Abstract

Disasters are catastrophic events that cause great damage or loss of life. In disasters, communication services might be disrupted due to damage to the existing network infrastructure. Temporary systems are required for victims and first responders, but installing them requires information about the radio environment and available spectrum. A cognitive radio (CR) can be used to provide a flexible and rapidly deployable temporary system due to its sensing, learning and decision-making capabilities. This thesis initially examines the potential of CR technology for disaster response networks (DRN) and shows that they are ideally suited to fulfill the requirements of a DRN.

A software defined radio based prototype for multiple base transceiver stations based cellular network is proposed and developed. It is demonstrated that system can support a large number of simultaneous calls with sufficient call quality, but only when the background interference is low. It is concluded that to provide call quality with acceptable latency and packet losses, the spectrum should be used dynamically for backhaul connectivity.

The deployment challenges for such a system in a disaster include the discovery of the available spectrum, existing networks, and neighbours. Furthermore, to set up a network and to establish network services, initially CR nodes are required to establish a rendezvous. However, this can be challenging due to unknown spectrum information, primary radio (PR) activity, nodes, and topology. The existing rendezvous strategies do not fulfill the DRN requirements and their time to rendezvous (TTR) is long. Therefore, we propose an extended modular clock algorithm (EMCA) which is a multiuser blind rendezvous protocol, considers the DRN requirements and has short TTR. For unknown nodes and topologies, a general framework for self-organizing multihop cooperative fully blind rendezvous protocol is also proposed, which works in different phases, can terminate when sufficient nodes are discovered, and is capable of disseminating the information of nodes which enter or leave a network. A synchronization mechanism is presented for periodic update of rendezvous information. An information exchange mechanism is also proposed which expedites the rendezvous process. In both single and multihop networks, EMCA provides up to 80% improvement in terms of TTR over the existing blind rendezvous strategies while considering the PR activity. A simple Random strategy, while being poorer than EMCA, is also shown to outperform existing strategies on average.

To achieve adaptability in the presence of unknown PR activity, different CR operating policies are proposed which avoid the channels detected with PR activity to reduce the harmful interference, provide free channels to reduce the TTR, and can work with any rendezvous strategy. These policies are evaluated over different PR activities and shown to reduce the TTR and harmful interference significantly over the basic Listen before Talk approach. A proactive policy, which prefers to return to channels with recent lower PR activity, is shown to be best, and to improve the performance of all studied rendezvous strategies.