ABSTRACT
This paper presents the new design of our network that we are implementing to improve control and protection stepping into the new generation protocols. It is divided in two parts: the first one treats control and telecommunication aspects and the second one is focused on IEC 61850 protection implementation.

INTRODUCTION – COMPANY OVERVIEW
Netmanagement is an operator for electricity and gas distribution networks in Wallonia, the southern part of Belgium. Netmanagement is a business unit of the well-known Electrabel. Due to the liberalization of the energy market in Belgium, Netmanagement has just left the Electrabel group and is now an independent company with a brand new name: ORES.

The ORES managed networks are split in several exploitation areas. Besides the areas, a Technical Departement brings support and defines guidelines to help exploitation teams become more proficient in their daily job.

CONTROL
TG80x based control technology
Among the about 40000 nodes electricity network, some 800 are remotely controlled (i.e. signaled or fully controlled). On the gas network, about 100 nodes are controlled (only signalization). This paper only presents the way the electricity networks are controlled and protected.

All the controlled nodes are point-to-point or serially connected to a central monitoring and control center as shown on figure 1. The SCADA server is of the TG8000 model and it talks with the remote RTU’s using the TG80x control protocol.

This old control system presents some drawbacks: it was designed for few data transmissions and uses low speed connections, it is not time stamped, and it is a proprietary trademark.

Implementing IEC-104
Motivations
The main reasons why we have decided to work with this protocol are the following: first of all, the protocol is basically constructor independent. Secondly, it is based on a TCP/IP communication protocol and in that way it allows us to take advantage of the IP based applications for further control and monitoring aspects. Finally, with this protocol, it will be possible to remotely check the status and modify the configuration of our RTU’s, which is very important on a 300 km spread network.

Telecom networks
As the IEC-104 protocol needs a permanent telecommunication support to work, this choice allows us to give up switched connections that are completely obsolete in the communication world.

ORES has got its own optical fiber based OTN network and
a private copper wire network. The OTN access and the own copper wire connection are used as far as they are available on the controlled node.

For the few other cases, we use the xDSL network from the local data provider. At this time, this solution gives good results for few information nodes. The biggest disadvantage of this type of data access is that the telecom operator in Belgium still doesn’t provide industrial modems and data equipments. Moreover this kind of data network is not power supply secured.

**Steps to replace TG80x by IEC-104 devices**

Our SCADA has been upgraded to support TCP/IP IEC-104 connections. Due to the fact that the server is obviously old, this upgrade is time limited and the replacement of the current SCADA by a more recent and more scalable one must be foreseen.

In Wallonia, there are about 140 HV/MV substations where ORES operates besides the Transport Network Operator. The OTN own data network is available in most of these substations. We have started the move to IEC-104 in those substations in 2008 and we would like to replace about 10 RTU’s per year. IEC-104 RTU’s are systematically foreseen for new HV/MV substation design projects.

Further in the network, IEC-104 RTU’s are foreseen for new node control as well as for the replacement of the oldest and/or defected ones.

**Security**

Turning remote control on an IP based network implies to think about security rules. In most of the cases, control data are exchanged on our private OTN network which reduces the hacking probability. Moreover, as the OTN network is also used as office data network, a separate segment has been created for control devices.

Nevertheless enterprise IP network has got interconnections with the outside world and security rules must be implemented to prevent external attacks. ORES is currently investigating this aspect.

**PROTECTION**

Some of our stations have been turned from the classically wired protection relay technology to the new IEC 61850 protection model.

**Advantages of the IEC 61850 protection solution**

Firstly, using IEC 61850 radically simplifies wiring between IED’s and the RTU (only an SFTP cable is needed) and the space needed for the installation. Auxiliary relays in the protection rack, in the RTU and other ones are suppressed compared to a classical control design. Secondly, it is possible to modify protection relays configuration remotely. At last, IEC 61850 gives lots of other practical functionalities (e.g. perturbography...).

**IEC 61850 LAN topology**

The current LAN topology used in the ORES IEC 61850 electrical nodes is shown on figure 3. Ethernet switches are interconnected in a fiber optic loop to ensure redundancy. All other connections (protection relay to switch, switch to RTU) are performed with a single SFTP data cable.

![Figure 3: IEC 61850 LAN topology.](image)

We would like to increase redundancy in the future. For example from a point of view of communication between the RTU and the switches by connecting a second link to the loop (see dotted line on figure 3). We would also like to improve the switches power supply by adding for instance a backup alimentation because in the current situation, if a switch falls down, there is no visibility anymore on the equipments linked to the concerned device.

Electronic devices and wiring used to build the IEC 61850 LAN must be compliant with electromagnetic fields present in the low voltage bays compartments of the substation, which is a strong limitation for the choice of devices.
Case study
The above IEC-104 and IEC 61850 topology has been implemented to control and protect some important nodes on our network.
The chosen example to be presented here is the “MédiaCité” substation located in the city of Liège. It is a new substation with a 3 cables infeed (3 x 3 x 400 mm² Alu), 17 circuit breaker bays, 5 switch coupling bays, and 3 bays for the supply of 3 MV/LV transformers.

The following table presents the cost of the new technology solution compared to the old technology one.

<table>
<thead>
<tr>
<th>Project : MédiaCité</th>
<th>IEC-104 &amp; IEC 61850</th>
<th>TG80x &amp; non communicant protection relays</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTU + protection</td>
<td>49.700,00 €</td>
<td>56.300,00 €</td>
</tr>
<tr>
<td>LAN (switch, wiring, …)</td>
<td>7.000,00 €</td>
<td>0,00 €</td>
</tr>
<tr>
<td>Wiring</td>
<td>4.950,00 €</td>
<td>12.359,50 €</td>
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<tr>
<td>TOTAL</td>
<td>61.650,00 €</td>
<td>68.659,50 €</td>
</tr>
<tr>
<td></td>
<td>100,00%</td>
<td>111,37%</td>
</tr>
</tbody>
</table>

Table 1 : Cost comparison for the project “MédiaCité”.

The results show that implementing a new protocol based control and protection topology is cheaper than the obsolete TG80x solution, mainly because of the wiring costs reduction.

CONCLUSIONS
Using IEC 60870-5-104 and IEC 61850 protocols for substations control and protection improves the monitoring quality and provides operators lots of advantages.
Wiring is strongly simplified in substations, which reduces the total cost of the projects. First results are very good and investigations must be continued in the fields of data security, devices redundancy and remote administration.

GLOSSARY
HV    High Voltage
IEC-104 IEC 60870-5-104
IED   Intelligent Electronic Device
LAN   Local Area Network
LV    Low Voltage : under 1 kV
MV    Medium Voltage : from 1 kV to 30 kV
ORES  Opérateur de RESeaux de gaz et d’électricité
OTN   Open Transport Network
RTU   Remote Terminal Unit
TCP/IP Transmission Control Protocol/Internetwork Protocol
xDSL  x Data Subscriber Line