

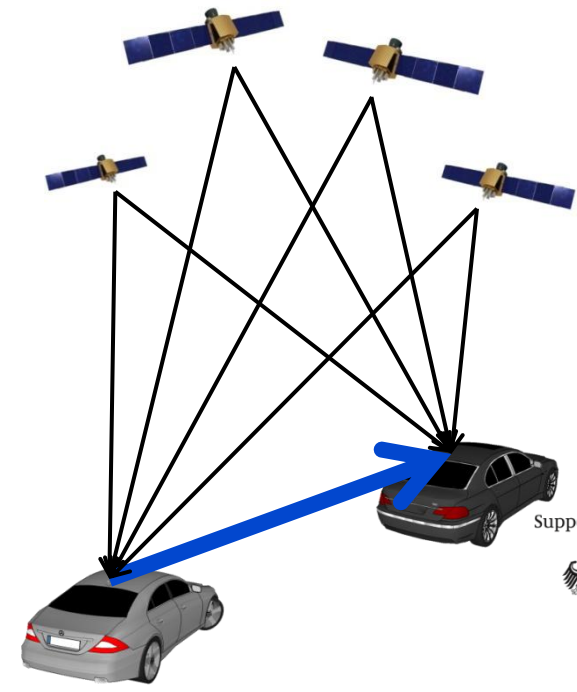


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Cooperative Localization

Kooperative Lokalisierung

Sebastian Papierok
Delphi Deutschland GmbH



Supported by:



on the basis of a decision
by the German Bundestag

Motivation

Basic Working Principle

System Overview

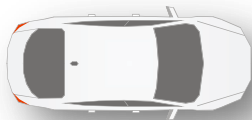
Results

Conclusions

- **The exchange of perception data is useless without a ‚precise‘ and inexpensive positioning system**
- **Precise positioning systems contribute to safety**

Why Relative Positioning?

Global Coordinates



**Where am I?
Static or moving?**

Why Relative Positioning?



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Relative Coordinates



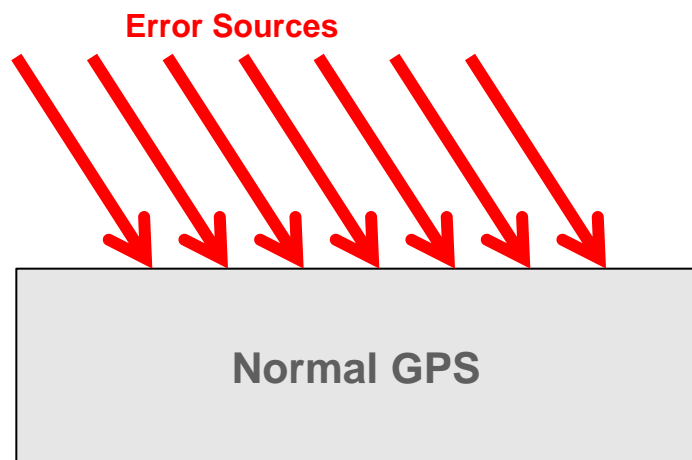


GPS Error Sources

Satellite position, satellite clock, and receiver clock error

Ionospheric, tropospheric, and multipath effects

Other errors

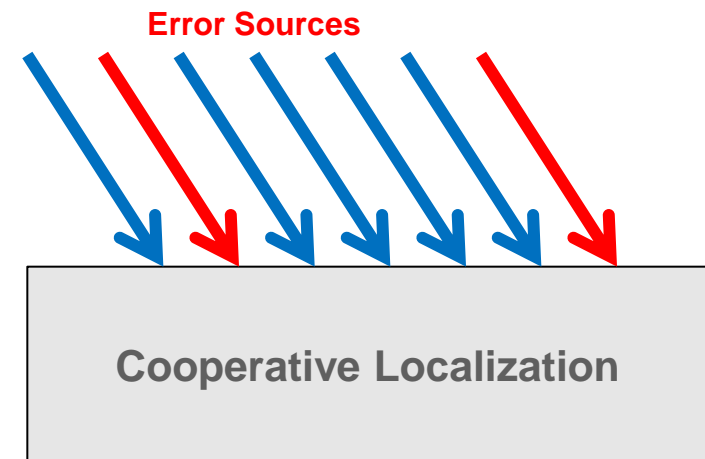
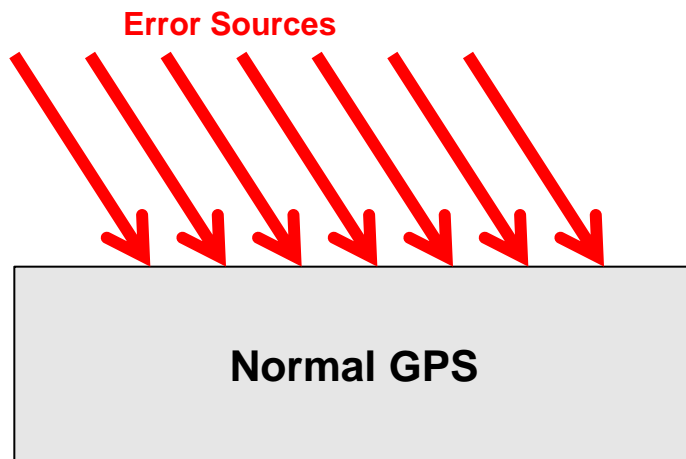


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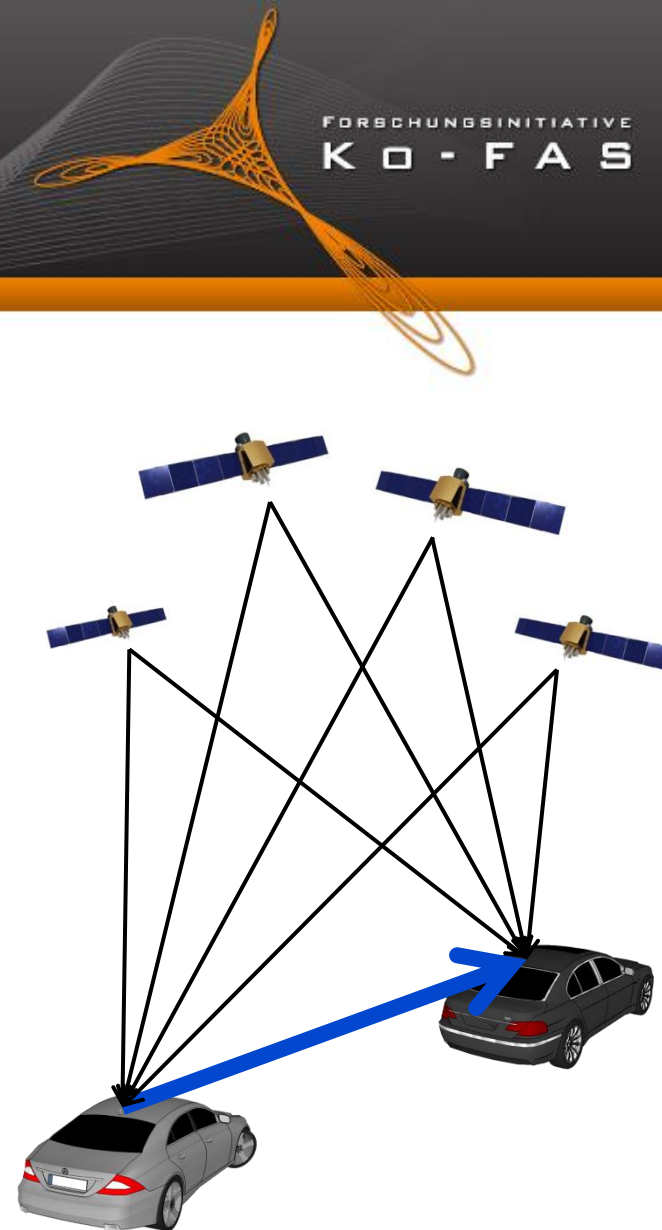


Message: Correlated errors have low impact in relative coordinates

Is there a better way to do it?

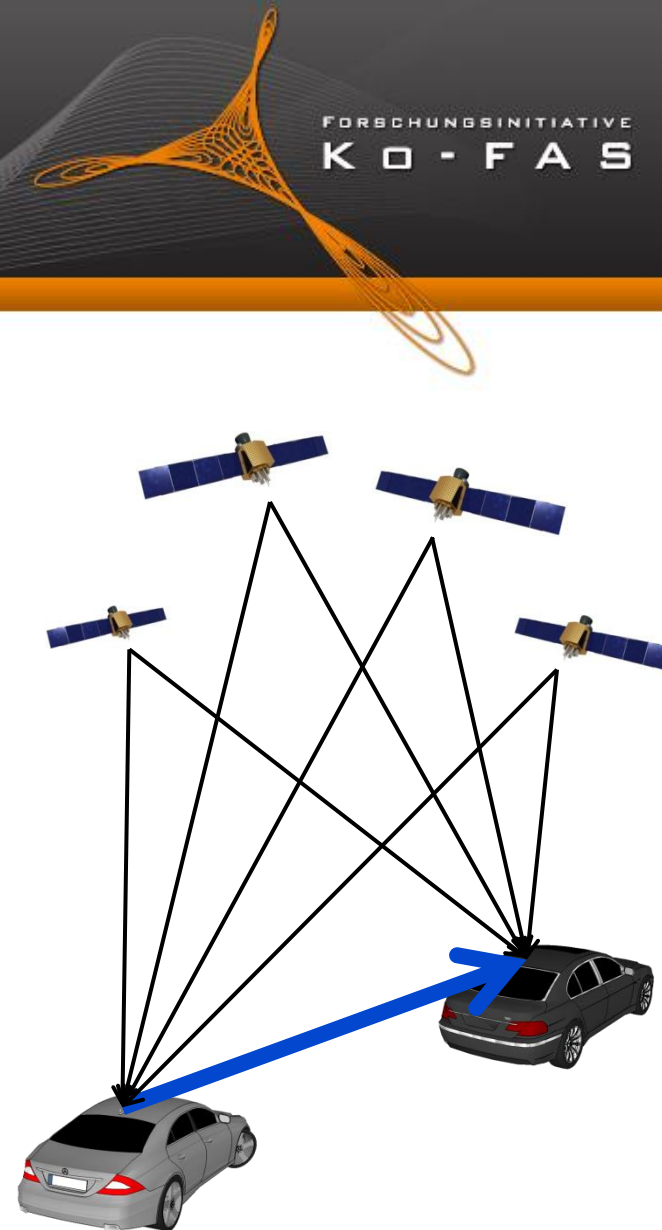
Direct difference of two positions

- Satellites for estimation unknown
- Fuse output of different algorithms?
- Impact on relative error?



Low level sensor data fusion

- Exchange of GPS raw data between the vehicles
- Determine common satellites
- Process pseudorange measurements
- Calculate satellite positions
- Estimate GPS position
- Calculate relative vector
- Data fusion with other data (e.g. velocity, yaw rate)

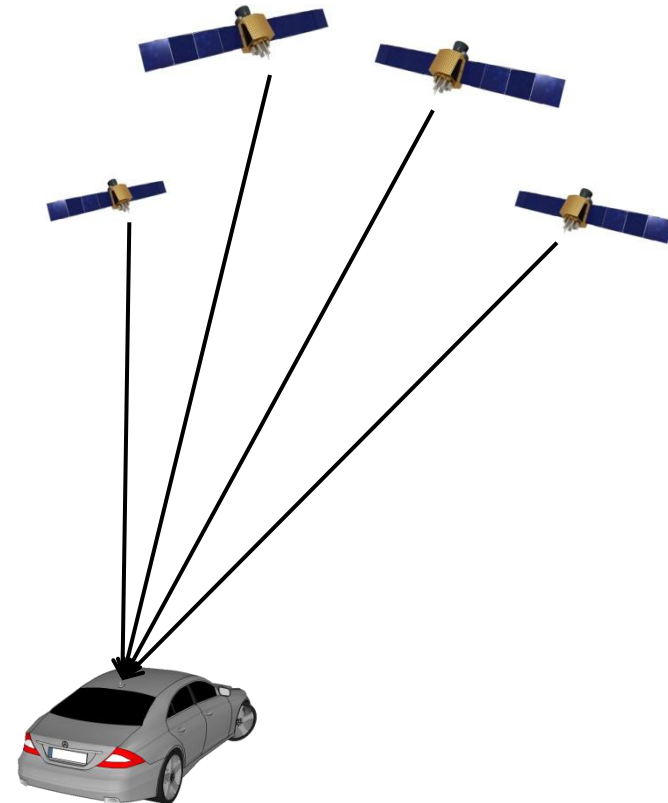


Navigation Data

- Satellite orbit information

Observation Data

- Receiver sampling time
- Satellite number
- Carrier-phase measurement
- Pseudorange measurement
- Doppler measurement
- Signal strength





Vehicles equipped with

Raw data GPS, GPS ground truth, V2V communication



DELPHI

DAIMLER

Cooperative

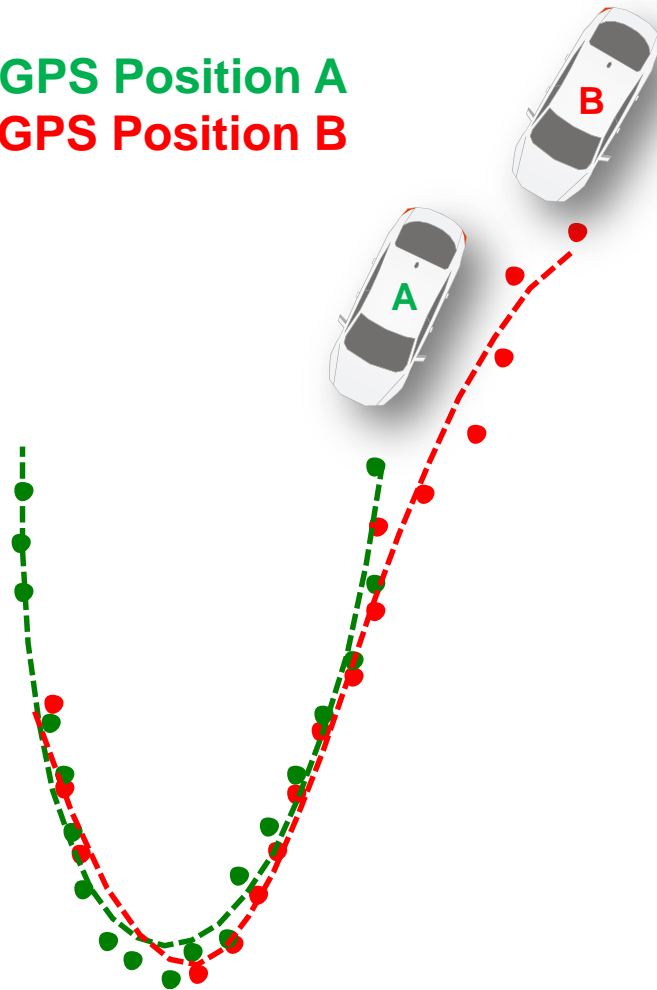
Localization

CLM

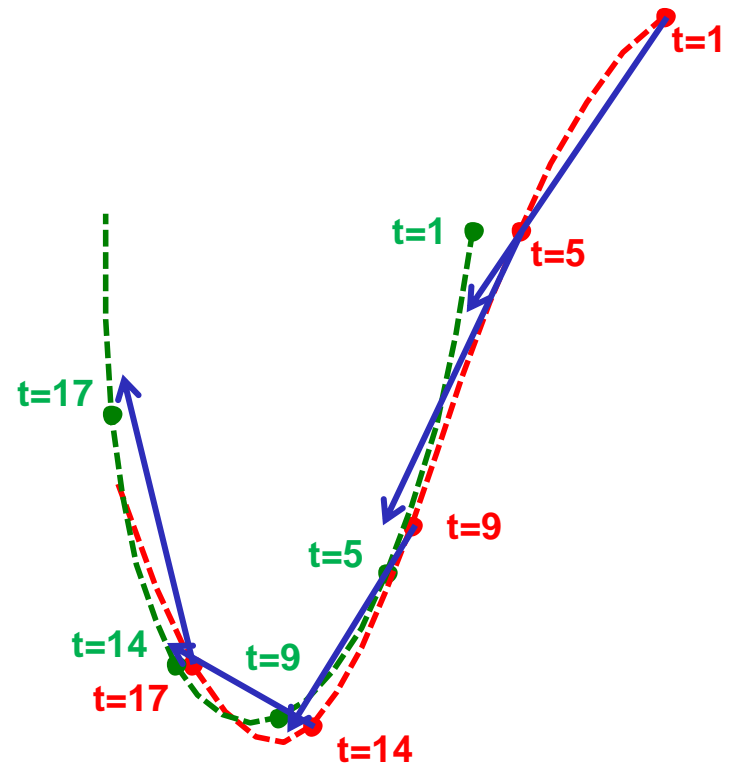
CLM



GPS Position A
GPS Position B



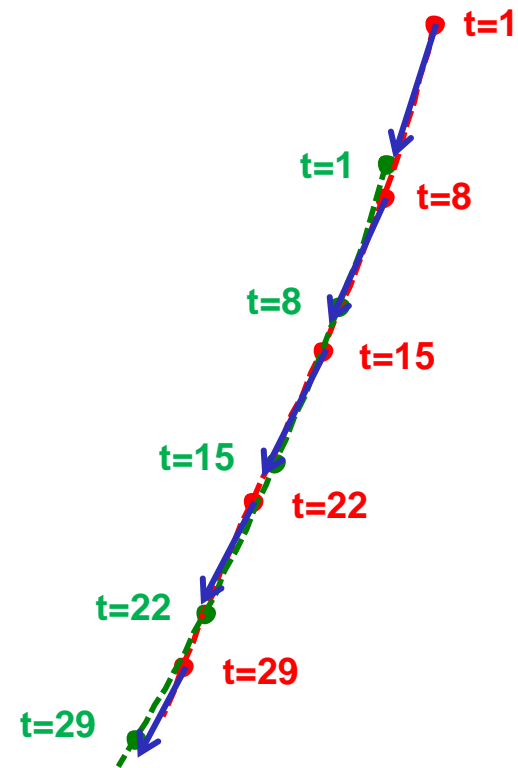
Model A
Model B
Model B + relative Vector



GPS Position A
GPS Position B



Model A
Model B
Model B + relative Vector



Innovations

- Usage of raw data GPS receivers
- Exchange of GPS raw data via V2V communication
- Elimination of systematic errors

Challenges

- Complex hardware architecture
- Synchronisation
- Effective information transfer

Future Directions

- Test different fusion algorithms

Thank You



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