

**Maximizing Broadcast Throughput Under Ultra-Low-Power Constraints**

**Abstract:**

Wireless object-tracking applications are gaining popularity and will soon utilize emerging ultra-low-power deviceto- device communication. However, severe energy constraints require much more careful accounting of energy usage than what prior art provides. In particular, the available energy, the differing power consumption levels for listening, receiving, and transmitting, as well as the limited control bandwidth must all be considered. Therefore, we formulate the problem of maximizing the throughput among a set of heterogeneous broadcasting nodes with differing power consumption levels, each subject to a strict ultra-low-power budget. We obtain the oracle throughput (i.e., maximum throughput achieved by an oracle) and use Lagrangian methods to design EconCast—a simple asynchronous distributed protocol in which nodes transition between sleep, listen, and transmit states, and dynamically change the transition rates. EconCast can operate in groupput or anyput mode to respectively maximize two alternative throughput measures. We show that EconCast approaches the oracle throughput. The performance is also evaluated numerically and via extensive simulations and it is shown that EconCast outperforms prior art by 6*×*–17*×* under realistic assumptions. Moreover, we evaluate EconCast’s latency performance and consider design tradeoffs when operating in groupput and anyput modes. Finally, we implement EconCast using the TI eZ430-RF2500-SEH energy harvesting nodes and experimentally show that in realistic environments it obtains 57%–77% of the achievable throughput.

**Existing System:**

Active tags that can be attached to physical objects, harvest energy from ambient sources, and communicate tag-to-tag toward gateways Relying on node-to-node communications will require less infrastructure than traditional (RFID/reader-based) implementations. Therefore, as discussed, it is envisioned that such ultra-low-power nodes will facilitate tracking applications in healthcare, smart building, assisted living, manufacturing, supply chain management, and intelligent transportation. A fundamental challenge in networks of ultra-low-power nodes is to schedule the nodes’ sleep, listen/receive, and transmit events without coordination, such that they communicate effectively while adhering to their strict power budgets.

**Proposed System:**

We formulate the problem of *maximizing broadcast throughput among energy-constrained nodes*. We design, analyze, and evaluate EconCast: Energyconstrained BroadCast. EconCast is an asynchronous distributed protocol in which nodes transition between sleep, listen/ receive, and transmit states, while maintaining a power budget. The nodes and network we focus on have the following characteristics:

**Broadcast**: A transmission can be heard by all listening nodes within the communication range of the transmitting node.

**Severe power constraints**: The power budget is so limited that each node needs to spend most of its time in sleep state and utilize ultra-lower-power communication, resulting in supporting data rates of a few kbps. Traditional approaches that spend energy in order to improve coordination through slotting and synchronization based on accurate clocks, or form some sort of structure (e.g., routing tables and clusters) are too expensive given limited energy and bandwidth.

**Unacquainted**: Nodes should not require pre-existing knowledge of their environment (e.g., properties of neighboring nodes). This can result from the restricted power budget or from unanticipated environment changes due to altered energy sources and/or node mobility.

**Heterogeneous**: The power budgets and the power consumption levels can differ among the nodes.