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# DATA EXCHANGE ISSUES
# WITHIN
# THE POWER SYSTEM OPERATION & CONTROL ENVIRONMENT

- A Benchmark Questionnaire Survey -

## Working Group
## C2.01

## August 2008

cigré

**WG C2.01**

# Data exchange issues

# within

# the Power System operation & control environment

## - A Benchmark Questionnaire Survey -


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# 1 . Introduction

Cigré Study Committee C2, Working Group one (WG C2.01) has embarked on an analysis of the data exchange issues related to control centres of different electricity supply industry (ESI) actors. Some of the questions we wanted to find answers to are, for instance, the following:

- What are the data exchange practices currently in place in the ESI organizations?
- What are the applications that use data?
- What kind of IT is being used for data exchange in terms of systems, infrastructure and communication software?
- What are the needs and practices with respect to standardisation?
- What are the most important problems regarding data exchange and its IT support?
- What are the plans for the future?

One of the recent Cigré efforts in the data exchange domain was published in [1] and a short version of this report has been presented in [2].

We have created a questionnaire (see Appendix 4 - Questionnaire), to acquire enough relevant responses directly from the ESI actors (see Appendix 2 - Definitions and Appendix 1 - Responding organization power and control system). The emphasis was not only on the content of data exchanged, but also on the IT environment, systems and standards that support that data exchange. The 26 answers to the questionnaire allowed us to analyse the current practices in that domain.

We have limited the scope of the study to data exchange between the entities participating directly in the electricity market, such as between two system operators or between a system operator and a market operator. Based on information acquired during the survey and its subsequent analysis, we draw conclusions regarding existing data exchange practices and related IT support used within ESI organisations. We hope that this technical brochure can provide some support material that organisations may find useful in their decision making process related to data exchange, as well as a reference on the current (and potentially new) practices that they could follow.

In this report, the analyses of the responses are presented under the following headings:

- Functions performed by the responding organizations (Chapter 2)
- What is the data exchanged (Chapter 3)
- By what means is the data exchanged (Chapter 4)
- What are the current problems with data exchange (Chapter 5)
- What are the medium term plans for improving data exchange (Chapter 6)
- Overall conclusions (Chapter 7)

# Part I – The "What" of data exchange

## 2 . Functions performed by the responding organizations

Depending on their type (TSO, VIC, ISO, ISMO, etc. - see Appendix 2 - Definitions), the responding organizations perform numerous transmission system and market operation functions. Within the **transmission and system operation realm**, the organization generally performs: (a) Asset management functions, (b) System operation support functions and (c) Transmission system access-related functions.

In the **asset management (AM) domain** about three quarters of organizations perform the following functions: Asset management financial aspects (69% of respondents), Network elements maintenance planning and execution (73%), Field operations such as ratings, condition monitoring or switching (73%) and Network expansion planning, design, construction (73%). Correlating asset management domain functions with the organization type allows a specific distribution to be observed, as depicted later in summary Figure 1 AM series, representing the total number of organizations of the specified type that perform some (at least one) of the specified AM domain functions. It can be seen that TSO type organizations are representative (7 of 7) as a type that performs AM functions.

In the **system operation (SO) support domain** almost all responding organizations perform the following functions: Real-time system operation (100%), Balancing generation and load (100%), Ensuring system security (92%) and Operations planning (100%). Correlating system operation support domain functions with the organization type, a specific type of distribution can be observed, as depicted later in summary Figure 1 SO support series, representing the total number of organizations of the specified type that perform some (at least one) of the SO support domain functions. For this functional domain (SO support), organization types: VIC, TSO and TSMO can be treated as representative.

In the **transmission system access (TRSA) domain** many organizations perform the following functions: Metering services (65% of respondents), Transmission capacity allocation and congestion management (69%), Maintenance schedule coordination (77%). Correlating transmission system access related domain with the organization type, a specific type of distribution can be observed, as depicted later in summary Figure 1 TRSA series, representing the total number of organizations of the specified type that perform some (at least one) of the transmission system access (TRSA) domain functions. For this functional domain (TRSA), TSO and TSMO organization types can be treated as representative.

Within the **market operation (MO) realm**, answers were mostly bounded to the organizations of the specific type (TSMO, ISMO, etc.) that have explicitly organized MO functions. In this domain, responding organizations perform the following functions: Operation planning coordination with the SO (23% of respondents), Processing of the bids and offers (27%), Settlement and billing (31%) and Providing market information to market participants (27%). It is obvious that some respondents, which do not belong to the required type, also perform some of the market related functions. Also, some organizations perform system balancing and imbalance settlement functions. Correlating market operation domain functions with the organization type, a specific type of distribution can be observed, as depicted later in summary Figure 1 MO series, representing the total number of organizations of the specified type that perform some (at least one) of the market operation (MO) domain functions. For this functional domain (MO) the TSMO organization type can be treated as representative.

As a result of previously retrieved organization data related to specific functional domains and their aggregation, it was possible to construct the summary diagram given in Figure 1 .

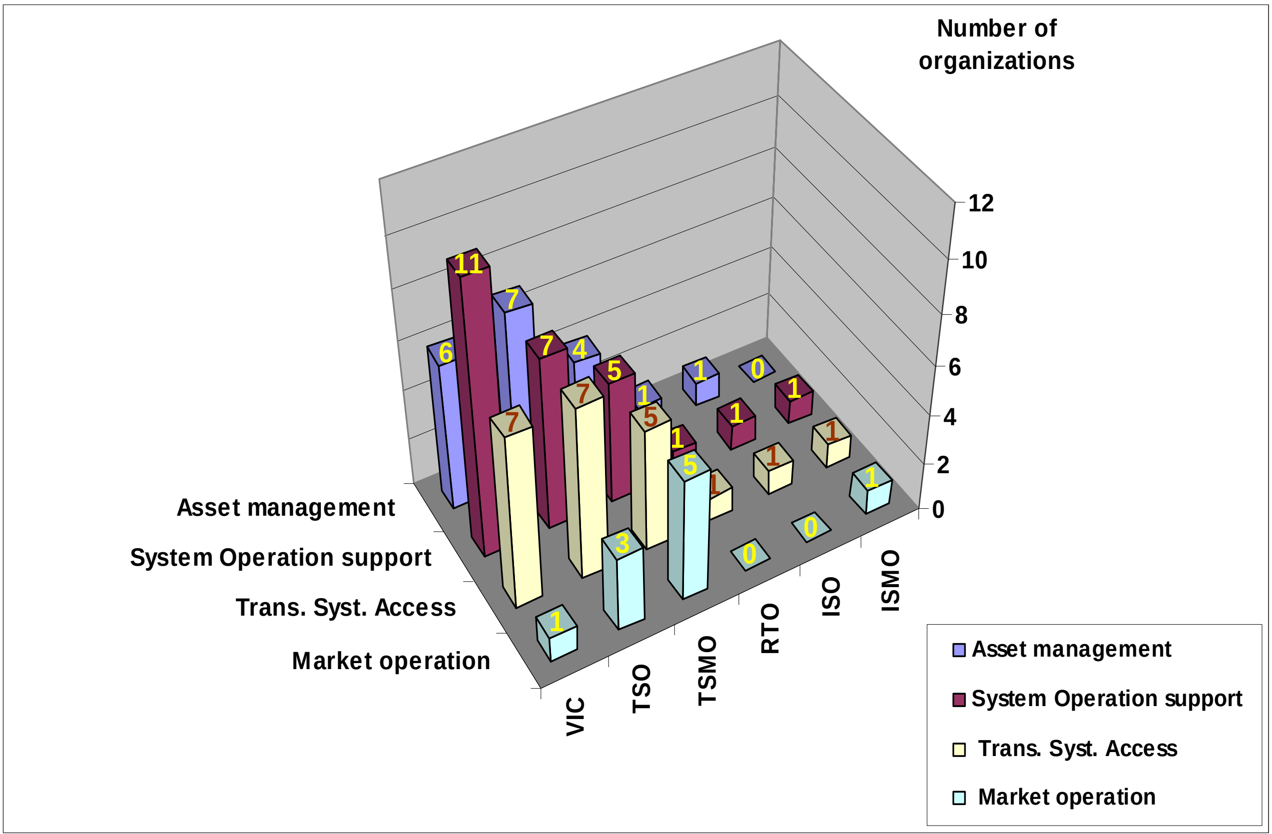



**Figure 1. Summary diagram for CC functions distribution per organization type**

From the last figure it is possible to conclude that all VIC type organizations perform system operation support functions (i.e. traditional functions). TSOs are performing mainly ''new'' functions like AM, TRSA, as well as traditional SO support functions. Finally, almost all responding TSMOs are performing all new and traditional functions.

# 3 . Data being exchanged

To successfully perform the above stated transmission, system and market operation functions, appropriate data exchange is a prerequisite. In part II of the paper we concentrate on data exchange in different contexts (i.e. ESI different participants) and on the periodicity of the exchange.

## 3.1 Data exchange with external neighbours

The first type of data exchange to be considered is that between the SO (of any type) and the neighbouring SOs, typically implemented as the communication between respective SO control centres; and secondly, between the SO and MO (of any type). Based on the acquired data it was possible to identify data classes that are exchanged between the parties, as well as the periodicity of that exchange. Those findings are provided in part II of the paper.

## Data classes exchanged between SO's

The distribution of answers for different real time (with refresh rates: A<5sec, B=5-15sec, C=15s-1min) and operation planning (h-hourly, d-daily, w-weekly, mo-monthly, yr-yearly) ''horizons'' (periodicity of data exchange) for all the identified data classes is depicted in summary Figure 2.

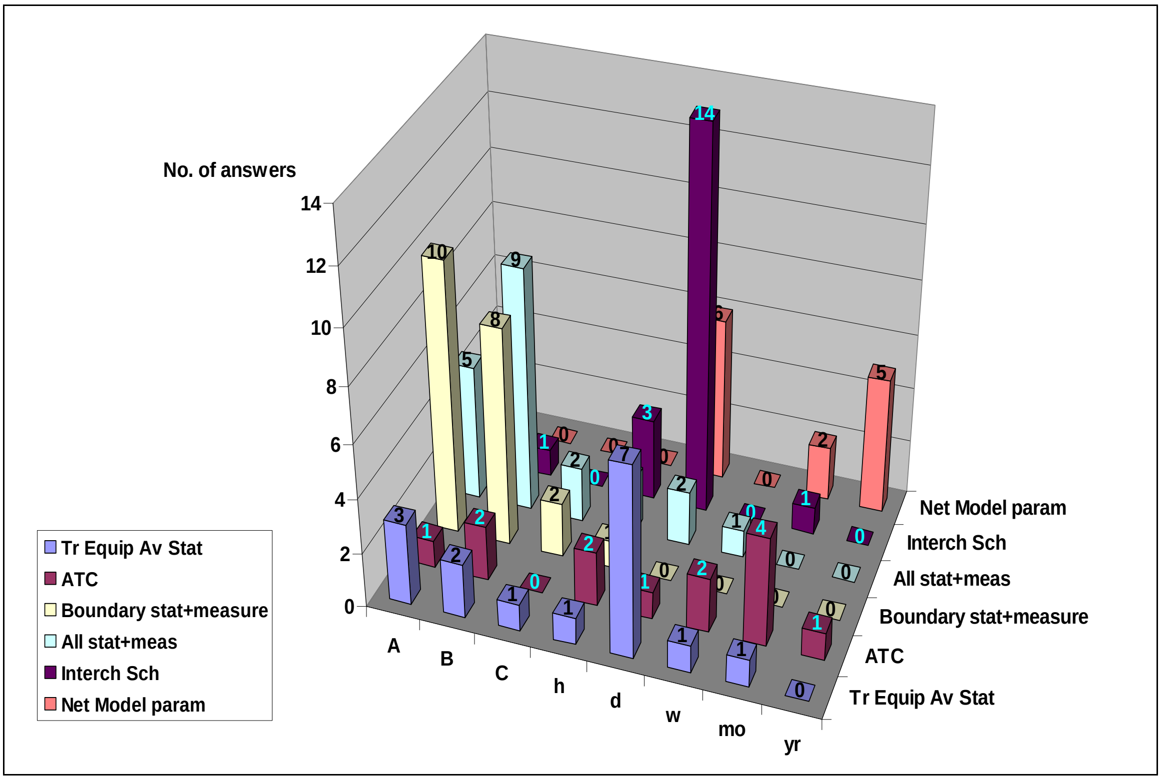



**Figure 2. Summary distribution of data exchange periodicity per data classes that SO-SO exchange**

From the above figure it can be concluded that identified data classes (Transmission equipment availability status, ATC, Status and measurements from boundary nodes, All statuses and measurements, Interchange schedules and Network model parameters) fall into two groups. The first one is related to exchange of node status and measurement data, typically in real time, with periodicity up to every 15 sec. The second group of data is exchanged mostly on a daily basis (Transmission equipment, availability status (44%), Interchange schedules (74%), Model data (46%)), sometimes monthly (ATC, Model data) or even yearly (Network model parameters).

## Data classes exchanged between SO and MO

The distribution of answers on different real time (A, B, C) and operation planning (h, d, w, mo, yr) time scales for all the identified data classes is depicted in summary Figure 3.

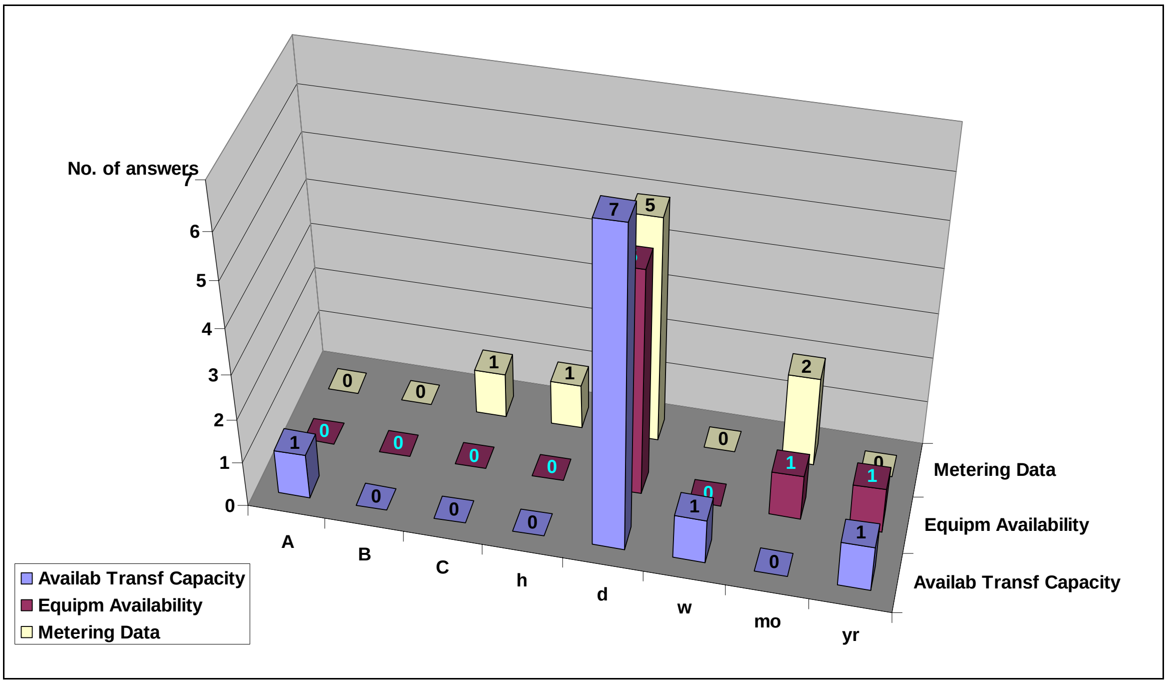



**Figure 3. Summary distribution of data exchange periodicity per data classes that SO->MO exchange**

From the above figure it can be concluded that identified data classes (Available transfer capacity, Equipment availability and Metering data) are exchanged between SO and MO mostly on a daily basis, i.e. 70% (of those SOs that exchange that data class with MO), 71% and 55%, respectively.

### Data classes exchanged between MO and SO

The distribution of answers for different real time (A, B, C) and operation planning (h, d, w, mo, yr) time scales for all the identified data classes is depicted in summary in Figure 4.

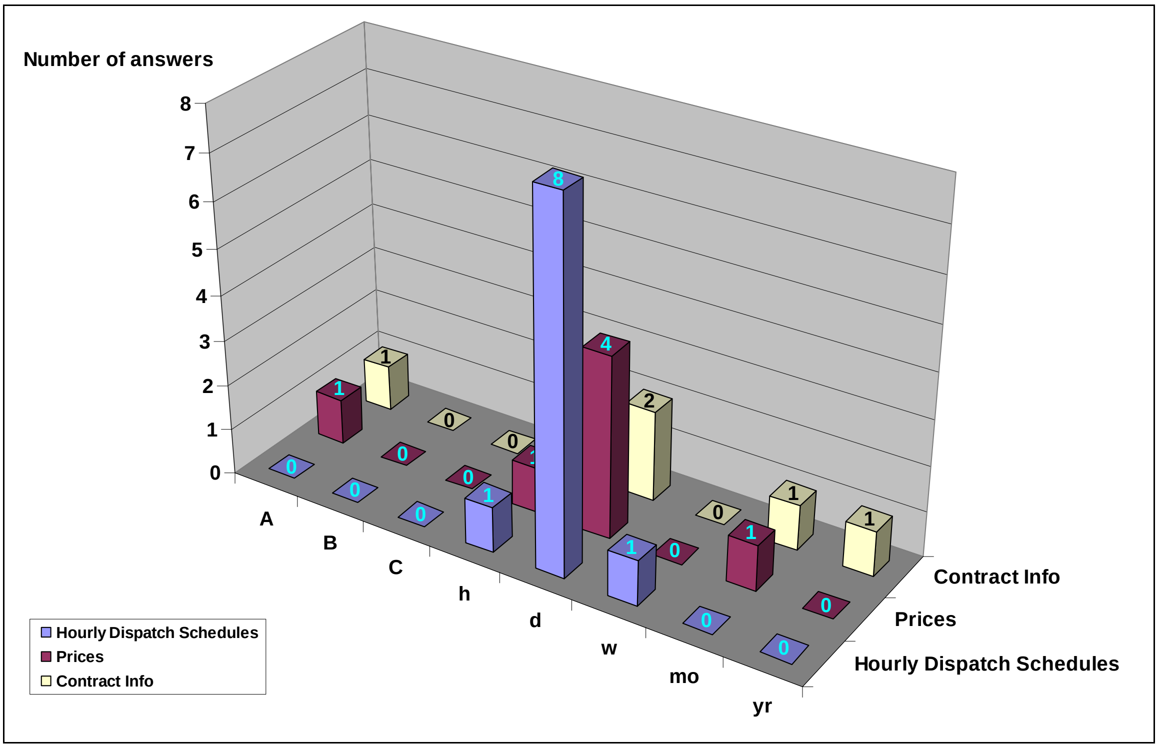



**Figure 4. Summary distribution of data exchange periodicity per data classes that MO->SO exchange**

It can be concluded that identified data classes (Hourly dispatch schedules, Prices and Contract information data) are exchanged between MO and SO mostly on a daily basis.

All data classes exchanged with external neighbours, acquired through the questionnaire, together with the periodicity of their exchange, are summarized in Table 2 provided in Appendix 3.

### 3.2 Data exchange with market participants

In addition to the data exchanged between SOs and MOs, the questionnaire identified data classes exchanged between SO and other ESI actors (like TO, Gen Co).

#### Data classes exchanged between SO and TO and SO and Gen Co

The distribution of answers for different real time (A, B, C) and planning (h, d, w, mo, yr) horizons for all the identified data classes is depicted in summary in Figure 5.

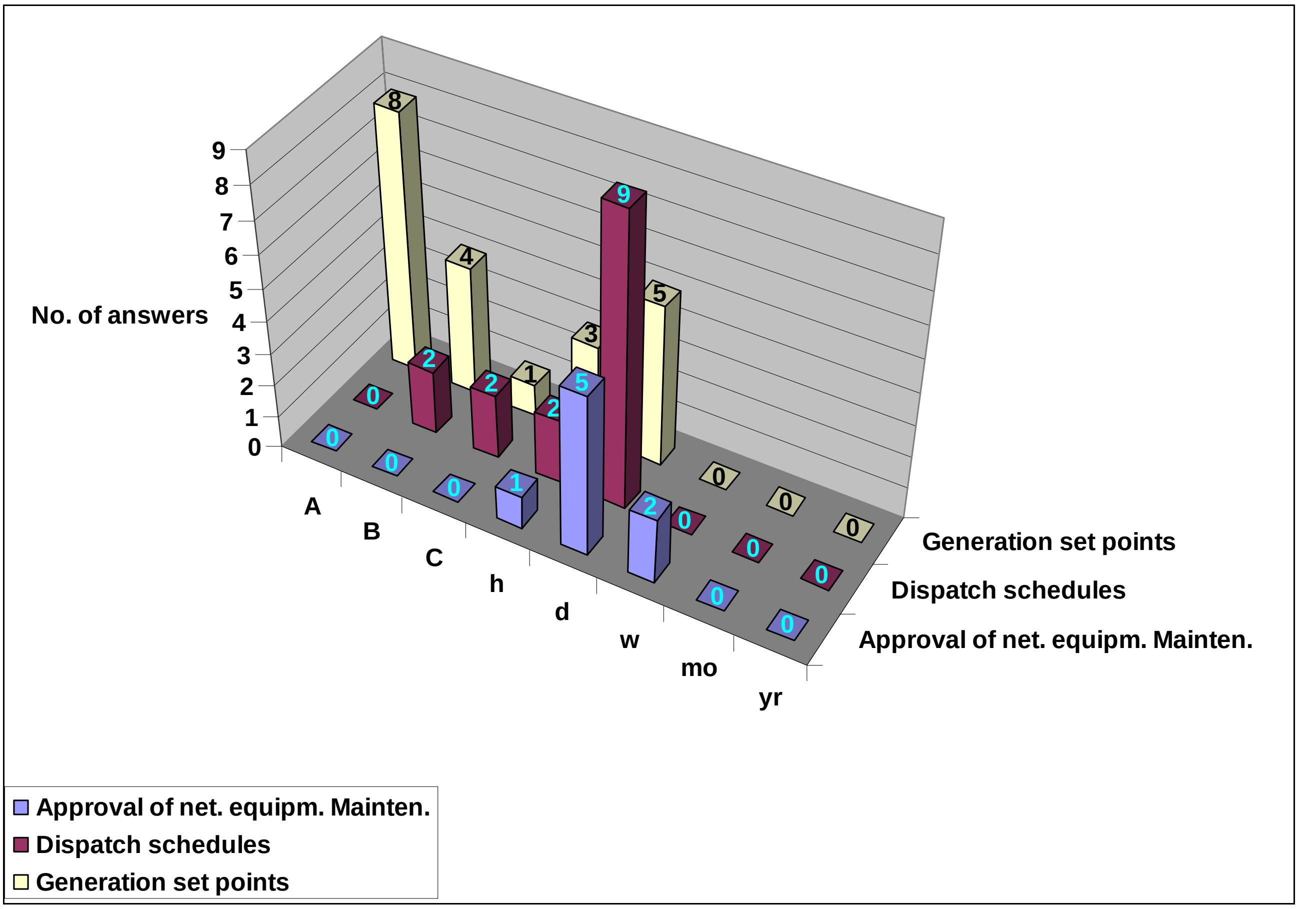



**Figure 5. Summary distribution of data exchange periodicity per data classes that SO->TO, SO->Gen Co exchange**

In conclusion, the most identifiable data class exchanged between SO and TO (Approval of network equipment maintenance) is exchanged on a daily basis, while exchanges between SO->Gen Co (Dispatch schedules and Generation set points) also occur on a daily (schedules) basis, with others (set points) mostly (62%) using one of the real time steps but hourly/daily (38%) periodicities are also common.

#### Data classes exchanged between Gen Co and SO

The distribution of answers on different real time (A, B, C) and planning (h, d, w, mo) horizons for all the identified data classes exchanged between Gen Co and So is depicted in summary in Figure 6.

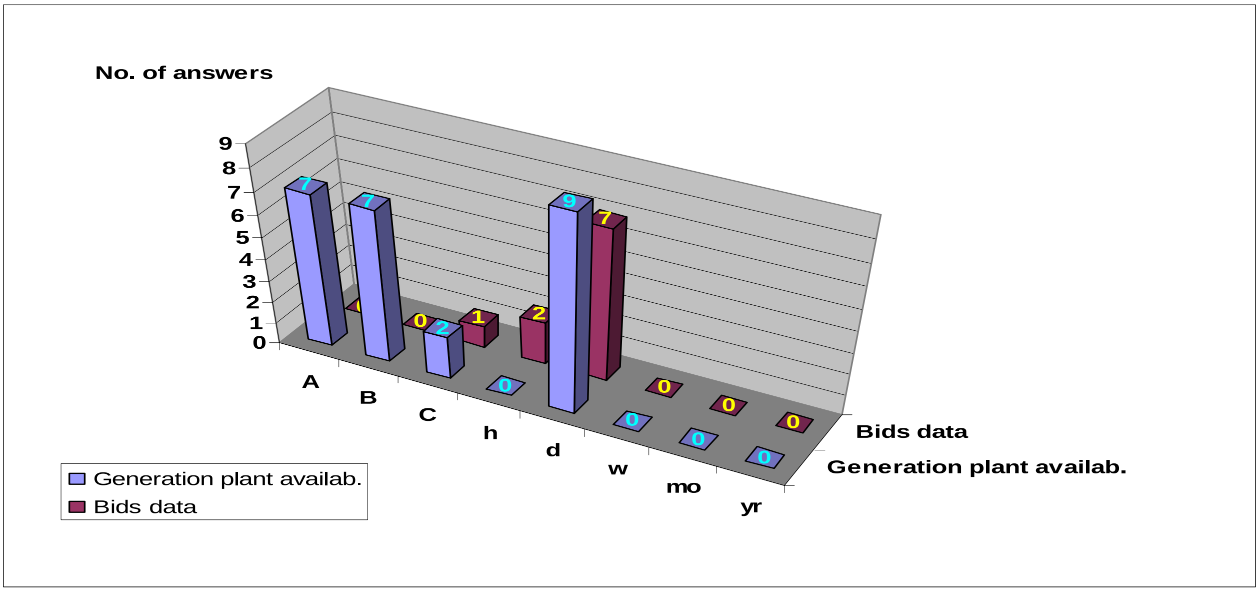



**Figure 6. Summary distribution of data exchange periodicity per data classes that GenCo->SO exchange**

It can be concluded that identified data classes (Bids data) exchanged between GenCo and SO are mostly (70%) exchanged on a daily basis, while others (Generation plant availability) are communicated mostly in real time (64%) or daily (36%).

All the above data classes, together with periodicity of their exchange are summarised in Table 3, provided in Appendix 3.

## General comments

The answers show that some data classes are exchanged in real-time, other in on-line/planning mode (hourly, daily, etc.), but some in both time frames due to their use for both real-time operation and operation planning purposes. It can be concluded that the majority of data classes exchanged with neighbouring SO or MO are exchanged mostly on the daily basis as depicted in Figure 7.

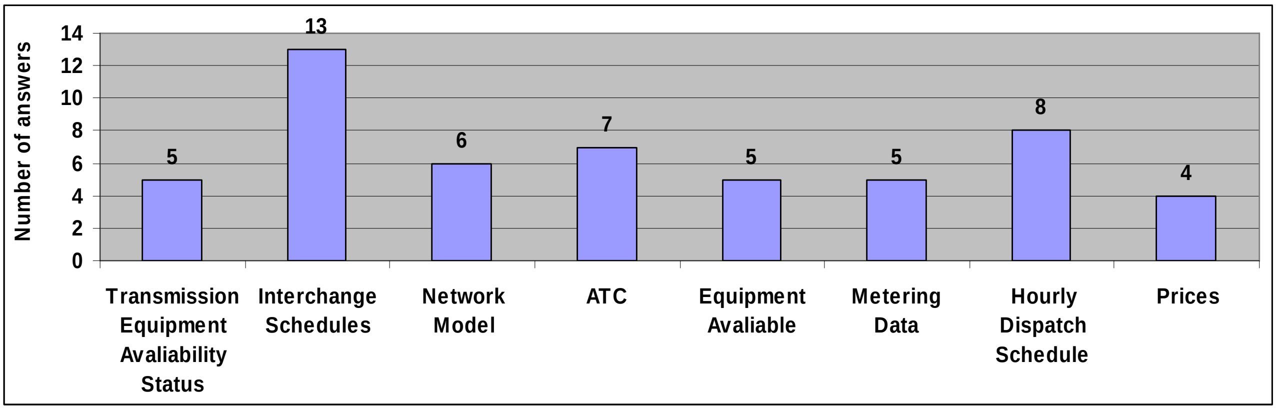



**Figure 7. Data classes with dominantly daily exchange**

Also, just a small amount of operational data available in the CC (like switching equipment statuses and measurements at boundary nodes and/or all statuses and measurements), as well as generation set point and generator availability data, are exchanged in real time with refresh rates ranging from less than 5 sec to 1 min, as depicted in Figure 8.

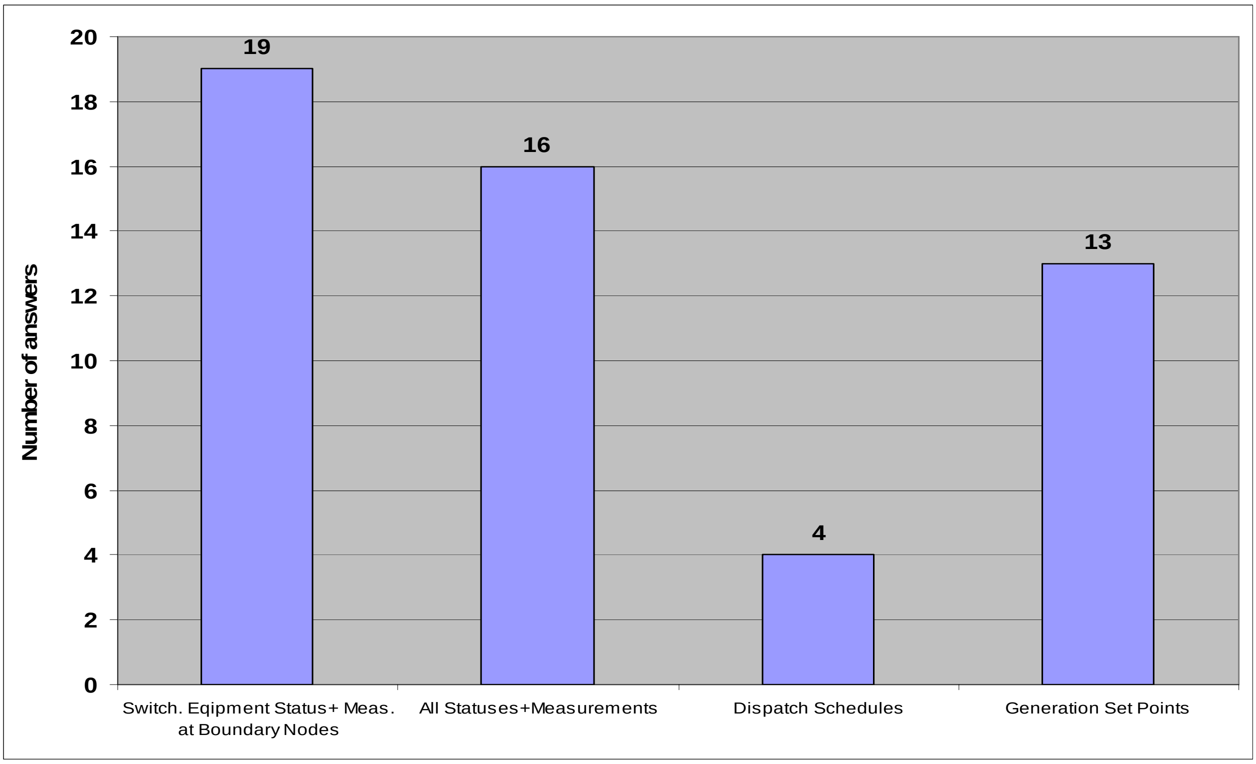



**Figure 8. Data classes with dominantly real time exchange**

## 3.3 Data exchange with internal systems

Beside the data exchange that the SO has with other ESI actors, SO control centres are an important source of data for numerous applications employed within the company. In that respect, the answers show that the organizations exchange data most often on an online basis (with different periodicities) with the following internal systems: ERP (such as historic production, consumption data etc.), work management systems, office automation systems (different process data), customer information/billing systems (metering data), network IS and engineering analysis systems (power flow data). It can be concluded that the most frequently exchanged data are metering data (monthly) for the CIS/Billing system and power flow data related to engineering analysis, exchanged both in real time and off line modes (with hourly and daily periodicities).

Based on the above analysis, we can conclude that the use of SO CC data outside the control centre is still limited and that the full potential of EAI has yet to be realized.

# Part II – The "How" of data exchange

## 4 . IT infrastructure & standards

This part of the questionnaire focused on different aspects of control centre networking for data exchange and on the applicable standards. It provided a number of standards/technologies as possible answers to the questions in this section (see Appendix 2 - Definitions). Some of these standards are electric utility specific (e.g., ICCP), whilst the others are general IT standards (e.g., XML).

### 4.1 Control centre and the external control centres/systems

The questions in this section dealt with the networking of the control centre with other control centres or the systems in other organisations (i.e., the context is WAN, VAN).

The first set of questions in this section dealt with the physical communications media. Four possible media types were provided as possible answers with the answer distribution shown in Figure 9. All the answers shown have been provided as yes/no items; respondents could choose more than one. Only one quarter or respondents tagged a single network media - the others effectively chose more than one. The results show that most organisations already use fibre optic networks, followed by the radio and power line carrier; these latter used to be typical for utilities up until recently. Three respondents added the comment that they lease lines from an external telecom provider.

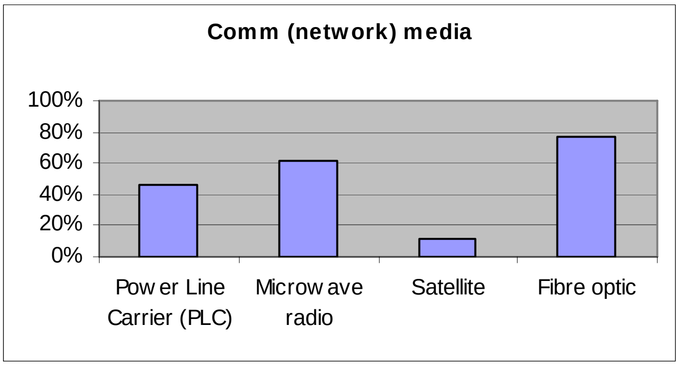



**Figure 9 - Communications media**

Concerning the typical bandwidth for communications with external organisations (both control centres and other IT systems), several responses have been provided, ranging from 1.2 kbps to 64kbps and up to 16 Mbps. It is important to note that one half of responses were 64kbps or lower (equivalent to an analogue modem over a telephone line), which also gives an idea of the still quite limited bandwidth used for data exchange by control centres with external systems.

Figure 10 gives an overview of the answers on the communication protocols and technologies used for data exchange. All the answers shown have been provided as yes/no items; respondents could choose more than one. As expected, more than half of control centres have TCP/IP-based communications with external systems, including the standard email and ftp protocols (which are based on TCP/IP). Also as expected, some 15% of control centres rely on a proprietary protocol, mainly the one provided by the control centre vendor or integrator. What is surprising is that there are still only 40% and 20% of control centres that have ICCP (TASE.2) and ELCOM (TASE.1) links with external systems, respectively. Another surprise, this time in the other direction, is that almost 30% of control centres already support some kind of exchange through Web Services, i.e., over standard HTTP protocol. Finally, one control centre supported data exchange using agent technologies. If the questionnaire were to be rewritten, it would have been interesting to learn what kind of data is exchanged with these latter two technologies, as they are not electrical utility domain specific, but are general IT technologies, widely used in e-commerce and B2B applications.

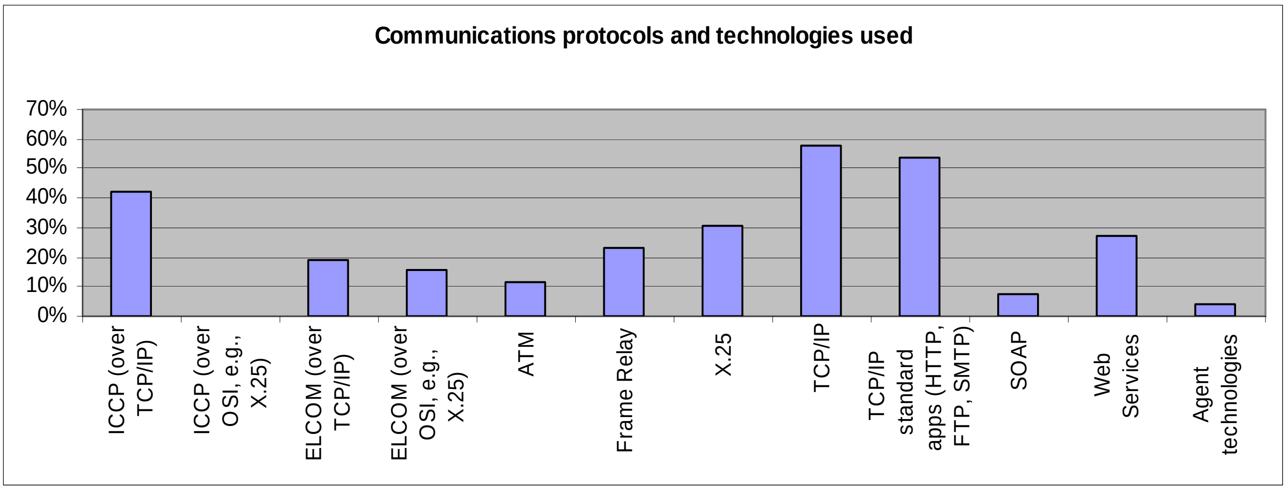



**Figure 10 - Communication protocols and technologies used**

The last question in this section dealt with file-base data exchange with systems in other organisations. The question offered four possible answers: EDIFACT/MHS (X.400), CIMXML/FTP, EbXML/HTTP and Other. All the answers have been provided as yes/no items and respondents could choose more than one. The response distribution is shown in Figure 11. On one hand, one half of organisations seem not to use any kind of file-based data exchange with other organisations. On the other hand, interestingly enough, as much as one third of respondents said they use files in CIMXML format as a means for data exchange. This is encouraging, given the relatively recent adoption of the standard. The tendency seems to be, for those that use file-based data exchange, to turn towards more recent standards (CIM, ebXML) in preference to the older ones (EDIFACT) or proprietary formats (used by only 2 organisations and not shown on the figure below).

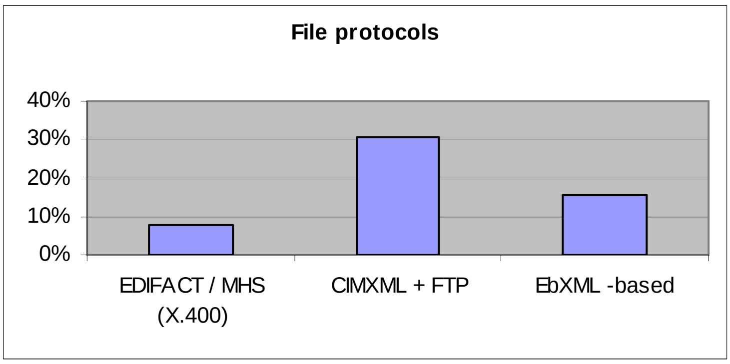



**Figure 11 - File-based data exchange**

## 4.2 Control centre and the IT infrastructure internal to the organisation

The questions in this section dealt with networking of the control centre with the systems within the same organisation (i.e., the context is LAN, or between LAN and WAN/VAN for organisations with distributed IT infrastructure).

About 80% of organisations have an established IT standard, which is usually a mix of different platforms. As expected nowadays, 70% of organisations rely on Microsoft platforms, 50% on Unix-based platforms, as many as 35% rely on open source platforms and 15% on Java-based platforms. Only one respondent (4%) has exclusively Unix and Java-based platforms, while six (23%) have pure Microsoft platforms.

Only one half of control centres follows the organisation IT standard, which means that control centres are still a "special kind of IT system" for many organisations. This is probably due to the fact that existing control centre software has been designed and installed long before the era of corporate IT standards and their porting is non-trivial and may be quite a challenging and high-risk task.

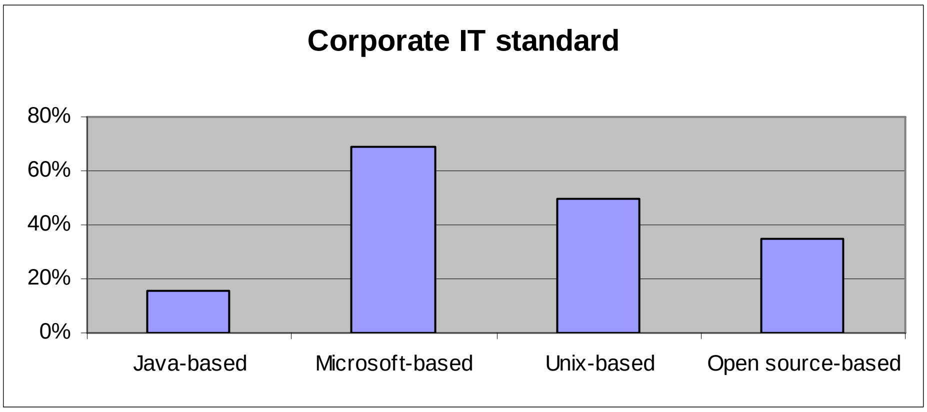



**Figure 12 - Corporate IT standards**

For possible answers to the question on the type of integration infrastructure for the organisation, we have provided many, ranging from EAI solutions (e.g., WebSphere of IBM), to RPC integration (COM, RMI, CORBA), to data integration (e.g., Oracle). Five organisations seem not to use any particular integration platform, which could be interpreted in two ways: either the respondents thought in terms of control centre only and not the whole enterprise, or there is some kind of proprietary integration solution. Not surprisingly, almost half of organisations use data integration based on Oracle products, usually combined with other middleware. This is the state of the art in IT today. However, we expect this to change in the future. Namely, the integration through direct access to data is certainly the "easiest" to achieve, as it requires minimum software design and implementation. However, it is probably the least maintainable, extensible and scalable approach, as there is no data encapsulation and every change to the underlying data schema has a direct impact on all the applications that use the data directly. The emerging standards should help the effort of building controlled access to data through more elaborate object-oriented layers in the software which runs within the chosen middleware.

On the question whether the control centre is integrated into the overall organisation IT infrastructure, only 23% of respondents answered positively. For them, the applications or systems with which the control centre system exchanges data belong to two categories. The first are mainly the market and settlement applications and historian which are typical electrical utility applications. The second category comprises enterprise resource planning systems, such as SAP and office applications. Example answers follow: "Integration with Settlement system and office applications via ICCP and Oracle", "Generation Scheduling and Historical DB using DB integration", "Integration with SAP using XML interface", "Integration with Market Management System and office applications" and "Integration with PS info providing system and equipment maintenance scheduling system - CCs send XML messages over HTTP to PS info providing system". We do not have statistics of what this figure was 5 or 10 years ago, but we believe that in the coming years, more and more control centres will be considered as one of the IT systems in an enterprise environment and in addition to integration with typical electrical utility applications, they will be better integrated with enterprise business systems. Here again, standards are being developed that will facilitate this task, in particular IEC 61968 for enterprise application integration.

The last question asked whether the organisation had set up and had been using a standard data format for control centres' data. Very surprisingly, only 3 respondents of 26 answered they had some data format standard – two of them use proprietary (in-house) format, while only one relies on CIM. This is significant, if compared to the case of exchange of data with external systems, where as much as 30% of control centres exchange their data based on CIMXML. This can lead to the conclusion that today, if a standard is applied, it is more for the purposes of integration with external systems, while the organisation's internal data exchange mechanisms seriously lag behind the standards,

### 4.3 Business processes & Place of standards

This section has focused on control centre people and system as a player in different business processes within the organisation, including those with other organisations. The respondents were first asked to think of all the tasks that could ideally be automated in the context of the control centre and to estimate the level of integration of the control centre in business processes within the organisation. Figure 13 shows a relatively uniform distribution of answers, with about one half of respondents having their control centres relatively or quite highly integrated with business processes. This means that for almost another half, there is still space for improvement, given the availability of modern technologies.

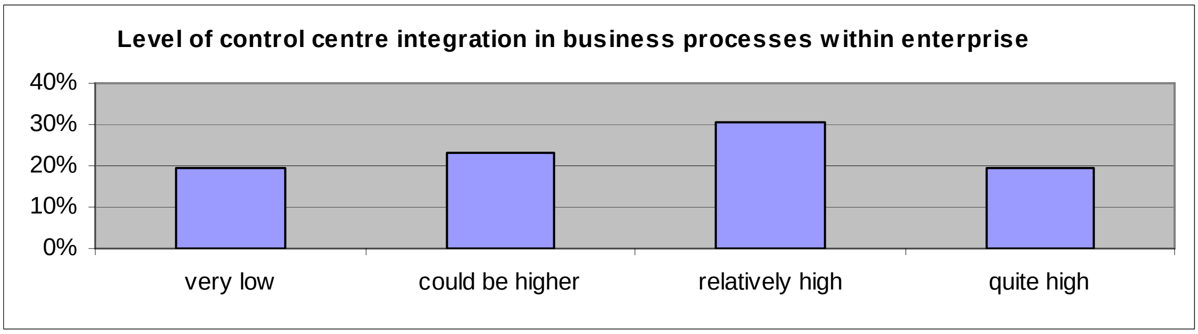



**Figure 13** - **Level of control centre integration in business processes within enterprise**

On the question of the importance of adopting open/international standards for integration of control centres into the IT infrastructure of the organisation, we have provided the answers and their distribution as shown in Figure 14. 60% to 75% of responses affirmed that standards help avoid vendor-lock, facilitate future extensions of existing systems,and provide the basis for requirement specifications for future systems. There were 2 respondents saying that the adoption of standards brings nothing to their organisation. This was somewhat surprising to us, but we could understand it in the light of the responses to the next question, which tried to identify the main risks in adopting standards, as perceived by these organisations.

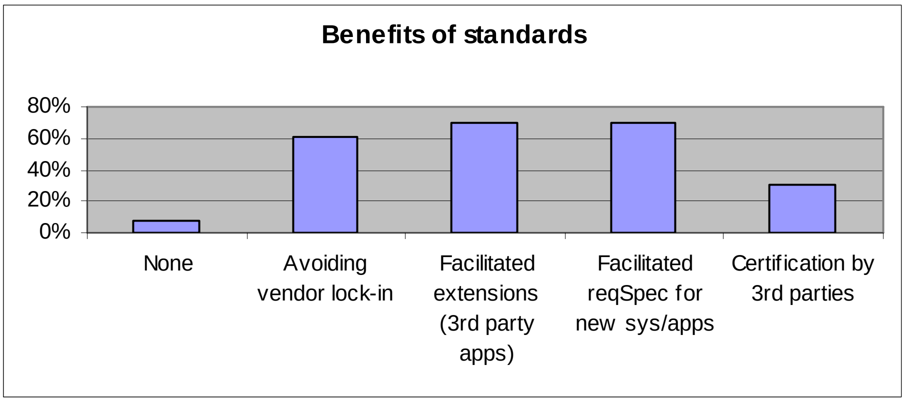



**Figure 14 - Benefits of standards**

The highest concerns with respect to standard adoption within an organisation are related to the time it takes to implement the standards and the budget constraints for such an activity (60% and 50%, respectively) - see Figure 15. For about 30% of respondents, mind shift in management and insufficient quality or scope of available standards are also seen as road blocks to the adoption of standards. One possible conclusion could be that there are organisations that have the philosophy of adopting only those standards that fully satisfy the requirements and thus justify the required time and budget.

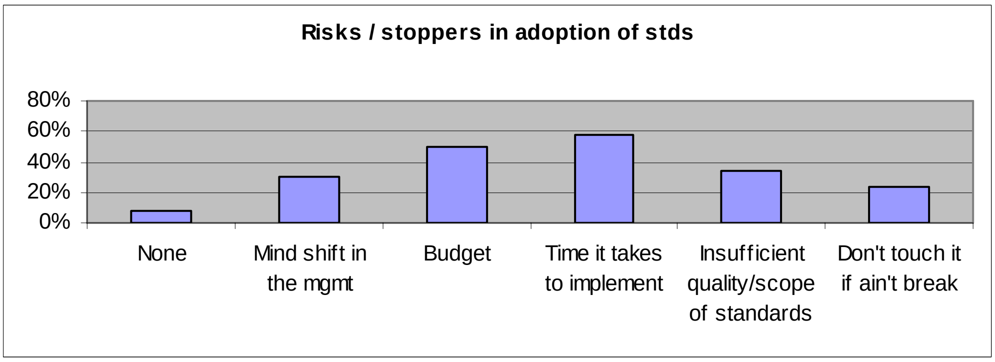



**Figure 15 - Risks and stoppers in corporate adoption of standards**

## 5 . Most important problems regarding current data exchange

The questions in this section dealt with the current problems that could be identified, which are due to the less than optimal data exchange and its IT support. Answers were offered for 4 aspects of data exchange:

- Data itself (syntax, semantics, lack of),
- IT infrastructure for external exchange,
- Internal IT infrastructure within the organisation and,
- Problems related to people and processes.

The suggested answers for the four groups of questions and their distribution are shown in Figure 16.

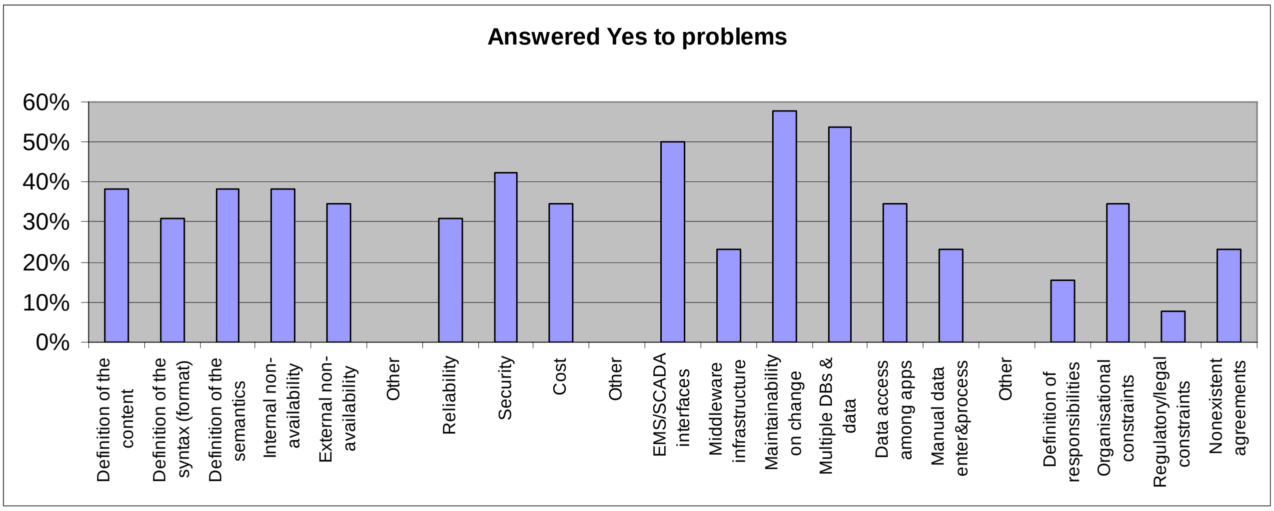



**Figure 16 - Kinds of problems in current data exchange**

Undoubtedly, the most relevant problems seem to be those related to internal IT infrastructure: between 50% and 60% of respondents confirmed difficulties in maintainability due to change in their control centre systems, difficulties in preserving data consistency among different data stores,and difficulties in using proprietary APIs of control centre systems' software. We are convinced that all of these could be significantly decreased with the use of standards.

The next most relevant concern for 42% of respondents is IT security. A few years ago, IT security would probably have not had this level of consideration and our guess is that in the coming years, this number is likely to grow.

For 38% of respondents, there are still concerns related to data exchange itself, namely, the definition of contents, the semantics of the data and the unavailability of data within the organisation due to organisational constraints. This latter issue is also the most significant for the category of people and processes. Adoption of standards and IT technologies should help with the definition of contents and the semantics of the data.

The above answers confirm that control centre systems generate the same type of issues with respect to integration and maintainability as any other enterprise-wide system would, most notably data consistency, maintainability and IT security.

# 6 . Future plans

The last section of the questionnaire asked about the future plans of organisations that will contribute in some way to improvements in data exchange. The question asked respondents to specify the time frame for the project, what kind of problem it solves, who benefits most from the project and whether there are issues that the deliverable might prompt. Only 60% of respondents provided answers in this section, with up to five future projects. The time frame for the projects ranges from 6 months to 3 years.

About one half of the projects are related to improving communication protocols (replacement of the proprietary ones, implementation of a standard where none exists, upgrade of the version or addition of communication links) – this is quite in line with the results discussed in Section 4.1.

About one quarter of projects relate to data itself: the plans are to exchange (import or export) more data with neighbours or within the organisation, in particular to improve state estimation and power system security applications.

The same number of projects will deal with adopting and implementing CIMXML as a standard data exchange format, which is also in line with the extremely low rate of internal data standards, as discussed at the end of Section 4.2.

The rest of the projects were in various domains, such as: installing a new control centre system, installing particular control centre applications (Operator Training Simulator, dynamic security analysis) and integration with back-office systems (planning applications, ERP systems).

## 7 . Conclusions

From the above analysis, we selected the following highlights as conclusions:

- Many of the global CC functions that the organizations perform are the same as in the pre-liberalization phase.
- The majority of data are exchanged on a daily basis, while mainly just measurements and status data from the boundary nodes are exchanged in real-time (with refresh rate up to 15 sec) between neighbouring organizations (SOs).
- Today relatively few control centres use the ICCP/ELCOM standards. However, their implementation and/or extension are planned within the next 3 years.
- A high proportion of the control centres exchange their data with external systems through CIM but very few use any data model standard for exchanges between internal systems. In fact, the level of data exchange between the control centre and internal systems is relatively low.
- The problems related to control centre integration into the IT infrastructure of the organisation are those typical for any enterprise-wide systems. These include data consistency, maintainability of changes and IT security issues.
- The trend is for better integration of the CC system into the enterprise IT environment.

## 8 . References


[1] N. Cukalevski, O. Gjerde, K. Lindstrom, N. Singh, ”Data Exchange Between the Electricity Supply Industry Actors”, ELECTRA, No.191, August 2000, pp.85-99

[2] T. Kostic and N. Cukalevski, on behalf of Cigré WGC2.01, "Data exchange issues within the power system operation and control environment", CIGRE-IEEE PES Symposium on Congestion management in a market environment, October 05-07, 2005, San Antonio, USA, paper 507.


## 9 . Acknowledgements


We wish to thank the organisations that answered the questionnaire as well as WG C2.01 members for their comments on both the questionnaire and report. We would also like to thank Mr. Goran Jakupovic from IMP for his support in making the questionnaire response data ready for analysis.

# 10 . Appendix 1 - Responding organization power and control system

To position data exchange practices in the appropriate context it was necessary to acquire and process basic data about the ESI organizations power and control systems, as well as data on the functions they perform.

For the definitions used, see Appendix 2 - Definitions. The full questionnaire can be found in Appendix 4 - Questionnaire.

## 10.1 The responding organization power system

### Power system related information

From a geographical point of view the organizations that responded are adequately represented, with a number of answers from all regions, i.e. Europe, Asia, America, Africa and Australia, as depicted in Figure 17.

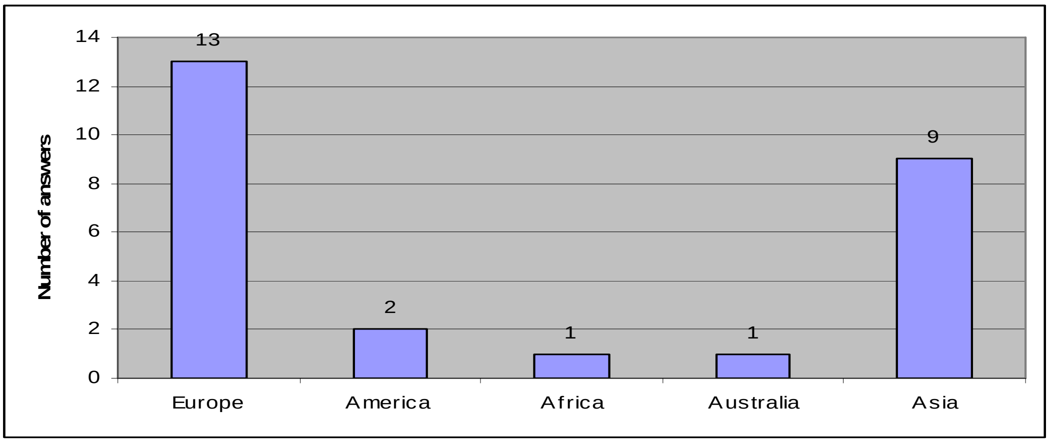



**Figure 17. Geographic distribution of answers**

Bearing in mind the number of answers from different regions, it is possible that some findings and conclusions are strongly influenced by the practices used in Europe and Asia (Japan mostly).

Different sized power systems as measured by their **peak load** are depicted in Figure 18. These range from small (up to 5 GW peak load) and medium (5-20 GW), to large (> 20 GW) and represent 11%, 54% and 35% of the respondents respectively.

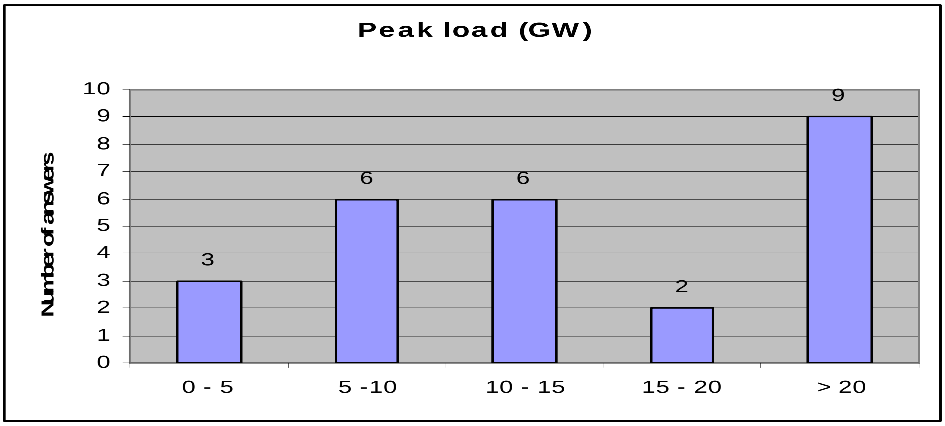



**Figure 18. Power system peak load distribution**

The available data is dominated by (5-20GW) in medium sized systems and > 20GW in large systems.

Transmission systems represented employ different **maximum standard voltage levels**, as depicted (aggregated within an individual level) in Figure 19.

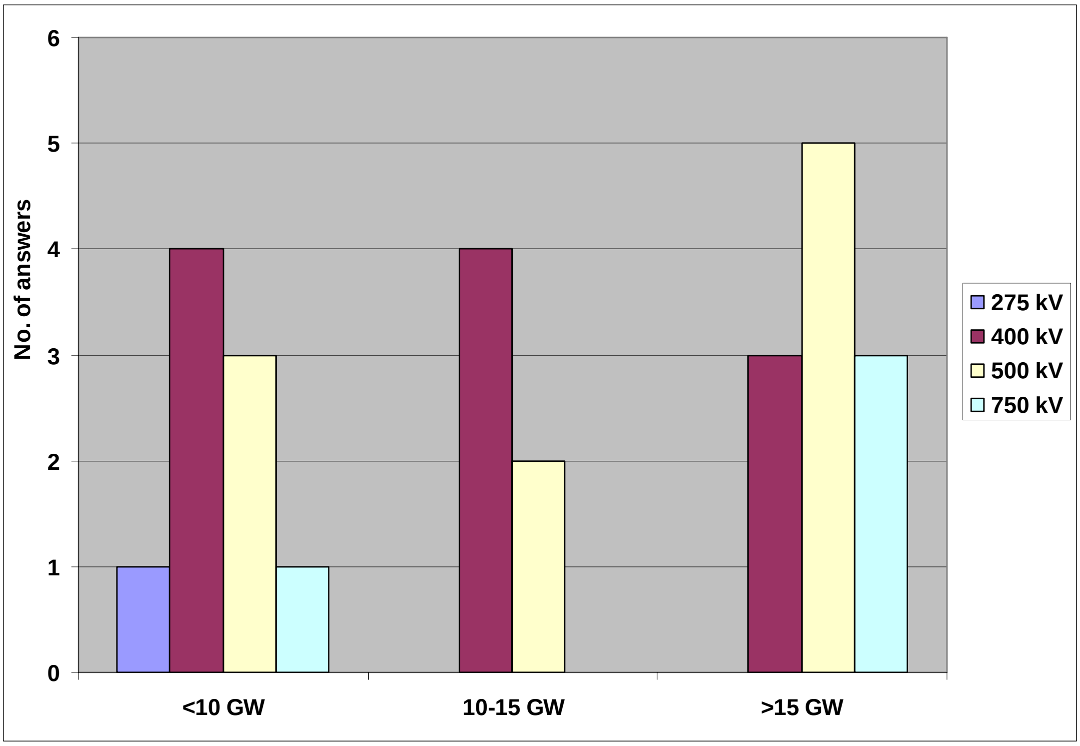



**Figure 19. Maximum Transmission voltage levels used distribution per systems peak load**

From Figure 19 we can observe that maximum transmission voltage levels of 275 kV, 400 kV, 500 kV and 750 kV are used in 4%, 43%, 38% and 15% of cases, respectively. Correlation between a power system peak load and maximum transmission voltage levels used, shows that systems with the peak load up to 10 GW (small/medium class) use different voltage levels (as shown in Figure 19) but the 380-400 kV level range is the one most often used. The situation within the ''midrange'' power systems (10-15 GW) is similar, with the 400 kV voltage level most frequently used. Within the upper zone (i.e. peak loads >15 GW) the 500 kV transmission voltage level is the most common.

## Organization related information

With regard of **organization type** (definitions given in Table 1 in the Appendix 2), almost all major types are represented, with the distribution shown in Figure 20 . The distribution shows a considerable participation of vertically integrated utilities (VIC), at 42%, (though those that responded will soon undergo profound changes) and organizations which explicitly perform market operation functions account for almost 23% of answers.

Correlation between organization type and system peak load, shows that about 27% of responding organizations are of the VIC type and have a ''midrange'' peak load (5-20 GW) , followed by the TSO type organizations (19%).

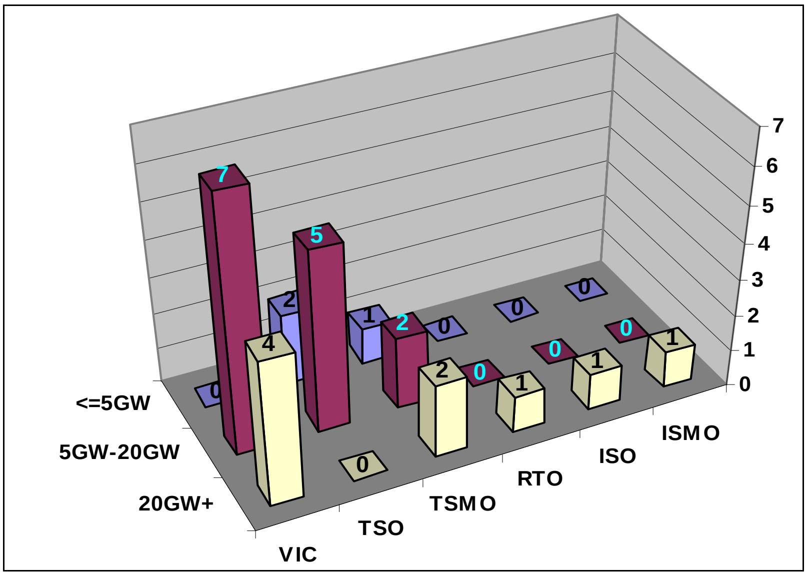



**Figure 20. Summary diagram for organization type distribution per system peak load**

Interesting data were collected regarding the **approximate number of people employed** in these organizations. The distribution of number of employees per organization data is given in Figure 21.

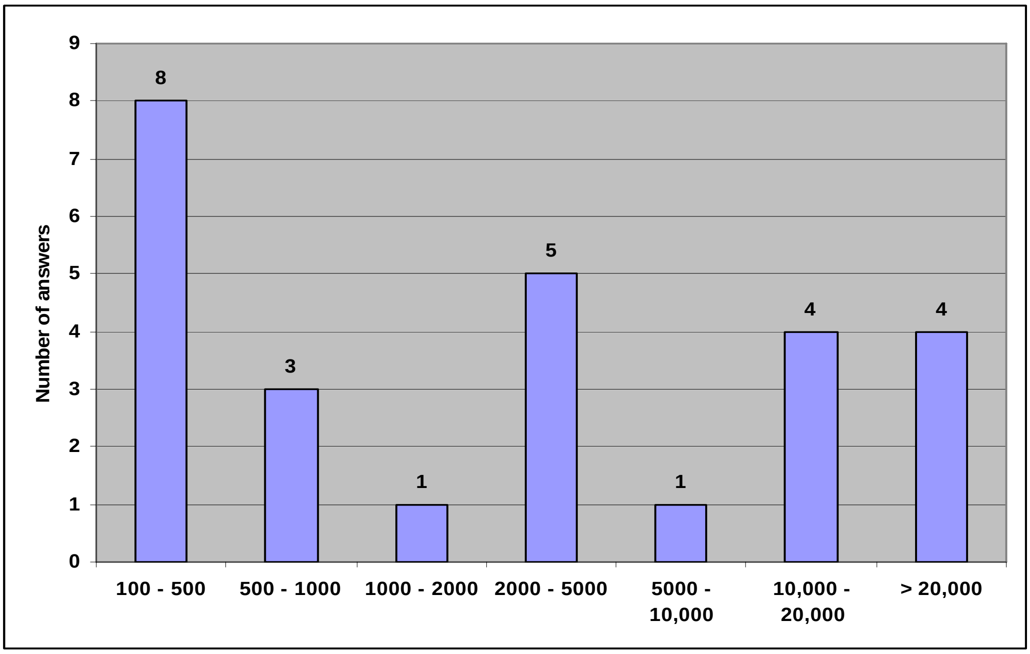



**Figure 21. Number of employees within an organization distribution**

These numbers vary across a wide range: from 100-500 (31%) and 2000-5000 (19%), to more then 10.000 employees (31%). Correlation between power system peak load and the average number of employees within an organization, as depicted in Figure 22, shows that systems with a peak load higher then 15 GW have, as expected, the highest average number of employees per organization. This is probably due to the influence of VIC type organizations.

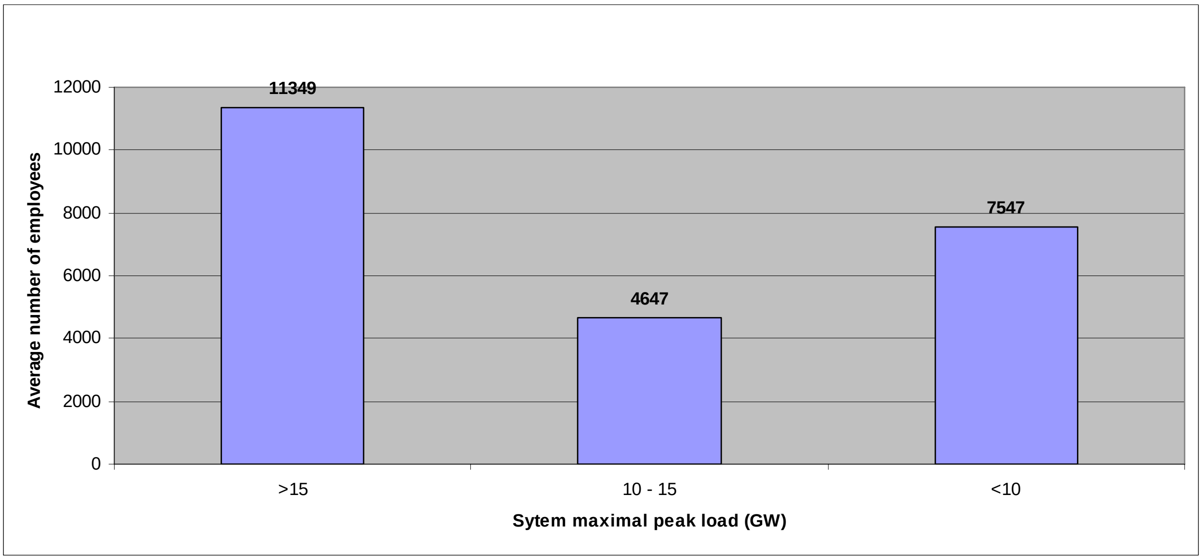



**Figure 22. Average number of employees distribution per system peak load class**

It should be noted that with the available data it was not possible to identify the average number of employees for small/medium sized systems (up to 15 GW peak load).

A correlation between an organization type and the average number of employees within the organization, as depicted in Figure 23, shows an interesting relationship. It demonstrates that systems of different types, i.e. systems with different structures and consequently functions, have different workforce requirements and that VIC type organizations have the largest workforce (average of 19'396 employees) within the analyzed pool of organization types.

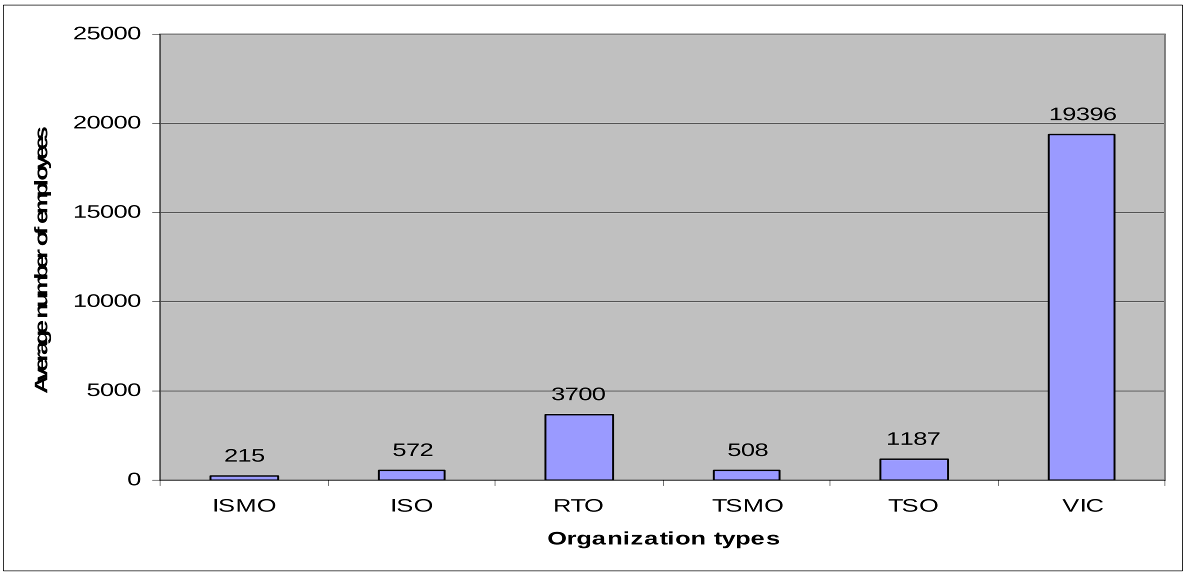



**Figure 23. Average number of employees per organization type**

It is interesting to note that, although the minimum and maximum number of employees differ considerably between organizations, the average number of employees within a TSMO-type organization that responded is 508 (Min/Max 180-1100), while an average number of employees for a TSO-type organization is 1187 (Min/Max 220-4000).

Finally, to normalize these data, the number of employees within the organization was divided by the peak load (MW) and those data were correlated with the organization type, with the distribution depicted in Figure 24.

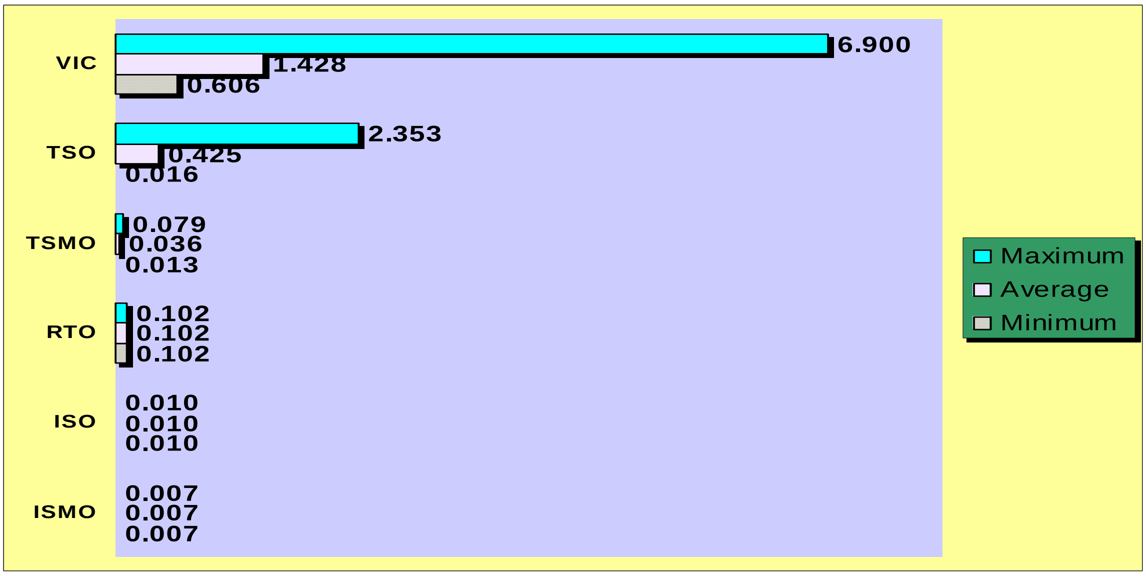



**Figure 24. Number of employees/ peak load MW distribution per organization type**

From Figure 24, it can be seen that with the increasing level of company restructuring the average number of employees per MW of peak load (used here as a substitution for installed capacity) is falling as expected, from 1.42 (VIC) to 0.42 (TSO) or even 0.01 (ISO).

## 10.2 The responding organization control system

### Hierarchical level

All facets of **hierarchical levels of control centres (CC)** i.e. national (15 NCC), regional (9 RCC) and area/district (2 ACC) are represented, as shown in Figure 25, with participation levels of 58%, 34% and 8% respectively. Correlation between the hierarchical level of a CC and the system peak load was also determined and presented for different load levels. It can be seen that the NCC is the dominant (57%) CC hierarchical level for ''midrange'' power systems, followed by the RCC (36%). Within the available sample for larger power systems (above 20 GW), participation of NCCs and RCCs is equal, i.e. 44%.

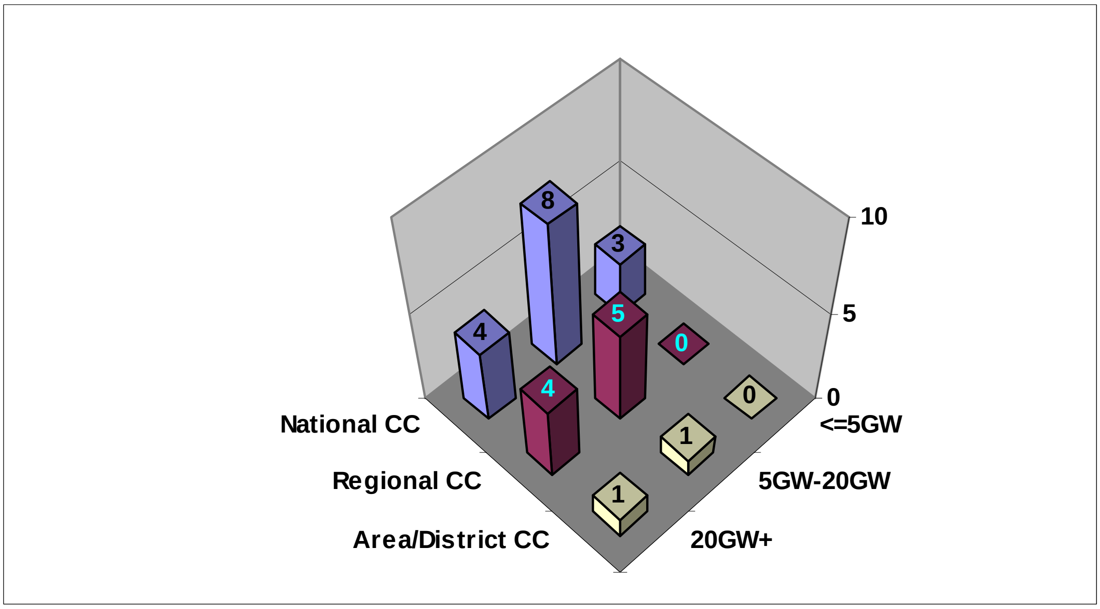



**Figure 25. Summary diagram for a hierarchical level of CC distribution per system peak load**

Correlation between the hierarchical level of a CC and the organization type was also determined and depicted for different organization types in Figure 26, from which it can be observed that at NCC level, TSOs account for 47%, while TSMO and VIC types, account for 36% and 14% respectively. At the RCC level the VIC type accounts for 78% of cases.

Also, TSOs (100% of CC for an organization of this type) and TSMOs (100%) are most frequently controlled from NCCs, while VICs are mostly controlled from RCCs (64% of CC for an organisation of that type).

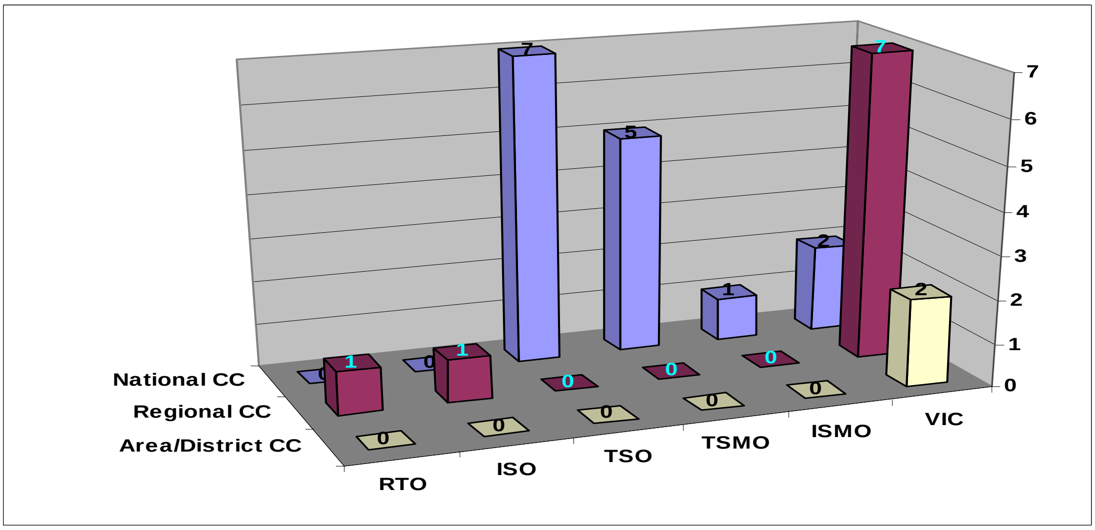
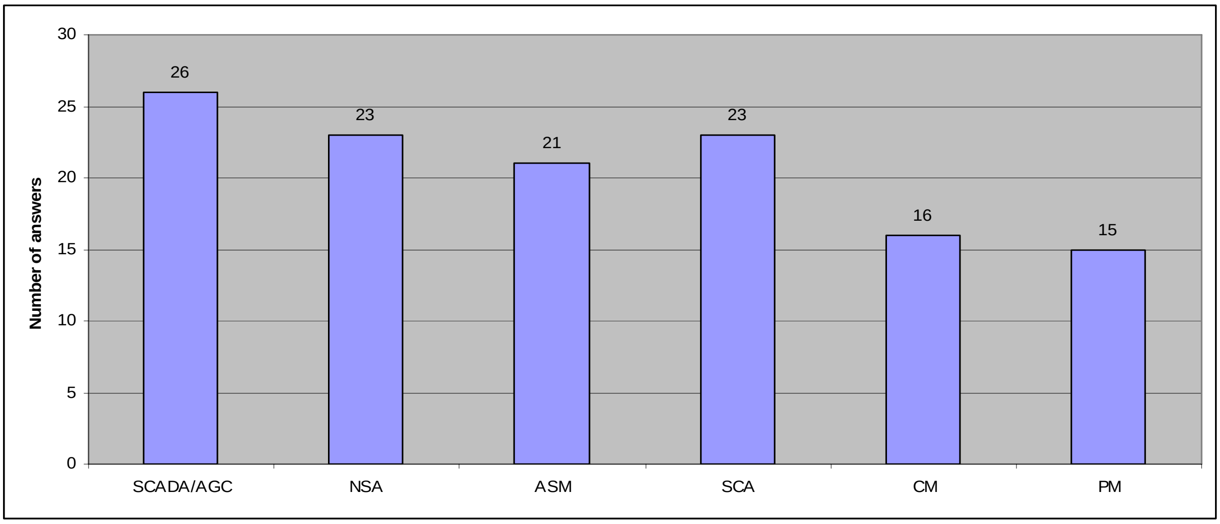



**Figure 26. Summary diagram of CC hierarchical level distribution per organization type**

## Control centre functionality

In respect of **control centre functionality**, expressed through its basic application components, the distribution of answers between the components is given in Figure 27.




**Legend**: **SCADA/AGC**-supervisory control and data acquisition/automatic generation control, **NSA**-network security applications, **ASM**-ancillary service management, **SCA**-scheduling applications, **CM**-congestion management applications, **PM**-fault/post-mortem analysis applications.

**Figure 27. Type of control centre functionality distribution**

As expected, all CC systems use SCADA/AGC (100%) and a majority use: network security applications (88%), ancillary service management (80%) and scheduling applications (88%), while just a little over a half of them employ congestion management (61%) and fault/post-mortem analysis applications (57%).

If we look at the individual CC application components in more detail, interesting facts can be identified. Correlating CC component functionality with the organization type, the following distributions emerged, as summarized in Figure 28 .

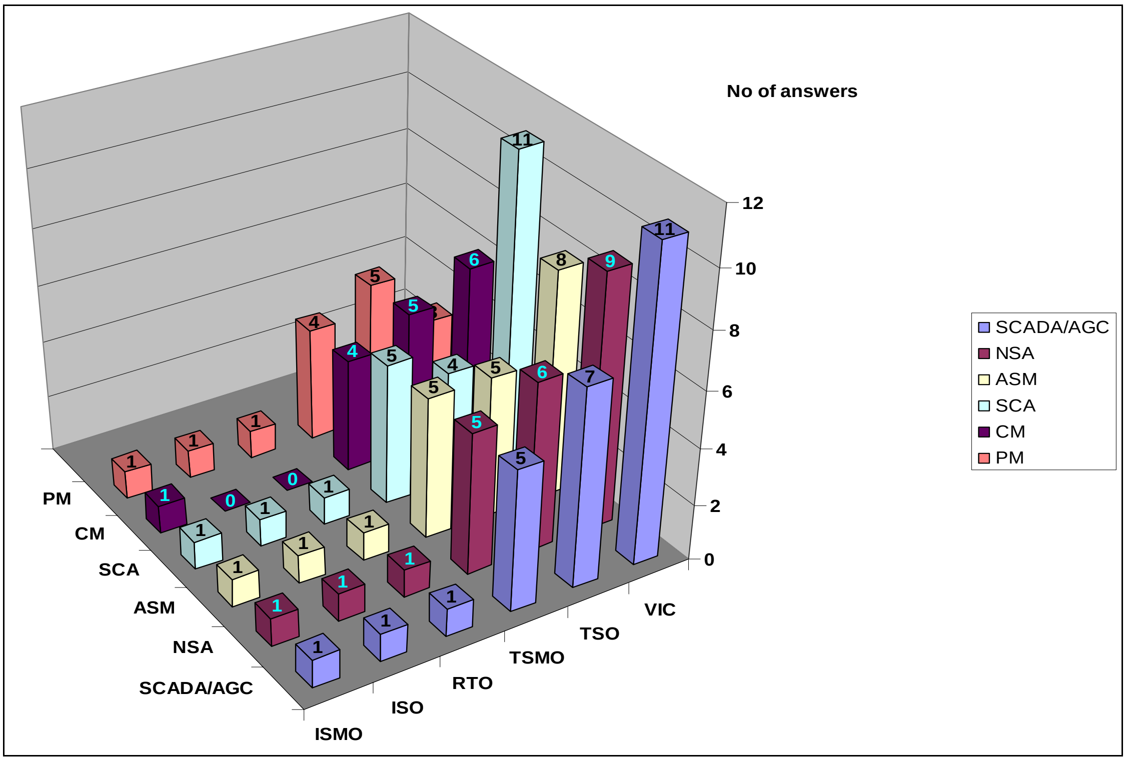



**Figure 28. Summary of CC functionality distribution per organization type**

For **SCADA/AGC functionality**, which is omnipresent (100%), the same distribution as for organization type holds (totals per specific org. type, Figure 20). For **NSA functionality**, as expected, the majority of organizations of VIC (81%) and TSO (86%) types and all (of those that participated in the questionnaire) of the TSMO type, use network security applications. For **ASM functionality**, as can be seen from the diagram, these functions are used in all (participating) new organization types (ISMO, ISO, RTO, TSMO) and in about 71% of TSO and 73% of VIC type organizations. For **SCA functionality**, as expected, well established scheduling applications are used routinely (100%) within the CC of VIC organizations and interestingly, TSMO type organizations.

**CM**, a relatively new type of functionality within the CC, is highly represented within the ''new type'' organizations, like ISMO (100%), TSMO (80%), TSO (71%) but has limited use (54%) within VIC type organizations. For **PM functionality**, it is interesting to observe that just about a quarter (27%) of VIC type organizations' CCs have fault/post-mortem analysis applications at their disposal, probably due to the lack of a modern, standard compliant, RDBMS based HIS system. But at the same time this functionality is often used in the CCs of TSO (71%) and TSMO (80%) type organizations.

Further correlation between CC component functionality, within a hierarchical level of CCs, prompted the following distributions to emerge, as summarized in Figure 29.

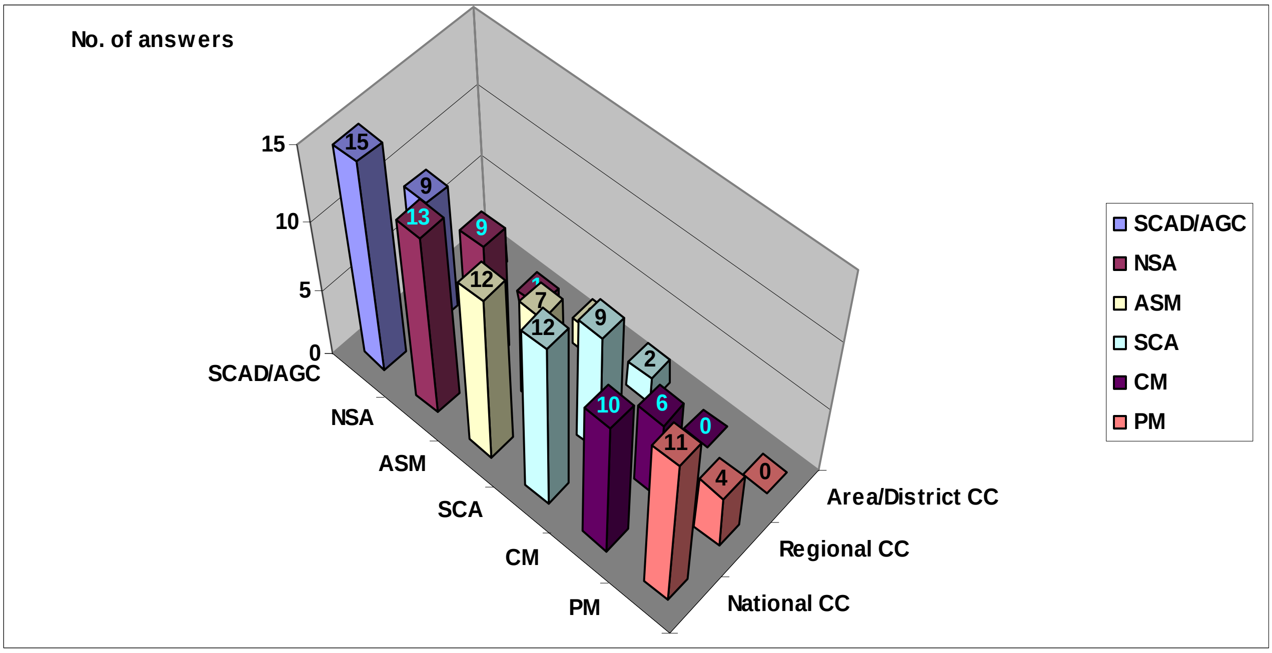



**Figure 29. Summary of CC functionality distribution per CC hierarchical levels**

As can be seen from the above figure, organizations' CCs at all hierarchical levels (NCC, RCC, ACC) employ SCADA/AGC functionality. It is clear that NSA functionality is mainly used at National (>86%) and Regional (100%) hierarchical levels and also that ASM functionality is used at all hierarchical levels but at a slightly reduced frequency (about 80% at NCC and RCC). SCA functionality is used at all hierarchical levels but surprisingly at a slightly reduced frequency (about 80%) at NCC level. We can also observe that CM functionality, which is relatively new, is used at NCC and RCC levels with a reduced frequency (66%). Finally, PM functionality is also used just at National (73%) and Regional (44%) levels but at even lower frequencies.

## Year of CC installation and upgrade

The **control centre systems** analyzed **were installed at different times**, with the distribution of answers summarized in Figure 30. It can be seen that 44% of CCs, of those that responded to this question (25 orgs.), were installed in the last 10 years (1996-2005), while 56% of CC systems were installed before 1995.

Correlating the year of CC installation and organization type, from a total of 10 CCs installed before 1990, it can be concluded that they relate mainly to VIC (54% of all organizations of this type) and TSO (almost 43% of all organizations of this type) type organizations. From a total of 4 CCs installed between 1991 and 1995, 2 were VIC and 2 TSMO. For 9 CCs installed between 1996 and 2000, it should be noted that they relate mainly to TSO (57% of all organizations of this type) and TSMO (almost 40% of all organizations of this type) type organizations.

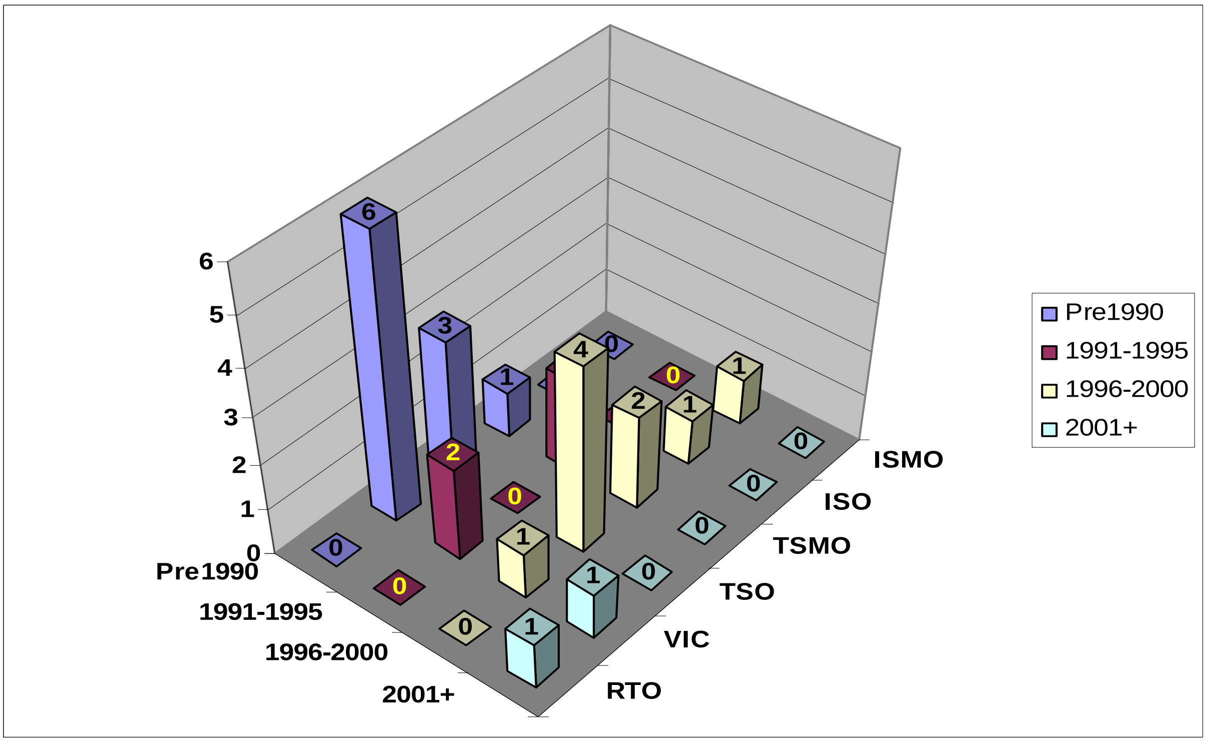



**Figure 30. Summary diagram for time period of CC installation distribution per organization type**

Likewise, among organisations that performed **control centre upgrades** (21 orgs.), 57% of them **upgraded** their systems in the last 5 years, 95% in the last 10 years, while just 5% of them did the upgrade before1995.

### Control centre main vendor

Also, all major **control system vendors** (ABB, Siemens, Areva, Toshiba, GE, etc.) were represented in the responses. The distribution of answers, between the main CC main vendors is depicted in Figure 31.

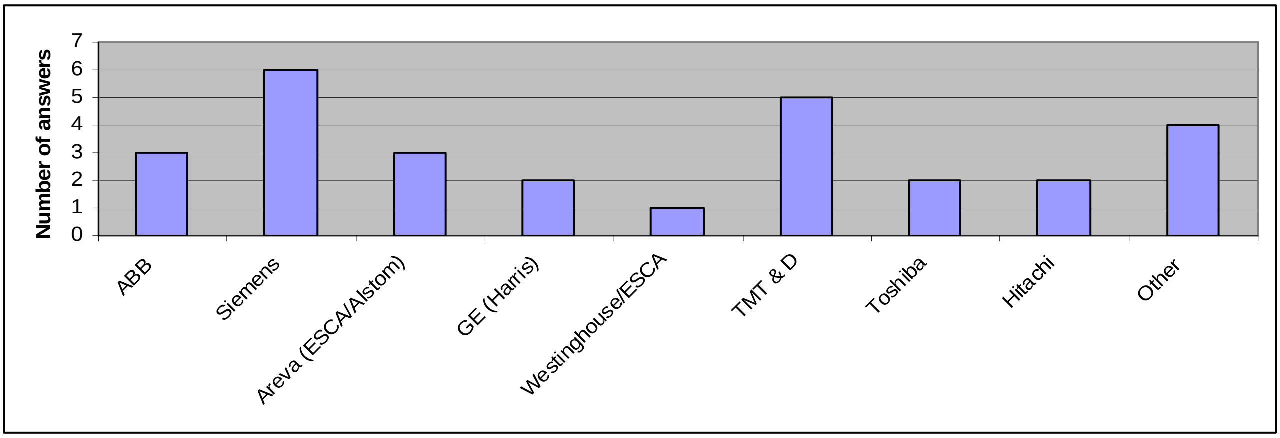



**Figure 31. Control centre main vendor distribution**

The **size of a control system**, with respect to the number of **RTUs/SAS** varies (Min/Max/**Average**: 0/1312/**192**) and the Min/Max/**Average** number of **computer to computer links** to other SOs is 1/8/**2.56** and similarly to other ESI actors is 1/22/**3.20**.

# 11 . Appendix 2 - Definitions

**Table 1. Organization types and description**

| Organisation | Description |
|---|---|
| VIC | Vertically Integrated Company |
| TSMO | Transmission, System and Market Operator, entity (organization) that owns, maintains and operates the transmission assets and manages both the system operation and market operation. |
| TSO | Transmission System Operator is a combined Grid Owner (Grid co) / System Operator organization. |
| MO | Market Operator function is defined as the responsibility for matching sales/generation and purchase/demand and by this establishing a market price for electricity for physical delivery. Also, it can include settlement, metering and payment for system services functions, etc. In practice this MO can be organised in different ways: as a Pool, as a Market Administrator or as a Power Exchange. |
| ISMO | Independent System and Market Operator is usually a mandatory market with central dispatch of all power plants. |
| SO | System Operator function is defined as the responsibility for the minute-to-minute energy balance and the security of the power system. |
| ISO | Independent System Operator is an entity that performs SO functions with no transmission ownership and also separate from Market Operator. |
| TO | Transmission Operator is an entity that does not own the transmission network (assets), but is contracted to maintain it and physically operate it. |
| RTO | Regional Transmission Operator. Organization responsible for the operating reliability, balancing and transmission service functions. |

| Term | Description (see http://en.wikipedia.org/wiki/<term>) |
|---|---|
| ATM | Asynchronous transfer mode, also known as cell relay, mainly used over ISDN media |
| B2B | Business-To-Business (data exchange, applications) |
| CIMXML | Common Information Model in XML: IEC 61970-301, -501 |
| COM | Component Object Model (Microsoft operating systems only) |
| CORBA | Common Object Request Broker Architecture: OMG standard |
| EAI | Enterprise Application Integration software |
| ebXML | e-business XML: ISO 15000 |
| EDIFACT | Electronic Data Interchange For Administration, Commerce, and Transport: ISO 9735 |
| ELCOM-90 | Predecessor of ICCP, also known as TASE.1: IEC 60870-6-501, -502, -504, -701 |
| ERP | Enterprise Resource Planning |
| FTP | File Transfer Protocol: RFC 959 |
| HTTP | Hypertext Transfer Protocol: RFC 2616 |
| ICCP | Inter Control Center Protocol, also known as TASE.2: IEC 60870-6-503, -505, -702, -802 |
| IT | Information Technology |
| LAN | Local Area Network |
| OSI | Open Systems Interconnection: ISO and ITU-T joint effort to standardize networking (7-layer reference network architecture) |
| RMI | Remote Method Invocation (java programming language only) |
| RPC | Remote Procedure Call |
| SMTP | Simple Mail Transfer Protocol: RFC 821 |
| SOAP | Simple Object Access Protocol: W3C Recommendation |
| TASE.1 | See ELCOM-90 |
| TASE.2 | See ICCP |
| TCP/IP | Transport Control Protocol / Internet Protocol: RFC 793 / RFC 791 |
| VAN | Value-added Network - a dedicated/private WAN |
| WAN | Wide Area Network |
| X.25 | An ITU-T standard protocol suite for WANs using the phone or ISDN system as media |
| X.400 | An ISO and ITU-T Message Handling Service Protocol for e-mail transmissions |
| XML | eXtensible Mark-up Language |

# 12 . Appendix 3 – Summary of Data classes exchanged

**Table 2. Data classes exchanged with external neighbours**

| | Number of answers | |
|---|---|---|
| **Data classes exchanged between** | **Real-time** **(refresh rate: 5 sec-1 min)** | **On-line** **(with max in h, d, w, mo, yr)** |
| **SO ⇔ SO** | | |
| Transmission equipment availability status | 6 | 10 (daily) |
| Available transfer capacity (ATC) | 3 | 10 (monthly) |
| Switching equipment status and measurements in the boundary nodes | 20 | 4 (daily) |
| All statuses and measurements (P,Q,V) | 16 | 5 (h/d) |
| Interchange schedules | 1 | 18 (daily) |
| Network model | - | 13 (daily) |
| Day ahead congestion forecast data | - | 1 |
| **SO ⇨MO** | | |
| Available transfer capacity | 1 | 9 (daily) |
| Equipment available | - | 7 (daily) |
| Metering data | 1 | 8 (daily) |
| Demand forecast | - | 4 (daily) |
| Actual demand, production | - | 1 (daily) |
| **MO ⇨SO** | | |
| Hourly dispatch schedule | - | 10 (daily) |
| Prices | 1 | 6 (daily) |
| Contract information | 1 | 4 (daily) |
| Metering data | - | 1 (hourly) |
| Trade balance (supply/demand) | - | 1 (daily) |

**Table 3. Data classes exchanged with market participants**

| | Number of answers | |
|---|---|---|
| **Data classes exchanged between** | **Real-time** **(refresh rate: 5 sec-1 min)** | **On-line** **(max in: h, d, w, mo, yr)** |
| **SO ⇨TO** | | |
| Approval of network equipment maintenance | - | 8 (daily) |
| **TO ⇨SO** | | |
| Network outages | 1 | 3 (h/d/w) |
| Request for network element maintenance | - | 7 (daily) |
| **SO ⇨ Gen Co** | | |
| Dispatch schedules | 4 | 11 (daily) |
| Generation set points | 13 | 8 (daily) |
| **Gen Co ⇨SO** | | |
| Generation plant availability | 16 | 9 (daily) |
| Bids | 1 | 9 (daily) |
| Reserve power bids | - | 1 (daily) |

# 13 . Appendix 4 - Questionnaire

Your organisation is likely to have data exchange not only with other organisations directly involved into the electricity market (as enumerated in the table above), but also with those that rather participate in the overall enterprise supply chain and are not specific for electricity market. ***It is important to set the scope for this questionnaire to the data exchange with the direct electricity market participants, only. Namely we focus on the relations between entities performing system operation function (SO-SO) and between those performing system operation and market operation functions (SO-MO).***

Although most of the data exchanged in this context will be directly related to your control centre and its IT infrastructure, it is likely that some data originates from other systems deployed in your organisation. ***It is one of the objectives of this questionnaire to identify also those (non control centre) data and their originating systems.***

There are many existing and emerging standards particular to the electricity supply industry (e.g., ICCP, CIM) and those that are the IT-related general standards (e.g., EDICOM, XML, ebXML). In the Table 2, we enumerate some of them for your reference.

Table 2 - Relevant IT-related standards and technologies

| Standard/Technologies | Description |
|---|---|
| ELCOM | (TASE.1) |
| ICCP | (TASE.2) |
| OSI | Open Systems Interconnection 7-layer reference model |
| EDIFACT / MHS (X.400) | EDI For Administration Commerce and Trade / Message handling systems (Electronic mail over OSI) |
| (base) CIM XML | Developed by WG13 of IEC TC57. |
| CIM XML Nerc profile | Subset of (base) CIM for power flow data exchange. |
| Distribution CIM | Developed by WG14 of IEC TC57. Applicable to the whole utility organisation. |
| Market CIM | Developed by WG16 of IEC TC57. |
| XML (proprietary schema) | Choice to use XML as syntax, but content (semantics) defined in-house. |
| HTTP (over TCP/IP) | Web applications, access through a browser. |
| FTP | File Transfer Protocol (TCP/IP) |
| SMTP | Simple mail transfer protocol – Electronic mail (TCP/IP) |
| SOAP | Simple Object Access protocol – messaging. |
| WebServices | HTTP + SOAP + WSDL |
| ebXML | Electronic Business using XML |
| Agent technologies | |

Having in mind different principles, rules and technologies for data exchange used worldwide, it is not easy to exhaustively enumerate all imaginable answers. If none of the provided answer choices fits your case, use the section “other” to describe your own practice. Use “Tab” button to navigate to write-enabled (white background) fields.

Finally, according to the usual principle for the Cigré questionnaires, all the information collected and analysed will be used with care that will guaranty full anonymity of the responding organization.

Please take a few minutes to answer the following questions as they relate to data exchange practices (and also plans) used in your organization, country or region. In return for completing the survey, you will receive summary of the survey results.

Based on information acquired during the survey and its subsequent analysis, conclusions drown regarding existing data exchange practices and related IT support used within ESI worldwide, together with the open problems and future plans identified, will be presented as a paper or brochure, to serve as a guidance, and support in the decision making process in this field, organizations may find useful to follow.
We expect that the preliminary results will be presented during next WG meeting in Paris, while the final results are expected until the end of this year (2004), and will be published during 2005 either in Electra or as a Technical Brochure.

| | | |
|---|---|---|
| **I** | **General Information** | |
| | **Respondent Contact** | |
| **Q1** | Name: | |
| **Q2** | Email address: | |
| **Q3** | Date: | |
| | **Organisation** | |
| **Q4** | Name of the organisation: | |
| **Q5** | Country/region/town: | |
| **Q6** | Peak load (MW): | |
| **Q7** | Year of the peak load: | |
| **Q8** | Transmission voltages in use (e.g. 380kV, 220kV, etc.): | |
| **Q9** | Type of the organization (see Table 1): | (choose one) |
| | | (if other, please comment here) |
| **Q10** | Approximate number of people employed: | |
| | **Control Centre** | |
| **Q11** | Hierarchical level of the Control System: | (choose one) |
| **Q12** | Type of Control System functionality: | |
| | SCADA/AGC: | (choose one) |
| | Network security applications: | (choose one) |
| | Ancillary service management: | (choose one) |
| | Scheduling applications: | (choose one) |
| | Congestion management applications: | (choose one) |
| | Fault/Post-mortem analysis applications: | (choose one) |
| | | (if other, please comment here) |
| **Q13** | Year of Control System installation: | |
| **Q14** | Year of Control System latest upgrade: | |
| **Q15** | Main Control System vendor: | |

| | | |
|---|---|---|
| **Q16** | Number of Remote Terminal Units (RTU) or integrated Substation Automation System (SAS): | |
| **Q17** | Percentage of data collected over direct acquisition: | |
| **Q18** | Percentage of data coming over computer-computer link: | |
| **Q19** | Total number of (computer to computer) links (ICCP/ELCOM) to control centres of other SO: | |
| **Q20** | Total number of (computer to computer) links to other ESI actors, or to entities performing functions of MO, GenCo, DisCo, etc.: | |

## II Functions Performed

**Transmission and System Operation Functions**

| | | |
|---|---|---|
| **Q21** | What main asset management functions does your organisation perform? | |
| | Asset management (financial aspects, equipment cost, accounting, etc.) | (choose one) |
| | Network elements maintenance planning and execution | (choose one) |
| | Field operations (equip. ratings, condition monitoring, switching, emerg. Repairs, etc.) | (choose one) |
| | Network expansion (planning, design, construct.) | (choose one) |
| | | (if other, please comment here) |
| **Q22** | What main system operation and support functions does your organisation perform? | |
| | Real time system operation | (choose one) |
| | Balance generation and load | (choose one) |
| | Ensure system security | (choose one) |
| | Operations planning | (choose one) |
| | | (if other, please comment here) |
| **Q23** | What main transmission system access-related functions does your organisation perform? | |
| | Metering services | (choose one) |
| | Transmission capacity allocation and congestion management | (choose one) |
| | Coordinate maintenance schedules | (choose one) |
| | | (if other, please comment here) |

**Market Operation Functions**

| | | |
|---|---|---|
| **Q24** | What main market operation functions does your organisation (if TSMO, MO, ISMO) perform? | |
| | Operation planning, coordination with the SO | (choose one) |
| | Processing off the bids and offers | (choose one) |
| | Settlement and billing | (choose one) |
| | Provide market information to market participants | (choose one) |
| | | (if other, please comment here) |
| **Q25** | For which other functions do you exchange data with your market operator? | |
| | | (please specify and comment here) |
| | | (please specify and comment here) |
| | | (please specify and comment here) |

## III Data Exchange

To successfully perform above stated system and market operation functions, appropriate data exchange is the necessary prerequisite. In the following questions we are concentrated on the data exchange in different contexts and on the periodicity of their exchange. Some of the stated exchanges might not be applicable to your organisation.

**Data exchange with external neighbours**

Data exchange to consider primarily is that between the SO (of any TSO/ISO type) and the neighbouring SO's (in the same or other countries), typically implemented as the communication between respective SO control centres; and secondly, between the SO and MO (of any type).Please select (and add where appropriate) the relevant data classes and select appropriate periodicity for each of them.

| **Q26** | Data classes exchanged between SO<->SO | In real time (refresh rate) | On-line data (periodicity) |
|---|---|---|---|
| | Transmission equipment availability status | (choose one) | (choose one) |
| | Available Transfer Capacity (ATC) | (choose one) | (choose one) |
| | Switching equipment status and measurements in the boundary nodes | (choose one) | (choose one) |
| | All statuses and measurements (P, Q, V) | (choose one) | (choose one) |
| | Interchange schedules | (choose one) | (choose one) |
| | Network model | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |

| Q27 | Data classes exchanged between SO->MO | In real time (refresh rate) | On-line data (periodicity) |
|---|---|---|---|
| | ATC | (choose one) | (choose one) |
| | Equipment available | (choose one) | (choose one) |
| | Metering data | (choose one) | (choose one) |
| | Demand forecast | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| **Q28** | Data classes exchanged between MO->SO | In real time (refresh rate) | On-line data (periodicity) |
| | Hourly dispatch schedule | (choose one) | (choose one) |
| | Prices | (choose one) | (choose one) |
| | Contract information | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |

**Data exchange with market participants**

The context for the following questions is data classes exchanged with market participants. Please select (and add where appropriate) the relevant data classes and select appropriate periodicity for each of them.

| Q29 | Data classes exchanged between SO->TO | In real time (refresh rate) | On-line data (periodicity) |
|---|---|---|---|
| | Approval of network equipment maintenance | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| **Q30** | Data classes exchanged between TO ->SO | In real time (refresh rate) | On-line data (periodicity) |
| | Network outages | (choose one) | (choose one) |
| | Request for network element maintenance | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |

| | | | |
|---|---|---|---|
| **Q31** | Data classes exchanged between SO->GenCo | In real time (refresh rate) | On-line data (periodicity) |
| | Dispatch schedules | (choose one) | (choose one) |
| | Generation set points | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| **Q32** | Data classes exchanged between GenCo->SO | In real time (refresh rate) | On-line data (periodicity) |
| | Generation plant availability | (choose one) | (choose one) |
| | Bids | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |

**Data exchange with internal systems**

The context for the following questions is data classes exchanged with internal systems. Please write in relevant data classes where appropriate and select appropriate periodicity for each of them.

| | | | |
|---|---|---|---|
| **Q33** | Data classes exchanged between SO<->ERP (Enterprise Resource Planning System) | In real time (refresh rate) | On-line data (periodicity) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| **Q34** | Data classes exchanged between SO<->WMS (Work Management System) | In real time (refresh rate) | On-line data (periodicity) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| **Q35** | Data classes exchanged between SO<->Office Automation System | In real time (refresh rate) | On-line data (periodicity) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| **Q36** | Data classes exchanged between SO<->CIS (Customer Information System)/Billing | In real time (refresh rate) | On-line data (periodicity) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |

| | | | |
|---|---|---|---|
| **Q37** | Data classes exchanged between SO<->NIS (Network Information System, Technical data DB, Asset registry) | In real time (refresh rate) | On-line data (periodicity) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| **Q38** | Data classes exchanged between SO<->Engineering analysis (e.g., power flow, extension planning, etc.) | In real time (refresh rate) | On-line data (periodicity) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| **Q39** | Data classes exchanged between SO<->Other | In real time (refresh rate) | On-line data (periodicity) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |
| | (please specify and comment here) | (choose one) | (choose one) |

## IV IT Infrastructure & Standards

**Your control centre and the external control centres/systems**

These questions deal with networking of your control centre with other control centres or the systems in other organisations (i.e., the context is WAN, VAN).

| | | |
|---|---|---|
| **Q40** | What kind of communication media (network) is used from yours to other control centres? | |
| | Power Line Carrier (PLC) | (choose one) |
| | Microwave radio | (choose one) |
| | Satellite | (choose one) |
| | Fibre optic | (choose one) |
| | | (if other, please comment here) |
| **Q41** | Are there dedicated (computer to computer) links used? | (choose one) |
| **Q42** | If yes, which type? | |
| **Q43** | What bandwidth? | |

| | | |
|---|---|---|
| **Q44** | What are the communication protocols and technologies used? | |
| | ICCP (over TCP/IP) | (choose one) |
| | ICCP (over OSI, e.g., X.25) | (choose one) |
| | ELCOM (over TCP/IP) | (choose one) |
| | ELCOM (over OSI, e.g., X.25) | (choose one) |
| | ATM | (choose one) |
| | Frame Relay | (choose one) |
| | X.25 | (choose one) |
| | TCP/IP | (choose one) |
| | TCP/IP standard applications (HTTP, FTP, SMTP) | (choose one) |
| | SOAP | (choose one) |
| | Web Services | (choose one) |
| | Agent technologies | (choose one) |
| | | (if other, please comment here) |
| **Q45** | What is the bandwidth of the data links used? | |
| **Q46** | What are the file-based data exchange protocols? | |
| | EDIFACT / MHS (X.400) | (choose one) |
| | CIMXML + FTP | (choose one) |
| | EbXML -based | (choose one) |
| | | (if other, please comment here) |

**Your control centre and the IT infrastructure internal to your organisation**

These questions deal with networking of your control centre with the systems within your organisation (i.e., the context is LAN or LANàWAN/VANàLAN for distributed organisation IT infrastructure).

| | | |
|---|---|---|
| **Q47** | Has your organisation adopted and implemented corporate IT standards? | (choose one) |
| **Q48** | If yes, choose one or more of the following: | |
| | Java-based | (choose one) |
| | Microsoft-based | (choose one) |
| | Unix-based | (choose one) |
| | Open source-based environments | (choose one) |
| | | (if other, please comment here) |
| **Q49** | If yes, does this apply to your Control Centre and its software systems as well? | (choose one) |

| | | |
|---|---|---|
| **Q50** | What kind of integration infrastructure your organisation has? | |
| | TIBCO | (choose one) |
| | WebSphere (IBM) | (choose one) |
| | BizTalk (Microsoft) | (choose one) |
| | WebMethods | (choose one) |
| | SeeBeyond | (choose one) |
| | SISCO UIB | (choose one) |
| | CORBA-based (RPC) | (choose one) |
| | COM-based (RPC) | (choose one) |
| | Oracle-based | (choose one) |
| | | (if other, please comment here) |
| **Q51** | Is your control centre integrated into it? | (choose one) |
| **Q52** | If yes, what other enterprise systems does your control centre communicate with (e.g., client office applications, Enterprise Resource Planning systems, Work Management Systems, etc.) and how (e.g., authorised client's web browser, ERP adapter calls the CORBA-based EMS API method, EMS sends a SOAP message with info on the work clearance tag to the WMS, etc.))? | (please comment here) |
| **Q53** | Does your control centre system currently rely on a standard data model (as opposed to a proprietary, i.e. vendor specific or in-house defined data model)? | (choose one) |
| **Q54** | If yes, what standard data model (refer to Table 2): | |
| | Base CIM | (choose one) |
| | Nerc profile of the base CIM | (choose one) |
| | Distribution CIM | (choose one) |
| | Market CIM | (choose one) |
| | | (if other, please comment here) |

**Business processes & Place of standards**

Consider your control centre people and system as a player in different business processes in your organisation, including those with other organisations (i.e., data exchange). There are probably a number of tasks that the control centre system could automatically perform (behind the scenes), without involving people. For instance, instead of creating a printout report and bringing it to another department, the IT infrastructure could support sending this as an email to the designated person, or still better, send it as data to the designated system directly. Try to think of all the tasks that could ideally be automated in the context of your control centre.

| | | |
|---|---|---|
| **Q55** | What is the level of your control centre integration into the organization (company) business processes? | (choose one) |
| **Q56** | What are the benefits of adopting the open / international standards for your organisation? | |
| | None | (choose one) |
| | Avoiding vendor lock-in | (choose one) |
| | Facilitated extensions (e.g., integration of a 3rd party application into existing systems) | (choose one) |
| | Facilitated requirements specifications for new systems/applications | (choose one) |
| | Certification by 3rd parties | (choose one) |
| | | (if other, please comment here) |
| **Q57** | What are the main stoppers / risks with respect to the adoption of new standards and the implementation of automated tasks by integrating control system into enterprise IT? | |
| | None | (choose one) |
| | Mind shift in the management | (choose one) |
| | Budget | (choose one) |
| | Time it takes to implement | (choose one) |
| | Insufficient quality/scope of standards | (choose one) |
| | Don't touch it if ain't break | (choose one) |
| | | (if other, please comment here) |

## V Most important problems regarding current data exchange

These questions deal with the current problems you could identify, which are due to an under-optimal data exchange and its IT support.

| | | |
|---|---|---|
| **Q58** | Data related problems (i.e. lack of): | |
| | Definition of the content | (choose one) |
| | Definition of the syntax (format) | (choose one) |
| | Definition of the semantics (meaning) | (choose one) |
| | Internal non-availability (e.g., non-accessible electronically from another system within your organisation) | (choose one) |
| | External non-availability (e.g., not "offered" by the neighbour as confidential data) | (choose one) |
| | | (if other, please comment here) |

| | | |
|---|---|---|
| **Q59** | IT (communications with the neighbours) related problems: | |
| | Reliability | (choose one) |
| | Security | (choose one) |
| | Cost | (choose one) |
| | | (if other, please comment here) |
| **Q60** | IT (communications with the internal applications and infrastructure) related problems: | |
| | EMS/SCADA (proprietary and/or complex) interfaces | (choose one) |
| | Middleware (integration) infrastructure | (choose one) |
| | Maintainability on change (e.g., time required for software upgrade, including testing) | (choose one) |
| | Multiple databases & maintaining data consistency | (choose one) |
| | Data access among applications (e.g., metered energy history in EMS vs. billing in ERP system) | (choose one) |
| | Manual entering and processing of data | (choose one) |
| | | (if other, please comment here) |
| **Q61** | People & processes-related problems: | |
| | Definition of responsibilities (e.g., unclear who is authorised to modify a database) | (choose one) |
| | Organisational constraints (e.g., existence of the intra-department barriers) | (choose one) |
| | Regulatory/legal constraints (e.g., like the NERC requires CIMXML network model) | (choose one) |
| | Nonexistent agreements with the neighbours | (choose one) |
| | | (if other, please comment here) |

## VI Future Plans

This question relates to your plans with respect to data exchange and the current problems/limitations they should address. Consider the standards from Table 2, if applicable. Consider topics like, e.g., real time data exchange within and outside your organisation, reporting to authorities, energy metering, capacity allocation, balance management, auctioning procedures, internal accounting automation, connection with new neighbours, etc.

| | | |
|---|---|---|
| **Q62** | Please fill out appropriately the fields for your planned actions. | |
| | Planned action 1: | |
| | Completion within time (e.g., 6 months, 3years): | |
| | Problem(s) it solves: | |
| | Who in the organisation benefits the most? | |

| | |
|---|---|
| Kind of benefit (e.g., simplified usage, automated processing, additional applications supported, etc.)? | |
| Problem(s) it induces? | |
| Planned action 2: | |
| Completion within time (e.g., 6 months, 3years): | |
| Problem(s) it solves: | |
| Who in the organisation benefits the most? | |
| Kind of benefit (e.g., simplified usage, automated processing, additional applications supported, etc.)? | |
| Problem(s) it induces? | |
| Planned action 3: | |
| Completion within time (e.g., 6 months, 3years): | |
| Problem(s) it solves: | |
| Who in the organisation benefits the most? | |
| Kind of benefit (e.g., simplified usage, automated processing, additional applications supported, etc.)? | |
| Problem(s) it induces? | |
| Planned action 4: | |
| Completion within time (e.g., 6 months, 3years): | |
| Problem(s) it solves: | |
| Who in the organisation benefits the most? | |
| Kind of benefit (e.g., simplified usage, automated processing, additional applications supported, etc.)? | |
| Problem(s) it induces? | |
| Planned action 5: | |
| Completion within time (e.g., 6 months, 3years): | |
| Problem(s) it solves: | |
| Who in the organisation benefits the most? | |
| Kind of benefit (e.g., simplified usage, automated processing, additional applications supported, etc.)? | |

| | | |
|---|---|---|
| | Problem(s) it induces? | |
| **Q63** | Do some actions exist that you think would be necessary to take, but are difficult to justify to the top management of your organisation? | (please comment here if yes) |
| **Q64** | Any additional remarks, comments, concerns: | (please comment here if yes) |