HRVATSKI OGRANAK MEĐUNARODNE
ELEKTRODISTRIBUCIJSKE KONFERENCIJE – HO CIRED
1. savjetovanje
Šibenik, 18. - 21. svibnja 2008.

SO3 – 15

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PRIMJENA RADIJSKOG SUSTAVA TETRA KAO KOMUNIKACIJSKOG MEDIJA ZA DALJINSKI NADZOR I PROCESNU KONTROLU U INDUSTRIJSKIM APLIKACIJAMA

SAŽETAK

U današnjim elektroenergetskim i drugim javnim komunalnim mrežama zahtijeva se brz i pouzdan sustav daljinskog nadzora i procesne kontrole kako bi se u slučaju problema u sustavu minimizirali ekonomski gubici i vrijeme nedostupnosti usluge. Stoga je ključno realizirati pouzdanu komunikaciju između nadziranih udaljenih točaka i kontrolnih centara. Uz lokacije koje su dohvatljive putem vlastitih komunikacijskih sredstava samih komunalnih službi, kao što je bakrena i optička kabelska infrastruktura, postoji znatan broj lokacija koje su komunikacijski pokrivene samo javnim telekomunikacijskim, uglavnom GSM i GPRS mrežama, koje ne osiguravaju zadovoljavajuću razinu pouzdanosti i žilavosti. Postoji opravdan rizik da u slučaju izvanrednih okolnosti čak ni ti resursi neće biti dostupni. Primjena vlastitih TETRA mreža predstavlja jedno od rješenja tog problema.

Ovim stručnim člankom prikazane su prednosti korištenja sustava TETRA kao komunikacijskog medija namijenjenog za daljinski nadzor i procesnu kontrolu uz komparaciju s drugim komunikacijskim tehnologijama. Prikazani su i mjerni rezultati iz sustava u primjeni, u različitim scenarijima implementacije.

Ključne riječi: TETRA, telekomunikacije, pouzdanost, elektroenergetska mreža, procesna kontrola

APPLICATION OF RADIO SYSTEM TETRA AS A COMMUNICATION MEDIA FOR REMOTE MONITORING AND CONTROL PURPOSES IN UTILITY APPLICATIONS

SUMMARY

In case of problems today's utility networks require fast and reliable supervision and control in order to minimize loss of revenues and outage time. Therefore reliable communication between the supervised sites and the control centre is a crucial demand. Besides those sites which are reachable via communication resources of particular utility, like copper cables or fibre optic cables, there are still a lot of sites which are reachable through public telecommunication networks only, mainly GSM and GPRS, which do not assure the satisfactory level of reliability and resilience. There is a big risk that at catastrophic events or power loss even those resources will not be available. TETRA networks might provide a solution for this problem.

This lecture shows the advantages of using TETRA as a communication media for remote monitoring and control purposes and compares it with other communication technologies. Figures from real applications in various implementation scenarios are shown as well.

Key words: TETRA, telecommunications, reliability, power network, process control

1. INTRODUCTION

Today, various communication media and technologies are at hand which could be used to serve communication purposes within utility telecommunication networks, however we are focusing in the following on communication within SCADA *(Supervisory Control and Data Acquisition)* networks and automatic remote metering networks.

In the past almost every utility had its own network resources to serve internal communication needs. This strategy changed due to a significant increase of public, provider-based communication capacity and services combined with cost effective usage of those services. Compared to fixed line services which were in most cases too expensive, especially the mobile services like GSM, GPRS and UMTS experienced a renaissance to a certain extent caused by an easy and unproblematic access and the nearly country wide coverage of the networks. After the privatisation along with its extraordinary high competition installation and operation of utility-owned resources became more expensive than using public networks. Consequently applications like remote metering, measurement networks, supervision and control were shifted to public communication services.

Nevertheless, with the increasing amount of mobile subscribers from all sectors as well as the increasing number of total services, the weak points of public networks became more and more visible: availability, reliability, radio coverage and independency – crucial demands for every utility – were the focal points of rethinking the strategy to completely rely on public communication systems.

Utilities need to have access to their networks even in the case of power loss or catastrophic events, functional requirement that is by far not guaranteed with public networks. The last big power black outs in the United States and Europe revealed those problems more than once. Nowadays the pendulum is swinging back and utilities again want to become more independent from public operators with own communication resources at least for the supervision and control of their supply networks.

2. COMPARISON OF COMMUNICATION TECHNOLOGIES

As the important sites (e.g. primary substations) were still connected to own fixed line resources (copper cables, fibre optics) other sites were not reachable. The decision process on which technology to use took all currently available communication technologies into consideration. Fixed line technologies were mainly eliminated for cost reasons so mobile services had been left only. The table below gives a glance on the strengths and weaknesses of the different communication technologies.

Table I. Strengths and weaknesses of various communication technologies

Own Line **+**	POTS./ISDN/GSM **+**	GPRS **+**	TETRA **+**	Power Line **+**
Independent Permanent connection Large bandwidth (up to 2 Mbps)	Easy to handle Low modem cost 64Kbit (ISDN) 9.6 Kbit (GSM)	Easy to handle Low modem cost Permanent connection IP Cost effective tariffs	Independent High availability High reachability IP Additional services	Independent High reachability Permanent connection IP
Own Line	POTS./ISDN/GSM	GPRS	TETRA	Power Line
Expensive	Operator dependencies e.g. SIM, service No influence in case of problems Reachability No permanent connection Limited bandwidth with POTS and GSM	Operator dependencies e.g. SIM, service No influence in case of problems Reachability Additional security Limited bandwidth	Limited bandwidth (with the current standard)	High equipment and installation cost Low bit rates Complex network structure

3. TETRA COMMUNICATION

Today, in general wireless networks at utilities primarily serve the demand to establish voice communication services and most systems are still analogue radio systems. The substitution of analogue radio by digital TETRA systems is in progress and one major driver for this is the capability to additionally carry IP based data other than voice channels. This increases the profitability of the entire network, e.g., especially transfer of metering application data could use and fully load the network during night times where only a limited demand for voice services exists.

TETRA networks are currently installed at a lot of utilities and the users discover more and more the capability to transmit data for different applications. As TETRA is limited in bandwidth (maximum defined gross bit rate of 7.2 kbps per TDMA time slot) TETRA can be assumed to be a substitute for those services that are currently being run over GSM/GPRS.

Typical applications at utilities are:

- Metering (load profile meters, consumption meters in households),
- Supervision of transformer stations,
- Infrastructure supervision and security related issues.

Technologies like WiMAX and wireless LAN are in the consideration phase but not yet implemented with the exception of trials to gain experience. The biggest problem in using broadband wireless services is the transmission range and the reachability. High frequencies are always a problem in urban areas and if we look to consumption meters, which are typically installed in the cellar or installation rooms of a building nearly every wireless technology needs external antennas to communicate to the base station. In this domain power line becomes a real alternative as it is available in every building and every room.

Local radio communication can be used for in-house communication (e.g., sensors, meters) but does not reach the necessary distances on the distribution network level. Hence, in the short term transformer stations of a power utility will be a focal area of application since usually there are no other connections than power line or wireless services.

The new TETRA standard TEDS *(TETRA Enhances Data Service)* provides improved digital data transmission capabilities with data rates from 115 kbps (25 kHz channel spacing) up to 691 kbps (150 kHz channel spacing) enabling new applications such as video transmission for remote surveillance. Whilst increasing the data transmission capabilities, with the introduction of advanced modulation schemes and various radio communication channel widths, TETRA systems remain fundamentally PMR *(Private/Professional Mobile Radio)* systems with guaranteed network reliability, availability and resilience complemented with the increased functionality in the way of data transmission and cellular telephony type of advanced voice communication.

4. AUTOMATIC METER READING

Load profile meters are read currently once a week or month as the meters are storing the 15 min values over the entire period. During the night there is a limited demand for voice services only and therefore reading those meters could be an ideal application for a TETRA network because more or less the entire capacity is available for this purpose. If there are several load profile meters available (e.g. industrial areas) sub networks based on UHF (433/868 MHz) might act as feeder systems to a TETRA modem.

Most probably new EU regulations will force the utilities to read consumption meters in the households on a monthly basis. Due to the huge amount of meters bandwidth calculations are crucial to guarantee the meter readings in time.

5. AUTOMATION OF THE DISTRIBUTION NETWORK

About 80% of the problems in power networks occur in the medium voltage network, which is currently supervised rudimentary only. The supervision and control of transformer stations saves operational cost and significantly shortens the power outage time. As it provides spontaneous events only it represents a minor load for the TETRA network. In combination with meter reading in the households, where the reading values are transferred through power line to a concentrator in the transformer station, two important communication functions can be realized which further improves the cost effectiveness.

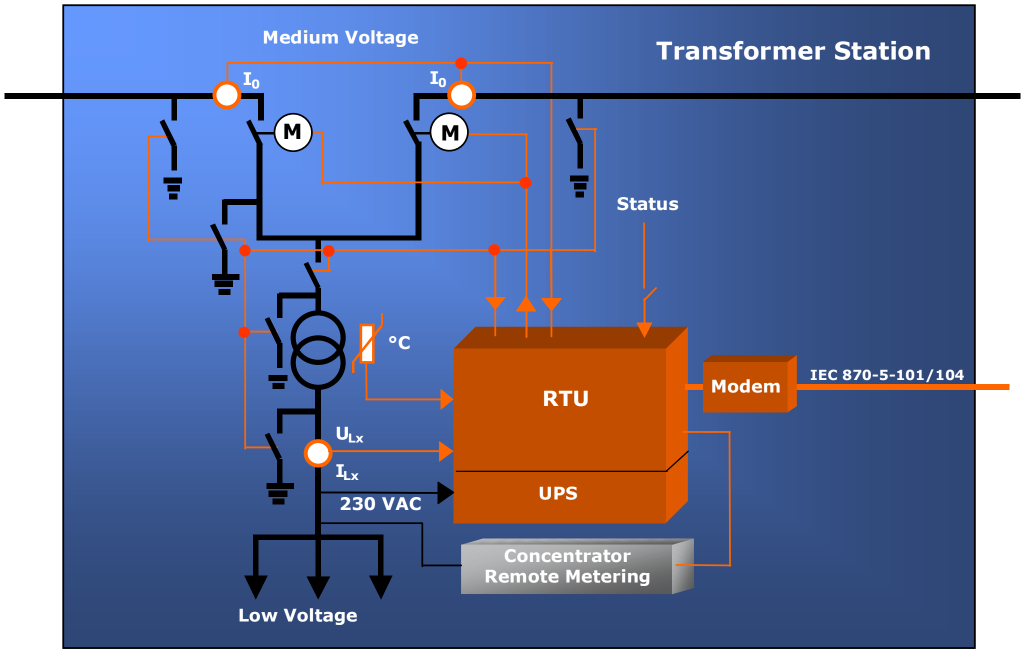

Figure 1 General principles of the distribution network automation

6. EXPERIENCES

Experiences with TETRA communications have been made so far in the automation of distribution networks. TETRA mobile radio communication system proved its availability and reachability during many situations like power outages and big events where GSM and GPRS services were definitely no more available.

The following figure shows how the power outage time can be reduced dependent on the number of automated stations.

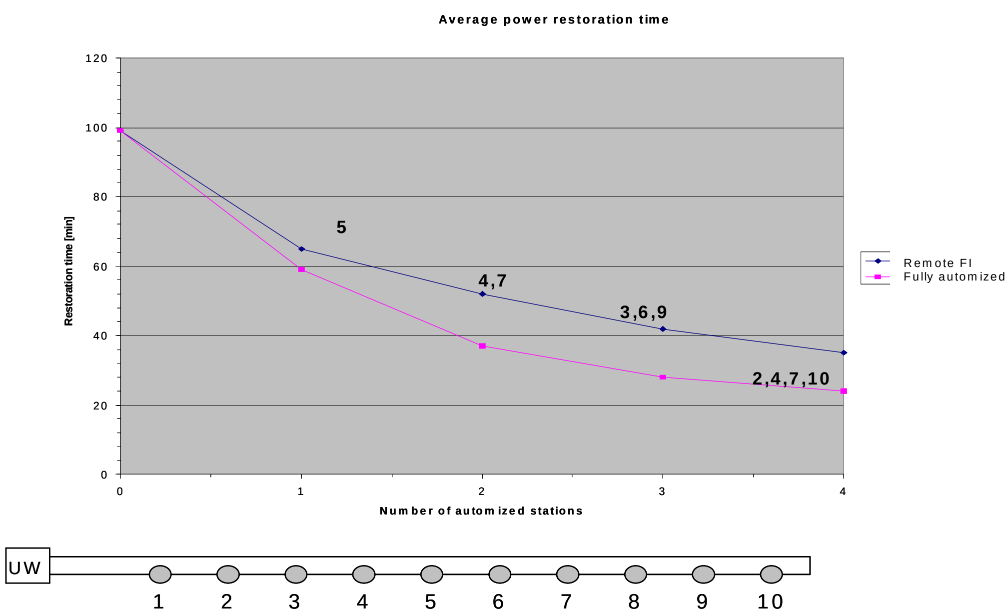

Figure 2 Reduction of power outage time consequential to the number of automated substations

7. CONCLUSION

For utilities owning a TETRA network availability, reachability, security and independency are the major advantages compared to public mobile networks. Using its capability to carry voice communication along with data services for supervision, control and remote metering enhances the cost effectiveness of the investment without bringing too much load to the network. Remote metering is an ideal task during night where the voice services take a back seat and more or less the full capacity of the network is available. GSM/GPRS services are typical candidates to be taken over by TETRA.

The new TEDS standard, which significantly increases the bit rate of a time slot, overcomes the obstacle of limited bandwidth and makes TETRA a future proof communication technology.

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