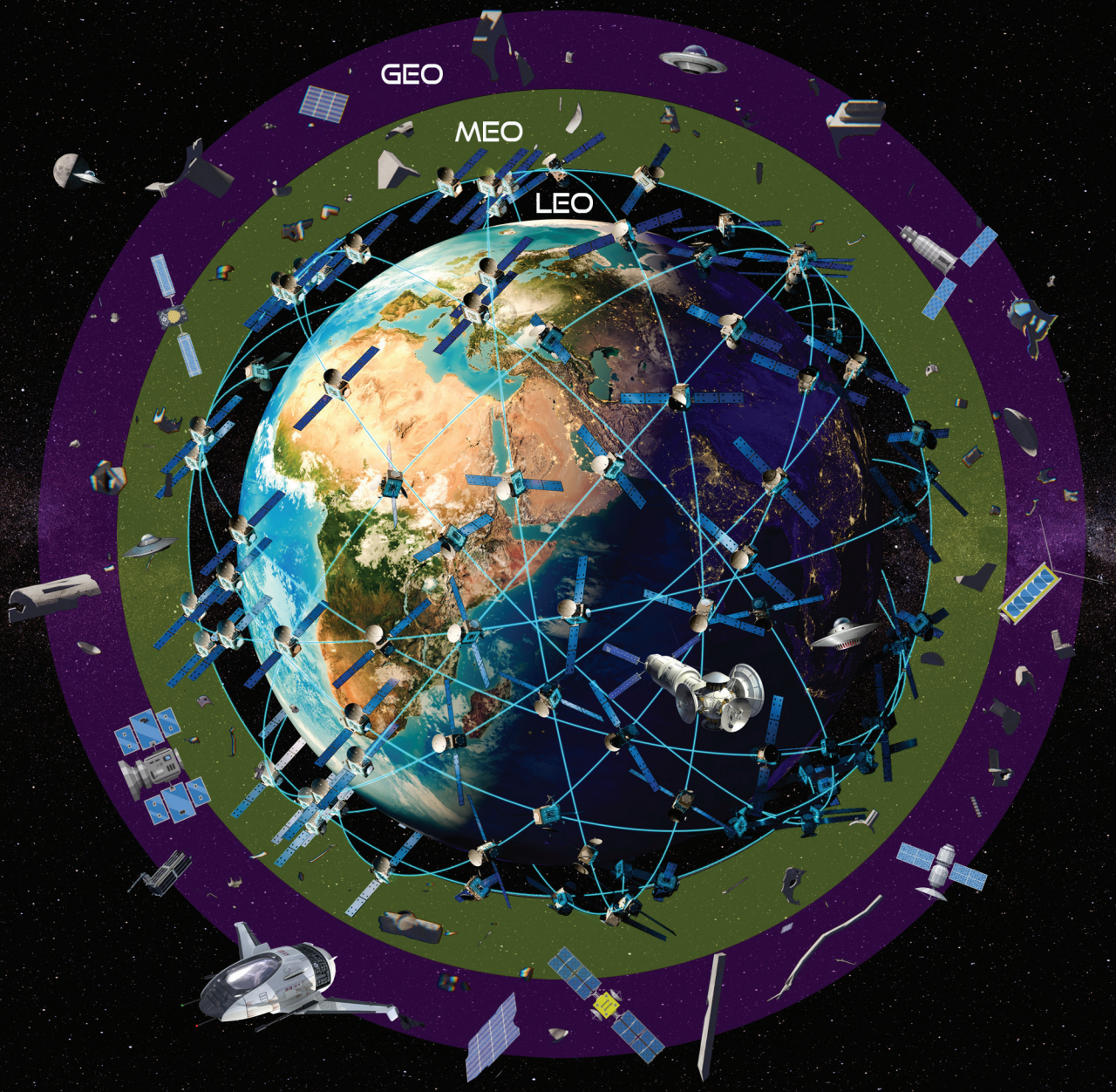
Space Domain Awareness

. . . A Global Concern



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Space Domain Awareness

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"If I (we) have seen further, it is by standing on the shoulders of giants."

Sir Isaac Newton

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Preface

In 2022, more than 80 countries have civil space agencies, and about one-third of them also have military interests in space. Hundreds of corporations around the globe offer space-related products and services. All these organizations—civil, commercial, and military are exploiting or hoping to exploit the many advantages of space.

We've titled this book *Space Domain Awareness* (SDA) to distinguish it from space situational awareness (SSA), which, according to the US Space Foundation, "refers to the ability to view, understand and predict the physical location of natural and man-made objects in or around Earth, to avoid collisions." A related term common in the literature is space traffic management (STM), which we define as "the set of technical and regulatory provisions and processes used to oversee, coordinate, regulate, and promote safe and responsible space activities."

Our working definition of space domain awareness focuses on SDA practitioners-organizations responsible for maintaining space domain awareness. **Space domain awareness is the actionable knowledge required to predict, avoid, deter, operate through, recover from, and attribute the cause to losing or degrading space capabilities and services.**

In essence, SDA practitioners establish a baseline of objects in Earth orbit, note changes to the baseline, understand what changed and why, assess possible outcomes due to the change, and determine a course of action to deal with the change, if necessary. The space objects in the baseline may range in size from entire space stations to golf-ball-sized (or smaller) objects, including functional spacecraft, non-functional spacecraft, and to some extent natural and artificial debris that could threaten functional spacecraft. We use the term resident space object (RSO) to denote objects of interest to SDA practitioners.

This book aims to provide an overview of space domain awareness and establish basic principles, philosophies, and approaches that are useful to conduct SDA operations. These operations include, but are not limited to, detecting, identifying, tracking, and characterizing objects and their behaviors; detecting changes associated with selected RSOs; and potentially mitigating threats.

Space operators face many threats, ranging from on-board anomalies, space weather events, potential collisions, inadvertent re-entry, radio frequency interference, and actions taken by well-meaning operators or nefarious actors.

Personal Perspective

For me, this book is a dream come true. After 40 years of working in the space community, we persuaded the "best-of-the-best" thought leaders in space operations to

contribute their wealth of experience and lessons learned to this project. This is good for me, but REALLY good for you because you'll benefit from the 200-plus years (that's over two centuries!) of collective experience in operating space systems.

Several very talented individuals have provided the leadership of this project over the last 30-plus years! I wish to express my deepest gratitude to Brigadier Generals Bob Giffen, Mike DeLorenzo, and Marty France for their vision and persistence in leading this community effort. Lieutenant Colonel Mark Charlton and later Colonel Luke Sauter supplied the hands-on leadership to make this SDA book a reality. Thank you!

Space Domain Awareness is the 30th book in the Space Technology Series. Most of the other titles within the Series support SDA: *Understanding Space; Space Mission Analysis and Design; Human Spaceflight; Space Propulsion Analysis and Design; Space Launch Systems Design and Operations; Space Mission Operations; Applied Space Systems Engineering; Applied Project Management for Space Systems,* and others provide necessary background information that supports the development of SDA practitioners.

Here I must recognize the forbearance and suffering of the numerous contributing authors, artists, and editors of this text. They have outlined, drafted, reorganized, reviewed, and re-crafted their material for six years to suit the editors' demands. This book would not be possible without their expertise, persistence, and patience. As editors, our goal has been to create a useful, professional book of which the authors can be proud.

The true heroes of this effort are Anita Shute, Marilyn McQuade, Linda Gentsch, and Mary Tostanoski. As a team, they edited every word and did everything necessary to create a camera-ready copy that truly represents the quality of the author and editor team. Anita Shute personally entered and formatted every page of the book, as she has done for 27 others. Marilyn McQuade spent untold hours reviewing, editing and updating the draft of the book. Mary Tostanoski created initial drafts of graphics and dealt with the myriad modifications. Linda Gentsch powered through all issues for years to format this eBook using the Habitat System provided by Inkling. Thank you all for your dedication and excellence!

For me, the joy of this endeavor was greatly enhanced by my two exceptional co-editors: Pamela Magee and Moriba Jah. They dedicated themselves to working with their teams to write this book and made the six years stimulating and enjoyable! Many of the authors have expressed their gratitude for the editorial team's leadership, insights, and wisdom.

Finally, I want to express my heartfelt appreciation to my family and friends for their unswerving support and encouragement while suffering my dream with me!

The authors and editors of *Space Domain Awareness* hope that our colleagues, young and old, will find this book useful in preparing to meet the challenges ahead in managing space operations for national defense, civil application, and commercial enterprise.

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