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C.A.S.H.
Connecting Authorities for Safer Heavy Goods Traffic in the Baltic Sea Region

STATE-OF-THE-ART TECHNOLOGY TO CONTROL HEAVY GOODS VEHICLES FROM POLICE PERSPECTIVE

Chief Inspector Jarmo Puustinen

National Traffic Police of Finland

Baltic Sea Region
Programme 2007-2013

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EXECUTIVE SUMMARY

As part of the C.A.S.H. project, the Finnish National Traffic Police and the traffic monitoring equipment working group appointed by the National Police Board have been surveying and testing traffic monitoring equipment, applications, and technological solutions suitable for the monitoring of heavy goods transport.

The investigators went on two fact-finding missions to trade fairs, to Birmingham in spring 2011 and to Amsterdam in spring 2012. They also acquired information on automatic traffic monitoring and its latest applications in the monitoring of heavy goods transport. The most important benefits of the trade fair visits were being introduced to the most recent surveillance technology, making contact with equipment suppliers, and bringing suitable devices back for testing in field conditions. These days, establishing contact with equipment suppliers and conveying the requests of the monitoring authorities to them are of key importance in the early stages of the development of new devices.

The monitoring of heavy goods transport and its loads, including weight control, is a key challenge of effective police work. Overloading, for instance, has a multitude of knock-on effects on the traffic environment that are not always immediately apparent.

Overloading presents a safety risk in the form of tyre failures, obstruction of other traffic, and unstable driving, thereby compromising road safety.

Road damage results, in the form of rutting, causing running-off-road accidents, and shortening the effective life span of the road surface. Road repairs necessitated by increased road damage involve work sites, temporary changes to lanes, and hence a higher risk of accidents in these areas. Traffic congestion leads to increased emissions, tailgating, frustration, near misses, and higher fuel consumption. Environmental impacts, with increased emissions and energy consumption, include exacerbation of the greenhouse effect. Economic

impacts include unfair competition, causing losses to operators who operate within the bounds of the law.

The present report includes key observations on the latest technology and the key monitoring equipment tested in the course of the project.

DESCRIPTION OF C.A.S.H. PROJECT

This study is part of the C.A.S.H. project - Connecting Authorities for Safer Heavy Goods Traffic in the Baltic Sea Region. The C.A.S.H. project is part-financed by the European Union (EU) (European Regional Development Fund) through the Baltic Sea Region Programme 2007-2013. To find out more about the programme, visit http://eu.baltic.net/.

In the following, the project and its regional partners will be described.

Project introduction – C.A.S.H.

The C.A.S.H. (Connecting Authorities for Safer Heavy Goods Traffic in the Baltic Sea Region) project aims at developing practical solutions to make international road freight transport safer, more predictable and affordable in the Baltic Sea Region (BSR). The project intends to do this by:

- improving cooperation between authorities
- harmonizing training of inspection officials
- testing safety equipment and IT systems to be used by relevant authorities

The C.A.S.H. project is due to run for three years, from September 2009 to September 2012. The project will benefit not only the authorities inspecting the traffic through harmonized practices, but logistics business as a whole. The project is co-ordinated by Turku School of Economics in Finland, as part of University of Turku.

The C.A.S.H. project partnership is made up of 13 organisations in eight countries around the BSR (Figure 1), including:

- police and other authorities dealing with road traffic safety
- regional councils
- research institutes

The locations of the C.A.S.H. partner organisations and countries

With about one million road haulage companies in Europe and over 560,000 million tonne kilometres of goods transported annually on the roads of the BSR, road freight transport is big business.

Despite similar regulations, authorities in European countries may apply different practices and equipment to inspect the traffic. This puts additional pressure on road haulage companies which have to comply with regulations when they are already facing the challenges of a very competitive market.

In addition, more than 1,300 fatalities involving a heavy goods vehicle took place in the BSR in 2007, equal to 10 % of all accidents.

This is why 13 organisations from eight countries in the Baltic Sea area created the C.A.S.H. project. The project brings together police officers and other authorities inspecting Heavy Goods Vehicles (HGV) in the Baltic Sea area in order to spread good inspection practices across the region.

To find out more about the project and the different work packages, as well as a list of the participating countries and organisations, please visit the project website www.cash-project.eu.

Partner introduction

- *Danish National Police, National Traffic Center, Denmark*
- *Hamburg University of Technology (TUHH), Germany*
- *Hamburg Waterways Police, Germany*
- *Latvian Transport Development and Education Association, Latvia*
- *National Police Board, Sweden*
- *Norwegian Mobile Police Service, Norway*
- *Personal Protection and Law Enforcement Police / Traffic Supervision Division, Estonia*
- *Police of Finland, Finland*
- *Regional Council of Kymenlaakso, Finland*
- *Regional Council of South Karelia, Finland*
- *Regional Council of Southwest Finland, Finland*
- *Turku School of Economics (University of Turku), Finland*
- *University of Turku, Finland*
- *Vilnius Gedimino Technical University (VGTU), Lithuania*

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1 AUTOMATED HEAVY GOODS TRANSPORT SPEED MONITORING

In most cases (as in Finland), automated speed monitoring involves in-roadway sensors, i.e. sensors embedded in the road, which measure wheel bases and thereby distinguish between types of vehicle. In practice, it has been found that this technology does not always work, with one problem domain being distinguishing between coaches and heavy goods vehicles. Also, radar-based monitoring cannot distinguish between types of vehicle on its own; assistive equipment is required.

In the course of the C.A.S.H. project, WP5 participants acquainted themselves with various automatic speed monitoring applications, with specific reference to heavy goods transport. The most promising system was that being tested in Basel, Switzerland, where modern camera technology and IT were used to distinguish between vehicle types. A separate report was compiled on this fact-finding trip, and its key points are summarised in the present paper. For more about this system, see http://www.news.admin.ch/NSBSubscriber/message/attachments/25821.pdf.

The section control measurement system was presented to us by Volker Fröse, the project manager of the pilot project. He said that we were the first group to whom the system was presented on this scale.

The section control measurement system was installed in Arisdorf Tunnel, on the A2/E25/E35 road in Basel. This system was introduced in test use in January 2011 and entered production use in May 2011. The system records 80 to 100 speed violations per day.

The motorway has two lanes in each direction. The section control measurement system was installed for only one direction on the motorway. The tunnel consists of twin tunnels, one in each direction, each with a variable speed limit of either 80 or 100 km/h. The control section begins before the tunnel entrance and ends immediately after the tunnel exit. Vehicle registration plates are scanned from the rear at the beginning and the end of the section. Vehicles exceeding the speed limit are photographed from the rear and from the front, with driver identification immediately after the end of the control section.

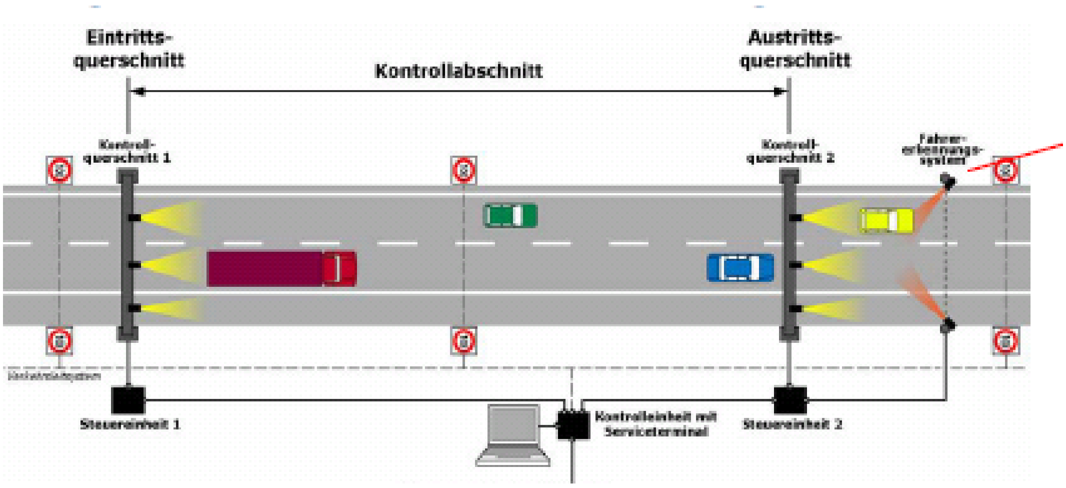

Figure 1 Principle of the travel time measurement.

Figure 2 The vehicle's registration plate is scanned at the beginning and end of the measurement, after which the vehicle is photographed from the front to identify the driver and for comparison of the registration plate to the image scanned from the rear.

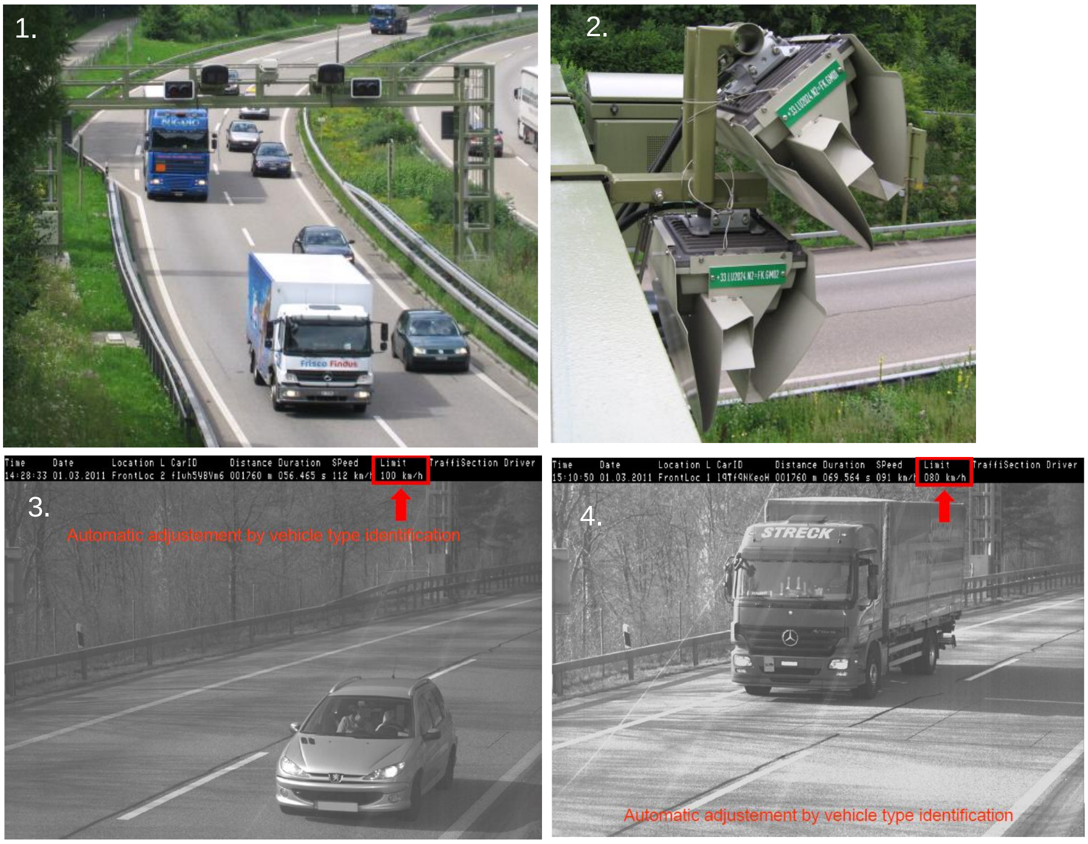

Figure 3 Image series. Small images 1 and 2 show the equipment used (Image 1: equipment gantry; Image 2: vehicle type identification laser). Images 3 and 4 are vehicle images taken by the system after measurement of average speed.

The beginning and end portals of the control section have separate cameras for both lanes, to scan vehicle registration plates from the rear, and an infrared light for illuminating registration plates for low-light photography. Two lasers are used for vehicle type identification, installed at different angles in the portal (see Figure 3, image 2). One laser points directly down, while the other is at a 45° angle. Vehicles return different signal patterns by virtue of remaining under the laser beams for varying amounts of time. Vehicle types can be identified and their maximum permissible speed determined on the basis of the signal returned – e.g., car vs. HGV. At the end of the control section is a camera installation that takes front and rear photos of vehicles exceeding the speed limit.

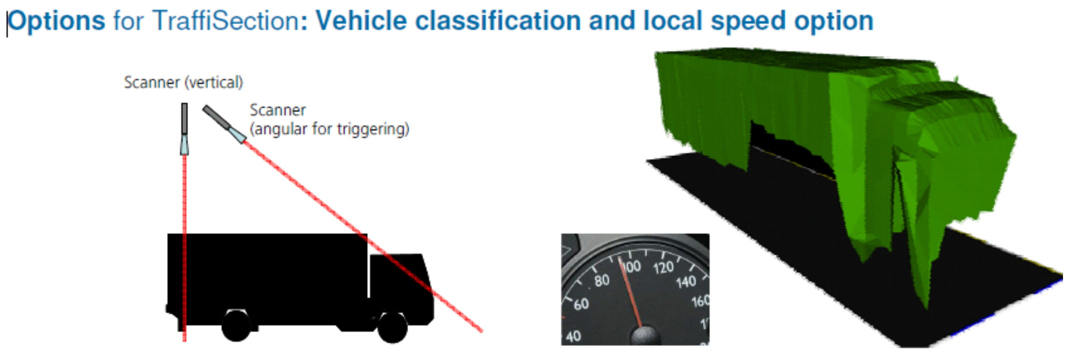

Figure 4 Laser scanning returns an image on the basis of which the vehicle type can be identified and its maximum permissible speed determined.

The control section has variable speed limits. The speed limit displays are continually monitored with video cameras at three locations, to ensure that the displays have been showing the correct maximum speed. All camera equipment is synchronised with the same clock over cable connections.

The registration plate of every vehicle is scanned at the beginning and the end of the control section, and the registration number is encrypted to generate a name for each image file. The beginning and end image file pair is retrieved at the end of the control section, and if the timestamps of the files indicate that the vehicle has exceeded its maximum permissible speed, the vehicle is then photographed so that the driver can be identified. The time available for performing the calculation and determining whether to photograph the vehicle after the end of the control section is 0.4 seconds. For every vehicle that has been driving within the speed limit, all material collected is immediately deleted.

In cases of violation, the images and data are assembled into a case file that is forwarded to the police. The case file includes images of the vehicle entering and leaving the control section and also the photo of the vehicle, driver, and registration plate taken from the front. The case file further includes timestamped images of the speed limit displays from three locations, to show that the current speed limit was being correctly displayed.

The system is able to distinguish between these vehicle types: car, car + trailer, HGV, HGV + trailer, and others. When the general speed limit is 100 km/h, the system is able to apply the speed limit of 80 km/h for HGVs automatically. Unfortunately, however, the system still has difficulties in distinguishing between coaches and HGVs (50% certainty). The system is being further improved for the next test period.

A separate office software application has been acquired for processing cases from this system in Switzerland, linked to the vehicle registers in Switzerland, Germany, and France. Case files can be automatically retrieved from the server. The speed limit violation tolerance deduction in Switzerland is 6 km/h, while in Finland, for instance, it is only 3 km/h.

2 AUTOMATED HEAVY GOODS TRANSPORT WEIGHT MEASUREMENT

In the course of the C.A.S.H. project, WP5 participants acquainted themselves with the latest technologies used to weigh HGV loads. One of the leading systems in this field is the one tested in the ASSET project in Rosenheim, Germany, with specific reference to heavy goods transport. A separate report was compiled on this fact-finding trip, and its key points are summarised in this paper. For more information on this system, see http://www.vtt.fi/files/news/2010/asset/3_roc.pdf.

A drive-over checkpoint was built on a motorway lay-by in Rosenheim. This is intended mainly for HGVs but may later be used for inspection of lighter vehicles too.

A separate speed measurement system using KRIA 3D speed cameras was installed on the motorway before the checkpoint to measure the speeds of passing vehicles via video technology (see Figure 5). The system sends a real-time video feed to the control room at the checkpoint in the lay-by, and vehicles that exceed the speed limit are automatically flagged for attention. One of the two KRIA cameras was mounted near the in-roadway weight in motion (WIM) sensor (see Figure 6). On the basis of screening or registration plate data, flagged vehicles are pulled out of traffic and into the lay-by by police, by traditional means (see Figure 7).

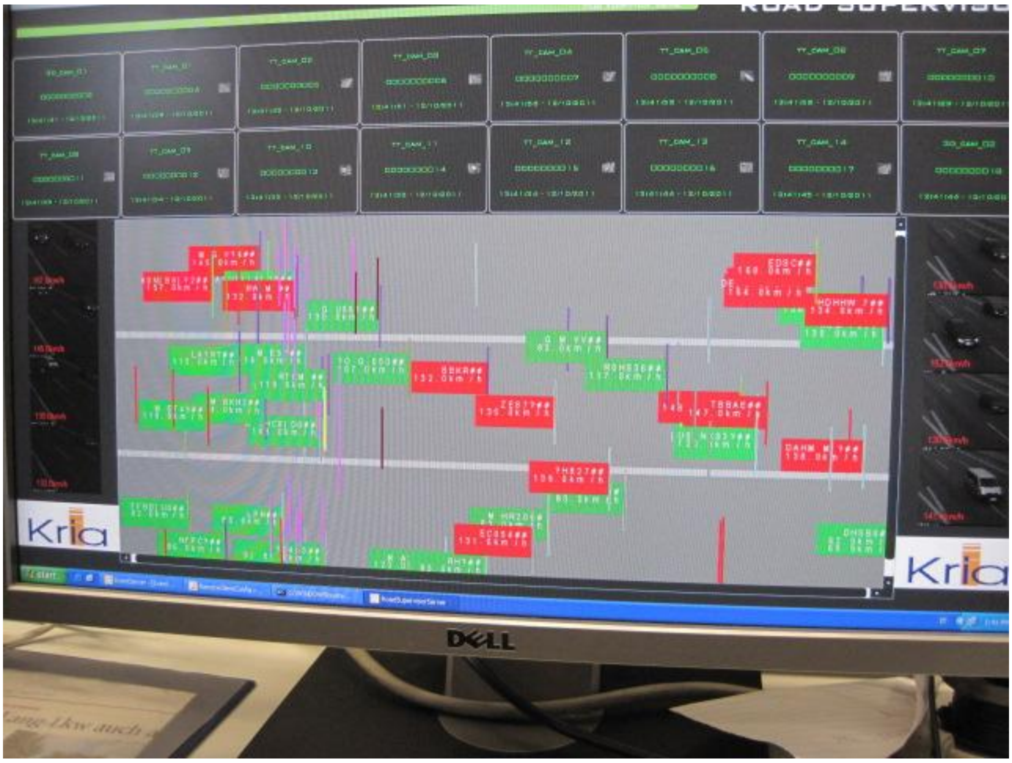

Figure 5 A separate speed measurement system using KRIA 3D speed cameras was installed on the motorway before the checkpoint to measure the speeds of passing vehicles via video technology

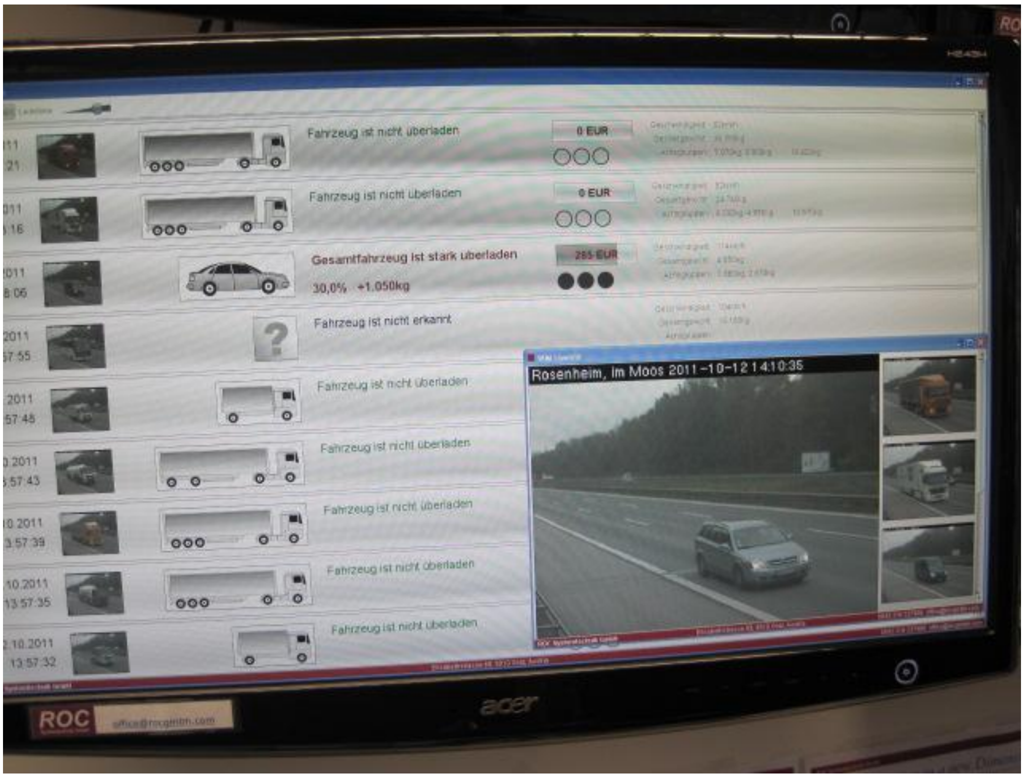

Figure 6 One of the two KRIA cameras was mounted near the in-roadway weight in motion (WIM) sensor

Figure 7 On the basis of screening or registration plate data, flagged vehicles are pulled out of traffic and into the lay-by by police, by traditional means

At the checkpoint, the vehicle is first guided over equipment that measures tyre tread depth. The checkpoint consists of a 50-metre lane and an adjacent control room (portacabin). Various sensors to measure vehicles for the data required are installed along the checkpoint lane. The data from the sensors and equipment along the lane are fed to the screens in the control room, viewed by a police officer. Drivers of vehicles that exceeded the tolerance threshold are requested to step into a police vehicle at the checkpoint. A traffic signal is used to admit one vehicle at a time into the checkpoint lane. The lane has a speed limit of 6 km/h, in keeping with the accuracy of the sensors and the speed limit violation tolerance.

At the checkpoint, the vehicle is first guided over equipment that measures tyre tread depth. Unfortunately, on the day of our visit, this equipment was not working, so we could not assess its qualities. The visible portion of this equipment is a cast aluminium cover with a narrow, 5 cm window through which the embedded laser scans the surface of the tyre and measures tread depth. The underground space required for the equipment (laser and prism) is surprisingly large, almost 1.5 m deep (see Figure 8).

Figure 8 The underground space required for the equipment (laser and prism) is surprisingly large, almost 1.5 m deep.

Then, each axle of the vehicle is weighed, one at a time, by driving of the vehicle slowly over the scale (see Figure 9). This system is used to confirm overloading flagged by the screening WIM sensor earlier in the system. An overload reading on this scale results in sanctions.

The WIM sensor used for screening (similar to that in Figure 9) is installed before the checkpoint and measures weight highly accurately at speeds of 80 km/h; the system flags overload readings from the WIM sensor so that the vehicles in question can be pulled over to the lay-by for more accurate weighing. The screen in the control room clearly shows what type of vehicle triggered the WIM sensor overload flag and by how much the weight of the vehicle exceeded the limit. The system seems to function very well indeed, enabling screening of HGV weight within the flow of traffic and thereby increasing the likelihood of an overweight HGV being caught. The actual scale unit is rather compact, and we were told that the newer version of the unit is even smaller without compromising reliability. The new version measures about 6 cm high by 10 cm wide.

Figure 9 Each axle of the vehicle is weighed, one at a time, by driving of the vehicle slowly over the scale.

The next component in the system is an in-roadway thermal camera rig (see Figure 10) that records the temperature of the vehicle chassis and tyres. The thermal camera readout is on a separate screen in the control room (see Figure 11), and the image can be adjusted. The camera can show an overall image of the chassis of a vehicle passing above it, from middle to rear, giving an overview of the range of temperatures.

Figure 10 The next component in the system is an in-roadway thermal camera rig.

We concluded that one thermal camera is not enough to return sufficient information on the vehicle chassis, mainly because of the wide angle. The wide angle and autofocus cause the monitor image to be ‘overexposed’, depending on the hottest points, usually the exhaust pipes. Manual adjustment would require one person to adjust the camera for each vehicle and a much lower speed for the vehicles in the lane.

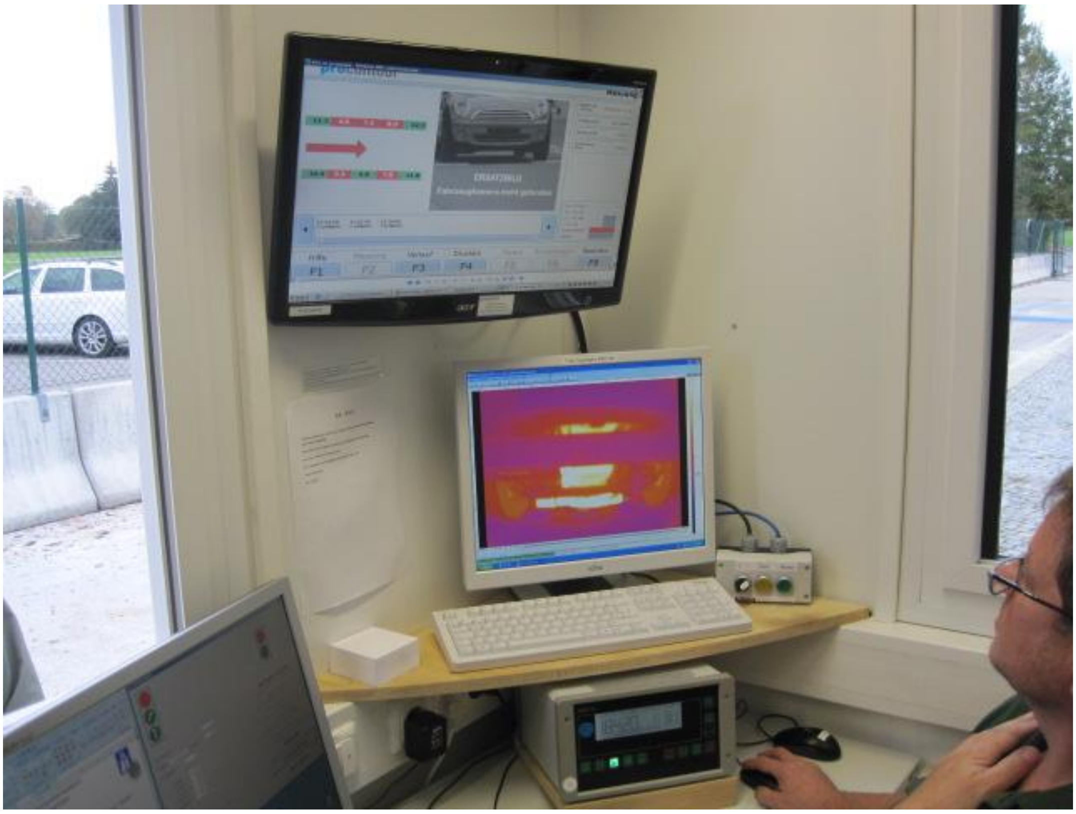

Figure 11 The thermal camera readout is on a separate screen in the control room.

There should be at least two cameras, pointed toward the sides of the vehicle chassis and hence the critical points. Even with autofocus, the system would then give a better image of the temperatures of and temperature differences between the tyres, brake discs, and wheels.

We asked the project personnel about this and were told that the thermal camera rig is intended primarily to identify HGVs that do not use their rear brakes or trailer brakes at all. In this form, the application is not completely what we would require. A further unreliability component is introduced by the fact that a vehicle’s brakes may cool down during queuing to access the checkpoint lane (especially if the weather is cold).

3 THERMAL CAMERA

In the course of the C.A.S.H. project, WP5 participants acquainted themselves with how thermal cameras may be used in the monitoring of heavy goods transport. This involved an extremely thorough survey of how thermal cameras are used to examine the condition of HGV wheels. A separate report was compiled on this survey, and its key points are summarised in the present paper.

A thermal camera is a device that registers heat radiation. It produces an image of the thermal radiation from the source photographed. The sensor in the thermal camera converts the thermal radiation into temperature data, and the thermal image based on these data is constructed digitally in real time. Thermal cameras are used principally to illustrate temperature differentials across a surface (for more details on thermal imaging, see http://www.flir.com/).

Every object whose temperature is more than absolute zero (-273 °C) radiates heat, which cannot be detected with the bare eye. A camera may be used to create an image of the thermal radiation from by an object. A thermal image is essentially a colour map of the surface temperatures of the object (note that a thermal camera indicates only the temperature on the surface of an object, not beyond the surface).

A thermal camera has potential as a screening device for surveying the condition of a vehicle’s brakes in traffic. Its benefits include rapid deployment, ease of handling, flexibility, and the element of surprise (fixed checkpoints do not need to be set up). The primary purpose of the survey was to explore the suitability of a thermal camera (FLIR i40) as a tool for monitoring the condition of the brakes of HGVs in the context of roadside monitoring. The survey was also intended to explore other potential uses of a thermal camera (damage to bearings or tyres, etc.).

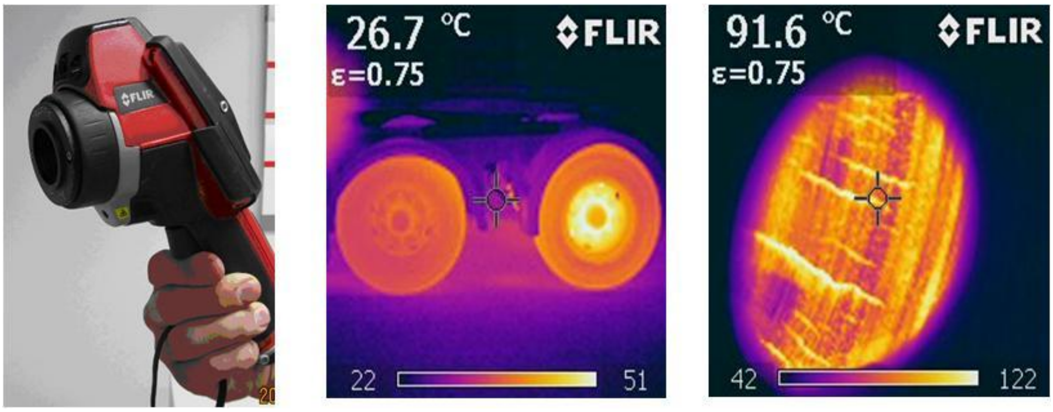

Figure 12 The thermal camera application tested is shown on the left; the middle image illustrates temperature differentials between a vehicle’s wheels; and the image on the right shows hairline fractures in a brake disc.

4 VIDEO ENDOSCOPE CAMERA

Over the course of the C.A.S.H. project, WP5 participants acquainted themselves with how video endoscope cameras may be used in the monitoring of heavy goods transport. This involved testing of how a video camera with a flexible tube attachment could be used in the monitoring of heavy goods transport. An endoscope, or borescope, has a flexible tube enabling visual inspection of cavities and other narrow spaces that are otherwise inaccessible. A separate report was compiled on this survey, and its key points are summarised here.

The device is suitable for inspecting narrow spaces to ascertain the technical condition of a vehicle or to look into its load compartment without opening or dismantling any structures. The device also enables detection of manipulative devices intended, for instance to override the vehicle's maximum speed limitation device or to alter the driving- and rest-period data recorded by the tachograph.

The device makes it easier to inspect spaces of a vehicle that are otherwise difficult to inspect and also indicates to HGV drivers that any such manipulation will be addressed by the police. The device has a good price–quality ratio.

The device is suitable for the procedures of the police, and there are other models on the market, operating on the same principle (see http://www.industrial needs.com/measuring instruments/video endoscopes.htm).

Figure 13 On the left, the video endoscope is used to inspect narrow spaces in a vehicle’s structures; on the right, how to inspect the load without opening the covers.

5 DIGITAL TACHOGRAPH ARCHIVING DEVICE VDO TIS-COMPACT III

In the course of the C.A.S.H. project, WP5 participants acquainted themselves with how digital tachograph archiving devices may be used in the monitoring of heavy goods transport. This involved testing how the archiving device, which is no larger than a USB memory stick, could be used in the monitoring of heavy goods transport. The purpose of the device is to read and clarify the data recorded by a vehicle's digital tachograph to identify any incorrect vehicle use or driver action. A separate report was compiled on this testing, and this paper summarises its key points. For more information on the device, see http://www.vdonl.nl/Tachografen en toebehoren/Uitleesapparatuur/Voor onderweg/TIS Compact III/Products.aspx?id=933.

The VDO TIS Compact III archiving device includes software for analysing data retrieved from a tachograph. The memory capacity of the device is sufficient for field operations. The data retrieved may later be transferred, for instance, to a separate hard disk. The VDO archiving device allows analysis of speed data over a longer period of time than does an application for monitoring driving time and rest time (e.g., OCTET) while also retrieving rpm figures. The data retrieved may still be transferred to an application for monitoring of driving and rest time for closer analysis.

However, the analysis software requires EXE4 Java Home 32-bit JDK or JRE, which police computers normally do not have. Operation of the analysis software requires thorough training before one is able to read the data correctly.

Figure 14 VDO TIS archiving device.

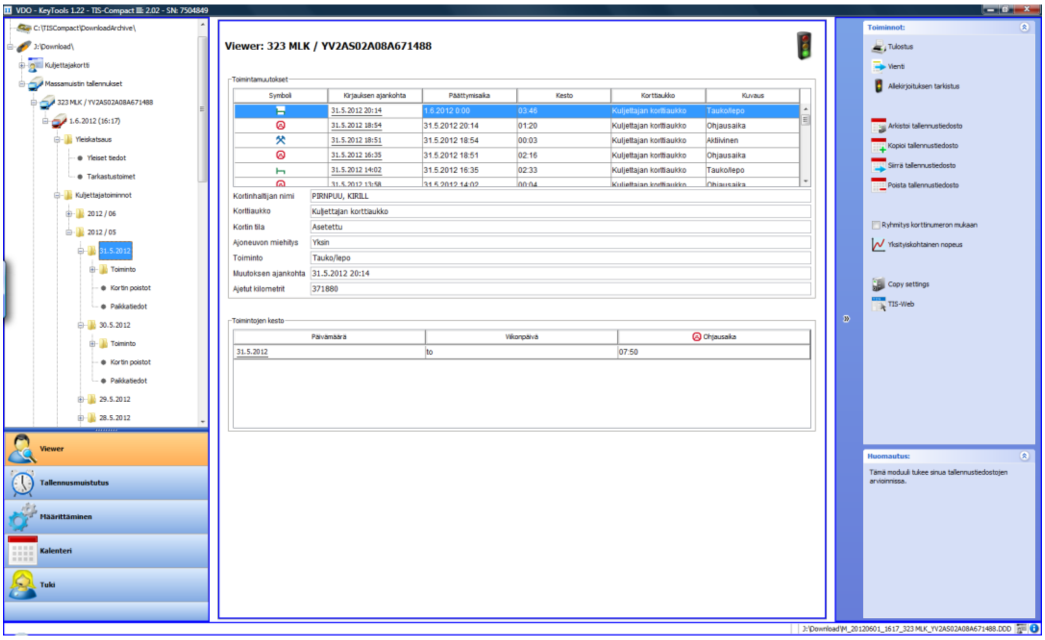

Figure 15 The analysis software.

6 CONCLUSION

The C.A.S.H project showed us; how important is to find right traffic control devices to control Heavy Good Vehicles.

During the C.A.S.H. project, we got to know the most modern techniques in European level to control heavy traffic in modern environment.

Lack of finance is forcing police forces to improve technical solutions to control traffic on nowadays. At same time the similar technical solutions are keeping the traffic control in same level where the similar technical devices are used. The fact is that we really need the technical solutions to solve out tricky challenges in traffic environment. And finally, we also need the real police officer to see that technical solutions are working proper way and keeping up the important discussion of Traffic in changing world.

Jarmo Puustinen
Chief Inspector
National Traffic Police of Finland

This study is part of the C.A.S.H. project - Connecting Authorities for Safer Heavy Goods Traffic in the Baltic Sea Region - running from September 2009 to September 2012.

C.A.S.H. project aims to develop practical solutions to make international road freight transport safer, more predictable and affordable in the Baltic Sea region. The project intends to do this by:

- **improving co-operation between authorities**
- **harmonising training of inspection officials**
- **testing safety equipment and IT systems to be used by relevant authorities**

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