**Motivation**

- **Applications**
  - High data-rate mission critical (e.g., SHM)
  - Real-time continuous monitoring (e.g., wildfire, security-surveillance, environmental)

- **Challenges: Scheduling and Routing**
  - **TDMA Scheduling**
    - Half-duplex transceivers (primary conflict)
    - 2-hop interfering links (secondary conflict)
  - **Routing Topology**
    - High node degree + small radius (SPT) => fewer concurrent transmissions but low delay
    - Low node degree + large radius (MIT) => more concurrent transmissions but high delay

**Problem Formulation and Solution**

- **Bounded-Degree Optimization Formulation**
  - **Bounded-Degree Minimum-Radius Spanning Tree (NP-Hard)**
    - Given a graph $G = (V,E)$, communication range $R$, and a constant $\Delta^* \geq 2$, construct a spanning tree $T$ of $G$ rooted at sink $s \in V$, such that:
      - Radius (max hop count to sink) of $T$ is minimized
      - Degree of any node in $T$ is at most $\Delta^*$
  - **Approximation**
    - Design an $(\alpha, \beta)$ bi-criteria approximation to BDMRST on Unit Disk Graphs such that:
      - Maximum node degree in $T$ is at most $\Delta^* + \alpha$
      - Radius of $T$ is at most $\beta$ times the optimal radius

- **Approximation Algorithm ($\mathcal{A}$) for BDMRST**
  - **Phase 1: Backbone Tree ($T_B$)**
    - Tessellate the region into hexagonal grid cells of length $R/2$
    - Choose one local root arbitrarily from each non-empty cell
    - Let $\mathcal{R} = \{r_1, \ldots, r_n\}$ be the set of local roots
    - Connect the local roots in a Breadth-First-Search order starting from the sink $s$ (using helper nodes when direct links do not exist), while ensuring the radius is not too long compared to an SPT on $\mathcal{R}$
  - **Phase 2: Local Spanning Trees ($T_j$)**
    - Nodes within each hexagonal cell form a complete graph
    - Construct local spanning trees $T_j$ with the remaining nodes in each cell such that no node exceeds degree $\Delta^*$
  - **BDMRST** = $T_B \cup \{T_j\}$

**Main Result and Evaluation**

- **Theorem**
  - Algorithm $\mathcal{A}$ gives an $(\alpha, \beta)$ constant factor approximation to the Bounded-Degree Minimum-Radius Spanning Tree problem on Unit Disk Graphs, where $\alpha = 10$ and $\beta = 6$.

**Evaluation**

- Evaluation of the interference-aware link scheduling algorithm in [1] on different trees. BDMRST achieves the best trade-off in terms of maximizing the aggregated sink throughput and minimizing the maximum delay.

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**References**


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