INDOOR MILLIMETER WAVE LOCALIZATION USING MULTIPLE SELF-SUPERVISED TINY NEURAL NETWORKS

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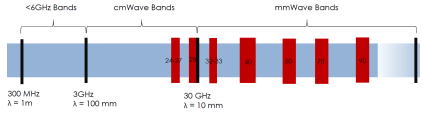
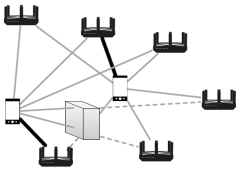
Why mmWaves for localization?

- Large available bandwidth
- Quasi-optical propagation results in dominant LoS and fewer NLoS paths
- But they are short-ranged, hence dense deployments are inevitable

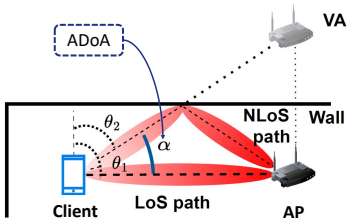




- Location information can be useful for:
  - Predictive handovers to prevent blockage events
  - Assistance in beam training procedure

Self-supervised tiny neural networks

- 3 hidden layers in the NN model
- Input features: angle-difference of arrivals (ADoAs)
- Trained in self-supervised manner using training labels obtained from JADE algorithm
- Why JADE?
  - Jointly estimates location of the clients and the APs
  - Requires zero knowledge of the indoor environment

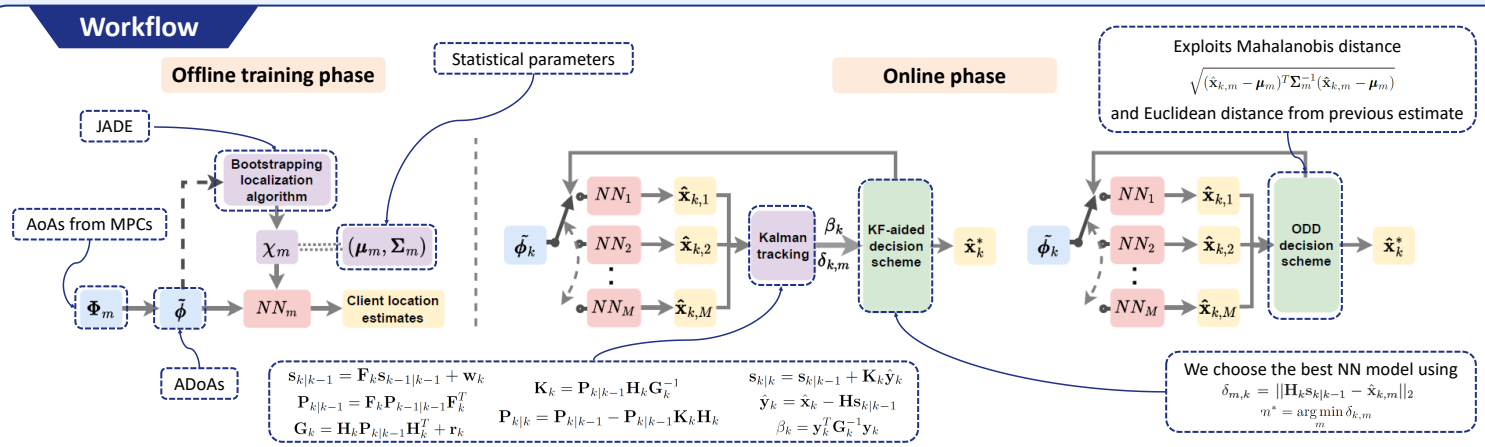


Challenge: A single NN learns feature mapping specific to the environment it is trained in, hence, it cannot generalize to generic and large environments

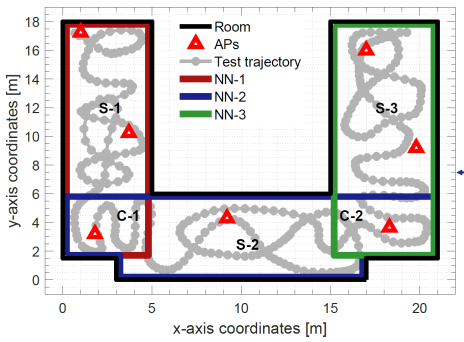
Problem statement

Use multiple self-supervised tiny neural networks for localization, but how to decide which one to switch to and when?

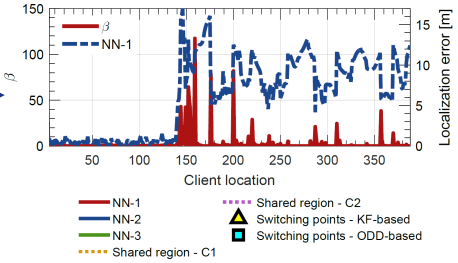
Workflow



Results

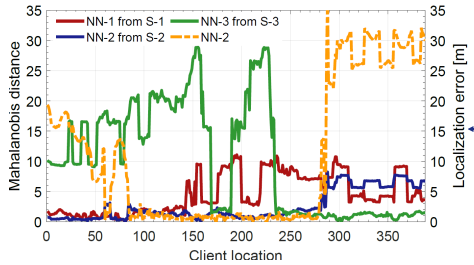


- Trajectory consisting of 388 client locations
- AoAs are perturbed with 5° error
- NNs have (53, 48, 48, 24, 2) neurons

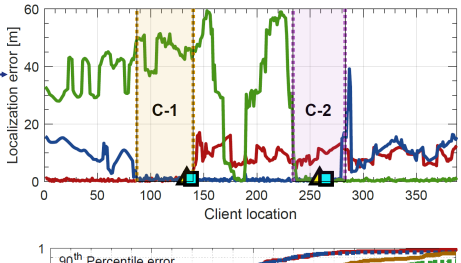


- β is normalized innovation squared metric (NIS)
- Threshold on β for switching = 2

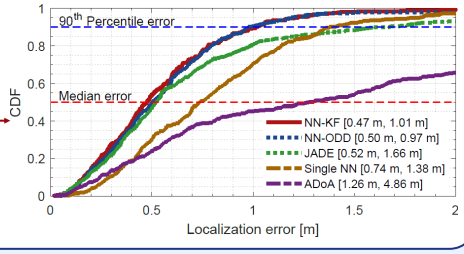
Note that wrong location estimates could be clustered together, resulting in small Mahalanobis distance



Trajectory reconstructed by switching to the right NN and stitching the location estimates



Reconstructed trajectory after NN switching achieves sub-meter localization error in 92% of the cases



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