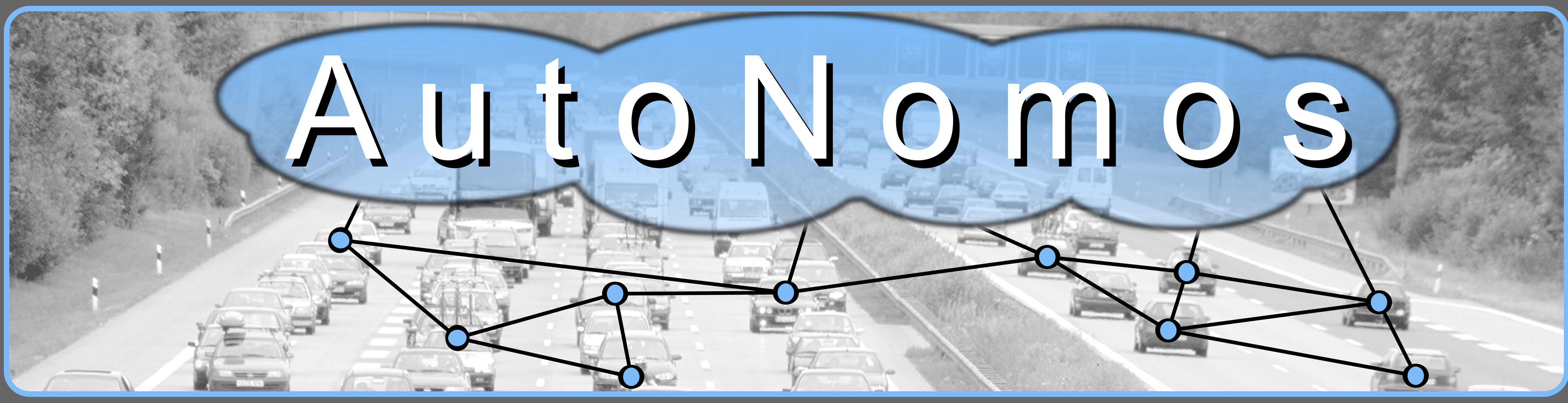
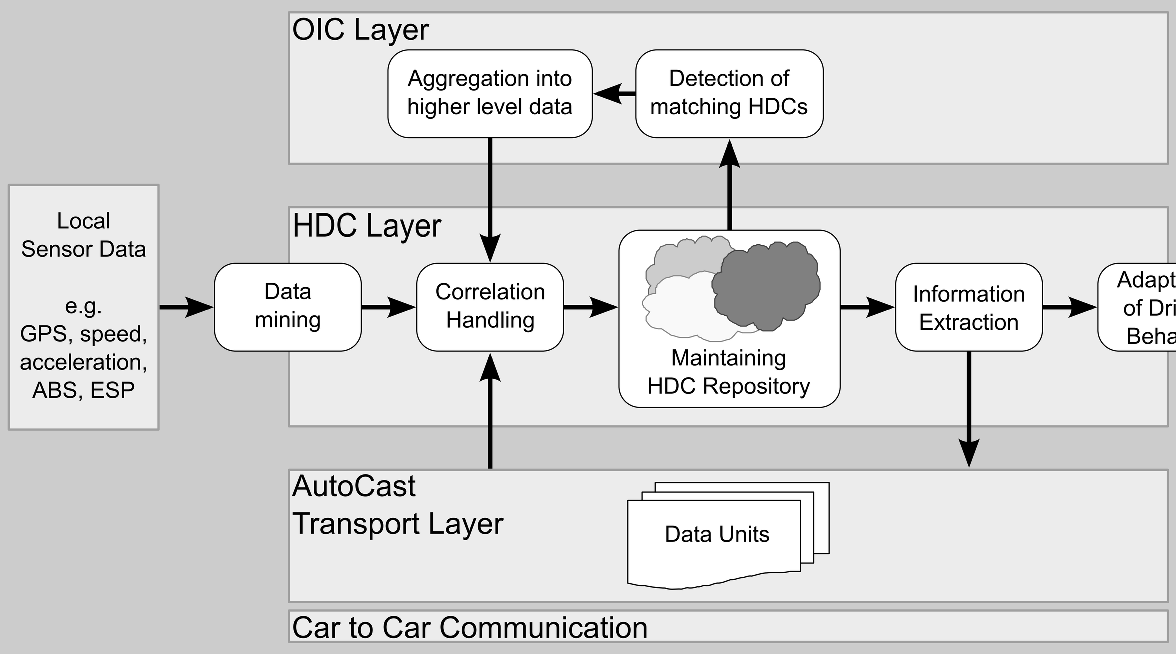
Deutsche Forschungsgemeinschaft
DFG

Schwerpunktprogramm 1183
"Organic Computing"



AutoNomos: A Distributed and Self-Regulating Approach for Organizing a Large System of Mobile Objects.

Concept



General

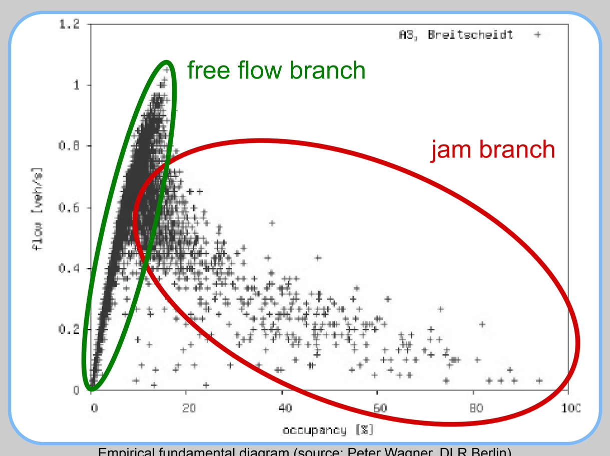
- Architecture of software running on each host (vehicle)
- Manages hovering data clouds (HDC) and organic information complexes (OIC)
- Provides retrieval, storage and dissemination of traffic information

Layers

- *OIC layer* searches for and aggregates matching HDCs
- *HDC layer* correlates incoming data from sensors or other vehicles to stored HDCs and distributes them to other layers
- *AutoCast layer* takes care of dissemination of data units independent of vehicle density

The network of connected hosts constitutes a *distributed feedback loop* spreading information like gossiping

Fundamental Diagram of Jam-ADS



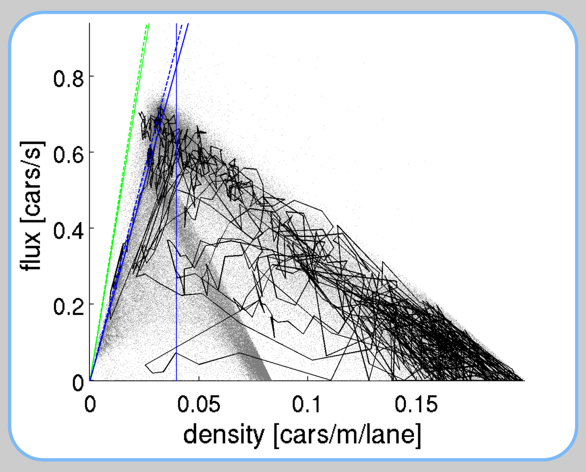
Empirical fundamental diagram (source: Peter Wagner, DLR Berlin)

The Fundamental Diagram from Traffic Research

- One of the most important diagrams from traffic research
- Consists mainly of two branches: Sharp branch of free flow and cloudy branch of congested traffic
- The gradient of the free branch (i.e., ratio of flux over density) resembles the speed of free-flowing cars
- The gradient of the jam branch resembles the speed at which a traffic jam moves upstream; that value (between -10 km/h and -20 km/h) is nearly always the same worldwide

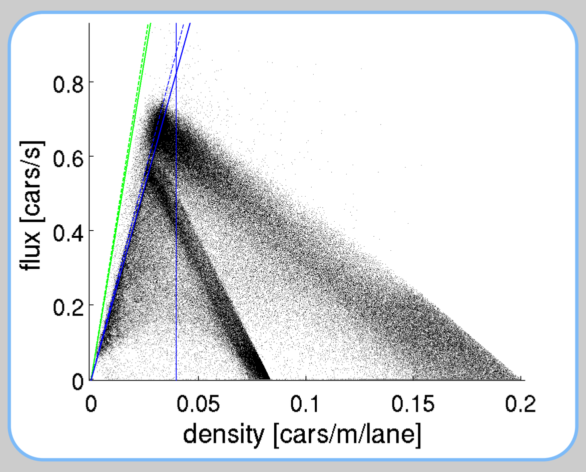
Trajectory of a Single Vehicle

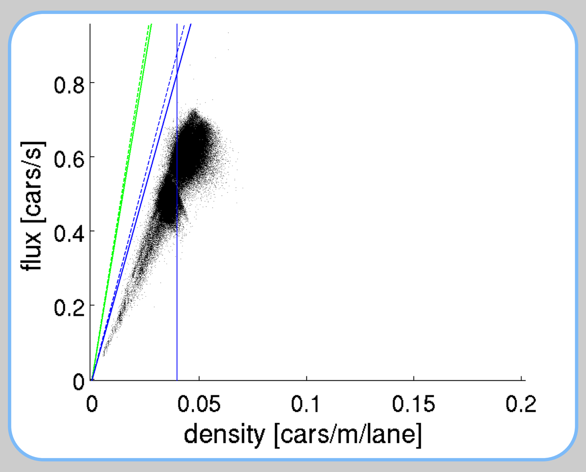
- Dots belonging to a single vehicle are connected in order of timesteps
- This shows that a vehicle normally covers all parts of the diagram



Fundamental Diagram of a Simulation Run

- Generated by a single simulation run
- One dot per vehicle and timestep
- Flux and density is computed by velocity and gap to predecessor
- High total vehicle density, in this case leading to a more populated jam branch
- This diagram shows two jam branches due to exactly two simulated vehicle classes (cars and trucks)
- Jam branch has a gradient of approx. -15 km/h which is the empirical velocity of free traffic jams on highways





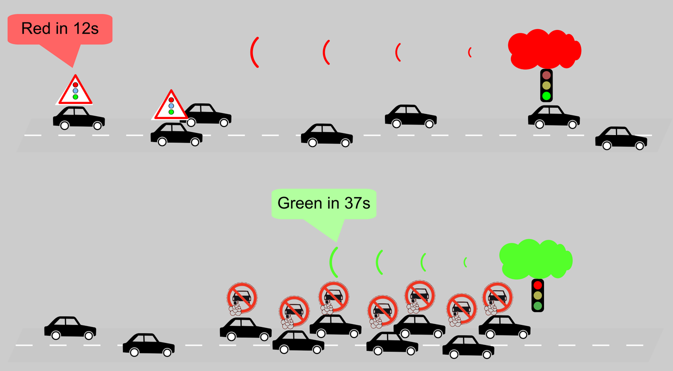
Fundamental Diagram with Jam-ADS

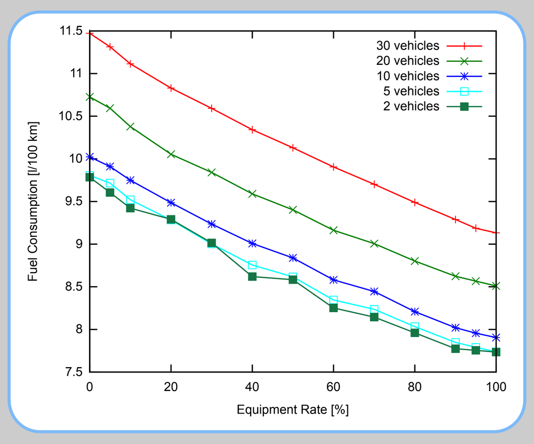
- Jam-ADS is the advanced distributed strategy (ADS) developed by project AutoNomos
- Jam-ADS changes the coupling of vehicles by providing information about the vehicles ahead
- Jam-ADS can erase the jam branch almost completely
- The gradient of the free-flow branch (velocity of free flow) is slightly lower, but since there is no traffic jam, the average velocity does not change significantly

Urban Traffic

Traffic lights set up hovering data clouds (HDC) in their area

Traffic Lights Emit Phase Information

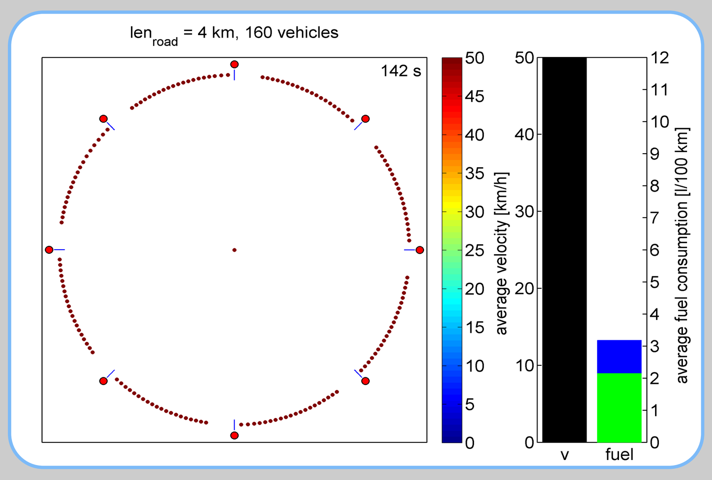




- A traffic light HDC contains information about the next phase(s)
- Approaching vehicles can optimize their velocity
- Waiting vehicles can estimate whether to turn off the engine
- Vehicles can improve their flow through successive traffic lights
- First simulations with a single traffic light show promising fuel savings

Randomness of Real Traffic vs. Ideal Behavior

Simulation of synchronized traffic lights with ideal and real behavior of vehicles

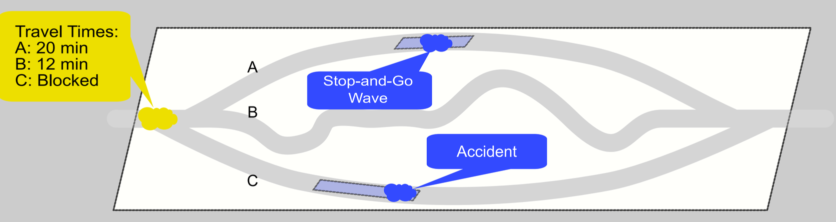


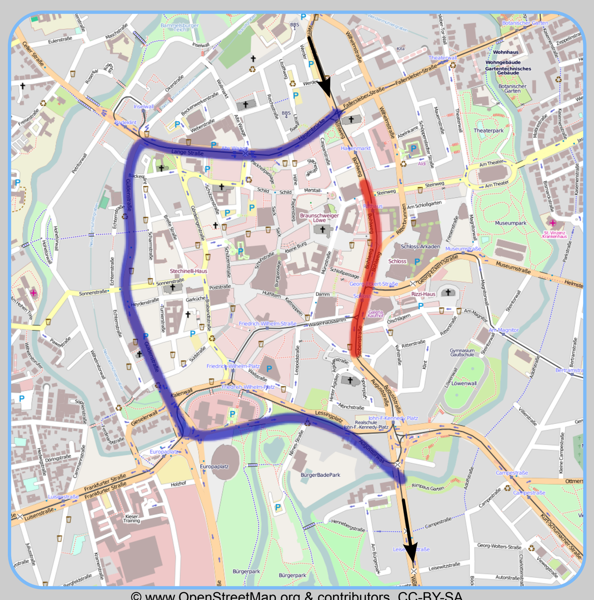
- Without random behavior we see perfect platoons going through phased traffic lights
- Despite red lights, the average velocity is exactly 50 km/h

- Turning on randomness breaks down the perfect "green wave"
- Average velocity drops by almost 50 %, while fuel consumption is more than doubled because of necessary accelerations
- Even when the lights are green there are still standing vehicles

Traffic Lights Emit Congestion Information

- A traffic light HDC contains information about congestions on the next sections
- Vehicles can decide to take a detour to avoid the congested link
- This may also be used on other roads with the HDC hosted by vehicles close to a junction





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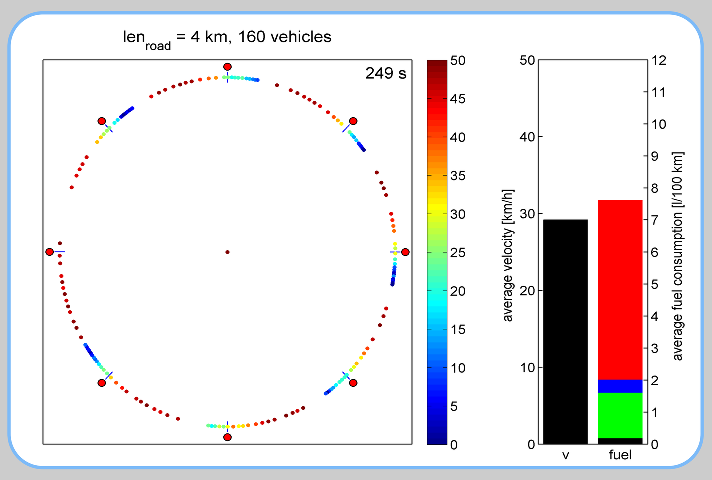

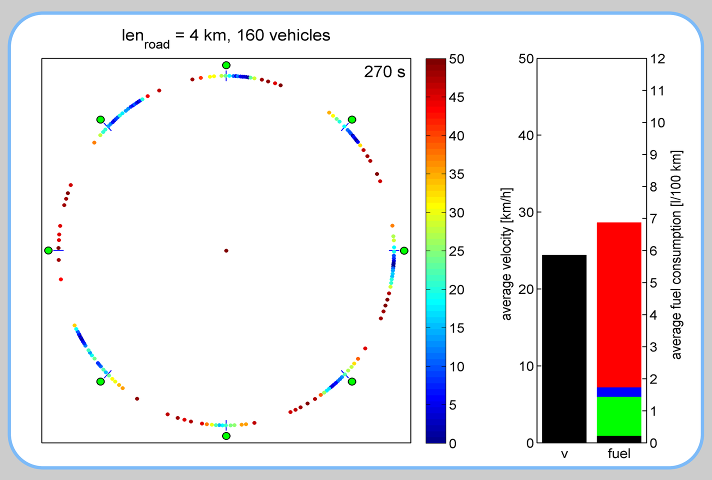

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