

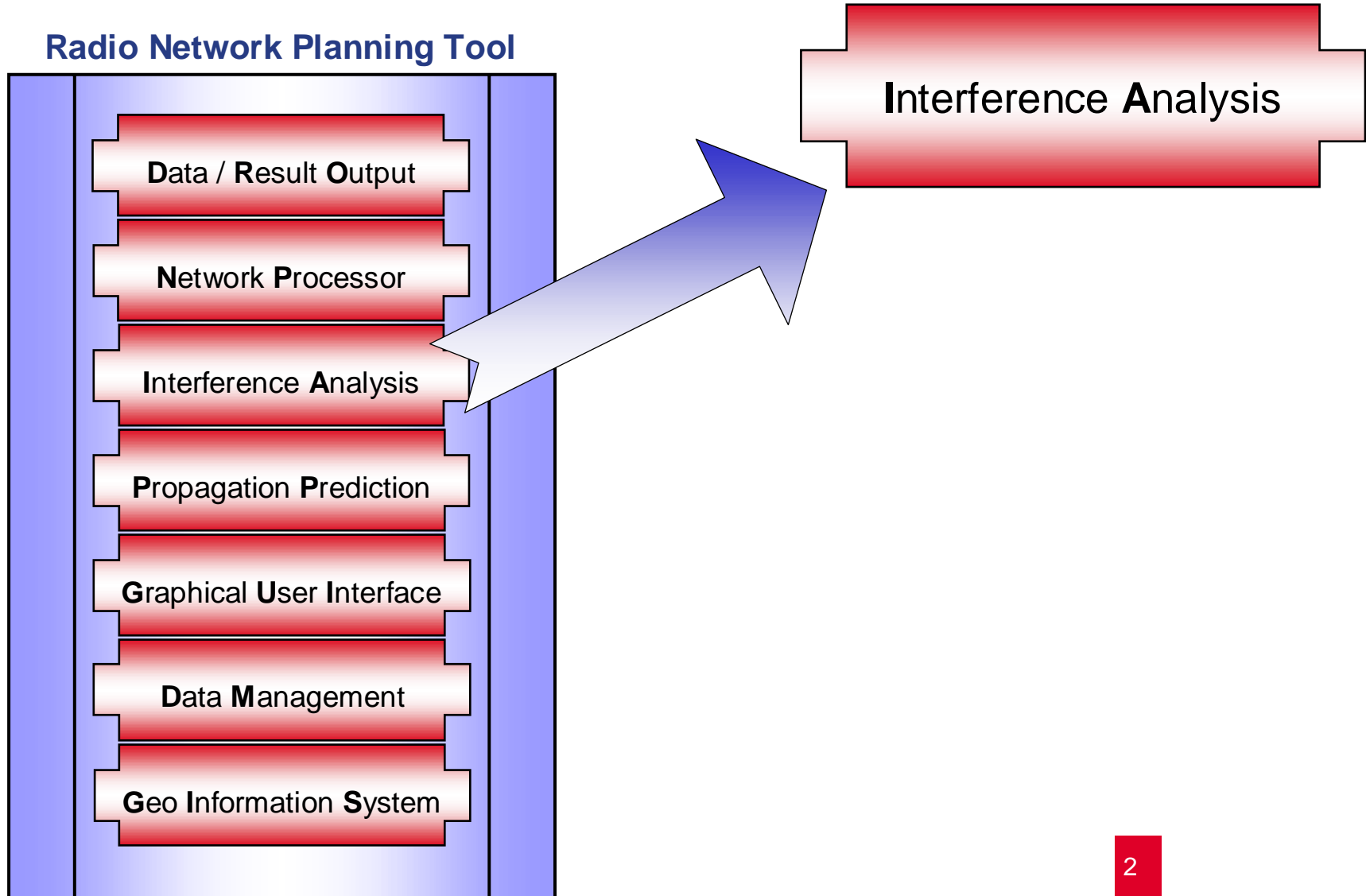
***Session 5.8***

***Supporting Network Planning Tools I***

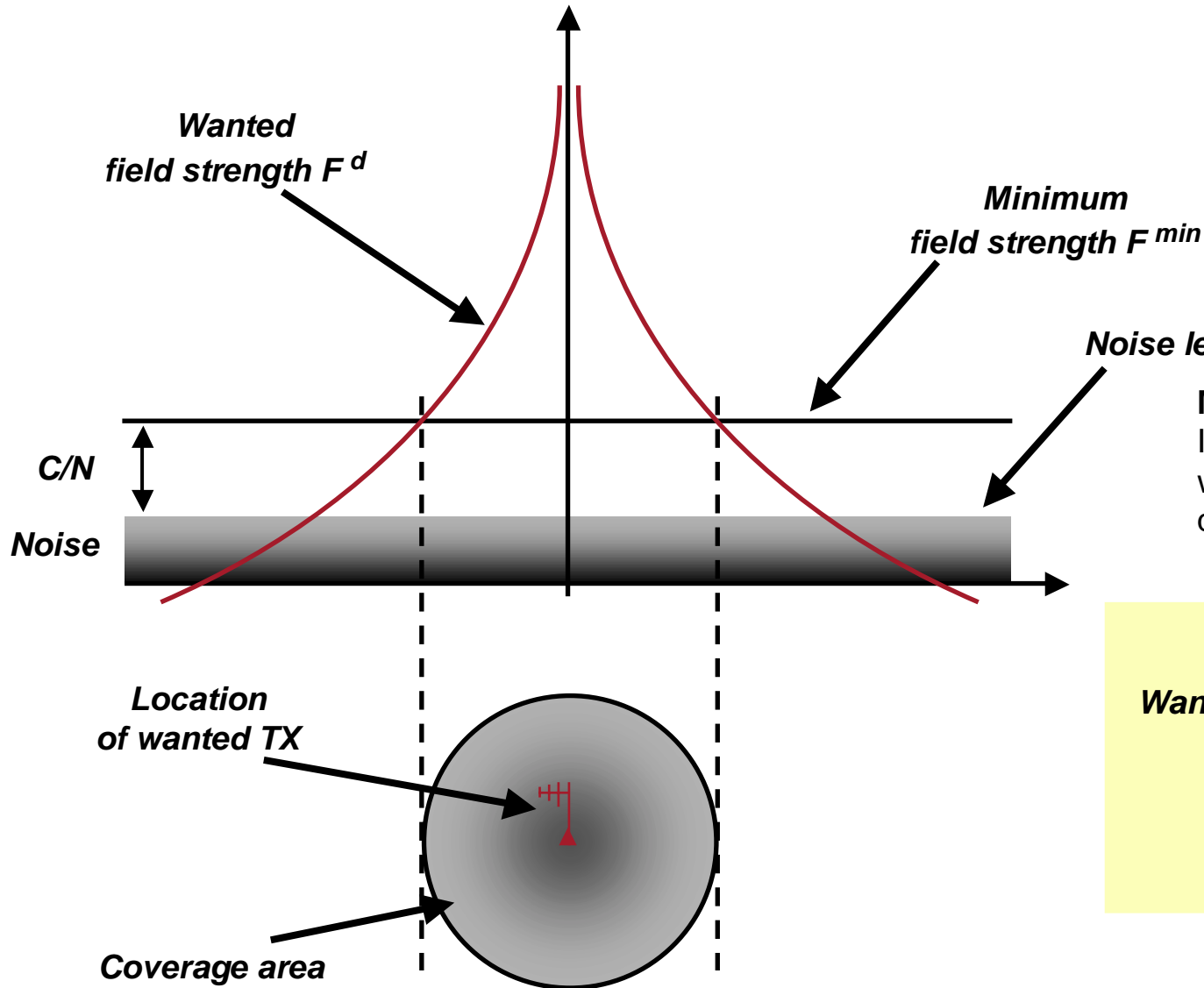
*by*

*Roland Götz*

*Spectrocan / LS telcom AG*



Interference Analysis



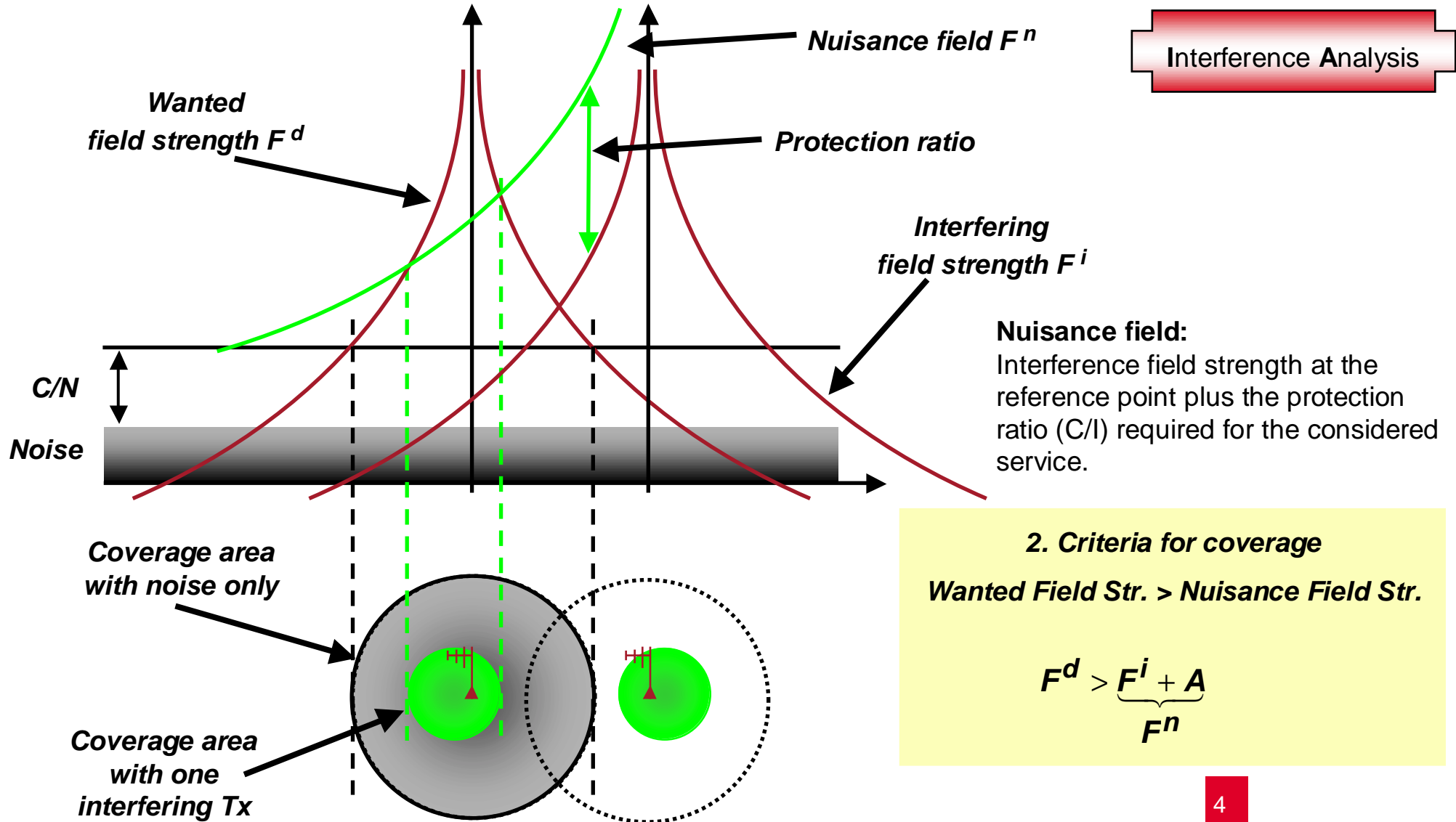
**Minimum field strength (C/N):**  
It is a minimum field strength level which is necessary to fulfil the signal quality for coverage.

1. Criteria for coverage

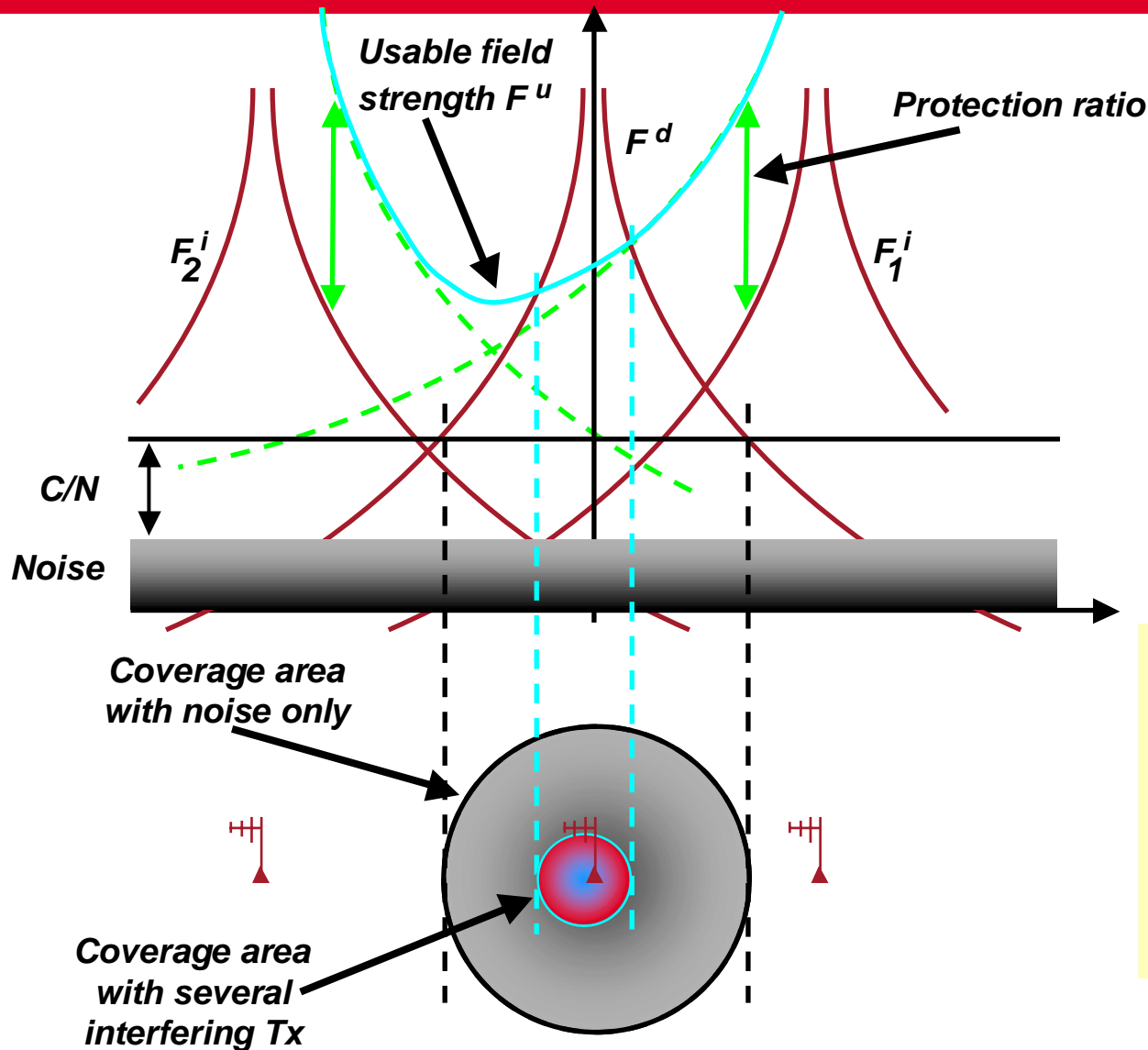
Wanted Field Str. > Minimum Field Str.

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

Interference Analysis



Interference Analysis



**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.*

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

**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



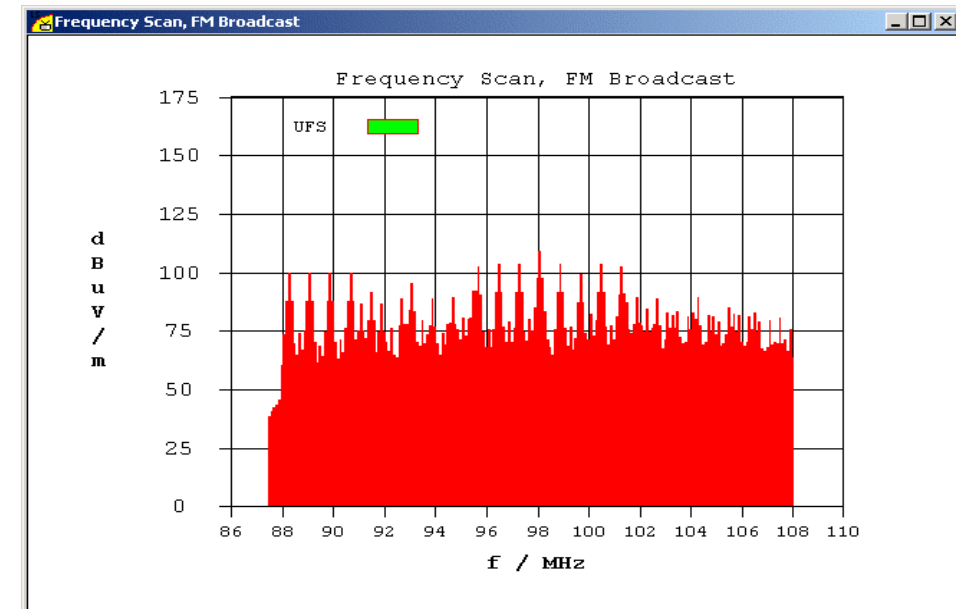
**Most use is made of the power-sum method and the simplified multiplication method**

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

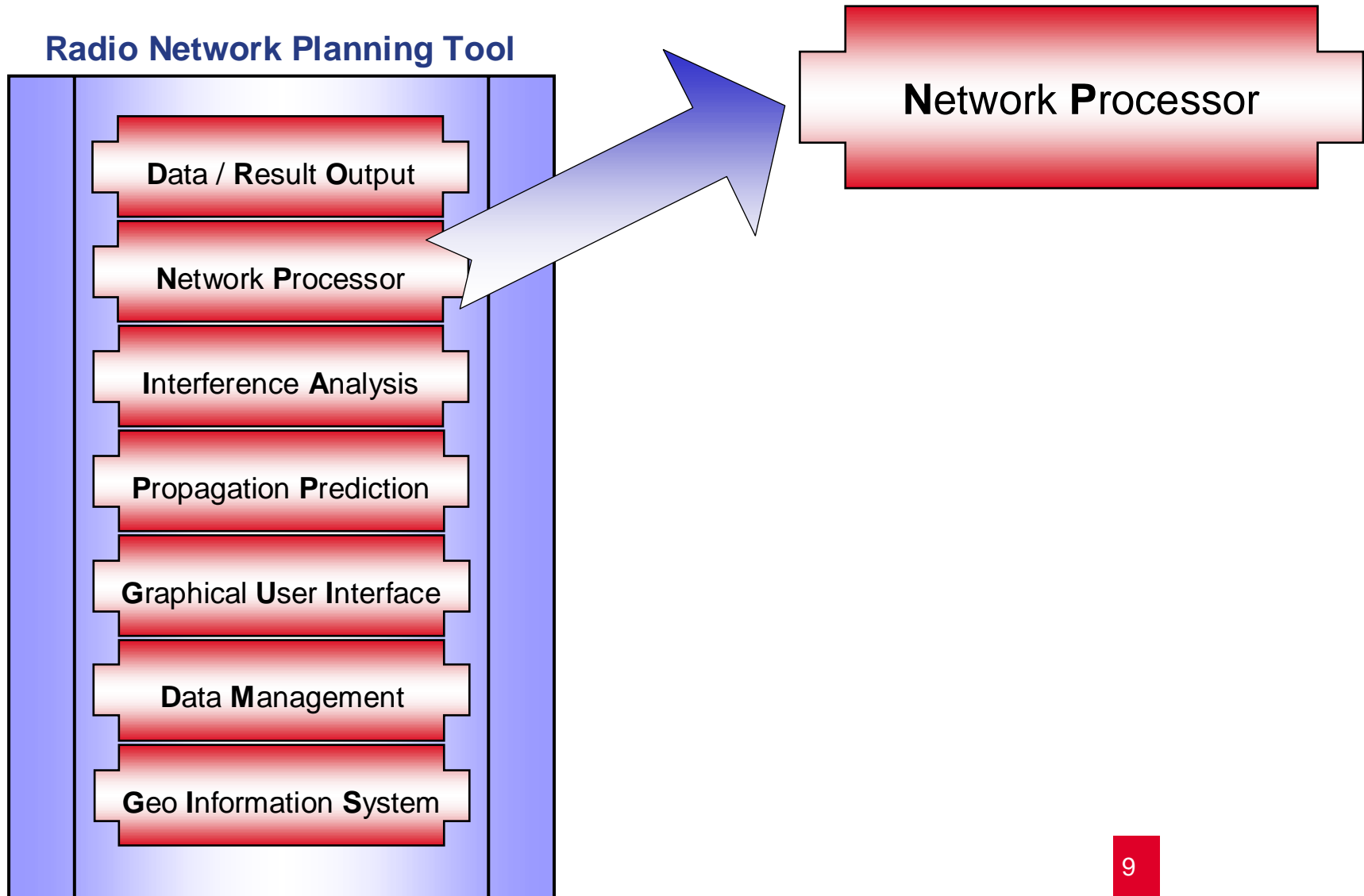
## Frequency Scan

- ➔ ***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	Walwa/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





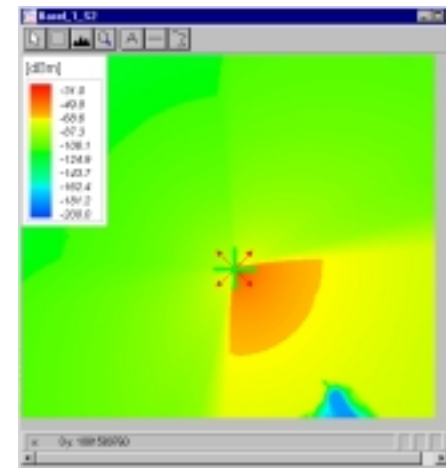
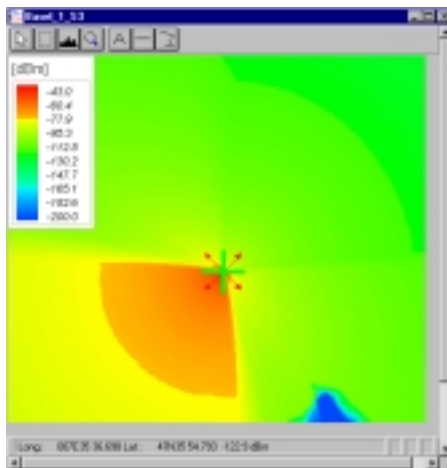
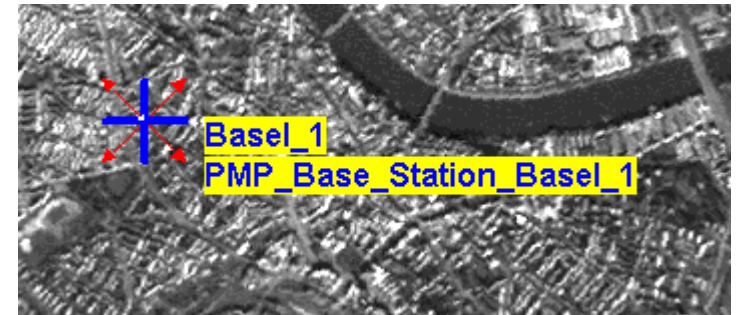
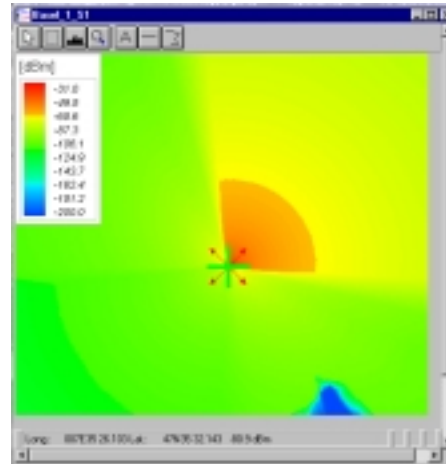
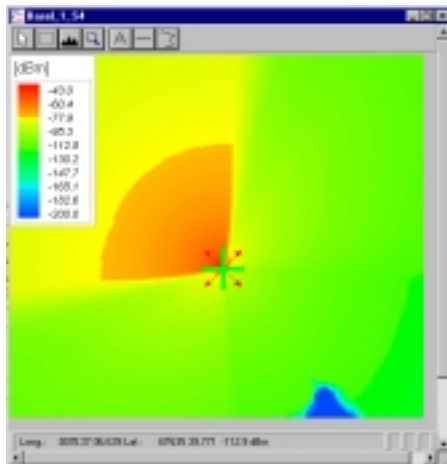


## The Network Processor

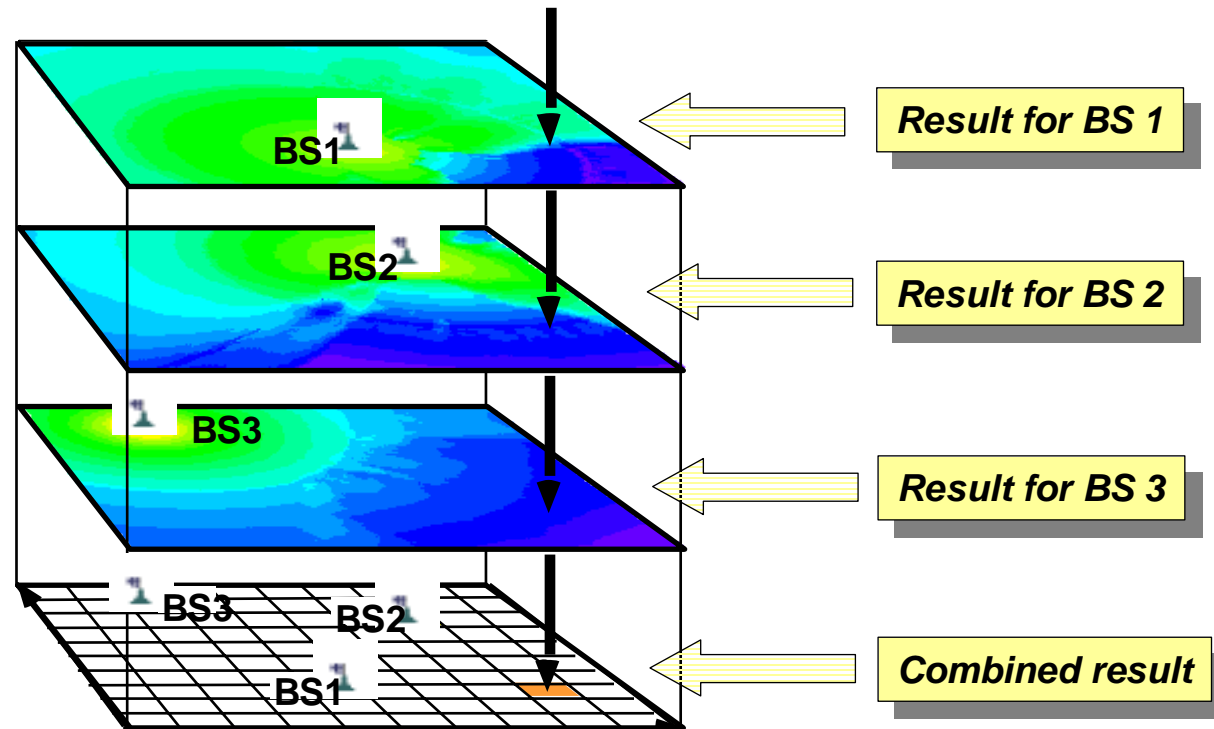
- produces network-wide results out of the single-cell-based results
- allows to analyse the radio network
- allows to simulate changes of the network parameter
- allows to simulate changes of the network design
- allows to optimise the radio network
- allows to plan the future roll-out phases
- produces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

**Each Service needs an own service-specific Network Processor**

Network Processor



Principle of calculation: Combination of different results



**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**

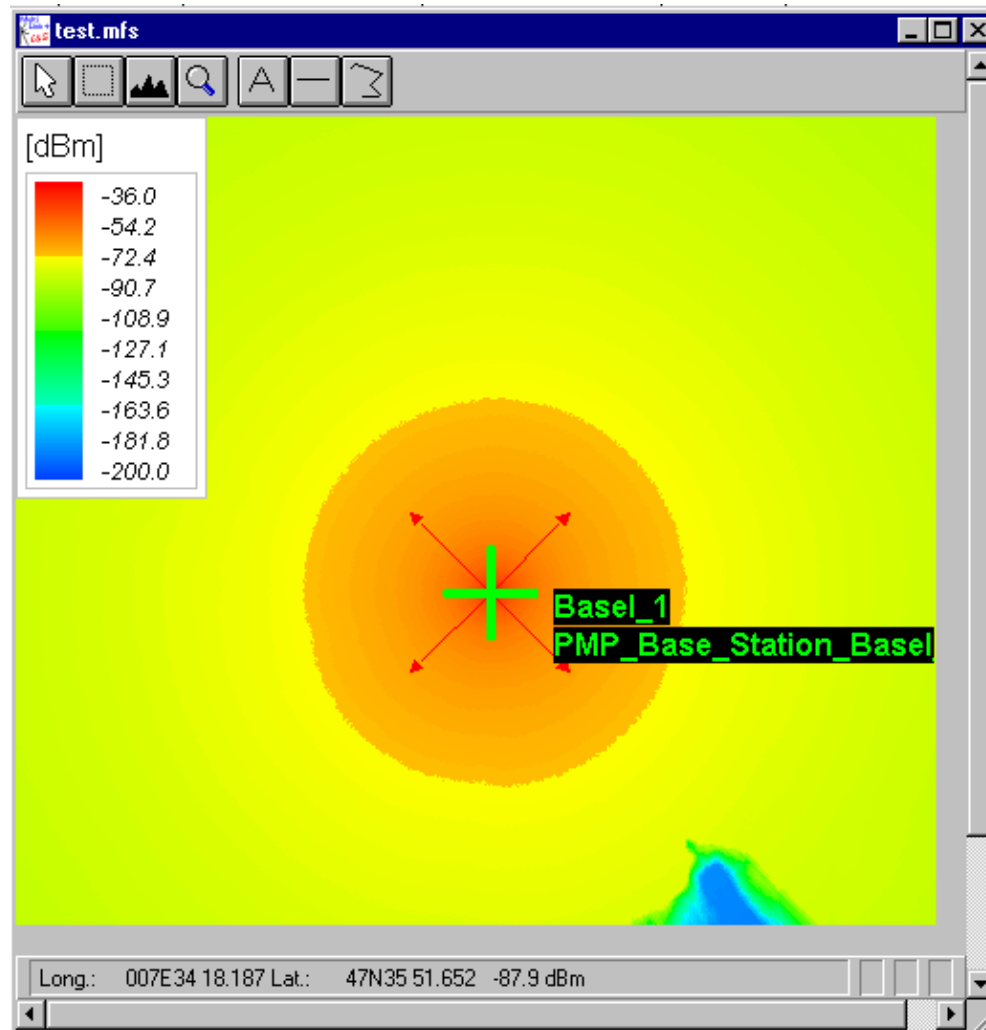
-95	-80	-75
-90	-75	-70
-85	-70	-65

**Sector 3**

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

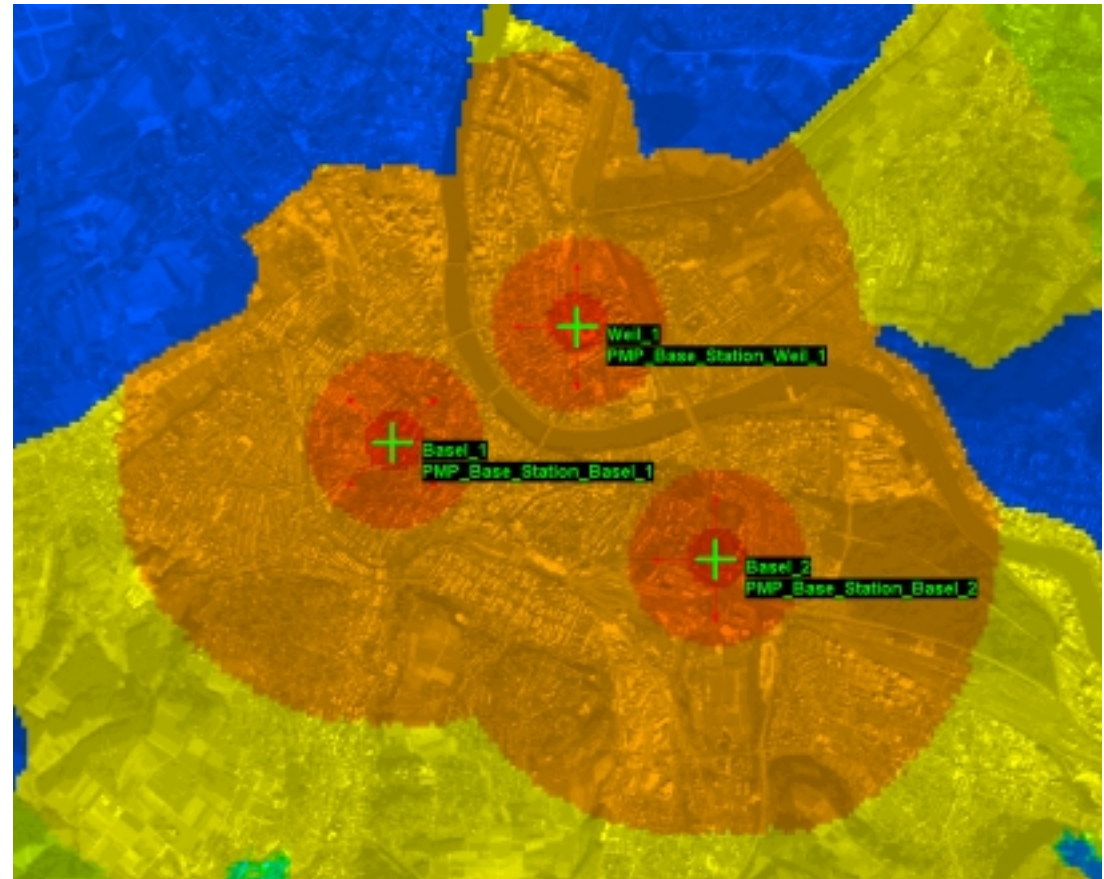
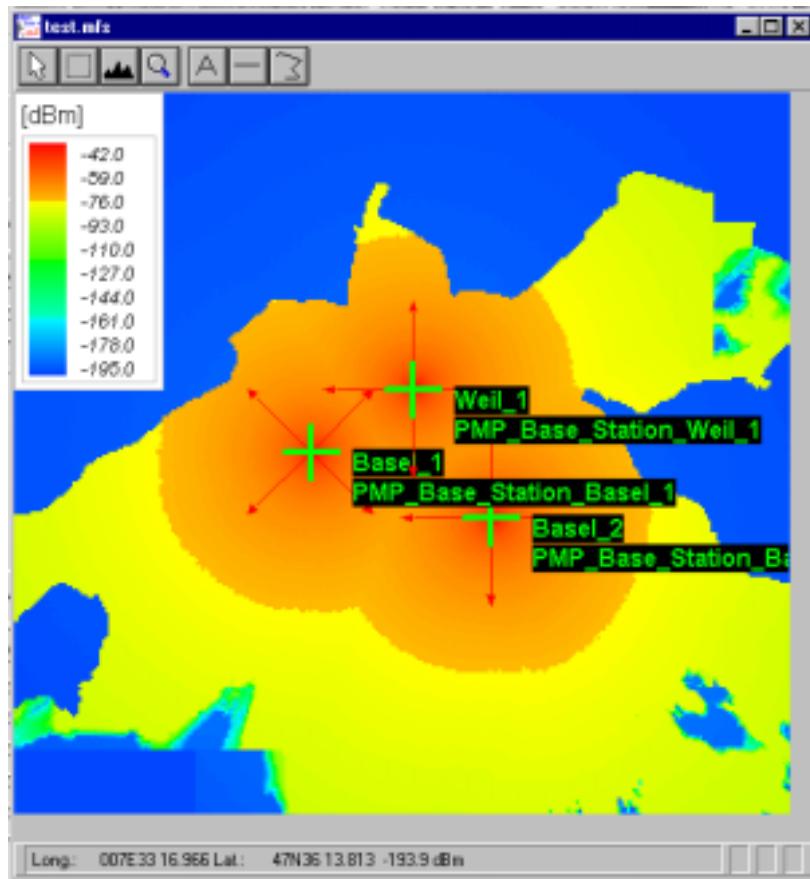
**Max. Field.**

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



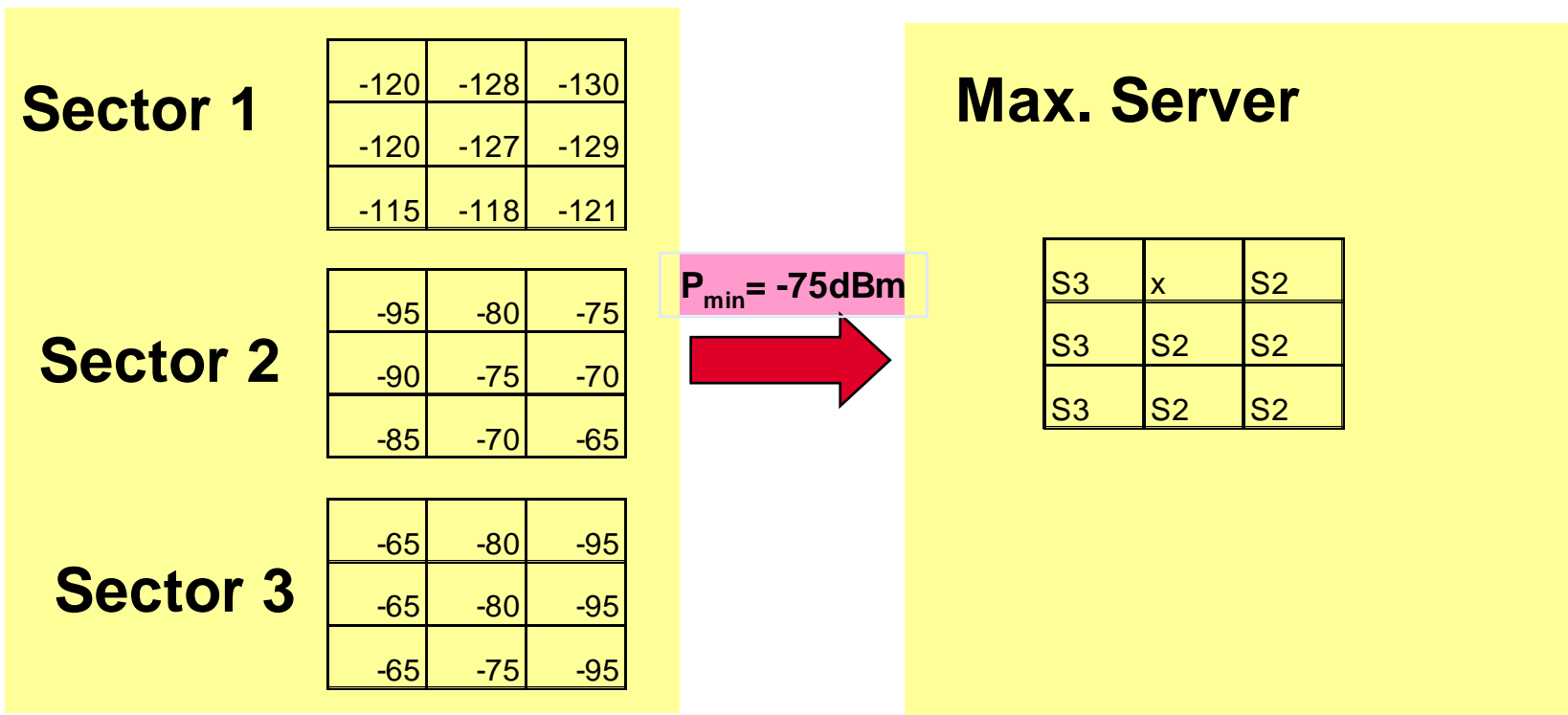
Network Processor

Network Processor



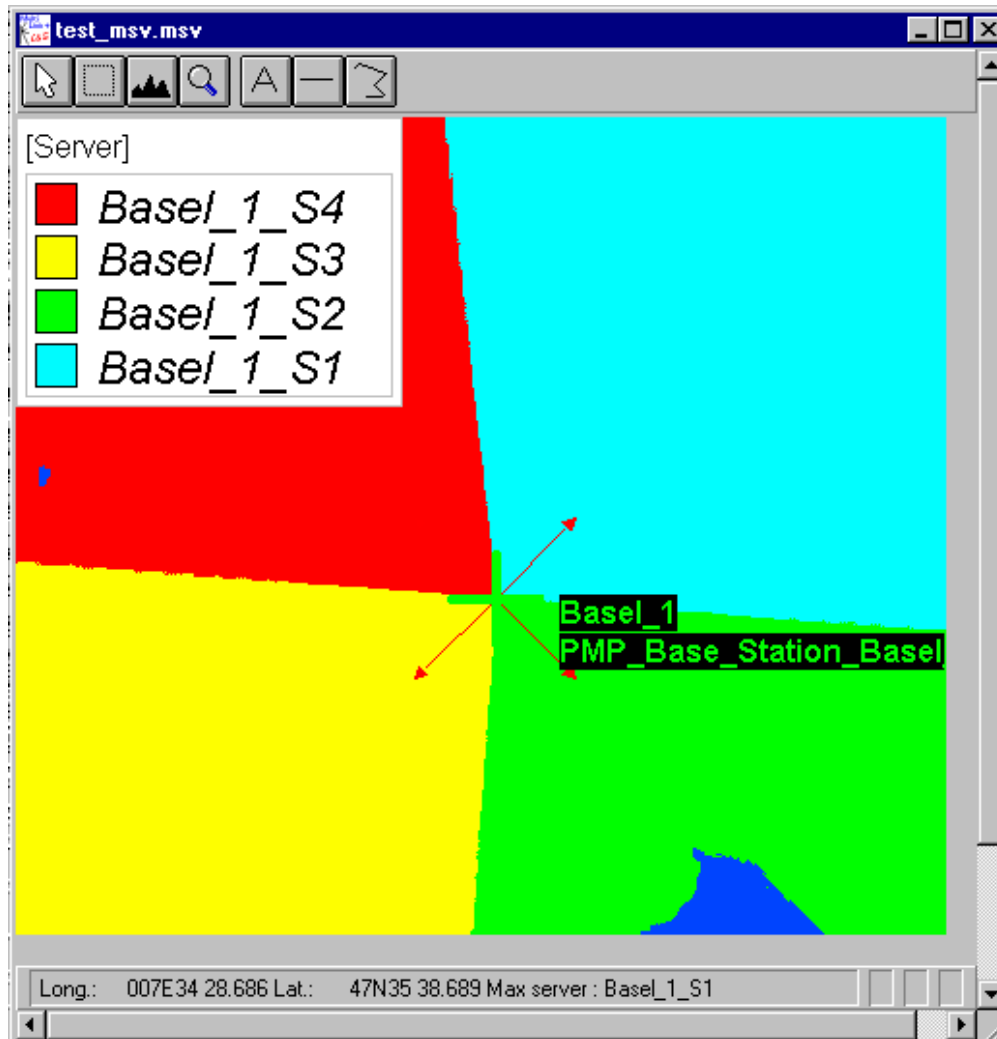
**Maximum Server:**

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,  $E_{\min \text{equiv}}$ .

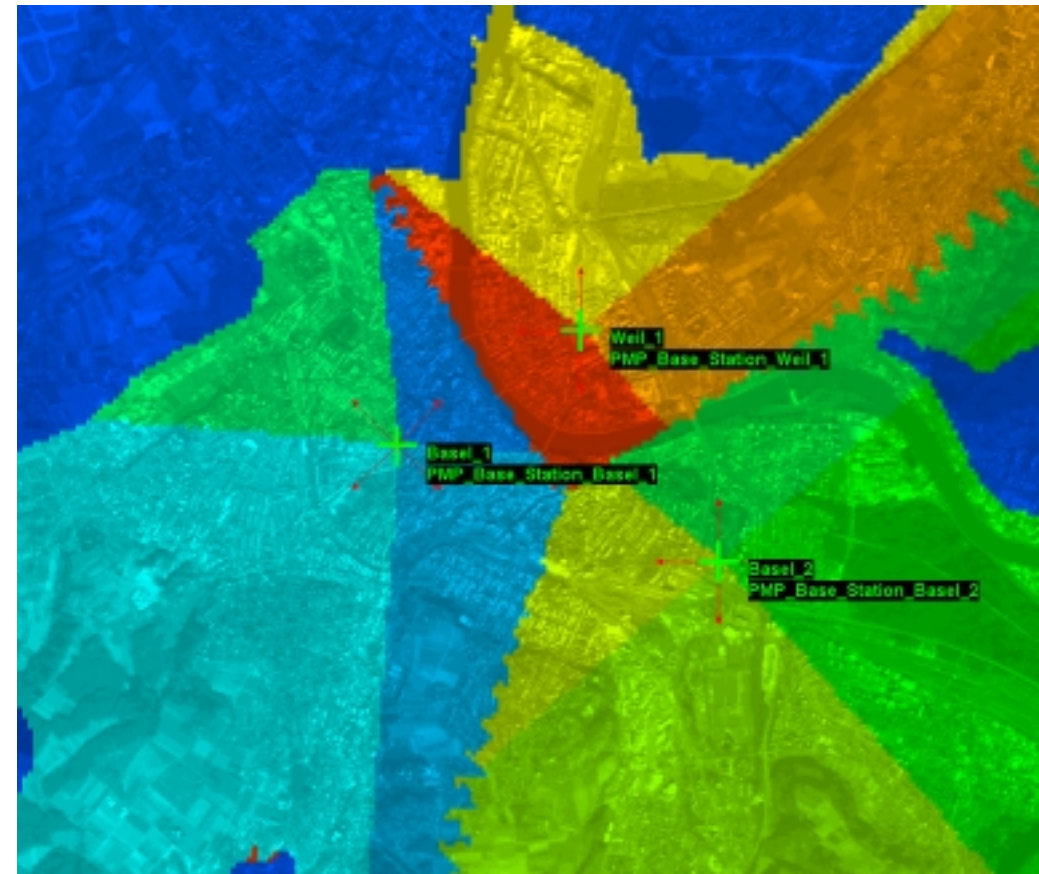
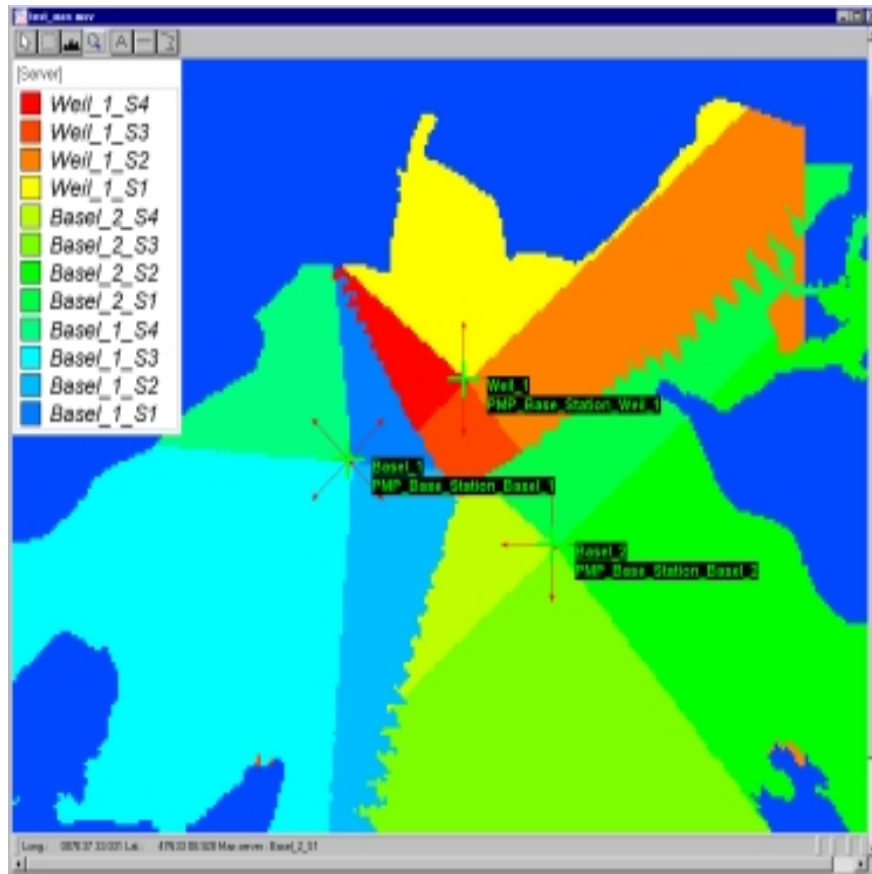




Network Processor

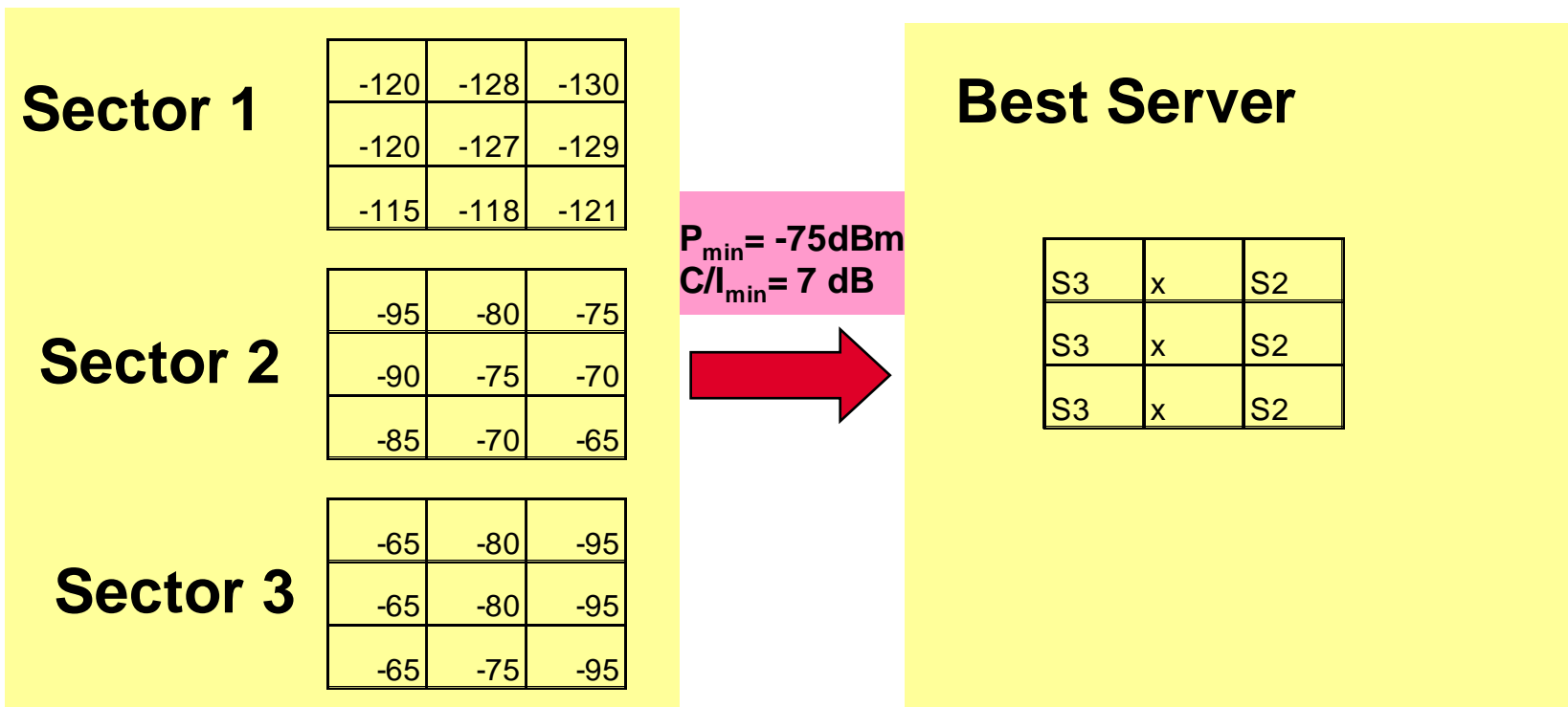


Network Processor



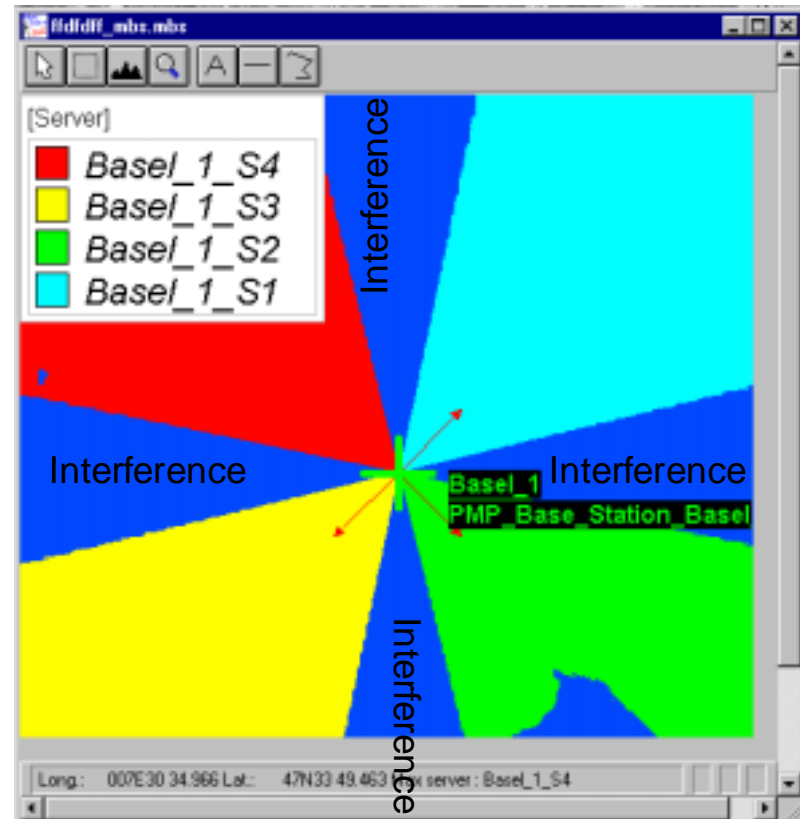
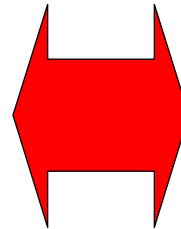
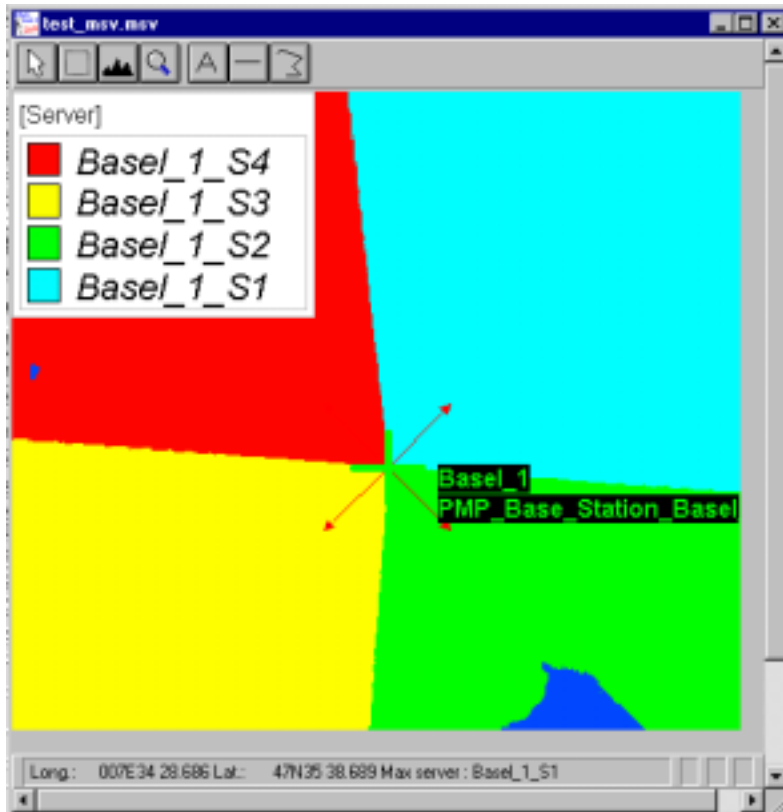
**Best Server:**

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



Maximum Server

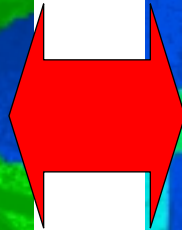
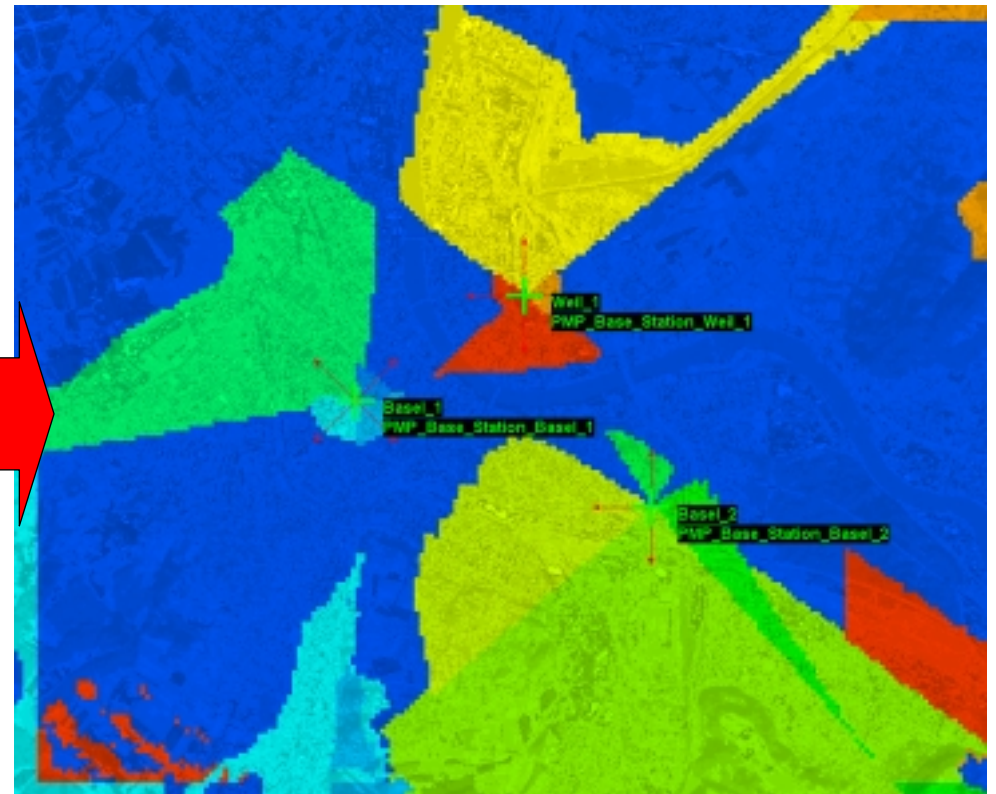
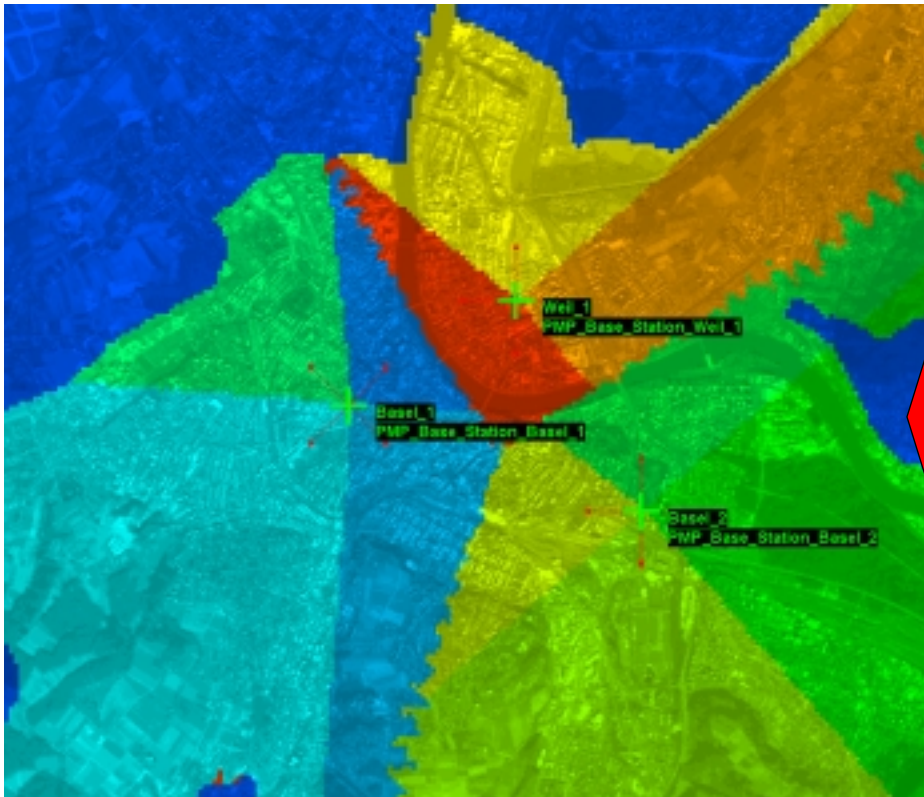
Best Server

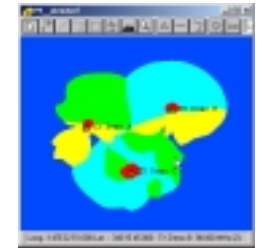
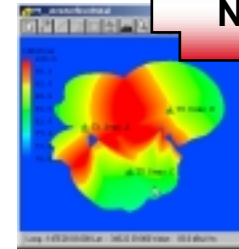
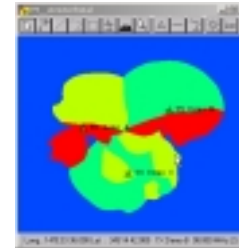
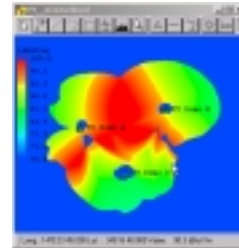
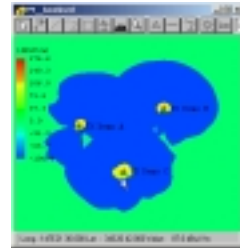
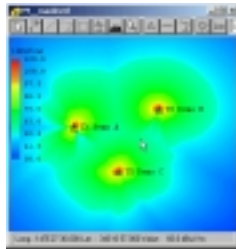
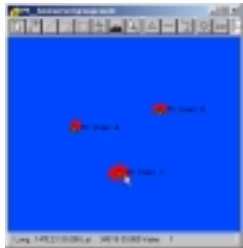


Network Processor

Maximum Server

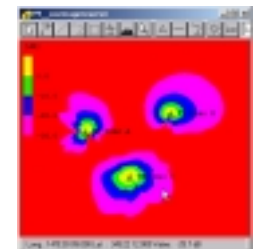
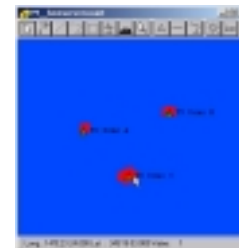
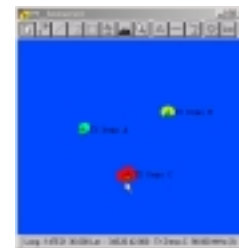
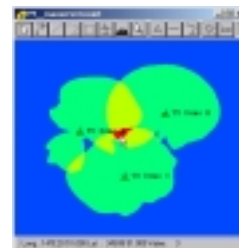
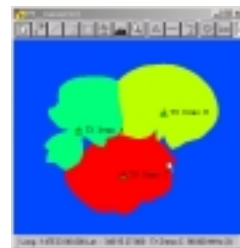
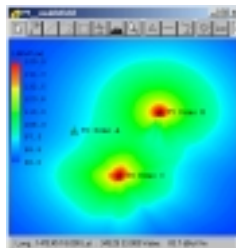
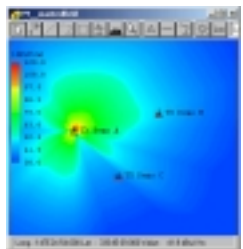
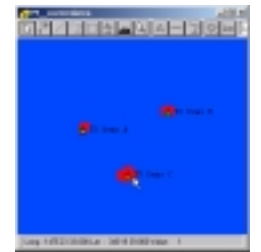
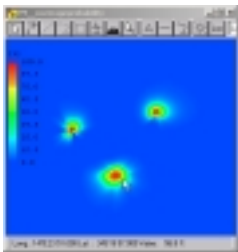
Best Server




 Network Processor


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

- Number of Max Sever
- Number Best Server
- Strongest Interferer
- Level of Strongest Interferer
- Coverage Probability
- Coverage Reserve
- Power Difference
- Assignment Probability
- Handover Zone
- Requeired Channels
- Coding Scheme Area (GPRS)
- SFN Level Gain
- ...



**Automissed Frequency / Channel Assignment**

Interference Analysis

*Network wide parameter*

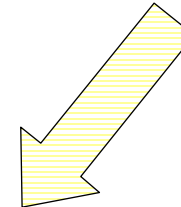
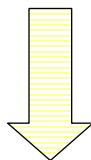
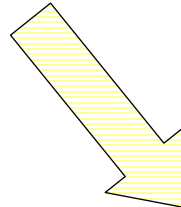
*Frequency spectrum*

*Cell specific parameter*

*Number of required carriers  
Channel constraints*

*Cell relations*

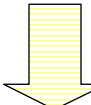
*Neighbour relations  
Channel separation matrix*



**Interference Analysis  
Interference Matrix**



**Allocation algorithm**



**Channel allocation**

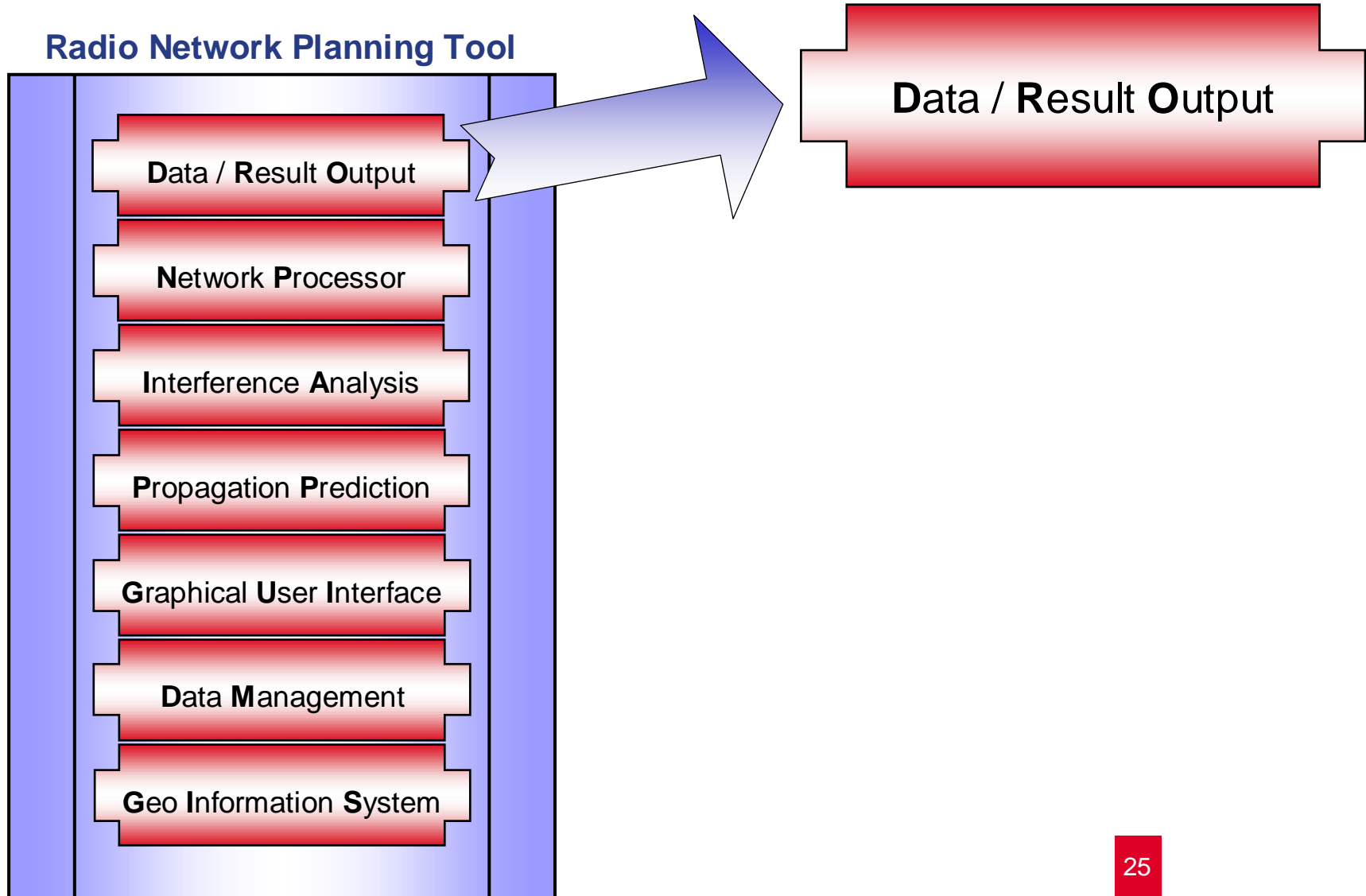
- LS Box algorithm
- Simulated annealing algorithm

# Live Planning Tool Demonstration



## „MULTIlink“ Design Tool for Engineering Microwave Links and PMP / WLL / LMDS Planning

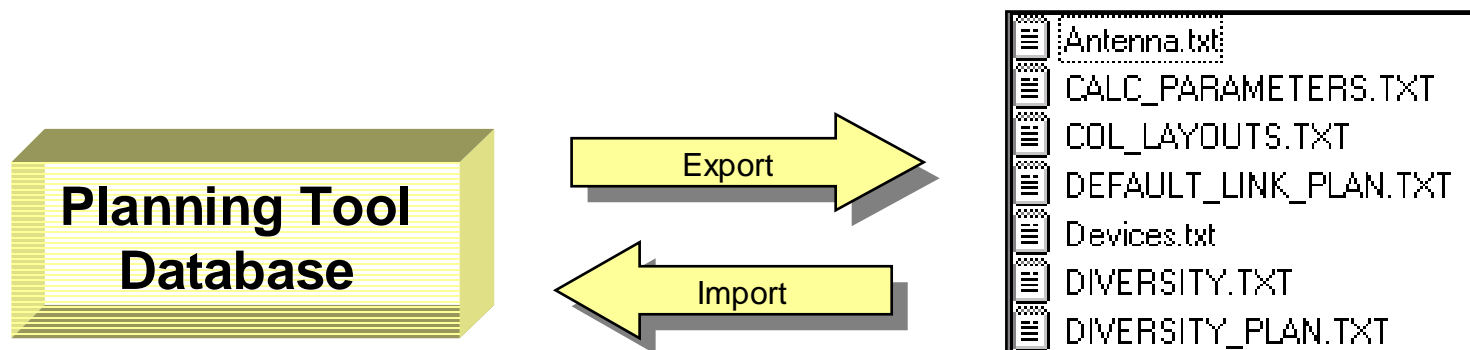




**•Import and Export of**

Databases and Tables ( Sites, Antennas,...)  
Result Files  
Measurement Data

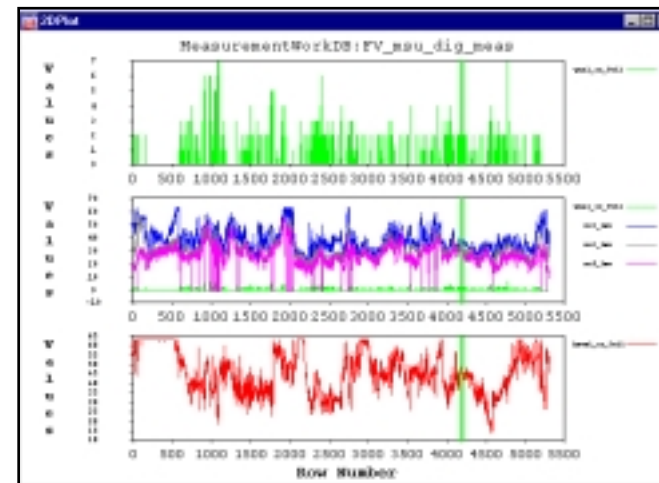
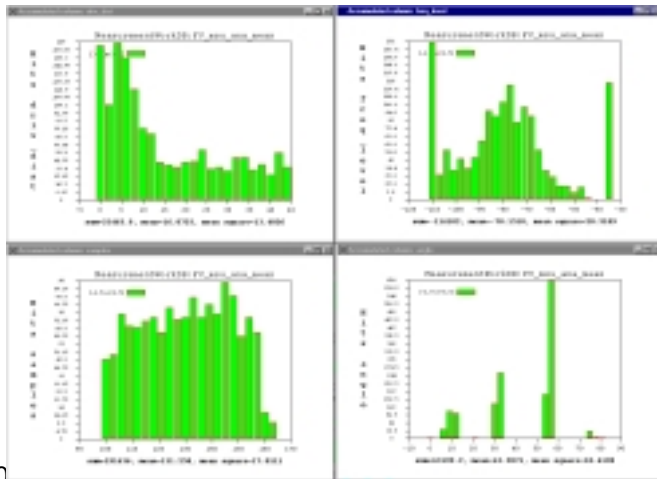
Should be possible in several formats (.txt, .xls, ASCII, .jpg, ...)



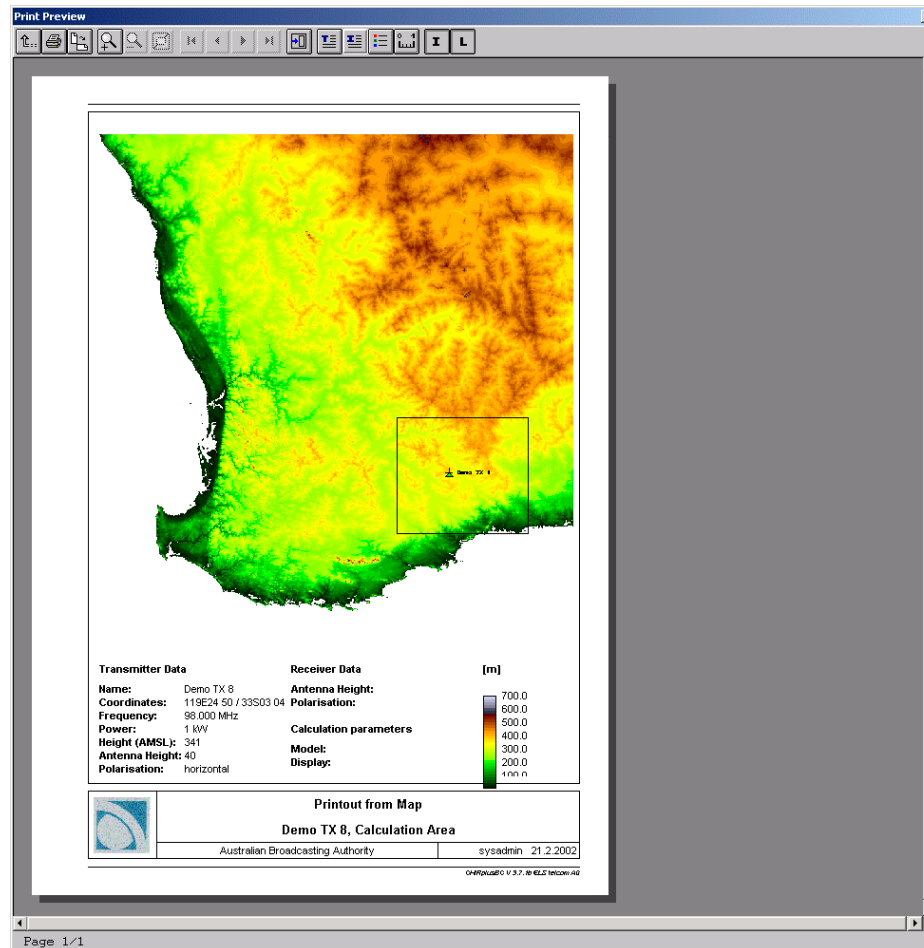
Data / Result Output

- 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

Mark	dig meas	file	time	date	level sc full	qual sc full
4186	4185	1	13:05:37.666	25.07.19...	41	0
4187	4186	1	13:05:38.000	25.07.19...	40	0
4188	4187	1	13:05:38.500	25.07.19...	42	0
4189	4188	1	13:05:39.000	25.07.19...	42	0
4190	4189	1	13:05:39.500	25.07.19...	41	0
4191	4190	1	13:05:40.000	25.07.19...	42	0
4192	4191	1	13:05:40.500	25.07.19...	42	0
4193	4192	1	13:05:41.000	25.07.19...	41	0
4194	4193	1	13:05:41.500	25.07.19...	42	0
4195	4194	1	13:05:42.000	25.07.19...	40	0
4196	4195	1	13:05:42.500	25.07.19...	35	0
4197	4196	1	13:05:43.000	25.07.19...	40	0
4199	4197	1	13:05:43.500	25.07.19...	40	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

FM Info Database (All Entries) FMInfo.mdb

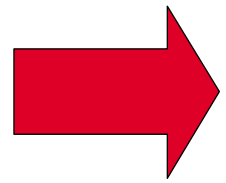
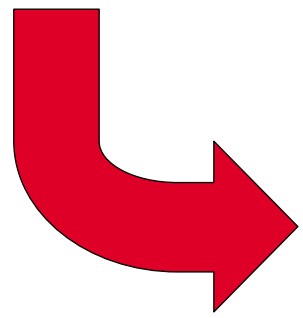
	Lock	Mark	TX-Name	Freq.	ERP	Heffm.	Ch.	OS	Ctry	Provin.	Pol.	Longit.	Latit.
1			GOROKA	100.2000	0.1905	40		P	PNG		H	145E23 00	06S04 00
2			PT MORESBY	100.3000	1.9055	40		P	PNG		H	147E43 00	08S37 00
3			KIETA	100.4000	0.1905	40		P	PNG		H	147E43 00	08S37 00
4			MT HAGEN	100.4000	0.1905	40		P	PNG		H	147E43 00	08S37 00
5			LAE	100.5000	0.1905	40		P	PNG		H	147E43 00	08S37 00
6			RABAU	100.5000	1.9055	40		P	PNG		H	147E43 00	08S37 00
7			MADANG	100.8000	0.1905	40		P	PNG		H	147E43 00	08S37 00
8			WEWAK	100.8000	0.1905	40		P	PNG		H	147E43 00	08S37 00
9			KUNDIAWA	101.0000	0.0794	40		P	PNG		H	147E43 00	08S37 00
10			Jundah	107.3000	0.0250	15			AUS	QLD	V	147E43 00	08S37 00
11			Jundah	105.7000	0.0250	15			AUS	QLD	V	147E43 00	08S37 00
12			Jundah	104.1000	0.0250	15			AUS	QLD	V	147E43 00	08S37 00

Rows:5240 Selected: 0

Print Preview

Tx-Name	Freq.	Longit.	Latit.
GOROKA	100.2000	145E23 00	06S04 00
PT MORESBY	100.3000	147E43 00	08S37 00
KIETA	100.4000	147E43 00	08S37 00
MT HAGEN	100.4000	147E43 00	08S37 00
LAE	100.5000	147E43 00	08S37 00
RABAU	100.5000	147E43 00	08S37 00
MADANG	100.8000	147E43 00	08S37 00
WEWAK	100.8000	147E43 00	08S37 00
KUNDIAWA	101.0000	147E43 00	08S37 00
Jundah	107.3000	147E43 00	08S37 00
Jundah	105.7000	147E43 00	08S37 00
Jundah	104.1000	147E43 00	08S37 00
Jundah	103.5000	147E43 00	08S37 00
Jundah	99.3000	147E43 00	08S37 00
Jundah	97.1000	147E43 00	08S37 00
Jundah	96.1000	147E43 00	08S37 00
Meandarra	100.3000	149E36 34	27S29 24
Meandarra	97.1000	149E36 34	27S29 24
Meandarra	97.5000	149E36 34	27S29 24
Meandarra	97.1000	149E36 34	27S29 24
Meandarra	96.3000	149E36 34	27S29 24
Mieville	105.3000	148E36 40	26S32 33
Mieville	104.5000	148E36 40	26S32 33
Mieville	102.5000	148E36 40	26S32 33
Mieville	101.1000	147E38 00	26S30 21
Mieville	100.3000	147E38 00	26S30 21
Mieville	99.5000	147E38 00	26S30 21
Mieville	98.7000	147E38 00	26S30 21
Mieville	97.9000	147E38 00	26S30 21
Mieville	96.3000	147E38 00	26S30 21
Mieville	97.1000	147E38 00	26S30 21
Mieville	96.3000	147E38 00	26S30 21
Mieville	100.5000	144E32 08	22S36 54
Mieville	98.5000	144E32 08	22S36 54
Mieville	105.3000	151E32 18	32S53 23
Mieville	97.3000	144E32 08	22S36 54
Mieville	96.7000	144E32 08	22S36 54
Mieville	94.1000	144E32 08	22S36 54
Mieville	92.5000	144E32 08	22S36 54
Qilike	104.3000	144E15 51	26S37 13
Qilike	102.5000	144E15 51	26S37 13
Qilike	98.1000	144E15 51	26S37 13
Qilike	96.1000	144E15 51	26S37 13
Strat	106.7000	149E38 07	27S08 36
Strat	105.3000	149E38 07	27S08 36
Strat	105.1000	149E38 07	27S08 36
Strat	103.5000	149E38 07	27S08 36
Strat	102.1000	149E38 07	27S08 36
Strat	101.5000	149E38 07	27S08 36
Tambo	101.1000	146E16 00	24S00 59
Tambo	99.5000	146E16 00	24S00 59
Tambo	97.3000	146E16 00	24S00 59
Tialoa	101.3000	148E51 08	28S38 10
Tialoa	93.3000	148E51 08	28S38 10
Tialoa	92.5000	148E51 08	28S38 10
Tialoa	91.7000	148E51 08	28S38 10
Tialoa	90.1000	148E51 08	28S38 10

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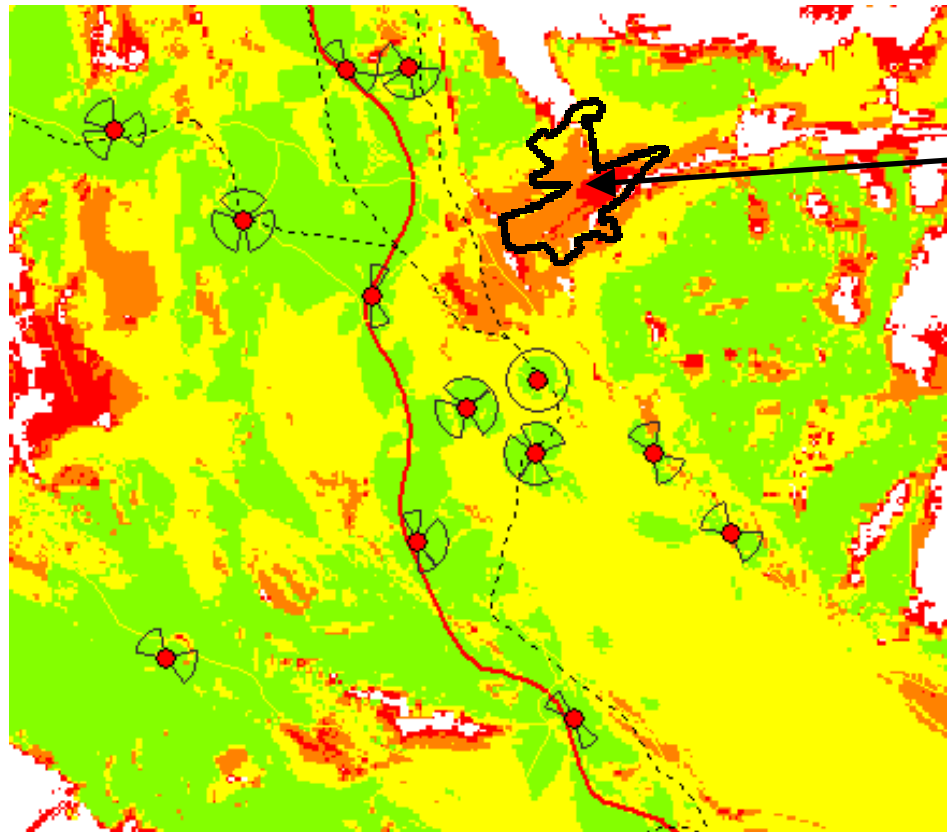
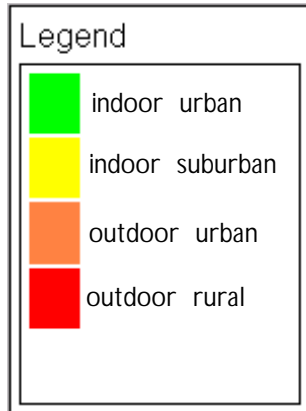
## Example



## Network Optimization

Current network coverage

Network Processor

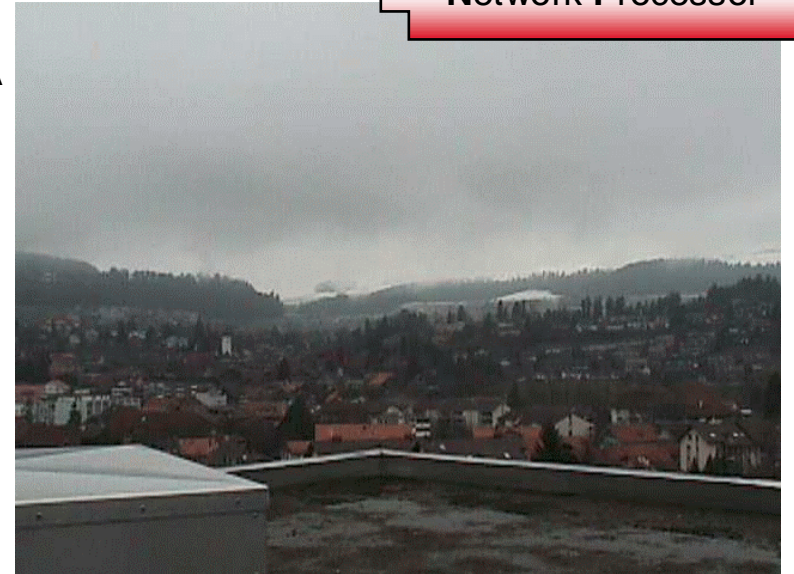
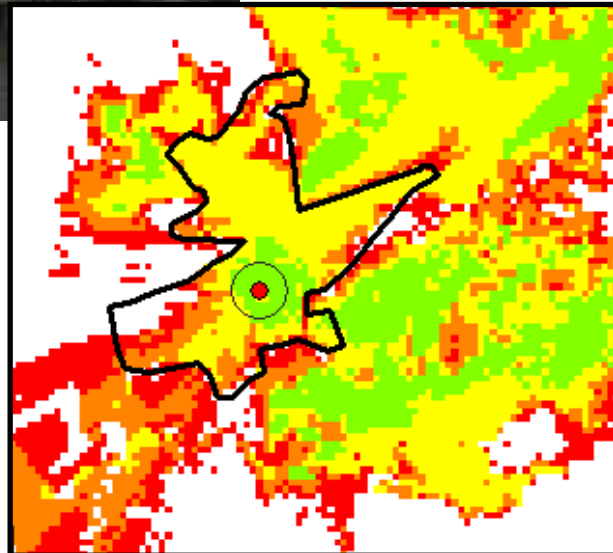


Now, we want to improve the coverage in this region.

Network Processor



Candidate Steffisburg A



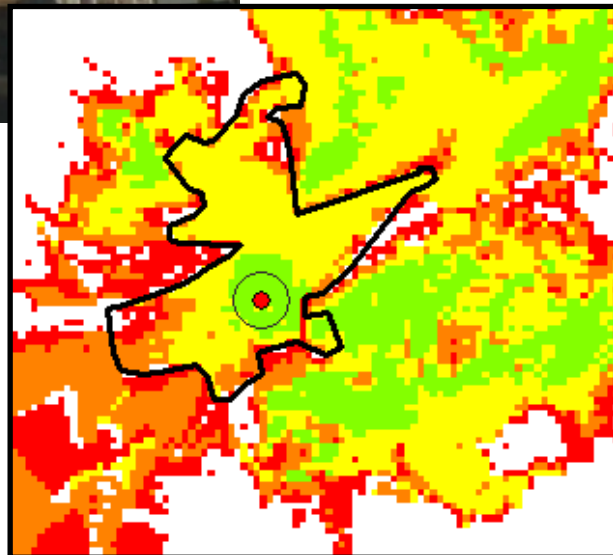
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Network Processor



Candidate Steffisburg B

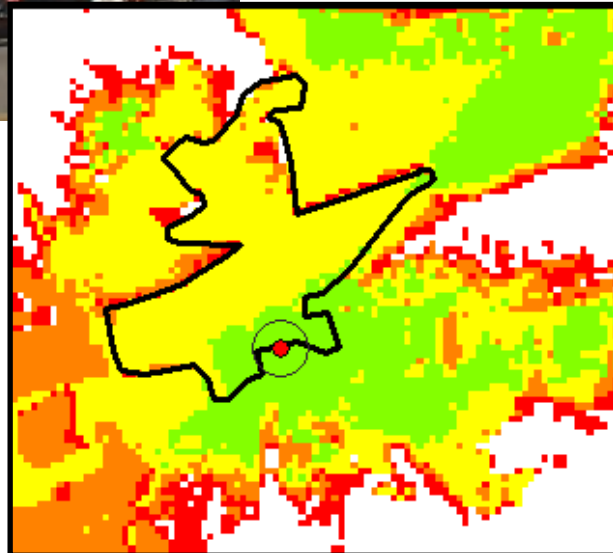


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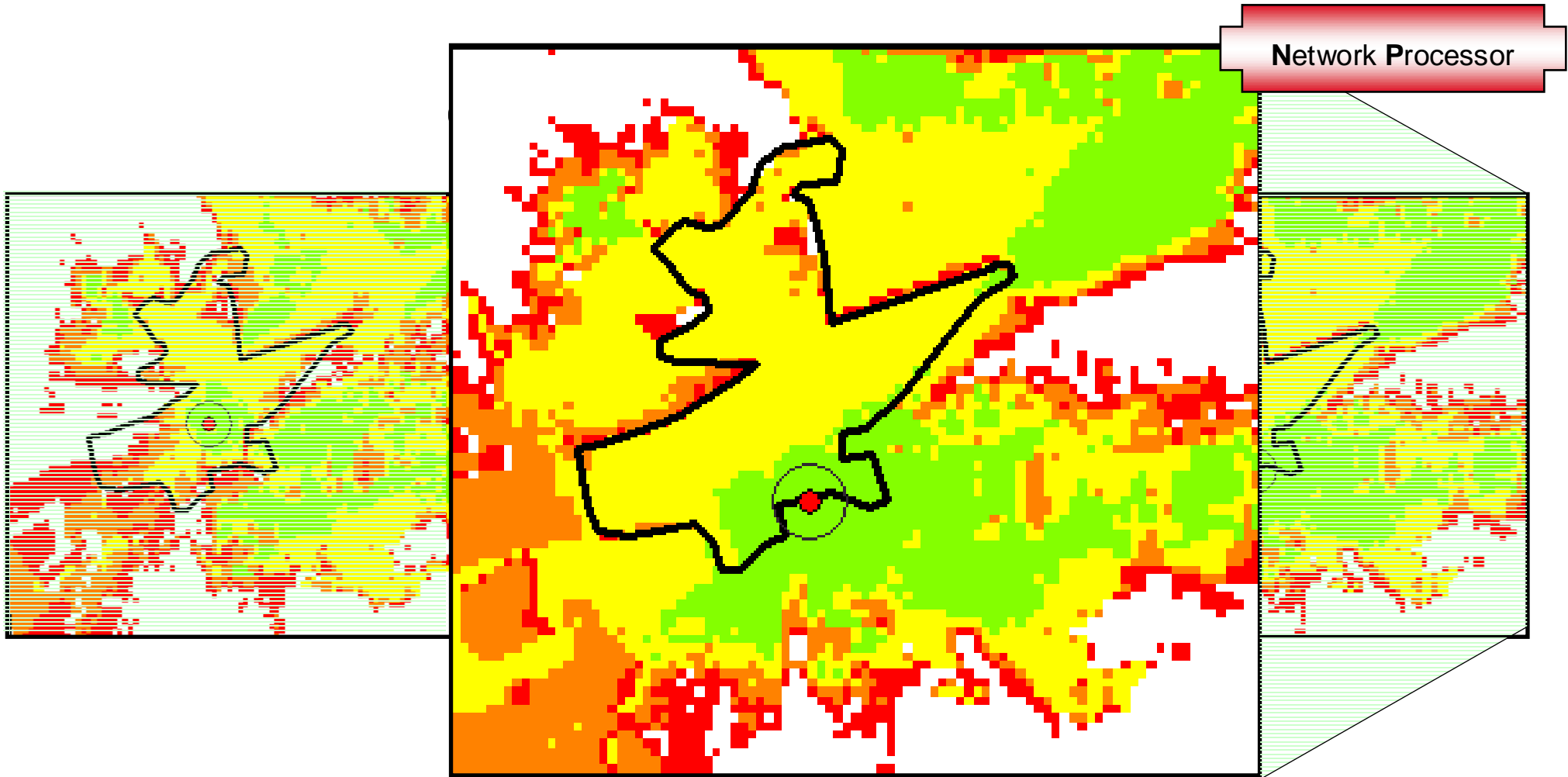
Network Processor



Candidate Steffisburg C



00°

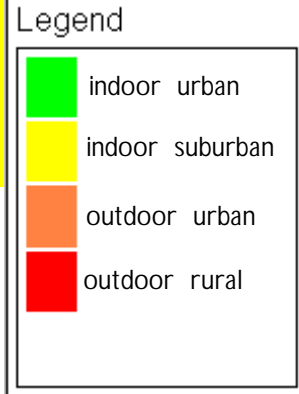
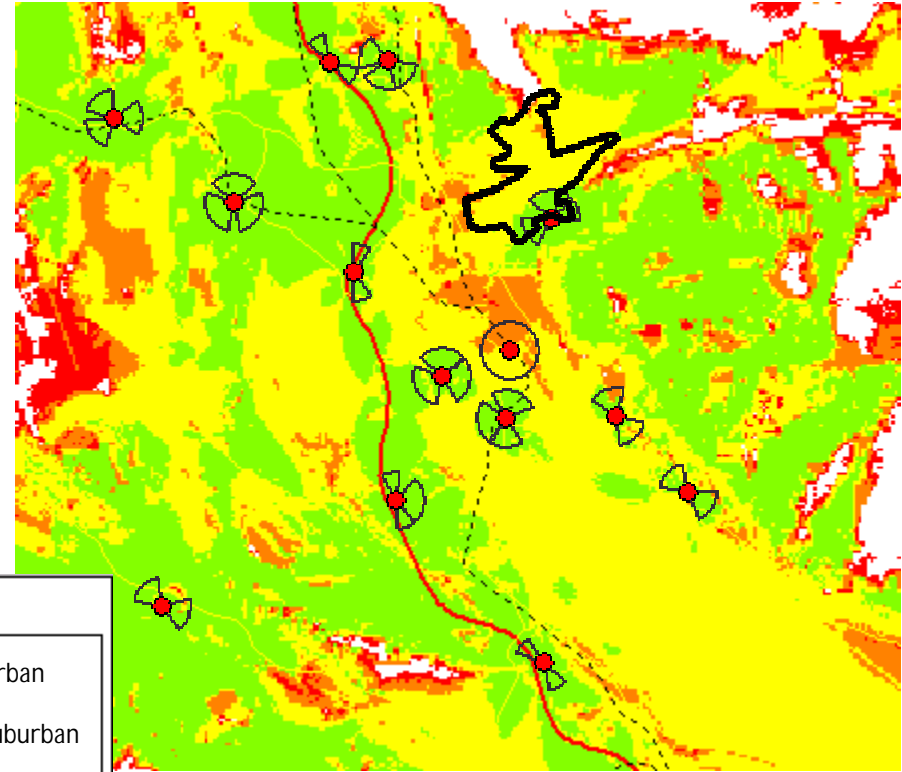
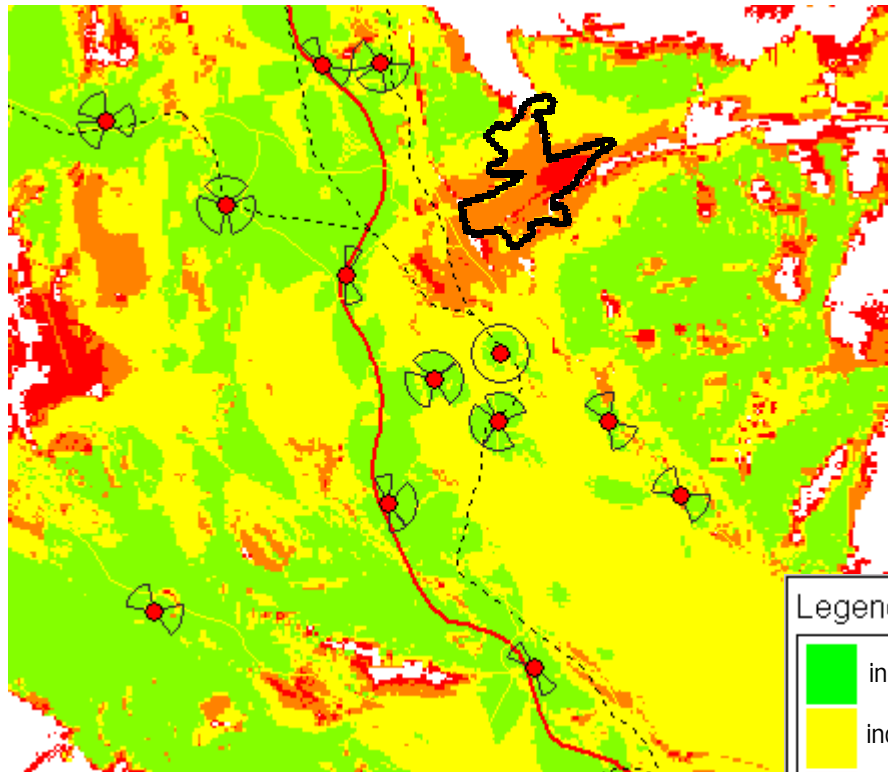


Selection of Candidate Steffisburg C

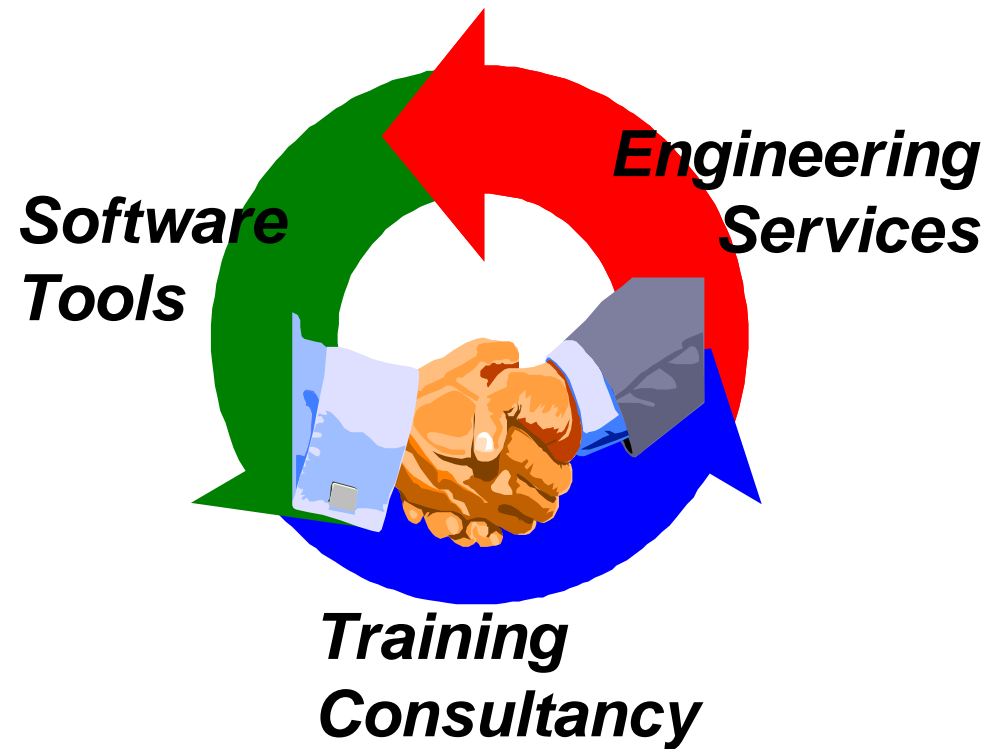
Previous coverage

Improved coverage

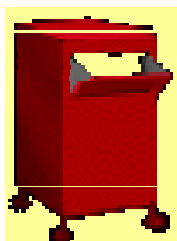
Network Processor



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