

Further Development of RWIS and Its New Potential Marketplaces in Latvia

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Abstract: In the past, development of road weather information system (RWIS) mainly reflected in gradual expansion of a network of environmental sensing stations (ESS) along the main roads in Latvia. Since a concept of common platform of Intelligent Transportation System (ITS) became mature and has a Pan European framework, RWIS as its integral part, got opportunities for more effective usage, but at the same time, new challenges of data accessibility and interoperability occurred. The presentation deals with ongoing projects and future vision about: how existing ESS stations should be built up to a multifunctional road, traffic and environment control points; how RWIS of different authorities and other data sources should be integrated; how to cover road network (including secondary routes) with low-cost sensors and provide proper decision-making tool for antiicing strategy and overall road management; how RWIS data can be used wider and processed for new marketplaces in Latvia.

Key words: RWIS, data, environmental sensor, ITS.

1. Introduction

RWIS, as a decision-making tool for road winter maintenance of the national road network is gradually implemented since 1997. in Latvia. Now, when a concept of common ITS platform became evident, RWIS got opportunities for more broad use, as its integral part. There is also growing interest on RWIS handled data from other sectors, so, new challenges of data accessibility and interoperability appeared. The main directions of RWIS future development in Latvia are:

- technical upgrading of existing and new RWIS stations to measure growing amount of data in more effective and precise way;
- integration of RWIS with other related systems and data sources to get new analytical products for road industry, as well as to cover secondary road network with low-cost sensing technologies (to encourage decision-making tool for road winter maintenance and management;
- RWIS data use for new marketplaces (not only in

transport), through involvement in common meteorological models and merged with other data.

2. Background of Latvian RWIS

Winters in Latvia are quite severe and weather in three last winter seasons was distinctively different from average statistics of previous decades. Concerning road service standards, the transport network is to be maintained, using deicing strategy (antiicing is only optional contractor's choice), that performance is divided into four levels: from bare pavement policy to snow covered roads (similar as in Finland). Overall Latvian network consists of about 70thous. km., with a density of around 1km. of roads to 1 km. of state territory. Common mobility needs of society are provided by public (state and municipal) roads. State roads (around 20thous.km.) are the most significant routes in interurban and rural areas and this network has absolute national priority to manage and develop. They are operated by SJSC "Latvian State Roads" (LSR), therefore this part of public transport infrastructure

provides the main scope of this proceeding. Municipal road networks, in their turn, are very different: from highly trafficked urban areas of Riga and other big Latvian cities to small communities in countryside, and specific needs of these roads are not described here. Road assets commonly are characterized well-worn (about a third of asphalt and a half of gravel pavements is in poor technical condition). Therefore, road administrations try to invest in road repair as more as possible, and winter service is realized as a compromise between a provision of acceptable traffic safety on primary roads and uninterrupted passability of other roads, from the one part and permanent optimizing of spent resources for that, from the other part [1]. That's why proper decision making tools for road winter maintenance are so important for road authorities.

In the past, RWIS development of the national road network (1600 km.) mainly reflected in gradual expansion of amount of ESS to support road maintenance actions and dissemination of traffic information. Today, 53 ESS provide monitoring of meteorologically typical or remarkable spots, when road slipperiness tends to occur more often and firstly along specific sections (bridges, cuts, shadowed stretches etc.) of the main national roads, with a 20-50km. long sections between them (Figure 1.). Vaisala ROSA station equipment (as a typical combination of meteorological and pavement sensors) is mainly used here, however 3 ESS are equipped with remote road surface sensors DSC111. Initially, ESS equipment

was installed in a cage type housing, considerably far from road edge (more than 5m.), but more modern installations were on a road lighting type column just near the road shoulder. All ESS are electricity powered, therefore they can be used as a base for another roadside telematics nearby. Now, a majority of real-time traffic counters (overall amount is 25) and some weigh-in-motion devices in use are joined there. However, in some cases it was a reason, why to provide a less expensive compromise for power supply infrastructure, ESS were not placed in the possibly best functional location.

In recent years, all ESS are additionally equipped with IP cameras to provide visual picture of road situation (mainly Axis211 and Mobotix M12 cameras), that are combined with IR projector RayMax 25 for night monochrome regime on unenlightened road spots. Data transfer from ESS to RWIS central server is provided via GPRS network on a period of 15 minutes. Maintenance of RWIS roadside equipment is done by a contractor, which is chosen in procurement process for a period of three years (instead of one-year agreement before). In accordance with technical specification, contractor must provide periodic upkeep of ESS, as well as obliged to react on possible technical troubles in limited time. RWIS programs are in-house and developed by LSR IT specialists in accordance with specific needs. Access to different scope of RWIS data in web for different target groups of users is through some principal interfaces:

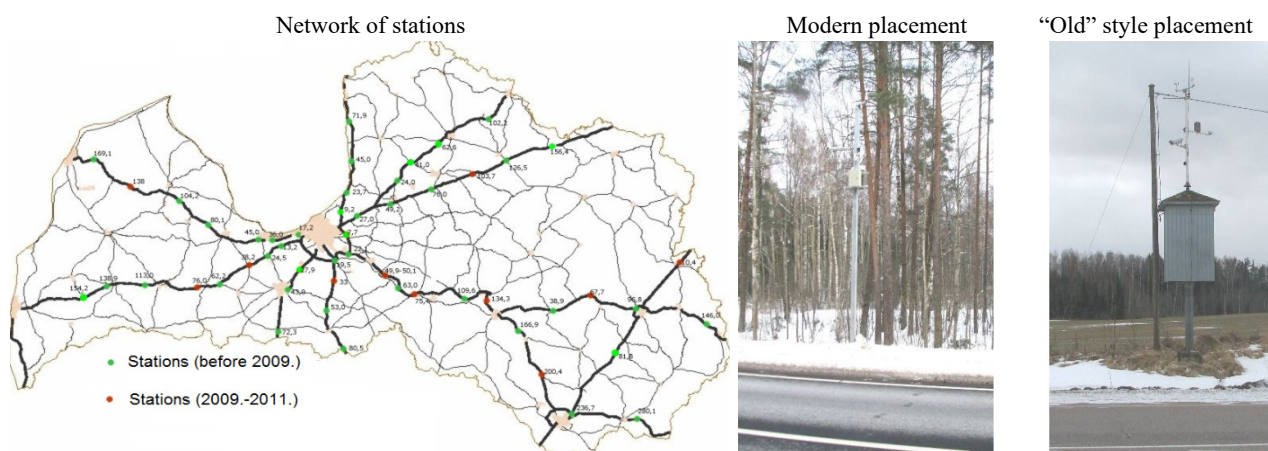


Fig. 1 ESS placement near Latvian national roads.

- www.balticroads.net – international portal on road weather conditions (only real-time major data, mostly descriptive for driving conditions) in Baltic countries, which is aiming on public use;
- GIS of road network – full range RWIS data, for needs of network’s management and planning (a module for public use as interactive route planner is

formed right now and it will be on LSR web page);

- winter staff’s webpage – multisourced feed of road (full range of RWIS data, traffic profiles, videosurveillance) and common meteorological (forecasts, alarms, radar and satellite images, numerical models ect.) information, that is united there for needs of road maintenance (Figure 2).

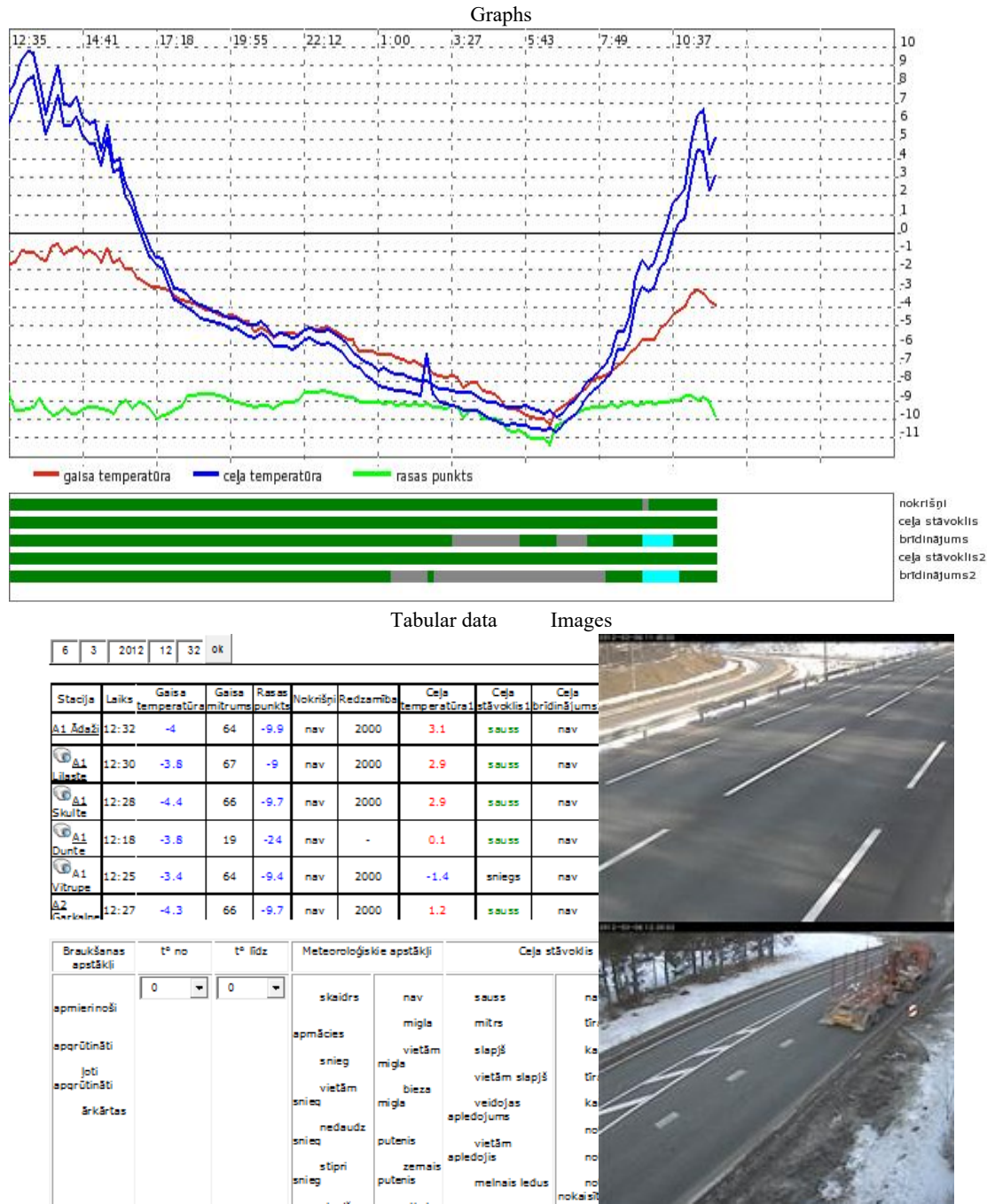


Fig. 2 Screenshots from LSR winter staff’s webpage on RWIS data.

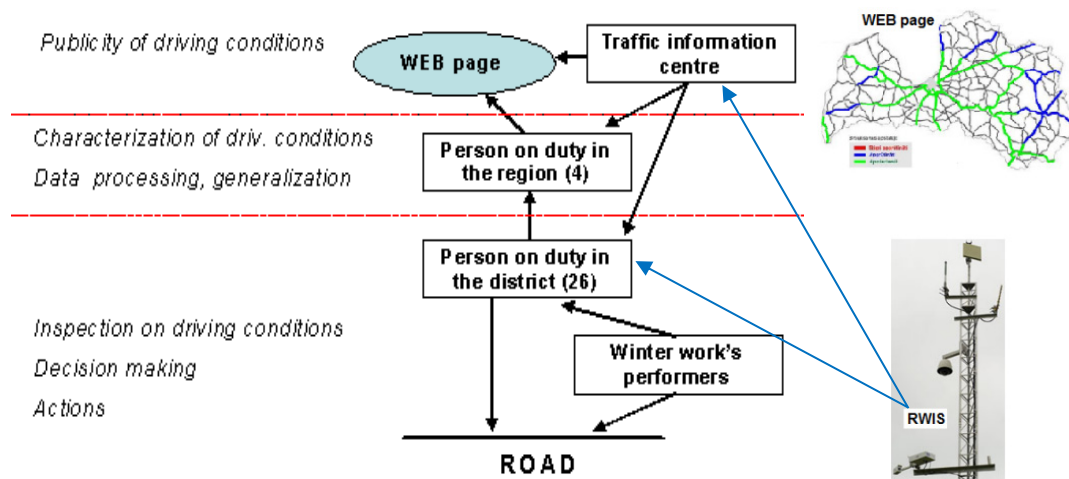


Fig. 3 The structure of the tour of duty for winter maintenance of Latvian national roads.

Actually, there are basic alarm indications on hazardous situations, when pavement tends (by linear extrapolation) or are already slippery (ESS producer's embedded) and no RWIS data technical integration with other sources of meteorological information, to provide automated well-grounded forecast of changeable road situation in short-term perspective. The formal base of decision making in road winter service for Latvian state road network still is a tour of duty, performed by road maintenance contractors with respect of provision timely actions on roads, but RWIS and other external data give additional input there (Figure 3.) [2]. The detailed route-oriented description of actual driving conditions is an extra product here, restored at least each two hours during snowstorm by contractors.

The other kinds of RWIS use outside winter in road industry are quite fragmentary, where RWIS provides additional/explanatory data for subjective analysis rather, than a strict control of certain threshold values:

- monitoring of pavement temperature in a period of spring thawing, as an indirect reference for seasonal heavy traffic restrictions on secondary roads (only sub-representative, because the main process is under the road surface, that is not actually under instrumental control and concern other roads);
- monitoring of pavement temperature in a period of summer heat, when daytime restrictions for heavy traffic are possible (in fact, not experienced yet);

- monitoring of actual ESS data during a process of road construction, to identify conformity of performed or planned works to technical specifications;
- use of ESS statistic data for guidelines optimisation on road maintenance and management.

Some other RWIS implementations are also in municipalities. Big cities (f.i. Riga, Jelgava, Ventspils) each has developed their own ESS network from different producers (Lufft, Boschung, Vaisala, etc.), that rather may be characterized as pilot projects for spot control, than well-structured network's RWIS. Thus, Riga now has 3 specific stations to measure air quality at roadside in the city centre (CO₂ and PM₁₀), as well as pavement control on the main bridges. These systems are not linked to national RWIS or between each other.

3. Existing Problems and Challenges

As described before, existing RWIS is enough mature and ESS coverage of the main national road network isn't very low in Latvia. Therefore, it is a stable base for further development of corresponding services to higher level. Concerning actual and perspective needs, they depend on promoted targets. Up to now, while amount of ESS continuously seemed to be insufficient, RWIS was mainly developed by only "measure and describe" principle, without long-term concept, as well as RWIS community was quite small (mainly contractors and supervisors of winter works),

how had no concrete request on further priorities. Also, RWIS related aspects were out of strategic and legal framework on national level [3]. This situation principally changed after EU Directive 2010/40/EU on ITS came into force in 2010, and constantly growing amount of ITS services, where RWIS data is needed. ITS terms are introduced in the Traffic Law in 03.2012., and a comprehensive national ITS action plan (where a role of RWIS also will be encouraged) for a period of 5 years should be finished in this autumn.

Additionally to further strengthening of existing RWIS functions by widening of ESS coverage and improving quality of measurements and resolution of data processed, two other directions are to be developed, that firstly will promote better reactive (immediate response on events) and proactive (predictive and advisory) roles in winter road maintenance and data input to other possible services:

- addition of new devices and sensors for ESS to widen their functionality;
- promote effective data exchange solutions

between actors in the field, which lie under integrated services.

Proactive services are quite ambitious by themselves for RWIS holders, therefore enough contribution of road authorities seems to be in proper data input here, but tasks of integration should be carry by ITS market, including professional meteorological authorities. Actual tasks on RWIS development for Latvian national network are summarized below (Table 1.), that are discussed in the following chapters with more details.

The latest case, actualised broad discussion on RWIS in Latvia, was 04.february of 2012., when many car crushes happend due to icy pavement on new Sothern bridge above Daugava river (equipped with ESS) in Riga city. The main reason was formation of slipperiness at extreme low temperatures, when salt is ineffective, but there was no also information for approaching drivers on potential hazard. After that, the municipality decided to equip all incoming ramps with elctronic screens, indicated on slippery pavements and avoid such situations in the future.

Table 1 Ways of optimisation existing RWIS (not prioritized).

<i>RWIS functions</i>	<i>Added value</i>	<i>Tools</i>
Better sensing quality; minimisation of damage and troubles of ESS	More precise data input to RWIS; savings for maintenance of ESS	Revision of ESS placing, calibration and maintenance guidelines; optimising of data transfer ESS – RWIS core
Broader ESS network	Optimal ESS coverage of the main road network for implementation of proactive services (more dense, than now); ESS introduction to other roads	Gradual expansion of classic ESS along the main roads. Low-cost ESS introduction to secondary roads
Extra sensing equipment for ESS	Control of road subbase's state; traffic control (where still not), other measurements, taking into account, that ESS provide ready to use mounting, power supply and data transfer infrastructure	Probe sensors; traffic counters etc.
ESS partial functionality for another road devices	More primary meteorological data (temperature, humidity ect.) on spots, where no ESS installation	Cameras with graphical input of weather sensors
Extra signalling devices for ESS	Traffic information at roadside; speed control in hazardous driving conditions	Electronic screens; variable message signs (VMS)
Road weather data between ESS	Input in high-accuracy decision-making services along specific road stretches	Thermal mapping of road network
Data from mobile sensors	Actual data, measured along full stretches	Equipment on contractor's fleet (skid meters; surface's analysers, videoregistrators ect.)
Data interoperability	Effective data input to a common ITS platform (sharing between actors) and feedback as proactive services	Probably data exchange in XML format, through DATEX II nodes
Decision-making (proactive) modules	Derivative service, as input to automated: antiicing treatment; adaptive spreading; advisory traffic info, technological indices ect.	Programs, based on multisourced data integration and analysis

4. Nearest Tasks and Ongoing Projects

RWIS development doesn't have a high priority in Latvian road industry yet due to objective reasons, however there is achieved awareness about its high importance and potential benefit for mobility provision. Thus, the permanent task is to raise effectiveness of existing RWIS, by the following measures:

- introduction of more stable ESS columns instead of previous model, because the last ones suffered from some demolition cases last years, as well atmospheric equipment is affected by traffic (dust, spatter) and ask for higher and stronger (for possible extra equipment) placement;
- provision of all site data transfer to central system, through one controlling unit (now there are different modems for ESS and other devices) to optimize data transfer;
- looking for more appropriate ESS hardware and its calibration techniques, based on a feedback from road maintenance staff (cases, when detected and real situations often differ);
- working with RWIS software on effective data sharing solutions at present IT level, which are asked by meteorological agency, national forest authority, some municipalities, private ITS service providers and others.

The abovementioned measures need to be taken into account, when continue to expand ESS network along the main national roads (planned 3-4 new stations annually in 2012.-2015.) and replace outdated equipment.

Concerning broader scope of data, gathered from one ESS, the more valuable from road management point of view seems to be measurements of road subbase state and temperature by multisegmented probes. Unfortunately, a pilot project of it (5 probes in different regions) is postponed, but principal technical solution is already clear. In any case, installed subbase probes can give very valuable statistics to actualize methodology of road design and management and to be a more precise reference point for introduction of

spring restrictions for heavy transport (however this data will not be truly descriptive, because are gathered not in the place, where traffic is restricted).

The other trial to reach added value to existing RWIS at reasonable expenses, is introduction of electronic monitors to ESS in 4 – 5 places with high traffic. The idea is to depict simple symbols (blinked snowflake, short alarm text a.o.), when hazardous road conditions due to slippery pavement or bad visibility are detected there. Then, if the pilot will be successful, this equipment can be expanded to all ESS network. The principle will be quite important in perspective to both: road authority and drivers, as almost first adaptive signalling traffic advisory devices in Latvia. This will form a step to use VMS in combination with RWIS in future (there are also some legal difficulties to introduce VMS straightforward).

Notwithstanding other kinds of use, the main function of RWIS still is the same as before: to support road winter maintenance. The most actual goal there is to introduce antiicing strategy in practice. That approach means ensuring a constantly clean surface without any ice and in this context only preventive treating with chemical anti-skid materials is necessary [4]. It is not suitable for roads with low traffic intensity, as well as, in some meteorological situations (f.i. long-lasting snowstorms), when it need to be combined with classic deicing and use of abrasive anti-skid materials. Antiicing is especially proper in cases, when it is self-sufficient and other activities do not follow (f.i. black ice, hoar frost). In general, both strategies should be applied together, increasing technological diversity of processes, so for in specific conditions it would be possible to choose the best solution. Potential benefit of antiicing is increased traffic safety with more economical use of chemical agents, providing less environmental impact [5]. Looking for antiicing is perspective because potentially it could be applied to about half of all cases when roads become slippery in Latvian climatic conditions. The base of preventive measures is adequate and timely decision making, based on accurate

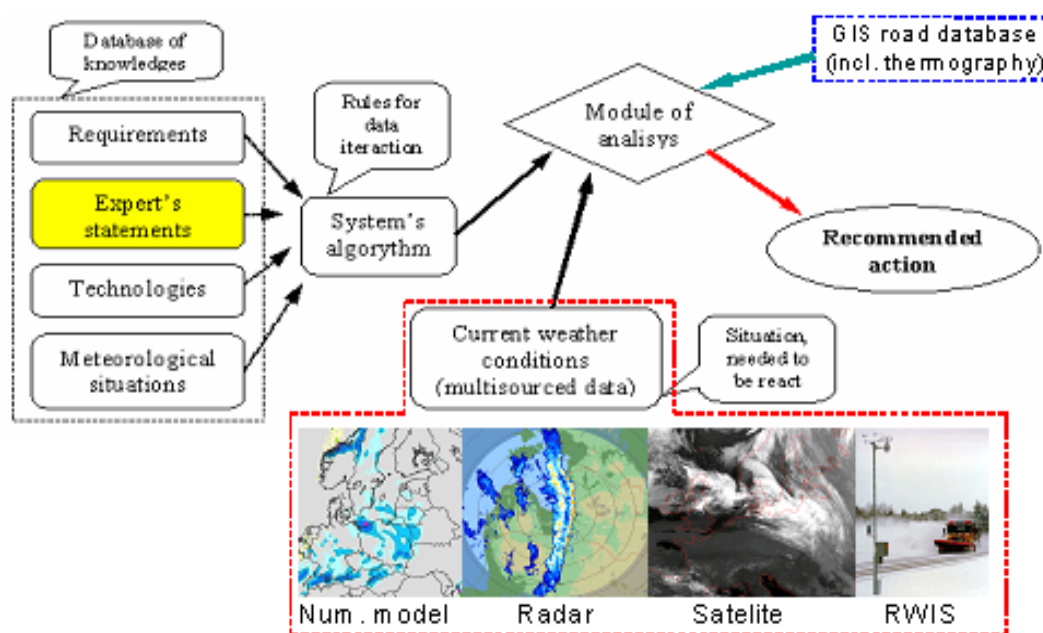


Fig. 4 Concept of expert system's prototype for winter road maintenance.

(probability more than 90 %) forecast of road condition for the next 2 – 8 hours. To predict slippery conditions, several information sources need to be integrated and treated by corresponding algorithms, providing expert systems (Phase 1 – advanced alarming; Phase 2 – concrete technological recommendations for winter fleet; Phase 3 – automation of spreading patterns in combination with fleet on-boarding devices). Several steps are being taken in this direction, although sufficient level of standardisation and implementation of antiicing strategy still is not reached in Latvia. Now, a concept of such advisory service is on discussion between LSR and national meteorological agency (Figure 4.).

The development of such decision making tools at end-product level is not really professional competence of road authorities, therefore we are looking for the partners to provide that as external or outsourced service.

5. Concept of RWIS Development and New Marketplaces

Considering that winter road works are of partly prospective and immediate character for achieving

technically short-term goals, many diverse aspects should be taken into account. That includes, for example, technical standardization of process, contract terms and framework, form of payment, work registration and especially performance evaluation (including different complex sub-criteria, such as index of weather's severity). So, the aspiration to ensure more qualitative road service level with limited resources, and effective control provision becomes a driving force in the field. A concept of harmonized ITS, provides a proper platform for achieving these goals by influencing all actors synergically (Figure 5.). The common ITS approach allows to develop modular integrated services, which are economically feasible and oriented on technological succession. Thus, RWIS should be developed further under united ITS framework. In the structure of ITS, three sequential inner functions may be identified: data acquisition → data processing → final services, and their mutual cohesion is the primary task [6]. From that point of view, direct integration of different types of RWIS is not necessary, instead specified data accessibility through unified coding system (DATEX II) on "pull" and "push" distribution principles is quite enough between involved partners. Tools for supporting decision

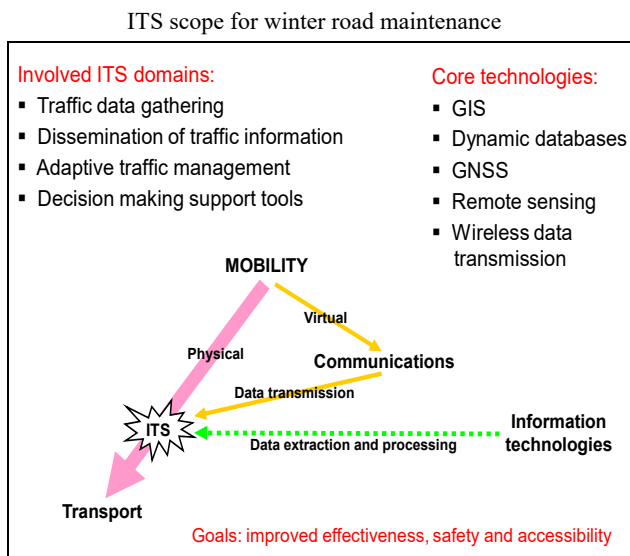


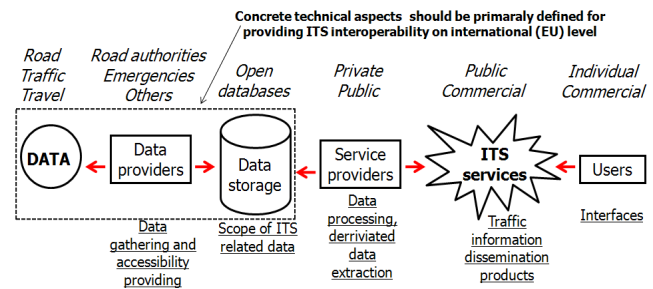
Fig. 5 ITS concept.

making, automatic registration of performed works (MBDE by Novasib is introduced since 2009. to spreading fleet) and traffic information services are the basic directions where ITS meets winter road maintenance in Latvia. Dissemination of traffic information also is a one of the priority areas to be harmonized on international level (Directive 2010/40/EU).

In general, the balanced long-term development of ITS isn't an easy task, if the sector cannot hope for sufficient state investments in the nearest future. Some principles for ITS (and RWIS as part of it) development here are:

- maximal orientation to “light” technologies (wireless data transmission, GNSS, GIS virtual user interfaces etc.) that allows to raise ITS efficiency without investments in physical assets (roadside telematics, traffic management centres, wired communications)
- ITS solutions should be as multi-functional as possible with the emphasis on combined technologies of road monitoring that are able to fix initial data and to provide its derivations (f.i., road video surveillance should support the following functions: visual picture → traffic counting/interpretation of pavement's condition → active traffic sensor).
- from administrative position, PPP schemes have to be supported, where road authorities provide basic

Harmonized data flow throughout ITS



elements of ITS (develop road monitoring systems and ensure availability of their data, as well as, support data circulation), but investments in the final services lie on market's concern.

The one of the latest research projects in transport field, which is in progress with support of LSR is “Development of of multifunctional ITS point's prototype” doing by Research Institute of Electronics and Computer Science (2011.-2014.). The practical target is to provide working prototype of low-cost modular equipment, which can gather a broad amount of road, weather and traffic data and to be used also as active sensor for roadside signaling devices (practically traffic lights). Scientists have ambitions to provide an experimental solution of that ITS point, that can be available on market at a price around 500Eur. The approach here is to use simple and cheap weather sensors and camera image procession to recognize traffic parameters and pavement conditions. The initial hypothesis below allows significant deviations from RWIS professional measurements, therefore potentially such equipment is to be used as cost-effective monitoring network only on secondary road network. Local national, as well, as rural municipal and forest roads are the scenes, where project's achievements may be actual.

Table 2 New identified marketplaces for RWIS data in Latvia.

<i>Marketplace</i>	<i>RWIS contribution</i>	<i>Status of interest</i>
Project of speed cameras	Sharing of physical infrastructure	Initial negotiation with Police
Investigations (under private data protection law)	Camera images, statistical data	Cooperation with official bodies
Common meteorological information	ESS data input will provide broader sensor's network	Partnership in progress
Logistic planners for heavy traffic	Data on pavement critical conditions, when heavy traffic is not desirable or even restricted	Initial interest (especially from forest industry)
Municipalities; operators of municipal and forest roads	Accessibility of neighbouring ESS real-time data through user interface	Partnership in progress
Commercial traffic information services	Accessibility of ESS real-time data under unified IT framework	Initial negotiation with some actors
Agriculture	Data on road sub-base conditions, as reference to input for specific soil forecasts	Initial interest

Apart from its main functions on road winter maintenance, RWIS has to be open for new external marketplaces, where RWIS input is somewhere possible or already requested (Table 2.). The other one is quite narrow, but important contribution to objective decision-making in overall management of road network (processes of road sub-base, statistics of weather and pavement data etc.), that is internal strategic issue for road industry. Actually, LSR is looking on national meteorological agency as on the main partner, which provides added-value of shared RWIS data. This is reflected in improved and new meteorological services for almost all sectors of economy, including specific ones for road authorities (route-oriented forecasts).

6. Conclusions

The proceeding summarized the main ideas, that lie under preliminary feasibility study on RWIS in Latvia. It seems, RWIS that is initially developed for quite narrow needs, has a huge potential (and not only for transport sector). Following steps should be: a realisation of abovementioned experimental projects and evaluation of their results, which would help to prioritise and plan implementation of certain services.

Looking for higher RWIS data conformity to monitored processes is still important from qualitative point of view, but classification of data scope and provision of its interoperability is vital for RWIS further diffusion to all possible marketplaces.

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