# Accepted Manuscript


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PII: S0304-3975(17)30707-7
DOI: https://doi.org/10.1016/j.tcs.2017.10.002
Reference: TCS 11338

To appear in: *Theoretical Computer Science*

Received date: 16 December 2015
Revised date: 18 September 2017
Accepted date: 2 October 2017

# The Topology of Wireless Communication on a Line

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October 3, 2017

**Abstract**

This note considers a 1-dimensional wireless network consisting of a set of $n$ stations located on a line, in the SINR model, which compares the received power of a signal at a receiver against the sum of strengths of other interfering signals plus background noise. The behavior of a multi-station network is described using the convenient representation of a *reception diagram*. In the SINR model, the resulting *SINR diagram* partitions the plane into reception zones, one per station, and the complementary region of the plane where no station can be heard. We use the minimum principle, recently shown to hold for the SINR function, to derive a tight bound on the number of connected components in 1-dimensional networks.

## 1 Introduction

**Background and motivation.** There is a wide range of challenges in wireless communication for which a more elaborate theory of the fundamentals of the communication network may be useful. Specifically, understanding the topology of the underlying communication network may lead to more efficient algorithms for problems such as scheduling, topology control and connectivity. We consider a wireless network $\mathcal{A} = \langle S, \Psi \rangle$, with a set $S = \{s_1, s_2, \ldots, s_n\}$ of $n \geq 2$ concurrently transmitting *radio stations* using power assignment $\Psi$, embedded in the 1-dimensional space. We employ the widely used *Signal to Interference-plus-Noise Ratio (SINR)*, by which, letting

$$\mathrm{SINR}_{\mathcal{A}}(s_i, p) \;=\; \frac{\psi_i \cdot \mathrm{dist}(s_i, p)^{-\alpha}}{\sum_{j \neq i} \psi_j \cdot \mathrm{dist}(s_j, p)^{-\alpha} + N} \;,$$

a receiver at point $p \in \mathbb{R}^1$ successfully receives a message from the sender $s_i$ if and only if $\mathrm{SINR}_{\mathcal{A}}(s_i, p) \geq \beta$, where $N$ is the environmental noise, the constant $\beta \geq 1$ denotes the minimum SINR required for a message to be successfully received and $\alpha$ is the path-loss parameter. Throughout, we assume the SINR function[1] with *free-space* path loss (that is, when the signal decays in proportion to the square of the distance between the transmitter and receiver, i.e., $\alpha = 2$).

Avin et al. [1] studied the topology and geometry of wireless communication in the SINR model, and their application to the point location problem, in the setting of *uniform transmission powers*, namely, assuming all stations transmit with the same power level. They have shown that

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[1] We may omit the subscript $\mathcal{A}$ when the network is clear from the context.