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**PROCROSS**

Development of Procedures for Cross Asset Management Optimisation

Good practice in Cross Asset Management Optimisation
Deliverable No. 1

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Executive summary

This deliverable reports on the findings of good practice in cross-asset management in Europe and covers the result of the 1st PROCROSS TAB workshop. It summarizes the work carried out by the PROCROSS partners together with National Road Authorities and Operators from 5 countries (Austria, Finland, Germany, Slovenia and Switzerland) at the 1st TAB workshop and afterwards.

The 1st PROCROSS TAB Workshop was held in Ljubljana at Slovenian National Building and Civil Engineering Institute on 9th and 10th of March 2011. At the workshop attended 16 participants from 6 countries. The main topics of the workshop were: organisation of infrastructure asset management in different countries; whether there is any cross asset management procedure already effective; a set of common definitions in cross asset management; how organisational structure, network type, source of money and coordination among different maintenance work influences cross asset maintenance activities; and the identification of stakeholders’ objectives in cross asset management.

Interviews with the participating road authorities revealed that cross asset management of maintenance activities is already to some extent common practice in some countries (e.g. Finland, Austria, Switzerland, Germany). From these interviews the following governing influencing factors were deduced: Minimizing cost of maintenance operation; effective use of available funds; avoiding multiple road interventions/closures; increase availability and reducing user costs; and reducing negative effects on neighbours. The self-assessed level of cross asset management indicates the relevance of organisational structures, the network type and how maintenance work is funded.

Another objective of the workshop was to identify stakeholder objectives, therefore 6 stakeholder groups (Road Authority, Road Operator, Road Owner, Road User, Neighbour, Society) were defined and linked to the total road infrastructure. Their specific objectives were considered and then clustered in safety, costs, environment, availability and customer satisfaction (comfort). The remaining questions were: What cost function needs to be applied in optimisation (direct and indirect costs) to reflect these objectives; what weights are needed for this; how different kinds of benefits (e.g. societal) are valued or weighed. These items will as well be elaborated in the 2nd TAB workshop.
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1 Introduction

1.1 PROCROSS overview and objectives

One of the key tasks in the asset management process is an improved and optimised coordination of all maintenance activities on the different sub-assets according to the expectations and requirements of road users, road operators, road owners and other affected parties. It is a complex process which needs flexible and adaptable methods, the experiences from the road owners and operators and a clear definition of the stakeholders’ requirements.

Description

The main objective of the project is the development of optimised procedures for cross asset management of the total road infrastructure (including all sub-assets like pavements, structures, road furniture etc.). The project aims at a recommendation for a holistic road asset scheme to balance the maintenance expectations of different sub-assets and stakeholders.

This is somehow different to the traditional approach in asset management where monitoring and measurement data are used to assess condition levels for each sub-asset in the road transport system more or less separately. Overall life-cycle costs/performance and asset values are of secondary order within many actual procedures.

An asset management approach should consider all influencing parameters (e.g. age, environment, materials, deterioration processes, loadings, maintenance policies, etc.) and impacts from a more practical point of view. Different sub-assets (e.g. pavements, tunnels, bridges, culverts, walls, noise barriers, variable message signs, drainage systems, etc.) through experience and good practice are proposed into a combined cross asset framework.

The main benefit of introducing such a holistic road asset scheme is to save monetary and non-monetary resources and minimising of negative impacts from socio-economic, technical and environmental points of view.

Expected results

The result of the PROCROSS project is a holistic approach for the cross asset optimisation of maintenance activities on the total road infrastructure. Based on a state of the art investigation, which is carried out in close cooperation with European road administrations, the procedures to be developed will enable to combine maintenance activities on different sub-assets and thus to reduce all negative impacts and effects to road users and other affected parties under different requirements and expectations.

This project will be tested in practice to show the exploitation and potential for road administrations.

The results will cover an extensive field of application concerning:

- Make a survey of the State-of-the-Art to find out good practice in cross asset management optimisation;
- Benchmark of cross asset management optimisation procedures
- Improve efficiency of asset management of the total road infrastructure
- Assess maintenance activities from different stakeholders’ expectations and requirements
- Support of the decision makers to underline the necessity of maintenance activities from a holistic point of view
• Provide a basis for the implementation of cross asset management optimisation procedures in the form of the Final report “The Procedures for Cross Asset Management Optimisation”

1.2 Method

To achieve the project goals and objectives a close cooperation between the Consortium and the European Road Administrations is essential. Thus, the whole project will be based on an intensified dialogue approach between interested European Road Administrations and the Consortium in the form of

- Workshops,
- Interviews and
- Discussions.

The dialogue approach will focus on the following main tasks of PROCROSS:

- Identifying best practice of asset management processes and understanding cross asset interdependencies and costs/values to evaluate impact of maintenance activities on the different sub-assets
- Deducing monitoring requirements from road authorities needs (top-down approach) to collect the most important key performance indicators (KPIs)
- Development of procedures for cross asset optimisation with consideration of the expectations and requirements of the different stakeholders
- Analyzing efficiency and applicability of the proposed procedures for implementation

For this dialogue a separate Technical Advisory Board (TAB) was established and chaired by an experienced Technical Advisor (Prof. J. Litzka). The European Road Administration of the PEB members and other selected countries are invited to participate on this board and to provide the Consortium with the necessary information.

With regard to the objectives of PROCROSS and the results to be achieved four dialogues will be carried out by the Consortium in mutual agreement with the client and the Technical Advisor of the TAB. Dialogue 1 - Identification of best practice, Dialogue 2 - Monitoring requirements, Dialogue 3 - Development of cross asset management optimisation procedures, Dialogue 4 – Implementation guide support the exchange of experiences and expectations. The first Dialogue 1 - Identification of best practice with a Workshop focussing on:

- Existing cross asset procedures
- Impact of maintenance activities on different sub-assets
- Stakeholders’ requirements and expectations for cross asset optimisation
- Interviews focussing on cross asset interdependencies

took place in Ljubljana on 9th and 10th March 2011 and provided the basis for this first deliverable (see chapter 1.4 ff).

1.3 Definitions

For the assessment of existing and new or advanced cross-asset management procedures it is important to define those terms which will be mostly used within this project. The basic for the following definitions are on the one hand the actual respective literature (e.g. COST354, 2008) and on the other hand the discussions within the Project Team and during the
Workshops.

**Total Road Infrastructure Asset**

The *Total Road Infrastructure Asset* is the comprehensive term of all single assets (pavements, bridges, tunnels, culverts etc.) of the road infrastructure, which are necessary to operate a road under given requirements and pre-conditions (safety, comfort, environment etc.). The assets can be directly linked to the road or can be an independent part of this infrastructure. In the context of this project those assets, which are independent parts of the road will not be taken into consideration.

**Asset (also single asset, sub-asset)**

The term *Asset* will be used to describe elements and/or components of the *Total Road Infrastructure Asset* (see definition above). A single asset can consist of different sub-elements or components, e.g. bridge consist of the superstructure, edge beams, expansion joint etc., which are sub-elements of the bridge. Furthermore it is possible to group different single assets from a more general point of view, e.g. bridges, tunnels, culverts, etc. may be collectively grouped as Engineering Structures, whilst road signs, guard rails, lighting may be collectively grouped as Road Furniture.

**Stakeholder**

In the context of this project *Stakeholders* are defined as a specific or general group of people which are directly or indirectly affected by the planning, construction, operation and maintenance etc. of the *Total Road Infrastructure Asset*. According to the PIARC-definitions the *Stakeholders* can be categorised into the following groups:

- Users
- Owners
- Operators
- Neighbours
- Financing body
- Society

**Asset Management**

*Asset Management* is the comprehensive term to describe all management activities on one or more *Assets* of the *Total Road Infrastructure Asset*. It refers primarily to maintenance and operation activities but also to improvement and extension of existing *Assets*.

**Cross Asset Management**

*Cross Asset Management* is the combination of management tasks and activities over different *Assets* of the *Total Road Infrastructure Asset* within a pre-defined management process. These tasks and activities can to various degrees have technical, economic, strategic and environmental objectives/considerations.

**Performance Indicator**

*Performance Indicator* is a comprehensive term indicating the condition of the *Total Road Infrastructure Asset*. It can be expressed in the form of a Technical Parameter and/or in the form of an index (dimensionless).
**Single Performance Indicator**

A *Single Performance Indicator* is a dimensional or dimensionless number related to only one technical characteristic of an *Asset*, *Sub-asset* or the *Total Road Infrastructure Asset*, indicating the condition of that characteristic.

**Combined Performance Indicator**

A *Combined Performance Indicator* is a dimensional or dimensionless number related to two or more different characteristics of an *Asset*, *Sub-asset* or the *Total Road Infrastructure Asset*.

**General Performance Indicator**

A *General Performance Indicator* is a mathematical combination of *Single and/or Combined Indicators* which describe the a *Single Asset* or the *Total Road Infrastructure Asset* condition concerning different aspects like safety, environment, etc. (also called *Global Performance Indicator*)

### 1.4 TAB Workshop

The 1st PROCROSS TAB Workshop was held in Ljubljana at Slovenian National Building and Civil Engineering Institute on 9th and 10th of March 2011. At the workshop attended 16 participants from 6 countries.

The invitation to participate in the TAB were sent to the Road Authorities from Austria, Belgium (Flanders), Denmark, Finland, France, Germany, Ireland, Lithuania, Netherlands, Norway, Slovenia, Sweden, Switzerland and United Kingdom. Further a separate invitation was sent to the members of the ENR PEB and the other ENR SRO4 project coordinators. Unfortunately, only 6 of 14 countries participated at the workshop. Nevertheless the information to be collected is a good basis for any following up work within this project. All project members still have the impression and confidence that the next TAB workshop will attract a larger group of experts and thus filling possible gaps of information.

The main topic of the first part of the workshop was the organisation of road infrastructure asset management in different countries and whether there is any cross asset management procedure already effective. Further it was discused how the impact of maintenance activities on different sub-assets is assessed. During the discussions it was agreed that clear and common definitions were needed for further elaboration and analysis. The discussion among participants showed that cross-asset management of maintenance activities is already more or less common practice in some countries. Further it was discussed how organizational structure, network type, source of money and coordination among different maintenance work has strong influence on cross-asset maintenance activities. The question remained which single assets of the infrastructure are included in cross-asset management activities. The results are reported in chapter 3 of this report.

Another objective of the workshop was to identify the stakeholders’ objectives of cross asset management. The participants made their thoughts about main objectives for six stakeholder groups linked to the total road infrastructure. The stakeholder groups were defined at the beginning of the session as Operators, Users, Neighbours, Society, Financing Body and Owners. The results are reported in chapter 2.2.

The second part of the workshop was dedicated to maintenance activities, performance indicators and how the importance of maintenance activities is assessed. The question was raised whether it is appropriate to group certain assets and how KPI (Key Performance Indicators) are related to sub-assets and cross-asset management. During the discussion
objective functions, minimization of costs and maximization of performance were mentioned. The question remained, what cost function needs to be applied in optimisation (direct and indirect costs) and what weights do we need. Further, it was asked if some kind of weighing of benefits is already in use. These items will be further elaborated in the 2nd TAB workshop.

At the last part of the workshop the TAB identified the governing influencing factors for two groups of stakeholders (Group 1: Road Authority, Road Operator, Road Owner and Group 2: Road User, Neighbour, Society). Further, the TAB assessed what influencing factors (e.g. costs, safety, CO2) might be used for cross asset management optimisation.

Participants

TAB members:

ASFiNAG Karl Gragger (AT)
ASTRA Luzia Seiler (CH)
DARS Andrej Zakrajišek (SI)
DRD Mikkel Bruun (ENR SRO4 PEB Chair, DK)
DRSC Nevenka Zakrajišek (SI), Liljana Herga (SI)
FTA Vesa Männistö (ENR SRO4 PEB member, FI)

Project Partners

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PMS Alfred Weninger-Vycudil (AT)
TU Johann Litzka (Technical Advisor, AT)
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ZAG Bojan Leben (ENR SRO4 PEB member, SI), Lojze Bevc (SI), Darko Kokot (SI)

2 Stakeholders’ requirements and expectations; governing influencing factors; value, cost, environmental impact and benefit consideration

2.1 How is the impact of maintenance activities on different sub-assets assessed?

The idea of cross-asset management is not a ‘one-stop-shop’ solution, but rather a best practice, robust methodology through which the entire road transportation network may be maintained and operated in a safe and efficient fashion with an emphasis on cost minimisation. The term ‘cost’ does not necessarily mean the liquidity at any point of time and covers a broader financial aspect.

Some specific characteristics of cross-asset management include high-quality information on asset inventory, the condition of such assets, the management strategies of such assets and customer perceptions. Additionally, unlike a standard management system of a certain type of sub-asset (e.g. a Bridge Management System), cross-asset management explicitly
encourages cost-effective data collection, monitoring and target oriented asset appraisal. In this context, the importance of infrastructure maintenance management is the key. The sub-assets, having formed a network within the asset management framework significantly bias the investment options through their respective risk ratings or rankings. The various hierarchical stages of risk ratings and rankings ranging from expert ratings using from visual data to testing, deterministic assessment and semi-probabilistic and probabilistic assessment have already been investigated in depth. It is the agreed synthesis of the final risk ratings and rankings that are crucial for the final decision in a cross-asset management format. Such an impact, quite naturally, supports centralised and rigorously defined standards of infrastructure maintenance management formats. It is to be noted here, that the term maintenance activities extend to the nature and the frequency of inspections of sub-assets and may include the requirement or the level of training of the personnel in charge of such inspection. Decision-making processes, under such a framework allocate resources for capacity expansion balanced holistically by maintenance, operations, and preservation needs. Consequently it involves life cycle costs, constructability, inspectability and maintainability – all of which are directly related to the impact of maintenance related activities on the sub-assets. In short, the weights of the activities have a significantly greater magnitude in influencing the final decision in this format than it ever has been.

In financial terms, for illustrative purposes, it can be quoted from Haardt and Holst (2008), that the fixed road assets of the German road infrastructure is valued at €170 billion and the maintenance needs are at approximately 1%, representing a need of €500 million per year. The maintenance activities on the sub-assets do not merely reflect the budget, but also represent the influence on traffic infrastructure and the economy and the society as a whole in a cross-asset management format. These factors, in turn reflect the true cost on the sub-assets. The main departure from a traditional rating and ranking system in this case is that often the risk based ranking underweights the true cost of the sub-assets. Currently, the decisions based on information on the sub-assets are almost uniformly used in either an independent or in an ad-hoc basis. A major reason behind this is a lack of data sharing, either in reality or in the willingness of the owners, consultants and the end-users.

2.2 What are the Stakeholders’ requirements and expectations for cross asset optimisation?

When the complete information on an entire network of assets, including its sub-assets is not shared or the information is retained within different clusters, the decision making may either have independent components, (leading to sub-optimal and non-unique final results) or may be unreasonable. The equilibrium or the minimisation, in such cases does not consider all the stakeholders and consequently their expectations and requirements are not reflected appropriately. Even when some information is shared and the assessment of assets ranges wider than traditionally considered objectives, the asset optimization may become a speculator’s optimisation problem with different speculators having different requirements, expectations and possessed information.

The stakeholders were classified as operators, users, neighbours, society, financing body and owners. The findings from the TAB workshop on stakeholder objectives were (repetitions and overlapping possible):

OPERATORS:
- Asset management and demand be linked for a vision
- Honest competitions for tenders
- Clear technical normative
- Assured works and payment
- Optimise working hours (avoid unnecessary repetition of a kind of maintenance)
- Customer satisfaction
- Improve cooperation between different units of the RA
- Provide necessary funds at the right time for each sub-asset
- Ensure consistent infrastructure operation
- Increase safety of road workers
- More effective maintenance activities
- Value, cash-efficiency
- Minimise cost of maintenance operation
- Good coordination of activities on road network
- Good mobility across the road network
- Combining activities means spending less time on the road/being exposed to different dangerous situations
- No duplications of work on same sections
- Take maintenance into consideration at decisions on new constructions
- Optimal mobility
- Economical/optimal realization of construction investments
- Optimal maintenance with respect to the available funds
- Keep roads open with as little disruption as possible

FINANCING BODY
- Cost-effectiveness
- High value of asset
- Good ratio for budget/value of asset
- Maximize profit
- Lower budget for activities to be available
- Reduce cost – make them efficient
- Low costs for good quality of maintenance
- No complaints from users
- To get the best for the available money
- Equalized Budget
- Use money at the right time
- Reduce maintenance costs
- Increase effectiveness of maintenance activities
- Effective/optimal use of available resources/funding
- Maximize return investments over lifetime of network
- Minimum requirement for investment
- Optimal use of available budget
- Better possibility of argumentation against other internal competitors for money (often sections of public households)

OWNERS
- Effective/optimal use of available resources/funding
- A tool to improve understanding of effects of maintenance
- Unproblematic system of maintenance
- Level of quality of maintenance that covers needs and avoids collisions
- Low risk
- No surprises
- No headaches from: Operator, Financing Body, Owner, Society, Users, Neighbours
- Raise the value of asset
- Reduce costs
- Better distribution of budgets
- Optimal maintenance status, condition of asset
- Fulfil political/strategic requirements
- Optimal maintenance planning
- Reduce user disturbance
- Reduce negative effects on neighbours
- Keep infrastructure in good condition
- Prolong the service life of structure at minimum costs
- Good quality but not too high
- No problems with the neighbours
- A road network with a high value for the population
- Good network for the users of the road (people, economy)
- Lower overall expenses for maintenance activities
- More effective budget allocation
- Keeping value of assets

SOCIETY
- Keeping optimal mobility by minimal impact on the environment
- Avoid wasting tax money
- Optimal use of tax payers’ money
- Less pollution
- Fewer (potentially) dangerous situations
- Environmental impacts (noise, CO₂, aerosols) should be limited
- Quality of overall infrastructure → direct effects on economy
- Reduce environmental impacts of roads
- Reduce numbers of congestion hours → reduction of macro-economic negative effects
- Safe infrastructure
- Minimise disruption
- Minimise environmental impacts
- Minimise costs
- Optimal use of existing (limited) budget
- Having smooth traffic with as little disruption as possible
- Reducing pollution as much as possible
- Not working during the night and at weekends
- Providing transport infrastructure
- Not too high an influence on the environment
- Fast transport of people and goods
- Well built and maintained infrastructure at low costs

NEIGHBOURS
- Unproblematic life next to the road infrastructure
- Fast and effective solving of problems
- Nothing special except information
- Minimize negative effects of road infrastructure
- Reduce noise, pollution, etc.
- Minimize the impact on the quality of living (noise) and environment (pollution)
- Make sure that protective measures are active (noise barriers, functional pavements, etc.)
- Less disturbance by repair workers
- Good planning of maintenance → fewer interruptions/less hassle
- Low noise
- Environmental effects
- Minimise nuisance (noise, pollution, disruption, etc.)
- Fewer bypasses or other disruptions or harmful effects on their life activities
- Good environmental activity (low noise, little emissions)
- Small negative influences of the road network on air, people (noise)

**USERS**

- No delays
- Smooth traffic
- Reduced queues, delays
- Minimize disturbance
- High quality of the road
- Ensure consistent infrastructure for users’ needs
- Minimise interruption, avoid unnecessary obstacles
- Provide reliable infrastructure. Safe journey from A→B
- Well maintained roads through the year
- No or as few as possible road blocks
- Mobility of the road network
- Optimise the factor value/money
- Safety, efficiency, reliability
- Ensure good condition of all sub-assets
- Avoid multiple road interventions/closures → reduced users costs (included accident risks)
- Traffic flow, not too many construction sites
- Less disruption to traffic
- Fewer dangerous situations
- Optimal mobility

The TAB assessed the influencing factors on Asset Management (AM) and the level of cross asset management relevance with the result shown in Figure 1.

![Figure 1](image)

*Figure 1: Relevance of stakeholder objectives for asset management and potential for cross-asset management.*

The owners naturally tend to strive for a system optimal equilibrium for which the cross-asset optimisation may be lucrative as long as the impacts are assessed in terms of direct investment. On the other hand, the users’ requirement may often encompass intangible costs which not only includes the cost to the road user, but also the cost to the environment, for noise pollution or even the cost of comfort. Such markers directly affect the perceived level of service and are thus valid weighting parameters in a cross-asset optimisation process. The
neighbours are expected to have a mix of the previous two requirements, although they may be pliable through legislations and agreements, including existing conditions. The societal expectation very strongly reflects the perceived safety and the perceived level of service of the asset as a whole. Such expectations directly encourage cross-asset management, where the guiding philosophy very closely follows the broad reflections of the society. The financing body’s expectation, ideally, forms a long term cost minimised solution where a cost prioritisation is expected in line with the available cash flow. However, the expectations of the financing body have increasingly acknowledged the importance of perception of the users towards the network as a whole.

The expectations are usually qualified by quantitative and qualitative terms and such juxtaposition is acknowledged and taken into account for cross-asset optimisation. The value of the network of assets is a common but a qualitative parameter in this regard having different interpretations of implicit weighing of directly measurable parameters for the stakeholders. The cost is a more direct measure, but the weight of each type of cost is quite different. The environmental requirements are significantly legislated and are often well defined. Consequently, under a common framework of cross-asset optimisation, this term can be standardised independent of the perceived value of it. Some factors, like noise pollution are not necessarily within the framework but appropriate legislation based approaches can uniformly accommodate new environmental factors. The benefit may be viewed as a qualitative term with multiple interpretations but in reality, within the asset management framework it can become a strictly defined output once the influencing variable, including an agreed definition of the value of the network is accepted. Mobility is another expectation having a strong relationship with travel time and accessibility of the users within the network. This variable implicitly affects the weights of the other variables in this optimisation problem.

It is to be noted here that although each optimisation problem will prove certain valid solutions – the final decision is not unique and may either be multiple or dependent on the definition and representation of qualitative variables (or both). Consequently, the planning and conceptual design concepts remain exactly the same while considering multiple objectives of requirements of different groups of stakeholders.

2.3 How are value, cost, environmental impact and benefit considered?

The value of the asset network is comprised of a number of tangible and intangible combinations of factors. There is no single definition of this combination, but the perceived level of safety and service, the real cost to the network, the life-cycle-cost, the environmental cost, the impact on the society and the economy as a whole. There seems to be a unanimous agreement on using life cycle costs when considering the cost and the cost to the road user has gained a significant acceptance in this aspect. The environmental impact is mostly guided through legislation and is directly reflected through the specific contractual conditions associated with the lifetime maintenance management of the network. The benefit, as obtained from cross-asset management, targets all different types of stakeholders and consequently the final benefit is rarely expressed as a unique value of investment required or saved. Rather, the benefit in terms of financial savings can be translated contextually and related perfectly to the expectations of different stakeholders. Such a targeted interpretation and quantification of benefit does not contradict with the traditional idea of financial benefit since the benefit of each class of stakeholder is represented in their specified and customised definition allowing them the maximum control over a network.
3  Asset management structures; cross asset procedures; maintenance for sub-assets

3.1  How is asset management organised in different countries?

The different types of asset management organisation are an essential input parameter for the assessment of existing and the definition of new or advanced cross asset management procedures. The organisation of asset management is dependent on a high number of influencing factors and parameters such as:

- Type of network (motorway, state road network, community road network, etc.)
- Size (length) of network
- Structure /organisation of road administration (central, regional, etc.)
- Number and type of assets to be managed within the organisation
- Responsibilities
- Financial preconditions and requirements
- Level of education
- etc.

A main influencing factor in the organisation of asset management is the organisational structure of the road administration. Based on the collected information a first general categorization or grouping of road administrations could be carried out according to the responsibilities in:

- Asset related management structure, or
- Task or objective related management structure.

The asset related management structure is characterized by different administration units, departments or divisions, which cover the management responsibilities for one single asset (pavement, bridge, tunnel, etc.) or a group of assets (e.g. engineering structures). In comparison to this asset related management organisation the second group shows a task or objective related structure, characterized by units or departments, which fulfil a single management task or function, like planning, financing, operation, maintenance, etc.

In many road administration authorities a mixture of both categories can be found, where some units or departments are responsible for separate assets (e.g. bridge, pavement, etc.) and some of them hold special (in many cases strategic) tasks (e.g. financing, strategic planning, etc.).

A second grouping of asset management can be carried out from the geographical or topographical point of view. This is strongly dependent on the size of road network but also from the number of activities within the management processes. E.g. if the operational activities are outsourced it is not necessary to have a high number of regional branches.

According to the information to be collected, asset management organisation can be organized from the geographical view as follows:

- Centralized organization, where the asset management activities will be carried out mainly in the “headquarter”
- Decentralized or regional organization, where the asset management activities will be carried out mainly in regional offices

Of course, in many organisation a mixture of both groups can be found, where some asset
Management tasks will be carried out in the regional branches and some of them are located at the headquarter. In case of a mixture the strategic tasks could be found mainly at the headquarter level.

Taking into consideration both grouping the following figure (see Figure 2) can be drawn. With this figure it is possible to “locate” each road administration with a point or circle and to give a clear overview about asset management organization. The size of the network to be managed is represented by the diameter of the circle and the filling colours are used for different road network definitions (motorways, state road network, etc.).

In the following chapters different road administrations are described according to their asset management organisation. These administrations are either strongly engaged within PROCROSS or are being supported by at least one of the project partner in the field of asset management.
Austria

In Austria the Federal Ministry for Transport, Innovation and Technology with the Department of Roads is the national road administration and the Road Operator “ASFiNAG” operates the federal motorway and expressway road network with a total length of approx. 2100 km. The other roads (state roads, secondary roads, etc.) are in the responsibility of the Austrian states and municipal authorities. There were no representatives of these road networks attending the workshop. Thus, the following information refers to the federal road network (motorways and expressways) only. Nevertheless, experiences from project team members from Austria about these types of road network will be taken into consideration in the phase of procedure development.

For the national motorway network the objectives for Asset Management are organised by federal law. The topics “road safety, fluid traffic flow and neighbour protection” are of particular importance. The road operator “ASFiNAG” is to 100% owned by the Austrian Federal Government. The company has committed itself to highest efficiency in managing its financial resources. ASFiNAG does not receive any money from the federal budget. The receipts derive from road user charge, rest areas and traffic fines. ASFiNAG focus on availability, information, safety and promoting intermodality by interlinking with public transport. The company considers what the customers (road users) are expecting from them.

Regarding the federal ministry there are a variety of regulations and guidelines that have to be taken into account, for example building product and motor vehicle regulations. Furthermore, the Austrian Association for Research on Road – Rail – Transport (FSV) publishes the Austrian Code for the design, construction and maintenance of roads to standardise road engineering. Due to legal requirements the operator ASFiNAG cooperates with the federal ministry of transport, innovation and technology concerning asset management and road maintenance systems.

With regard to road infrastructure assets: ASFiNAG’s existing network is 2175 km with 5020 structures (340 km bridge length). In total 145 tunnel facilities with a total tube length of 340 km in operation. Current noise protection is on a length of 1090 km of a total area: approximately 3.4 km². The Asset Management of the road network is organised in the Service Company (SG) in the division Management of existing road network. It comprises a maintenance management group, a group for tunnels and electricity, road safety, an environment (noise) group and the management of buildings.

Finland

The Finnish Transport Agency is a Government Agency, established on the 1st of January...
2010, operating under the Ministry of Transport and Communications. Its remit is to maintain and develop the standard of service in the transport system’s traffic lanes as overseen by the government. In this regard it is responsible for asset management on the Governments:

a) Road Network, 78,000 km public roads (i.e. motorways to rural roads including pavement and gravel roads) + 14,000 bridges

b) Rail Network, approx. 9,000 km as well as

c) The Waterways (7,600 km coastal fairways + 7,900 km inland waterways).

The central administration has 5 main units: Transport Systems, Investments, Maintenance, Traffic Management and Administration as illustrated in Figure 4. It is the Maintenance Unit which is responsible for Cross Asset Management at a Network level. The Central Administration coordinates the activities for 9 regional administrative offices that are responsible for Cross Asset Management at a programme and project level.

The agency receives a centralised budget allocation which it must distribute amongst all assets. Whilst it receives no ‘Strategic Advice’ in how to allocate this budget from a Cross Asset Management perspective, it does have a division for cross asset management coordination (i.e. the Maintenance Division) which applies generalised strategic requirements concerning Safety, Condition and Satisfaction.

Information provided in discussion and via the questionnaire completed at the 1st TAB meeting listed current procedures for assessing maintenance needs of the following specified sub assets:

(a) Pavements:
- Information available includes: inventory, condition and traffic loading with

![Figure 4: Finnish Transport Agency Organisational Structure](image-url)
• **Determination of Maintenance Needs** based upon: simple ranking based upon condition at a programme level and prioritization based upon cost benefit analysis (LCA/LCCA) at a network level.

(b) Bicycle Paths:
- **Information** available includes: inventory and condition rating with
- **Determination of Maintenance Needs** based upon: simple ranking based upon condition at a programme level.

(c) Gravel Roads:
- **Information** available includes: inventory, condition and loading with
- **Determination of Maintenance Needs** based upon: simple ranking based upon condition.

(d) Bridges, Tunnels, Piers, Retaining Walls:
- **Information** available includes: inventory, condition and traffic loading with
- **Determination of Maintenance Needs** based upon: simple ranking based upon condition at a programme level and with an aim in the near future to develop prioritization protocols based upon cost benefit analysis (LCA/LCCA) at a network level.

(e) Road Signs, Markings and Other Furniture:
- **Information** available includes: partial inventory with
- **Determination of Maintenance Needs** based upon: demand.

**Germany**

There was a confirmed interest from the German Authority to participate in the TAB and at the workshop. Further, the project members agreed that the input from Germany would be very valuable and an “asset” for the PROCROSS project. In order to keep Germany as member in the TAB the suggestion of one project partner (SEP Maerschalk) to look into the common practice in Germany and report the results according to his holistic expertise and knowledge on the German situation was very much appreciated by the project consortium. Thus, the following information is not based on interviews within the workshop, but on a detailed analysis of the German situation. In doing so, it was possible to keep Germany within the TAB and include their structures and situation in asset management for further analysis in PROCROSS and its aligned solutions. Therefore, this section and the part in chapter 3.2 on cross asset management in Germany are more extensive compared to other countries. The next PROCROSS workshop will reveal if this approach can be extended on other countries as well.

A description of the organisation of the asset management process in Germany must first address the structure of road administration (based on Federal Ministry of Transport 1994).

The German Constitution mandates tasks and responsibilities in road construction and maintenance. Germany is a federal republic, i.e. a constitutional union wherein both the federation and its constituent states are legal entities.

Each German state has its own constitution, a territory and public authority. The execution of responsibilities is incumbent upon the individual states unless the Constitution prescribes or permits an alternative ruling. One such alternative ruling (Article 90 – Constitution) declares the Federal Republic as the owner and construction agency of Federal Trunk Roads and assigns it the tasks of building, developing and maintaining Federal Motorways (“Bundesautobahnen”) and Federal Highways (“Bundesstrassen”). In this field, the Federal Republic has legislative power. The 16 states may become active only if the Federal Republic makes no use of this legislative power. The states, however, have legislative
authority over state roads, district roads, inter municipal roads, local roads and all purpose rural roads. Just as the Federal Republic has adopted a “Federal Trunk Road Act”, the states have adopted their own specially commissioned “Laender Roads Acts”. As a matter of principle, the states are responsible for the execution of Federal laws within their jurisdiction, and may provide for the establishment of agencies and administrative procedures.

The Federal Trunk Roads are built and managed by the states on behalf of the Federal Republic (Art. 90 – Constitution). The Federal Republic as the “principal” has certain rights to assert its ideas towards the states. These rights are based on:

- Constitution acknowledging the authority of the responsible Federal Ministries to give directions to the state agencies;
- a “natural” Federal competence for supra-regional central planning and coordination;
- the financial responsibility of Federal Government.

Table 1 summarizes the allocation of property, construction/maintenance responsibilities and administration for all types of German roads.

### Table 1: Property, financial obligation for construction/maintenance and administration of roads in Germany

<table>
<thead>
<tr>
<th>Highway class</th>
<th>Property/financial obligation (construction/maintenance)</th>
<th>Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Trunk Roads</td>
<td>Federal Government</td>
<td>--</td>
</tr>
<tr>
<td>Federal motorways</td>
<td>&lt; 80.000 inhab.</td>
<td></td>
</tr>
<tr>
<td>Local auth.</td>
<td>&gt; 80.000 inhab.</td>
<td>Local auth.</td>
</tr>
<tr>
<td>State highways</td>
<td>States</td>
<td>&lt; 30.000 inhab.</td>
</tr>
<tr>
<td>Local auth.</td>
<td>&gt; 30.000 inhab.</td>
<td>Local auth.</td>
</tr>
<tr>
<td>District roads</td>
<td>Districts</td>
<td>&lt; 30.000 inhab.</td>
</tr>
<tr>
<td>Local auth.</td>
<td>&gt; 30.000 inhab.</td>
<td>Local auth.</td>
</tr>
<tr>
<td>Local roads</td>
<td>Local authorities</td>
<td></td>
</tr>
</tbody>
</table>

(Inhabitant limitation of 30.000 varies in several states; districts often transfer administrative tasks to states)

The States build and manage Federal Trunk Roads on behalf of the Federal Government. The Federal Government, represented by the Federal Ministry of Transport, has the right of legal and technical supervision to ensure that a uniform, safe and efficient network of Federal Trunk Roads is available throughout the national territory.

As administration of the Federal Trunk Roads is accomplished by the states there are no subordinate road construction/maintenance authorities to the Federal Ministry of Transport. Road construction and maintenance administration in most states is based on a three-tier system:

- The State Ministry (highest authority);
- The State Agency for Road Construction, its District Administration and the Office for Roads and Transportation (intermediate authority);
- Motorway/highway offices with motorway maintenance depots, highway maintenance depots, telecommunication depots (subordinate authorities).

The “city-states” of Berlin, Bremen and Hamburg and the state of Saarland have two-tiered administrations. The civil servants working in the states authorities are employed by the respective states, even if their work is only concerned with Federal Trunk Roads.

For the necessary cooperation with state authorities the Federal Government may issue, by
agreement of the parliamentary chamber representing the states ("Bundesrat"), “general administrative provisions” or directives to technical standards and specifications. Two important general administrative provisions govern:

- The procedures governing the Federal Government’s rights of intervention vis-a-vis the states authorities (e.g. the obligation to report in matters of principal importance or particular financial implications);
- The management of Federal funds for the construction/maintenance of Federal Trunk Roads by the states.

Table 2: Road Infrastructure Assets in Germany

<table>
<thead>
<tr>
<th>Traffic Assets</th>
<th>Road Pavement</th>
<th>Other Assets - of Roads</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Carriageways</td>
<td>Drainage Facilities</td>
<td>Bridges</td>
</tr>
<tr>
<td></td>
<td>Continuous Lanes</td>
<td>Gulleys, Deep Drainages and Seepage Ranks, Drainage Pipes, Watercourses, Ditches, Curved Channels</td>
<td>Rectangular Between the Abutments or Walls Measured Openings of Less than 2 m Clearance</td>
</tr>
<tr>
<td></td>
<td>Junctions, Acceleration/Deceleration Lanes, Hard Shoulders</td>
<td>Embankments, Slopes Shoulders</td>
<td>Rectangular Between the Abutments or Walls Measured Openings of at Least 2 m Clearance</td>
</tr>
<tr>
<td></td>
<td>Roadside Lanes</td>
<td>Earthworks</td>
<td>Tunnels</td>
</tr>
<tr>
<td></td>
<td>Cycle Tracks, Sidewalks, Parking Lanes</td>
<td>Subgrade</td>
<td>Trough Structures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Planting</td>
<td>Retaining Structures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Road Hardware Equipment</td>
<td>Noise Barrier Structures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The directives to technical standards and specifications issued by the Federal Ministry of Transport for state authorities refer to construction, maintenance, extension and improvement of the Federal Trunk Road network (Federal motorways and highways). Elements of the network include all road infrastructure assets shown exemplary in Table 1. District authorities and especially local authorities (see Table 1) are generally not bound by such directives, but largely adapt to it in their road infrastructure asset management.

Asset management should be organized by the described administrative units as a business process and a decision-making framework that covers an extended time horizon, draws from economics as well as engineering, and considers the broad range of assets shown in Table 2. The asset management process should run both at the network and at the project level, incorporating the economic assessment of trade-offs between alternative investment options, and using this information to help make cost-effective investment decisions.
Slovenia

In Slovenia there are two companies responsible for management of the road infrastructure. DARS, Motorway Company in the Republic of Slovenia is a joint-stock company responsible for the management of the motorways while DRSC, Slovene Roads Agency is a body affiliated to the Ministry of Transport of the Republic of Slovenia and is responsible for the management of all other national and regional roads. DRSC is also responsible for national cycle routes. DARS manage and maintain motorway sections for which it acquires building concessions. For the management and maintenance both companies have their own separate budget, which are approved in National Assembly. Each year they have to report about their plans and activities to the National Assembly.

Figure 5: Asset management in Slovenia (Ljiljana Herga, 2010)

Figure 6: Road network in Slovenia (Ljiljana Herga, 2010)
Switzerland

The ASTRA is the Swiss Federal Motorway Operator and fulfils the road operation by a performance contract from the parliament. The asset management is organized in the Infrastructure division within 5 regional offices (see Figure 7). The strategy and standards on how to maintain the road network are developed in the networks division.

In total the ASTRA operates a road network with ~1789 km comprising motorways (1406 km), express ways (271 km) and mixed traffic trunk roads (112 km).

The other roads (cantonal roads, municipality roads, etc.) are in the responsibility of the cantons and municipal authorities. Unfortunately, there were no representatives of these road networks attending the workshop. Thus, the following information refers to the federal road network (motorways, expressways and mixed traffic trunk roads) only as no PROCROSS partner has this information at hand.

3.2 What cross asset procedures are already in place?

In many countries cross asset management procedures are used in practice on different levels (strategic, financial, technical, etc.) within their administration. The extent of cross asset management is strongly dependent on the available information (performance indicators) but also from the number of pre-defined asset management processes in place.

As an output of the literature investigation of the European Asset Management Conference 2008 (Coimbra, Portugal) and the International Conference on Managing Pavement Assets 2008 (Calgary, Canada) it could be seen that many countries (road administrations) are using Pavement Management Systems, followed with a "big gap" by Bridge Management Systems. Almost no administration is using management tools for other assets. Thus, it is essential to know how and to which extent the different assets are management on pre-defined processes.

The following chapters should give an overview about existing cross asset management
procedures in those countries, which are strongly engaged within PROCROSS or which are being supported by at least one of the project partner in the field of asset management.

**Austria**

In Austria the federal road network is in the responsibility of the road operator ASFINAG organising asset management and maintenance planning. They are using different management systems for each sub-asset. For pavements (VIA PMS) the management system uses condition data and the prioritisation is done based on a cost/benefit analysis and LCA/LCC approach. For bridges, engineering structures (BAUT), noise barriers, tunnels etc. the ranking is done based on condition data (visual inspection and assessment). On a strategic level the ASFINAG has strategic requirements for maintenance planning matching its vision (e.g. permitted maximum number of congestion hours). The communication between the different asset management engineer/departments and parties is intensive and coordinated. A specific department for coordinative planning of all sub-asset maintenance activities exists. The budget requirements are based on a fixed key (to some extent) and for coordinated maintenance projects (including all sub-assets within a maintenance project). The level of cross asset management was self assessed on a 0 to 4 scale with 3 meaning intensive cross asset coordination and coordinative planning.

The Austrian Asset Management System is used for a net-wide objective maintenance planning process in consideration of different aspects and demands on different decision levels (project-level, network-level). It is applied on the whole motorway- and expressway-network of the ASFINAG.

The primary aim of the system is to allocate a comprehensive basis for an objective maintenance planning process of the following sub-assets:

- Pavements
- Bridges
- Tunnels and galleries
- Culverts
- Noise protection walls
- Retaining walls
- Gantries

To guarantee a high availability and road user-orientation the different management tasks are coordinated in this process.

The main elements of the ASFINAG Asset Management System are defined as follows (see Figure 8):

- Pavement Management System for the systematic maintenance planning of pavements
- Engineering Structure Management System for the systematic planning of bridges, tunnels, walls, etc.
- Management System for the coordination and execution of measures on sub-assets of the road infrastructure

The processes are defined in form of different sub-tasks which guarantee a holistic and sustainable execution of road maintenance.

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1 0-4: with 0 meaning no cross asset management and no coordination and 4 having cross asset optimization routines in use and a holistic cross asset planning process based on strategic requirements.
For the state road network the responsibility lies within the 9 member states’ road administrations. At least 6 Administrations are using similar procedures and approaches as the ASFiNAG with modifications addressing their specific needs and requirements. In all these cases cross asset management is based on engineering insight.

Finland

The remit of the Finnish Transport Agency extends to roads, rail and waterways. As it receives a single budget allocation which it must distribute amongst all of the asset classes under its control. The Maintenance Division is nationally responsible for Cross Asset Management activities. However, to date the distribution of maintenance budgets and allocation to sub-assets is still performed on the basis of individual calculated maintenance needs. In this regard, in discussion it was suggested that there is:

- a general, if not intensive, exchange of information about maintenance activities with some degree of coordinated planning communication with both individual planning for each sub-asset and follow up coordination of the construction programme and some degree of coordinated planning of maintenance activities for short- and medium-term construction programmes,

- Ultimately the current level of cross asset management exercised by the Finnish Transport Agency was suggested to be somewhere between: No cross asset coordination but an exchange of information between sub-assets and General cross asset coordination/adjustment with individual planning of maintenance needs of the different sub-assets. In this regard, in facilitating and encouraging cross-asset management, through its new management structure, it is ahead of many of its European contemporaries.

Germany

As far as possible based on the data situation in Germany since the mid-80's all road infrastructure assets (Table 1) were considered jointly in financial demand forecasts at the network level.
The results of financial demand forecasts for the road infrastructure assets of the Federal Trunk Road network are included in the “Requirement Plan” containing the future design of the Federal Trunk Roads. This Plan is part of the “Federal Traffic Infrastructure Plan (FTIP)” which, due to its political importance, must be adopted by the Federal Parliament (as Annex to the Law concerning the Development of the Federal Trunk Road Network). In context with the actual FTIP of 2003 a long term prognosis of the financial requirements for the maintenance of the Federal Trunk Road network has been set up for the period 2001 - 2015. As practiced in the prognosis of 1984 and 1991/92, complete road infrastructure assets were included. Object of the prognosis was the maintenance of these assets, including the part of the remodelling and development treatments of modernization, which are realized in connection with maintenance treatments (Maerschalk, Rübensam 2002).

Varyingly different and capable methods were inserted into the above mentioned prognosis estimation referring to the data availability. In the forecast of 2002 because of federation wide elevations of the planning and inventory data and regarding the actual traffic and condition data, with the Pavement Management System (PMS) an objective method could be applied to road pavement, which takes up the greatest part of the maintenance expenses. This method makes possible to get objectives prescriptions for different prognosis scenarios and contains a qualitative evaluation of maintenance treatment variants, so that not only the maintenance practice of the past would be actualized. Maintenance requirements for the structures were determined based on inventory and age with a limited scenario-enabled statistical strategy model, because then condition data were only partially available. The rest of the asset aggregates was treated with global methods like trend extrapolation and exit calculation.

For the carriageways quality scenarios have been considered with requirements for service quality for users and a continuous operator acting. Additional financial scenarios have been regarded to determine the effects of a prescribed financial management of the operator. The operationalization of objective functions was made by a user-oriented utility, which offers quality features in terms of performance and security (usability), and an operator-oriented asset value, which describes the requirements of the building stock in terms of a timely and cost-optimal operator action. For quality scenarios, the objective descriptions consisted in retaining of the national average of serviceability and economic value, as it was recorded around the turn of the millennium (status quo scenario), as in an improvement of these criteria to the 1990 level. The financial lines for the financial scenarios have been ascertained from different model images of the federal trunk road budget. Regarding the bridges, two scenarios with different maintenance intervals for bridge components have been regarded.

Currently, the financial demand forecast for the road infrastructure assets of the Federal Trunk Road network is updated. For structures a prototype of a Structure Management System (Bauwerks Management System BMS)” is used which is based on inventory, age and condition of structures components.

The link between the above summarized investigations on network level and actual programming and resource allocation decisions on project level is generally tenuous because state-of-the-art engineering, economic, and business practices are often not in place. Especially for Local Roads and District Roads, but as well mostly for State Roads and frequently for Federal Highways, decisions within and among asset aggregates tend to reflect tradition, intuition, personal experience, resource availability, and political considerations, with systematic application of objective analytical techniques applied to a lesser degree because of lack of availability, technical constraints related to data inputs, and theoretical understanding. For the above road categories success is often measured in terms of controlling backlogs, not in optimizing system performance, maximizing return on investment, or minimizing user impacts.

Existing management systems are applied on project level for Federal Motorways, in many
cases for federal Highways, and to some extent for State Roads. In a tactical rather than a strategic approach the existing management systems are limited to monitoring conditions and then plan and program their projects with the focus on one particular class of assets. The currently used systems are:

- The Pavement Management System (PMS).
- The Structure Management System (Bauwerks-Management-System BMS).

The PMS was developed in the mid-90's and is used in 11 area-states and in Berlin for the development of object-related maintenance programs of Federal Motorways and (partly) Federal Highways in connection with the "Guidelines for the Planning of Maintenance Treatments on Road Pavement ("RPE-Stra 01", FGSV 2001) since 2003. The PMS connects road allocation data, cross-sectional data, structure data (type, strength, installation year of layers), maintenance data, traffic data, and, as the main data group, pavement condition data.

Similar as the PMS the Structures Management System BMS should provide proposals of the type and timing of maintenance treatments on the basis of a condition forecast and an assessment of monetary benefits and costs (Holst 2006). Currently, the BMS is tested in a pilot application with structures in several states.

For other assets of roads (see Table 1) there are no procedures that include an evaluation and optimisation of maintenance treatments.

As some other countries, Germany currently has with a pavement and a structures management system the two most common elements that provide information into the Asset Management process. These management systems are focused on individual asset classes. As BMS was developed by bridge engineers, and PMS was produced by pavement engineers, there is little consistency with respect to investment decision procedures. As a result, these systems are not able to evaluate trade-offs between various classes of assets, in this case carriageway sections versus bridges.

As inter-asset evaluations are no yet possible a Federal Ministry of Transport demanded route presentation according RPE-Stra 01 (FGSV 2001) is a first still largely manual approach of a comprehensive object-related management of all asset classes. Limited on Motorways and on four planning years in this presentation is to be registered and coordinated location, type and cost of maintenance treatments of all road asset classes.

Figure 9 shows an overall view of this kind of route presentation. In addition to location and cross section information the top layer types of pavement are marked. Figure 10 shows enlarged the three blocks in which the treatments scheduled for the carriageways, the structures, and other assets of roads can be registered for four years.

The route presentation of Figure 9 is a small but an important first step in the direction of an object-based asset management system for road maintenance. Continuous work focuses on a better computer aided support for the creation of the route presentation (and the accompanying list). An application for other road categories, e.g. Federal Highways or State Roads, is currently not intended.
To initiate a further step towards asset management, in a research project (Pommerening,
Freitag, Maerschalk, Stadler 2007) models and procedures of the PMS and the BMS were compared. Main focus was:

- Analysis of procedures for the condition survey and evaluation of pavement and structures with a presentation of the similarities and differences.
- Suitability of procedures for condition forecast related with maintenance planning.
- Development of proposals of possible adjustments to the procedures.

The discussion of the results of this project at the appropriate boards is still pending. It can anticipated however, that, due to the differences, in closer future there will be no overall system for maintenance planning of pavement and structures, but independent subsystems of a PMS and a BMS.

Since an asset management system as a comprehensive system for pavement, structures, and other assets of roads seems out of reach at the moment and in the near future, a process-oriented approach to coordination is in the spotlight. Apart from the continuously required and accomplished activities to improve the subsystems, some major work packages for initialization and consolidation of an asset management process can be summarized as follows:

- Better coordination of the results of subsystems by utmost formalization with (interactive) computer aided support.
- Coordination of maintenance programs with programs of improvements (modernization) and extensions on the basis of a comprehensible procedure.

These compressed and generally addressed steps include an abundance of sub-problems, which to a lesser extent already begun or forethought resolutions will still take some time. The requirement for coordination necessitates for example ultimately that, in the long run, the evaluation processes are aligned as far as possible, e.g. for road sections and bridges, or even for maintenance investments and improvement investments. It will therefore be necessary to operate for longer periods with partly finished "compromise solutions" in implementing an asset management process.

**Slovenia**

In Slovenia for both motorways (DARS) and state and regional roads asset management of the road infrastructure is divided between pavement, bridge, tunnel and culvert structures. In recent years there is an attempt to extend management also to the high retaining walls with special emphases on ground anchors as the most influential element for the stability and safety of the retaining wall. The condition of the structure is obtained by regular and major inspections and based on these results maintenance activities are planned for a certain period of time. Road furniture is usually maintained separately when needed (e.g. replacement of damaged safety barriers due to the collision). Due to new safety requirements and higher safety standards for the safety barriers the old safety barriers are usually replaced with the new ones while resurface of the pavement is carried out. Maintenance activities are carried out separately for the motorway and other national roads, although there is some timing coordination between the projects from both maintenance administrations with the aim to avoid unpopular congestions. Asset management is individually structure oriented and at the moment there is no global view of the condition of all assets on the certain road section, which would direct maintenance activities for the whole road section.

**Switzerland**

In Switzerland motorways, expressways and mixed trunk roads are managed by ASTRA. As no representatives from cantonal roads and no PROCROSS partner is from Switzerland the
provided information is limited to this network and organisation. The ASTRA is using different management systems for each sub-asset including inventories, condition and loading. They organise asset management and maintenance planning. All sub-assets (pavements, engineering structures, noise barriers, tunnels etc.) are ranked based on conditions (worst first). No cost/benefit or LCA/LCC is used for the optimization. On a strategic level the ASTRA uses detailed strategic requirements for maintenance planning (e.g. 50km no other construction, 15km max. length, etc.). The communication between the different asset management engineer/departments and parties is intensive and coordinated which is done in the regional offices. The coordinative planning of all sub-asset maintenance is not organized within one single division/department but is dispersed over several offices. The budget requirements are based on coordinated maintenance projects (including all sub-assets within a maintenance project). The level of cross asset management was self assessed on a 0 to 4 scale\(^2\) with 3 meaning intensive cross asset coordination and coordinative planning.

### 3.3 What are the governing influencing factors for cross asset management?

An essential question in the context of cross-asset management is related to the governing influencing factors. As already described in the previous chapters the type and extension of cross-asset management is strongly dependent on the organisational structure of each national road administration, how the funds are allocated and finally how the different stakeholder expectations will be taken into consideration.

The following graph shows in a comparable form how the road administrations are generally organized and how the responsibilities are defined for asset management issues.

\(\text{Figure 11: General comparison of national road administration in the field of asset management}\)

\(^2\) 0-4: with 0 meaning no cross asset management and no coordination and 4 having cross asset optimization routines in use and a holistic cross asset planning process based on strategic requirements.
As a summary of interviews with the representatives of national road administrations the following governing influencing factors showed the main impact within cross-asset management:

- Minimizing cost of maintenance operation and optimal use of tax payers’ money.
- Economical optimal realization of maintenance investments and effective use of available funds.
- Avoiding unnecessary repetition of maintenance activities.
- Reducing negative effects on neighbours.
- Avoiding multiple road interventions/closures, increase availability and reducing user costs.

The implementation of strategic cross-asset management requirements is the consequence of these factors. To which extend or level cross-asset management will be applied in practice shows the following table, which is again based on the output of the interviews with representatives from 5 participating national road administrations. During these interviews the participants were asked to self-assess the level of Cross Asset management in their organisation. The results of this query (incl. Germany) are reported in Table 3.

**Table 3: Level of Cross Asset Management**

<table>
<thead>
<tr>
<th>Administration</th>
<th>CH (ASTRA)</th>
<th>FI (FinnRA)</th>
<th>AT (ASFiNAG)</th>
<th>DE (Federal Ministry of Transport)</th>
<th>SI (Slovenian Roads Agency / DARS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>3</td>
<td>3 - 4</td>
<td>3</td>
<td>X³</td>
<td>2 - 3</td>
</tr>
</tbody>
</table>

0 – No cross asset management or coordination
1 – No cross asset coordination but exchange of information between sub-assets
2 – General cross asset coordination/adjustment with individual planning of maintenance needs of the different sub-assets
3 – Intensive cross asset coordination and coordinative planning
4 – Cross asset optimization procedures in use; holistic cross asset management planning process based on strategic requirements and preconditions

The table shows, that the level of cross asset management could be found between 2 and 3 which means, that a general cross asset coordination will be carried out at least, but the majority executes an intensive cross asset coordination and coordination planning. Only FinnRA (FI) is starting with cross asset management procedures on strategic level in the context of a pilot project.

### 4 Summary

This deliverable reports on the findings of good practice in cross-asset management in Europe and covers the result of the 1st PROCROSS TAB workshop. It summarizes the work carried out by the PROCROSS partners together with National Road Authorities and Operators from 5 countries (Austria, Finland, Germany, Slovenia and Switzerland) at the TAB workshop and afterwards. The main topics of the workshop were: organisation of

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³ Due to the fact that no official representative from the German Road Authority was present at the 1st TAB workshop no self-assed value could be reported. The PROCROSS partners will use the 2nd TAB workshop to receive this information.
infrastructure asset management in different countries; whether there is any cross asset management procedure already effective; a set of common definitions in cross asset management, how organisational structure, network type, source of money and coordination among different maintenance work influences cross asset maintenance activities; and the identification of stakeholders’ objectives in cross asset management.

Interviews with the participating road authorities revealed that cross asset management of maintenance activities is already to some extent common practice in some countries (e.g. Finland, Austria, Switzerland, Germany). From these interviews the following governing influencing factors were deduced: Minimizing cost of maintenance operation; effective use of available funds; avoiding multiple road interventions/closures; increase availability and reducing user costs; and reducing negative effects on neighbours. The self-assessed level of cross asset management indicates the relevance of organisational structures, the network type and how maintenance work is funded.

Another objective of the workshop was to identify stakeholder objectives, therefore 6 stakeholder groups (Road Authority, Road Operator, Road Owner, Road User, Neighbour, Society) were defined and linked to the total road infrastructure. Their specific objectives were considered and then clustered in safety, costs, environment, availability and customer satisfaction (comfort). The remaining questions were: What cost function needs to be applied in optimisation (direct and indirect costs) to reflect these objectives; what weights are needed for this; how different kinds of benefits (e.g. societal) are valued or weighed. These items will as well be elaborated in the 2nd TAB workshop.
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Annex A: Interview - Template

<table>
<thead>
<tr>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisation</td>
</tr>
</tbody>
</table>

**How is your organisation structured (Graph)?**

**For which road types / categories are your organisation responsible?**
### How do you assess your different sub-assets according to maintenance needs?

<table>
<thead>
<tr>
<th>Sub-asset</th>
<th>Category?</th>
<th>What information is available?</th>
<th>Determination of maintenance needs?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement</td>
<td>Pavement</td>
<td>Inventory</td>
<td>No determination, just on demand</td>
</tr>
<tr>
<td></td>
<td>Engineering structures</td>
<td>Condition</td>
<td>Simply ranking based on condition or other information (worst first)</td>
</tr>
<tr>
<td></td>
<td>Road furniture and equipment</td>
<td>Loadings</td>
<td>Prioritization based on cost/benefit analysis and/or LCA/LCCA and/or optimization</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering structures</td>
<td>Pavement</td>
<td>Inventory</td>
<td>No determination, just on demand</td>
</tr>
<tr>
<td></td>
<td>Road furniture and equipment</td>
<td>Condition</td>
<td>Simply ranking based on condition or other information (worst first)</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>Loadings</td>
<td>Prioritization based on cost/benefit analysis and/or LCA/LCCA and/or optimization</td>
</tr>
<tr>
<td>Road furniture and equipment</td>
<td>Pavement</td>
<td>Inventory</td>
<td>No determination, just on demand</td>
</tr>
<tr>
<td></td>
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<td>Condition</td>
<td>Simply ranking based on condition or other information (worst first)</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>Loadings</td>
<td>Prioritization based on cost/benefit analysis and/or LCA/LCCA and/or optimization</td>
</tr>
<tr>
<td>Others</td>
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<td>Inventory</td>
<td>No determination, just on demand</td>
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<td></td>
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<td>Condition</td>
<td>Simply ranking based on condition or other information (worst first)</td>
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<td></td>
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<tr>
<td></td>
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<tr>
<td>Inventory</td>
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<td>Condition</td>
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<td></td>
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<td>Loadings</td>
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<td></td>
<td>Simply ranking based on condition or other information (worst first)</td>
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<tr>
<td>Loadings</td>
<td>Pavement</td>
<td></td>
<td>Prioritization based on cost/benefit analysis and/or LCA/LCCA and/or optimization</td>
</tr>
</tbody>
</table>
### What procedures for cross asset management are in use in your organization?

<table>
<thead>
<tr>
<th>Strategic cross asset management requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ No strategic advice</td>
</tr>
<tr>
<td>☐ General strategic requirements existing (e.g. minimize disturbance of users):</td>
</tr>
<tr>
<td>☐ Detailed strategic requirements existing (e.g. max. number of congestion hours):</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ No communication between the different asset management engineers / departments / parties</td>
</tr>
<tr>
<td>☐ General exchange of information about maintenance activities, but no coordinated planning communication</td>
</tr>
<tr>
<td>☐ Intensive exchange of information about maintenance activities; coordinated planning communication</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ No department or division for cross asset management/coordination within the organisation</td>
</tr>
<tr>
<td>☐ Department and/or division for cross asset management/coordination existing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Planning of maintenance activities for short- and medium-term construction program</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Individual planning for each sub-asset and no coordinated construction program</td>
</tr>
<tr>
<td>☐ Individual planning for each sub-asset and following up coordination for the construction program</td>
</tr>
<tr>
<td>☐ Coordinative planning of all sub-asset maintenance activities</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Budgeting and budget allocation to sub-assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Distribution of maintenance budget based on a fixed distribution key</td>
</tr>
<tr>
<td>☐ Distribution of maintenance budget based on the calculated individual maintenance needs</td>
</tr>
<tr>
<td>☐ Total budget for coordinated maintenance projects (total maintenance needs of all sub-assets within a maintenance project)</td>
</tr>
<tr>
<td>☐ Others:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level of cross asset management</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ 0 No cross asset management and no cross asset coordination</td>
</tr>
<tr>
<td>☐ 1 No cross asset coordination but exchange of information between sub-assets</td>
</tr>
<tr>
<td>☐ 2 General cross asset coordination/adjustment with individual planning of maintenance needs of the different sub-assets</td>
</tr>
<tr>
<td>☐ 3 Intensive cross asset coordination and coordinative planning</td>
</tr>
<tr>
<td>☐ 4 Cross asset optimization procedures in use; holistic cross asset planning process based on strategic requirements and preconditions</td>
</tr>
</tbody>
</table>