This dissertation proposes a complete solution to provision 6LoWPAN with semantic annotation to power the development of IoT applications on Web. We aim to bring smart object services to the Web and make them accessible by plenty of existing Web APIs in consideration of 6LoWPAN constraints such as limited resources (ROM, RAM, and CPU), low-power, and low-bitrate communication links. There are four contributions: (i) The first contribution is about the overall architecture of the semantic service provisioning for IoT application on Web consisting of three subsystems: service communication, service provisioning, and service integration. (ii) The second contribution studies the internetworking model between 6LoWPAN and regular IPv6 networks by a design, implementation, and performance evaluation of a 6LoWPAN consisting of MTM-CM5000-MSP TelosB motes with TI MSP430F1611 microprocessors and CC2420 IEEE 802.15.4 radio transceivers for smart objects, and Raspberry Pi for an edge router; (iii) The third contribution presents the detailed architecture, algorithms, and mechanisms for provisioning reliable, scalable, and secure smart object services with respect to its resource-constrained requirements; (iv) The fourth contribution is in application domain for service integration in which we apply the proposed architecture on two innovative IoT applications on Web: a building automation system (SamBAS) and a Social IoT platform (ThingsChat).