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Pavement asset management practice for national and state highways in Bavaria

Tokyo, November 1th, 2017

Germany



Japan



357 000 km²



378 000 km²

80 m



127 m

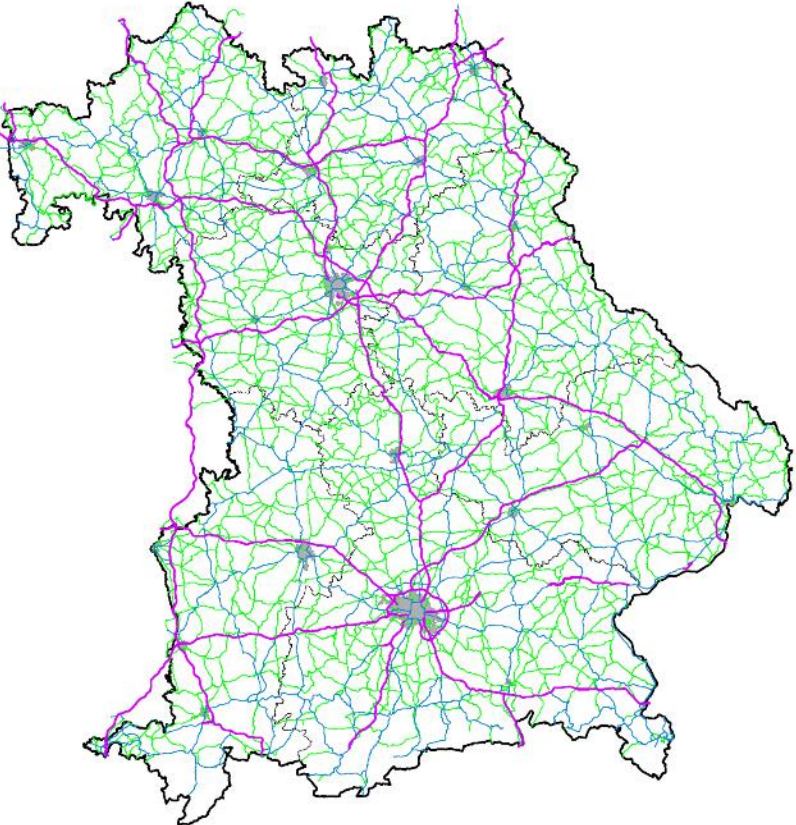
46 000 \$

GDP per capita

48 000 \$

Free State of Bavaria

- federal motorways
- federal highways
- state roads



70 550 km²



12,8 m



2 500 km

6 500 km

14 000 km

federal motorways

federal roads

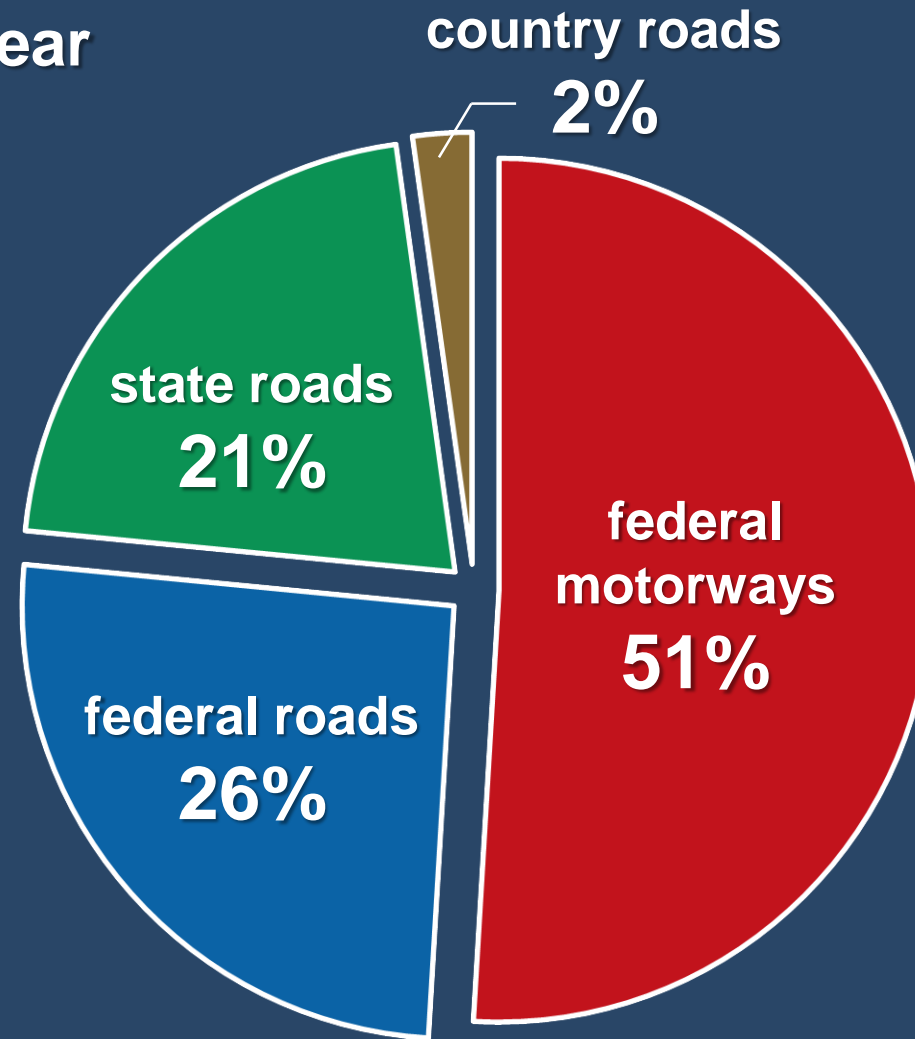
state roads

federal
trunk
roads

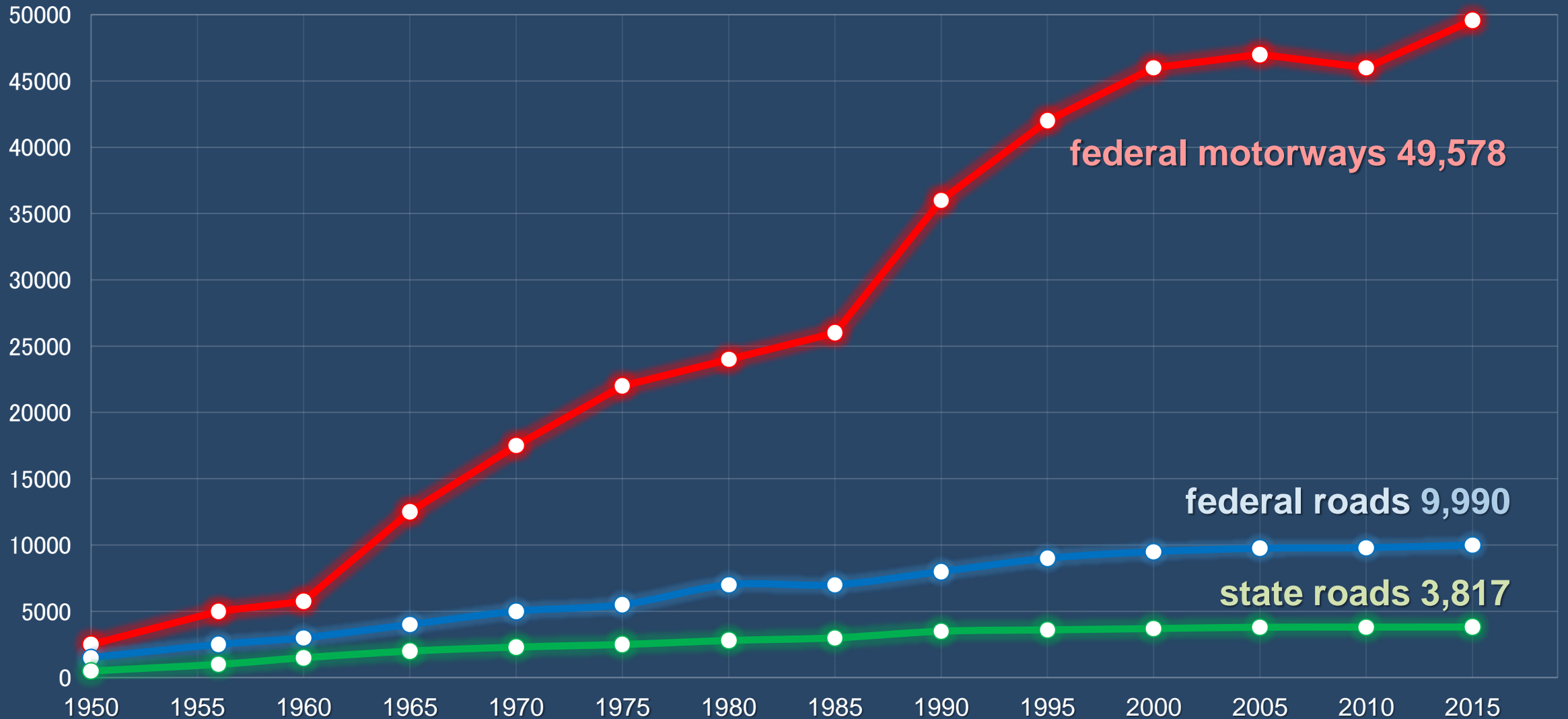


Traffic performance in Bavaria

90 bn vehicles × kilometers / year



Road traffic development 1950 – 2015 (ADT) [vehicles/day]



Roads expenditure

Maintenance

Routine maintenance
(operating)

Structural maintenance
(renewal)

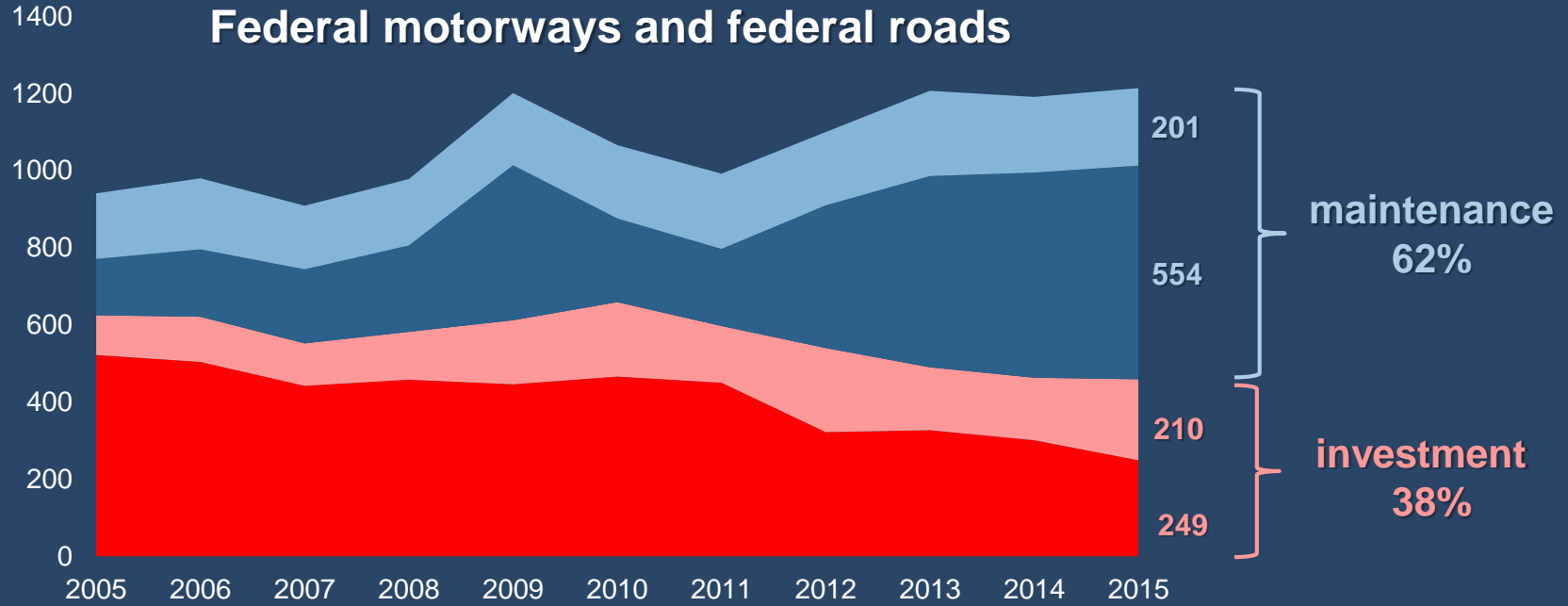
Investment

Expansion of existing
infrastructure

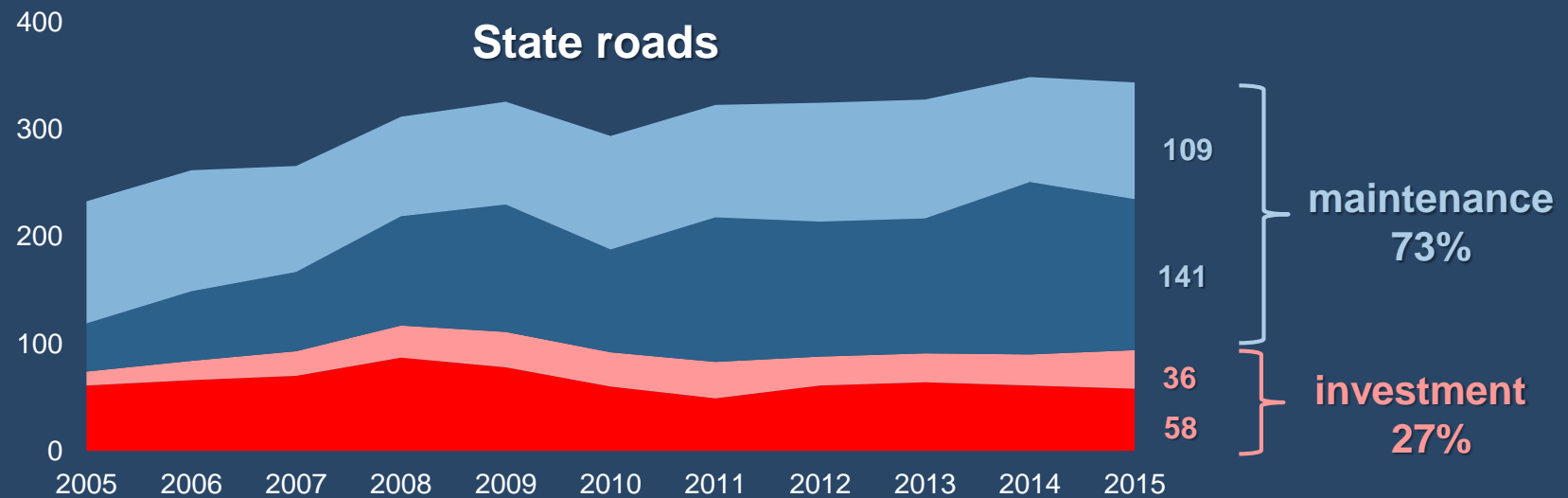
New infrastructure

[million Euro]

Federal motorways and federal roads



State roads



Road administration



Supreme Building Authority

Department for Roads and Bridges

7 Bavarian Government
Offices for the Regions

19 State Building Offices

64 Road maintenance
depots

federal roads
state roads

2 Motorway Head Offices
with 6 Regional Offices

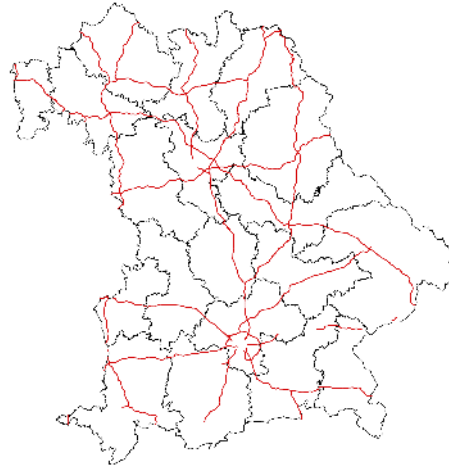
29 Motorway maintenance depots
2 Traffic Management
and Operating Centres

federal motorways

Maintenance planning



Federal motorways

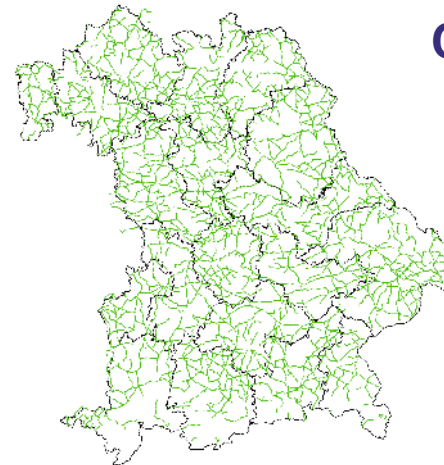


Pavement Management System PMS

Federal roads



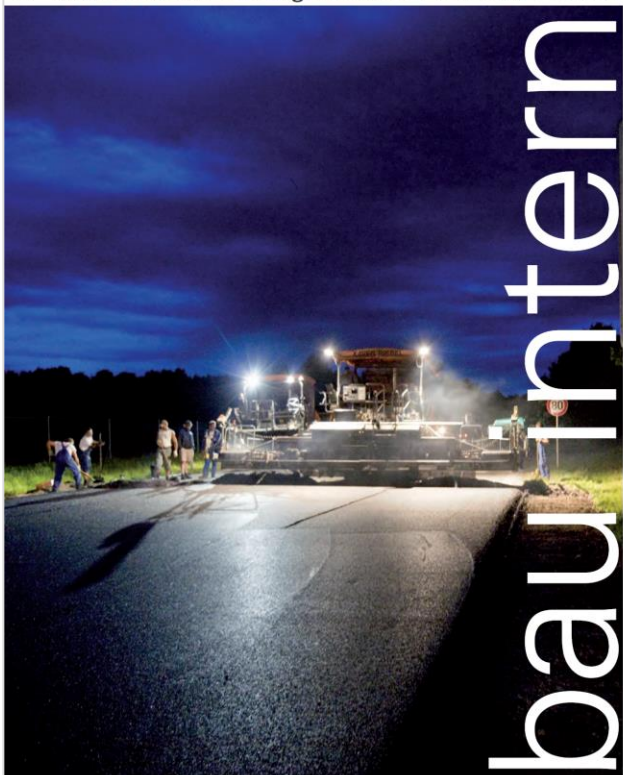
State roads



Coordinated Maintenance and Building Program KEB



Maintenance management for Bavarian roads



Special edition August 2011 second, updated edition



Figure 3: Pavement construction on a motorway

of the bound and unbound layers attempted to develop under load. Both methods work locally, i.e. they provide information for a specific measuring point. Statements concerning linear structures or areas are not possible. It was therefore

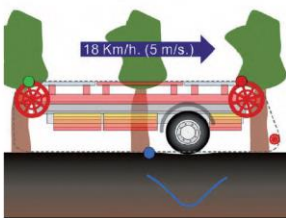


Figure 4: Curviametro methods

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which uses lasers to measure the deformation of the road surface when stressed by the load of a truck tyre. A similar method has been applied for several years in Spain. It uses a chain with acceleration sensors instead of the laser (Curviametro method). The purpose of these methods is to derive information on the road

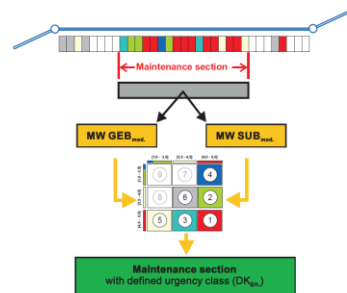


Figure 2: Generating the maintenance sections and determining the urgency class

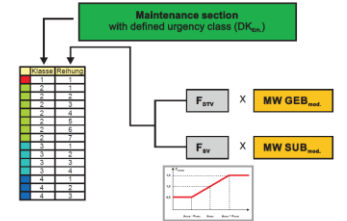


Figure 3: Urgency ranking, taking traffic load into account

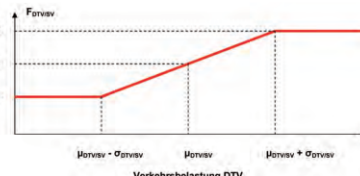


Figure 4: Function to calculate the weighting factors F_{EV} and F_V

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condition distribution.

Urgency ranking of VEP

The urgency ranking of the defined maintenance sections within the same urgency class takes into account the significance of its traffic and the use of this road.

- Rut depth
- Longitudinal/transverse cracks
- Broken-off corners
- Edge damage.

Once the survey has been completed, the measured data (elementary data) are used to calculate condition characteristics. Standardisation functions are used to convert the values into dimension-free and therefore comparable condition marks ranging from 1 for "very good" to 5 for "very bad". The marks characterise the state of the road regarding the different condition characteristics and can be combined to form a usage value and a substance value, using defined calculation and weighting rules (Fig. 4). The usage value takes into account the safety and comfort of the road users. The substance value describes the surface condition of the road as seen by the road-building authorities and provides important information for road maintenance. The substance value is exclusively determined from surface condition characteristics and is therefore also referred to as "substance value (surface)". The usage value and the substance value are combined to form the total value.

The road condition and the need for renovation are evaluated by using 1.5 values, warning values and threshold values.

- The 1.5 value (mark = 1.5) usually corresponds to the acceptance value after performing construction measures.
- Roads that reach or exceed the warning value (mark = 3.5) are in a condition that requires intense observation and analysis of the causes. When the value is exceeded, suitable maintenance measures might be planned.
- Roads that reach or exceed the threshold value (mark = 4.5) are in a condition that requires construction measures. Traffic restrictions have to be considered.

The ZEB includes statistical evaluations and extensive visualisation of the condition data on maps and condition profiles. They are used as a basis for systematic maintenance planning at network and object level. They are intuitively comprehensible and are therefore well accepted among the users (Fig. 5 and Fig. 6).



Figure 5: Excerpt of a condition map for motorways (total value)

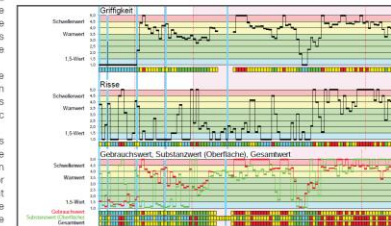
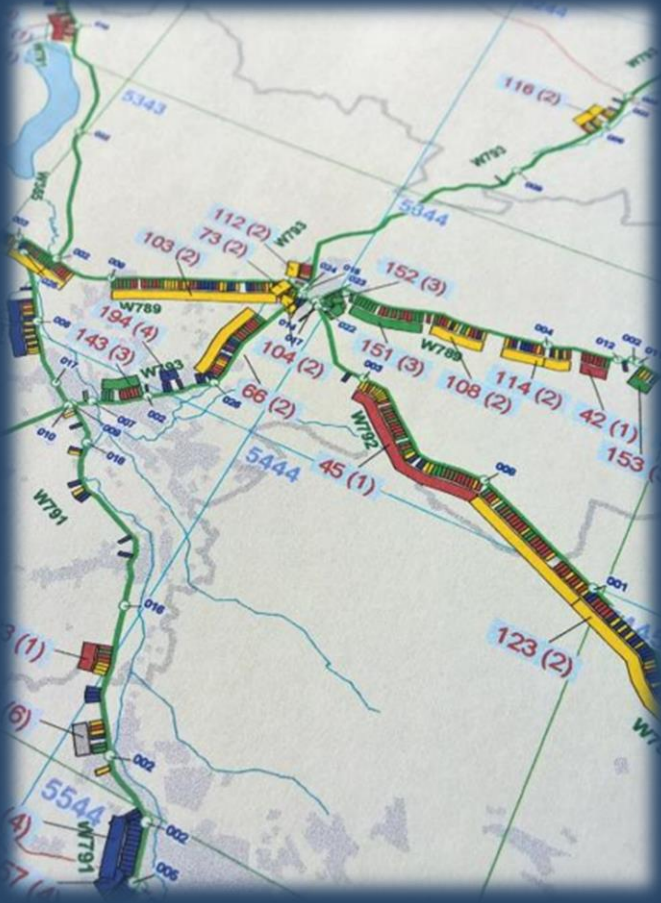


Figure 6: Section of a condition profile

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Coordinated Maintenance and Building Program



Strategic level

- Maintenance strategy
- Financial resources
- Pavement condition data



Supreme Building Authority

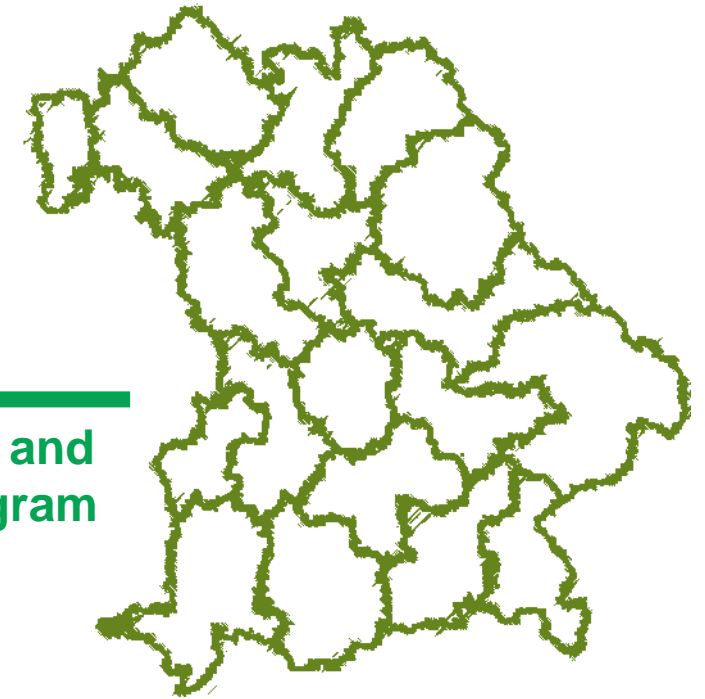
Maintenance sections



Maintenance and building program



Operational level



19 State Building Offices

Monitoring and assessment of pavement condition



pavement indicators (asphalt)

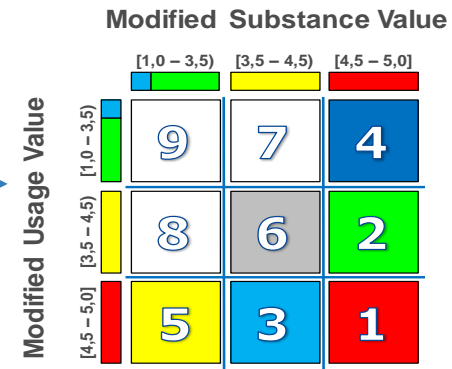
- Longitudinal unevenness
- Rut depth
- Virtual water depth
- Skid resistance
- Cracks
- Patching
- ...

Complex indicators

Substance value

Usage value

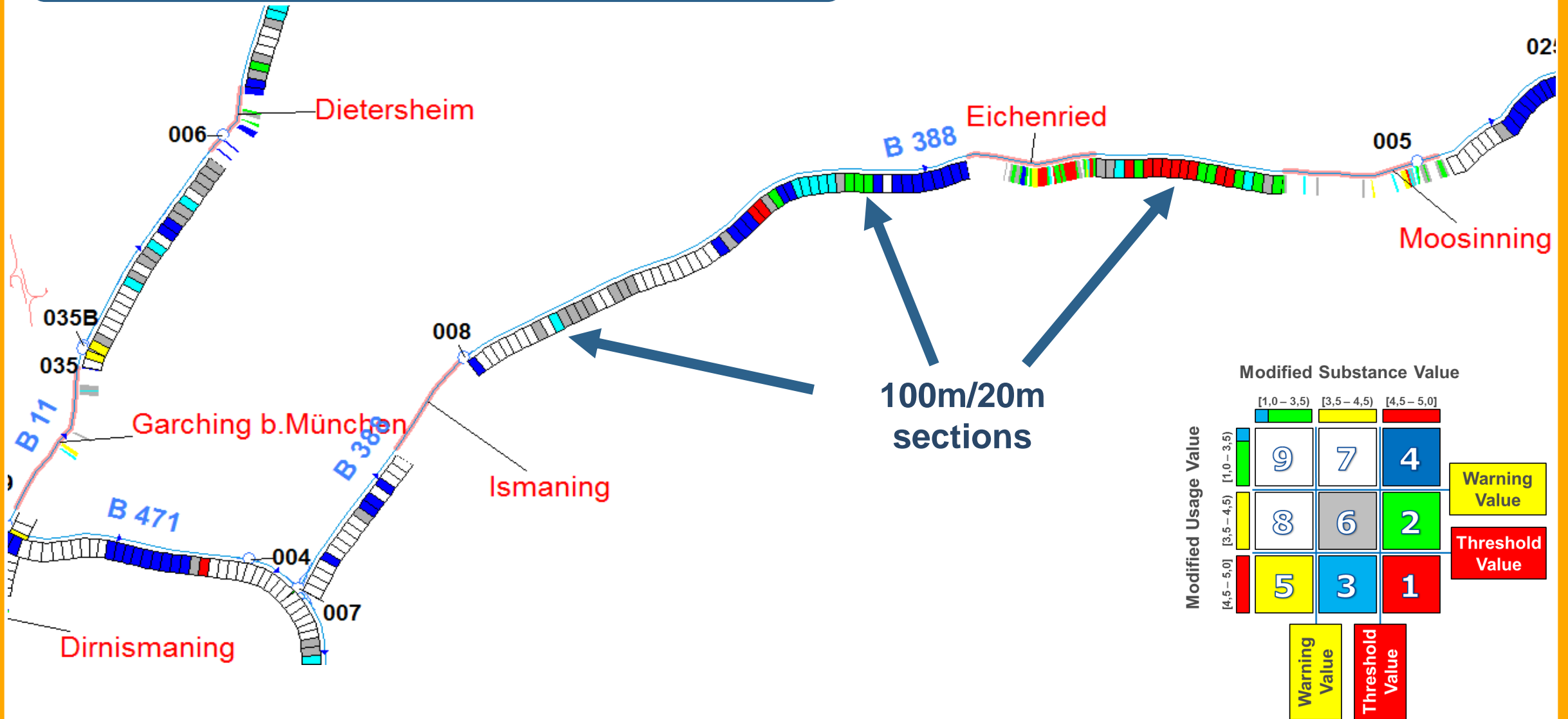
Urgency matrix



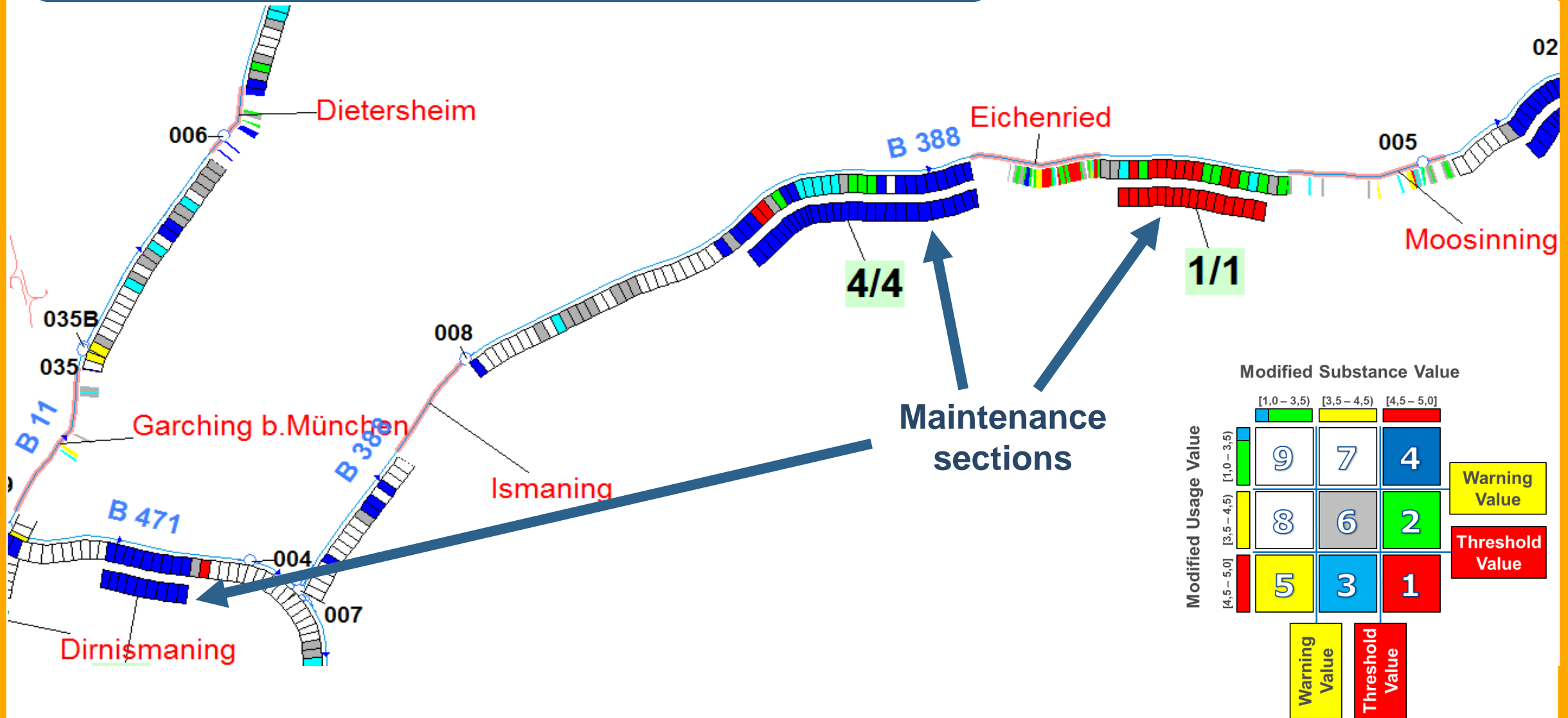
Urgency class

100m sections
(20m in cities)

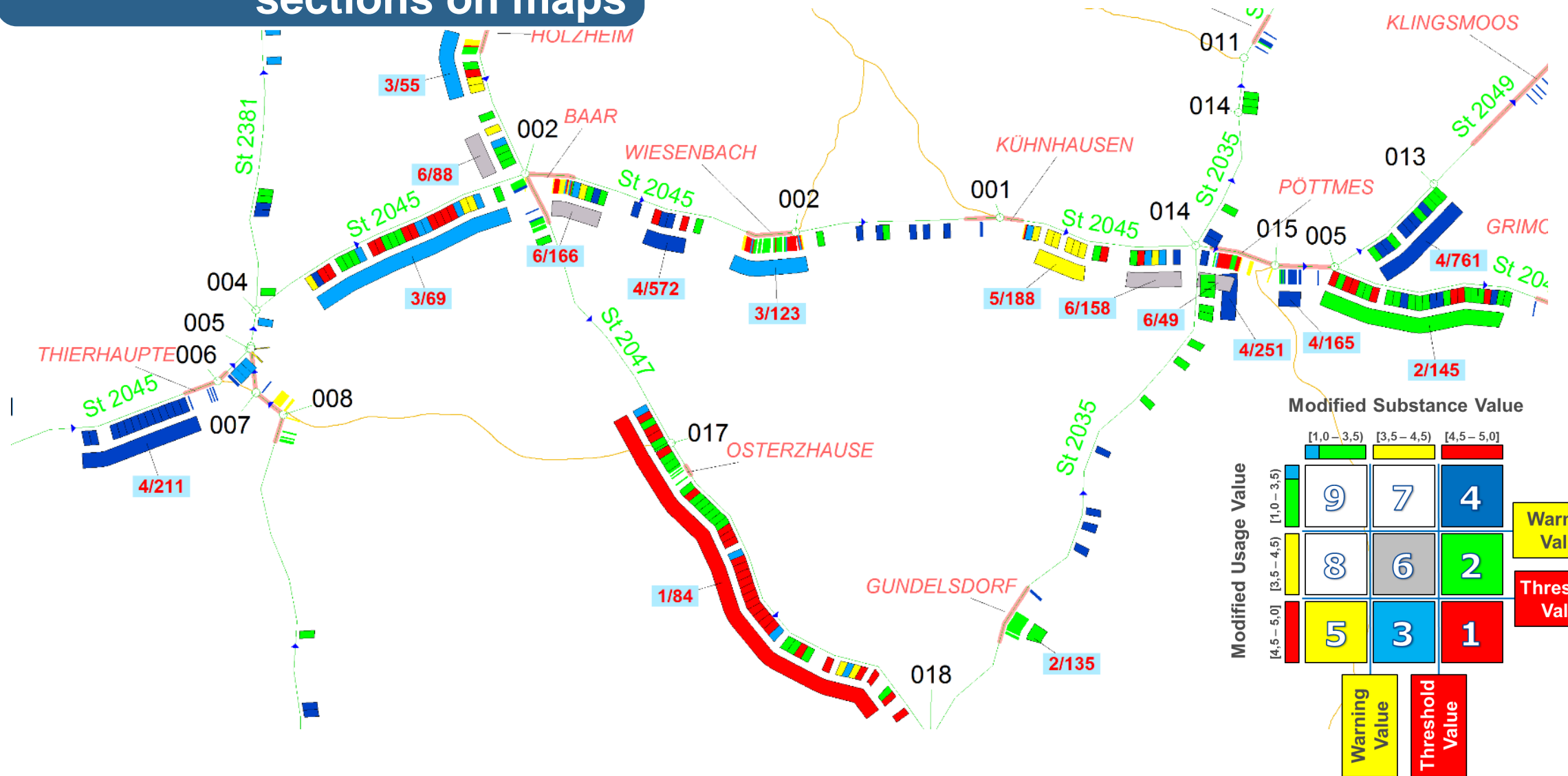
100m/20m sections with urgency class



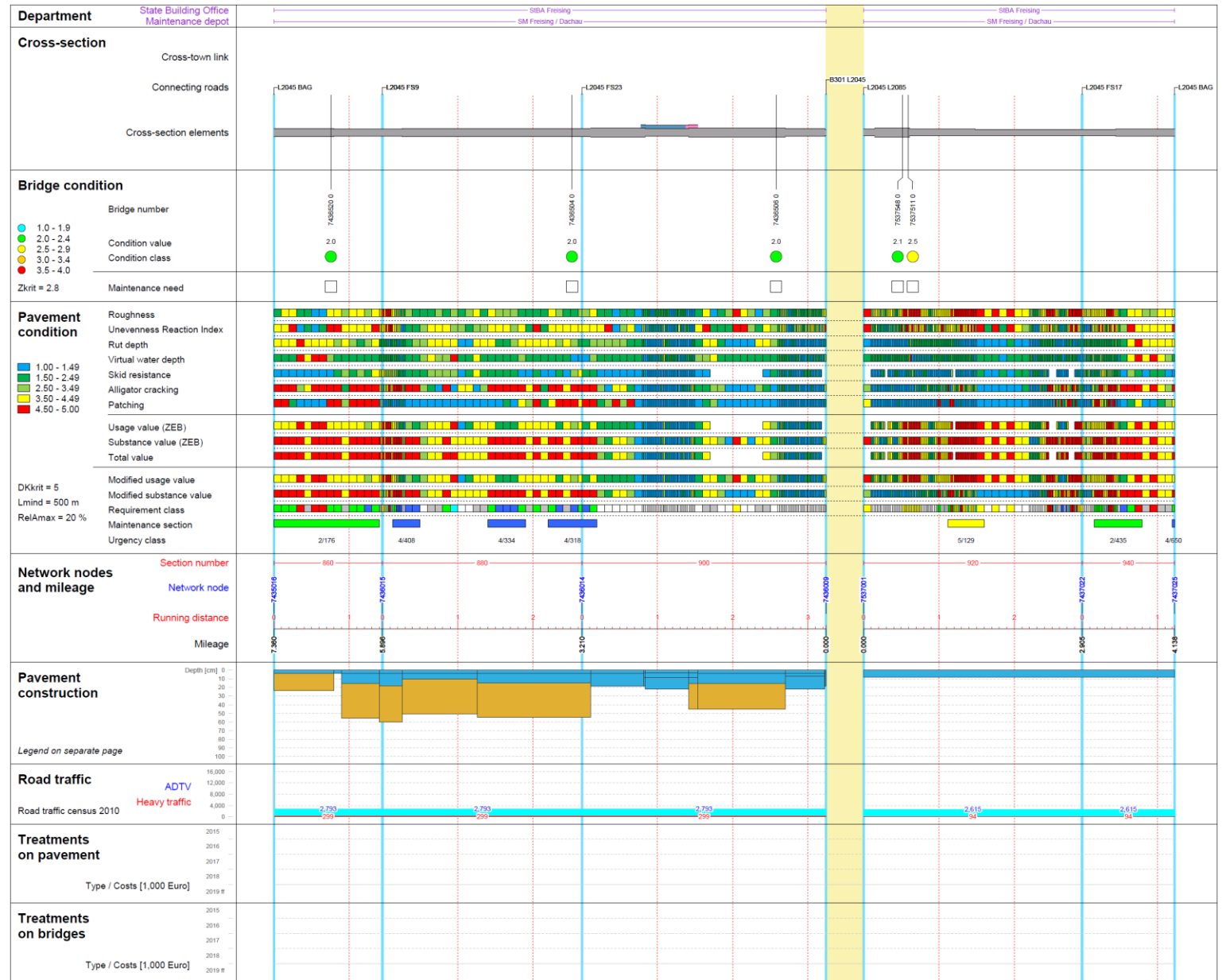
Automatic generation of maintenance sections



Visualization of maintenance sections on maps



Visualization on road profiles



Visualization with online expert-system IT-ZEB-Server

The screenshot displays a comprehensive software interface for road condition analysis, organized into several main panels:

- Oberflächenkamera (Surface Camera):** Shows a top-down view of a road surface with a vertical white line indicating the current position. The view is zoomed in at 30%.
- Frontkamera (TP13) (Front Camera):** Shows a perspective view of the road ahead, zoomed in at 57%.
- Erhaltungsband (Maintenance Band):** A central panel containing a detailed data table and associated graphs. The table below shows various metrics across different road segments.
- Karte (Map):** A map view at the bottom showing a network of roads. A specific path is highlighted in red, with a yellow crosshair indicating the current location. A scale bar shows 0.1 km.
- Navigation:** A button at the bottom left of the main data area.

Data Table from Erhaltungsband:

7.36	10.76	43.89	15.52	4.28
3.40	12.19	28.97	5.01	3.28
1.04	2.31	4.12	1.04	5.02
11.15	21.02	29.49	9.23	6.23
1.12	2.82	4.98	2.17	1.19

11.66	14.43	16.12	16.35	6.81
1.20	6.39	4.11	12.71	3.54

0.776	0.761	0.739	0.744	0.726
11.22	23.22	25.55	46.67	19.00
9.00	0.00	29.78	9.00	0.00
0.00	0.67	0.98	0.00	0.00
9.00	0.00	3.00	3.00	5.00
9.00	0.00	0.00	0.00	0.00

Visualization of Key Performance Indicators

The interface displays a central map titled "Pavement Condition, State Roads >> Maintenance Potential (2003)". To the left, a sidebar contains several interactive elements:

- Regions and Indicators:** Dropdown menus for "Regions" and "Indicators".
- Indicator Selection:** A section for "Maintenance Potential" with an explanation: "Percentage of maintenance section in the whole network".
- Legend:** A legend for "State Building Offices" with five color-coded classes: 3,7 - 8,3 (dark green), 8,4 - 10,3 (medium green), 10,4 - 13,2 (light green), 13,3 - 21,1 (yellow), and 21,2 - 35,1 (red). It also includes checkboxes for "District roads", "State roads", "Federal roads", "Federal motorways", and "World topographical map".
- Frequency Distribution:** A pie chart showing the distribution of the selected indicator across its classes.

Below the map is a horizontal bar chart where the size of each bar represents the value of the selected indicator for a specific region.

On the right side of the interface:

- Table:** A table titled "Maintenance Potential (2003)" listing 16 regions and their corresponding values.

Region	Maintenance Potential (2003)
Rosenheim	35,1
Weilheim	25,2
Freising	25,1
Passau	21,1
Aschaffenburg	19,8
Würzburg	14,9
Regensburg	13,2
Kempten	13,2
Nürnberg	12,2
Traunstein	11,6
Bayreuth	11,3
Augsburg	10,3
Landshut	9
Bamberg	8,7
Schweinfurt	8,5
Ansbach	8,3
Innoletzt	5,9
- Comparison data:** A section showing "Bayern" with a value of 13,95 and a "Gini-Coefficient" of 30,6%.
- Time series:** A line chart showing the "Maintenance Potential (2003)" for Bayern across the years 2003, 2007, and 2011. The values are approximately 13,95 in 2003, rising to about 30 in 2007 and 2011.
- Navigation:** A control panel with arrows and year selectors (2003, 2007, 2011) to switch between time periods.

At the bottom right, it is noted: "Created for SIMI-OBB IID2 by HELLER Ingenieurgesellschaft mbH".

Activates a list for the selection of a region category

Activates a filter for the selection of regions

Thematic map; coloration of regions depends on the class of the selected indicator

Table with indicator values for each region (State Building Offices)

Activates a list for the selection of an indicator

Explanation text relating to the selected indicator

Legend with coloration for each class of the selected indicator

Checkboxes for the activation or the deactivation of layers

Frequency distribution for classes of the selected indicator

Bar graph; size of bars is proportional to the value of the selected indicator

Time series for the selected indicator

Switch between time periods of pavement diagnostic

Conclusions

- *Coordinated Maintenance and Building Program* is constantly being improved and developed further.
- Pavement asset management is regarded as an element of a complex Asset Management. Guidelines for the asset management are currently being developed.
- The Key Performance Indicators (KPIs) play an important role.

Thank you for your attention

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