IVB SGP4 Propagation Software Development Process

csa propagation software development

# Software Life Cycle and IVB SGP4 Design Requirements

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The software development life cycle is a multistep process that covers development, implementation, and retirement of information systems. There are several life cycle [models](http://en.wikipedia.org/wiki/Software_development_process#Software_Development_Models), each describing different approaches to a variety of [tasks or activities](http://en.wikipedia.org/wiki/Software_development_process#Software_development_activities) that take place throughout the process. IVB SGP4 propagation software development process consists of five inter-related phases, including: requirements analysis, design, implementation, system testing and maintenance, as shown in Figure 1.  Each phase produces deliverables required by the next phase in the software development life cycle.  Initially, the IVB SGP4 propagation software requirements are identified and translated into a feasible design.  Then, code is produced during implementation, which is driven by the design deliverables.  Finally, testing verifies the deliverable of the implementation phase against requirements identified earlier in the cycle. Each phase of the IVB SGP4 propagation software development process will be discussed.

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| **Figure 1: Software Development Life Cycle used for IVB SGP4 Software development** |

**Satellite Communication Requirements**

Defining the IVB SGP4 propagation software requirements is the first phase of a software development life cycle.  To determine the software requirements, meetings are held with system users, managers, and other stakeholders.  Some of the questions posed during a typical requirements gathering include:

1. What are the functional requirements of the system?
2. What data should be input into the system?
3. What data should be output by the system?
4. Who is going to use the system?
5. How will they use the system?

The primary function of the IVB SGP4 propagation software is to track satellites as they orbit in space. The requirements identified to address the needs and functions of this orbital prediction software can be summarized as follows:

**Accuracy** - The first requirement of the IVB SGP4 was accurate prediction capability. The spacecraft must be targeted by the antenna with an accuracy of ± 0.4 degrees at all times. This region is known as the Region of Visibility, as the signal strength drops quickly outside this region. The loss of signal strength is known as attenuation, and a misalignment of 0.4 degrees would cause an attenuation of 3dBm. This attenuation is represented in Figure 2.

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| http://www.darkgovernment.com/news/wp-content/uploads/2009/09/solar-satellite.jpg  **Figure 2: Region of Visibility [1]** |

**Reliability** - Satellite communication with Low Earth Orbit (LEO) satellites involves accurate timing and planning. Because the satellite is in view for only a limited amount of time, each pass is crucial to scientific research and has a large monetary value. Because of this, the TT&C system must be extremely reliable. This requirement places severe constraints on communication and tracking methods, some of which are listed here. In this context, the software Reliability is the probability of failure-free software operation for a specified period of time in a specified environment. Software Reliability is also an important factor affecting system reliability.

**Data Format** - The program must have the ability to provide data in a variety of forms. The data input and output requirements included full data, visible only, pass list and solar. This requirement was used in the design of data output format, the details of which are presented in Appendix B [1].

**Integration** - The propagator must allow multiple applications to obtain data simultaneously.

**Execution speed** - The code must be able to generate an entire overhead pass within a second with reasonable accuracy. This entails the use of recursive programming methods, search algorithms, and optimization of reading and writing operations using buffers.

**Feature addition -** The program must allow features (functions and outputs not present in the original code) to be added that will tailor system operation and results to TT&C needs. Enabling variable time steps, multiple output formats, and a sub method for projecting XYZ coordinates onto a 2D earth map are features that were added to the new software.

The above requirements were gathered from different stakeholders over time. The new software, IVB SGP4, needed to satisfy each of these requirements. In addition, an analysis of the scope of the development must be determined and clearly stated.

**References**

[1] Ilia V. Baranov and David Effa, “CSA propagation software development”, WCDE 00087-01, Waterloo Cases in Design Engineering, July 2010

[2] 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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