SYSTEM FOR PROGNOSTIC CALCULATION OF THE OPTIMAL SPREADING DENSITY IN WINTER ROAD CLEARANCE SERVICES

- **Günter Hausmann**
- KOMMZEPT-Ingenieurbüro Hausmann
- hausmann@kommzept.com

0. CONTENT

1. INTRODUCTION

What is the problem?

The setting of the spreading density by the specialists during road maintenance in winter is characterized by many subjective factors.

Using assistance systems that process all available information, the application of melting substances could be optimized.

2. Task definition

The following questions were to be answered:

1.Which influencing factors must be considered for the formation of slipperiness?

1.Is there a practical algorithm to calculate the optimum spreading density?

1.How is an algorithm for controlling the spreading machine technically realized?

3. Influencing factors for ice formation

Main factors:

- Surface temperature of the carriageway
- Remaining quantity of salt on the carriageway
- Quantity of liquid on the carriageway

Road surface temperature

- Air temperatur
- Subsurface temperature
- Spreading
- Cloudy
- Wind
- Volume of traffic
- Road surface
- Type of de-icing substance
- Quantity of de-icing substance
- Depth of water film

Concentration of the dissolved de-icing substance on the road surface

- **Quantity of salt**
  - Spreading density
    - Quality of applying the de-icing substance
    - Technology for applying de-icing substance
    - Quality of de-icing substance
  - Residual salt
    - Quality of applying the de-icing substance
    - Technology for applying de-icing substance
    - Quality of de-icing substance
    - Road surface
    - Volume of traffic
- **Depth of water film**
  - Precipitation
  - Water drain
  - Drying
    - Road temperature
    - Air temperatur
    - Relative air humidity
    - Type of de-icing substance
  - Condensation
    - Road temperature
    - Air temperatur
    - Relative air humidity
  - Road surface
  - Road surface
    - Structure
    - Geometry
  - Traffic influence
    - Quantity
    - Speed

Type of de-icing substance

- NaCl
- $CaCl_2$
- $MgCl_2$

4. Development of a calculation algorithm for the optimum spreading dosage

4.1 Algorithm

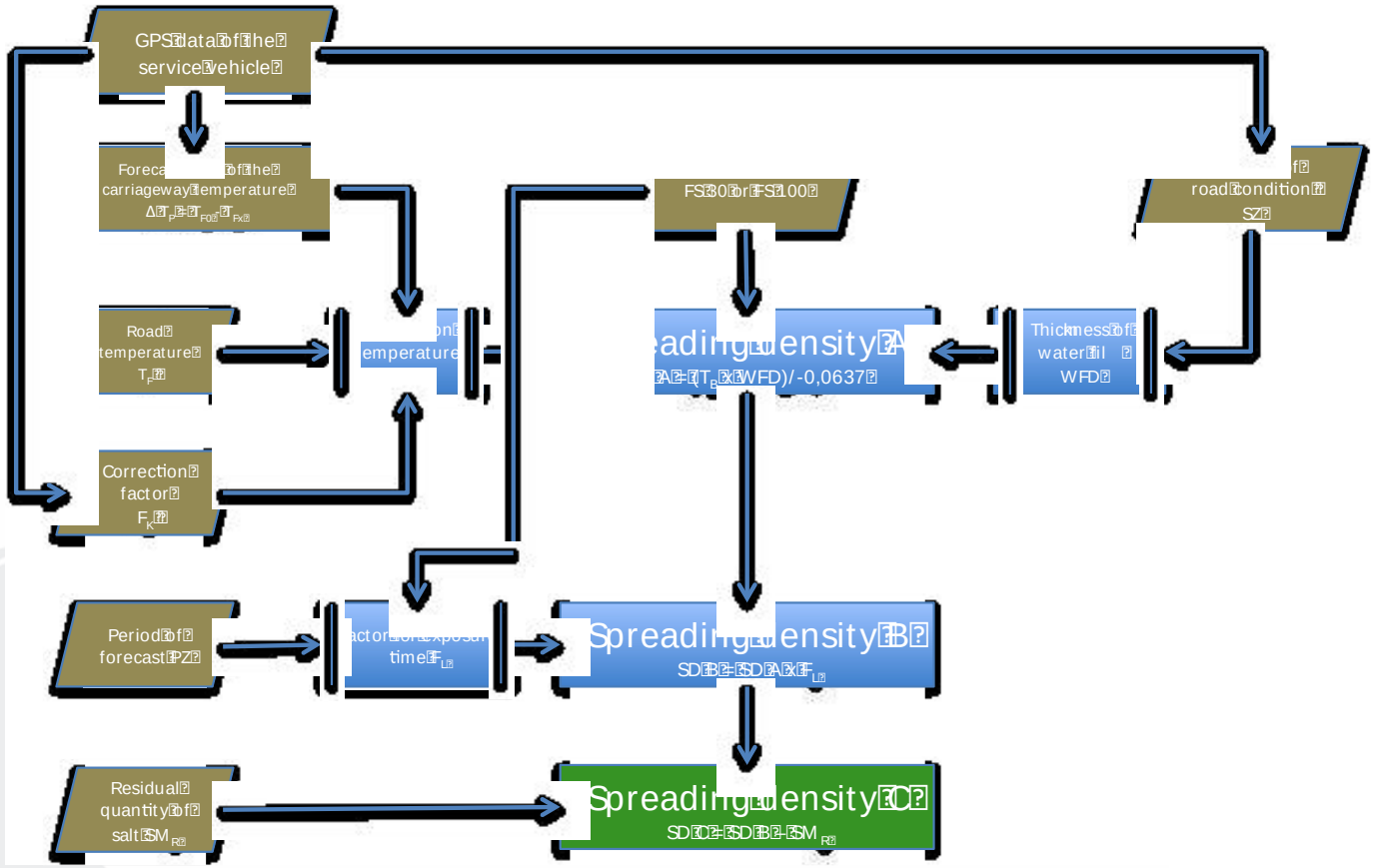
A fundamental basis for the algorithm is the recognized phase diagram NaCl- H_2O.

$$SD_{Opt} = f\ (T_{Fmin}, WFD_{max}, SM_R, SM_{loss})$$

SD_{Opt} in g/m^2	Optimum Spreading Density
T_{Fmin} in °C	Lowest road surface temperature to be anticipated within the technologically required period.
WFD_{max} in mm	Maximum quantity of liquid converted to depth of water film present on the road surface within the technologically required period.
SM_R in g/m^2	The quantity of spreading material, from being spread previously, present on the road at the time of the actual spreading.
SM_{loss} in g/m^2	The quantity spread on the road which is anticipated to be lost within the period planned.

4. Development of a calculation algorithm for the optimum spreading dosage

4.2 Flowchart of the algorithm



4. Development of a calculation algorithm for the optimum spreading dosage

4.3 Forecast values

For the forecast values, data is used provided by the German Weather Service (DWD) with the "point weather forecast“.

The forecast is prepared differentiating for small sections of road and updated hourly. The data required is directly transmitted to the vehicle.

4. Development of a calculation algorithm for the optimum spreading dosage

4.4 Calculation temperature

The calculation temperature T_{Fmin} is generated taking into consideration the actual measurement using the infrared pyrometer installed on the vehicle and the forecast temperature trend.

4. Development of a calculation algorithm for the optimum spreading dosage

4.5 Depth of water film

Road condition (SZ)	DWD Code	Depth of water film [mm]
dry	0	0.01
moist	1	0.02
wet	2	0.06
frost	3	0.02
snow	4	0.10
ice	5	0.06

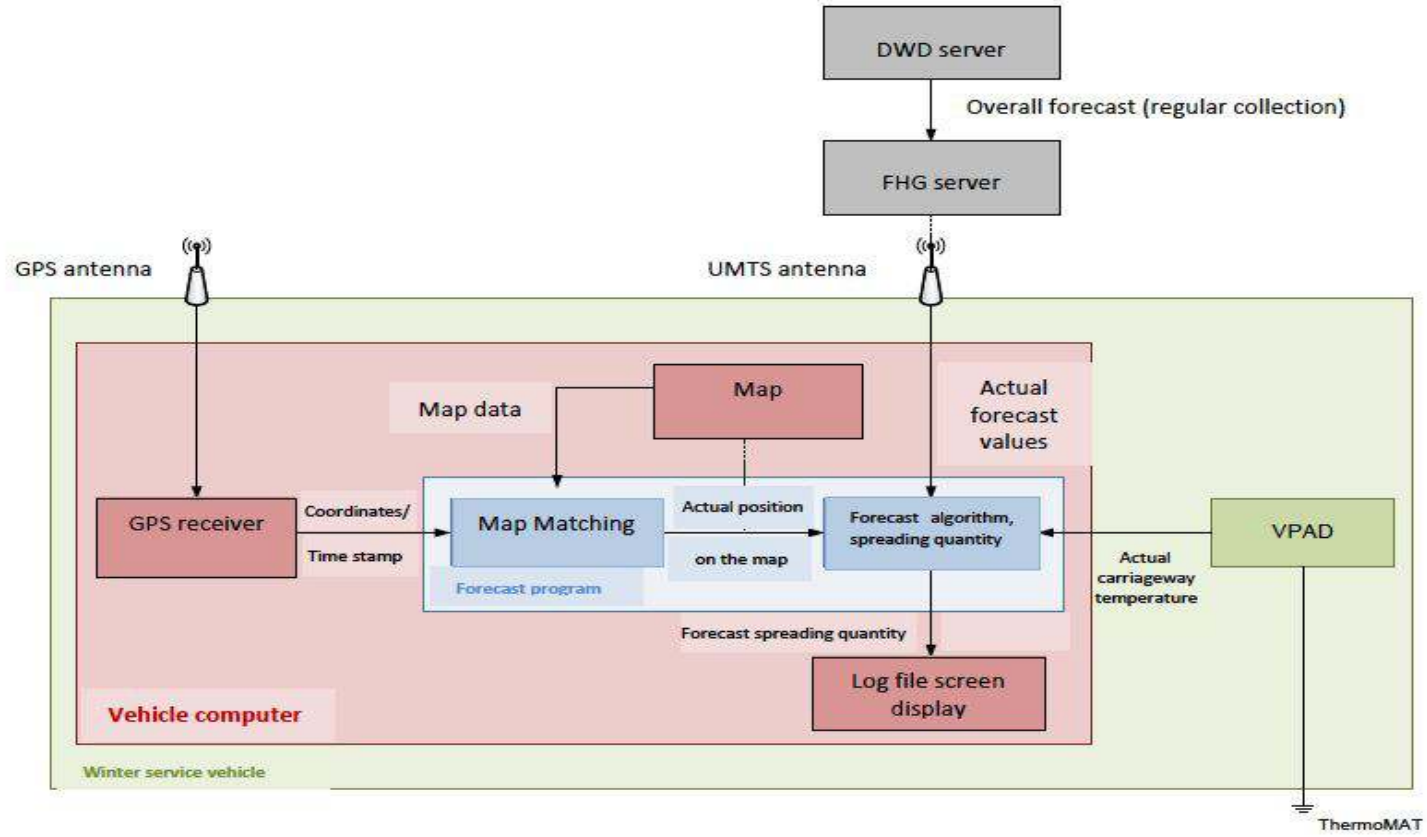
4. Development of a calculation algorithm for the optimum spreading dosage

4.6 Residual salt

At present, the remaining quantity of salt cannot be measured from the vehicle. Initially, it has been considered by taking a fixed value.

5. Realization of the System in Service Vehicles

5.1 Function schematic



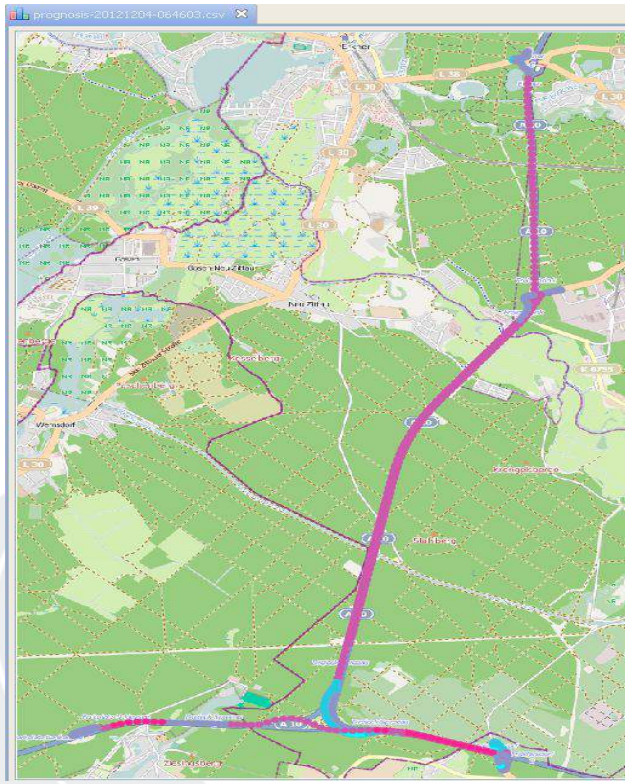
5. Realization of the System in Service Vehicles

5.2 Hardware

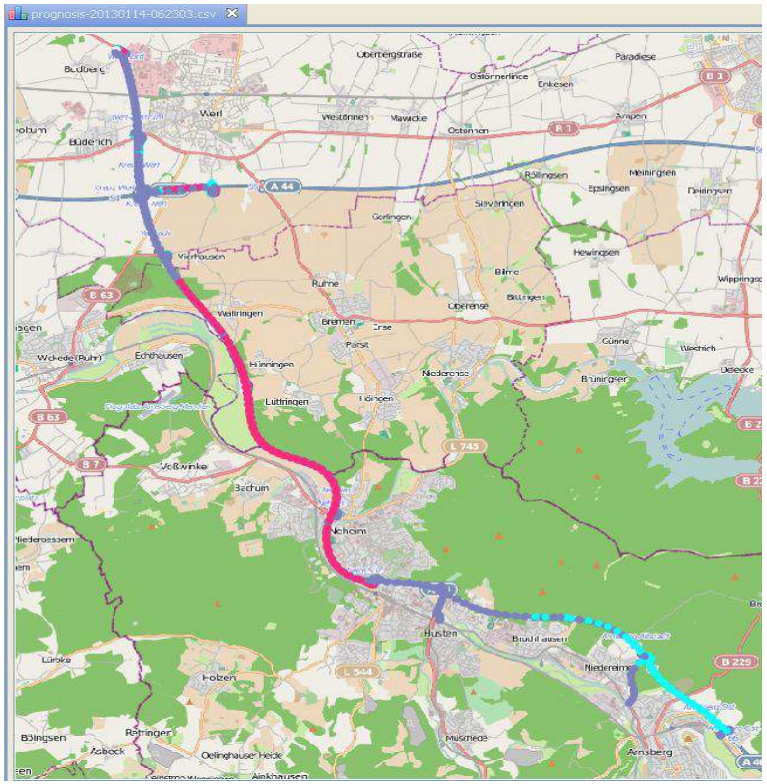
5. Realization of the System in Service Vehicles

5.3 Test routes

Motorway A 10 east of Berlin



Motorway A 46 near Werl



6. Results

- The functionality of the system has been verified.
- In particular in case of preventive applications, the use of salt could be significantly reduced.
- Until it is practically introduced, further tests must be carried out.

Thank you for your interest!

- **Günter Hausmann**
- KOMMZEPT-Ingenieurbüro Hausmann
- hausmann@kommzept.com