High Resolution Radio-Based Positioning System

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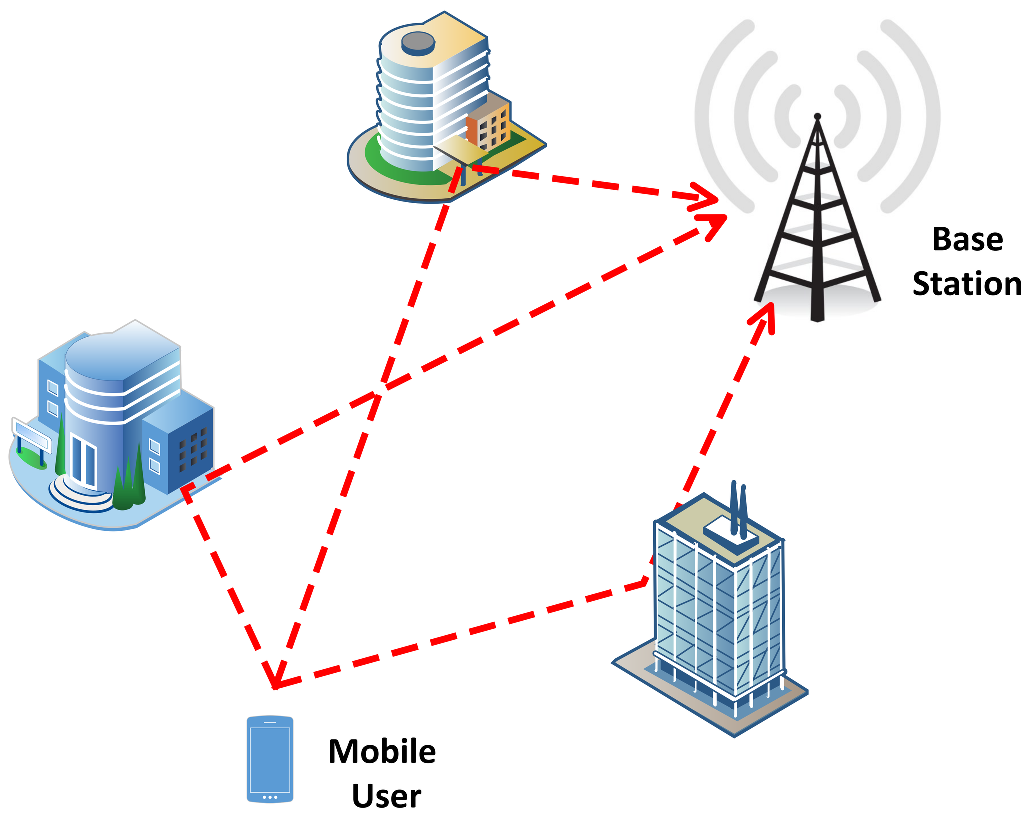
Description:

The research work focuses on high resolution radio-based positioning algorithm based on available signals from future cellular and wireless systems. Our recent research on positioning and tracking using phase information from Massive MIMO radio signals indicates the potential of providing centimeter-level accuracy with standard cellular bandwidths of 20-40 MHz. It opens the possibility to provide continuous and high-quality localization services for autonomous systems in any scenarios.

Background & Motivation

High resolution radio-based positioning service is a key enabler for improved cellular services and many highly autonomous systems, especially in those GPS harsh environments. It is important and challenge to provide accurate positioning service by utilizing standard cellular bandwidths both in indoor and outdoor scenarios, without additional cost of spectrum and infrastructure.



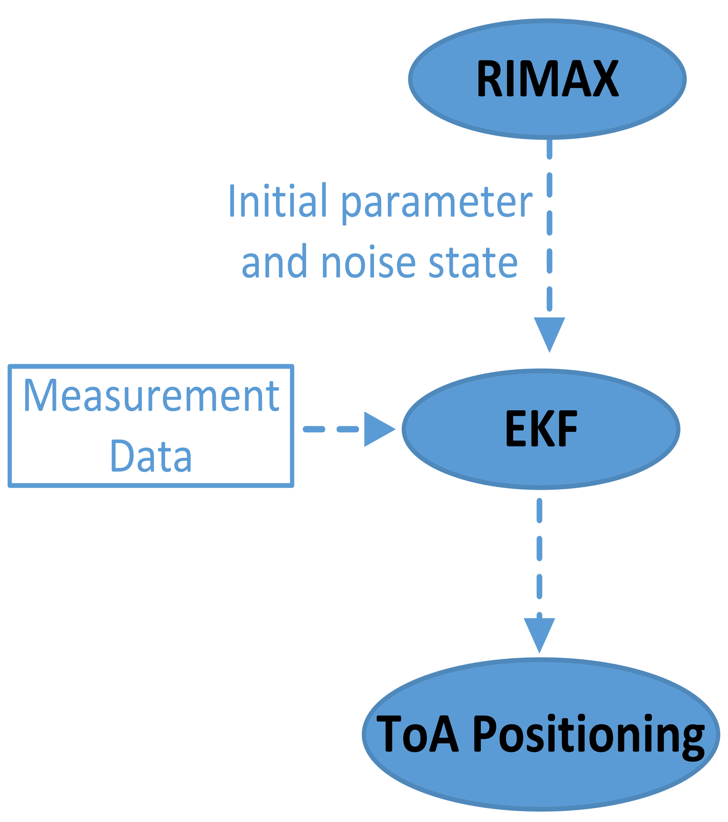
Methods & Preliminary Results

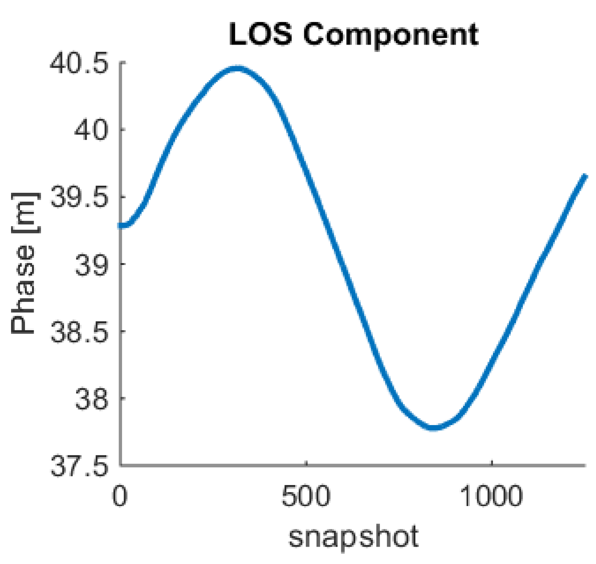
Wireless propagation channel is commonly modelled as superposition of specular–like paths, e.g. the double-directional channel model:

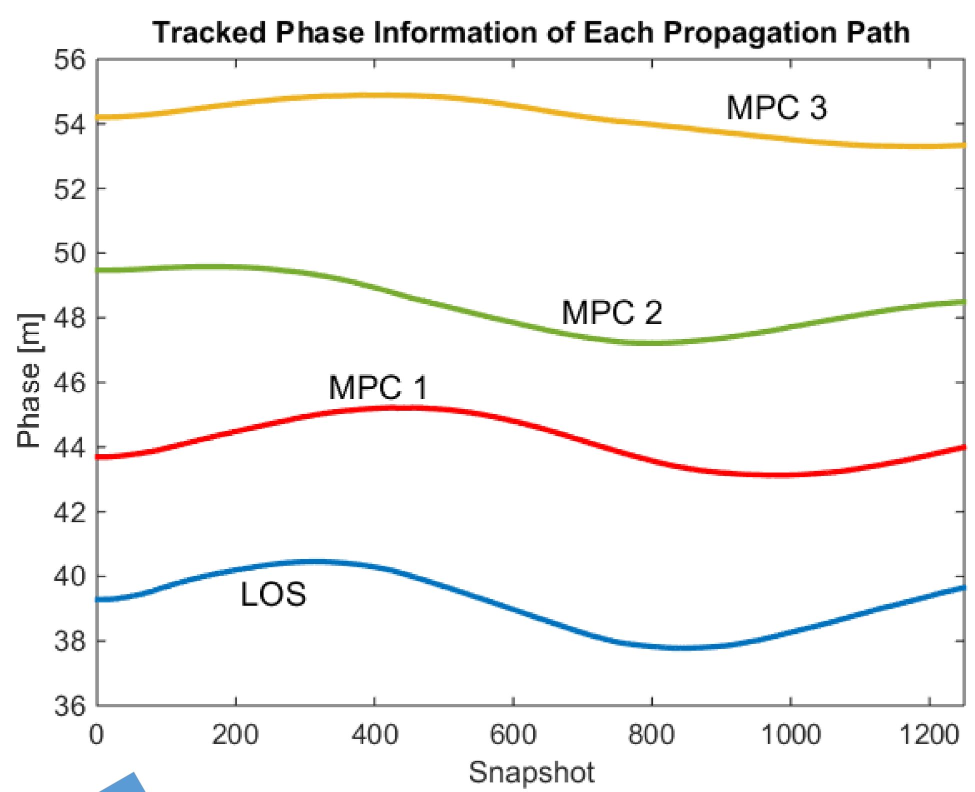
$$\mathbf{H}(f) = \sum_{l=1}^{L} \alpha e^{j\phi} e^{-j2\pi f \frac{d_l}{c}} \mathbf{G}_{\mathrm{Rx}}(\phi_{\mathrm{Rx},l}, \theta_{\mathrm{Rx},l}) \mathbf{G}_{\mathrm{Tx}}(\phi_{\mathrm{Tx},l}, \theta_{\mathrm{Tx},l})^{\mathrm{T}}$$

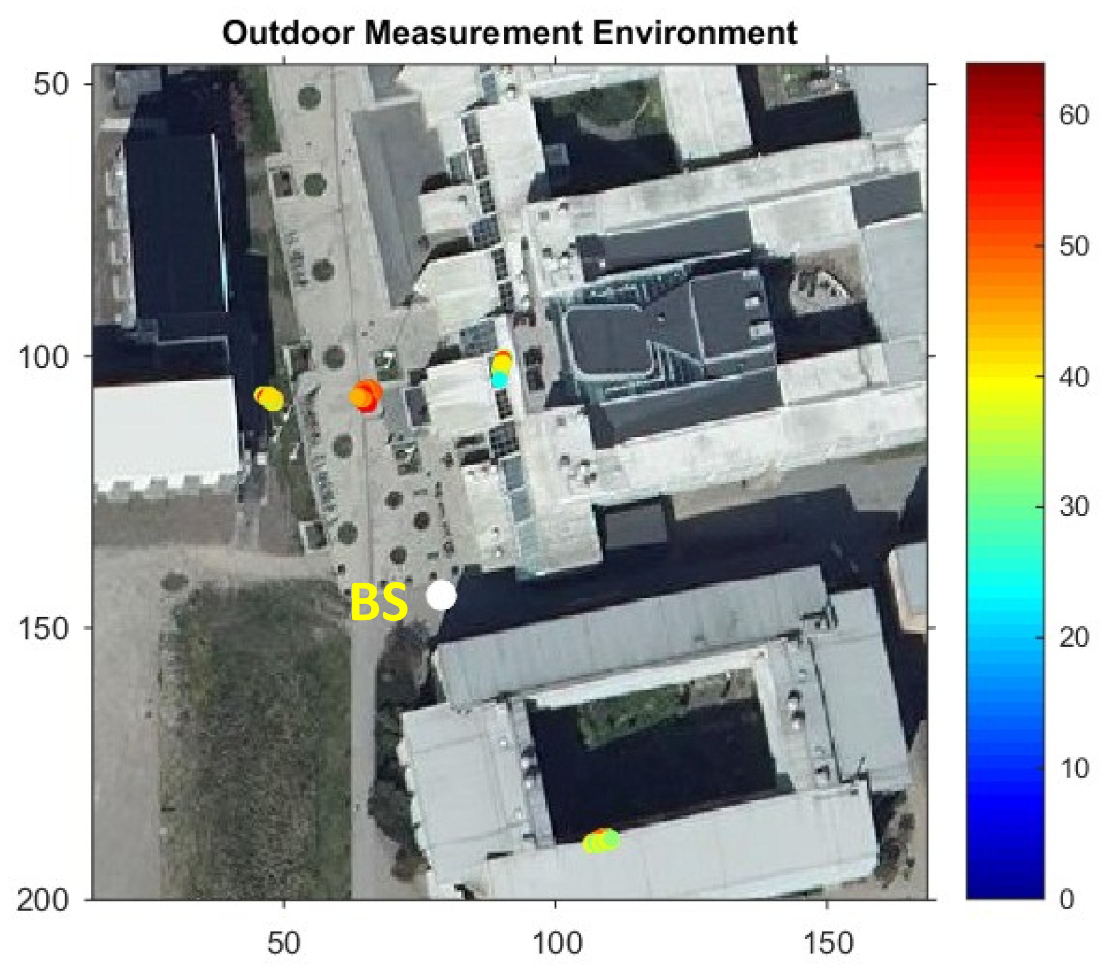
Extended Kalman Filter (EKF) is used to capture the slow-varying behavior of the path parameters, with the initial parameter state specified by utilizing The Joint Maximum Likelihood Estimator (RIMAX). The mobile user movement is then estimated with a far field time-of-arrival (ToA) based positioning algorithm with the output from EKF. Dense multipath component (DMC), which contains the non–resolvable concentrated paths is also considered when statistically modeling the noise.

An example is given below, several MPCs are tracked with the outdoor measurement for circular movement.

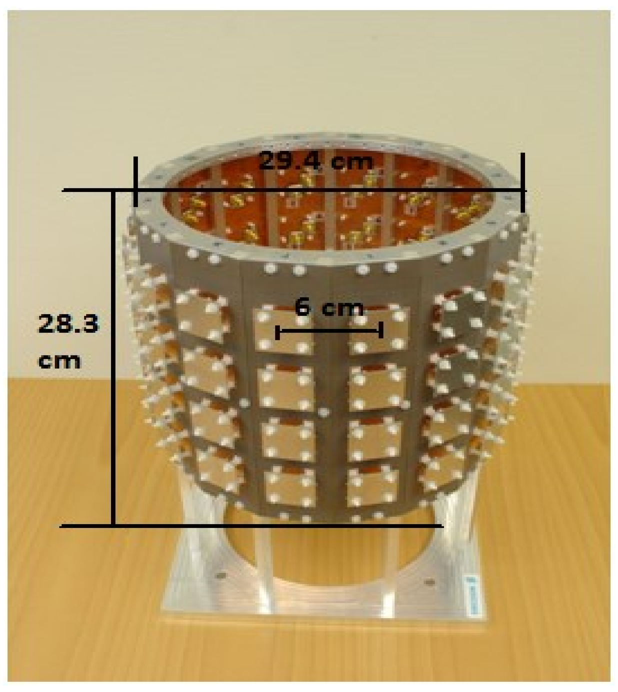


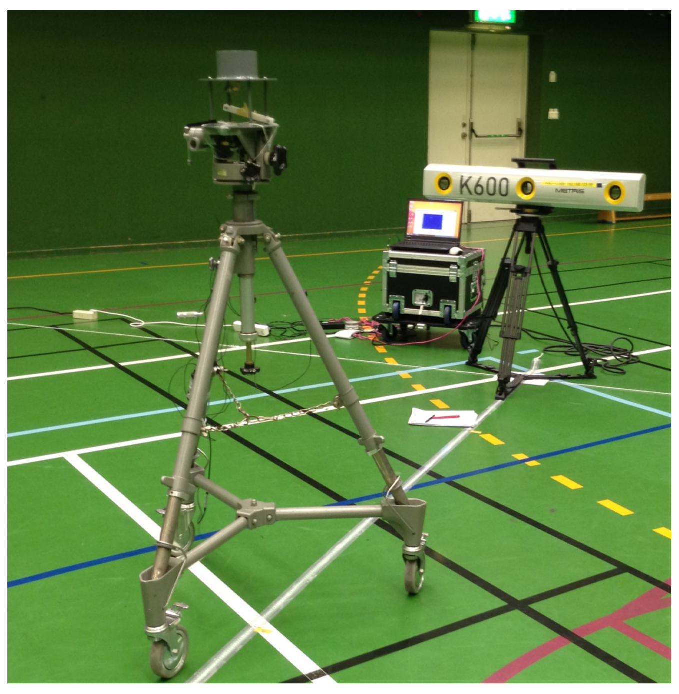






Measurement Campaign





Our measurement campaign is performed with the RUSK LUND channel sounder. The measurement data is recorded at a center frequency around 2.6 GHz with a bandwidth of 40 MHz. A cylindrical array with 64 dual–polarized antenna elements is used at the base station (BS) side. A conical monopole omnidirectional antenna is placed on a high tripod with wheels to represent a mobile user (MS), which is moved along predefined trajectories. The ground truth of the TX movement is recorded with a high resolution camera-based positioning system.

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