1 Complex Systems in Spaceflight
Complex systems require detailed system engineering for their design, construction, verification, and finally for testing their completion and final validation. For many years system engineering has been supported by computer-based system simulation techniques. In fact, as early as the Apollo program, NASA and its contractors applied such methods. However, with today’s significantly more powerful computers and sophisticated software tools, one can derive much greater performance from simulation infrastructures.

Such simulation techniques in principle are used in every industry sector from space, through the automotive industry to plant manufacturing. In every domain of use, special requirements concerning the design and verification tools are applicable. This book introduces the techniques for system simulation in the context of "Model-based System Engineering". Provided real-world examples mainly originate from the field of satellite development. However, the introduced underlying steps of system design, verification and the provided software methods are of universal use.

The following are some examples of complex systems originating from the field of space applications, which require system simulation for their development. To maintain the analogy from ground into space firstly all launch vehicles will be addressed.

**Rocket Launchers**

![Cutaway of an Ariane 5 rocket](Figure 1.1: Cutaway of an Ariane 5 rocket. © ESA)

![Figure 1.2: Soyuz launcher](Figure 1.2: Soyuz launcher. © ESA)