As various of wireless techniques have been proposed to achieve fast and efficient data communication, it's becoming increasingly important to protect wireless communications from being undermined by adversaries. A secure and reliable wireless physical layer design is essential and critical to build a solid foundation for upper layer applications. This dissertation present two works that explore the physical layer features to secure wireless communications towards the data confidentiality and user authentication. The first work builds a reliable wireless communication system to enforce the location restricted service access control. In particular, the work proposes a novel technique named pinpoint waveforming to deliver the services to users at eligible locations only. The second work develops a secure far proximity identification approach that can determine whether a remote device is far away, thus preventing potential spoofing attacks in long-haul wireless communications. This dissertation lastly describes some future work efforts, designing a light-weight encryption scheme to facilitate sensitive data encryption for applications which cannot support expensive cryptography encryption operations such as IoT devices.