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14. ABSTRACT
We examined the validity of empirical models (e.g., Hata models) in large urban environments. A three-dimensional ray tracing method is used to propose modifications for Hata model and obtain accurate estimation in large urban cities. The mean propagation path loss and the loss exponent n values are calculated as a function of length of street, number of side streets, transmitting antenna heights, and in the presence of unique site topologies such as mountainous. It is shown that for large cities and transmitters higher than any building, n values similar to those of free space propagation may be used for estimating path loss. For transmitters at heights lower than most of

15. SUBJECT TERMS
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a. REPORT	b. ABSTRACT	c. THIS PAGE			Magdy Iskander
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Report Title

Final Report: Advanced Propagation Models for Accurate and Real-time Predictions in Wireless Communication Systems

ABSTRACT

We examined the validity of empirical models (e.g., Hata models) in large urban environments. A three-dimensional ray tracing method is used to propose modifications for Hata model and obtain accurate estimation in large urban cities. The mean propagation path loss and the loss exponent n values are calculated as a function of length of street, number of side streets, transmitting antenna heights, and in the presence of unique site topologies such as mountainous. It is shown that for large cities and transmitters higher than any building, n values similar to those of free space propagation may be used for estimating path loss. For transmitters at heights lower than most of buildings and for streets further away from transmitters, n values that are three times larger than those from Hata model are required for accurate path loss estimation. It is shown that reflections from mountains may have minimal effects except when transmitters are placed on mountains and for routes near or along these mountains. The new propagation models include parameterization that would enable fast local calculations in defined categories of the propagation environment and leads to estimating path loss in streets near or further away from transmitters.

Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in peer-reviewed journals:

(b) Papers published in non-peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in non peer-reviewed journals:

(c) Presentations

Number of Presentations: 0.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

(d) Manuscripts

Received Paper

TOTAL:

Number of Manuscripts:

Books

Received Book

TOTAL:

Received	Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

Graduate Students

NAME	PERCENT_SUPPORTED	Discipline
Darcy Bibb	0.50	
FTE Equivalent:	**0.50**	
Total Number:	**1**	

Names of Post Doctorates

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

NAME	PERCENT_SUPPORTED	National Academy Member
magdy Iskander	0.10	
Zhengqing Yun	0.10	
FTE Equivalent:	**0.20**	
Total Number:	**2**	

Names of Under Graduate students supported

NAME	PERCENT_SUPPORTED	Discipline
Daisy Green	0.30	Electrical Engineering
FTE Equivalent:	**0.30**	
Total Number:	**1**	

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period:	1.00
The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:	1.00
The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:	1.00
Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):	1.00
Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:	0.00
The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense	1.00
The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields:	1.00

Names of Personnel receiving masters degrees

NAME
Darcy Bibb
Total Number: 1

Names of personnel receiving PHDs

NAME
Total Number:

Names of other research staff

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

We examine the validity of empirical models (e.g., Hata models) in large urban environments. A three-dimensional ray tracing method is used to propose modifications for Hata model and obtain accurate estimation in large urban cities. The mean propagation path loss and the loss exponent n values are calculated as a function of length of street, number of side streets, transmitting antenna heights, and in the presence of unique site topologies such as mountainous. It is shown that for large cities and transmitters higher than any building, n values similar to those of free space propagation may be used for estimating path loss. For transmitters at heights lower than most of buildings and for streets further away from transmitters, n values that are three times larger than those from Hata model are required for accurate path loss estimation. It is shown that reflections from mountains may have minimal effects except when transmitters are placed on mountains and for routes near or along these mountains

Technology Transfer