The goal of Web services is to enable interoperability of heterogeneous software systems. Semantic Web services enhance syntactic specifications of traditional Web services with machine processable semantic annotations to facilitate interoperability. AsWeb services get popular in both corporate and open environments, the ability to deal with uncompatibilities of service requesters and providers becomes a critical factor for achieving interoperability. Process mediation solves the problem of interoperability by identifying and resolving all incompatibilities and by mediating between service requesters and providers. In this thesis we address the problem of process mediation of Semantic Web services. We introduce an Abstract Process Mediation Framework that identifies the key functional areas to be addressed by process mediation components. Specifically, we focus on process mediation algorithms, discovery of external services, monitoring, and fault handling and recovery. We present algorithms for solving the process mediation problem in two scenarios: (a) when the mediation process has complete visibility of the process model of the service provider and the service requester (complete visibility scenario), and (b) when the mediation process has visibility only of the process model of the service provider but not the service requester (asymmetric scenario). The algorithms combine automated planning and semantic reasoning with discovery of external services that act as data mediators. In dynamic open environments, such as Internet, discovery is a necessary part of process mediation since external services might not be known to the process mediation component. We introduce a combined and a composed match as a suitable approach to discovery in the process mediation context. We identified three types of collisions which might need to be avoided in combined matches. These include undesired side-effects, effect duplications, and contradictory effects.