




Nationwide Geodetic Adjustment of
Integrated GPS Networks
in Korea


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Republic of Korea



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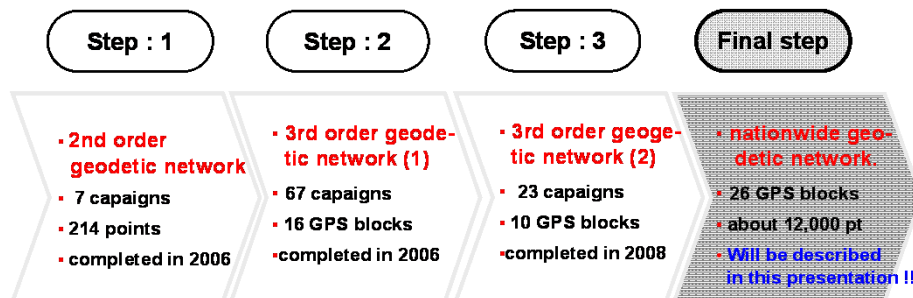
- Outline -

-  **I. Introduction : KGD2002 adjustment**
- II. Adjustment of Integrated GPS Network**
- III. Best Practice for Adjustment Procedures**
- IV. Conclusions**

Overview of KGD2002 adjustment

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- KGD2002 is new Korean horizontal geodetic datum based on world geodetic datum and was adopted on 1st January 2003.
- *KGD2002 was aligned ITRF2002(Epoch 2002.0) & GRS80 ellipsoid and is compatible with international standard.*
- The steps of KGD2002 adjustment are shown in figure.



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Steps of KGD2002 adjustment

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- The step1 consists of 7 campaigns and was adjusted as single network in 2006. And , *the baseline length is from 10km to 100km.*
- *In step 2 and step 3, 3rd order geodetic networks were adjusted by the GPS block. GPS blocks consist of nearby campaigns.*
- The step 2 consists of 67 campaigns & 16 GPS blocks and step 3 added 23 campaigns & 10 GPS blocks to step 2. *The baseline length was composed from 2km to 5km.*
- *The campaigns are going to full cover all around country.*



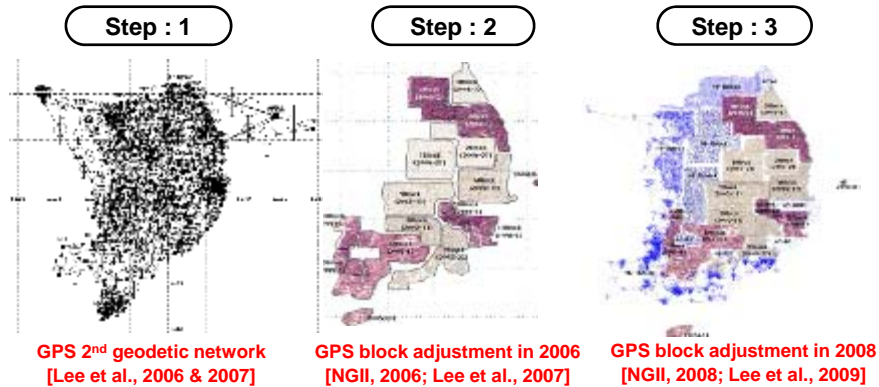
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Steps of KGD2002 adjustment

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- ◆ From step 1 to step 3 have already been completed.
- ◆ *The step 2 and step 3 were presented at FIG 2008 (Lee et al, 2008).*
- ◆ This figures are network map of step 1-step 3.



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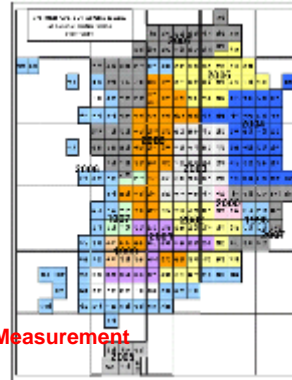
I. Introduction : KGD2002 adjustment

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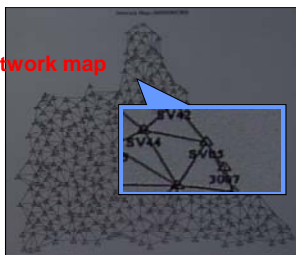
- The integrated GPS network is a single network which was combined with all GPS data of national control points (e.g., CORS network, 2nd and 3rd order network)
- All control points about 12,000 points were measured by GPS technique in 1996 to 2008.
- In integrated GPS network adjustment, it used GPS data such as next slides.



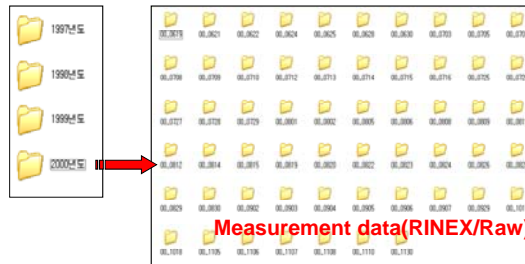
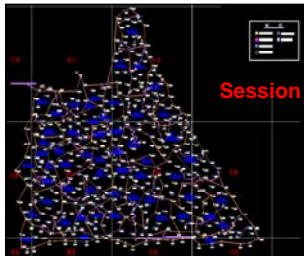
Index of GPS Measurement



Network map



Session map



Measurement data(RINEX/Raw)

관측기록부											
세션	점번호	측량 일자	계측기	안테나	안테나고도	측량 방법	반경	점의 상태	수준동치	관측시간	관측자
4-8-23	2005	2005년 11월 13일	20050501	CometNet L1/L2	0.00	Static	1.812	1.883	정상	0.000	조영환
4-8-26	2007	2007년 11월 29일	20070701	CometNet L1/L2	0.00	Static	1.512	1.561	정상	0.000	김영환
4-8-304	2014	2008년 11월 28일	20140301	Mikro-cometNet L1/L2	0.00	Static	1.744	1.530	정상	0.000	박정환
4-8-305	2012	2008년 11월 28일	20120301	CometNet L1/L2	0.00	Static	1.596	1.596	정상	0.000	김영환
4-8-312	2042	2008년 11월 28일	20140301	CometNet L1/L2	0.00	Static	1.705	1.634	정상	0.000	김영환
4-8-412	2042	2008년 11월 28일	20140301	CometNet L1/L2	0.00	Static	1.585	1.590	정상	0.000	조영환
4-8-413	2043	2008년 11월 28일	20140301	CometNet L1/L2	0.00	Static	1.569	1.439	비정상	0.000	조영환
4-8-414	2044	2008년 11월 28일	20140301	CometNet L1/L2	0.00	Static	1.542	1.530	정상	0.000	조영환
4-8-415	2045	2008년 11월 28일	20140301	CometNet L1/L2	0.00	Static	1.585	1.584	정상	0.000	조영환
4-8-416	2046	2008년 11월 28일	20140301	CometNet L1/L2	0.00	Static	1.709	1.568	정상	0.000	조영환
4-8-417	2047	2008년 11월 28일	20140301	CometNet L1/L2	0.00	Static	1.624	1.624	정상	0.000	김영환
4-8-418	2048	2008년 11월 28일	20140301	CometNet L1/L2	0.00	Static	1.585	1.585	정상	0.000	김영환
4-8-419	2049	2008년 11월 28일	20140301	CometNet L1/L2	0.00	Static	1.815	1.480	정상	0.000	김영환
4-8-420	2050	2008년 11월 28일	20140301	CometNet L1/L2	0.00	Static	1.551	1.548	정상	0.000	조영환
4-8-421	2051	2008년 11월 28일	20140301	CometNet L1/L2	0.00	Static	1.708	1.475	정상	0.000	조영환
4-8-422	2052	2008년 11월 28일	20140301	CometNet L1/L2	0.00	Static	1.584	1.589	정상	0.000	조영환

Field book



Adjustment procedures

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- The integrated GPS network was adjusted according to procedures of next section 3.
- *It was adjusted by method of minimally constrained adjustment for outlier detection.*
- Next, the integrated GPS network was adjusted by over constrained adjustment and then computed a official coordinate about 12,000 points.
- *It's results were analyzed comparing with the results of network adjustment of various types.*



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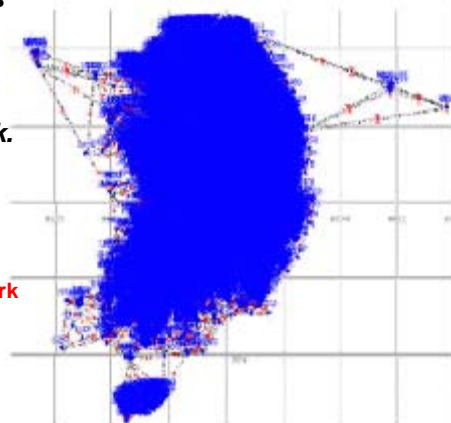


Completion of network adjustment

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- The adjustment of integrated GPS network was completed through adjustment procedures ad previous slide.
- *This figure appear a network map of integrated GPS network.*

Integration GPS Network



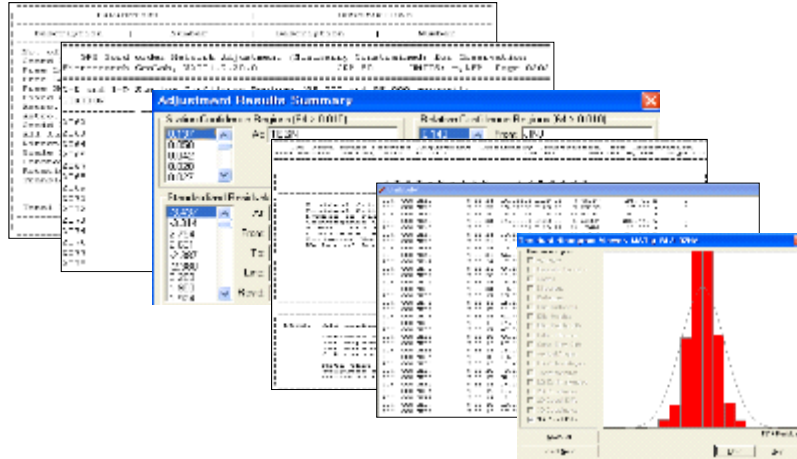
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Results (1)

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- ◆ This figures appear the results of adjustment (e.g., list file, residual histogram, adjustment results summary)



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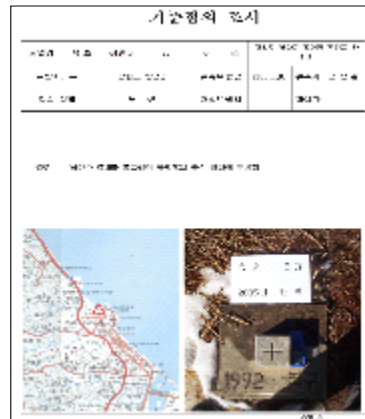
Results (2)

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- ◆ This figures are control point data list and records of surveying point and it is a summary of information of control point.

The image shows a table titled '기점정보' (Control Point Information) with columns for '기점번호' (Control Point No.), '기점명' (Control Point Name), '기점종류' (Control Point Type), '기점좌표' (Control Point Coordinates), and '기점고도' (Control Point Elevation). The table contains several rows of data. To the right of the table is a small map showing the location of the control points.

Control point data list



Records of surveying point



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Adjustment Procedure 1 & 2 14/21

- In procedure 1, GPS data should be arranged and checked. In case of antenna height, APC, ARP, antenna offset must be confirmed to apply a exact height.
- *In procedure 2, GPS baseline processing generate the 3-D baseline vector and the VCV matrix between points. The outlier detection of GPS data were checked through miscloser calculation of baseline vector.*

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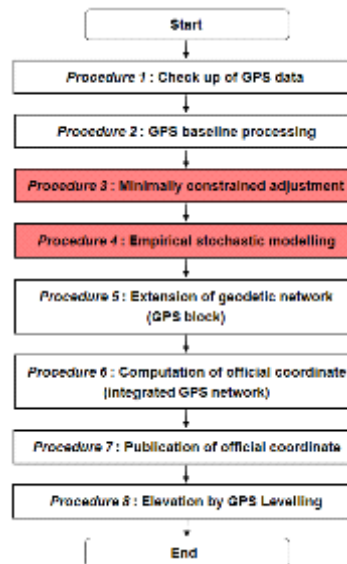
graph TD
    Start([Start]) --> P1[Procedure 1: Check up of GPS data]
    P1 --> P2[Procedure 2: GPS baseline processing]
    P2 --> P3[Procedure 3: Minimally constrained adjustment]
    P3 --> P4[Procedure 4: Empirical stochastic modelling]
    P4 --> P5[Procedure 5: Extension of geodetic network (GPS block)]
    P5 --> P6[Procedure 6: Computation of official coordinate (integrated GPS network)]
    P6 --> P7[Procedure 7: Publication of official coordinate]
    P7 --> P8[Procedure 8: Elevation by GPS Levelling]
    P8 --> End([End])
    
```

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Adjustment Procedure 3 & 4

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- In procedure 3, after GPS network was adjusted by minimally constrained method, χ^2 test and outlier detection of GPS data was carried out. And, the approximate accuracy of GPS network was calculated.
- In procedure 4, empirical stochastic modelling was applied to reflection of practical accuracy of GPS data. It corrects the diagonal element of variance-covariance matrix.



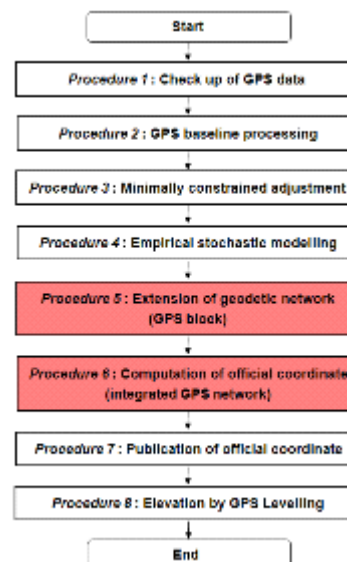
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Adjustment Procedure 5 & 6

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- In procedure 5, the geodetic network should be extended step by step as GPS blocks, integrated GPS network. And, the coordinate difference of overlapped points was compared between adjacent campaigns.
- In procedure 6, the over constrained adjustment was carried out to determine the official coordinate. The results of adjustment must be compared with check results of reliable accuracy.



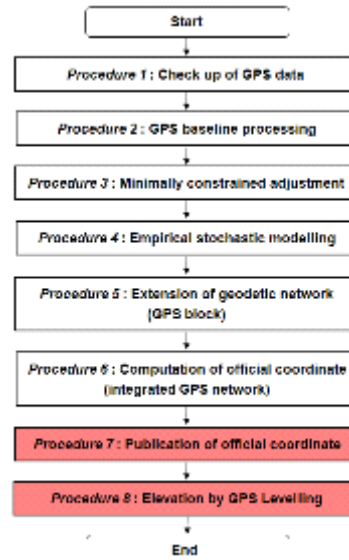
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Adjustment Procedure 7 & 8

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- In procedure 7, the results of integrated GPS network were published as official coordinate. The published contents are a essential information of control points(e.g., station name, order, address, route, official coordinates)
- In procedure 8, the elevation of national control points should be determined. The elevation of control point can be used for generating national geoid model.



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I. Introduction : KGD2002 adjustment

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➔ IV. Conclusions

Conclusion

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- In South Korea, 2nd and 3rd order network by the block were adjusted and it's overview described in this presentation.
- *This presentation has described issues related with integrated GPS network adjustment for the final densification of KGD2002 and official coordinates of control points were published in South Korea.*
- The best practice for adjustment procedure has been derived from experience of South Korea.
- *In the future, a tectonic velocity vector should be implemented for semi-dynamic datum. We should develop a technique enabling updating and re-computation of official coordinate of national control points.*



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Conclusion

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- In South Korea, the 44 KORS network added 30 CORS of (former)GAHA to 14 CORS network of NGII in April 2008.
- *The bulletin result of KORS network need to newly calculate using precise method(e.g., software, procedures, calculation method).*
- Also, the coordinate of national control points should be re-estimated because coordinate and status of fixed points were modified according to extension of CORS network.



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Thank you for your attention

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