Ultimate Navigation Chip: Synthetic Aperture Navigation with Cellular Signals and IMU

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### Motivation
- Americans spend, on average, 90% of their time indoors
- No single infrastructure-free technology exists today that provides submeter-level or meter-level localization indoors

### Our Approach
Exploit cellular long-term-evolution (LTE) signals of opportunity due to their inherent desirable characteristics:
- **High received carrier-to-noise-ratio:** $C/N_0 \approx 55-80$ dB-Hz in different indoor environments
- **Free to use:** exploit LTE reference signals (dataless) without being a subscriber
- **Abundant:** dozens of nearby eNodeBs corresponding to different providers are available
- **High bandwidth:** up to 20 MHz and even higher with LTE-Advanced (up to 100 MHz)
- **Favorable geometry:** geometrically diverse by construction to provide maximum communication coverage

### Challenges
- Unknown eNodeBs’ states (position, clock bias, and clock drift)
- LTE eNodeBs’ clocks are less stable than GNSS clocks and not perfectly synchronized
- **Short-delay multipath**
- **No multipath**
- **Multipath**
- **Multichannel CR**
- **Overall CR**

### Framework 1: LTE-IMU

### Framework 2: LTE-SAN

### Experiment 1: LTE-IMU

### Experiment 2: LTE-SAN

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REFERENCES


