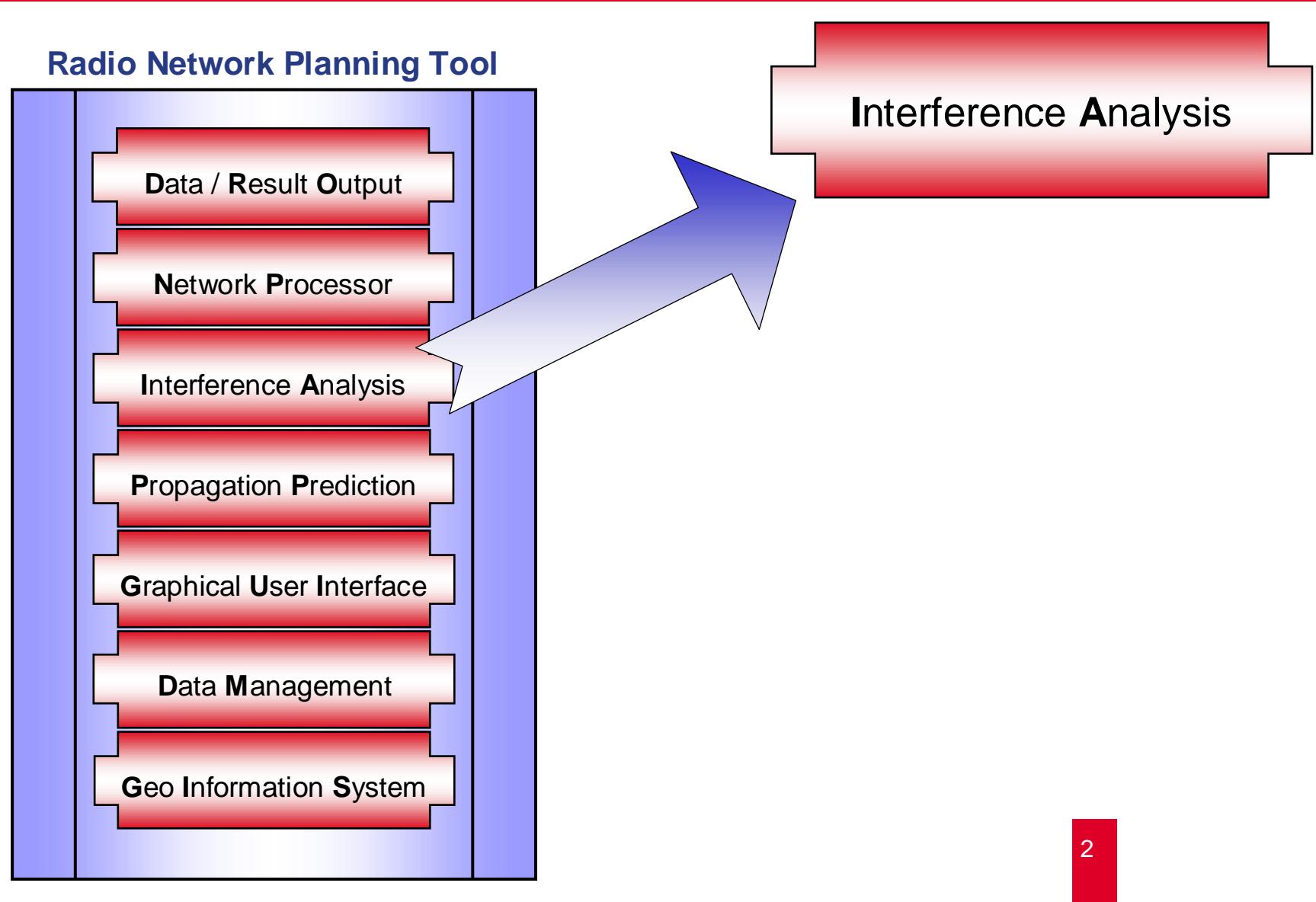


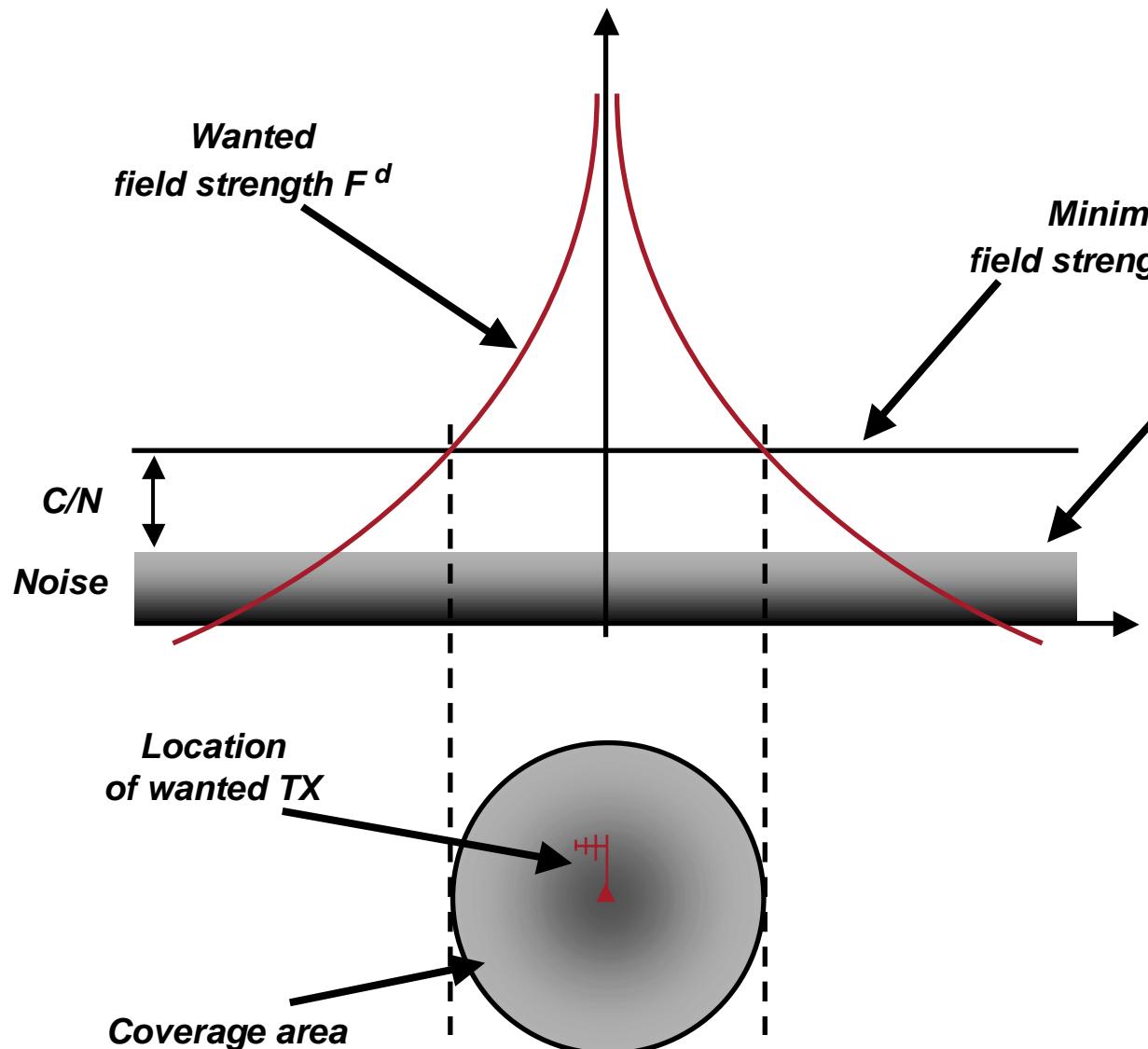
Session 5.8

Supporting Network Planning Tools III

by

Roland Götz



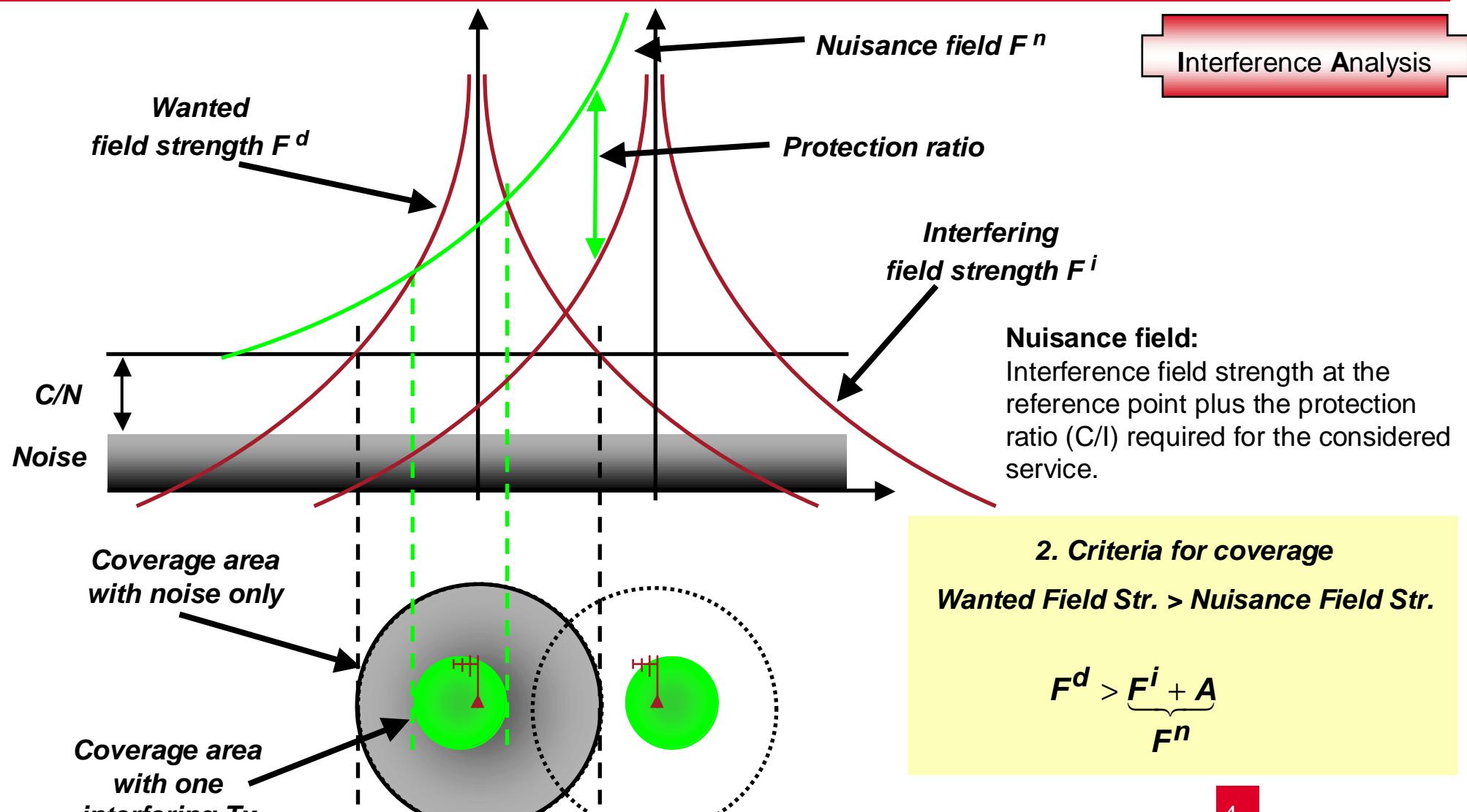


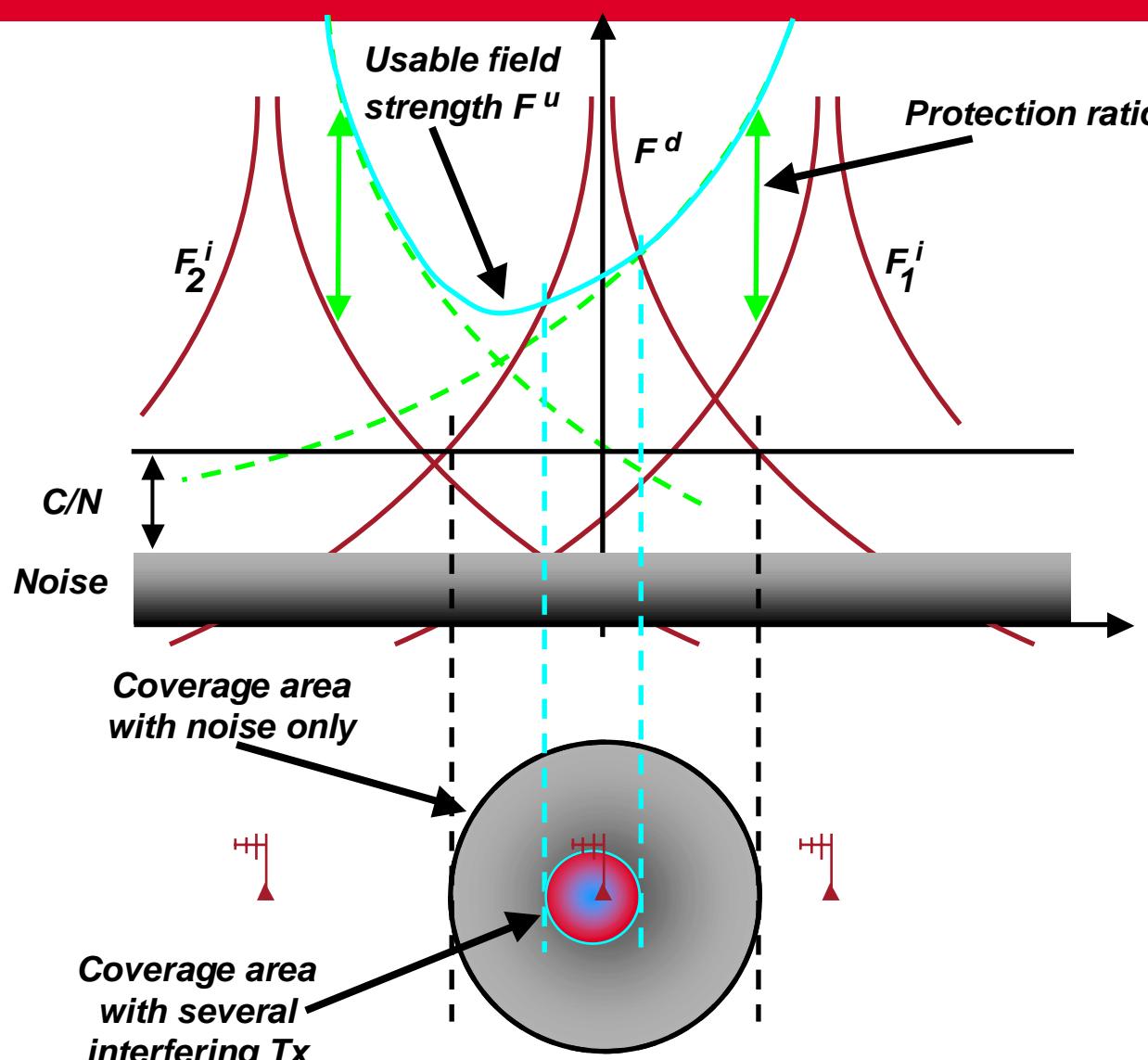
Minimum field strength (C/N):
It is a minimum field strength level which is necessary to fulfil the signal quality for coverage.

1. Criteria for coverage

Wanted Field Str. > Minimum Field Str.

$$F^d > \underbrace{F^N + C/N}_{F^{min}}$$



**Usable field:**

Summation of the nuisance fields of the interfering transmitters according to a certain summations algorithm (maximum, simplified multiplication, ...)

It is the fieldstrength value which is *usable* by a possible new site just to fulfill the condition of coverage ($C/I>0$) by the existing interferer situation.

3. Criteria for coverage

Wanted Field Str. > Usable Field Str.

$$F^d > \sum_{j=1}^M F_j^n$$

F^u

In modern Planning Tools, the cumulation of the single interfering fields can be done in several different ways.

The various procedures differ in the way how simplifications are used to minimize the calculation effort.

In the following a short overview is given for the procedures which are most often used in interference calculations.

Non-statistical methods:

- ☞ Maximum procedure
- ☞ Power-sum method

Statistical methods:

- ☞ Integration method
- ☞ Log-normal method
- ☞ Multiplication method
- ☞ Simplified multiplication method
- ☞ Simplified Log-normal method
- ☞ Trilinear Log-normal method

Interference Analysis



Most use is made of the power-sum method and the simplified multiplication method

Reference CCIR Report 945-2: Methods for the Assessment of Multiple Interference

Automissed Frequency / Channel Assignment

Interference Analysis

Network wide parameter

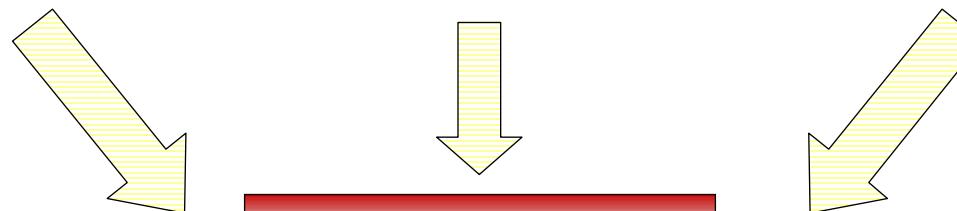
Frequency spectrum

Cell specific parameter

Number of required carriers
Channel constraints

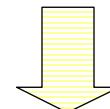
Cell relations

Neighbour relations
Channel separation matrix



Interference Analysis
Interference Matrix

Allocation algorithm



Channel allocation

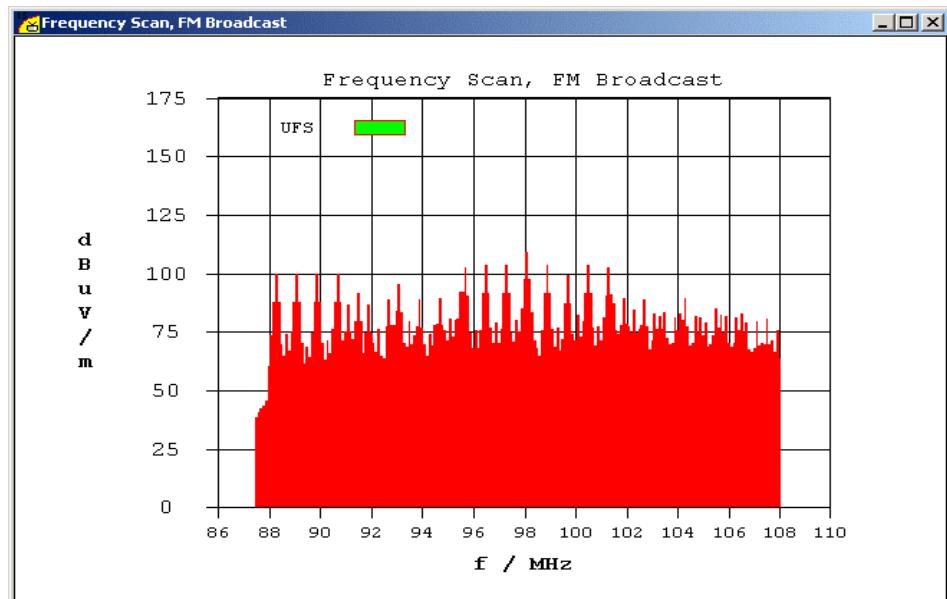
- LS Box algorithm
- Simulated annealing algorithm

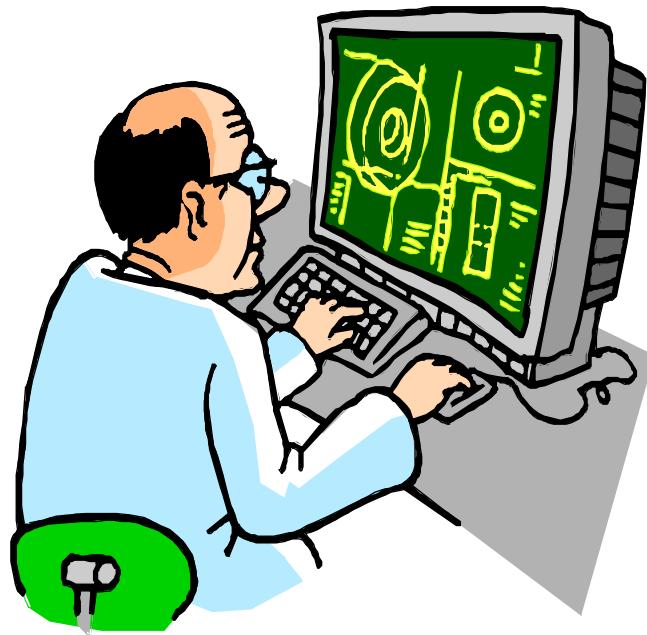
Interference Analysis

Frequency Scan

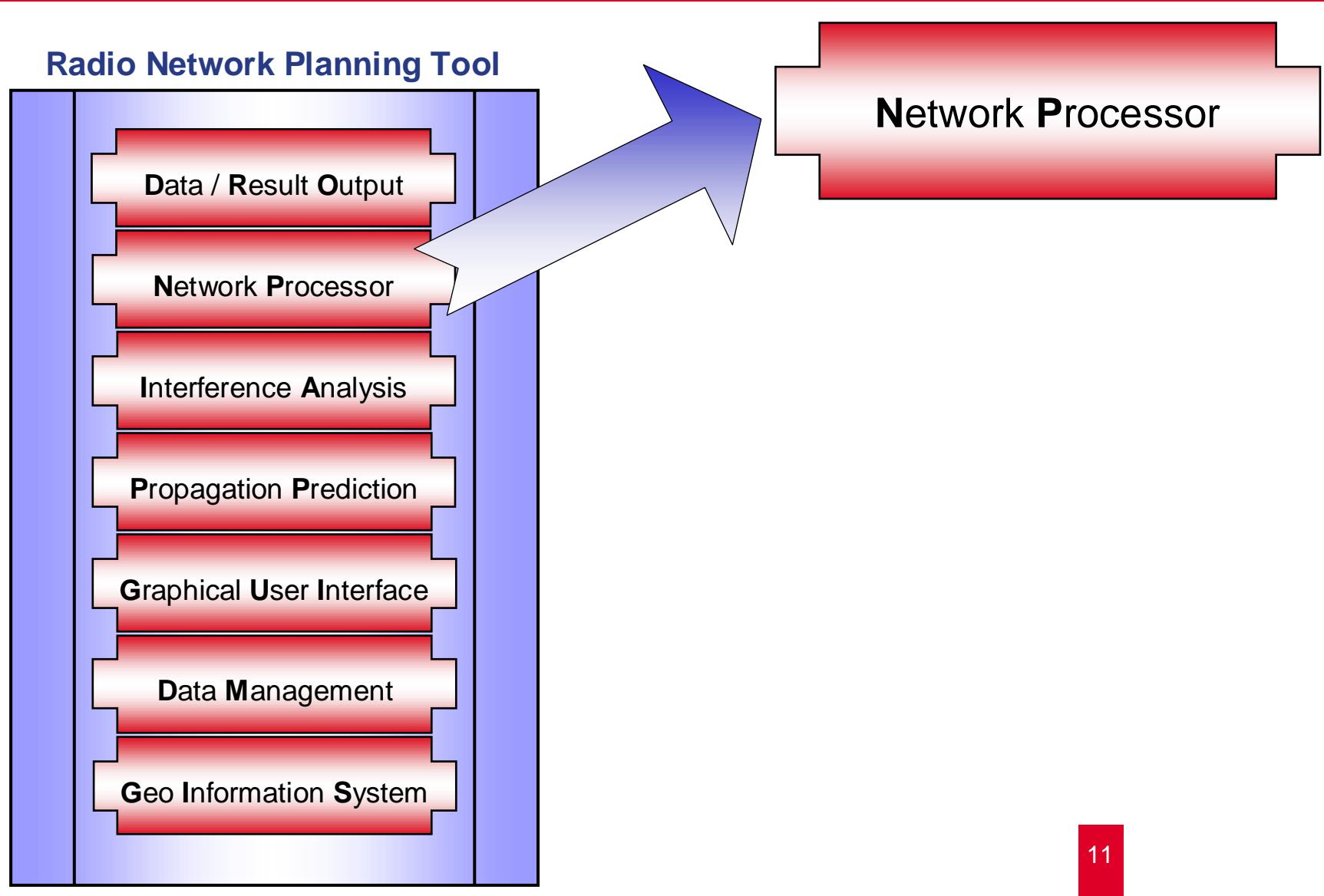
☞ This function is used to find out gaps in the frequency spectrum where new TV or FM transmitters could be planned. At a desired transmitter site (transmitter coordinate) a wanted transmitter calculation based on a frequency range given by the user is done and the usable field strength calculated for each frequency point.

No	Frequency	Channel	UFS	A/sqkm	Max. Interferer	
1	87.50000	-2	38.7	0.00	SW Slopes/E Riverina	88.30 AUS
2	87.60000	2	40.7	0.00	SW Slopes/E Riverina	88.30 AUS
3	87.70000	+2	42.7	0.00	SW Slopes/E Riverina	88.30 AUS
4	87.80000	-3	43.7	0.00	SW Slopes/E Riverina	88.30 AUS
5	87.90000	3	45.5	0.00	SW Slopes/E Riverina	88.30 AUS
6	88.00000	+3	60.4	0.00	SW Slopes/E Riverina	88.30 AUS
7	88.10000	-4	73.6	0.00	SW Slopes/E Riverina	88.30 AUS
8	88.20000	4	87.7	0.00	SW Slopes/E Riverina	88.30 AUS
9	88.30000	+4	99.7	0.00	SW Slopes/E Riverina	88.30 AUS
10	88.40000	-5	87.7	0.00	SW Slopes/E Riverina	88.30 AUS
11	88.50000	5	70.0	0.00	SW Slopes/E Riverina	88.30 AUS
12	88.60000	+5	65.0	0.00	SW Slopes/E Riverina	88.30 AUS
13	88.70000	-6	74.4	0.00	Walva/Jingellic	88.70 AUS
14	88.80000	6	66.8	0.00	SW Slopes/E Riverina	89.10 AUS
15	88.90000	+6	75.3	0.00	SW Slopes/E Riverina	89.10 AUS
16	89.00000	-7	87.7	0.00	SW Slopes/E Riverina	89.10 AUS
17	89.10000	7	99.7	0.00	SW Slopes/E Riverina	89.10 AUS
18	89.20000	+7	87.7	0.00	SW Slopes/E Riverina	89.10 AUS
19	89.30000	-8	70.3	0.00	SW Slopes/E Riverina	89.10 AUS
20	89.40000	8	61.8	0.00	SW Slopes/E Riverina	89.10 AUS
21	89.50000	+8	68.9	0.00	Orange	89.50 AUS
22	89.60000	-9	64.5	0.00	SW Slopes/E Riverina	89.90 AUS
23	89.70000	9	74.9	0.00	SW Slopes/E Riverina	89.90 AUS
24	89.80000	+9	87.7	0.00	SW Slopes/E Riverina	89.90 AUS
25	89.90000	-10	99.7	0.00	SW Slopes/E Riverina	89.90 AUS
26	90.00000	10	87.7	0.00	SW Slopes/E Riverina	89.90 AUS
27	90.10000	+10	70.2	0.00	SW Slopes/E Riverina	89.90 AUS
28	90.20000	-11	63.0	0.00	SW Slopes/E Riverina	89.90 AUS
29	90.30000	11	71.1	0.00	Bendigo	90.30 AUS
30	90.40000	+11	66.1	0.00	SW Slopes/E Riverina	90.70 AUS
31	90.50000	-12	76.3	0.00	SW Slopes/E Riverina	90.70 AUS





Live Planning Tool Demonstration



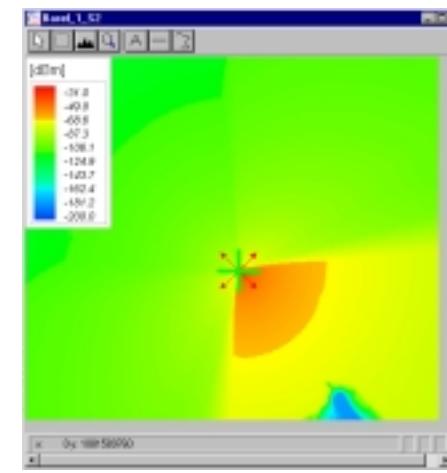
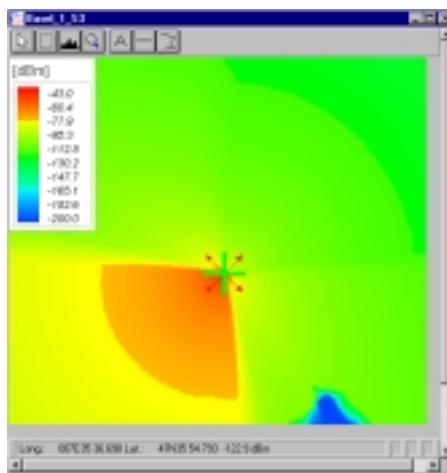
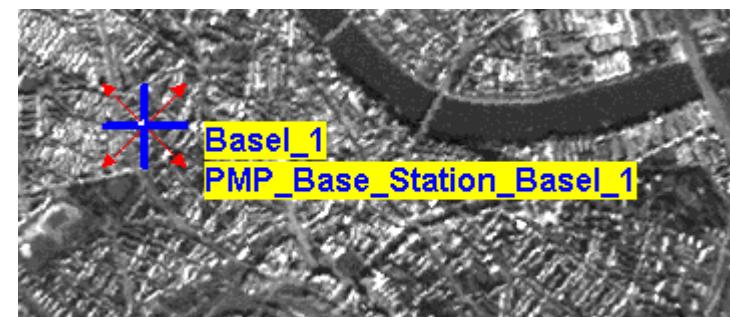
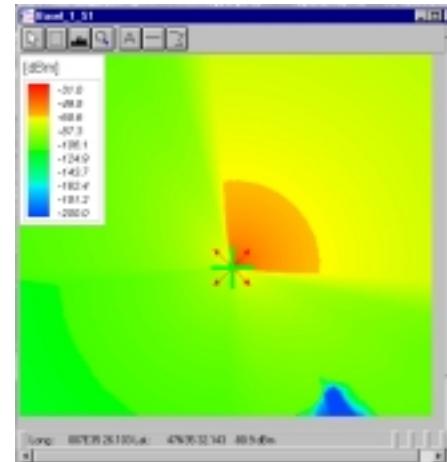
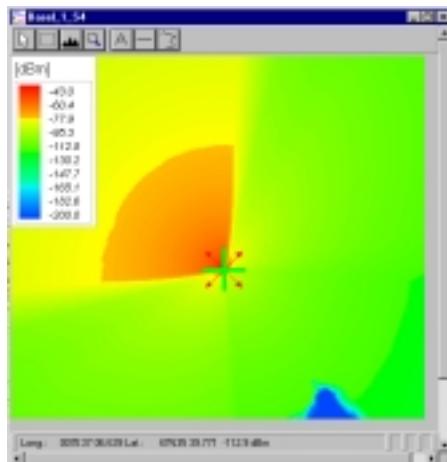
Network Processor

The Network Processor

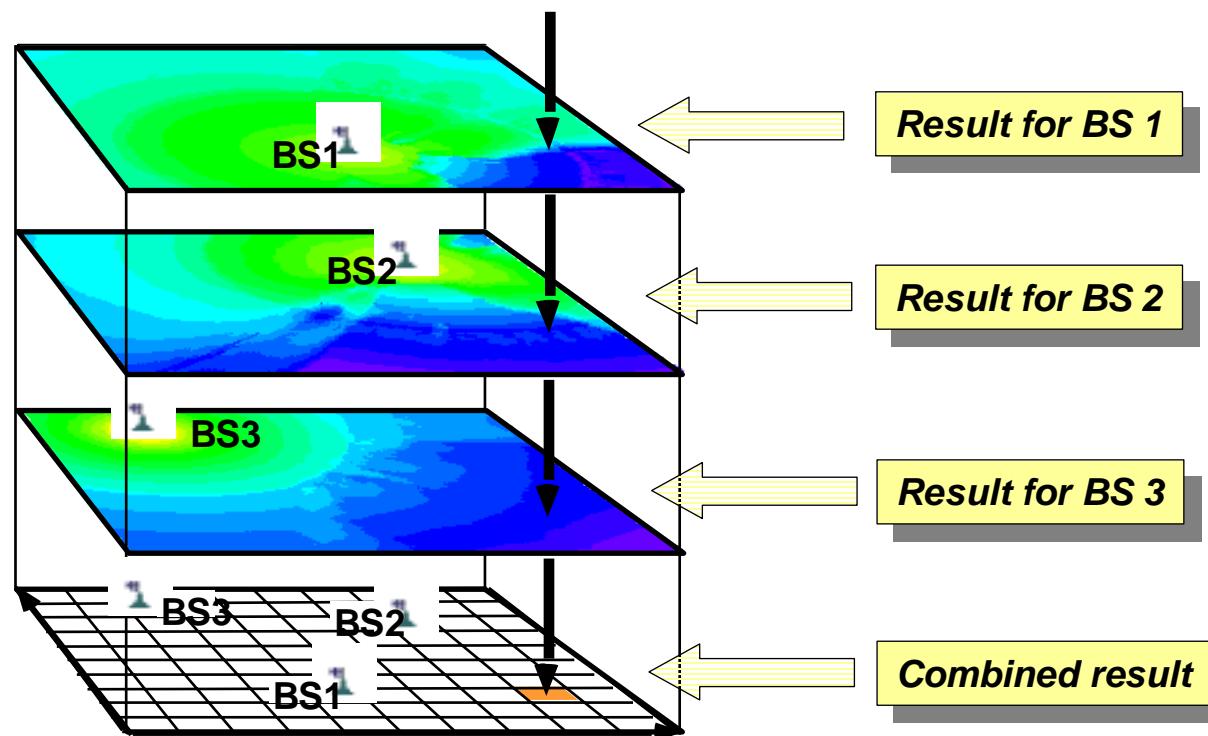
- produces network-wide results out of the single-cell-based results
- allows to analyse the radio network
- allows to simulate changes of the network parameter
- allows to simulate changes of the network design
- allows to optimise the radio network
- allows to plan the future roll-out phases
- produces statistics on the selected results

Each Service needs an own service-specific Network Processor

Network Processor



Principle of calculation: Combination of different results



Network Processor

Maximum Field Strength:

For every pixel, this plot shows the signal level of the cell/transmitter producing the maximum single field strength.

Sector 1

-120	-128	-130
-120	-127	-129
-115	-118	-121

Sector 2

-95	-80	-75
-90	-75	-70
-85	-70	-65

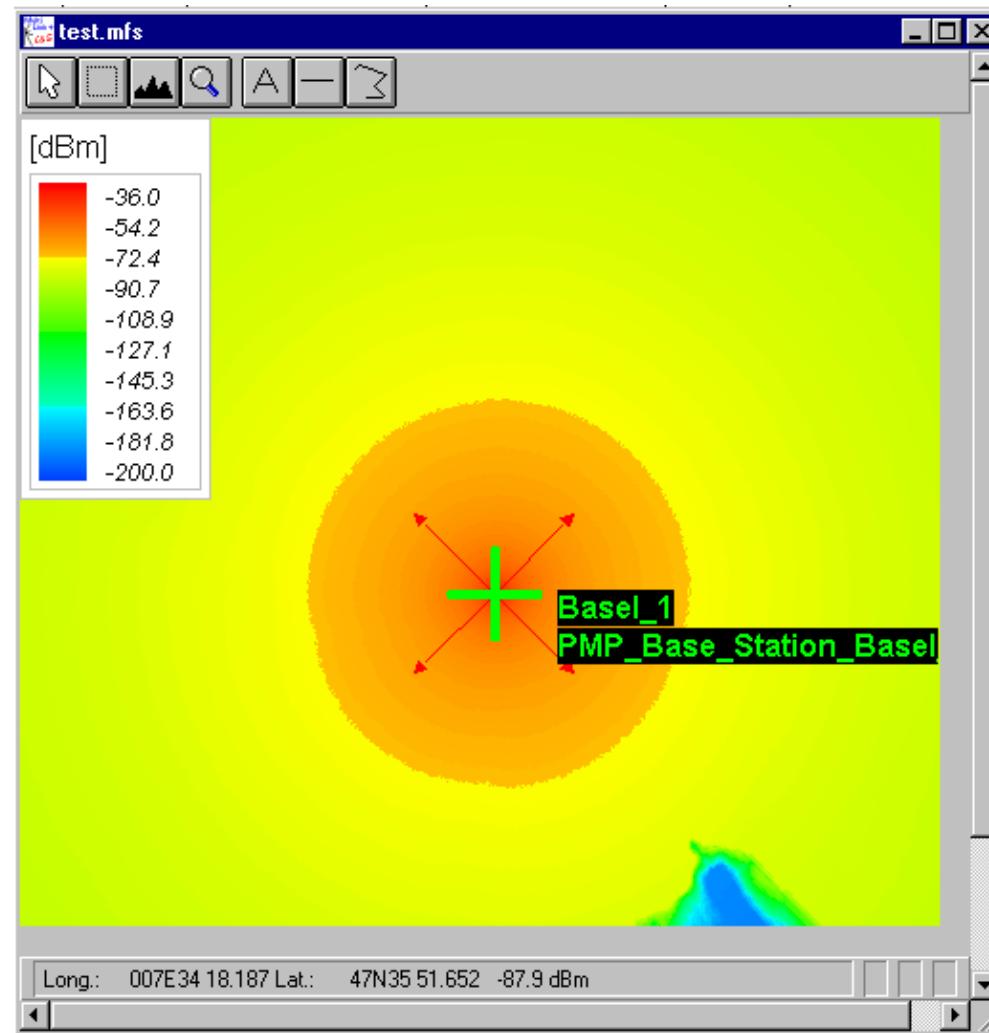
Sector 3

-65	-80	-95
-65	-80	-95
-65	-75	-95

Maximum Field Strength**Max. Field.**

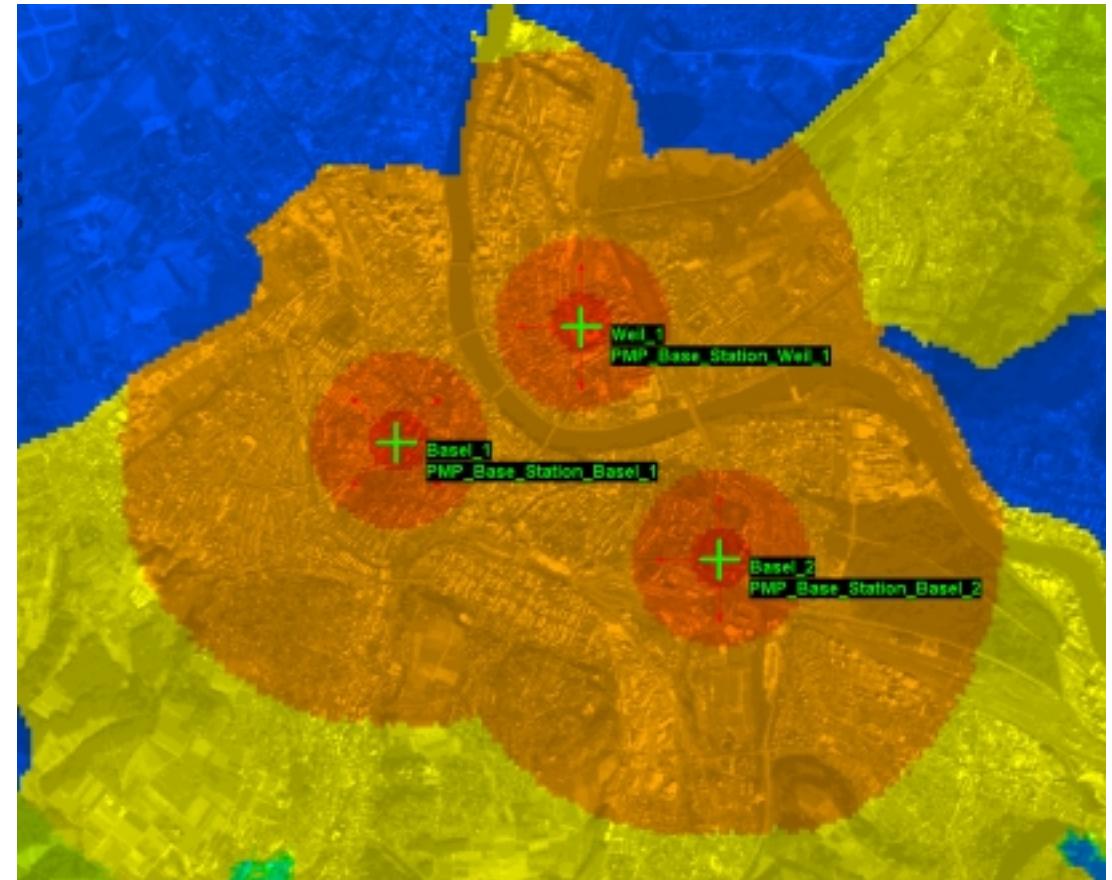
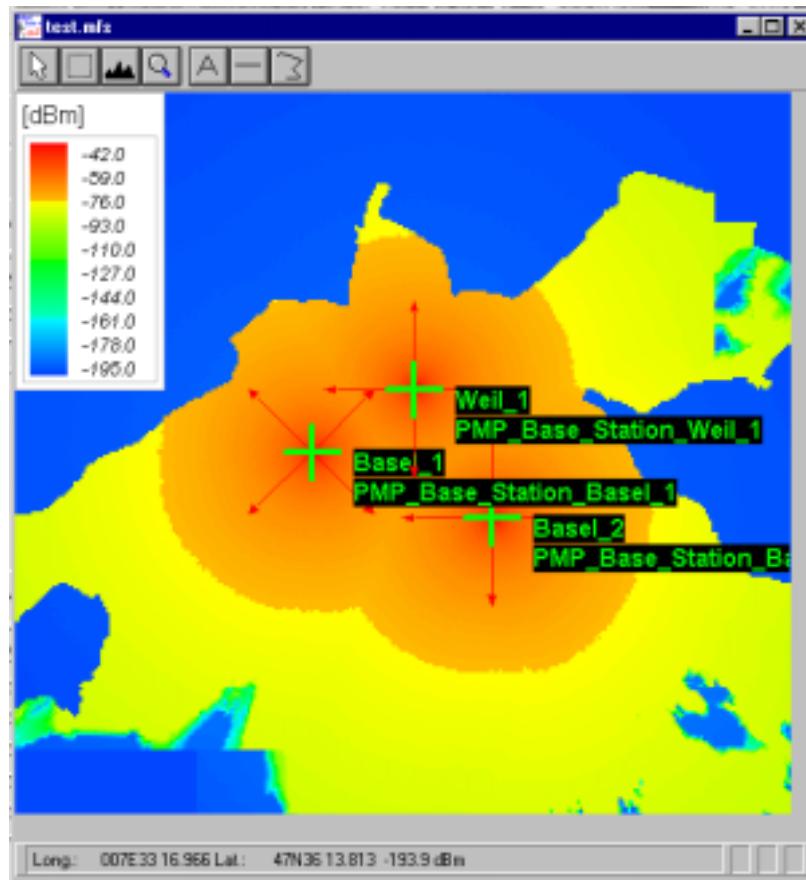
-65	-80	-75
-65	-75	-70
-65	-70	-65





Network Processor

Network Processor



Maximum Server:

The maximum server plot shows, for a certain pixel, the name of the transmitter featuring the maximum signal; its field strength must exceed the minimum field strength required for coverage, E_{min} equiv.

Sector 1

-120	-128	-130
-120	-127	-129
-115	-118	-121

Sector 2

-95	-80	-75
-90	-75	-70
-85	-70	-65

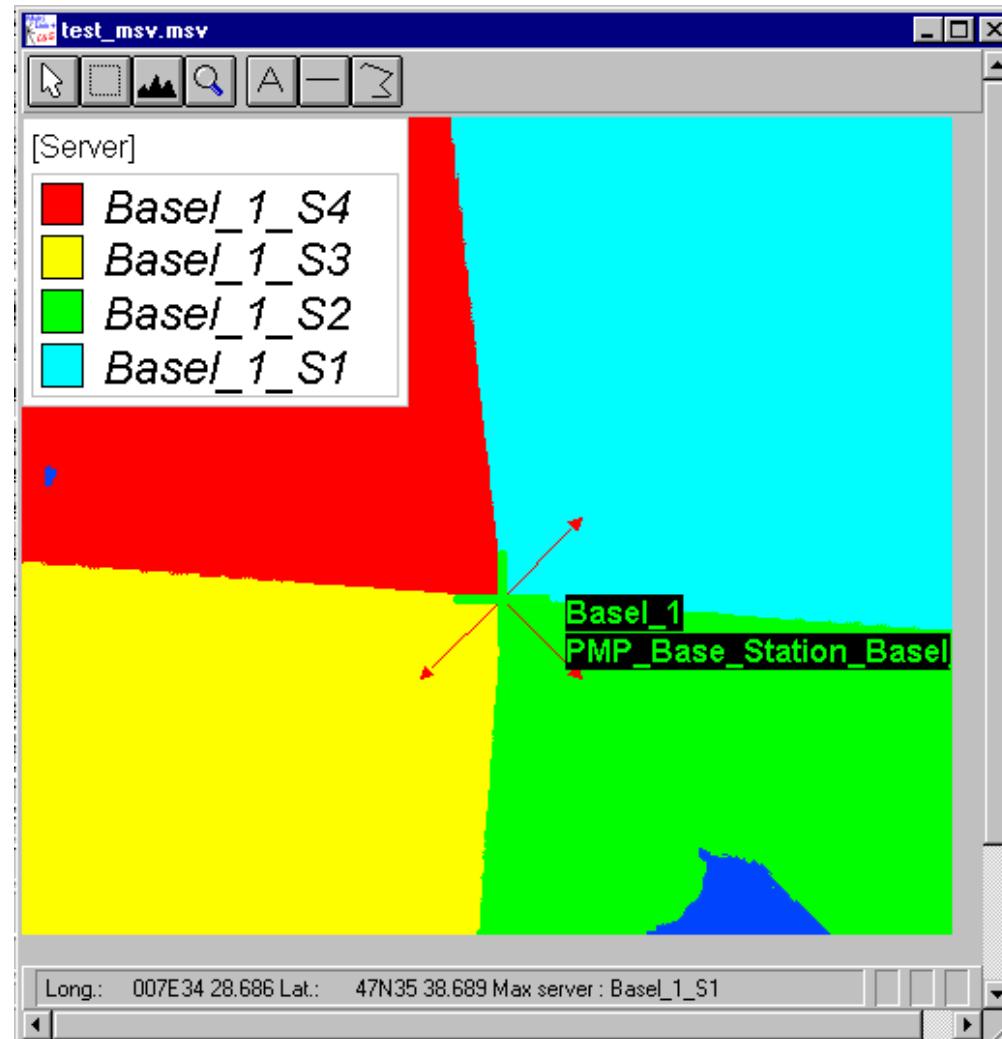
Sector 3

-65	-80	-95
-65	-80	-95
-65	-75	-95

$$P_{min} = -75 \text{ dBm}$$

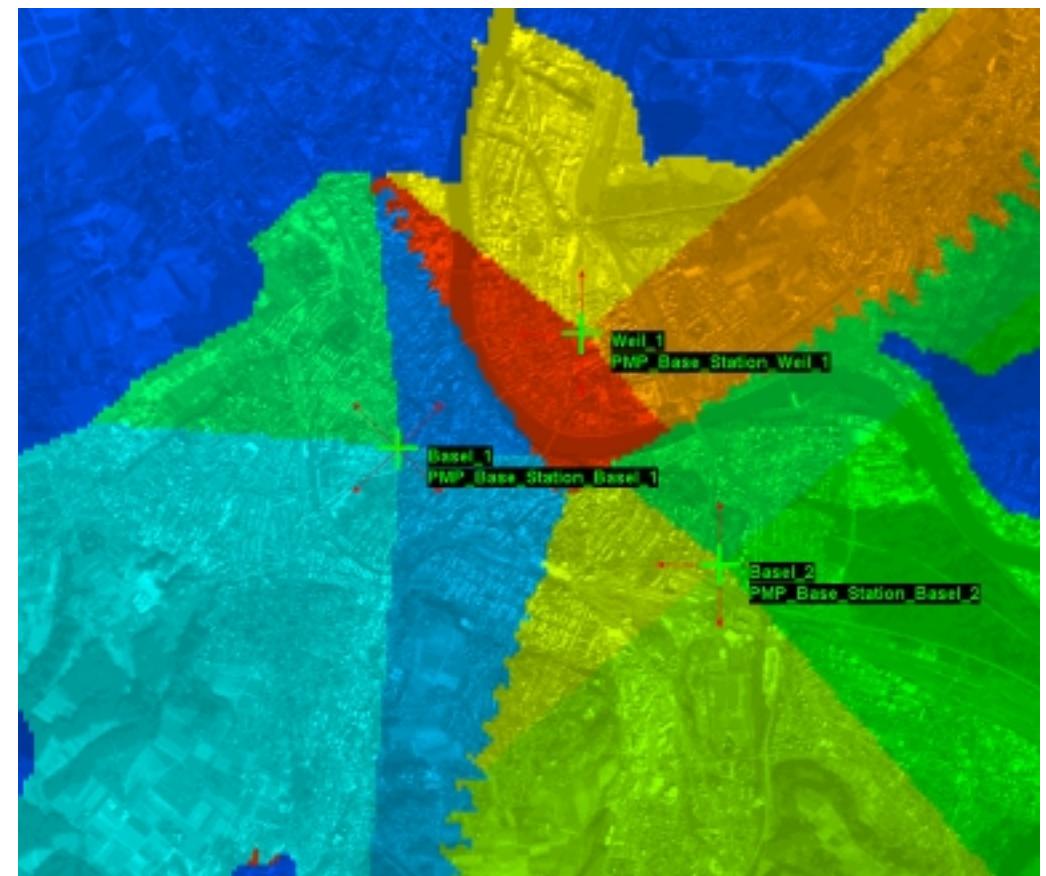
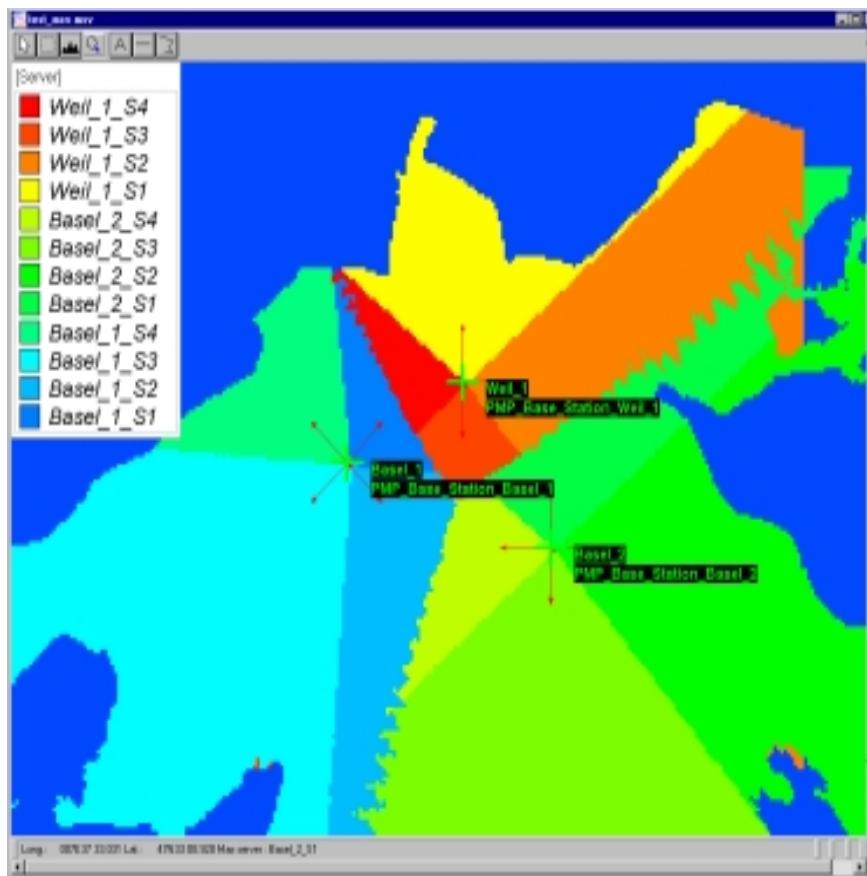
Max. Server

S3	x	S2
S3	S2	S2
S3	S2	S2



Network Processor

Network Processor



Best Server:

The maximum server plot shows, for a certain pixel, the name of the transmitter featuring the maximum signal; its field strength must exceed the minimum field strength required for coverage, $E_{\min \text{ equiv}}$ and the Minimum C/I

Sector 1

-120	-128	-130
-120	-127	-129
-115	-118	-121

Sector 2

-95	-80	-75
-90	-75	-70
-85	-70	-65

Sector 3

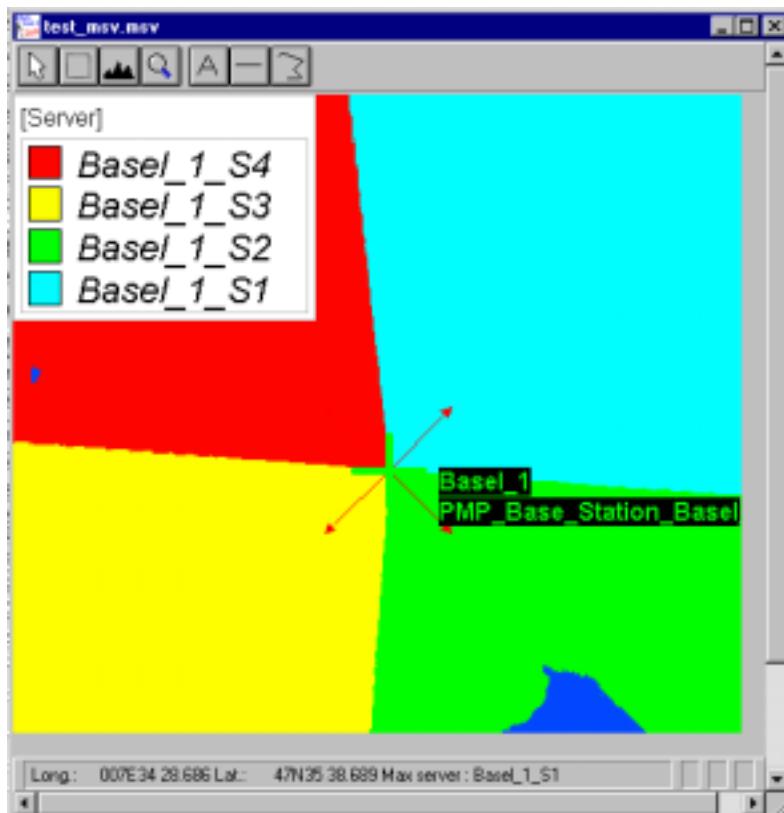
-65	-80	-95
-65	-80	-95
-65	-75	-95

$$\begin{aligned} P_{\min} &= -75 \text{ dBm} \\ C/I_{\min} &= 7 \text{ dB} \end{aligned}$$

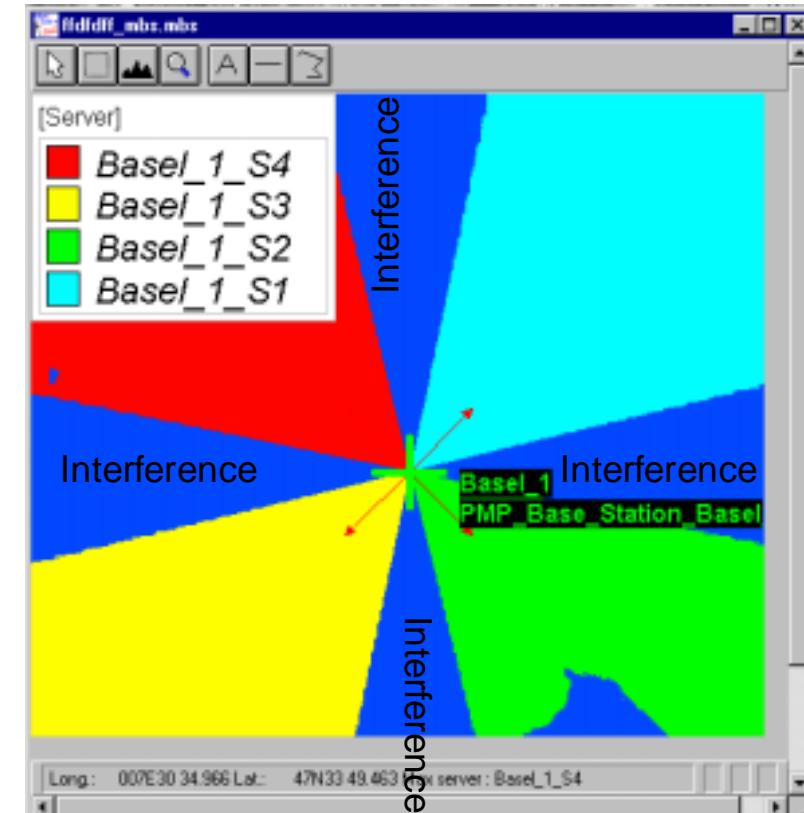
**Best Server**

S3	x	S2
S3	x	S2
S3	x	S2

Maximum Server

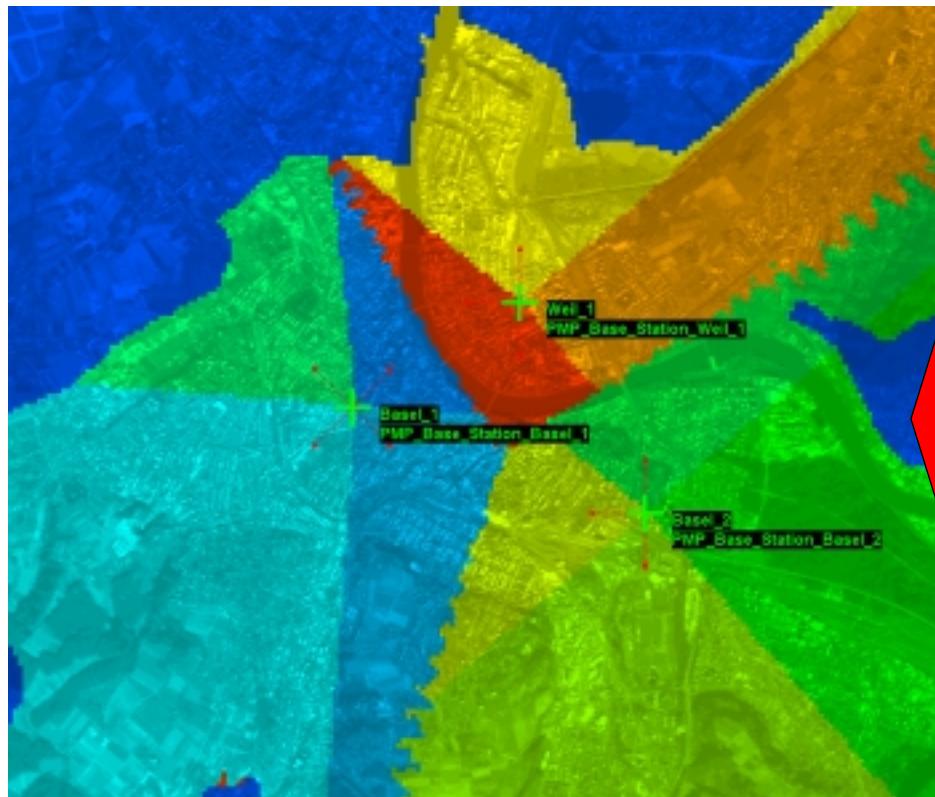


Best Server

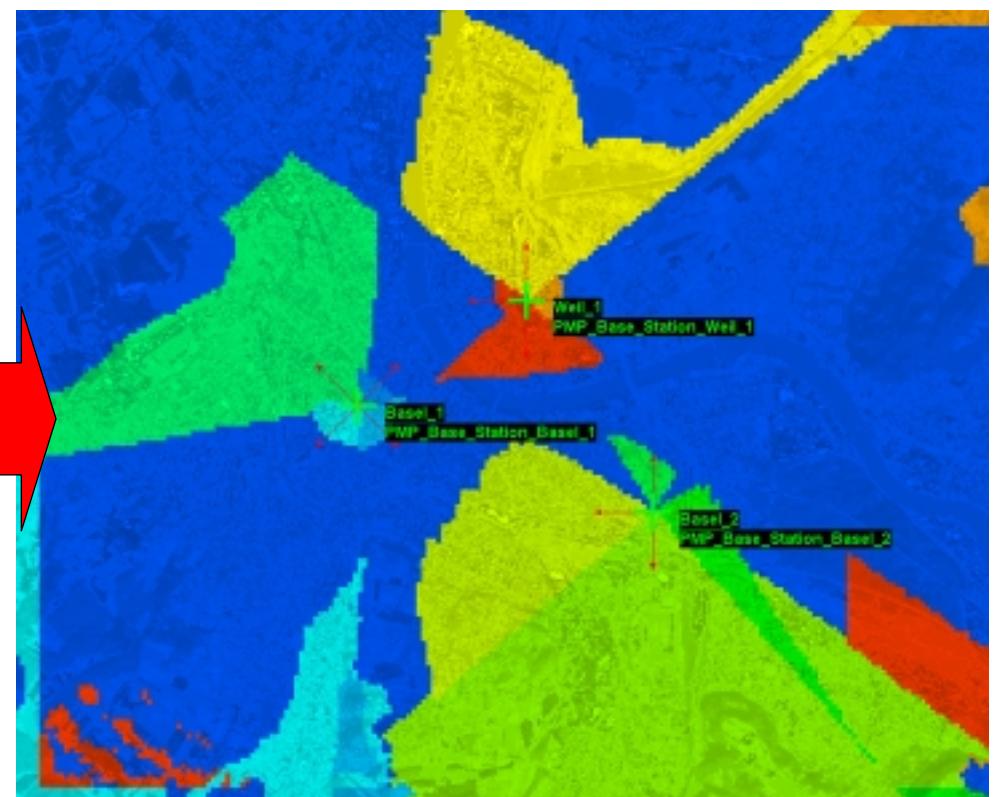


Network Processor

Maximum Server



Best Server



Network Processor

C/I at Max. Server:

C/I at sector with highest power at a certain position

Parameters: Minimum Level (P_{min})

Sector 1

-120	-128	-130
-120	-127	-129
-115	-118	-121

Sector 2

-95	-80	-75
-90	-75	-70
-85	-70	-65

Sector 3

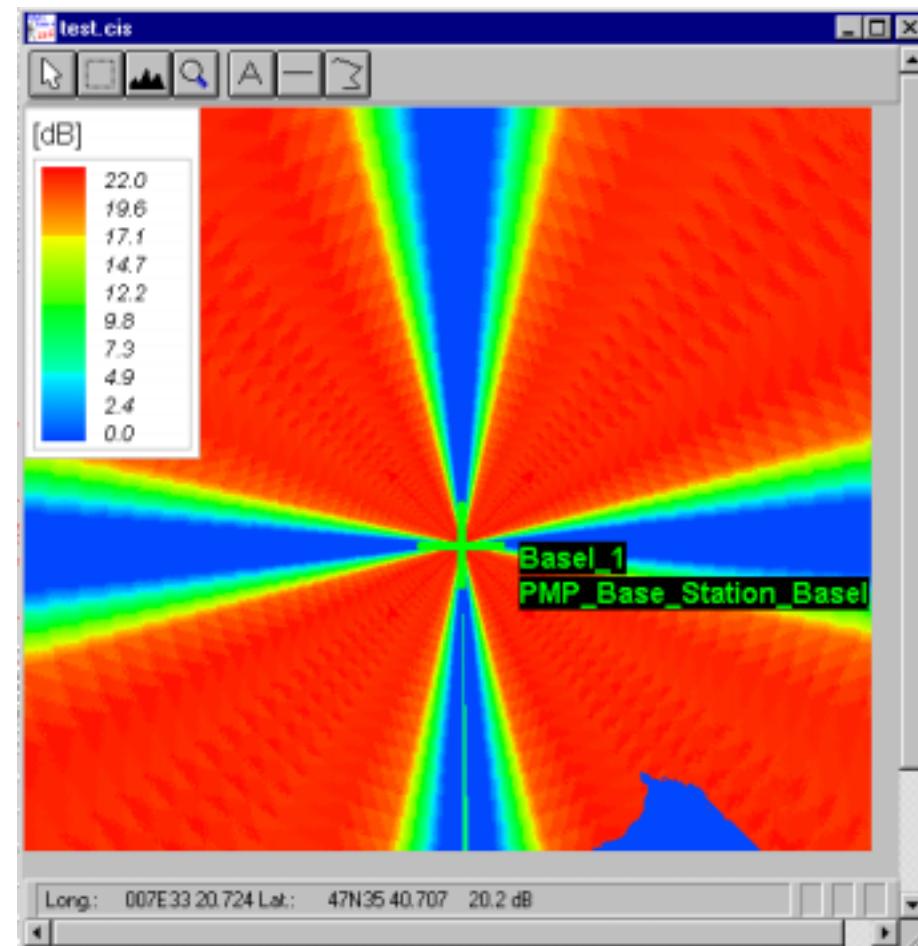
-65	-80	-95
-65	-80	-95
-65	-75	-95

$$P_{min} = -75 \text{ dBm}$$

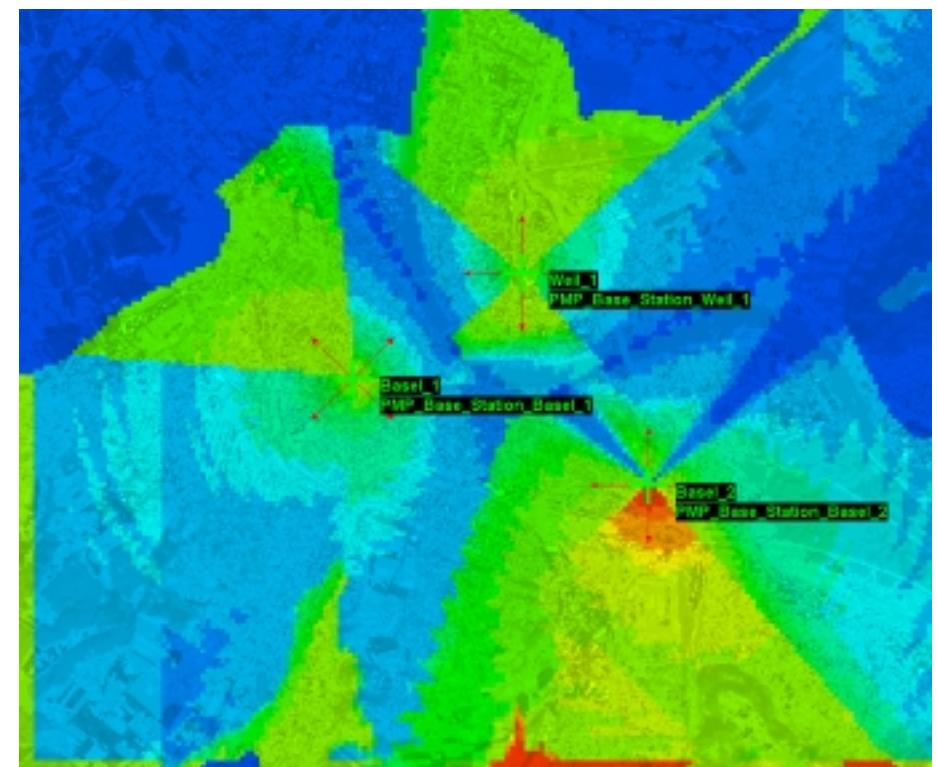
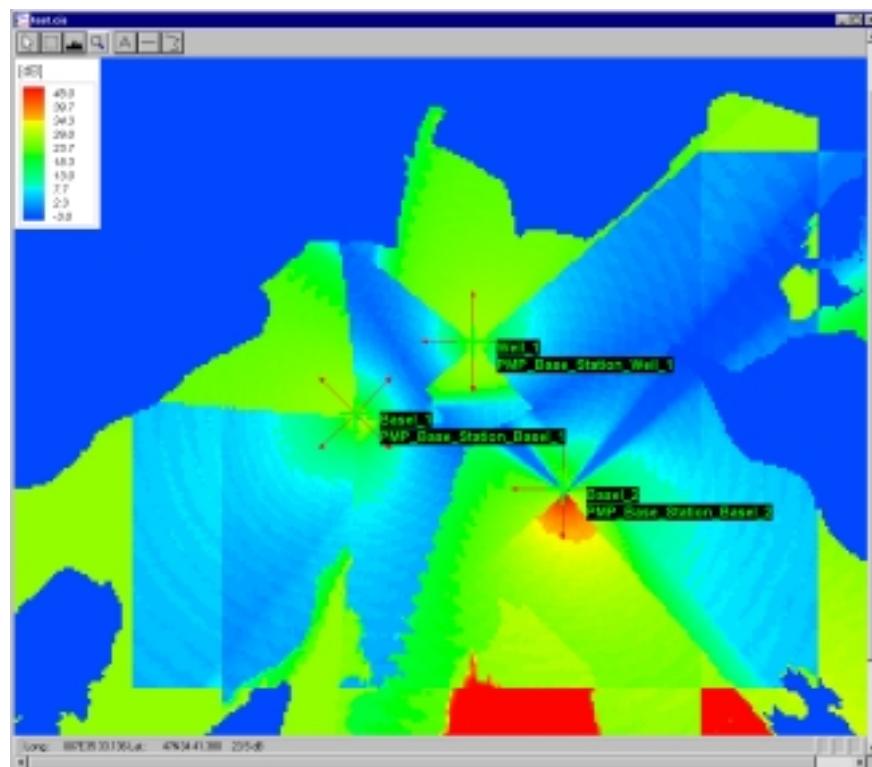
**C/I at Max. Server**

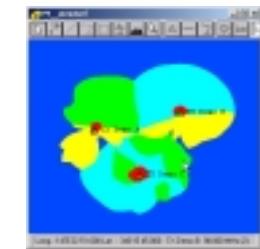
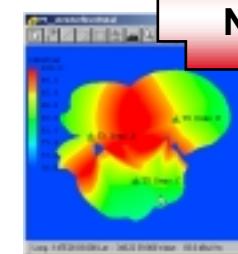
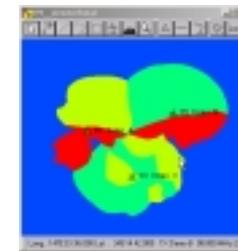
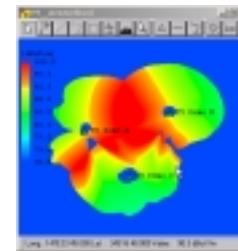
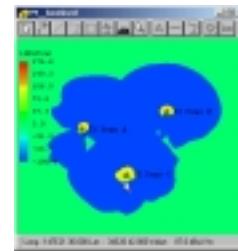
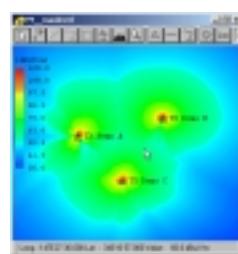
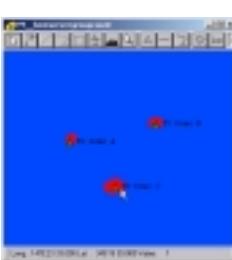
30	x	20
25	5	25
20	5	30

Network Processor



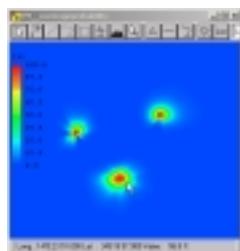
Network Processor



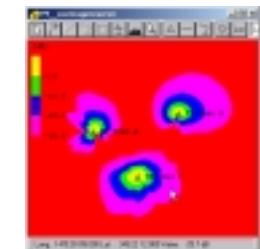
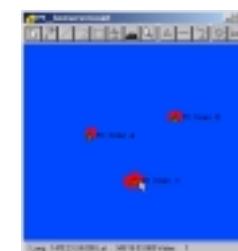
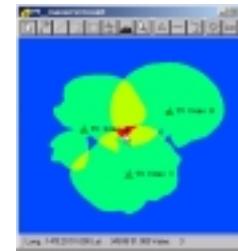
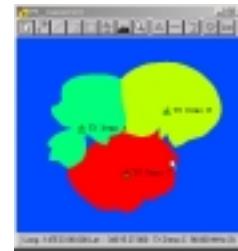
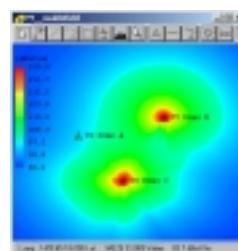
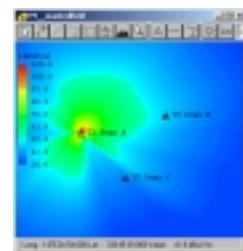


Network Processor

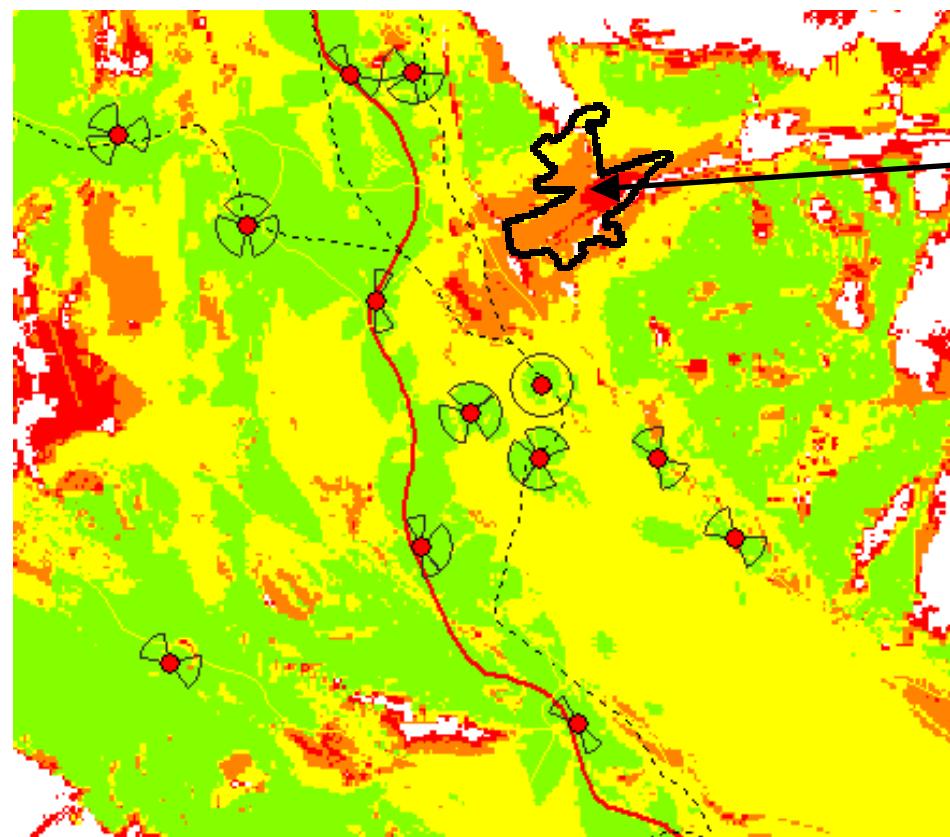
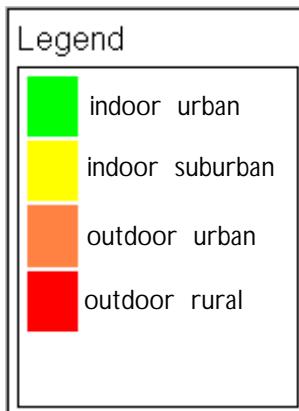
Many other service-specific results can be processed by a powerful Network Processor, like:



- Number of Max Server
- Number Best Server
- Strongest Interferer
- Level of Strongest Interferer
- Coverage Probability
- Coverage Reserve



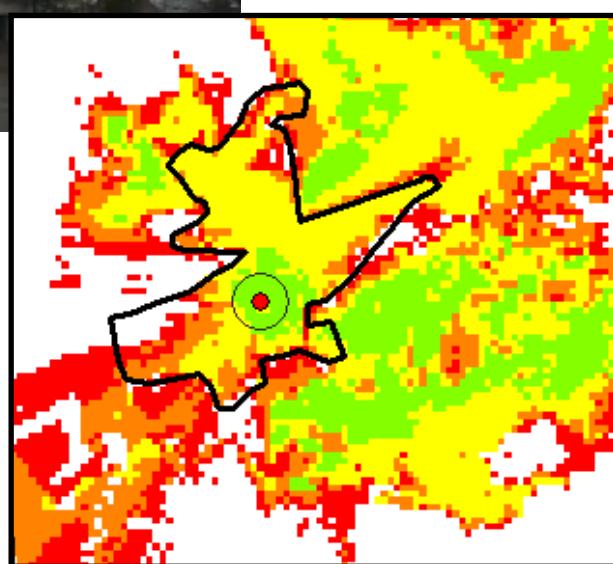
- Power Difference
- Assignment Probability
- Handover Zone
- Required Channels
- Coding Scheme Area (GPRS)
- SFN Level Gain
- ...

Current network coverage**Network Processor**

Now, we want to improve the coverage in this region.



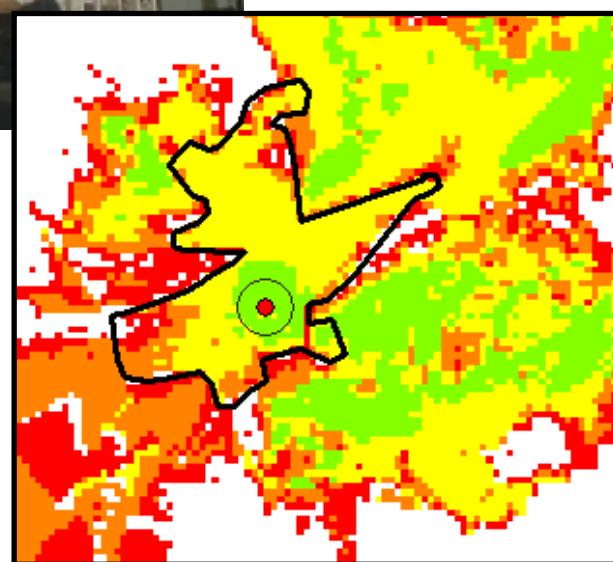
Candidate Steffisburg A



00°



Candidate Steffisburg B

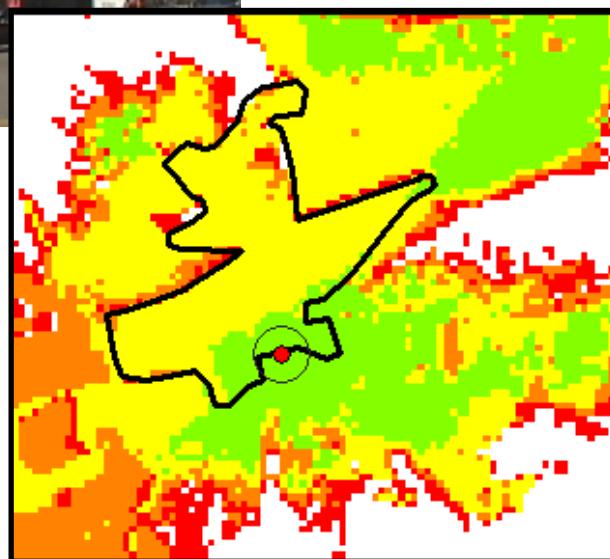


Network Processor

00°

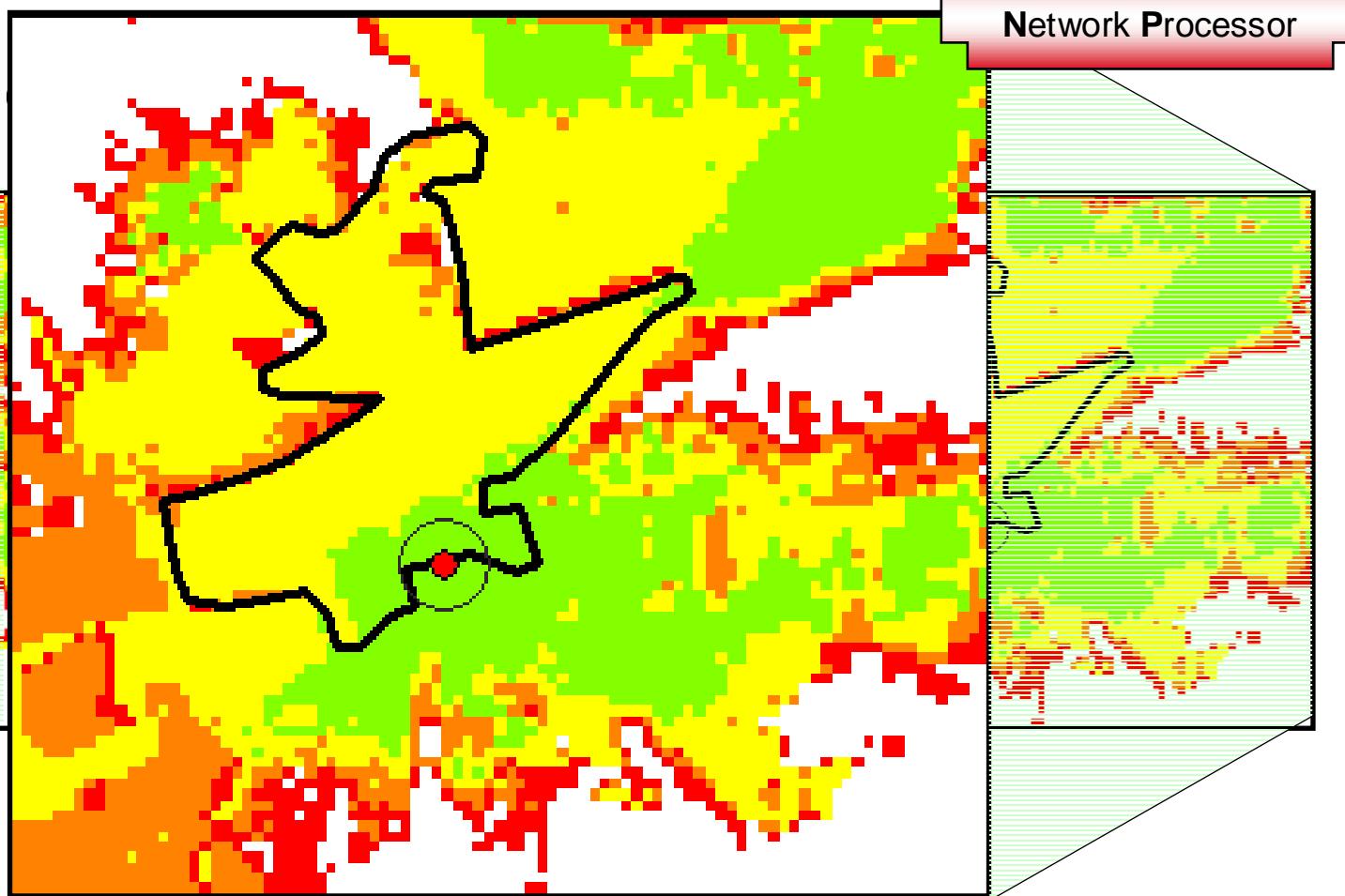
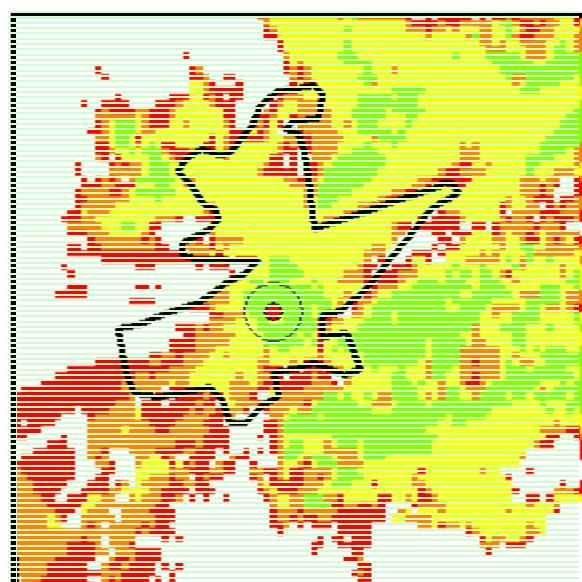


Candidate Steffisburg C



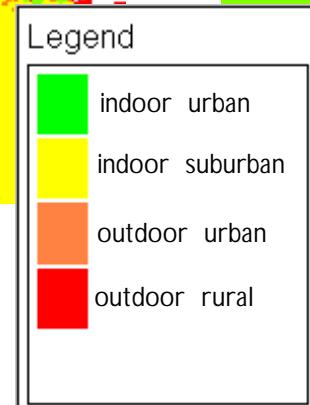
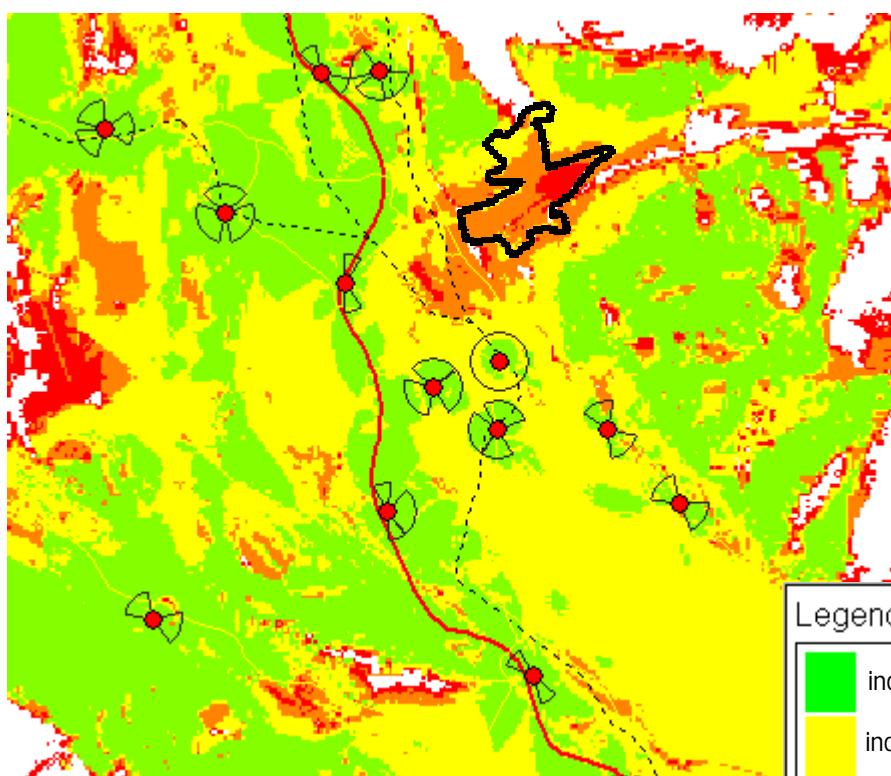
Network Processor

00°

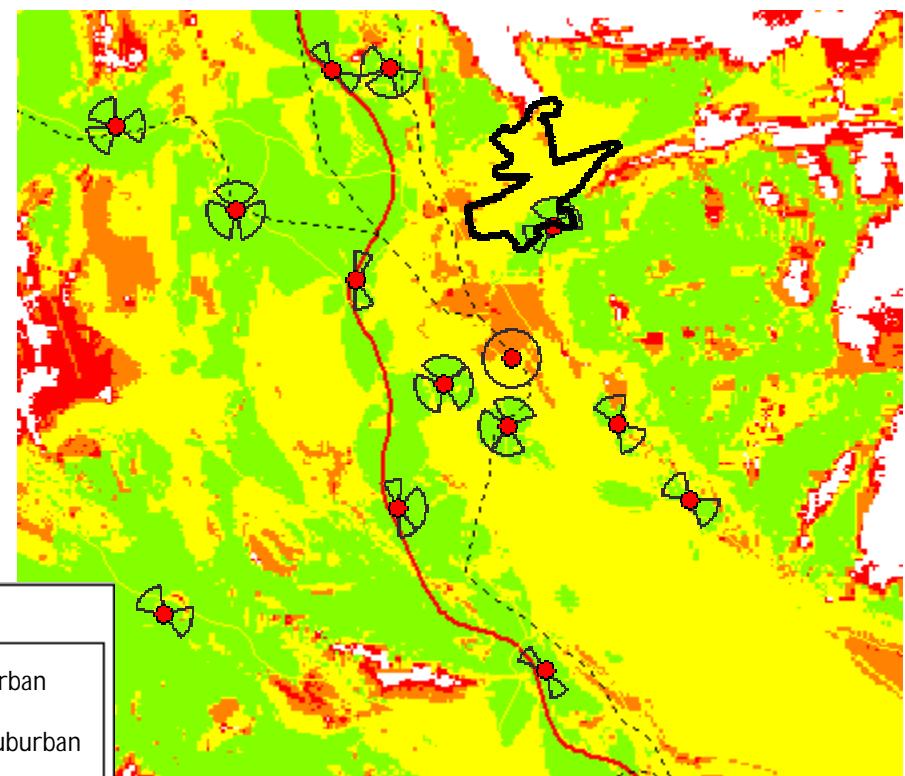


Selection of Candidate Steffisburg C

Previous coverage



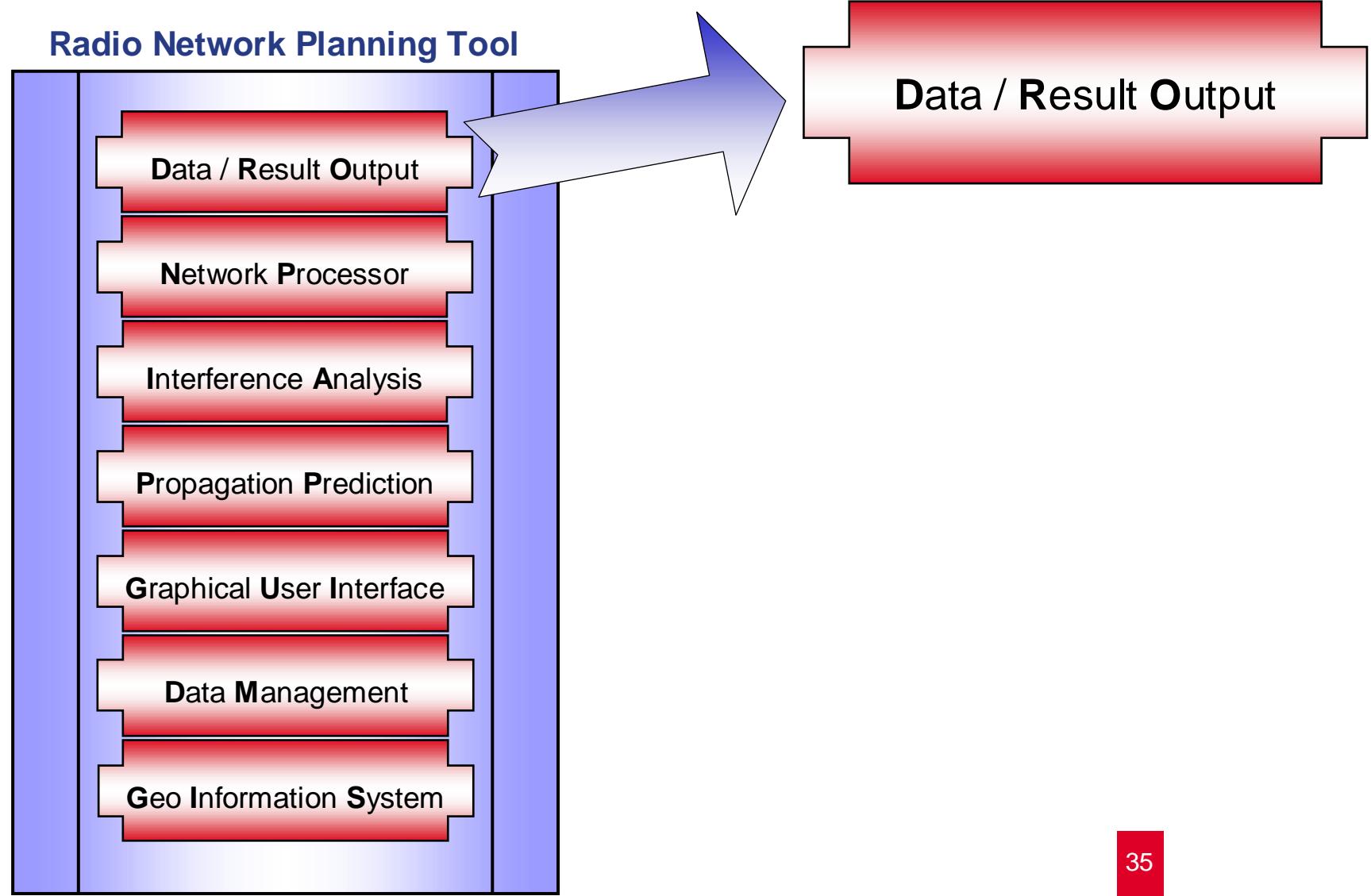
Improved coverage



Network Processor



Live Planning Tool Demonstration



Data / Result Output

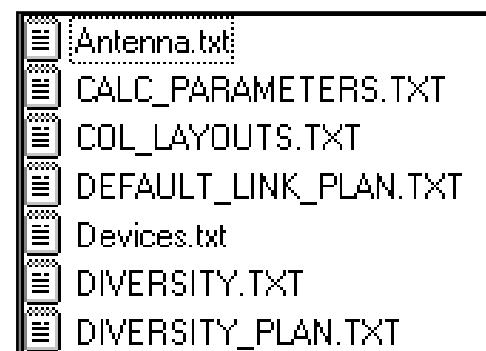
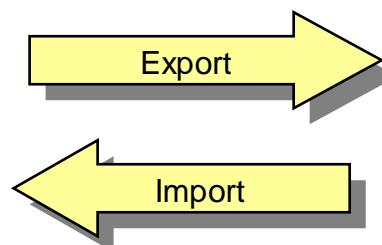
- Import and Export of

Databases and Tables (Sites, Antennas,...)

Result Files

Measurement Data

Should be possible in several formats (.txt, .xls, ASCII, .jpg, ...)

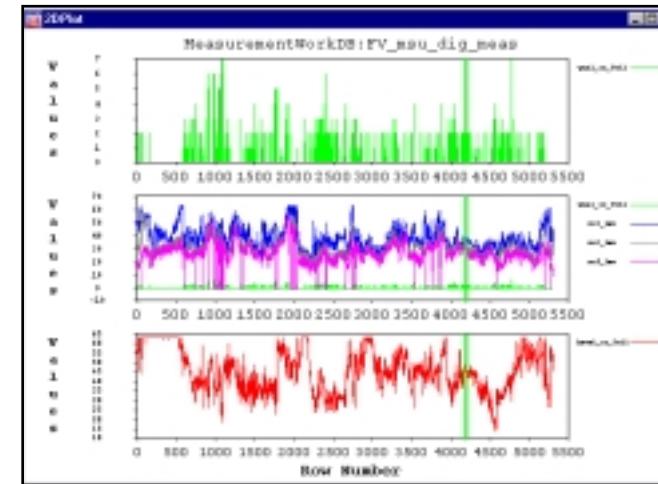
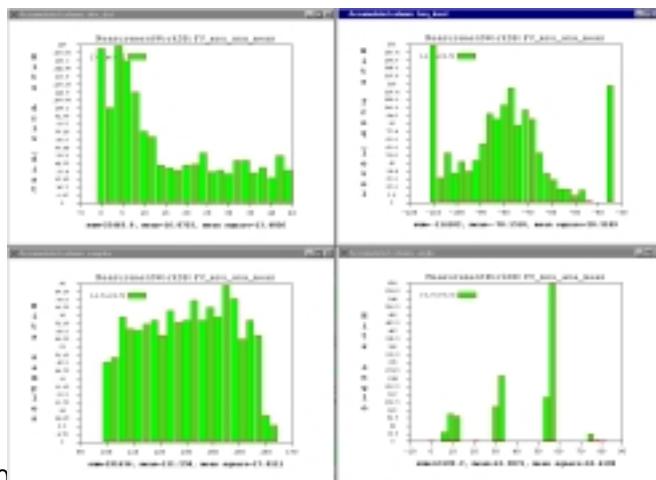


- Import measurement data
 - Analogue
 - Digital
 - BER
- Evaluation of measurement data
 - Rohde&Schwarz,
 - Alcatel, Ericsson TEMS, generic ASCII
- Plotting of measurement data
- Calibration
 - Path loss fit
 - Calibration of extended OH model

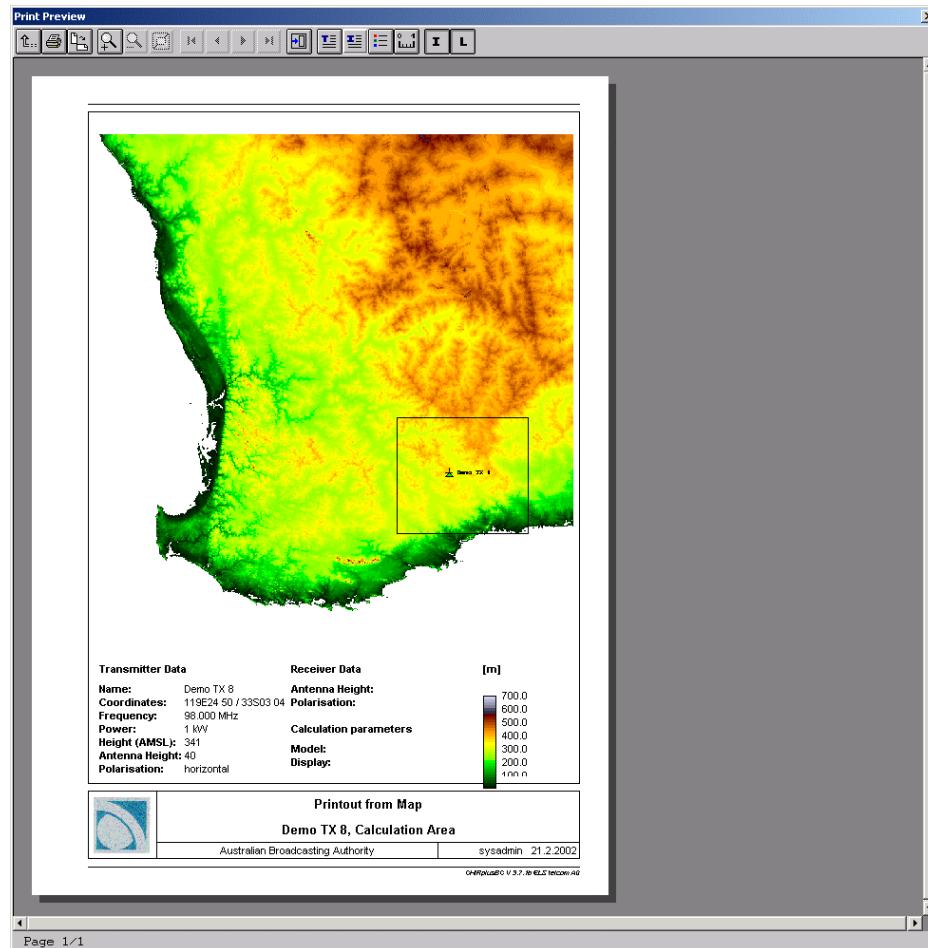
Data / Result Output

The screenshot shows a Windows application window titled "Measurement WorkDB:Digital Measurement". The window contains a table with columns: Mark, dig_meas, file, time, date, level_sc_full, and qual_sc_full. The table has 5301 rows and 0 selected. The data shows measurements taken at various times on different dates, with levels and qualities recorded.

Mark	dig_meas	file	time	date	level_sc_full	qual_sc_full
4186	4185	1	13:05:37.666	25.07.19941	0	0
4187	4186	1	13:05:38.000	25.07.19940	0	0
4188	4187	1	13:05:38.500	25.07.19942	0	0
4189	4188	1	13:05:39.000	25.07.19942	0	0
4190	4189	1	13:05:39.500	25.07.19941	0	0
4191	4190	1	13:05:40.000	25.07.19942	0	0
4192	4191	1	13:05:40.500	25.07.19942	0	0
4193	4192	1	13:05:41.000	25.07.19941	0	0
4194	4193	1	13:05:41.500	25.07.19942	0	0
4195	4194	1	13:05:42.000	25.07.19940	0	0
4196	4195	1	13:05:42.500	25.07.19935	0	0
4197	4196	1	13:05:43.000	25.07.19940	0	0
4198	4197	1	13:05:43.500	25.07.19930	0	0

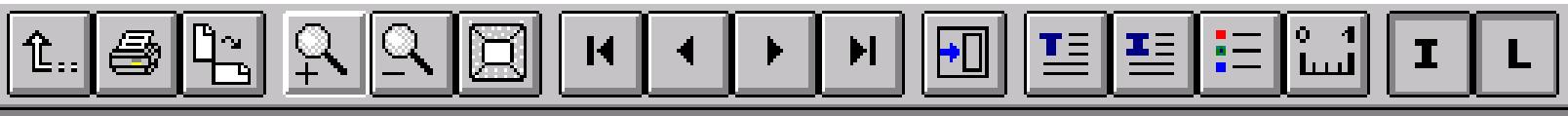


Data / Result Output



Print Process Preview

- ☞ Application specific frame
- ☞ Legend
- ☞ Print in specific map scale
- ☞ Specify margins and borders
- ☞ Multiple printing
- ☞ Support various paper sizes
- ☞ Add site specific information



Data / Result Output

The screenshot shows the 'FM Info Database (All Entries)' window with the database file 'FMInfo.mdb' selected. The main table displays various entries with columns for TX-Name, Freq., ERP, Heffm, Ch., OS, Ctry, Provin., Pol., Longit., and Latit. A 'Print Preview' dialog box is open, showing a detailed list of the same data. Red arrows indicate the flow from the main database table to the print preview.

	TX-Name	Freq.	ERP	Heffm.	Ch.	OS	Ctry	Provin.	Pol.	Longit.	Latit.
1	GOROKA	100.2000	0.1905	40	P	PNG		H		145E23.00	06S04.00
2	PT MORESBY	100.3000	1.9055	40	P	PNG		H		147E12.00	08S27.00
3	KIETA	100.4000	0.1905	40	P	PNG		H			
4	MT HAGEN	100.4000	0.1905	40	P	PNG		H			
5	LAE	100.5000	0.1905	40	P	PNG		H			
6	RABAUL	100.5000	1.9055	40	P	PNG		H			
7	MADANG	100.8000	0.1905	40	P	PNG		H			
8	WEWAK	100.8000	0.1905	40	P	PNG		H			
9	KUNDIWA	101.0000	0.0794	40	P	PNG		H			
10	Jundah	107.3000	0.0250	15		AUS	QLD	V			
11	Jundah	105.7000	0.0250	15		AUS	QLD	V			
12	Jundah	104.1000	0.0250	15		AUS	QLD	V			

Print Preview Data:

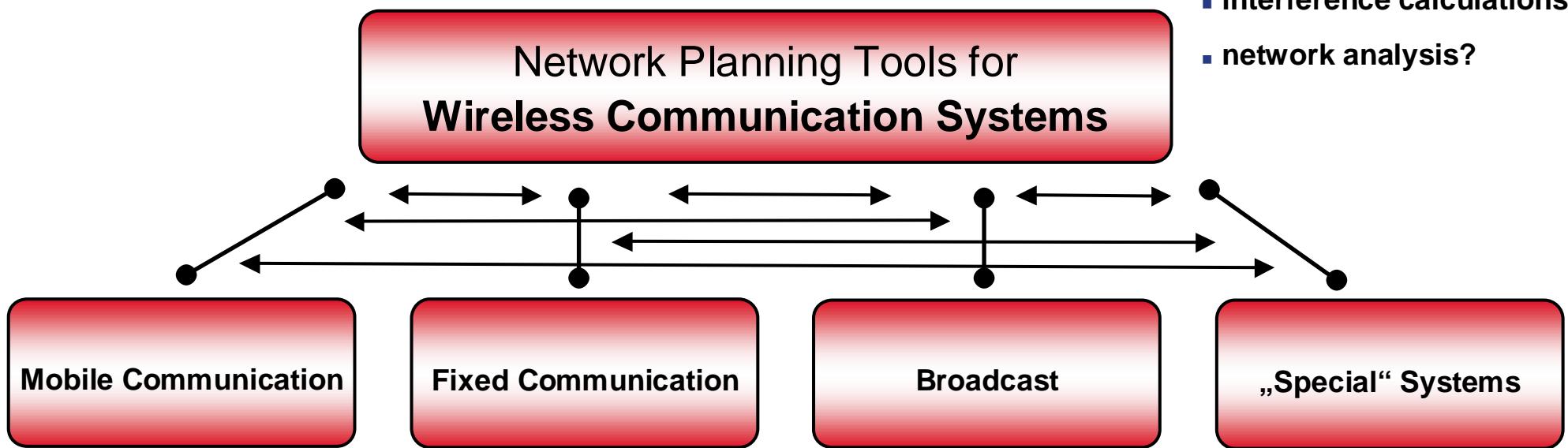
TX-Name	Freq.	Longit.	Latit.
GOROKA	100.2000	145E23.00	06S04.00
PT MORESBY	100.3000	147E12.00	08S27.00
KIETA	100.4000	155E13.00	06S12.00
MT HAGEN	100.4000	144E13.00	06S05.00
LAE	100.5000	152E13.00	04S22.00
RABAUL	100.5000	145E47.00	06S14.00
MADANG	100.8000	143E38.00	06S14.00
WEWAK	100.8000	143E38.00	06S14.00
KUNDIWA	101.0000	145E47.00	06S14.00
Jundah	107.3000	141E03.37	24S49.55
Jundah	105.7000	143E03.37	24S49.55
Jundah	104.1000	143E03.37	24S49.55
Jundah	103.5000	143E03.37	24S49.55
Jundah	99.5000	143E03.37	24S49.55
Jundah	97.7000	143E03.37	24S49.55
Jundah	95.1000	143E03.37	24S49.55
Meaura	100.5000	145E38.00	27S29.24
Meaura	98.7000	145E38.00	27S29.24
Meaura	97.5000	145E38.00	27S29.24
Meaura	97.1000	145E38.00	27S29.24
Meaura	95.5000	145E38.00	27S29.24
Meaura	93.5000	145E38.00	27S29.24
Meaura	91.5000	145E38.00	27S29.24
Meaura	90.5000	145E38.00	27S29.24
Meaura	105.5000	148E03.40	26S32.33
Meaura	103.5000	148E03.40	26S32.33
Meaura	101.5000	148E03.40	26S32.33
Meaura	100.5000	147E03.40	26S32.21
Meaura	99.5000	147E03.40	26S32.21
Meaura	98.5000	147E03.40	26S32.21
Meaura	97.5000	147E03.40	26S32.21
Meaura	95.5000	146E03.40	25S00.38
Meaura	97.1000	147E03.40	26S32.21
Meaura	96.5000	147E03.40	26S32.21
Meaura	95.5000	146E03.40	25S00.38
Meaura	93.5000	146E03.40	25S00.54
Meaura	105.5000	151E32.18	32S53.23
Meaura	97.5000	144E32.08	22S28.54
Meaura	95.5000	144E32.08	22S28.54
Meaura	94.5000	144E32.08	22S28.54
Meaura	92.5000	144E32.08	22S28.54
Orkope	104.5000	144E15.51	26S32.13
Orkope	102.5000	144E15.51	26S32.13
Orkope	97.5000	144E15.51	26S32.13
Orkope	96.5000	144E15.51	26S32.13
Orkope	105.7000	149E03.07	27S03.36
Orkope	105.5000	149E03.07	27S03.36
Orkope	105.5000	149E03.07	27S03.36
Orkope	105.5000	149E03.07	27S03.36
Tambu	101.5000	149E03.07	27S03.36
Tambu	101.5000	149E03.07	27S03.36
Tambu	99.5000	149E03.07	24S03.59
Tambu	97.5000	149E03.07	24S03.59
Tiallo	101.5000	149E51.58	28S38.10
Tiallo	99.5000	149E51.58	28S38.10
Tiallo	98.5000	149E51.58	28S38.10
Tiallo	97.5000	149E51.58	28S38.10
Tiallo	96.5000	149E51.58	28S38.10

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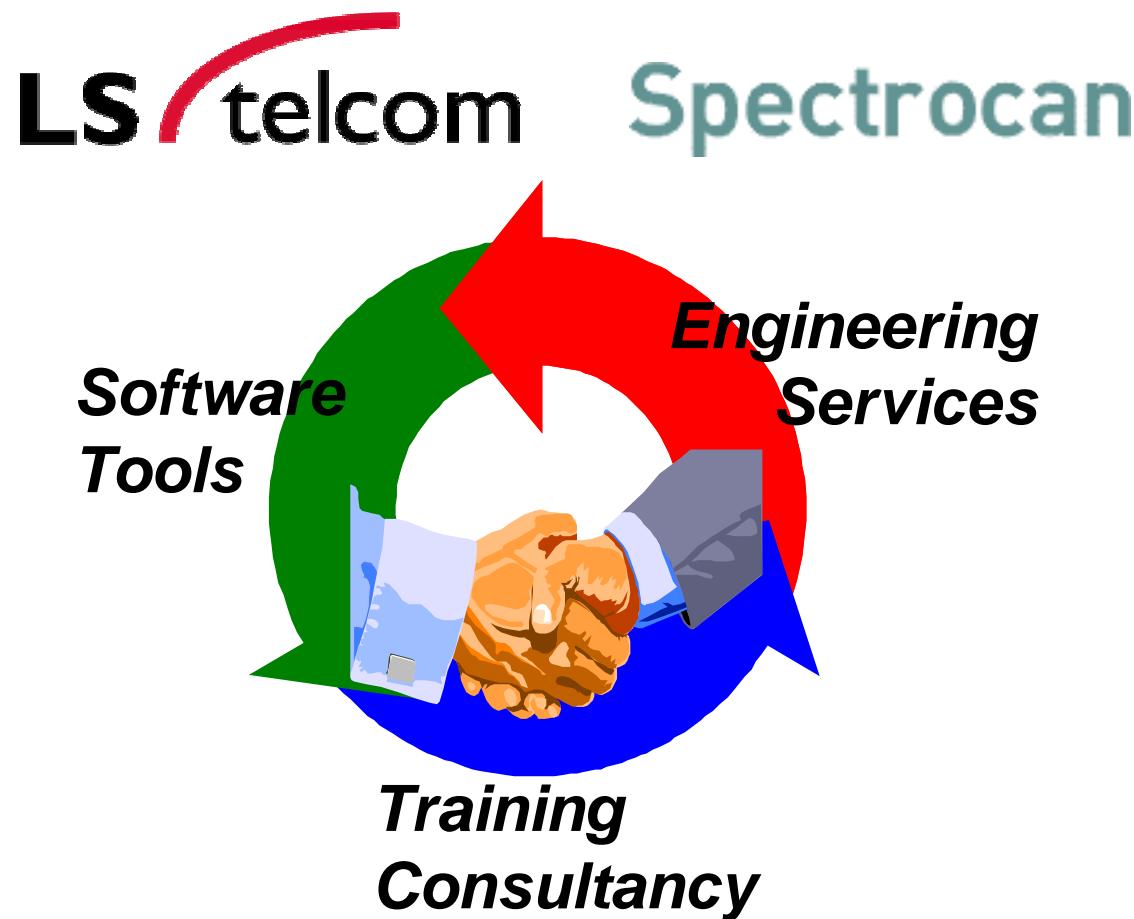
Live Planning Tool Demonstration

One fits All?



for:

- basic coverage maps?
- interference calculations?
- network analysis?



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Radio/TV Broadcast, DVB, DAB, Trunked Radio, TETRA, Paging, Satellite Services*

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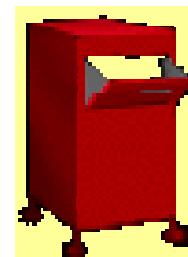
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