SAFETY SERVER

Ko-HAF
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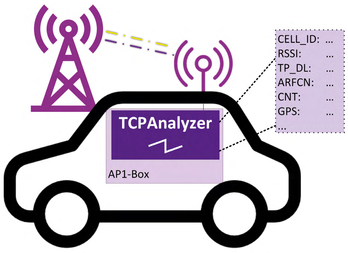
LTE Throughput Measurement and Predicition

RESEARCH TOPIC

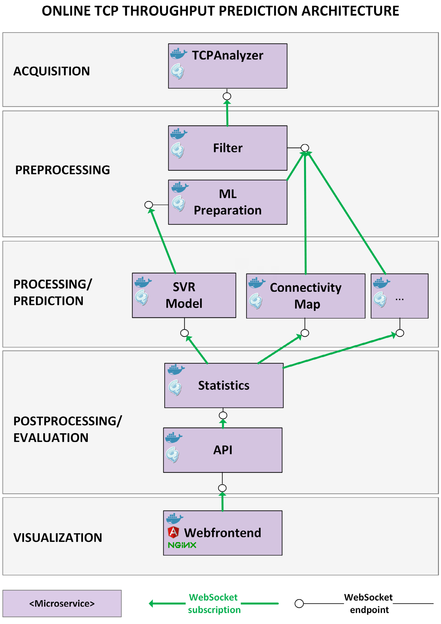
In order to ensure a **reliable connection** between AP1-Box and the Safety Server the overall **Quality of Service** and especially the **maximal data throughput** of the LTE mobile network were investigated.

DATA AQUISITION

- A measurement tool called **TCPAnalyzer** was developed, which countinously measures connection details **passively.**
- Therefore, the TCPAnalyzer monitors control messages of the TCP protocol for establishing (SYN, SYN-ACK, ACK) and closing a connection (FIN, ACK). Based on these values, round trip times (RTT) and data throughput are calculated.
- Additionally, physical properties of the connection, e.g. **RSSI** and **SINR**, are retrieved from the modem.

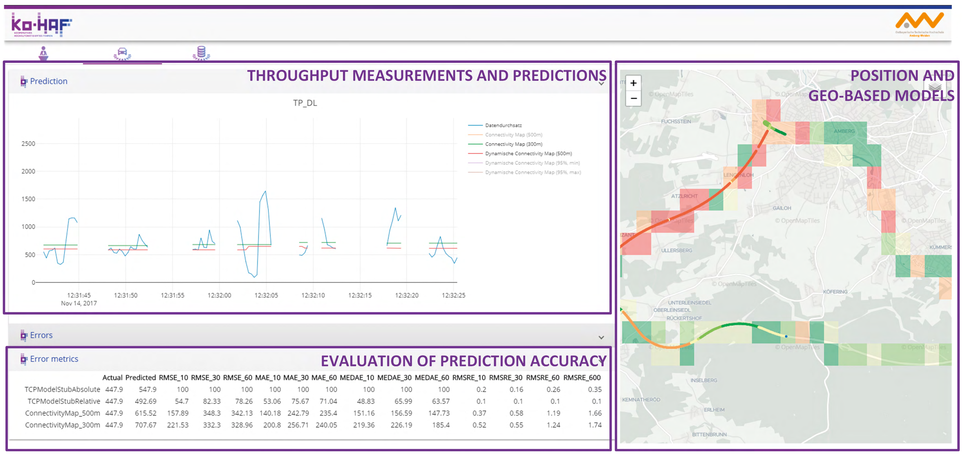


PREDICTION ARCHITECTURE



- Based on the aforementioned measurements different estimators either using geo-based **aggregation methods** (connectivity maps) or **machine learning algorithms** (support vector regression, random forests) are created in order to predict the upcoming data throughput.
- The general idea is to use geo-based estimators while historical data is available and to use machine learning algorithms for unknown areas.
- These trained models are inserted into a **data processing pipeline** based on a **microservice architecture** which is designed for online prediction and evaluation of the data throughput.
- Each microservice implements a specific loose part in the processing pipeline to increase cohesion of the component.
- All microservices are containerized using **Docker** to simplify deployment. This composition is running on the AP1-Box.
- Microservices are connected using **WebSockets** provided by the Tornado framework (Python).

ONLINE VISUALIZATION AND EVALUATION



	Actual	Predicted	RMSE_10	RMSE_30	RMSE_60	MAE_10	MAE_30	MAE_60	MEDAE_10	MEDAE_30	MEDAE_60	RMSRE_10	RMSRE_30	RMSRE_60	RMSRE_600
TCPModelStubAbsolute	447.9	547.9	100	100	100	100	100	100	100	100	100	0.2	0.16	0.26	0.35
TCPModelStubRelative	447.9	492.69	54.7	82.33	78.26	53.06	75.67	71.04	48.83	65.99	63.57	0.1	0.1	0.1	0.1
ConnectivityMap_500m	447.9	615.52	157.89	348.3	342.13	140.18	242.79	235.4	151.16	156.59	147.73	0.37	0.58	1.19	1.66
ConnectivityMap_300m	447.9	707.67	221.53	332.3	328.96	200.8	256.71	240.05	219.36	226.19	185.4	0.52	0.55	1.24	1.74

Web frontend for online visualization of measurements and prediction model accuracy

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