EUROPEAN TRANSMISSION SYSTEM OPERATORS

Key Concepts and Definitions for Transmission Access Products

Final Report
April 2001

CONTENTS

EXECUTIVE SUMMARY

This paper describes a range of possible Transmission Access Products in terms of a set of basic characteristics. The paper is focused on congestion management methods which involve the allocation (most likely by auction) and/or trading of these products; it does not address market splitting, which is the subject of a separate ETSO paper.

The basic characteristics are used to identify the types of products which would be consistent with the Congestion Management Guidelines contained within the conclusions of the November 2000 Florence Regulatory Forum.

The same concepts are then used to characterise the transmission capacity auction schemes which have already been introduced in the IEM area. The methods used have been successful in rapidly introducing market-based methods into congestion management. However, the analysis indicates that they do not comply with all of the Florence Guidelines, and they are unlikely to be generally effective if extended in their present form to the whole of the IEM. In particular, more sophisticated methods will be necessary where the transmission system is highly meshed and individual auctions would become strongly interactive. A possible method of dealing with this situation is described in a separate ETSO paper.

Subject to further consideration of the feasibility of market splitting, the paper recommends that further regional auction schemes should be encouraged. However, a significant level of harmonisation and coordination will be necessary, and it is proposed that ETSO should facilitate this by providing guidance on the characteristics of products and allocation methods.

INTRODUCTION

Background

1. Effective congestion management is regarded as essential for successful operation of the European Internal Electricity Market (IEM). It is therefore one of the main topics being progressed by representatives of governments, the European Commission (EC), regulators, transmission users, transmission system operators (TSOs) and other interested parties through the 'Florence process'.

2. The conclusions of the Florence Regulatory Forum held in November 2000 contain a set of guidelines on congestion management. These require TSOs to develop congestion management methods which meet a number of high level principles. There is now a need to translate these into practical proposals.

3. Some practical progress has already been made. Market splitting methods have been operating well in Scandinavia for some time. More recently, some neighbouring TSOs have jointly auctioned capacity across a small number of national borders. This experience indicates that both market splitting and auctions can provide effective market-based congestion management, at least in the particular circumstances to which they have been applied.

4. There are no plans to impose uniform market processes throughout Europe. It is therefore assumed that pan-European congestion management will develop through evolution and co-ordination of initially separate regional schemes. Each of these will necessarily be designed to interface with local market arrangements.

The purpose of the present paper

5. Given the situation described above, the way forward depends on answers to questions such as the following:
   - do current congestion management methods comply with the Florence Guidelines?
   - can neighbouring congestion management schemes be made to work together, even if they use different methods?
   - what degree of harmonisation is necessary for effective co-ordination?

   This paper begins to address such questions for congestion management methods which involve the allocation (most likely by auction) and/or trading of transmission access products. Market splitting is addressed in a separate ETSO paper.

6. The approach taken is to describe the range of possible access products in terms of their basic characteristics. These are then used to compare currently used auction methods with the requirements implied by the Florence Guidelines. This leads to conclusions on the type of harmonised access products which would be both effective and compliant with the Guidelines.

TRANSMISSION PRODUCT CHARACTERISTICS

Rights

7. A 'right' enables a market participant to derive financial benefit from operating at, or below, a particular generation, consumption or transaction level. Rights have positive value to market participants, and will therefore attract a positive price if they are in limited supply.

8. Transmission rights may be implemented physically, for example by requiring a user to prove that he holds a right before scheduling a transaction through scarce transmission capacity. Alternatively, they may be implemented financially by relieving holders of additional congestion charges when they transmit specified amounts of power. This document assumes that rights are implemented financially.

Obligations

9. An 'obligation' requires a market participant to provide a service by operating at, or above, a given generation, consumption or transaction level. Obligations have negative value to market participants, and they may therefore require payment.

10. A right and an obligation can be combined in the same access product. A right and an obligation provides the TSO(s) with a measure of assurance that the market participant will operate at a given level, rather than above or below it. The combination of both therefore provides the most effective congestion management product, and in particular may permit opposing flows to be 'netted'. The market price of the combined right and obligation will depend on its value to the marginal participant.

Location model

11. Transmission products are most straightforwardly defined in terms of the two locations at the 'ends' of an energy transaction. In general, these could be generation, consumption or trading (eg power exchange) locations.

12. To remove the transaction dependence, all products can be referred to a common 'hub' location. Each product is then characterised by only one location, and counterparty locations need not be revealed. These are referred to below as 'entry/exit' products.

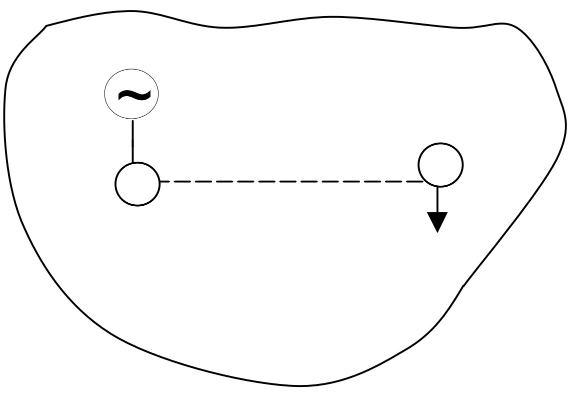

Fig 1a: Location-to-location model

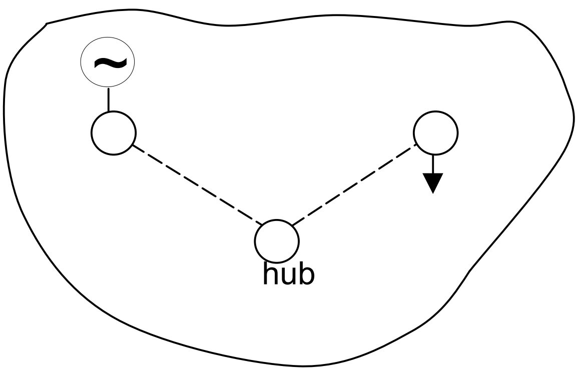

Fig 1b: Entry/exit model

13. More general models might also be feasible. For example, regional hubs could be placed at energy trading locations and used to define entry/exit products for intra-regional transactions. Inter-regional transactions might then be supported by further products linking the regional hubs, perhaps with reference to a single inter-regional hub.

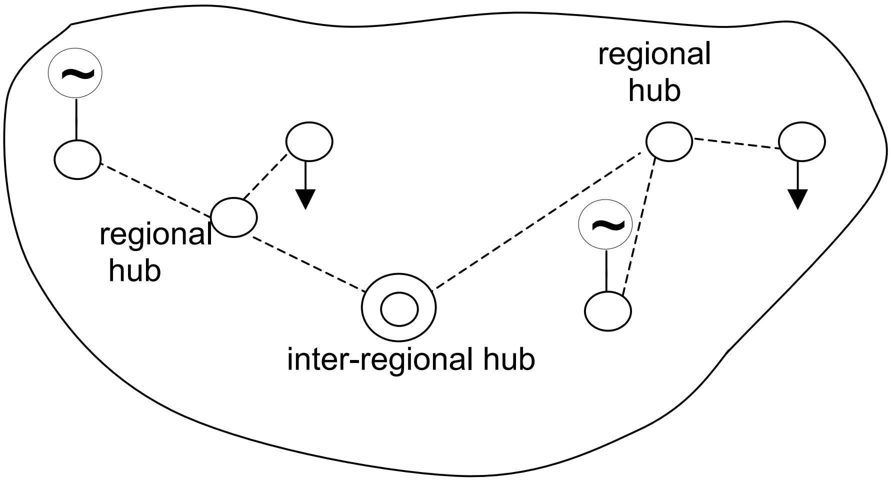

Fig 2: Hierarchical entry/exit model

Path model

14. To date in both Europe and the US, trades between and across transmission systems have usually been programmed and treated commercially in 'contract path' terms. This approach simply identifies a chain of contiguous transmission areas, with no reference to the multitude of flow paths (parallel flows) which exist in practice on a meshed system. Except for the special case of peninsular boundaries, this failure to consider physical flows limits the usefulness of contract path methods for congestion management.

15. In general, accurate congestion management requires physical paths to be quantified. This may be done using standard loadflow software, and the results expressed with sufficient accuracy in the form of a matrix of factors. It is, however, a relatively sophisticated process which needs to be repeated at least when the system configuration changes as a result of switching operations.

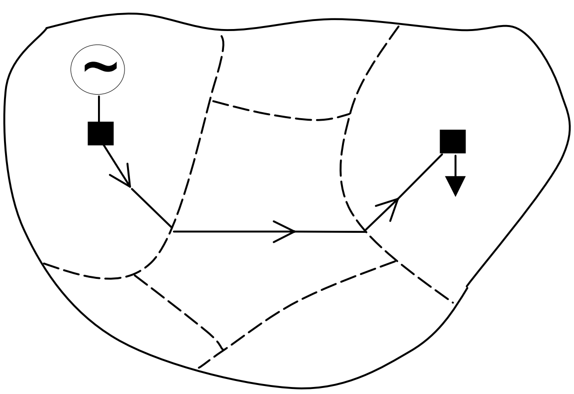

Fig 3a: Contract path

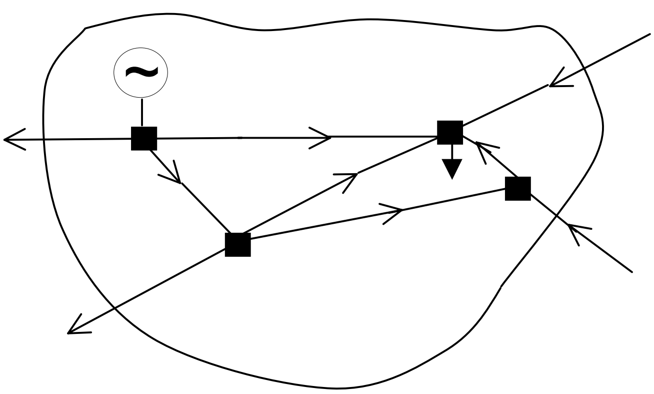

Fig 3b: Physical path

Location resolution

16. Locations can be represented as points (nodes) on the transmission system, or as zones. Zones could, for example, be defined as groups of nodes, control areas or countries.

17. In continental Europe, control of the UCTE power system has been structured and organised by decentralising the load/generation balance using the 'control area' concept. Control areas are managed through the use of real-time automatic devices (load-frequency controllers) which continuously adjust the generation level inside each area according to programmed exchanges, the actual flows on interconnectors, and the measured frequency. The control area concept is fundamental to UCTE system operation and security. Consistency with current UCTE operational practice would therefore suggest that zones should be identified with control areas.

18. The choice of location resolution is a trade-off between accurate constraint representation and access market liquidity. If transmission products are defined for large zones, relatively few constraints are captured but the number of participants able to trade products within each zone is relatively high. Conversely, products related to small zones or nodes are potentially capable of fine control of congestion, but the opportunities for trading among market participants are limited or non-existent.

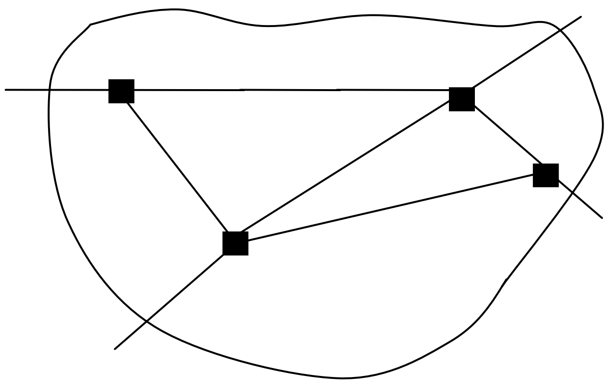

Fig 4a: Nodal resolution

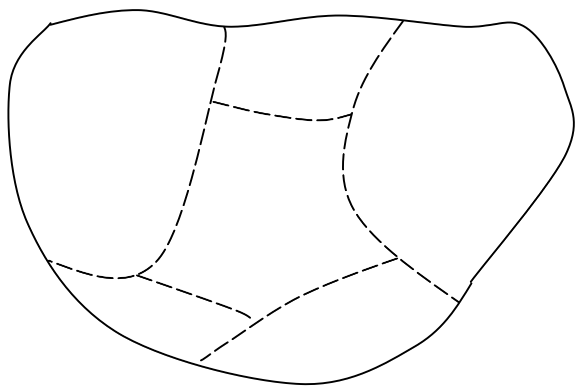

Fig 4b: Zonal resolution

Constraint representation

19. A constraint (congestion) can arise on a transmission system for a variety of reasons. It is often necessary to limit physical flows to reduce the risk of thermal damage, unacceptable voltage levels, or electrical instability. Such risks may be significant while operating as intended, or they may appear following transmission faults resulting in loss of equipment. A particular constraint may be a relatively permanent feature of the system, or it may appear only temporarily as a result of particular operational circumstances. Transmission products could in principle be defined in terms of the detailed technical nature of each constraint, but such a scheme would be highly complex and unworkable in practice.

20. A common simplification is to limit active power flows across 'bottlenecks' in the transmission system. These are typically groups of circuits in the same electrical vicinity, and are sometimes called 'flowgates', particularly in the US. In a physical path flowgate model, the sensitivities of flowgate loadings to entry/exit flows can be represented by linear loadflow factors.

21. A particular application of this principle is the identification of flowgates with tie-lines linking adjacent zones, with flowgate limits which take into account congested lines situated inside the zones as well as on the tie-lines themselves. The physical flow through such 'tie-line flowgates' is then limited to the value reached by the flow on the tie-lines when the flow through the most congested line is at its maximum. This approach is compatible with the 'control area' concept (see paragraph 17), which in turn is usually aligned with political boundaries.

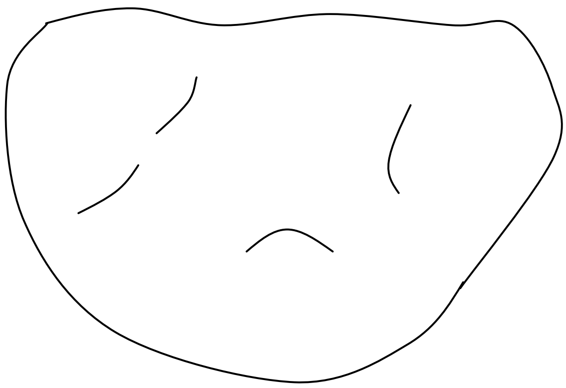

Fig 5a: Flowgates

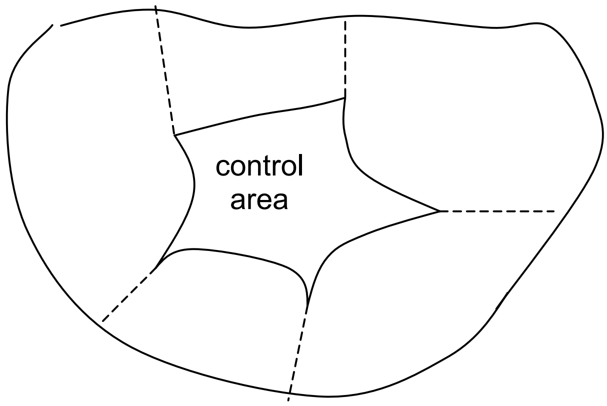

Fig 5b: Tie-line flowgates

22. A further simplification is to limit flows across a set of partitions, each of which divides the transmission system into two separate parts. The loadflow sensitivity factors relating to each partition are then either 0 or 1, depending on whether both counterparties (or the entry/exit point and the hub) are on the same or opposite sides of the partition.

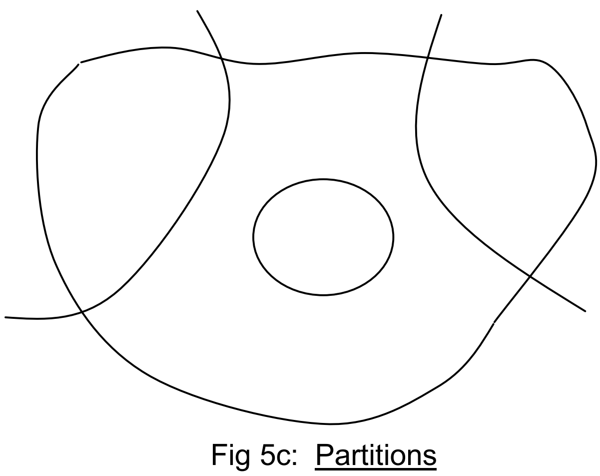

Fig 5c: Partitions

23. The choice of constraint representation is again a compromise. A representation which reflects the technical capabilities of individual circuits allows fixed limits to be directly applied, but is complex and difficult to reconcile with a transparent and liquid market. The limits corresponding to more simplified flowgate or partition representations require assumptions to be made regarding the outturn disposition of generation and demand, and are therefore approximations. Ultimately, partition models suffer from the same disadvantages as contract paths and market splitting, and are probably fully relevant in practice only to special regions in Europe.

24. Rights (and obligations) can be associated directly with individual constraints, flowgates or partitions. Market participants then have the task of assembling a portfolio of such products for each constrained part of the transmission system, in proportions which are informed by loadflow factors. Such 'flowgate rights' have been promoted by some as an alternative to locational pricing methods used in the US. They devolve a high level of activity to the marketplace, but are complex for market participants to manage, especially as the loadflow factors are subject to change. Assuming that flowgate products are combined in proportions determined by accurate loadflow factors, the resulting 'bundles' are equivalent to the location-to-location and entry/exit products described above.

Firmness

25. For transmission products to be useful for congestion management, they should, at least on a short-term (day-ahead) basis, be regarded as firm by system users. This implies that there is some means of enforcing or incentivising users to operate in conformance with their access product holdings. Direct physical control by TSOs is incompatible with unbundled, competitive electricity markets. Monitoring and disclosure ('name and shame') methods are unlikely to be either popular or fully effective. Commercial sanctions are more desirable, although they require systems for settlement of any differences between measured generation/consumption and access product holdings.

26. For products which combine both rights and obligations, charges (or payments) for both underruns and overruns are necessary to provide appropriate commercial incentives. Imbalance prices should be related to the local value of access. In this case full netting of counter-flows is possible.

27. Transmission products can also be firm on the TSO. This takes the form of a liability to either re-purchase rights at market price (perhaps offset by re-selling obligations) or to fund re-dispatching operations to 'buy out' commitments which the TSO is unable to honour.

28. Firmness to TSOs provides an incentive on them to accurately predict and manage transmission capacity. However, it may also expose TSOs to considerable risks, especially on large interconnected systems where energy schedules and parallel flows are beyond the control, or even prior knowledge, of individual TSOs. Care must therefore be taken to ensure that firmness on TSOs does not incentivise uneconomic risk-averse behaviour.

Duration

29. Each transmission access product must be associated with a specific time interval. Near to real time, accurate control of congestion will only result if products can be traded for time intervals similar to those used for short-term energy trading (typically one hour or less). Initial allocation and subsequent forward trading can, however, be conducted with products bundled into longer time periods.

30. Users in different market sectors may wish to deal in products of different lengths. Encumbent baseload generators and large industrial customers, for example, are likely to be interested in purchasing longer 'strips' of access rights than short-term traders or generators with expensive or intermittent fuel sources.

31. For the above reasons, access markets are likely to have to accommodate products of varying duration. New capital-intensive interconnectors are likely to require products covering a number of years. More generally, long-term products might be allocated in annual auctions, medium-term products in monthly auctions, and short-term ones day-ahead. The longer-term products could be broken down by users and traded for shorter periods, where possible down to individual market intervals of one hour or less.

FLORENCE GUIDELINES

32. The guidelines address various factors which relate to the choice of transmission products for congestion management. They are as follows:

Economic efficiency

33. Guideline 2 calls for both short-term economic efficiency and efficient investment signals.

34. The requirement for economic efficiency implies that congestion management methods should be capable of revealing short-run marginal costs. In principle, a transmission access market can achieve this, but conditions for success are likely to include:

- *combined rights and obligations*
- *a physical path model*
- *as far as possible, both high locational resolution and high trading liquidity*
- *an accurate constraint representation.*

Directional price signals

35. Guideline 6 states that the price signals emerging from the congestion management process should be ‘directional’. Guideline 31 explains that this is required for correct treatment of counterflows on congested circuits.

36. Directionality will result as a necessary consequence of economic efficiency. It therefore imposes no new requirements beyond those already listed above in paragraph 34.

Netting

37. Guideline 7 states that requests to use transmission circuits in opposite directions should be netted, and specifically that transactions relieving congestion should never be denied. Guideline 29 recognises that safe operation of the power system should not be compromised, and invites TSOs to propose a workable scheme.

38. A workable scheme in which flows can be safely netted requires a degree of certainty that notified flows will materialise in practice. In terms of the product characteristics described above, this requirement implies:

- *combined rights and obligations*
- *a physical path model*
- *bi-directional firmness on users (eg both underrun and overrun imbalance settlement).*

Unused capacity

39. Guideline 8 specifies that any unused capacity must become available to other agents, and refers in particular to the ‘use-it-or-lose-it principle’.

40. In general, some form of underrun imbalance settlement is required to incentivise market participants to use or trade their transmission product holdings. This provides further confirmation that such products should be:

- *combined rights and obligations*
- *firm on users.*

In financial terms, the 'use-it-or-lose-it principle' is simply a special case in which the underrun price is zero.

Firm capacity

41. Guidelines 9 and 10 indicate that products should be firm on TSOs, in the sense that they should be responsible for re-dispatching if outturn transmission capacity is less than that anticipated. Guidelines 10 and 26 do, however, suggest that varying degrees of firmness may be appropriate, presumably in the form of interruptible rights.

42. In terms of the characteristics discussed above, products should therefore be:

- *normally firm on TSOs (with the possibility of some products with decreased firmness).*

Transaction independence

43. Guideline 20 express a preference for non-transaction based methods. It also suggests that market splitting would satisfy this preference in principle, but is too difficult to implement in the short term.

44. It is understood that this preference derives from two concerns. The first is that transaction-based transmission access would be strongly linked to specific energy trades, potentially destroying liquidity in both the access and energy markets. The second is that market participants may be reluctant to entrust the identity of contract counterparties with other parties, including TSOs.

45. All location-to-location products are transaction-based, at least in the sense that energy volumes at both ends of the transaction must be related to the same access product in the access settlement process (assuming commercial settlement is required, as suggested above). Taken at face value, therefore, Guideline 20 implies a preference for:

- *an entry/exit model*

46. The precise nature of this preference should, however, be examined further. Transaction-based settlement does not imply that counterparty locations need to be revealed to TSOs for operational purposes (except perhaps for checking and validation of exchange programmes between control areas in the UCTE network). Furthermore, zone-to-zone products are robust to trading between parties within zones. For a scheme using independent settlement agents and large zones (eg control areas or countries), an acceptable variant could be:

- *a zone-to-zone model.*

Timing

47. Guideline 26 refers to composite auctions with products of varying duration. Guideline 27 proposes a series of auctions, possibly taking place yearly, monthly, weekly, daily and intra-daily.

48. The Guidelines therefore confirm that transmission products should be characterised in terms of:

- *a range of durations, varying from at least a year to less than one day.*

Risk assignment

49. Guideline 30 states that the financial consequences of deviations from notified flows should be borne by the responsible parties, and suggests that re-dispatching costs could be funded by penalties on such deviations.

50. The implications of this Guideline for product definition are similar to those of the 'economic efficiency', 'netting' and 'unused capacity' guidelines described above. They are:

- *combined rights and obligations*
- *a physical path model*
- *as far as possible, both high locational resolution and high trading liquidity*
- *an accurate constraint representation*
- *firmness on users via underrun and overrun settlement.*

Tradability

51. Guideline 33 addresses the creation of liquid energy markets, and states that auction products should be freely tradable before notification.

52. If secondary access markets are not sufficiently liquid, the energy markets could be impeded by the difficulty of matching energy contracts with suitable access products. High liquidity can be obtained either by trading through TSOs acting as market-makers, or by requiring market participants to deal directly in flowgate products. Direct trading of entry/exit products is only possible between market participants in the same location, and is therefore only likely to provide sufficient liquidity if locations are defined as relatively large zones. Location-to-location products are inherently less liquid that entry/exit ones, because they can only be traded between transactions with the same entry and exit locations. The requirement for liquid trading therefore favours:

- *an entry/exit model*
- *low location resolution (ie large zones)*
- *trading via TSOs*

  <u>or</u>
- *individual flowgate products (see paragraph 24 above).*

CURRENT AUCTION SCHEMES

Characteristics of current schemes

53. Current auction schemes within the IEM are:
- Denmark-Germany (DK-D)
- Netherlands-Germany/Belgium (NL-D/B)
- France-England (F-GB)
- France-Spain (F-ES)

The characteristics of the products sold in these auctions are shown in Table 1.

Limitations of current methods

54. Experience to date has demonstrated that cross-border capacity can be successfully auctioned. However, an important question is whether acceptable IEM-wide congestion management would result if current methods were simply extended to all congested interfaces, with no particular co-ordination or harmonisation arrangements. The following paragraphs describe the possible shortcomings of such a strategy.

55. Table 1 shows that all of the existing auction schemes are based on contract paths. This is of little consequence for the peninsular borders (DK-D, F-GB and F-ES). These constitute system partitions (see Fig 5c) so parallel flows are minimal or non-existent, and physical paths coincide with contract paths.

56. The NL-D/B scheme is the first one to introduce the possibility of interactions between multiple paths. While these interactions are expected to be manageable in this case, extension to more central UCTE regions is likely to be more difficult. In general, parallel flows may cause significant interactions between nominal contract paths. There is also scope for market participants to select contract paths which they expect to be commercially beneficial, rather than those which most closely match physical paths. In these circumstances, the result could be poor congestion management with potential security problems and inaccurate price messages, conflicting in particular with Florence Guideline 2, relating to economic efficiency.

57. Although 'use-it-or-lose-it' provisions are incorporated in the current auctions, trading and settlement of obligations is not well developed. As a result, the costs of capacity under-utilisation may not be accurately assigned to market participants. Furthermore, TSOs may lack the necessary confidence to take counterflows into account when making capacity available. The guidelines on netting and risk assignment may therefore not be adequately addressed.

58. All of the current auctions effectively allocate zone-to-zone products, since no distinction is made between locations within the countries concerned. They are therefore only able to address congestion associated with the borders themselves, rather than with intra-zonal constraints. Zone-to-zone auctions are also transaction-based, contrary to the preference expressed in Guideline 20 (but see paragraph 46). Although liquidity is increased by the application to large zones, it is limited by the need to co-locate both entry and exit parties in any trade. Guideline 33 is therefore compromised to some extent.

CO-ORDINATED AUCTIONS

59. ETSO has produced a separate paper entitled 'Co-ordinated Auctioning of Transmission Capacity in Meshed Networks'. This describes a method of allocating transmission products in the presence of multiple constraints or congested borders, using loadflow-derived distribution factors to take interactions into account.

60. The characteristics of this method are shown in Table 2. The loadflow factors provide a physical path model. The constraints need not be physically located on tie-lines, although in practice they could well be represented as tie-line flowgates (see paragraph 21). The method places no restrictions on whether products are rights and/or obligations, on the choice of location model or resolution, or on product firmness or duration.

61. The proposed approach overcomes some of the shortcomings of currently used methods. In particular, it takes parallel flows into account and eliminates exploitation of the contract path approximation. In consequence, it should be possible to control congestion and reveal economically efficient prices in the presence of interacting constraints.

62. Implementation of the proposed method would require a high level of co-ordination between TSOs. Wide-area (perhaps even pan-European) loadflow calculations would be necessary to produce the distribution factors. Auction clearing and subsequent trading would also need to be jointly organised, at least on a regional basis.

HARMONISATION REQUIREMENTS

63. The above analysis of existing auction methods suggests that satisfactory pan-European congestion management is unlikely to result from unco-ordinated development by individual Member States. As described above, ETSO is developing co-ordination methods, but these require a high level of co-operation and standardisation across borders. The following paragraphs identify the areas in which harmonisation may be required.

64. The Florence Guidelines themselves dictate a degree of harmonisation of access products. The characteristics which result from compliance with the Guidelines are listed (in italics) in paragraphs 34 to 52 above.

65. In addition to harmonising the nature of the transmission products themselves, the allocation, trading and settlement processes will also require harmonisation to enable effective inter-working, notably between Regulators and between TSOs. Although initially this will only be necessary on a local or regional basis, difficulties will subsequently appear if pan-European compatibility is not considered at the outset.

66. It is of fundamental importance that a commonly agreed location model is adopted. This is needed to relate entry and exit locations to power exchanges and other trading hubs, and to border and/or constraint (flowgate) locations. This model must form an unambiguous framework for posting transmission capacity forecasts, calculating loadflow distribution factors and allocating transmission products.

67. It may be necessary to co-ordinate the timing of auctions throughout Europe, in order to avoid discriminating between users in different locations. The efficient allocation of products might also be facilitated if the duration of products allocated at different lead times were harmonised.

68. In general, forecasting transmission capacities and loadflow distribution factors, together with subsequent re-dispatching to correct forecasting errors, are all joint TSO activities. If transmission products are to be firm on TSOs, there needs to be a harmonised way of assigning liability for re-dispatching costs between them.

CONCLUSIONS

69. The current strategy of auctioning access across individual borders is an efficient means for initial implementation of market-based capacity allocation schemes. Ultimately, however, it is unlikely to result in effective congestion management throughout the IEM.

70. Current auction schemes are not compliant with all of the Florence Guidelines on congestion management.

71. To ensure general effectiveness and compliance with the Guidelines, it will be necessary to complement the current strategy by establishing:

- a harmonised definition of access rights and obligations based on physical flows
- an agreed locational model relating access points or zones to trading and congestion locations
- effective methods of incentivising compliance with rights and obligations
- liquid trading of access rights and obligations
- methods for co-ordinating auctions, trading and settlement where congested flows are interactive.

72. The above requirements suggest that transmission access products should be based on:

- combined rights and obligations
- an entry/exit location model, incorporating trading hubs
- physical flow paths
- zones selected to optimise the trade-off between congestion management effectiveness and trading liquidity
- constraint representation at the flowgate level
- firmness on both TSOs and transmission users
- a range of timescales over which transmission products can be acquired and traded.

RECOMMENDATIONS

73. The EC, Regulators and transmission users should be invited to agree with TSOs that the above conclusions are valid.

74. Subject to further consideration of the feasibility of market splitting, the present strategy of auctioning cross-border access should be encouraged, since it enables a quick response to the challenge of allocating capacity on a market-oriented basis. However, ETSO should complement this by providing:

- guidance on the form of transmission products which should be auctioned and traded
- the co-ordination necessary to build an effective ‘map’ of access zones and trading locations
- methods for co-ordinating access auctions, trading and settlement where it is necessary to take interactions into account.

	Rights	Obligations[1]	Location model	Path model	Location resolution	Constraint representation	Firmness		Duration
							TSO	user	
DK-D	yes	no	zone-to-zone	contract	zonal	boundary	yes	yes (UIOLI)	1 yr, 1mth, 1 day (hourly)
NL-D/B	yes	no	zone-to-zone	contract	zonal	boundary	yes[2]	yes (UIOLI)	1yr, 1mth, 1day, (hourly)
F-GB (DC cable)	yes	no	zone-to-zone	contract	zonal	boundary	no	yes (UIOLI)	3yrs, 1yr, 1 day
F-ES (planned)	yes	no	zone-to-zone	contract	zonal	boundary	yes	yes (UIOLI)	1yr, 1mth, 1wk, 1 day (hourly)

1. note that ‘Use-it-or-lose-it’ (UIOLI) is not included here as an ‘obligation’
2. except for force majeure

Table 1: Current Auction Schemes

Rights	Obligations	Location model	Path model	Location resolution	Constraint representation	Firmness		Duration
						TSO	user	
yes	yes[1]	location-to-location or entry/exit	physical	zonal or nodal	any (probably flowgate)	yes[2]	yes[1]	any

1. dependent on settlement arrangements
2. dependent on TSO regulation/incentivisation arrangements

Table 2: <u>Co-ordinated Auctions</u>