Active Traffic Management – innovatie op de Engelse M42 snelweg

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Inhoudsopgave

Samenvatting

Active Traffic Management – innovatie op de Engelse M42 snelweg

Active Traffic Management (ATM) gebruikt een aantal technologieen op de M42 snelweg rond Birmingham om de capaciteit te vergroten, en hopelijk de noodzaak tot verbreding the vermijden. Het project wordt beschouwd als een pilot studie, en een belangrijk onderdeel van het project is een voor- en na-studie, die moet informeren of en hoe ATM elders op het Engelse snelwegennet kan worden toegepast.

In de paper wordt een beschrijving gegeven van het project. We discussieren de karakteristieken van ATM in het algemeen en de implementatie die invloed hebben op de manier waarop alle impacts van het project kunnen worden bepaald, in zijn totaliteit maar ook van de individuele componenten (Operational Regimes).

Een literatuurstudie leidt tot de conclusie dat nooit eerder een soortgelijk project is geevalueerd op dezelfde schaal, en daarom wordt een monitoring framework ontwikkeld dat tracht op statistisch robuuste wijze met alle onzekerheden om te gaan.

Summary

Active Traffic Management – innovation on the English M42 Motorway

The aim of the ATM Pilot is to bring together a number of technologies to demonstrate how they can be used in parallel to make better use of existing road space, thus providing additional capacity, possibly reducing the need for widening. An important component of the study is monitoring the before and after situation, to inform the potential future implementation of ATM elsewhere on the motorway network.

A literature study has not identified any similar monitoring studies on the same scale as implemented for the M42 ATM Project, and hence a monitoring framework is developed from scratch. The framework is based around indicators that reflect the objectives of the scheme and the Highways Agency overall, and deals in a statistically sound way with all the uncertainties involved in the monitoring process.

1. Introduction

In July 2001, John Spellar, the former Minister for Transport, announced that the Active Traffic Management (ATM) Project would be piloted on a section of the M42 corridor between junction 3a and 7, to the south-east of Birmingham. The ATM scheme is scheduled to go live next year with the innovative traffic management measures (Operational Regimes) being introduced in a phased manner.

- This section of motorway is 17km long
- There will be over 50 gantries
- There will be over 250 advance motorway indicator signs on the gantries
- There will be 41 emergency refuge areas
- Well over 120,000 vehicles use this section of motorway every day
- 28% of traffic leaves the M42 at junction 7 to join the M6

The aim of the ATM Pilot is to bring together a number of technologies to demonstrate how they can be used in parallel to maximise their benefits. Using a combination of existing tried and tested technology, infrastructure and procedures, along with a pilot of a number of new and innovative concepts, ATM aims to make the best use of existing road space, thus providing additional capacity possibly reducing the need for widening.

ATM could be regarded as a 'tool-box' of technologies and procedures, which can be used separately or in combination to provide solutions to particular problems. Each potential application will have to be reviewed for the most appropriate 'tools' to be used to solve the problems of the location.

2. Scheme Description

A number of potential locations were assessed for the possible benefits that ATM could bring to the area.

The M42 between junctions 3a and 7 was chosen because of its strategic importance to the Midlands area in distributing local and national traffic, providing a link between the M40 and M6 motorways. This route also serves the National Exhibition Centre (NEC) and Birmingham International Airport, not to mention the business parks and busy residential areas also along this corridor.

This route is also a particularly good site to trial ATM due to local issues, such as:

- High flows on both carriageways
- Relatively high accident rate, particularly between junction 5-6
- Merge and diverge congestion points
- Problems associated with major events at the NEC, Birmingham International Airport and Birmingham International train station
- Future growth in the area

The M42 ATM will incorporate the following features where appropriate:

- Lightweight gantries with lane-specific signals (Advanced Motorway Indicators) and signs (Advanced Motorway Signs), which are the next generation of variable message signs. These can be used to open and close lanes, control speeds to prevent flow breakdown, and to provide enhanced driver information
- CCTV cameras to monitor traffic conditions and automatic queue detection (MIDAS - Motorway Incident Detection Automatic Signalling) to detect queuing traffic and set warning signals
- Digital speed enforcement equipment
- Rapid incident response teams to remove obstructions, assist with traffic management and repair roadside equipment
- A form of access management may be employed, which could allow traffic to join the motorway in a controlled manner

- Controlled use of the hard shoulder as an additional running lane for incident management and during periods of congestion
- Emergency Refuge Areas, for use in case of breakdown, and equipped with emergency telephones, automatic detection loops, lighting and monitored by CCTV

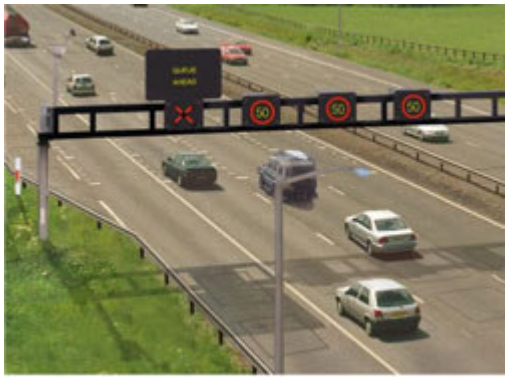
3. How Will it Work?

Drivers will experience Active Traffic Management mainly through the use of signals on the overhead gantries. The signals will be driven by a number of Operational Regimes (ORs), which will become active when triggered by certain traffic conditions. The Operational Regimes encompass the following:

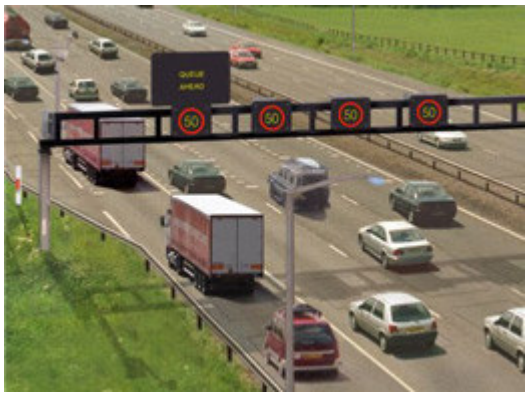
- Variable Speed Limits (3-Lane VSL)
- Hard Shoulder Running (4-Lane VSL)
- Exit Queue Management (using the hard shoulder as a queuing lane on the approach to a junction)
- Lane Control (during incidents and maintenance)
- Access Management (controlling on-ramps)
- Lane Marshalling (lane designation by destination)
- Designated Vehicle Lane (hard shoulder availability to e.g. buses and coaches)

Of these the first two are expected to be introduced first, and to provide the greatest benefits. Other ORs may be introduced later.

Normal Motorway - When traffic is free-flowing and there are no incidents, there is no need for signal intervention to control speeds or lane availability. During this state all signals on the overhead gantries will be blank, national speed limits should be observed and the hard shoulder will be available for emergency use only and will provide access to the Emergency Refuge Areas.



3 Lanes Variable Speed Limits - As traffic flows increase, or in response to an incident, clear instructions will be given via the overhead signs and signals. The first thing a driver on the motorway will notice is that the message signs display a message such as 'Caution Queue' or 'Caution Accident'. The signs and overhead signals will be used to warn of congestion ahead, control speeds and lane availability. Speed restrictions must be obeyed and a red cross above a lane indicates that the lane is not in use. Drivers should move into the lanes available for use. A red cross above the hard shoulder indicates that this lane is not available as a running lane and the hard shoulder will be available for emergency use only and will provide access to the Emergency Refuge Areas.



Hard Shoulder Running - Controlled use of the hard shoulder will be used to provide additional capacity during periods of congestion and in case of incidents. The hard shoulder will only be available for use between junctions and its status will be indicated by the provision of a signal over the hard shoulder. During hard shoulder running there will be a maximum speed limit of 50mph across all lanes, and prior to opening the hard shoulder the ATM operator will put in place a number of checks to ensure that the hard shoulder is free of obstructions, vehicles, pedestrians and debris. Emergency Refuge Areas will be available for broken down or stranded vehicles.

4. The Need for Monitoring

The anticipated benefits of the ATM Pilot include the following:

- Reduced congestion through more efficient use of the road space
- Faster response to incidents and reduced incident clear up time
- Reduced impact of incidents
- Enhanced driver information

- More reliable journey times
- Safety benefits
- Reduced driver stress

Before and after monitoring and assessment is being carried out to establish the effect of ATM on a range of factors including traffic conditions, accidents and environmental factors. From this information a business case can be developed and this could inform decisions on the use of ATM elsewhere on the Strategic Road Network.

There are a number of issues affecting the complexity of the monitoring exercise:

- The introduction of ATM and its components takes place over a long period of time. Construction was started in the Summer of 2003, and the first Operational Regime, 3-Lane Variable Speed Limits, is expected to become operational early next year. The other ORs will come on line as part of a phased programme over a number of months or years. Hence, the before and after situation themselves are far removed, and in the monitoring the exogenous changes in the traffic system in the intervening period must be accounted for.
- Some of the changes in observable traffic conditions due to ATM will be quite small, whilst the exogenous changes in the traffic flows may be substantial. For example, motorway traffic has grown by about 45% in the ten years between 1993 and 2003 (DfT, 2004a), and the number of airport passenger movements in the West Midlands (mainly focused on Birmingham Airport)) has increased by more than a third between 1997 and 2002 (DfT, 2003). Such changes illustrate the impacts of a lapse of 2 or more years between the before and after situation, and the importance of accounting for this in the monitoring approach.
- There is substantial day-to-day variability in traffic conditions (flows and speeds), which may well exceed the differences in traffic conditions that ATM will effect (see figure 1 for an example). In addition, many of the measuring instruments have random errors attached, for example due to the sampling procedures used, or the characteristics of equipment employed. A statistical framework must be developed to handle these uncertainties.

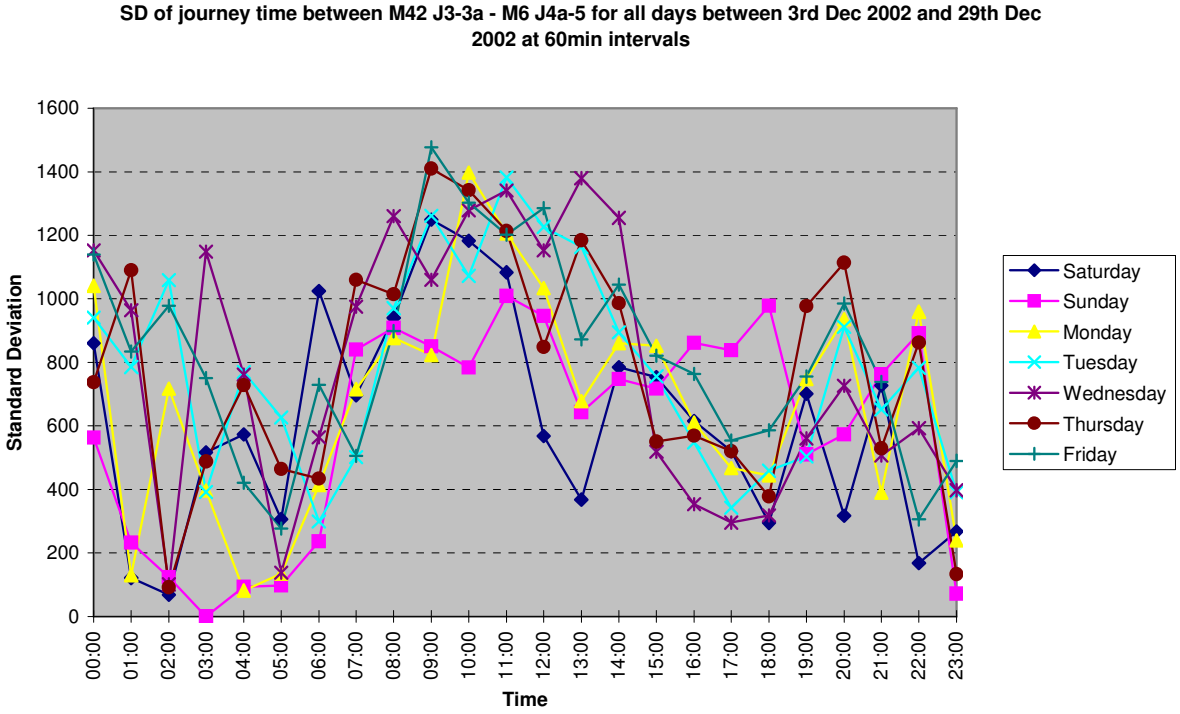


Figure 1: Example of observed variability in journey times along M42 ATM section

- The impact of ATM will not be limited to the instrumented part of the M42 only – we anticipate changes in traffic flow and route choice in the rest of the Motorway network, and also roads further down the hierarchy. However, the scale of impacts is expected to be reduced further away from the scheme, whilst also the time period needed to observe such changes may be longer than for the immediate impacts on the instrumented M42 stretch.
- The Operational Regimes will be implemented and fine-tuned over time. Their effect on traffic conditions may therefore be expected to change. Also, when subsequent ORs come on-line, there may be (positive or negative) interaction between the measures.
- Although ATM will be continuously operational on the M42, not every OR will be active at any one time. When ORs are active, they may give drivers different information, for example different advisory or mandatory speed limits. In other words, during operational ATM there will be a range of system states, determined by, among others, the traffic conditions at the time.
- The monitoring exercise has access to a wide range of data sources, with varying levels of reliability: inductive loops at 500m intervals (100m intervals in the after

situation), automatic numberplate recognition cameras (ANPR), automatic traffic counts (ATC) on the Motorway and the surrounding network, GPS-based floating vehicle data, air quality and noise monitoring data, safety/accident data, CCTV footage and more. In addition, extensive user and non-user survey have been carried out.

- These data sources are used (independently or in combination) to create indicators (before and after) which relate to the Highways Agency's objectives for the ATM Project, separating primary indicators (directly related to the objectives) and secondary indicators, which serve as proxies for any of the objectives – see tables 1 and 2.

Table 1: Indicators developed for the M42 ATM Monitoring Project

Primary indicators	**Secondary indicators**
P1: Mean journey times	S1: total time speed less than 25 mph/50 mph
P2: variability in journey times	S2: number of occurrences speed less than 25 mph/50 mph
P3: throughput and peak throughput	S3: mean time speed less than 25 mph/50 mph
P4: number & severity of accidents	S4: lane utilisation
P5: environmental pollutants levels	S5: weaving
P6: noise levels	S6: swooping
P7: emissions and fuel consumption	S7: queue lengths
	S8: speed limit compliance
	S9: driver stress
	S10: vehicle speed distribution
	S11: speed differential between lanes
	S12: proportion of critical headways
	S13: stop-start behaviour
	S14: safety of maintenance personnel
	S15: variability of queue length and time on sliproads
	S16: Speed of attendance at incidents
	S17: Delay per hour/day
	S18: Travel pattern changes

Table 2: Use of indicators to monitor scheme objectives

Objective	Primary Indicator	Secondary Indicator
Improve safety	P2, P4	S4, S5, S6, S8, S9, S10, S11, S12, S13, S14
Reduce congestion and delay	P1, P2, P3	S1 S2 S3, S7, S11, S13, S17, S18
Provide more reliable journey times	P2	S10, S15
Reduce the impact of accidents/incidents	P1, P2, P3, P4	S1, S2, S3, S4, S10, S11, S12, S13, S14, S16
Reduce emissions	P5, P7	S1, S2, S3, S7, S8, S10, S13, S15
Enhance driver comfort	P1, P2, P3, P4, P6	S1, S2, S3, S5, S6, S7, S8, S9, S10, S11, S12, S13

As a result of these complexities, a statistical monitoring framework has been developed. The framework needs to deal with the problem of identifying the effects of ATM and its component Operational Regimes in an environment that itself contains considerable variability, and which will change (to an unknown extent) exogenously from the before situation.

5. Monitoring Framework

A brief literature review of previous experience in evaluating ATM (Grant-Muller, 2003) has been carried out with the following objectives:

- To find evidence on any guidelines that are currently in place for the assessment of ATM projects
- To find evidence of practical implementation of schemes similar to the M42 project and in particular on the assessment methodology used, indicators and similar information of relevance

In terms of the scope of the review, a distinction has been drawn between the following types of study:

- Appraisal – defined as ex-ante study of transport schemes, eg the comparison of the costs and benefits of two or more alternative schemes prior to implementation
- Assessment – defined as the monitoring and judgement of a scheme as it is implemented

- Evaluation – defined as the ex-post study of a scheme following implementation

Within the M42 ATM project the emphasis is on assessment and ultimately evaluation of the success of the technology, therefore the literature review has focused on these two types of study. Two types of sources were identified as being of relevance to the M42 ATM. These were firstly examples of specific implementations and trials and secondly examples of assessment guidelines or methodologies (sometimes arising out of specific implementations). The findings are summarised below. The monitoring exercise will be guided further by the UK Department for Transport's Guidance on the Methodology for Multi-Modal Studies (GOMMMS), (DfT, 2004b).

Table 3: Previous experience of ATM-type monitoring

Guidance Source	**Document reference**
HA guidance on the assessment of ATM	
FITS	Viking Guidelines for the evaluation of ITS projects
CONVERGE	CONVERGE deliverable D2.3.1 CONVERGE deliverable D2.4.1
DIATS	DIATS Final report DIATS deliverable 17

Implementation example	**Document reference**
TABASCO	Final Evaluation and Exploitation Plan. Deliverable 10.3
DACCORD	Telematics 2C: TR1017
Monitoring of M25 controlled motorways	42553/Doc/2514, issue A (2003) 42553/Doc/2503 issue B (2002)
EAVES	DRIVE II: V2020
INVAID II	DRIVE II: V2015

- The sources of assessment guidelines tended to be generic and to focus on the process of assessment rather than specific recommendations on a core set of indicators for example. This is possibly a result of producing guidelines that are intended to cover a very wide range of possible instruments and application contexts.
- Some guidelines merged the process of assessment with evaluation and took the process of setting objectives, indicators and measurements onwards to Cost Benefit Analysis and Multi Criteria Analysis.

- Other ATM implementations tended to be of a less complicated nature than that of the M42, ie a single or smaller number of instruments generally introduced simultaneously.
- It was possible to gain evidence on specific performance indicators that had been used for some implementations. In general these were consistent with those proposed for the M42 project. It was interesting to note that user acceptability/perception was given a strong role in most assessments with questionnaires being the most common means of assessing this.
- In all cases, results were provided as simple statistics, graphs etc showing values before and after implementation together with interpretation of these. To date little evidence of formal statistical testing has been found, but this may exist in unpublished documents.

The M42 ATM assessment framework has been informed by this previous research, and guided by the issues described in Chapter 4. The principles are logical, and illustrated further in a process chart in Figure 3:

1. Identify appropriate indicators
2. Derive a sample frame
3. Establish as accurate as possible a base assessment
4. Determine as accurate as possible a projected 'do-nothing' (reference or counterfactual) case
5. Identify sources of inherent structural variability
6. Develop scenarios around the structural variability (daily/monthly variation, state of OR, weather, incidents, etc)
7. Analyse and interpret changes in indicators for each scenario, allowing for remaining random variability

Key issues to mention are:

- Indicators are determined by the objectives of the scheme, and the Highways Agency overall, with further influence of the ultimate appraisal requirements
- Uncertainty is explicitly recognised, and reduced by the use of scenarios

- Scenarios are being developed based on before data analysis. It is anticipated that things such as weather, events and incidents will affect traffic conditions such that explicit scenarios can be developed. Alternatively, we will investigate the use of cluster analysis, to identify scenarios with minimum internal variability and maximum variability between scenarios.
- The effectiveness of ATM (or individual ORs) will be established for each of the scenarios – a further procedure must be developed to generalise the results for input into the business case – for example, annualisation accounting for the frequency of occurrence of each of the distinguished scenarios.
- Network modelling plays an important role. In the first place, to estimate the counterfactual, i.e. what would have happened if the ATM Project had not been implemented, and secondly to generalise the observed findings over a larger study area, as input to appraisal. However, introduction of this modelling element introduces uncertainty in itself – as illustrated in figure 2.

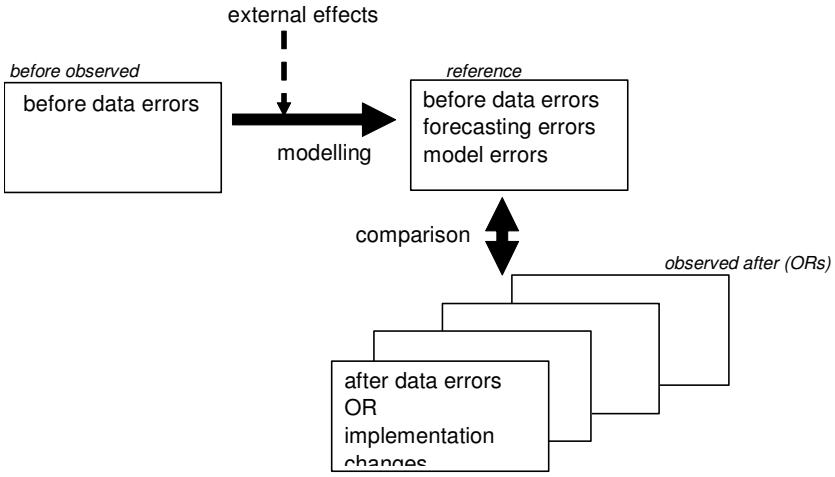


Figure 2: Role of network modelling, and impact on uncertainty

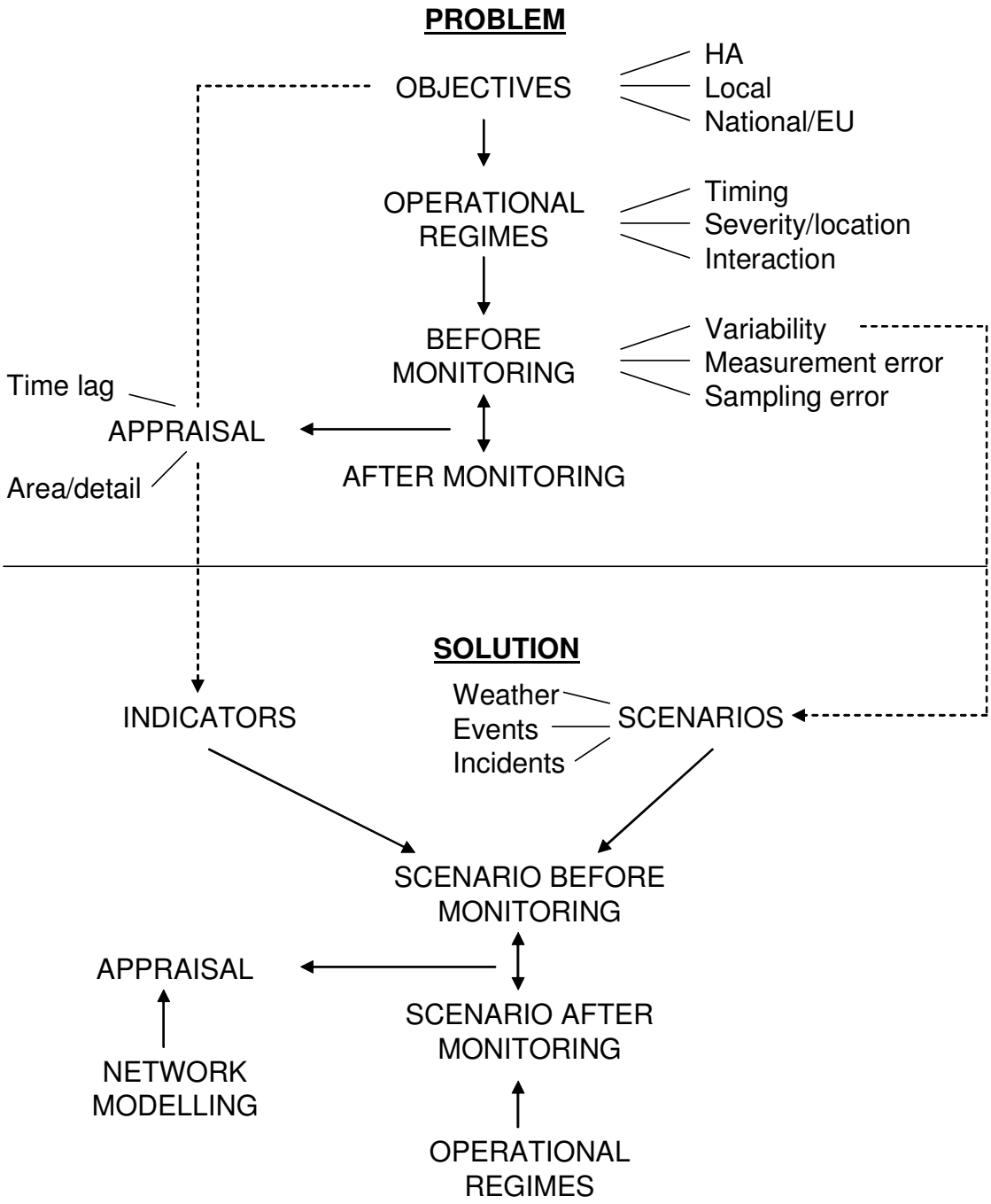


Figure 3: M42 ATM Monitoring Framework

6. Conclusions

The M42 Active Traffic Management Pilot is one of the most comprehensive implementations of Adavanced Traffic Telematics in the world. The scheme aims to bring together a number of technologies to demonstrate how they can be used in parallel to make better use of existing road space, thus providing additional capacity, possibly reducing the need for widening.

An important component of the study is monitoring the before and after situation, to inform the potential future implementation of ATM elsewhere on the motorway network. The monitoring approach has been developed to be able to:

- Make use of a wide variety of data sources, directly related to traffic but also of e.g. environmental conditions, weather, and the status of the surrounding network
- Reflect the statistical reliability of each of the data sources
- Increase statistical robustness of the monitoring exercise by identifying sources of structural variability and building scenarios around these
- Make use of network modelling approaches to deal with the long implementation time and hence lapsed period between the before and after situation

The M42 ATM scheme is innovative in the technical contents of its implementation. In addition, it is supported by an innovative monitoring approach which may be of value in future applications, where possibly small changes in traffic conditions must be determined in a continuous, dynamic and evolving transport system.

7. References

DfT (2003) Regional Transport Statistics 2003, London, HMSO, November 2003

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