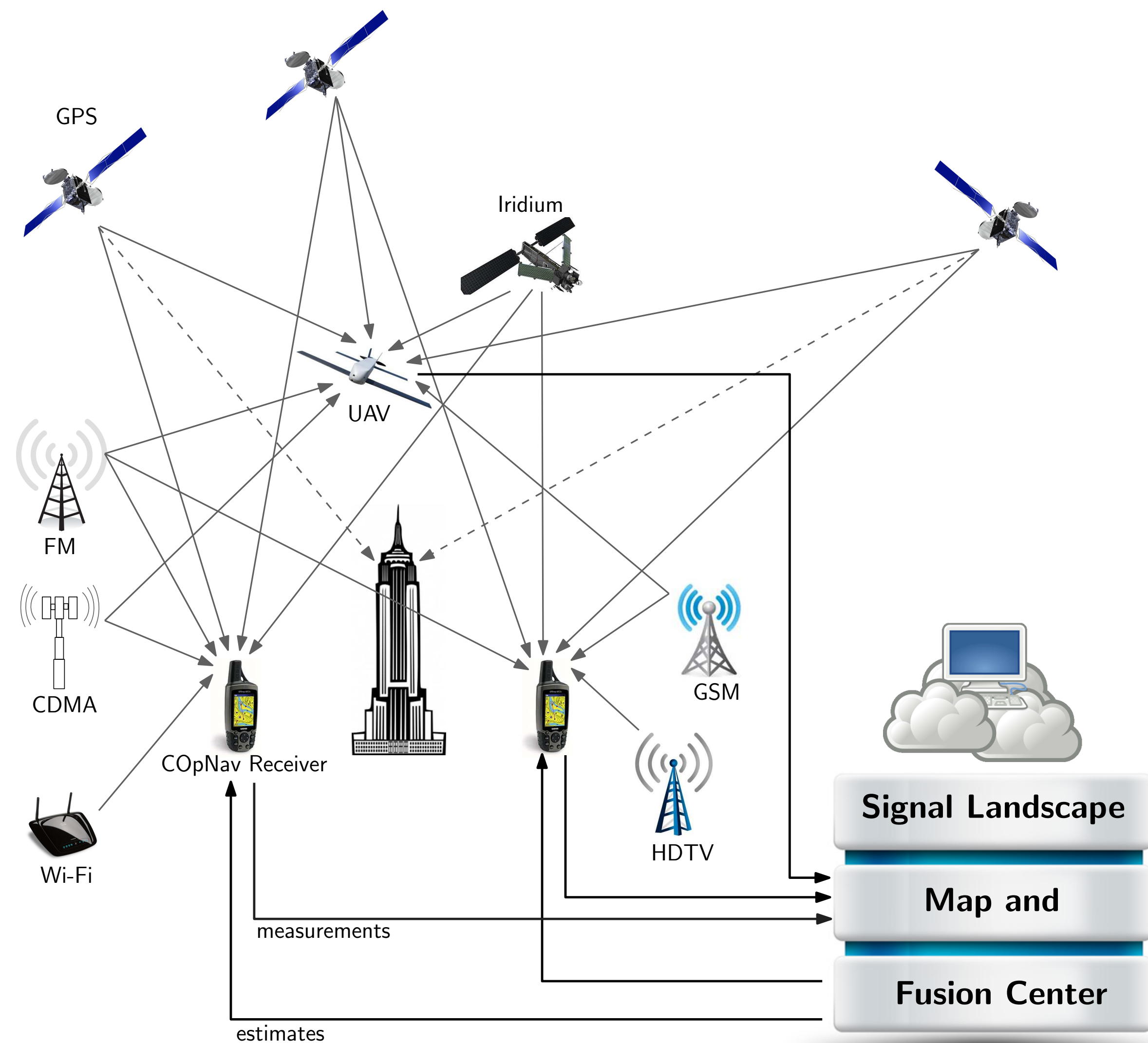


THE PROBLEM

GNSS signals are insufficient for anytime, anywhere navigation, particularly in deep urban canyons, indoors, and environments experiencing intentional jamming, as they attenuate $\sim 30\text{--}50\text{ dB}$.



COPNAV SYSTEM OVERVIEW

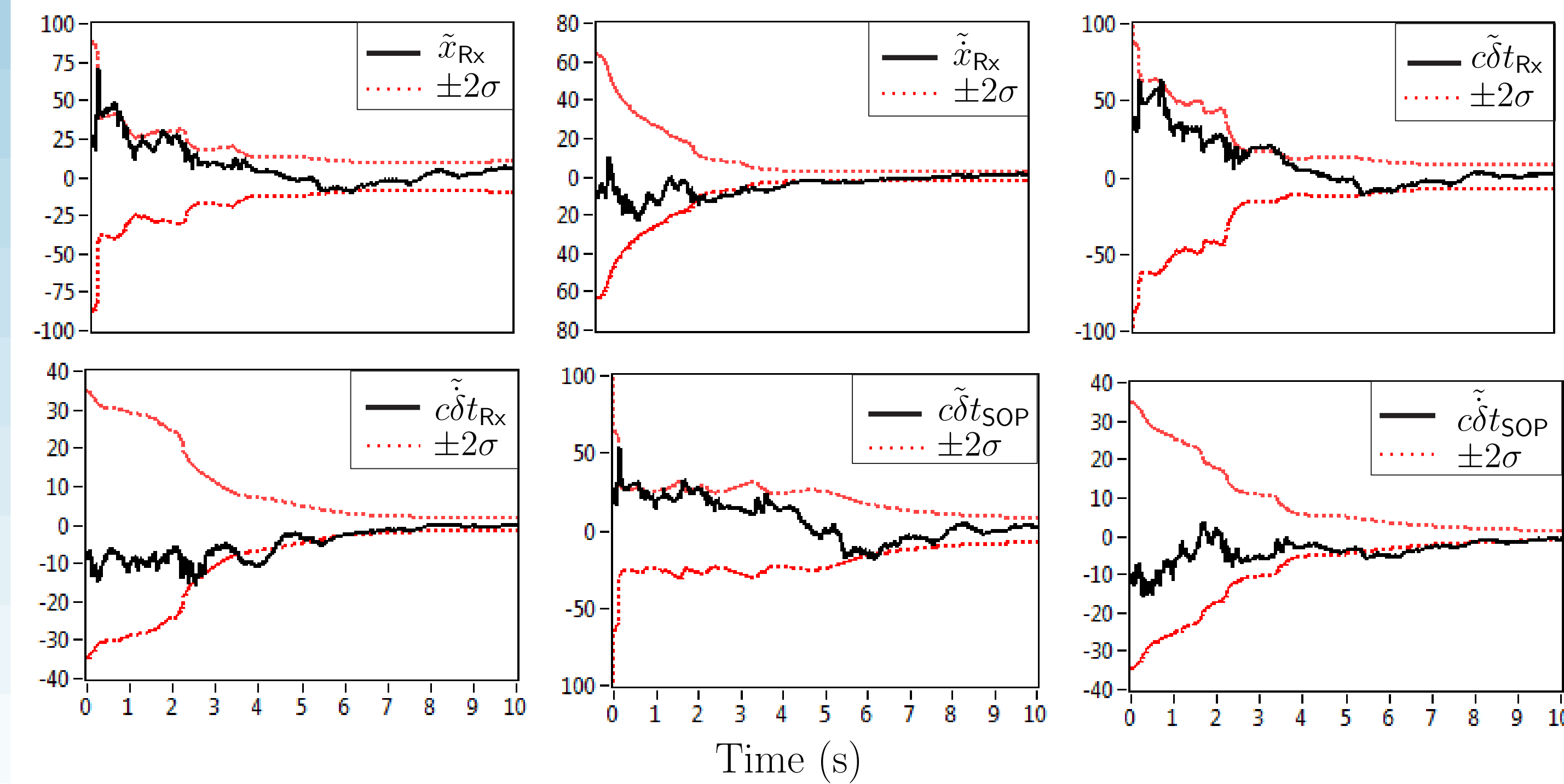


THEORETICAL RESULTS: OBSERVABILITY

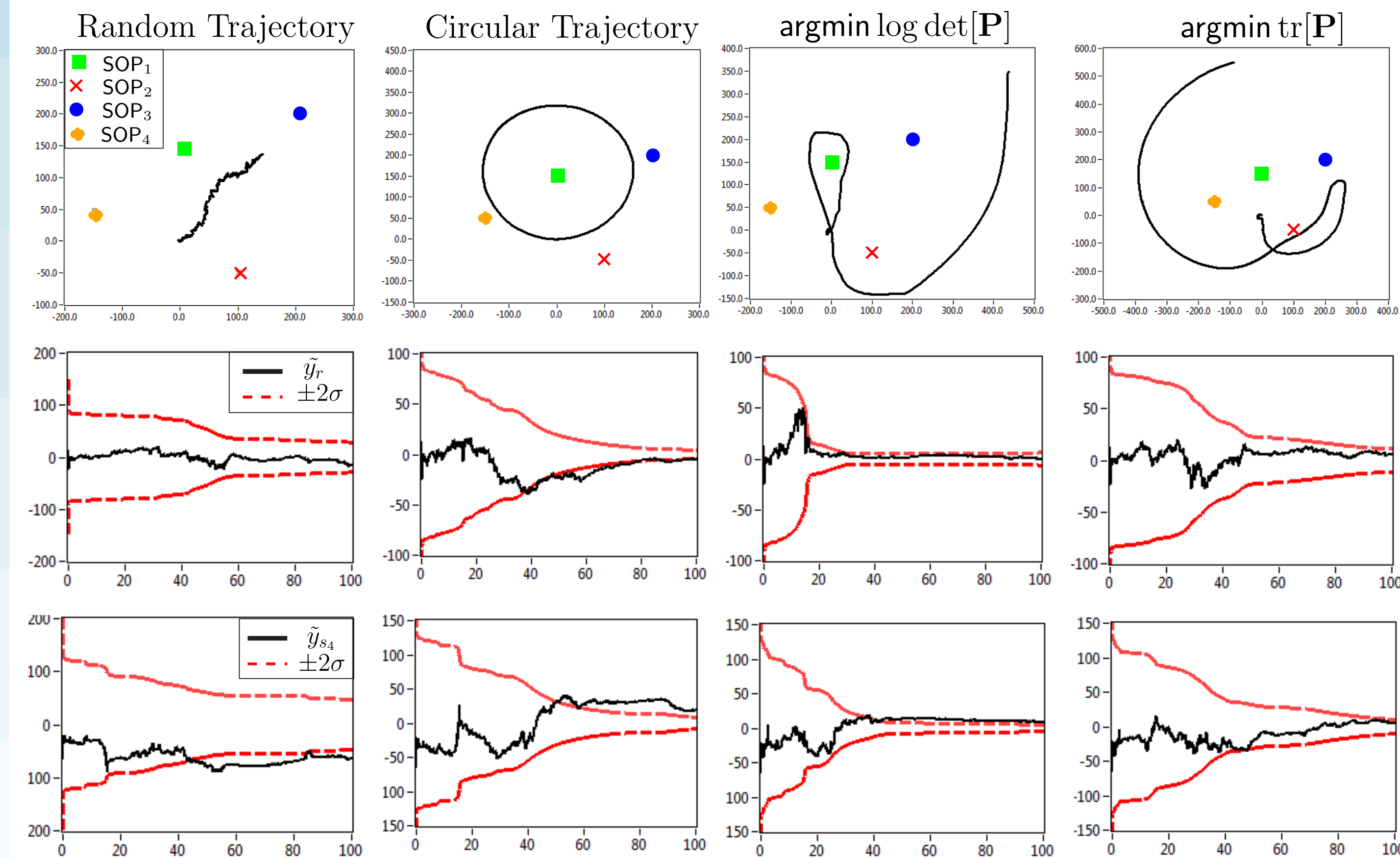
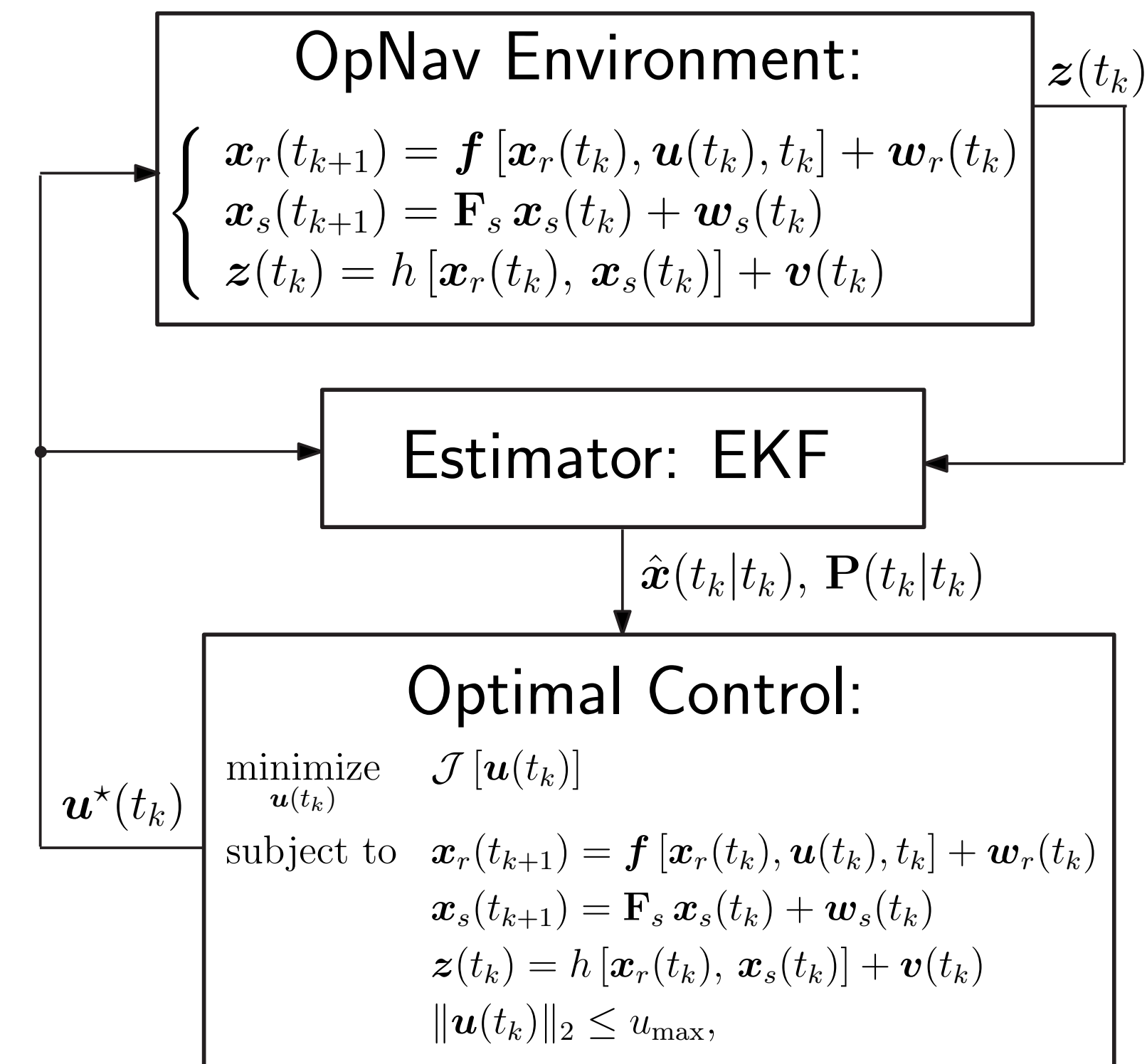
Case	Rx(s)	SOP(s)	Observable States
1	1 U.	m P.K.	$m = 1$: none, $m \geq 2$: $x_r, y_r, \dot{x}_r, \dot{y}_r$
2	1 U.	1 F.K.	$\delta t_r, \dot{\delta t}_r$
3	1 U.	1 F.K. & 1 P.K.	all
4	n P.K.	1 U.	$\dot{x}_{r_i}, \dot{y}_{r_i}, x_s, y_s, i = 1, \dots, n$
5	n P.K.	m P.K.	$\dot{x}_{r_i}, \dot{y}_{r_i}, i = 1, \dots, n$
6	1 P.K.	1 F.K.	all
7	1 F.K.	1 U.	all

SIMULATION RESULTS: OBSERVABILITY

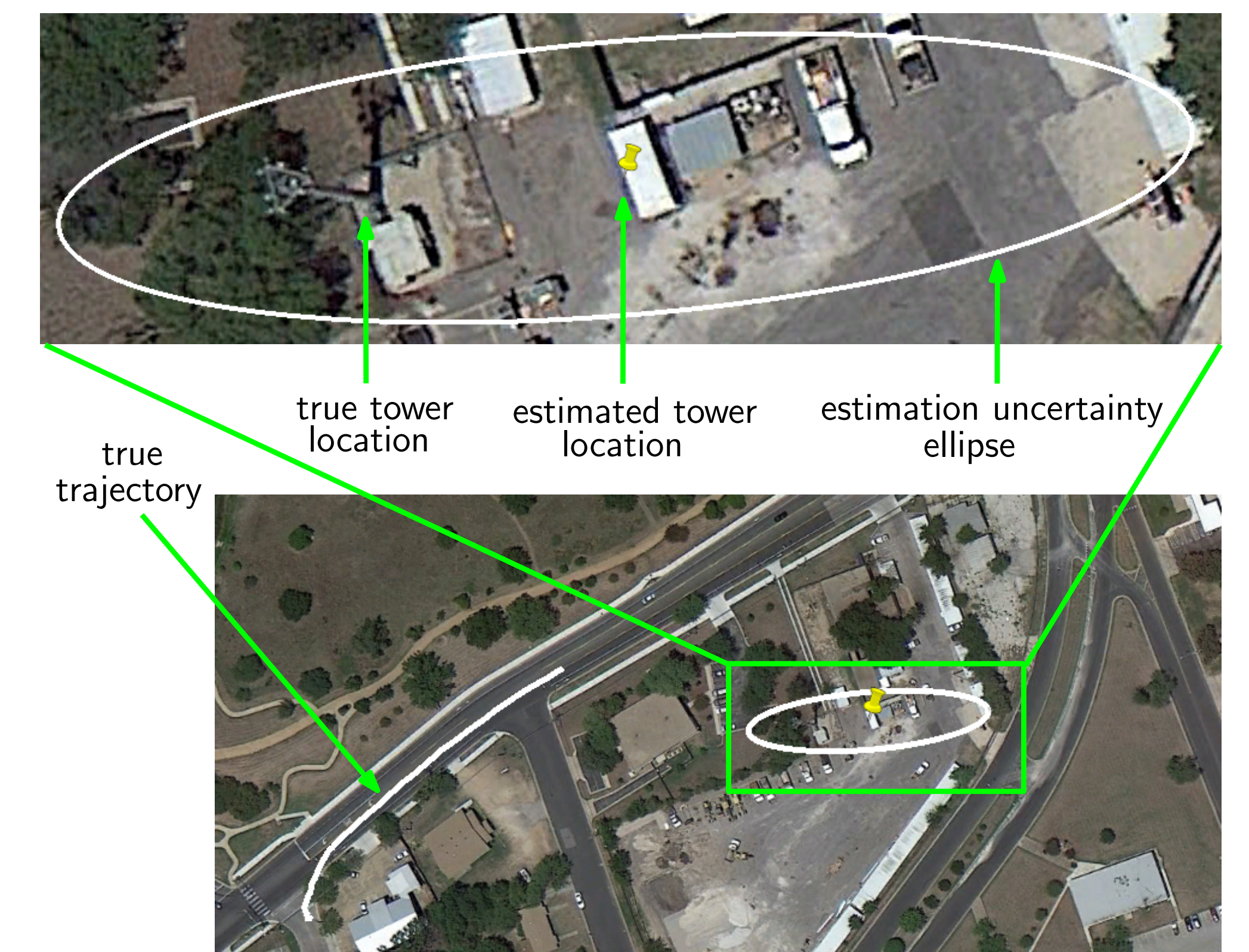
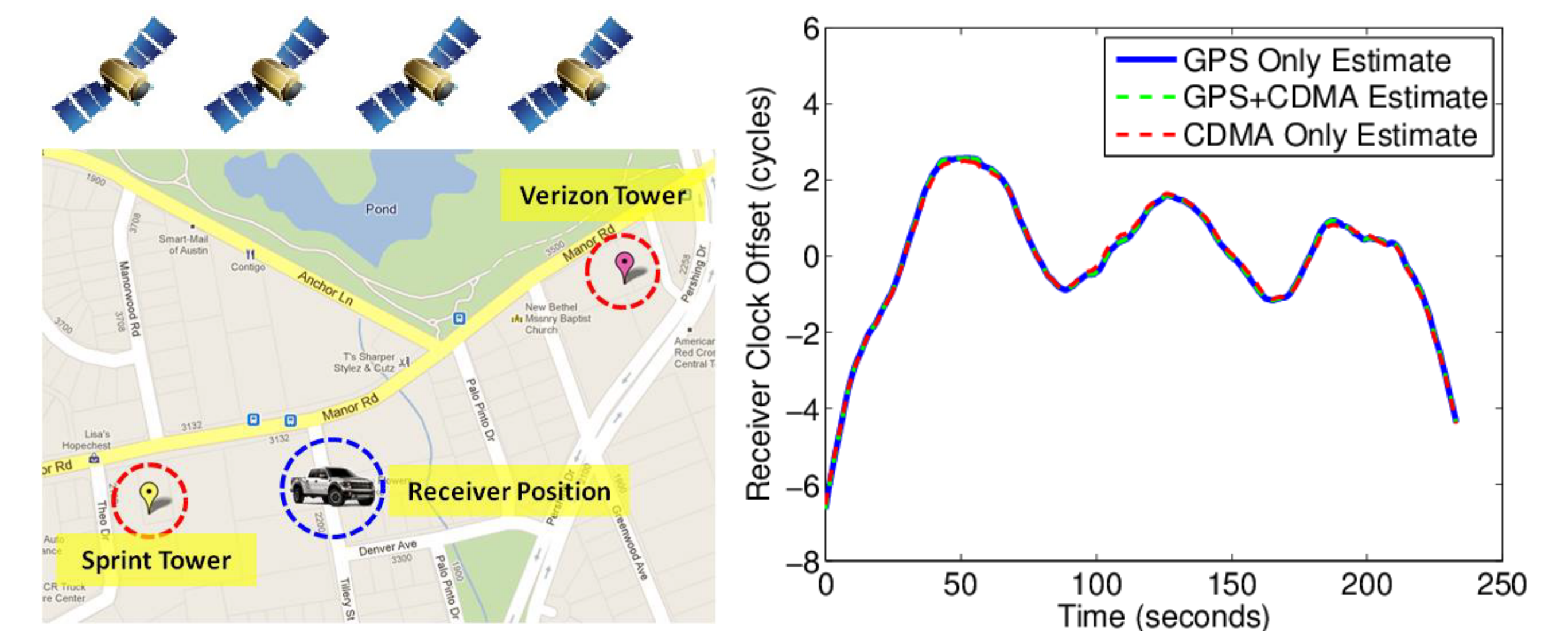
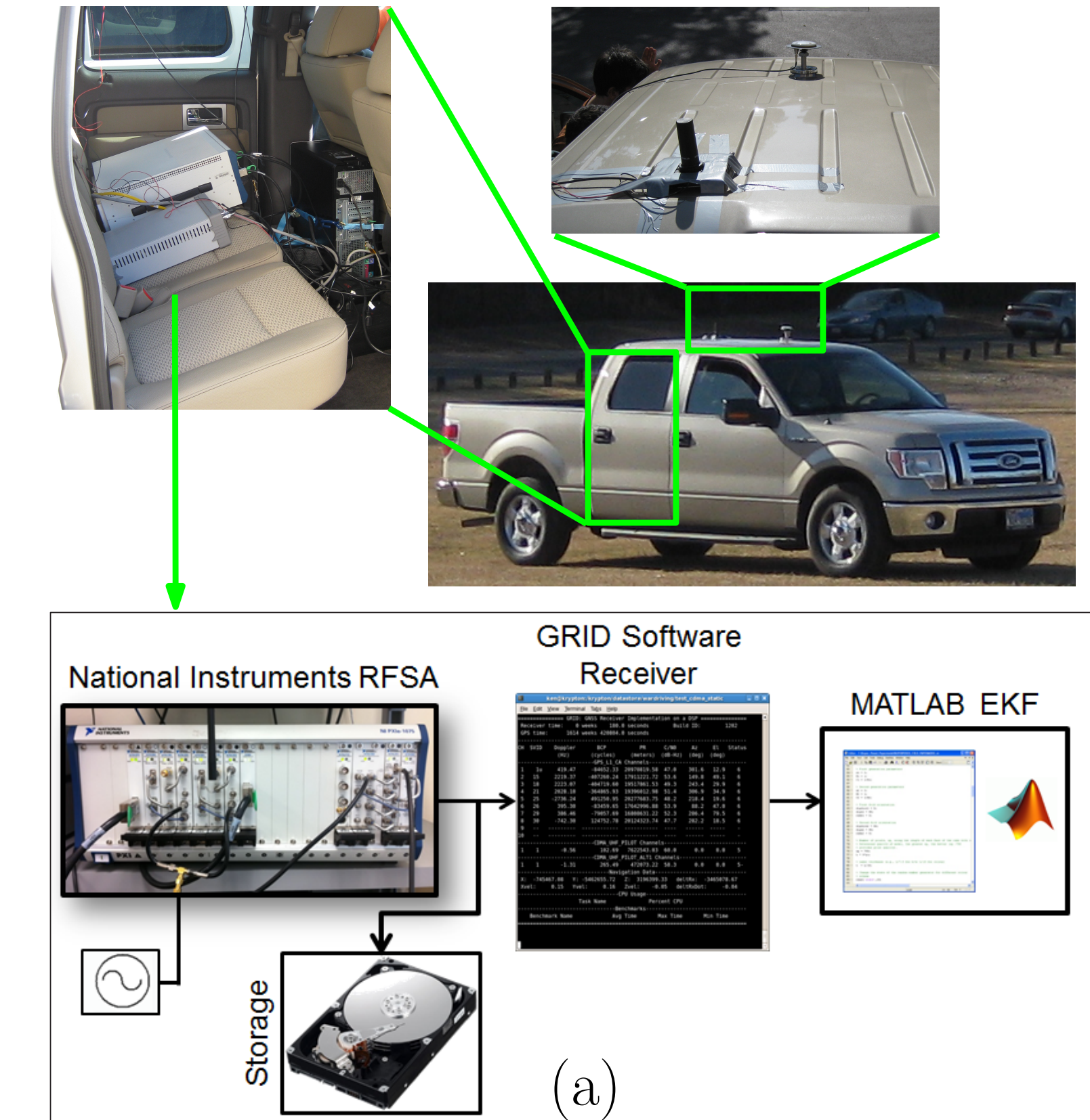
Environment with 1 fully-known SOP and 1 partially-known SOP



TRAJECTORY OPTIMIZATION



EXPERIMENTAL RESULTS



REFERENCES

- [1] Z.M. Kassas and T. Humphreys, "Motion Planning for Optimal Information Gathering in Opportunistic Navigation Systems," *AIAA GNC 2013*
- [2] Z.M. Kassas and T. Humphreys, "Observability Analysis of Opportunistic Navigation with Pseudorange Measurements," *AIAA GNC 2012*