



A light autonomous telecommunications and observation mast – applicability for ITS

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ABSTRACT

Cameras and radio communications aerials placement on the few tens of meters high tower enables broad observation and analysis of the situation in a significant surrounding, enabling even installation of the mobile communications systems for own observation systems needs as well as for other goals. Article presents multifunctional mast construction – called metamast – enabling multi-variant observation and communications equipment, which can be fitted appropriately to local and functional user needs. Energy-related autonomy of the metamast, based on the renewable sources, allows easy installation in places with hindered access to electric grid. Possibilities of metamast usage for various important applications of intelligent systems area, mainly related to traffic control and its security, on the basis of detailed information concerning traffic and road state and conditions are described. Underlines also the meaning of the facilitated communications between driver, vehicle, road side equipment and mentioned telematic systems.

KEYWORDS: intelligent transport, renewable energy, electronic communication

1. Introduction

Truss tower constructions are commonly applied for wireless telecommunications purposes. At the same time they can be bearing structures for observation equipments and various sensors systems and as such ones, may be effectively utilized for various functionalities in ITS. Obviously a device installed on the towers needs to be continuously supplied with electric energy, usually of a limited, relatively not so high power. One of the possible solutions in such a case is tower installations equipped with wind turbines, obviously supported by emergency power source (Emergency power may be taken from t.ex. battery bank, motor generators or solar panels). An evident value of such a solution is that a main source of the energy is renewable one, not offensive against environment and enabling installations in the places with limited access to the electric grid. Such a construction shall we call further as a “metamast”. An example of the construction with vertical wind generator is

presented on the fig. 1 (Metamast built near Doktorce (Poland) by Townet System Ltd.).



Fig. 1. Metamast near Doktorce (Poland) [own study]

2. A metamast idea

A *metamast* is a construction of information and telecommunications devices bearing tower, equipped with an autonomous energy source, based on wind powered electric supply system. It allows to locate a construction at almost any place, especially isolated areas, separated from electric grid and support with communications and observations means – among other – intelligent services in transport domain.

2.1. Basic tower construction and power supply system

A metamast is a truss tower 47,5 m high, composed from four parts of descending dimensions. It has a form of the equilateral triangle with sides 6,7 m long at the ground and 2,6 m at the top. There is situated a tubular stem with front place for a turbine fastening. Height of the complete construction attain 56 m. A basic version of the metamast consists also a necessary maintenance and monitoring system appropriate to the construction settlement and surrounding environment.

A structure of the metamast's power supply system is typical, but it's specific configuration is derived from economic calculation of power sources installation and exploitation costs, as well as from – in some extend – quantity of installed power. Such a typical universal structure is presented on Fig. 2, in which, depending on needs and circumstances, arrangement may be limited to the rationally necessary elements.

In real projects concerning the analyzed applications one can utilize already collected multiannual and multi-application practical experience

Estimated energy to be wined from the wind (optionally completed by solar energy system) in discussed constructional solution of the metamast will be about 75 MWh by year. But typical amount of the energy needed by for example cellular BTS computed with maintenance and monitoring system attains a level of 120 MWh/year. In the case of deficiency of power grid accessibility, lack of energy will be covered from motor generator.

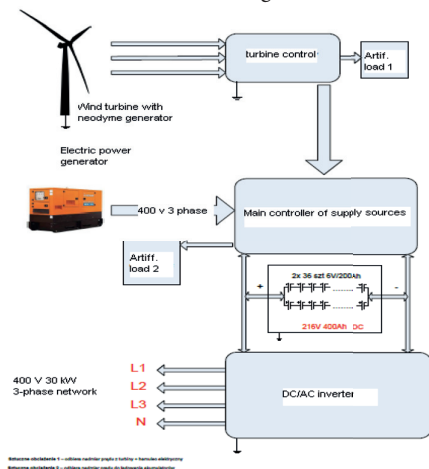


Fig. 2. Block diagram of the telecommunication mast power system [2]

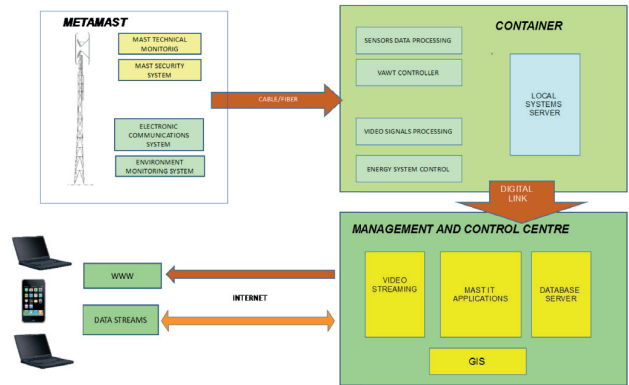


Fig. 3. Block diagram of the metamast ICT arrangement [3]

2.2. Observation systems

In the ITS applications observation and monitoring solutions are broadly applied, especially by video systems, but even by radiolocation and acoustic ones.

Generally for video observation are used day light cameras, night vision devices and thermo-sensitive cameras. Those enables observation of the occurrence and movement of living beings, as well as mechanical ones, but even weather and environmental occurrences, like for example precipitations, fogs or fires.

Compete observation systems includes dedicated information applications enabling automatic situation analysis: detection of moving objects, their identification with accuracy up to details, such as recognition of the number plates. Obviously the aim of a such observation is to bring on the proper activities in the scope of observation function (for example dangers elimination or preventive activities). The results of observations are usually registered, creating data documentation for possible prosecution actions or analytic researches.

On the market there is a wide range of the observation means and systems presenting technologically matured solutions.

Other technology applicable for detection of the objects in interesting surroundings are a noise radar systems. For the "illumination" of the objects is use a noise signal generated by own transmitter. It allows for reliable determination not only location and speed of the object, but even some its meaningful distinctive features, for example the shape. With an emitted signal of the range of 100 mW moving objects can be detected from the few kilometres long distance (Noise radars are still in the experimental and research state and have not yet a great practical dissemination (See [5]).

From the ITS point of view, noise radars can be used in anti-collision systems, traffic detection, recognition and penetration of the inaccessible objects, detection of the living beings in formally inaccessible or covered places. A valuable feature of the noise radar is the possibility of implementation of function, enabling description of the object localization in geographic coordinates.

It is worth to mention, that besides of upper discussed direct monitoring systems, there exist also systems of indirect ones, which are constructed for collection of information from remote groups of sensors and gauges arranged in the area of observation,

while data from its are transmitted to the processing and usage point. Such a systems are called wireless sensor network. Just a towers, seems to be suitable for such a networks.

2.3. Applicable wireless telecommunications technologies

For information exchange and distribution necessary for ITS telematic applications, various electronic telecommunications technologies are used.

Due to possibilities of communications among moving objects, people and/or them and surroundings, wireless technologies plays more and more important role. Those technologies, broadly offered in the market, are functionally and applicable diversified. A list of main, most widely distributed is shown in Tab. 1.

For the specific transport telematic needs a choice is dependent of transmission range and speed (bitrate) - it is worth to point, that too big range is often not acceptable. More, in some cases it is necessary to have limited range

WiMAX	10 km	2 to 11 GHz	to 175 Mb/s	Ca. 2 Mb/s (to 75 Mb/s)	Practically in Poland - 4 Mb/s
TETRA (Terrestrial Trunked Radio)	ca. 10 km	380 to 933 MHz	Speech: 2,4 – 7,2 kb/s Data: 9,6 – 28,8 kb/s	Speech: 2,4 – 7,2 kb/s Data: 9,6 – 28,8 kb/s	Public services, security
GSM (Global System Mobile)	ca. 35 km	900,1800 i 1900 MHz		9,6 - 57,6 kb/s	
GSM/GPRS (General Packet Radio Service)	ca. 35 km	400, 900 i 1800 MHz	30 to 80 kb/s	30 - 80 kb/s	
GSM/EDGE (Enhanced Data Rates for GSM Evolution)	ca. 35 km	400, 900 i 1800 MHz	236 kb/s	236 kb/s	
GSM-R (GSM Railway)	ca. 35 km	400, 900 i 1800 MHz	Bands 2 x 4MHz	Bands 2 x 4MHz	Applications in railways
Radioline	From hundreds m to tens km	7 – 76 GHz	Few Mb/s to Gb/s	Few Mb/s to Gb/s	

Tab. 1. Transmission ranges and speeds of the most popular wireless technologies

Technology	Range	Bandwidth	Bitrate		Remarks
			DL	UL	
RFID (Radio-Frequency Identification)	0,5 to 6 m	125 kHz, 1MHz, 2,4 or 5,8 GHz			Range dependent on bandwidth
Bluetooth	1 to 100 m	2,4 GHz	21 kb/s to 40 Mb/s	21 kb/s to 40 Mb/s	Range dependent on power
IrDA (infrared)	1 m	850 – 900 nm	115 kb/s or 4 Mb/s	115 kb/s or 4 Mb/s	Range to visible distance
DSRC (Dedicated Short Range Communications)	35 to 330 m	0,915 or 5,8 GHz	0,5 or 1 Mb/s	0,5 or 1 Mb/s	Applications in ITS (EFC)
3G (UMTS (Universal Mobile Telecommunications System))	50 m, 1 km, 35 km	0,900 or 2,1 GHz	0,384 – 21 Mb/s	0,384 – 21 Mb/s	Range of pico- mikro- and makrocell
GSM/HSDPA (High Speed Downlink Packet Access)	6 to 35 km	0,900 or 2,1 GHz	21,6 Mb/s		Part of UTM standard
GSM/HSUPA (High Speed Uplink Packet Access)	6 to 35 km	0,900 or 2,1 GHz		5,76 Mb/s	Part of UTM standard
GSM/HSCSD (High Speed Circuit Switched Data)	6 to 35 km	0,900 or 1,8 GHz	57,6 kb/s	14,4 kb/s.	
HSPA (High Speed Packet Access)		0,900 or 2,1 GHz	14,4 Mbit/s	1,92 Mb/s.	
HSPA+ (Evolved High Speed Packet Access)		0,900 or 2,1 GHz	42 or 56 Mb/s	11 or 22 Mb/s	
LTE (Long Time Evolution)	ca. 1 km (to 5 km)	0,800, 1,8 or 2,1 GHz	to 300 Mb/s	to 50 Mb/s	
LTE-A (Long Time Evolution Advanced)	to 1 km	0,800, 1,8 or 2,1 GHz	to 1 Gb/s	to 500 Mb/s	

3. Possible applicability in ITS

At the contemporary state of technology and knowledge, about the efficiency and quality of the transport systems functioning decides – beside the state of infrastructural modernization (for example road qualities, dimensions of the transport network and coverage of the territory, rolling stocks etc.) – more and more their equipment with solutions based on various information and telecommunications technologies. Implementation of those technologies brings many transport processes improvements in the areas of traffic and journey efficiency, their security, economy of use and comfort. As the example there can be enumerated [6]:

- more intensive harness of the existing infrastructure and rolling stocks,
- increase of economic effectiveness and competitiveness in all the branches of transport,
- increase of the traffic security level,
- reduction of the environmental pollution,
- enhancement of the cooperation among all the sides interested in transport processes,
- multimodal transport development,
- facilitation of the infusion into globalization and integration processes especially in transport systems area.

IT methods and tools introduction obviously needs implementation of many technical elements necessary for acquisition, processing and delivering of adequate, current and credible data. Now, the systems constructed for transport information management and informatics support of the transport [6, 7], mutually compatible and complementary – even possibly geographically seamless – becomes a integral elements of the land, maritime and aerial transport systems.

A information and data which can be acquired from the adequately equipped metamast are:

- meteorological data concerning for example weather conditions, weather depending state of roads (rain, snow, ice, mist, fog etc.) for weather alerts,
- traffic data like numbers and types of vehicles moving or passing some places, vehicles characteristics concerning speed, dimensions, types etc.,
- information about incidents like crashes, accidents, collisions, congestions, overstepping of regulations, times of travels, times of waiting (in points of fee payments, border crossings, ferries, etc.),
- observations of selected parts of road, roads infrastructural elements, video-detection, number plates recognition, living beings detection and others.

For possible functional utilities in transport telematic systems metamast installations may be useful mainly in transport operations at junctions of roads and railways, travellers service points, toll collection points, harbours and small airstrips. The most important systems and processes of application are as follows:

- traffic control,
- security services,
- information support of the drivers and travellers,
- information delivering to the services and centres attributable to the transport system functioning.

For illustration of the question below are presented some selected examples of the mast-based systems in mentioned areas of ITS applications.

The Pomeranian Metropolitan Railway (PKM) route is served by 6 telecommunications masts supporting traffic control system ETCS level 2, responsible for automatic supervision of trains movement. As in this system traffic control is based on permanent bidirectional information exchange, radio links between trains and traffic control means will be realised by GSM-R connections. GSM-R signals will be transmitted from on the mast installed antennas directionally only along the trains routes. Locations of the masts, their number and heights (four of 32,5 m one of 22,5 m and one of 48 m) are selected as to cover whole trains routes.



Fig. 4. Telecommunications mast in PKM traffic control system [own study]

In Tri-City (Gdańsk, Gdynia, Sopot) the masts are not only in PKM system. A 40 m high GSM-R mast is installed in Kamienny

Potok (Sopot) as one of 54 planned in “E 65/C-E 65 Modernization Project” for the railway line Warsaw – Gdynia.

Other related sample applications in ITS are installations for road, their sides and traffic visual observation. There can be mentioned:

- Visual systems for incident detection and parking monitoring on Saxon highways. For image processing are utilized mainly stochastic, non-typical characteristics in visual data. Those systems are standing out in terms of independency from weather conditions and lightning and low requirements concerning exactness of camera direction.
- A system of vehicle driving security assessment based on the analyse of the moving vehicles video images sequence. An intelligent device connected to 3G cellular network collects and sends sensors data – video images streams, vehicles speeds and accelerations, as well as theirs GPS detected positions. It allows to determine distances between vehicles by simple geometric calculations.
- Marine intelligent transport systems comprising water born traffic control in the ports areas and their surroundings. Such a system for example controls ships traffic on VTS Gulf of Gdansk. The system works mainly on visual information from network of shore observation by CCTV cameras, supported with five shore radars, automatic ships identification system (AIS), radio direction finders (RDF) hydro-meteorological sensors and mandatory reports by VHF radio.
- Numerous various road users protection systems based on image processing intelligent systems.

Obviously, almost similar methods of traffic and security control are applied in air transport processes.

4. Conclusion

The metamast installation may become an useful infrastructural element supporting possibility of implementation of various telematic functionalities and applications which can be active primarily in metamast area of visibility and influence. Its energetic self-sufficiency allows to easy installation and implementation in arbitrary place, what is especially advantageous just in case of transport network spread localisations.

Cameras location on few tens meter high tower brings the possibility of a broad observation of transport systems activity and conditions of roads network and its surrounding, including weather state.

Simultaneous placement on the tower mobile communication means brings opportune situation for creation of easy communication between drivers, travellers, vehicles, road infrastructure elements and systems of traffic control and transport processes security and comfort.

Obviously, a scope of the telematic functionality of the metamast installation in each particular case have to be mutually related with the place of location, more precisely – with informative needs of the area in sense of transport processes applications, wireless telecommunications and related possible functionalities in environmental problems.

The metamast, as even the source of electric energy, may serve also as a place enabling electric vehicle charging.

As main places and areas of metamast installation can be pointed between other:

- big road crossings,
- small airports and harbors,
- energetically isolated Passengers Service Points,
- toll collection points,
- places of borders surveillance,
- filling and battery loading stations

especially situated in locations with difficult access to electric grid.

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