

# Re-measuring and Processing of the Israeli GNSS-Based 3-rd Level Geodetic Control Network

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1



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## Re-measuring and Processing of the 3-rd Level Geodetic Control Network (G2)

- The levels of the Israeli coordinate system
- Selection of the points of the G2 class network
- Organization and description of the field measurements
- Processing
- Preliminary adjustment

2



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## The levels of the Israeli coordinate system

According to the new Regulations, the Israeli National Grid will be based on the permanent GNSS stations. The primary class G is to be established and measured by Survey of Israel only.

It consists of 3 levels

3



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## The levels of the Israeli coordinate system

- G0 – The array of 19 (to be extended up to 24) active permanent network stations (APN)
- G1 – High accuracy network of 155 stations built specially for geodynamic monitoring
- G2 – A network of about 1200 control points with easy access, at the density of about 1 point per 20 sq km

4



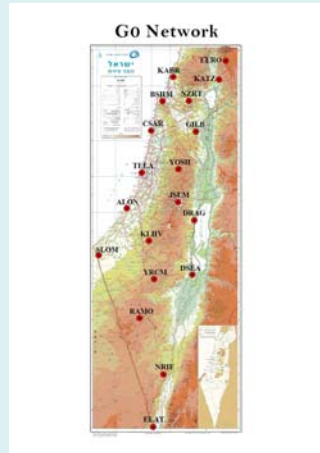
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## The levels of the Israeli coordinate system

**G0 – The array of 19 active permanent network stations**



5



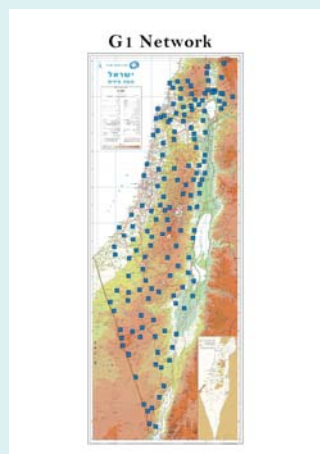
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## The levels of the Israeli coordinate system

**G1 – High accuracy network of 155 stations built specially for geodynamic monitoring**



6



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## Selection of the points of the G2 class network

### 4 groups of G2 class points

- The first and the largest group (**414 points**) consists of the points constructed in 1994-2001 within the framework of the Undulation project and used as horizontal and vertical control points



7



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## Selection of the points of the G2 class network

### 4 groups of G2 class points

- The second group comprises the layer of the control points used to base the GNSS projects made since 1998. These points (**about 220**) do not belong to the first group



8



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## Selection of the points of the G2 class network

### 4 groups of G2 class points

- The third group (**about 260 points**) includes the benchmarks that could be used as base points for GNSS positioning



9



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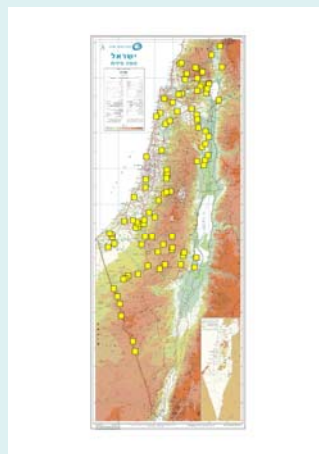


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## Selection of the points of the G2 class network

### 4 groups of G2 class points

- The fourth group (**about 200 new points**) was created in order to condense the existing network



10



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## Selection of the points of the G2 class network

4 groups of G2 class points



11



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## Organization of the field measurements

The requirements for the receivers and measurements to minimize the possible errors

- Dual-frequency receivers with the p-code
- The occupation time at least 40 min (for baselines less than 5 km)
- The epoch interval equal 1 sec
- The baseline measured by two identical receivers with the same type of antenna
- The distance between the antenna and the receiver in the time of measurement was at least 3 meters

12



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## Organization of the field measurements

- The inspection of the existing points was performed to estimate their physical condition
- The special set of maps was issued to back up the project
- Special type of log was developed to avoid errors in the recordings
- Special forms for each type of antenna were developed to minimize the errors of the measurements of the antenna height



13



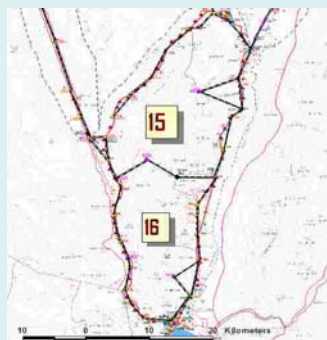
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## Organization of the field measurements

- The project of measuring about **1200** network points consists of **67** elementary units of work (loops). Each loop consists of about **30** points



14



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## Description of the field measurements

- Each loop was measured by two receivers to provide uncorrelated loop closures
- Every station of the loop was determined from at least two occupations by means of two baselines
- The height of the antenna had to be changed at least once in different occupations of one station
- To connect the network to the high class stations, the stations G1 were observed (at least two in each loop).
- G1 class stations were connected to the G0 class APN stations

15



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## Description of the field measurements

- The occupation time on the stations while measuring the baselines (at least):
  - Less than 5 km long – 40 min
  - 5 to 10 km long – 60 min
  - 10 to 20 km long – about 120 min
  - More than 20 km – 180 min and more
  - Occupation time on the G1 network stations had to be at least 90 min
- The measurements could not be performed if PDOP was greater than 4
- The cut off angle was 10 degrees

16



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## Processing

- Processing was performed by means of the TTC program
- Each loop was processed separately
- Only double difference fixed solutions were accepted for further use (about 2000 baselines were processed)
- The processed baseline error does not exceed 3 mm
- Loop closure was less than 5mm + 1 ppm

17

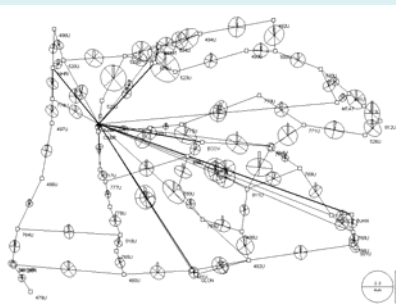


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## Processing



	$\sigma X$ (mm)	$\sigma Y$ (mm)	$\sigma Z$ (mm)
average for 279 baselines	1.6	1.5	1.4
standard deviation	0.6	0.5	0.5
minimal value	0.5	0.3	0.3
maximal value	3.7	3.0	3.2

Processing of the loop #28

Results of processing for the  
network segment  
(loops #28,29,33,41)

18



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## Preliminary adjustment of the network

- Each loop was adjusted separately as minimally constrained network with one fixed G0 station and the coordinate values of G1 stations were compared with the known ones
- Next step: connection of some loops into sub-network and adjustment of minimally constrained and fully constrained network
- The end step is to join the fragments into G2 network based on G0 and G1 class points

19

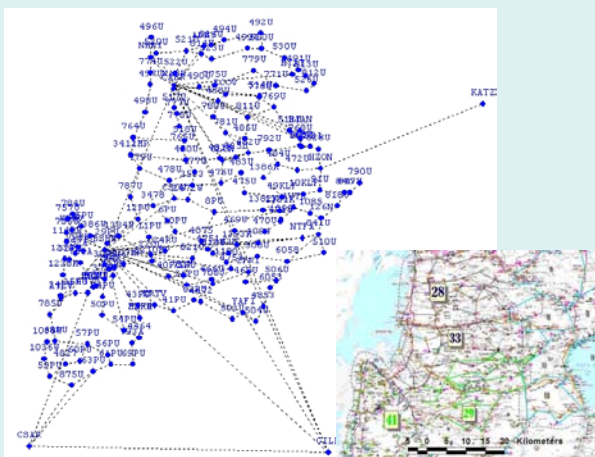


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## Preliminary adjustment of the network



Example:

- Fragment consisting of **279** baselines, **186** points (loops # 28,29,33,41).
- Area of **3500** sq km
- Average baseline length **5.9** km

20



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## Preliminary adjustment of the network

Results of the G1 and G2 class points adjustment. The G0 class points are constrained

Microsearch GeoLab, V2001.9.20.0				
2-D and 1-D Station Confidence Regions (95 percent):				
Order	Value	Semi axis		Vertical
		Major	Minor	
G1: 19 points	average	0.013	0.011	0.015
	max	0.018	0.016	0.023
	min	0.006	0.006	0.006
G2: 162 points	average	0.021	0.019	0.023
	max	0.040	0.035	0.041
	min	0.006	0.005	0.007

21



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## Preliminary adjustment of the network

Residuals of the coordinates of the G1 class points with respect to the constrained network adjustment

Name	Residuals (m)		
	Latitude	Longitude	Ellipsoidal Height
BSHM	0	0	0
GSAR	0	0	0
GILB	0	0	0
KABB	0	0	0
KATZ	0	0	0
ADMT	0.010	0.008	0.015
AVTL	-0.007	0.000	0.016
AVTL	-0.008	-0.008	-0.010
BIAN	-0.008	-0.019	-0.001
CABR	-0.011	-0.021	-0.013
CSON	-0.015	-0.011	-0.010
ECCV	-0.005	0.009	-0.024
GLOH	-0.006	-0.013	-0.015
HZON	-0.009	0.001	0.025
KRML	-0.002	-0.014	0.009
KSMV	0.016	0.015	0.016
KRTV	-0.010	-0.005	0.007
MIAI	0.017	0.016	0.019
PARK	0.012	0.011	0.013
MRKA	-0.008	-0.008	-0.001
NHRI	-0.007	-0.021	-0.001

average	-0.008	-0.008	-0.002
Std	0.007	0.009	0.014
Max	-0.002	0.010	0.025
Min	-0.026	-0.021	-0.040

Residuals of the coordinates of the G0/G1 class points with respect to the minimally constrained network adjustment

Name	Residuals (m)		
	Latitude	Longitude	Ellipsoidal Height
BSHM	0.000	0.000	0.000
KATZ	0.005	-0.000	-0.021
CSON	0.002	0.000	0.011
GILB	-0.002	0.008	-0.024
CABR	-0.005	0.015	0.004
ADMT	0.009	-0.013	0.015
AVTL	-0.007	0.000	0.017
AVTL	-0.008	-0.010	-0.011
BIAN	-0.013	-0.017	0.003
CABR	-0.017	-0.018	-0.008
CSON	-0.015	-0.011	-0.010
ECCV	-0.010	0.003	-0.020
GLOH	-0.010	-0.012	-0.012
HZON	-0.008	-0.021	0.014
KRML	-0.002	-0.014	0.009
KSMV	-0.008	0.005	-0.006
KRTV	-0.010	-0.005	0.006
MRKA	-0.008	-0.008	-0.001
MIAI	0.003	0.010	0.020
NHRI	-0.012	-0.018	0.003
NHRI	-0.010	-0.009	0.010
PARK	-0.002	0.000	-0.014
YAFI	-0.026	-0.017	-0.016

average	-0.009	-0.008	-0.003
Std	0.008	0.012	0.015
Max	0.009	0.015	0.020
Min	-0.026	-0.036	-0.040

22



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## Preliminary adjustment of the network

Results of the G2 class points adjustment. The G0 and G1 class points are constrained (24 points)

average	0.023	0.021	0.025
st dev	0.008	0.007	0.009
min	0.006	0.005	0.007
max	0.047	0.041	0.048

23



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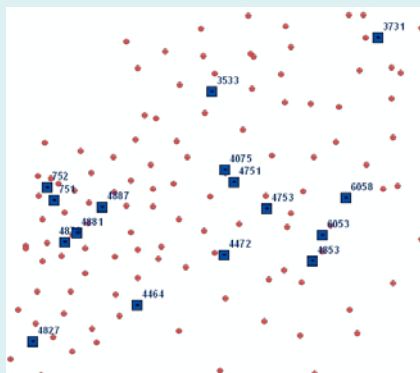
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## Testing the validity and reliability of the Israeli undulation model

Comparison of orthometric heights values calculated by means of ILUM1.0 with leveled values

Benchmark Name	Model Accuracy	Height Residuals
4881	0.038	-0.021
751	0.045	-0.011
3731	0.054	-0.010
4878	0.045	-0.003
4887	0.036	0.003
4464	0.062	0.004
4827	0.058	0.005
4472	0.052	0.006
6058	0.040	0.009
4853	0.058	0.010
752	0.039	0.010
4075	0.036	0.016
4751	0.049	0.017
4753	0.051	0.020
6053	0.050	0.026
3533	0.058	0.034
average	0.007	
stdev	0.014	
max	0.034	
min	-0.021	

The benchmarks that were measured by means of GNSS measurements in the loops 28,29,33,41



24



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## Conclusions

- The ultimate goal of the Survey of Israel is to define the cadastral boundaries with the accuracy of 5 cm at 95% level.
- To reach this goal the new national grid based on APN stations was established
- The new measurements and calculations project is on the way and will be completed by the end of 2009
- The field material analysis ensures that the quality of measurements is high enough to solve the problem of renewing national coordinate system

25



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## Thank you for your attention !

26



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