ASFINAG

Operations Monitoring System

PSI

The ASFINAG Operations Monitoring System

Datum: 01.03.2009

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Inhalt

1 National traffic telematics

ASFINAG installs and operates all of the traffic telematics facilities on the highways and express highways throughout the whole of Austria. These systems are distributed over the entire country as part of a transport network stretching over approximately 2,200 kilometres. Approximately 200 kilometres of this network run over bridges and through tunnel systems. In addition to the telematics facilities, there are also diverse operating facilities in the highway network, in the tunnel areas in particular.

The spectrum of telematics facilities ranges from a simple traffic data acquisition system using non-invasive detection systems (overhead detectors), complex traffic management facilities using video technology and environmental data collection, right through to systems which provide a range of traffic information services. This naturally includes a large number of data transmission systems, as well as central and peripheral IT systems. Particularly in the field of traffic telematics, i.e. traffic data acquisition and traffic management including their related services, a very complex and widely distributed landscape containing the most diverse, interlinked systems was created in the briefest period.

From a process management and monitoring viewpoint, this naturally boasts a wide range of manufacturers, functions and unit characteristics.

On the one hand, the facilities operate and communicate based on familiar, and sometimes open, standards, such as the TSC[1] or SNMP[2] or according to the unreserved standards drawn up by ASFINAG itself, e.g. the ASFINAG video standard[3]. On the other hand, proprietary interfaces must be linked, such as the ASFINAG traffic computer centre or special data formats which can be transferred between the systems as data.

Another distributed IT system is the result of the different components from individual subsystems and the related communications systems.

This wide system basis makes ASFINAG a globally active operator – which has responsibilities and must meet demands which far surpass those for conventional highway service providers. These can only be met through the use of innovative solutions and technologies, and with an optimised and integral holistic approach.

Traffic telematics systems and their components are typically distributed over large road sections or areas. Because of this, the achievement of quick and reliable fault detection through the positioning of personnel on the highway cannot be justified for economic reasons. Today's demands on the efficiency of the road services would require comprehensive and continuous inspections.

The mere monitoring of operating statuses for faults would neither fulfil ASFiNAG's demands on quality, nor would they meet the customer's expectations. Instead, what is required is a comprehensive quality assurance system which comprises the maintenance management of the entire infrastructure – yet one which simultaneously observes the traffic conditions, the local and temporal highway requirements and a range of unanticipated events.

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[1] Technical supply conditions for roadway station units, German Federal Highway Research Institute, 2002; a guideline for the construction and operation of traffic management systems.
[2] Simple Network Management Protocol
[3] ASFINAG planning manual for telecommunications engineering: video systems / video based detection systems; PLaNT 170.010.10 and PLaNT 170.020.10, ASFINAG, 2007

Comprehensive maintenance management must essentially fulfil 2 tasks:

1. The operative execution of corrective maintenance, meaning the event-driven rectification of malfunctions and damage and
2. preventative maintenance which not only includes the monitoring of the system's regular maintenance and inspection performance, but also the support of the process used to plan these activities.

Therefore, the responsibility of the system must be extended to include the entire planning, execution and co-ordination of all of the measures for corrective and preventative maintenance.

2 Planning & Choice of system

2.1 Requirement analysis

The initial intention when setting up the telematics systems, which were created on a large scale in just a few years, was to expand their central control system to include maintenance management components. When doing so, the plan was to revert to established maintenance management systems (MMS). The system messages originating from the process monitoring system were to be also drawn upon as input signals.

Here, it should be noted that, when installing the traffic telematics systems, ASFINAG reacted very quickly to modern trends and any changes or additions to the requirement profile of the system in question, with the result that it was able to properly exploit the opportunities offered by innovative technologies. However, this also meant that the technological and functional spectrum of the systems to be monitored quickly became very large.

The requirements analysis resulted in the areas of focus and requirements briefly described below.

- The most important requirement is the quick and reliable acquisition of operating statuses and, in particular, malfunctions in real time. To achieve this, the system must also deal with an influx of messages, i.e. a large number of messages within a short period of time, and must be able to aggregate and correlate them so that related messages regarding the same cause can be prepared for processing by the technical support personnel.

- The system's performance management facility also means that the measured values from the connected systems must be taken into account, threshold values must be monitored and, for example, communications malfunctions caused by network overloads must ideally be detected before a fault actually occurs.

  And it goes without saying that corresponding interfaces which are modularly expandable are required.
- Fault management and performance management must correctly allocate the messages to the corresponding units to allow maintenance orders to be generated with the aid of ticketing.

  A central database to hold the significant volume of the system (inventory) and message data is essential if pending tasks are to be completed. This is also accompanied by contractual data and information about affiliated organisations, assigned data regarding the operative maintenance measures and preventative maintenance planning data.
  All of the related programme sections and users must have access to this data. Data consistency and security must always be guaranteed, even during simultaneous access attempts.
- As regards the users, a complex concept of roles with different access levels is required.

- Only by applying a handling method which offers a uniform and consistent or internally tuned system, right up to the user, can any preventative and corrective maintenance be planned or executed with the highest degree of efficiency.

- Data and system statuses must be suitably visualised both graphically and in text form. An additional central requirement is derived from this: the continuity of data and the associated visualisation system. This requires the best possible consistency between the system components for monitoring and operating status visualisation, as well as the operating interface for ticketing.

- The usual supporting requirements for maintenance management systems such as warehouse management, reporting and other possible data connections – which, if necessary, may also lead directly to the operating service vehicles – are also included in the catalogue of requirements.

  It must be guaranteed that the system can be operated by different users with different operational and contractual roles at geographically distributed locations.

- The system should be functional and expandable. At a later stage, it should be just as possible to integrate any additional operating systems which normally work with telecontrol engineering as it is to practically extend the facilities to be monitored as required. It must also be possible to swiftly and easily adapt the system to any organisational changes or changes in work sequences.

  It must be possible to increase the system availability to well over 99% by simply upgrading the hardware. 99% is the basic requirement as regards system availability.

As the above summary shows, there is a very wide spectrum including the most diverse requirements. To ensure the success of the project, the fundamental aspects of the afore-mentioned points were concentrated on when executing the project. This way it was possible, for example, to omit the better part of classic ERP system functions as ASFINAG already has such a system. The ERP sub functions which are necessary for direct technical processing as part of maintenance support and which are not covered by the existing ASFINAG system, have been integrated in the operations monitoring system (e.g. warehousing for technical components incl. the tracking of their "history").

Above all, the link through the process connection of different systems with the operator's standardised work sequences turned out to be very complex.

2.2 Market environment & system choice

With "standard MMS components", it was not possible to cover the diversity of the systems at ASFINAG to the required extent as regards process connection, the illustration of specific work sequences in traffic telematics systems for many participants with different degrees of authority.

The integral solution for the operations monitoring system which was aimed for, and which was intended to meet the demands identified in the requirement analysis, needed an extensive market analysis including an appraisal of reference systems. The aim was to use standard finished products to minimise the project execution risks for ASFINAG.

A glance over the market of software systems which could be potentially suitable for the project exposed a fundamental problem relatively quickly, one which planners and system operators are often faced with when implementing innovative and integral solutions:

Milestones:

- On the one hand, there are different proven control systems with comprehensive monitoring functions and a large choice of interfaces.
- On the other, there are the globally classic MMA and ERP systems with a number of management features for maintenance, however with opportunities for process connection which are limited or missing completely.

A decision had to be made about which control system would best harmonise with which maintenance management system. The integral approaches adopted in the transport sector which join together both "worlds", were only available with too few functions and only limited adaptation possibilities.

Thus, it was established that, particularly in the transport sector – but also by all means in the infrastructures distributed in other areas of the operation – an answer to the requirements presented by ASFINAG was nowhere to be seen.

3 Implementation concept

3.1 System planning

During the introductory market analysis, it became clear that intended results are more likely to be yielded if the future system is directed to the needs and specifications of the operator as opposed to selecting a "best of breed" approach. The latter would ensure the highest functional characteristics of the respective partial solution (control system, MMS, resource planning, warehouse management, etc.), however would involve a considerable amount of time and effort during the connection, standardisation and achievement of system consistency. Integrated solutions offer both advantages during project processing and during productive operation.

The planning of the future system was tackled under an "integral solution" premise. The actions were strictly oriented to the operator's specifications. However, the knowledge of the features identified on the market as available were also included as benchmarks to ensure that the project could be realised.

The planners set themselves a goal of using a finished product which successfully fulfils comparable tasks in the transport or infrastructure sector – as regards widely distributed systems and networks - and which, with the aid of additions or adaptations, can be tailored to meet the specific needs of ASFINAG.

On this basis, and by paying stringent attention to the requirement analysis, a system was planned which it was hoped would satisfy the following, briefly summarised criteria:

- Proven market or standard software with corresponding references.
- The achievement of monitoring functions/process connection and – ideally – combined with maintenance management functions in a continuous system.
- A consistent, or at least a harmonised operating interface with common central system-internal data management with a high data persistency.
- Proven high system availability.

Possibility of flexible system adjustments once the system has been completed. This applies for the user (operative adjustments) and the system set-up engineer (functional additions). A prerequisite for the latter is complete and long-term access to all of the software components used.

Due to the decision in favour of "concentrating on the basics", it was foreseeable that further adjustments and additions would need to be made once the system had been completed. To ensure that this requirement would be met, a comprehensive specification and design phase was held before the actual implementation of the system. With this procedure, ASFINAG had an opportunity to use the "Specification completion" milestone to once again exactly estimate if the requirements were achievable – a further contribution to planning reliability.

3.2 System choice

In the experience of ASFINAG and the planner, there was only one awarding procedure with sensible prequalification steps which could be sensibly applied to tender such a complex system. In an awarding procedure which was extensive, yet performed within the specified time, a suitable system was found which fulfilled the technical and economic specifications and offered a crux comprising existing software which had proven successful in the management of major networks in many critical projects.

The process control and management system from PSI AG/ PSI Production GmbH with the main components PSI*contro*l and PSI*command* emerged as the selected system following the process of requirement and market analysis and the subsequent decision-making and assignment procedure.

It comprises both the process connection with corresponding visualisation system and the complete processing of maintenance in a form-sheet system which operates on the basis of system-internal, centrally structured data management. Extensive system references from the energy supply sector provide proof it can meet the high availability required.

Even on this system, more adjustments and additions were required to meet the special needs for operating and maintaining transport telematics systems. They were able to be achieved efficiently and reliably as the contractor had developed the software entirely himself and thus owned all of the access rights and could make all possible changes. Furthermore, the contractor had proven experience in maintaining his software systems over a period of far in excess of 10 years, thus ensuring its operative service.

The realisation of a system "from a single supplier" allowed ASFINAG to achieve simplified project processing and a reduced project risk through the clear separation of obligations and responsibilities.

4 System realisation

4.1 Design and implementation

When designing the operations monitoring system, in addition to the usual demands on operator guidance, operational reliability, redundancy and an availability of 99%, particular attention was paid to the seamless integration of all functional sectors in the system to be realised.

The operations monitoring system of the national traffic telematics facilities comprises the entire TSC[4] hierarchy, from the communications computer interface (CCI) and the control module (CM) through to the individual data terminals (DT). Here, each DT is monitored by connecting the operations monitoring system (OMS) to the CCI via standardised TSC telegrams. By modelling the TSC objects based on their physical, hierarchal and geographical relationships, it is possible to localise the individual DTs in the geography (co-ordinates or positioning) as shown in the schematic drawings (figure 1, top left). The drawings are created through the automatic conversion of the final planning documents taken from the installation projects. This automatic conversion not only led to considerable time savings during the execution of the project (no manual drawings) but also particularly paid off in the operating phase when new road sections were added to the OMS or existing roads were updated.

Above and beyond the pure telematics infrastructure, the video cameras from the traffic surveillance system (figure 1, bottom, 4th monitor from the left), the servers of the traffic control centre and the entire national IP network which assists the smooth transfer of the telematics data, are monitored by the OMS. Here too, modelling using geographical relationships which are typical for IT networks forms the basis for the national localisation of IP-based units (figure 1, top right).

If one considers all of the transfer routes, from the individual DTs through the control module and CCI, routers, switches, and SDH network components and then on to servers and operating station units, a malfunction warning or a failure is not a singular occurrence (figure 1, bottom, 2nd monitor from the left). In fact, the complete implications of a unit malfunction are detected and further faults resulting from this are displayed as consecutive faults. This way, the system effectively relieves the operators from any analysis activities so that the personnel can concentrate on their actual job which is the process control which leads to the fault elimination on the affected object. This inter-technological approach thus stops one of the gaps found thus far in the monitoring of heterogeneous infrastructures which are distributed far away from one another.

The software components of the operations monitoring system for fault elimination and preventative maintenance are directly connected to the software components of the PSI*traffic* monitoring system. With it, the alarms from the infrastructure monitoring system can manually or, using parameters, fully automatically generate and apply a ticket for eliminating the fault. In the opposite direction, the presence of a maintenance engineer at the scene of a malfunction event is fed back from the fault elimination component into the monitoring component. Events which, for example, would cause the actions of a technician on site to trigger an alarm, are thus masked by the system and differentiated from the "proper" alarms. This makes a fundamental contribution to relieving the operating personnel.

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[4] Technical Supply Conditions for Roadway Stations 2002 (National Federal Highway Research Institute, Bergisch-Gladbach 2002) – a standard for control and communication in the transport telematics sector

Due to the precise identification of the device from which the fault is to be eliminated or maintenance is to be performed, the organisations responsible (and above all external contractors) are established and informed based on the contracts concluded for the object in question and the event which has occurred. (Figure 1, bottom, 3rd monitor from the left)

The times arranged in the contract such as the acceptance, beginning of the assignment and recovery time are not only automatically recorded but are checked by the system to ensure they have been observed and the information is then documented and analysed.

Preventative maintenance is planned by the creation and updating of specified work schedules (both standard and individual work schedules) in which all maintenance activities are recorded together with the cycle duration. An annual schedule is proposed by the system for each contractor and this is then precisely scheduled by the contractor. The authorised annual schedule is then used as a basis for the creation of a weekly schedule through the allocation of resources (employees, utilities, warehouse material). For operative reasons, it must be approved by ASFINAG before being put to practical use. These procedures can also be time-monitored by the operations monitoring system so that no maintenance interval is missed.

An important constituent of the operations monitoring system is an effective reporting component. Here, on the one hand, the demands for regular monthly/quarterly reports are to be fulfilled, on the other, the flexibility needed to create customised reports on special tasks must be provided at short notice. Due to the fact that reporting is not only used for recording purposes, but also forms the basis for accounts with the maintenance contractors, a PDF document has been decided upon as the output format to make the manipulation of the content more difficult.

4.2 Launch of operation

To start up the operation of a system with the complexity described, a system which is structured and subdivided into logical steps must be gradually launched. This gradual introduction must be oriented, on the one hand, towards the availability of the client's personnel (who must master the introduction/training alongside the running operation) and, on the other, to the availability, completeness and consistency of the data to be transferred to the system.

For this reason, the first step was taken when the basic system for data administration and inventory management was installed in March 2008. The connection to the process and the data import interfaces were then subsequently realised and made available.

The components for malfunction elimination including reporting were already activated in the summer of 2008. The last stage of the operations monitoring system, the preventative maintenance system, was then started up in January 2009.

The procedure ensured that the client had to work with the system from an early stage. Initial experiences with its operation were gathered and promptly reported back to the contractor and – very importantly – it was possible to transfer the data to the new system in such a way that the personnel were able to do so in addition to their other everyday work.

5 Perspectives

5.1 Diversity of functions in the systems to be monitored

As already stated, new telematics concepts were promptly transferred by ASFINAG into construction projects which, in addition to an already large number of different systems, led to additional variants with different characteristics. This diversity of variants has been reproduced in the operations monitoring system and is being mastered by the system. The data structures have been created in a way which allows them to be extended further. This ensures that future innovations can be displayed in the operations monitoring system and the system is thus able to keep up with any technical developments.

ASFINAG's OMS is a operation-supported system which supports the specified maintenance needs and requirements and the processes connected with them. These processes are also subject to change. Starting with optimisations resulting from experiences gathered during operation (e.g. in the sense of continual improvements) through to organisational changes in the company – it must be possible to display all changes connected with this in the OMS. This aspect poses a further requirement on the flexibility of the system and is taken into consideration in the OMS basic concept.

Both of the above-mentioned aspects – and indeed others – achieve the expandability for the monitoring and maintenance of technical equipment and systems in tunnels which was already specified in the requirement analysis. In addition to the traffic telematics equipment, here there are also systems for energy distribution, ventilation, air surveillance, emergency equipment and many more.

The specifications drawn up by ASFINAG and the planners currently assign the OMS a purely monitoring function. The PSI*traffic* is basically designed so that it can also have a controlling effect on technical processes. Here, the subordinate controllers connected to the technical equipment are not replaced, but rather the OMS is able to perform control functions system-wide. This "effective direction" is an integral part of the system. It can thus also be extended in this direction.

5.2 System growth and migration

The construction and extension of the traffic telematics facilities on the ASFINAG road network is being advanced even further. The volume of traffic which is growing throughout the whole of Europe is now, more than ever, in need of intelligent solutions in the field of telematics. In addition to this, there are traffic telematics facilities which can be used to manage the traffic from an environmental viewpoint. With it, further growth as regards the number and the diversity of systems which can be connected to the OMS is foreseeable.

Reserves are already available to achieve this. Due to the structured modular system construction, it can be extended at any time using the existing reserves.

In the future, the system will be greatly distributed over the area – there will be access via the internet for the maintenance personnel and a possible distribution of work places throughout the network ensure a broad area of applications available at any location (motorway maintenance areas, tunnel control centres, etc.).

A special feature of the PSI concept is that system extensions, regardless of they are functional extensions of the OMS or additional (control system) work places, can always be made while the systems are running, without interrupting them. Of course, this also applies for any updates or upgrades made to the existing system.

5.3 Future potential

From a current viewpoint, the OMS has growth potential, amongst other things, in the following directions:

1) Growth in the sense of quantities and contents, i.e. the connection of additional telematics equipment and network components, as well as telematics services.
2) Growth in the sense of additional task areas, i.e. an extension to include additional infrastructure areas (tunnels, toll systems, intra-urban equipment).
3) Growth in the sense of function extensions, e.g. the transfer of operational guidance tasks, controlling interventions in the process, work sequence control, documentation tasks and aspects of quality management.

6 Conclusion

With the concept of an operations monitoring system with integral maintenance management which was drawn up together with the planners from PTV AG, ASIFINAG has now conquered new territory. A comparable concept had yet to be specified in the field of traffic telematics. An advantage is the clear separation of operative guidance (traffic management) from the functional safeguarding of the systems needed to do so and the connected processes of event-oriented and planned maintenance.

PSI Production GmbH was able to use the integral system approach comprising system monitoring in real time (PSI*traffic*) and workforce management for the maintenance (PSI*command*) to fulfil the requirements of the functions and processes specified in the tender. In addition to this, the system concept offers a high degree of flexibility when it comes to the expansion of the system (extension of the quantity structure), inclusion of additional task areas and expansion to include additional functions.

It was possible to turn the project into reality within the specified time and cost framework. It has been successfully in operation at ASFINAG since the autumn of 2008 with functions for preventative maintenance being added in the first quarter of 2009. In the first six months of 2009, all of the contracted work including the corresponding tests and acceptance tests will have been completed.

Illustrations:

Figure 1: Photo of a workplace