS network)

**GNSS**

MEASUREMENT TECHNIQUES

**EDM**

**Leveling**

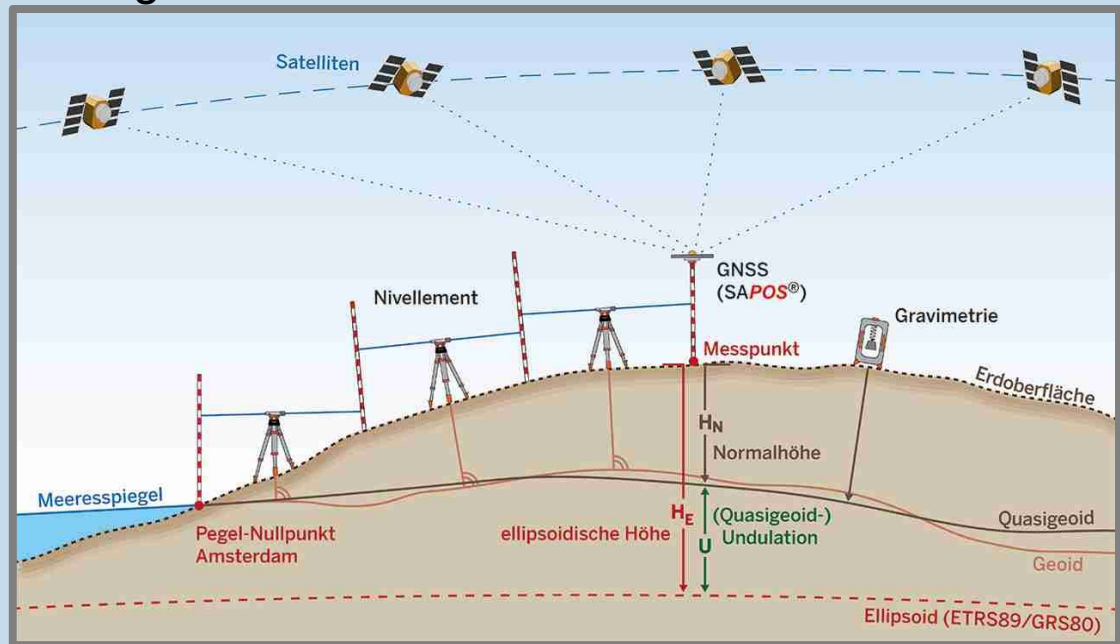
**Gravimetry**



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# Integrated Geodetic Spatial Reference

- **Holistic view of the geometrically and physically defined components** - Determination of 3D / 2D position / ellipsoidal height / normal height / gravity / undulation / geoid.
- **Geodetic Fundamental Points (GGP)** – multifunctional representatives of the integrated geodetic spatial reference.
- **„cm“-geoid**: precisely modeled height reference surface.
- points have a function as **geo-sensors**.
- monitoring with respect to the **product standard**
- Integrated Geodetic Spatial Reference (t) !!!





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# Integrated Geodetic Spatial Reference

**absolute  
gravity  
100 GGP (D)**

**rel. gravity  
6000 points  
(example NRW)**

**GNSS  
250  
GGP (D)**

**1. order leveling: 30.000 km (D)**

**Reference  
2016**

**ETRS89/  
DREF91  
(realisation 2016)**

**DHHN2016**

**DHSN2016**

**GCG2016**

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016







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# 1. order leveling 2006-2012

## 1. order leveling network (DHHN)

312 loops (level of error):

224 (72%) in the 1. third

78 (25%) in the 2. third

10 ( 3%) in the 3. third

permissible inconsistency

$$Z_U = \pm 2 \cdot \sqrt{U}$$

mean error: 0,32mm/km

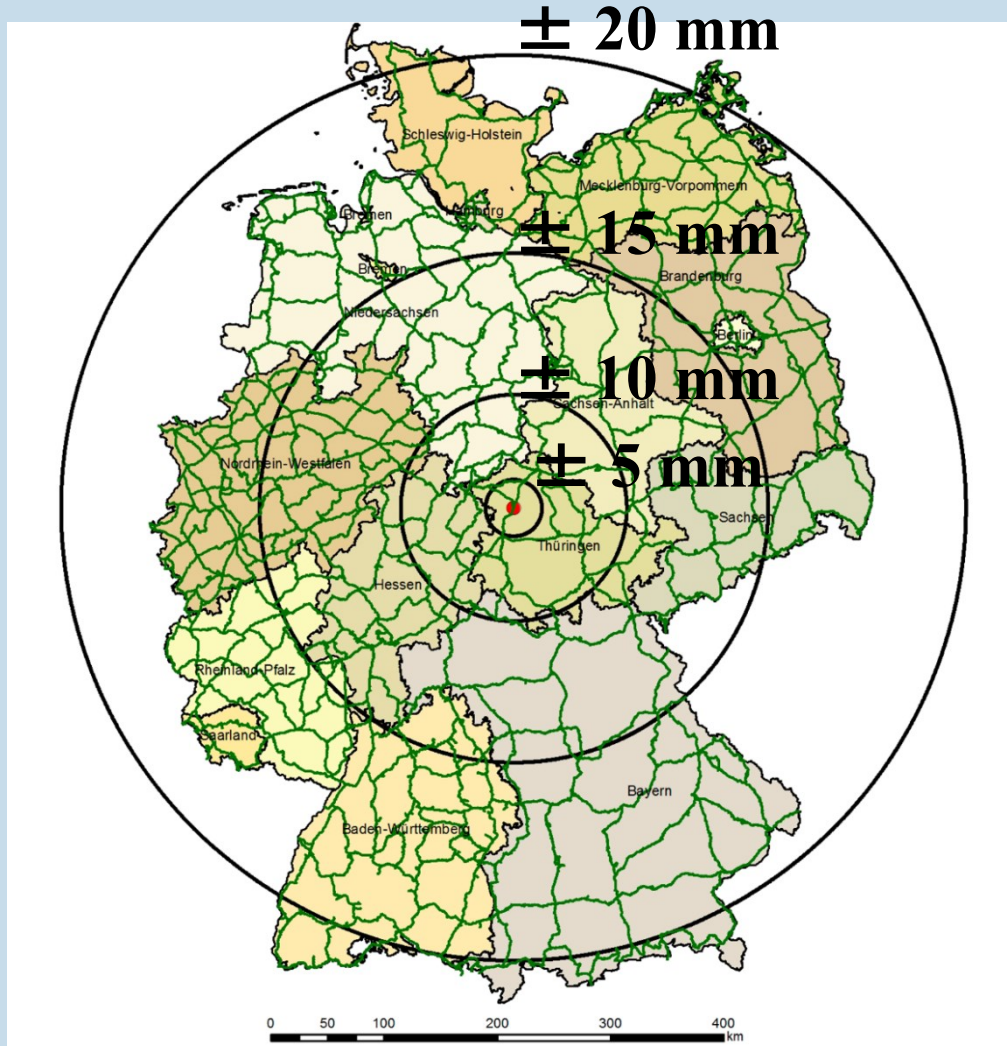
inconsistency of the outer loop of the  
entire network (5350km):

|                    | 1992  | 2016  |
|--------------------|-------|-------|
| outer loop [km]    | 4743  | 5350  |
| inconsistency [mm] | 138,3 | 13,3  |
| permissible [mm]   | 137,7 | 146,3 |



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# accuracy 1. order leveling network (DHHN 2016)



source:



Bundesamt für  
Kartographie und Geodäsie



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# Integrated Geodetic Spatial Reference realisation 2016

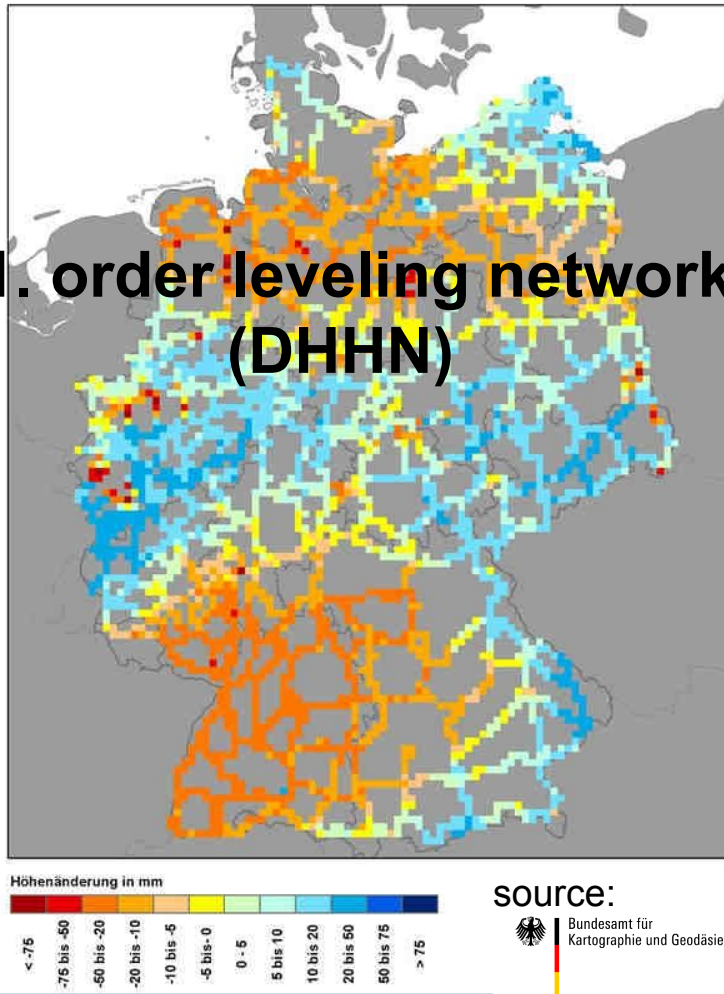
- **2D:** The introduction of (new) coordinates ETRS89 / DREF91 (realization 2016) in SAPOS has no impact on the real estate cadaster
- **height:** Elevation changes in the range of +/- 35 mm occur between (DHHN) 1992 and 2016, and significantly higher changes occur in areas with mining activities.
- **„1cm“-geoid:** GCG2016 (geoid derived by BKG) will increase the importance of GNSS. The GNSS measurement technique will replace other measurement techniques as the most economical and accurate once.
- **Geodetic Fundamental Points (GGP)** realize the integrated spatial reference, **SAPOS (RTK-GNSS-network)** actively provide the spatial reference as a contribution to the spatial data infrastructure.



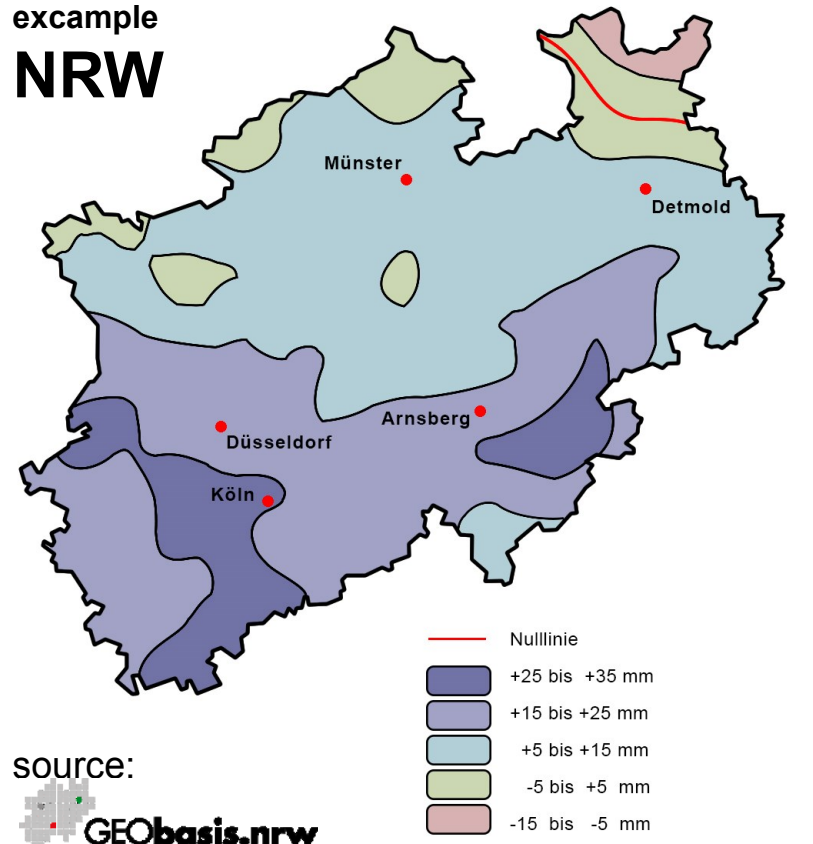
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# 1. order leveling network (DHHN) changes between the realisations 1992 - 2016

## 1. order leveling network (DHHN)



## example NRW



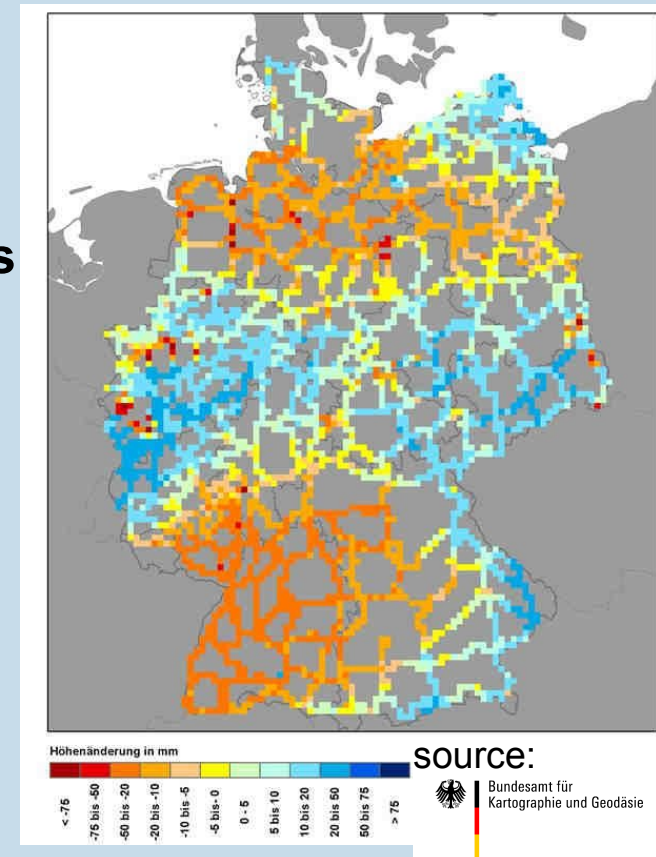




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# Integrated Geodetic Spatial Reference temporal changes

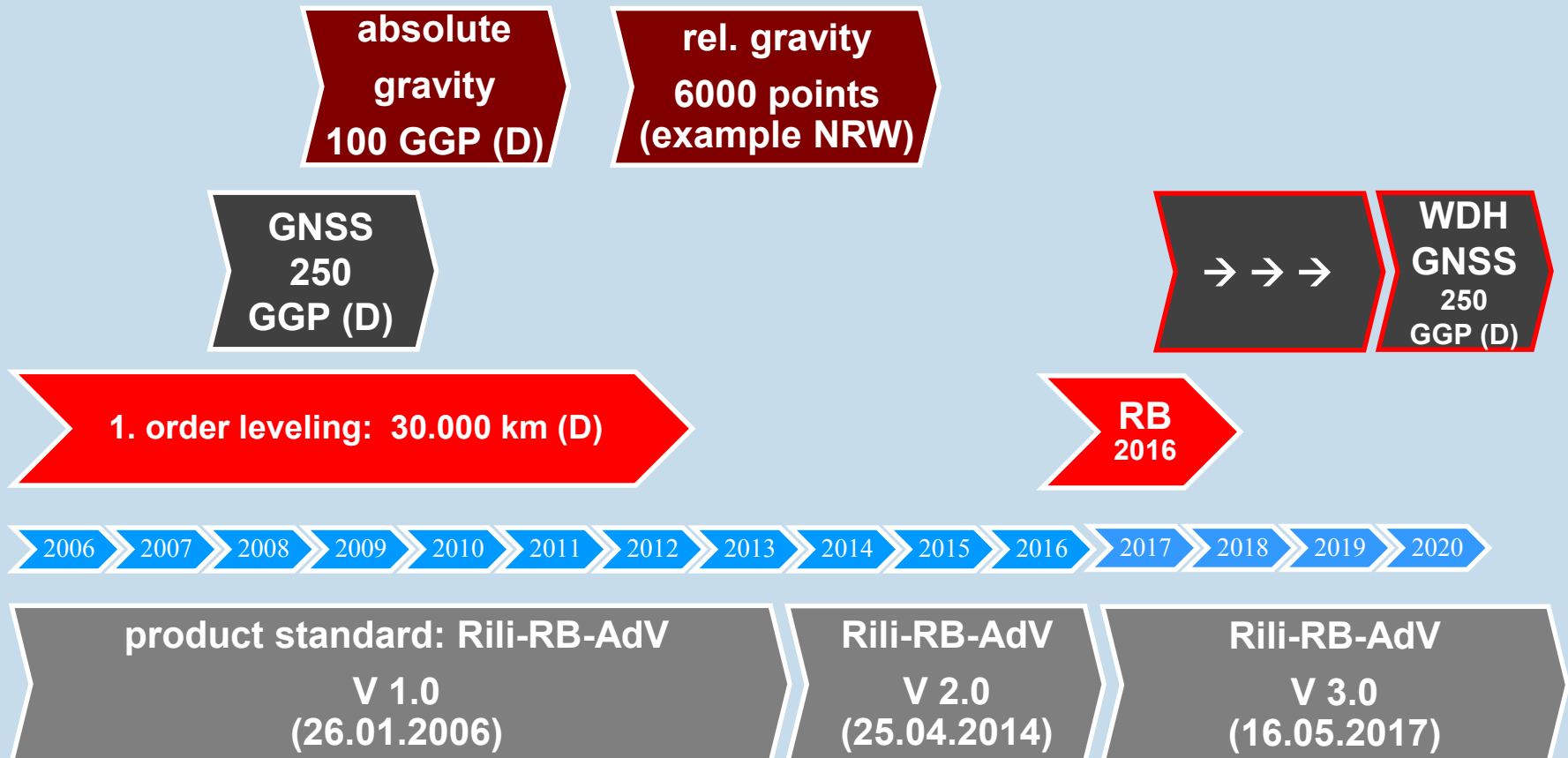
- **Time series show relative movements** (for example, long-term co-ordinate monitoring in GNSS networks (SAPOS) or in leveling networks)
- **Marked points** lose their original importance. As **geo-sensors**, they can provide a monitoring function.
- the **updating of 2D/3D** coordinates and heights will be a result of significant changes.
- The **scientific and social benefit** (e.g., climate change) can be exploited by evaluating (historical) measurements.
- Tendency: **Integrated Survey Concept** ("mix of methods")





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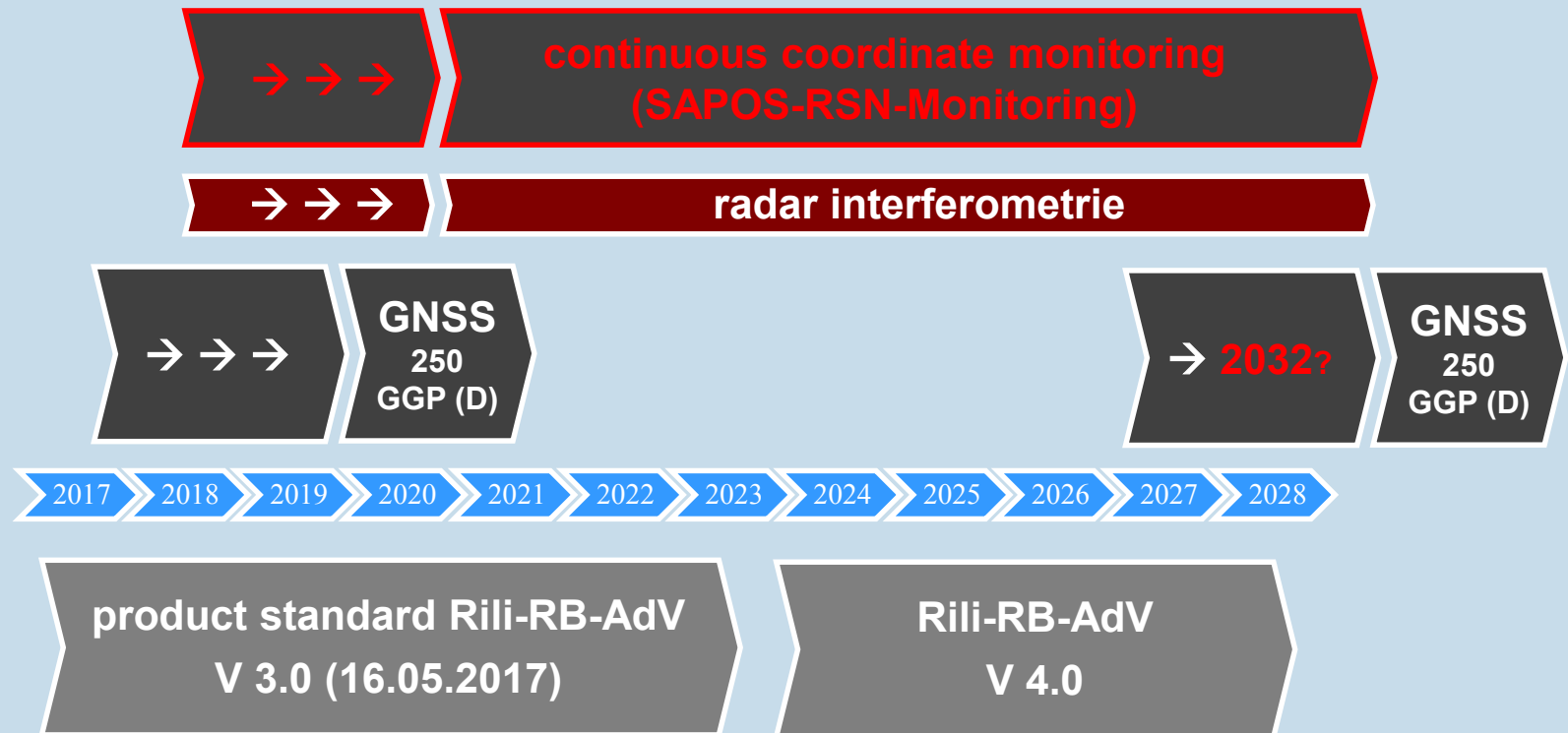
# Integrated Geodetic Spatial Reference quality management “GNSS campaign 2020”





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# Integrated Geodetic Spatial Reference quality management 2020++





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# Integrated Geodetic Spatial Reference product view & quality management

“The currently available **geodetic infrastructure** is ready for future applications, for example, for the centimeter-accurate vehicle navigation as a component of autonomous driving or for precision farming.”

## **Plan**

and provide  
product definition

## **Do**

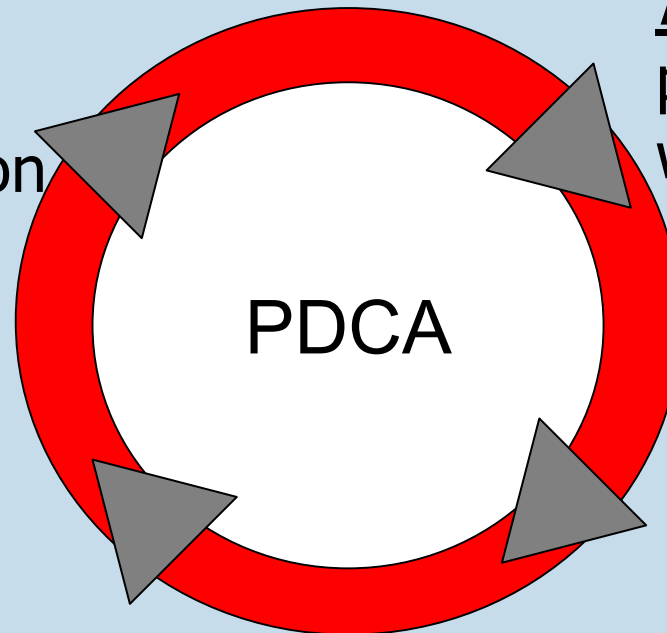
provide the product  
with respect to definition

## **Act**

and improve  
product definition

## **Check**

product definition







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**Gracias**

**Tānan**

**Tack**

**Сағ олун**

**Merci**

**Thank you**

**Kiitos**

**Tak**

**Děkuji vám**

**Danke**

**Ačiū**

**Dǎkujem vám**

*further reading: <http://www.adv-online.de>*

**Dank u**

**Paldies**

**Dziękuję**

**Grazie**

**ευχαριστο**

**Mulțumesc**

**Obrigado**

**Köszönöm**

**Благодаря**

**Hvala**