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Adaptation of a Remote Control System for Data Exchange using a Mobile Data Channel

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Introduction

Monitoring and control of remote automatic processes has been analysed by many authors in various aspects [1,2], however, there are at least two topics that have not been analysed before.

We analyse usage of remote automatic control and monitoring applications in Lithuanian technical and economical environment. Available systems in the country for remote control of automatic applications are analysed from costs and precision point of view. The most optimal solution for integrators and companies that require automation services are selected.

It is also recommended to use data exchange among remote automatic applications and the central server using more than one mobile network provider. This rapidly increases reliability of remote control and minimises downtime of the system. It also helps to optimize operational costs of the overall system. An algorithm of an add-on to mobile automatic application that supports two mobile data channels is investigated. Calculations of system availability and price using two mobile network providers are presented as well.

Remote data transmission

There is a big variety of remote automation control applications in Lithuania, like, equipment monitoring, surveillance, traceability, remote tracking and control for heating stations, electricity distribution stations, air conditioning and similar. Our main objective is remote control of widely distributed remote automation systems of high importance, where on-line data exchange has to be reliable and discontinuous. It should be noted that all automation control systems are characterized by mechanism inertia from about 10 sec., for a motor till hour's in a heating systems. Even an automatic fire extinction system has a delay in valve mechanism for about 5 – 10 seconds.

A typical remote automation (wireless) channel is shown in Fig. 1.

Fig. 1. Typical remote data transmission channel

The most suitable communication channel for monitoring and control of remote systems is the GPRS/EDGE mobile data transmission network. The coverage of the network is about 98 % of territory of the country and it does not have time dependent charge on the standby mode. Therefore, data transmission is possible on-line in both directions at any moment.

In some cases it is also possible to use other technologies. For example:

- Use the fixed data network and DSL or similar wire line or optical technologies. It is a very costs effective and reliable solution, however a physical line (phone, Ethernet or optical fibre) must be available on-site.
- Install a dedicated line. It is a very expensive solution and could be used only for very important and high data volume generating stations.
- Use GSM-dialup or SMS. It does not require a physical line, however it is a very expensive solution if there is a need to monitor the system on line and transfer a bigger amount of data.
- Use a proprietary radio technology. It requires large investments into the network of base stations and the radius of coverage of the base station is only about 30km. A radio frequency license may also be necessary [2,3].

All these alternative technologies are either expensive, proprietary or do not provide continuous connectivity. Some of them require a physical line to the station that may not be possible to install. More about alternative networks in [4].

In Table 1 calculations of installation and operational costs of several alternative networks that can be used for remote automation control in Lithuania market are presented.

Table 1. Comparison of installation investments and operational costs for different data transmission technologies

	PSTN	DSL	GSM-Dial	GPRS/EDGE	RF com
	cable	cable	wireless	wireless	wireless
Installation costs, Lt	~30	~180	~ 400	~ 400	~ 8000
Operational costs, Lt					
one's/min	6696	49	8035	50	1,5
one's/hour	112	49	133	35	1,5
one's/day	4,6	49	5,5	35	1,5
one's/month	0,15	49	0,18	35	1,5

Source: UAB "TEO", UAB "Omnitel", UAB "Klinkmann Lit".

From comparison of costs it could be noted that for online monitoring we have two cheap alternatives: DSL – where a cable network is available and GPRS/EDGE mostly in all territory of Lithuania. Using these technologies it is possible to interconnect a distributed automation system without any additional investments into the infrastructure of communication network.

Security of remote automation

There are two possible ways for transmitting data among the central server and remote systems using mobile data networks. The first one is to use an open internet network supplied by default by a network provider. The remote automation systems could connect directly to the open internet network and using the Getaway access the central server. It is very cost effective way that does not require any additional services from the network provider.

The main disadvantage of this solution is low security level. This causes useless and parasitical data going from the Internet over a GPRS/EDGE channel to remote devices. Useless data increases the bill from the network provider and can influence/affect automation systems.

For secure connectivity among the central server and remote devices we recommend to use the solution shown in Fig. 2. In this case a private Accesses Point Name (APN) should be ordered from the network provider. Using a private APN each remote device will create a secure tunnel to the gateway (G). For secure connectivity between the gateway and the central server a Virtual Private Network (VPN) and firewalls also should be used [5].

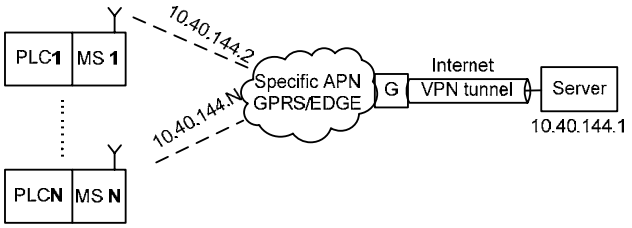

Fig. 2. Secure data transmission for a remote automation system

Use of APN and VPN technologies allows creating a automation system that is totally closed from external data networks. That increases data security and reduces charge from the mobile network provider.

Continuous connectivity of automation systems

Availability and reliability of data connection are the most limiting factors of using the GPRS/EDGE data transmission technology for the control of the remote process. GPRS/EDGE has been designed as a data transmission service for low to medium speed Internet access from personal computers, PDAs and mobile phones [5]. From long term experiment results it could be stated that probability to send a data packet from the first try using the GPRS/EDGE network in Lithuania is in average about 98 %. It is so because the GSM and GPRS/EDGE networks shares the same network recourses and the number of mobile data users quickly increases. It also depends on quality of the radio channel [6].

Nowadays, availability of the connection to the remote automation system is becoming very important especially for a high priority objects like power stations, moving objects, heating or cooling stations.

We analyze possibility to realize reliable remote system operation with discontinuous connectivity that is needed for highly important remote automation systems. In order to increase connection reliability we propose to use two providers of mobile data services. It is possible for remote automation applications to have two independent communication channels. If one of the communication channels fails due to the problems related with the modem (SW or HW failure), with the mobile network problems or network maintenance works, the second channel could be automatically used for remote system control and for diagnostic of communication problems.

Remote automation systems of high importance could be connected to the central server using two network providers like shown in Fig. 3.

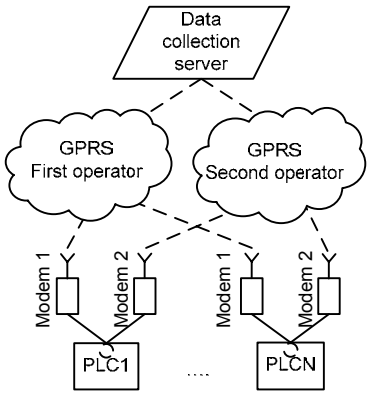

Fig. 3. Remote automation systems connected to the central server using two network providers

Two different modems with SIM cards of two different network providers can increase network availability in case that a programmable logic controller (PLC) has router functions installed [7, 8].

Using this architecture, when one of the channels is down, an engineer can immediately examine status of the

equipment from his desktop and solve the problem by connecting through the second channel [9].

The second advantage of using this architecture is significantly reduced down time of the remote system that occurs because of failure of modems (when a modem should be changed by an engineer going on site).

Usage of two network providers has an additional economical benefit because it is easy to negotiate with network providers regarding better prices of services.

Operation algorithm of a redundant automation system

To implement a reliable communication channel of a remote automation system an algorithm, shown in Fig. 4, could be used. There, MS1 and MS2 are the first and the second modems with SIM cards of two different network providers. While the main MS1 modem is transferring data to the server over a mobile data channel the second one is in the ready mode (registered to the network). If the connection to the central server using the MS1 modem is lost the MS2 modem starts data transmission. In order to forward packets to the active data channel at a particular moment. Functionality of routing of data packets into software of the controller should be implemented.

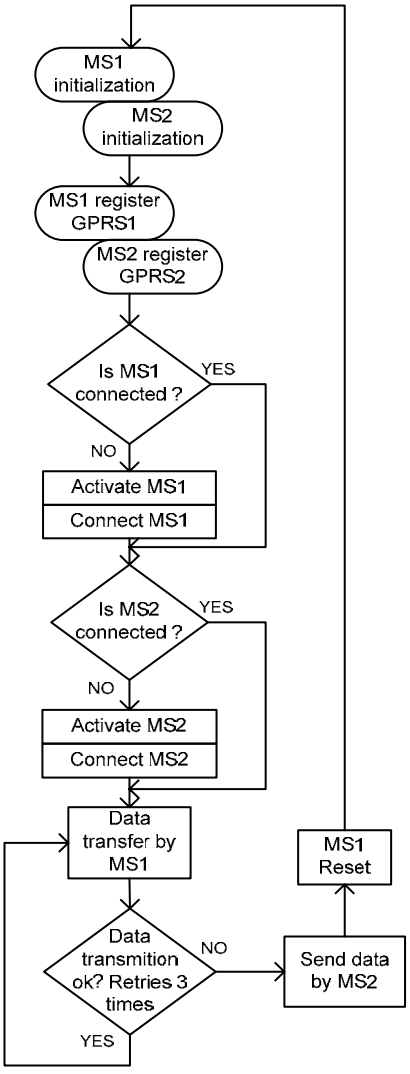

Fig. 4. Algorithm of a redundant automation system

Using the algorithm shown in Fig. 4 connection reliability of an automation system connected to the central server could be calculated using formula 1 [10].

$$M_P = \left(1 - \frac{S_U^B}{S_K}\right) \cdot 100\ \%, \quad (1)$$

here M_P – reliability of the connection; B – number of network providers; S_U – probability to send successfully the data packet from the first try; S_K – number of retries.

Calculation results using two network providers and considering that probability to send the data packet from the first try is 98 % are shown in Fig. 5.

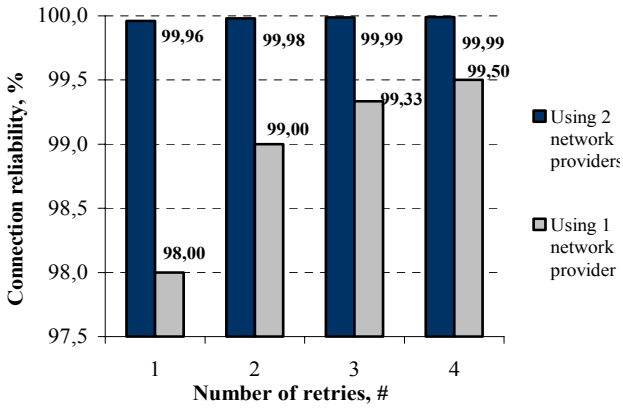

Fig. 5. Connection reliability of an automation system connected to the central server using two network providers

From Fig. 5 it could be noted that connection reliability using two network providers could be increased from 98 % up to 99,99 %. Such high connection reliability enables remote automation systems of high importance to be always connected to the central server.

Conclusions

1. The most suitable communication channel for monitoring and control of remote systems is the GPRS/EDGE mobile data transmission network. The coverage of the network is about 98 % of territory of the country and it does not have time dependent charge on the standby mode. Therefore, data transmission is possible on line in both directions at any moment.

2. From comparison of costs it could be noted that for on line monitoring we have two cheap alternatives: DSL – where a cable network is available and GPRS/EDGE mostly in all territory of Lithuania. Using these technologies it is possible to interconnect a distributed automation system without any additional investments into the infrastructure of communication network.

3. Use of private APN (Accesses Point Name) and VPN (Virtual Private Network) technologies allows creating an automation system that is totally closed from the Internet and other external data networks. That increases data security and reduces charge from the mobile network provider.

4. Remote automation systems of high importance could be connected to the central server using two network providers. It increases connection reliability from 98 % up to 99,99 % and significantly reduces down time of the remote system that occurs because of failure of modems (when a modem should be changed by an engineer going on site). Such high connection reliability enables remote automation systems of high importance to be always connected to the central server.

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Vygintas Batkauskas, Vaidas Batkauskas. Adaptation of a Remote Control System for Data Exchange using a Mobile Data Channel // Electronics and Electrical Engineering. – Kaunas: Technologija, 2007. – No. 3(75). – P. 61–64.

Analysis results of usage of remote automatic control and monitoring applications in Lithuanian technical and economical environment are presented. Available systems are analysed from costs and precision point of view. The most suitable communication channel is the GPRS/EDGE mobile data transmission network. The coverage of the network is about 98% of territory of the country and data transmission is possible online in both directions at any moment. From comparison of costs it could be noted that for online monitoring we have two cheap alternatives: DSL – where a cable network is available and GPRS/EDGE mostly in all territory of Lithuania. Usage of private APN (Accesses Point Name) and VPN (Virtual Private Network) technologies for increasing communication security of a remote automation system is analysed. It is recommended to use data exchange among remote automatic applications and the central server using more than one mobile network provider. It increases connection reliability from 98% up to 99,99% and significantly reduces downtime of the remote system. An algorithm of an add-on to mobile automation system that supports two mobile data channels is presented. Ill. 5, bibl. 10 (in English; summaries in Lithuanian, English, Russian).

Вигинтас Баткаускас, Вайдас Баткаускас. Приспособление системы дистанционного управления для обмена данными с использованием мобильных сетей // Электроника и электротехника. – Каунас: Технология, 2007. – № 3(75). – С. 61–64.

Представлены результаты анализа использования и применения дистанционных автоматических систем управления и контроля в Литовской технической и экономической среде. Имеющиеся системы проанализированы по цене и точности. Самым подходящим каналом связи является передача данных по мобильным сетям GPRS/EDGE. Зона действия технологии передачи данных охватывает около 98 % территории страны и передает данные в реальном времени в обоих направлениях. После сравнения цен инсталляции и эксплуатации, замечены две не дорогие альтернативы передачи данных в реальном времени: DSL – там где широко развита сеть фиксированной связи, и GPRS/EDGE – действующие почти по всей территории Литвы. Для гарантирования безопасности передачи данных, для дистанционных систем автоматизации, анализированы технологии точки доступа (APN) и виртуальные частные сети (VPN). Посылая данные среди важных автоматических систем и центрального сервера, рекомендуется использовать несколько провайдеров мобильной связи. Это увеличивает надежность соединения от 98 % до 99,99 % и значительно уменьшает время остановки системы. Также представлен алгоритм дистанционной автоматической системы, разрешающий поддержку двух сетей мобильных операторов. Ил. 5, библ. 10 (на английском языке; рефераты на английском, русском и литовском яз.).

Vygintas Batkauskas, Vaidas Batkauskas. Nuotolinių automatinių sistemų pritaikymas duomenų mainams mobiliuoju tinklu // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2007. – Nr. 3(75). – P. 61–64.

Pateikiama nuotolinių automatinių sistemų valdymo ir stebėjimo galimybių analizė, atlikta įvertinus technologinę ir ekonominę padėtį Lietuvoje. Sistemos buvo tiriamos atsižvelgiant į jų kainą ir tikslumą. Nuotolinėms automatinėms sistemoms prijungti labiausiai tinka bevielis GPRS/EDGE duomenų perdavimo kanalas. Ši duomenų perdavimo technologija veikia realiu laiku ir aprėpia apie 98 % šalies teritorijos. Lyginant įrengimo ir eksploatacijos kainas, matyti, kad pigiausios duomenų apsikeitimo realiu laiku technologijos: DSL – ten, kur išplėtotas fiksuoto ryšio tinklas, ir GPRS/EDGE – beveik visoje Lietuvos teritorijoje. Tam, kad užtikrinti nuotolinėmis automatinėmis sistemomis perduodamų duomenų saugumą, buvo analizuojamos privataus prisijungimo kreipties taško (APN) ir virtualaus privataus tinklo (VPN) technologijos. Siunčiant duomenis tarp didelės svarbos automatinių sistemų ir centrinio serverio, rekomenduojama naudoti daugiau nei vieną mobiliojo ryšio operatorių. Taigi nuo 98 % iki 99,99 % padidinamas sistemos pasiekiamumas ir gerokai sutrumpinama sistemos prastovos trukmė. Pateikiamas mobilios automatinės sistemos veikimo algoritmas leidžia sukurti duomenų perdavimo kanalą per du mobiliųjų operatorių tinklus. Il. 5, bibl. 10 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).

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