FINAL REPORT v1.0

DfT - TRANSPORT DIRECT
Project Support & Consultancy Services Framework

FareXChange Scoping Study
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Executive Summary

Background

Over the last decade significant progress has been made in making information on public transport services more accessible to the general public, both before travel and during their trips, and via a wide range of media including telephone enquiries and the internet. In the rail, coach and air sectors, services are widely available enabling journeys to be planned, fares options to be selected, seats reserved, and the journey to be booked and paid for on line.

In the bus sector, where there are far more services and operators, providing comprehensive easily accessible information to the public has always proved difficult. The introduction of traveline in 2000 and subsequently Transport Direct have represented major steps forward, providing trip planning and timetable information services with national coverage. In Scotland, the North East and later in 2006 in the South West, the traveline regions are linking fares information electronically to their journey planning systems. However, while most other traveline regions are able to offer some fares information (normally by a telephone call centre agent looking the fare up either from computer files or fare tables and price lists on paper), there is not a national standard or infrastructure for the electronic exchange of fares information, in the same way that there is for public transport service and timetable information.

The vision for FareXChange (FXC) is therefore that it will be a national standard for the electronic exchange of fares data for all modes of public transport service. The standard should also be part of the family of British standards, alongside TransXChange, NaPTAN and others.

Study Objectives

The objectives of the FareXChange scoping study have been:

- To validate if there is a need for a FareXChange standard;
- To prepare a specification detailing what needs to be done to develop the FareXChange standard;
- To collect useful background information for the development phase; and
- To engage the key stakeholders in the process.

Stakeholders

The study has engaged a broad range of stakeholders for fares data, from the bus, coach and rail sectors. These stakeholders have included:

- Public transport service representation groups;
- Public transport service operators;
- Local authorities and PTEs;
- Public Transport Information service providers; and
- Systems and ticketing equipment suppliers to the industry.

The stakeholder involvement commenced at the beginning of the project, with the appointment of 2 external stakeholder representatives to the project board. The broader group of stakeholders have been engaged in the project through a mix of face to face meetings, telephone discussions, targeted questionnaires and data exchanges.

On the 27 March 2006 a stakeholder meeting was held to which all the stakeholders were invited. At this meeting, the results of the study were presented with feedback invited both during the meeting in discussion sessions and afterwards.

A draft report was circulated to stakeholders for comment in April and further feedback received has been taken into account in this report.

The Need
Most of the stakeholders consulted (around 75%) thought that FareXChange could have a valuable part to play in the provision of public transport information.

The main identified need for FareXChange by the stakeholders, was to support the provision of fares information via traveline, Transport Direct and other information providers.

A number of other uses for FareXChange were identified. These included enabling new business opportunities for booking services similar to those in the rail and air sectors, data exchange between differing systems and potentially supplying data for concessionary travel fares reimbursement.

Technical Analysis Results
A Gap analysis was done against Transmodel and existing UK standards. Transmodel was found to be a good basis to proceed - a number of specific gaps and other issues were identified. To help validate what is a complex subject it will be especially important to develop realistic examples.

Development Specification
A draft specification detailing the proposed content of a FareXChange standard is included in this report. The principal components are:

- Compliance with Transmodel and relationship to other UK and European information and ticketing standards.
- IPR and open standards certification.
- XML schemas.
- Test cases and validation.
- Performance and efficiency.
- Publisher.
- Public Access to Deliverables.
- Consultation.

Modelling and Data Issues
The fares systems currently in common use by operators and their suppliers in the UK do not generally incorporate geographic coding of fare stages. If geographic coding is to be done it is desirable that it is done on the basis of NAPTAN, that is to say that the relationship of any fare stage layer to a topographical or geographical mapping information layer should make use of the stop and locality model established by NaPTAN and the NPTG, which already embody just such a mapping projection onto geospatial data. This approach will both reduce the amount of work required to establish a National fare stage data set, and allow the consistent integration of fare systems with timetabling and other systems

Issues to be considered for such a fare stage layer of named “NaPTAN Clusters” include its complexity and data requirements and the precise nature of the relationships to NaPTAN stop points, as well as the need for any intermediate

grouping levels. There are also questions as to the extent of sharing and reuse of the fare stage data which in turn has implications for the data model, for example, should NaPTAN clusters be coordinated between operators and within regions?

Some operators were concerned about the need to preserve confidentiality of fares data (particularly in competitive situations) until the date of implementation. We suggest therefore that appropriate security needs to be incorporated within any business system using FareXChange. The technical implementation of security and confidentiality measures is likely to be primarily a matter of process and the appropriate use of the enveloping infrastructure (for example encryption of embargoed documents), rather than of consequence to the FXC model itself, but nonetheless needs to be designed into the overall architecture.

Business Issues

There is considerable concern amongst stakeholders generally, but particularly bus and tram operators and some local authorities, that one or both of a commercial business case or a public policy case must be established before development of a FareXChange protocol is commissioned. For the bus and tram sector the value of individual fares transactions is relatively low and therefore it is likely that the case for developing FareXChange needs to be proved in public policy terms in that sector.

The primary practical issues are business related: responsibilities for supplying and managing fares data, maintaining confidentiality of fare models and fare changes and enforcing a level playing field for presenting fares. These may need some form of Code of Practice which may be voluntary or statutory.

The resources available for this study did not permit testing of a financial business model but we recommend that before development of FareXChange a study should be undertaken in selected traveline regions to quantify latent demand and reliably estimate the times and costs involved in providing the required service.

Findings

- Widespread research using the internet and other published sources, questionnaires, interviews and consultation with key stakeholders reveal a majority consensus on the need for FareXChange.
- In particular the view has been expressed on behalf of the rail industry that if FareXChange is not developed they will independently need to procure a similar standard to sit alongside their Rail Journey Information System and Rail Settlement Plan systems.
- National Express have already included a sophisticated fares enquiry and booking engine within their coach management systems, and believe that is preferable for fares enquiries to be answered directly by the operator concerned where fares are set dynamically (i.e. vary according to occupancy and other criteria).
- Both rail and coach information are essential for the traveline regional network and the Transport Direct portal.
- Ticket machine suppliers have expressed interest in using TransXChange and FareXChange within a new architecture for loading journey and fares information into their systems.
- An outline specification against which FareXChange might be procured has been produced as part of this study.
- The main need for FareXChange is to support journey planning systems by the addition of accurate journey pricing.

- Additional business opportunities include:
  - integration of fares setting and implementation processes with other business systems, particularly in bus companies and their ticketing equipment and systems suppliers.
  - rapid and accurate provision of fares information to transport authorities for use in integrated transport modelling and planning work, for the calculation of concessionary travel reimbursement and for other governmental purposes requiring fares information.
  - development of new on-line booking services for local and inter-urban transport in the UK.
  - further standardisation of interfaces between transport equipment suppliers increasing competition and efficiency in the market place.

Recommendations

- Experience with TransXChange, ITSO and a number of other recent technical standards suggests that FareXChange should be designed so that it is modular and can readily be reviewed and updated in the light of experience.
- Notwithstanding the majority view of the potential usefulness of FareXChange there are significant concerns that could not all be fully resolved in the scoping study. These include:
  - Costs both of assembling and maintaining the databases to supply fares through information services and who should pay for them.
  - The capacity of both operators and authorities to handle the volume of data that may need to be generated.
  - Linking fare stages accurately to geographic data.
  - Ensuring security of commercial data.

  Many of these could be tested by policy and business case analyses informed by the findings of this report.
- A financial business case should be built and tested using data collected in selected traveline regions on latent demand for fares information and the time, revenue and cost implications of providing it.
- In view of the identified needs of the rail industry we recommend that the Department for Transport and Rail Settlement Plan Ltd discuss with other stakeholders the case for a joint programme for the procurement of a fully tested FareXChange specification as a UK national standard.

1 Introduction

1.1 What is FareXChange?

Just as considerable effort has been devoted by international and national standards bodies to developing standards for the description of bus routes and timetables and technical standards for interoperability of systems, FareXChange (FXC) is proposed as an XML data structure that enables the exchange of public transport fares information between electronic systems such as public information systems and ticketing systems.

FareXChange is an open standard designated to support the delivery of Fares information by Transport Direct, traveline, etc. FXC aims to cover all modes, including bus, rail and coach.

1.2 Background

FareXChange aims to create an e-gif compliant XML protocol that enables the exchange of complete details about the fares chargeable for public transport journeys. The protocol is required to be compatible with the existing NaPTAN, NPTG, TransXChange and JourneyWeb standards, all of which follow closely the relevant elements of the European pre-standard Transmodel. It is also highly desirable that FareXChange structures should be compatible with the fares elements in ITSO and emerging European standards for smartcard ticketing and payment systems.

TransXChange was developed in 2000 and updated to be e-gif compliant between 2002 and 2005. It is a standard for interchanging bus schedule and related data (details of operator, route, journals and timetables) between heterogeneous information systems. It is used both for the electronic registration of bus routes with Vehicle and Operator Services Agency (VOSA) and the Traffic Area Networks (TAN), and for the exchange of bus routes with other computer systems, such as journey planners and vehicle real-time tracking systems.

NaPTAN (National Public Transport Access Nodes) database and XML schema is a nationwide system for uniquely identifying every point of access to public transport in the UK (bus stops, coach stops and termini, bus and rail stations, airports, ferry terminals, etc). The NaPTAN database provides an essential source of information to be used within TransXChange so that bus stops are referenced consistently between all operators and all services. NaPTAN is also related to a national gazetteer of public transport localities (NPTG), comprising cities, suburbs, towns and villages across the UK.

JourneyWeb is an dynamic XML protocol that allows journey planning engines from traveline systems to provide public transport information, in many cases integrating data from more than one region to build up a complete door to door journey. JourneyWeb depends on NaPTAN for identifying stops, stations and other access points to Public Transport.

ITSO is the UK national specification for interoperable smartcards. Industry led development with DfT support commenced in 1999. ITSO includes a scheme for the description of ticket types originally published in 2000. ITSO is now coming into significant use in a number of areas in the UK. The Oyster smartcard, developed under a pre-ITSO PFI, is used in London and a “roadmap” for convergence with

ITSO has been developed for DfT. Work on harmonisation of smartcard standards in Europe continues with DfT providing leadership and coordination of UK input. Starting with the South Western Franchise (to be let in autumn2006 with smartcard ticketing to be available by January 2009), ITSO ticketing will be rolled out across the National Rail Network.

FareXChange (FXC) is proposed to build on these foundations to allow fares information to be added for comprehensive transport information. It is expected to be used extensively within an enhanced traveline service in the future. In some traveline regions, bus operators and local authorities responsible for running traveline have already agreed that fares information should be available from traveline services as soon as it is technically feasible.

In this context, FXC is seen as a means of communicating fares information from bus, coach and train operators to the relevant regional traveline systems.

FareXChange may also be valuable as a tool for standardising the communication of information on fares between different components of an operator'soperator's IT systems, for example between the programs producing fare tables and electronic ticket machines.

1.3 Scoping Study Objectives

The objectives of the Scoping Study are as follows:

- To validate that there is a need for FareXChange.
- To prepare a specification detailing what needs to done to develop the FareXChange standard.
- To collect useful background information for the development phase.
- To engage the UK stakeholders in this process through consultation.

1.4 Acknowledgments

This document has been prepared by the FareXChange Scooping Study team lead by Carl Bro,

- Richard Mejía (Carl Bro),
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- Costas Hadjimanolis (Carl Bro),
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- John Carr (Elan Public Transport Consultancy),
- John Austin (Austin Analytics),
- Mike Ness,

under direction of Roger Slevin of the Department for Transport.

2 Consultation and Research

2.1 Who we consulted

An extensive research and consultation exercise was carried out between January and March 2006. The initial phase comprised widespread research of printed literature and internet sites describing fares and ticketing practice and giving information on fares, tickets and availability. A list of web sites is in the Appendix at 15.2.

This desk and electronic research was followed up by telephone calls, visits and correspondence with:

- Operators of bus, coach and train services.
- Transport for London.
- Representative Groups: Association of Train Operating Companies / Rail Settlement Plan Ltd (ATOC/RSP), Association of Transport Coordinators (ATCO), Bus Users UK (BUUK) and Confederation of Passenger Transport (CPT).
- Providers of information services – JourneyPlan Ltd, traveline regions, Transport Direct.
- Local Authority representatives.
- Suppliers of electronic ticket machines and other ticketing systems, transport industry software and systems developers.
- ITSO and smartcard specialists.

The Project Board of DfT and Stakeholder representatives held 3 meetings.

2.2 How we consulted

Questionnaires were distributed to operators, traveline regions and local authorities. A good response was received from traveline regions and a wide spread of operators. Appendices at 15.3 and 15.4 summarise the results for operators and traveline regions respectively.

Follow up telephone calls and visits were undertaken with a selection of bus and coach operators, traveline regions, RSP, ITSO and a number of suppliers. This resulted in further printed or electronic information being made available, some on the basis of strict confidentiality.

An invited panel of stakeholders met the study team on 27 March 2006 and a draft report was subsequently circulated for comment to stakeholders.

The study team is very grateful to the many individuals and their organisations who gave generously of their time, knowledge and advice in support of the study. It would be invidious to list them here but they have been separately acknowledged in further correspondence.

2.3 Overview of Results

Scotland, the North East and the South West traveline Regions already give - or are developing - fares information based on electronically supplied data: *the team is very grateful to have had access to the work of them and their suppliers.* One supplier of journey planning software has already provided a successful system capable of integrating bus, rail, ferry and underground fares information including point-to-point,

zonal and period fares. Most other traveline regions have access to fares information either in printed or electronic (spreadsheet or scanned) form and answer fares queries but with heavy qualifications in respect of interpretation.

At least 75% of consultees thought FareXChange could have a valuable part to play in:

- Facilitating the exchange of fares information across open standard interfaces, reducing costs because the need to accommodate different proprietary formats would be removed.
- Transferring fares information quickly and accurately. Fares information is sensitive commercially and several organisations suggest that fares should not be open for editing.
- Improving the availability and accuracy of public information on fares for journeys recommended through traveline, Transport Direct and other information providers. This was considered to be particularly helpful for multi-leg, multi-modal and multi-operator journeys and is seen as the principal need by most consultees.

Further uses for FareXChange were foreseen as:

- To assist with integrating operators' fares systems with other business systems (e.g. scheduling).
- Potential use in supplying fares data for concessionary travel reimbursement (this is increasingly important!).
- Development of new commercial information and booking services.

Contrasting with these positive views several respondents raised significant concerns:

- The difficulty of maintaining data when fare stage naming is inconsistent and may not be uniquely identified with stops - let alone be in NaPTAN format! This was seen as a considerable practical issue that would need to be satisfactorily resolved before systems based on FareXChange are implemented. As with NaPTAN good tool support for editing data would be important.
- Competition implications – "advance notice" of fares initiatives was seen as undesirable and could give major operators a clear advantage. The team considers this can be met by appropriate security and business rules relating to the ownership, access rights and release dates of fares information within systems using FareXChange.
- Would authorities gain a means of control or influence? The team does not believe that FareXChange gives any additional power to authorities as the majority of them already have access, albeit in far less convenient forms, to all of the information considered.
- What rights do each of the actors have? How would data providers be reassured their data would be used equitably?
- Management of the data should lie exclusively with the operators or their suppliers contracted to create fares information.

More detailed findings and comments on the results of our research and consultation appear in the body of the report.

3 The Fare Setting Process and the roles of interested parties

3.1 The Actors

Whilst the setting of fares is properly a key decision area for public transport operators, the relativity of fares to other prices, particularly motoring costs, is of interest in a policy context to government and transport authorities and sometimes to regulatory bodies. As with any other trading activity, easy access to accurate information on the costs of public transport travel is highly desirable to facilitate informed choices by travellers and for this reason the Department for Transport (DfT) through Transport Direct have commissioned this scoping study for a Fare Exchange protocol (FareXChange – FXC) that fits within the group of UK standards developed to support the national traveline and Transport Direct information services.

The key actors in the fields in which a FXC is likely to be deployed are:

- **Operators**
  Bus, Coach and Rail are considered in this study but there is no *a priori* reason that the scope cannot extend to ferry and air fares relatively straightforwardly, and to flexibly routed (and priced) transport such as DRT and taxis provided that in all cases the base prices and business rules governing the calculation of fares are available.

  Because of the nature of the services offered and the high degree of price differentiation in their markets, Coach and Rail fares are already well described in terms of data structures and the information that would need to be handled in a FXC. This is not the case for buses, by far the most used form of public transport in terms of passenger journeys in the UK, and the emphasis of this report will necessarily be to examine problems and potential solutions in exchanging bus fares data.

  There are approximately 8000 active bus and coach operators in the UK and 3949 million vehicle kilometres were run in 2004/05 (DfT, 2005, Public Transport Statistics Bulletin GB: 2005 Edition). Around 24,000 local bus service registrations are held by these companies (DfT, 2004, Traffic Commissioners' Annual Reports 2003–04). These carried 4,609 million passenger journeys in 2004/05 of which almost 40% were in London (DfT, 2005, ibid). It is estimated that at least three quarters of all passenger journeys are carried by companies within 5 large groups: Arriva, Go-Ahead, First, National Express, and Stagecoach. A handful of other medium sized companies account for much of the remaining business leaving a large number of very small businesses sharing only a few percent of the total bus market.

  In some areas, such as Greater Manchester and Tyne & Wear, operators, together with the local Passenger Transport Executive (PTE), have formed companies to administer tickets which are available for use on the services of all appropriate participating operators – multi-operator and multi-modal tickets.

- **Government and local authorities**
  As already noted, it is essential that government and local authorities know the price relativities between different forms of transport for their integrated and sustainable transport and environmental policies. FXC should provide an efficient method of ensuring that this information is fully up-to-date which is not always the case at present.

Authorities and government also need accurate knowledge of fares to calculate the compensation due to operators participating in statutory Concessionary Travel Schemes (CTS). The same principles apply to multi-operator, multi-modal ticketing schemes, often brokered by a PTE or other transport authority where detailed knowledge of fares is necessary to distribute revenues collected between participating operators.

Authorities responsible for the payment of subsidies for services not provided commercially are responsible for setting fares on those services. This is often, but not always, done on the basis of compatibility with the general levels of commercial fares in the area. Again FXC will provide an accurate vehicle for collecting commercial fares and then for communicating the authority's fare scale directly to the operators' systems.

In London, bus, underground, Docklands Light Railway and tram fares are set by the Mayor as advised by Transport for London (TfL) and subject to budgetary approval by the Greater London Authority. There is liaison with the rail industry on the levels of TfL and London commuter rail fares in particular. The Government is transferring a number of powers in respect of rail services to the Mayor and is also mandating TfL to set rail fares zonally within Greater London so that fares charged on Train Operating Company (TOC) services operating in Greater London will be the same as those for Underground services.

Although FareXChange is not concerned with ticket media, the increasing use of smartcards – Oyster in London and ITSO elsewhere – for both concessionary travel and commercial ticketing will create large volumes of data that can be used for transport planning and marketing purposes. The ability to hold and maintain corresponding fares databases through the use of FareXChange will increase the power and accuracy of models available for policy analysis.

Public investment by central government in developing FareXChange is likely to be justified in terms of its policy impacts. However, the responsibility for developing and maintaining the necessary databases will fall on operators and local authorities, as it does for journey planning systems, and they will require to show how the costs of doing this can be met through business case analyses.

- **Regulatory bodies**
  Bus and Coach fares are unregulated, although the levels of fares charged may on occasion be of interest to the competition authorities, the Office of Fair Trading (OFT) and the Competition Commission (CC).

  Rail fares are partially regulated; increases in commuter fares and standard class return and saver ticket prices being capped under the terms of the Railways Act 1993. Other, Train Operating Company (TOC) specific and non-regulated fares can be set at whatever level desired by the TOC or, for jointly available fares, ATOC (the Association of Train Operating Companies that owns Rail Settlement Plan Ltd (RSP), the joint company responsible for distributing revenue from multi-operator tickets amongst the TOCs). RSP represents the TOCs in the London Scheme which distributes travelcard and other revenues from tickets available on both TOC and TfL services. Again the competition authorities may from time to time take an interest in rail fares, particularly for TOCs' own tickets where there may be *de facto* competition with other TOCs.

- **Suppliers**

  Suppliers of equipment such as Electronic Ticket Machines, Gates and Kiosks, software developers and systems integrators are already involved in use of fare

data to meet the needs of their customers. The availability of a FareXChange standard should facilitate the development of further applications and integration of business systems.

3.2 Fare Stages and Fares Tables

In the UK bus industry, the division of routes into fare stages is the most common system of pricing. There is some ambiguity in the term “fare stage” which is often used to indicate the points (usually stops) at which fares increase as the bus proceeds. The term more properly refers to the portion of the route, perhaps covering several stops, for which a particular set of fare values apply. At one time it was common for fares to be distance related and a regression analysis could be used to estimate an equation relating fare to distance travelled. However, there has been almost universal coarsening of fare scales and adjustment of different fares at successive increases so that such relationships are now far more difficult to identify.

Fare stages typically range from 0.5 to 1 mile with longer stages in rural areas. In urban areas at least a typical fare stage usually includes three or four separate stops (intermediate stops). A fares table is a half matrix showing the fare between any pair of fare stages on the route. A full matrix is used for circular routes (routes that return to the starting point within a single timetable journey) or where, for some reason, inbound and outbound fares may be different. Fares from intermediate stops are generally calculated from the fare stage point before the boarding point to the fare stage point after the alighting point. A consequence of this is that intermediate stops need to reference two fare stage points, before and after the intermediate stop.

Fare stage points usually, but not always, coincide with bus stops. Fare stages are adjusted rarely – this may be done for reasons of fares simplification (fewer fare stages corresponding to fewer fares values) or to move a generator of high passenger numbers up to the next fares values by redefining the fare stage point before it to put that generator within the next fare stage. Estimates vary as data on fare stages is not easily aggregated but it is suggested that there could be around 135,000 fare stage points (average of range of estimates 90,000 to 200,000) in the UK, compared to over 350,000 bus stops.

For a variety of reasons, a single operator may use different sets of fare stages on different routes, even where these have sections in common. Similarly, different operators may use different sets of fare stages on the same sections of route.

```
Service 7 Leeds - Rothwell (Adult Single)
09:  Rothwell Abraham Hill(09)
10:  60  Wood Ln Est(10)
11:  100  60  Spibey Ln(11)
12:  140 100  60  Stepping Stones(12)
13:  140 140 100  60  John O'Gaunts(13)
14:  140 140 140 100  60  Websters Farm(14)
15:  170 140 140 140 100  60  Haigh Pk Rd or Chem Works(15)
16:  200 170 140 140 140 140  60  Thwaite Gate(16)
17:  200 200 170 170 140 140 100  60  Rocheford Gdns, Joseph St(17)
18:  200 200 200 200 170 140 140 100  60  Sth. Accom Rd(18)
19:  200 200 200 200 200 170 140 140 100  60  Crown Point Rd(19)
20:  200 200 200 200 200 200 140 140 140 100  60  City Sq(20)
```

Figure 3-1: A typical fare table – the highlighted section indicates a portion of the route within which a zonal day ticket may be used.

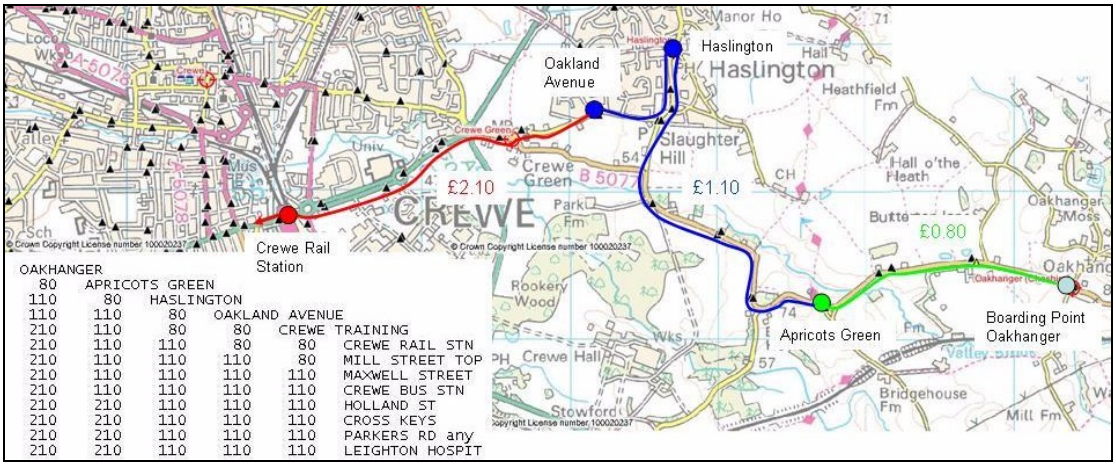


Figure 3-2: Faretable for a route imposed on a map of NaPTAN points in the area. Different fare stages are indicated in red, green and blue.

3.3 Flat and Zonal Fares

Flat fares are uniform fares that are charged for any journey made on a particular route or group of routes or even within an operator's whole route network.

Zonal fares are defined by boundaries which may be either genuinely geographic or the polygon contained by a set of stops identified for each route as the points at which the next fares increments become payable. Zones may be based on:

- Administrative or other convenient boundaries (e.g. Merseyside, Strathclyde).
- Concentric polygons/circles (e.g. London, West Yorkshire).
- "Honeycombs" (e.g. Tyne & Wear).

In each of these types of scheme there may be some boundary stops that are in two or more zones.

Fare zones are set by the appropriate ticket owner, either an operator for operator specific area tickets, or sometimes an authority acting on behalf of all participating

operators (most PTE and local authority areas) or a joint ticketing company (e.g. Greater Manchester and Tyne & Wear) or TfL in London.

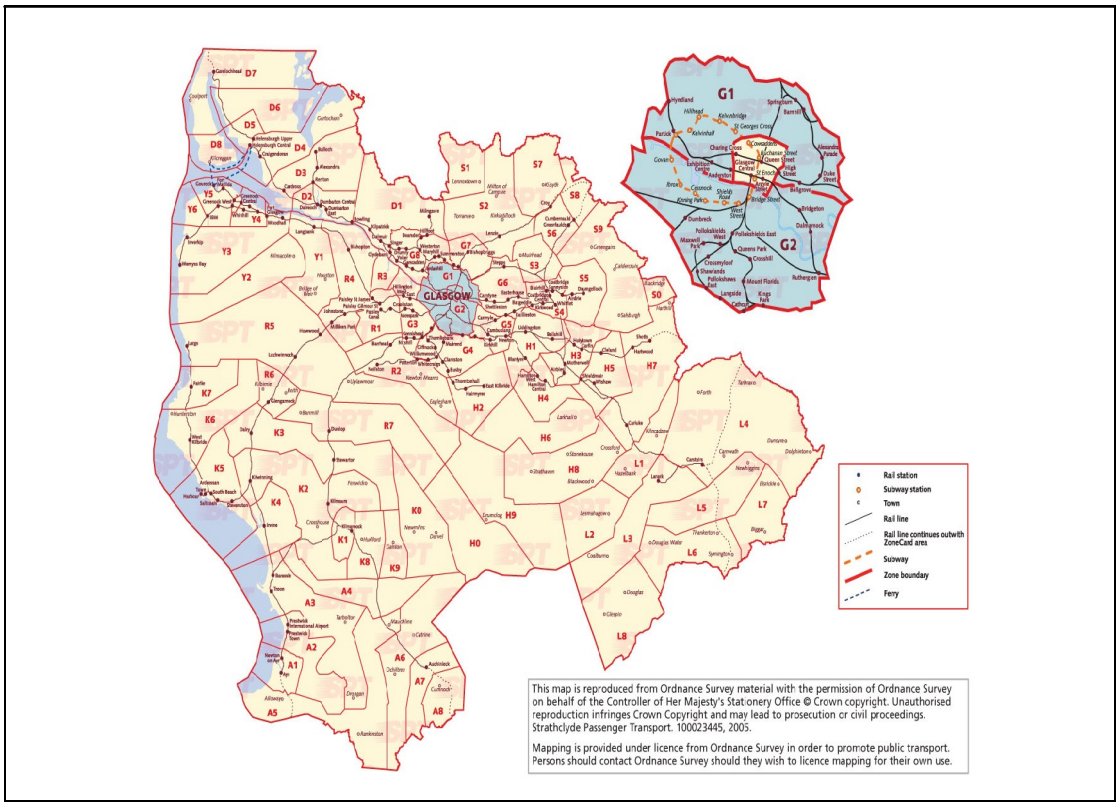


Figure 3-3: Zones for Strathclyde Zonecard, the largest zonal system in the UK.

3.4 Rail and Tram Fares

Rail fares are partially regulated under the terms of the Railways Act 1993 and the Transport Act 2000 which give the DfT the power to regulate fares through its franchise agreements with the train operators, where this is in the interests of passengers. The DFT uses these powers to regulate most fares used by commuters, where rail travel has a degree of monopoly power, and long-distance 'Saver' tickets, to ensure that reasonably-priced “walk-up” (i.e. on demand) travel remains available.

The regulated fares include:

- All standard class weekly season tickets for journeys where a weekly season existed in June 1995.
- All 'Saver' tickets for journeys where a Saver ticket existed in June 1995.
- An unrestricted standard class return, for each journey where no Saver fare existed in June 1995 (typically journeys under 50 miles, or journeys within the old Network SouthEast area).

Rail and tram fares are set on a station to station basis, and again distance relationships are becoming more and more tenuous. For example in Nottingham, NET operates a flat fare regime on its trams. Rail fares in many parts of the country are determined on the basis of “zones” which are groups of stations in a particular locality or group of localities.

	Select outward journey time Wednesday 12 April 2006					Select return journey time Wednesday 12 April 2006				
NOTTINGHAM to LONDON BRIDGE Tickets / Price	Depart	08:07	08:26	08:31	08:50	09:07	Depart	14:55	15:15	15:32	15:35	15:45
	Arrive	10:41	11:09	11:26	11:33	11:41	Arrive	17:37	17:49	18:17	18:18	18:26
	Changes	1	1	2	2	1	Changes	2	1	2	2	1
Singles from 8.00		**For best value fares**						**2 singles could be cheaper**				
SAVER RETURN 45.70						✓			✓			
BUSINESS SAVER 65.50				✓	✓			✓		✓		
FLEXI RETURN 73.00									✓			✓
FLEXI RETURN 79.00				✓				✓		✓	✓	
TRAVELCARD PEAK 95.00				✓	✓			✓		✓		
STANDARD OPEN RETURN 96.00				✓	✓			✓		✓		
STANDARD OPEN RETURN 104.00		✓				✓			✓			
STANDARD OPEN RETURN 110.00			✓	✓	✓			✓		✓	✓	
FIRST OPEN RETURN 142.00		✓				✓			✓			✓
FIRST OPEN RETURN 144.00				✓	✓			✓		✓		
FIRST OPEN RETURN 148.00			✓	✓	✓			✓		✓	✓	
		« Find earlier trains	Find later trains »					« Find earlier trains	Find later trains »			

This symbol means that your ticket includes a One Day Travelcard.
If your booking includes a 'Tube' journey and you are travelling late at night or early morning, please check the opening and closing times for this service. Click here for more information

Figure 3-4: Sample Rail Fares, the regulated fares are highlighted. Where there are multiple fares with the same description this reflects different routing restrictions, for example via Midland MainLine or Grantham and GNER (source: www.thetrainline.com)

3.5 How Fares are Set

In general, the fare setting process involves steps such as the following:
(i) Analyse route or network.
(ii) Establish fare stages and / or zones.
(iii) Establish fare types.
(iv) Construct fare table with prices.
(v) Input traffic levels to model yields.
(vi) If necessary adjust resulting fares.

This may be done iteratively.

In practice, networks are reasonably stable with relatively few completely new routes or operators so the most common process will be updating or extension of existing fares tables.

Basis of charge → Type ↓	**Point to point**	**Zonal**	**Area (operator, network or authority)**
flat		✓	✓
single	✓	✓	✓
return	✓	✓	✓
season	✓	✓	
travelcard	✓	✓	✓
multi-journey	✓	✓	✓
time-limited (including transfers)	✓	✓	✓
Matrix can be expanded multi-dimensionally to add factors such as time, eligibility conditions etc.			

Figure 3-5: Fares (Type vs. Basis of Charges)

3.6 Setting Fares Analytically

Some train operating, coach and large bus companies and Transport for London use analytic procedures for setting fares. The operator uses information on elasticities (e.g. from the Passenger Demand Forecasting Handbook (TRL 593) or internal research or consultancy work) in a model to test iteratively sets of fares that achieve or exceed the required revenue yield. Typically the fares variations will be:

$$Fv(i)_n = Fv(i)_c + round_{10}(x\%)$$

Where Fv(i) is the fare for the i^{th} fare stage, n is new, c is current, x is % increase which is rounded to nearest/next higher 10p (preferred increment for adult fare).

Similar models may be derived for flat and zonal fares.

Child and operator offered concessions (e.g. for unemployed people) are often, but not universally, derivatives (e.g. half fare, giving multiples of 5p increments) as are return fares where the rule may be similar to $2*Fv(i)_n - f(y)$. f(y) may be a constant or a proportional reduction.

Local Authority concessions may involve flat or zero fares in addition, but boundary issues arise. Notwithstanding recent legislative changes and announcements, local authority funded child and scholar concessions and cross-boundary rules leave many remaining non-zero fare concessions.

Some fare-setters (e.g. TfL) may use multipliers for single fares to set the rates for period tickets. Elsewhere market considerations will more generally apply.

The calculations may be automated to a large extent and are typically output to an Excel workbook. In principle, with increasing integration of business systems, a fares module could be added to operators' scheduling and timetable production suites.

3.7 Setting Fares Comparatively

The majority of smaller bus operators and sometimes large group subsidiaries in competitive situations “adopt” fare tables as set by (often larger) competitors, and may make adjustments to particular (“popular”) fares to gain competitive advantage. This will almost certainly be a manual process. Note that this is not equivalent to setting of fares by a cartel, but reflects common retail practices in price matching.

In the limit, operators (regardless of size) could offer a “lowest price guarantee” so that they would always match or better the lowest fare charged on a route. So far as is known this has only occasionally been used in inter-modal competition on inter-city routes.

3.8 Transfers

Although common in Europe, relatively few non-rail operators in the UK offer single journey tickets that allow one or more changes of route. This is often limited by time, for example the journey must be completed within 45 minutes or one hour.

3.9 Time and Other Restrictions

Most operators offer fares that are restricted by time, for example:

- Peak only fares (before 09.00 or 09.30, sometimes later, there may be evening peak fares and restrictions too, especially on rail).
- Off-peak fares (most commonly all day after 09.00 or 09.30 but there may also be restrictions in the evening peak).

3.9.1 Examples of Peak and Off-Peak fares – Nottingham Tram

- Peak Single (Before 09:30, Mon-Fri) £2
- Off-Peak Single £1.20

http://www.thetram.net/times/fares.asp

Figure 3-6: Peak and off-peak fares

- All day Saturday, Sunday and Public Holidays (usually equivalent to weekday off-peak)
- Season tickets allow unlimited travel between a pair of points for a defined period (e.g. day, week, month, quarter, year)

Travelcards allow travel within a given area (e.g. administrative boundary, set of zones) for a given period (e.g. day, week, month, quarter, year). They may be further restricted to (for example) off-peak hours

Travelcards for Bus Travel

The System 1 Adult Bus Saver
The No.1 choice for regular travellers going to and from work, shopping, going out for the evening or simply meeting friends and family at the weekends. Users require a System 1 Travel Club membership card.

Adult Bus Saver 7 day*.....£13.50
Adult Bus Saver 28 day*.....£47.00
Adult Bus Saver Annual*.....£490.00 (only available from GMPTE Travelshops)

You can buy Adult Bus Saver tickets from GMPTE Travelshops.
Adult Bus Saver 7 and 28 day are also available from local PayPoint outlets

.* This refers to those buses operating in the System 1 Travel Network.

The System 1 Adult Buscard Extra
If you want to combine train or Metrolink travel with unlimited bus use, then the Adult Buscard Extra is the one for you.
Available as an "add-on" ticket to your rail season ticket or Metrolink season ticket costing £10.50 or more per week or £40.00 or more per month

Adult Buscard Extra 7 day*.....£5.25
Adult Buscard Extra 28 day*.....£21.00
you can buy Adult Buscard Extra tickets from GMPTE Travelshops.

* This refers to those buses operating in the System 1 Travel Network.

http://www.gmpte.com/content.cfm?subcategory_id=102863

Figure 3-7: Examples of single and multi-modal travelcards (System 1 Manchester)

- "Rainbow fares" used on First's Green Line services on the Berkshire/Hampshire - London corridor where fares are different according to individual journey as a means of spreading peak demand.

Adult Single (One Way) Tickets

Ordinary fares are available for local journeys between Bracknell and Langley. However, these fares are never more than the maximum single fare for that particular colour (e.g. never more than £2 adult single on Indigo coloured journeys).

	R	Y	B	I
Bracknell to London	£9	£6	£3	£2
Ascot to London	£9	£6	£3	£2
Windsor to London	£9	£6	£3	£2
Slough to London	£5.60	£5.60	£3	£2

NOTE: fares may change during January 2006

Red journeys are for weekday commuters to London.
Yellow journeys have standard off-peak fares as they are generally the busiest.
Blue journeys are primarily provided for tourists looking for a cheaper return journey from Windsor, having purchased a single ticket from London.
Indigo journeys are ideal for those looking for a cheap day out in London.

http://www.rainbowfares.com/

Figure 3-8: Rainbow Fares

3.10 Frequency of Fare Changes

Bus operators are free to change fares at any time they wish. Most give at least two weeks notice. Many operators have a commercial policy of changing prices only once a year, but rapidly changing prices (for example fuel costs) may cause more frequent changes.

Fares set by TfL in London change normally on the first Sunday in January.

Many TOCs aim to have annual increases in January of each year. However, rail fares can change up to 3 times per year. The last 3 fares change dates were Sunday 12th June 2005, Sunday 25th September 2005 and Sunday 1st January 2006.
In areas where there are tickets administered by an authority, bus fares often, but not always, change also on the same date as rail fares or on days that the authority changes its concessionary fares.

4 Specific Types and Uses of Fares

4.1 Concessionary Travel

From 1 April 2006, all authorities in England offer free concessionary bus travel for elderly and disabled people within their administrative boundaries. The situation for cross-boundary travel is complex and there will be many local variations such as reciprocal free bus travel in adjoining areas, or a reduced fare in the adjoining area on all or some journeys, or concessions on cross-boundary journeys only or no concession at all. Belatedly the Treasury has acknowledged the bureaucratic problems and costs this creates and a national free scheme for England is to be introduced from 1 April 2008. In Scotland and Wales national free travel concessions will apply on bus services within the devolved administrations and in Scotland will extend in due course to internal ferry services.

These changes have led to some inconsistencies: an example of this is the concessionary schemes in Devon and East Devon. In East Devon a district of Devon a concessionary pass holder is only entitled to free travel within the East Devon area but for someone who lives in one of the other district council areas in Devon they are entitled to a Devon-wide pass for travel across the whole of Devon including East Devon.

4.2 Ticketing Schemes and Multi-operator Tickets

Operators may agree to enter into arrangements to set common fares and sell inter-available tickets but are subject to the Competition Act 1998 and such agreements must be accepted by the OFT as being in the public interest. The Transport Act 2000, introduced the concept of a ticketing scheme promoted by a Local Authority to promote integrated ticketing. The Director General of Fair Trading has produced guidance on a block exemption for ticketing schemes (Public transport ticketing schemes block exemption, OFT 439, 2002). The main classes of fares to which this applies are the multi-operator/multi-modal travelcards etc in PTA and some local authority areas, PlusBus and a few joint bus operations. Many of these are very longstanding and have continued from before deregulation.
Journey Solutions has been set up jointly by the Bus and Rail industries (acting through the Confederation of Passenger Transport (CPT) and ATOC) to promote multi-modal travel. Thus far it has introduced PlusBus tickets in both day and season forms which may be combined with either or both ends of a rail journey between PlusBus zones within which the ticket is used as a travelcard on buses.

There are a number of other rail add-on tickets (e.g. airport rail-links, coaches to large towns without rail services). There are currently 161 PlusBus zones which include 260 national rail stations.

National Express and Scottish Citylink offer an extensive range of through coach and bus add on fares.

4.3 Yield Management and Dynamic Fares

Yield management has been used very successfully by the airline industry first to maximise seat occupation and then to maximise revenues by application of more sophisticated pricing methods. The principles are that any fare which is greater than the marginal cost of carrying that passenger is worth selling (so very low fares are possible as the marginal cost is effectively the costs of ticketing, boarding and alighting), that on a well chosen route there is a market segment (e.g. business travellers) that requires flexibility and is prepared to pay for it (this will largely cover fixed and semi-variable costs), that there is a large price-sensitive segment (leisure

travellers) and that quota systems can be used to determine and respond to sales patterns.

Yield Management has been adopted with great success by National Express and others for coaches and on rail by the inter-city TOCs (e.g. Virgin, GNER, Midland Mainline).

A yield management system implemented on-line to retailers (including self service) is capable of providing fully dynamic fares whereby in principle every seat could be differently priced. Some airlines have moved close to such a system and National Express coaches are also investigating its potential. However, for land travel in the UK fares are currently dynamic only in the sense that the quotas are periodically adjusted (generally overnight) so that a controlled number of seats at each reduced price level is available on each train or coach. Quotas may be zero.

In isolated instances the bus industry has in the past attempted to adopt yield management techniques to determine optimum level of fare on a route.

Below are the fares for a single journey from Chesterfield to London using Stagecoach "Megabus.com". These fares were collected on Wednesday 5th April 2006. The lowest possible fare is £1 which is available for several journeys. From this advanced booking system it can be seen that the fares will fluctuate back above the threshold value.

	Wed	Thurs	Fri	Sat	Sun	Mon	Tue
5/4/06 - 11/4/06	N/A	£10	£7	£7	£7	£7	£7
12/4/06 – 18/4/06	£5	£5	£5	£5	£5	£5	£5
19/4/06 – 25/4/06	£3	£5	£3	£5	£5	£3	£1
26/4/06 – 2/5/06	£3	£3	£3	£5	£3	£3	£3
3/5/06 – 9/5/06	£1	£1	£1	£5	£1	£1	£3

Figure 4-1: Megabus.com, an example of Yield management and "dynamic fares"

4.4 Rail Fares

As already noted, rail fares are in two classes:

- Some rail fares – commuter fares, standard returns and savers - are **regulated**, and franchise operators are required to ensure that the yield from the regulated fares in their "baskets" do not increase by more than rpi $\pm$ x%
- Other fares are set directly by the TOCs either directly or in consultation with one or more, or all, other TOCs. Such fares may include:
  - Fares on TOC's own services only.
  - Fares on TOC's own services and approved connecting services only.
  - National promotions (often voucher or presentation of relevant rail ticket and applying in combination with any appropriate rail fare).
  - Tickets such as Business Savers.

RSP (Rail Settlement Plan Ltd), a subsidiary company of ATOC (the Association of Train Operating Companies) settles and clears fares between TOCs and is the custodian of the full set of UK rail fare data which is readily available to third parties, e.g. thetrainline.com and travel agents.

	Select outward journey time Wednesday 12 April 2006				
	Dep	10:13	11:13	12:13	12:20
	Arr	12:41	13:41	14:41	15:02
BEESTON to LONDON BRIDGE Tickets / Price	Chg	1	1	1	3
GNER STD ADVANCE4 18.00					
GNER 1ST ADVANCE3 30.50					✓
GNER 1ST ADVANCE4 37.50					✓
SAVER SINGLE 41.80					✓
SAVER SINGLE 44.70		✓	✓	✓	
STANDARD OPEN SINGLE 48.00					✓
STANDARD OPEN SINGLE 52.00		✓	✓	✓	
STANDARD OPEN SINGLE 55.00					✓
FIRST OPEN SINGLE 71.00		✓	✓	✓	
FIRST OPEN SINGLE 72.00					✓
FIRST OPEN SINGLE 74.00					✓

Figure 4-2: Sample Rail Fares including "dynamic" (denoted GNER and highlighted pink) and regulated (Standard Open Single and highlighted yellow). The different prices in the regulated fares reflect route restrictions (Source: www.thetrainline.com).

4.5 Transport for London and rail fares in the Greater London Area

Within the Greater London Authority (GLA) area, the Mayor sets overall policy and decides on fares for Bus, Underground, Docklands Light Railway and Croydon Tramlink with advice from TfL officers. He is subject to London Assembly scrutiny and has to consult with stakeholders such as the London Borough Councils. He must raise enough from fares, with other funding sources, to ensure the books of TfL

are balanced after taking account of any revenue support he is prepared to recommend through the GLA budget.

It has recently been agreed that all fares in Greater London will be set zonally using TfL's Zones 1 to 6. All bus, train, light rail and tram services in this area will accept Oyster and ITSO smartcard tickets will also be recognised for use on all services. Further changes may follow the transfer of responsibility for certain rail franchises to the Mayor.

Travelcard prices must be agreed with the London TOCs and a joint TfL/ATOC-RSP working party does this under "The London Scheme Agreement". The responsibilities for the various fares and tickets are shown in Figure 4.3

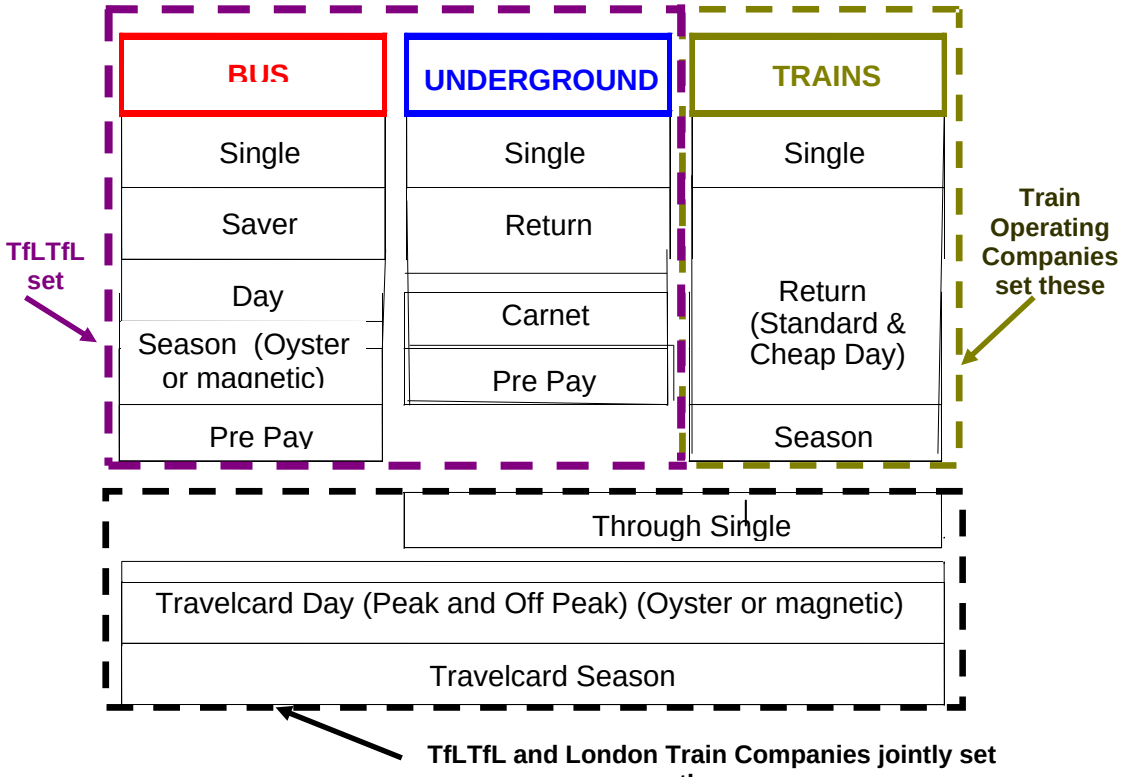


Figure 4-3: Responsibilities for setting fares in London (TfL, 2005)

5 Use Cases for FXC

To help envisage how a FareXChange standard might be used, and to provide a framework for assessing the scope to be included in the specification we have produced a set of scenarios – "use cases" – to examine potential situations in which the availability of a standard would assist transfer of data relating to fares. When developing schema for FareXChange it will probably be helpful to develop these, and other, examples using process flow ("string") diagrams to assist interpretation, modelling and testing.

5.1 UC-#CRE1 Creation of Fare Data – General Pattern

The fare officer of the transport operator or fare setting authority compiles or updates a set of fares for a network or route.

Fare models between different operators and modes may be significantly different.

To update an existing fare, the user (usually an Operator) may:

- Apply an across-the-board rise and then refine it.
- Select particular fares for specific monetary increases: others may be left unaltered or increased by different amounts (this is probably the most frequent case for large bus operators).

This is not usually done entirely on paper. It may however often be done using only basic office software; say a Word document, Word table or spreadsheets. Larger operators could potentially have direct transfer from their analysis programs to their scheduling and timetabling suites, but this is believed to be very rare.

Depending on the complexity of the route and the fare structure this can be a simple table or a much more complex set of objects. The fare model may contain objects such as fare stages that need to be collated with service data such as stop points, and availability restrictions that need to be collated with specific journeys. An effective date will be assigned to the fare table overall.

The output of all the processes will be fare tables in electronic form, and may be in either structured or unstructured form.

Fare amounts need to be quantised to convenient values that can be handled by humans and/or ticketing machines, e.g. £1, 10p or 20p steps. There may be a minimum and maximum fare.

To create a new fare (e.g. for a new route) the operator may start with a standard fare to mileage relationship and then refine the figure. Increasingly however, the starting point will be based on the operator's business intuition as to an appropriate fare based on estimated demand, experience elsewhere and similar factors.

For dynamically-determined fares a standard set of fares values and quotas is generally set which the software reviews and selects the most advantageous solution for the operator.

For concessionary and other fares such as returns that are derived from standard single fares, there will usually be a primary fare table; and the derived fares will be computed as a standard percentage (again quantised to round values by a step

function). There may be more than one concessionary fare rate, for different groups. of concessionary travellers (such as Elderly, Disabled, Blind, Companions of Disabled, Child, Young Person or Student) See Use Case: UC-#CRE3 *Setting Concessionary Fares* (see section 5.3).

Rules will be necessary for cases such as very young accompanied children who usually pay no fare but there may be a limit on the number of such children permitted to accompany a fare payer. Other cases to be considered include dogs, bicycles and luggage generally for which either flat or graduated fares may apply.

Depending on the size of the operator the responsibility to create fares may reside with the same parties that are responsible for the schedule, or within a separate department.

The results of the fare process will be sent to a number of different actors, for example:

- To ticket issuing machines in booking offices and on vehicles (electronic ticket machine modules are sometimes updated by the suppliers on an agency basis).
- To create printed information or promotional publications.
- For on-line publication as web pages or .pdf files.
- For online delivery through a journey planner.
- To provision ticket vending machines and kiosks.
- To a local authority for use in concessionary travel reimbursement.
- To a regulator (e.g. DfT, TfL, OFT).

5.2 UC-#CRE2 Creation of Fare Data – Demarcating Fare stages and Fare zones

Most bus fares are related to geographically identified fare stages as described above. In general, most Fares Zones apply to fares where the Local Authority or PTE or TfL determines fares (e.g. Travelcards). Rail fares are determined between every station pair for which there is a valid route between them and subject to valid routes contained within a routing guide. However, there are many exceptions to this general rule (e.g. area-wide fares determined commercially by bus operators).

Zonal fares require the geographic delineation of a fare zone. Each fare zone will have a different name or number within the transport network. Each zone will be bounded by a polygon or more complex shape e.g. torus. Fare zones may overlap, i.e. a stop may be in two zones (see Figure 5-1).

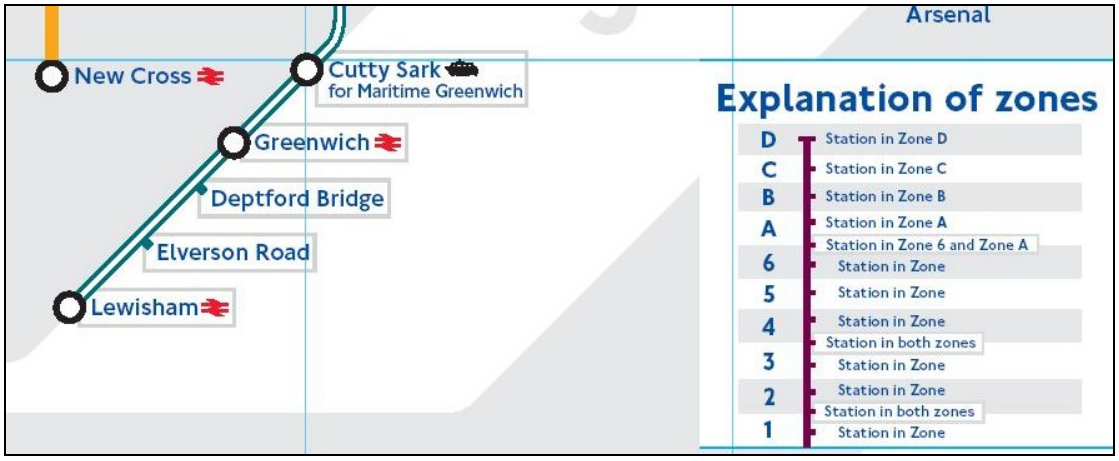


Figure 5-1: London Underground & DLR diagram excerpt showing key to stations on zone boundaries, also showing that all the stations between Lewisham and Cutty Sark lie in both zones 2 and 3.

Fare Zones can be delineated in two different ways:

- Explicitly: every single stop in the network is directly 'attached' to the named zone. In this case a map is purely a visual aid to understanding the zones.
- Indirectly: Zone areas are described by a polygon and fares are considered to be in the zone if they reside within that boundary. In this case the geographic boundary is essential for computing the zone. PlusBus zones are defined in this way – see Figure 5-2.

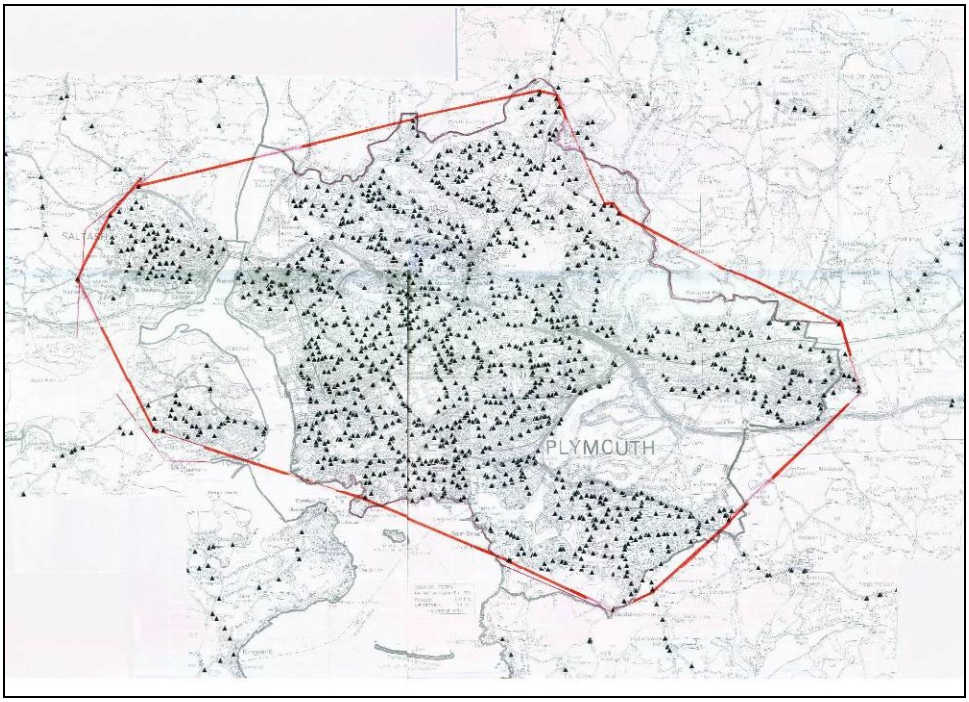


Figure 5-2: Plymouth PlusBus zone defined by a NaPTAN polygon.

Zones may correspond to jurisdictions, network sectors, NPTG localities or other abstract objects.
There may be both geographic and schematic maps of zones.

5.3 UC-#CRE3 Setting Concessionary Fares

There are two approaches in common use to the setting of fares for concessionary travel:

(a) **Derivative fares:**
A derivative fare is usually a simple multiplier of the standard or base fare, for example half or two thirds which are usual for childrens' fares or a multiplier such as the number of days in a school term which might be used for a scholar's season ticket. Occasionally the multiplier may be a formula, often generically $F_c = k + m \times F_b$ where F_b is the base fare, F_c is the concessionary fare, k is a constant ("boarding charge") and m a multiplier.

(b) **Flat (**including zero) **fares**:
Concessionary fares for elderly and disabled people are commonly set to a standard flat value (for example 50p for any journey in Greater Manchester in 2005/06). A special case is zero fares as now apply for off-peak travel for elderly and disabled people at least in their local areas in all parts of Great Britain. In some areas the concession extends into the peak and to rail travel as well.
Whilst outside the scope of this study it should be noted that zero fares create complications when determining generation factors for reimbursement purposes and that this will make the accurate and timely exchange of fares data between operators and authorities even more important following the introduction of zero fare concessionary travel locally in England and nationally in Scotland and Wales from 1 April 2006. The 2006 Budget Statement also announced that England will have a national scheme from 1 April 2008.

Having determined the derivation rule, this is then applied to fare tables or zonal or flat fares determined as in UC-#CRE1 (section 5.1) and UC-#CRE2 (section 5.2)

5.4 UC-#CRE4 Creation of fare data – Cross-boundary Fares

Cross-boundary journeys between areas where fares or particular types of fares may be set or influenced by authorities have taken on increased significance in the light of the statutory availability of free concessionary travel for elderly and disabled people on local buses in each local authority area in England since 1st April 2006. There is considerable variety in the treatment of fares for through concessionary travel between areas ranging from agreements to extend free travel for the entire journey, through a variety of derivative fares (for example, half fare) to full fare for the portion of the journey beyond the final fare stage wholly within the area in which the concession applies. In some cases, three or more areas may be traversed in a single journey.

Cross-boundary fares are also of interest around metropolitan areas in which a Passenger Transport Executive plays a part in determining rail fares but outside its boundary there has to be a transition to the "normal" fares levels applying to the TOCs serving the routes concerned.

In such cases, there will be a variety of approaches that can be followed, ranging from simple combination of fares tables created as in UC-#CRE1 (section 5.1) and UC-#CRE2 (section 5.2) to derivation of completely separate tables (where there is a transitional element to "smooth" the difference between in and out area fares. In the latter case, the cross-boundary fares would effectively be separately computed using the approach of UC-#CRE1 (section 5.1) and then merged with the in and out area fare tables.

5.5 UC-#CRE5 Creation of fare data – *Buses*

The fare-setting process for bus follows the general pattern, but sometimes involves the operator passing the fares data file to the ticket machine supplier for processing by bespoke software prior to loading into ETM modules. Larger operators will have their own copies of this software. Where derivative fares are used the software will have appropriate rules for processing it, and there are often also specific rules for building fares tables in circumstances such as route variants within the same service.

5.6 UC-#CRE5a Creation of fare data – *Buses -Joint Fares Schemes*

Where there is a Ticketing Scheme as defined in the Transport Act 2000 (see 4.2) or a legacy multi-operator ticketing agreement, the manager of the scheme will convene discussions between participating operators to determine and confirm the pricing rules and fares to be charged. Fare tables will then be created in a similar fashion to UC-#CRE1 or UC-#CRE2 as appropriate.

5.7 UC-#CRE6 Creation of fare data – *Rail*

The fare setting process for rail follows the general pattern, except that there are three levels of Fare authority:

- RSP determines regulated rail fare rules in accordance with DfT guidance. These rules may be interpreted as defining derivatives based on the current fares charged.
- RSP for non-regulated fares that are accepted by all members of RSP.
- TOC-specific fares, including through fares between some but not all TOCs.

RSP is keen to overhaul its procedures for the exchange of fares information. It is suggested that if it is decided to proceed with development of FXC, more detailed use cases should be agreed with RSP and used as input to producing a full national multi-modal specification.

A further level of refinement in rail fares is that there are many instances where alternative routes are available between origins and destinations (for example via London or not via London). Routing guides are produced and these need to be associated with fares where there are restrictions as to use. The fares elements are also different because fares will often be priced according to class (Standard - often colloquially called “2nd Class” - and First class).

There are therefore three particular subsidiary use cases to be developed:

5.8 UC-#CRE6a Creation of Regulated Rail fares

These fares are updated nationally by RSP in the light of agreement by ATOC on behalf of all TOCs. Variants for class, period (for season tickets), peak and off-peak restrictions etc will be incorporated as rules. The maximum extent to which rail fares may be increased is determined by the DfT.

5.9 UC-#CRE6b Creation of Single TOC Fares

Each TOC has to comply with restrictions on the fares in the basket defined in its franchise agreement. In addition it may set its own fares as required to achieve its commercial objectives. There are no restrictions on such fares which are specific to services operated by that TOC (see below for through fares to other TOCs). These fares are then passed to RSP for inclusion in the National Fares Manual.

5.10 UC-#CRE6c Creation of Multi-TOC Fares

Individual TOCS are able to add their own specific fares available on their own services without seeking additional RSP agreement. In many cases they will reach agreement with other TOCs to extend these fares to include connecting services (this is common with dynamic ticketing) and RSP will provide allocation and settlement services.

All rail fares must be produced and published according to industry standards and processes administered by RSP and subject to the regulatory overview of both DfT as franchising authority and the Office of Rail Regulation (ORR).

5.11 UC-#CRE7 Creation of Fare Data – *Ferries*

The fare setting process for ferries is believed to follow the general pattern, but may use a simple point to point model with incorporation of different types of discounts, group tickets, and possibly special fares for cycles, motorcycles, and for circular itineraries.

FARES: OBAN – CRAIGNURE

All tickets must be purchased before boarding vessel		SINGLE	SAVER SINGLE	SAVER 5 DAY RETURN	6 JOURNEY*
Driver/Passenger (each)		£4.05	£4.05	£6.95	£17.30
Car (each), or Motorhome	up to 5m	£36.00	£28.50	£48.50	£104.00
	up to 8m	£54.00	£43.00	£73.00	£156.00
	up to 10m	£72.00	£57.00	£97.00	£208.00
Caravan, Boat/Baggage Trailer	up to 2.5m	£18.00	£14.25	£24.25	N/A
	up to 5m	£36.00	£28.50	£48.50	N/A
	up to 8 m	£54.00	£43.00	£73.00	N/A
Bicycle (Sgl) £1.00	Motorcycle	£18.00	£14.25	£24.25	£52.00

*6 Journey tickets are valid for one passenger or one nominated motorised vehicle not valid for caravans or trailers.

Pier Dues (included in fares shown) Craignure: Passenger 24p, Car 78p.

Figure 5-3: Sample Caledonian MacBrayne published fares matrix for Oban – Mull services.

5.12 UC-#CRE8 Premium and Economy Service Fares

Services such as airport express buses and some trains, and some advertised “low cost” services such as Magicbus, Megabus and Megatrain have special fares structures distinct from those on other services of the same operator. Whether the fares charged are premium as in the case of most airport services or economy, they will generally follow the principles already described. In the case of the economy services, Megabus and Megatrain a form of yield management starting with offers of low fares (subject to booking fee) subject to tight quotas is used.

Where the fares follow standard flat, fares table or zonal patterns treatment by FXC will be identical to other services. For premium or economy services using yield management FXC might be used to pass fares enquiries directly to the operators for quotation.

5.13 UC-#CRE9 Preparation of fare ticket type conditions and associated conditions of carriage

For some operators there will be particular conditions associated with the use of fares and the conditions of carriage may require the customer to fulfil particular requirements. The most common example is concessionary travel where the

concessionaires will be expected to present their passes or permits in order to obtain the required fare and to present them again if required for in journey inspection.

Tables specifying the conditions applying to each fare have to be prepared and transmitted together with the relevant fares data. The prime requirements for this are in the rail and ferry industries but in principle the requirements apply equally to other modes.

5.14 UC-#CRE10 Creation of Combination Fares (including non-Transport Entities or with add-ons, such as Sleeping Accommodation)

Combined transport and entry tickets are often used in the promotion of museums, special events and other attractions. In addition transport operators may offer tickets that include sleeping accommodation, carriage of a car and occupants on a ferry or meal entitlements for example.

FXC will need to transfer such entitlements together with information on the fares themselves.

5.15 UC-#CON1 Submitting a Fare Scheme for Approval

Whenever a new fare scheme is developed it will be necessary to exchange fares data between the participants as previously discussed and also to advise OFT or respond to requests by them for information if they wish to investigate any competition implications. An FXC publisher will be a useful component of the FXC suite for the latter purpose.

Use Cases for Distributing Fare data

The opportunity must be taken to ensure that all media, paper, magnetic, call centre, internet, smartcards, RFID and NFC, mobile telephones, barcodes etc. whether used for publication or to carry tickets and information relating to fares should be encompassed within FXC which should itself interface seamlessly with other standards such as ITSO and GSM.

5.16 UC-#DIS1 Provisioning of on-board, bus stop & retail ticket issuing machines

Fares must be provided to equipment such as onboard ticketing machines, both ETMs and handheld devices, Point of Sales Terminals (POSTs) such as booking office and agents' ticketing issuing equipment, Ticket Vending Machines (TVMs) and kiosks with ticket issuing capability. Availability of FXC will promote further automation of these processes and enable much needed interoperability between equipment from different suppliers.

5.17 UC-#DIS2 Provisioning of ticket checking devices

Equipment such as barriers / gates at rail stations and devices such as hand-held units used by on-board inspectors should have fares data in order to check the validity of tickets. Such devices may also hold databases of customers in order to check the validity and authenticity of travelcards and season tickets. A link to AVL systems and a time-recoding device clock may also be useful for determining validity. Again, availability of FXC will enable automation of these processes and encourage much needed interoperability between equipment from different suppliers.

5.18 UC-#DIS5 Distributing fares for publication

Customers must be informed of fare values, fare changes and fares conditions. This can be provided in several ways including printed material and electronic media.

The new or revised fare table is input to ETMs and other POSTs and transmitted to information providers either from the working documents input to the fares back office system or the fares back office system itself.

Information must also be provided to the customer on where specific types of fares can be purchased (e.g. On-Board, at Staffed Stations, through Kiosks, over the Internet, by Phone), and using what means (e.g. Cash, Credit / Debit card, Smartcard). The passenger also needs to know whether advanced booking is required and if so what are the required advanced booking periods. (S)he will also need to know whether there are quota restrictions on the availability of particular fares, and will need to know the terms / conditions / restrictions of particular fares.

5.19 UC-#DIS6 Distributing fares to online systems

Online journey planners have a data factory and a build process that imports data feeds from different sources including stops, timetables and geographic information, checks and validates it, and integrates it into a common internal representation that is efficient for journey planning.

The Journey planners that support fare queries will also import fares data. Standard formats are used for stop (NaPTAN) and timetable (ATCO cif, Rail cif TransXChange) data, but fare data is not currently standardised.
The fare model will be sent to **traveline data managers.**

Fare tables will be sent to the data factories of the journey planner data operations team either separately, or along with the timetables for which they provide the fares.

Transmission may be automatic (e.g. by FTP and a timer process) or triggered by manual processes, e.g. email attachments.

In order to be used by online journey planners the fares model may contain objects such as fare stages that need to be collated with service data such as stop points. It may also contain availability restrictions that need to be collated with specific journeys.

This collation may be done either by the Fare Creator or by the data factory, either automatically or as a manual process
The following sorts of error might be found, e.g.:

- An unknown fare stage.
- An unknown stop point.
- An availability condition that is impossible. E.g. Child over 60.

If an error is detected by the data build the fare will be rejected.

Fare tables are usually quite small so once the collation of fare stages with geo-coded bus stops is complete, the overhead of these processes should be small.

Use Cases for FXC with Passenger-centric On-line travel planning

Note that this activity may be carried out by the traveller, or by an agent (e.g. at a Call Centre) and that the traveller may access this information through a variety of media including PCs , telephones, PDAs and other mobile devices or dedicated information kiosks.

5.20 UC-#TRAV1 Finding out the cost of a journey

The user (traveller) wants to know the cost of the journey in order to make her own comparisons. (S)he uses a web or mobile online journey planner to select the journeys (s)he wants. The journey planner will optimise the journey choices by time and route constraints, and return results that include the fares.

The user's primary inputs are the journey route and time of travel.

- If the fare structure is simple – e.g. a flat fare or a zone or distance related fare, the planner has sufficient input to determine the fare using a simple fare table based on the origin and destination.
- If the mode of transport has a complex fare structure (with different type of fare, discounts, and availability conditions), the on-line system may ask the user for additional inputs that allow it to find the best fare out of a large and complex choice and simplify the results for the user. The inputs may be obtained as part of the other parameters, as a separate step, or be derived from the user's stored preferences.
- Additional inputs may include number of passengers, age, discount cards, [etc] and whether there is a return journey.

Fares are shown in the context of the results. In the simplest case there is a standard fare, and in complex cases there may be many fares with different conditions attached.

- There may be a single overall fare, or separate fares for different legs, especially if there are options for different legs.
- The planner is likely to omit fares that are not applicable, though in some circumstances it is useful to show them as unavailable, so that the user is aware of them for another time
- If some fares have limited availability, the system may also access an availability system to check for unavailable fares and remove them if no longer available
- The journey planner may order the available fare in price order, but it is not primarily searching for the cheapest route in its underlying search. The primary optimisation of the journey planner will usually be 'most convenient' i.e. shortest time / least changes, not cost.

There may be a great difference in the levels of sophistication of the fare computation between different inquiries. The final result may also have to include end-leg costs, such as parking and taxis. The results may have to exclude certain fares that are not available for particular routes.

5.21 UC-#TRAV2 Journey planning to find the cheapest fare

The user's primary objective may be to find the cheapest fare or a sufficiently cheap way to travel. In requesting the fare (s)he will indicate that cheapest is the goal. In this case the journey planner can use a completely different routing algorithm, assigning weight by price rather than convenience of travel. The cost of end legs may be of especial interest. This will involve access to separate fares for each journey leg as well as any end-to-end fare that may already exist.

If the fare structure is complex, finding the best fare may be extremely complex. This requires a means of evaluating not only any end-to-end fares that may be available but also combinations of individual fares for each leg or combination of intermediate legs together with restrictions on routes, times and other conditions.

We believe that it has been shown that optimal solutions to problems of this type cannot be guaranteed computationally. There are further considerations in respect of its practicality such as the increasing availability of dynamic fares or short-lived special offers. Several consultees suggested that they would not wish to take responsibility for advising on cheapest journeys. Nonetheless travellers are quite likely to ask information service providers "what is the cheapest way from A to B?"

The question of whether or not cheapest journey planning is possible is a question of application that should not impact on the development of FXC as a standard for the exchange of fares data. It is likely that should cheapest journey planning become a feasible option for widespread use in the future, FXC will be able to support it.

5.22 UC-#TRAV3 Cross-boundary Journeys

Cross-boundary journeys will only be a consideration where there is a different fares authority responsible either side of the boundary. This may lead to different fares structures as well as fares levels. This situation is most likely for concessionary travel, but also applies around metropolitan areas where authorities have an input to rail fare levels.

Computing fares will involve similar considerations to those discussed in UC-#CRE4 Creation of fare data – Cross-boundary Fares. There will either be summation of fares from different tables or a combined cross boundary table will have to be used.

5.23 UC-#TRAV4 Combining different fare products

There may be circumstances where users wish to use different fare products at different stages of a journey, for example to travel first class on the trunk leg, or to make use of a combination fare. Another instance would be where a party included members travelling at concessionary rates, such as children or elderly people. The solution is likely to involve summation of the separate fares, but there may be complications if, for example, cross-boundary concessionary travel is involved.

5.24 UC-#TRAV5 Selecting end leg options

As well as public transport access or agrees modes, end leg options including modes such as taxis or car parking at termini or park and ride sites may be of interest to the user. Currently these are not well developed within publicly available Journey Planners although their importance is recognised.

A user wanting to evaluate end leg alternatives such as these would need the Journey Planner to provide indicative taxi fares, parking charges and estimated car mileage costs for the end legs in question as well as the calculated end-to-end fares for the available public transport options. FareXChange should be designed to exchange data for the other end leg options if necessary.

5.25 UC-#TRAV5 Comparing individual fares with Area or Period tickets

Increasingly, travelcard type day and weekly tickets valid in particular areas or across a network are promoted by operators as an attractive alternative to paying a separate fare on each journey. For weekly or longer periods season tickets should also be considered. The user needs information to decide whether (s)he is better off buying an area or period ticket or using several regular fares

For given route(s) or journey(s) the user will be interested in the range of fare products including at least:

- ✓ Regular single or return fares.
- ✓ Area or network day or season tickets.
- ✓ Carnet or bulk discount tickets.
- ✓ Full season ticket.

To find out the cost (s)he will give her travel origin and destination and the planner will have to evaluate all options. One of the suppliers already has a product that can potentially present results in this way.

Use Cases for FXC and online fare data for Management Information

Management information may need to be transferred both from publicly-accessible websites used by the traveller directly to purchase tickets, or from private websites or from remote electronic devices linked directly to electronic management information systems of sales outlets.

5.26 UC-#MINF1 Obtaining details of numbers of purchases of particular fares for specific journeys (or, for types of Travelcards, for specific time periods)

Operators require this for a number of reasons:

- To analyse fares gaps in the market. Marketing departments may be interested in which fares users are seeking but cannot satisfy. By logging behaviour in online journey planners and returning the results useful information can be found.
- To determine which fares are the most popular: finance and costing departments may be interested to know which are the most popular fares sold
- To determine whether or not a particular fixed fare has reached any quota level or band, and therefore to halt sales of that fare.
- To determine the level of dynamically-driven fares.

5.27 UC-#MINF2 Obtaining details of when and from where particular fares are purchased

Time-of-sales patterns may be required to monitor the success of advertising campaigns and to determine dynamic advertising campaigns. Sales performance of different outlets will be required to determine sales commissions, and the cost-effectiveness and value of different sales outlets.

5.28 UC-#MINF3 Obtaining details of numbers of queries for a particular fare

The user makes a fare query looking for the cheapest fare and the journey planner logs all types of queries, including the fare type selected for information. The log of the output by the planner is fed to a data warehouse. A weekly analysis process analyses the percentage of different fare types queries, and creates a report, etc.

In conjunction with analysis of actual sales (see above) this information may be very valuable for marketing.

5.29 UC-#MINF4 Ticket inspection

Fares information is needed for checking the validity of tickets that are presented to the inspector: holding this data electronically makes the task of checking tickets much easier and substantially reduces any problem of different inspectors giving different judgments on whether a particular ticket is valid.

5.30 UC-#MINF5 Management of Quotas

Some operators, particularly in the rail and coach industries use quotas as a method of yield management. Quotas (which may be zero) are set for particular timetabled journeys. FXC will need to cope with a dynamic enquiry situation in which having identified that a quota controlled fare may be available the enquiry engine will check that the quota is not exhausted before passing the result to the passenger.

When yield management is fully dynamic, a situation contemplated by National Express and some Train Operating Companies, the preferred solution may be for the enquiry to be passed on to the operator's booking engine as fares will change very quickly. For casual enquiries where early purchase is not envisaged it may be necessary to pass on ranges of prices or a clearly labelled indicative cost. FareXChange should be capable of coping with whichever mode of operation is required, these choices being business decisions of the operators concerned.

5.31 UC-#MINF6 Loyalty Schemes

Some operators use loyalty schemes as part of their marketing portfolios. These typically award points (expressed through a variety of tokens – miles, pounds spent, journeys taken etc) to be redeemed later for rewards or discounts on future travel.

In terms of FXC requirements it may be sufficient to pass through information on the nature of the scheme, but equally the actual points value could be exchanged.

Other Uses for FXC

5.32 UC-#BUS1 Justifying, or providing arguments for, specific financial arrangements

As discussed in the use case for concessionary travel (UC-#CRE3 (5.3)) authorities responsible for concessionary travel schemes need up-to-date knowledge of fares charged by participating operators in order to set budgets, calculate reimbursement, monitor costs and update generation factors. They will need to handle fares changes rapidly. Availability of FXC will enable standard software to be written by the suppliers with the possibility of linking seamlessly into other databases for electronic information and transport planning.

This need has increased with the introduction of free travel on bus schemes by all relevant authorities and will increase further with the introduction of a national schemes in England in April 2008.

5.33 Integrated Revenue Management

Several operators and suppliers have noted that with the coming availability of smartcards and the capacity of their back offices to provide more convenient and detailed information than is available from present equipment it will be possible to use exchange standards to bring together all the information that is required for allocation, settlement and distribution of revenues from concessionary travel and multi-operator tickets between the appropriate back offices. FXC will enable the necessary current fares information to be available for this.

5.34 UC-#BUS 2 Customer Relationship Management (CRM)

Customer Relationship Management (CRM) is an approach that makes use of any and all available data about customers to improve management of the business to increase customer satisfaction, development of new products responding to trends in customer behaviour and targeted marketing. Combining information on travel patterns, for example collected by smartcards or data analysis of ETM records, with fares automatically will enable operators to increase their use of CRM.

6 Business Issues for FXC

6.1 The Need

The majority of responses to the consultation questionnaires, interviews and draft report confirmed that there is a need and desire for a UK fares exchange standard and that, subject to the resolution of data management, cost and business case issues, this view is supported in the bus, rail and authority (information co-ordination) sectors.

FXC is currently envisaged within a UK context. Although most fares systems elsewhere in the world are rather simpler than those in the UK, there is considerable advantage both to suppliers of systems and their customers if standards can be international. FXC should therefore be developed in the context of international standards such as Transmodel.

Three main uses were identified for FXC, which are:

- Delivering fares data to travel information systems such as traveline, via a single open standard.
- Exchanging fares data between ticketing equipment and supporting systems, for example enabling the back office system from one supplier to provide fares data to another supplier's system. This will encourage interoperability between equipment and systems allowing greater choice amongst suppliers.
- Delivering static and semi static (e.g. quota controlled) fares data required for the off vehicle booking and sales of tickets for both single and multi-leg journeys.

6.2 Confidentiality of Fares Data

In a non-regulated market, public transport fares data is commercially sensitive, especially prior to the fares information being publicly released for the sale of tickets. A strong view emerged in the consultations that only the operators themselves or their contractors should be able to create and edit fares data.

From a FXC perspective the commercial confidentiality of fares data raises two distinct questions:

1. What features should be built into FXC to help maintain the confidentiality of the data?
2. What processes and policies should be put in place by the users of FXC to ensure that the commercial confidentiality of FXC is not breached?

The second of these questions is a business issue largely outside the scope of the study to be resolved between the bus operators and traveline regions for example.

Within the FXC exchange files there should be options to indicate that the fares data is confidential, or confidential up to a "public release" date. Some options for the information necessary to mark the level of confidentiality include:

- Confidentiality Statement. The option to carry a textual statement within the TXC file.
- Copyright Statement. The option to carry a textual statement within the TXC file.
- Disclosure Statement. The option to carry a textual statement within the TXC file.

- Confidentiality Period. Optional start and end dates of a period of time within which the data is not to be disclosed to 3rd parties.
- Permitted use, inside/outside the confidentiality period(s). e.g. fare enquiry for a trip, fare enquiry for the whole fare table, publication of the fare table on the internet, publication of the fare table on paper. Use for fare enquiries in advance.

Encryption does not need to be included within the FXC standard. If required by particular applications, the encryption process would be undertaken on the FXC formatted data by a higher level system process within the application.

6.3 Confidentiality of Fares Structures

The fares structure is information on the general format of the fare tables and how the rules are applied for concessions and other ticket types. The "structure" does not include any data such as the fares/prices themselves.

FXC is intended to be an open standard for use in the UK and potentially within Europe as well. In order for a particular type of fare structure to be exchanged using FXC, the structure of the fares will need to be available to the FXC development team, so that they can analyse it and code it into the FXC standard. It is not proposed at this stage that there should be any confidential annexes to the standard containing FXC extensions for fare structures which would only be used between parties to that confidentiality.

6.4 Security

It is not intended to build any specific security features into the FXC schema itself, though they may be used as part of the process established to exchange FXC documents. If FXC files containing sensitive data are to be exchanged, then 3rd party encryption software could be used to encrypt the FXC files, or to secure a communications path.

6.5 How does FareXChange (FXC) relate to TransXChange (TXC)?

The FareXChange (FXC) schema is an XML data structure for exchanging public transport fares information between electronic systems such as public information systems and ticketing equipment.

Fares are expressed as the price for the trip between an origin and destination, this may be accompanied by a variety of constraints including validity times and periods, routes, class, etc. The origins and destinations are typically locations which encompass several NaPTAN points. They may be fare stages of several stops, a group of neighbouring railway stations, fare zones, or network wide tickets.

Fares data is generally expressed or presented in terms of an origin/destination matrix, in either a triangular format, where the fares are the same in both directions, or in a square where the fares are different in each direction. Attached to the fare table would be notes on the validity of the fares and rules on the calculation of concessions, etc.

An important thing to note here, is that while a fare matrix can be route specific, for example in the case of many bus tickets issued on vehicle, this is not always the case. Network wide, multi operator and zonal fares would be good examples of this.

TransXChange (TXC) is an XML data structure for exchanging public transport service and timetable information between electronic systems such as public transport information systems. A TransXChange file contains the information for a single route, including variants to that route if required. TransXChange can hold all the information required to electronically register a bus service with the Traffic Commissioners, including the details of the geographic path the route follows. TransXChange does not include any provisions for exchanging fares data.

A design choice for the development of FareXChange, is whether it should define all the fares options for a specific route, in order to have a one to one correspondence with TransXChange; or whether FareXChange should describe individual ticket/fare types separately, and route independently. This second option is recommended.

A FareXChange data file should therefore define all the fares derived from a single type of ticket. The derived fares might, for example, be child concessions, returns or any other fare calculated from the standard. Depending on the ticket type, this fare could be for a single route, with a one to one correspondence to the TransXChange file for the route. Equally the FareXChange file could define the fares for a network, zonal or route independent ticket, covering many routes in TransXChange terms.

6.6 Bus Ticketing Systems

Ticketing systems for buses have historically been independent from timetabling systems and passenger information systems. In more recent times there has been some linking of these systems, typically based on pragmatic approaches, as distinct to the adoption of a fully integrated systems architecture and set of data models. In particular, ticketing data is handled independently of timetabling data.

One example of where linking has been achieved between the ticketing systems and passenger information systems, has been automatic vehicle location (AVL) on buses. In this scenario, the ETM has typically acted as a data entry console (so the driver entered route and journey pattern identifiers to the AVL system which also drives real time passenger information), with the vehicle location being used to automatically update the ticket machine to the correct fare stage along the route. If we were to assume that the ticket machine primarily obtained its data from FareXChange and the real time information system obtained its data from TransXChange, this would place the following key requirements on these two standards:

- The information used to identify the specific route and journey pattern along the route for an individual trip, must be consistent between the two standards, e.g. route numbers, destination identifiers, running board numbers etc.
- For automatic updating of the ticket machine fare stage, the real time information system could provide the ticket machine with either information on the vehicle location (such that the ticket machine can decide when to update the fare stage), or it could provide a command appropriately timed to select a specific fare stage.

6.7 NaPTAN Linking

NaPTAN has been established as a National database of Public Transport service Service Access Nodes. This database was established to provide a definitive unique reference for each bus stop and other service access node and to provide a single source for reasonably comprehensive information to be stored for those locations.

The creation of this database was fundamental to improving the quality of public transport journey planning results and information. It provided a means of harmonising the names of bus stops between services and bus operators, and a

means of holding information on the access node, such as its geographic location, facilities available and administrative information.

NaPTAN has been used to underpin the journey planning facilities of traveline and Transport Direct and the Electronic Registration of Bus Services. NaPTAN is a fundamental standard used by TransXChange for the exchange of timetable information.

Public transport fares data does not currently use or make reference to NaPTAN. Instead fares table origins and destinations use their own set of names, which are not necessarily harmonised between service providers, etc, and sometimes even between different routes of the same operator.

In order for traveline or other journey planning engines to be able to interpret fares information, linkages would have to be created between the fares table origins/destinations and NaPTAN points. Since for bus services the number of fares table origins/destinations (fare stages) is much smaller than the number of stops on a route, creating the linkages is not necessarily a mammoth task. Never the less it will need to be done. Normally the operators, as the originators and prime beneficiaries of fare stage information, but sometimes local authorities or fares companies (such as System 1 in Greater Manchester, as custodians of the NAPTAN and NPTG information for their areas, should be responsible for the creation and maintenance of these links. Local authorities who are ultimately responsible for the accuracy of the NAPTAN and NPTG data can act as brokers if required to assist these processes.

Where operators print fare stage names on tickets it may be necessary to agree conventions for abbreviating full NAPTAN names if necessary.

It should be noted that bus fares are usually referenced to fare stage points, which are designated as the points on the route where the fare changes. The intermediate bus stops between fare stage points are generally ignored by the ticketing and fares systems as they are priced from the preceding fare stage point of the boarding stop to the succeeding fare point stage of the alighting stop. In order for a fares information system to calculate the fare for an intermediate bus stop, the system will have to be able to link it to the corresponding fare stage points. There therefore has to be a mechanism put in place to enable fare stages to be associated with all the bus stops, in that fare stage. There are in principle two ways to achieve this linking.

- The fare information system could interrogate the TXC description of the route to determine the corresponding fare stage stop for any stop along the route.
- Alternatively NaPTAN points could be grouped together into clusters, which in turn correspond to all the stops for a given Fare Stage. This process could potentially be automated, though the automatic interrogation of TXC descriptions of routes from the previous option.

It is therefore recommended that a new ‘Fare Stage point’ layer is created in the FXC model. Fare Stage points would have their own names and identifiers and would be linked directly to one or more NaPTAN points. Fare Stage points will be the fundamental topological points used by FXC, in a similar relationship to that of NaPTAN stop points and TXC (In Transmodel terminology Fare Stage points would probably be represented as “Tariff Zones” for a “Distance Matrix”).
The fare table origin/destination entries could be linked to NaPTAN points directly or via NaPTAN Stop Areas. This is because typically the relationship between a fare table origin/destination and stopping/NaPTAN points is one to many.

The comments above have been derived from an analysis of standard fares based on fare stage increments along a route. The model can however be developed and applied equally well to zonal, area wide and network wide tickets. In this case, all the applicable NaPTAN nodes in the zone would become part of the Cluster or "Tariff Zone". For larger areas it would make sense to allow clusters of clusters. An explicitly modelled approach would permit a much more precise linkage between fares and routes for journey planning purposes.

The basic cluster elements of a Tariff Zone model provide a uniform national framework upon which more complex tariff structures can be built through the additional of additional element types describing various constraints on the use of clusters. Examples of constraint that should be include are fare routing Via (and Not Via) other specific NaPTAN Clusters, (e.g. a Zone 2 to Zone 2 journey in London, not via Zone 1).

In devising a model based on clusters of NaPTAN points, consideration needs to be given to the viability of data management: the task of establishing and maintaining the data relationships must not be too onerous. A simple model that can be populated as far as possible automatically will be needed.
Another important consideration is the extent to which the fare stages can be shared and reused by different operators (which in turn has implications for their data management as to who is responsible for creating or changing data). It will be necessary to allow for multiple sets of fare stages over the same stop points, as may be found in different operator/service combinations. For example, the precise zones of the network wide fare offered by Joe Blogg's buses, may be different geographically from the product offered for the area by rival Superbuses. However it would be desirable to have a way of establishing a default set to be used in the absence of an operator or service specific override.
The availability of a uniform way of identifying fare stages that FXC provides would allow common fare stages to be adopted to coordinate and rationalise fare structures between different areas – but whether this is desirable or useful needs to be established.

6.8 Building the Business and Policy Cases

The original requirements for this study did not call for a business case but it appears to us that data for assessing the financial and policy impacts for FareXChange can be fairly easily obtained. In Scotland there is direct experience already of supplying fares data electronically although the service there is not currently available as a result of change of contractor. However, later this year the North East, Scotland and South West traveline regions should all be in a position to supply fares information electronically.

By conducting surveys of the numbers of requests for fares information and lengths of calls in call centres in three categories:

- ✓ not supplying fares information currently at all;
- ✓ supplying information either from printed material or displaying fare tables on screen;
- ✓ supplying fares information with electronic support;

it should be possible to construct models showing the differences in time between not answering and answering fares enquiries and between electronic and non-electronic support. A separate call back survey could assess users requirements and values of fares data. From these both costs and user benefits could be estimated.

Because of the relatively low value of bus fares, the benefits of the availability of FareXChange in terms of journey planning and traveller behaviour for many local journeys are more likely to be in terms of modal shift that financial returns. They will therefore accrue to the public sector as successful delivery of policy. An assessment of the policy benefits of FareXChange should also be carried out.

6.8.1 Benefit Issues

Our research found that between 10% and 25% of enquiries to traveline call centres seek fares information. Most call centres have available either electronic or paper versions of fares tables for their areas and answer such queries by manual searching. A time saving may be expected from automating the process using FareXChange giving financial benefits from faster response to customer and possibly through generated income if the enquiry translates into journeys.

The resources available for this study did not permit us to do any form of user survey of the latent demand for fares information or the likely range of journey lengths and revenue conversion resulting from successfully providing fares information. To be financially worthwhile the conversion of an enquiry to a bus passenger needs to involve repeated travel; conversely the return for rail or coach - where fare levels are rather higher - can be achieved with fewer new or modified journeys.

6.8.2 Cost Issues

It is possible that the costs of answering fares enquiries will increase the average costs per call in traveline call centres, although not to the same extent through the Transport Direct portal. However, against that, experience suggests that time saved from not having to explain why fares information cannot be given could also be worthwhile.

6.8.3 Relationship to other business opportunities for stakeholders

Other potential uses of FareXChange identified in the study include:

- Better integration of fares with other business processes, particularly in the bus industry.
- Standardisation of interfaces between bus operators' management systems and electronic ticketing equipment.
- The identified need of the rail industry to develop a fare exchange protocol to complement their RJIS (Rail Journey Information System) and RSP (Rail Settlement Plan) systems for revenue allocation and settlement.
- New business opportunities for the provision of journey planning and booking services.
- Opportunities for central and local government to develop better models for transport planning based on the availability of more accurate fares information.
- Improving public knowledge of public transport alternatives through adding fares information automatically to journey planning services.

6.8.4 Recommendation

We suggest that it will be worthwhile for further work to be done on the business case. This could be done by way of a survey of the content of current enquiries and customer opinions in several traveline regions providing different levels of fares information, together with further assessment of the additional business and policy opportunities arising from completion of a FareXChange specification.

7 Technical Requirements for FXC Standard

7.1 Scope of FXC

7.1.1 FXC Scope: Purpose of FXC

FXC shall be developed as a standard to enable the exchange of comprehensive fares data between systems for a variety of uses
The computation of fares is typically done as a two step process:

(i) A fare product model is devised comprising a set of fare tables and pricing rules.
(ii) This fare product model is then applied to price a fare for a specific journey between specific points in specific circumstances.

This distinction leads to two different ways of exchanging fare data in order to price fares:

- A **static exchange** in which the fare model is previously distributed to separate delivery systems, which then all independently apply the same rules to price journeys in a given set of circumstances. The fare model might be fully computed or consist of base fares plus fare parameters such as rounding values used to compute the derived fares.
- A **dynamic exchange** in which a delivery system delegates back to an authoritative fare system to price a journey for given circumstances. This requires modern systems with robust high-availability communications.

The static model requires the systemisation of the pricing model into a repeatable fare model, pricing parameters, and a set of behaviours. There is considerable complexity in the models used, and variation in the different transport modes as to the nature of these behaviours.
The dynamic model allows the application of true real time fares, taking into account booking availability from a reservation system and applying dynamic pricing to maximise yields. For data exchange it is much simpler as it requires only an interface that exposes the inputs to the actual pricing function, and its results, rather than the pricing model itself.
It should be noted that a static model can include information that allows the delivery system to be aware of dynamic behaviours that it does not possess itself, for example to identify that seats need to be pre-booked and that fares are available with prices that vary dynamically, or even to apply some predefined knowledge of typical quota availability over time in a “pseudo-dynamic” manner.
The scope of FXC is primarily to cover a static exchange model. The systemisation of the inputs to the FXC pricing model should however be highly relevant to creating a dynamic pricing service in future, for example as an extension to JourneyWeb or other dynamic API.

7.1.2 FXC Scope: Functional Coverage

FXC should cover the majority of fare products in use in the UK both as to modes of transport, in particular Rail, Bus and Coach. Key aspects of fare products include:

- Support for different fare models including point to point, fare stage and zonal models.
- Support for different Ticket product types, Availability conditions and restrictions.
- Support for concessionary and other derived fare rules.
- Support for Rounding.
- Support for payment rules.

The fare products and other scope aspects are further described in the Analysis section.

FXC shall include the facilities required to handle the fares data supported by the ATOC RJIS/RSP interface specifications as qualified in the Analysis section. FXC shall have the potential to be used as an open standard replacement for the ATOC RJIS/RSP interface specifications.

FXC must cover the fares structures supported by the bus ticket machines from the leading suppliers in the UK, including Almex, ERG, Wayfarer and other electronic ticket machine suppliers as qualified in the Analysis section.

FXC shall be developed to be compatible with Transmodel and the ITSO and European Smart Card standards. FXC shall include and support the fare types and charging structures included within Transmodel and the ITSO and European Smart Card standards as qualified in the Analysis section.

FXC should be designed so that that Fare data can be managed and exchanged independently of other related content such as Stop data and Timetable data, though it should make appropriate reference to shared entities to which the fares relate in order to support efficient computerised processing.

7.1.3 FXC Scope: Deliverables

The deliverables from the FXC Standard development shall include:

- An FXC XML Schema along with any supporting sub-schemas.
- Notes on recommended changes to other standards e.g. TransXChange and NaPTAN to enable FXC efficiently or improve harmonisation.
- Examples of fares tables encoded as XML documents in the FXC format, covering different types of fare products.
- FXC Schema and User guides explaining the conceptual model and the detailed schema elements. This should also include documentation of any required integrity rules, both those that are applied by the schema and those which must be implemented by applications when processing FXC documents.
- A FXC Publisher; a tool to publish FXC documents, and appropriate user documentation.
- Some presentation material to introduce the FXC model to stakeholders.
- Supporting web page content to introduce the FXC model. This should be consistent with the common navigation and organisation used for the NaPTAN, TransXChange, NPTG and JourneyWeb sites and include subject sections.
- Website hosting providing public access to the deliverables for development and testing purposes. This should be designed for handoff to the DfT Standards hosting site at the end of the project.

The deliverable should be developed under an open process with preliminary drafts available for open review from the website.

7.2 Linking and Harmonisation with Other Standards

FXC shall be developed to form an integrated part of the Transport Direct and UK national public transport standards and the overall data model into which they fit. These standards include the TransXChange, NaPTAN, NPTG, and JourneyWeb XML schemas, and the Transmodel conceptual model for PT systems -- which also

includes some Fare related concepts. FXC shall make full use of the terminology and data structures used in these standards so as to provide both consistency and a common look and feel to the set of standards. In particular:

- FXC shall reuse the relevant common type packages used by the other UK PT standards, and any other relevant packages that are identified. It should seek to reuse both low level types such as day types and high level types such as NaPTAN stop definitions.
- The encoding of the FXC schemas shall follow the naming conventions and documentation conventions and XML best practice as used and described in the other standards and as specified by GovTalk. Schemas should declare a distinct complex type for each semantically significant entity. Schemas shall include metadata in line with GovTalk requirements.
- The schemas should seek to encode and enforce validation rules and constraints that ensure the maximum integrity of documents prior to use by applications.
- All FXC schemas and example documents shall be versioned in line with the GovTalk guidelines and best practice as used in other Public Transport Standards.
- The FXC schema shall itself be modularised into appropriate packages to facilitate reuse and maintenance.
- An appropriate namespace should be declared and be used for FXC XML artefacts.
- The schemas should be National Language enabled to support Welsh and other languages.

If appropriate, recommendations shall be made for changes to other standards such as TransXChange, where changes to the overall data model would be beneficial for efficient implementation of the standards by system suppliers and ease of use by end users.

FXC shall be developed to be eGOV and eGIF compliant. FXC shall be submitted for approval as an eGIF/GovTalk standard and pass the validation requirements applied by the eGIF administrators.

As well conforming to existing concrete UK PT XML standards, FXC should follow the informational science principles and software modelling patterns embodied in *Transmodel*, a general abstract model for describing public transport information systems. In particular:

- **Layered Semantic Models**: The efficient modelling of public transport information requires a number of distinct models, representing different levels of discourse. For example, (i) the geospatial location (i.e. map) layer, (ii) the network topology layer, (iii) the service pattern layer, (iv) the timed vehicle journey layer, (v) the operational running layer, etc.
- **Projection**: It should be possibly to combine the different models in order to compute over them, relating the corresponding elements of different levels of discourse precisely and unambiguously, using a common frame of reference. For example, route links should map onto geospatial objects such as roads; timing links should map onto route links, etc. The establishment of equivalences between distinct model layers is termed projection.
- **Common Terminology:** A standard set of common conceptual entities should be used for the elements making up the models at each different layer,

and a standard *Transmodel* terminology should be used. For example, Line, Journey Pattern, Vehicle Journey, Location.

- **Point and Link Structures:** Public Transport Information System models typically involve complex networks which are modelled in computer systems by graphs; that is, as networks of nodes (points) and edges (links). Depending on the information of interest in a particular application, it may be appropriate to use ordered collections of links, ordered collections of points, or combinations thereof. Links of a given type should only connect to points of the corresponding semantic level of discourse. Only one unambiguous sequence of points (whether modelled as a point sequence, or link sequence) may be used in a given journey or service pattern.
- **Well-defined Data Systems.** Elements corresponding to external entities should be assigned unique identifiers from agreed data reference systems.

7.3 Intellectual Property

FXC shall be developed to be an open standard under Crown Copyright. It is intended that the FXC schema will be available for public use under a free licence, subject to the terms and conditions of use. All works included must be free of other Intellectual Property rights and claims. Where other schemas are referenced, appropriate IPR requirements, such as the GovTalk copyright notices, must be upheld.

All FXC schemas examples, documents and other artefacts must have a Crown Copyright notice and there must be an appropriate statement of conditions of use in the guide and web site.

7.4 Documentation

The documentation for FXC will comprise four main components which should be evolved at the same time as the schema, and be delivered with the first version of the Schema for consultation. These will be subsequently revised in line with the final deliverables.

- **FXC Schema User Guide.** This will be a user friendly introduction guide to FXC, with technical appendices where appropriate. Its main focus will be on explaining FXC, with an emphasis on the data model and context within which the schema is used. The User guide must explicitly state processing assumptions and rules that are not encoded or enforceable in the schema and will constitute part of the full FXC specification. It is envisaged that this document along with the examples will be of particular interest to data providers and consumers.
- **FXC Schema Annotations**. The schemas and subschema packages should be fully annotated with comments and annotations so that they constitute a well documented easy to use specification for programmers. It is envisaged that most developers will use a XML IDE such as XMP SPY or Oxygen to browse and explore the scheme and examples and the schemas should be organised to optimise this practice. Elements, structures, attributes and enumerated values must all be annotated with appropriate explanations. Where appropriate syntactic mechanism such as Groups and index elements should be used to improve readability and attention should also be paid to the logical order of elements. Good programmer level commenting and documentation shall be included within the Schemas and their modules in line with XML best practice. This shall enable professional users of the schemas to understand and follow them relatively easily, and enable the schemas to be maintainable by 3rd parties.

- **FXC Examples.** There should be a full set of examples comprising XML documents which have been validated against the FXC schema. The examples should be chosen to exercise all the capabilities of the FXC schema according to realistic use cases in as economical a manner as possible, and should include coherent interpretations of both simple and complex cases. The examples should be linked together by appropriate web pages to explain each example and link to XML and published output. The TransXChange 2.0 project provides a specimen of the desired collateral.
- **FXC Web Site.** There should be introductory web pages and resource links for the FXC artefacts, organised under the common navigation as used for the other UK PT standards.

UML notations should be used where appropriate for diagrams of software structures and processes. All diagrams should be separately available in internet publishable forms such as JPEG, GIF or PNG.

All releases of documents must be versioned. Document releases must be available from the FXC website.

Final versions of Documents should be published in pdf format.

Each release of the FXC schema should be accompanied by a "read me" providing a manifest and identifying the significant changes since the previous version and indicating any changes that affect compatibility of existing documents.

7.5 Validation

The XML schema and FXC examples shall be tested and validated in a number of ways, including:

- The schema shall be validated directly using the mainstream XML validators for Windows and Linux platforms, including the Microsoft and Sun tools.
- A set of standard test files, comprising FXC compliant XML documents containing example FXC data shall be provided. The examples shall be chosen to give efficient coverage of FXC features. The documents can be validated against the schema using main stream validators for well formedness. The delivered schema shall have been tested against the test documents.
- The Publisher shall be used to validate the FXC Schema and may apply and report on further integrity rules that cannot be enforced by the schema.

7.6 Efficiency of Processing of XML Documents

In designing the FXC schema consideration should be given as to how the processes used to generate and manage fare data need to be reflected in the size of documents, the granularity of content and the frequency of exchange. Schemas should be designed to support the efficient processing of data, avoiding documents which are too large or complex to process, and including change tracking mechanisms which allow the efficient processing of updates.

7.7 Publisher

The purpose of the FXC Publisher is to provide a tool to transform a FXC XML document (which is primarily a machine readable object) into a rendering of a fares table that is convenient for a human reader to read. The Publisher shall transform FXC compliant XML documents into pdf documents which can be viewed and printed

with an Adobe Acrobat reader or other tool capable of reading encapsulated postscript.
The Publisher will constitute a downloadable standalone executable capable of running on mainstream personal computing platforms, including Windows and Linux
The Publisher should be built from mainstream components and technology platforms that do not require a development or run time licence, such as open source platforms and tools (e.g. Apache, Xerxes, Xalan J).

The FXC Publisher shall be able to render all FXC compliant fares structures and details into the human readable pdf documents.

The requirements of the Publisher should be considered as part of the schema design, in case there is a need to include additional derivable information as annotations to facilitate ease of use, in particular so as to be able to process a FXC document as a self-contained artefact. For example, machine readable use might use Fare Stage codes, but it may be necessary to include descriptive names of fare stages for human readability.

The publisher shall be made available prior to the commencement of the FXC testing and be used as part of these tests.

The Publisher should be downloadable from the FXC site.

End user documentation shall be delivered for the Publisher. The key documentation for the Publisher is a set of installation instructions to configure the recommended software environment needed to render documents using the Publisher. Including any prerequisites are and their versions.

7.8 Public Access to the Deliverables

Public access to the deliverables shall be provided through a website with similar, structure, content, and look and feel to that used for the TransXChange standard.

The FXC deliverables will include version controls to distinguish all released drafts and final versions which will be made available on the website. The website will host all released versions, along with their documentation, publishers, examples and release notes.

7.9 Consultation

Consultation shall be undertaken with the following objectives:

- To ensure the resulting FXC Schema is in line with the needs and aspirations of the stakeholders.
- To gain stakeholder buy in to the new FXC Schema.
- To obtain adoption of the new FXC Schema at the earliest opportunity.

Given that broad consultation on the existing FXC Schema has just been completed, the initial emphasis within this project will be on understanding the outcomes of that consultation and developing the FXC Schema and documentation taking the consultation results into account.

The stakeholders will include the suppliers of ticketing and information systems used within the public transport industry, the providers of travel information systems, and the clients for such systems within transport operators, local authorities and elsewhere.

8 Data Structure Requirements for the FXC Standard

8.1 Introduction

This section provides an outline analysis of the entities and parameters making up a fare model and that should be considered for inclusion in the FXC schema, subject to consultation.

It includes a preliminary modularisation that serves to indicate the relationship of FXC to other standards such as TXC. This modularisation is needed to make what is a large and quite complex subject tractable, but should be considered provisional and open to further adjustment in the light of discussion and detailed design.

The analysis should be use in conjunction with the use cases given in section 5, which provide end to instances of functional use of the FXC data, and capture the high level intent that can be used to inform detail design decisions.

The use cases include gathering and setting fares, exchanging them, and reporting on their use.

The analysis is based on the CEN *Transmodel* abstract standard for PT systems. There exists already Transmodel terminology for most of the entities needed to describe FXC concepts. Where possible relevant Transmodel terms are used for both Fare and general PT concepts, but there remain some gaps and some areas where exact interpretation will depend on the final scope of FXC, as well as a few areas where Transmodel does not yet appear to have exactly appropriate concepts.

In making a gap analysis against Transmodel it is useful to note three categories of function:

1. Function that is found in Transmodel but not used in the UK.
2. Function that is found in the UK but is not in Transmodel.
3. Function that is found in Transmodel that might be used in the UK but requires enhancements to other standards as well.

Transmodel itself emphasises that Fares are a subject of considerable complexity and subject to great regional and modal variation, and furthermore that advances in technology are leading to a rapid evolution in process and practice.

8.2 Key Reference Specifications

We also note the following external specifications as being of primary importance for the FXC:

1. The ATOC RJIS/RSP interface specifications. FXC should include the facilities required to handle the fares data supported by this. The Rail fare model is a comprehensive and fairly complex model that includes both fare and retailing aspects and complex availability conditions. Some further analysis needs to be done on size implications of encoding in an XML format, in particular to look at ways of partitioning the price data set and of encoding an equivalent to the flow model efficiently.
2. Fares structures supported by the bus ticket machines from the leading suppliers in the UK, including Almex, ERG, Wayfarer and other electronic ticket machine suppliers. Some of the key aspects of data exchange used by these are discussed in section 8.8 and the study has considered input supplied by Wayfarer concerning their fare management products; it may in

future be further described by more input from Suppliers such as Almex, ERG and other electronic ticket machine suppliers.

3. The contents of the fare exchange interfaces developed by Journey Plan & AIM (now Trapeze) to transfer data to travel information systems. The Journey Plan fare schema is a small and straightforward schema well suited for exchanging just Bus Fare tables, and provides a useful example of a real implementation to carry out one of the specific purposes of FXC.
4. Transmodel and the ITSO and European Smart Card standards. FXC should include and support all the fare product types and charging structures included within Transmodel and the ITSO and European Smart Card standards.

In the case of (2) and (3) the aim of FXC is to support the principal functionality represented by current best practice and to harmonise this into the UK Public Transport Standards in a way that is as helpful as possible to existing suppliers. FXC will welcome for consideration any specific needs that such suppliers put forward to facilitate this harmonisation.

8.3 Relative Complexity of Fares for different Transport Modes

In general higher value products, such as rail fares, are typically accompanied by much more elaborate product types (in order to maximise yields) - and hence availability rules. These in turn require much more complex data models and complex data structures to capture the different fare structure elements and rules.

It would appear that a significant proportion of bus fare information for transfer to a journey planner could be represented by a relatively simple model with a small number of ticket types, and without complex availability conditions and rules for combining different types of product. In fact it is not strictly necessary to include any representation of the fare structure element composition just to exchange prices, other than a basic ticket type. The Journey Plan schema illustrates this ‘FXC Lite’ approach well. See section 12.

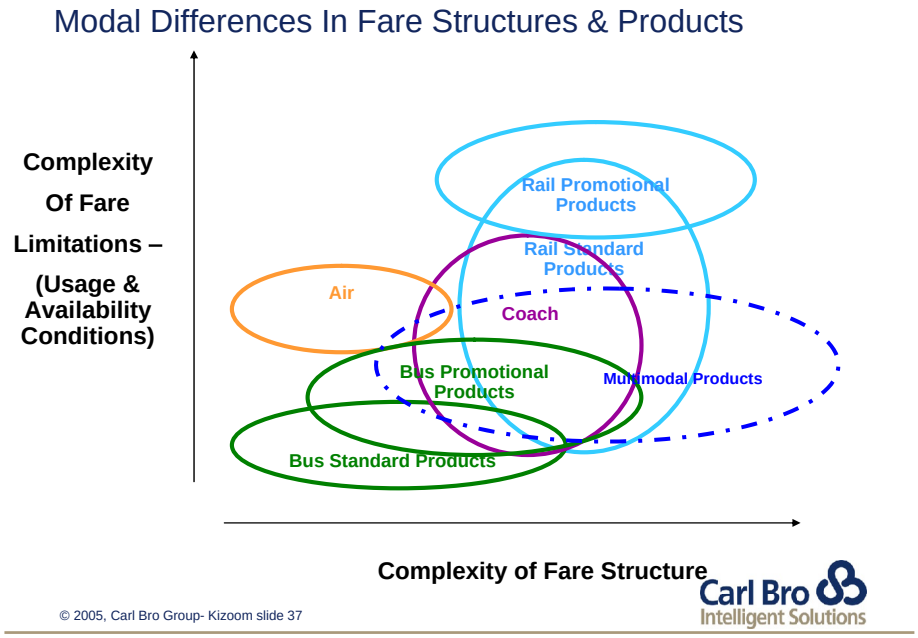


Figure 8-1: Relative Complexity of Fare Products by Mode

8.4 Overall Modularisation

8.4.1 Separation of Concerns

A Fare model should be considered as a separate layer of an Integrated PT Informational model that sits over other layers containing shared entities such as routes, stops, and service schedules already described by the TXC and NaPTAN standards. The fare model needs to reference data in these underlying layers (and is constrained by the characteristics of the entities in those layers), but constitutes an independent model that persists in its own right and that is managed by different stakeholders and to a different timescale to other data sets.

The FXC should reflect this through the ability to create and exchange documents that encode Fare models and Fare model elements without repeating data from other layers unnecessarily.

Figure 8-2: illustrates this principle by showing different types of data being exchanged as separate documents. Documents of one type may include references to entities in other types of documents. More than one document type may be described by a single schema – as is the case say, for TXC, which can be used to describe different components of a timetable together or separately.

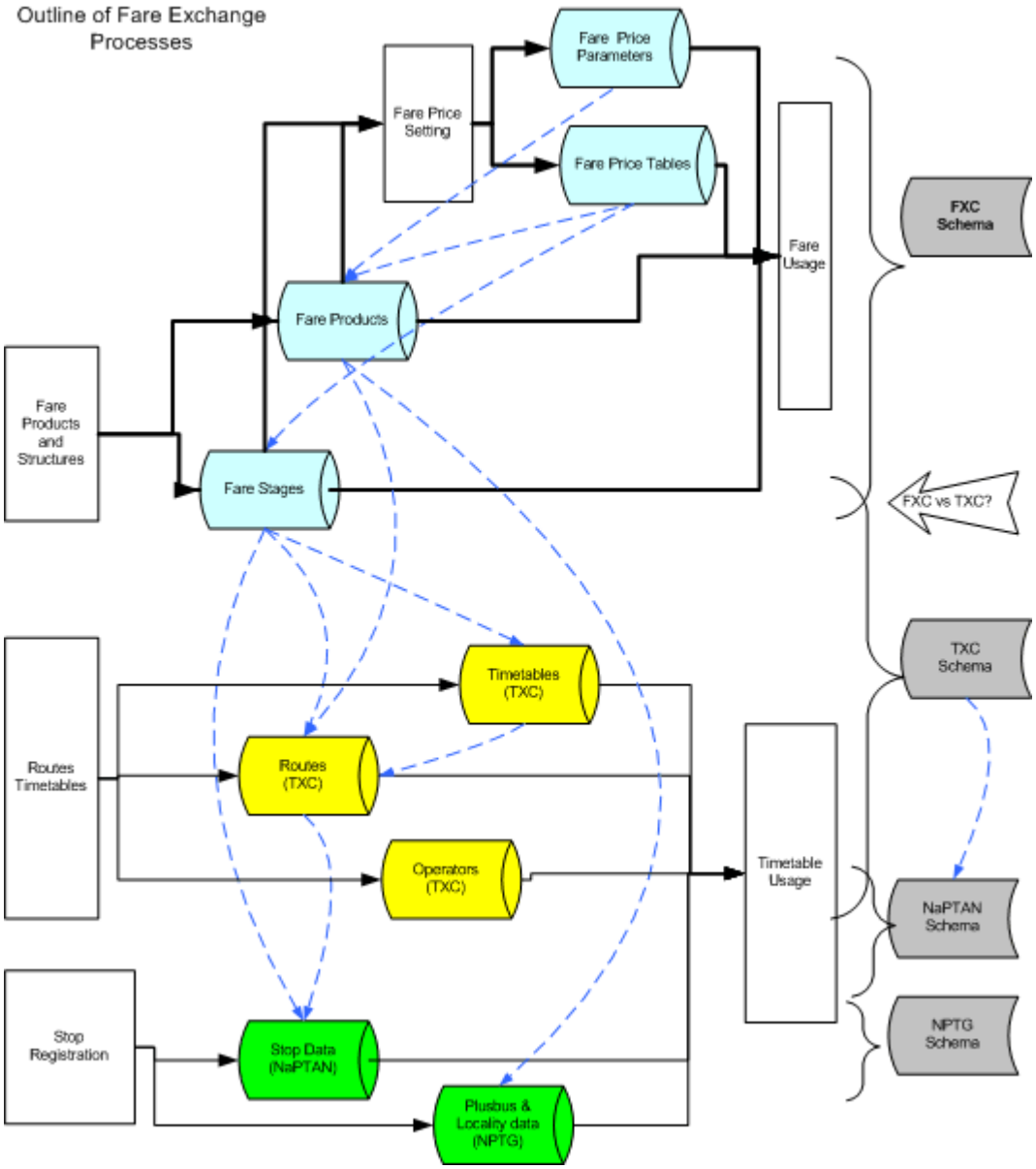


Figure 8-2: Exchange of fare data

➔FXC should support the exchange of fare data in some intermediate 'virtual fare' formats to support the efficient maintenance of fare prices. See later below.

8.4.2 Fare Processes

Fare pricing is a process involving several stages, and which may involve the exchange of different data for different purposes, for example a Published Fare Table is a fully resolved set of prices for journeys, and might list fares for each type of concession and each timeband. However most ticket machines and other electronic fare devices do not hold a fully resolved table, but rather hold a base fare set along with a set of price parameters with which to compute the fare.

➔FXC should support the exchange of fare data in some intermediate 'virtual fare' formats to support the efficient maintenance of fare prices. See later below.

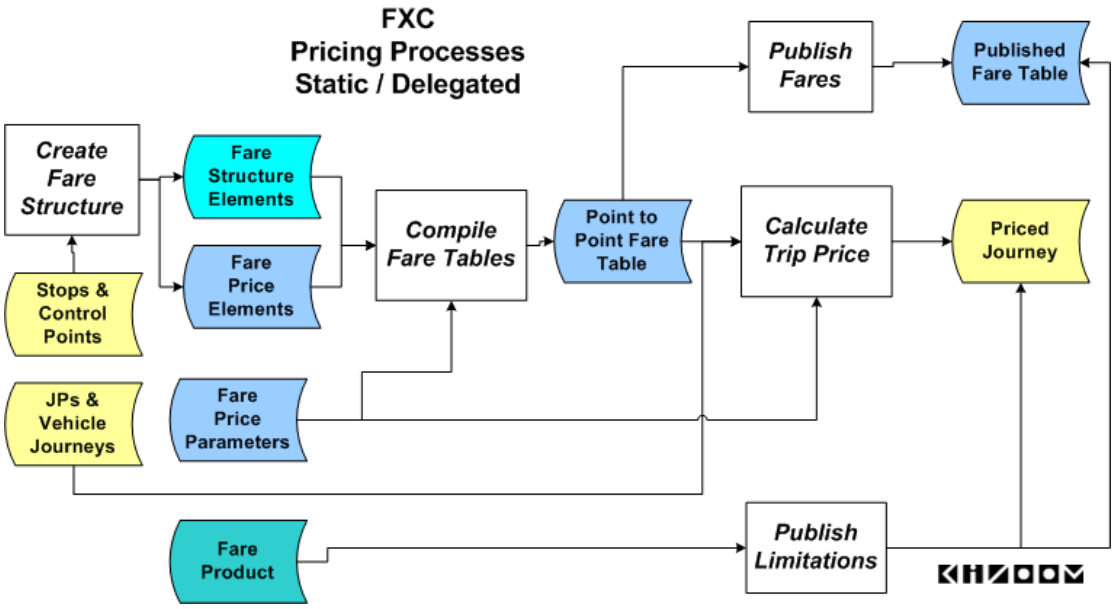
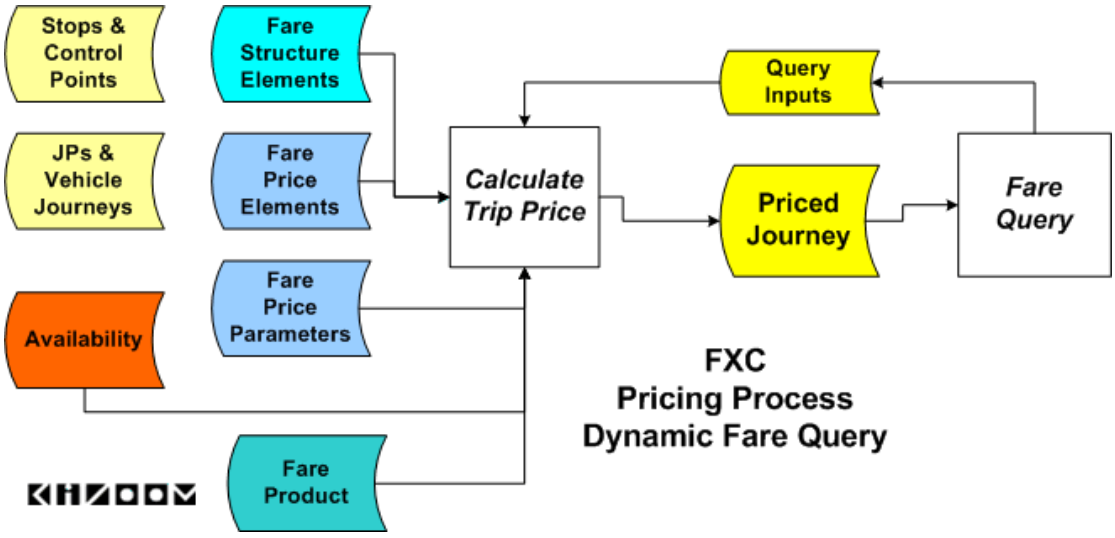


Figure 8-3: Fare Data processes



8.4.3 Schema modularisation

The separation of concerns should be reflected in the modularisation of FXC schema into discrete packages of type definitions that are composed into one or two final FXC leaf schemas, just as TXC has two leaf schemas composed from a number of common packages, many of which are shared with NaPTAN.

➔The FXC schema should be constructed as a set of distinct schema packages that reference appropriate existing schema packages, and which modularise the Fare model into coherent loosely coupled packages with a strictly linear dependency graph. For example

- Fare stages should be described in a way that can reference the NaPTAN stop model, but must allow Fare Stages to exist independently of these points.
- Route specific fares should be related to Routes or journey patterns as described in TXC.

- Fare Products should also use the same temporal representations for validity conditions, such as Day Types and intervals, that are used to describe service availability of the corresponding TXC routes.
- Higher level Fare model elements such as Fare structures should be described in terms of lower level FXC entities such as Fare stages and other relevant lower level concepts. Fare pricing will be assembled from Fare stages and products.
- Cyclic dependencies should be avoided: where necessary common elements may need to be refactored into additional reusable packages.

Figure 8-4: shows a preliminary modularisation for FXC. Existing packages are shown in yellow (TXC), green (NaPTAN) and grey (GovTalk) at the bottom of the page. Possible FXC packages are shown in various shades of blue above. The core FXC modules are shown within the larger pale blue circle.

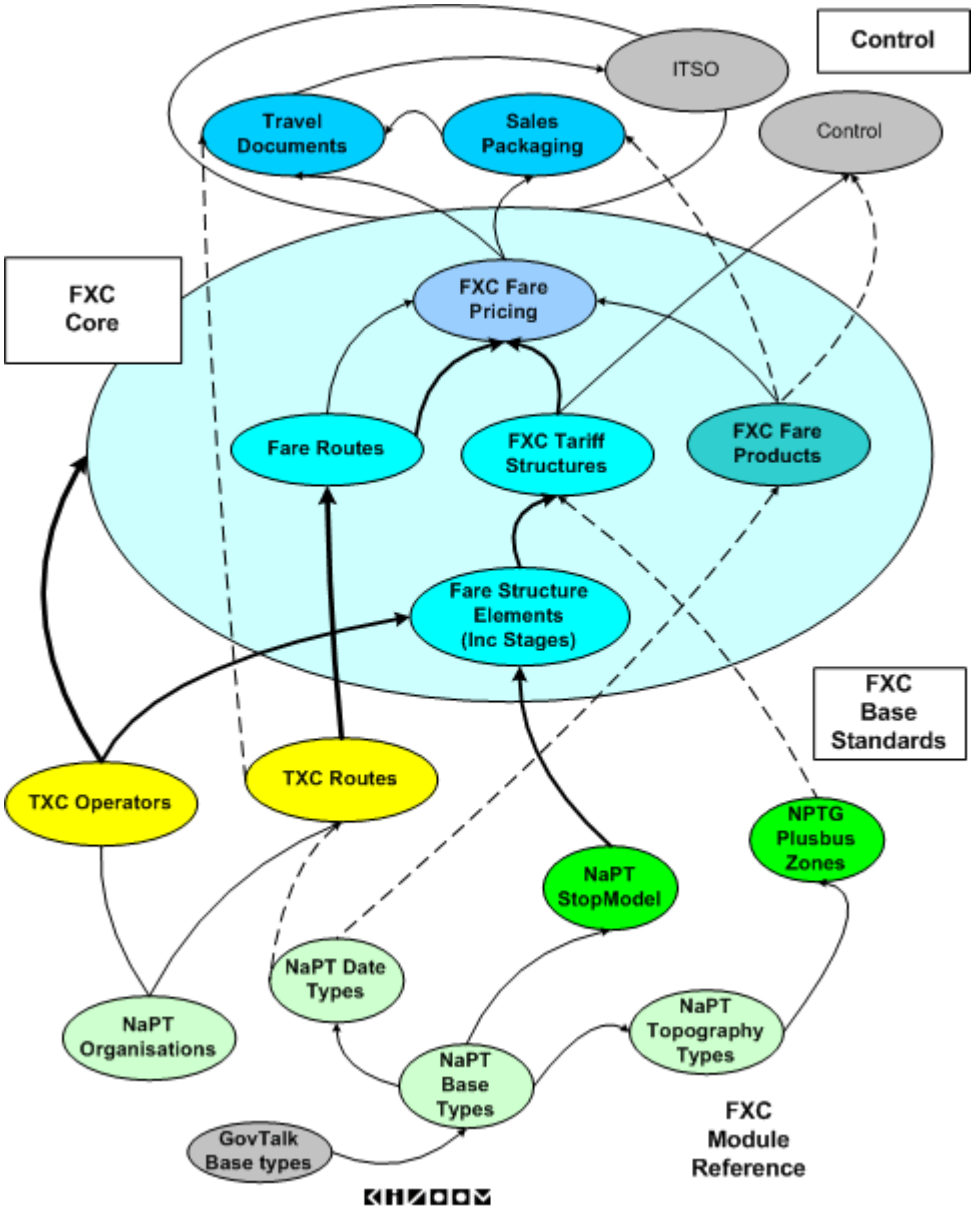


Figure 8-4: Modularisation Layers

It is an open question as to whether how many distinct schemas are needed. (FXC data could even be done as extra elements in TXC). In general it will be desirable to have different types of data – Fare Products, Fare stages as independent elements in the schema so they can be used by themselves if needed, just as say the TXC general schema allows operator data or journey pattern data to be exchanged without all other data elements being present.

8.4.4 Relationship between Fare and Journey Pattern Sections

In the current TXC, journey pattern links can be marked as belonging to a fare stage (see appendix below). The TXC FareStage Number used is arbitrary. From a modelling point of view, this can be regarded as a projection of what is in effect a separate fare section layer onto the journey pattern section -- done purely for convenience. Since this usage is entirely optional, it would be straightforward to instead use a separate model for the fare sections that has an independent existence and which can be projected either by location or direct semantic reference to the journey pattern sections. The TXC use could either be deprecated or retained as an annotation.

Separation would decouple the maintenance of the different types of data so that services times could be revised without affecting fares and vice versa.

8.5 Administrative Model & Operators

As for other UK Public Transport Standards which support distributed data management, a very real practical consideration is the inclusion of appropriate mechanisms in the data model to enable data management both (i) to assign ownership of data management of specific items with the data set; (ii) to manage the assignment of unique identifiers and (iii) to allow the distribution of updates and (iv) support the detection of change efficiently.

For data exchange as an XML document, a model from one system must be serialised into a flat byte stream and then, after transmission, be de-serialised and re-referenced back into another model on a different system. In order to exchange data efficiently it must be possible to partition a large model into smaller coherent subsets that include references to objects that are not included in the export. This raises considerations for ensuring integrity of reference and in particular for the management of the identifiers that are used to implement the reference. In practice the coherent subsets of data that are needed for efficient exchange must reflect the operational processes and frequency of change of the data.

8.5.1 Operator Identifiers

The FXC model will need in particular to assign a unique identity to Operators, since most data will be owned and managed by them, and this can be used as a name space for data belonging to the operator. TXC already has an operator representation used for Bus Registration: this could be related to a National Data base of Operators to allow unique identifiers to be assigned to all types of operator.

An Operator is described by a NapT_Organisation-Vx.x.xsd package, which is part of the NaPT set or packages and can be reused in different schemas.

Additional Mechanisms to Group Operators may be needed.

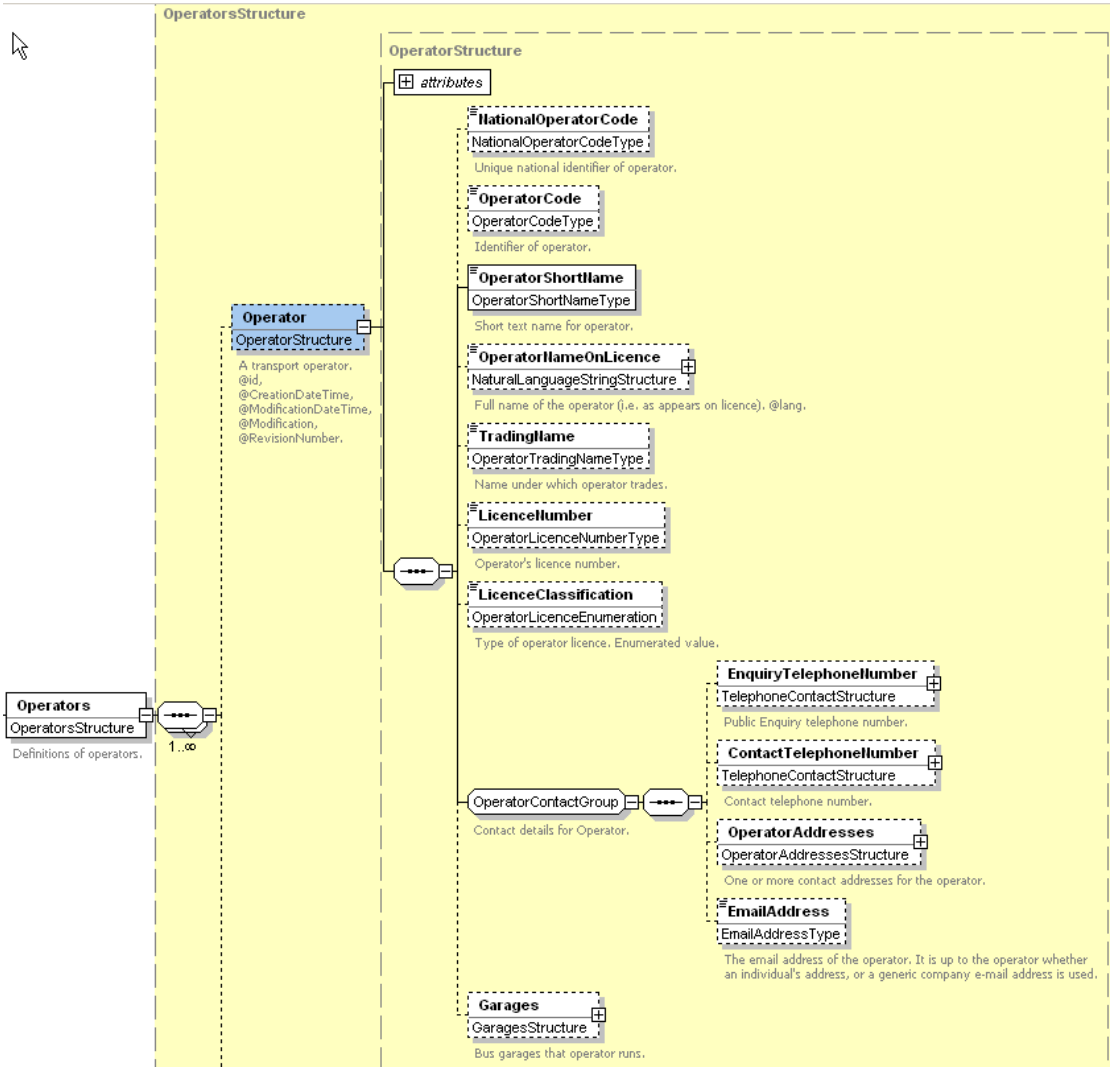


Figure 8-5: TXC Operators Structure

8.5.2 Changes to Fare Data

There is a need to reflect the temporal pattern of fare setting. Typically major rounds of fare change will occur only once or twice a year. Smaller changes may be made as deltas in between.

→The FXC should reflect this through the ability to create and exchange changes to fares without the need to retransmit the entire Fare table.

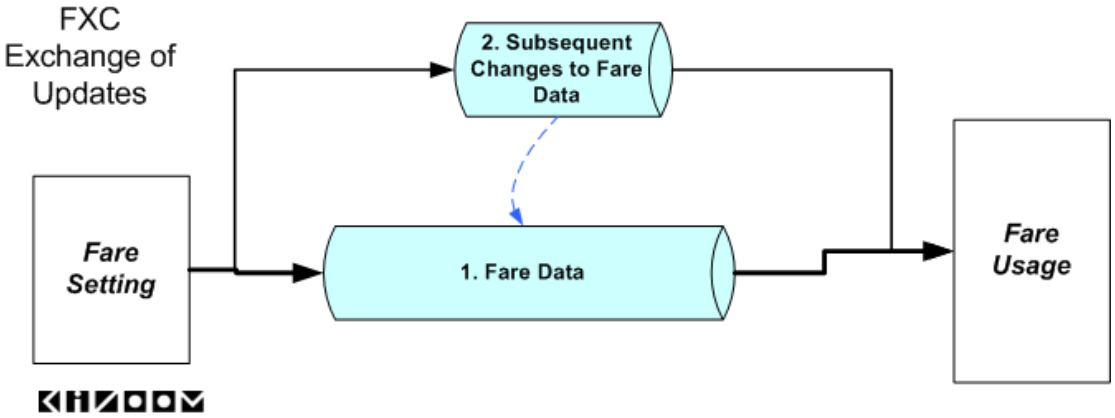


Table 8-1: Changes to fares.

8.6 Composition of a Fare Model

In Transmodel terms, FXC is concerned to describe a **Fare Policy**, that is, the functional area of Fare collection concerned with the fare structure. FXC is *not* directly concerned with other fare related functions identified in Transmodel such as *Sales organisation*, *Control of Consumption* and *Enforcement*, nor with *Payment systems* or *revenue management*.

A Fare policy is made up of the *access rights* allowed on a network by purchase of the fare elements (e.g. point to point travel, 2nd class, plus parking) the *fare structure* applied to these rights (e.g. fare sections), the ways of *controlling their consumption* (e.g. tickets and validators), the marketable *fare products* (e.g. packaging as elements as a saleable product such as a single, return, or season tickets) and the *sales principles* (e.g. retailers) that distribute the fare.

- An important characteristic of the Transmodel model is to introduce certain additional abstractions that give a greater generality and allow much more sophisticated commercial models, and that are in particular suitable for modern card-based electronic ticketing products. For example, the concept of fares based on theoretical *access rights*, instead of on simple prices is a generalisation. An access right granted to a customer is a part of a service that a user is entitled to consume, and of which the service provider (or another organisation) is able to control the consumption. To such a particular access right may be attached a large variety of prices, and it may be sold in a wide range of marketable combinations.

The FXC fare policy model can itself be broken down into a number of distinct constituents to facilitate analysis – some degree of modularisation being needed to cope with the complexity of the subject. We introduce these submodels here (in line with a Transmodel analysis), and then later discuss each in more detail later below. The three models are:

1. **Fare Structure Model.**
2. **Fare Product Model**.
3. **Fare Pricing Model**.

8.6.1 Fare Structure Model - Introduction

The Fare STRUCTURE model relates the fare pricing mechanism to use of the transport network. There are number of quite different ways this can be done, for

example by distance, fare section, zone, time, etc., and the Transmodel model gives an extensive (but not exhaustive) analysis. In practice different elements are found in different modes.

- For UK bus this is most commonly done in terms of use of fare sections delimited by Fare Stages (typically corresponding to access points such as stops and stations), or Fare zones, or else by specific end to end routes. The fares stages and sections depend on the existence of specific journey patterns, but typically are more general and exist and are managed independently of the specific scheduled services that run the journey patterns.
- In Transmodel terms the fare structure is composed of FARE STRUCTURE ELEMENTs which typically -- but not necessarily -- correspond to CONTROLLABLE ELEMENTs, that is units of travel which can be controlled by the network operator by means of entry and other enforcement points in the system.
    - Particular considerations apply to circumstances such as “doughnutting” when fare elements do not correspond to controllable elements, so there arises the opportunity for fare evasion. (A similar case can occur on rail routes when on-board ticket inspection is less frequent than the stops and there are no ticket barriers at the stations.)
    - The fare structure model may include complex constraints and limitation rules that relate to specific routes and specific topography.
- The FARE STRUCTURE model may also include VALIDITY CONDITIONS relating to services that may be used with the fare.
- Typical UK bus practice use a fare matrix as part of the FARE STRUCTURE similar to the Transmodel concept of a FARE DISTANCE MATRIX with fare stage bands rather than say geographical distance units. A fare matrix in essence simplifies the allocation of fares by assigning coded price bands to the fare sections which can then be assigned via a separate table of prices for each band. Fare prices can thus be changed without changing the fare structure. In practice there are a limited number of fare matrix models in use and FXC needs to represent an agreed set.

8.6.2 Fare Product Model - Introduction

The Fare PRODUCT model comprises the Ticket types, Validity Conditions, Concessionary fares, Allowed Retailing information (e.g. Payment types, Retail outlets) and other entities that are assembled into named product types for marketing and retail processes. These may involve complex rules, especially when it is possible to combine products into composite products. In practice Fare product models are constrained by the need to be understandable by staff and users, -- and to be implementable by POS retail technology such as ticket machines.

- Broadly speaking, the UK rail industry works in terms of a number of standard products which are subject to regulation and close central agreement, and then also a changing family of promotional products which are defined by the TOCS and controlled more loosely. Many bus products are similar. In practical terms the distinction between standard and promotional products is likely to be highly significant for FXC. Standard products are well defined, and remain similar (apart from price) over a long period of time. In contrast, promotional products may be short lived and have complex conditions which are hard to represent. Thus the utility of modelling them in FXC may be less.
- There is a correlation between ticket price and the complexity of Fare products (and indeed fare structures) found - Bus Fare product models tend to be simpler than rail.

- A part of the Fare Product model covers The SALES PACKAGE – which describes how the Fare product is manifested as a TRAVEL DOCUMENT i.e. tickets or other token; there may be different travel documents available in different media from different retail outlets. There may also be limitations as to which packages are available from particular types of outlet (e.g. TOD tickets, season tickets etc). FXC will need to capture some of this information where it is relevant for passenger information.
- It would possible to have a form of FXC that exchanges Fare structure data and Fare price data without exchanging all details of the Fare product.

8.6.3 Fare Pricing Model - Introduction

The Fare PRICING model constitutes parameters and rules for applying a set of prices to the fare product and fare structure model to arrive at specific fares for specific routes in specific circumstances (e.g. specific time and date of travel, type of traveller or group of travellers).
Fare computation can in principle be done statically so as to pre-compute every possible combination of fare for every possible fare stage and product: However for other than the simplest cases this is combinatorially explosive, so the fare computation is usually implemented by a mixed strategy of a set of computational rules for deriving a fare from a base fare (For example, how to round calculations) – and a set of base fares.
Different degrees of parameterisation and of dynamic computation are found for different modes and circumstances. For example, quite often for buses the full table is resolved for the basic fare, and the concessionary fares are derived from the full fares. For UK Rail the full set of base “flows” for every point to point fare are computed.

- In order to represent computational behaviour in a static software model for data exchange, each different computation method must typically be reified as named elements representing different computational strategies, and be sufficiently described to be reproducible in different implementations.
- In practice certain *intermediate* representations of the price structure are also important for managing fare data. See ‘*Fare Structures & Pricing Representations’* below. The appropriate for in which to exchange data may depend on whether data is to be used for further processing or to present directly to passengers. In comparing pricing processes it appears that there are important differences found in practice depending on the scale of operation. A small operator running a simple service will probably have a single fixed table of fares. A large operator running a sophisticated fare model with computerised ticketing might hold prices in intermediate form and only compute an actual price when needed – though she may still provide indicative fares for say a standard ticket for a route.

Fare models are complicated by the need to allow for different business practices as to when and how the computation of fares takes place.

8.7 FXC High Level Scope

In this next section, before moving on to describe the content of specific submodels, we summarise those aspects of fare model currently being considered for FXC, without making detailed consideration of the actual model structure itself. This is intended to provide a high level view of the functional scope of FXC.
Industry readers considering FXC should examine this high level list for (i) completeness (are there other elements they think should be included?) and (ii) relevance to their own objectives.

8.7.1 The Primary purposes of FXC are

- Distribution of fare information to online passenger information systems.
- Provisioning of fare retailing machines.

8.7.2 Primary Functional Capabilities of FXC Fare Model

FXC should include elements to describe the following aspects of fares:

- **Geographic Scope**
  - Mode(s).
  - Point-to-Point (single) (i.e. Fare Matrix model).
  - Point-to-Point (return).
  - Point-to-Point (multi-journey).
  - Zonal (multi-journey).
  - Zonal (unlimited journeys).
  - Combination (e.g. PlusBus {i.e. rail Point-to-Point + unlimited bus journeys within a Zonal area}, One-Day TravelCard from outside London area {i.e. rail Point-to-Point + multi-modal Zonal}).
  - Routing Constraints.
  - Zone traversal constraints e.g. Honeycomb, circular.
  - Geographical Limits on using same Modes.
  - Geographical Limits between Modes.
- **Time Scope Limitations**
  - One-off (i.e. Single or Return).
  - Period (e.g. Daily, Weekly, Season-Ticket etc.).
  - With or without Peak-Hour Restrictions.
  - Time interval – fixed period of use after purchase or first use (for example transfer tickets or multi-journey products with expiry dates).
- **Other Usage Limitations**
  - Class of Travel.
  - Available only for use on certain Operator(s).
  - Only available for use with a reservation on a particular service
  - Only as add-on fare (e.g. Dog).
  - Event related promotion.
- **Retail Availability Limitations**
  - Available/Only available for Advance purchase.
  - Advance purchase requirements.
  - Available/ Only available for Walk-on Purchase.
  - Allowed Retail outlets: Station, Web, TOD, etc.
  - Any Required proof of identify or eligibility.
  - Whether subject to Seasonal availability.
  - Whether fare product can be booked.
  - Whether Price dependent on availability / capacity.
- **Other Retail Limitations**
  - Whether refundable in full or in part.
  - Whether or not exact fare is required.
  - Whether Provable.
- **Pricing Rules**
  - Individual Passenger Rate.
  - Passenger Group rates.
  - Concessionary fares e.g. Student , OAP, Disabled, etc.
  - Promotional fares.
  - Travel Discount card in home area.
  - Travel discount in other areas.

- Fare Class (for certain modes only).
- Restrictions on Combination of different Rates & concessions.
- Capping rules.
- Rounding rules.
- Performance-related Refunds (e.g. for Season Tickets).
- For Add-on products.
  - Reserves seat as part of ticket purchase process.
  - Sleeper Travel?
  - Animals e.g. Dog.
  - Carriage of Bicycles?
  - Parking.
  - Meals.

- **Data Management**
  - Data source/supplier.
  - Data version & Change dates.
  - Fare owner (e.g. Operator, LA / PTE, Marketing Consortium).
  - Fare coordinator.
  - Privacy / Disclosure Level (for internal project information).
  - Regulated fare / unregulated fare.

8.7.3 Fare Model Elements

In order to fulfil its primary purpose, FXC will need to have ways to describe the following aspects of fares as a coherent fares model. Furthermore it will be appropriate to organise and modularise fare elements according to the respective Transmodel concepts and modularisation:

- **Fare Structure Parameters**
  - Definition of Fare Points.
  - Definition of Fare Zones, Availability Zones.
  - Definition of Permitted Routes.
  - Definition of Permitted Trains.
  - Definition of permitted travel times.
  - Day Types.
- **Fare Product Parameters**
  - Definition of Passenger Groups (e.g. "Family").
  - Definition of Passenger-Types.
  - Definition of Ticket Types.
  - Definition of Combined product types (e.g. plusbus).
  - Definition of Add-ons and Supplements.
  - Purchase & Booking restrictions.
- **Fare Pricing Parameters**
  - Definition of Fare Bands.
  - Definition of Group & Concessionary Fare Bands/Discount Rules.
  - Rounding Bands/Rules.
  - Capping Bands /Rules.
  - Performance related refunds.
- **Fare Retail Parameters**
  - Definition of refund restrictions / rules.
  - Types of retail Agents.
    - Driver / Conductor On-vehicle.
    - Staffed Station or Travel-centre.
    - Kiosks.
    - Internet.
    - Phone, Mobile device.

        - Travel Agents, Shops.
    - Types of retail fulfilment.
        - Counter, retail agent.
        - TOD, TOD Collection.
        - Mail, email, self-print.
        - Mobile.
    - Ticket media (e.g. paper, e-card, warrant, mobile, self-print, etc).
    - Documents required to prove Passenger-Type Eligibility (e.g. NUS Card).
    - Links to Conditions of carriage.
    - Fare quotas.
- **Fare Sales Packaging Parameters**
    - Names of products and sales packages.
    - Add-ons.
    - Additional “attractors”.

- **Special Smartcard Retail Parameters**
    - Capped / Uncapped fares.
    - Where E-purse can be provided.
    - Whether anonymous or registered.

8.7.4 Fare Model Dependencies

FXC will be dependent on the following aspects of other PT data models:

- Operator definitions should relate to operators as defined in TXC and NCSD.
- Fare sections need to relate to TXC Journey patterns.
- Fare stages need to relate to NaPTAN stop points, NaPTAN StopAreas and/or NPTG.
- PlusBus Fare zones need to be related to PlusBus Zones, as for example defined in NPTG.
- Service restrictions need to relate to services as defined in TXC.

8.7.5 Fare Model Granularity & Size

FXC needs to be able to support data exchange as documents of manageable size – these need to bear in mind the volumes (and hence size) found in practice.

Data may be exchanged for a singe route, or for various aggregations such as a region, authority, mode or an operator services.

8.8 Fare Structures & Pricing Representations – The DISTANCE MATRIX

Given that ticketing machines (and journey planners) may hold the data used to calculate a fare rather than exact fare, certain intermediate representations of the price structure are also important for exchanging fare data.

For example, a fare pricing table may hold fare band identifiers rather than absolute prices; each fare band points to a separate table of prices, allowing price increases to be applied to product elements, together with a set of parameterised tables.

This is illustrated below.

- Table 8-2 provides an example of a simple *triangular* fare pricing table with absolute prices. In a triangular table a return fare is the same as two single fares.
- Table 8-3 shows the same table as represented with *fare bands* from a separate table, Table 8-4. The fare band table can hold different prices for different ticket types, e.g. standard and concession.
- Table 8-5 shows the same fare bands also being used for a *Square* table which holds a different fare set for separate fares for return.

Outward (Absolute Fare Price)

Ask Av					
Bath Pl	£0.40				
Cam Sq	£0.50	£0.40			
Dee St	£0.75	£0.75	£0.50		
Ely Rd	£1.00	£1.00	£0.75	£0.40	
	Ask Av	**Bath Pl**	**Cam Sq**	**Dee St**	**Ely Rd**

Table 8-2: Example Triangular Fare Table with Absolute Prices

Outward ('Virtual Fare Price')

Ask Av					
Bath Pl	P				
Cam Sq	Q	P			
Dee St	R	R	Q		
Ely Rd	S	S	R	P	
	Ask Av	**Bath Pl**	**Cam Sq**	**Dee St**	**Ely Rd**

Table 8-3: Example Triangular Fare Table with Fare bands

FareBand	**Standard**	**Concession**	**Group rate**
P	£0.40	£0.30	50%
Q	£0.50	£0.40	50%
R	£0.75	£0.50	60%
S	£1.00	£0.60	60%

Table 8-4: Example Fare band table

Return ('Virtual Fare Price')

Ask Av		P	Q	Q	R
Bath Pl	P		P	P	Q
Cam Sq	Q	P		P	Q
Dee St	R	R	Q		Q
Ely Rd	S	S	R	P	
	Ask Av	**Bath Pl**	**Cam Sq**	**Dee St**	**Ely Rd**

Table 8-5: Example Square Fare Table with Fare bands

The appropriate intermediate representation depends on the pricing model used. But a matrix can be used in most cases – or a set of matrixes, for example there may be different fare band tables in effect for different hours of travel – as for example for London Underground.

A DISTANCE MATRIX format can be used regardless of whether the related points are single stops or Zones, or whether the price function is quantised or continuous. For example if a distance function is used a distance matrix would hold the geographical distances, and the pricing function would apply a distance cost (and any rounding and capping functions).
If a simple count of fares sections or zones is used (i.e. use of each zone has the same price, then the distance unit in the model is the zone count to go between fare points.

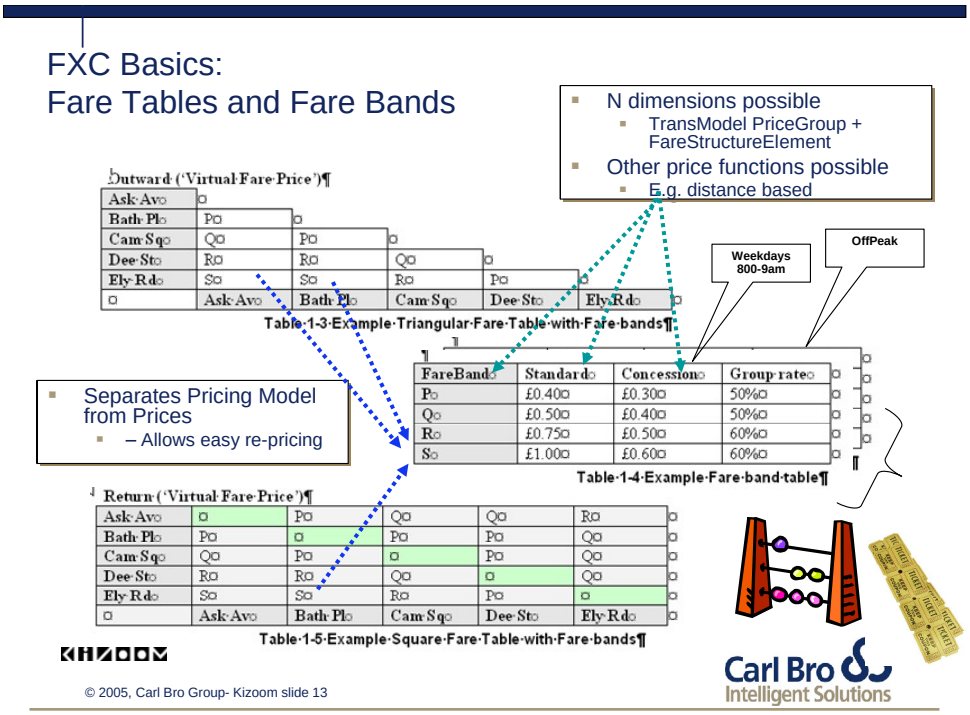


Figure 8-6: Relationship of Distance Matrix to Price tables

8.8.1 Areas Currently out of Scope

It is also useful to note some of the functions considered to be out of scope of FXC.

- Ticket enforcement / fare element consumption.
- Travel Document physical descriptions.
- Payment and clearing rules.
- Database of Registered Ticket Holders.
- Linking of Fare Stages to Vehicle Location in Real Time to check for valid use of tickets.
- Linking to Database of Ticket Holders in Real Time to check for valid use of smartcards / season tickets.

It is an open question as to whether FXC should also include descriptions of a standard Fare Query, either as an extension to JourneyWeb or as a separate Fare API. Fare queries can include both:

- "Static" Fare queries (e.g. addition of detailed request/response data to JourneyWeb), i.e. fare data is integrated with other timetable data in the engine.
- “Dynamic” Fare queries: i.e. fares are dynamically computed according to availability – These may include additional information on the currency of an offer, for example "4 seats remaining".

8.9 Expository Approach

In the subsequent sections we discuss each of the Fare Structure, Fare Product and Fare Pricing models in turn. For each model we first of all consider the general Transmodel structure, and then relate it to a possible specific UK concrete interpretation.

9 Fare Structure Models

The **Fare Structure model** describes the use of the transport network by passengers as entities that can then be used to allocate fares through the fare product model and fare pricing mechanisms. Transmodel notes that the FARE STRUCTURE model is made of quantitative rules about the *access rights* to public transport that the fare structure element gives, together with parameter *limitation rules*, that apply restrictions as to the validity of the access rights.

See the TransModel manual 2.11.2.CD TM FIG. 51 FARE STRUCTURE for a UML diagram of TransModel fare structure elements.

A Transmodel TARIFF STRUCTURE element may be composed of three different types of spatial, temporal or qualitative FARE STRUCTURE ELEMENTS, or a combination thereof.

- GEOGRAPHICAL STRUCTURE FACTORS
  - Point to Point – The right to travel between two fixed points, a boarding and an alighting stop.
  - Zonal – The right to travel between stops within predefined zones.
  - Route – The right to travel on a specific service via a specific route.
- TIME STRUCTURE FACTORS
  - Time Interval; The right to travel on the network (anywhere or in specific zones) for a predefined period after the start of travel.
- QUALITY STRUCTURE FACTORS
  - Other more complex considerations e.g. different fare structures for early / late booking, for whether a change is allowed etc.

Geographic structure factors are used predominantly in the UK as the main basis for fares. However this is typically not done as a simple distance function between stop points, (an historic approach on the railways using a GEOGRAPHIC UNIT) but rather in terms of discrete fare bands.

9.1 Geographical Structure Factors

Geographical Structure factors relate the Fares to the network via *Access rights*, such as use of a zone, boarding point or fare class.

The terms “Fare Stage” “Fare Point” and “Stage Fare” are not found in Transmodel. Transmodel has equivalent concepts, but they are stated slightly more generally.

- Geographical structure models can be captured as a table of DISTANCE MATRIX ELEMENTs, each associated with one or more TARIFF ZONEs or STOP POINTs and with an associate PRICE GROUP (i.e. fareband table). Whether they are “Fare Stages” or “zones” doesn’t actually matter.

Relating this to our previous discussion of fare representations

- The cell of a Fare table is a DISTANCE MATRIX ELEMENT.
- For each cell there is a GEOGRAPHICAL STRUCTURE FACTOR which indicates the FARE STRUCTURE ELEMENT (or ELEMENTs) and a PRICE GROUP which indicates the prices for the cell.
- Each cell i.e. DISTANCE MATRIX ELEMENT can thus be associated with a further n dimensional price table or tables of product types / fare types (as composed with the ***FareStructureElement***).

Note that within the Fare Product model, Transmodel also has the concept of a type of access right called a service FARE SECTION which identifies a part of a journey that may be used. A FARE SECTION is only meaningful in the context of a specific JOURNEY PATTERN, since it is a grouping of an ordered sequence of stops *for that specific journey pattern*. A stop point may belong to different fare sections for different Journey patterns.

9.1.1 A Basic Distance Matrix

Figure 9-1: Illustrates the basic DISTANCE MATRIX elements. In effect the four entities shown describe a general purpose fare table, where the ***DistanceMatrix-Element*** describes a cell with an associated ***DistanceMatrixElementPrice*** and a ***DistanceMatrixReference*** relates it to a fare stage or zone.

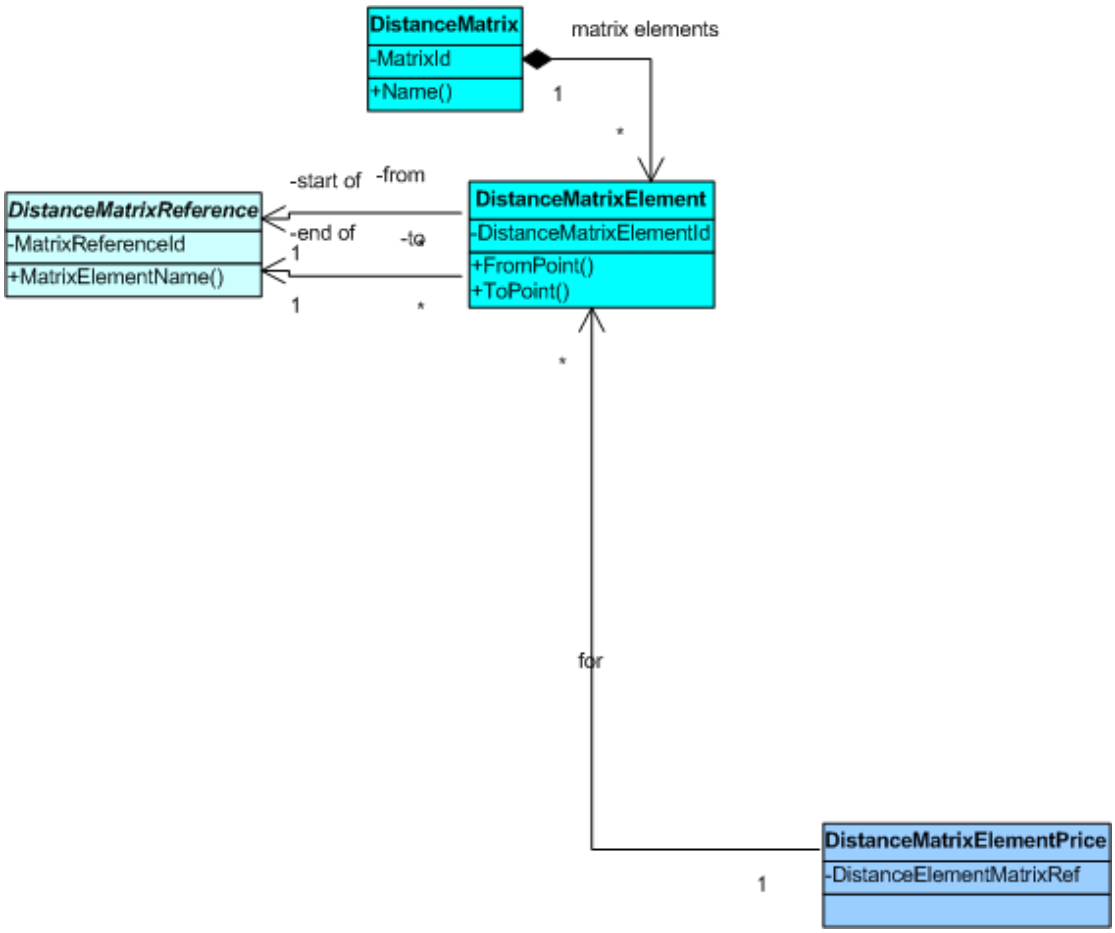


Figure 9-1: UML Diagram of Basic Distance Matrix

9.1.2 Distance Matrix Associations

Figure 9-2 expands Figure 12-1 to show a UML diagram of a distance matrix and the possible associations that relate it to stop points and fare zones, as well as to different price groups. In effect this associates each row/column of the matrix with identified fare stages or zones through the use of reusable ***TariffZone*** elements, and each ***DistanceMatrixElement*** cell of the matrix with one or more prices, as organised by a ***PriceGroup***. The price group can be used to build up a n-dimensional matrix allowing different types of price to be associated with a cell.

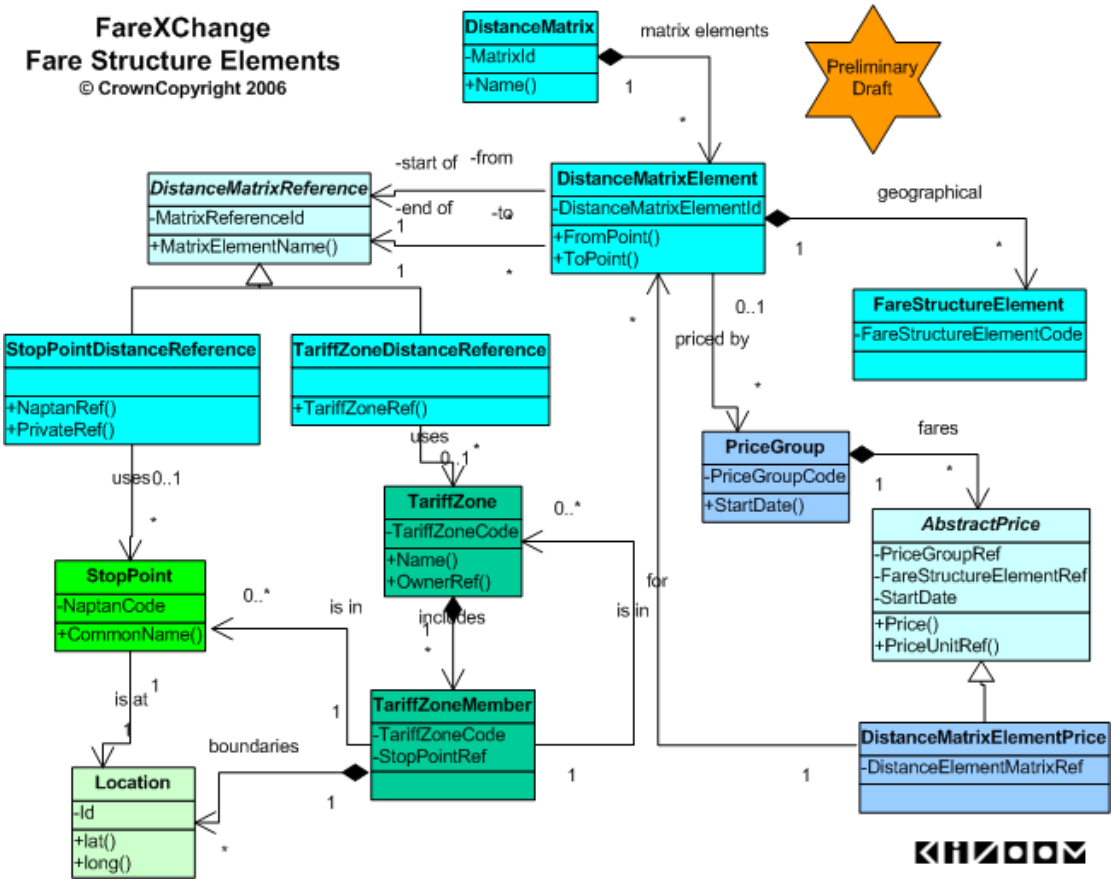


Figure 9-2 UML Diagram of Distance Matrix related to geographical factors

9.2 Time Structure Factors

Time based pricing can be done through TIME STRUCTURE FACTORS (which associate predefined TIME BANDS with a fare): these may either be used for stand-alone pricing – e.g. an Hours travel from purchase, or in combination with Geographic Structure factors. E.g., Valid in a Zone for one day.

9.3 Quality Structure Factors

Quality Structure Factors provide a means of specifying access rights within the TARIFF STRUCTURE to other aspects of the service e.g. the SEAT CLASS. These may also correspond to Product Types, (in which case they do not necessarily need to be defined separately as Quality Factors) or be used to compose Product types . By defining them as distinct Tariff Structure elements, discrete prices can be specified for individual supplements (e.g. upgrades) that can be used to compute an overall price.

9.4 ValidableElements and Fare Structures

Access rights may have more complex rules. For example, the access right might entail being allowed to use a particular FARE STRUCTURE ELEMENT a specified number of times (E.g. 3 trips) or in a specified order. This is captured by VALIDABLE ELEMENT entities which are related to a FARE STRUCTURE ELEMENT via a FARE STRUCTURE ELEMENT IN SEQUENCE element which can specify how many times an element can be used and in what order.

Figure 9-3: Illustrates the UML elements used to link Fare structure elements to products. The Transmodel representation employs a number of intermediate generalisations that are useful for constructing more complex types of fare structure. For the simplest cases - for example a simple single use fare, they are not explicitly needed. Transmodel shows the appropriate place to include generalisations in the model. For example if a product contains a number of parts that must be consumed and validated in a particular sequence (as say a return ticket) the model can represent this exactly.

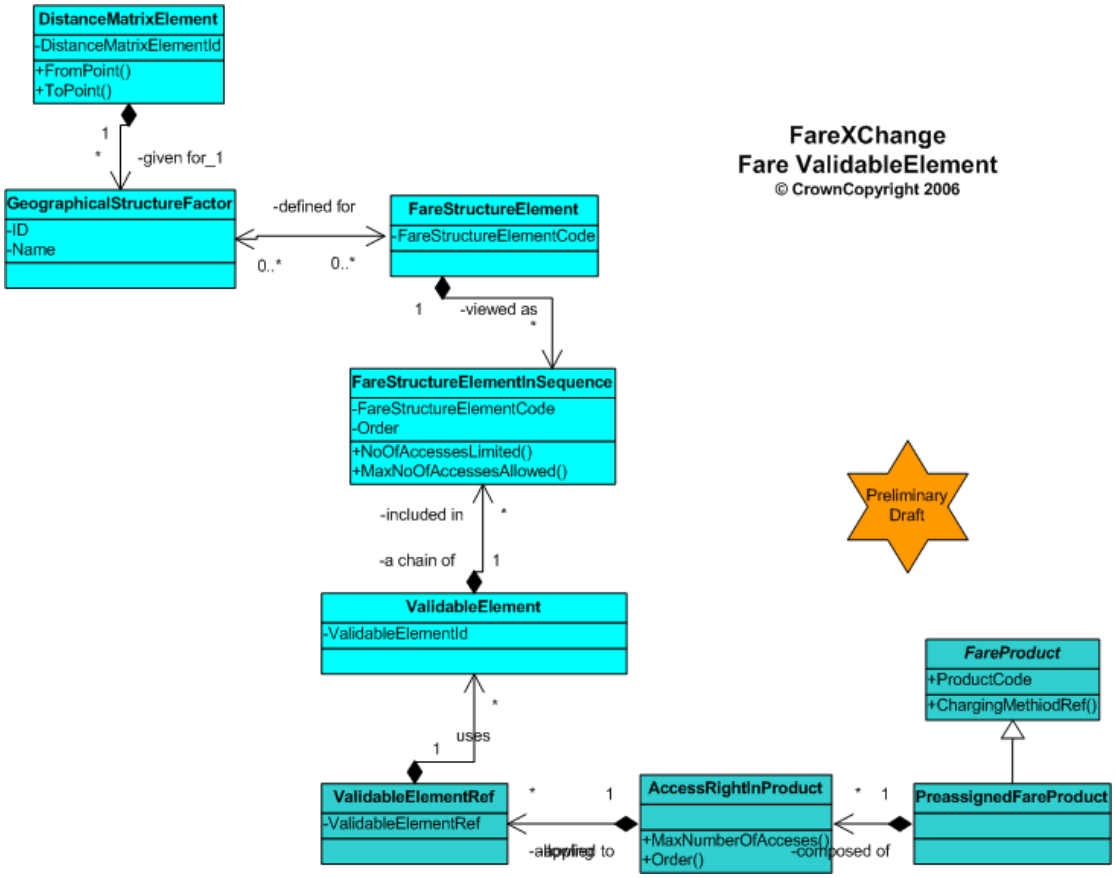


Figure 9-3: UML Diagram of a Validable Element

9.5 Fare Structure Straw Man

How might we choose to represent FXC as an actual concrete XML schema?

For FXC, a fairly direct implementation of the Transmodel fare structure (see Transmodel manual 2.11.2.CD TM FIG. 51 FARE STRUCTURE) would appear to be useful, making a number of simplifications reflecting UK specific usage.

Such a Schema would allow (i) The Declaration of external references such as StopPoints, Operators, etc (ii) The definition of the constituent elements of a Fare as reusable elements that can be used in different Tariffs –(And which can be exchanged independently) and (iii) The description of composite Tariff Structures Fare Products using the elements from (i) and (ii).

This is very similar in principle to the existing TXC schema, which allows Stop Points (or references to stop points), and Operators to be declared, and Routes and

Journey Patterns to be defined as distinct reusable elements which can then be composed into Services that reference the base elements.

9.5.1 Summary of a possible FXC Schema model

Figure 9-4 shows an introductory UML diagram of a possible XML schema for a Fare Structure component of FXC showing the main elements which can be declared and referenced independently.

- NB In this and subsequent diagrams, Versioning and data management constructs should be included – these are mostly generic and are not indicated in the draft model.
- NB At this stage little consideration has been given to the use of defaults and inheritance to reduce document sizes. There are several obvious candidates. For example, a default price unit at various levels.

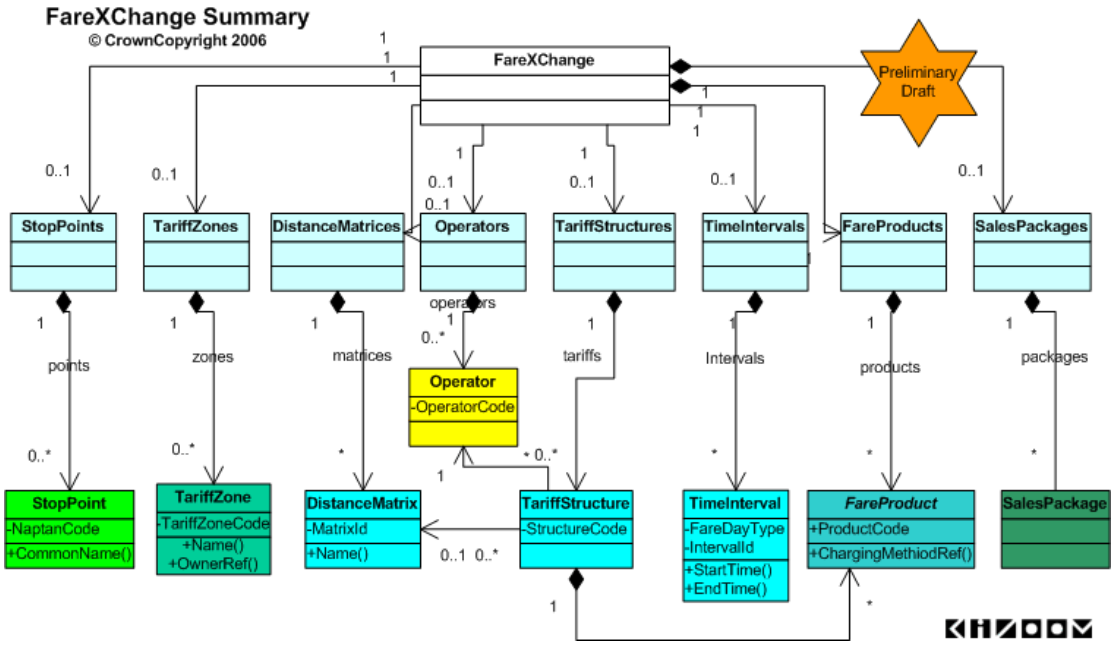


Figure 9-4: Summary UML Diagram for FXC

9.5.2 Elaboration of a possible FXC Schema model

Figure 9-5: elaborates Figure 9-4 to show a fuller possible submodel for all the main FXC fare structures elements, including price distance matrix elements. While, non-trivial, this is still relatively compact and tractable.

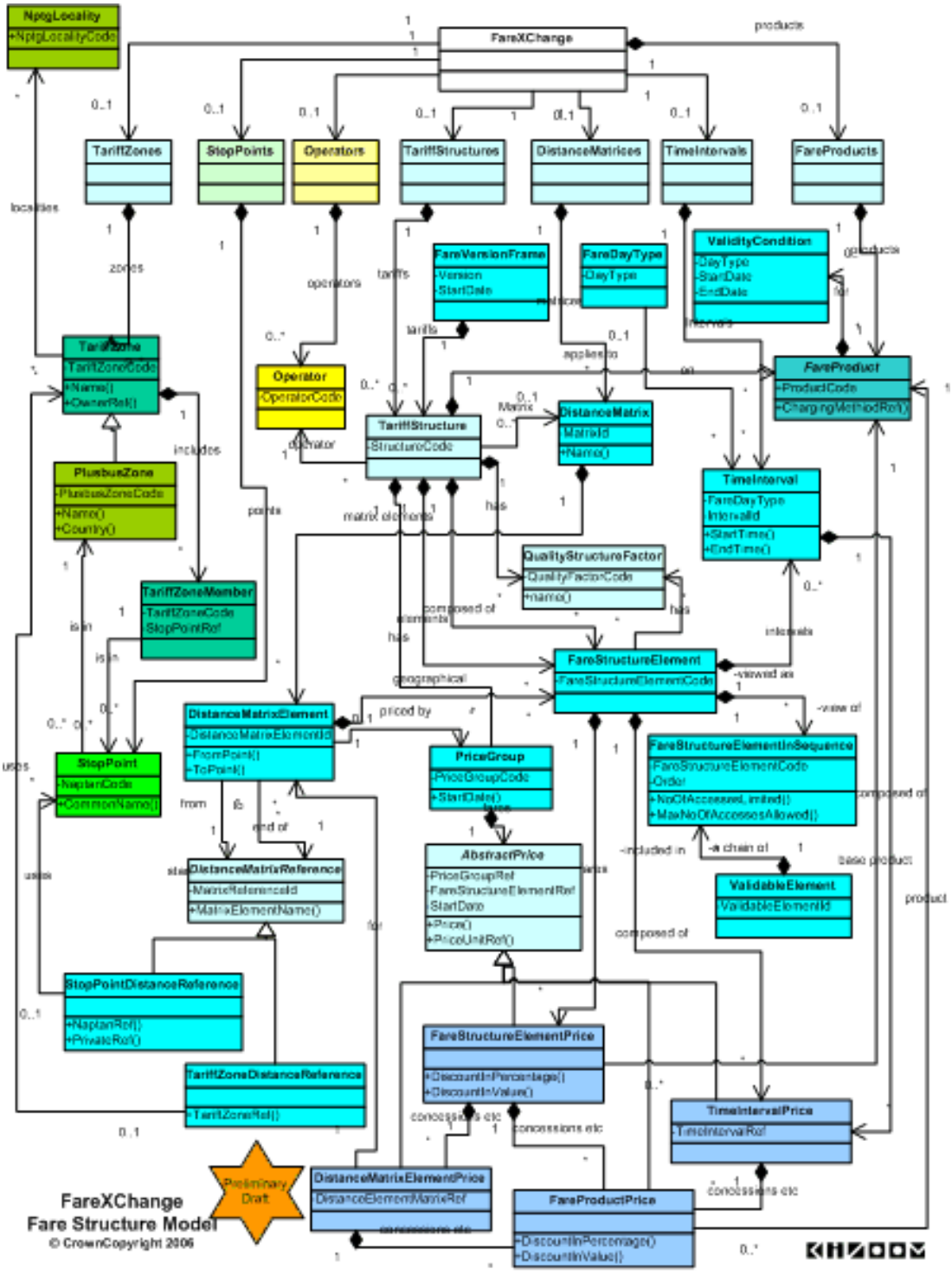


Figure 9-5: UML Diagram for a draft FXC Fare Structure Model

The following are some specific points to note about the suggested provisional FXC XML model.

- **Reference elements**
  - As for TXC, where existing elements, such as NaPTAN points, NPTG Localities or Operators are referenced it should be possible to declare their use either by a reference, or by a local definition using the common package.

    - A general ***TariffZone*** should be introduced as an independent persistent entity with its own identifier. Plus Bus Zones are a particular case. It should be possible to associate these with an ***NptgLocality*** locality as well as specific NaPTAN stops.
- **Fare Structures**
    - The two fundamental data structures of the Fare Structure model are (i) the ***DistanceMatrix***– which defines a point-to-point table of controllable access points, and (ii) the ***PriceGroup,*** which provides a multi-dimensional set of prices tables, allowing different prices for each fare structure element.
    - Within a ***PriceGroup***, prices can be tabulated by ***DistanceMatrix-Element*** or ***TimeInterval***, and further elaborated by other ***FareStructureElement*** *types.*
    - →*FXC* A geographic distance structure element does not appear to be needed in the UK (But could be added in future).
- **Fare Products**
    - The ***FareStructureElement*** is referenceable by a Fare Product using a ***ValidableElement***. This is discussed further under Fare Product.
    - →*FXC* The usage conditions on ***FareStructureElementInSequence*** should be reviewed carefully against UK Practice.
- **Namespaces for fare Structure elements**
    - Most Fare structure elements will be local to a document. Where a persistent identifier is needed, the **Operators** who provide the fares should be used as the name space for most of the fare entities.

10 Fare Product Models

The Fare Product Model describes the available products that the customer may purchase. A FARE PRODUCT is immaterial -- it gets materialised on TRAVEL DOCUMENTS, that is the tickets or cards that are used as tokens for validation. Each FARE PRODUCT has associated with it a variety of **Limiting Fare Parameters** which describe when it can and can't be used – these are discussed in more detail below.

10.1 Fare Products and Fare Structures

In Transmodel, a Fare Product is related to a Fare Structure via one or more ACCESS RIGHT IN PRODUCT entities, which in turn reference one or more VALIDABLE ELEMENTs, which are associated with FARE STRUCTURE ELEMENTS – and can be controlled. The use of a VALIDABLE ELEMENT allows the FARE PRODUCT (and individual access rights of the FARE STRUCTURE) to be systematically related to the Fare Enforcement systems.

10.1.1 Fare Product Types

Transmodel considers a FARE PRODUCT to be specific to a CHARGING METHOD, which is combination of payment method (prepayment, post payment) and account location (i.e. is Account stored on a TRAVEL DOCUMENT or in a central account).

The most common Charging Methods are:

- *Pre-payment with cancellation*, (throwaway ticket).
- *Prepayment with debit* on a TRAVEL DOCUMENT (a value card).
- Prepayment without registration for the consumption (unlimited pass) Debit.
- Post payment.(electronic card with central account and monthly billing).
- Free of charge.

10.1.2 Fare Product Subtypes

Transmodel breaks a FARE PRODUCT down into four *distinct* and separate subtypes. (I.e. each FARE PRODUCT is of only one type).

1. PRE-ASSIGNED FARE PRODUCT is a marketable combination of specified VALIDABLE ELEMENTs. It is the most common FARE PRODUCT in public transport (materialised e.g. as single ticket, monthly pass etc.).
2. AMOUNT OF PRICE UNIT is a FARE PRODUCT expressed by a specified number of PRICE UNITs (currency unit, token...). It is not pre-assigned, which means that it gives the right to consume any VALIDABLE ELEMENT from a specified list. The main types of AMOUNT OF PRICE UNIT are value cards or electronic purses, which are debited for each transaction. In some cases, single tickets should be considered as AMOUNT OF PRICE unit, when it is required to punch a variable number of tickets according to the length of the intended trip.
3. SALE DISCOUNT RIGHT is a FARE PRODUCT allowing its holder to benefit from discounts when purchasing specific SALES PACKAGEs. Train companies for instance usually propose such discounts (e.g. 30 % discount card).
4. USAGE DISCOUNT RIGHT is a FARE PRODUCT allowing its holder to benefit from discounts when consuming specified VALIDABLE ELEMENTs. For instance, such a product grants to its holder a discount when consuming park and ride sequences, whereas parking or PT rides consumed alone are charged at the normal fare. This kind of discount is particularly meaningful with post-payment methods.

→*FXC* This does not appear to allow for a composite FARE PRODUCT, say a Season Ticket that includes discount rights. This might be considered to be a Sales Package, or it might be useful to allow a composite product that is made up of several types.

10.2 Fare Product Straw Man

Figure 10-1: shows a UML diagram of a possible model for a Fare Structure component of FXC. It is based on a direct implementation of the Transmodel fare structure (see Transmodel 2.11.2.CD TM FIG. 53 FARE Products & Sales)

Some specific points:

- **Fare Product Types**
  - It is ***PreassignedFareProduct*** that corresponds to the classic idea of a Product or "Ticket Type", comprising a number of ***AccessRightInProducts*** that allow the user to use parts rights. Consideration needs to be given to how composite products are represented. (Are they packages or separate products?)

- **Types of Travel Documents & Packaging**
  - Transmodel clearly separates out the physical embodiment of a Fare product as part of a Sales package as a ticket say printed on a particular media from its virtual representation. However Transmodel has very little to say about ticket types available or how they should be presented for sale. This is of relevance for electronic ticketing – for example the Rail industry has prescribed formats for relating the fare product contents to be printed on different sizes of ticket from different devices on different types of media and these are described in the RJIS feed.
  - It is an open question as to what packaging aspects should be captured in FXC.
  - A textual catch-all could also be used to cover unstructured packaging descriptions.

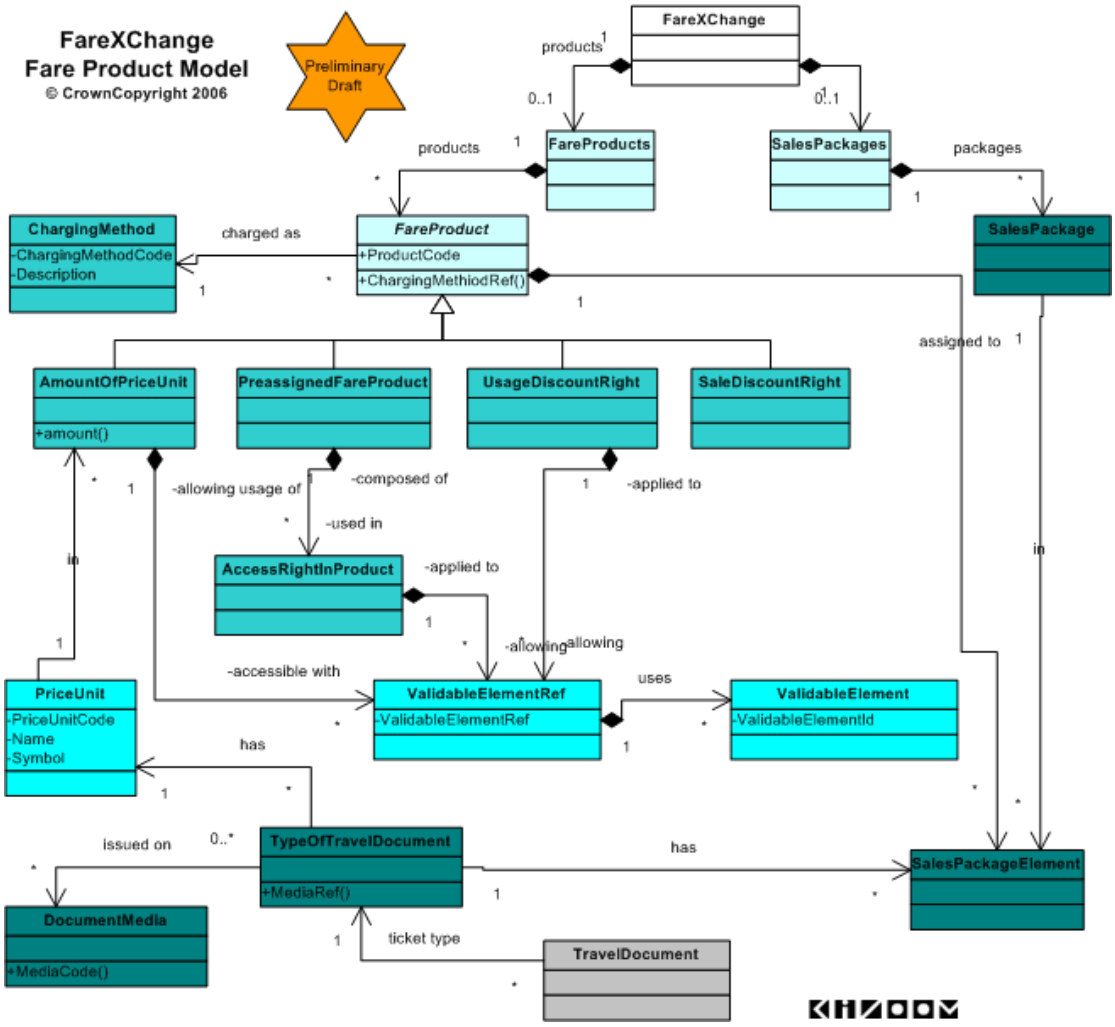


Figure 10-1: UML Diagram for a Draft FXC Fare Product Model

10.3 Limiting Fare Parameters

A Fare PRODUCT may include a wide range of Limiting Fare Parameters which specify restrictions on the access rights. These fall into two main Groups:

1. Generic Validity Parameters.
2. Usage Parameters.

10.3.1 Generic Validity Parameters

Validity parameters specify factors to do with the use of other defined entities corresponding to access rights, both temporal and network

- **Temporal Restrictions**
  - TIMEBANDs.
  - OPERATING DAY.
  - FARE DAY.
- **Quality Structure Factor Restrictions**
  - SEAT CLASS.
- **Restrictions on use of the Network**
  - TRANSPORT MODE.
  - TARIFF ZONE, STOP POINT, SITE.
  - LINE, GROUP OF LINES.

- AUTHORITY, OPERATOR, GROUP OF OPERATORS.

- **Restrictions on use of specific services**
  - FARE SECTIONS, JOURNEY PATTERNS.
  - VEHICLE JOURNEYS, SPECIAL SERVICES.
- **Restrictions on use of specific services**

10.3.2 Usage Parameters

Usage restriction parameters specify factors to do with the eligibility to use products and how the products may be consumer.

- **How**
  - GROUP TICKET characteristics
  - TRANSFERABILITY
- **Who**
  - USER PROFILE eligible to use service

10.4 Fare Product Limitations Straw Man

10.4.1 Fare Product Limitations – Basic Access Rights

Figure 10-2 shows a UML diagram of some basic access right assignments, illustrating the principles underlying the use of Transmodel fare product parameters (see 2.11.2.CD TM FIG. 52 FARE Parameters).

Each ***FareProduct*** can have one or more ***AccessRightAssignment,*** which states whether the access right is included or excluded from the fare product. Each assignment may also have a textual description which can be used to compose a fare Product description. For example, the ***OperatorAccessRightAssignment*** specifies that a fare product is restricted to a particular operator, the ***OperatingDayAssignment*** restricts it to certain types of day, etc.

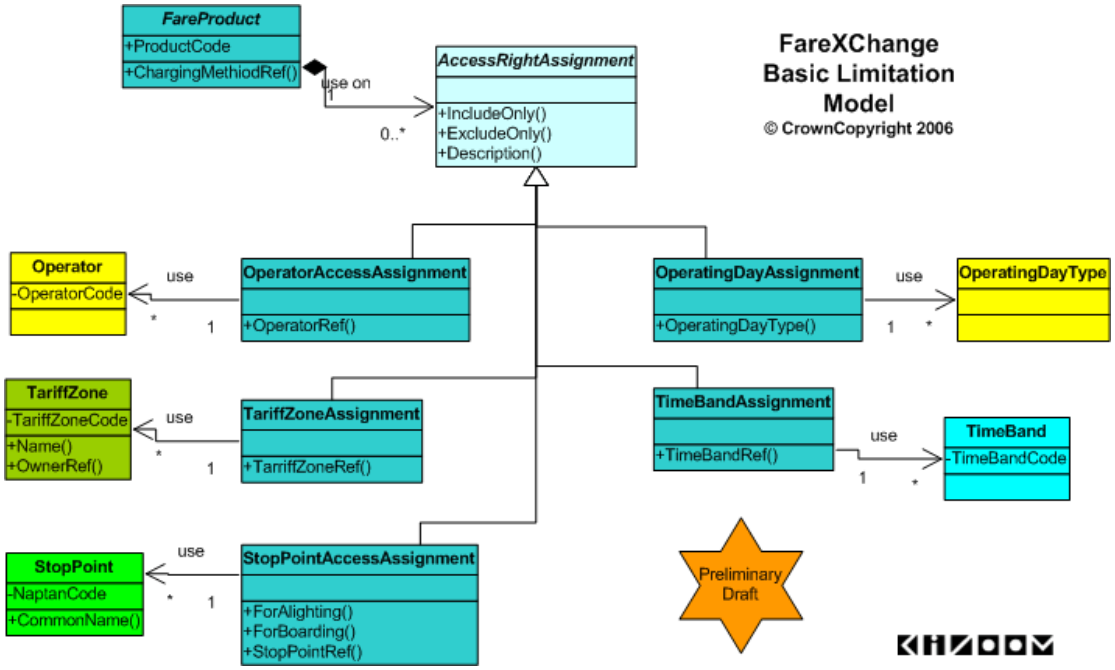


Figure 10-2: Basic Access Right Assignments

→FXC It is an open question for FXC as to how many of the Fare Parameter limitations need to be represented by a structured and/or quantitative model, or whether a purely descriptive model for some elements (E.g. just a text string) would suffice.

10.4.2 Fare Product Limitations – Basic Usage Rights

Similarly each Fare Product may have usage parameters associated with it.

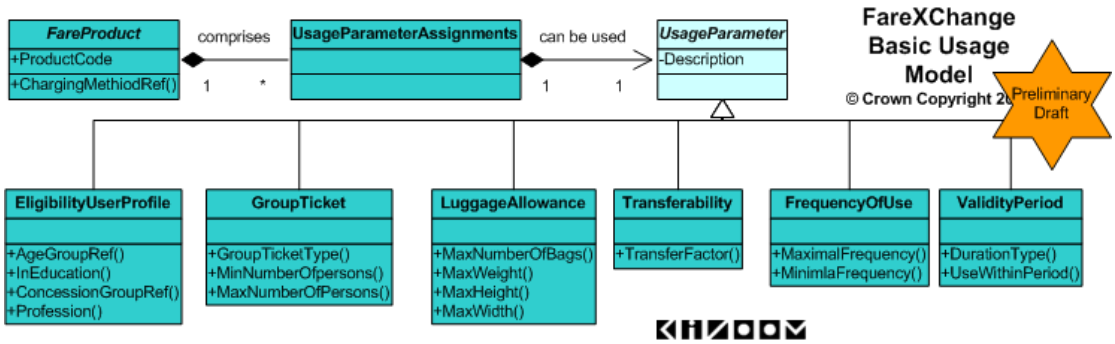


Figure 10-3: Fare Product usage parameters associated with it

10.4.3 Fare Product Limitations – Full model

Figure 10-4 shows a UML diagram of a possible model for a FXC Fare product implementation covering a wider range of parameters. This is an interpretation of the Transmodel fare product parameters (see 2.11.2.CD TM FIG. 52 FARE Parameters) reflecting UK specific usage.

Some other specific points are discussed below.

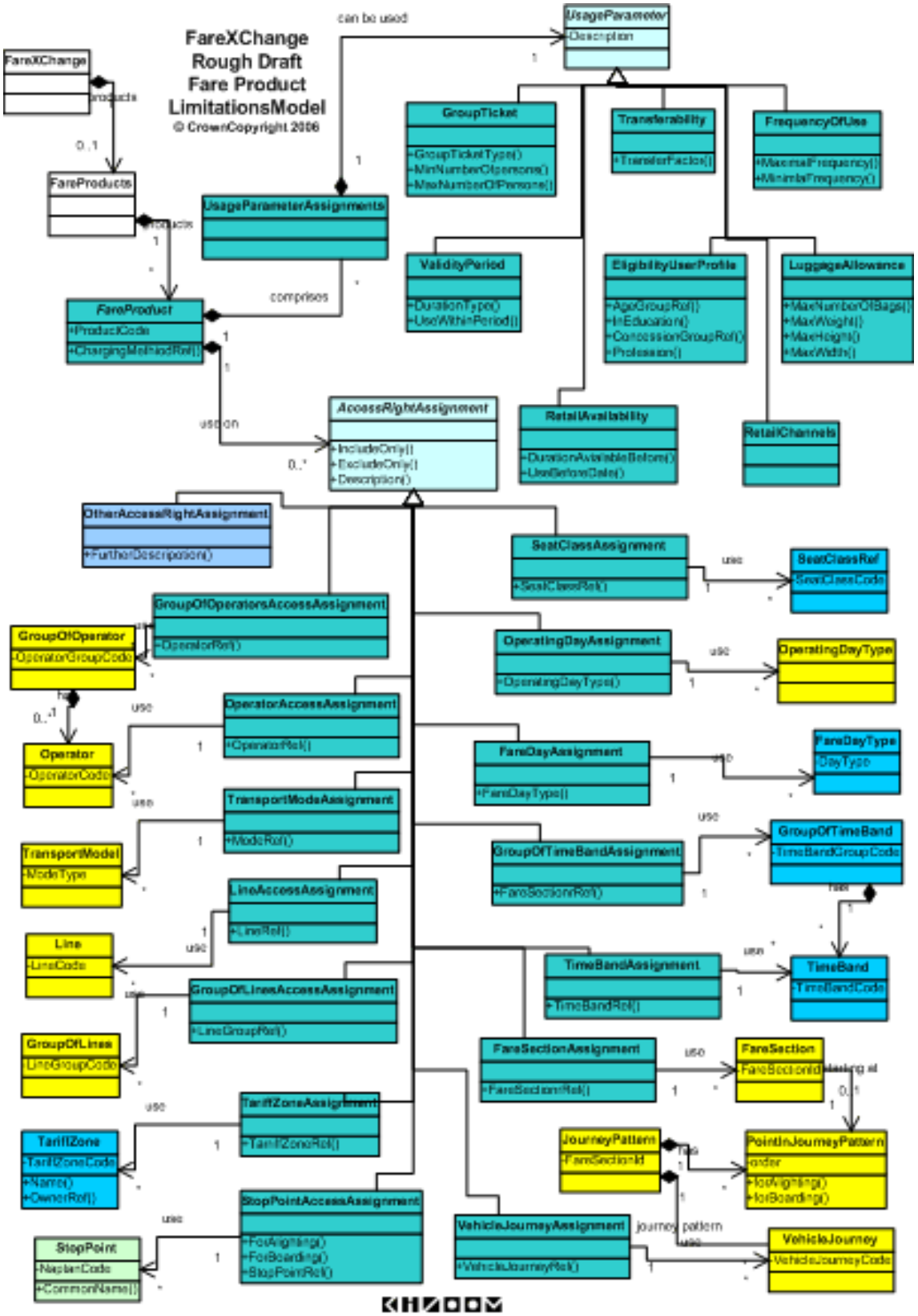


Figure 10-4: UML diagram for a draft FXC Fare Limitation Model

10.4.4 Generic Validity Parameters

The generic validity assignments make assertions about whether use of specific entities is allowed by the product: they make references to predefined NaPTAN, TXC or FXC entities to define an access right.

- **Groups Of Lines**
  - TXC already has concepts of ***Operator*** and ***Line***, but not of ***GroupOfLine*** and ***GroupOfOperator***. If useful (i.e. persistent and reused) they will need to be added either to TXC or FXC as reusable groupings of Operator and Line with distinct identifiers.
- **Fare Sections**
  - A ***FareProduct*** can include or exclude particular sections of a route. TXC does not currently have a true fare section (i.e. a grouping of Points in Journey Pattern that is independent of the timing links). It would be useful to add POINT IN JOURNEY PATTERN and FARE SECTION to TXC to do this. The current ***FareStageNumber*** on a TXC timing link could be used to project this
- **Vehicle Journey Identifiers**
  - Specific services can be included or excluded from a fare product. This requires the existence of a present unique identifier for the service. A similar concern applies to journey patterns which may include a more general concept.

10.4.5 Usage Parameters

The Fare Usage parameter assignments describe what type of user may use the product and a number of types of restrictions on its use. These are descriptive elements that are included if appropriate to a fare product.

→FXC A question for the final FXC schema design is whether the specific instances of some or all usage parameters are common to a large number of products; in which case they should be declared within the schema as reusable elements with an identifier in their own right, and referenced (similar to the Generic Validity parameters), or whether they are specific to each fare product instance.

- **User Profile**
  - The Transmodel USER PROFILE is slightly curious as it seems intended for more general use. It would seem more appropriate to use an ***EligibilityUserProfile*** to represent specifically those characteristic of a user that are relevant for being able to purchase a ***FareProduct***, such as age, in education or on benefit, etc.
  - It may be possible to relate some of these to GovTalk APD parameters of structures.
- **Common Reference Code Types for**
  - Some other usage parameters have classifiers (such as DurationType - Daily, Monthly Weekly) that should be standardised and encoded either as an enumeration or a reference to a code table.
  - .It may be possible to relate some of these to existing TXC and /or GovTalk APD parameters

10.4.6 Additional Retail Usage Parameters

Figure 10-5 shows a typical set of Fare Product limitations for a UK Rail Product type as presented to a use on the NRE Web site. In principle this is the kind of product description that a Travel Information system would ideally be able to create from a set of atomic Fare limitation parameters, each with a text string or able to be rendered automatically as a human readable text string.

It can be seen that some of the elements correspond to a text description associated with an ACCESS RIGHT ASSIGNMENT (e.g. “Train Operator” = ***OperatorAccess-Assignment***, Conditions = ***SeatClassAssignment***); others correspond to different types of FARE PRODUCT (e.g. “Discounts” = USAGE DISCOUNT RIGHT) already encompassed by the Standard Transmodel Model.

However there can also be seen some conditions that either represent additional types of standard USAGE PARAMETERS mostly to do with retailing (E.g. “Refunds”), or a different way of expressing a general constraint (e.g. “Break of Journey”).

The following would be some useful additions in FXC as independent Usage Parameters.

- **Usage Related**
  - BREAK OF JOURNEY (This is Fare action rules)
- **Retail Process Related**
  - BOOKING DEADLINES
  - RETAIL AVAILABILITY PERIOD
  - REFUNDABILITY
  - CHANGES TO TRAVEL PLAN (I.e. if these are allowed or allowed subject to a penalty - Penalty fees could be represented through a FareStructure element)
  - REQUIRED PROOF OF ELIGIBILITY DOCUMENTS
  - FARE QUOTA: Where a known quota is applied to a fare product it may be of use to the user to know this and the usual sell-out date
- **Retail Channel Related**
  - RETAIL FULFILMENT CHANNEL TYPE (Possibly with assignment to outlets)
  - AVAILABLE AT RETAIL CHANNEL

Please find below a summary of the conditions that apply to your selected ticket(s).	
GNER 1st Advance 4	
Overview	GNER Advance tickets are one-way fares allowing you to mix-and-match outward and return journeys to get the best value fares. The more flexible you can be with your journey arrangements, the better the deal. The Advance fares will sell quickly, so we advise you to book early.
Train Operator	GNER and all connecting train operators.
Booking Deadlines	Tickets will be sold up to 18.00 on the date prior to travel. The most popular trains will sell out well in advance of this so customers are advised to book early.
Discounts	34% Railcard discount. 50% child discounts
Refunds	Your ticket is non refundable, should you decide not to use it. If the GNER train on which you are reserved is cancelled or delayed by more than 60 minutes, special arrangements will be made to accommodate you on another train (although a seat cannot be guaranteed), or to refund your ticket provided your journey has not yet commenced.
Changes To Travel Plan	Changes are only permitted until the departure time shown on your ticket. Changes to tickets can be made by calling the Web Support team or at manned stations on presentation of your ticket and reservation.Changes are only allowed if the origin and destination are the same. For each change made, you have to pay an excess charge, plus a change fee of GBP10 per single ticket.You must travel with the Train Company stated on your ticket.
Conditions	GNER First Advanced tickets do not entitle access to GNER First Class Lounges at stations.
Break Of Journey	You may not break and resume your journey at an intermediate station except to change to/from appropriate connecting trains where these are shown on your ticket(s).
Availability	Tickets will be sold up to 18.00 on the date prior to travel. The most popular trains will sell out well in advance of this so customers are advised to book early.
Validity	Your ticket is only valid for the date, GNER train(s) and reserved seat(s) shown on your ticket (s), plus those of appropriate connecting train companies.

Figure 10-5: Example of Public Presentation of Fare Product Limitations

10.4.7 Efficient representation of Routing Restrictions

Routing restrictions, such as the RSP flow model, can be represented by a Journey Pattern access right assignment. However a naïve implementation of FXC that requires the repetition of every journey pattern is likely to be repetitious and verbose, and some re-usable section mechanisms are likely to be needed to allow efficient and compact representations. Similar issues arose for TXC resulting in the introduction of a reusable section mechanism in TXC 2.0.

This is an area requiring further analysis and study in the next stage.

11 Fare Pricing Models for FXC

The Pricing model states how the Fare pricing tables can be used to calculate actual fares. It uses Prices – organised according to the Fare Structure Elements-- together with Pricing Rules and Pricing Parameters to derive actual fares for specific trips.

Pricing parameters may include Rounding tables.

Pricing rules may include how to calculate base fares, how to calculate discounts, how to apply rounding and capping functions, etc. Where there are several possible well-known variant methods of performing computations they may each be given a name.
For example **RoundingMethod**: Dont Round | Round to Specified Precision | Round according to table, **Capping**: Don't Cap: | Cap to Specified Table, **Discount** : By Table | By Value etc

11.1 Fare Pricing Straw Man

Figure 11-1 shows a UML diagram of a possible model for a FXC Fare pricing implementation. Fare pricing parameters are not part of the current Transmodel Model

- A set of ***PricingParameters*** can be included in a FXC document, defining Price units, rounding matrix etc. (Possibly the latter should be part of a Tariff Structure.)
- ***RoundingMethod*** and ***Discounting*** methods can also be declared and referenced by a ***FareProduct*** to indicate they should be used when computing the price for a ***FareStructureElement***.

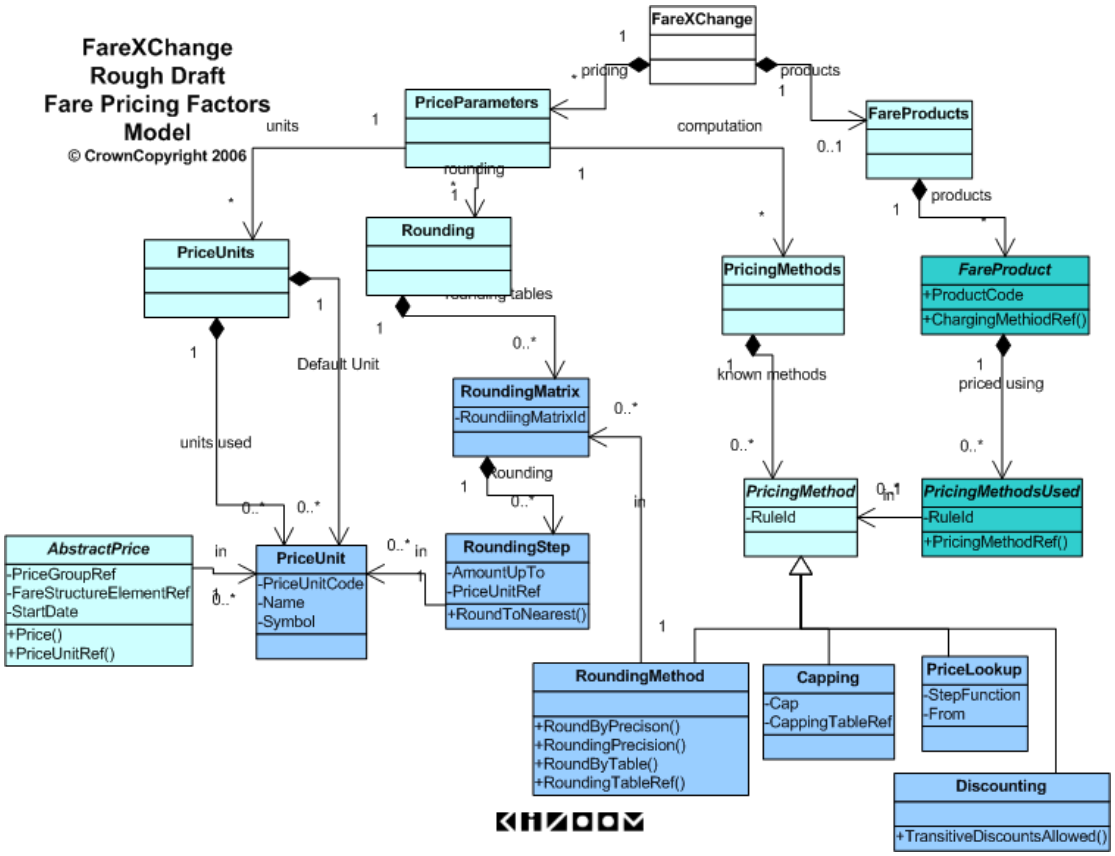


Figure 11-1: UML diagram for a draft FXC pricing model

11.2 Fare Query

It is an open question whether the FXC specification should include a dynamic fare query, either as a separate query, or as an addition to an existing journey query such as that found in JourneyWeb. A Fare query is similar to a Journey planning query but requires additional input parameters apart from an origin and destination such as the number of passengers and whether they are eligible for concessions. The results are similar to journey planning results but include fares values and any restrictions on use – (or at least references to explanations for the restrictions).

Since a primary purpose of FXC is to provide data to support fare queries by journey planning engines, it is in any case useful to identify the possible inputs and results for such a query and to relate the elements to the FXC model.

11.2.1 Fare Pricing Query – Inputs

Table 11-1 shows input parameters relevant for pricing.

	Element	Input Type	
Travel Specification	**Origin**	Place	As resolved to boarding stop
	Destination	Place	As resolved to alighting stop
	Via	Places	
	Time of Travel	Date time	One or other may be derived
	Time of Arrival	Date time	
Product Use	**Product Type**	Code	E.g. open closed ,
	Class of travel	Code	
Passenger	**Number of Adults**	Non-negative integer	
	Number of Adult Railcards of each type	Non-negative integer	
	Number of Children	Non-negative integer	
	Number of Child TravelCard of each type.	Non-negative integer	
Add-ons	**Number of Animals**	Non-negative integer	
	Bicycle	boolean	
Concession	**Concession cards**	Card types	
	Travel cards	Card types	
Policy	**Optimize**	Fastest | Cheapest | Most expensive | Most comfortable travel |	There may be different ways to optimise. Usually fastest or cheapest

Table 11-1: Fare query Inputs

11.2.2 Fare Pricing Query - Results

A Journey Fare pricing query will typically return fare prices as list of product types and fares. Table 11-2 shows some typical results. There may be different fares for

individual legs, and a cheaper fare for the overall journey. Conditions of Purchase and conditions of travel can be implied by the Product type.

	Element	Data Type	
Scope	**Origin**	Stop	As resolved to boarding stop
	Destination	Stop	As resolved to alighting stop
	Via	Stop	
	Time of Arrival	Date time	
Product	**Product Type**	Product Identifier	
	Part of Compound		Complex structure
Price	**Price**	Non-negative integer	
	Discount applied	Non-negative integer	
	Conditions of Travel		Complex structure
	Conditions of Purchase		Complex structure

Table 11-2: Fare Pricing Query Results

12 SUPPORTING MATERIAL FOR ANALYSIS

In this section we include summary extracts and notes on fare concepts in existing tools and data representations.

12.1 Fare Concepts in Existing UK Public Transport Standards and Specifications

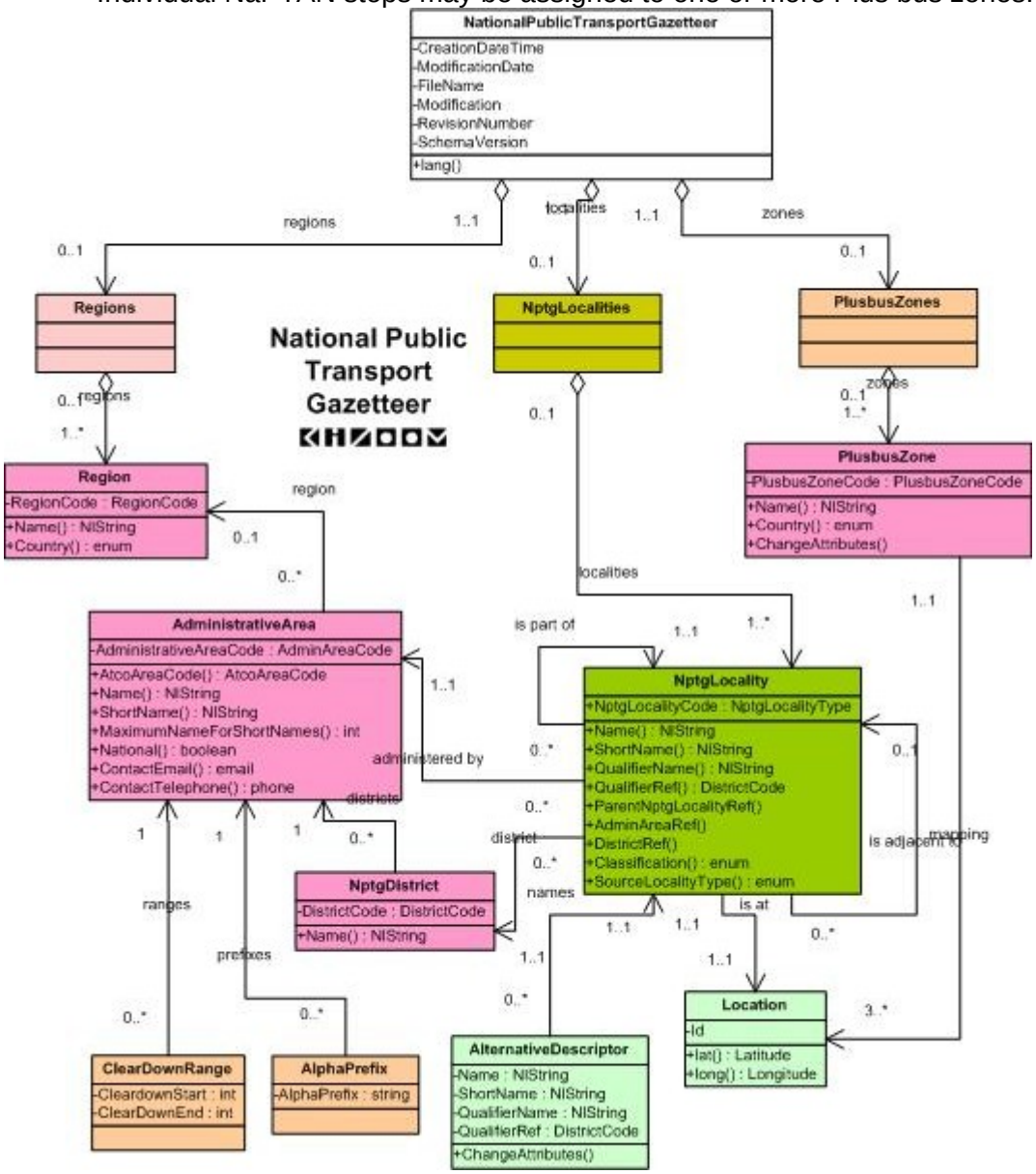
We note the following Fare related elements in existing UK Standards

12.1.1 Notes on fares in Public Transport Standards

12.1.1.1 NPTG & NaPTAN Plus Bus Zones

NaPTAN and NPTG do not include general fare concepts except for ***Plusbus*** zones, Plusbus is a national scheme which defines a combined Bus and Rail retail product which adds local bus use in a predefined zone to a rail fare.

- The NPTG includes a list of all the Plusbus Fare zones in the UK. NPTG does not include the spatial bounding boxes of zones.
- Individual NaPTAN stops may be assigned to one or more Plus bus zones.



12.1.1.2 TransXChange

TransXChange allow the association of ***FareStages*** with journeys of a specific service. A ***FareStageNumber*** is used to indicate the fare stage.

In the *TransXChange* model, fare stages are a property of timing link stop usage, so that both Stage Fare and Zonal models can be supported. Fare stage values can be specified at both the journey pattern and vehicle journey level of discourse as a successive property, that is one that carries onto succeeding links in the series until reset.
The fare stage change occurs at the point of pick up, that is, at the originating end of the link, as shown in Figure 12-1 which shows examples of link sequences over a zone boundary for both fare models, with fare stage numbers and fare stage points marked. Whether a stop usage for a given link is a fare stage is properly determined by whether the ***FareStageNumber*** changes when traversing a sequence of timing links: the ***FareStage*** indicator can be used to store a statically computed determination of this property for convenience of implementation.

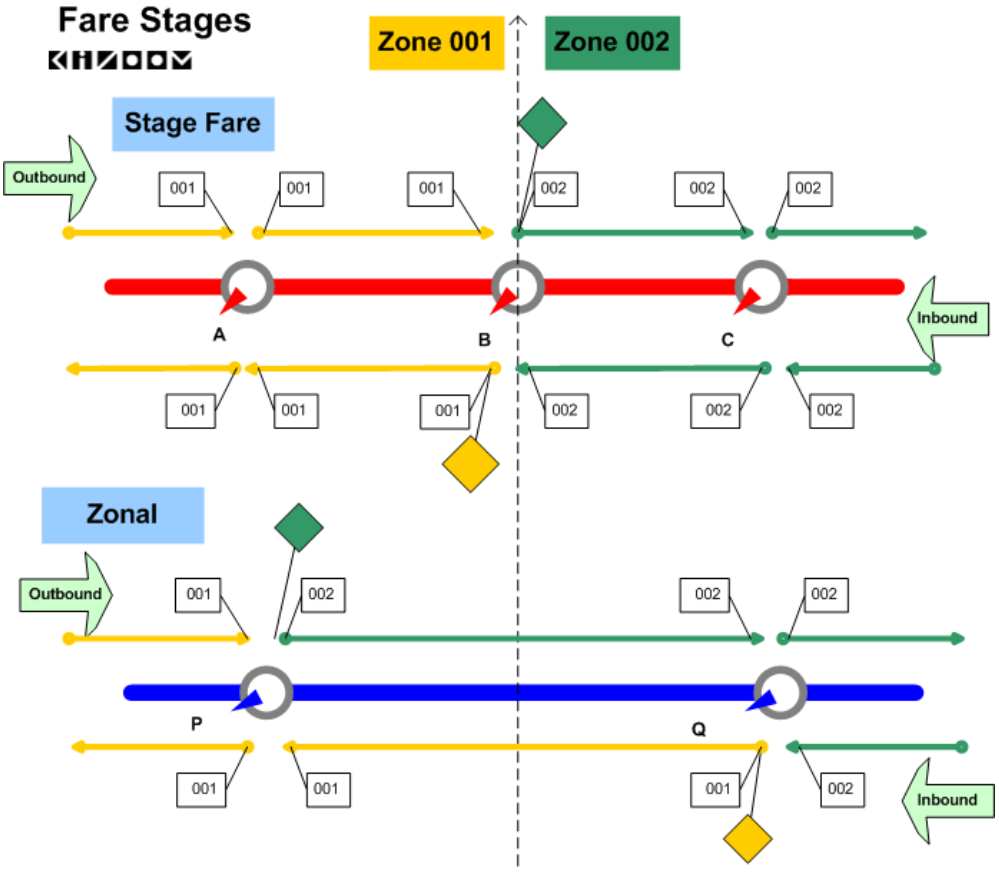


Figure 12-1: Fare Stages & Links

Figure 12-2 shows the basic TransXChange elements for a normal service, including Operators, Journey Patterns.

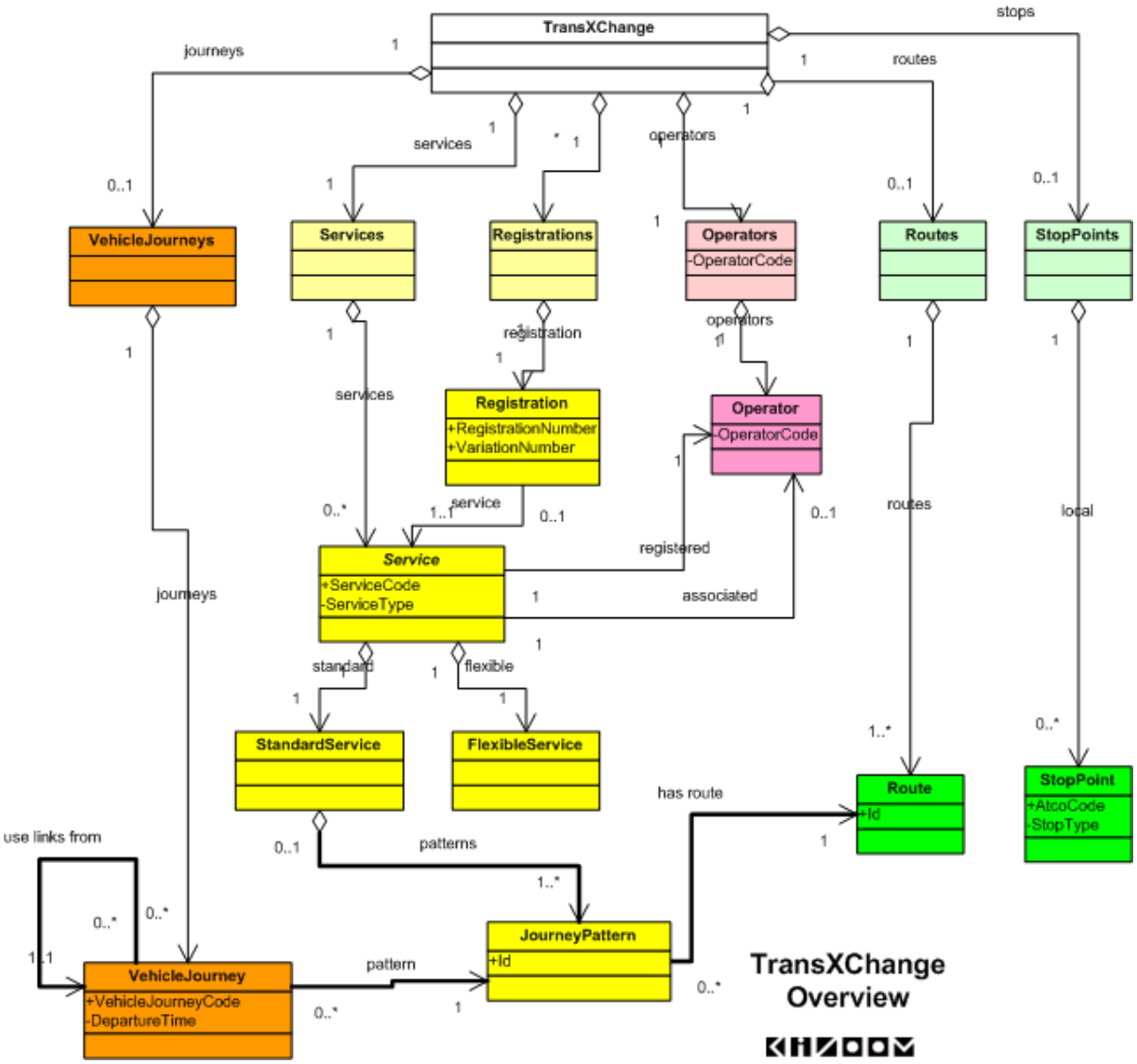


Figure 12-2 – Overview of TransXChange Model for a StandardService

12.1.1.3 Journey Web

The JourneyWeb ***JourneyResponse*** (Figure 12-3) does have a placeholder "***Fares***" element to allow the inclusion of fare data. However this is only at the whole journey level, rather than also at the individual Leg level, so does not cover many requirements.

The JourneyWeb ***JourneyRequest*** lacks the Fare Query inputs such as number of travellers, concession cards etc that would be needed to support any non-trivial dynamic fare query.

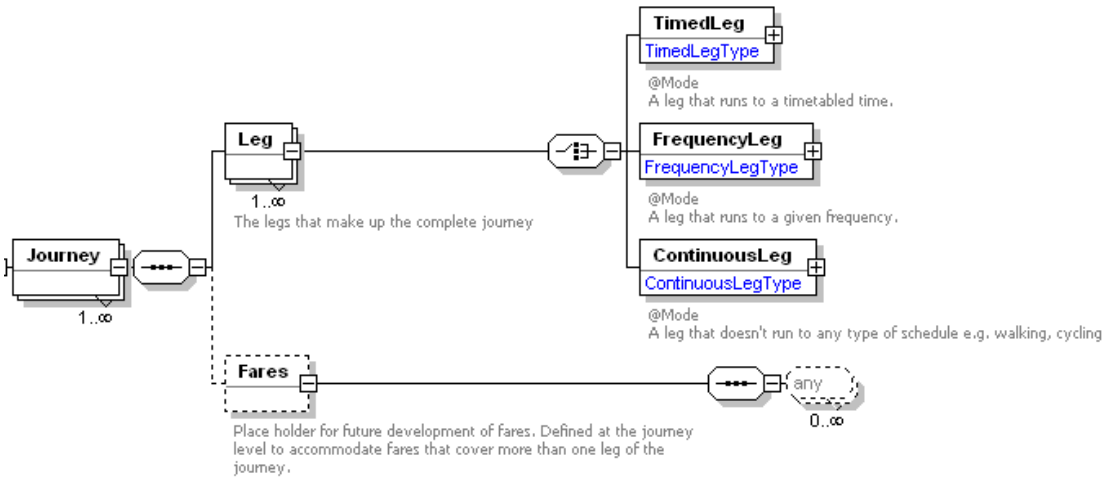


Figure 12-3: JourneyWeb JourneyResponse Fare element

12.2 Notes on UK Rail Fare data

RSP is the responsible organisation for collating and distributing UK Rail fare data, a large (300 million fares) and complex data set.

The RSP '*RJIS Data feeds interface Specification for Fare sand Associated data'* (ATOC SP0035) lists the current RJIS fare data formats. Additional data is described in the RSP Date feed specification 'Additional data' (Ref20040615 v2-0). Both data sets are available as a number of flat files in a proprietary csv based format from the RJIS data factory.

Rail Fare Data may be obtained from RJIS in two extracts formats: a full data set, or a data set just of change since a certain date.

The RJIS data can be summarised as follows:

- **Fare Structure Elements**
  - **Station Clusters**: A grouping of stations into zones for Fare assignment.
  - **Locations**: Locations including group locations.
  - **Routes**: Route descriptions including included/excluded locations.
  - **Restrictions** file. Applicable restrictions including time restrictions, train restrictions, railcard restrictions and ticket calendars.
  - **Packages**: Add-ons and inclusive supplements.
  - **Supplements**; Supplements (e.g. weekend first) and availability rules.
  - **PlusBus** data – (In Additional data)
    - **Plusbus Master .** Links between stations and Plusbus schemes.
    - **Stations in zone**: Data to identify which stations are in plusbus zones.
    - **Included Operators**: Which Bus operators are included in the scheme.

- **Fare Product Elements**
  - **Ticket Types** Tickets codes, and categories such as fare class, type, e.g. single, return or season. Includes restrictions such as min and max number of passengers of different types (adult child) allowed on

ticket, the usage restriction types (Date, area, train, validity code) and retail restrictions such as whether needs booking. Has pricing parameters such as discount category, and some packaging info such as
    - **Ticket Validity** codes : provides details on how long the ticket remains valid for outward and return use, whether there is a minimum stay, whether a break is allowed on the outward and the return.
    - **Railcards** Railcard Types and associated information.
    - **TOC file**: TOC codes and names.
    - **TOC specific Ticket Types.**
    - **Advance Purchase Tickets:** Ticket types and booking horizons.

- **Fare Price Data**
    - **Flow file**: A full (100MB) matrix of all point to point adult fares in the UK. Includes separate fares for each direction, each Ticket Types, Ticket Validity codes. The points may be actual stations or Station clusters, representing groups of stations.
    - **Non-derivable Fares file**: A full (50MB) matrix of overrides to the standard flow fares. Point to point adult and child fares that cannot be discounted in the normal way, and special fares.
    - **Non-standard discounts** Adjustment to be applied to fares where non standard discounts apply.
    - **Rail Rovers** and **price** details.

- **Fare Pricing Parameters**
    - **Railcard Minimum fares.** Minimum fares to **be used.**
    - **Status Discounts:** Discount information for use with railcards.
    - **Rounding Rules** Rounding to apply when a derived fare is calculated

- **Sales Packaging elements**
    - **Class Legends**: Text to be printed in credit card sized tickets
    - **Print formats** : textual information for the printing of tickets on supplement vouchers
    - **Journey Segments**: Codes for the use in LUL magnetic stripe encoding

- **Passenger Information Elements**
    - Ticket Publication data: Ordering information for printing tickets in the National Fares Manual.

12.3 Notes on ITSO Model format

The ITSO specification defines data formats for a number of different Travel Product types that can be stored in electronic format on a customer media (card, smartphone etc). Product types include one- off tickets, carnets, season tickets supplements, proof of travel, etc.

In Transmodel terms a smart card is a primarily a TRAVEL DOCUMENT and SALES PACKAGE rather than a fare structure pricing element; it combines product and consumption control elements as a sales package. The concern for FXC is thus merely to ensure that all the types of fare product element that are used on ITSO customer media can be described in the FXC model. For an element of a given type (e.g. Retailer ID, or ticket type) it is not necessary to use the same data coding

system on the card and in FXC – in fact the ITSO card production process will typically map values to its own compact encoding.

The ITSO product specification is introduced in "*ITSO TS 1000-0 Interoperable public Transport ticketing using contactless smart customer media. Part 0 Concept & Context"* and product details are given in "*ITSO TS 1000-5 Interoperable public Transport ticketing using contactless smart customer media. Part 5 Customer media data record definitions.*

There do not appear to be fare structure or product concepts in the Card Products that are not already found in other products. Though there are a few points of detail to discuss – see Notes below. The main concepts found on the ITSO card formats can be summarised as follows

- **Fare Structure Elements**
  - **Geographic scope**
    - ValidAtOrFrom
    - ValidTo
    - IntermediatePoint
    - NotViaPoint
  - **Temporal scope**
    - PassDuration
    - ExpiryTime
    - TimeLimit
    - ArrivalBandStart
    - ArrivalBandEnd
    - DepartureBandStart
    - DepartureBandEnd
    - NotValidTime
    - FirstUseTime
    - DayType
    - HalfDayType

- **Fare Product Elements**
  - AccomodationClass (economy, first etc)
  - TypeOfTicketCode
  - JourneyTypeCode (Single return etc)
  - RestrictionCode
  - Entitlement TypeCode
  - ProfileCode Concessionary class (I.e. concession code)
  - PromotionCode
  - ValidOnDayCode

- **Sales Packaging elements**
  - ProductRetailer

- **Travel Document elements**
  - PartySizeAdult
  - PartySizeChild
  - PartySizeConcession
  - PhotocardNumebr
  - WarrantNumber
  - ReservationNumber

- **Control Elements**
  - MaxTransfers
  - MaxDailyJourneys
  - Passback Time (Time delay before can be reused to go through a barrier)

12.3.1 Further Remarks

1. As well as a DayOfWeek DAY TYPE, ITSO uses a HalfDayOfWeek. This may need to be reflected in a FXC FareDayType.
2. If MaxTransfers, MaxDailyJourneys and Passback Time are primarily control elements, then they do not need to be reflected in FXC Product structures per se. If they are part of the sales product then they should be in FXC as Fare Parameter elements.

12.4 Notes on Journey Plan Exchange format

The *T2FareExchange* "Stage Fare" exchange format developed by Journey Plan Ltd allows the exchange of Stage fare data. It declares a simple XML allowing the exchange of fare data as a Point to Point matrix of fare stages. Each fare stage can be associated with multiple NaPTAN points. Each fare stage the matrix can have multiple fare 'entries'. Figure 12-4 shows a UML diagram of the *T2FareExchange* schema which can be summarised as follows:

- **Fare Structure Elements**
  - **FareStageTable:** A Distance Matrix for a given Operator
    - **Fare Points:** Ordered list of Named Points generating named axes of Fare Matrix.
    - **Fare Stages**: Distance Matrix Elements: Cells in Table representing intersection of each point. Each "stage" can be associated with multiple "Stops", and each Stop can be associated with multiple NaPTAN points.
    - **Entries**: Fare price values for each FareStage cell. There can be a separate price for each Ticket.
- **Fare Product Elements**
  - **Ticket (Types)** Declares Ticket code, (i.e. Fare Products) and names used in StageFare tables.

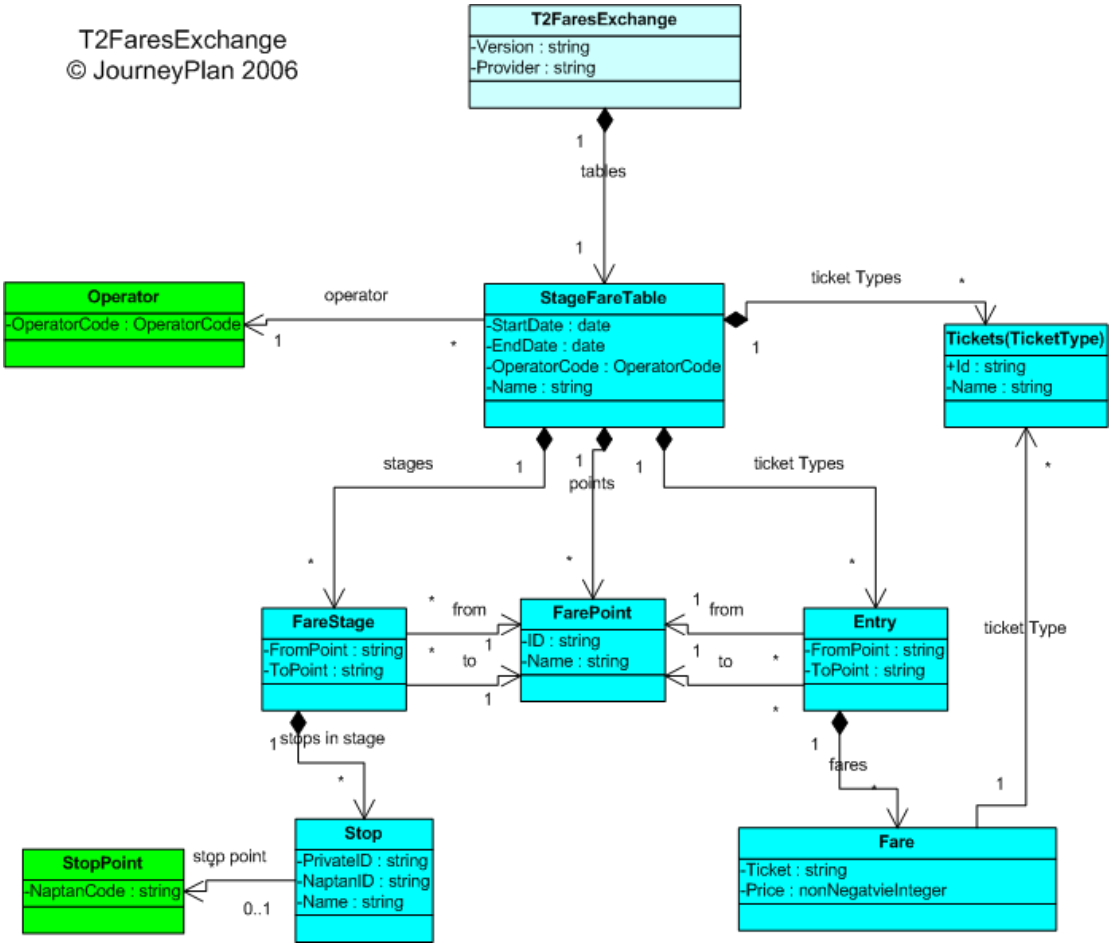


Figure 12-4: UML Diagram of T2FareXchange model

12.5 Notes on Wayfarer WayCon

Wayfarer Transit Systems made available to the FXC study team the user guide for their Waycon product (WAYFARER CONFIGURATION SOFTWARE USER'S MANUAL Publication Number 53450 Version 1.72, Build 1 © Wayfarer Transit Systems Limited 2004). This was reviewed as an example of a leading fare preparation product that might in future support the output of FXC documents, and which would give insight into current business practice for fare setting rules.

The Waycon product provides a Windows based user interface to manage and set fares and export them to downstream devices. Waycon is a product containing many of the fare representation features that FXC would need to support in order to be useful.

Overall it would appear that both the process and the underlying fare model can be aligned with Transmodel & FXC concepts.

12.5.1 Fare Structure

The Waycon product supports as its fundamental representation triangular and square fare tables exactly equivalent to Transmodel "Distance Matrixes". When the fare is based just on the number of stages and not on the actual stops a simple List (which can be considered a degenerate form of a Triangle) can be used. An editor allows the interactive creation of stages, zones and fare tables.

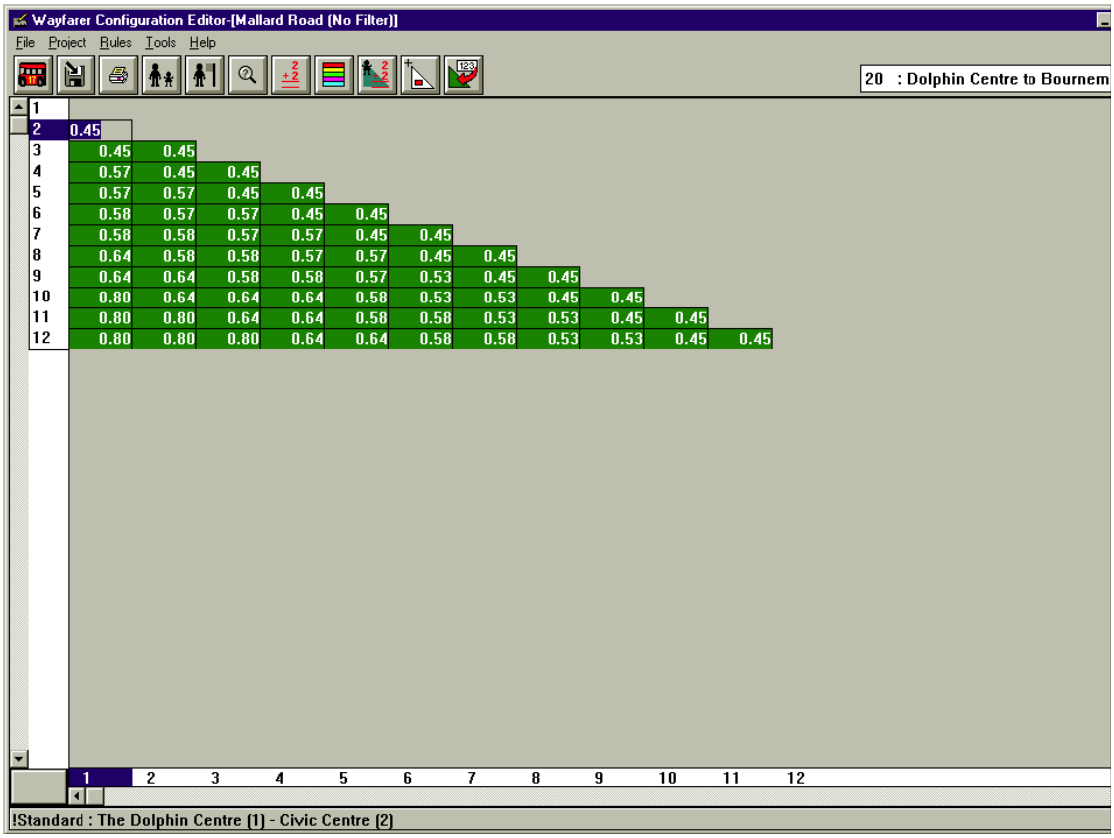


Figure 12-5: Waycon Fares Table Editor (C) 2004 Wayfarer

Currently the fare stages are created and managed independently of the other informational layers such as NaPTAN points.

The Wayfarer system captures some additional attributes that are relevant for presenting or managing fares - for example whether the route is circular. Transmodel normally regards these as part of the service pattern, but it might be useful to support these also in the fare layer so that it can be used independently. Another practical feature that FXC has is a grouping mechanism so that Fares tables can be managed into named Groups.

12.5.1.1 Fare Products

Waycon supports up to 237 Fare "Classes", for example Adult Single, Adult Return, Child Single, Child Return. As well as concessionary fare types. These can be used to construct fare types similar in concept to a Transmodel FARE PRODUCT. A number of restrictions such as time-bands can be specified.

12.5.1.2 Fare Parameters & Price Groups

Waycon allows the specifying of pricing parameters to be applied to the basic fare structure elements, such as a stage, area, fare product, or time band, to create derived fares computed from the basic fares using the parameters and rules. The rules editor allows completing arbitrary expressions to be constructed for deriving fares from base fares and other inputs, including rounding and capping fares. It would appear that the approach fits exactly onto the TransModel concept of describing the fare combination for a given cell matrix as an n- dimensional PRICE GROUP matrix. Waycon in effect supports a rich set of derivation functions for

computing derived fares, but appears to use similar area and temporal and quality structure factors in a similar tabular organisation to describe the inputs and outputs. Transmodel does not concern itself with the exact nature of the derivation functions (and there is little value in representing these in a schema) but the FXC model could include all of the input and output parameters needed to support data exchange, such as rounding values, capping values, time-bands, etc.
WayCon includes the following operators in its derivation functions:

- **Arithmetic** Operators: Add, Subtract, Multiply, Divide.
- **Conditional**: If... Conditionals (greater, less, equal, not equal).
- If Time used to signify a time band class.
- **Comparison**: less or equal, greater or equal).
- **Lookup** Table lookup (value pairs) Get reference fare from fare table.
- **Rounding**: Round up, Round down, Round to nearest.
- **Assignment**: Set equal to Set fare value or Execute rule.
- **Cap**: Check fare caps, Disable excess.

12.6 Glossary & Transmodel terms

12.6.1 Transmodel Fare related Entities

Transmodel includes a fairly rich model to describe Fares Structure and Fare Products. Table 12-1 lists all the main Fare terms, grouped approximately according to submodel and Table 12-2 lists terms that are relevant to some fare concepts.

		Transmodel	
Informal		Fare Policy	
General		FARE VERSION	A set of fare collection data to which the same VALIDITY CONDITIONs have been assigned.
Fare Structure	**Geographic Structure**	TARIFF STRUCTURE	A particular tariff, described by a combination of parameters.
		TARIFF ZONE	A ZONE used to define a Zonal fare structure in a zone-counting or zone-matrix system.
		FARE STRUCTURE ELEMENT	A sequence or set of CONTROLLABLE ELEMENTs to which rules for limitation of access rights and calculation of prices (fare structure) are applied.
		FARE STRUCTURE ELEMENT IN SEQUENCE	A FARE STRUCTURE ELEMENT as a part of a VALIDABLE ELEMENT, including its possible order in the sequence of FARE STRUCTURE ELEMENTs forming that VALIDABLE ELEMENT, and its possible quantitative limitation.
		GEOGRAPHICAL STRUCTURE FACTOR	The value of a GEOGRAPHICAL INTERVAL or a DISTANCE MATRIX ELEMENT expressed by a GEOGRAPHICAL UNIT.
		GEOGRAPHICAL INTERVAL	A geographical interval specifying access rights for the FARE STRUCTURE ELEMENTs within the range of this interval: 0-5 km, 4-6 zones etc.
		GEOGRAPHICAL UNIT	Geographical structure factor used for graduated fare such as number of Fare Sections or Geographical units
		DISTANCE MATRIX ELEMENT	A cell of an origin-destination matrix for TARIFF ZONEs or STOP POINTs, expressing a fare distance for the corresponding trip: value in km, number of fare units etc.
		FARE SECTION – consecutive STOP POINTS in the pattern	A subdivision of a JOURNEY PATTERN consisting of consecutive POINTs IN JOURNEY PATTERN, used to define an element of the fare structure.
	Time Structure	TIME STRUCTURE FACTOR	The value of a TIME INTERVAL expressed by a TIME UNIT.
		TIME INTERVAL	A time-based interval specifying access rights for the FARE STRUCTURE ELEMENTs within the range of this interval: 0-1 hour, 1-3 days etc.
		TIME UNIT	A unit for calculating time-based graduated fares.
	Quality Structure	QUALITY STRUCTURE FACTOR	A factor influencing access rights definition or calculation of prices, based on the quality: traffic congestion threshold, early/late reservation etc.
		FARE DAY TYPE	A type of day used in the fare collection domain, characterised by one or more properties which affect the definition of access rights and prices in the fare system.
		GROUP TICKET	The number and characteristics of persons entitled to travel in addition to the holder of an access right.
		SEAT CLASS	A parameter indicating the quality of transport (e.g. 1st class or 2nd class).
		LUGGAGE ALLOWANCE	The number and characteristics (weight, volume) of luggage that a holder of an access right is entitled to carry.
		TRANSFERABILITY	The number and characteristics of persons entitled to use the public transport service instead of the original customer.
Control	**Control**	CONTROLLABLE ELEMENT	The smallest controllable element of public transport consumption, all along which any VALIDITY PARAMETER ASSIGNMENT remains valid.
		VALIDABLE ELEMENT	A sequence or set of FARE STRUCTURE ELEMENTs, grouped together to be validated in

			one go.
		CONTROLLABLE ELEMENT IN SEQUENCE	A CONTROLLABLE ELEMENT as a part of a FARE STRUCTURE ELEMENT, including its possible order in the sequence of CONTROLLABLE ELEMENTs grouped together to form that FARE STRUCTURE ELEMENT, and its possible quantitative limitation.
		CONTROLLED ACCESS	A validated use of a CONTROLLABLE ELEMENT.
		CONTROL PARAMETER ASSIGNMENT	An ACCESS RIGHT PARAMETER ASSIGNMENT relating a fare collection parameter to a CONTROL ENTRY.
	Use	VALIDATED ACCESS	A validated use of a VALIDABLE ELEMENT, composed of ACCESSED FARE STRUCTURE ELEMENTs.
		ACCESSED FARE STRUCTURE ELEMENT	A validated use of a FARE STRUCTURE ELEMENT, composed of CONTROLLED ACCESSes.
		DEBIT	A log entry providing data for a debiting action in case of post-payment or value card debiting.
		OFFENSE	A log entry providing data on a violation of fare rules.
		CONTROL TYPE	A classification of passenger controls, e.g. entry, exit, en route or occasional controls.
		CONTROL MEAN	A particular mean (control device or manual control procedure) used to control TRAVEL DOCUMENTs.
		CONTROL ENTRY	The description of a control action, i.e. the comparison of actual and current parameters (time, location, ...) to the access rights to which the holder of a TRAVEL DOCUMENT is entitled.
		VALIDITY PARAMETER ASSIGNMENT	An ACCESS RIGHT PARAMETER ASSIGNMENT relating a fare collection parameter to a VALIDATED ACCESS or one of its components.
	Access Right	ACCESS RIGHT PARAMETER ASSIGNMENT	The assignment of a fare collection parameter (referring to geography, time, quality or usage) to an element of a fare system (access right, validated access, control mean, etc.).
		DEVICE PARAMETER ASSIGNMEMNT	An ACCESS RIGHT PARAMETER ASSIGNMENT expressing the location (or other fixed parameters) of a CONTROL MEAN.
Fare Product		FARE PRODUCT	An immaterial marketable element (access rights, discount rights etc), specific to a CHARGING METHOD.
		PRE-ASSIGNED FARE PRODUCT	A FARE PRODUCT consisting of one or several VALIDABLE ELEMENTs, specific to a CHARGING METHOD.
		ACCESS RIGHT IN PRODUCT	A VALIDABLE ELEMENT as a part of a PRE-ASSIGNED FARE PRODUCT, including its possible order in the set of all VALIDABLE ELEMENTs grouped together to define the access right assigned to that PRE-ASSIGNED FARE PRODUCT.
		AMOUNT OF PRICE UNIT	A FARE PRODUCT consisting in a stored value of PRICE UNITs: an amount of money on an electronic purse, amount of units on a value card etc.
		CHARGING METHID	A classification of FARE PRODUCTs according to the payment method and the account location: pre-payment with cancellation (throw-away), pre-payment with debit on a value card, pre-payment without consumption registration (pass), post-payment etc.
		VALIDITY PERIOD	A time limitation for validity of a FARE PRODUCT or a SALES PACKAGE. It may be composed of a standard duration (e.g. 3 days, 1 month) and/or fixed start/end dates and times.
	Concession	SALE DISCOUNT RIGHT	A FARE PRODUCT allowing a customer to benefit from discounts when purchasing SALES PACKAGEs. (no own attribute)
		USAGE DISCOUNT RIGHT	A FARE PRODUCT allowing a customer to benefit

			from discounts when consuming VALIDABLE ELEMENTs.
Price		CONTROLLABLE ELEMENT PRICE	A set of all possible price features of a CONTROLLABLE ELEMENT: default total price, discount in value or percentage etc.
		FARE STRUCTURE ELEMENT PRICE	A set of all possible price features of a FARE STRUCTURE ELEMENT: default total price, discount in value or percentage etc.
		VALIDABLE ELEMENT PRICE	A set of all possible price features of a VALIDABLE ELEMENT : default total price, discount in value or percentage etc.
		DISTANCE MATRIX PRICE	A set of all possible price features of a DISTANCE MATRIX ELEMENT: default total price etc.
		TIME INTERVAL PRICE	A set of all possible price features of a TIME INTERVAL, e.g. default total price etc.
		USAGE PARAMETER PRICE	A set of all possible price features of a USAGE PARAMETER: discount in value or percentage etc.
		GEOGRAPHICAL INTERVAL PRICE	A set of all possible price features of a GEOGRAPHICAL INTERVAL: default total price etc.
		FARE PRODUCT PRICE	A set of all possible price features of a FARE PRODUCT: default total price, discount in value or percentage etc.
		PRICE GROUP	A grouping of prices, allowing the grouping of numerous possible consumption elements into a limited number of price references, or to apply grouped increase, in value or percentage.
Sales Package		SALES PACKAGE	A package to be sold as a whole, consisting of one or several FARE PRODUCTs materialised thanks to one or several TRAVEL DOCUMENTs. The FARE PRODUCTs may be either directly attached to the TRAVEL DOCUMENTs, or may be reloadable on the TRAVEL DOCUMENTs.
		SALES PACKAGE ELEMENT	The assignment of a FARE PRODUCT to a TYPE OF TRAVEL DOCUMENT in order to define a SALES PACKAGE, realised as a fixed assignment (printing, magnetic storage etc.) or by the possibility for the FARE PRODUCT to be reloaded on the TYPE OF TRAVEL DOCUMENT.
		SALES PACKAGE PRICE	A set of all possible price features of a SALES PACKAGE: default total price etc.
		RECORDED PT TRIP	The actual PT trip undertaken by a passenger from an origin to a destination. Origin and destination of the trip may be expressed in terms of STOP POINTs, TARIFF ZONEs or FARE SECTIONs, for instance.
		RECORDED RIDE	A ride made by a passenger on a public transport vehicle from one STOP POINT to another, without intermediate alighting.
		USAGE PARAMETER	A parameter used to specify the use of a SALES PACKAGE or a FARE PRODUCT.
		SALES TRANSACTION	A SALE OF a FIXED PACKAGE or a SALE OF a RELOADABLE PACKAGE.
	Query	FARE QUERY	A PASSENGER QUERY about fares.
		TRAVEL SPECIFICATION	The recording of a specification by a customer of parameters giving details of an intended consumption (e.g. origin and destination of a travel).
Ticket, Customer Media, Card	**Document**	TRAVEL DOCUMENT	A particular physical support (ticket, card...) to be held by a customer, allowing the right to travel or to consume joint services, to proof a payment (including possible discount rights), to store a subset of the CONTRACT liabilities or a combination of those.
		TYPE OF TRAVEL DOCUMENT	A classification of TRAVEL DOCUMENTs expressing their general functionalities and local functional characteristics specific to the operator.

			Types of TRAVEL DOCUMENT e.g. throw-away ticket, throw-away ticket units, value card, electronic purse allowing access, public transport credit card etc. may be used to define these categories.
		CONTRACT	A contract with a particular (but possibly anonymous) customer, ruling the consumption of transport services (and joint services). A CONTRACT may be designed for a fixed SALES PACKAGE (e.g. ticket) or to allow successive purchases of SALES PACKAGEs.
		CONTRACT EVENT	A log entry describing an event referring to the life of a CONTRACT: initial contracting, sales, validation entries, etc. A subset of a CONTRACT EVENT is often materialised on a TRAVEL DOCUMENT.
	Usage	CONTROL ENTRY	The description of a control action, i.e. the comparison of actual and current parameters (time, location, ...) to the access rights to which the holder of a TRAVEL DOCUMENT is entitled.
		VALIDATION ENTRY	The result of the comparison between one or several CONTROL ENTRies and the theoretical access rights attached to the TRAVEL DOCUMENT controlled, validating the right to consume and possibly providing a DEBIT or one or more OFFENCEs.
		VALIDATED ACCESS	A validated use of a VALIDABLE ELEMENT, composed of ACCESSED FARE STRUCTURE ELEMENTs.
		TRAVEL SPECIFICATION	The recording of a specification by a customer of parameters giving details of an intended consumption (e.g. origin and destination of a travel).
		USAGE PARAMETER	A parameter used to specify the use of a SALES PACKAGE or a FARE PRODUCT.
	Profile	COMMERCIAL PROFILE	A category of users depending on their commercial relations with the operator (frequency of use, amount of purchase etc.), often used for allowing discounts.
		USER PROFILE	The social profile of a passenger, based on age group, education, profession, social status, sex etc., often used for allowing discounts: 18-40 years old, graduates, drivers, unemployed, women etc.
		BLACKLIST	A list of identified TRAVEL DOCUMENTs permanently barred for a specific reason such as an offense committed by the customer, etc.

Table 12-1: Transmodel Fare Terms

12.6.2 Other Relevant Transmodel Elements

	Transmodel	
Network	TRANSPORT MODE	A characterisation of the operation according to the means of transport (bus, tram, metro, train, ferry, ship).
	LINE	A group of ROUTEs which is generally known to the public by a similar name or number.
	GROUP OF LINEs	A grouping of lines which will be commonly referenced for a specific purpose.
Actor	AUTHORITY	The organisation under which the responsibility of organising the transport service in a certain area is

		placed.
	OPERATOR	A company providing public transport services.
	GROUP OF OPERATORa	A group of OPERATORs having for instance common schemes for fare collection or passenger information.
	CUSTOMER	An identified person or organisation involved in a fare process. There may be a CONTRACT between the CUSTOMER and the OPERATOR or the AUTHORITY ruling the consumption of services.
	GROUP OF OPERATORS	A group of OPERATORs having for instance common schemes for fare collection or passenger information.
Journeys	STOP POINT	A POINT where passengers can board or alight from vehicles.
	JOURNEY PATTERN	An ordered list of STOP POINTs and TIMING POINTs on a single ROUTE, describing the pattern of working for public transport vehicles. A JOURNEY PATTERN may pass through the same POINT more than once. The first point of a JOURNEY PATTERN is the origin. The last point is the destination.
	POINT IN JOURNEY PATTERN	A STOP POINT or TIMING POINT in a JOURNEY PATTERN with its order in that JOURNEY PATTERN.
	VEHICLE JOURNEY	The planned movement of a public transport vehicle on a DAY TYPE from the start point to the end point of a JOURNEY PATTERN on a specified ROUTE.
Time	OPERATING DAY	A day of public transport operation in a specific calendar. An OPERATING DAY may last more than 24 hours.
	TIMEBAND	A period in a day, significant for some aspect of public transport, e.g. similar traffic conditions or fare category.
	GROUP OF TIMEBANDs	A grouping of TIME BANDs.
	VALIDITY CONDITION	Condition used in order to characterise a given VERSION of a VERSION FRAME. A VALIDITY CONDITION consists of a parameter (e.g. date, triggering event, etc) and its type of application (e.g. for, from, until, etc.).
units	PRICE UNIT	A unit to express prices: amount of currency, abstract fare unit, ticket unit or token etc.
	DISTANCE UNIT	
	TIME UNIT	A unit for calculating time-based graduated fares.

Table 12-2: Other Related Transmodel Terms

12.6.3 Some Other Fare terms Used

- Rounding Matrix
- Rounding Step
- Retail Fulfilment Channel
- Break of journey
- Booking deadlines
- Retail availability period
- Refundability
- Changes to travel plan
- Required proof of eligibility documents
- Fare quota:

12.6.4 Other Fare terms Noted

Glossary of Other terms noted but not used in Transmodel. These terms are used informally elsewhere in the document

- Single Fare
- Return fare
- Square Fare Table
- Triangular Fare Table
- Fare Stage
- Stage Fare
- Fare Point
- Stage Fare Point

13 Conclusions

Our research and consultation indicate that all stakeholders – operators, information providers, authorities and suppliers – would welcome the development of FareXChange.

Although the volume of fares data is very considerable, it is more stable than the timetable information handled by TransXChange which the main uses of FareXChange would sit alongside and FareXChange products would be readily added to systems already developed to use TransXChange. It is significant that all suppliers soon saw commercial potential for their future product developments.

Development of FareXChange should accommodate both static and dynamic fares. National Express coaches and the rail industry are already using dynamic fares extensively. Indeed representatives of the rail industry consider that if development of FareXChange does not go ahead they would need to procure their own alternative. There is therefore scope for joint action to procure the standard to meet already identified needs.

Transmodel has powerful generalisations which can be used to build Fare structures, fare Products and fare limitation conditions equivalent to the current Fare Structures & Products found in the UK. The Transmodel model needs interpreting in terms of the specific subset of function and specific practical implementation issues (e.g. identifier namespaces) appropriate to the UK's PT info

Transmodel offers a clear separation of functionality into separate submodels for Fare Structure, Fare pricing, Fare Product construction, and Ticket Packaging and a similar separation should be followed in FXC.

A gap analysis reveals a number of specific areas where Transmodel will need extending to cover UK practice: there are appropriate places to add these to the Transmodel framework. For example:

- Retail fulfilment restrictions and conditions.
- Tariff zones.
- Rounding and Capping tables.

Similarly there are a few areas where TransXChange or NaPTAN would need additional entities in order to support a full fare model – for example the concept of Named "Groups of Operators".

It would be useful to include a number of standard product types (e.g. single, return concessionary fares appropriate to UK modes) in the UK implementation.

There are qualitative differences between the Transport structures of different modes: Train tends to have more complex restrictions and conditions, bus tends to have simpler availability conditions – and possibly more complex interzonal products. This may lead to different priorities for different modes.

Process and business issues, such as equitable comparison of fares, and data confidentiality are vital: these mostly require organisational rather than technical solutions.

14 Recommendations

A FareXChange schema should be developed to communicate fare data to journey planning engines and retailing systems and to facilitate further development of products enabling fares to be linked more directly to other systems used by operators and authorities.

Any technical standard should be accompanied by codes of practice and guidance on publication and use of fares, and in particular on the presentation of price comparisons in journey planners.

From a Technical Point of view the FXC is viable and can be developed in a modular and phased manner. The following specific points are noted.

- To develop a first release, particular emphasis should be placed on developing a set of examples that can be used to verify the design.
- The implementation should follow the detailed Technical standards set out in this paper, and be based on Transmodel.
- The design should allow the exchange of deltas as well as the full data set.
- It will be important to have a basic Fare Table publisher as a way of visualising and verifying in human readable form data held within an FXC XML document.
- Since Operators are likely to be the owners and originators of much of the fare data, a Data system for identifying Operators and Operators Groups Nationally is needed. This can be used to ensure that persistent Tariff Zone (or “Fare Stage Point”) identifiers are unique.
- The TransXChange fare Usage model should be extended to cover the richer retail model found in the UK.
- The FXC should include ready-made fare products corresponding to the common UK fare types in the bus and rail industry.
- Further work should be done to investigate the representation of flow and routing fare restrictions for Rail to ensure that an efficient model can be coded in XML.
- There should be a work item to develop a Dynamic Journey Fare Query as part of the standard as a way of validating the design for end-to-end use. This could be done as a JourneyWeb extension.
- There should be mechanisms in the data model to allow the embargoing of publication of data.
- There should be support for encryption of content to allow distribution ahead of release.

This study was not resourced to test the business case for FareXChange but we have identified some key elements and proposed a survey and consultation based method for doing this either as an extension to the current study or a separate project.

The rail industry has already identified a need for a protocol similar to our FareXChange standard proposals. There will be considerable synergy benefits if the development takes place with stakeholder partners fully involved and we recommend that DfT and ATOC/RSP in consultation with other stakeholders should proceed to procure the development of the FareXChange standard.

15 Appendixes

15.1 Organisations Consulted

AIM (Action Information Management Ltd)
Almex Information Systems (Höft & Wessel Group)
Arriva PLC
Atkins
ATOC (Association of Train Operating Companies) and Rail Settlement Plan Ltd
Atos Origin
Brighton & Hove City Council
Carmen Systems
CPT (Confederation of Passenger Transport UK)
EAPTIS Ltd (East Anglia Public Transport Information Service)
East Riding of Yorkshire Council
FirstGroup plc
Herefordshire County Council
Integrated Transport Smartcard Organisation Ltd
JourneyPlan Ltd
MDV (Mentz Datenverarbeitung GmbH)
National Express Coaches
National Express Group
Oxfordshire County Council
PayPoint plc
PTI Cymru Ltd
Shere Limited
South West Public Transport Information Ltd
Stagecoach UK Bus + 9 Subsidiary Companies
The Go-Ahead Group plc + 1 Subsidiary Company
thetrainline.com
Ticketing Solutions Ltd
TouchStar Technologies Ltd
Transport Direct
Transport for London
Trapeze Group
Traveline
Traveline East Midlands
Traveline North East
Traveline North West
Traveline Scotland
Traveline South East
Traveline Yorkshire & Humberside
Wayfarer Transit Systems Ltd.
West Midlands Transport Information Services Ltd.

15.2 Source Information Websites

Name	Type	URL	About / Notes
Aberdeenshire	Fares in Local Authority area	http://www.aberdeenshire.gov.uk/publictransport/fares/index.asp	Shows Bus Fares in Aberdeenshire
Airlink 757	Branded bus service	http://www.airlink757.co.uk/info/fares.htm	
Airport Commuter	Travel Ticket	http://www.airport-commuter.co.uk	Shows Special Fares for Employees of Heathrow, Gatwick, Stansted Airports
Aldborough Community Bus	Bus Operator	http://www.aldborough.org/comm/bus/	Community bus services
Armchair	Commuter Coach Service	http://www.armchair.co.uk/publicframe.html	
Arriva	Bus Operator	http://www.arrivabus.co.uk	Click on 'Latest Fares' gives general fares info for that area with hyperlinks to more detailed info
Arriva Trains Wales	National Rail service	http://www.arrivatrainswales.co.uk/uploads/documents/371.pdf	Shows Details of ticket types available
Bakers of Biddulph	Bus Operator	http://www.bakerbus.com/timetable/index.php	
Bala Lake Railway	Heritage Railway	http://www.bala-lake-railway.co.uk/fares.htm	
Banburyshire Community Transport Association (Kidlington Lynx and Cherwell Villager)	Bus Operator	http://www.banburyshire-cta.co.uk/	Click on 'Dial a Ride', 'Cherwell Villager' and 'Kidlington Lynx' buttons
Bath & North East Somerset FareCar	Branded DRT service	http://www.bathnes.gov.uk/BathNES/transportandroads/travel/buses/SupportedServices/FareCar.htm	
Battlefield Line Railway	Heritage Railway	http://ourworld.compuserve.com/homepages/ChrisSimmons/Timetabl.htm#STANDARD RETURN TRAIN FARES	
Beaumont Travel	Bus Operator	http://www.beaumont-travel.com/routes.htm	Some timetables also show Fares info (e.g. the 'Link' services)

Bedford DART	Branded DRT service	http://www.bedforddart.co.uk	Shows Individual area .PDF files show fares info
Big Bus Company	Hop-on / Hop-off bus service	http://www.bigbustours.com/uk/html/uk_our_tours.html	
Blackburn Transport	Bus Operator	http://www.blackburntransport.co.uk/tickets/index.htm	
Blackpool Express	Express Coach service	http://www.blackpoolexpress.com/html/fares.html	
Blackpool Transport / Metro Coastlines	Bus Operator	http://www.blackpooltransport.com/	Click on 'Ticket Info' tag
Blue Star	Branded bus service	http://www.bluestarbus.info/fares.html	
Bluebell Railway	Heritage Railway	http://www.bluebell-railway.co.uk/bluebell/bluett.html#fares	
Blyth Connect Shared Taxi service	Branded DRT service	http://www.northumberland.gov.uk/drftp/5709.pdf	
Brecon Mountain Railway	Heritage Railway	http://www.breconmountainrailway.co.uk/fares.html	
Brighton & Hove	Bus Operator	http://www.buses.co.uk/	Click on 'Money Savers' and 'Tickets on Line' tags
Bristol Ferry Boat	Ferry	http://www.bristolferryboat.co.uk/timetabled/daily.html	
Bristol Visitor	Hop-on / Hop-off bus service	http://www.bristolvisitor.co.uk/	
Brookesbus	Branded bus service	http://www.brookesbus.net	Click on 'Brookes Pass Scheme'
Buglers	Bus Operator	http://www.buglercoaches37.freeserve.co.uk/511.htm	
Bure Valley Railway	Heritage Railway	http://www.bvrw.co.uk/	Once site is loaded click on 'Standard Fares' and 'Railcard' tags
Burnley & Pendle	Bus Operator	http://www.burnleyandpendle.co.uk/	Click on 'Fares & Tickets' tag
Bus 2 Jet	Branded bus service	http://www.bus2jet.com/	Click on 'Fares on Bus 2 Jet'
Buses4U	Branded DRT service	http://www.buses4u.org.uk/fares.htm	
Buzzlines	Commuter Coach	http://www.buzzlines.co.uk/images/home/timetable.pdf	

	Service		
c2c	National Rail service	http://www.c2c-online.co.uk/	Click on 'To Work' and 'To Play' buttons
CalMac Ferries	Ferry	http://www.calmac.co.uk/timetables.html	Also click on 'Island Hopscotch' tag
Canterbury Park & Ride	Park & Ride bus service	http://www.canterbury.gov.uk/cgi-bin/buildpage.pl?mysql=1566	
Cardiff Bus	Bus Operator	http://www.cardiffbus.com/fares/fares.htm	
Cardiff Cats Waterbus	Ferry	http://www.cardiffcats.com/	
Carousel Buses	Bus Operator	http://www.carouselbuses.com/fares.htm	
Catamaran Cruisers	Ferry	http://www.catamarancruisers.co.uk/cat/index.html	Click on 'Sightseeing Cruises'
Central Trains	National Rail service	http://www.centraltrains.co.uk/	Most headings have links to specific fare information for that class of traveller
Chalkwell Coaches	Commuter Coach Service	http://www.chalkwell.co.uk/commuter/fares.html	
Chester Park & Ride	Park & Ride bus service	http://www.chester.gov.uk/main.asp?page=183	
Chiltern Railways	National Rail service	http://www.chilternrailways.co.uk/content.php?nID=1	
Churnet Valley Railway	Heritage Railway	http://www.churnet-valley-railway.co.uk/timetable.htm	
City Boats (Norwich: Elm Hill Quay - Pulls Ferry Quay - Station Quay - Whitlingham Park Quay - Thorpe St Andrew: Griffin Lane Quay)	Ferry	http://www.cityboats.co.uk/scheduled.htm	
City Cruises	Ferry	http://www.citycruises.com/rrrinfo.php	
Clarkes of London	Commuter Coach Service	http://www.clarkesoflondon.co.uk/fares.asp	
Compass Travel	Bus Operator	http://www.compass-travel.co.uk/information.html	

Cornwall	Fares in Local Authority area	http://www.cornwall.gov.uk/index.cfm?articleid=7365	
Cotswold LineRailbus - Fares on DRT services	Branded DRT service	http://www.railbus.co.uk/Page02_Charlbury.htm	
Cumbria - The Lake District - Travel & Transport	National Park sponsored services	http://www.roomcheck.co.uk/scripts/ea_browse.asp?dc=CU&wc=cu&tg=../cu/img/header_travelticket.htm&bg=../cu/img/footer_info.htm&itemtype=391&easi=true	
DalesBus	National Park sponsored services	http://www.dalesbus.org	Click on 'Special Fares'
Darlington	Fares in Local Authority area	http://www.darlington.gov.uk/Transport/TownOnTheMove/BusTravel/StandardFareInfo.htm	
Delaine Buses	Bus Operator	http://www.delainebuses.com	Click on 'Saver Tickets'
Delta Coaches	Express Coach service	http://www.delta-holidays.co.uk/x30_Blackpool.htm	
Derbyshire	Fares in Local Authority area	http://www.derbysbus.net	Click on 'Fares, Tickets & Passes'
Devon	Fares in Local Authority area	http://devonwide.devon.gov.uk	Shows Devon Concessionary Fares Schemes
Diamond Bus	Bus Operator	http://www.birmingham-coach.co.uk/3_2_ticketing_1.htm	
DoRiS	Branded DRT service	http://www.westsussex.gov.uk/ccm/content/roads-and-transport/public-transport/community-and-rural-transport/doris.en?page=5	
East Lancs Railway	Heritage Railway	http://www.east-lancs-rly.co.uk/fares.htm	
East Sussex	Fares in Local Authority area	http://www.eastsussex.gov.uk/roadsandtransport/public/concessionaryfares/default.htm	
East Yorkshire Motor Services	Bus Operator	http://www.eyms.co.uk/	Click on 'Discount Tickets' tag
Eastbourne Buses	Bus Operator	http://www.eastbournebuses.co.uk/	Click on 'Fares and Tickets'
easybus	Express Coach service	http://www.easybus.co.uk	
Espress	Express Coach	http://www.espress.info	Click on 'Fares'

	service		
Essex	Fares in Local Authority area	http://www.essexcc.gov.uk/vip8/ecc/ECCWebsite/content/binaries/documents/A5_flyer_sunday_saver_one_page.pdf	Shows Info on the Sunday Saver ticket
Explore Card	Fares in Local Authority area	http://explore.suffolkonboard.com/	
Explorer North East	Travel Ticket	http://www.explorernortheast.co.uk/	
Falmouth - St Mawes ferry	Ferry	http://www.stmawes-ferry.co.uk/timetable.htm	
Falmouth Park & Float (Ponsharden P&R - Falmouth - National Maritime Museum)	Ferry	http://www.falriverlinks.co.uk/html/parking.html	
Faresaver	Bus Operator	http://www.faresaver.co.uk/tickets.htm	
Ferrytoll Bus Park & Ride	Park & Ride bus service	http://www.ferrytoll.org/fares.html	
Ffestiniog Railway	Heritage Railway	http://www.festrail.co.uk/	
First for Students	Travel Ticket	http://www.firstforstudents.co.uk/	
First Great Western	National Rail service	http://www.firstgreatwestern.co.uk/travelinfo/faresandtickets.php	
First in Aberdeen	Bus Operator	http://www.firstgroup.com/ukbus/scotland/nescot/fares/faresindex.php	
First in Berkshire & the Thames Valley	Bus Operator	http://www.firstgroup.com/ukbus/southeast/berkshirethames/fares/faresindex.php	
First in Bradford	Bus Operator	http://www.firstgroup.com/ukbus/yorkhumber/bradford/fares/faresindex.php	
First in Bristol	Bus Operator	http://www.firstgroup.com/ukbus/southwest/bristol/fares/faresindex.php	
First in Chester & the Wirral	Bus Operator	http://www.firstgroup.com/ukbus/northwest/chesterwirral/fares/faresindex.php	
First in Devon and Cornwall	Bus Operator	http://www.firstgroup.com/ukbus/southwest/devon/fares/faresindex.php	
First in Dorset	Bus Operator	http://www.firstgroup.com/ukbus/southwest/dorset/fares/faresindex.php	

First in East Anglia	Bus Operator	http://www.firstgroup.com/ukbus/eastanglia/eastanglia/fares/faresindex.php
First in Edinburgh, Central and the Borders	Bus Operator	http://www.firstgroup.com/ukbus/scotland/sescot/fares/faresindex.php
First in Essex	Bus Operator	http://www.firstgroup.com/ukbus/southeast/essex/fares/faresindex.php
First in Greater Glasgow	Bus Operator	http://www.firstgroup.com/ukbus/scotland/swscot/fares/faresindex.php
First in Halifax & Huddersfield	Bus Operator	http://www.firstgroup.com/ukbus/yorkhumber/halihudd/fares/faresindex.php
First in Hampshire	Bus Operator	http://www.firstgroup.com/ukbus/southeast/hampshire/fares/faresindex.php
First in Leeds	Bus Operator	http://www.firstgroup.com/ukbus/yorkhumber/leeds/fares/faresindex.php
First in Leicester	Bus Operator	http://www.firstgroup.com/ukbus/eastmidlands/leicester/fares/faresindex.php
First in Manchester	Bus Operator	http://www.firstgroup.com/ukbus/northwest/manchester/fares/faresindex.php
First in Northampton	Bus Operator	http://www.firstgroup.com/ukbus/eastmidlands/northampton/fares/faresindex.php
First in Somerset & Avon	Bus Operator	http://www.firstgroup.com/ukbus/southwest/somerset/fares/faresindex.php
First in South Wales	Bus Operator	http://www.firstgroup.com/ukbus/wales/swwales/fares/faresindex.php
First in South Yorkshire	Bus Operator	http://www.firstgroup.com/ukbus/yorkhumber/southyorkshire/fares/faresindex.php
First in Staffordshire & south Cheshire	Bus Operator	http://www.firstgroup.com/ukbus/northwest/staffordshire/fares/faresindex.php
First in Worcestershire & Herefordshire	Bus Operator	http://www.firstgroup.com/ukbus/westmidlands/worcest_hereford/fares/faresindex.php
First in York	Bus Operator	http://www.firstgroup.com/ukbus/yorkhumber/york/fares/faresindex.php

First ScotRail	National Rail service	http://www.firstgroup.com/scotrail/content/travelinfo/ticketsandfares.php	
Gatwick Express	National Rail service	http://www.gatwickexpress.com/	Click on 'Fares'
Gatwick Flyer	Express Coach service	http://www.gatwickflyer.co.uk	Click on 'Prices'
Glasgow Citybus	Bus Operator	http://www.glasgowcitybus.co.uk/tickets.htm	
GNER - Great North Eastern Railway	National Rail service	http://www.gner.co.uk/GNER/tickets/default.htm	
Go North East	Bus Operator	http://www.simplygo.com	Click on 'Fares & Tickets' tag
Gosport Ferry	Ferry	http://www.gosportferry.co.uk/	
Greater Manchester PTE	PTE	http://www.gmpte.com/content.cfm?category_id=103842	
Green Line easyjet offer	Bus Operator	http://www.greenline.co.uk/__80256E2700397232.nsf/vWeb/wpNPOK6CBKG7?OpenDocument	
Green Line. RainbowFares.com	Travel Ticket	http://www.rainbowfares.com/	
Gwynedd	Fares in Local Authority area	http://www.gwynedd.gov.uk/gwy_doc.asp?cat=2772&doc=12653	
Halton	Fares in Local Authority area	http://www2.halton.gov.uk/publictransport/content/concessionaryfares?a=5441	
Handcross (&) District Community Bus	Bus Operator	http://www.warninglid.org.uk/warninglid_handcrosscommunitybus.htm	
Harrogate & District	Bus Operator	http://www.harrogateanddistrict.co.uk/	Click on 'Fares & Tickets' tag
Harwich Harbour Ferry Services	Ferry	http://www.harwichharbourferry.com/fares.html	
Heathrow Express	National Rail service	http://www.heathrowexpress.com/	Click on 'Fares'
Henderson Travel	Bus Operator	http://www.henderson-travel.co.uk/	Click on 'Special Fares'
Hertfordshire	Fares in Local Authority area	http://www.intalink.org.uk/	Click on 'Information'
Horsham Park & Ride	Park & Ride bus service	http://www.horsham.gov.uk/your_area/your_area_1933.asp	

Hovertravel: Southsea - Ryde	Ferry	http://www.hovertravel.co.uk	Click on 'Fares'
Hull Trains	National Rail service	http://www.hulltrains.co.uk/fares.htm	
Huntingdon & District	Bus Operator	http://www.huntsbus.co.uk/hd_tickets.html	
Ipswich Buses	Bus Operator	http://www.ipswichbuses.co.uk/	Click on 'Fares'
Island Line	National Rail service	http://www.island-line.co.uk/	Click on 'Tickets / Fares'
Isle of Wight Steam Railway	Heritage Railway	http://www.iwsteamrailway.co.uk/	Click on 'Timetables and Fares'
Kangaroo Bus Ticket	Travel Ticket	http://www.itsnottingham.info/kangaroo.htm	
Keighley & District	Bus Operator	http://www.keighleyanddistrict.co.uk/	Click on 'Fares & Tickets' tag
Lancashire United	Bus Operator	http://www.lancashireunited.co.uk	Click on 'Fares & Tickets' tag
Leighton Buzzard Railway	Heritage Railway	http://www.btinternet.com/~buzzrail/page6.html	
Llangollen Railway	Heritage Railway	http://www.llangollen-railway.co.uk/fares.html	
London	Transport for London	http://www.TfL.gov.uk/TfL/fares-tickets/2006/index.shtml	
London Flyer	Express Coach service	http://www.bakersdolphin.com/flyer_timetable.asp	
Lothian Buses	Bus Operator	http://www.lothianbuses.co.uk/	Click on 'Tickets' tag
Luton	Fares in Local Authority area	http://www.luton.gov.uk/internet/transport_and_streets/public_transport/fares_passes_and_permits/Concessionary%20Fares	Shows Details on new Concessionary Fares scheme
Marshalls Coaches	Commuter Coach Service	http://www.marshalls-coaches.co.uk/prices.asp	
Mersey Ferries	Ferry	http://www.merseyferries.co.uk/ticket-prices/index.aspx	
Merseyrail	National Rail service	http://www.merseyrail.org/travelling/?sGUID=07fc5315ee8232f0bbcf5b3370bf2747	
Merseyside (Merseytravel)	PTE	http://www.merseytravel.gov.uk/information_tickets.html	
Metrobus	Bus Operator	http://www.metrobus.co.uk/fares.php	
Metrolink	Tram service	http://www.metrolink.co.uk/tickets/index.asp	

Mid Norfolk Railway	Heritage Railway	http://www.mnr.org.uk/services/fares.html	
Midland Mainline	National Rail service	http://www.midlandmainline.com/	Click on 'Tickets & Promotions'
Midland Metro	Tram service	http://www.midlandmetro.co.uk/tickets/index.asp	
Milton Keynes	Fares in Local Authority area	http://www.mkweb.co.uk/transport/DisplayArticle.asp?ID=14686	Shows Details of adult Cityrider tickets
MK Metro	Bus Operator	http://www.askmk.com/mkmetro/mkmetro.html	Click on 'Metro Savers' and 'Special Offers' buttons
MoorsBus	National Park sponsored services	http://moors.uk.net/uploads/publication/3155.pdf	
National Express	Express Coach service	http://www.nationalexpress.com/save/index.cfm	
National Rail - Main	National Rail service	http://www.nationalrail.co.uk/times_fares/purchasing_tickets/	
National Rail - Promotions	National Rail service	http://www.nationalrail.co.uk/promotions/	
National Railcard	Travel Ticket	http://www.railcard.co.uk/	
Network Ticketing	Travel Ticket	http://www.networkticketing.com/	
Newport Bus	Bus Operator	http://www.newporttransport.co.uk/	Look under 'Bus Services' then 'Fares'
North Birmingham Busways	Bus Operator	http://www.northbhambusways.co.uk/faresindex.htm	
North East Lincolnshire 'How to get Cheap Fares'	Fares in Local Authority area	http://www.nelincs.gov.uk/transportstreets/concessionaryrates/cheap-fares.htm	
North East Lincolnshire Phone 'n'Ride	Branded DRT service	http://www.nelincs.gov.uk/transportstreets/phone-n-ride-cost.htm	Shows Details of Phone'n'Ride scheme
North Norfolk Railway	Heritage Railway	http://www.nnrail.co.uk/	Click on 'Fares'
North Yorkshire Moors Railway	Heritage Railway	http://www.northyorkshiremoorsrailway.com	Click on 'Visitor Services', then 'Fares'
NorthLink Ferries	Ferry	http://www.northlinkferries.co.uk/fares.html	

Nottingham City	Fares in Local Authority area	http://www.nottinghamcity.gov.uk/sitemap/transport_and_streets/cdtp_public_transport/fares,_passes_and_permits.htm	
Nottingham City Transport	Bus Operator	http://www.nctx.co.uk/	Click on 'Ticket Options'
Nottingham Express Transit (NET)	Tram service	http://www.thetram.net/times/fares.asp	
Nottingham Skylink	Branded bus service	http://www.skylink.co.uk/fares.html	
Nottinghamshire - All Day Travel Tickets	Fares in Local Authority area	http://www.nottinghamshire.gov.uk/home/traffic_and_travel/buses/buses_makingmostof/alldaytraveltickets.htm	
NoWcard	Travel Ticket	http://www.nowcard.org	
Nu-Venture	Bus Operator	http://www.nu-venture.co.uk/info/Ticketing.htm	
Oban & District / West Coast Motors	Bus Operator	http://www.obanbuses.co.uk	Click on 'Promotions' ('Fare Guide' doesn't work)
One	National Rail service	http://www.onerailway.com/timetable/tickets/	
One-ticket	Travel Ticket	http://www.one-ticket.co.uk	
Oxford Bus	Bus Operator	http://www.oxfordbus.co.uk	
Peak Rail	Heritage Railway	http://www.peakrail.co.uk/timetabl.htm	
Plusbus	Travel Ticket	http://www.plusbus.info	
Portsmouth - Hayling Island	Ferry	http://www.langstoneharbour.org.uk/harbour/ferry.htm	
Preston Bus	Bus Operator	http://www.prestonbus.co.uk/ticket.asp	
Railair	Express Coach service	http://www.railair.com/fares.html	
Rapsons / Highland Country / Orkney Coaches	Bus Operator	http://www.rapsons.co.uk	Click on 'Explorer Tickets'
Reading Buses / Newbury Buses	Bus Operator	http://www.reading-buses.co.uk/trav.htm	
Red Funnel: Southampton - Cowes / East Cowes	Ferry	http://www.redfunnel.co.uk/redfunnel/travel/html/main2.shtml	

Reliance Coaches / Grangeville	Commuter Coach Service	http://www.reliance-travel.co.uk/commuter.html#fares_and_tickets	
Ribble Valley Day Ranger	Fares in Local Authority area	http://www.lancashire.gov.uk/environment/bus/ribble_valley_day_ranger/ribval.asp	
Richards Brothers	Bus Operator	http://www.gobybus.net/fares.htm	
Richmonds Coaches	Commuter Coach Service	http://www.richmonds-coaches.co.uk/prices.pdf	
Road Car	Bus Operator	http://www.roadcar.co.uk/	Click on 'Tickets'
Romney, Hythe & Dymchurch Railway	Heritage Railway	http://www.rhdr.org.uk/rhdr/timefares.html#fares	
Rossendale Transport	Bus Operator	http://www.rossendalebus.co.uk/faredeals.html	
Route X3 - X13	Branded bus service	http://www.x3xpress.com/x3_x13-full-details.pdf	
Sargeant Brothers	Bus Operator	http://www.sargeantsbros.com/pages/bus_pass.htm#	
Saveaway Tickets	Travel Ticket	http://www.transportmerseyside.org/images/uploads/1090578386.pdf	
Scillonian III	Ferry / Air services	http://www.islesofscilly-travel.co.uk/fares.htm	
Scottish Citylink	Bus Operator	http://www.citylink.co.uk/savings.htm	
Severn Valley Railway	Heritage Railway	http://www.svr.co.uk/timetable.php	Click on the ticket for Fares Information
Shamrock (Travel) / Venture Travel	Bus Operator	http://shamrocktravel.co.uk/lang/offers.php	
Shetland Islands Council Ferry Service Information	Ferry	http://www.shetland.gov.uk/ferries/documents/2005A4FREEBLUEMULLFaressheet3.doc1.pdf	
Silver Choice (Travel)	Express Coach service	http://www.silverchoicetravel.co.uk/edin-glas.htm	
Silverlink Trains	National Rail service	http://www.silverlink-trains.com/	Click on 'Commuter' and 'Leisure'
Sittingbourne & Kelmsley Light Railway	Heritage Railway	http://www.sklr.net/timetable/index.htm#Fares	
Solent Travelcard	Travel Ticket	http://www.solent-travelcard.org.uk	

South Gloucestershire Bus & Coach	Bus Operator	http://www.southgloucestershirebus.co.uk/	Click on 'Tickets'
South Lancs Travel / South Lancs Transport	Bus Operator	http://www.southlancs.com/	Click on 'Fares'
South West Trains	National Rail service	http://www.southwesttrains.co.uk/	Click on 'Tickets and Railcards'
South Yorkshire PTE	PTE	http://www.sypte.co.uk/tickets/index.html	
Southampton - Hythe	Ferry	http://www.hytheferry.co.uk/extra.mhtml?page_no=2&count-num=130877	
Southern Railway	National Rail service	http://www.southernrailway.com/main.php?page_id=30	
Southern Vectis	Bus Operator	http://www.svoc.co.uk/rover.html	Shows Rover Tickets
Spa Valley Railway	Heritage Railway	http://www.spavalleyrailway.co.uk/SpaFares_04.htm	
Stagecoach Bluebird	Bus Operator	http://www.stagecoachbus.com/bluebird/promotions.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Bassetlaw	Bus Operator	http://www.stagecoachbus.com/bassetlaw/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Bedford	Bus Operator	http://www.stagecoachbus.com/bedford/promotions.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Cheltenham	Bus Operator	http://www.stagecoachbus.com/cheltenham/localoffers_552.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Chesterfield	Bus Operator	http://www.stagecoachbus.com/chesterfield/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Cumbria	Bus Operator	http://www.stagecoachbus.com/northwest/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Darlington	Bus Operator	http://www.stagecoachbus.com/darlington/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Devon	Bus Operator	http://www.stagecoachbus.com/devon/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in East Kent	Bus Operator	http://www.stagecoachbus.com/eastkent/localoffers.html	Click on 'Local Offers' or 'Tickets'

Stagecoach in Fife	Bus Operator	http://www.stagecoachbus.com/fife/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Glasgow	Bus Operator	http://www.stagecoachbus.com/glasgow/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Gloucester	Bus Operator	http://www.stagecoachbus.com/gloucester/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Grimsby-Cleethorpes	Bus Operator	http://www.stagecoachbus.com/grimsbycleethorpes/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Hampshire	Bus Operator	http://www.stagecoachbus.com/south/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Hartlepool	Bus Operator	http://www.stagecoachbus.com/hartlepool/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Hastings	Bus Operator	http://www.stagecoachbus.com/hastings/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Hull	Bus Operator	http://www.stagecoachbus.com/hull/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Inverness	Bus Operator	http://www.stagecoachbus.com/inverness/promotions.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Manchester	Bus Operator	http://www.stagecoachbus.com/manchester/ticketsoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Mansfield	Bus Operator	http://www.stagecoachbus.com/mansfield/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Newcastle	Bus Operator	http://www.stagecoachbus.com/newcastle/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Northants	Bus Operator	http://www.stagecoachbus.com/northants/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Oxfordshire	Bus Operator	http://www.stagecoachbus.com/oxfordshire/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Perth	Bus Operator	http://www.stagecoachbus.com/perth/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Peterborough	Bus Operator	http://www.stagecoachbus.com/peteborough/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in South Shields	Bus Operator	http://www.stagecoachbus.com/southshields/localoffers.html	Click on 'Local Offers' or 'Tickets'

Stagecoach in South Wales	Bus Operator	http://www.stagecoachbus.com/southwales/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Sunderland	Bus Operator	http://www.stagecoachbus.com/sunderland/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Swindon	Bus Operator	http://www.stagecoachbus.com/swindon/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in the Cotswolds	Bus Operator	http://www.stagecoachbus.com/cotswolds/localoffers_419.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Warwickshire	Bus Operator	http://www.stagecoachbus.com/warwickshire/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach in Wye & Dean	Bus Operator	http://www.stagecoachbus.com/wyeanddean/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach on Teesside	Bus Operator	http://www.stagecoachbus.com/teesside/localoffers.html	Click on 'Local Offers' or 'Tickets'
Stagecoach Oxford Tube	Express Coach service	http://www.oxfordtube.com/tube_fares.php	Click on 'Local Offers' or 'Tickets'
Stagecoach Supertram	Tram service	http://www.supertram.net/ticketinformation.htm	Click on 'Local Offers' or 'Tickets'
Stagecoach West Scotland	Bus Operator	http://www.stagecoachbus.com/western/ticketsandoffers.html	Click on 'Local Offers' or 'Tickets'
Stanley Buses	Bus Operator	http://www.stanleytaxis.co.uk/	Click on 'Return Tickets' and 'Megapass'
Stansted Express	National Rail service	http://www.stanstedexpress.com/	Click on 'Fares'
Stephensons of Essex	Bus Operator	http://www.stephensonsofessex.com/soefiles/londonlinkexpress.htm#londonlinkfares	
Strathclyde	PTE	http://www.spt.co.uk/tickets/index.html	
Suffolk - Revised bus fares	Fares in Local Authority area	http://www.suffolk.gov.uk/TransportAndStreets/PublicTransport/RevisedBusFares.htm	
Sullivan Buses	Bus Operator	http://www.earthfish.co.uk/ft/	Each file in the index list is fare table for a different route. List of routes is at http://www.sullivanbuses.com/ (Click on 'Routes')

Sureline	Bus Operator	http://www.surelinebuses.co.uk	Click on 'Fares' and 'Smartrider'
Surrey	Fares in Local Authority area	http://www.surreycc.gov.uk/sccwebsite/sccwspages.nsf/LookupWebPagesByTITLE_RTF/Ticketing+and+fares?opendocument	
Swanage Railway	Heritage Railway	http://www.swanagerailway.co.uk/timetabl.htm	
System One Travel	Travel Ticket	http://www.system-1-travel.co.uk	
Talyllyn Railway	Heritage Railway	http://www.talyllyn.co.uk/fares.html	
Terravision - Luton Airport service	Express Coach service	http://www.lowcostcoach.com/london_luton.html#	
Terravision - Stansted Airport service	Express Coach service	http://www.lowcostcoach.com/london.html#	
Thames Clippers	Ferry	http://www.thamesclippers.com/fares/	
Thames River Services	Ferry	http://www.westminsterpier.co.uk/fares.htm	
Thamesdown Transport	Bus Operator	http://www.thamesdown-transport.co.uk/fares/fares.htm	
Thameslink	National Rail service	http://www.thameslink.co.uk/main.php?page_id=30	
The 36	Branded bus service	http://www.the36.co.uk	Click on 'Fares on 36'
The Airline	Express Coach service	http://www.oxfordbus.co.uk/airlinefares.html	
The King's Ferry	Commuter Coach Service	http://www.thekingsferry.co.uk/02commuterfares.asp	
The Lancashire Way	Branded bus service	http://www.thelancashireway.com/	Click on 'Fares on The Lancashire Way'
The Shuttle 662	Branded bus service	http://www.theshuttle662.co.uk/	Click on 'Fares on the Shuttle'
The Train Line	National Rail service	http://www.thetrainline.com	
The Travellink	Commuter Coach Service	http://www.thetravellink.co.uk/general_information.asp?in=5	
The Witch Way	Branded bus service	http://www.thewitchway.co.uk/	Click on 'Fares on The Witch Way'
Translinc	Express Coach	http://www.translinc.co.uk/tllonxp&tnew.htm	

	service		
TransPennine Express	National Rail service	http://www.tpexpress.co.uk/tickets/default.asp	
Travel Coventry	Bus Operator	http://www.travelcoventry.co.uk/cards/index.asp	
Travel Dales	National Park sponsored services	http://www.traveldales.org.uk/bus_services.cfm	
Travel Dundee	Bus Operator	http://www.traveldundee.co.uk/	Click on 'Tickets & Prices' tag
Travel West Midlands	Bus Operator	http://www.travelwm.co.uk/cards/index.asp	
Trent Barton	Bus Operator	http://www.trentbarton.co.uk/fares/index.html	
Truronian	Bus Operator	http://www.truronian.com/index.cfm?articleid=192	
Tyne & Wear PTE (Nexus)	PTE	http://www.nexus.org.uk/ticket_info.htm	
Ullswater Steamers	Ferry	http://www.ullswater-steamers.co.uk/fares.htm	
Unilink	Branded bus service	http://www.uni-link.info/	Click on 'Fares'
Unilinx	Branded bus service	http://www.unilinx.net/fares.html	
Vale of Rheidol Railway	Heritage Railway	http://www.rheidolrailway.co.uk/fares.htm	
Volks Electric Railway	Heritage Railway	http://www.brighton-hove.gov.uk/index.cfm?request=c298	
WAGN - Commuter	National Rail service	http://www.wagn.co.uk/wcomm/wcomm-taqf.html	
WAGN - Leisure	National Rail service	http://www.wagn.co.uk/	Click on 'Leisure'
Wales Flexipass	Travel Ticket	http://www.walesflexipass.co.uk/eng/index.php	
Warrington Borough Transport	Bus Operator	http://www.warringtonboroughtransport.co.uk/new/ticket.htm	
Welshpool & Llanfair Light Railway	Heritage Railway	http://www.wllr.org.uk/fares.htm	
Wensleydale Railway	Heritage Railway	http://www.digitalfox.co.uk/wensleydale/fares.htm	

West Coast Motors / Oban & District	Bus Operator	http://www.westcoastmotors.co.uk/fare_guide.asp	
West Midlands PTE (Centro)	PTE	http://www.centro.org.uk/wwwroot/TicketSales/New%20ticket/usrTktGuide.asp	
West Somerset Railway	Heritage Railway	http://www.west-somerset-railway.co.uk/	Click on 'Timetables and Fares'
West Wales Rover Ticket	Fares in Local Authority area	http://www.sirgar.gov.uk/eng/index.asp?locID=1533&docID=-1	
West Yorkshire PTE (Metro)	PTE	http://www.wymetro.com/PassesandSavings/	
Westminster Passenger Services	Ferry	http://www.wpsa.co.uk/fares.html	
Wightlink: Portsmouth - Fishbourne	Ferry	http://www.wightlink.co.uk/travel/fares/index.htm	
Worcestershire - Project Express	Fares in Local Authority area	http://worcestershire.whub.org.uk/home/wccindex/wcc-transport/wcc-transport-project-express/wcc-transport-project-express-fares-ticketing.htm	
Wrextreme Pass	Fares in Local Authority area	http://www.wrexham.gov.uk/english/travel/wrextreme/wrextreme.htm	
Wycombe Park & Ride	Park & Ride bus service	http://www.wycombeparkandride.com/fares.html	
Xprss	Branded bus service	http://www.xprss.info/fares.aspx	
Yellow Buses / Bournemouth Transport	Bus Operator	http://www.yellowbuses.co.uk	Click on 'Buzz Cards'
York City	Fares in Local Authority area	http://www.york.gov.uk/roads/concessions/index.html	
Yorkshire Coastliner	Bus Operator	http://www.coastliner.co.uk/	Click on 'Fare Deals' page
Yorkshire Traction	Bus Operator	http://www.tracky.co.uk/busbargains.asp	
Zak's Buses	Bus Operator	http://www.zaksbuses.com/	Click on 'Fare Information' and 'Season Tickets'

15.3 Operators' Questionnaires

Questionnaire for Operators ***(answers relate to a sample of each Group's subsidiaries)*** **:**		**Group A**	**Group B**	**Group C**	**Group D**
Fares Structures – general					
1	Are fares and fare revisions determined in your group:				
	Centrally?		Determined at subsidiary company level	Locally with some central assistance	Either centrally (with varying degrees of local input) or determined locally but reviewed centrally
	Separately by each subsidiary company?	All, but in accordance with a centrally agreed budget.			
2	Are your fares tables constructed using:			Use all of these – mainly fare stages.	Use all of these – mainly fare stages.
	Fare stages?	Completely or mostly	Predominantly stages, but some subsidiaries have zones and some night services have flat fares		
	Zones?	Some operators only, and in part only. For instance: one subsidiary is just about to extend zonal fares to some towns; another subsidiary has some zones but these are built as stages			
	Flat fares?	Some operators for some services			

3	If you use fare stages are these related to:			All of these	
	Distance (e.g. every 0.5 miles etc.)?	In general, but in some areas is changing away from this, e.g. one subsidiary had distance-based originally but is now operating a fare structure from 40p to £7.00 with 43 steps with variable increases at 5p, 10p, 15p, 20p, 25p and 50p.			Fare stages are related to distance. They are generally around 1 km / 3 bus stops – but they are essentially the historic locations (dating back many years) with some tweaking.
	How do the distances between stages vary between different routes or parts of routes (e.g. rural, urban etc.)?	In some areas may be nominally 0.5 miles apart, but this is historic and at least some operators are moving away from this. Where stages are distance-based the usual distance between stages may vary between rural and urban areas (higher distance in rural areas).	Most fare stages located at key stops en route		
	Stops near to landmarks such as shopping centres, pubs, schools, etc.?	This is very common, but one operator stated that this was largely historic	Generally landmarks		Generally no Stops near to landmarks – but when fares stages are by necessity moved (e.g. pedestrianisation) or new developments served the new fares stages tend to be landmark based.
	Number of stops passed, e.g after 2nd, 4th, 8th, 15th, 25th…etc.	No			

	Are there any instances where fare stages do not correspond with stops (e.g. District or County boundaries)?	Marked differences. For most respondents fare stages always correspond to stops. However, in one subsidiary in many cases stages refer to all stops on a particular road. One operator also mentioned 'ghost' fares stages which may need to be inserted in Limited Stop services for Concessionary Fares purposes.	No	Yes	Generally not on the fares triangle itself. But the notes at the bottom often refer to "non-stop" fares boundaries for Travelcards; Concessionary passes etc.
4	For graduated fares we are also interested in knowing how course or fine the fare scales are. Please give the typical / average fare scales for your group or company, e.g. for fare-stage based fares:	Fairly course, with (generally) minimum fare of between 55p and 70p and moving up in reasonably course steps. But one subsidiary is a significant exception (see question 3 above), while, another has a very fine fare scale, with a lowest fare of 45p.		Impossible to say and depends on territory. Obviously the longer services/inter urban routes will have more fare stages.	One major urban subsidiary has only two fares. Other subsidiaries generally have finer fare scales
	1 -5 stages, xxx pence				
	6 - 10 stages, yyy pence				
	11 - 15 stages, zzz pence				

	Please indicate the maximum and typical average number of standard fare values that might exist within a route.	Very variable: The maximum and typical average number of standard fare values that might exist within a route vary widely - as few as two in defined urban areas (for one subsidiary) but many, many more on a rural cross-county route. Fare per x stages can vary widely within the same company, depending on the route (rural services with long distance between fare stages may have much higher fare per x stages than an urban service where the stages are much closer together). For some operators there are wide variations in fare scales, with around 12 district scales in both urban and rural operations for one operator.	Varies: some subsidiaries have fare scale which increases by 40p for each fare band: others have much larger differences between fare bands	Typically 8, maximum as high as 30	
	(Note that we are not interested in absolute fares levels but only in the number of different fares within a fare scale and of how they change within the fare scale, so, if you wish, please give the figures as an index (e.g. your lowest fare within a fare scale =100).				
	If it is not possible to give a typical average across your different subsidiaries, can you give figures by different type of operations, and if				

	so, how would you differentiate between these different types of operations? e.g. different areas of the country, urban / rural?				
5	Have there been any changes in fares structures in recent years (e.g. number of fare values reduced)? If so do these differ from one group subsidiary to another? Do fare stages largely remain stable? If not, how often are they reviewed?	There has been a general process of removing redundant fare stages. For one operator fare values have reduced as it has moved towards a silver scale of 10p adult increments, with fare stages largely remaining unaltered. Although one subsidiary is changing to a fine fare scale, by contrast, several other subsidiaries are moving toward coarser fare scales with a reduction in the number of fare values.	Fare structures have generally been stable or have coarsened, with one subsidiary recently rationalising the number of period/area-wide tickets as the previous range was highlighted as over-complicated by both users and road staff.	Yes there have been some structural changes in some areas and this does differ by region. Reviews take place as appropriate, there are no fixed timescales.	Number of fare values has been reduced and heavily simplified over the last five / six years. Has been a general strategy; but for local reasons a finer scale has been kept in one subsidiary, while the different fares structure in a recently-acquired subsidiary has also been retained. Fares stages were reviewed on a one off basis a few years ago, but largely in the context of clarification / description / commonality between routes. Also tend to get altered when routes change / new developments appear (route extensions)
6	Does your company use the following:				
	Area-wide tickets: how are the boundaries of these defined?	Company-wide area ticket, plus area-wide ticket within city / town boundaries, landmarks, housing developments. But not all subsidiaries of this group have these city tickets, and for some the city area may correspond with the area of the company itself	Area-wide day and period tickets are available, with some tickets being confined to urban conurbation boundaries.	Yes	Yes - generally company wide.

	Period tickets, either:				
	Point-to-point seasons?	Usually yes, but often restricted to scholars. However, the group also has a multi-journey ticket (for some subsidiaries) which is not restricted to a particular route or to a particular time-period but to a particular fare-value	One subsidiary has point to point seasons but is currently phasing them out in favour of area-wide & multi-journey tickets.	Yes	No
	Area-wide?	Yes		Yes	Yes
	Inter-available tickets with other operators? If so is the ticketing scheme facilitated by:				
	a consortium of operators?	Not usually, but does depend on local circumstances		Yes	Yes
	a joint ticketing company?	Participation in PTE-led joint-ticketing scheme and a joint-ticketing scheme in SE Scotland		Yes	No
	a PTE or Local Authority?	PTE-led Travelcards in Strathclyde and in other areas	Some subsidiaries participate in local-authority led travelcards that are inter-available with most neighbouring operators	Yes	Yes
7	Can you given any indication of possible future trends in fare structures?	In general, simplification wherever possible and some operators mention possibility of some zonal fares. One operator says "Future trends are likely to see a coarsening of urban fare structures and some simplification of longer-distance scales with more than 30 stages but otherwise little change". However, in contrast, one subsidiary plans to continue to work towards a graduated fare structure.	Further simplification of fares planned, with greater use of zonal fares planed by some subsidiaries.		Best guess is that in the key urban areas the fares structures will further simplify. However once this is achieved, the structure will be re-structured in different ways (e.g. time of day; mobile phone type tariffs etc). Inter-urban and rural fares structures are expected to remain more complex than their urban counterparts

Fares Change Processes and Timing					
8	How are fares revisions calculated in your company/group?		All three methods taken into account.	Confidential	
	Using models (based on elasticities, patronage and external cost trends for example)	Where models are used they appear to be very simple, using a (probably) single elasticity			Yes – but with considerable sensitivity analysis
	Using judgement of the market to adjust individual fares to achieve required yield	But in addition to this one operator says that "there is significant modification to suit local market conditions, especially the most popular fare groups in urban operations. Segmental marketing is confined to multi-journey tickets and return fares".			Yes
	Scaling up fares to next convenient monetary values.	Scaling up fares to next convenient monetary values is often practised, particularly at lower fares values			Or down – in context of yield / marketability / resistance / ease of payment
9	Are the fares tables produced:		Both		
	Manually?			- Yes	- Yes
	Automatically by computer software?	Principally automatically, but there does appear to be often some significant manual intervention afterwards		- Yes (WAYCON)	- Printed excel spreadsheets only – not via the ticket machines themselves.
10	For fares with external inputs (such as on tendered services and concessionary travel) how are these related to your standard fare scales?		Some input from Local Authority, Generally commercial fare scales apply, although on some services there is some input from the Local Authority.	- Local Authority – usually % of adult fare	- Generally free – but some half and flat fare schemes

	Concessionary fares:	Varies: In England changes to OAP / disabled concessionary travel from April 2006 are expected to mostly remove the simple relationship to standard fares and one operator claims that these will require the creation of separate route-specific tables. In Scotland and Wales free concessionary travel scheme is considerably simpler. Child fares are calculated using a straightforward discount: usually either 33 or 50 per cent.			
	Tendered (subsidised) services	Varies considerably: some are the same as standard fare scales, in some areas these farescales are typically10-25 % lower than commercial scales. One operator stated that the fares differential is greater on rural services		- Local Authority	- Generally the same

11	In general do all fares increase by a similar % at any fares increase or is there a deliberate policy of using the fares increase to change the fares structure and / or the relationship between different fares?	In general, fares increase by a similar percentage at any fares increase, but the fares structure and the relationship between different fares can change to give a more convenient monetary value, or to concentrate the yield on more significantly tendered values. Policy at one subsidiary has been to reduce number of fares to simplify structure. At some fare changes some fares may not change. For another subsidiary a fares increase will normally aim at a similar increase on all fares, subject to maintaining 5p multiples, but changes to structure are almost always carried out at the same time. For this operator changes to multi-journey tickets will normally be made on a separate occasion to a revision of fares; unless a new ticket is to be introduced.	In general, yes. Some fares may receive different changes for market reasons and to assist rounding fare values for change-giving purposes.	Depends on local circumstance	Varies from year to year and what needs to be achieved. General strategy is to simplify and make the fares structure much more marketable. However simplification tends to mean freezing/reducing some fares at the expense of increasing others disproportionately. With bus fares being typically around the £1 mark; and inflation comparatively low rounding is a big issue (e.g. £1 again gives no/little yield; whereas £1.05 is 2x rate of inflation). During the last year or two operational costs have been increasing very heavily with circa 6-8% average fare increases. Whilst the policy is still one of simplification this has been heavily tempered by the need to try and ease an already “high” average increase becoming even worse in the instance of specific fares.

12	How are the new fare values transferred to the ticket machines and revenue analysis software?	Varies. Electronically, but process appears to differ between operators (possibly varying with ETM manufacturer)	Electronically through various means at different subsidiaries	Usually via WAYCON software to update depot reader	For some subsidiaries through Waycon the proprietary system supplied by Wayfarer Transit Systems (WTS). For another subsidiary Almex A90 equipment is used
13	Is there any integration with your timetable and schedule production systems?	No, although for one subsidiary real-time information does, however, take certain information from the ticketing system.	No	Some limited integration for those companies using GPS	Yes
14	Are there significant differences in the process between different companies in your Group? If so, what are these?	Apparently, ERG and Wayfarer have very different processes, and are used by different subsidiaries of this group		Yes, depending on the age of ticket machines & associated software, which influences the automation of process	Some subsidiaries do their updates in-house
15	Please describe which types of organisations (e.g. ticket machine suppliers, local authorities, information centres etc.) and systems the final fares tables / matrices / lists are sent to once	Faretables sent in electronic form to some County Councils, to others in paper format, and to others not at all.	In printed form to local authorities within operating area. General information leaflet products to ticket agents including tourist information centres.	Depends on company. Some do not issue, others send printed copies to Local Authorities	Generally to own staff, and to local authorities and PTEs, and traveline etc. A variety of hard copy outputs and Excel .spreadsheet versions

	finalised, when, and in what form.				
16	What is the typical number of general fares changes per year in your company/group, and has this changed recently?	A typical number of general fares changes per year might be two; though many operators still have just one. Others have one, but different areas of the same operator change fares at different times. It is common for Point to point fares (singles and returns) to change at a different time of year from Rider-type Tickets.	One	Impossible to say – no preset policy – depends on local operating conditions.	1 per year - No
Issues related to a possible FareXChange schema					
17	How are fare stages and fare zones identified and who is responsible for doing this? How are the boundaries of fare zones described and who does this? How often do they change?	Most stages are historical and apart from occasional changes if buildings/landmarks used to define stage names alter or disappear there is very little alteration: annual review is common. Where local authority partnership arrangements exist there may be consultation as to a specific boundary, but in general these do not change very much. Boundaries of Local-authority-set fare zones are determined by the Local Councils, and they do not change.	Locally by responsible manager. Generally these are only revised in response to significant changes to routes/ticket products.	Confidential	Depends on individual situation – could be local management; Statistics and Data Manager or Commercial Strategy Director. Changes to fares stages are generally events-driven. Revisions to boundaries of fares zones are likely to be driven by Commercial Strategy Director. Fares stages – generally static; Rest once every few years
18	Are the names used for fares stages consistent between fares tables or might there be local variants in use (e.g. because a pub or	Usually consistent between faretables but not necessarily the same as other sources.	Yes	Generally yes, but not 100%, and working towards completeness	Significant attempts are made to try and keep them consistent and tie them in with Bus Stop Names

	building has been renamed).?				
19	Do fare stages always coincide with and carry the same names as:				
	Stops?	Fare stages usually carry the same names as stops, but may not always be the same.	Generally yes	No	- Generally – but not always
	Timing points?	It appears that generally they do, but it is a long way from being universal.		No	- Sometimes
	If not, what are the reasons for variations (e.g. follow local authority boundaries)?	For one subsidiary a fare stage will in many cases cover all stops along a stretch of road, which it is claimed is much more passenger friendly. There are also many cases for other operators where a fare stage might cover a whole village. One operator said that there may occasionally be a variation to follow a local authority boundary.		Usual historical	Yes - follow card /LA boundaries Timing Points need to be located where vehicles can safely wait time; rather than where historic fare stages are.
20	Does the software and data your companies use in calculating fares and fare changes have any links to NaPTAN (national bus stop location system) and schedule data used in other applications within the operation (e.g. those functions linked to TransXChange) or is the	No links to NaPTAN or schedule data used in other applications within the operation. For some operators there is, however, a link between the ticket machine and the local real-time information system which technically can access fares data but not used as such. One operator stated that NaPTAN numbers may be used to denote certain stages such as boundaries.	No	No links to NAPTAN	The systems are stand alone. Any links between fares stages & NaPTAN system are done and used externally by Local authorities / PTEs

	software / data stand-alone (e.g. separate spreadsheets)? If it does have links to NaPTAN, please describe the link (e.g. "Fares module within the Trapeze scheduling system ...")				
21	Can you give examples of where the typical fare-setting process described above does not apply (e.g. for inter-available fares or when fares are changed in response to competition or where special fares are introduced to attract travel on particular corridors)? Please describe the general process of changing fares in such circumstances	Inter-available fares or when fares are changed in response to competition, or where special fares are introduced to attract travel on particular corridors. However, the general process of changing fares in such circumstances would still be based on the operator's perception of the market. In addition, one operator has special fares operating throughout its main local authority area , including specials to major towns and cities outside the area and these are reviewed on an annual basis and amended in accordance with demand and yield requirements. Where special fares are added to faretables the software mechanisms may be used to create usable blocks or areas within the system so that they can be easily identified. For another operator there are many instances where returns in particular have been capped, in some cases due to competition that has long disappeared. The operator here	On joint routes, fares changes may follow those of other operators but are not necessarily made at the same time. Where joint-operator travelcards exist price is set with agreement with all parties including local authorities. Special promotions may also exist and premium-rate fares may also exist on special services	No	Group does participate in Multi-Operator Travel Card schemes; prices are set by operators in accordance with the scheme rules and Competition Act Ticketing Schemes Block Exemption. Yes – group does have occasional promotions e.g. summer specials; holiday specials; occasional route specials.

		tends to initially apply the standard percentage increase, then review the fares that this creates and adjust accordingly. Capping the return in this way often results in a number of different value singles carrying the same return over the relevant sections.			
Child and Concession Fares					
Note: we appreciate that there will be changes to concessionary travel from 1 April 2006. It will be helpful if your answers can relate as far as possible to the situation following the introduction of statutory free travel for elderly and disabled people.					

22	Do child fare structures follow the same pattern / structure as adult fares? If not, how are they different? If they follow the same patterns is there a standard relationship between adult fares and child fares?	Child fare structures in the main follow the same pattern / structure as adult fares. For some operators there is no standard relationship between adult fares and child fares, as county conditions have been historically different, resulting in child fares of anything between half and three-quarters adult. In one subsidiary, children pay a Flat Fare with no particular correlation to the Adult structure.	Under-16s generally travel at half adult fare, but some minor exceptions may apply for certain tickets.	mostly – usually a % of adult fare – but not a standard relationship – depends on local authority	Generally yes (but have considered moving to a "no" situation). In some operations the relationships are standard; in others they are not.
23	What is/are the Concessionary fares for Elderly, Disabled and Blind people (i.e. the statutory groups defined in regulations) required by the relevant authority or authorities in your area(s)? Please state how these relate to your standard fare scales.	Concessionary fares for Elderly, Disabled and Blind people (i.e. the statutory groups defined in regulations) will vary significantly between English districts after 01/04/06 in respect of cross-boundary travel. There is not likely to be any consistent relationship to standard scales. One operator has to handle a variety of concessionary fare schemes specified by 25 local authorities and generating a complexity of cross-boundary rules: the variations include free fares, flat fares, half fares, full fares and 60% discounts.	Yes currently concessions are half adult single fare rounded to nearest penny. This will end in April 2006, when free concessionary travel starts.	Too early to give details	Free mandatory entitlement. However some (generally peripheral) schemes also allow for peak and / or cross-boundary travel.
24	Apart from Local Authority Concessionary fares for Elderly / Disabled / Blind people do you have any other Concessionary fares, e.g.				

	Fares for special classes of passenger (e.g. Unemployed people), or for special types of journey	This Group currently offers half fare for New Deal holders (long-term unemployed). Some other concessions (not thought to be uniform across the group, inc. police, street wardens, puppy walkers) In one subsidiary there are special tickets for scholars over 16 (to college only)	Some subsidiaries offer half-fare for the unemployed commercially. Various other concessions may also apply, including those financed by the Local authority, e.g. Half fare for children aged 14 & 15 after 0900 and certain categories of older people in full time education up to the age of 19	Yes – students, night bus	Some "New Deal" arrangements; although the Group does not consider these as true concessions
	Fares for concessionary holders of Travelcards or other schemes.	Fares for concessionary holders of the operator's own half-fare pass (intended for use by those still receiving bus tokens). These Concessionary fares are determined by the operator. In another subsidiary on certain services a commercially-based concession may be offered (not half-fare) but concessionary season tickets have been phased out by the operator unless supported by the local authority. In another operator scholars' ticket holders can have a Blue Peter Ticket giving a maximum return of £1.80 at weekends and in school holidays.			Yes – children in the peak in most areas: exact relationship to other fares varies between subsidiaries
	Please give examples, and indicate whether or not the Concession fare's existence and its level is determined by the local authority, and indicate their relationship		Concessions on Day-out tickets, as a standard percentage, with some travelcards having reduced concessions to reflect particular local circumstances.		

	to Standard fares				
25	Do concessions usually have peak restrictions? If so, are these restriction hours usually uniform across different subsidiaries?	Concessions now do not usually have peak restrictions. But this may well change (for England) after 01/04/06	Some Peak time restrictions, but these vary between subsidiaries	Yes No	Yes No
Restrictions on Fare Types					
26	Do you have any fare types for which restrictions apply as to time of use, for example day type (e.g. weekend only) or where time bands (e.g. off peak) apply. What sort of restrictions do you impose?	Varies quite widely. Some areas have off-peak special returns or Area tickets which apply only after 0900 or 0930. One operator has night services with special fares after certain times (depending on local route)	Some Peak time restrictions, and some subsidiaries have special evening or night fares	Some places have time restrictions e.g. off peak day tickets or Sunday Rovers	Yes; off peak only (Definitions of off peak may vary by ticket type – e.g. whether there is an evening peak restriction as well)
27	Do you have any fare types for which booking restrictions apply, for example advance booking, on-line booking only?	None	Some period tickets are available only from ticket offices or other sales points	Online student tickets, some special airport fares for customers of specific airlines	Generally not – but there is some on-line only booking
28	Do you have any fare types for which journey or routing restrictions apply? – e.g. must be used on a specific route or a specific journey.	Generally no, but can apply to Park & Ride returns, some scholars' season tickets. One subsidiary has route restrictions for some return tickets: Some tickets for another operator are route-specific	Very few, where they exist some companies are gradually removing them	Yes : point-to-point tickets	No – but by their very nature some of the Travel Card options may also allow travel on other modes / operators

FareXChange Business Case					
29	Do you see any potential benefits from FareXChange other than for conveying fares information to enquirers faster and more accurately? If so, what?	Several see no additional benefits, but one operator sees a benefit of its existence as the better facilitation / encouragement of pre-purchase. Two subsidiaries would appreciate easier interpretation of fares information, and suggest that this might be a possible outcome of FXC. Another operator suggests that FXC might make it less work to change from one ETM supplier to another.		Not really	Under certain scenarios, there are some potential benefits in having more options in respect of data distribution etc
30	What aspects of fare data exchange would give you benefits if standardised?	Another subsidiary sees greater operator interavailability, encouragement of further simplification of fare structures, increasing system integration. However, another subsidiary considers that standardisation would give disbenefits through forcing operators to work within certain parameters. One operator thinks that FXC should bring internal communication improvements on fares and pricing issues. Some operators have mixed feelings about standardisation seeing both potential pluses (less confusion for passenger and fewer anomalies) and potential minuses (possibly less flexibility to change fares)		None	Data format

15.4 Traveline Regions Questionnaires

Questionnaire for traveline Regions	Summary
The fares information that traveline gives	
1 Does your traveline Region currently give any fares information?	Several do, but only two regions currently give it systematically (and electronically - currently being introduced by one of these regions) for most services at a basic standard single fare level. A third region is about to and a fourth has stated that it will investigate this once the protocol used in the third region is shown to be successful. Several traveline call centres give it for certain operators or services only, using manual, printed methods Several traveline call centres do not give it at all, and always refer callers to the operator One call-centre for on traveline region also offers fares (if they have info) as part of the traveline service
If not, please go to question 6, otherwise, please describe:	
Where the information is obtained from and in what form?	Apart from the three regions that have either introduced electronic fares information or plan to, fares information is generally received manually (sometimes in Excel spreadsheets). It is also understood (from operators) that a fifth region receives at least some bus fare tables but under current procedures doesn't actually use them
What is the form of publication?	Apart from he three regions above even if info is received electronically, fares info is given out to caller from paper copies (where it is given out at all). One region is using fares info on its Call Centre screens but has no plans for its website currently. Another region did show fares on its website but does not do so currently, at the time of writing. One region has limited fares info on its website but appears to be distancing itself from giving fares information currently
What caveats are given?	Caveats are often given, saying it is 'Best Information available, or that info is current today but cannot be guaranteed as correct for the date of travel

2 What fares have you decided to collect and to show, and what to omit? It would be helpful to know the reasons for deciding this.	Usually: basic fares, such as Adult Single, Adult Return, Child Single, Child Return. In one region zonal fares information is also now being given out, whilst in another some travelcard information is also provided. However, for some areas where fares information is given only for specific services by the local traveline call centre, comprehensive fares information is given for those services.
3 What is included in the specification that you have created for exchanging fares data within your traveline region?	For one region, the ability to pass those fares by fare stage mapped to the exact stops on the ground, and everything necessary to do this.
The fares transfer processes	
4 Please describe the process by which fares information is conveyed to you	In two regions the system captures data from the back office system used in the Almex, ERG, Wayfarer and other electronic ticket machine systems' set up: In another the operators provide ticket machine export and imports it through a proprietary Faretable Reader or can send a file direct from their ETM.
5 Are there any links / exchanges between the fares information you hold and the ticket machine equipment, their manufacturers and other organisations? If so, please describe these	See above
Information on Fares generally in your region	
6 Do you have any information on how operators within your traveline region create fares? Do you know of any links with NaPTAN / NPTG/ other information systems?	Varies substantially between Regions. Software is provided by at least the ETM manufacturers Wayfarer (Waycon) and Almex to create fares for use in their ETMs. None of the operators make any reference to NaPTAN or NPTG in their fares, as far as is known: the concepts are entirely alien.
7 Can you given an indication of fares sizing in your region, i.e. the number of fares in your region, by type	Impossible to say. In one region each operator has a different way of describing a ticket type, and even generic types, such as 'day out' have time restrictions that apply, or age restriction, or geographical ones, so naming all the different fare type is a tall order. One of the major operators in a large traveline region had 220 ticket types when last questioned. The number of concessionary fare

	schemes in England will grow from April. For example, there will be schemes which offer free travel within the district and then half fare travel up to the county boundary
the number of fare stages and/or fare zones	One region estimates 15 fare stages per service on average, and 1000 services for that Region
the number of different fare values	Impossible to estimate. English Concessionary fares scheme from April means that Concessionary fares will vary by the location of the home of the passenger and by time of day, even between the same bus stops on the same route
the maximum number of fare stages/zones that a fare covers	30 on some long-distance services in Lancashire and parts of the North East (but this is thought to be an underestimate)
the frequency of fares changes.	In one region major changes for multi-journey and day out type tickets twice a year and major changes on adult single/return etc type tickets twice yearly in between the multi-journey changes. Fuel and insurance costs increases mean that at least twice-yearly changes are now very common. One region mentions that although actual fare changes are relatively infrequent, service changes are not. It is not uncommon to see substantial service revisions where "tail ends" are switched from one service to another. Fares have not changed but overnight most of the service related fares data work is out of date. So the updating of data relates not just to fares changes but to service changes where the line of route is altered.

Your plans for giving fares information

8 What are your aspirations for publishing fares, both in call centres and on the Web	It is estimated that about half the traveline regions may aspire to fares with the other half ruling it out. One region that provides fares information has tried to provide, in most cases, what they think most people will want rather than every possible product/combination/permutation that exists. Two regions want to provide

	electronically-generated fares info over the phone but not via the Web at this stage, partly due to the difficulty of getting across complex information through a Web interface.
9 What is preventing you doing this now, in terms of: a) administrative processes; b) any limits in the Fares Exchange protocol you have c) any other barriers. (We are assuming that fares legislation and concessionary fares legislation does not change but you are welcome to share any views on how changes to this might make some of your aspirations easier to achieve)	Fares complexity and lack of both a working protocol and a reliable process seem to be the major barriers.
Your general views on FareXChange	
10 Do you see any potential benefits from FareXChange other than for conveying fares information to enquirers faster and more accurately? If so, what?	Offering information on cheapest journey Reconciliation between data of fares issued and journey requests could open up powerful opportunities for further analysis of travel patterns FXC should ensure that data is transferred from the ETM to the traveline regions in a standard format. May enable larger operators to get fares information more easily and hence analyse competitors' fares more efficiently, thereby leading to market instability.
Existing requests to traveline for Fares Information	
11 Regarding the calls to your traveline enquiry service: What percentage of your traveline call enquiries relate to fares?	As high as 25% for one region in terms of enquiries that have some fares element within them. Much lower for some other regions: less than 5% in some cases
Of these, what percentage are you able to answer?	One call-centre claims to answer 80% of enquiries, another region nearly 100%. Remainder that quote a figure are considerably lower
What data would help you answer fares-related traveline calls?	Links to NaPTAN references

Are there specific types of fares enquiries that you get asked about but are unable to answer?	Rail fares
Are callers primarily concerned to understand the costs of travel they have chosen to use; or to find the cheapest means of travel?	Both (approx. even split between respondents)
Are fare related questions mostly about individual journeys, or do you also get asked about season tickets and travelcards?	Both (a 50/50 split is quoted by several regions)

15.5 References

Type	Standard	Document	Author / Publisher
Info	Transport Direct Standards Catalogue and Future Developments.	Transport Direct Standards Review: Final Report. CC-PR114-D003-1.0.December 2001. Reissued 2006	DfT (Centaur)
Meta	GovTalk XML Coding Standards	Office of the e-Envoy Schema Guidelines Best Practice Advice. Version 3.1. February 2004	Office of e-Envoy
Meta	GovTalk XML Coding Standards	e-Government Metadata Standard. Version 3.0 April 2004.	Office of e-Envoy
Abstract	TransModel CEN TC 278	French Ministry for Transport Reference Data Model For Public Transport. January 2004.	CEN / DfT
Reference	NaPTAN	Project 783, Transport Direct NaPTAN hosting, NaPTAN uploading data P78324003 Issue 1 Draft A. October 2003.	DfT (Kizoom)
Reference	NPTG	National Public Transport Gazetteer. As per NaPTAN Schema Guide 2.1	DfT (Kizoom)
Reference	TransXChange	Schema Guide 2.1. September 2005	DfT (CarlBro / Kizoom)
Dynamic	JourneyWeb	UK Department for Transport Schema Guide 3.0b. January 2004.	DfT/WS Atkins (Kizoom)

15.6 Glossary of Abbreviations

ATCO	Association of Transport Coordinators
ATOC	Association of Train Operating Companies
AVL	Automatic Vehicle Location
BUUK	Bus Users UK
CC	Competition Commission
CEN	Centre for European Normalisation (i.e. Standards)
CPT	Confederation of Passenger Transport
CTS	Concessionary Travel Scheme
DfT	Department for Transport
DRT	Demand responsive transport
ETM	Electronic Ticket Machine
FXC	FareXChange
GLA	Greater London Authority
HOPS	Head Office Processing System
IDE	Integrated Development Environment
IPR	Intellectual Property Rights
ISO	International Standards Organisation
ITSO	Integrated Transport Smartcard Organisation
NaPT	National Public Transport
NaPTAN	National Public Transport Access Node
NPTG	National Public Transport Gazetteer
OFT	Office of Fair Trading
ORR	Office of Rail Regulation
POST	Point of Sales Terminal
PT	Public Transport
PTE	Passenger Transport Executive
RJIS	Rail Journey Information System
RSP	Rail Settlement Plan Ltd
RTPI	Real Time Passenger Information
TAN	Traffic Area Network
TfL	Transport for London
TOC	Train Operating Company
TRL	Transport Research Laboratory
TVM	Ticket Vending Machine
TXC	TransXChange
UML	Unified Modelling Language
VOSA	Vehicle and Operator Services Agency
XML	eXtensible Mark Up Language