

Simulation of Radar Profiles for Satellites Using Mercury Method of Moments

Daniel Topa
HII-TSD
daniel.topa@hii-tds.com

October 4, 2024

Abstract

A brief survey of characterizing the three dimensional radar cross section of satellites.

Contents

1	Overview	1
2	Mercury Method of Moments	2
2.1	Copyright Statement by the Author	2
2.2	Legal Statement	2
2.3	Obtaining Software and Documentation	4
2.4	Distribution Contents	4
2.4.1	Executables	4
2.4.2	Documentation	4
2.5	YouTube Videos	4
3	Command Examples	5
3.1	ldd	5
4	Further Reading	5

1 Overview

Topa 2020b Working with CAF files, producing output, compressing data. Topa 2020c Topa 2020c The goal is to be able to resolve the workings of an executable file exploiting the ELF structure show in figures ???. The next figure, ???, shows the relationship between source files, header files, shared objects, and the executable program.

2 Mercury Method of Moments

2.1 Copyright Statement by the Author

=====

MERCURY MOM(TM) (Copyrighted and Patents Issued)
MATRIX COMPRESSION TECHNOLOGIES, LLC

For licensing information contact:

John Shaeffer

3278 Hunterdon Way

Marietta, Georgia 30067

770.952.3678

Copyright 2006 Matrix Compression Technologies, LLC.

This software was developed under NASA Contracts NAS1-02057, NAS1-02117, NNL08AA00B, and NNL13AA08B, and the U.S. Government retains certain rights.

The Government, and others acting on its behalf, retain a paid-up, nonexclusive, irrevocable, worldwide license to reproduce, prepare derivative works, and perform publicly and display publicly (but not to distribute copies to the public) by or on behalf of the Government, without any obligation of confidentiality on the part of the U.S. Government. Such license extends to use by NASA contractors, and others working under agreements with the U.S. Government; provided that use of the software shall not be allowed to any person or entity where such use is not in direct performance of a contract with the United States; and provided that such use is not for internal research and development by the contractor or others that is not directly funded by the United States.

=====

2.2 Legal Statement

MERCURY MOM™

Copyrighted

US Patents: 7,742,886; 7,844,407; 8,209,138; 8,725,464

Copyright 2006 Matrix Compression Technologies, LLC.

This software was developed under NASA Contracts NAS1-02057, NAS1-02117, NNL08AA00B, and NNL13AA08B, and the U.S. Government retains certain rights.

The Government, and others acting on its behalf, retain a paid-up, nonexclusive, irrevocable, worldwide license to reproduce, prepare derivative works, and perform publicly and display publicly (but not to distribute copies to the public) by or on behalf of the Government, without any obligation of confidentiality on the part of the U.S. Government. Such license extends to use by NASA contractors, and others working under agreements with the U.S. Government; provided that use of the software shall not be allowed to any person or entity where such use is not in direct performance of a contract with the United States; and provided that such use is not for internal research and development by the contractor or others that is not directly funded by the United States.

Matrix Compression Technologies, L.L.C. expressly disclaims any and all warranties, including the warranty of non-infringement, the warranty of merchantability, and the warranty of fitness for a particular purpose. Matrix Compression Technologies, L.L.C. shall not be obligated to indemnify or pay any party for consequential damages or any other damages arising from the use of the MERCURY MOM™ software. Non-U.S. Government entities shall not distribute the MERCURY MOM™ software to any third party without the express written permission of Matrix Compression Technologies, L.L.C.

MATRIX COMPRESSION TECHNOLOGIES, LLC

John Shaeffer
3278 Hunterdon Way
Marietta, Georgia 30067
john@shaeffer.com
770.952.3678

=====

NASA ITAR notice:

Note: The enclosed software falls under the purview of the U.S. Munitions List (USML), as defined in the International Traffic in Arms Regulations (ITAR), 22 CFR 120-130, and is export controlled. It shall not be taken out of the U.S. nor transferred to foreign nationals in the U.S. or abroad, without specific approval of a knowledgeable export control official, and/or unless an export license/license exemption is obtained/available from the United States Department of State. Violation of these regulations is punishable by fine, imprisonment, or both.

2.3 Obtaining Software and Documentation

For more information regarding this document contact the following:

Kam W. Hom
NASA
Langley Research Center
Mail Stop 207
Hampton, Virginia 23681-2199
757-864-9608
kam.w.hom@nasa.gov

or

Jeffrey A. Miller, PhD
NASA
Langley Research Center
Mail Stop 207
Hampton, Virginia 23681-2199
757-864-9611
jeffrey.allen.miller@nasa.gov

Figure 1: Contact information to request Mercury MoM Software and Documentations

2.4 Distribution Contents

2.4.1 Executables

1. Linux 64-bit
2. Windows 64-bit

2.4.2 Documentation

The distribution includes four documents in PDF:

1. User's Guide
2. Pill Tutorial
3. Code Validation Report
4. Benchmark Tests

2.5 YouTube Videos

One can find useful didactic presentations and simulations on YouTube.

1. The Radar cross-section of backscattering objects
2. Basic Concepts of Radar Cross Section (RCS)
3. Mie scattering
4. Mie theory (BME51 Lecture 5)
5. Mie Scattering

3 Command Examples

3.1 ldd

The command `ldd` prints shared object dependencies.

```
root@69cb14a32689:/# ldd /bin/bash
linux-vdso.so.1 (0x00007ffe64317000)
libtinfo.so.6 => /lib/x86_64-linux-gnu/libtinfo.so.6 (0x00007f842112d000)
libc.so.6 => /lib/x86_64-linux-gnu/libc.so.6 (0x00007f8420f04000)
/lib64/ld-linux-x86-64.so.2 (0x00007f84212e3000)
```

4 Further Reading

Radar rudiments

1. Peebles 2007
2. D. K. Barton 1969
3. Kolosov 1987

Radar cross section

1. Yuan, Gu, and Han 2009
2. Fuhs 1982
3. Knott, Schaeffer, and Tulley 2004
4. Crispin 2013
5. Madheswaran and Kumar 2012

Method of Moments

1. Gibson 2021
2. Lu and Luo 2003
3. Yuan, Gu, and Han 2009

Mercury MoM

1. Topa 2020a
2. Lu and Luo 2003
3. Yuan, Gu, and Han 2009

References

- Topa, Daniel (2020b). *Radar Cross Section Models for AFCAP Dashboard: Rapid Report 2020-02: Corrected*. Briefing.
- (2020c). *Radar Cross Section: Phase 1 Summary Report*. Tech. rep. ARFL/RVB.
- Peebles, Peyton Z (2007). *Radar principles*. John Wiley & Sons.
- D. K. Barton, H.R. Ward (1969). *Handbook of Radar Measurement*. New York, NY: Penguin Random House.
- Kolosov, Andrei A. (1987). *Over the Horizon Radar*. Artech House. ISBN: 9780890062333. URL: <https://us.artechhouse.com/Over-the-Horizon-Radar-P254.aspx>.
- Yuan, Jiade, Changqing Gu, and Guodong Han (2009). “Efficient generation of method of moments matrices using equivalent dipole-moment method”. In: *IEEE Antennas and Wireless Propagation Letters* 8, pp. 716–719.
- Fuhs, Allen E (1982). *Radar cross section lectures*. Monterey, California, Naval Post-graduate School. URL: <https://calhoun.nps.edu/server/api/core/bitstreams/9e69ec48-4628-4243-9f9b-7e879521f7f8/content>.

- Knott, Eugene F, John F Schaeffer, and Michael T Tulley (2004). *Radar cross section*. SciTech Publishing.
- Crispin, JW Jr (2013). *Methods of radar cross-section analysis*. Elsevier.
- Madheswaran, M and P Suresh Kumar (2012). “Estimation of wide band radar cross section (RCS) of regular shaped objects using method of moments (MOM)”. In: *Ictact Journal on Communication Tech-nology* 3.2, pp. 536–541.
- Gibson, Walton C (2021). *The method of moments in electromagnetics*. Chapman and Hall/CRC.
- Lu, Cai-Cheng and Chong Luo (2003). “Comparison of iteration convergences of SIE and VSIE for solving electromagnetic scattering problems for coated objects”. In: *Radio Science* 38.2, pp. 11–1.
- Topa, Daniel (2020a). *Mercury Method of Moments: AFRL Quick Start Guide*. Tech. rep. AFRL.