UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Linux-based Measuring Platform for Time-Based Location Observables in IEEE 802.11 Networks

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Joint ERCIM eMobility and MobiSense Workshop, June 2013

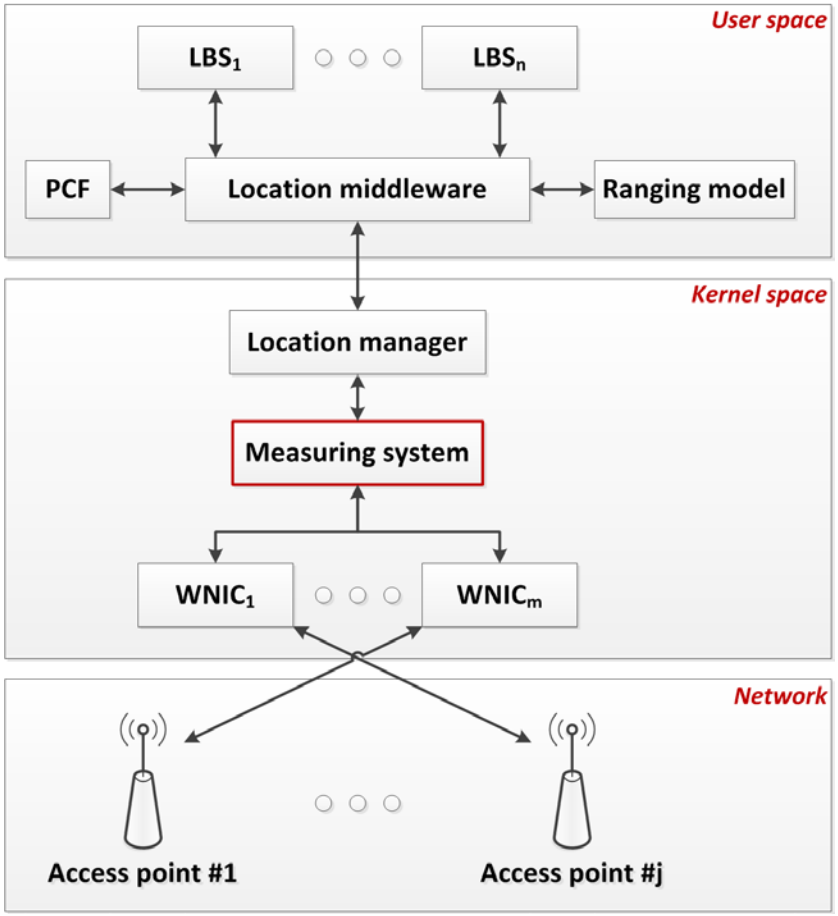
Outline

1. Indoor positioning
   - Introduction
   - Location platform approaches
2. Goals and requirements
3. The SoftMAC approach in Linux
4. The measuring system
5. Performance assessment
   - Scenario used for collecting data
   - Results

- Several technologies are currently available for indoor positioning in IEEE 802.11
  - ✓ Proximity-based
  - ✓ Direction of arrival
  - ✓ Fingerprinting
  - ✓ Range-based
- Time-of-flight (ToF) techniques
  - ✓ Time and time-differences can be used as observables
  - ✓ Good trade-off between accuracy and complexity

- Analytical and simulation assessment needs to be verified with real test beds
- Implementation of location techniques
  - Custom hardware
    - Best results in terms of QoS (e.g. 1m of accuracy)
    - Tight design: difficult to upgrade/enhance
  - Custom software
    - More flexible design at the cost of higher error
    - Is the QoS enough for most of the LBS?

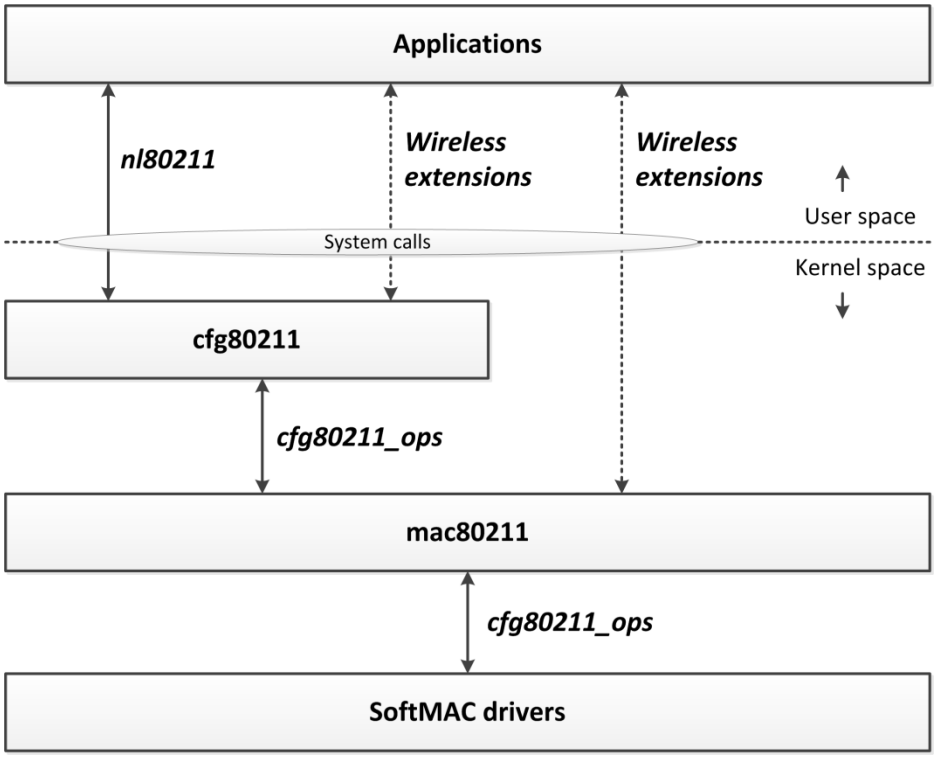
Providing a location platform aimed at:



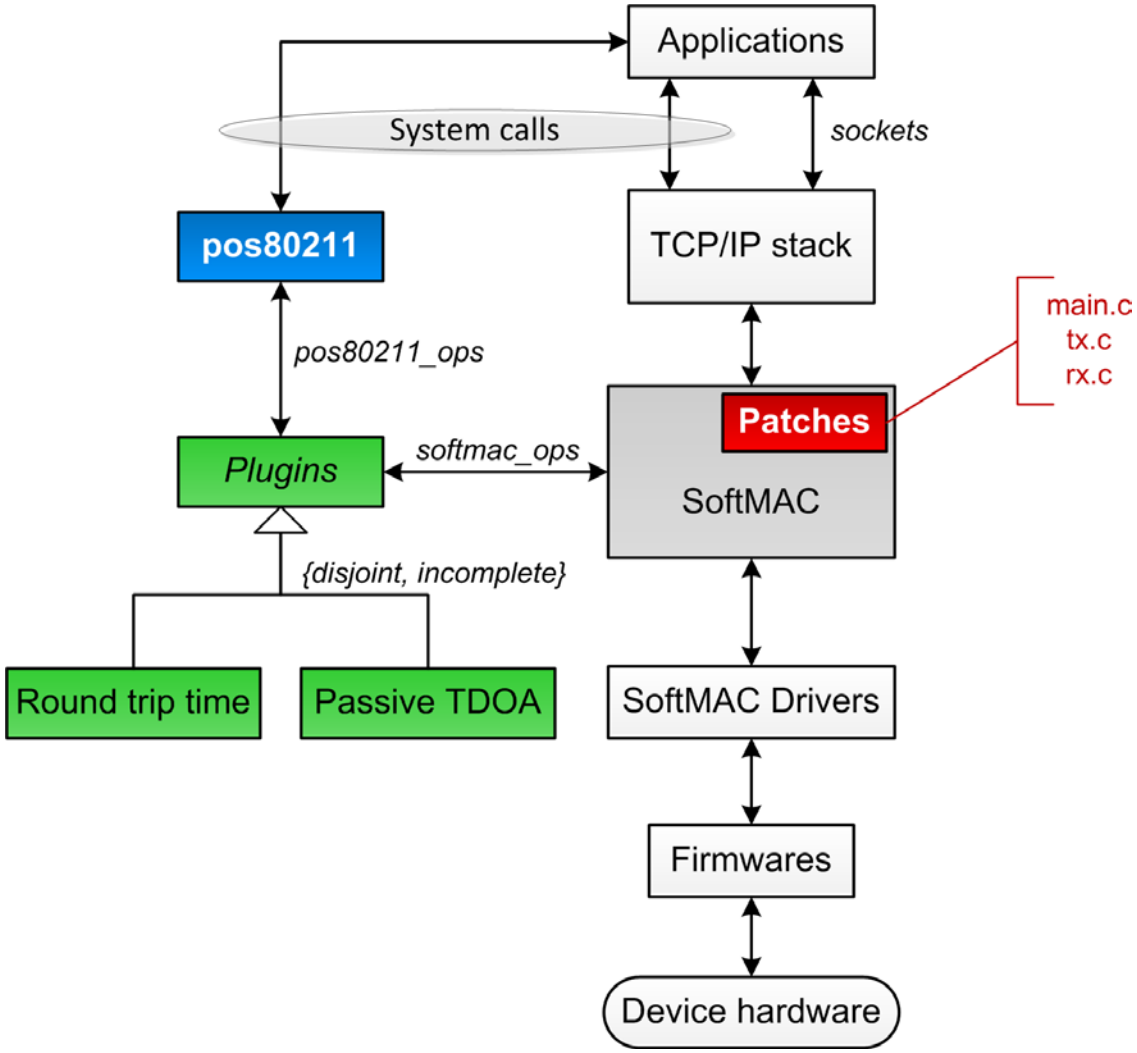
- Providing the best performance
- Supporting legacy hardware
- Portability of the platform to several architectures
- Supporting time-based location techniques
  - 2-way TOA (RTT)
  - Passive TDOA (TDOA)
- Flexibility for adding new features and techniques

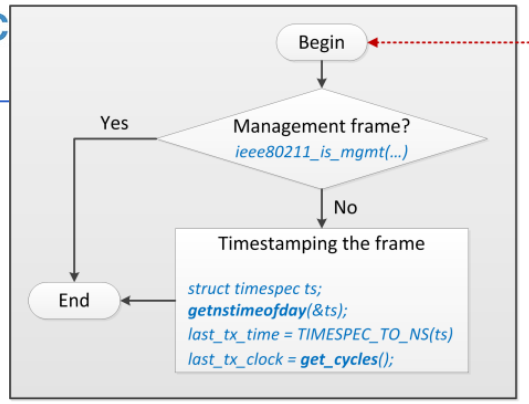
- Measurements taken in the MAC layer of the Linux IEEE 802.11 stack
  - Observing in the WNIC driver
    - Changes in the WNIC driver for observing the ToF
    - Specific changes for each driver
    - Best results
  - The SoftMAC approach (Linux / FreeBSD)
    - Common to all drivers
    - More software layers are crossed

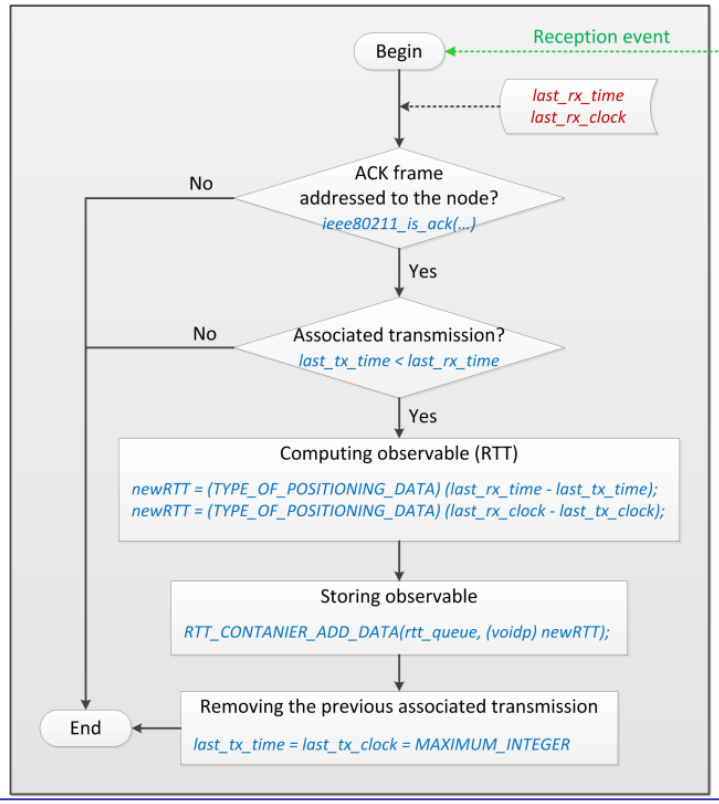
SoftMac in Linux: mac802.11 framework

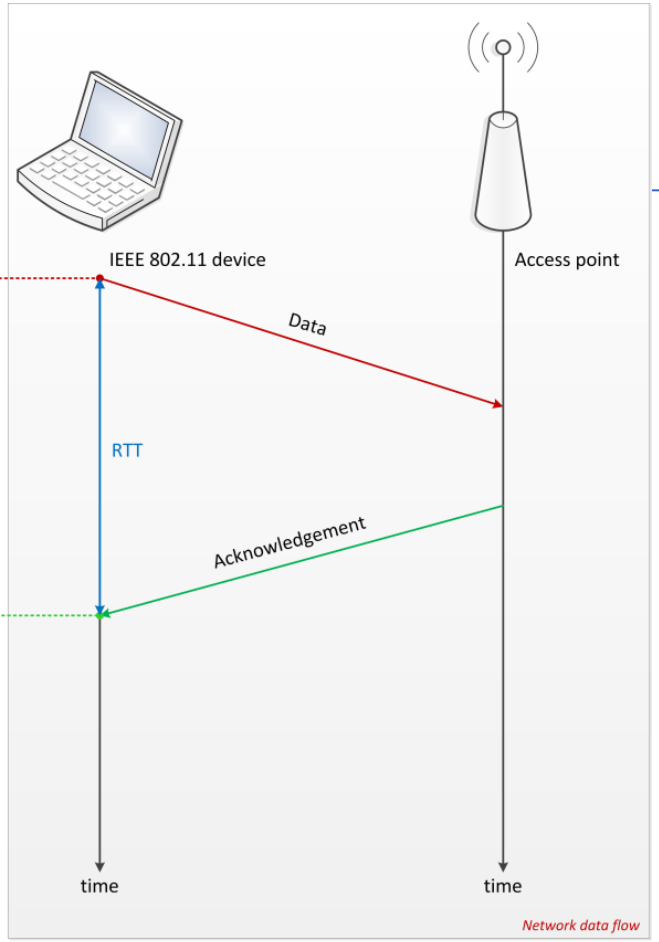


- **mac80211**: Common MAC operations
- **SoftMAC drivers**: Specific MAC operations
- **cfg80211**: WNIC configuration (succeeds *wireless extensions*)


Applications
System calls
sockets
pos80211
TCP/IP stack
pos80211_ops
main.c
tx.c
rx.c
Patches
Plugins
softmac_ops
SoftMAC
{disjoint, incomplete}
Round trip time
Passive TDOA
SoftMAC Drivers
Firmwares
Device hardware

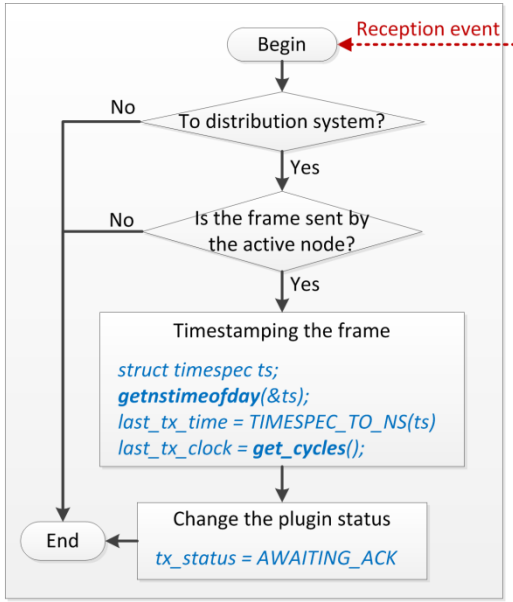


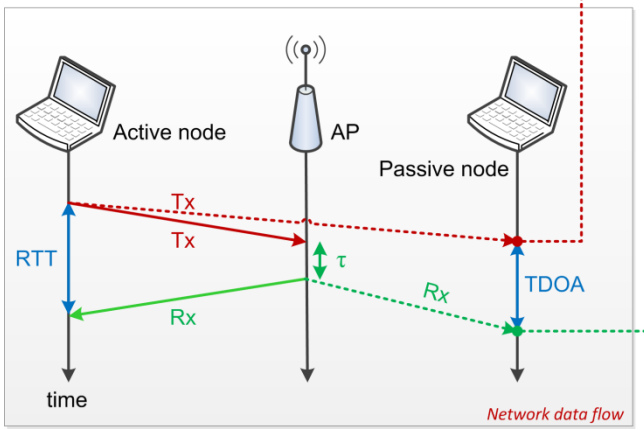


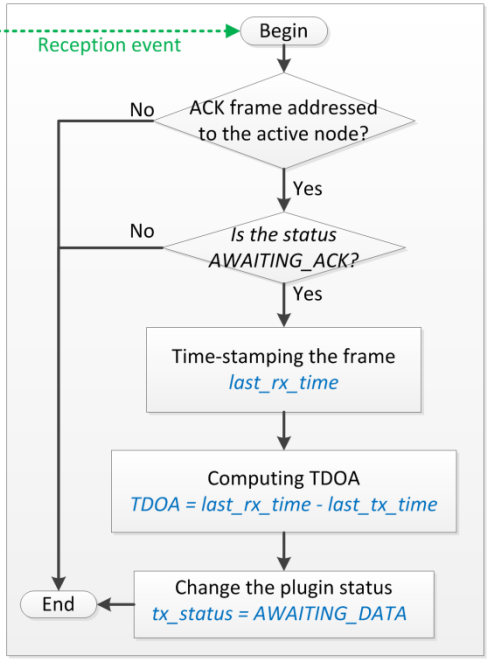


The round trip time plugin

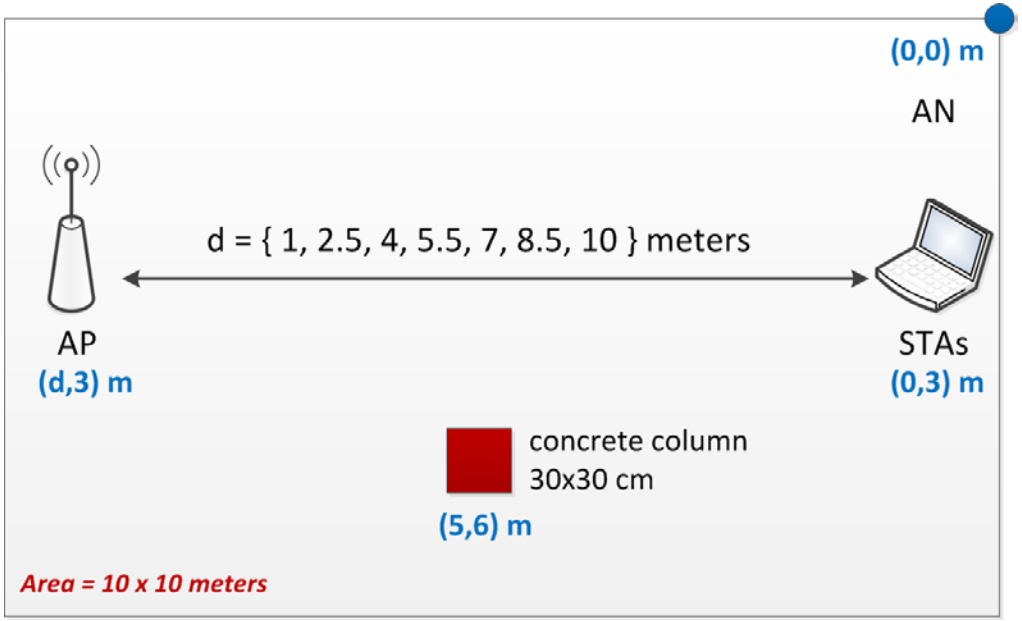
The passive TDOA plugin





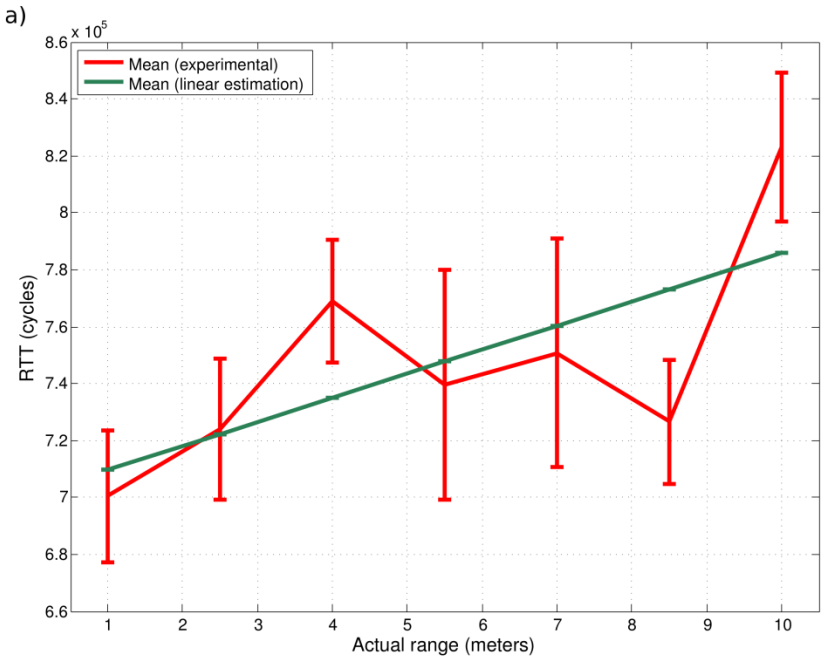


First results: focused on probing the concept

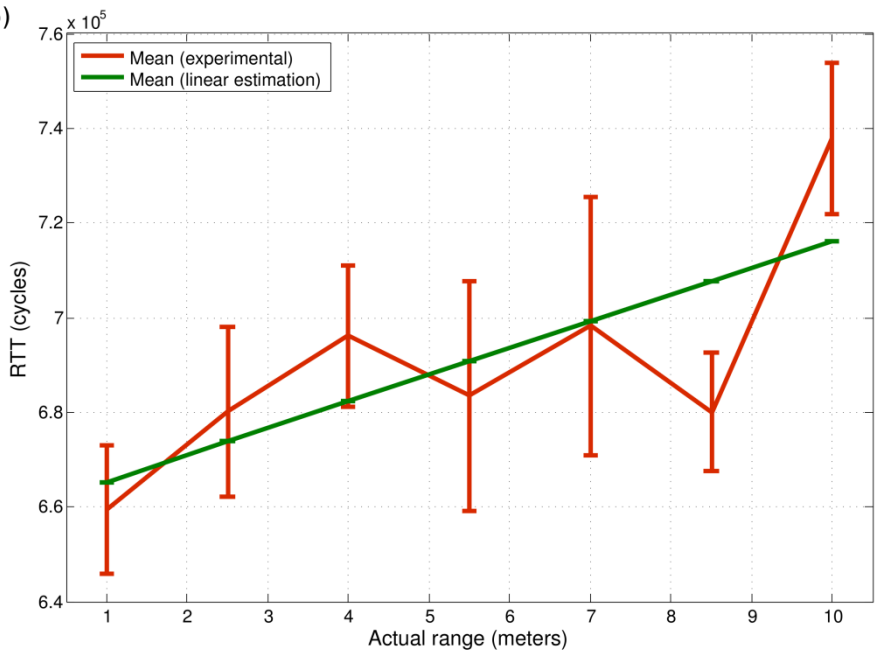


- Assessed scenario:
  - Concrete walls
  - LOS between nodes
  - Dedicated network
  - Passive and active STAs separated 0.5 m
  - Limited interference
  - Static conditions
- Experiment:
  - 10 x 10.000 pings from the active STA to the AP
  - No ping overlapping

The round trip time plugin

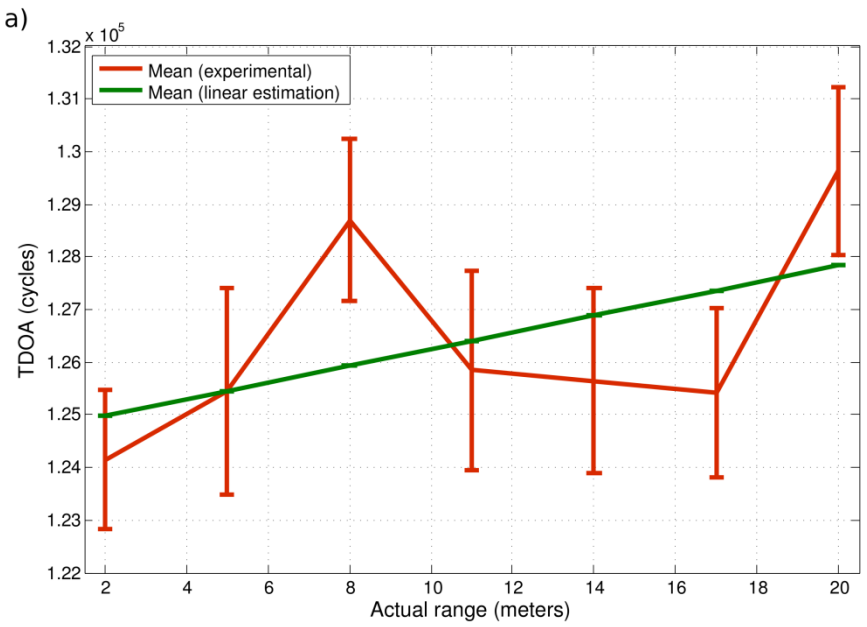


a) Raw

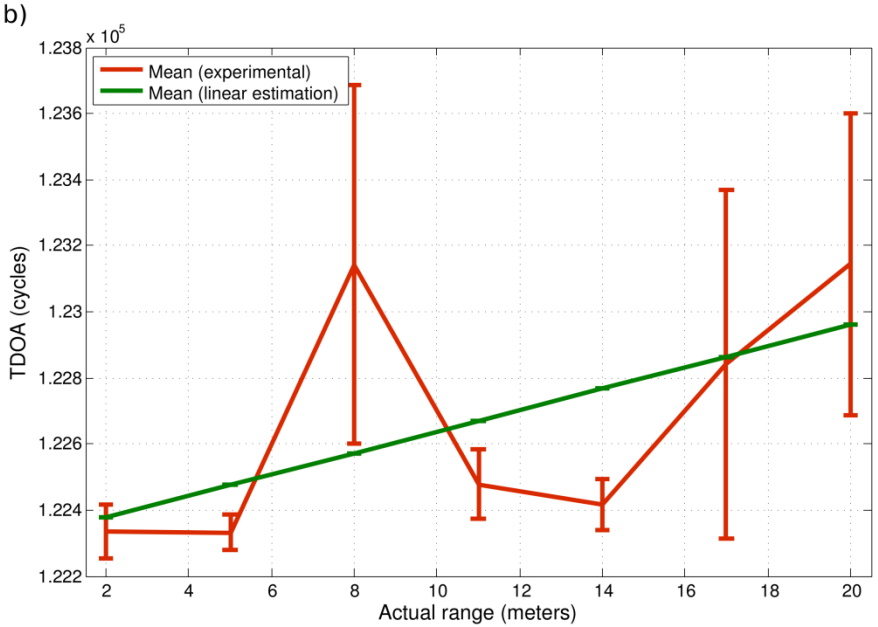


b) With Gaussian FILTER

The passive TDOA plugin



a) Raw



b) With Gaussian FILTER

Further questions?