

Spectrum Management System for Developing Countries (SMS4DC)

Training on SMS4DC 24-26 July, 2023 Livingstone, ZAMBIA

Ahmed BORAUD ahmed.boraud@gmail.com







PERFORMING BASIC ENGINEERING FUNCTIONS





SUMMARY OF PROPAGATION MODELS FUNCTIONS

	112	P			0	Network pr	ocessor	Ear
Propagation Models	Line	olvline	Area	Link	ontour	Max. Field Strength	Best Serve r	th-space
Free Space	Y	Y	Y	N	N	Y	Y	Ν
Line of Sight	Y	Y	Y	N	N	N	N	N
ITU-R P.370	Y	Y	Y	Y	Y	Y	Y	N
ITU-R P.1546	Y	Y	Y	Y	Y	Y	Y	N
ITU-R P.1812	Y	Y	Y	Y	Y	Y	Y	Ν
Okumura-Hata	N	N	Y	N	N	Y	Y	N
ITU-R P.526 (by diffraction)	N	N	N	Y	N	N	N	N
ITU-R P.526 (Smooth Earth)	N	N	N	Y	Ν	N	N	N
ITU-R P.452	N	N	N	Y	N	N	Ν	N
ITU-R P.530	N	N	N	Y	N	N	N	N
ITU-R P.618	N	N	N	N	N	N	N	Y

⁽¹⁾: 'Y' and 'N' stand for "Yes" and "No" respectively.





LIST OF SMS4DC PROPAGATION MODELS

Free space	Unaffected by any consideration other than distance
Line of sight	Propagation between two points for which the direct ray is sufficiently clear of obstacles for diffraction to be of negligible effect.
P.370	VHF and UHF propagation curves for the frequency range from 30 MHz to 1 000 MHz.
P.1546	point-to-area predictions for terrestrial services in the frequency range 30 MHz to 4 000 MHz
Okumura- Hata	Used for path loss prediction in urban areas.
P.1812	Used for prediction method suitable for terrestrial point-to-area services in the frequency range 30 MHz to 3 GH
P.526	Propagation by diffraction
P.452	Prediction procedure for the evaluation of microwave interference between stations on the surface of the Earth at frequencies above about 0.1 GHz
P.530	Propagation data and prediction methods required for the design of terrestrial line-of-sight systems.
P.618	Propagation data and prediction methods required for the design of Earth- space telecommunication systems



PROPAGATION TERMS USED IN SMS4DC

	Effective Earth- radius factor, k	Ratio of the effective radius of the Earth to the actual Earth radius. For the standard atmosphere, the effective Earth radius 4/3 that of the actual Earth radius.
Kfactor	Effectiv e antenna height	The effective height of the transmitting antenna is defined as its height over the average level of the ground between distances of 3 and 15 km from the transmitter in the direction of the receiver.
clearance angle Some propagation	% Time	The applicable time percentage values or range of values of the ITU Recommendation; %time is the percentage of time that the predicted signal is exceeded during an average year.
Delta h Radio horizon	% Location	The applicable percent location range of the ITU Recommendation; %location is the percentage of locations within, say, a square with 100 to 200 m sides that the predicted signal is exceeded.
%Time	Delta h	defines the degree of terrain irregularity
%Location	Radio horizon	The locus of points at which direct rays from a point source of radio waves are tangential to the surface of the Earth.



CALCULATION ALONG A LINE

- This function calculates field strength values produced by a station along a path profile at a given receiving height above ground level.
- In the case of the line-of-sight (LOS) model, the "Line" calculation sub- item provides only a visibility analysis along the line from the wanted station.
- Toactivate the "Line" sub items, a line must be drawn in advance on the

Station Ta	able	1				
			OK	Cancel		2
IDst	STname	STlat_deg	STIon deg	Sth agl		HIZan112
5	PBVHF1	24.5750	55,1833	60,0000	2	\mathbf{T}
7	Station-235	-2.4000	35,9750	0.0000	1	Jail I
8	TZA11	-3.5000	36.8083	0.0000	1	-{~ <u>⊥</u> ∿h
9	TZ2	-3.5583	36,6833	10.0000	5	HZap22
10	IMT700BTS	-5.8833	37.4000	30.0000	3	
1 11	Zan112	-5.9250	39.2583	30.0000	5	- TT)
2 12	Zan22	-6.2417	39.3750	30.0000		\sim
13	Tanz11	-6.4500	37.8000	20.0000		
14	Tanz22	-6.5583	38.0167	20.0000	3	
15	Tav FX1	-6.0917	38.1833	30.0000	5	
16	Tanz FX22	-5.9000	38.1250	20.0000	8 - C	• 1
17	tan fx 11	-7.0167	38.1417	20.0000	4	
18	tanz fx 22	-7.1917	38.3333	20.0000	4	



CALCULATION ALONG A LINE

 Geographical coordinates, terrain height, ground-distance from the left point (beginning point of the line) and field strength value (dBiV/m), or visibility status in the case of the LOS model, at the position of the vertical marker are displayed on the status bar



Select one of two stations

			OK	Cancel
IDst	STname	STlat_deg	STIon_deg	Sth_agl
5	PBVHF1	24.5750	55.1833	60.0000
7	Station-235	-2.4000	35.9750	0.0000
8	TZA11	-3.5000	36,8083	0.0000
9	TZ2	-3.5583	36.6833	10.0000
10	IMT700BTS	-5.8833	37.4000	30.0000
11	Zan112	-5.9250	39,2583	30.0000
12	Zan22	-6.2417	39,3750	30.0000
13	Tanz11	-6.4500	37.8000	20.0000
14	Tanz22	-6.5583	38.0167	20.0000
15	Tay FX1	-6.0917	38,1833	30.0000
16	Tanz FX22	-5.9000	38.1250	20.0000
17	tan fx 11	-7.0167	38.1417	20.0000
18	tanz fx 22	-7.1917	38,3333	20.0000
19	222	-5.1500	37.1417	0.0000
20	111	-5 2750	37 3500	0.0000
	m			





CALCULATION ALONG A LINE

 The graph is equipped with a vertical marker which is movable horizontally by the mouse while holding the left click.



Lat(5):06 * 01 * 13.846 ** Lon(E):039 * 17 * 36.625 ** Alt(m):8

Dist(km): 11.310

E(dBuV/m):66,711

17:20:24

Ready

Blue : No LOS, and red: LOSto the concerned station





AREA CALCULATION

- Calculates of field strength values produced by a selected station inside a rectangular area at a given receiving height above ground level.
- Toactivate the "Area" sub-items a rectangular area must be drawn in advance on the DEM using the "Draw Box" or "Draw Box from Database" toolbar buttons.
- In the case of the line-of-sight (LOS) model, the "Area" calculation sub-itemprovides only a visibility analysis along the line from the wanted station
- By choosing "Area" sub-item, a spreadsheet of stations in the database is opened and users may select a station inside the area by a mouse left click on the corresponding row of the record-select column.



	Propagation Models Vectors	Frequ	ency Allocations Coordina	tion Inte
2	Free Space			
	Line of Sight			
T	Former P.370	+	Line	
	P.1546-5		Polyline	
1	Okumura-Hata	*	Area	
	P.1812-3		Link	
i	P.526 (Diffraction)	+	Field Strength Contour	
	P.526 (Smooth Earth)		Network Processor	
1	P,452-15	+	and the second second	
	P.530-15	- F		
	P.618			
	Overlay			





AREA CALCULATION

Select station

	l		
STname	STlat_deg	STIon_deg	Sth_agl
PBVHF1	24.5750	55.1833	60.0000
Station-235	-2.4000	35.9750	0.0000
TZA11	-3.5000	36.8083	0.0000
TZ2	-3.5583	36,6833	10.0000
IMT700BTS	-5.8833	37.4000	30.0000
Zan112	-5.9250	39.2583	30.0000
Zan22	-6.2417	39.3750	30.0000
Tanz11	-6.4500	37.8000	20.0000
Tanz22	-6.5583	38.0167	20.0000
Tav FX1	-6.0917	38.1833	30.0000
Tanz FX22	-5.9000	38.1250	20.0000
tan fx 11	-7.0167	38.1417	20.0000
tanz fx 22	-7.1917	38.3333	20.0000
222	-5.1500	37.1417	0.0000
111	-5.2750	37 3500	0 0000
	PRVHF1 Station-235 TZA11 TZ2 IMT700BTS Zan112 Zan22 Tanz11 Tanz22 Tav FX1 Tanz FX22 tan fx 11 tanz fx 22 222 111	PRVHF1 24.5750 Station-235 -2.4000 TZA11 -3.5000 TZ2 -3.5583 IMT700BTS -5.8833 Zan112 -5.9250 Zan22 -6.2417 Tanz11 -6.4500 Tanz22 -6.5583 Tav FX1 -6.0917 Tanz FX22 -5.9000 tan fx 11 -7.0167 tanz fx 22 -7.1917 222 -5.1500 111 -5.2750	PRVHF1 24.5750 55.1833 Station-235 -2.4000 35.9750 TZA11 -3.5000 36.8083 TZ2 -3.5583 36.6833 IMT700BTS -5.8833 37.4000 Zan112 -5.9250 39.2583 Zan22 -6.2417 39.3750 Tanz11 -6.4500 37.8000 Tanz22 -6.5583 38.0167 Tav F×1 -6.0917 38.1833 Tanz F×22 -5.9000 38.1250 tan fx 11 -7.0167 38.1417 tanz fx 22 -5.1500 37.1417 111 -5.250 37.500

Area Calculation P370



Set parameters

ime(1 -> 50)/	Location(1 -> 99)/	Earth Curvature	OK.
50	50	1.3333333333	Cancel
System	Enviro	nment	
Analogue 🔹	Urban Area		
Land/Sea disc.	Receiver Height(m)		
Clearance Angle	3		

Calculation LOS







FIELD STRENGTH CONTOUR

- This function saves and displays field strength contours around a selected station where the field strength values inside the contour are higher than a given threshold.
- Adialogue box of the propagation model requests the user to enter a threshold value for this parameter.

1	Propagation Models Vector	s Frequ	ency Allocations Coordination Int	SMS 4DC	Station Tal	ble			
	Free Space Line of Sight	*		E				OK	Cancel
	Former P.370	*	Line		IDst	STname	STlat_deg	STIon_deg	Sth_agl
	D 15/6.5	-	Dolution	100	5	PRVHF1	24.5750	55,1833	60.0000
	F.1340-3		Folyme		7	Station-235	-2.4000	35.9750	0.0000
5	Okumura-Hata	*	Area		8	TZA11	-3.5000	36,8083	0.0000
P	0 1010 0		Link		9	TZ2	-3.5583	36,6833	10.0000
L	P.1012-3	-	LINK		10	IMT700BTS	-5.8833	37.4000	30,0000
	D 526 (D:0		Field Strength Contour	1	11	Zan112	-5.9250	39.2583	30.0000
L	P.526 (Diffraction)			× 0	12	Zan22	-6.2417	39.3750	30,0000
	P.526 (Smooth Earth)		Network Processor		13	Tanz11	-6.4500	37.8000	20.0000
		1	Construction of the Second Second	1.000	14	Tanz22	-6.5583	38.0167	20,0000
L	P.452-15		A DESCRIPTION OF THE OWNER OWNER OF THE OWNER OWNER OF THE OWNER OWNER OF THE OWNER		15	Tav FX1	-6.0917	38.1833	30,0000
	P 530-15				16	Tanz FX22	-5.9000	38.1250	20.0000
	135015				17	tan fx 11	-7.0167	38.1417	20.0000
	D 619			1 Gin	18	tanz fx 22	-7.1917	38.3333	20.0000
	F,010				19	222	-5.1500	37.1417	0.0000
	Quality				20	111	-5 2750	37 3500	0.0000
	Overlay			1		111			





FIELD STRENGTH CONTOUR

Choose contour parameters

lime(1 -> 50)%	Location(1 -> 99)/	Earth Curvature	OK
50	50	1.3333333333	Cancel
System	Envi	ronment	
Analogue 🔄	Urban Area Receiver Height(m)	▼ DeltaH from map	Contour Value (dBuV/m)

Field Strength Contour – P.370







FIELD STRENGTH CONTOUR

Using tools menu of the area calculation window the following items can be showed

Change color



Show legend





Coverage



Export results to google earth



Contour





MAXIMUM FIELD STRENGTH

- This item calculates and displays the maximum value of field strength values produced by more than one transmitting stations at any point inside a predefined rectangular area.
- Prior to the selection of this sub-item, a rectangular area must be selected using the "Draw Box" or "Draw Box from Database" toolbar buttons.







MAXIMUM FIELD STRENGTH

Select more than one station nearby

Free Space Maximum Field Strength

E .		OK	Cancel	
IDst	STname	STlat_deg	STIon_deg	Sth_agl
5	PBVHF1	24.5750	55.1833	60.0000
7	Station-235	-2.4000	35.9750	0.0000
8	TZA11	-3.5000	36.8083	0.0000
9	TZ2	-3.5583	36.6833	10.0000
10	IMT700BTS	-5.8833	37.4000	30.0000
11	Zan112	-5.9250	39.2583	30.0000
12	Zan22	-6.2417	39.3750	30.0000
13	Tanz11	-6.4500	37.8000	20.0000
14	Tanz22	-6.5583	38.0167	20.0000
15	Tav FX1	-6.0917	38.1833	30.0000
16	Tanz FX22	-5.9000	38.1250	20.0000
17	tan fx 11	-7.0167	38.1417	20.0000
18	tanz fx 22	-7.1917	38.3333	20.0000
19	222	-5.1500	37.1417	0.0000
20	111	-5 2750	37 3500	0.0000







BEST SERVER

- This function calculates and displays the best serving station, among various stations, at each point inside a predefined rectangular area.
- Prior to the selection of this sub-item, a rectangular area must be selected using the "Draw Box" or "Draw Box from Database" toolbar buttons.









BEST SERVER









LINK BUDGET CALCULATION

- Link budget calculation, displays calculation results between two stations as well as providing a visual user-interface to optimize the link characteristics.
- The link calculation contains: a path profile diagram, the Fresnel zone, Earth curvature and those technical characteristics of a link that are relevant to the propagation model in use.





LINK BUDGET CALCULATION







- Attenuation due to atmospheric gases
- Diffraction fading due to obstruction or partial obstruction of the path,
- Fading due to multipath, beam spreading and scintillation,
- Attenuation due to variation of the angle-of arrival/launch,
- Attenuation due to precipitation,
- Attenuation due to sand and dust storms
- Total Loss = [Free Space Loss]+ [Atmospheric Gaseous Loss]+ [Rain Attenuation]+
 [Clear Air Fading]+ [Diffraction Loss]+ [NFD].
- Flat Receive Level = PT + GT [Free Space Loss] [Atmospheric Gaseous Loss] –
 [Diffraction Loss] + GR [Receiver Insertion Loss]
- Fade Margin = [Flat Receive Level] [Receiver Threshold]





- Attenuation due to atmospheric gases
- Diffraction fading due to obstruction or partial obstruction of the path,
- Fading due to multipath, beam spreading and scintillation,
- Attenuation due to variation of the angleof arrival/launch,
- Attenuation due to precipitation,
- Attenuation due to sand and dust storms







Atmospheric gases considerable loss above 10 GHz









atmospheric Multipath



surface Multipath



Antenna Decoupling (governs the minimum beamwidth)



Beam Spreading (defocusing)



