In the thesis, we propose an approach to modelling of component-based systems and formal description of their behaviour. The approach is based on a novel component model defined by a metamodel in a logical view and by description in the pi-calculus in a process view. We show that the component model addresses the dynamic aspects of software architectures including the component mobility. Furthermore, we propose a method of behavioural modelling of service-oriented architectures to pass smoothly from service level to component level and to describe behaviour of a whole system, services and components, as a single pi-calculus process. Finally, we illustrate an application of our approach on a case study of an environment for functional testing of complex safety-critical systems. The support of dynamic architecture and the integration with service-oriented architecture compromise the main advantages of our approach.