Abstract

An emerging class of distributed systems such as the mobile adhoc networks (MANETs), wireless sensor networks (WSNs), and distributed embedded systems (DES), e.g., fly-by-wire (FBW) and steer-by-wire (SBW) systems, have attracted significant attention over the past few years. As these systems grow in size, they are likely to suffer from component failures due to the increased system complexity. The kind of faults these networks experience are also quite different from each other, and thereby necessitate the assumption of a different fault model for each such as a crash fault model, a value fault model or an intermittent fault model, under either a static or a dynamic fault environment. The diagnosis of faults in these distributed systems becomes important in order to ensure reliability of such systems. It is believed that the existing distributed diagnosis techniques provide a guiding framework for delivering a fault tolerant solution for the above classes of distributed systems. In distributed diagnosis, all or many nodes need to record the fault status of rest of the nodes in the system.

Motivated by the need for the design of appropriate fault diagnosis algorithms for the wireless adhoc networks and distributed embedded systems, the investigation in this thesis mainly resulted in devising four distributed diagnosis algorithms. The first distributed system level diagnosis algorithm in chapter 3 has been proposed for MANETs under a dynamic fault environment where the mobile nodes are subjected to both crash and value faults. The second distributed diagnosis algorithm presented in chapter 4 is used to diagnose intermittently faulty sensor nodes and faulty communication links in a WSN. In chapter 5, a linearly scalable distributed diagnosis algorithm has been proposed for large and complex wireless distributed systems consisting of both mobile nodes and static sensor nodes under the crash and value fault model. To see the feasibility of distributed diagnosis algorithm for safety-critical distributed system, the purpose of the fourth distributed diagnosis algorithm in chapter 6 is to diagnose faulty actuators in distributed embedded systems such as an FBW system within a designer specified deadline. The work in this dissertation primarily aims to investigate the voids identified

in the field of distributed system level fault diagnosis. Also, the current research work establishes a synergy between the distributed system level diagnosis theory and practical distributed systems.

All the proposed algorithms in this dissertation have been evaluated both theoretically and through simulation using generic diagnostic parameters such as the diagnostic latency and the message complexity.

Keywords: Distributed system level diagnosis, Crash and Value fault model, Intermittent fault model, Wireless ad hoc systems, Distributed embedded system, Hierarchical clustering, Heartbeat and comparison based testing strategy, Bounded correctness, Diagnostic latency, Message complexity, Identifiability.