The transmission of single photons enables the secure exchange of information via quantum key distribution (QKD), which is the first commercially available quantum information technology. Experimental QKD systems have reached high repetition rates, and communication channels beyond 200 km have been successfully implemented. In this presentation, we summarize how single photons can be efficiently generated based on semiconductor quantum dots integrated in microcavities, and how these single photons can be utilized to establish secure communication across a 500 m long free-space link in downtown Munich [1,2]. To realize long distance communication and overcome limitations of single photon absorption, quantum repeater protocols have been invented, which utilize the teleportation of quantum properties over distance to increase the distance of quantum communication links. We furthermore present and discuss the realization of single spin quantum memories [3,4], quantum dot spin-photon entanglement [5] and the generation highly indistinguishable single photons [6] as important building blocks for the realization of future quantum networks.