The Canadian Space Agency (CSA) is a government organization committed to promote the peaceful use and development of space knowledge for the social and economic benefit of Canadians and humanity. The Telemetry, Tracking and Control (TT&C) team within CSA is responsible for ensuring proper communication between most Canadian government satellites along with several other European satellites and ground stations. The team also maintains and upgrades the communication equipments and software at Canadian ground stations. TT&C used a commercially written Simplified General Perturbations Satellite Orbit Model 4 (SGP4) propagator to predict the position of satellites, as shown in Figure 1. This tracking allows for the proper orientation of the communications antenna, known as the antenna pointing angle. However, SGP4 was not up-to-date for the current demanded of satellite tracking and has some disadvantages. Ilia B. Baranov, a University of Waterloo co-op student, was hired to develop an updated version of the propagator in-house software, based on the existing source code.

**WCDE-00087-TN**  
Revision 100621

csa propagation software development

**Teaching Note**

Ilia V. Baranov and David Effa

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| **Figure 1: 2D projection of two passes** |

# Expected Learning Outcomes

This case study is intended for introduction to some of the basic methods and principles used by software engineers, including fundamentals of technical communication, analysis, and design. This case is particularly designed for **SE 100** (Introduction to Methods of Software Engineering) course, where students are introduced to some of the basic methods of the software development process, including problem identification, requirement analysis, design, implementation and testing.

After the completion of the case study, the student will be able to:

* Identify shortcomings in SGP4 source code
* Perform a needs analysis and write a design specification for the propagation program
* Describe the various phase used to develop the new software to address the problem
* Validate the results of a test code

# Organization of Case

In this case study, different aspects of an orbital propagation theory and satellite communication requirements are discussed. The application and limitations of the existing satellites tracking software is presented. The following is a breakdown of the four parts and gives brief details of the contents.

# WCDE-00087-01: Case Study

This module constitute the case itself and will present the problem description and background information about CSA and existing SGP4 software. The module will have

* Opening paragraph (Introduction)
* CSA Background
* Introduction to satellite communication and the role of SGP4
* Problem description

# WCDE 00087 - 02: Software Life Cycle and Design Requirement

This module provide the software development process in general used and the different

the case itself and will present the problem description and background information about CSA and existing SGP4 software. The module will have

* IVB SGP4 Propagation Software Development Process
* Need analysis for satellite tracking
* Satellite Communication Requirements

Recommended activities

Identify the existing problem/downfall

Discuss the different cycle in the software development

Discuss about the software design requirement

# WCDE 00087 - 03: Software Design, Implementation and Testing

This module consists the design aspect and implementation of IVB SGP4. it also contain the Test results of the updated software

* Design Specification for the Propagation Program
* Description of the features added to the source code
* Program Design and Implementation
* Methodology used to validate the updated software (IVB SGP4)

Recommended activities

* Discuss the activities in the design of the software
* Discuss the activities for updated software implementation
* Discuss the activities for updated software Test
* methods to integrate the new code into the existing TT&C infrastructure and foreseeable limitations
* examines the testing and validation procedures taken along with the results obtained.

**References**

[1] Ilia V. Baranov, “SGP4 Propagation Program Design and Validation”, 1A Work Term Report, Department of Electrical and Software Engineering, University of Waterloo, Waterloo, ON Canada, April 13, 2009

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