On the use of Dual-Band Reconfigurable Antennas in Delay-Sensitive Multi-Hop Wireless Sensor Networks

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Systems supporting various wireless standards (e.g., IEEE 802.11/16, WiFi, WiMAX, Wideband CDMA, and ETSI HIPERMAN) are now being deployed in increasing numbers. This trend is reflected by the growing interest in multi-hop wireless sensor networks and emerging concepts in this area have the potential to enable the next revolution in information technology – *pervasive computing and ubiquitous network access*. The strong demand for high-speed, broadband wireless connectivity stems mostly from new software-defined applications, utility computing, and a widespread desire for real-time information access. Thus, future wireless communication infrastructures will face the multifaceted challenge of supporting large traffic volumes and providing reliable service with low latency, power budgets, and costs. These issues will play a critical role outside the consumer and industrial sectors, where reconfigurable (ad hoc) networks used by disaster relief teams and sensor networks of homeland security systems will require near-real time functionality to maximize their impact and presence.

Most of the research on wireless systems found in the literature to date focuses on maximizing the Shannon capacity and spectral efficiency of point-to-point channels; on designing protocols for topology management, routing and congestion control in ad hoc environments; or on increasingly complex multi-terminal transmission paradigms for network information theory. An asymptotic framework is essential to many of these results where information is processed over very long blocks of data, thereby creating ever-increasing delay in the network. While classic information theory is suitable for the analysis of maximum throughput in point-to-point communications, it overlooks many important aspects of end-user objectives. For delay-sensitive applications, performance is not captured adequately by the sole attribute of Shannon capacity. Rather, queue-length distribution, loss probability, and overall delay all influence the perceived quality of a network connection. The performance criteria emanating from these criteria are especially important in real-time applications where avoiding untimely delays and service interruptions can have severe impacts. This work will amalgamate many of these concepts and address them through the use of dual-band reconfigurable antennas. Results will be provided to demonstrate the applicability and fundamental gains in throughput and latency reduction in these distributed multi-level sensor networks with a dynamic link to a hub or backbone.