Intelligent Traffic Management
Dear road users,

our motorways and federal highways in Baden-Württemberg are amongst the most intensively used traffic routes in Germany. The efforts of the Road Traffic Centre Feuerbach make for a smoother and safer traffic flow, and in many cases traffic jams can be prevented altogether. To this end, a committed team of operators and traffic engineers manages a large number of modern traffic control systems, monitors the motorway tunnel safety equipment and provides up-to-the-minute traffic information for all road users.

The integration of tunnel monitoring into the Road Traffic Centre is something that is only matched in a few other parts of Germany. The operators have the training required for both tasks. Round the clock and on 365 days a year, they are there to improve safety and the smooth flow of traffic on the particularly busy motorways and federal highways in Baden-Württemberg.

The Baden-Württemberg Road Traffic Centre is also responsible for the design and operation of the central road construction administration service’s traffic information system (www.svz-bw.de). Amoungt many other things, you can query data about the current traffic situation, view traffic cameras in congestion-prone sections on this website and call up many other items of information. There is also an app available for mobile end devices so that you can access the traffic data while you are under way.

Thus the information provided by the Baden-Württemberg Road Traffic Centre helps you to optimize your journeys by selecting the best time window and the route with the least disruptions. At the same time, it administers traffic flows in order to achieve the highest possible degree of safety and efficiency on the roads.

Wishing you continued safe travel – as free of congestion as possible.

Your

Klaus Tappeser
President of the Regional Council
THE TRAFFIC NETWORK IN BADEN-WÜRTTEMBERG

Our road network in Baden-Württemberg includes 1046 km of motorway and 4203 km of federal highways. They are the main arteries of the road network and equally essential for the economy, tourism and getting to work on a daily basis. The A 5, A 6, A 8 and A 81 bear the heaviest loads of traffic. These motorways are used very intensively, and they most prominently demonstrate the demand for mobility in the state.

The large proportion of heavy goods vehicles is indicative of the good economic situation and Germany’s economic strength. Also, the motorways in the south-western part of Germany are transit routes towards the Alpine countries, towards northern Germany and to all the neighbouring European states.

This is confirmed by the Average Annual Daily Traffic statistics (AADT). They show that between 1980 and 2015 the mean daily traffic volume on federal motorways rose from 35,296 to 63,332 vehicles per 24 hours. In comparison to previous years, the rate at which traffic loads were increasing slowed down significantly between 2000 and 2010, but since 2013 renewed acceleration has been observed.¹

However, the traffic loads on the busiest sections of motorways in Baden-Württemberg are significantly higher than this average value.

The consequence of increasing traffic densities are, amongst other things, more frequent traffic jams and a greater risk of accidents. In addition, the ecological effects have to be taken into account: In traffic jams and stop-and-go situations fuel consumption and exhaust emissions are higher than during normal driving.

¹ source: road traffic in Baden-Württemberg – annual comparison 2016 / 2015, page 12
National and international information exchange
Traffic management does not stop at frontiers. The Baden-Württemberg Road Traffic Centre (SVZ BW) maintains links with the traffic control centres in the Rhineland-Palatinate, Hesse, Bavaria, the SWISS traffic management centre and the Austrian ASFINAG. The operators exchange data on all current information regarding the Central European motorway network, ranging from incidents affecting the Alpine motorways to driving bans for heavy goods vehicles at given times.

Traffic data at the European scale
The Federal Highway Research Institute operates the Mobility Data Marketplace (MDM) as a broker for road, traffic and journey data. These data are prepared by specialist service providers and other users, and the resulting information is made available across Europe. The exchange of data between individual traffic control centres is also increasingly being conducted via the MDM. It is a data warehouse providing traffic safety data, journey time data and routing data supplied by all the Federal States – free of charge to all interested parties. Baden-Württemberg contributes all the data accumulating in its Road Traffic Centre to the MDM.

Ongoing exchange of information with the police traffic warning service
The Road Traffic Centre and the traffic warning service provided by the police exchange data all the time. This provides the basis for bundling police traffic information (accidents, wrong-way drivers, breakdown vehicles, obstacles on the road) with that of the Road Traffic Centre (roadworks, full closures, traffic loads) to make up a comprehensive information package. This ensures that people under way have access to the most up-to-date information of the highest quality.

Optimized traffic control, provision of high-quality traffic information
The chief objective of the Road Traffic Centre Baden-Württemberg is to achieve optimal exploitation of the available road network capacity. To this end, the Centre plans, develops and operates ‘intelligent’ traffic control systems and traffic influencing systems for motorways and federal highways. These systems process data that are gathered automatically at intervals between every 15 seconds to every 60 seconds concerning current traffic loads, weather conditions and road conditions. The resulting measures and displays optimize the safety situation and the flow of traffic for those using the roads.

If a police communication is received (after an accident, for instance), the Road Traffic Centre operators take over control of the system and manually direct the displays. This ensures the best possible operation of the traffic control systems, at all times of the day and night and tailored to each situation as it arises.

The Baden-Württemberg Road Traffic Centre makes all traffic information available to the general public. Precise information on current traffic conditions and disruptions on the road network are displayed in real time, allowing road users to modify their choice of routes or timing accordingly.

An important core component of the Baden-Württemberg Road Traffic Centre is the central computing system with several high-performance computers that process all the traffic control data.
The fundamental diagram of traffic flow is a graph that displays the relationship between traffic volume (vehicles per hour) and speed (km/h). The fundamental diagram is based on a macroscopic traffic flow model that describes the relationship between traffic density (vehicles per km), traffic speed (km/h) and traffic volume. The fundamental diagram makes it possible to draw conclusions about the capacity of a given section of road.

**Free-flowing traffic:** Depending on the vehicle, road surface conditions, the weather etc., drivers can drive at whatever speed they wish to; overtaking is possible practically at any time without the need to wait for an opportunity.

**Maximum traffic volume:** The capacity of a section of road is determined – in addition to its structural state – by the speed and spacing of the vehicles. As a rule of thumb, the ideal speed for smoothly flowing traffic of high density is around 80 km/h.

The fundamental diagram of traffic flow is a graph that displays the relationship between traffic volume (vehicles per hour) and speed (km/h). The fundamental diagram is based on a macroscopic traffic flow model that describes the relationship between traffic density (vehicles per km), traffic speed (km/h) and traffic volume. The fundamental diagram makes it possible to draw conclusions about the capacity of a given section of road.

**BASIC PROPOSITIONS**

- There is a connection between traffic density and vehicle speed: The more vehicles there are on a given stretch of road, the lower will be the mean vehicle speed.

- In order to prevent a traffic jam forming and to maintain a stable flow of vehicles, no more vehicles may enter a stretch of road than exit it over the same period of time.

- When a critical traffic density has been reached with a corresponding mean vehicle speed, the traffic flow state transitions from stable to unstable.

The causes of traffic jams are many and varied, ranging from too much traffic on individual sections of road to extreme weather conditions to breakdowns and accidents. Many traffic jams involve a bottleneck caused by a reduction in the number of available lanes, for instance because of vehicles that have broken down, roadworks or at the transition between an upgraded stretch of road and an unimproved section. There is also the phenomenon of the traffic jam ‘out of the blue’, perhaps just caused by the load of traffic or one lorry slowly overtaking another.

The use of traffic control systems (TCS) can reduce the number of and impact of traffic jams. Alternative Route Recommendation Systems guide traffic onto a different route in case of disruptions, allowing congestion to dissipate more quickly. They provide road users with reliable alternative route recommendations. Line control systems (LCS) manage traffic at peak times in order to improve safety and reduce congestion. They help to harmonize the traffic flow by prescribing a speed that ensures optimal flow volume, e.g. 80 km/h. Hard shoulder running (HSR) is a means of temporarily increasing capacity. Ramp metering systems (RMS) ease the traffic flow on the main highway and improve the safety situation when vehicles enter it.
THE TRAFFIC COMPUTING CENTRE – THE CENTRAL COMPUTING FACILITY FOR TRAFFIC CONTROL

Intelligent traffic management is only possible with the aid of a large and complex system of hardware and software. Therefore one of the Baden-Württemberg Road Traffic Centre’s main assets is the traffic computing centre where all the information from the sections of the Baden-Württemberg motorway network is amalgamated.

The Baden-Württemberg traffic computing centre is equipped with state-of-the-art technology at its facilities in Stuttgart-Feuerbach. This helps the staff to carry out their traffic management tasks effectively. It includes a control centre that is manned round the clock. The control centre is equipped with large-screen displays that provide graphical representations of the data collected from the road sections, so the operators can provide road users with the best possible service.

As an example, the system automatically detects when it is necessary to allow vehicles to use the hard shoulder and reports this to the operator by means of an acoustic signal. Before the operator permits the traffic to use the hard shoulder, she or he uses the video system installed along the route to check that all emergency stopping bays are free and no persons or obstacles are in the way. If these safety criteria are met, the hard shoulder can then be manually opened for vehicles.

AN EXTREMELY SOPHISTICATED IT SYSTEM

The Federal Government has commissioned the development of a uniform software system for traffic computing centres, the ‘Einheitliche Rechnerzentralensoftware’. The aim was to avoid the cost-intensive development of software in the individual federal states, whose software was previously not compatible from one state to another. The system is modular, with a data distributor as its core component. Standard interfaces allow practically any telematics application to be connected to the distributor. This allows for flexible deployment of the system.

The great advantage of the uniform software system consists in its being written as open source software. With access to the source code, all federal states can commission further development of the system components without becoming dependent on a single manufacturer.

This makes for a country-wide, state-of-the-art hardware and software system that provides a basis for presenting the current road traffic situation, detecting disruptions and forecasting traffic volumes.
The sheer number of existing and planned traffic control systems shows how much effort is being put into collective traffic control in Baden-Württemberg. This involves a large number of tasks, from planning and implementation of new systems to the operation of the existing ones to ongoing upgrading of the traffic centre.

Rerouting systems recommend alternative routes to road users when the traffic is disrupted and at the same time such routes are available with reserves of capacity. Ideally, they are deployed where there are two or more alternative routes for through traffic at a motorway interchange. For instance traffic approaching the Leonberg three-way motorway interchange on the way towards Mannheim can choose between the signed route via Heilbronn (motorways A 81 and A 6) and the alternative route via Karlsruhe (motorways A 8 and A 5). The system compares journey times for each route and displays the more favourable one if there are significant differences. Additionally, the cause and location of the disruption are displayed, e.g. “8 km traffic jam after Junction Sinsheim”.

Cross-border cooperation between the traffic computing centres involved is necessary to ensure that rerouting systems can take account of disruptions that affect traffic on motorway sections in neighbouring regions where this, too, needs to be redirected. Therefore the traffic computing centre maintains contact with the traffic management centre in Lucerne (CH) and the traffic computing centres in Frankfurt-Rödelheim and München-Freimann.
LINE CONTROL SYSTEMS

Line control systems serve both to provide warnings about traffic jams, roadworks and weather-related hazards as well as to homogenize the traffic flow by means of automatic operation of alternative routing signs. Baden-Württemberg operates systems that focus on different types of issue, such as warning against fog or a tailback of lorries up ahead. The primary effect of the system is to promote road safety; if less accidents happen there will be less traffic jams caused by them.

HARD SHOULDER RUNNING

Temporarily opening up the hard shoulder for drivers on sections with excessively high traffic loads provides for greater road capacity. Before stretches of hard shoulder are opened for use, a video check is carried out to ensure that no obstacles are in the way and the extra emergency stopping bays on such sections are free. This helps to maintain a high level of road safety. In Baden-Württemberg, this technology is implemented on the A 8 south of Stuttgart. More sections with hard shoulder running are planned for the A 81 at Zuffenhausen and at Sindelfingen, on the A 5 at Heidelberg and on the A 8 at Karlsruhe.

RAMP METERING

Ramp metering systems are implemented to optimize traffic flow. A ramp metering system separates large queues of vehicles into individual vehicles or small groups. The aim is not to reduce the number of vehicles joining the main highway, but to have them entering in a more uniform manner. This means that the main highway can accommodate them more readily. An independent expertise was commissioned to assess the system’s effectiveness on the B 27, and the findings confirmed that the three installations there have a beneficial influence. In particular, they help to accelerate dissipation of the morning congestion caused by excessive traffic loads travelling towards Stuttgart that cannot be avoided even with the aid of telematic measures.

You will find further information about the traffic control systems at www.svz-bw.de

OPERATIONAL TUNNEL MONITORING

ROUND-THE-CLOCK SAFETY

Partly because of their structural peculiarities, but also because of their psychological effects on many road users, tunnels require special safety measures. This includes permanent monitoring of the motorway tunnels by the Baden-Württemberg traffic computing centre – 24 hours per day, 365 days per year.

The importance attached to tunnel safety can be seen in the superordinated control technology monitoring and control system with its three-stage configuration (central, regional, local) and multiple fail-safe capacity.

The digital system monitors and controls all safety-relevant equipment, including functional integrity in case of fire and accident, operation of the observation cameras and tunnel ventilation. All alarm and warning signals from all 15 monitored tunnels are transmitted to the Baden-Württemberg traffic computing centre. In addition, video images of the traffic situation can be transmitted from most of the tunnels. The software of the superordinated control technology system provides a clear overview of and access to all functions at the click of a mouse.

The programming architecture is also conceived in such a way that very disparate tunnel equipment can be integrated into the system and hence subjected to its control. In case of incidents, the traffic computing centre functions as a communication centre for the fire service, police and motorway maintenance service.
ROADWORKS MANAGEMENT

THE NEW ROADWORKS COORDINATION AND INFORMATION SYSTEM

Baden-Württemberg has an effective and well established road infrastructure, and this high quality needs to be maintained. An unavoidable consequence of maintenance work and improving the road network is that roadworks have to be carried out. There is no way of avoiding the need to interfere with the flow of traffic in this way. To make sure that the impact on traffic and the encroachments on people’s activities are kept to a minimum, roadworks planning is now supported by a state-wide roadworks coordination and information system.

THE OBJECTIVES:

- Roadworks are coordinated with each other as far as both location and scheduling are concerned.
- Diversion routes are kept free.
- Night work is prioritized. Road users are provided with information about the traffic situation at roadworks in real time.
- Reliable roadworks data for heavy and oversized transports or in cases of full closures.
- Roadworks are announced at an early stage.

This figure will increase over the coming years. To this end, development work commenced on a successor system early in 2018. It will provide even more sophisticated functionality, and replace the old system in the course of 2019, allowing for even better coordination in future.

The data are updated by the minute, for instance being enhanced with data from the mobile warning trailers deployed to secure the roadworks that are transmitted online directly into the system. In addition, a slot management system is used to define the time windows within which roadworks may be scheduled. This includes an appraisal of the economic drawbacks involved (including financial losses) on account of congestion because of the planned roadworks.

The Baden-Württemberg Road Traffic Centre provides support to local roadworks supervisors through the central roadworks coordinator. The effects that the roadworks may be expected to have on traffic are investigated so as to achieve the best possible coordination. The roadworks information system (RIS) is available at www.baustellen-bw.de. This enables stakeholders such as drivers, German automobile associations, carriers and private service providers to obtain comprehensive information on the roadworks being carried out in the state.

In the past five years alone, over 16,500 roadworks were administered in the internal coordination and planning system.

TEMPORARY TRAFFIC CONTROL FOR ROADWORKS AND OTHER CRITICAL STRETCHES

The risk of accidents is significantly higher in the vicinity of roadworks than is the case on normal sections of road. The same applies to all locations that are regularly congestion-prone, such as overused motorway interchanges or where an upgraded stretch of road transitions back to an unimproved section with fewer lanes.

In recent years, manufacturers have presented a wide range of new developments in the area of temporary traffic control systems and components with a view to increasing safety levels and capacity levels on heavily used sections of road.

A project managed by the Federal Highway Research Institute is currently elaborating the implementation criteria and a range of application areas for such systems.

Baden-Württemberg’s motorways have also experienced the effects of intensified federal investment in the form of increased construction activity. Following the commencement of upgrading works for two sections of the A 6 between the Wilddieb and Weinsberg intersections, upgrading works on the A 8 where it crosses the valley of the river Enz and the restoration of the Engelberg Tunnel on the A 81 are under way. These major projects are expected to take around five years to complete. Some of the corresponding congestion warning systems are already being set up, so implementation periods of six or seven years may be expected.

In association with the Federal Highway Research Institute’s project, the State Office for Road Engineering is developing a new generation of congestion warning systems that will also be linked to the traffic computing centre. There, the data gathered from these systems will be processed for traffic control purposes.

A FEW EXAMPLES:

- Mobile congestion warning systems with LED alternative routing signs for hazard warning, speed control and lane guidance,
- Equipment for direction change operation in long-term roadworks using permanent light signals on mobile traffic sign gantries,
- LED traffic control panels,
- Barriers and easily moveable protective devices,
- Information according to requirements through dynamic alternative routing with integrated congestion information and/or journey time displays,
- Mobile camera systems for optimization of incident and roadworks management.
In 2019, cooperative systems in highways management will be implemented in Baden-Württemberg for the first time. This represents the first step into the world of vehicle-in-frastructure communication. In future, it will be possible for warnings and information on all short-term roadworks in Baden-Württemberg to be communicated to vehicles prior to their arrival at the roadworks using a special wireless network technology and mobile data communications. Drivers will then be prepared to be able to adjust their driving behaviour to take account of permitted maximum speeds and lane guidance in the vicinity of the roadworks. This will result in significant improvements in traffic safety upstream of and alongside short-term roadworks. The system has an interface to the roadworks information system and exchanges data with it. This ensures that all roadworks are correctly registered and clearly identifiable for all drivers.

In future, the cooperative traffic centre will also be able to receive vehicle data on the traffic situation as well as sending roadworks warnings. The traffic centre will then generate a detailed, real-time appraisal of the traffic situation and use the results for traffic management. Traffic congestion can be reduced by means of optimized route usage and network management. This also leads to a noticeable improvement in incident management results.

Baden-Württemberg is cooperating with various stakeholders at national and international level: other Federal States, the Netherlands and Austria. One benefit of this international cooperation is a transnational traffic management network that is not confined within national or provincial frontiers.
The Baden-Württemberg Road Traffic Centre operates the central traffic information portal for the state’s road construction administration at [www.svz-bw.de](http://www.svz-bw.de). Various types of traffic information are available to road users there. 135 webcams installed on motorways and federal highways provide an impression of current traffic and weather conditions. The network is to be extended so that images from around 200 webcams will be available in the future.

The motorway webcam images are presented together with roadworks and traffic information and a presentation of the motorway traffic situation in colour in the form of a map.

The motorway webcam images provide an even better basis for assessing the local traffic situation and weather conditions. The cameras are installed at 72 important and/or congestion-prone locations on motorways and federal highways. Each of the 135 webcams transmits one image per minute via mobile communication to the Road Traffic Centre, which is then published on the web page.

The messages from the roadworks information system provide details about the location, duration and type of roadworks – not only on the motorways, but also on federal highways, state highways and district highways. The traffic information regarding congestion and hazard points is adopted by the police traffic warning service. The traffic situation data from motorways and selected federal highways are adopted from the traffic computing centre and supplemented with ‘floating car data’ – traffic data obtained from vehicles. The current state of the traffic is shown in colour on the map in the information portal. Taken together, this provides comprehensive information for road users and enables those planning a journey to assess the current traffic conditions.

The ‘Verkehrs-Info BW’ app (‘Traffic information for Baden-Württemberg’ app) provides traffic information for any time and place (including a compact congestion overview for important sections and current traffic disruption caused by roadworks and traffic jams). The main page consists of the map representation, with a large amount of information on the road traffic. The 135 webcams can be accessed conveniently with the aid of the app, allowing navigation from location to location. Within the ‘weather conditions on the road’ section, weather symbols are used as a direct indication of the current weather situation at the respective stations. The app can convey all the traffic information supplied by the State Agency for Road Technology, and its user friendliness makes it an important aid to planning a journey.

This source of information is already being used more than 600,000 times every month. The app can be downloaded free of charge from the Apple App Store or from Google Play.
DIGITAL REGISTRATION OF PARKING SPACES
ON CAR PARKS AND CAR SHARING CAR PARKS

Along the federal trunk highways, Baden-Württemberg has provided more than 100 car park and car sharing car parks. These provide commuters with more than 4,800 parking spaces. Many people avail themselves of the car sharing options, so the car sharing car parks are often full. Baden-Württemberg is currently implementing a project involving innovative laser scanning technology with the aim of registering free spaces and informing users in real time. When the system is operational, the information will be available via the central traffic information platform (www.svz-bw.de and via the app). This will enable road users to find out where the nearest parking area with free spaces is to be found and plan their journeys accordingly. Also, the data will be transmitted online to the Mobility Data Marketplace (MDM). Once there, the information will be available to other service providers.

PARKING SPACE MANAGEMENT FOR MOTORWAYS
HGV (HEAVY GOODS VEHICLES) PARKING

There are not enough HGV parking spaces throughout the whole of Germany on motorways. HGV drivers are required to keep to specified driving and resting periods by law. To date, there is no system that provides comprehensive information to HGV drivers regarding free spaces on parking areas. Baden-Württemberg has had five service areas equipped with registration technology that informs HGV drivers about parking space occupancy on parking areas by means of roadside displays. The service areas are on the A 5 between the junctions Hartheim-Heitersheim and Efringen-Kirchen in the direction towards Basel.

The system also provides information about vacant spaces via the internet as well as an estimate as to when a parking area is likely to reach capacity and on the motorway itself the number of free spaces is displayed upstream of the parking areas. The aim is to reduce the number of parking infringements and capacity excess as well as making it easier for HGV drivers to plan their breaks.

Each evening, several hundred HGV drivers have to spend the night close to the Swiss border on account of the night driving ban in Switzerland. With a view to providing HGV drivers with comprehensive information regarding free spaces on parking areas, Baden-Württemberg operates a traffic control system on the A 5 near Weil am Rhein and on the A 61 near Rheinfelden.
Traffic volumes on federal motorways from the 2015 road traffic census

Road traffic censuses help to determine traffic loads and allow statistical assertions to be made about current traffic loads and the way traffic patterns are developing as an essential basis for future planning. The country-wide ‘major road traffic census’ is carried out in five-year cycles. In Baden-Württemberg, comprehensive and annual traffic loads can be assessed by means of a traffic monitoring system that has been in place since 2010. It is deployed mainly on state and district highways, but also on federal highways where technically feasible. The road traffic censuses in Baden-Württemberg are based on around 150 (currently) automatic, continuous counting locations, on sample measuring via traffic monitoring as well as on manual road traffic counts. The various techniques are explained in the following section.

**AUTOMATIC, CONTINUOUS COUNTING LOCATIONS**

As of 2017, general data on traffic loads is gathered on a continuous basis (365 days /24 hours) via 36 monitoring devices on motorways, 71 on federal highways and 44 on state highways. Change rates are computed from the annual averages of the Annual Average Daily Traffic volumes (AADT).

**MANUAL ROAD TRAFFIC CENSUS**

The road traffic census on federal motorways and federal highways is conducted manually at around 550 counting locations every fifth year (2015 was the last time). The information derived from up to 28 hours of monitoring data is published by the Federal Highway Research Institute.

**TRAFFIC MONITORING**

Mobile reflector posts equipped with radar technology perform automatic traffic counts. This completely replaces manual road traffic counts on state and local roads and largely replaces manual counting on federal highways.

Each year, counts are carried out one fifth of the counting points (distributed uniformly across the state) during a predefined period of time (usually two periods of two weeks each). In contrast to a manual census, this has the advantage that the traffic passing a given counting point is covered continuously each day for 14 days. This results in a significantly more comprehensive basis for extrapolating the respective AADT values.

**EXTRAPOLATION**

The hourly and daily values and the graphs obtained from the automatic, continuous counting provide the basis for extrapolating manually performed short-term counts or traffic monitoring counts. The monthly and yearly average fluctuation rates for the AADT values are used as the basis for future censuses.

A special extrapolation method developed by the Federal Highway Research Institute is used to compute the AADT values from the data gathered during traffic monitoring and the manual censuses.

**RESULTS**

The data and statistics gained from the traffic census are important factors when it comes to planning and dimensioning roads or computing noise emission values. In addition, the data are used for statistical purposes, e.g. for determining accident rates or annual mileage totals. As well as the AADT values (categorized according to vehicle class), other parameters such as the standard hourly traffic volume and noise level computation parameters are determined. These lists of results, drawn up annually, are publicly available at www.svz-bw.de. Information about the type and location of the counting points with the current AADT values is also available there in the form of a map.

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**Verkehrsmonitoring 2015: Amtliches Endergebniss für 1-bahnige, 2-straßige Landesstraßen in Baden-Württemberg**

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Extrapolated results in tabular form

Radar sensor in the top section of the reflector post

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