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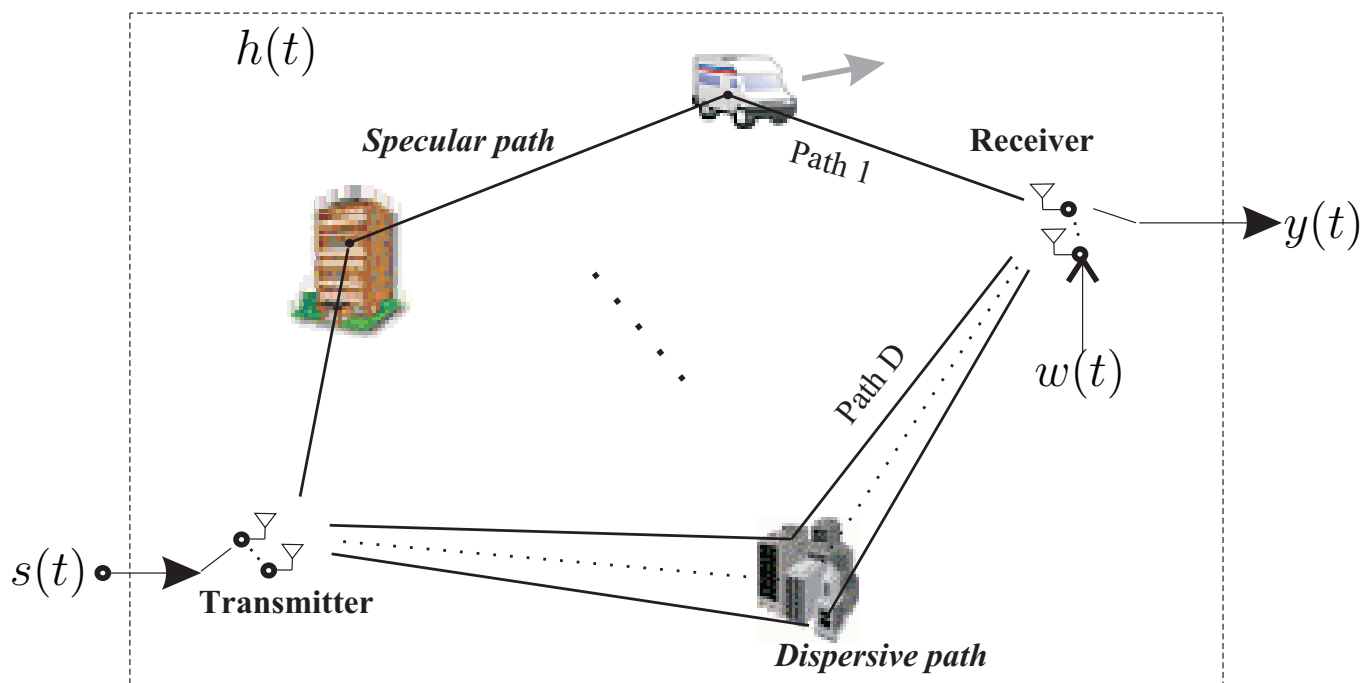
TONGJI UNIVERSITY

宽带无线通信与多媒体实验室

Broadband Wireless Communication and Multimedia Laboratory

Channel Emulation for Mobility Testing

Multipath Propagation Environment



- Dispersion dimensions of propagation paths:
delay, direction of departure (DoD), direction of arrival (DoA), polarizations and Doppler frequency.
- Variation of the parameters of propagation paths due to:
human movements, wind, pedestrian traffic, and moving portable terminals.



Time-variant Channel Emulation for Mobility Testing and Management

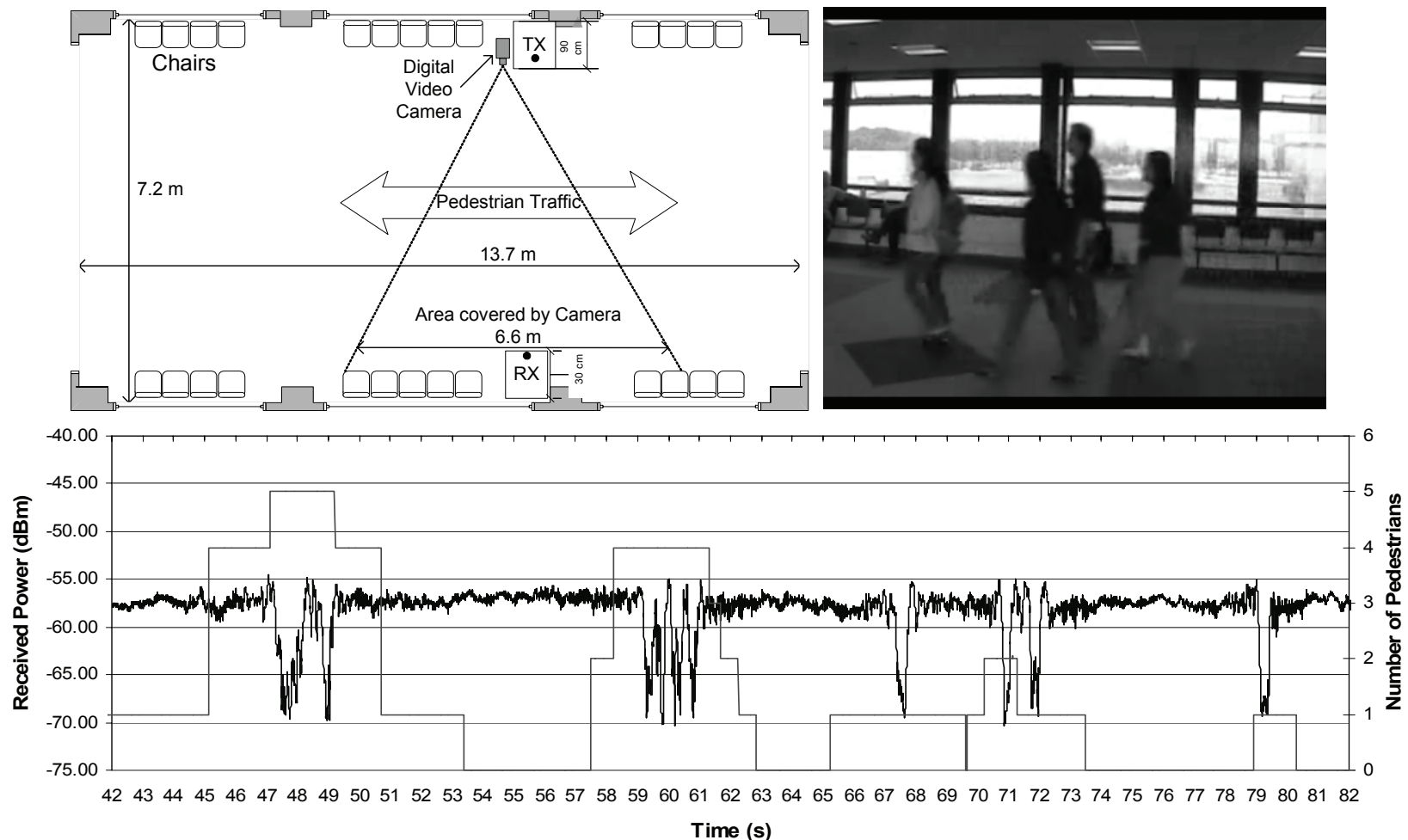
Characterization and emulation of propagation channels for

- a variety of mobility scenarios:
outdoor-to-indoor, vehicle-to-vehicle, ...
- different environments:
dense urban, suburban, streets, office, corridor, ...
- system configurations:
transmitter and receiver locations, antenna heights, ...
- different weathers:
rainy, windy, sunny, foggy, ...
- velocity of movements:
low and high Doppler frequency, ...



Experimental Characteristics of Time-variant Wideband Propagation Channels (Example I)

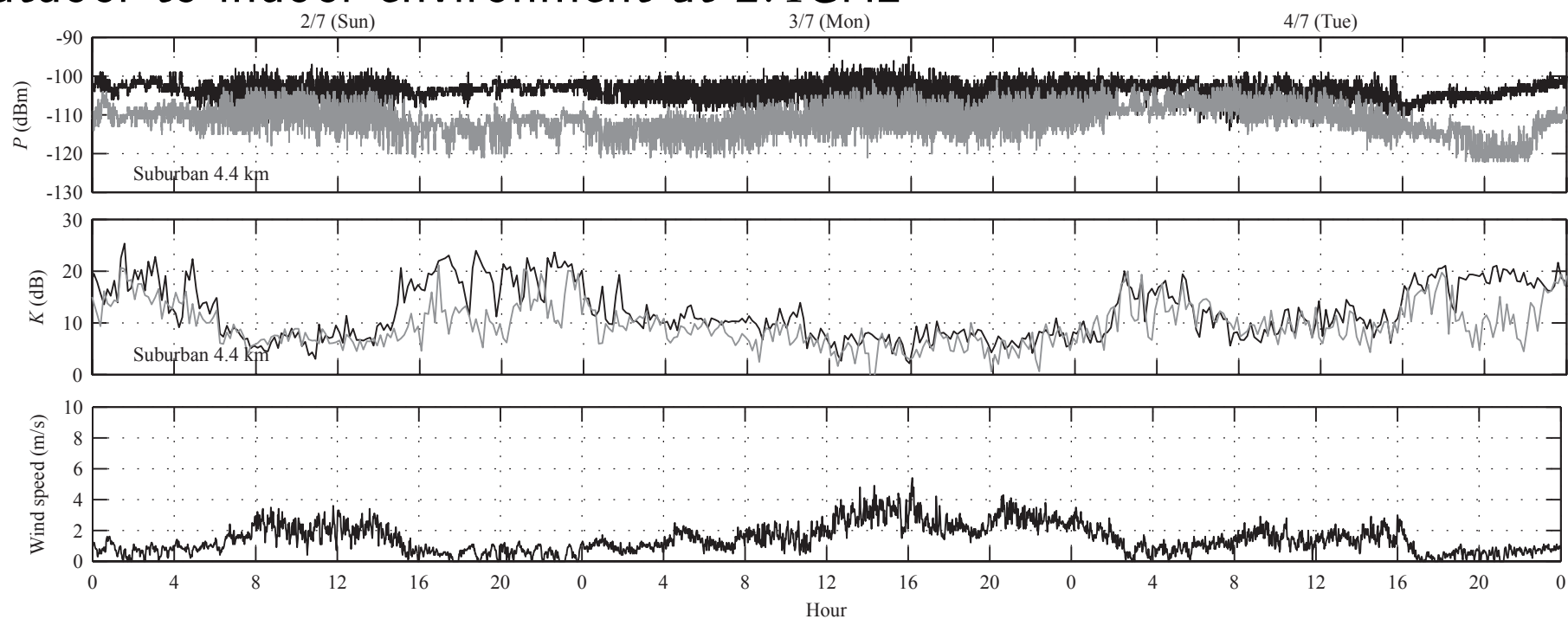
[Ziri-Castro, et al., 2006] Received signal power and number of pedestrians in a corridor at 5.2 GHz





Experimental Characteristics of Time-variant Wideband Propagation Channels (Example II)

[Suzuki, et al., 2006] Received power and K – factor in an outdoor-to-indoor environment at 2.4GHz



- Apparent correlation was found between the signal variation and local wind speed in the suburban environment on the ground floor.



Experimental Characteristics of Time-variant Wideband Propagation Channels (Example III)

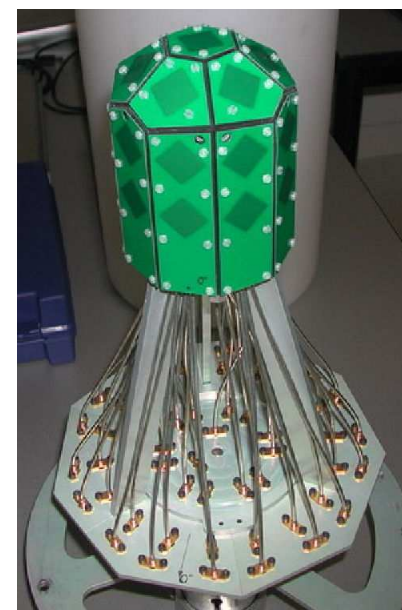
- MIMO channel sounder: Propsound
- Tx and Rx Arrays: 50-element omni-directional dual-polarized array
- 5.25 GHz Carrier frequency
- 100 MHz bandwidth



Tx trolley



Rx trolley

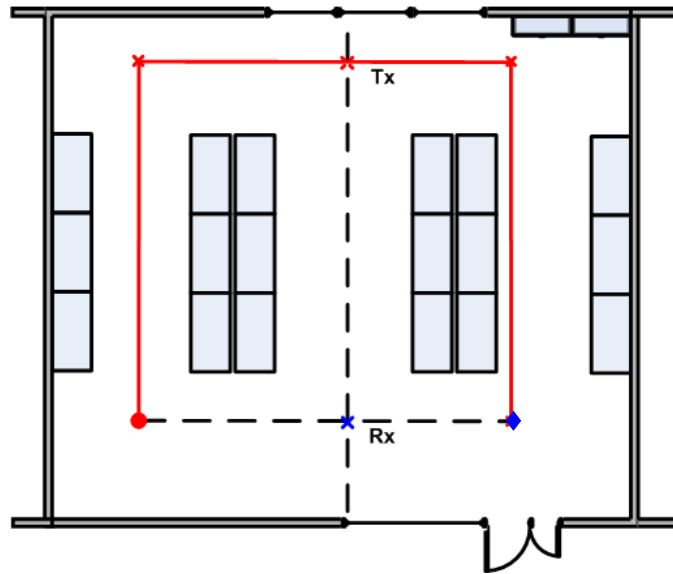


Tx/Rx Array



Experimental Characteristics of Time-variant Wideband Propagation Channels (Example III)

Measurement environment:



Constellation of propagation paths while the Tx is moving.

Dataset 1, Dataset 2, Dataset 3, Dataset 4

Motions of scatterers environments influence the propagation paths.



Characteristics of Time-variant Channel

- Mobility of the multiple time-variant paths
- Stochastic modelling of path evolution
- Channel statistics and thereof time-variability
 - ◆ Rayleigh, Rice distribution
 - ◆ K -factor
 - ◆ Spatial correlation
 - ◆ Fading correlation
 - ◆ Doppler-delay-direction spectrum



Particle-Filtering Path-Tracking Algorithms Developed Recently in the BWM lab

- Apply state-space models for the evolution of path parameter Ω_k ;
- Write received signal \mathbf{y}_k as a function of Ω_k ;
- Derive the posterior probability density function $p(\Omega_{1:K}|\mathbf{y}_{1:K})$
- Derive particle-filtering (PF) algorithms for estimation of $p(\Omega_{1:K}|\mathbf{y}_{1:K})$

$$p(\Omega_{1:K}|\mathbf{y}_{1:K}) \approx \sum_{i=1}^I w^{(i)} \delta(\Omega_{1:K} - \Omega_{1:K}^{(i)}).$$

Published in ICC 2008, IEEE RadarCon 2008, IEEE DSP/SPE 2009.



Experimental Investigation of the PF-based Path-Tracking Algorithm

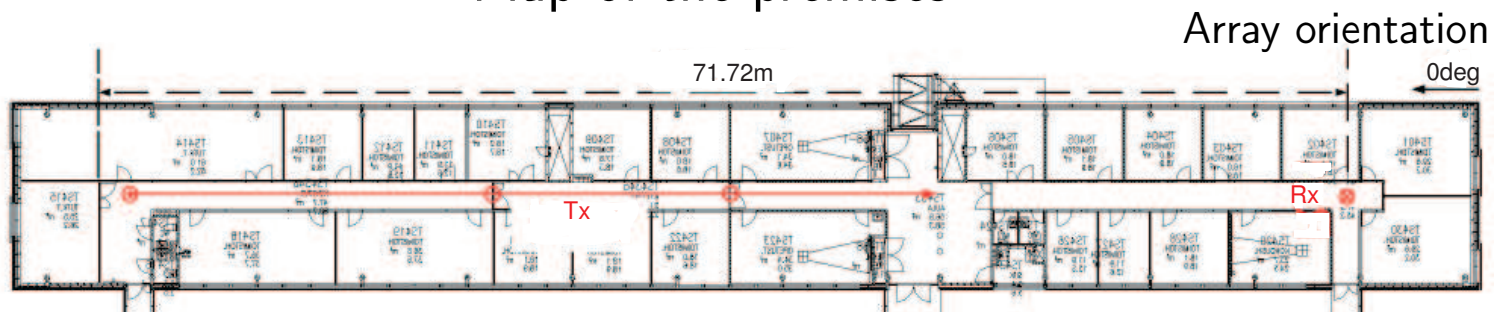
Tx surroundings



Rx surroundings



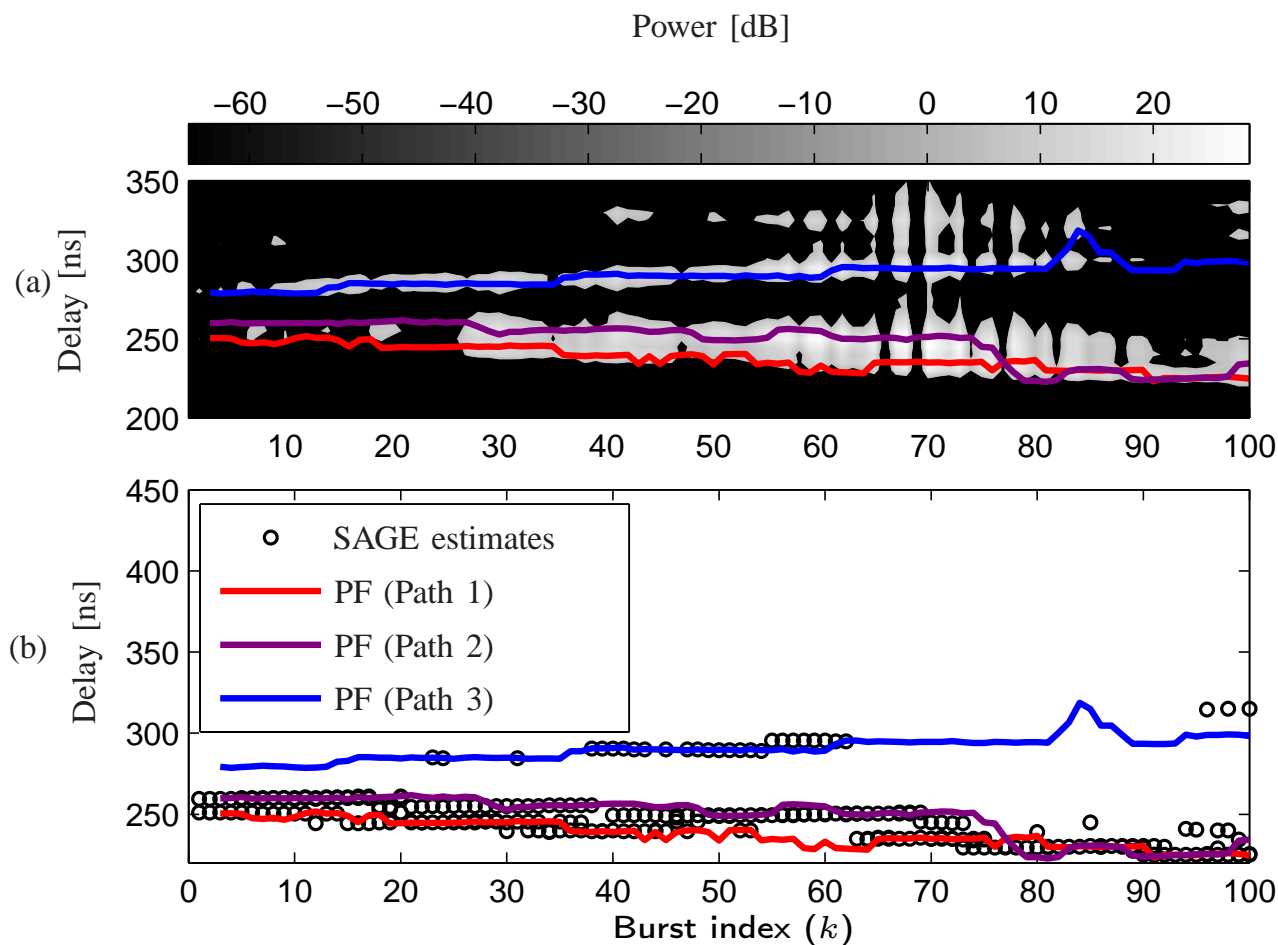
Map of the premises





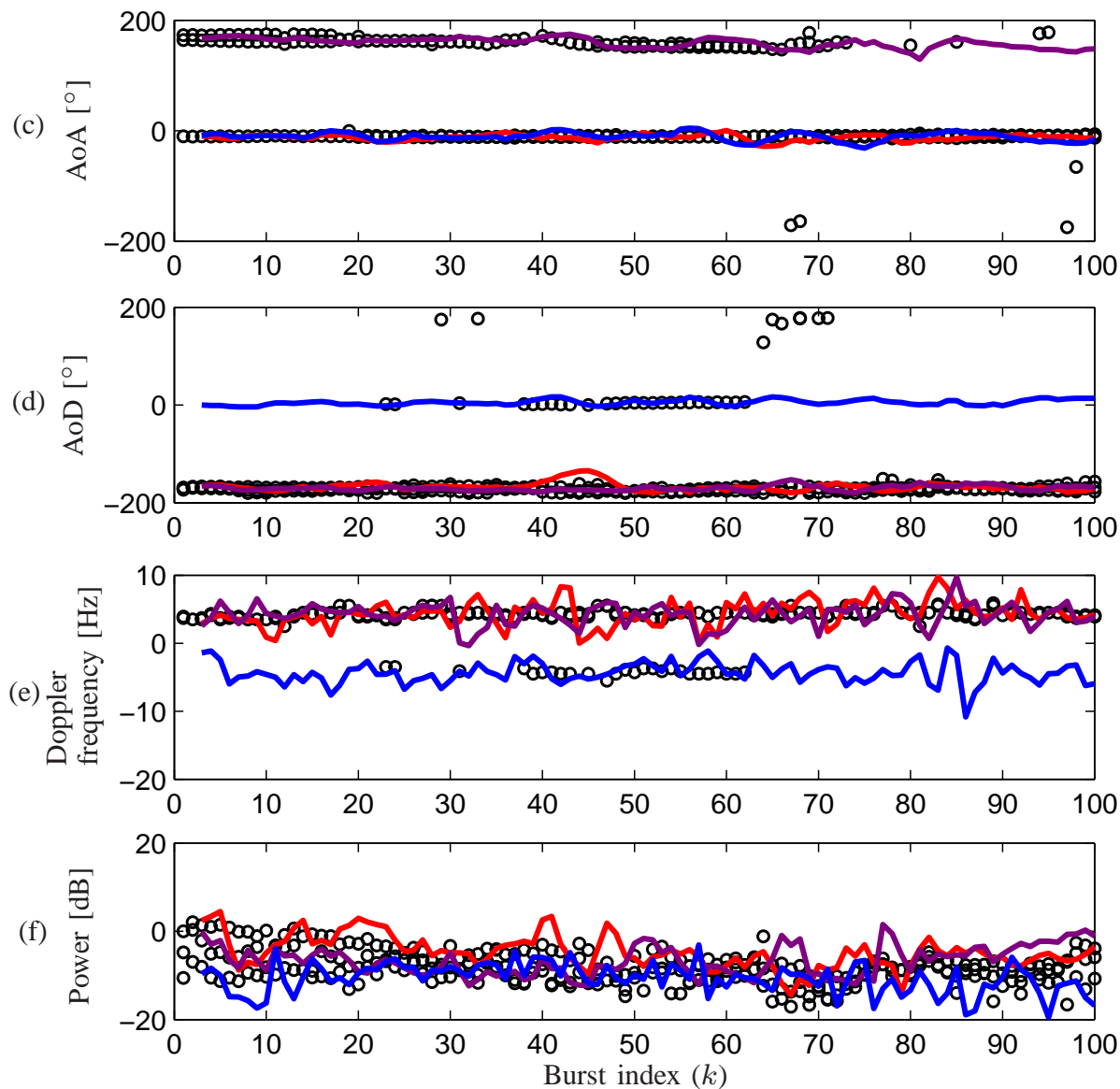
Estimation Result obtained using the PF

- Three paths are tracked, each of them allocated with 25 particles.
- Results are compared with that obtained with single-snapshot (non-tracking) algorithms.



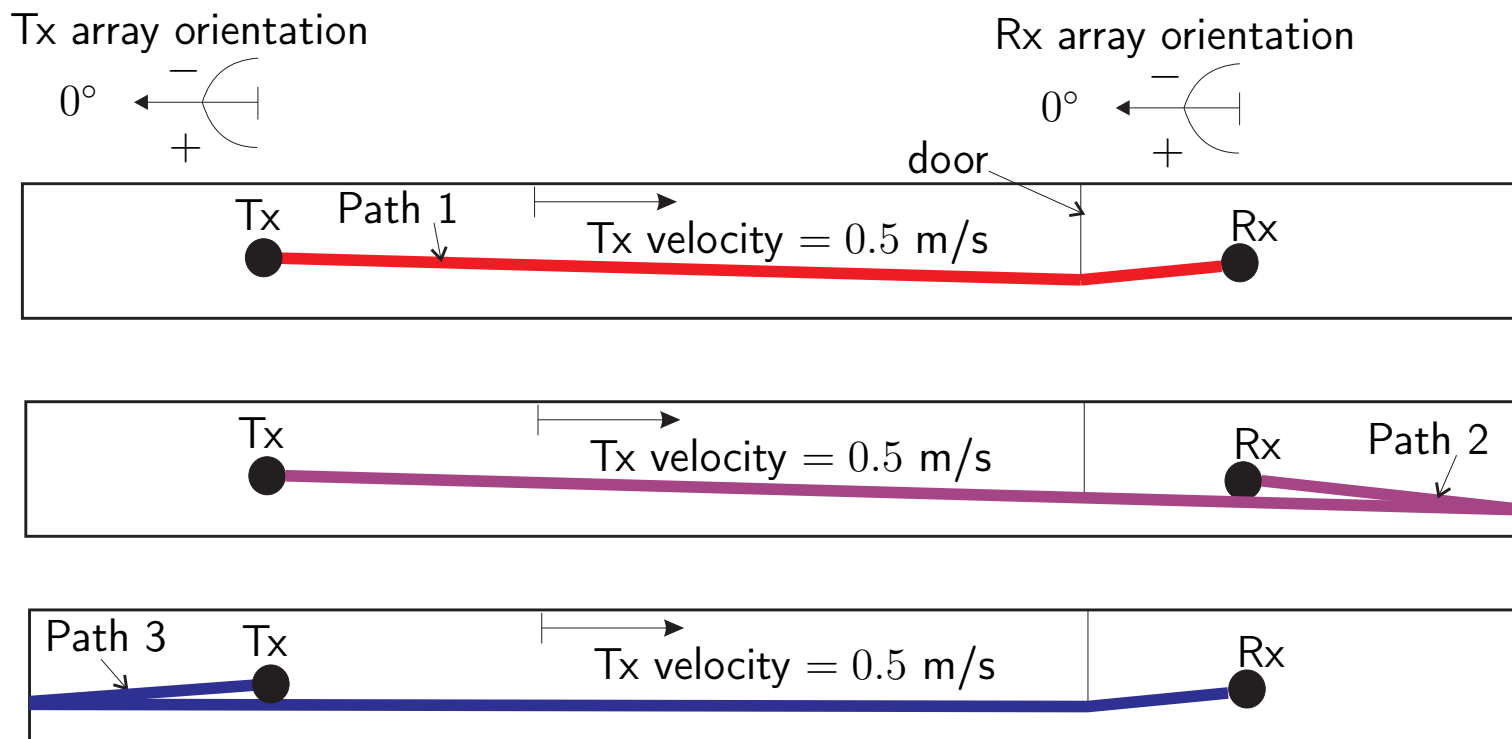


Estimation Result obtained using the PF (Cont.)





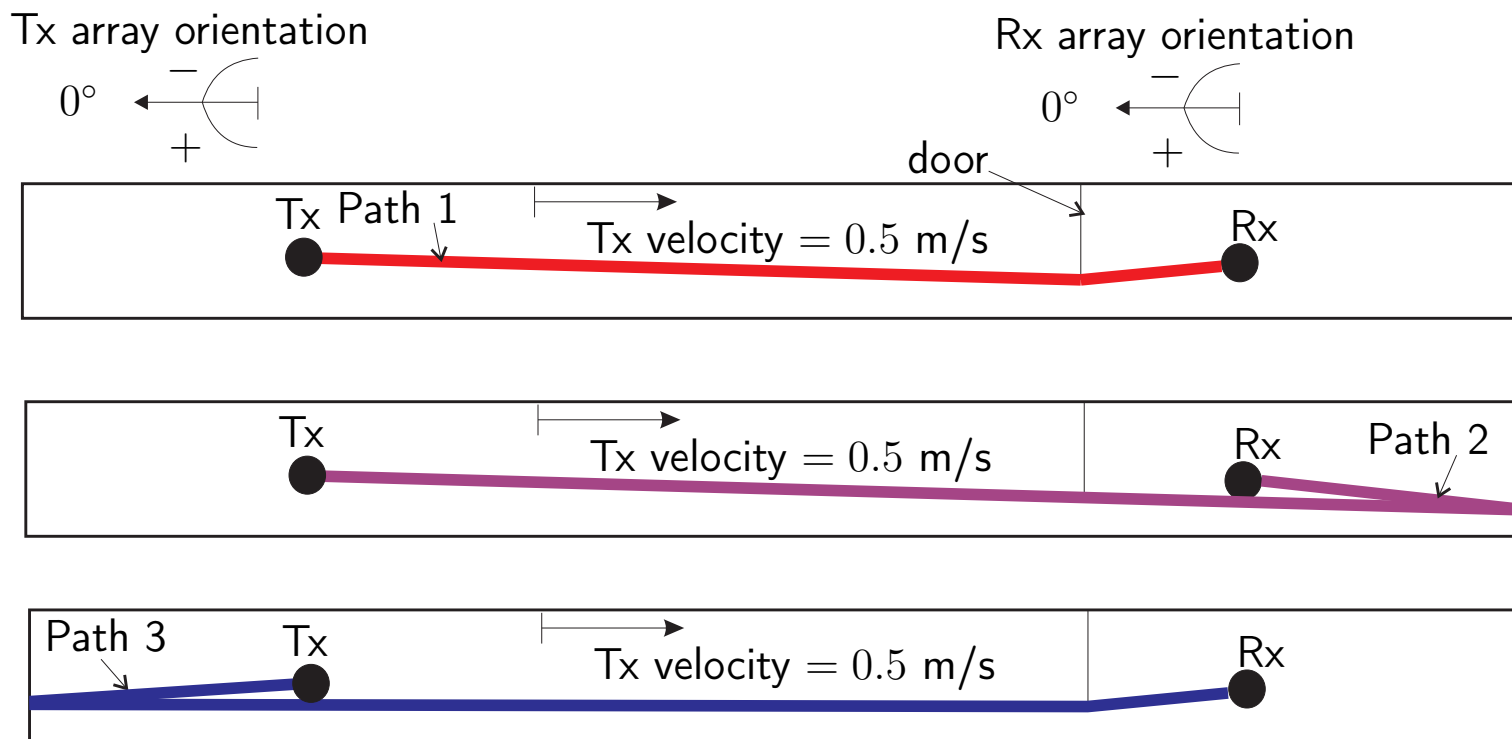
Characteristics of Reconstructed Paths



Path	delay time-evolution	AoA	AoD	Doppler frequency
No. 1	-0.5 ns/burst	0°	-180°	8 Hz
No. 2	-0.5 ns/burst	170°	-180°	8 Hz
No. 3	+0.5 ns/burst	0°	0°	-8 Hz



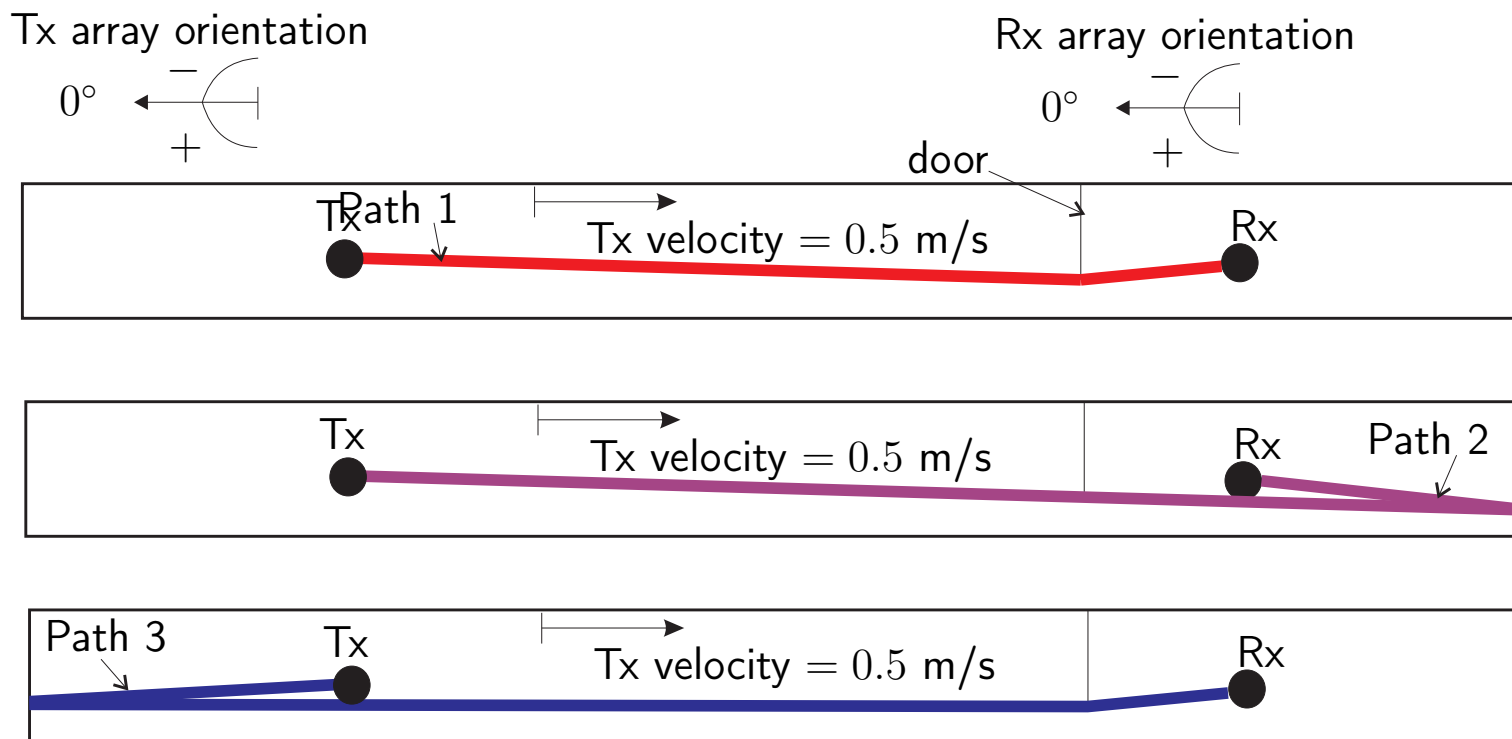
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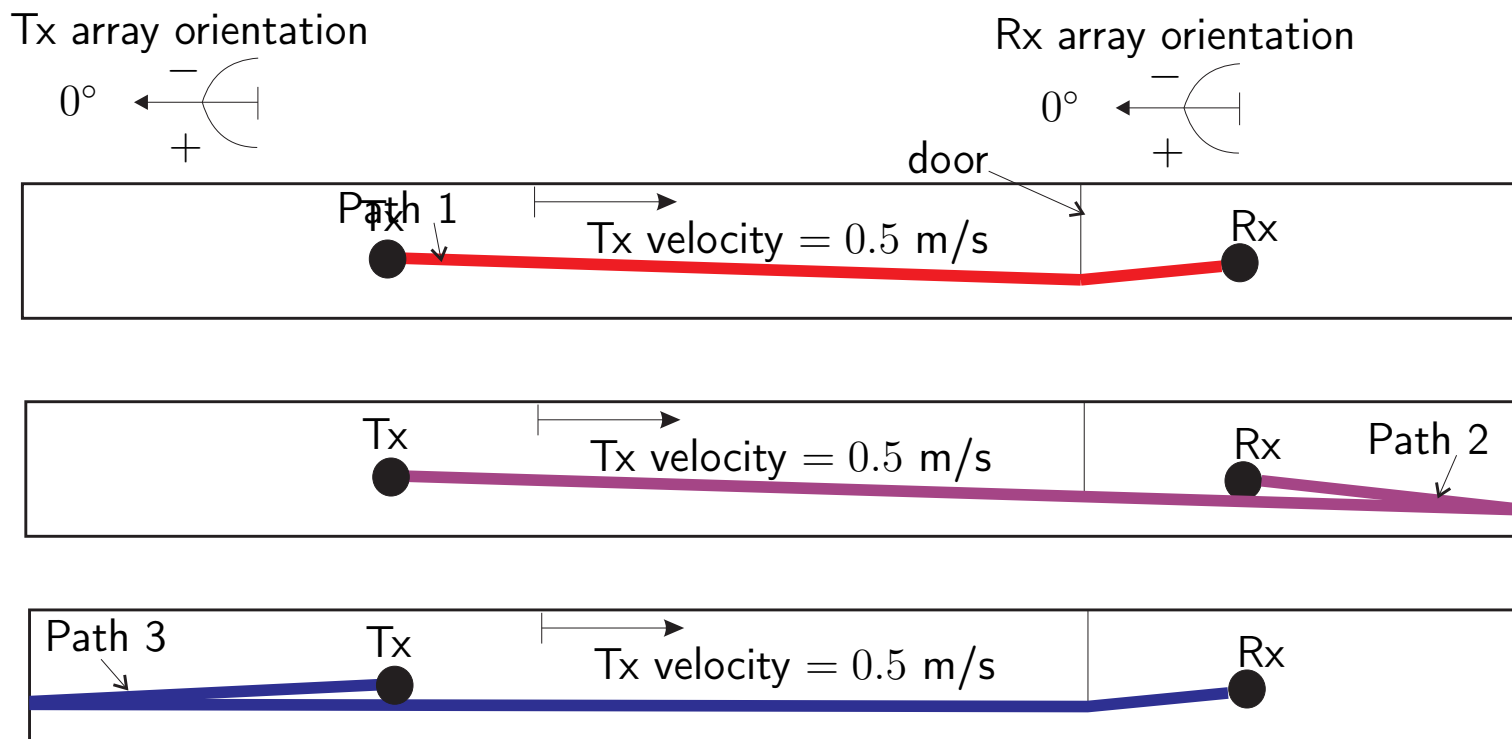
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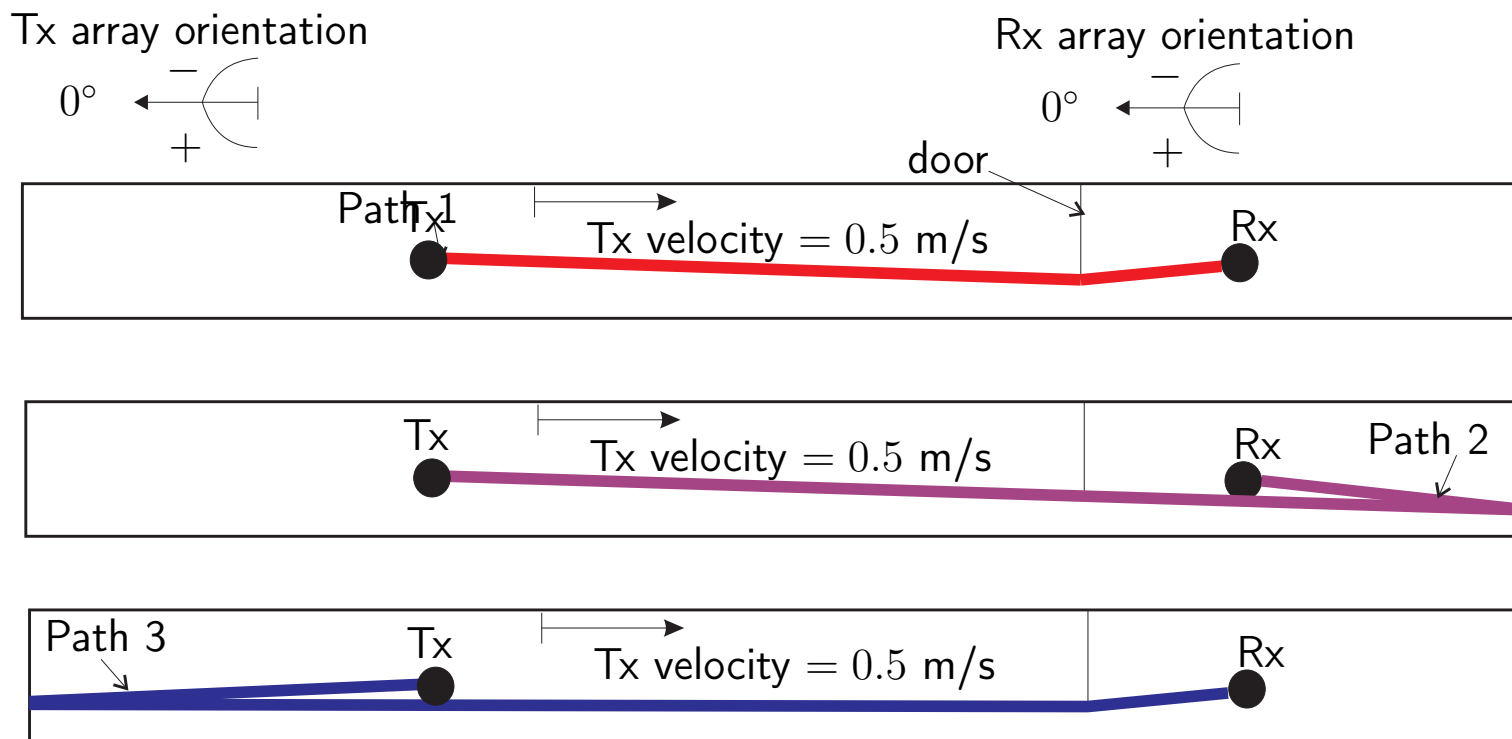
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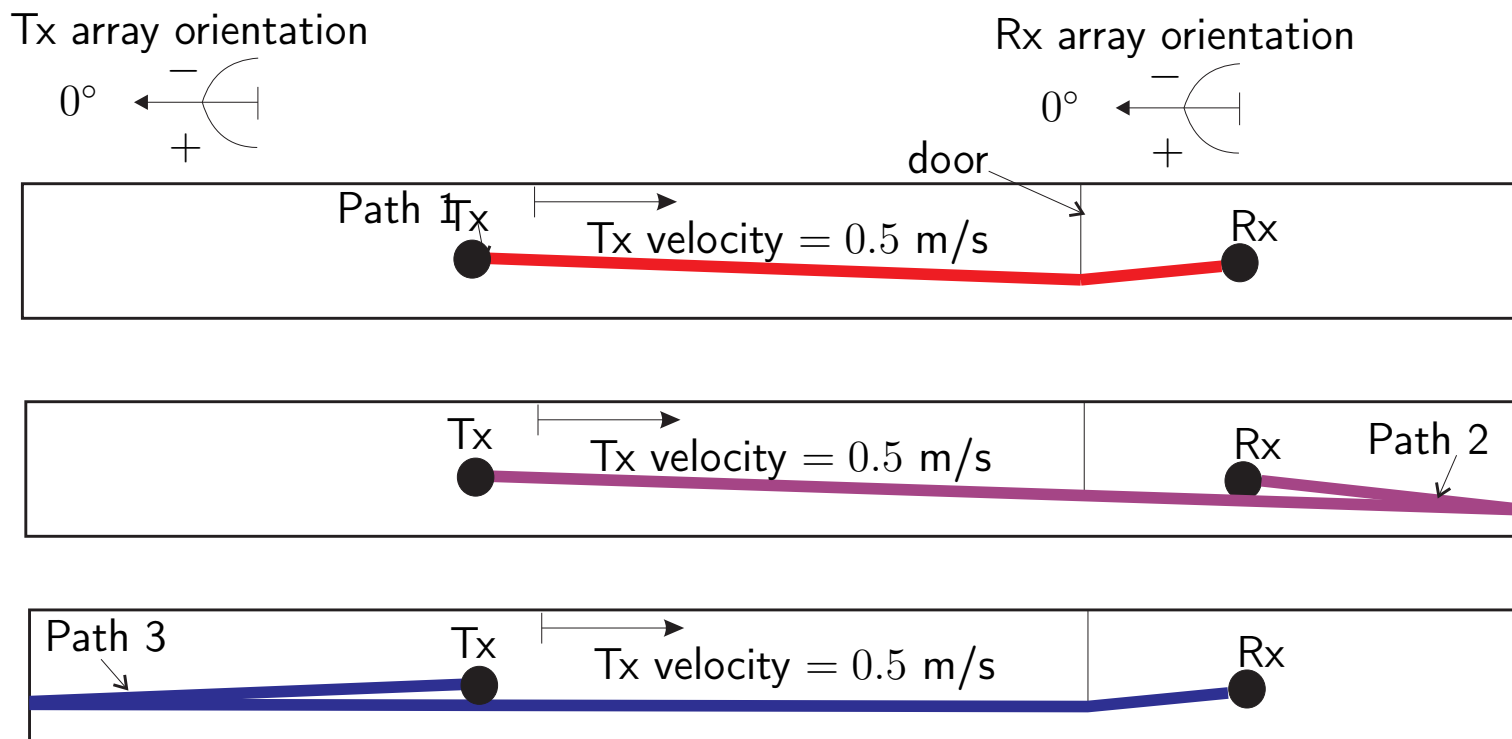
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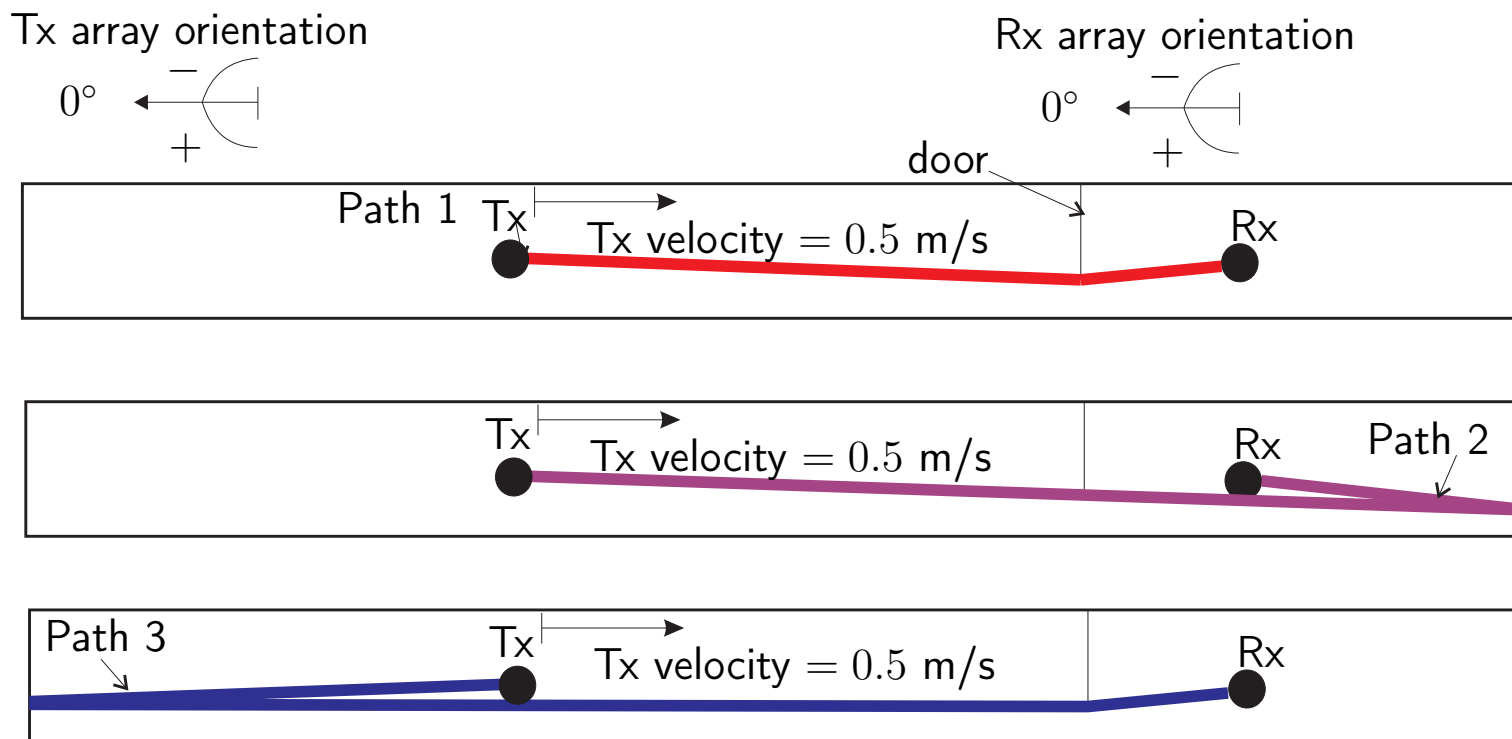
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Summary and Conclusions

- Time-variability is an important characteristics of propagation channels.
- Emulation of time-variant channels is essential for mobility testing.
- High-resolution reliable tracking algorithms were derived for estimation of time-evolution of of individual propagation paths.
- Experimental results brought insights into the path dynamics, which can be further exploited to build realistic models for time-variant channels.



References

- [Suzuki, et al., 2006] Suzuki, H.; Wilson, C. D. & Ziri-Castro, K. Time variation characteristics of wireless broadband channel in urban area Proceedings of 1st European Conference on Antennas and Propagation, 2006
- [Ziri-Castro, et al., 2006] K. I. Ziri-Castro, N. E. Evans & Scanlon, W. G. Propagation modelling and measurements in a populated indoor environment at 5.2 GHz Proceedings of the AusWireless, 2006
- [Yin, et al., 2008a] Yin, X.; Steinböck, G.; Kirkelund, G. E.; Pedersen, T.; Blattnig, P.; Jaquier, A. & Fleury, B. Tracking of Time-Variant Radio Propagation Paths using Particle Filtering, Proceedings of the International Communications Conference (ICC), 2008
- [Yin, et al., 2008b] Yin, X.; Steinböck, G.; Kirkelund, G. E.; Pedersen, T.; Blattnig, P.; Jaquier, A. & Fleury, B. Tracking Multi-Dimensional Time-Variant Parameters of Radio Propagation Paths using Particle Filtering, Proceedings of 2008 IEEE Radar Conference, 2008
- [Yin, et al., 2009] Yin, X.; Steinböck, G.; Kirkelund, G. E.; Pedersen, T.; Blattnig, P.; Jaquier, A. & Fleury, B. A Single-Stage Target Tracking Algorithm for Multistatic DVB-T Passive Radar Systems, Proceedings of IEEE Signal Processing Society 13th DSP Workshop & 5th SPE Workshop, 2009



Any questions?