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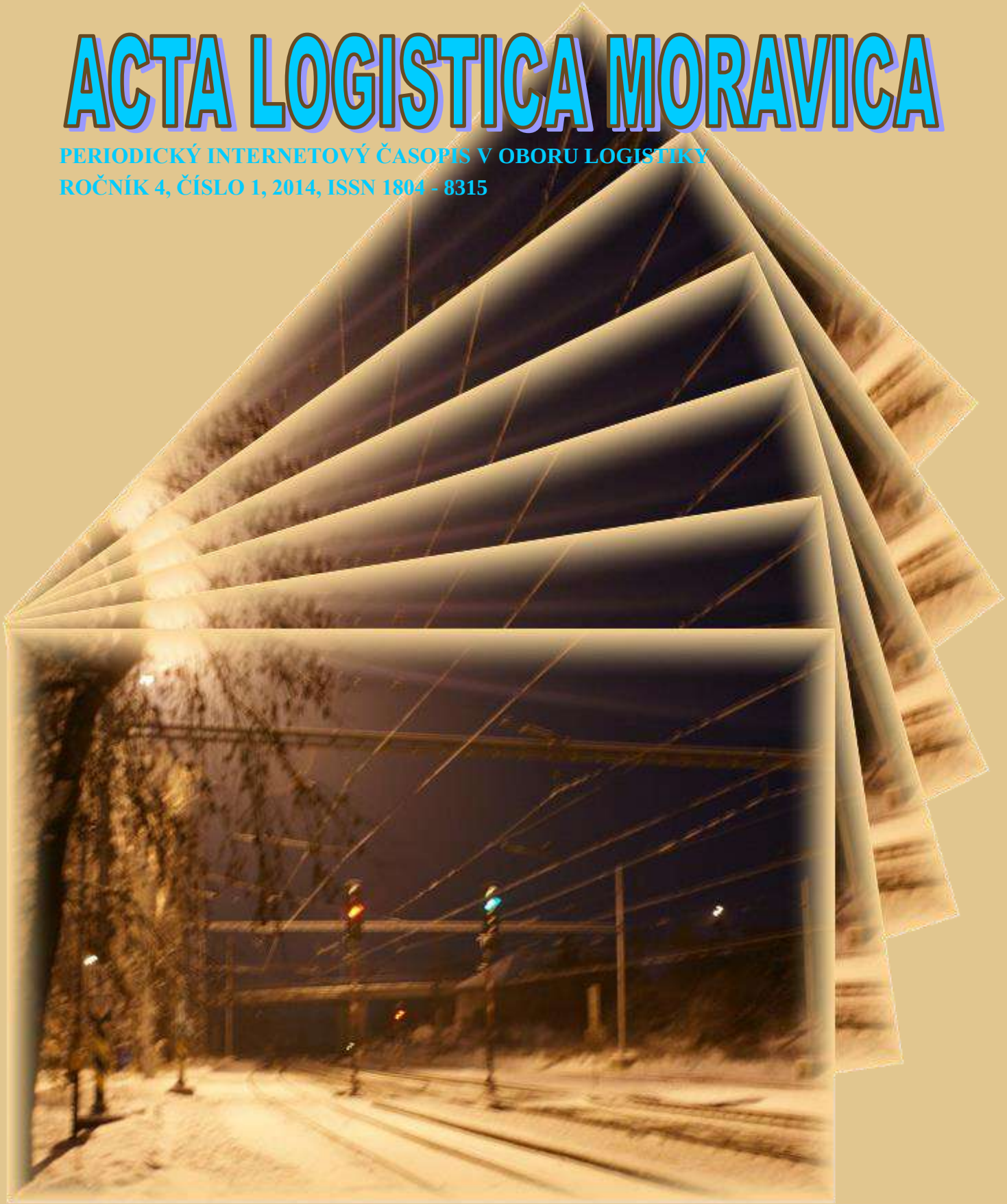

Vysoká škola logistiky o.p.s.

CONTENT

RENEWABLE SOURCES IMPACT ON LOGISTICS OF ELECTRICITY SUPPLY FOR THE PEOPLE

VLIV OBNOVITELNÝCH ZDROJŮ ENERGIE NA LOGISTIKU ZÁSOBOVÁNÍ OBYVATEL ELEKTRICKOU ENERGII

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Abstract

Electricity supply for the people can be understood as a standard logistical process and can be defined as an interconnection between producer and customer through electrical grid from which a customer can take off the product according to his demand, within in advance agreed limits. The most kinds of renewable energies have a disadvantage of a fluctuating and sometimes even an impulse supply to the electrical grid compared to conventional sources. An installation of such renewable sources into power grid of the Czech Republic, problems associated with their connection and an influence onto the transmission and distribution grid control are the main issues discussed in this paper. A transmission grid main description as well as weak point analysis and correspondent proposals have been made within this paper. An influence of some important renewables on behavior of transmission grid has been simulated in MATLAB.

Abstrakt

Zásobování obyvatel el. energií je klasický logistický proces jehož hlavní charakteristikou je to, že výrobce a zákazník jsou spolu propojeni přenosovou síti, ze které si zákazník odebírá produkt podle své potřeby, ale v předem dohodnutých mezích. Všechny druhy takových energií mají vzhledem k stabilním zdrojům el. energie nevýhodu a to je, že jejich nepravidelná a někdy nárazová dodávka do celostátní přenosové sítě. Problematika obnovitelných zdrojů elektrické energie v přenosové soustavě ČR, při jejich připojování a vlivu na energetickou páteřní síť a tedy na řízení celé zásobovací sítě je obsahem tohoto článku. Obsahuje popis přenosové soustavy a obnovitelných zdrojů, analýzu slabých míst a návrhy opatření pro bezpečný provoz přenosové soustavy. Vliv některých významných vlivů OZE na chování přenosové soustavy je namodelován v programu Matlab

Keywords:

Logistics, transmission grid, renewables, electrical energy, network modelling

Klíčová slova:

Logistika, přenosová síť, obnovitelné zdroje, elektrická energie, modelování rozvodů

1. INTRODUCTION

This paper was elaborated with a contribution of diploma thesis of MSc. Stanislav Šachl, defended on University of Logistics in Přerov.

Basic characteristics of electricity supply logistic process are that both suppliers and consumers are interconnected via robust power electric grid. The interconnection is thus anonymous and varying with time (i.e. new infrastructure installation, network reconfiguration, automatic back-ups etc.). Transport connection capacity is almost greater than a capacity required by customer. Transmission (transport) speed is almost reaching light

speed. Customer takes off such amount of "goods" which he needs in the limits agreed with grid operator in advance.

Transmission speed enables to sell "goods" instantly and with no respect to the political conditions in the area. All these characteristics related to a transport path and a transmission capability are the reason for a way of market arrangement other than in a standard purchasing system. Furthermore, a large amount of consumers, even if they are in compliance with their connecting conditions, may cause a situation, where some transmission connections are overloaded or even extremely overloaded. Moreover, it can also happen a situation, when a customer is consuming more amount in contradiction to the agreed limits. Above mentioned can be deemed as the main characteristics of electrical energy production and market specifics in extraordinary logistics power grid environment (Supply Network Management- SNM).

2. MANAGEMENT OF ENERGY SUPPLY FOR THE PEOPLE

Management of such supply system can be classified according to its purpose into a power generation management, a power transmission management and a demand side management. Behavior of such power system is determined by a consumption of customers. These are defining total amount of generated power at all as well as its cost. The power generation is thus dependent on requirement of the customers, which is consequentially determining size of the power network to be built.

Can we somehow influence from this point of view our environment? Of course, we can. Practically everyone, who is connected in the grid independently on his location. From this imagination we can sense that if we had only a theoretical knowledge at our disposal to do sensible interventions inside the system, we should be afraid of our wrong decisions. That's why a power network modelling is very helpful instrument at whatever level of management.

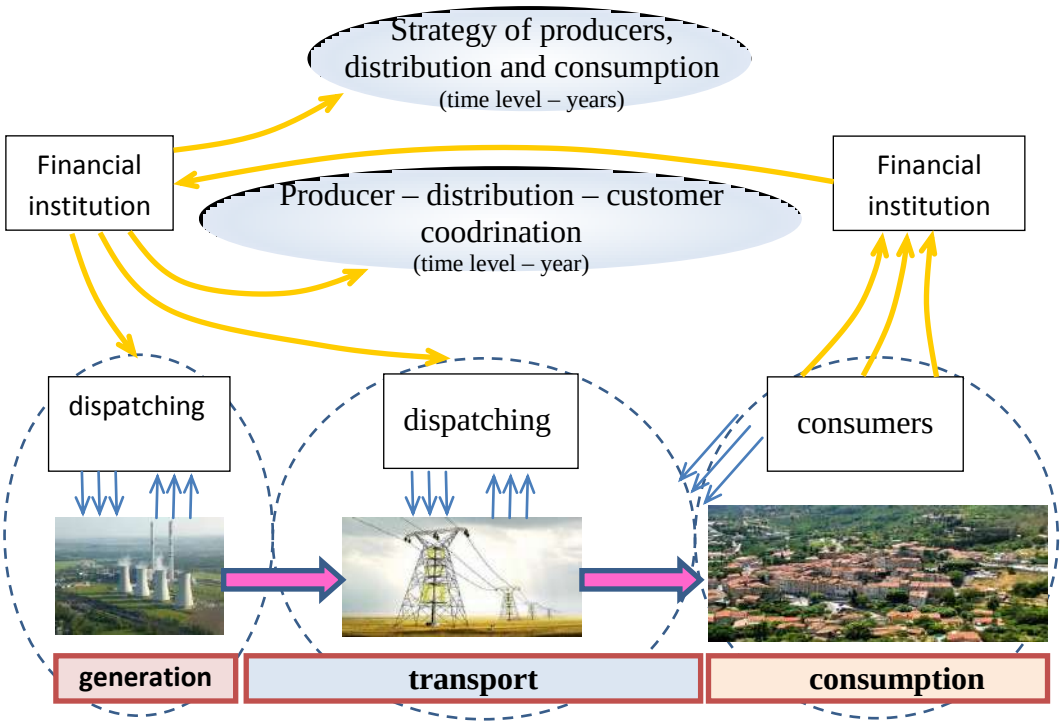

Fig. 1 Logistics and chain of supply (supply network management)

Power Generation Management has its primal aim – to generate an equivalent amount of product to satisfy the customers. In this case we speak about a real time management or an operative management.

Power Grid Management has its primal aim – to secure a sufficient transmission capacity for a supplier and consumer connection. The term "sufficient capacity" expresses a capacity of "transport" connection according to in advance and long term agreed amount. In addition to that, a new transport route built is usually highly time and cost demanding. In case of existing transport routes, a plan for modifications is highly demanding and thus shows a necessity to employ one of programs designed for network modelling.

Demand Side Management (real-time and operative) is based on the other principle. Each customer is taking off an amount of energy according to his need up to the specific limit agreed with supplier (grid operator) and customer. Instant consumers' offtake is thus a random quantity for the supplier, which can be predicted only with a certain probability.

Demand Side Management (strategic) is more complex problem, because is based on a development or an abandonment of generation instruments and/or a transmission grid reconstruction. These activities almost always interfere into third party properties and in addition to that, either a new construction or an existing facility termination has significant time and costs requirements (i.e. 2 new units construction in nuclear power plant Temelín). A good prediction in this type of management shows its necessity at time level. And that's why this prediction is strongly influencing product prices, which are transported through the grid.

Speaking about generation, transportation and consumption of electrical energy, let's better specify a supply situation. A producer or a transporter must set certain limit to the customers for that important reason the producer must generate electrical energy just in time of customer's wish. Therefore each customer has to have set maximum current $\boldsymbol{I}$ [A] which shall be taken off within supplier's obligation to be in compliance with quality of electrical energy (besides other things voltage level $\boldsymbol{U}$ [V] in specified limits). Therefore supplied power $\boldsymbol{P=U.I}$ [kW] chosen by the customer is guaranteed. Above mentioned limit is formed by rated current of main circuit breaker and is periodically paid on a lump sum basis. A customer further pays for a real amount of energy which has been taken off, on advance payment basis. The mutual differences are charged out after certain period.

3. TRANSMISSION NETWORK IN THE CZECH REPUBLIC

There are several important terms connected with a transmission network.

Transmission network is a mutually connected group of lines and devices operated at voltages 400 kV, 220 kV and 110 kV serving for electrical energy transport within all area of the Czech Republic and for interconnection with networks of other states in the neighborhood. *Power network* (grid) is a superior system, including all devices for generation, transmission, transformation and distribution of electricity, including terminal connections and lines. In addition to that, it includes metering, protections, control, safety instruments, computers and communication.

Fig. 2 Overhead line 400 kV

Blackout is a huge network outage affecting totally or in large areas the power

network, bringing interruptions of power supply to the customers, i.e. out-of-voltage state. For the society it means practically an emergency situation, because all the devices without a back-up source are completely out of order including some safety devices.

"N-1" criterion is basic criterion for an operation reliability and means a power grid ability to keep standard parameters (voltage, frequency) even after an outage of any element (i.e. part of line, transformer, power plant unit etc.) while a temporary local restriction on the consumption side may occur.

Cross border transmission capacity is a maximum transmission capacity of border connection between two neighboring transmission networks while all safety criteria are met.

Emergency state means a state when frequency, voltage or transported powers are at any place of the network out of tolerable values, of course in the case of supply interruption all over or partly in the network.

Quality of electrical energy is classified according to voltage and frequency. While frequency has rather global character across the whole network (should be 50 Hz), voltage has different values in different nodes of the network depending on reactive power flows. Voltage and frequency is on the side of producers regulated by grid operator.

Renewable energy sources (RES) are understood as natural non-fossil sources of energy which are exploitable for generating electricity (i.e. wind, solar, water, biomass, geothermal sources etc.).

Blackstart is an automatized reaction on blackout and means a process of restoration of supply in the affected area. Note that, many kinds of appliances are consuming significantly higher current than in normal operation.

4. RES INFLUENCE MODELLING ON BEHAVIOR ELECTRICAL SUPPLY NETWORK

In order to demonstrate these influences a simplified model in MATLAB environment was created. This software has an integrated environment for science computations, modelling, algorithm design, simulations, analysis and data presentation, parallel computations, measurements and signal processing, designs of control and communication systems. MATLAB is an instrument for either comfortable interactive work, or wide range of applications development.

Transmission network model can provide an overview on network behavior which can be seen from plots generated hereinafter. The observed parameters are an active power at outputs of aggregated inner sources (simulating dynamic behavior of a group of standard power plants), a frequency of these sources and a system voltage regulated by these sources (secondary voltage regulation). For some scenarios a time plot of wind speed is applied. Two network models have been constructed for the analysis purposes.

Fig. 3 shows first model, where 3 fictive sources demonstrating independent network areas are connected. They are modelled as standard power plants with automatic power and voltage control and represented by dynamic interconnected source models with nominal power:

- Power plant 1 – 2000 MVA
- Power plant 2 – 1000 MVA
- Power plant 3 – 1000 MVA

Power plant models consist of sub-models of steam turbine, synchronous generator, auxiliary as constant load and unit transformer 15/121 kV, 2000 MVA (1000 MVA). These fictive power plant units are connected via a circuit breaker to a transformation 110/400 kV and further to the transmission network. There is connected a load 1500 MW for the first and third power plant between transformer 110/400 kV and circuit breaker. Transmission network consists of six lines of lengths 3 x 50 a 3 x 100 km. An aggregated source module of wind park 500 MVA is additionally connected to the transmission network via transformer 110/400 kV. This module consists of sub-models of wind turbine, generator, auxiliary and transformer 22/121 kV. There is an input with a variable wind speed signal for the wind turbine. Cross-border supply is simulated by a module "External supply" as an ideal source with internal impedance. Several scenarios presented hereinafter are based on modification of value of this supply (by change of wind power generation supply to the network). An instrument powergui serves for a dynamic variables initialization before a simulation in a MATLAB component Simulink. The network works at frequency 50 Hz and nominal voltage 417 kV.

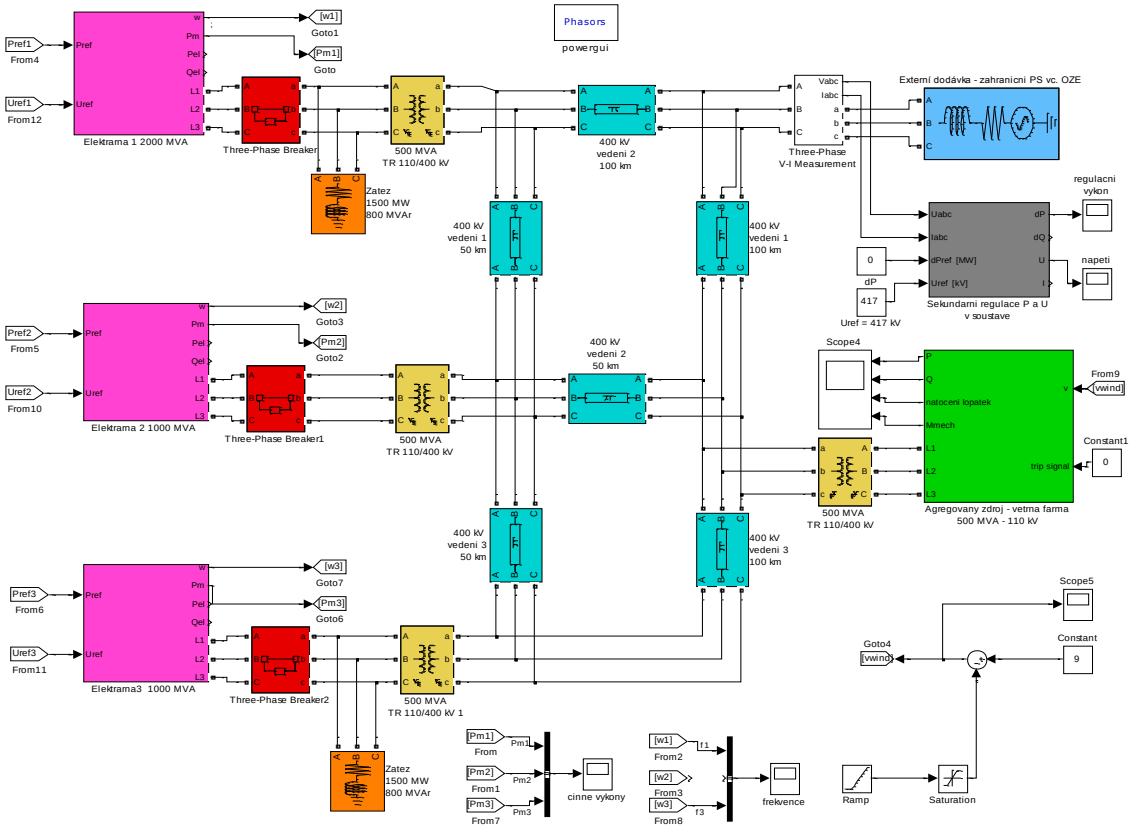

Fig. 3 Transmission network model No. 1 where a wind park is connected into inner part of the network

Second model, which is extended by next wind park connected to the outer transmission network, is depicted in the fig. 4. This model represents external RES which are dynamically acting on the inner network. The module consists analogically of sub-models of wind turbine, generator, auxiliary and transformer 22/121 kV. The module has the same input with a variable wind speed signal for the wind turbine.

There situations are modelled by following seven scenarios:

- Scenario 1 – balanced state
- Scenario 2 – fast decrease of wind speed in the wind park inside
- Scenario 3 – shut down of the wind park inside
- Scenario 4 – 5000 MVA from outer transmission grid with outer RES
- Scenario 5 – 1000 MVA from outer transmission grid without outer RES
- Scenario 6 – 10000 MVA from outer transmission grid without outer RES
- Scenario 7 – 1000 MVA from outher transmission grid with outer RES

An output from the scenarios are voltage, frequency, active power and in case of need wind speed plots. Simulation time is set at value of 600 seconds.

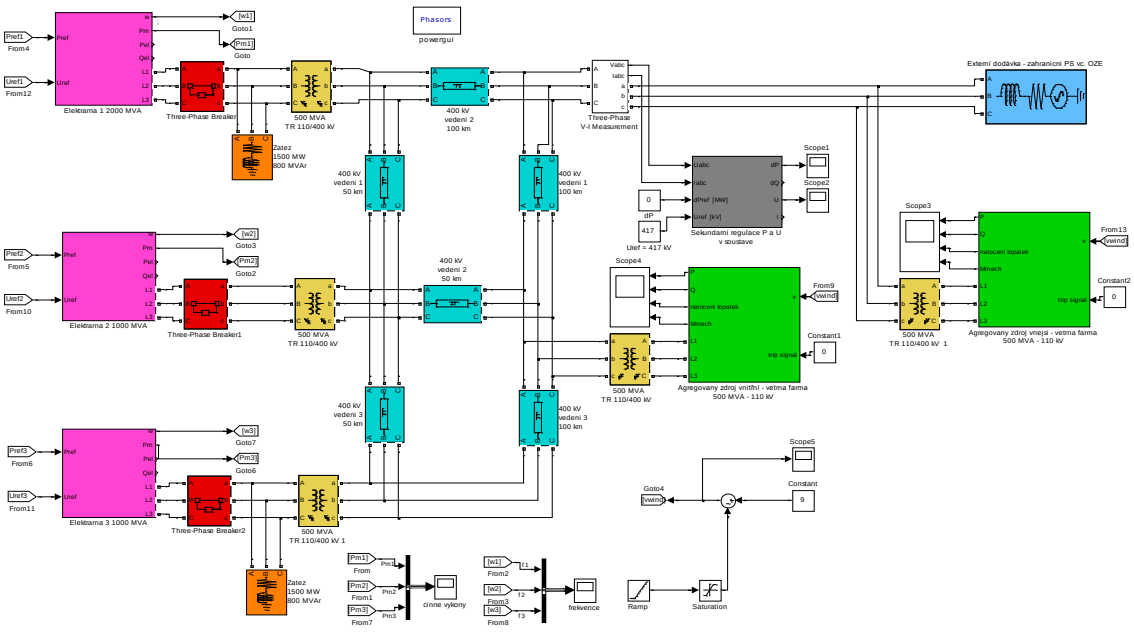

Fig. 4 Transmission network model No. 2 with a next wind park connection to the outer transmission network

4.1 Scenario 1 – balanced state in the transmission network

Scenario No. 1 represents a balanced state (i.e. without any dynamic change). All of the three power plants are generating their nominal power outputs, the wind park located inside is operated under wind speed of 9 m.s^{-1}, 10,000 MVA is incoming from the outer transmission grid. A network with balanced power flows doesn't require any dispatching actions or ancillary services from the TSO side, which can be seen in the fig. 5.

The wind speed remains constant 9 m.s^{-1}, without any wind gust. This speed represents maximum exploitable speed for considered turbine type. A nominal power of the wind park 500 MVA is generated just at this speed. In case of higher speeds, a propeller blade pitch angle is controlled not to exceed turbine's nominal speed. In case of wind speed, which cannot be regulated, blades turn along wind direction and wind pressure necessary for propeller movement disappears.

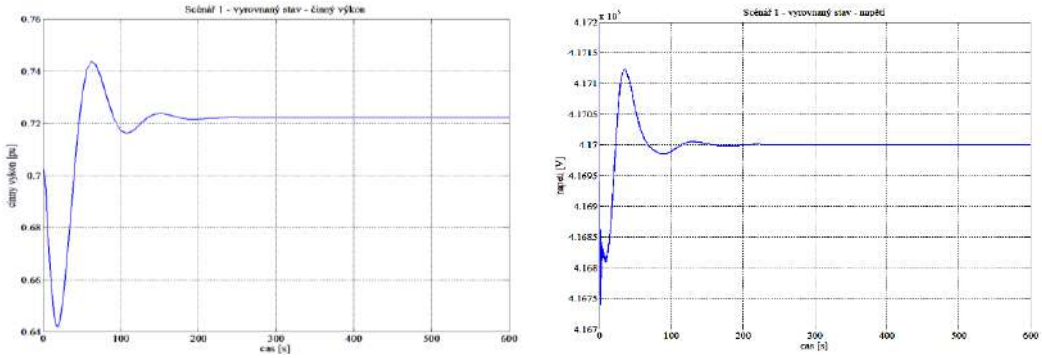

Fig.5 Active power and voltage plot at steady state in the power system.

Initial small changes are caused by some uninitialized model variables and do not represent network behavior There can be seen a small disturbance (less than 0,1%) in the voltage plot, which is caused by the model initialization and does not represent a transmission network behavior.

Frequency remains balanced on value 50 Hz in this case. This state (completely with zero system parameters regulators' deviations) can be called as an ideal. Note that this state cannot practically occur in real networks and therefore there is a need to control frequency permanently.

Active power has been settled to 0,72 p.u. after initialization.

4.2 Scenario 2 – wind speed fast decrease at wind park

The second scenario differs from the previous one just by an event of wind speed step change at time 200 s. A change from 9 m.s^{-1} to 7 m.s^{-1} however represents a change of total wind park power output by 53 %. This event represents a significant change where system parameters' controllers' reactions can be observed. Short circuit power of the external network is 10,000 MVA. Voltage, frequency and active power balance plots are studied.

There can be seen a power system reaction on the specified wind change on a voltage plot at time 200 s. Voltage increases temporary from 417 kV to value 417,5 kV, i.e. by 500 V. Secondary control is acting within following 100 s.

A wind park (aggregated source) supply change reduced by 53% can be seen also on frequency disturbance and power supply increase however secondary control can manage this transient. According to the rules of TSO, maximum tolerable deviation in common operation is ± 200 mHz.

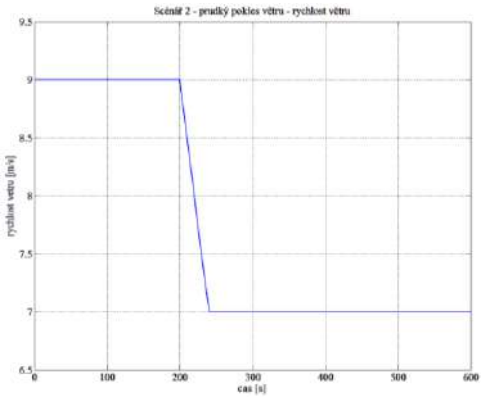

Fig. 6 Sudden wind speed decrease

There can be seen 8% increase in the active power plot. This increase means that every source connected to the secondary control system must supply 8% of its installed capacity more in order to meet contracted cross-border power flow.

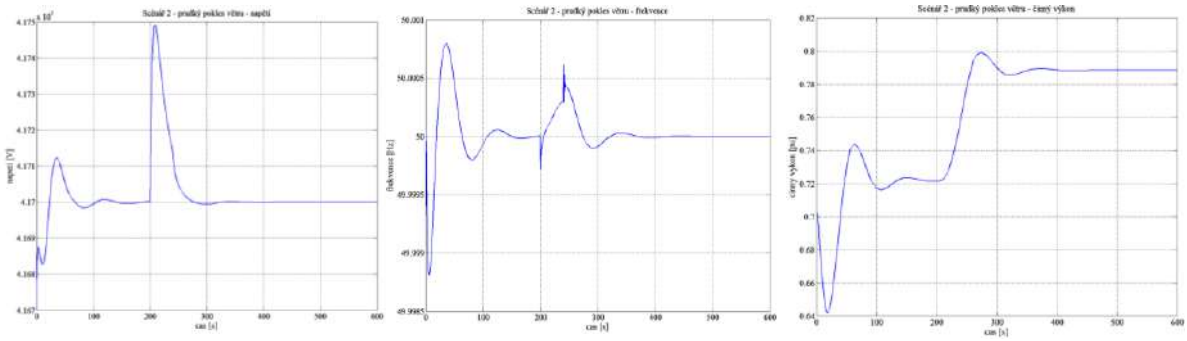

Fig. 7 Voltage, frequency and active power plots depicting a sudden wind decrease

4.3 Scenario 3 – wind park shut down

A sudden wind park shut down, which can occur very rarely, respectively is not probable taking into consideration overall reliability of transmission power network, causes a reaction which is depicted in fig. 8. Following plots are showing shut down of the wind park at 200 s. Short circuit power of the external network is 10,000 MVA.

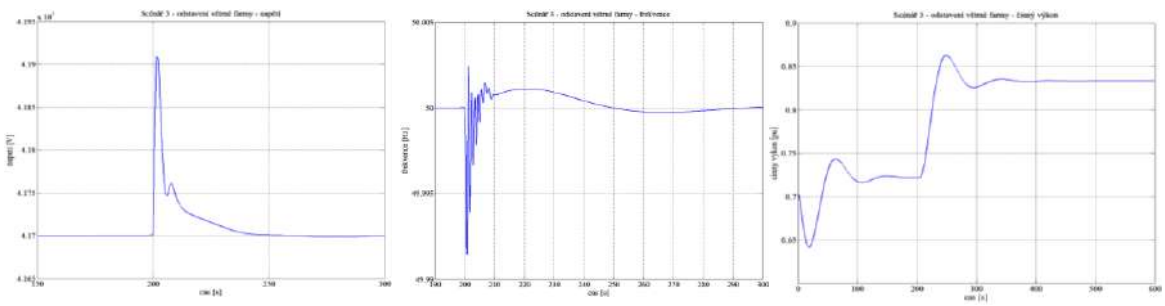

Fig. 8 Voltage, frequency and active power plots depicting a wind park shut down

A sudden wind park shut down causes at transmission grid connection point temporary a voltage peak 419 kV. Within 50 s a secondary control reaches back required original value of a voltage 417 kV. Contrary to the previous plots, for a better resolution there is changed a range of a time axis to 300 s.

Frequency disturbance corresponds to tolerable values (49.8 – 50.2 Hz), but significant frequency changes can be observed even in this case, despite shorter time of control.

A sudden wind park shut down shows above all a higher active power supply from the fictive power plant units. These units must generate circa 13 % more of their nominal power output, which is managed by secondary control.

4.4 Scenario - 4 interruption of cross-border supply 5000 MVA from the outer network

A short circuit power value of the external network to a level of 5000 MVA is at low level in this simulation (which at the same time means weakening the outer network connection to the inner grid) and in addition to that, both of wind parks are shut down, what means either the inner source integrated into evaluated transmission grid or the wind park connected to the outer (foreign) transmission network.

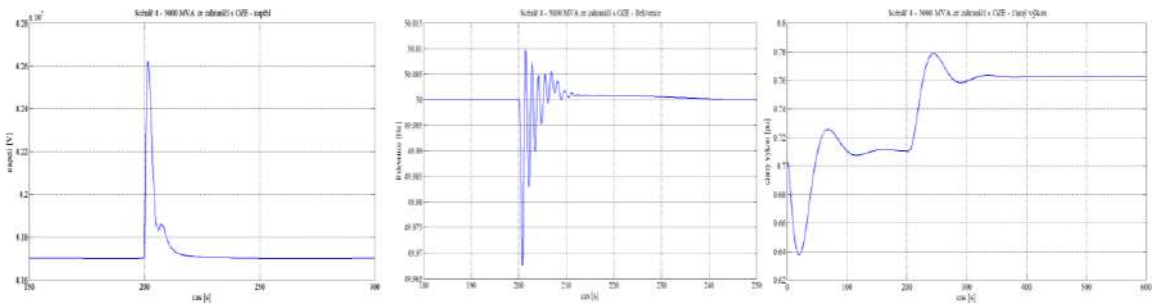

Fig. 9 Voltage, frequency and active power plots depicting a sudden 5000 MVA supply outage from the outer source

Fig. 9 shows very fast response of the control system, however, voltage has exceeded limit of maximum operating voltage 420 kV. This scenario doesn't threaten the power system fundamentally and secondary control can react on this described state appropriately.

4.5 Scenario 5 – blackout in the power system

A simulation according to the scenario No. 5 is representing a connection of 500 MVA wind park from the external power network side, but at the same time the short circuit power is considered to be 1000 MVA, which can occur for instance after an important line outage.

A voltage plot shows that a secondary control is attempting to keep voltage at set value at selected point in the network. Nevertheless, the network gradually tends to decay and total blackout i.e. an outage of supply and shut down of all the sources. This situation is extremely dangerous, since the subsequent start up ("black start") is very difficult lasting at least several hours. Contrary to the previous plots, there is changed a range of a time axis to 100 s for a better resolution. Blackout in the power grid can be also observed in frequency and active power plots.

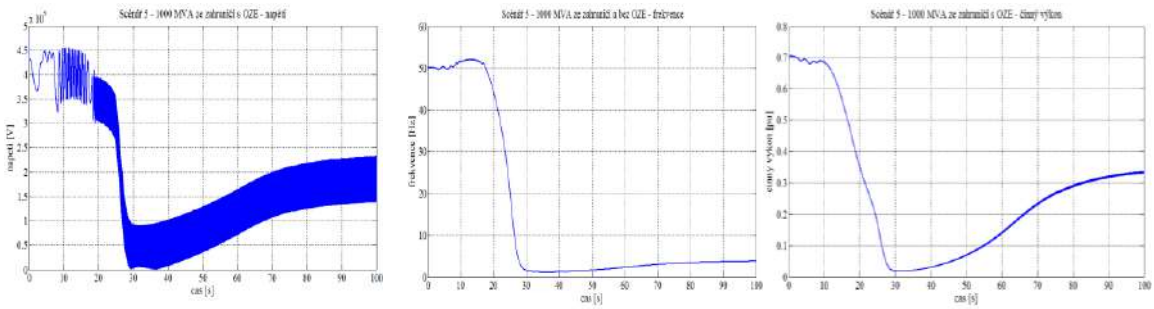

Fig. 10 Voltage, frequency and active power plots depicting a sudden decrease of short circuit power from the external network to 1000 MVA

In this situation the power plant units are disconnected from the grid although they are still working in an islanded operation state (either feeding a local area or generating electricity for running considered unit's auxiliary). Entire network has to be restored by a step-by-step interconnection of sources and appropriate loads.

4.6 Scenario 6 – power system with a balanced cross-border supply

This simulation represents a balanced cross-border supply. Short circuit power of the external power network is 10,000 MVA which helps to stabilize the inner network.

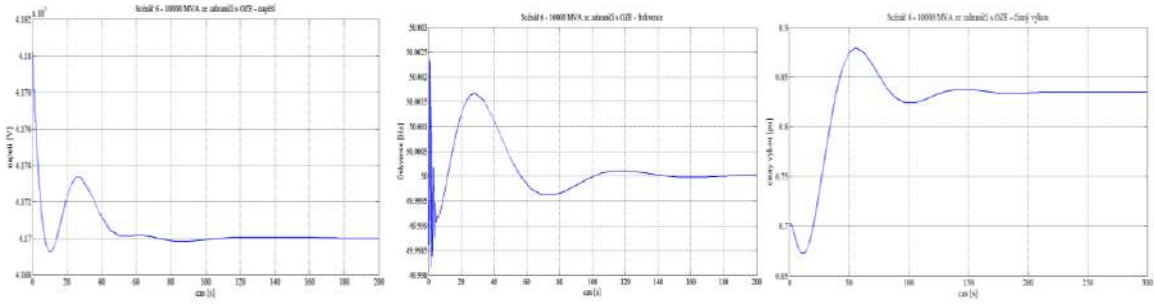

Fig. 11 Voltage, frequency and active power plots depicting a balanced cross-border supply

Neglecting an initialization phase, all the values are oscillating in tolerable limits according to consumers' offtake, therefore this situation allows to connect RES without expectation of any negative influence.

4.7 Scenario 7 – power system oscillations

In case of any kind of fault occurrence, a network with a significant amount of small RES without main control can be threatened with a possible destabilization. These oscillations do not mean in fact an emergency state, nevertheless, being several of these sources switched on, a power system may temporary oscillate, which can be shown in fig. 12. Neglecting an initialization phase, an active power supply is not considerably influenced.

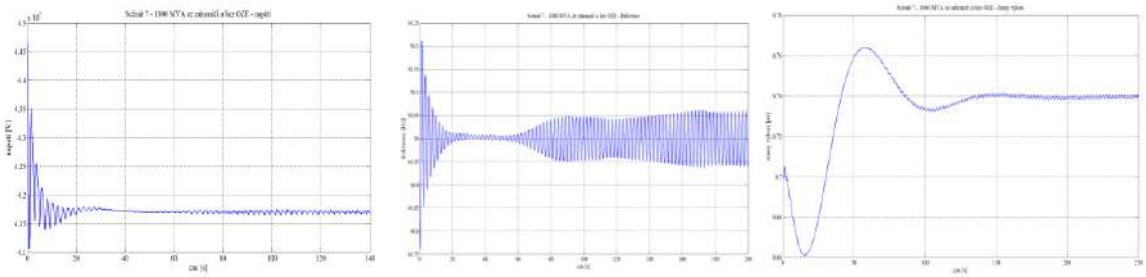

Fig. 12 Voltage, frequency and active power plots depicting a power system oscillations

5. RES POWER SUPPLY RELIABILITY

Quality of power supply is not only given by a voltage level and frequency, but also by reliability of power supply. That's reason why a power consumption planning belongs among important criteria.

Some kinds of RES, predominantly dependent on natural conditions, can be characterized by a significant unbalance of power generation. Therefore a replacement of conventional sources by RES seems to be a very questionable task.

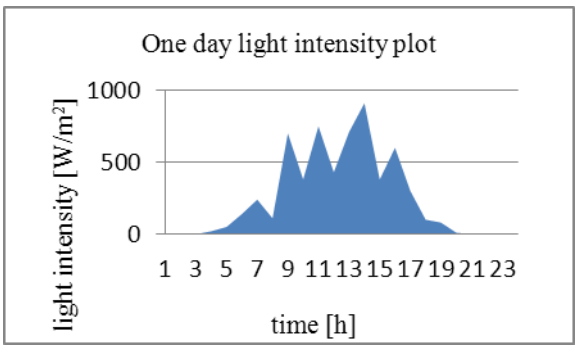

Fig. 13 One day sunlight intensity example

5.1 Photovoltaics

Fast power production changes are typical for photovoltaic (PV) power stations (or solar parks). Power generation is not only dependent on a day-night regime, changes are also caused by weather conditions. Power changes even in tens of percent of power rating within several minutes are possible. There is no remarkable influence on the network with

sources with installed power roughly of several kW – small installations on household rooftops, because energy is partly consumed in the location of consumption. Problems may arise if high number of these small sources connected to the network at 0.4 kV level are supplied by one transformer 22/0.4 kV (35/0.4 kV). Overpower and voltage rise problems may come to pass at maximum light intensity, in the case of insufficient local consumption. This can be evaluated by MV protections as a possible error. The network is more influenced by power plants of greater power output at level of tens of MW. Fast power output changes can cause voltage fluctuations event. flicker at point of common coupling (PCC).

Considering a significant PV power delivery discontinuity, this kind of source shall be deemed as a complementary source type with installed power outputs, under the best conditions, of hundreds of MW.

5.2 Wind Power Plants

A situation of wind power (WP) plants is different in several aspects compared to the previous one. Above all, a different shape of power generation time series, which is caused by wind blowing additionally in the night, nevertheless not so often than in the daytime.

A difference in power generation of a wind power compared to a photovoltaic lies in a higher concentration in specific locations and usually a greater rated power output. Good operating conditions for this kind of sources are obviously located in the places with a poor infrastructure, which can be a problem. These localities are not so much industrialized having a small density of population (Krušné hory, Jeseníky, Českomoravská vrchovina). Installed power of these farms is still not so significant, so we cannot await a network overloading during a wind gust.

An exploitable potential in the Czech Republic is about 2500 MW. This power output is big enough to influence a transmission grid. Especially a power of wind farms generated during summertime represents an important part of consumption.

A potential accumulation of higher number of wind farms in one area brings problems, when a line or feeder capacity is exhausted. For example, if transmission grid in northern Bohemia is loaded with a sudden power flow rise from the wind parks in Germany and at the same time the wind parks in Krušné hory start to generate power, this overpower is redundant and must be eliminated. Following mitigations can be done, either to shut down some other sources or to accumulate energy in hydro pumped storage plant or not to connect a part of redundant wind power plants.

Economy of such kind of “backup sources” is rather disadvantageous and repetitive start up and shut down of fossil power sources is not very contributive to such propagated ecology.

5.3 Biomass Power Plants

Biomass power sources are relatively stable sources without often power fluctuations compared to PV or WP. From technological point of view, this type of power plant is similar to thermal power plants combusting fossil fuels and thus a similar operation can be assumed. Despite of that, there can be situations leading to a power plant shut down. Power generation difficulties can happen in case of biomass delivery troubles. These can originate from a change of conditions in power plant’s gathering (harvesting) area. Taking into account biomass fuel long term contracts and existence of a fuel handling system inside power plant, the power generation changes have not a sudden character.

5.4 Hydroelectric Power Plants

Considering an influence of hydroelectric power plants on the network, we speak about their contributiveness, since they have an ability of fast connection to the grid within several minutes. Hydro turbines can be started up within 15 minutes. Small hydroelectric power plants may cause difficulties in network operation in several cases. These power plants are located dominantly on upper or smaller streams which have water flow varying with time. Their time-to-time shut downs and startups can negatively influence voltage profiles similarly to other sources. In case of run-of-the-river power plants, season changes play an important role (summer – dry, winter – ice).

An immediate shut down can occur for example during floods, when a turbine technology is at risk. This happened during floods in year 2002 on cascade on the river Vltava. In the end, the hydro pumped storage plants had to run. This situation occurs even in wintertime, when ice floes are cumulated in the inflow object.

Almost one half of technical potential of hydropower has been exploited while rest of locations is not attractive for possible investors because of small heads. From reliability and network influence point of view, they are supposed to be the most advantageous among existing renewables.

6. ANALYSIS OF DANGEROUS SITUATION IN 2002

The Czech transmission network faced the most demanding situation ever in period between 25th November and 16th December 2011. The reason was unplanned cross-border power flows through the area. There was transported up to 3500 MW through the transmission network in the most critical situation. Average value is 1000 MW.

Critical situations are caused usually under confluence of several events. In this case, to an original reason – wind farms in northern Germany with a significant power change during windy days there were added following events:

- shut down of eight nuclear power plants in northern and southern Germany
- grow of installed power of PV plants in Germany
- intensive purchasing with electricity, dominantly on spot markets
- lack of water for hydroelectric power plants in the Balkan, which caused higher import to this area

Thanks to the interconnection with neighboring networks, the Czech transmission grid lies in the center of a European network and therefore it serves as a transit network providing a realization of purchases from close or distant surrounding. Transit power flows behavior must subject to physical laws, where a power flow seeks the shortest path to the place of a final consumption without any consideration to state borders. In case of more paths, the transit flow is divided inversely proportional with an impedance of each path.

An opening and integration of European electrical energy markets is leading to a growth of trade volumes and their increasing dynamics which is dependent on real market situation. The power transit flows passing through our transmission grid can violate an optimal distribution of above mentioned agreed exports. Power lines enabling transit power flows are used either for export or import from or to the inner grid representing a key element for cross-border transmission capacity. Transit power flow is superposed on internal lines inside the network causing additional loading. Transit power flow maximum up to now has been recorded in December 2011 and reached 3500 MW, compared to an average value of 1000 MW. Two transmission paths were used:

- a direct path from nortern Germany (RES overpower)
- a parallel way through Poland to Moravia (a consideralble export joined from Polish)

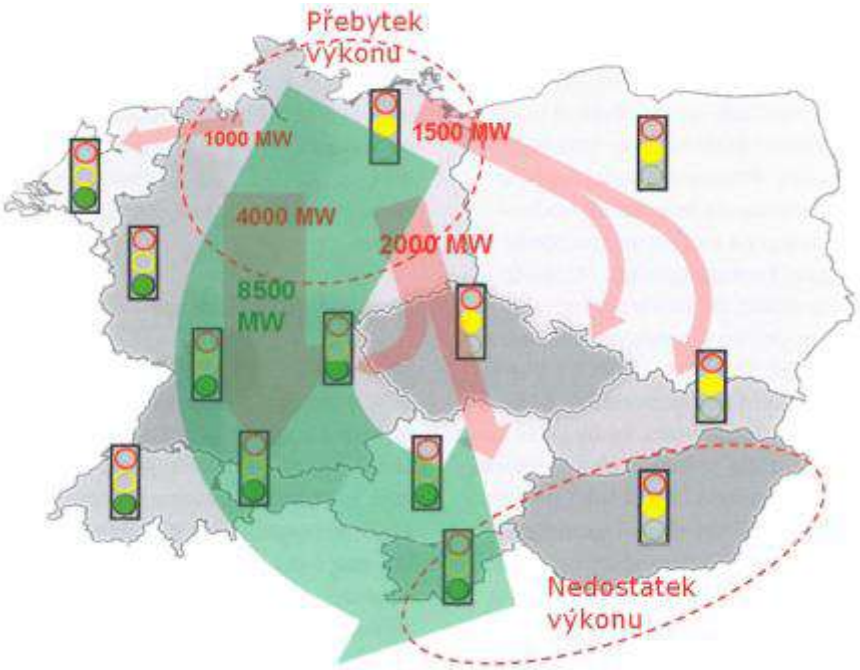

Fig. 14 Physical power flow division

The transmission network was loaded at its limit not only with TS operator from northern Germany – 50 Hertz Transmission (main cross-border path), but also with Polish operator PSE Operator and Austrian operator APG. This practically meant that any additional power flow decrease from Germany to the Czech Republic would cause a power flow growth from Poland. Furthermore, an export from our power system would reduce a transit from Germany and at the same time it would grow a load of connection with Austria. Any unexpected fault on the loaded lines would lead to the line outage and as a consequence next fault propagation. This operation is not admissible at all in long-term, since it would result to a local blackout in western and southern Bohemia. An impact to neighboring networks cannot be exactly foreseen.

We can clarify it on a simplification where a fully filled water channel system is subjected to torrential rains.

7. MITIGATIONS FOR ELIMINATING A NEGATIVE INFLUENCE OF RES ON TRANSNISSION NETWORK

Nowadays, renewable sources are playing an important role in the Czech power system. Despite a complicated control and uneasy connecting to distribution and transmission networks, their importance is considerable. The European and even worldwide ecology policy declares that renewables share must grow replacing share of fossil fuels and therefore it is necessary to discover paths how to use their advantages and eliminate their disadvantages.

There are not many solutions how to achieve such a goal, however, there are some suggestions for TSOs and DSOs for the future which is shown in the following text.

7.1 New Lines Construction

A construction of new lines empowers a transmission capacity of grid. A short circuit power is proportional to power system stability which was proved in the simulations. Price demands are not discussed, although each of following proposals represent investments of billions. More important problem of this solution is, above all, construction time demands and planning. A wind farm construction with installed capacity of 500 MW can be managed in 2 – 5 years depending on complexity of permitting and EIA processes. On the other hand, a power line construction with distance of 50 km represents a challenging task lasting at least 10 years. Neither design works nor an erection itself are not time demanding. It appears, that the most problematic part is a public hearing, especially negotiations with properties of estates located on a planned line route.

EIA documentation elaboration as so as related offices' statements is similarly demanding. Considering this situation, the Czech parliament is concerned with a proposal of law enabling an estate appropriation in case of strategic building purposes (including not only power networks, but also gas pipes and motorways). The legislation is nevertheless touching an inviolability of property principle. However, in such kind of affairs serving to the strategic interests of the republic, a need of the network building shall be above the property principle.

7.2 New power sources construction

The power network can be strengthened by a new power sources construction which shall be operated in a standby regime for supply outages from renewables. It is not necessary to mention cost demanding economic aspects of this solution. However, this option should be also presented for giving a complete overview. A good example of a power plant waiting in standby regime is a hydro pumped storage plant Dlouhé Stráně. The start is possible within 15 minutes and therefore can be certified for an ancillary service – quick starting 15 minutes backup. The power network could be definitely strengthened by a construction of pumped storage power plant which has pumped water into a reservoir in time of energy surplus and in the case of one of major RES outage would be able to run at full power within 15 minutes.

7.3 Phase-shifting transformer

Phase shifting transformers (PST) are transformers with a complex ratio, having an ability to change a phase angle. They are used for power flow control on transmission lines. A difference form the other types of serial compensation is based on ability to change a phase shift at the end points of power line. Each PST consists of a series unit and regulating main unit (excitation unit). Phase shift between main terminals is achieved by connection of the series unit with a transmission line. Operating principle shows, that despite a small rated power of PST, it allows to control relatively large-scale power throughputs.

On the other hand, phase shifting transformers installation represents a solution with a passive element, decreasing a short circuit power of the protected transmission grid. This arrangement protects one power system, nevertheless, making the second power system's behavior worse (see a small short circuit power in some modelled scenarios). From the cross-border cooperation point of view, this solution is very questionable. For instance, in the illustrative and many times discussed situation between the Czech Republic and Germany, a PST would be installed in one of substations in northern Bohemia in order to allow our transmission network TSO to build a barrier against unwanted power flow from Germany. It would result to a reduction of transport capacity in Poland and also inner German network. Polish side declares an installation PSTs in the all of border nodes by 2015. ČEPS (Czech TSO) is preparing feasibility studies of these cost demanding network modifications.

Nowadays, also political aspects come to play, since German government refuses to admit such an influence to the own power system from the neighboring networks.

7.4 Renewables mix

This topic is rather philosophic, dealing with RES power production forecast and their mutual share. There is a need of some forethought to build power plants using RES in a combination eliminating mutually their disadvantages and emphasizing the advantages. Thinking about sources planning with aggregation of PV and WP, it would be fulfilled a potential of supplementary sources (sun is shining and wind is not blowing and vice versa). As a technical problem it appears PV is generally from its nature a weak source and WP a strong source thanks to the propeller inertia. Non-technical aspect is to put more source types together, but the investors are not encouraged to build such an installation. Therefore such consideration is more likely meant to be discussed, nevertheless convenient to think of rather than to deserve a practical realization.

7.5 Accumulating the Energy on a Power Source Side

A close future is offering an option to accumulate just the energy which is possible to generate. Nowadays, when different types of technology for energy accumulation (supercapacitors, hydrogen production) are used and improved, this option represents a possible solution for a close future. An example of accumulation of energy can be following: if a wind blows during night time when energy demands are obviously not so high, this solution would be contributive for the supply stability avoiding overload the cross-flows. However, for a real application in (not only) the Czech TSO is this option unreachable at the moment.

8. CONCLUSIONS

Power system concept, power energy mix, green energy, green subsidies are the words, which are discussed by technical society more often than earlier. Nowadays, the green subsidies are spoken to be a purpose-built overpricing of power production satisfying interests of some parties.

Thanks to the so called ecological and green activities, a situation of today is influenced by the fact that sources have been grown like mushrooms after a fresh spring rain, without any concept and with short-term economic interest. Sponging on a state budget followed by subsidies' reflection to the final electricity price have been already solved by government and The Energy Regulatory Office. German and Austrian phobia from reliable nuclear power plants combined with a lust for generating an expensive and allegedly green energy and again combined with self-seeking investors to RES is a significant burden for a state budget and an attack to wallets of common people. The future doesn't seem very optimistic. Therefore there is a need to more think of our future, and less of today. As once Charlie Chaplin said: *„I am interested in my future because that is where I am going to spend the rest of my life"*.

BIBLIOGRAPHY

[1] Halásek, D.: *Odvětví služeb*.- Přerov: VŠLG 2010. 238 s.

[2] Kubín, M.: *Proměny české energetiky.* - 1. vyd. Praha: ČSZE, 2009. 615 s. ISBN 978-80-254-4524-2

[3] Heřman, J. a kol.: *Příručka silnoproudé elektrotechniky.* - 1. vyd. Praha: SNTL, 1984. 1032 s.

[4] Toman, P. a kol.: *Provoz distribučních soustav.* - 1. vyd. Praha: ČVUT, 2011. 264 s. ISBN 978-80-01-04935-8

[5] Tlustý, J. a kol.: *Návrh a rozvoj elektroenergetických sítí.* - 1. vyd. Praha: ČVUT, 2011. 254 s. ISBN 978-80-01-04939-6

[6] Mastný, P. a kol.: *Obnovitelné zdroje elektrické energie.* - 1. vyd. Praha: ČVUT, 2011. 256 s. ISBN 978-80-01-04937-2

[7] Tlustý, J. a kol.: *Monitorování, řízení a chránění elektrizačních soustav.* - 1. vyd. Praha: ČVUT, 2011. 256 s. ISBN 978-80-01-04940-2

[8] Ibler, Z. a kol.: *Technický průvodce energetika.* - 1.vyd. Praha: BEN–technická literatura, 2002. 616 s. ISBN 80-7300-026-1.

[9] Motlík, J. a kol.: *Obnovitelné zdroje energie a možnosti jejich uplatnění v ČR.* - 1. vyd. Praha: ČEZ, 2007. 183 s.

[10] Ibler, Z. a kol.: Energetika v příkladech. - 1. vyd. Praha: BEN–technická literatura, 2011. 383 s. ISBN 80-7300-097-1.

[11] Chemišinec, I. a kol.: Obchod s elektřinou. - 1. vyd. Praha: CONTE 2010. 383 s. ISBN 978-80-254-6695-7.

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APPLICATION OF MODERN INFORMATION TECHNOLOGY IN LOGISTICS

VYUŽITÍ MODERNÍCH INFORMAČNÍCH TECHNOLOGIÍ V LOGISTICE

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Abstract:

The application of modern information technology in logistics was the topic of the first international scientific conference at the College of Logistics in Přerov. The papers proved the wide range of applicability of IT technology in logistics processes and the presented ones confirmed the ability of logistics to take "on the fly“ the most modern means of the computing and communication resources so as to guarantee a constant increase in the quality of logistics services.

Abstrakt:

Využití moderních informačních technologií v logistice bylo tématem první mezinárodní vědecké konference na Vysoké škole logistiky o.p.s. v Přerově. Příspěvky dokladovaly široké spektrum aplikovatelnosti IT technologií v logistických procesech. Prezentované referáty potvrdily schopnost logistiky přebírat „ za pochodu“ nejmodernější prostředky výpočetních a komunikačních prostředků a zaručit tak neustálý růst kvality logistických služeb.

Keywords:

logistics, information and communication technologies, information systems, mobile technology, microelectronics, RFID, NFC, telematics, WMS, TMS, cloud.

Klíčová slova:

logistika, informační a komunikační technologie, informační systém, mobilní technologie, mikroelektronika, RFID, NFC, telematika, WMS, TMS, cloud

1. INTRODUCTION

The importance of the application of information technology in logistics has been growing. Logistics firms have to deliver more complex services. The firms are under pressure of the quality and speed of information flow requirements. Provided logistical services being extras recently are already average nowadays.

New information technologies are expected to bring greater benefits. Components of computer and communication technologies are becoming cheaper, a large variety of software tools appear at the market, there is a very rapid development of mobile platforms and a variety of other means.

For customers and partners of logistics companies there are web portals that allow data acquisition and tracking of shipments by the customer. There are complete systems for motion detection of transport equipment, measuring its basic parameters and the possibility of its visualization and retrospective reconstruction.

The deployment of smartphones and tablets deserves special attention. There are some possibilities of mobile applications for encryption in logistics processes. The possibility of monitoring of smart phones using GPS and thus to obtain detailed information about a position and perform direct communication with the device and a lot of other activities are available.

The application of information technology in logistics is very diverse as it comes out of the above mentioned.

We will briefly quote at least the most important findings presented at the conference.

2. INFORMATION SYSTEMS IN LOGISTICS.

Management of companies in current modern environment is under constant pressure of continues change and the need to make quick and qualified decisions. To handle the required management work asks for a range of tools and methods, the most important of which is the good information system (IS).

Information systems for logistics are at the forefront of our concerns. They are directed to production, logistics or distribution companies that are looking for simpler, faster and flawless ways of logistics activities. They are unique not only for internal logistics, but for the entire supply chain from suppliers to customers. They should be particularly flexible, built in a modular architecture; they should be open to the environment, especially in a situation where it is necessary to constantly create links to new customers and partners.

Nowadays firms acquire new information system (IS) primarily to reduce costs both the labour one and overheads. Therefore there is the stronger requirement for new IS to possess the optimization methods and the maximum of activities should be automated.

It is often difficult to estimate whether the proposed changes in the processes will lead to the expected effects. One of the ways how to reduce the risk of incorrect decisions is the use of advanced simulation tools based on the principles of discrete simulation. Optimization is especially useful in the area of collection and distribution of shipments, handling and movement of mechanization tools in warehouses and container terminals, or movements in the workplace.

Modern information systems for logistics should already have an integrated data warehouse, which brings a new dimension for work with data from the operational systems and looking at them. Data warehouses allow you to create dynamic reports and analysis. They are designed primarily for trade, marketing, controlling and management of these companies and their subsequent use for operational and strategic decision making.

Some small and medium-sized businesses with the aim of saving for the development and implementation of its information system take advantage of using a new phenomenon - cloud services (SaaS - software as a service). This solution ultimately may not be the cheapest, but the users of cloud services have less trouble in the final stage, they do not have to worry about functionality, IT infrastructure, updates, and others. They only pay for the lease of software services.

Mobile terminals (Wi-Fi) for wireless data collection and processing are an integral part of corporate systems. On-line solutions, where the terminal may share information with the desktop applications in real-time using the technology of bar codes or RFID technology, dominate in stock nowadays. The introduction of the mobile terminal brings a number of benefits, above all the reduction in the error rate of the services provided.

The smartphones represent new options for mobile data collection. On the market there are cheap smart phones that are capable of meeting the various phases of logistics processes and they can replace expensive specialized equipment, which do not have the ability to communicate with servers and information systems of the companies in real time. The big advantage is the easy development of software and its adaptation to the changing needs of logistics companies.

Integration of mobile devices into the corporate environment has its drawbacks and limitations. The key to successful commercial deployment of smart phones is not to introduce them across all the activities. After the careful evaluation of the benefits and losses for a given activity the mobile equipment are deployed only where they will be real benefit for a company asset. Now we notice some elements of information technology in detail.

3. PRESSURE ON THE MINIATURIZATION OF MICROELECTRONIC COMPONENTS

Increasing system integration in microelectronics is the key to the realization of advanced products and at the same time it is the source of necessary innovation. Constant pressure on the further miniaturization of microelectronic components is exerted. Interdisciplinary microelectronics passes into microsystems, which include the so-called MEMS (Micro-Electro-Mechanical Systems), MOEMS (Micro-Opto-and Electro-Mechanical Systems). Intelligent microsystems (Smart Microsystems), micro-optics and micro-mechanics appear. Currently, some of the mentioned technologies, but most in the near future, will find applications in various sphere of modern logistics processes.

In digital technology, we are often interested in computing performance which the given assembly is able to provide. Computing performance depends on many factors, such as clock (processor) frequency, bus width, quality and capacity of memory and others.

The original four-bit bus was quickly replaced by eight and then by sixteen bit bus. Currently, all of the "Smart" phones use the bus width of 32 bits.

In the production of microprocessors and memories the main players are Intel, AMD, Samsung, Global Foundries and others. With the development of processors for mobile devices around 2000 Intel abandoned the strategy of ever-increasing clock frequency, and began to develop the now widespread multicore processors with lower power consumption.

DDR4 SDRAM (Double Data Rate Synchronous Dynamic 4 Random Access Memory) is the direct successors of currently used type of operational memory DDR3. The architecture of DDR4 modules allows easier communication with the PCI bus.

At the same memory modules are equipped with multiple pins (DIMM - 284 and SO-DIMM - 256), the width of which is only 0.85 mm. Reduction of the structure make it possible to use higher frequencies and lower power requirements.

Among the first representative we include 4 Giga bits SAMSUNG chips, which are used for production of 16 GB and 32 GB DDR4 modules. At present however, the technology firms focused on a successor of DDR4 memory, which will be marked as GDDR5 and GDDR5 + (GDDR6).

The current development trend of semiconductor devices is estimated to be about ten years. From past experience of the semiconductor industry results that the new technologies have never released their hidden strength immediately. This happens only when the individual

devices have low production cost and they are provably incorporated into the functional system, which can be connected with the outside world.

4. THE IMPORTANCE OF MOBILE TECHNOLOGIES

Wireless transmission of information in the area of mobile devices is the fundamental technology. The general definition of a mobile device describes it as a portable device. In the context of communications technologies, the mobility is understood as the ability to communicate with other devices without wires.

Currently in logistics process in order to identify and track objects, the RFID (Radio-Frequency Identification) are deployed and also its modification to transfer information over short distances - NFC (Near Field Communication) gains ground.

It is known that RFID versus bar codes has many advantages. The most important advantages include providing significantly greater reading distance than it was with bar codes (up to tens of meters), and this distance does not require the clear line of sight. RFID technology can read several tags simultaneously. In contrast, the processing of goods identifiable by bar code means reading one by one.

A very important feature is that it allows writing or rewriting data stored on the RFID tag that can be encapsulated into any physical box. Tag may take forms such as stickers, plastic cards, buttons, key chains and the like. The physical form of a tag is very variable, tags can be placed in a durable housing that can withstand the most adverse conditions such as high temperature, radiation, chemically hazardous, dusty, or otherwise contaminated environment.

The difficult imitation and counterfeiting is another added value of RFID tag. While it is easy to print an exact copy of bar code, with RFID tags, the situation is somewhat more difficult to copy. RFID tag in itself can contain several levels of protection whose breaking requires specific knowledge and equipment.

NFC is an extension of RFID technology, while its main advantage is the current trend in implementation of NFC to common mobile devices. In general it can be said that NFC is a technology that has evolved from the original RFID with which it is backwards compatible and also share part of the technical specifications. The main difference compared to the NFC to RFID is usage only a single frequency of 13.56 MHz. RFID standards also specify extra bandwidth 134 kHz, 2.45 MHz and 960MHz. RFID technology is designed primarily for the purpose of identification, as a replacement for bar codes, while the NFC focuses in the field of application for the transfer of any data.

Very often RFID readers they are replaced by smartphones. This is partly due to reduced purchase price and, secondly, there is no need of another device. The actual load of information is done by the phone itself using the built-in camera. The smart phone is closely linked to the information system of logistics centre, and allows more effective processes, such as the tracing of important consignments or distribution planning. Information about the product and its history can be retrieved in the mobile phone from so called smart tag which is NFC tags equipped with a digital display unit. Using a NFC mobile phone equipped with application for programming smart tag it is possible only by „touch“ to transfer the necessary information about the shipment into the smart tag.

5. OTHER OPTIONS OF IT TECHNOLOGY IN LOGISTICS

By connecting information and telecommunication technologies with transport engineering and with the support of other related disciplines the field of telematics has successfully been developing. It acts as a tool for optimization of transport systems allowing an increase fluency and safety of transport, shortening travel time, reduce fuel consumption, simplify traffic management, etc. The most modern application of information and communications technology from the enterprise information system, internet, mobile systems, switching to applications based on wireless communication, and finally to the current deployment of intelligent phones - smartphones have been used.

Many transportation logistics company in connection with the use of modern information technology have been implementing so called Transportation Management System - TMS. As a rule, the system helps with the calculation of prices of individual shipments, tracking the movement of vehicles, vehicle crossings optimization, graphic transportation planning or checking the status of individual shipments and consignments on the dispatcher desk. This includes the integration of spatial information directly into the information system, and optimization of routes using advanced mathematical algorithms.

The modern information technology also support so called Warehouse Management System - WMS. These systems enable automated management of warehouse operations across all warehouse processes. The core of the system is the software completed with special hardware such as mobile terminals, wireless network printers, RFID automatic identification technology, and voice preparation and so on. They cover on-line warehouse management, they use optimization algorithms for loading and shipping, they register all processes in real time. The main benefit of WMS is the higher overall throughput and the acceleration of logistics processes.

5. CONCLUSION

This paper confirms the wide spectrum of utilization of IT in logistics. The explicit enumeration of potential use of IT technologies at different levels of the logistics chain shows that there is a direct relation between the level of deployed IT technology and the quality of the logistics process. Therefore, from the perspective of logistics the tracking of the further development of information and communication technologies is vital.

BIBLIOGRAPHY:

[1] RUKOVANSKÝ, I.; ČUJAN, Z. (eds.): Proceedings of the First International Conference on Application of Modern Information Technologies in Logistics. - VŠLG Přerov, 17 th September 2013, 136 pp., ISBN 978-80-87179-32-1.

[2] RUKOVANSKÝ, I.: Podkladové materiály k obsahové přípravě konference. Přerov: VŠLG, 2013.

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OPPORTUNITIES AND CONTRIBUTIONS OF SUPPLY CHAIN MANAGEMENT´S APPLICATION

PŘÍLEŽITOSTI A PŘÍNOSY APLIKACE SYSTÉMU ŘÍZENÍ DODAVATELSKÉHO ŘETĚZCE

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Abstract

The article contains system of supply chain management (SCM) not only in view of an information system, also widely describes system especially like an enterprise philosophy. The article describes opportunities and contributions in relation to an increase in a competitiveness and flexibility of enterprise and all of participating supply chain segments.

Keywords

Supply Chain Management, SCM, ERP, Flexibility, Competitiveness

Abstrakt

Článek analyzuje systém řízení dodavatelského řetězce (SCM), a to nejen z hlediska informačního systému, ale také široce popisuje systém, a to zejména jako filozofie podnikání. Popisuje možnosti a příspěvky ve vztahu ke zvýšení konkurenceschopnosti a flexibility podniku a všech zúčastněných segmentů dodavatelského řetězce.

Klíčová slova

Řízení dodavatelského řetězce, SCM, ERP, flexibilita, konkurenceschopnost

1. INTRODUCTION

The goal of many modern and prospering companies is to optimize internal processes and to reduce costs associated with them. The competitiveness of a company depends on the ability to involve management and employees in the optimization and ensure access to information and the status of each process. Today, perhaps no one imagine piles of papers and documents orbiting office. On-line information and automation processes in many companies provided by a suitable enterprise information system, in particular by the type of ERP (Enterprise Resource Planning). These software facilities of company integrate and automate most of the processes and provide transparent outcomes of their condition. In this way it helps to quickly respond to changes and better identifies further needs and business strategy.

The supply chain management is another important tool that helps to increase flexibility and competitiveness. Through the SCM (Supply Chain Management) the process time becomes shorter and confidence to customers increases. For example, SCM can be operated by itself or as a module and functionality already implemented enterprise information system, in particular the type of ERP.

2. SCM (SUPPLY CHAIN MANAGEMENT)

SCM can be euphemistically defined as a combination of art and science, which aims to improve all the processes needed to locate and track resources that companies need to create its product or service and to deliver them timely to customers. Other definitions describe the concept of SCM better:

"SCM - Supply Chain Management and networks - is a set of tools and processes that serve to optimize management and to maximize the efficiency of the operation of all elements (cells) throughout the supply chain with respect to the end customer. SCM systems are a concrete example of the interconnection suppliers with customers on the basis of information and communication technologies. Through networking and information exchange, partners in the chain (network) can collaborate, share information, plan and coordinate the overall processes to increase the responsiveness of the whole chain.[1]

"SCM is the designation for both managing supply chain management, and software for supporting this activity. It is usually a whole package of software that allows connections between the supply chain (supplier - manufacturer - distributor - retailer - customer), and this way it significantly improves its ability to respond to customer requirements, such as shortens the delivery time. SCM is nowadays often only one of the modules of a comprehensive ERP system.[2]

SCM can be understood as a designation for IS / IT application for managing of the logistics chain, which supports comprehensive planning, performance review and cargo control, storage of raw materials, tracking products from production to consumption .

SCM provides a comprehensive overview of the business. It supports strategic decisions and allows better focusing on the customer. The use of IS / IT significantly accelerates the production and exchange of business documents. The decisive criterion for supply chain management and aspects of the assessment of benefits is primarily the rate of satisfaction of the final customer, which provides a competitive advantage and higher financial income. Important role in promoting supply chain management is a flexibility, which allows modeling of the entire chain system, its features and links. SCM clarifies thus the logistics chain and the companies have better ability to analyze and predict customer behavior and quickly respond to the changes. SCM controls the information and material flow, processes linking all the activities of the company from purchasing to distribution or customer service.

SCM mainly integrates:

- Realization of production and production costs
- Strategy of stockholding, warehouse management
- Transfer of materials or products (including physical handling, transport, etc.), distribution network, optimization of nodes, distribution strategy
- Support processes (marketing, order processing, invoicing, payments), the sharing of information between partners, cash-flow (payment methodology, optimization of finance funds exchange)
- Optimization of Customer Service

Formerly rather linear supply chain (supplier - manufacturer - distributor - retailer - customer) was over time replaced by a more complex structure, creating complex relationships and community. The aim of the entire supply chain is to offer a faster, cheaper and competitive required product. Due to frequent outsourcing and the use of specialized companies that have a viable technology or know-how, is an essential to optimally manage, plan and organize processes of this relationship network.[1]

SCM includes five basic components:

1. Planning

Planning has a strategic share in SCM. Enterprises need a strategy for managing all the resources that aim to satisfy customers demand for their product or service. Much of SCM Planning includes developing a group of tools for monitoring the supply chain so that it is effective, less costly and providing high quality to customers.

2. Resources

Enterprises must choose a suitable supplier of the goods and services, they need for the creation of their product. Supply chain managers must develop a set of processes of negotiations and communications with suppliers and develop tools for monitoring and improving their relationships. SCM managers improve the quality of processes for inventory management of goods and services, income and control of supply, their translation to the manufacturing facilities and authorizing supplier payments.

3. Production

SCM managers schedule the activities necessary for production, testing, packaging and preparation for delivery to customers. This is the most intense part of the supply chain. Enterprises are able to determine the level of quality, production output and worker productivity at this stage.

4. Expedition

This is the part in which many SCM managers turning to logistics. Enterprises execute orders from customers, develop a network of warehouses, prepare means of transport to shipped products to customers and set the billing system and receiving payments.

5. Return

It can be the problematic part of the supply chain for many enterprises. Supply chain managers must create swift and flexible network for receiving erroneous and surplus products or packaging back from customers and support customers who have problems with products which were delivered.

Software for supply chain management is probably the most ambivalent group of software applications in the world. Each of the five main components of the supply chain, mentioned above, is made up of dozens of specific tasks. Many of them have their own specific software. SCM software makers gathered all of these processes and the individual partial software under one roof, but none of them offer a complete package that would be suitable for any company.

For many companies, it is important to monitor the demand and supply status, the status of production, logistics and distribution, in other words, the state of the process in different parts of the supply chain. For effective functioning of the supply chain is important **to share data with partners** throughout the supply chain and in ever increasing frequency. It is necessary to share correct data and data based on the reality of the process status. For example, if a user inserts into demand forecasts inaccurate information, gets vague answer. If the employee simply bypasses the supply chain system and try to execute the matter another way (using the fax or spreadsheet), then even the most expensive systems will provide an incomplete image of what is happening in the supply chain.

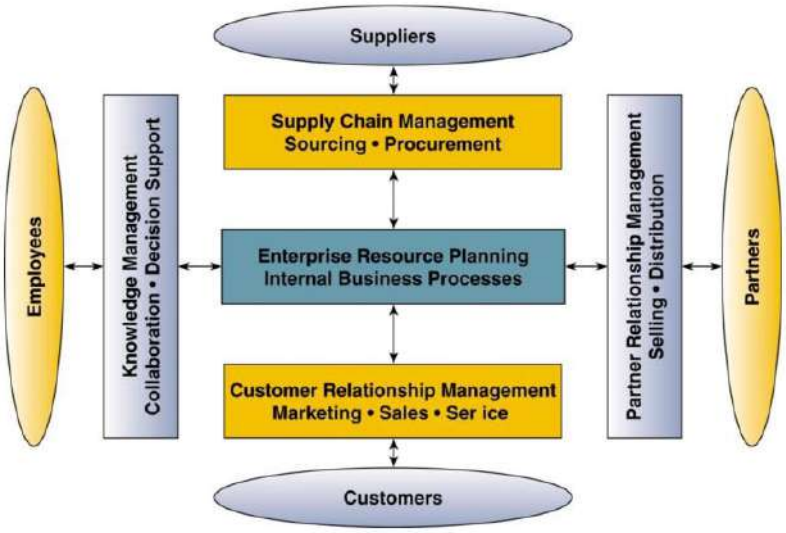
Relationship between SCM and ERP, CRM and Internet

Many SCM applications depend on the information stored within the software, ERP (Enterprise Resource Planning) and in CRM (Customer Relationship Management) in some cases. Theoretically, large companies may collect information needed for effective

functioning of the SCM applications from legacy systems (meaning, for example, the most commonly used system of a spreadsheet). It can be a nightmare for the user to get information flowing at high speed. However, ERP integrates all the information into one database and SCM application has a main source where it "goes" for updated information. The implemented ERP system is therefore the advantage.

ERP system solves all business processes, but for many companies it is expensive and difficult investment. Therefore, some managers look for other ways to provide information to their SCM applications. Now, however, most ERP vendors offer software possessing SCM modules, so it can be the implementation of ERP way to kill two birds with one stone. In addition, the rise and importance of CRM puts further pressure on the company to integrate everything into one enterprise-wide software package.

On current trends, it is important to pay attention to the software's ability to integrate into the Internet. If the company wants to create a web application for communication with customers and suppliers, will be required to disclose certain information from ERP and application of supply chain to enable to present updated information about orders, payments, deliveries and production status.



Source: O'Brien, James. Introduction to Information Systems, 12e, 2005

All tools should be accessible from the Internet, which adds a new quality to the whole project. This extension means that the solution is not available just to a great company, but even smaller companies can engage in mutually beneficial cooperation, can mutually coordinate and optimize their processes. Similarly, they can easily leave this connection. Freedom of choice of unlimited number of processes ensures maximum utilization of the partnership. Tools fully accessible from the Internet can be easily changed and adapted to the requirements without any disruption in the supply chain. [3]

Objective of implementation SCM software

Before the arrival of the Internet, the ability to predict demand and create a smoother functioning of the supply chain was limited. However, a cheap ubiquitous Internet's potential together with its simplicity and universal communication standards, opened wide possibilities.

Now enterprises can link your supply chain with the supply chain of its suppliers and customers and create one large network that optimizes costs and opportunities for all involved. This was also the reason for the explosion of B2B. Anyone who does business with some companies could be linked to the "one big happy family cooperating."

The reality is of course different. Today, however, most companies share at least some data with their supply chain partners. **The objective of the project is greater transparency in the supply chain**. The supply chain is a great card game in which the players do not want to show his hand because they do not trust each other. If they show hands, they could all profit in its chain. Suppliers should be able to estimate how much material have to order, producers could order only what they need and they could be sure that the contractor has enough available even in cases where the demand for their products rises unexpectedly. Retailers might have more profits, if shared with the manufacturer information to the sales of products in all their stores. Internet allows more to show cards, but distrust still complicates the situation. Over time, however, distrust is often overcome.

The benefit of timely and accurate information in the supply chain is the ability to produce or to send only the amount of product, which is necessary for the market. This method called just-in-time allows to companies to reduce inventory. It can also significantly reduce the cost, because you must not pay more for the production and storage of supernumerary goods. But still many companies and their supply chain partners have a long way to achieve high flexibility in the supply chain. [3]

Collaboration in the supply chain

As an example of cooperation we may use two companies that created the Supply Chain: Wal-Mart and Procter & Gamble. These companies have created an information system that combined P & G and distribution centers Wal-Mart. If the amount of P&G products in distribution centers decreases, the system sends an automatic alert to P&G to be sent more. In some cases, the system communicates directly with Wal-Mart, which allows P & G to check the racks through the secondary connection in real time. To manufacturers are sent messages always, when an item P & G is scanned by treasury. In recent years, improved relationships and communication technologies in particular integrates radio-frequency identification (RFID).

With these constantly updated information on products in stores is not needed to maintain the products accumulated in the warehouses. Billing and payments are realized automatically. The system saves time and order process costs. [3]

Implementation of supply chain software barriers

Automating the supply chain is extremely difficult, because complexity of the processes reaches beyond enterprise boundaries. Employees must change the way they work, as well as employees of each supplier within the established networks. Especially strong companies can take such a radical change. For example, objective of the company may be insufficient for others. It is necessary to take responsibility for inventory management throughout the supply chain. Managers and staff responsible for relationships with suppliers must be willing to do compromises and help all the partners achieve their goals. [3]

Resistance to change

Effective utilization of the supply chain is difficult outside and it's not much easier inside the company. Employees are accustomed to do business via telephone, fax, spreadsheet or notes "scribbled" on paper and they'll want to keep this standard way. Management must

convince employees that use SCM software that it will save them time and they will find an easier way to organize the various processes. [3]

Faults in the beginning

New supply chain systems process data as they are programmed. However, technology cannot absorb the company's history and processes in the first months after implementation. Tools for forecasting and planning must recognize that some information is good to "tune up". If employees are not notified of the initial naivete system, they will think that the data is useless.

For example, it may happen that just before the large automated industrial contractor installs a new application for forecasting demand, manufacturers place an order for an unusually large number of products. The system responds by predicting huge demand for the product, based largely on one unusual order. Blind following these outputs could lead to inaccurate material orders. Employees can lose faith in the system and can start working with your own data. The company must re-tune the system and start working again on trust employees. If employees understand that t**hey could combine their experience with increasing precision of system**, they begin to accept and use new technology. [3]

Extended Supply Chain

The extended supply chain is a way of describing all activities that participate in the manufacture of the product. For example, if a product of company is the printed books, then its extended supply chain should include factories, where the books are printed and bound, the companies selling the paper, producing of paper and material supplier of such companies, etc. For a company, it is important to track everything what is happening in its extended supply chain. It may happen, that a supplier or a contractor leaves the chain (as the old adage says: "A chain is only as strong as its weakest link"). For example, a fire at the mill might cause running out of inventory to the paper suppliers and others in the chain. If the books manufacturer knows what is happening in its extended supply chain can react in time and find another paper dealer. [3]

SCM phases

Management of logistics processes has its own history within the supply relationship, so the claim that SCM is the philosophy associated with the application of the Internet, is greatly simplified. Some publications have reported very interesting phase:

- **Phase 1** includes mainly reducing costs. Changing of processes is happened within the local improvement at the IT department and it helps in automating of certain tasks.
- **Phase 2** already connects teams and creates links among different departments. It focuses on improving the ability of order executing and customer service. Gradual communication through multiple functions helps to implement an effective information system. The outcome is in-time complete supply arranging.
- **Phase 3** is focused on creating an integrated enterprise and improving efficiency in the executing of orders. All processes and activities which are needed for executing the orders, are integrated on basis of ERP systems. The priority is monitoring of the total cost required for implementation of just-in-time supplies. This stage is typical for companies and it is completed by the using of internal intranets.
- **Phase 4** represents the extended supply chain, in which throughout electronic data interchange and internet it leads to an increasing of communication and process efficiency among the enterprises in the supply chain. The aim is to reduce the time and cost of processes. A customer is involved in the design and implementation of products.

- The last **phase 5** is a flexible arrangement of all partners in the supply chain network by processes which can be flexibly adjusted. The outcome is the optimization of processes and a measure is the value which the final arrangement provides to individual partners in the chain. This stage already uses all the opportunities which information technologies can provide. [1]

The impact of globalization on supply chain

The Just-in-time production is not only the way the companies were using to reduce supply chain costs. Production in developing countries is significantly cheaper than in developed ones, mainly due to the low cost of labor. Overseas production, however, has many difficulties. It is not easy to set up on- line data sharing with a factory in China with the factory in Europe, for example. There is also a large distance that goods must overcome. In addition there is an increasing risk of delayed delivery. International production brings a lot of uncertainty. The positive fact is the technologies, capable of tracking consignments, are getting better. The negative fact is these technologies are still very expensive. Lots of locations have not the necessary infrastructure. There is not also technology that can compensate whim of Chinese customs official. In addition, labor costs may not be in some places so low and IT automation and monitoring project costs can rise above efficient boundary.

Increasing of flexibility and competitiveness can be achieved by using therefore any system that increases the transparency of the whole supply chain. Application of the just-in-time production can be problematic in global scale, but by applying technologies and optimal selection of supply chain partners, who are willing and qualified to share data, an enterprise can thrive under these conditions.[3]

3. RFID TECHNOLOGY

While barcodes only identify the product, RFID tags can testify about what it is, where it was, when its expiration time ends - basically any information that you wish to insert into these labels. RFID generated data about the location of pallets, crates, boxes and individual products in the supply chain. Publish information about when and where the goods were produced, picked up, packed and transported. It gives information to merchants about expiration dates. They help to manage the warehouses. They help in financial and other enterprise systems. RFID technology in supply chain operations have spread to many manufacturers, suppliers and dealers.

The main benefit of RFID technology in the supply chain is an automatic reading. Truck carrying container of diverse goods entering into a shipping terminal is read by a sensor and place of moving the container or the information, which it contents, are automatically sent to users without the need a car slowed down. RFID adds a substantial amount of transparency in the supply chain.

Obstacles to the mass spread of RFID are still high cost of building infrastructure to manage RFID data and the lack of return on investment for many small and medium sized manufacturers involved in the supply chain. [3]

Influence of on-demand and SaaS software on supply chain management

These types of software obtained market in the product area of customer relationship management (CRM) and extend into the area of ERP. The reason why companies now prefer using of these SaaS (Software As Service) solutions than traditional on-premise software solutions is the speed of their implementation. Many vendors now offer advanced SaaS SCM products based on e-commerce. For supply chain managers and IT staff is using of SaaS software enjoyable, but in the area the SaaS software it is important security and return on investment.

Users are easy about the business applications are on-premise or in the cloud, user interface is their priority is the user interface. A transparent interface makes an access to information faster, makes communication more efficient and improves productivity. It is really the competitive advantage.[3]

The functionality of SCM solutions

Currently, SCM is focused on increasing customer satisfaction and offer e.g.:

- Possibility to configure the resulting product by the customer
- Permanent on-line providing of information about the order status to customer
- Eliminating the occurrence of delayed and incomplete deliveries
- Flexible interventions and solving of unexpected situations during the process of order executing throughout the supply chain

As mentioned above, the reducing costs and shortening time of order executing is beneficial for individual partners in the supply, and also:

- Improving the management of the entire process, including reactions to the changes and problems
- Elimination of "blind" spaces in process
- Opportunity of automating of purchasing activities
- The ability to share information about the current status of order
- Improving of collaboration and trust among partners

One of the most important functions of SCM is the ability and support of planning:

- Planning requirements in the chain on the basis of information from the history of the processes related to the opportunity of purchasing, production, distribution and transport
- Support for determining the optimal locations and forms of supply chain
- Integration of material requirements for e-commerce opportunities with aim to receive an offer from multiple suppliers [1]

The benefits of the SCM implementation

Enterprises, which are deciding whether they want to enter the supply chain or to purchase individual tools to manage this network, of course, they must solve the issue of the price, return on investment and benefits of integration into this network. Some enterprises statistics show that the use of SCM has been achieved:

- Improving customer service 5-25%
- Reduction of errors in forecasts 50-60%
- 10-50% reduction in inventory
- Reduction of 30-70% of the business cycle
- Increase productivity 25-30%

From practical experience, it is also apparent that the using of SCM can increase sales and reduce costs. In addition, these quantitative evaluations of benefits can include positive aspects as:

- Removing barriers in communication among partners
- The creation of effective relationships
- Organization and personalization of individual processes of mutual cooperation
- Synchronization of planning and implementation
- Eliminate redundant processes and elements [4]

The current state of IS in the Czech Republic

The obtaining the maximum from enterprise information systems is the effort of firms and suppliers. The development of the IS constantly grows. Many vendors currently offering SCM products, but they are increasingly a part of ERP systems and they are implemented throughout the software "package".

In the Czech Republic, for example, companies offer the software of ERP (SCM) systems: SAP Business Suite, Oracle, Microsoft Dynamics AX, Microsoft Dynamics NAV, ABRA, Helios.
For example, one of these - Microsoft Dynamics AX implemented in a manufacturing company with its lean manufacturing modules and controlled managing of storage and supply helps to optimize logistics processes and transparency. It includes tools for implementation methodologies Kanban, Just in Time, 5S, optimizes inventory levels, monitors production, shopping and logistic activities, reveals dangerous places.

4. CONCLUSION

The information systems for supply chain management and the system of supply chain management itself we can already find in plenty of enterprises and they are used fully and effectively. How it was mentioned in this article, effective using of IS/IT or SCM can´t be without trust, motivation and service in the shape of skilled employees interventions. The success of enterprise, which uses IS/IT tools or supply chain management, is related to experience and know-how of system´s users and increasing of the system´s accuracy.

References:

[1] Basl, J. - Podnikové informační systémy: Podnik v informační společnosti. - Praha: Grada, 2002, 142s, ISBN 80-247-0214-2

[2] Wikipedia – encyclopedy (online), Supply Chain Management. - Official web page, retrieved from: http://cs.wikipedia.org/wiki/Supply_Chain_Management

[3] Cio.com, Supply Chain Management Definition and Solutions by Thomas Wailgum (online). - Official web page CIO.com, 2013, retrieved from at: http://www.cio.com/article/40940/Supply_Chain_Management_Definition_and_Solutions?page=3&taxonomyId=3207

[4] System On Line, Supply Chain Management (Markéta Szabová, Petr Popruh) (online). - Official web page, retrieved from: http://www.systemonline.cz

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SURFACE MODELLING IN TOURISM

MODELOVÁNÍ PLOCH V TURISMU

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ABSTRACT

Tourism is inextricably linked with space, i.e. with the landscape. The landscape can be modeled and subsequently analyzed many ways. Surface modeling of geoscientific and anthropogenic variables is an initial step of analysis of possibilities to realize tourism activities. Formal concept of natural and anthropogenic objects is universal base of evolved method. The analysis and description of the structure and development of the fields of spatial variables is a starting step. For the representation of any study area (e.g. real terrain, energy and material fields, meteorological phenomena) can be use a variety of approaches. Selection of the appropriate procedures is rather complicated question. It depends on both the amount and the reliability of the original data and on character and complexity of the studied field. Spatial modeling with subsequent analyzes can show actual use and potential possibilities of interested area.

ABSTRAKT

Cestovní ruch je neoddělitelně spjatý s prostorem, tedy s krajinou. Tu lze modelovat a následně analyzovat mnoha způsoby. Povrchové modelování geovědních a antropogenních proměnných je prvním krokem analýzy možností realizace turistických aktivit. Formální pojetí přírodních a antropogenních objektů je univerzálním základem rozpracovaných metod. Výchozím krokem je analýza a popis struktury a vývoje polí prostorových proměnných. Pro prezentaci jakéhokoliv studované oblasti (např. skutečného terénu, energetických a materiálových polí, meteorologických jevů) lze použít různé přístupy. Výběr vhodných procedur je poměrně složitá otázka. Záleží jak na množství a spolehlivosti původních dat, tak na charakteru a složitosti studovaného pole. Prostorové modelování s následnou analýzou může ukázat skutečné využití a potenciální možnosti zainteresované oblasti.

KEY WORDS

Surface modeling. Geosciencific and anthropogenic variables. Formal concept. Structure and development of the fields. Selection of the appropriate procedures.

KLÍČOVÁ SLOVA

Plošné modelování. Geovědní a antropogenní proměnné. Formální pojetí. Struktura a vývoj polí. Výběr vhodných postupů.

1. INTRODUCTION

Most of the activities connected with tourism are associated with certain territorial entities that are characterized by specific features such as interesting ecotope or habitat, abundance of minerals, fossils, plants and animal species, mineral springs, interesting and historical buildings, archaeological sites, etc. Territorial terms and conditions thus created a non-uniform due to the nature of the geographical environment, a complex multidisciplinary system, in which takes place all the processes associated with tourism. For the most objective approaches in evaluating the potential of tourism can be considered synthetic approaches to evaluation, both natural and cultural-historical potential (Zvara, 2010).

In general it can be said that tourism is inextricably linked with space, i.e. with the landscape. The landscape can be modeled and subsequently analyzed in many ways, from the formal geodetic approach, statistical and geostatistical means, methods of mathematical morphology to geographic information technologies. Among the natural assumptions that play an important role in the localization of tourism activities include the overall appearance of the landscape, covering the type of relief, climate, hydrology (water flow and surface), natural medicinal resources, types of vegetation, character fauna and flora, etc.

An essential component of the study, therefore, is a surface modeling of geoscientific and anthropogenic variables as an initial step of analysis possibilities to realize tourism activities. There are many methods of study of morphology and structural properties of arrays of these variables. Therefore, the principles of possible techniques are given below, together with the principles and applications of potential limitations.

1. FORMAL CONCEPT OF NATURAL AND ANTHROPOGENIC OBJECTS

Any natural object (geoobjects) or anthropogenic object can be thought of as quasi-homogenous random field V, i.e. the part of the geographic space-time

$$\{ X,Y,Z,T;\ G_1, G_2, \dots , G_n;\ A_1, A_2, \dots , A_m \} ,$$

X, Y and Z are spatial coordinates, T time, G_1, G_2, … , G_n set of determining geoscience variables and A_1, A_2, …, A_m set of anthropogenic variables. Every point $v \in V$ with coordinates (x, y, z) belongs certain values of variables U_i that characterize a given object, such as the values of physical, socio-economic and technological variables, etc., i.e.

$$\forall\ v_{x,y,z} \in V \quad \exists\ u_k \in U_k$$

being understood that

$$u_k = f_k (X,Y,Z,T;\ G_1, G_2, \dots , G_n;\ A_1, A_2, \dots , A_m) + e_k ,$$

where e_k is a random component. Usually, the spatial distribution of variable values U_k is expressed as some function of spatial coordinates

$$U_k = f_k (X,Y,Z) ,$$

while outside of the field V shall take at least those variables U_k, on the basis of which the object was defined values smaller or larger than a certain limit values for ε_k (e.g. threshold thickness, the minimum number of people for the definition of the minimum number of trees per unit area in the definition of forest, minimum capacity of services at the center, etc.). Often, for purposes of determining the boundaries of the object defines a geometrical function of membership of point v to the body V

$$g\ (v) = \begin{cases} 1 \dots v \in V \\ 0 \dots v \notin V \end{cases}$$

If required to describe temporal changes in the characteristics of objects (e.g. the development of the natural environment, floods or landslides), we use the expression by using spatial coordinates and time

$$U_k = f_k (X,Y,Z,T) .$$

Expression of variables values as a function of the determining factors

$$U_k = f_k (G_1, G_2, \dots , G_n;\ A_1, A_2, \dots , A_m)$$

is generally more difficult and is used e.g. for forecasting natural potential in models of landscape evolution, the study of the state of biological communities in the assessment of socio-economic and epidemiological parameters, etc.

Data on spatial interactions are difficult to access, particularly for larger territorial units. Practically the only generally available data sources, data on migration of population, specifically travel (commuting to work, to school, shopping or tourist traveling), data on production and accommodation capacities, economic data, etc can be. Problems with the data by Halas and Flaps (2010) to overcome both a poll survey (what a difficult realization), and modeling. The advantage of the second method is that it can be applied practically on any area. The question remains, however, how the results of modeling correspond to reality.

3. MODELING OF SPATIAL FIELDS

One of the basic tasks is the analysis and description of the structure and development of the fields of spatial variables. The tasks of analyzing the field for the needs of modeling include a description of continuity, homogeneity or non-homogeneity, stationarity or non-stationarity and isotropy or anisotropy field. Some of these tasks can be solved using statistical techniques (e.g. definition of statistically homogeneous areas of the field, anisotropy field study using the directional variability analysis, etc.), a comprehensive solution is based on geostatistical structural analysis, i.e. the analysis semivariograms, which contain all the necessary structural information.

The representation of any study area (e.g. real terrain, energy and material fields, meteorological phenomena) can be use a variety of approaches (Fig. 1). Approaches to spatial fields modeling, which are a regular part of data analysis in all disciplines - thus in tourism, can be used in accordance with the principle divided into several groups, namely at:

a) deterministic partitioning and description (tessellation and triangulation);
b) statistical description of the quasi-homogeneous areas;
c) description by global functions (trend analysis);
d) description by local functions, namely the type of interpolation procedures

- moving weighted linear estimation (e.g. methods IDS)
- procedures of smooth surfaces (spline functions)
- geostatistical method named kriging.

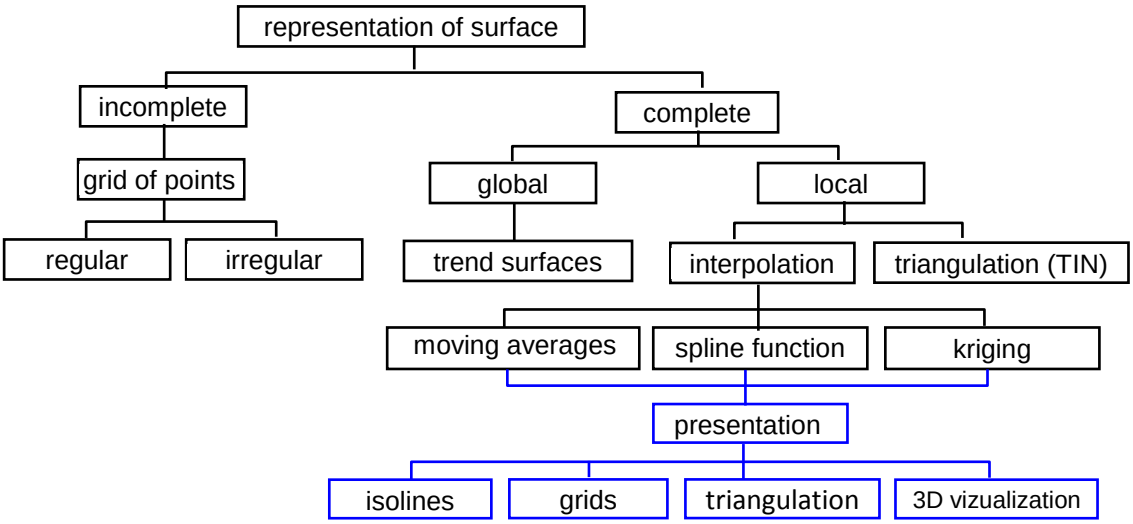

Fig.1 Methods of analysis and presentation of areas of geographical, physical and material variables

Description of the field is based on the geometric division field according to zones of influence of each observation point (tessellation), or divided into triangles connecting the observation point (triangulation).

Voronoi or Dirichlet tessellation is a method of decomposition of a metric space determined by the distance to the discrete set of objects in space, such as a discrete set of points. Shortcomings of this method are evident. Each estimate of formed polygon is based on only one value, i.e. although the phenomenon under review continuous, the resulting structure will always discreet. Another problem is that the polygon boundary points are theoretically infinite space, so they must therefore be cut off outside the study area.

Delaunay triangulation can be generally defined as follows. Let is given n points in the plane. Let us join is not intersecting lines so that each area of internal convex hull formed a triangle. The set of these triangles is called triangulation. The method of triangulation is therefore based on the generation of an irregular triangular net. It is desirable that the triangles are formed the most equilateral. Another desired characteristic of the triangulation process is to be produced clear triangulation independently of the starting point or the direction of a data set. These results will be predictable and easily repeatable. If you perform these steps, each triangle should best represent the local value of the surface. Thus it can be constructed e.g. a topographic surface model, or processed by linear interpolation map of isolines.

Statistical description after quasi-homogenous areas is based on the traditional way of describing the examined objects in geosciences. The studied field is described in sections whose boundaries can be determined by factual aspects, such as the borders of rock or biotic complexes (forest, field, meadow, etc.), tectonic units, land area, zones of significant changes in field values, etc.). After defining quasi-homogenous blocks must be examined statistical homogeneity of appropriate selection using statistical criteria, and then each j-th block characterized by the usual statistical manner, i.e. estimates of mean E_j (U_i), variances D_J^2 (U_i) and relationship of variables U_i, (i = 1,2,...,m) of each j-th part of the field. It is clear that the stability of the solution in this case ensures researcher its erudition and knowledge of the particular problem.

In the description field by global functions is considered planar or spatial distribution of variable values as the function of location, i.e. the regression function of areal or spatial coordinates. It is basically interleaving a certain surface by set of experimental points. The most widely used type of so-called trend analysis is usually based on a manifold polynomial regression model which is interleaved through a set of experimental points (areally or spatially localized observations) by the method of least squares. Less frequently is used model type of polyharmonic function. Choice of a suitable type of regression equation is a serious problem and the solution is rather subjective character. Theoretically it should reflect factors that control the spatial distribution of values studied variables. In practice, based on a visual comparison of the resulting trend map with input data as maps, residue and evaluation of some statistical indicators-fit trend surface to the experimental data (e.g. index of multiple correlation and determination, test the statistical significance of members regression model, the minimum sum of squared deviations, etc.). They compare to a solution with gradually increasing the degree of the polynomial according to these criteria, sometimes using the mosaic trend (division into sub-surface). To select the "best" form of the regression equation is the most appropriate procedure combined stepwise regression.

In the description field of by local functions to create morphology of empirical curves or surfaces using gradual interpolation or approximation functions whose coefficients are derived from observations in the sub-sections of the field. Frequently used procedures are moving averages and related approximation formulas (e.g. Sheppard or Spencer). A very common practice is the inverse distance method. It is a weighted average, in which it acts as a observation weight a certain power of the inverse of distance d_i observation u_i from the point estimate of u^*. This procedure gives at roughly evenly distributed points of observation very good results. Problem represents "clusters" of points, anisotropy properties of the object and the existence of discontinuities. Therefore in the calculation are introduced various modifications, such as quadrant or octant tests or define the selection area of values for estimating as an ellipse of anisotropy.

In addition to these procedures also use methods based on interpolation of *smooth surfaces* that require continuity of interpolating function and the specified number of derivatives. Usually, methods of thin plate are applied. A common approach is to use cubic *spline functions*, while continuity of local functions at the border of field sections ensures their first derivative and minimum curvature second derivative. *Multiquadric method* is based on the assumption that any irregular continuous surface can be expressed with some accuracy by sum of partial regular functions (in this case quadratic).

Selection of a suitable type of interpolation procedures is a serious problem. Therefore, it is necessary to verify its suitability using the boomerang test (also the method of "Jackknife").

Kriging methods are based on the theory of random functions. For surface modeling is applied point kriging. The result is a regular grid of estimates as a basis isoline or three-dimensional model space. The essential advantage of this procedure is that it is based on the structural characteristics of the field (homogeneity, anisotropy, stationarity) and respects the spatial distribution of the observation point. An important prerequisite for success is a reliable valuation of structural function (usually semivariogram).

The problem is the possible existence of discontinuities in the surface. If these "embedded systems" do not affect the original character of the distribution of values is useful them in modeling eliminated. Otherwise, it is necessary to divide the field into sub-segments.

The advantage of kriging estimate is that respects both the structural character of variables spatial distribution describing the object and distribution and density of reconnaissance system.

Kriging procedures are a standard part of modern software products. The calculation is after entering the required parameters automatically implemented. The only problem is the evaluation of the character field using structural analysis, which requires the active cooperation of professional solvers.

4. MODELLING OF STRUCTURAL ELEMENTS OF FIELDS

Detection and modeling of structural elements of studied fields (borderline and skeletal structures) based on the methods of filtration, respectively mathematical morphology. For given purposes are used upper gate type filters and directional filters, often in combination with thresholding are used.

The specific nature of the analyzed data requires the use of spatial analysis. In principle, the definition and original resolution of spatial patterns, clusters, relations, etc. due to their absolute and relative position, i.e. implementation of the various transformations,

expressed in the areal (pixel) or spatial (voxel) unit may be applied. Operators of transformation are functions of map algebra, mathematical morphology or any classification or reclassification of spatial objects by selected aspects. The procedures of image analysis can be divided into two groups namely on the point and areal transformations. Point transformation involving the direct edit values of each elementary unit area (pixel) of the original field to the new value using transformation function, whereas the resulting value of areal transformation depends on the value of adjacent pixels.

A simple type of modification is the transformation of data layers to a binary array - thresholding, i.e. transfering of the field into two classes in search of border between partial regions. The bound is defined on basis of the observed frequency histogram of pixel values of the studied original field. It requires to make the separation of mixed distribution, which is not in the case of close subpopulations (close averages or large variances) simple. Therefore, it is often used empirically determined threshold by solver. Thresholding is usually used in combination with other methods of transformation field, such as various types of filtration field.

Common operation map analysis of raster data is field filtration. Essentially it comes to convolution of field around evaluated grid cells (pixels). There are basically three types of filters namely low-pass filter that reduces the contrast field, high-pass filter highlighting the details field and band-pass filter, which enhances the array elements in a certain direction. Filters are also known as core (kernel) function. The basic filter types may be amplified in different ways using weights of transformed pixel. Very often are used combined weighted filters.

Filtration of field is a standard procedure for processing digital images of remote sensing, as it allows the elimination of unwanted noise on one side and highlighting differences and emphasize object boundaries and lines on the other. This increases the reliability of the identification of objects and the possibility of their classification according to selected criteria.

A strong tool for image analysis provides a mathematical morphology, which is essentially based on set theory. Allows you to search and analyze structural elements of the field using edge detection, thresholding, skeletization, dilation, erosion, etc. Transformation of field is always in some local neighborhood of each pixel called structuring element (square, cross and other).

There are basically two types of morphological transformation, namely binary transformation and transformation of gray scale. Most morphological operations is based on simple operations using five primitive operators and this dilation, erosion, intersection and negation, combination of which allows to create more complex operators and perform morphological analysis and reconstruction.

5. OBJECTIVES TERRAIN MODELING

Choice of procedure for processing has heuristic nature. Application of these procedures requires regular square grid of values of the studied field, respectively. transferring to it. This way we can make surface analysis - terrain model, which is determined by:

- Slope and slope direction - for grid model is output a new raster layer, for triangular irregular network (TIN) these data are available basically implicitly. Data analysis of slope inclination and direction are quite important as an input for further analysis such as weighted distance, demands of hiking trails or erosion analysis.

- Morphological analysis - finding of local minima and maxima, convexity and concavity. The output is the point layer containing the above elements, which are used to study and description of the terrain geomorphology or the development of the analyzed variables, the selection of tourist attractions, etc.
- Analysis of the field illumination - enables calculate the amount of light on the given site. Its application is suitable for example to analyze selection slopes for locating tourist facilities, searching the best location for growing wine, etc.
- Visibility analysis - identifying areas visible from a particular point.
- Creation of contours - it is a transfer between representations: a digital terrain model (DTM) to vector lines.
- Generation of profiles - using DTM is possible to calculate the profiles of line elements.

6. CONCLUSION

Tourism is inseparably linked to landscape. The landscape can be modeled and subsequently analyzed means of geographic information technologies (O'Looney, 2000). Selection of the appropriate procedures of local estimates is rather complicated question. It depends on both the amount and the reliability of the original data and on character and complexity of the studied random field. We must also take into account the influence of researcher competence (his erudition and experience). It is also necessary to distinguish assessing suitability for treatments which ensure compilation of interpolation or buffer surfaces. Very common is the depiction of surfaces in the form of contour lines, ie lines connecting points of equal value of continuous variables (physical, sociometrical or other). Spatial modeling with subsequent analyzes can show the disproportion between actual using and potential possibilities of interested area.

REFERENCES

Čerba, O.: Databázové systémy GIS. - *Západočeská univerzita, prosinec 2003 - únor 2004. Dostupné na <http://gis.zcu.cz/studium/dbg2/Materialy/html/index.html>*

Klokánek, M.: Digitální modely terénu. – *MZLU, Brno. ISBN 978-80-7257-982-3. 2008*

Lloyd, CH. D.: Local Models for Spatial Analysis. - *CRC Press, New York, ISBN 0-4153-1681-2. 2006*

Machalová, J. - Vajčnerová, I. – Ryglová, K.: Prostorové modelování předpokladů rozvoje cestovního ruchu s využitím geografických informačních technologií.- *Acta universitatis agriculturae et silviculturae Mendelianae Brunensis, roč. LVIII, č. 6, 2010*

Novotná, M.: An evaluation of the conditions for the recreational explotation of the region (Geografická analýza mikroregionu Vimpersko). - *In: Sbornik referatů z 10. ročniku konference GIS. Ostrava 2003.*

O'Looney, J.: Beyond Maps: GIS and Decision Making in Local Government. - *ESRI Press, USA. ISBN 1-879102-79-X. 2000*

Schejbal, C.: Comparison of the trend analysis models with models of moving weighted average surfaces and their stepwise optimization. – *Symposium Hornická Příbram ve vědě a technice, sborník sekce Matematické metody v geologii, Příbram, 1975*

Schejbal, C.: Data, teorie a modely v logistice cestovního ruchu. - *VŠLG Přerov, 2011, ISBN 978-80-87179-15-4*

Schejbal, C.: Optimalizace produktů cestovního ruchu. – *VŠLG Přerov, 2011, ISBN 978-80-87179-11-6*

Zvara, J.: Evaluation of partial potentials and assumptions for recreation aand tourism in the south Moravian region. – *XXII. Sjezd České geografické společnosti, Ostrava 201*

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THE USER INTERFACE OF CURRENT OPERATING SYSTEMS

UŽIVATELSKÉ ROZHRANÍ SOUČASNÝCH OPERAČNÍCH SYSTÉMŮ

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Abstract:

We are currently witnessing an unprecedented boom in the development of operating systems, whether for desktop or smart phones, that consistently brings new possibilities of usage for computer operators. In order the users are able to apply the maximum extent of the provided computers functions, tools - called user interface - are embedded between the user and operating systems (OS). The user interface enables clear and effective utilization of computational resources of the machine and it differs for the individual operating systems.

Abstrakt:

V současné době jsme svědky nebývalého rozmachu rozvoje operačních systémů ať již desktopových, nebo smartphonových, které trvale přináší nové a nové možnosti využití pro uživatele počítače. Aby uživatel byl schopen v maximální míře uplatnit operačním systémem nabízené funkce počítače, jsou zpravidla mezi uživatele a OS vloženy prostředky - zvané uživatelské rozhraní - umožňující přehledné a efektivní využití výpočetních kapacit stroje. Uživatelské rozhraní se u jednotlivých operačních systémů liší.

Keywords:

User interface, operating system, WIMP, Metro, Aero, Aqua, Symbian OS, Android, Windows Phone

Klíčová slova:

Uživatelské rozhraní, operační systém, WIMP, Metro, Aero, Aqua, Symbian OS, Android, Windows Phone

1. INTRODUCTION

User interface – UI on the PC is usually a set of certain displays and controls that the user uses for clearly control of the course of the entire system. The operating system provides the basic services of the user interface for communication with the user.

Communication in relation with the human being – the computer running through the user interface is interactive in nature, as the user enters inputs which are to be executed by the computer (tasks, requirements) and the computer evaluates the optimal outputs which are presented through the user interface towards the user (executing of the action, starting / closing applications).

The user interface significantly affects how the system will be successful and useful. Within the text UI, interaction takes place through the commands of the defined language that the user must master (e.g. a command line). Graphical UI facilitates the user work with the program through the graphical presentations such as windows, dialog boxes, icons, menus,

and other graphical elements; the user does not have to know the commands and their syntax to communicate with a computer.

The voice user interface uses a user´s voice input through a natural language and the system responds to them by the output in the audio form. The Braille line is one of the output devices which are used by blind users working by touching and hearing. The information is displayed using the Braille alphabet and the most commonly used variant is the eight points one (this is due to the single character compatible with one byte). There are still a number of other specific interfaces which hereafter will not be analysed.

2. TYPES OF USER INTERFACES

2.1 The graphical user interface

The Graphical User Interface (GUI) is a user interface that allows you to control the computer using interactive graphical controls. The user uses the keyboard, mouse, touchpad input and graphical elements such as menus, icons, buttons, scroll bars, forms and others. Through the use of icons and other auxiliary elements the device on which the interface is, can comfortably be used by any user.

GUI is usually used in computers, mp3 players, portable multimedia players, mobile phones, digital cameras or cameras, gaming devices and navigation devices, etc. GUI provides a consistent visual language that represents information stored on your computer. It enables the users with less computer knowledge to use the computer software and even the entire operating system in an easy way. WIMP (Windows Icons Menus Pointing device) is the most common combination of these elements in a graphical user interface technology. These elements are usually embedded in the system by widgets.

The basis of today's user interface is the concept of the main means of interaction between the user and the computer abbreviated WIMP - which is a technology that allows controlling the computer using the elements.

Window (s). In computer terms, with this expression, we call the area that shows the output data from the computer and at the same time they allow the user to control running processes. The term window is mainly used in conjunction with a graphical computer output that makes it possible to communicate with the computer using a cursor controlled by a computer mouse or other pointing device.

Pointing device (s). Commonly, this involves a computer mouse or touchpad. Sometimes the letter P is used for the word „program“.

Widget (s) - is the basic element of the computer for the interaction of the program with the user. The control element is visually designed and is typically used to manipulate the data in the program. Various implementations of these basic elements are usually bundled in the widget toolkit that programmers use to create the user interface. A similar concept (but in a different way) provides desktop widget which is a small specialized GUI application that provides some visual information or offers easy access to frequently used features and applications, such as displaying a clock, calendar, news, calculator, weather forecast, etc.

Nowadays, the GUI is known to most people primarily as a system of Microsoft Windows family or Mac OS X used on computer systems, notebooks, or like Symbian, BlackBerry OS, Android, Windows Phone, Palm OS / Web OS used for mobile devices. [7, 8, 9]

2.2 Text user interface

Text User Interface (TUI) is the user interface that represents an intermediate step between a command line interface (CLI) and graphical user interface (GUI). It works in the text mode, where the screen is divided into a fixed grid (columns and rows), while in each position at most one character from a given set (ASCII, EBCDIC, etc.) can be displayed. Using special characters (parts of the frame, the mouse pointer) the similar control elements as in the GUI are designed, so the environment contains windows, menus, buttons, sliders, scrolling lists, and more common elements in the GUI. [10]

2.3 Command line interface

Command Line Interface (CLI) is the interface in which the user communicates with programs or operating system by writing commands in the command line. Unlike a text user interface and a graphical one, it does not use a mouse or menu and it cannot work with the whole screen (terminal). The users type the command, which should be executed, and then they press the key “Enter“. After the key “Enter” has been pressed the command will be executed and the computer will display the result. [11]

3. THE USER INTERFACE MICROSOFT WINDOWS

Windows 1.0 – provided a simple graphical interface in which most programs originally designed for DOS could have been run.

Windows 2.0 emerged later.

Windows 3.0 and 3.1 - brought an improved user interface and CPU utilization. The programs written for MS-DOS could have been run in the window. The opening of applications with the help of the command line has been replaced by the opening of programs via File Manager based on icons, which resulted in an easier start of programs. The system includes a simple aplications such as Word, Painting and Calculator.

Graphical superstructure for Microsoft Windows 3.1x provides a graphical user interface that allows to represent programs as icons and to ensure that they are easy to run by users. The programs present their output in windows and there are buttons, input fields, menu controlled by a computer mouse.

In 1995, Windows 95 comes and brings the change of the appearance of the graphical interface, which brought more intuitive control and the higher interest of users. Windows 95 also included support for TCP / IP, which meant direct access to the Internet without auxiliary installations and the ability to detect and to configure new hardware connected to the PC automatically. (Plug and Play - used till nowadays).

The next release of the Windows 98 (1998) added support for USB, automatic updating of the computer, Internet Explorer 4.01, the Quick Launch toolbar and more.

Windows ME (Millennium Edition) - It is more or less improving existing Windows 98 and it is the last system running as an extension of the MS-DOS. It assumes the new look of Windows 2000 and some new functions such as Universal Plug-and-Play, System File Protection and Automatic Updates. In order to make the user interface more pleasant it contains (compared to Windows 2000) some other application or functions (Internet Explorer 5.5, Windows Media Player 7, Windows Movie Maker ...)

Windows XP - (2001). It is designed for general use at home or business personal computers, laptops and media centers. The acronym "XP" refers to experience. Windows XP have the modified appearance of the graphical user interface and a redesigned Start menu. Number of other items (different control panels, the login screen) was also adapted. The

possibility of fast switching of users, function of remote assistance, integrated support for burning CD / DVD and others were included. [12]

Windows Vista - (2007). The designation „vista" means views (one of the definitions is a mental view of a succession of remembered or anticipated events). In the basic structure of the operating system there were implemented major substantial adjustments, which include, inter alia, new graphics and audio subsystem, better support for software installation. The completely redesigned graphical interface called Aero appears in Windows Vista and it uses 3D computer graphics. It supports transparency of windows and menus, three-dimensional animation, icons tailored to a higher resolution, etc. In Windows Vista the completely new implementation of a set of computer network protocols is covered. It contains more complete IPv6 support, the built-in support for burning DVDs, enhanced file encryption, etc. [1, 2, 13]

The operating system Windows 8 is the successor to Windows 7; it was introduced in 2012 as the newest OS from Microsoft. It is designed for use in desktops and portable computers including tablets. The version of 32-bit and 64-bit for the processors x86 and version for ARM processors used in mobile devices have been released. The Windows 8 is based on Modern User Interface Metro. It is an environment that seems to be rather more for the control of mobile devices - mobile phones and tablets. As a result, it is often the target of criticism

because it does not enable to work with more applications simultaneously (multi-tasking) as comfortably as it is in the Aero. In the system applications the pull-down menu Ribbon has been extended and it is to replace the classic text menu and it has already been used in some applications of Windows. [4, 14, 15]

4. LINUX OPERATING SYSTEM

This is an operating system based on the principles of Unix systems. It is freeware so you can freely use, modify, and distribute it. There are many Linux distributions such as Suse, Ubuntu, Fedora, Redhat. According to the chosen distribution it is necessary to apply the specific installation.

Most distributions, however, offer both textual and graphical installation.

With installation we usually install not only the operating system itself, but also all the software needed to use the computer. The installation usually takes place in a few steps.

The programs installation in Linux (in general) is fundamentally different from the way of installing programs in Windows. You do not have to browse through the websites of the programs and look for the installation files. In Linux there are some sort of central software libraries and programs that can work with these libraries.

Software Centre is an essential tool for installing and removing programs. Its interface is very simple and easy and even the novice will learn to work with it very quickly.

The installation package (in Ubuntu suffix is .deb). It is similar to the setup of exe file in Windows and it contains the programs of the file.

Source repository is mostly on the Internet and it contains hundreds of thousands of packages (Ubuntu contains several tens of thousands). Sources are designed to suit a specific issue and allow the system easy to install and update all the installed programs.

In Linux there is the super user called the root. An administrator in Windows is a version of the root as the administrator of the computer can do absolutely anything, its routine

use is very dangerous; just misspell a command may crash the whole system. In some cases it is necessary to use the root account but in most cases –for the classic work the ordinary user is enough. By default, the root account is locked. Computer Management can be performed by a user created during the installation (that is the first created user) using the sudo command.

The user interface in Linux is based on commands. Almost every guide you find here contains instructions to run a command. To run the commands, there is a program called Terminal. The terminal is also often called the command line, shell or console.

To work with the command line does not require any special knowledge; it's like any other program. In Linux, most things can be done from the command line. Although most applications have a graphical interface, sometimes it is just not enough. Using the command line is often faster and easier than a graphical interface.

It is worth installing a file manager (Midnight Commander-MC), which runs in text mode. It contains a lot of functions, including a built-in text editor, support for FTP, SSH, browsing files, etc. It can also be useful in the case that you are unable to start the graphical interface.

A graphical file manager (Nautilus) serves for the work with files. It can be run immediately after installation with double-click the icon on its home folder in the sidebar. Working in Nautilus is very intuitive as you are basically just dragging the icon with the mouse and clicking. Nautilus creates live previews of text files, images, videos and documents. It can work with bookmarks, can connect and disconnect the archives, restore files from the bin. It supports intelligent selection and copy files, plugins and others. [3, 6]

5. USER INTERFACE MAC OS X

Apple’s Mac OS X has been the latest operating system for Macintosh computers since 2001. Earlier - since 1984 Apple had used Mac OS for its Macintosh computers.

The current system originated as a combination of several different technologies. The base of the system is called Darwin (OS of UNIX mode with open source code from Apple Inc.) and it is composed by a hybrid core Unix-like type XNU along with BSD (Berkeley Software Distribution), GNU and other open source tools. Above the core there is a set of libraries, services and technologies that are taken mostly from the previous operating system Mac OS.

The graphical user interface is called Aqua and it was developed by Apple Company. Mobile phone Apple iPhone, multimedia handheld iPod touch and iPod tablet use the corrected version of Mac OS X named iOS.

Mac OS X is fully adapted to Macintosh computers. Although the Mac can run Windows, the reverse is not possible. The Apple policy - the development of the hardware and software eliminates the problem of incompatibility. Apple does not intend to allow running Mac OS X on a PC (x86-based computer that is not electronically identified as a Mac). However, it is possible to run (illegally) operating system Mac OS X on some PC. [16]

6. OPERATING SYSTEMS FOR MOBILE PHONES

The first operating system in mobile phones Symbian was from the same named company, which was later taken over by Nokia. It appears in several versions for touch phones. In the newer touch phones the version Symbian Anna was widespread and it was then replaced by another version under the name Nokia Belle.

Approximately five years later after Symbian, the platform Android developed by Google comes into the world. This is an operating system designed for mobile phones and also for the tablet computer. The mobile phones use most widely the version 2.3 called Gingerbread and 4.2 Jelly Bean. The versions are particularly dependent on the hardware of the phone.

The newest currently available operating system for mobile phones is Windows Phone. It was released in late 2010 by Microsoft.

Each operating system has its advantages and disadvantages as well as supporters and opponents. [17, 18, 19]

6.1 Symbian

The actual operating system Nokia Belle came after a big revolution and the entry of Android, which is largely reflected in its arrangement. While previous versions of Symbian Anna and the older ones inherit properties and approach of the original contactless version of Symbian, Nokia Belle approached rather the form of Android, both with a drop down menu similar to Android and the layout of the main menu and other features. However, it regards only the visual aspects of the interface, the gestures and methods of control are typically "Symbian like".

Symbian was harmed by his initial standoff; development of application was available only to those who purchased an expensive license and development kit. Opening the system in 2010 came too late and the market share declined in favour of Android and Apple. Despite of that, it is a good operating system and it still has its place in the mobile market, although it was crossed by the entry of Windows Phone as the main operating system for Nokia smartphones.

Currently Nokia Belle is available on phones Nokia N8, E7, 603, 701 and 808 PureView. [20, 21]

6.2 Android

Android is a comprehensive open source platform, which was created especially for mobile devices (smart phones, PDA, navigation, tablets). It includes an operating system based on Linux kernel, middleware, user interface and applications.

Android has been developed by the consortium of Open Handset Alliance, whose members include software companies such as eBay Inc., Google Inc., Myriad, telecom operators: China Telecommunications Corporation, Sprint Nextel, T-Mobile, Telefónica, TELUS, Vodafone and also manufacturers of mobile devices, such as Acer Inc., Dell, FUJITSU LIMITED, HTC Corporation, Lenovo Mobile Communication Technology Ltd., LG Electronics, Inc., Motorola, Inc., Samsung Electronics, Sony Ericsson and others.

Android OS has five-layer architecture. The lowest layer of the architecture is the kernel of the operating system, which forms a layer between the hardware and the software. Because of the relative easy applications on different devices the Linux was selected for the kernel and it uses many of its properties, the support for the memory management, the network management, the built-in control or management processes.

The lowest layer of the architecture is the operating system kernel, which forms an abstraction layer between the used hardware and the rest of the software in higher layers. The core of Android is based on Linux version 2.6; its features, such as support for memory management, network management, built-in control or management processes, such as

running parallel applications that run as separate processes with permissions set by the system.

The next layer are libraries that are written in C or C + + code and they use the various components of the system. For example, Media Libraries that supports playback of video and audio formats as well image files such as MPEG4, H.264, MP3, AAC, AMR, JPG, and PNG.

The next layer contains the application virtual machine that has been developed specifically for the Android by the team at Google. The basic libraries of the Java programming language are also included in this layer.

Application Framework layer is the most important for developers. It provides access to a large number of services that can be used directly in applications. These services enable to access data in other applications, user interface elements, advisory status bar, and the applications running in the background, the hardware of the used equipment and many other services and features.

Basic applications that the ordinary users use to create the highest layer of the system. The application may be pre-installed or subsequently downloaded from the Android Market. For example, e-mail client, SMS program, calendar, maps, browser, contacts, and other applications of the "third" parties, too.

OS Android is currently available on many devices of different manufacturers; the most significant are Samsung, HTC, LG, Sony Ericsson, Google, ZTE and many others. Moreover, it also occurs on computer tablets and further expansion of market share is expected in the future. [22, 23, 24]

6.3 iOS

The seventh version of the operating system for Apple devices, called iOS7 has been launched and for the testing partners even the third beta version of iOS is introduced.

Originally, this system was called iPhone OS till its fourth version. It is a UNIX-like type that does not have all the functionalities of OS X, but adds the support of touch control. The system consists of four layers. The first is Cocoa Touch with frameworks for development of applications. Media layer, which is the second layer, allows creating complex graphics and audio applications. The third layer Core Service offers high-level services to make payments within the application for additional content, or cancelling ads, to track the current location of the user. The last layer Core of OS provides the low-level functions to other technologies.

Design of the Apple’s mobile system was based on the assumption that graphics applications should be as the real objects. Are application of calendars so far in the iOS looked like a real leather calendar, application for notes management looked like a block, contact management looked like a traditional machine directory.

Apple kept this approach for a long time. In the version iOS7 it got rid of all shadows and other graphic fancies and succumbed to the spirit of minimalism. Apple has improved its multitasking; new intelligent grasp of several concurrently running applications and according to the application allocates the processing power.

Most users say that Apple is more intuitive and easier to learn. It looks after the standard of design, which is reflected for example through the icons of the same size, as if they match one another. It offers immediately high functionality. On the other side, Android is suitable for those who like playing with the phone. It offers a lot of possibilities for

experimentation and adjusting so that each user can create a system according his/her imagination.

With iOS you are sure that nearly 85 % of users are using the latest version of the operating system, so there are no problems with backward compatibility. The disadvantage is the need to learn the programming language Objective-C which has hardly any utilization except iOS application. The programmer must also consider the rules and approval process for each application. [25, 26, 27]

6.4 Windows phone

It is the youngest of the mentioned operating systems. Like other operating systems from Microsoft, it is a system with a proprietary license and the source code therefore is not accessible for free. On the other hand, the Microsoft released the development environment and distribution of application goes through Microsoft's certification process. This increases the security of the system and also ensures a certain level of applications quality.

Regarding the actual user interface, you can see a large degree of unification. All the control elements are the same across all phones and the user can adapt only a few properties of the phone. On the one hand, it is advantageous since the user can pick up any phone with Windows Phone and he/she will be able to use it instantly. On the other hand, it is basically restricting his freedom in modifying the interface to own image. [5, 28]

7. CONCLUSION

As already mentioned, the user interface gives the user the means to take full advantage of the possibilities of the computer system. The efforts of all manufacturers, both laptop and mobile device, is to get as many customers as possible. Competition and continuous comparison will continue in the future. The field where these actions take place will also expand. The car industry may be the examples of the combat of various platforms. Apple announced a partnership with BMW, Mercedes, Honda, GM and others to develop a system for dashboard computer that would take care of multimedia, maps and communication. Audi is planning a similar activity, although it chose the Android platform. Hyundai plans the use of smart glasses from Google to unlock or start a car.

BIBLIOGRAPHY

Books:

[1] BITTO, O.; JANEČEK, V.: Windows Vista. - Praha: Computer Press, 2010. 336 s. ISBN 978-80-251-1724-8.

[2] CAFOUREK, B.: Windows 7. - Praha: Grada, 2010. 326 s. ISBN 978-80-247-3209-1.

[3] JELÍNEK, L.: Jádro systému Linux, Kompletní průvodce programátora. - Praha: Computer Press, 2008. 688 s. ISBN 978-80-251-2084-2.

[4] PACINOVSKÝ, J.: Windows 8. - Praha: Grada, 2012. 128 s. ISBN 978-80-247-4338-7.

[5] VÁVRŮ, J.: iPhone. - Praha: Grada, 2012. 179 s. ISBN 978-80-247-4457-5.

[6] WELSH, M.; KAUFMAN, L.: Používáme Linux. - Praha: Computer Press, 1997. 680 s. ISBN 80-722-6698-5.

Website:

[7] Wikipedie otevřená encyklopedie. Uživatelské rozhraní. [online]. - 2012 [cit. 2012-12-30]. Dostupné z: http://cs.wikipedia.org/wiki/U%C5% BEivatelsk%C3%A9 _rozhran%C3%AD

[8] Root.cz Seriál Historie vývoje grafického uživatelského rozhraní. [online]. 2012 [cit. 2012-12-30]. Dostupné z: http://www.root.cz/serialy/historie-vyvoje-grafickeho-uzivatelskeho-rozhrani/

[9] Wikipedie otevřená encyklopedie. Grafické uživatelské rozhraní. [online]. 2012 [cit. 2012-12-30]. Dostupné z: http://cs.wikipedia.org/wiki/Grafick%C3%A9_u% C5%B Eivatelsk%C3%A9_rozhran% C3%AD
[10] Wikipedie otevřená encyklopedie. Textové uživatelské rozhraní. [on-line]. 2012 [cit. 2012-12-30]. Dostupné z: https://www.google.cz/?gws_rd=cr&ei=nprfUs_TMZL 3yAOy3oGoCg#q=textov%C3%A9+u%C5%BEivatelsk%C3%A9+rozhran%C3%AD
[11] Wikipedie otevřená encyklopedie. Příkazový řádek. Wikipedie otevřená encyklopedie. http://cs.wikipedia.org/wiki/P%C5%99%C3%ADkazov%C3%BD_%C5%99%C3%A 1dek
[12] Wikipedie otevřená encyklopedie. Windows XP. [online]. 2012 [cit. 2012-12-30]. Dostupné z: http://cs.wikipedia.org/wiki/Windows_XP
[13] Wikipedie otevřená encyklopedie. Windows 7. [online]. 2012 [cit. 2012-12-30]. Dostupné z: http://cs.wikipedia.org/wiki/Windows_7
[14] Wikipedie otevřená encyklopedie. Windows 8. [online]. 2012 [cit. 2012-12-30]. Dostupné z: http://cs.wikipedia.org/wiki/Windows_8
[15] Microsoft. Windows 8 [online]. 2012 [cit. 2012-12-17]. Dostupné z WWW: < http://windows.microsoft.com/cs-CZ/windows-8/meet>.
[16] Wikipedie otevřená encyklopedie. Mac OS X. [online]. 2012 [cit. 2012-12-30]. Dostupné z: http://cs.wikipedia.org/wiki/Mac_OS_X
[17] Mobilmania. Smarthphony. [online]. 2013 [cit. 2013-12-21]. Dostupné z: http://www.mobilmania.cz/smartphony/sc-319/
[18] Android. [online]. 2012 [cit. 2012-12-11]. Dostupné z: http://www.android.com/
[19] WindowsPhone.[online]. 2012 [cit. 2012-12-11]. Dostupné z: http://www.windowsphone.com/
[20] Wikipedie otevřená encyklopedie. Symbian OS [on-line]. 2012 [cit. 2012-12-11]. Dostupné z: http://cs.wikipedia.org/wiki/Symbian_OS
[21] Wikipedie otevřená encyklopedie. Symbian Ltd. [on-line]. 2012 [cit. 2012-12-11]. Dostupné z: http://cs.wikipedia.org/wiki/Symbian_Ltd.
[22] Wikipedie otevřená encyklopedie. Android operační systém [online]. 3. 1. 2014 [cit. 2014-01-08]. Dostupné z: http://cs.wikipedia.org/wiki/Android_%28opera%C4% 8Dn%C3%AD_syst%C3%A9m%29#Z.C3.A1kladn.C3.AD_.C4.8D.C3.A1sti_aplikace_Android
[23] Zdnet: How android works big picture [online]. 28. 1. 2008 [cit. 2014-01-08]. - Dostupné z: http://www.zdnet.com/blog/burnette/how-android-works-the-big-picture/515
[24] Svetandroida. Smartphone. [online]. 2013 [cit. 2013-12-21]. Dostupné z: http://www.svetandroida.cz/smartphone-roku-2013-201305
[25] Wikipedie otevřená encyklopedie. iOS [online]. 6. 11. 2013 [cit. 2014-01-08]. Dostupné z: http://cs.wikipedia.org/wiki/IOS_%28Apple%29
[26] Root: Bezpečnost iOS a Android [online]. 14. 10. 2013 [cit. 2014-01-08]. Dostupné z: http://www.root.cz/zpravicky/google-os-android-je-bezpecnejsi-nez-ios/
[27] Blog.Applause: Android or ios [online]. 18. 4. 2013 [cit. 2014-01-08]. Dostupné z: http://blog.applause.com/android-or-ios-a-multi-stat-head-to-head-battle/2013/04/

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SYSTEM FOR MONITORING ENVIRONMENTAL PARAMETERS OF ROAD INFRASTRUCTURE

SYSTÉM PRE MONITOROVANIE ENVIRONMENTÁLNYCH PARAMETROV CESTNEJ INFRAŠTRUKTÚRY

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Abstract:

Monitoring systems of environmental parameters as a tool to ensure minimum cost and effective operation of the monitored object. The parameters of road infrastructure and its relation to the provision of logistic processes. Description of the monitoring system and its expansion options.

Abstrakt:

Monitorovacie systémy environmentálnych parametrov ako prostriedok na zabezpečenie minimiálnych nákladov a efektívnej činnosti sledovaného objektu. Parametre cestnej infraštruktúry a jej súvis so zabezpečením logistických procesov. Opis monitorovacieho systému a jeho možností rozšírenia.

Keywords:

monitoring system, sensory system.

Kľúčové slová:

monitorovací systém, senzorický systém.

1. INTRODUCTION

Systems for monitoring environmental parameters are a necessary part of every industry. One of the main tasks of such monitoring systems is using the monitored parameters to ensure minimal cost to operate the system while maintaining a defined operational efficiency.

Road infrastructure is a key part in numerous industry sectors, especially in logistics. Monitoring of environmental parameters such as temperature, humidity, intensity of solar radiation or rainfall on the roads has its undeniable importance, especially in winter, when these data may be used for operative intervention gritting vehicles, or to predict the situation in the next time period. Using special sensors it is also possible to monitor the load on the road, or the behavior of asphalt layers according to the ambient temperature (expansion).

This paper presents the purpose and structure of the sensory system for monitoring parameters determining the qualitative properties of roads.

2. DESCRIPTION OF MONITORING SYSTEM

nSoricRoad monitoring system is a comprehensive solution consisting of sensors of physical quantities (temperature, humidity, atmospheric pressure, solar radiation intensity), hardware and software solutions. The system also includes infrastructure and communication layer.

Following requirements were defined for the sensory system:

- number of sensors: 1 to 500,
- minimum of cabling,
- minimal hardware requirements,
- autonomous operation,
- remote management of the measuring point.

The main system requirements, which places great demands on the functionality of the measuring system is just the maximum number of connectable sensors. Sensory system communicates with the master control computer via a serial interface that uses RS232 respectively RS485 based communication protocol, which allows a theoretical maximum bus length of 1200 m and the maximum number of connected devices is 32. These parameters are unsatisfactory for the sensory system. In order to increase the number of connected sensors on the bus, increase the length of the bus and to reduce the volume of the necessary wiring, there were specifically developed blocks that provide an interface to the 1-wire bus.

1-Wire is a device communications bus system designed by Dallas Semiconductor Corp. that provides low-speed data, signaling, and power over a single signal. 1-Wire is similar in concept to I²C, but with lower data rates and longer range. It is typically used to communicate with small inexpensive devices such as digital thermometers and weather instruments.

The principle of using 1-wire bus is shown in Fig 1. Blocks 1-W bridge in Fig. 1 extend a standard RS485 bus. The number of these blocks can be up to 32, which in result gives the maximum number of sensors around 2000. The length of the branch from the main bus is more than 500m, which in total gives 32x500m = 16,000 m. With such a bus length it is possible to cover a wider area. The entire bus system is connected to a single control computer.

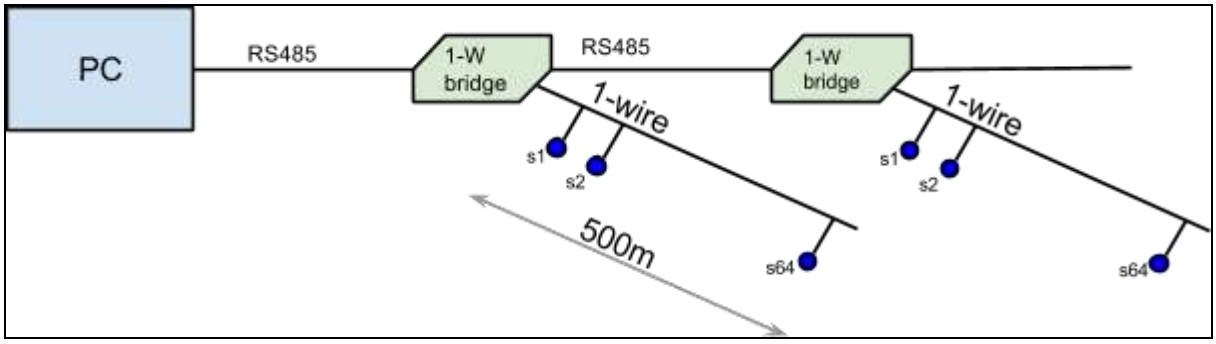

Fig 1. Extension of RS485 bus

As a control computer it is recommended to use micro-computers with low power requirements. Performance of this computer does not play such a big role, because the entire system is designed primarily for running under the operating system GNU/Linux in the server edition (Ubuntu server). Suitable hardware solution is for example BeagleBone Black (Fig. 2) based on Texas Instruments chips, especially because of the presence of two gigabytes MMC

FLASH memory for embedded systems, which is directly integrated on the board. More examples are IGEPv2 by ISSE, or raspberryPi by the Raspberry Pi Foundation. The disadvantage of these other options is the fact that as the main memory is used microSSSD or SSD cards that in long term use may show signs of error, that make the entire operating system inoperative.

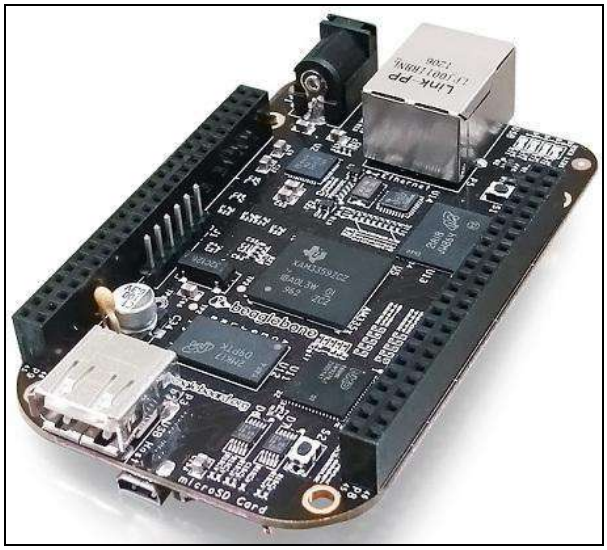

Fig. 2: Microcomputer Black, Source: **[2]**

BeagleBone Black specifications:

- CPU: AM335x 1GHz ARM® Cortex-A8
- 512MB DDR3 RAM
- 2GB 8-bit eMMC on-board flash storage
- 3D graphics accelerator
- NEON floating-point accelerator
- 2x PRU 32-bit microcontrollers
- USB client for power & communications
- USB host
- Ethernet
- HDMI
- 2x 46 pin headers
- Power input: 5V DC

The software requirements are as follows:

- Java Runtime Environment ver 6 or higher. The measurement services of the system are programmed in Java.
- MySQL server. Used to store the measured data.
- Python (is a standard part of the used OS). In Python is written unified communication interface for communicating with the client part of the sensory system.

All the software tools and libraries used are licensed under open source licenses, their use is not subject of a license fee. When using GNU/Linux OS, the cost of the software itself

is also zero. Supported OS systems are all compatible with OS Debian (Debian, Ubuntu, Mint,...) When using MS Windows it is a price of one OS license. Supported are Windows XP and Windows 7.

When installing the measuring system under MS Windows OS, the software requirements do not change, but other hardware solution is required because BeagleBone platform does not support the Windows OS. In this case, the solution should be based on miniPC. These are standard PCs with minimum dimensions and energy consumption.

3. THE STRUCTURE OF THE CONTROL AND MEASURING SERVER

As mentioned in the previous chapter, the ideal solution for the measuring computer is an economical solution, for example BeagleBode Black. Structure of the solution from the perspective of software architecture is shown in Fig. 3.

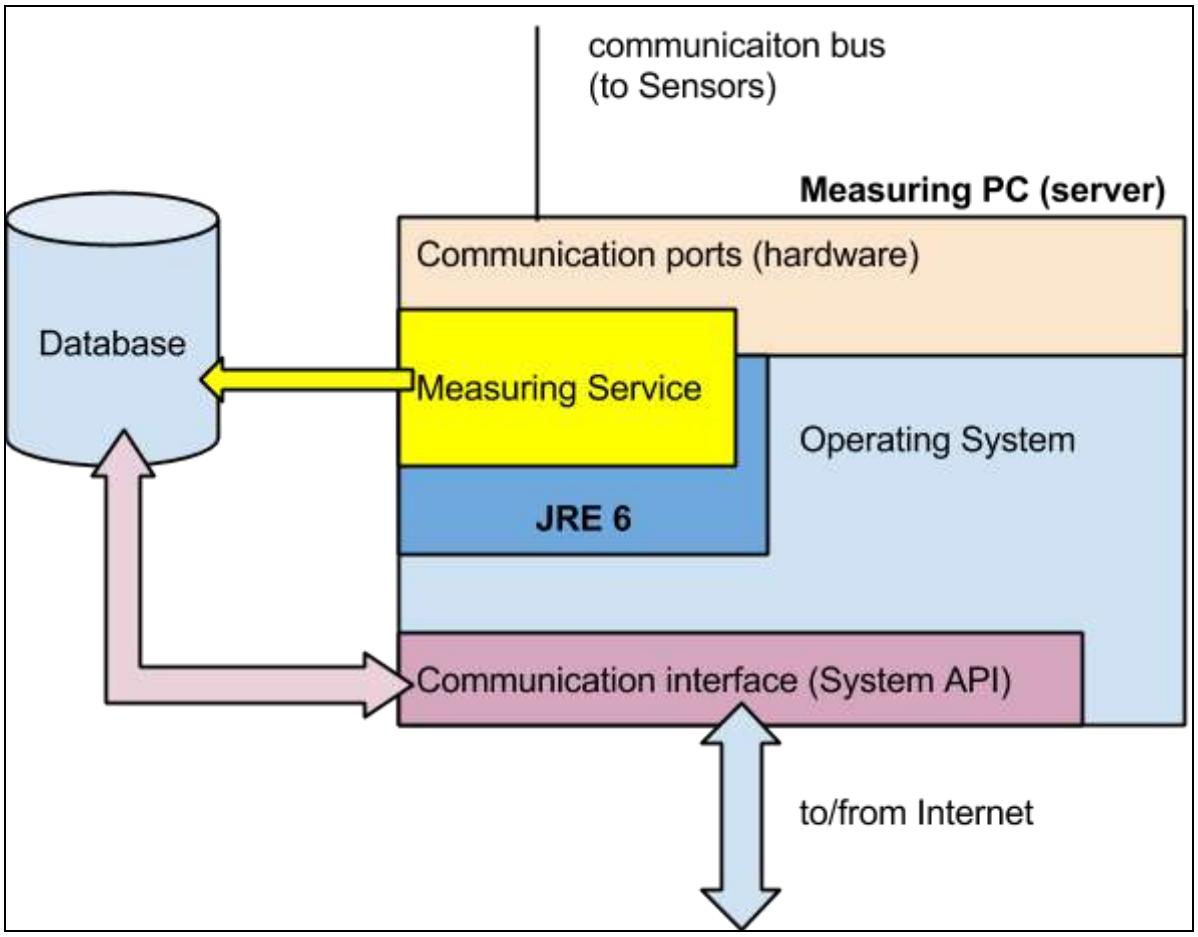

Fig. 3 Structure of the measuring server

A few notes on the proposed solution:

The database may or may not be part of the server installation. If the database server is part of the installation, it has the following benefits:

- saving the expenses of buying additional hardware for installation of the database server,
- system reaction in communication with the database is faster because the server does not need to connect to a remote server

Measurement service is designed as a system daemon (service), which correct functioning is ensured by the operating system.

The communication interface is the sole mean of communication with the measuring server. For security reasons there is disabled direct communication with the database server. This interface provides access to data in the database (data and configuration settings) and to the control and diagnosis of connected sensors.

4. MONITORING OF THE ROAD INFRASTRUCTURE

The purpose of the proposed system is to monitor environmental parameters of road infrastructure. Basic monitoring parameter is temperature as this parameter has the highest explanatory value in assessing the current status. An important factor is the deployment of sensors. Road infrastructure can distinguish longitudinal distribution in the direction of travel, transverse layout and positioning in depth. In reality, it is practical to use longitudinal placement and location in depth (Fig. 4).

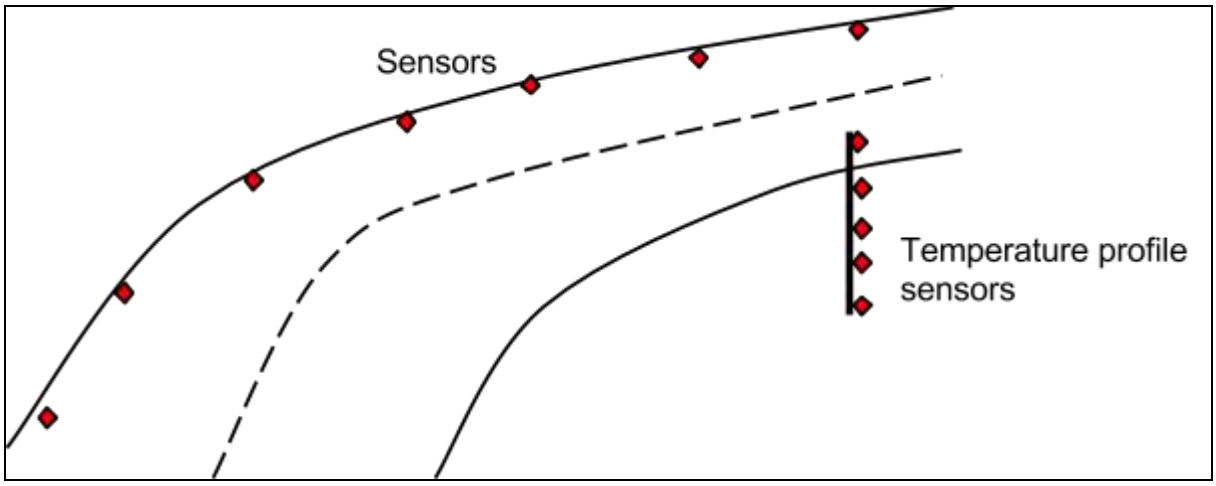

Fig. 4 Sensors placement

The longitudinal deployment provides information on temperature (and other monitored parameters) in the monitored sections. Spacing between the sensors depends on the specific requirements and overall length for one measuring station is limited by the physical parameters of the RS485 bus and 1-Wire.

The second way is the vertical placement of the sensors. This is a method where sensors are installed on the guide bar, which is placed in a vertical position in the road or beside the road. From this location is obtained temperature profile of the monitored section.

In Fig. 5 is an example of the real temperature profile of the soil. The sensors were placed at the following distances from the surface: 100cm, 10cm, -10cm, -75cm and -150 cm.

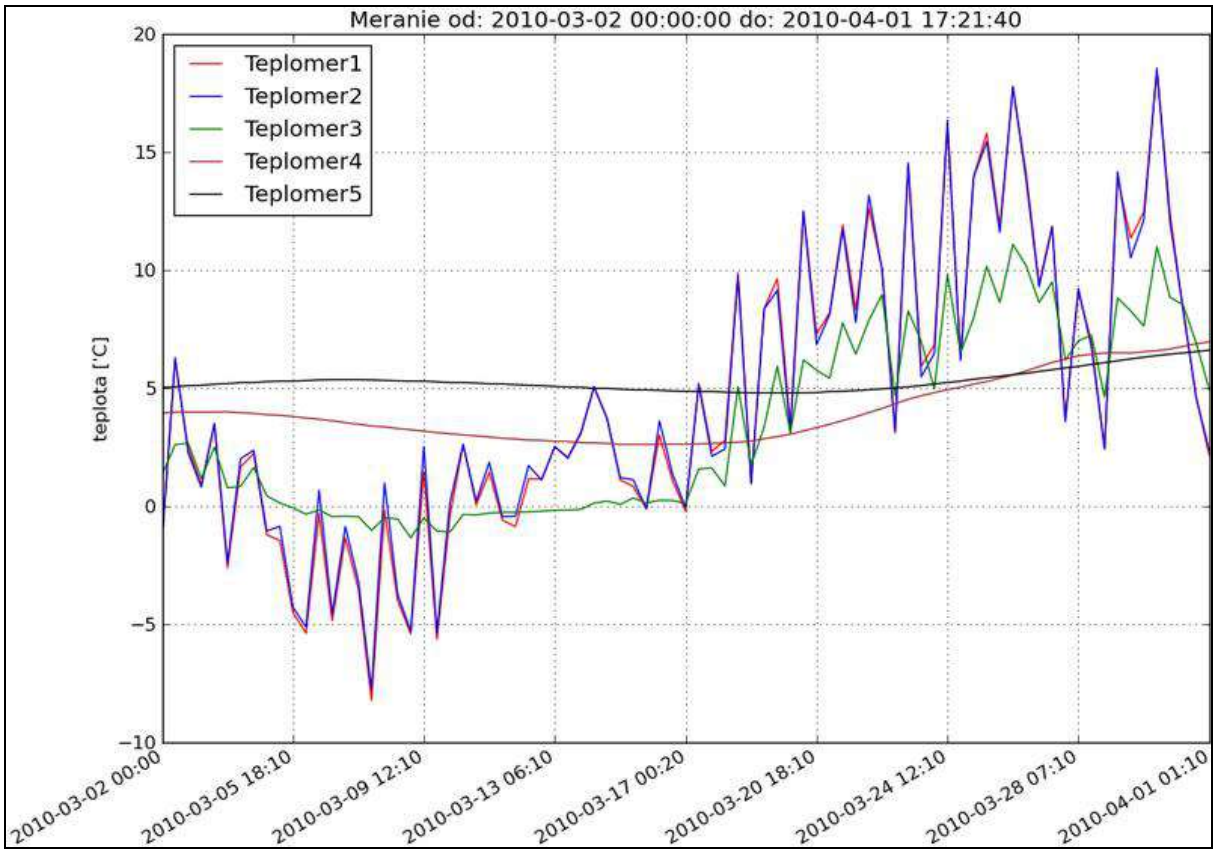

Fig. 5 Soil temperature profile

From the above graph can be derived phase shifts between the different curves, thus the heat transfer in a given environment. The long term monitoring clearly shows the rate of freezing, respectively heating of the soil profile at different depths.

Using the system for measuring the temperature and humidity on the roads can save considerable resources when planning and optimizing trips of gritting vehicles in winter season.

5. CONCLUSIONS

In the paper was presented sensory system for monitoring of environmental parameters. The usage of such a system is possible in several industries. Primarily it has been designed for use in monitoring parameters of road infrastructure, but the application in other sectors such as the monitoring of buildings with a focus on heat loss, or aimed at the optimization of the cost of heating the building. When supplemented with other sensors, such as the intensity of solar radiation sensor, sensor atmospheric pressure sensor and wind speed and direction, we can get a functional local weather station.

The quality of road infrastructure has a major impact on the entire set of other sectors, as a functioning business relationships depend on the transfer of goods between trading partners. The quality of roads is undeniable relation to logistics, which deals with planning and transport efficiency.

SOURCES AND REFERENCES

[1] *Analog, linear, and mixed-signal devices from Maxim/Dallas Somiconductor* [online]. 2014 [cit. 10. 2. 2014] Available at www: <http://www.maxim-ic.com>

[2] *BeagleBoard.org: BeagleBone Black. BEAGLEBOARD.ORG. BeagleBoard.org - BeagleBone Black* [online]. 2013. vyd. [cit. 2014-02-12]. Dostupné z: http://beagleboard.org/products/beaglebone%20black

[3] ĎUĎÁK, Juraj; PAVLÍKOVÁ, Soňa; GAŠPAR, Gabriel; KEBÍSEK, Michal. *Application of Open Source Software on Arm Platform for Data Collection and Processing*. In: Proceedings of 14th internatinal conference on mechatronics. Trenčianske Telice, 2011, s. 76-78. ISBN 987-80-8075-476-1.

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BOAT LIFTS AS TECHNICAL TOURIST ATTRACTIONS

Lodní výtahy jako technické atraktivity cestovního ruchu

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Abstract:

Boat lifts are specific technical facilities which help to overcome the different altitude of two parts of inland waterways. Nowadays the boat lifts do not take only the transport role but are used as technical tourist attractions as well. The boat lifts have a huge potential in addressing tourists across the age and interests. The paper focuses on The Falkirk Wheel boat lift, the most visited technical facility of that type. According to the particular example the paper deals with possibilities and limits resulting from tourism development in the particular region. The survey carried out at The Falkirk Wheel boat lift in Scotland covers the questions of tourism infrastructure, number of visitors or position of The Falkirk Wheel among other tourist attractions in the region. It also aims at visitors, their incentives for visiting this place as well as the process of visit and the use of services offered.

Abstrakt:

Lodní výtahy jsou specifická technická zařízení umožňujícího překonat výškový rozdíl mezi rozdílně položenými úseky vodní cesty. V dnešní době již neslouží pouze jako zařízení s výhradní dopravní funkcí, ale řada z nich se stává technickými atraktivitami cestovního ruchu, které mají poměrně značný potenciál oslovit návštěvníky napříč generacemi a zájmy. Článek se zaměřuje na konkrétní skotský lodní výtah The Falkirk Wheel, světově nejnavštěvovanější technické zařízení tohoto druhu. Na příkladu této lokality vymezuje článek možnosti a limity, které mohou lodní výtahy při rozvoji cestovního ruchu v regionu přinášet. Na základě výzkumu provedeného na místě odpovídá na otázky infrastruktury cestovního ruchu vázané na tuto specifickou atraktivitu, důvody značné míry návštěvnosti či postavení lodního výtahu ve srovnání s blízkými atraktivitami cestovního ruchu. Zaměřuje se také na samotné návštěvníky, jejich motivaci k návštěvě, na konkrétní průběh návštěvy a využití nabízených služeb návštěvníky.

Keywords:

boat lift, tourism, Falkirk Wheel, Scotland

Klíčová slova

lodní výtah, cestovní ruch, Falkirk Wheel, Skotsko

BOAT LIFTS AS THE TECHNICAL SOLUTION TO INLAND WATERWAYS

Boat lift (also ship hoist, lifting appliance) is a facility on waterway which helps to overcome the different altitude of two parts of inland waterways where it is not efficient to use other ways (e.g. canal locks). There are two basic types of hoists – vertical or sloping. The difference is also in the transport of the boat itself – in water bathtub with or without water. The Scottish Falkirk Wheel is a special type of boat lift; it is not vertical or sloping, but the first and still only rotating boat lifts in the world. It was chosen as an example of the successful technical solution, which plays an important role in the Scottish tourism. It also presents the successful model for possible further projects.

The idea to lift boats from one to another level of the canal was developing independently in Germany and in England, both during the end of 18th century. The first mentioned boat lift was built in between the years 1988-89 on the Chuprinz canal in Saxony, German. The hydraulic boat lifts were successful at the turn of the 19th and 20th century.

THE ORIGIN AND PARAMETERS OF THE FALKIRK WHEEL

The first Scottish canal, the Forth & Clyde canal from Glasgow to Grangemouth, connecting Irish and North Sea, was opened in 1790. The canal defined the new standards in inland waterways. It was the first canal connecting the Seas. In 1822 the canal was connected with the new Union canal leading from Edinburgh to Falkirk, close to Grangemouth. The difference of the level surface was 35 meters and 11 locks were used in order the boats could get from the lower Forth & Clyde canal to the upper Union canal. The interconnection of the two largest towns was ensured.

The canals were affected by development of the railway system. Thus both canals were in operation till the WWII. The development of road infrastructure nearby has quit the canal transport in the 60s of 20th century. Then the canals were abandoned for several tens of years.

The idea of using the canals in tourism appeared in the mid-70s of the 20th century. The idea came true with the Millenium Link project, which has renewed the canals function. In the beginning of 90s the place for boat lift construction was chosen, close to the former system of 11 locks. Many proposals were submit but only one has won. The proposal of the current situation then won several awards all over the world. Total costs of the whole complex were 20 million GBP, the boat lift itself cost approx. 5 million GBP.

Fig. 1, The Falkirk Wheel boat lift. Source: own picture

Fig. 2, Current situation of the Union canal. Source: own picture

The lifting appliance itself is located at the end of the strengthened concrete aqueduct, which is connected to the Union canal throw the new tunnel by the double lock. The boat sails into the water bathtub and by the turn motion is moved into the artificial bay close to the Forth & Clyde canal. At the same time, the boat from the lower level is moved up. Using ten hydraulic engines, the lift works very efficiently. The costs of one turnaround are not higher than a few Czech crowns. One turnaround, which is 180°, brings the ship either up or down, takes over 4 minutes and consumes only 1.5 kWh. The reason of this effort is the balance of both water bathtubs with approx. the same weight, no matter if there is a boat or not. Archimedes' principle is used – the weight of water displaced by the boat out of the bathtub equals the weight of the boat. The displaced water gets back to the canal. The equal weight of both bathtubs, around 300 tons, is then ensured.

TOURISM SPECIFICS: REGION AND ATTRACTIVENESS

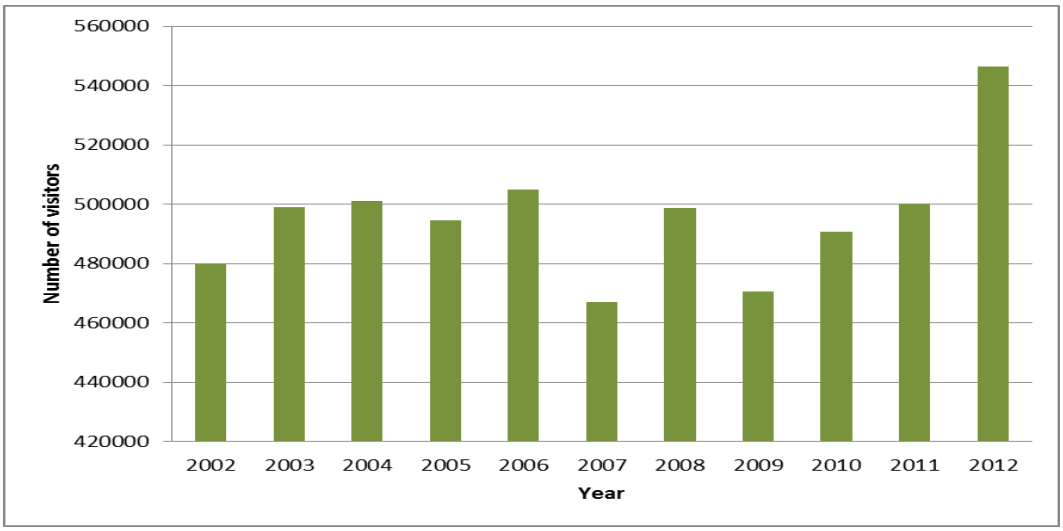
According to the Visit Scotland, the Scottish tourism organization, Scotland is divided into 15 regions. The Falkirk Wheel boat lift is located in the Loch Lomond region, in The Trossachs & The Forth Valley in the middle Scotland. There is a map showing the position of both canals and the Falkirk Wheel boat lift.

Fig. 1, The Falkirk Wheel between Glasgow and Edinburgh

Nearly 200 000 people in 20 000 different companies are employed in tourism sector in Scotland. 16 million tourists staying overnight visit Scotland each year, only 2, 35 millions of them come from abroad. Annual earnings form Scottish tourism overcome £4 mild. According to the Visit Scotland, the most popular attractions in 2011 were National Museum of Scotland (1, 49 mil of visitors), Edinburgh Castle (1, 30 mil of visitors) and Riverside Museum (1, 07 mil of visitors). The Falkirk Wheel does not belong to the top 10 most popular places but its place with more than 500 thousand of visitors occupies also high position.

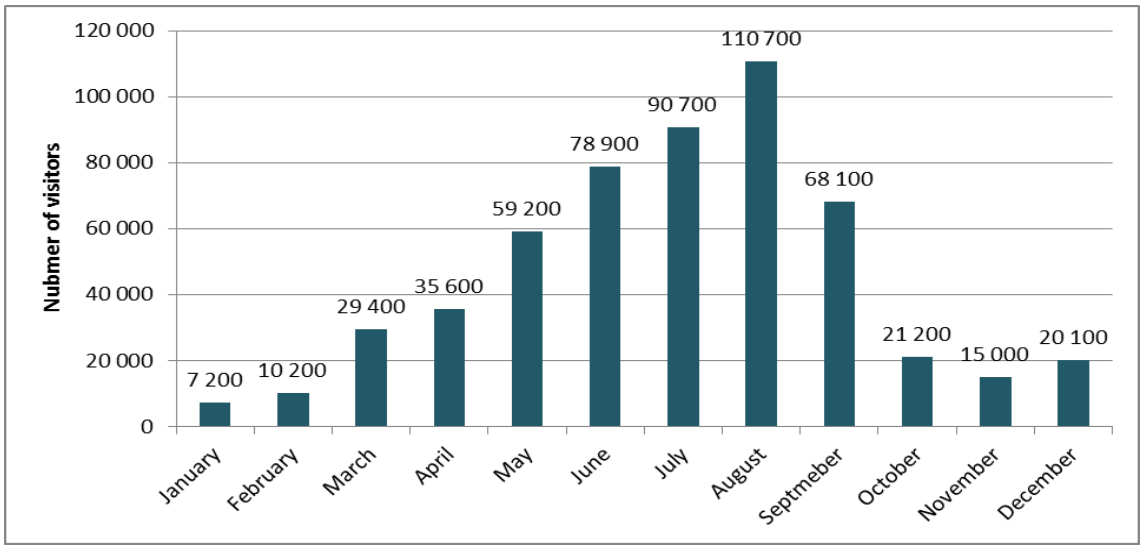
Since the official opening of the Falkirk Wheel on May 24 2002 it hosted more than 5 millions of visitors. In 2002, after 7 months of its operation, about 480 000 tourists have visited the new attraction. During the next years the attendance was around 500 000 tourists per year. The maximum attendance was reached in 2012 thanks to the wide marketing campaign.

Chart no. 1, Attendance of the Falkirk Wheel in 2002 - 2012
Source: Findlay Withers, Customer Operations Manager, Scottish Canals



The seasonal attendance of the Falkirk Wheel boat lift correlates the tourism high season in Scotland, thus in between June and September. The numbers of Events influence the general attendance too (e.g. Santa Clause trips in December).

Chart no. 2, The Falkirk Wheel boat lift attendance in particular months in 2012
Source: Findlay Withers, Customer Operations Manager, Scottish Canals



The attendance of the Falkirk Wheel may be compared to other boat lifts all around the world. Two of the boat lifts with the maximum attendance are in England, another one is located in Canada. Nearly 117 thousands of visitors have visited the Anderton boat lift in 2010, the Petersborough boat lift was visited by 77 thousands of visitors in 2011. That means that the Falkirk Wheel boat lift does not have a serious competition among similar technical attractions. The architecture and design of the Scottish boat lift which is much more interesting and differing from the general standard brings the significant added value.

Tourism products can give the interesting analysis of the Falkirk Wheel potential. Looking at the offer of Czech travel agencies, it is obvious that the Falkirk Wheel belongs among the most important attractions in Scotland. Practically each travel agency organising European roundtrips offers at least one in Scotland.

Most of the trips use coach transport through Germany and Netherlands. Tourists also visit interesting places during the short or longer stops during the journey. Then the coach takes a ferry to Newcastle. Some trips use air transport from Prague to Glasgow or Edinburgh, then using coaches across Scotland. The Scottish Highlands and both towns (Glasgow and Edinburgh) are the most important destinations of the trips offered. The Falkirk Wheel boat lift visit is involved in ¾ of all roundtrips to Scotland.

TOURISM INFRASTRUCTURE

As noticed above, the Falkirk Wheel boat lift together with both canals is used in tourism nowadays. The surrounding of the attraction is customized to meet the tourism goals – visitors centre with coffee and gift shop is in immediate vicinity. Several parking places, educational park for children or educational path are close to the boat lift. Total capacity of parking places is 200 places for cars and 10 places of coaches, which is not sufficient during the high season.

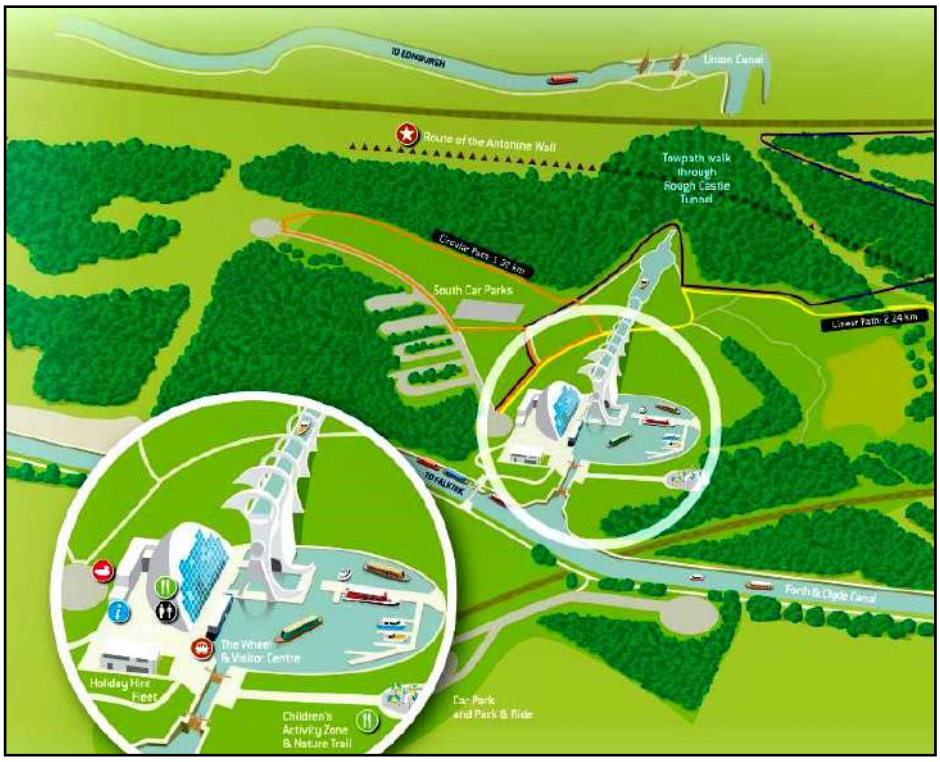


Fig. 3, The Falkirk Wheel boat lift premises. Source: http://issuu.com/

You can enter the boat lift through the information centre of the Visit Scotland organization, where you can get the information not only about the Falkirk Wheel boat lift but also about other atractions in the region. The design of the information centre is very attractive, as the whole complex itself.

The focus on families with children is evident. Water zorbing activities (running in a huge beach ball on the water surface) are offered in an artificial bay. There is also a water park since 2011[1], where children and adults can try to pump the water out of the lower up to the upper part by different types of pumps, bicycle pumping water or Archimedes´ screw. There is also a playground for children beside the water park.

Fig. 4, Running boat lift and visitors centre. Source: own pictures

Fig. 5, Visitors centre. Source: own pictures

[1] Scottish Waterways Trust. [online]. Scottish Waterways Trust, 2012. [cit. 2013-3-9]. Available at: <http://www.scottishwaterwaystrust.org.uk/what-we-do/communities-and-regeneration/our-successes/water-play,-the-falkirk-wheel >

Accommodation facilities are not available in immediate vicinity. The closest ones are in the 3 km remote town of Falkirk. Despite the undeniable effort to keep the visitors of the boat lift at the place itself as longest as possible, it still is only a point attraction with a limited ability. Thus there is no need to provide accommodation facilities in its immediate vicinity. Kitchens and catering services are located directly in the area of the visitors centre (Falkirk Wheel Café). The Wheel House restaurant is then few hundreds of meters away. Tourism infrastructure as a whole is satisfactory.

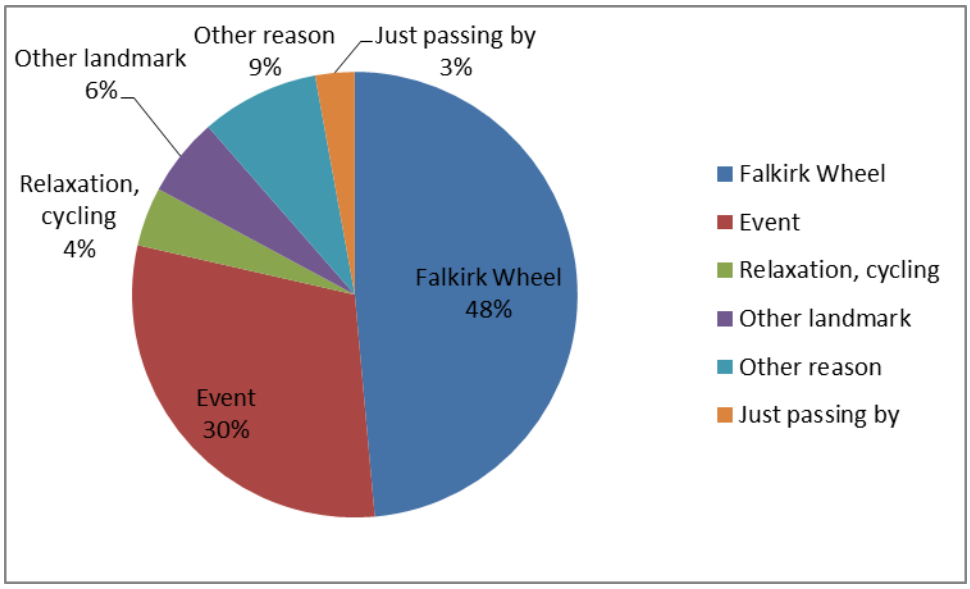
VISITORS OF THE BOAT LIFT

The two day survey on the spot was made in order to know the motivation and structure of visitors. The survey was aimed at visitors of the boat lift who were leaving the area after the visit. Interviews took place at the end of the season during 2 days, September 30 2012 and October 4 2012, in the area of the boat lift. 70 respondents were interviewing to answer the questions. The most important results are as follows.

56 (80 %) respondents came from Scotland. This fact is influenced by the time of the survey carried out, thus at the end of the season. It is possible to assume the higher rate of foreigners during the high season. Five of the respondents come from England, two from Northern Ireland and two from the USA. Also respondents from Australia, Bosnia and Herzegovina, Qatar, Egypt or Taiwan took part of the survey.

Nearly half of the survey participants (49 %) stated that the Falkirk Wheel boat lift is well known, thus they did not need any source to be persuaded about the visit. Those were visitors coming from the region, approx. 50 km far from the attraction. Next 19 % of survey participants declared the source they were informed from – TV, radio, newspaper, magazines, internet, 11 % know the boat lift from family members, 11 % of the survey participants have already visited the boat lift before. 7 % of the participants found the information about the boat lift in the brochure of the travel agency.

Chart no. 3, Predominant content of the Falkirk Wheel boat lift visit
Source: own survey



Half of the respondents visit the attraction because of the boat lifts itself. One of the Events was the reason of visit for 30 % - children´s band, dance programme or the soft toys paragliding. Only 6 % of respondents have visited the boat lift as a sideshow.

The entrance is free of charge to the area and visitors centre. Only 50 minutes boating through the boat lift is paid. One-fourth of survey respondents took part at the boating, which most of them were visitors from abroad.

CONCLUSION

The Falkirk Wheel boat lift belongs undoubtedly among the most significant world technical tourist attractions. In spite the boat lift is relatively new, so it has proved the interest of wide range of people and has established a new scale for technical attraction all over the world. Many aspects as visit rate, infrastructure or tourism products providing indicated the success.

LITERATURE:

DOWDS, Thomas. *The Forth and Clyde Canal: A History*. Edinburgh: Tuckwell Press, 2003. ISBN 1-86232-232-5.

FISHER, Stuart. *The Canals of Britain*. London: Adlard Coles Nautical, 2009. ISBN 978-1-4081-0517-7.

FLEMING, George. *The Millenium Link*. London: Thomas Thelford Publishing, 2000. ISBN 0-7277-2945-4.

GRAHAM-CUMMING, John. *The Geek Atlas*. Sebastopol, CA: O'Reilly Media, 2009. ISBN 978-0-596-52320-6

HAYWARD, David. *The Falkirk Wheel*. Hamilton: Buchanan McPherson Ltd., 2012. ISBN 978-0954162825.

KLIMEK, Radim. *Lodní výtah The Falkirk Wheel jako atraktivita cestovního ruchu.* 2013. Bachelor Thesis. Vysoká škola logistiky. Thesis supervisor: Jan Rája.

Heriot-Watt University. [online]. Regeneration of the Forth & Clyde and Union canals, Scotland, 2000. [cit. 2012-12-27]. Available at: <http://web.sbe.hw.ac.uk/staffprofiles/bdgsa/site_vists/fw/paxton.pdf>

Scottish canals. [online]. The Falkirk Wheel, 2012. [cit. 2012-1-15]. Available at: <http://www.thefalkirkwheel.co.uk/about-the-wheel-/history>

Scottish Waterways Trust. [online]. Scottish Waterways Trust, 2012. [cit. 2013-3-9]. Available at: <http://www.scottishwaterwaystrust.org.uk/what-we-do/communities-and-regeneration/our-successes/water-play,-the-falkirk-wheel>

VisitScotland. [online]. What We Do, 2012. [cit. 2012-12-18]. Available at: <http://www.visitscotland.org/what_we_do.aspx>

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