



Tuomo Lehtilä<sup>1</sup>  
Sanish Gurung  
Taoufiq Damir  
Amy Sokhna Sidibé  
Gizem Akman  
Valteri Niemi

<sup>1</sup> Department of Mathematics  
and Statistics,  
University of Turku  
others: Department of  
Computer Science,  
University of Helsinki

# FINDING FAKE BASE STATIONS

WITH DIRECTIONAL ANTENNA USING MEASUREMENT REPORTS

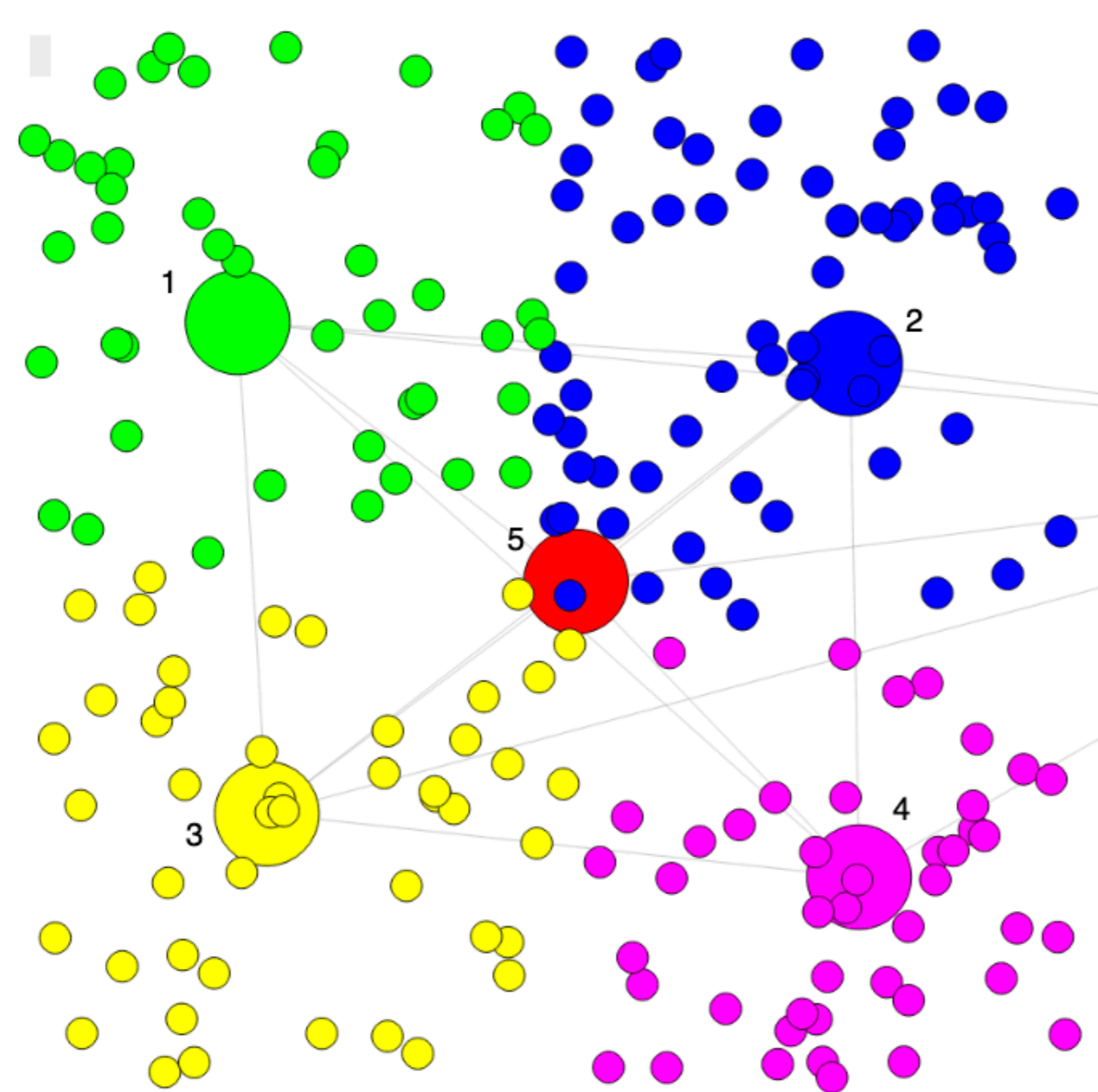
## BACKGROUND & GOALS

**FBS Localization:** is the process of pinpointing the geographical position of unauthorized cellular towers.

**Measurement reports (MRs):**

- ▶ They are used in handover decisions, as they contain information on cell signal strength (RSRP) and quality.
- ▶ MRs are collected from the serving and neighboring cells by mobile devices in Connected or Idle states.

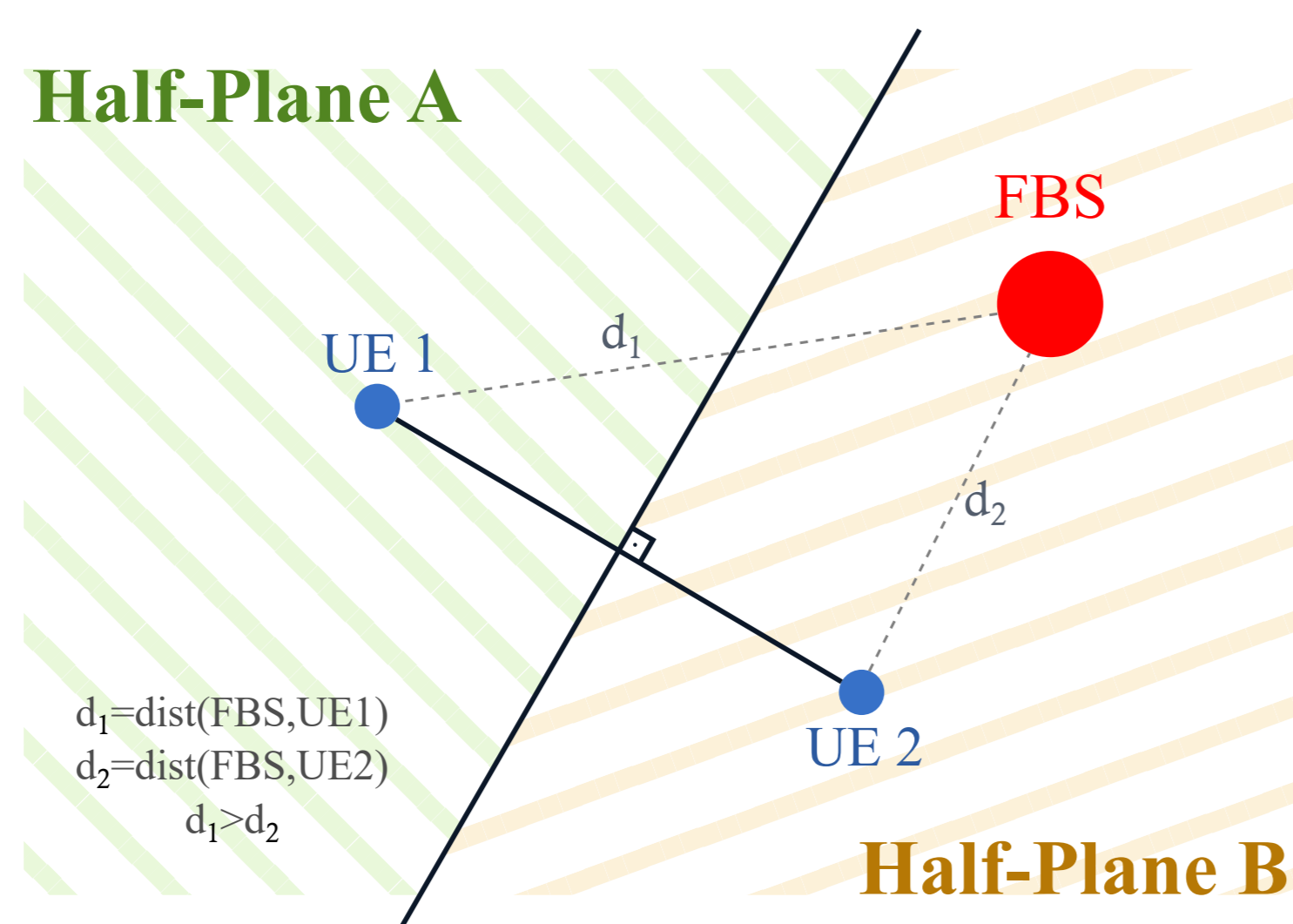
## EXPERIMENTAL SETUP (NS3)



Simulation Topology of 4 legitimate BSs with unique PCIs: {1,2,3,4}, one FBS (PCI=5, in red), and 200 UEs.

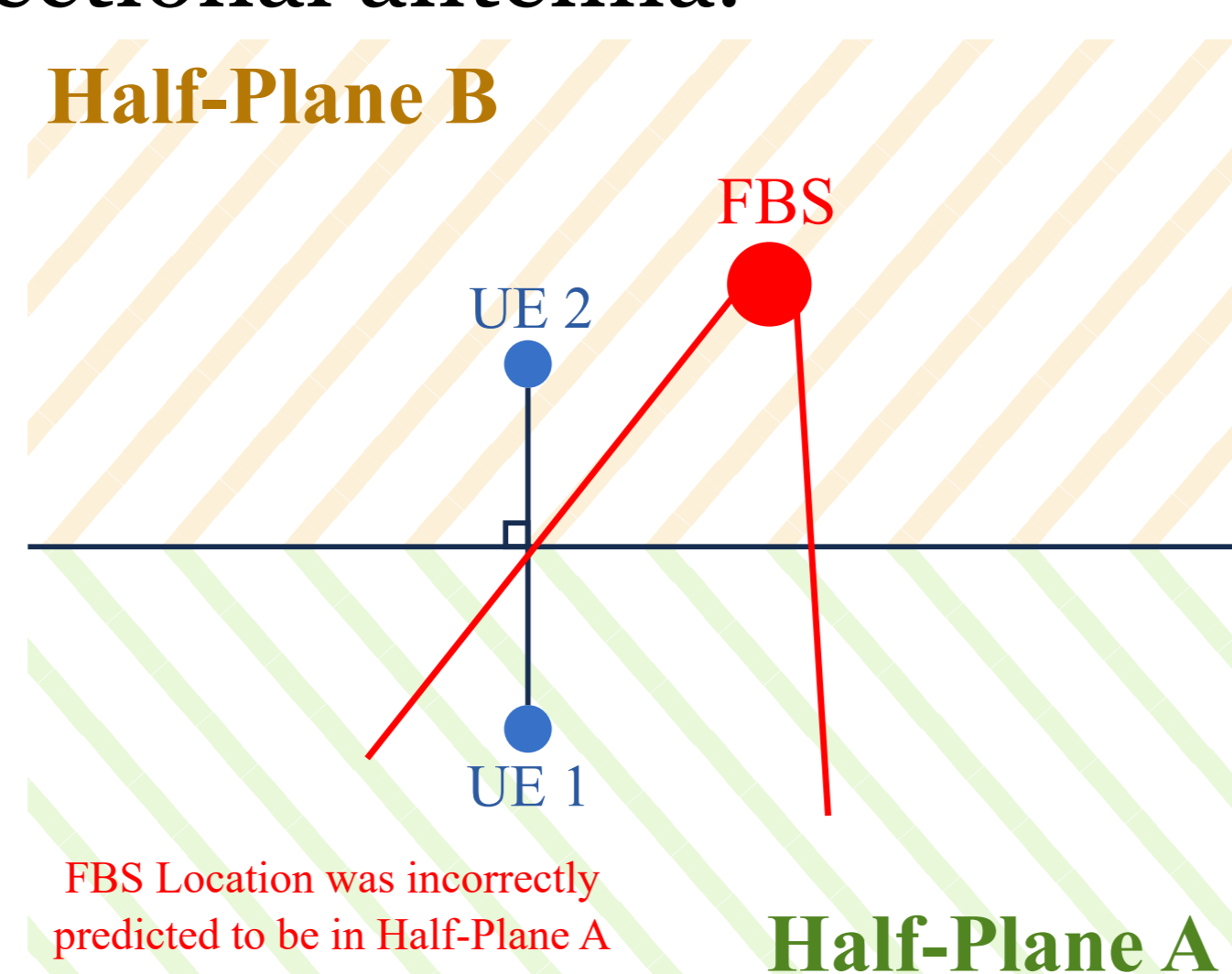
## PRIOR ART METHOD [1]

- ▶ For each pair of mobile devices that get the signal from the FBS, this FBS can be localized into a half-plane (HP).



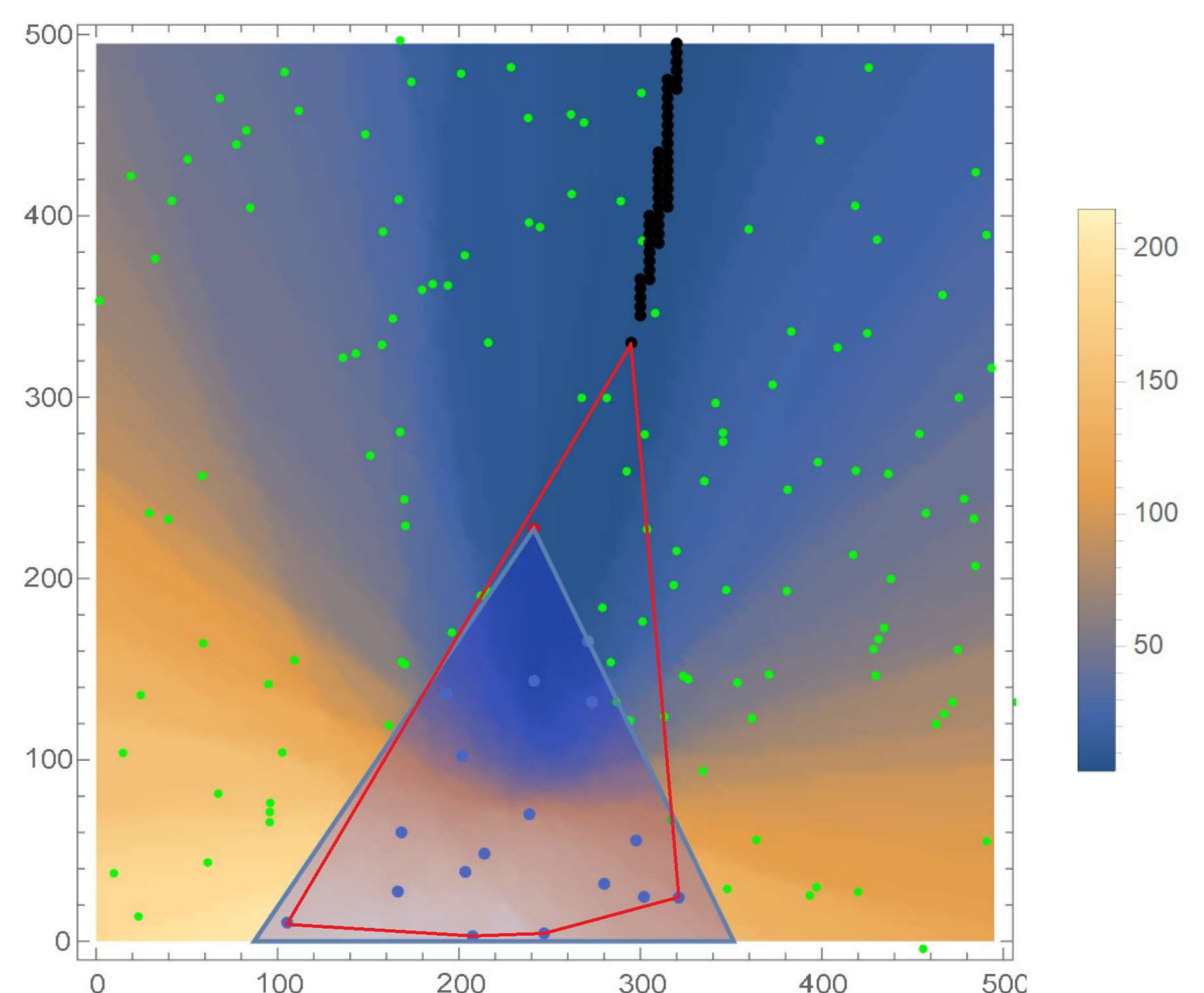
With many pairs of mobile devices, the FBS is localized into an intersection of many half-planes.

- ▶ We observed that the HP method does not work for an FBS with directional antenna.



## OUR METHOD

- ▶ We combine the **Half-Plane** with a **Convex Hull**.
- ▶ The blue points are UEs that receive signals from the FBS, while green ones do not receive signals.
- ▶ The black points have the best (lowest) score in the area after applying the HP method. The red point is the FBS position.



For each candidate point (location), a convex hull is formed over the blue points and this single point. In the figure, the convex hull for one of the black points is shown by the red line. The eight green points inside this hull give hull score 8. The lower the score, the more likely it is that the candidate point is the true FBS location.

## RESULTS

Location errors for an FBS with a  $120^\circ/90^\circ$  antenna.  $A/B$ , where  $A$  is obtained with the Friis model and  $B$  is obtained with the log-distance propagation loss model. (HP: Half-plane, HP-CH: HP and convex hull).

	Model	Average error (m)	Standard deviation (m)	Median error (m)
$120^\circ$	HP	17.5/17.8	21.8/22.4	12.7/11.9
	HP-CH	13.8/12.9	10.9/14.1	10.7/8.4
$90^\circ$	HP	31.2/35.1	36.8/41.4	20.5/18.7
	HP-CH	18.5/18.6	12.0/14.6	15.5/15.1

This paper will be presented at SECRIPT'26 [2].

## REFERENCES

- [1] Leyli Karaçay et al. "A Network-Based Positioning Method to Locate False Base Stations". In: *IEEE Access* 9 (2021), pp. 111368–111382. DOI: 10.1109/ACCESS.2021.3103673.
- [2] Tuomo Lehtilä et al. *Finding Fake Base Stations with Directional Antenna Using Measurement Reports*. URL: <https://secrypt.scitevents.org/Home.aspx>.

HELSINGIN YLIOPISTO  
HELSINGFORS UNIVERSITET  
UNIVERSITY OF HELSINKI

MATEMAATTIS-LUONNONTIETEELLINEN TIEDEKUNTA  
MATEMATISK-NATURVETENSKAPLIGA FAKULTETEN  
FACULTY OF SCIENCE