# *Radio Networks Design & Frequency Planning Software*

**Application area:**

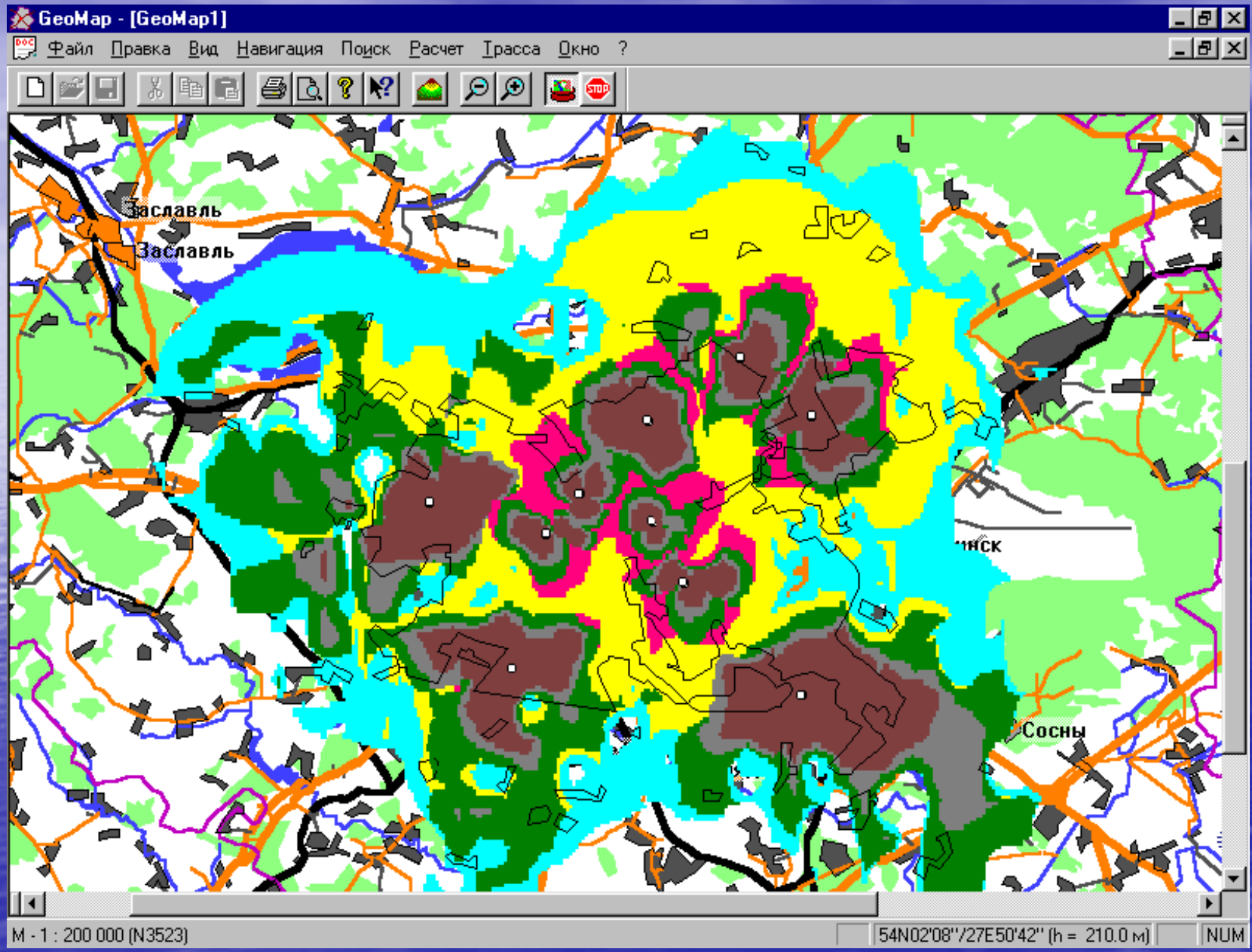
1. **Radio network frequency planning and system design, system EMC simulation/modeling and analysis with the use of digital area maps**
2. **NFPS software is used for design of complex space-scattered ground systems (radio communication systems, radio navigation systems, TV and radio broadcasting systems etc) in the 30 MHz -40 GHz frequency range using EMC criteria**

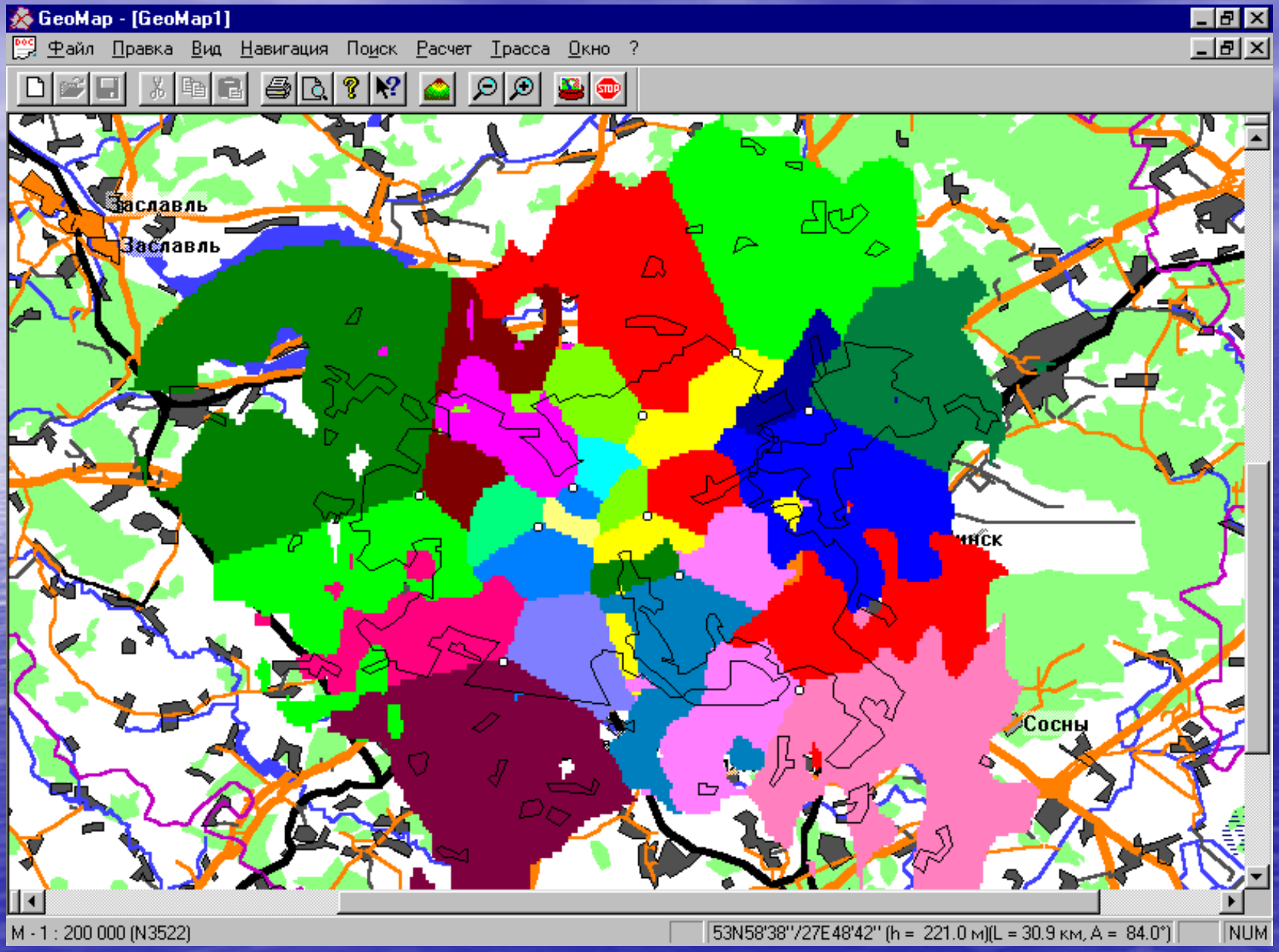
# *NFPS Software Structure*

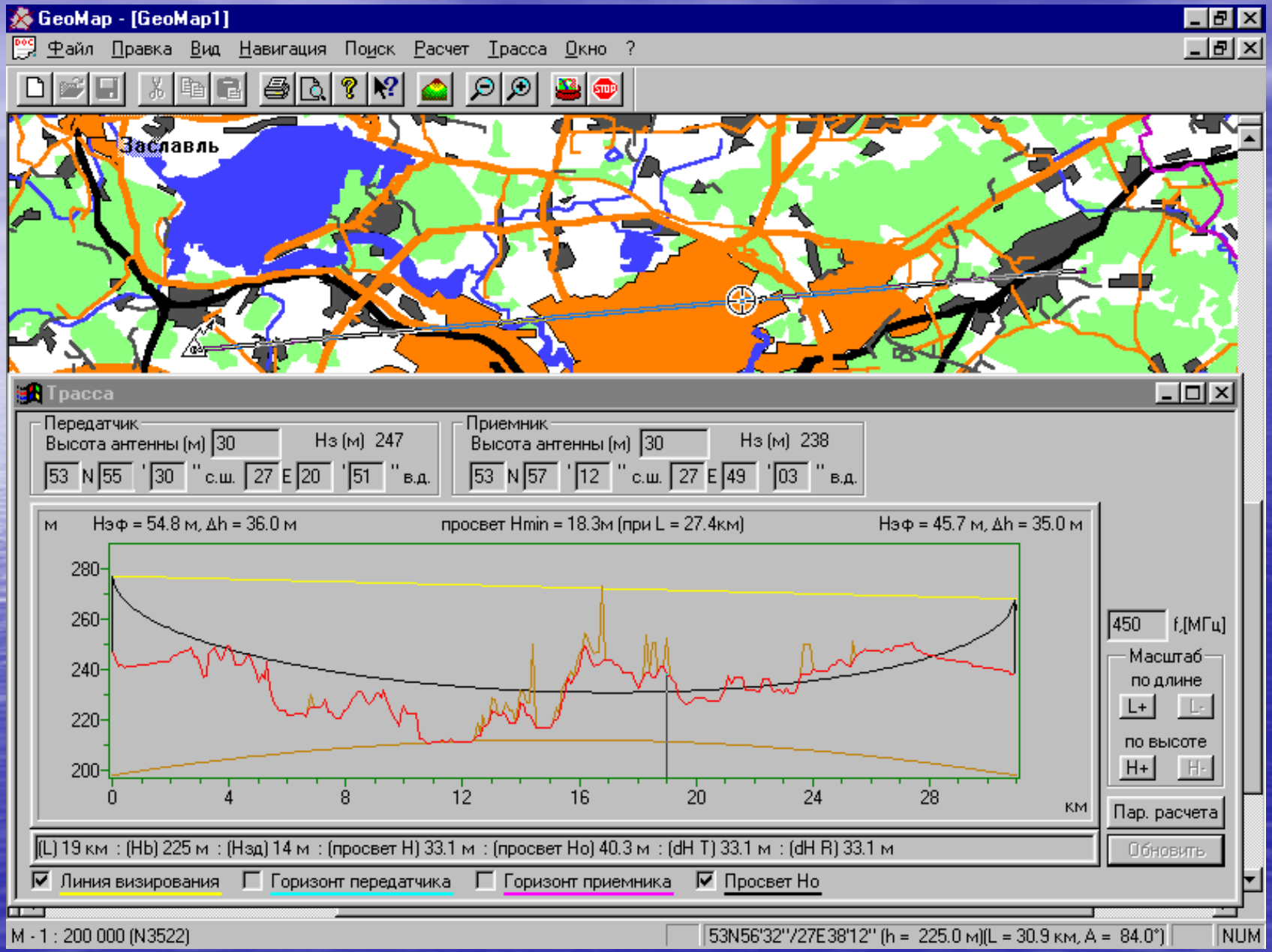
1. Digital Area Map database
2. Radio Environment database
3. Simulation/modeling results database
4. Subsystem for radio wave propagation process modeling
5. Subsystem for computation of coverage areas / responsibility areas / interference areas for network transmitters
6. Subsystem for analysis and simulation/modeling of intrasystem EMC in space-scattered radio communication networks
7. Subsystem for frequency plan optimization of space-scattered networks
8. Subsystem for results visualization, registration and output

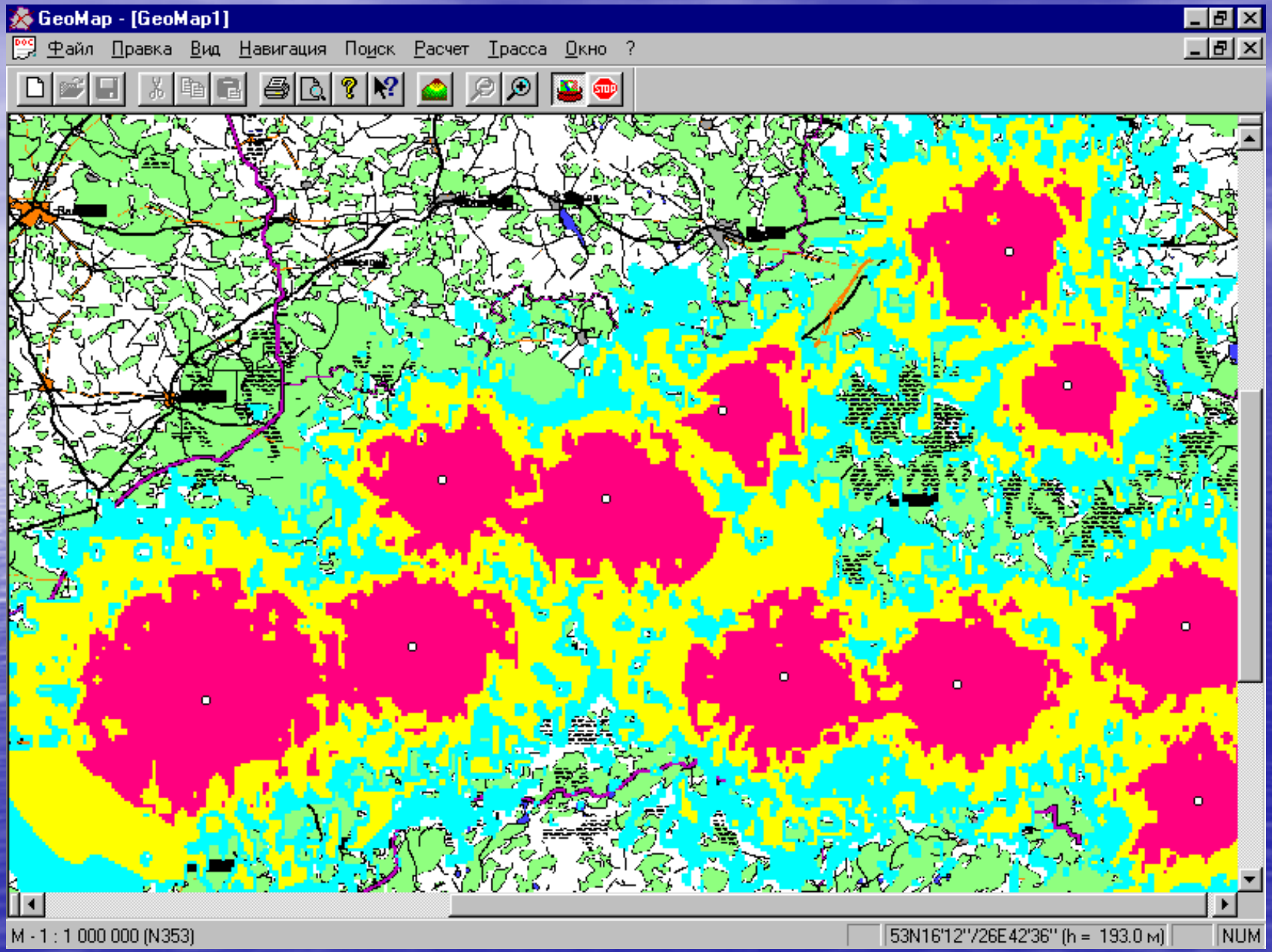
# *NFPS Software Functionality*

1. Computation of base propagation losses and radio signal levels
2. Computation of SIR (signal-to-interference) ratios
3. Computation and visualization of coverage and responsibility areas
4. Computation of radio transmitter interference areas
5. Estimation of handover boundaries
6. Computation and visualization of radio wave propagation paths between any point (location) pairs
7. Map legend displays reliable service areas and interference areas


GeoMap - [GeoMap1]
Файл Правка Вид Навигация Поиск Расчет Трасса Окно ?
Заславль
Заславль
Сосны
M - 1 : 200 000 (N3523)
54N02'08''/27E50'42'' (h = 210.0 м)
NUM


GeoMap - [GeoMap1]
Файл Правка Вид Навигация Поиск Расчет Трасса Окно ?
Заслaвль
Заславль
Сосны
M - 1 : 200 000 (N3522)
53N58'38''/27E48'42'' (h = 221.0 м)(L = 30.9 км, A = 84.0°)
NUM


GeoMap - [GeoMap1]
Файл Правка Вид Навигация Поиск Расчет Трасса Окно ?
Заславль
Трасса
Передатчик
Высота антенны (м) 30 Нз (м) 247
53 N 55 ' 30 '' с.ш. 27 E 20 ' 51 '' в.д.
Приемник
Высота антенны (м) 30 Нз (м) 238
53 N 57 ' 12 '' с.ш. 27 E 49 ' 03 '' в.д.
м
Нэф = 54.8 м, Δh = 36.0 м
просвет Hmin = 18.3м (при L = 27.4км)
Нэф = 45.7 м, Δh = 35.0 м
280
260
240
220
200
0
4
8
12
16
20
24
28
км
450 f,[МГц]
Масштаб
по длине
L+ L-
по высоте
H+ H-
Пар. расчета
Обновить
(L) 19 км : (Hb) 225 м : (Нзд) 14 м : (просвет H) 33.1 м : (просвет Ho) 40.3 м : (dH T) 33.1 м : (dH R) 33.1 м
Линия визирования
Горизонт передатчика
Горизонт приемника
Просвет Ho
M - 1 : 200 000 (N3522)
53N56'32''/27E38'12'' (h = 225.0 м)(L = 30.9 км, A = 84.0°)
NUM


GeoMap - [GeoMap1]
Файл Правка Вид Навигация Поиск Расчет Трасса Окно ?
M - 1 : 1 000 000 (N353)
53N16'12''/26E42'36'' (h = 193.0 м)
NUM

# *NFPS Software practical usage*

**Since 1995, various versions of NFPS software have been used by a number of departments and organizations for system design, EMC analysis and EMC simulation/modeling of radio networks and systems.**

**Over 1000 projects have been implemented in Belarus, Russia and other countries and regions, including frequency planning and system design of NMT, GSM, AMPS, CDMA, UMTS cellular networks, Smartsone, MPT-1327, TETRA and APCO-25 trunking systems, POCSAG radio paging systems, fixed service systems in 0.4, 2.0, 10, 14, 17 and 24 GHz ranges, WLL systems in 2.4, 3.5 and 5.3 GHz ranges, corporative radio communication systems, TV and UHF FM broadcasting systems**

# *NFPS subsystem: Hop Designer*

**Hop Designer is developed to automate link budget calculation for line-of-sight digital radio-relay links**

**Hop Designer: application background**
**Hop Designer is used since 2002 by a number of Belarusian and Russian organizations in order to design various nationally deployed line-of-sight digital radio-relay links for 7, 10, 14, 17, 23 and 27 GHz frequency ranges, including line-of-sight digital radio-relay links for NMT/CDMA and GSM-900/1800 cellular communication systems**

**Hop Designer was used in the process of computations and frequency planning for nationally deployed 1550-2000 MHz radio relay links (P-404 and P-414 stations).**

# Hop Designer for line-of-sight digital radio-relay links is implemented on the basis of the following ITU-R Recommendations:

1. P.530-11 Propagation data and prediction methods required for the design of terrestrial line-of-sight systems
2. P.676-6 Attenuation by atmospheric gases
3. P.834-4 Effects of tropospheric refraction on radiowave propagation
4. P.836-3 Water vapour: surface density and total columnar content
5. P.837-4 Characteristics of precipitation for propagation modelling
6. P.838-3 Specific attenuation model for rain for use in prediction methods
7. F.1093-1 Effects of multipath propagation on the design and operation of line-of-sight digital radio-relay systems
8. F.1101 Characteristics of digital radio-relay systems below about 17 GHz
9. F.1102 Characteristics of radio-relay systems operating in frequency bands above about 17 GHz
10. P.453-9 The radio refractive index: its formula and refractivity data
11. P.526-8 Propagation by diffraction

# *Hop Designer functionality*

1. Generation of the radio-relay link path profile with the use of digital maps on the basis of assigned radio-relay station deployment coordinates or manual input of the profile obtained from topographic maps and surface charts. Radio-relay link path profile provides separate display of Earth surface, forests, hydrographic objects, buildings and constructions.
2. Radio-relay link path profile provides display of the first Fresnel zone boundary (with an arbitrary multiplier) for effective Earth radius exceeded for arbitrary percentage of time.
3. Functionality for quick selection of antenna heights and sites for deployment of radio-relay link facilities in order to fulfill the line-of-sight criteria for the radio-relay link path.
4. Prediction of quality parameters for line-of-sight radio-relay links (outage probability due to clear-air effects and outage probability due to rain) with the use of the ITU-R Recommendation P 530-10.
5. Capability for more detailed calculation of radio-relay links which takes account of diffraction losses and surface reflection losses for the radio-relay link path. Detailed calculation makes it possible to design digital radio-relay links with partially or fully closed paths as well as to optimize antenna heights in order to minimize losses due to surface reflection.
6. Visualization and printing of results, management of databases for technical specifications, deployment and ownership parameters of radio-relay link equipment.

MRNPT-HP - [Minsk_ZelenyBor]

File Edit View Window Help

Refresh | Terrain ... | Parameters ... | Print margins setup ... | Advanced calculation ... | Calculation P. 530-10 ...

TX coordinates: 53 ° 53 ' 0 "N 27 ° 30 ' 0 "E

RX coordinates: 53 ° 53 ' 0 "N 27 ° 45 ' 0 "E

Path length=27.05 km

Current point parameters

| | | |
|---|---|---|
| Distance = 14.373 км | Clearance G= 31.6374 м | Clearance G/F1= 1.8627 |
| H = 151.715 м | Clearance B= 17.8572 м | Clearance B/F1= 1.05137 |

H antTx 45 m (182.5 m)

H antRx 90 m (203.3 m)

Min. clearance point parameters

- KeqG=1.40192
- KeqB=0.59631
- Clearance G/F1=0.680943
- Clearance B/F1=0.0675117
- Clearance G=8.74458 м
- Clearance B=0.866976 м
- Dist.min.cl. G=4.65 км
- Dist.min.cl. B=4.65 км


Ready NUM

## Select system parameters

System parameters list

- Ericsson 17x2/34 Mbit/s
- Ericsson 17x2/34 Mbit/s 18 GHz
- Ericsson 17x2/34 Mbit/s 7 GHz
- Ericsson 2x4/8 Mbit/s

OK

## System parameters

System name: Ericsson 17x2/34 Mbit/s 18 GHz

System parameters

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $P_{tx}$ | 17 | dBm | $P_{rx0}$ | -76 | dBm | | |
| $L_{ftx}$ | 0 | dB | $L_{frx}$ | 0 | dB | $L_{ctx}$ | 0 dB, $L_{crx}$ 0 dB |
| $W_M$ | 0.021 | GHz | $W_{NM}$ | 0.024 | GHz | $\tau_{r,M}$ | 6.3 ns |
| $B_M$ | 14 | dB | $B_{NM}$ | 11 | dB | $\tau_{r,N,M}$ | 6.3 ns |

OK Cancel

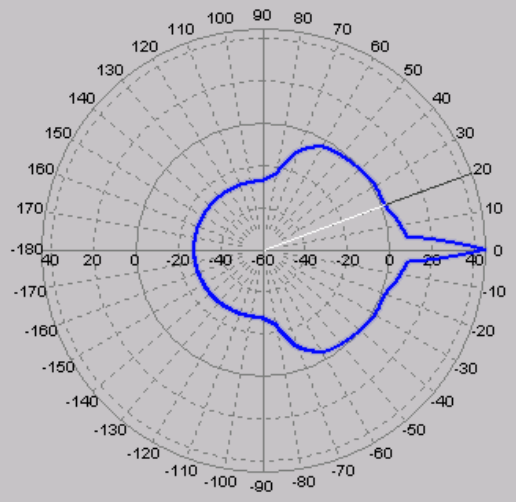
## Path terrain

| Dist., km | Height asl, m | H wood start, m | H wood interm... | H wood end, m | H building start... | H building end,... | Surface type |
|---|---|---|---|---|---|---|---|
| 0.000 | 137.50 | | | | | | |
| 0.300 | 133.50 | | | | | | |
| 0.305 | 133.50 | | | | | | |
| 0.810 | 122.50 | | | | | | |
| 0.930 | 122.50 | | | | | | |
| 0.990 | 123.50 | | | | | | |
| 0.995 | 123.50 | | | | | | |
| 1.180 | 127.50 | | | | | | |
| 1.350 | 127.50 | | | | | | |
| 1.370 | 122.50 | | | | | | |
| 1.390 | 122.50 | | | | | | |
| 1.500 | 131.50 | | | | | | |
| 1.505 | 131.50 | | | | | | |
| 1.600 | 132.50 | | | | | | |
| 1.790 | 132.50 | | | | | | |
| 2.220 | 135.00 | | | | | | |
| 2.490 | 135.00 | | | | | | |
| 2.970 | 142.50 | | | | | | |
| 3.100 | 142.50 | | | | | | |
| 3.250 | 140.00 | | | | | | |
| 3.270 | 135.00 | 20.00 | | | | | |
| 3.310 | 142.50 | | | | | | |
| 3.340 | 142.50 | | | | | | |
| 3.370 | 140.00 | | | | | | |
| 3.450 | 150.00 | | | | | | |

## Antenna radiation pattern

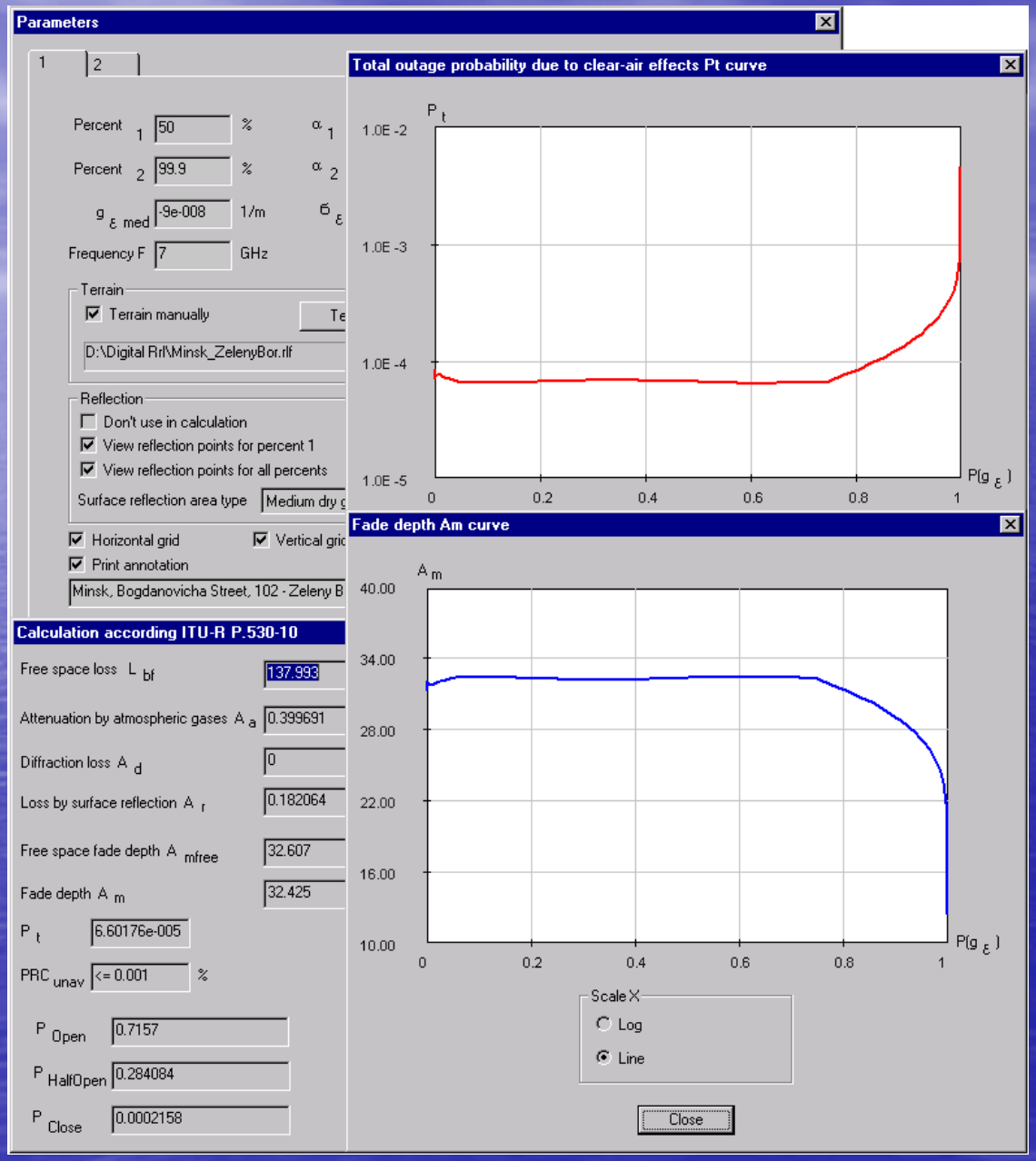
Antenna name: 18 GHz 1.2 m

Antenna radiation pattern - vertical plane:




Log scale  Angle: 20.3 deg  Gain: 1.00 dB

Minimum displayed gain, dB - 60  Refresh  Close


Parameters
1
2
Percent 1 50 %
Percent 2 99.9 %
Frequency F 7 GHz
Terrain
Terrain manually
D:\Digital Rrl\Minsk_ZelenyBor.rlf
Reflection
Don't use in calculation
View reflection points for percent 1
View reflection points for all percents
Surface reflection area type
Horizontal grid
Vertical grid
Print annotation
Minsk, Bogdanovicha Street, 102 - Zeleny B
Calculation according ITU-R P.530-10
Free space loss L bf 137.993
Attenuation by atmospheric gases A a 0.399691
Diffraction loss A d 0
Loss by surface reflection A r 0.182064
Free space fade depth A mfree 32.607
Fade depth A m 32.425
P t 6.60176e-005
PRC unav <= 0.001 %
P Open 0.7157
P HalfOpen 0.284084
P Close 0.0002158
Total outage probability due to clear-air effects Pt curve
P t
1.0E -2
1.0E -3
1.0E -4
1.0E -5
0
0.2
0.4
0.6
0.8
1
P(g ε)
Fade depth Am curve
A m
40.00
34.00
28.00
22.00
16.00
10.00
0
0.2
0.4
0.6
0.8
1
P(g ε)
Scale X
Log
Line
Close

# *For further information please contact us at:*

**Belarusian State University of Informatics and Radioelectronics (BSUIR)**
emc@bsuir.by

**EMC Technologies LLP**
emctechsoft@yahoo.com

**Vladimir Mordachev**
Head of BSUIR R&D EMC Laboratory
+37517-2938994, 2938438; emc@bsuir.by