Model-based system architecture (MBSA) combines the two key technologies: model-based and system architecting. Both are major parts of the future state of systems engineering [57].

Many systems result from an evolutionary development. They are driven by their parts and do not emerge from the architecture. The parts could be anything that in combination are assembled to a man-made technical system. System architecture is exhibited by a complete system. Often system architecture is referred to the architecture from the perspective of a software architecture in combination with the hardware or the architecture of software-intensive systems [20]. We understand system architecture is more holistic and also consider systems without any software. Although systems without any software that are handled with systems engineering processes and model-based system architecture concepts like described in this book are very rare, a system architecture is always present. In today’s and future systems engineering, it is crucial to apply explicit system architecting for the success of the system project [57]. Chapter 4 defines the term system architecture within its context.

Studies clearly show that system architecting is critical for the performance and success of the system [34]. This is particularly evident for projects that require significant architectural work or rework. Due to more and more dynamic and complex markets and environments,
the system architecture must more and more withstand the changing requirements and requests for radical changes. Chapter 3 lists the benefits of system architecting.

System architecture is about establishing solutions that are checked for feasibility by the corresponding experts, about designing interfaces that are agreed from both sides, and about ensuring that the people who should know the architecture of a system have a common understanding of it. MBSA uses models for enabling the creation of healthy communication around the architecture of the system and for ensuring that the architecture is validated from different points of view. Models are a key tool to be capable of developing complex systems on time and in a feasible quality. Chapter 5 defines the term model and MBSA and discusses the related terms.

Models are more than graphics. There are even models without any graphical representations. Just the graphics is not modeling, but drawing. To create a model you need semantics, which you find in a modeling language. We use the international standard Systems Modeling Language (SysML) as language for the system requirements and architecture models. Appendix A gives an overview about SysML. Although we extensively use SysML in this book, our methods and concepts are independent on SysML and could also be implemented by other modeling languages.

The system architect is the one in charge of shaping the system architecture. This is a big responsibility and a big challenge. The organizations dependent on the system should carefully select the people who are allowed to architect the system — and these people’s work results will be tightly monitored by stakeholders everywhere in the organization. Chapter 19 describes how system architecting could be embedded in an organization and Chapter 10 discusses the interfaces to the stakeholders of system architecting. In particular Chapter 8 introduces the adjacent discipline requirements engineering that closely collaborates with the system architecting. The SYSMOD zigzag pattern presented in Chapter 7 shows the relationship between requirements and architecture and clearly demonstrates the need for a close collaboration. Artifacts of the model-based requirements and use case analysis are important inputs for the system architects especially to elaborate a functional architecture using the so-called FAS method.

Chapter 14 is a comprehensive presentation of the Functional Architectures for Systems (FAS) method. Functional architectures are built of functions only and are independent of the physical components that implement the functions. The functional architecture is more stable than
a physical architecture that depends on the steadily changing technologies. The architecture principle to separate stable from unstable parts is covered in Chapter 7 about architecture patterns and principles.

Besides the functional architecture we define and discuss further system architecture kinds: the base architecture that fixes the preset technologies and adjusts the scope for innovation, the logical architecture that specifies the technical concepts and principles, and the product architecture that finally specifies the concrete system. All three architecture kinds are physical architectures. The layered architecture is an orthogonal aspect to these architecture kinds and is presented in Chapter 9.

Another orthogonal aspect is the modeling of variants. Variability is increasingly important. The markets are no longer satisfied by commodity products. The market requests customized products that fit to personal demands of the customers. In addition, global markets with different local environments and policies require different configurations of a system. Chapter 15 presents a model-based concept to specify different product configurations.

The architecture concepts are presented with a consistent example system. The “Virtual Museum Tour” system provides virtual visits by driving with camera-equipped robots through a real museum. The system is easy to understand and at the same time is sufficiently complex to demonstrate the system architecting concepts. The system is introduced in Chapter 2.

The system architect who thinks that his job is to make a diagram and save it on a shared network drive will most probably fail. Same for the system architects who think they are the bosses of the development staff and can instruct the other engineers. It is neither an archeological job nor a chief instructor job. System architecting is a collaborative work that requires communication and soft skills. The basics for a good communication is a common language and media to transport the information. Chapter 6 covers the artifacts of the architecture documents. In Chapter 16, we extend our scope to system of systems and architecture frameworks.

Typically, engineers are focused on the technology challenges of their job. Nowadays, communication and more general soft skills are getting more and more important capabilities. The engineering disciplines are growing together. For instance, that could be seen by the modern discipline mechatronic. And the worldwide mankind is growing together due to the Internet, other communication, and transportation technologies.
In consequence, an engineer has an increasing number of communication relationships. She is no longer successful when she only manages her technology tasks. It is also important to collaborate well with team members, stakeholders, communities, and so on. Chapter 20 gives an introduction about soft skills for engineers.