

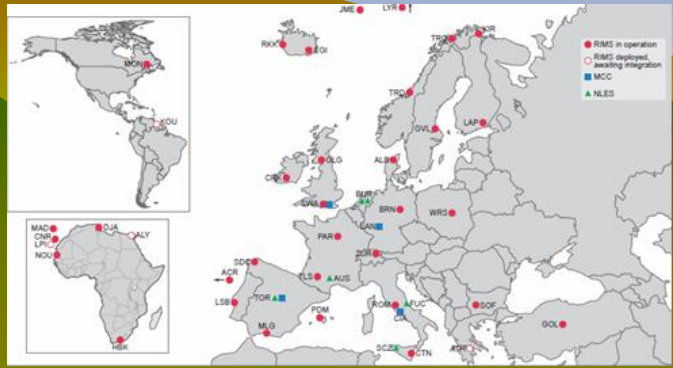
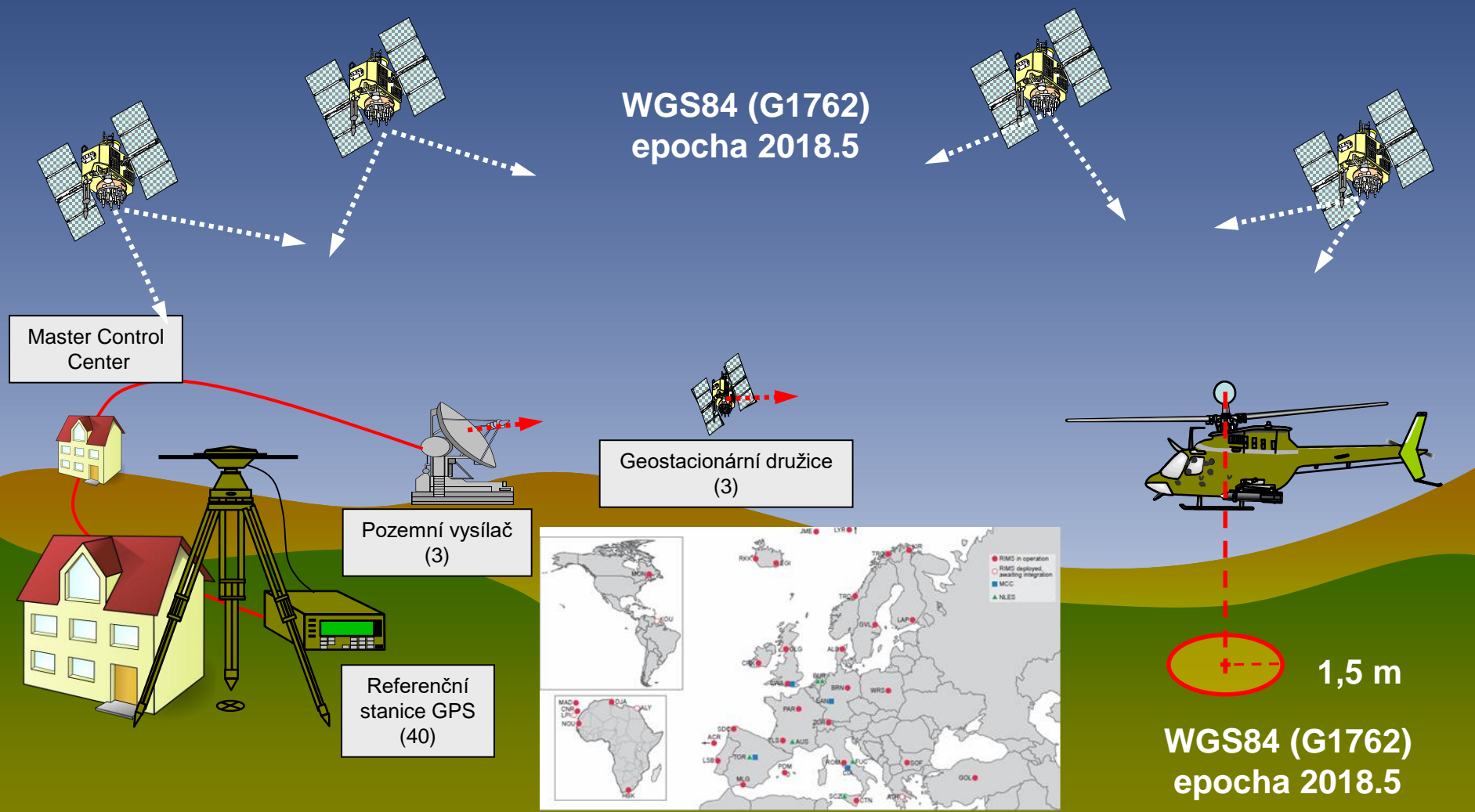


Přesnost přijímače GARMIN GPSMap 64s s využitím systému EGNOS

*Ing. Petr JANUS
GNSS informační a sledovací služba AČR*



EGNOS



Cíle testování



- Stanovení přesnosti určení polohy přijímačem GARMIN GPSMAP 64s s použitím podpůrného systému EGNOS.
- Posouzení praktických přínosů podpůrného systému EGNOS pro navigační přesnost určení polohy v pozemních aplikacích.



Garmin GPSMAP 64s



- Satelitní systém
GPS
- WAAS/EGNOS
Zapnuto
- Jazyk
Cesky
- Propojeni
Garmin Spanner
- Typ baterií AA
Tr. bat. NiMH



Testovací bod





Měření na testovacím bodě



Satelitní systém
GPS

**WAAS/EGNOS
Zapnuto**

Jazyk
Cesky

Propojeni
Garmin Spanner

Typ baterií AA
Tr. bat. NiMH

**Věty NMEA
Zapnuto**

Režim Autopilot
Vypnuto

Ident. čísla tras. bodů
Názvy

Přesnost minut
MM.MMMM' (4 číslice)

**GSA, GSV
Zapnuto**

WPL, RTE
Vypnuto

Mastní věty Garmin
Zapnuto

33U WR 84059 GPS
MGRS 71737 3m

320 m

Franson GpsGate v2.6.0.402

Input | Output | Advanced

Set input - from where GPS data is received

Garmin USB

Running OK!
GPS data with valid position.

Advanced

Retry connection to input: On Error

Close input when no outputs are opened:

Close input when computer hibernates:

Use multiple inputs (MUX):

Setup Wizard... Help

GPS-NMEA monitor [Recording : 2GE_pole.nmea]

File(F) Tool(T) Option(O) Language(L)

GPGLL		GPRMC		GPGLL		GPVTC		GPZDA	
Latitude	50°17'30.384"N	Status	Valid	Latitude	50°17'30.384"N	Course/T	254.5	UTC	09:24:39
Longitude	16°10'48.348"E	Longitude	16°10'48.348"E	Course/M	250.8 M	Spd(knot)	0.0N	dd/dd/dd	09:24:39
Pos Fix	DGPS fix	Spd(knot)	0.0	Spd(km/h)	0.0K	Mode	Differential	Zone offs	
Used Sat	11	Mag Vari	3.7 E	Mode	Differential				
HDOP	0.9	Mode	Differential						
Altitude	320.3M	Nav. Sta.							
Geoid	43.9M								
DGPS age									
DGPS-ID									

GPVTC: 254.5 T, 250.8 M, 0.0N, 0.0K, Differential

GPZDA: 09:24:39, Zone offs

SV# SNR 0.0

0 0 1 1 2 2 2 2 3 3 3 3
2 6 2 4 4 5 6 9 1 2 6

Not Selected

UTC: Illegal Date or Time.

Not supported sentence



Zpracování dat

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Původní data NMEA

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Transformovaná data NMEA

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Zředěná data NMEA



Výpočty – charakteristiky přesnosti, grafy

Microsoft Excel - Garmin_EGNOS_Výpočty_pole.xls

SPS

Garmin_GPS + EGNOS_pole										Směrodatná odchylka			Střední souřadnicová chyba										
Správná hodnota: GRITs WGS84 (G1762) epocha 2017.6										Výsledky GRITs			výška geoidu										
										584 059,30 5 571 734,46 364,09			KvACR										
										584 059,26 5 571 734,45 364,06			plus výška antény 1,54										
										584 059,28 5 571 734,46 364,08			43,49 320,59 322,13										
Výška bodu plus výška stavivu (1,54 m)										h	E	N	$\sigma = \sqrt{\frac{\sum \epsilon_i^2}{n}}$	$\sigma_w = \sqrt{\frac{\sigma_x^2 + \sigma_y^2}{2}}$									
prumer. počet družic										95%	7,25	3,99											
8	datum	čas	kvalita	počet družic	EHE	EVE	EPE	h	E	N	ϵ	ϵ^2	Suma ϵ^2	n	Suma ϵ^2/n	σ_ϵ	ϵ	ϵ^2	Suma ϵ^2	n	Suma ϵ^2/n	σ_N	
													1 145,69	1156	0,99107933	0,99552967			4 998,18	1156	4,323682526	2,079346658	0,0
1124	50917	90057	2	12	3,0	3,0	4,2	315,6	584 061,23	5 571 738,06	-1,95	3,8025					-3,6	12,96					
1125	50917	90142	2	12	3,0	3,0	4,2	315,3	584 061,23	5 571 738,25	-1,95	3,8025					-3,79	14,3641					
1126	50917	90227	2	12	3,0	3,0	4,2	315,0	584 061,59	5 571 738,07	-2,31	5,3361					-3,61	13,0321					
1127	50917	90312	2	12	3,0	3,0	4,2	314,9	584 061,94	5 571 738,44	-2,66	7,0756					-3,98	15,8404					
1128	50917	90357	2	11	3,0	3,0	4,2	314,9	584 061,94	5 571 738,63	-2,66	7,0756					-4,17	17,3889					
1129	50917	90442	2	11	3,0	3,0	4,2	315,1	584 061,94	5 571 738,44	-2,66	7,0756					-3,98	15,8404					
1130	50917	90527	2	12	3,0	3,0	4,2	315,8	584 061,45	5 571 738,99	-2,17	4,7089					-4,53	20,5209					
1131	50917	90612	2	12	3,0	3,0	4,2	316,3	584 061,35	5 571 738,25	-2,07	4,2849					-3,79	14,3641					
1132	50917	90657	2	12	3,0	3,0	4,2	316,6	584 061,35	5 571 738,06	-2,07	4,2849					-3,6	12,96					
1133	50917	90742	2	12	3,0	3,0	4,2	316,4	584 061,23	5 571 738,43	-1,95	3,8025					-3,97	15,7609					
1134	50917	90829	2	12	3,0	3,0	4,2	316,6	584 060,99	5 571 738,43	-1,71	2,9241					-3,97	15,7609					
1135	50917	90913	2	12	3,0	3,0	4,2	316,9	584 060,62	5 571 739,17	-1,34	1,7956					-4,71	22,1841					
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1137	50917	91043	2	12	3,0	3,0	4,2	316,9	584 060,49	5 571 739,90	-1,21	1,4641					-5,44	29,5936					
1138	50917	91129	2	12	3,0	3,0	4,2	316,8	584 060,49	5 571 739,90	-1,21	1,4641					-5,44	29,5936					
1139	50917	91215	2	12	3,0	3,0	4,2	316,5	584 061,56	5 571 740,11	-2,28	5,1524					-5,65	31,9225					
1140	50917	91300	2	12	3,0	3,0	4,2	316,8	584 061,32	5 571 740,10	-2,04	4,1616					-6,01	36,1201					
1141	50917	91345	2	12	3,0	3,0	4,2	316,6	584 061,19	5 571 740,47	-1,91	3,6481					-6,01	36,1201					
1142	50917	91430	2	12	3,0	3,0	4,2	316,6	584 061,31	5 571 740,47	-2,03	4,1209					-6,01	36,1201					
1143	50917	91515	2	12	3,0	3,0	4,2	316,6	584 061,32	5 571 740,10	-2,04	4,1616					-5,64	31,8096					
1144	50917	91600	2	12	3,0	3,0	4,2	316,1	584 061,43	5 571 740,29	-2,15	4,6225					-5,83	33,9889					
1145	50917	91645	2	12	3,0	3,0	4,2	315,5	584 060,85	5 571 739,91	-1,57	2,4649					-5,45	29,7025					
1146	50917	91730	2	12	3,0	3,0	4,2	315,6	584 060,85	5 571 739,72	-1,57	2,4649					-5,26	27,6676					
1147	50917	91815	2	12	3,0	3,0	4,2	315,9	584 060,61	5 571 739,72	-1,33	1,7689					-5,26	27,6676					
1148	50917	91900	2	12	3,0	3,0	4,2	315,8	584 060,37	5 571 740,09	-1,09	1,1881					-5,63	31,6969					
1149	50917	91945	2	12	3,0	3,0	4,2	316,3	584 060,49	5 571 739,72	-1,21	1,4641					-5,26	27,6676					
1150	50917	92030	2	12	3,0	3,0	4,2	316,5	584 061,20	5 571 739,92	-1,92	3,6864					-5,46	29,8116					
1151	50917	92111	2	12	3,0	3,0	4,2	316,5	584 061,43	5 571 740,29	-2,15	4,6225					-5,83	33,9889					
1152	50917	92151	2	12	3,0	3,0	4,2	316,6	584 061,32	5 571 740,10	-2,04	4,1616					-5,64	31,8096					
1153	50917	92232	2	12	3,0	3,0	4,2	316,5	584 061,08	5 571 740,28	-1,8	3,24					-5,82	33,8724					
1154	50917	92313	2	12	3,0	3,0	4,2	317,0	584 061,19	5 571 740,47	-1,91	3,6481					-6,01	36,1201					
1155	50917	92354	2	12	3,0	3,0	4,2	317,2	584 061,43	5 571 740,48	-2,15	4,6225					-6,02	36,24040001					
1156	50917	92435	2	12	3,0	3,0	4,2	317,6	584 061,31	5 571 740,47	-2,03	4,1209					-6,01	36,1201					
1157	50917	92517	2	12	3,0	3,0	4,2	318,1	584 060,96	5 571 740,28	-1,68	2,8224					-5,82	33,8724					
1158	50917	92559	2	12	3,0	3,0	4,2	318,8	584 061,20	5 571 740,29	-1,92	3,6864					-5,83	33,9889					
1159	50917	92642	2	12	3,0	3,0	4,2	318,6	584 061,54	5 571 740,85	-2,26	5,1076					-6,39	40,8321					
1160	50917	92721	2	12	3,0	3,0	4,2	318,7	584 061,78	5 571 741,22	-2,5	6,25					-6,76	45,6976					
1161	50917	92801	2	12	3,0	3,0	4,2	318,6	584 061,54	5 571 741,22	-2,26	5,1076					-6,76	45,6976					

$$\sigma = \sqrt{\frac{\sum \epsilon_i^2}{n}}$$

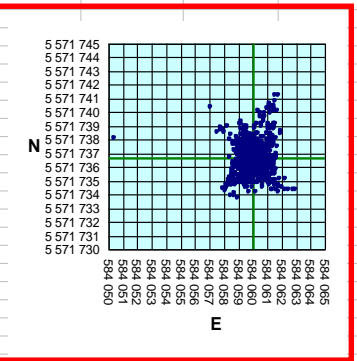
$$\sigma_w = \sqrt{\frac{\sigma_x^2 + \sigma_y^2}{2}}$$

Střední souřadnicová chyba (95%)

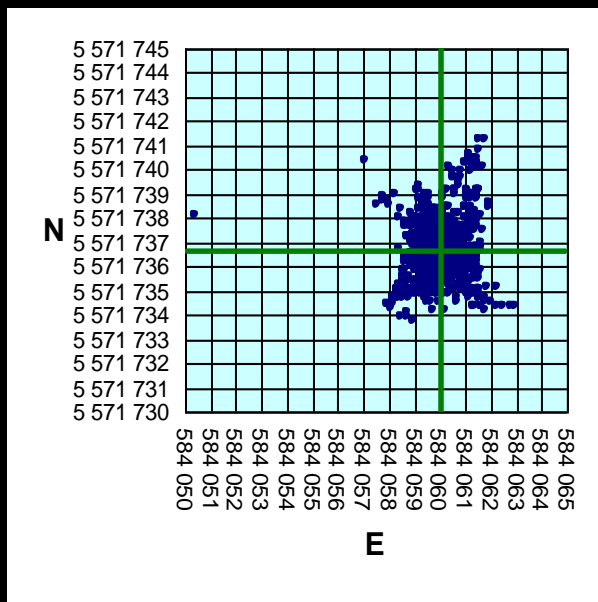
Směrodatná odchylka

Střední souřadnicová chyba

Převod zeměpisných souřadnic Fi, La na souřadnice UTM (aplikace CalGeo)



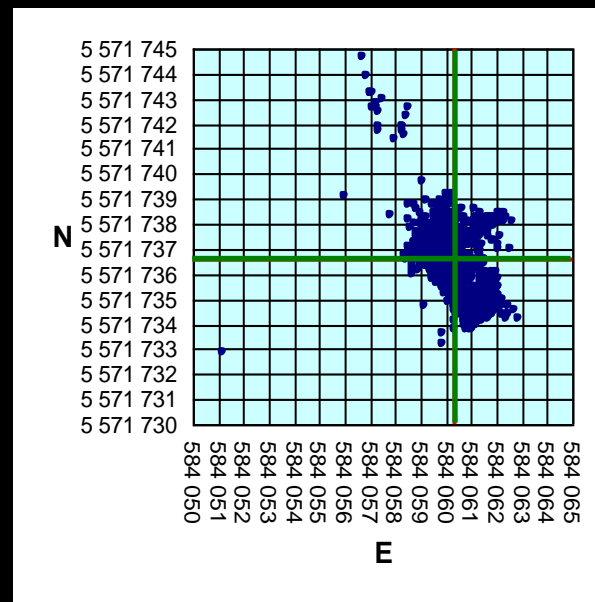
GPS + EGNOS



GPS + EGNOS		
Správná hodnota	σ_{EN} (95%)	σ_H (95%)
Průměr z měření	2,10 m	3,86 m

Souřadnice E, N, h		
h	E	N
318,67	584 060,04	5 571 736,62

GPS



GPS		
Správná hodnota	σ_{EN} (95%)	σ_H (95%)
Průměr z měření	3,01 m	4,05 m

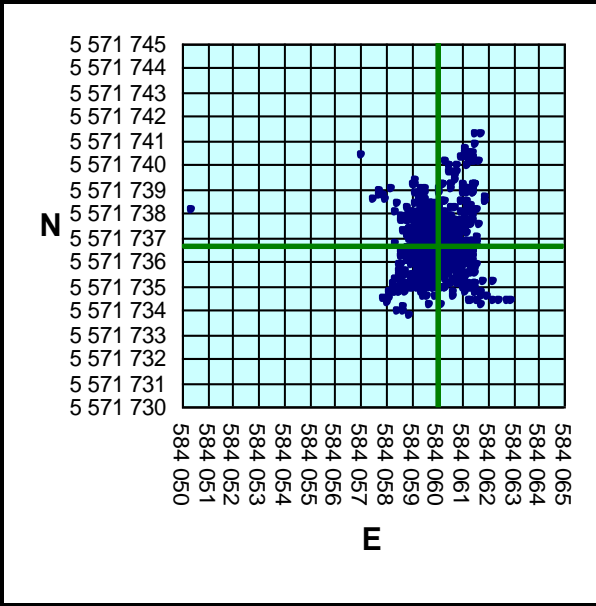
Souřadnice E, N, h		
h	E	N
317,08	584 060,37	5 571 736,54



Dílčí výsledky

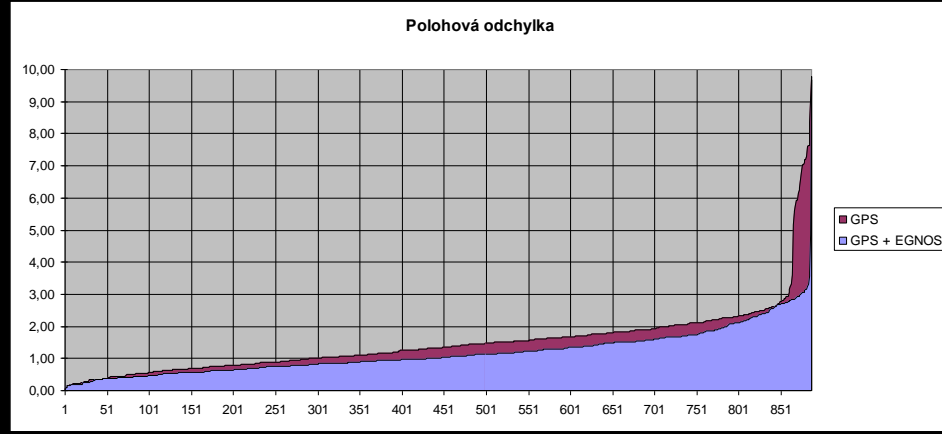
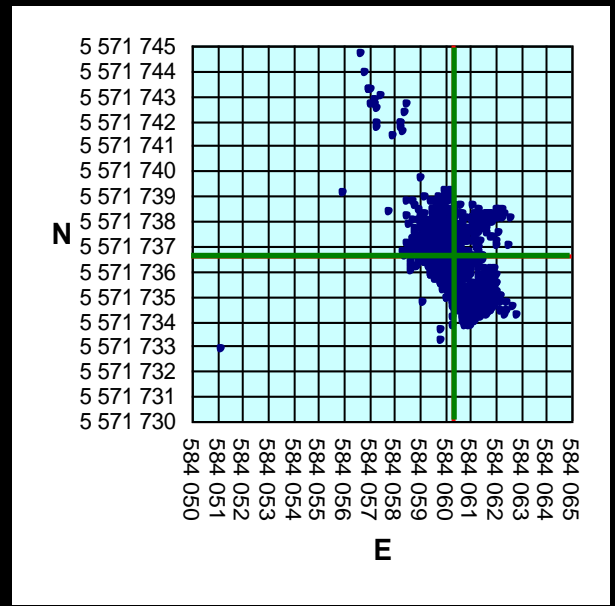


GPS + EGNOS



Polohová odchylka P		
GPS + EGNOS	[m]	GPS
[%]		[%]
13,6	$P \leq 0,5$	8,6
50,7	$P \leq 1,0$	33,5
75,6	$P \leq 1,5$	57,8
88,9	$P \leq 2,0$	80,8
94,5	$P \leq 2,5$	93,6
98,6	$P \leq 3,0$	96,8
	*	
0,1	$P > 5,0$	2,5

GPS





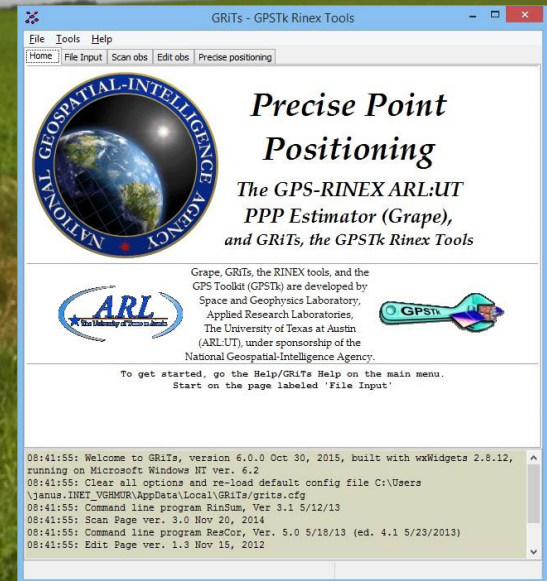
Testovací bod – přesné zaměření



Broadcast Ephemeris
WGS84 (G1762)
epocha 2017.5

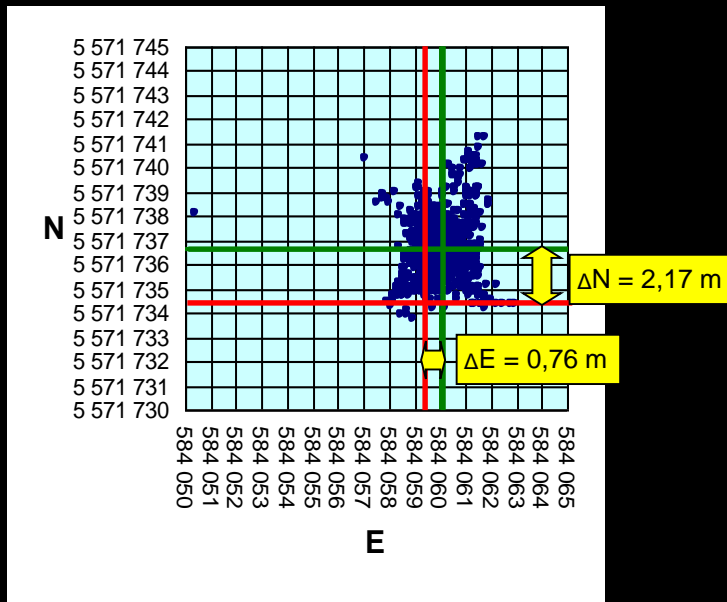
Precise Ephemeris
WGS84 (G1762)
epocha 2017.64

50° 17' 30.2623"
16° 10' 48.3065"
364.08 m



Konečné výsledky

GPS + EGNOS

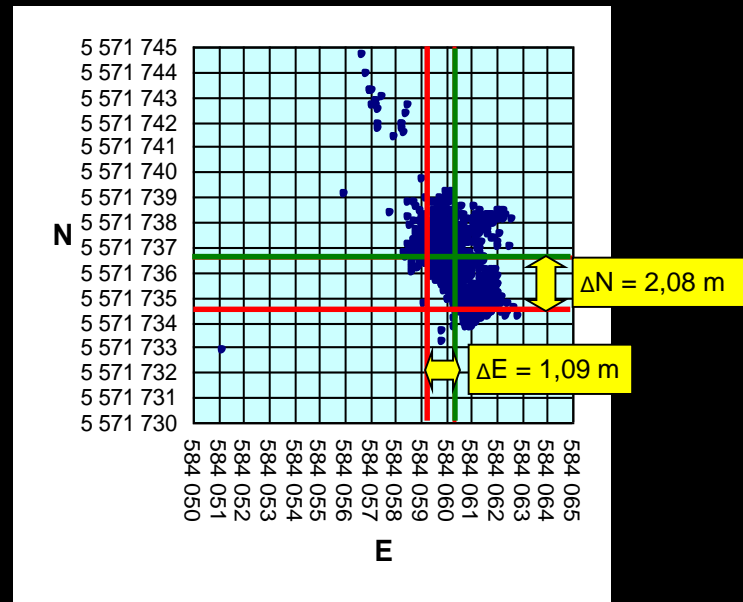


GPS + EGNOS		
Správná hodnota	σ_{EN} (95%)	σ_H (95%)
Průměr z měření	2,10 m	3,86 m
GRiTs	3,99 m	7,25 m

Souřadnice E, N, h		
h	E	N
318,67	584 060,04	5 571 736,62
322,13	584 059,28	5 571 734,46

Δh **3,46**

GPS



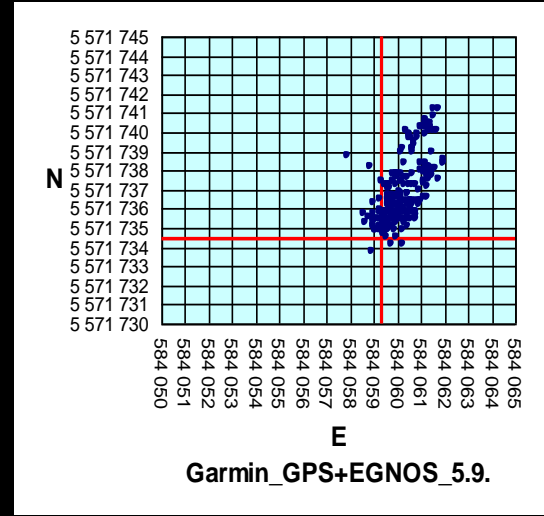
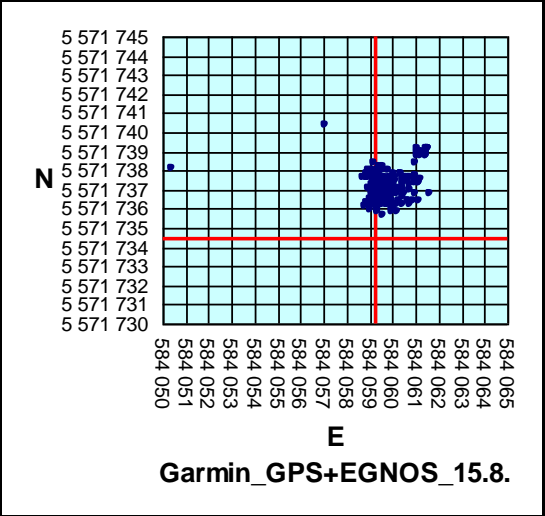
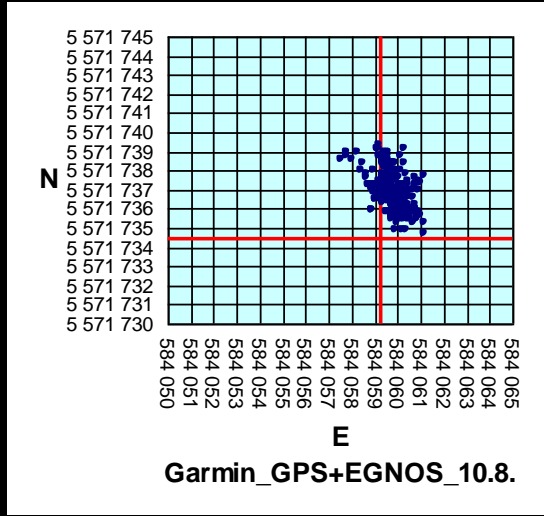
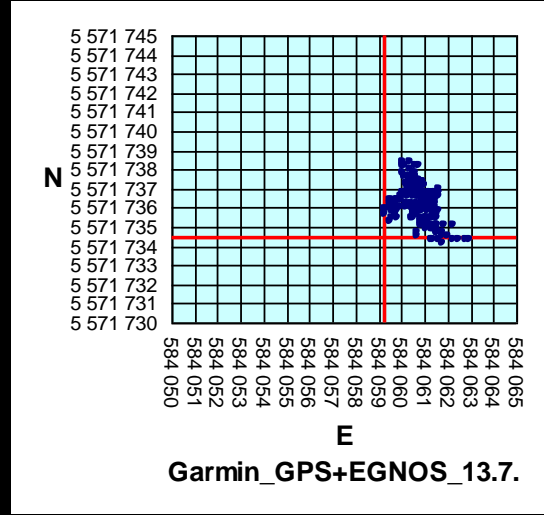
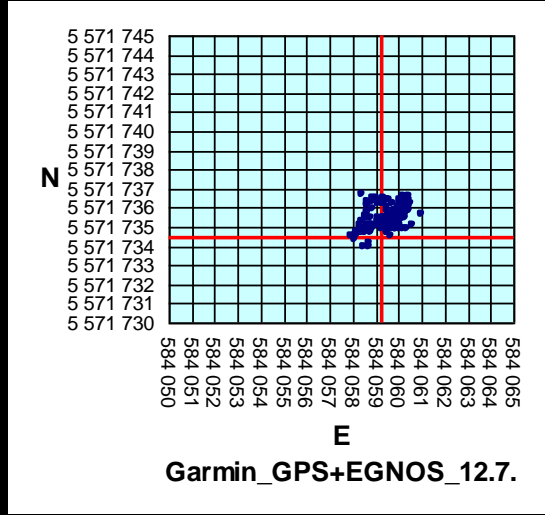
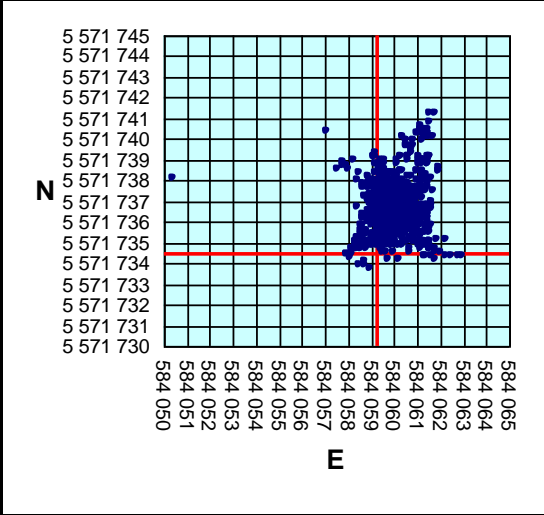
GPS		
Správná hodnota	σ_{EN} (95%)	σ_H (95%)
Průměr z měření	3,01 m	4,05 m
GRiTs	4,63 m	9,25 m

Souřadnice E,N, h		
h	E	N
317,08	584 060,37	5 571 736,54
322,13	584 059,28	5 571 734,46

Δh **5,05**

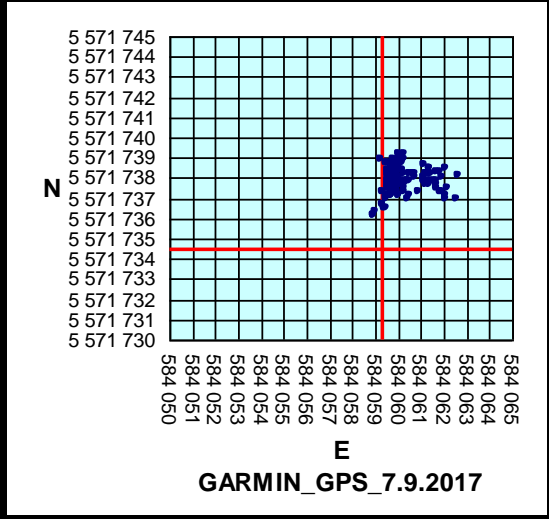
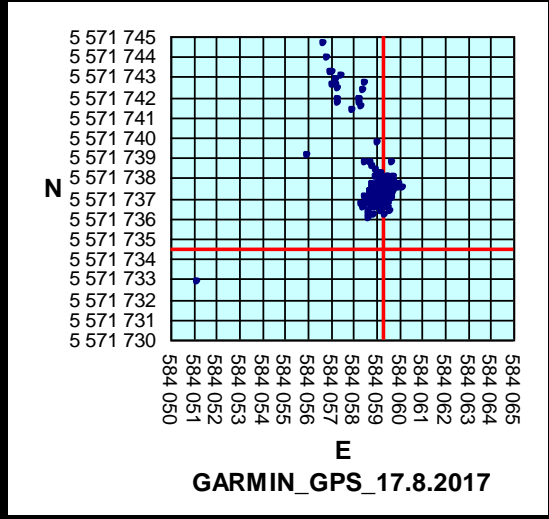
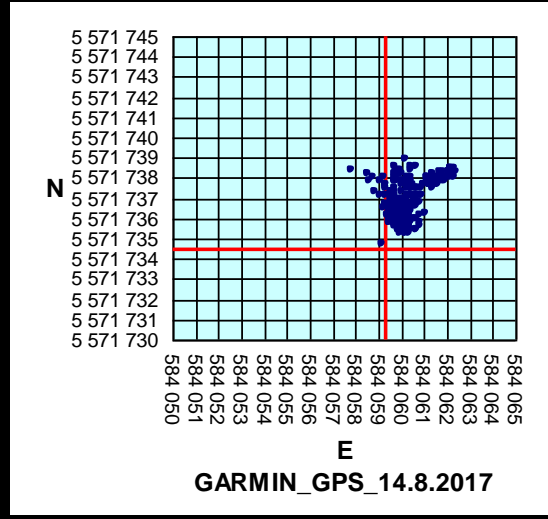
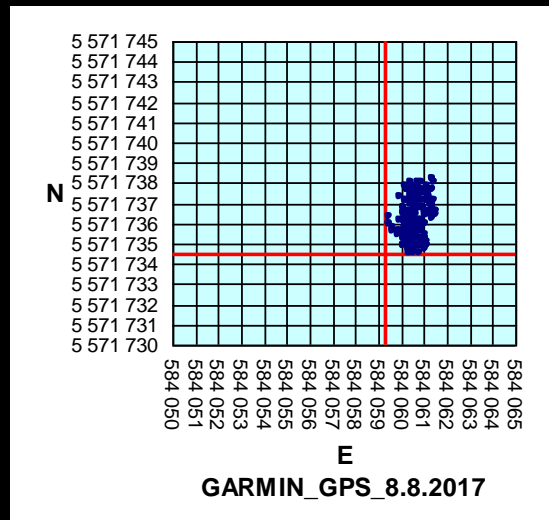
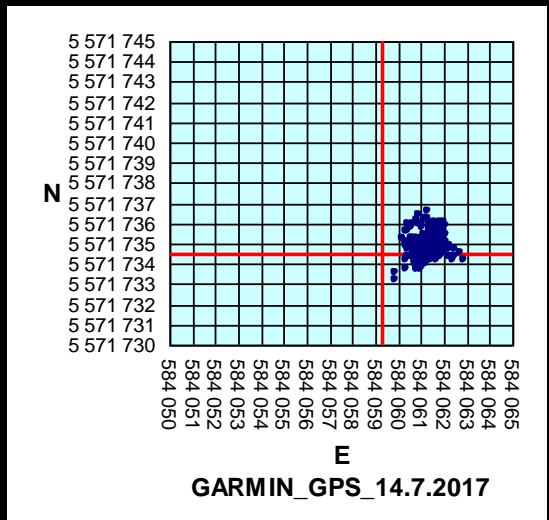
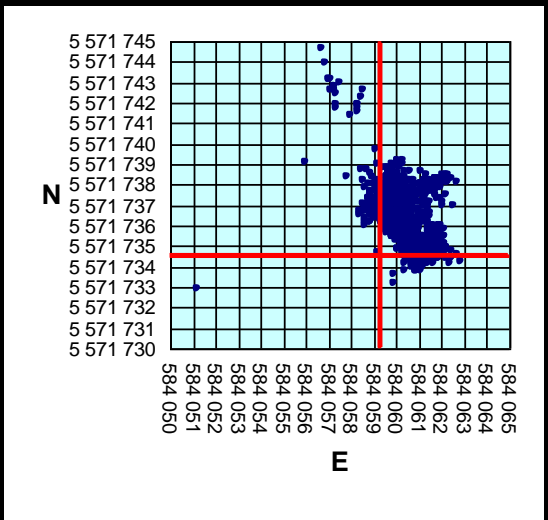


GPS + EGNOS



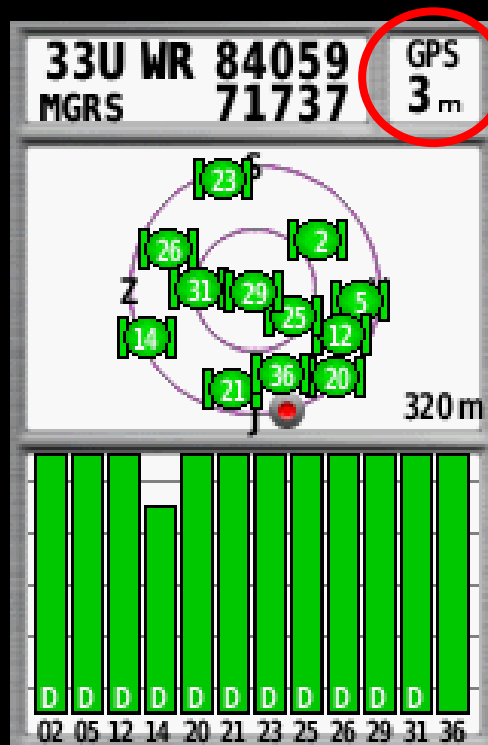


GPS





Závěry





- EGNOS zvyšuje přesnost určování polohy GPS, nicméně v případě turistické navigace GPSSMAP 64s **zdaleka** nedosahuje deklarované přesnosti 1,5 m (95%) v horizontální rovině.
- Určování polohy s využitím systému EGNOS je kompaktnější, s menším výskytem odlehlých hodnot.
- Praktický přínos pro pozemní aplikace - ?



Děkuji za pozornost!

Dotazy?