5G Networks and Device Positioning

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Scope: 5G user node positioning

- Ultra-dense 5G networks: devices can see/hear multiple access nodes (ANs)
- Also access waveforms have very wide bandwidth, carrier bandwidths in the order of 100MHz and beyond
- Furthermore, access nodes and devices likely to have antenna arrays with lots of antenna units

- These will enable, e.g., highly accurate TOA, TDOA & DOA measurements
- When fused across multiple measurement/observation points
  → extremely high positioning accuracy is achievable
Scope: 5G user node positioning

- Positioning can be carried out on the network side using UE/uplink reference signals → “always on” without heavy burden on UE batteries

- Alternatively, UE-centric positioning is another viable option, and also studied

- Environment learning → enables also tracking and prediction of UE positions

New markets for network operators: *self driving cars, robots, intelligent traffic systems, …*

Advanced radio network functionalities: e.g. *proactive radio resource management and mobility management*
Research Topics in more details

WP1: 5G Radio Network and Positioning Architecture
• Task 1.1: Network planning for joint communications and positioning
• Task 1.2: Signaling for joint communications and positioning
• Task 1.3: Positioning technology requirements in the access nodes and devices

WP2: Position Technology and Technical Enablers
• Task 2.1: Channel and environment learning methods
• Task 2.2: Ranging and angle estimation algorithms
• Task 2.3: Location and tracking algorithms

WP3: Enhanced Location-Based Services and Location-Aided Radio Resource Management
• Task 3.1 Enhanced Location-Based Services
• Task 3.2 Enhanced Location-Aided Radio Resource Management
Example: Joint position and UE clock offset estimation & tracking

**Time-of-arrival (ToA) estimates** → **Clock model** + **UE movement model** → **UE clock offset estimates**

**Direction-of-arrival (DoA) estimates** → **Clock model** + **UE movement model** → **UE position estimates**

**Extended Kalman filter (EKF)**

**Setup:**
- METIS stochastic channel model
- 200 MHz waveform bandwidth
- Urban environment, 15km/h mobility
- Only 2 line-of-sight ANs
- Estimate every 1.7 ms using uplink reference signals

**Accuracy (RMSE):**
- Clock offset 0.4 μs
- Position 1.3 m
Example: Joint position and UE clock offset estimation & tracking

• Video example, attached as .mp4