Technical Report 136

Spatial Covariance Estimation for Millimeter Wave Hybrid Systems using Out-of-Band Information

Research Supervisor: Robert Heath
Wireless Networking and Communications Group

Project Title: Spatial Correlation Estimation of Millimeter Vehicular Communication Channels Using Out-of-Band Information

May 2019

Data-Supported Transportation Operations & Planning Center (D-STOP)

A Tier 1 USDOT University Transportation Center at The University of Texas at Austin

D-STOP is a collaborative initiative by researchers at the Center for Transportation Research and the Wireless Networking and Communications Group at The University of Texas at Austin.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
D-STOP/2019/136		

4. Title and Subtitle	5. Report Date
Spatial Covariance Estimation for Millimeter Wave Hybrid Systems using Out-of-Band Information	May 2019
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Anum Ali, Nuria Gonz´alez-Prelcic, and Robert W. Heath Jr.	Report 136
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Data-Supported Transportation Operations & Planning Center (D-STOP) The University of Texas at Austin 3925 W. Braker Lane, 4th Floor Austin, Texas 78701	11. Contract or Grant No. DTRT13-G-UTC58
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
United States Department of Transportation University Transportation Centers 1200 New Jersey Avenue, SE Washington, DC 20590	14. Sponsoring Agency Code

15. Supplementary Notes

Supported by a grant from the U.S. Department of Transportation, University Transportation Centers Program.
Project Title: Spatial Correlation Estimation of Millimeter Vehicular Communication Channels Using Out-of-Band Information

16. Abstract

In high mobility applications of millimeter wave (mmWave) communications, e.g., vehicle-to-everything communication and next-generation cellular communication, frequent link configuration can be a source of significant overhead. We use the sub-6 GHz channel covariance as an out-of-band side information for mmWave link configuration. Assuming: (i) a fully digital architecture at sub-6 GHz; and (ii) a hybrid analog-digital architecture at mmWave, we propose an out-of-band covariance translation approach and an out-of-band aided compressed covariance estimation approach. For covariance translation, we estimate the parameters of sub-6 GHz covariance and use them in theoretical expressions of covariance matrices to predict the mmWave covariance. For out-of-band aided covariance estimation, we use weighted sparse signal recovery to incorporate out-of-band information in compressed covariance estimation. The out-of-band covariance translation eliminates the in-band training completely, whereas out-of-band aided covariance estimation relies on in-band as well as out-of-band training. We also analyze the loss in the signal-to-noise ratio due to an imperfect estimate of the covariance. The simulation results show that the proposed covariance estimation strategies can reduce the training overhead compared to the in-band only covariance estimation. The benefit of proposed strategies, however, is more pronounced in highly dynamic channels. Therefore the out-of-band assisted covariance estimation strategies proposed in this work are more suitable e.g., for vehicle-to-everything communication.

17. Key Words	18. Distribution Statement
Covariance estimation, out-of-band information, hybrid analog-digital precoding, millimeter-wave communications, subspace perturbation analysis	No restrictions. This document is available to the public through NTIS (http://www.ntis.gov): National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif.(of this report)	20. Security Classif.(of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	38	

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

Disclaimer

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated under the sponsorship of the U.S. Department of Transportation's University Transportation Centers Program, in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Acknowledgements

The authors recognize that support for this research was provided by a grant from the U.S. Department of Transportation, University Transportation Centers.