SYSTEMATIC ANALYSIS OF GEO-LOCATION AND SPECTRUM SENSING AS ACCESS METHODS TO TV WHITE SPACE

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Introduction

Geo-location database and spectrum sensing are the accepted methods of detecting TV white spaces (TVWSs). Limitations of spectrum-sensing have been emphases a lot in the literature, and are based mainly on the developed world environment. This is the case because the idea to use TV white space (TVWS) originated from the developed world and the initial experiments were conducted there. This poster looks at the critical performance requirements of each technique in so doing determining the region that it can perform well.

Critical Performance Factors

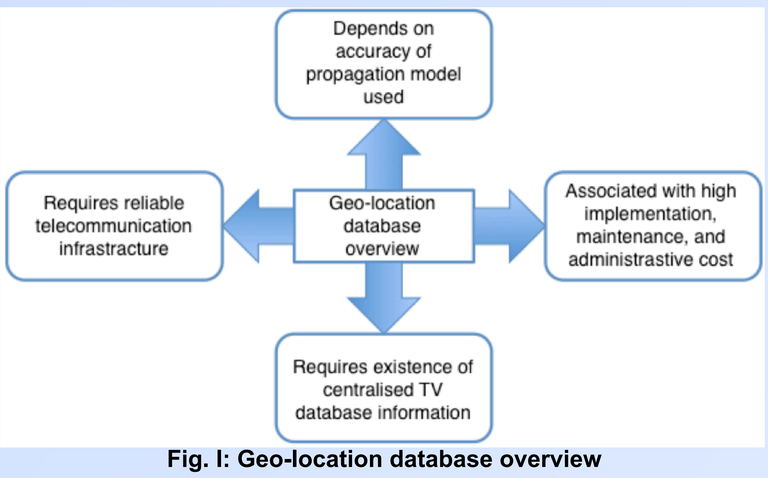

Fig. I: Geo-location database overview

Geo-location critical performance factors:

- Propagation models whose prediction in the area of interest is close to the measured data.
- Internet backbone infrastructure to facilitate efficient and frequent communication.
- Existence of detailed centralized TV database information.

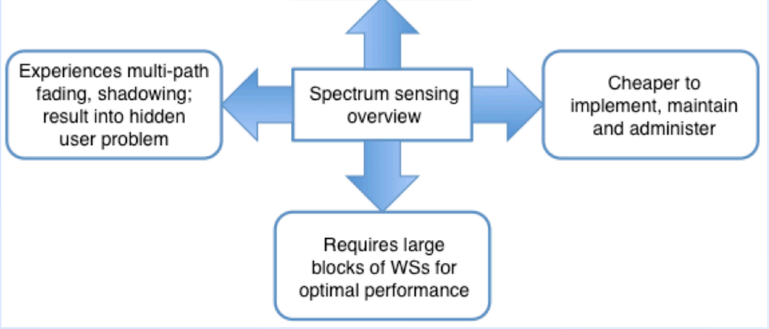

Fig. II: Spectrum sensing overview

Spectrum sensing critical performance factors:

- Detection threshold that is optimal – no interference to the primary users or any missed opportunities by secondary users.
- Minimal to no multi-path fading and shadowing to avoid hidden user problem.
- Large blocks of TVWSs in the area of interest.

So what is the best approach?

Critical performance factors not may not be present or exist in some regions. Consequently, none can produce superior performance in all possible regions.

Developed vs developing regions

Conditions in these two regions are different.

Table I: Condition in developed vs. developing regions

In developed regions	In rural areas of developing regions
Propagation models have been tried and tested extensively.	Propagation models have rarely been tested such that there is no model clearly known to perform better.
There is reliable Internet backbone infrastructure.	Internet backbone infrastructure is poor and unreliable especially in the rural areas.
A centralized detailed TV database information is available.	Spectrum usage information is scattered and stored in many formats.
Fading, shadowing can be severe because of many tall close-together buildings.	Small isolated traditional building structures exist, which are unlikely to cause considerable fading or shadowing.
There is less unused spectrum in the TV radio frequency band	There is more unused spectrum in the TV radio frequency band

All critical performance factors required by geo-location database exist in developed regions while these factors are lacking in rural areas of developing regions. Consequently, geo-location database is expected to perform better in developed regions than in developing regions. On the other hand, critical performance factors required by spectrum sensing are present in developing regions while they are lacking in developed regions. Consequently, spectrum sensing is expected to perform better there than in developed regions.

Experimental evaluation

As argued that there is no propagation models clearly known to perform better in regions of the developing world that can be used in geo-location databases, a limited physical evaluation of the approaches was done by conducting spectral measurements and comparing values of path losses obtained from the measurements against those estimated by some common propagation models suggested for use in geo-location databases. The experiments were conducted in the city of Cape Town in South Africa.

An analog terrestrial television (ATT) transmitter of one of the public TV broadcasters called **South Africa Broadcasting Corporation 2** (SABC2), located on latitude 33◦52′31′′S and longitude 18◦35′44′′E, was used as a base station (BS) transmitter. Its transmission parameters are: **UHF channel** = 22, **frequency** = 479.25 MHz, **Effective Radiated Power** (ERP) = 2 KW = 63.01 dBm, **antenna polarization** = vertical.

Measurements points

Twelve locations located at different distances from the BS transmitter site were identified where measurements were done. The spectral measurements were done for 8-hours at each measurement site using an hand-held RF Explorer model WSUB1G. The model was fitted with a Nagoya NA-773 wide band telescopic antenna with vertical polarization.

Results

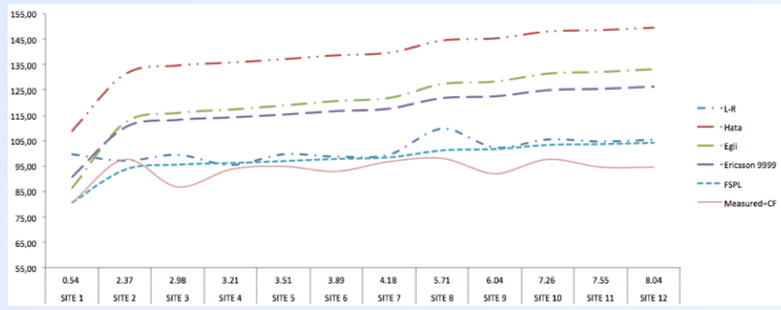

Fig. III: Plots of path losses

Table II: Mean error, mean absolute error and standard deviation

No.	Name	Path loss Errors (dB)				
		Measured & FSPL	Measured & L-R	Measured & Ericsson 9999	Measured & Egli	Measured & Hata
1	Tygerberg Natural Reserve	0.00	18.99	9.98	5.61	28.17
2	Harl Bremmer Hospital	-4.06	-0.52	12.56	14.40	33.55
3	Bellville Business Park	8.78	12.73	26.43	29.22	47.86
4	Parow Centre	2.53	1.74	20.52	23.63	42.09
5	Tyger Valley Shopping Centre	2.13	4.86	20.52	24.00	42.25
6	Bellville Market	4.96	5.90	23.82	27.72	45.74
7	Tygerberg Hospital	1.74	2.85	20.91	25.12	42.98
8	Bellefleur Flats	3.12	11.63	23.71	29.22	46.36
9	Parow Industrial Area	9.59	10.21	30.43	36.18	53.18
10	UWC	5.63	7.85	27.29	33.81	50.40
11	Unibell	9.05	10.13	30.89	37.57	54.07
12	HPR	9.62	10.85	31.74	38.69	55.04
	Mean	4.42	8.10	23.23	27.10	45.14
	Mean absolute	5.10	8.19	23.23	27.10	45.14
	Standard deviation	4.32	5.45	6.87	9.67	8.11

Discussion of the results

From Fig. III and Table II of path loss errors, the FSPL is the closest model to the measurements seconded by the L-R (ITM). Although the FSPL model is closest to the measurement data, we cannot conclusively say that is the best-fit model for the area within the distances where the measurements were taken. Extensive long-hours spectral measurements are needed and also more measurement sites need to be included to confirm the validity of a model for the area, which may be costly and time consuming.

Conclusion

The poster looked at factors that affect the performance of geo-location database and spectrum sensing and how the presence or absence of these factors in a developed region and/or in a developing region affect their performance. In so doing, the poster has highlighted the need to conduct more research on the performance of spectrum sensing in regions where plenty of white spaces are available, e.g., rural areas of developing world countries.

References

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