VDV Die Verkehrsunternehmen

VDV Recommendation 454

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Real-time data interface - timetable information Version 2.1

Based on VDV Recommendation 453 (v2.5.0)

REF-SIS reference data service for timetable information
SIS timetable information

Editing
Committee for Information Processing (AIV)

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Cooperation

RUDY Joint Project
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Project coordination:
Research Institute for Applied Sciences, Ulm

The initial version of the interface was created with funding from BMVBW.

This means that the specification is freely available.

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History of changes from V 1.2.2 to 2.0

VDV, Winfried Bruns

Position	Change	Author	Date
5.1.3.4, 5.2.2.4, 5.2.2.5, 5.4.	Inclusion of a template for extending the formations for ScheduleTrip and RealTrip from sub workgroup formations (for the VDV conference on 30/6/14 in Bern)	SL	16/06/2014
5.1.3.4, 5.2.2.4, 5.2.2.5, 5.4.	Document extended to include the review findings of the VDV conference and feed-back regarding the formations	SL	21/07/2014
3.3, 5.1.1, 5.1.1.1, 5.1.1.3, 5.1.2, 5.1.3, 5.1.3.1, 5.1.3.3, 5.2.1, 5.2.2.1, 5.2.2.3, 5.5, 6.1.2, 6.1.3, 6.1.7, 6.1.11	Modifications relating to the sub workgroup reference data service	WK	31/07/2014
4.2	Subscription process: Adaptation to the subscription communication procedures including Figure 3	SL, DHo	19/12/2014
5.1.1, 5.2.1	Definitions of SISRefSubscription / SIS-Subscription: New filter added	SL, DHo	15/12/2014
5.1.3.1, 5.1.3.3, 5.2.2.1, 5.2.2.3	Definitions of ScheduleTrip, ScheduleStop, RealTrip, RealStop: Description of DirectionText and FromDirectionText modified. The optional element of FromDirection-Text was renamed (German version only) New PatternID element added.	SL, DHo, MZ RuD WK RuD	15.12.2014 19.01.2015 16.02.2015
5.2.2.2	Clarifications on the use of TripStartEnd	SL, DHo	15/12/2014
10.9, 10.10	New enumeration lists for TransportModeText and ProductID	SL, DHo	15/12/2014
3.2.3, 3.3, 6.1.3, 6.1.12, 6.1.13	Modification of the reference data exchange	SL, DHo	02/03/2015

Position	Change	Author	Date
5.1.3.1	New optional TimeStamp attribute added to ScheduleTrip	SL, RuD	20/03/2015
	Layout	RuD	04/05/2015
5.1.1, 5.2.1	BlockFilter added, BlockID removed	SL, RuD, DHo	13/05/2015
From here on, corrections from V 2.0 to V 2.0.1			
06/01/2012	Trip cancellations: textual adaptation of case b)	DHo	10/02/2016
10.2	Enumeration list for FoVehicleEquipmentCode (FoFahrzeugAusstattungsCode) supplemented with the values “CycleRacksResRec” (AbteilFahrradResPflicht) and “NumberCycleRacksResRec” (PlaetzFahrradResPflicht).	SL	10/02/2016
5.1.1.5	Spelling in ‘TransportModeText’ (VerkehrsmittelText) corrected	DHo	11/12/2015
From here on, corrections from V 2.0.1 to V 2.1.0			
5.1.2.1	New chapter, ‘Using AllData (DatensatzAlle)’, added	DRu	28/10/2016
5.1.3.1 / 5.2.2.1 / 5.2.2.3	Optional, multiple element ‘TripNameText’ (FahrtBezeichnerText) and TransportModeNumber (Verkehrsmittel-Nummer) added for ScheduleTrip (SollFahrt) and RealTrip (IstFahrt) (CR_0016). In the case of a CompleteTrip (Komplettfahrt), ScheduleStops (SollHalte) and RealStops (IstHalte) shall already be supplied in the correct sequence in which they were services (CR0032 from VDV Committee, dated 21/06/2016). CR_0028: Trip relationship structure added for referencing between trips.	StL JW JW JW	14/06/2016 14/12/2016 26/08/2016 14/12/2016

Position	Change	Author	Date
5.1.3.3 / 5.2.2.3	Optional elements “ArrivalSectorText (AnkunftsSektorenText)” and “Departure-SectorText (AbfahrtsSektorenText)” added for ScheduleStop (SollHalt) and RealStop (IstHalt) (CR_0015)	StL	14/06/2016
6.1.2 / 6.1.4	Supplementation rule specified in more detail (CR_022)	JW	16/08/2016
5.2.2 Item 1 6.1.8 6.1.15 (new)	Insurance of plausible prognoses (CR 59)	RR	16/11/2016
5.2.1	New operational element ‘OnlyUpdate (NurAktualisierung)’ added to AboAUS (CR_0038).	DRu	15/12/2016
10.4	“FoTechnicalAttributeCode = Low-FloorEntrance” FoTechnischesAttributCode= NiederflurEinstieg added (CR052)	JW	17/01/2017
5.1.3 , 5.1.3.1 , 5.2.2.1 6.1.7 , 6.1.10	[Not compatible retrospectively] CR_0060 ‘PredictionPossible’ (PrognoseMoeglich) field removed from ‘LineSchedule’ (Linienfahrplan) and ‘ScheduleTrip’ (SollFahrt) New ‘ResetTrip’ (FahrtZuruecksetzen) element added to RealTrip (IstFahrt) Trip/prediction reset description adjusted in Chapt. 6.1.10	W.Isajkin (Init)	26/01/2017
6.1.9 9.1	‘PredictionInaccurate’ (PrognoseUngenau) specified in more detail: CR_0023 - Non-specified delays - New ‘unknown’ value - References ‘PredictionQuality’ (PrognoseQualität) - Differentiated from ‘Prediction-Status’ (PrognoseStatus) - Chapter 9.1. ‘PredictionQuality’ (PrognoseQualität) linked to Chapter 6.1.9 ‘PredictionInaccurate’ (PrognoseUngenau)	StL	30/01/2017 17/03/2017
5.1.3.1 5.2.2.1	‘RunNumber’ (KursNr) added to ‘ScheduleTrip’ (SollFahrt) and ‘RealTrip’ (IstFahrt) (CR0067).	DRu	24/03/2017

1 Foreword

This VDV Recommendation presents the initial extensions on the basis of the 'Integration Interface for Automatic Vehicle Location and Control Systems' in accordance with VDV453 Version 2. It deals with interfaces for linking control systems (*automatic vehicle location & control system, AVLC, formerly:* automatic vehicle location system AVL) with timetable information systems. Based on the wide range of different types of AVLC and timetable information systems currently in use, a standardised interface will significantly ease the process of providing comprehensive dynamic passenger information. The aim is to provide a means of making AVLC data concerning the current timetables as well as the real-time data on the actual operational situation available to the timetable information systems, in order to be able to offer the passengers more accurate travel information.

The underlying concept as outlined in Recommendation VDV453 Version 2 follows the approach of a universal interface for the integration of AVLC systems, which allows the participating transport operators to implement such functionality at an acceptable cost. The technical implementation is based on standard technologies (http/XML). It defines common limiting requirements on the design of the interface and describes the data exchange in detail (subscription procedure). Experience gained from the first practical implementations has already been incorporated into version 2. All references in this paper to VDV453 relate to VDV453 version 2.

The modern service architecture with a communication structure based on the subscription method provides a simple means of integrating further services, even to external non-AVLC specific systems. Together with the new interfaces specified here, the available inter-operational services are now as follows:

Service	Purpose	Document
Reference data service for transfer protection (REF-CP)	Exchange of planned timetables for transfer protection	VDV453
Process data service for transfer protection (CP)	Exchange of actual data for transfer protection	VDV453
Reference data service for passenger information (REF-DPI)	Exchange of location-related timetables for passenger information	VDV453
Process data service for passenger information (DPI)	Exchange of actual data for passenger information	VDV453
Process data service for visualisation (VIS)	Exchange of actual data for the visualisation of vehicles in third-party control centres	VDV453
General message service (GMS)	Exchange of written information between the control centres	VDV453
Reference data service for timetable information (REF-SIS)	Exchange of planned timetables for timetable information	**VDV454**
Process data service for timetable information (SIS)	Exchange of actual data for updating the timetable information with current data	**VDV454**

This VDV454 paper is based on a proposal that has been worked out by the partners of the BMBF commissioned RUDY project [1] under the overall control of FAW Ulm, which is also to include implementation and testing. Coordination with the wider circle of timetable information system manufacturers and the AVLC industry in general, including transport operators, will be undertaken within the scope of the FOPS 70.0701/2002 research project of the Federal Ministry for Traffic, Construction and Housing (BMVBW) by BLIC, IAV and FAW Ulm under the technical supervision of VDV. This includes consolidation of the specification as well as verification of compatibility with VDV453. The users of timetable information systems are included via the DELFI work group.

This document does not repeat the basic communication information outlined in VDV453, it simply references certain important areas.

In comparison with the previous version, various errors have been corrected, functionality has been partially extended and the new formation elements have been added. Furthermore, implementation tips have been added, which do not refer directly to the interface specification but are included to clarify use of the interface as well as application and interpretation of the transmitted data.

The associated XML schema (structure definition) has the file name VDV453_incl_454_V2017.a.xsd

The current XML schema serves as a reference for implementation of the services (see the VDV website http://www.vdv.de/i-d-s-downloads.aspx),

The respective text line represents an explanation of the given application.

2 Introduction

2.1 General tasks

Timetable information systems are already widely available in Germany. Depending on the level of data integration, the coverage of individual systems ranges from consortium or countywide coverage right through to timetable information systems that offer nationwide coverage. Furthermore, the individual systems are linked via the DELFI network, which facilitates continuous connection information without the need for data integration.

A timetable information system must be able to respond to customer enquiries concerning departure times, arrival times and connections for different periods of time:

- Long-term: 'How do I plan my journey to X next week?'
- Mid-term: 'What's the best way to the opera tonight?'
- Short-term: 'When does the next bus leave from the stop opposite?'

In general, only the published timetables that are valid for longer periods are made available to the information system for all request periods. For the purpose of long-term journey planning, this data represents the most up-to-date and with that provides the best foundation. However, neither the day-to-day changes in the journey planning nor the current events within the operation can be included in the timetable information on the basis of this data. It is therefore obvious that the quality of information provided in response to mid and short-term enquiries can be significantly improved when using more up-to-date data.

It is extremely important for a good timetable information system that the actual data is not just available for individual stops or connection areas but for the largest possible number of (or ideally all) routes and stops. On the basis of current data, it is possible to implement the following dynamic timetable information system functionalities:

- Stop monitoring (departures and arrivals board):

  ‘When does the next bus arrive at this stop?'

  'When does the next bus depart from this stop?'

- **Connection enquiry:**

  'How do I get from A to B?'

- **Passenger travel guide**
  (information before and during the trip on a 'pre-booked' journey)

  'Now approaching stop...'

  'Fetcher vehicle at station X will be missed. Next possible connection with route 11'

'Please change to route 13 at the next stop'

- Commuter information service (similar to the travel guide service but for regular journeys)

  'Your regular bus is not operating today. Next possible service....'

Current scheduled operational day data, such as the subsequent dispatch of additional trips or cancellations, is recorded in the operational trip planning and imported into the automatic vehicle location and control system (AVLC) before the start of operation. Actual real-time information, such as current delays, trip failure or short-term disturbances only exist in the AVLC system.

Until now, operators have only had access to proprietary exchange mechanisms and formats between the tools of the journey planning and timetable information systems. These mechanisms permit the updating of the timetable information system data with the modified timetable planning data on a daily basis and are already being used in productive operation. Prototype interfaces between AVLC and timetable information systems for transferring the real-time operational data have already been tested in various pilot projects. These are also product-specific in design.

With ever increasing numbers of AVLC systems, some regional, and the different planning systems they use, the operators of timetable information systems are being confronted with a huge number of necessary system links. This relates to the different ways in which planned interfaces have been implemented, the real-time data interfaces and in particular the shortfall in compatibility between the different software packages for real-time and planned data exchange. This has restricted the distribution of exchange mechanisms, as they are associated with unacceptable expenditure in terms of time and cost for each individual system coupling. Furthermore, it is almost impossible to guarantee the customer consistent quality standards.

It is a similar situation for the AVLC operator, for whom a common solution for the various services involved in both an AVLC link and links to other external systems would be extremely advantageous in terms of purchase and operating costs. Under the initiative of the Federal Ministry for Traffic, Construction and Housing (BMVBW) something is finally being done about the latter. With VDV453 we have started the standardisation process for a universal interface for AVLC systems.

From a technical point of view, the communication infrastructure for linking heterogeneous computer systems has been separated from the services within the interface. This means therefore that it is well suited to extension in the direction of timetable information systems.

2.2 Requirements on the data exchange

2.2.1 Transferring updated planning and operational data

Within the validity period of a regular seasonal timetable stored by the timetable information system, customer relevant changes have been made in the following areas:

- **Operational scheduling**
  The daily operational planning involves the creation of timetable data only. The transfer of this data, prior to the operational day, is relatively non time critical. In the operational processes, this data is overwritten by actual data whenever there is a deviation from the timetable. It is therefore referred to as the reference data.

- **Operational control centre**
  Short-term timetable predictions are worked out in the control centre and short-term dispatch actions established. This is real-time data from the current operational processes (process data).

Modification data must therefore be transferred to the timetable information system from two different sources. The daily operational timetable exists not only in the trip planning but also in the AVLC control centre. In the opposite direction however, it is very unusual for dispatcher changes to be re-imported from the AVLC into the planning system.

Furthermore, both sources of data have different time horizons when it comes to their effectiveness. And on the basis of its function as a reference for the actual data, the planned data must be managed differently in the timetable information system (see below). It is therefore advisable to transfer the operational scheduling data completely separately from the actual data.

2.2.2 Referencing the real-time data

In order to generate updated information, the timetable information system must be able to incorporate the actual (real-time) data, which is transferred online, into its planned data and order it accordingly under strict time-critical conditions. This involves:

a) Trip identification via ID or route number etc.
b) Difference forming: Establishing any changes that have occurred.

A decisive factor for exact referencing is that the transferred actual data is coordinated with the planned data held by the timetable information system. The quality of the dynamic information is hugely dependent on this, as experiences with installations of such interfaces have shown. In a considerable percentage of cases, there are often issues with the incorporation of real-time data into the planned data which must be analysed and collected over the course of the project. And although the actual data is of great significance in itself, it can only be used effectively in the timetable information system where there is exact referencing to the underlying database.

2.2.3 The supply of planned data

With regard to the planning data supply, there are various possible situations, typified below:

- **Identical data sets (ideal case)**
  The AVLC system and the timetable information system have a common data supply with all seasonal timetables Using proprietary update mechanisms, mid-term decisions, affecting the following operational day, are also communicated.

- **Partially identical data sets**
  The AVLC system and the timetable information system only have a common status of the seasonal timetables. Any further updates are not normally communicated.

- **Inconsistent sources**
  The timetable information system cannot be sure of having the same planned and daily-adjusted timetables as the AVLC interface partner. This inconsistency is caused by organisational conditions such as geographic overlapping, multiple responsibilities between operators and agencies, as well as connection problems among others. Furthermore, technical conditions can also restrict the consistency of the databases. In general, different terms are used in the timetable planning, the AVLC and the timetable information system. This referencing problem is solved by the creation of conversion tables (see chapter 3.3), but these require constant management and updating.

Against the background of the importance of coordinated planned timetable data as a reference, the resulting demands on the exchange of planned data are as follows for the different situations:

Type	Reference data supply
Identical data sets (ideal case)	No further actions necessary
Partially identical data sets	Day to day exchange of modifications to the seasonal timetables
Inconsistent sources	Day to day exchange of all daily scheduled timetable information

2.2.4 Definition of the universal values

In order to avoid unnecessary data mapping between the partners and also to guarantee data consistency, we recommend managing a value list for the elements that are to be used as universally as possible.

These elements are hereafter highlighted with [VL] along with a reference to the respective value list.

The individual value lists are provided as an appendix (see Value lists, chapter 10).

3 Introduction and basic terms

3.1 Structure of the interface

3.1.1 Communication versus service layer

The interface consists of two layers (Figure 1: Overall architecture).

- Communication layer
- Technical service layer

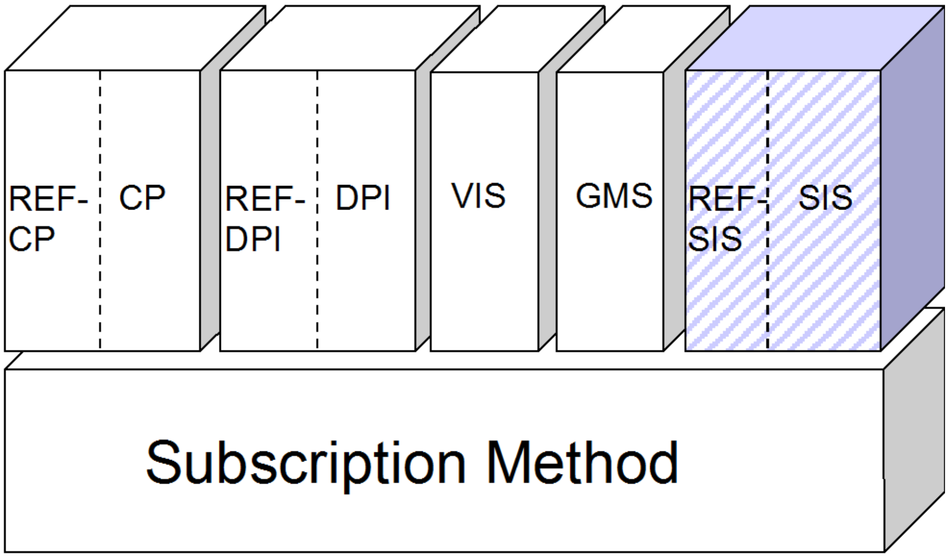


Figure 1: Overall architecture

The communication layer defines a standard procedure for requesting and then exchanging data. This procedure is hereafter referred to as the subscription method. The data consuming system creates so-called subscriptions, which define the type and amount of data to be exchanged. This definition is technically specific and with that already encapsulated in the technical layer. The communication procedure is the same for all services and represents the interface infrastructure (message referencing, error handling, reset behaviour). Reusing it for the various technical services ensures cost-effective implementation and extension of the interface.

The technical services are in turn built on the communication layer and address various application areas such as transfer protection, dynamic passenger information, etc. The services are independent of one another, allowing any number of services to be implemented. This guarantees application-specific implementation.

3.1.2 Reference data versus process data

The data exchanged via the technical services can be split into two classes:

- Reference data (planning data)

- Process data (actual data)

In the services of VDV453 (CP, DPI) the exchange of reference data provides a basic data supply for the subsequent exchange of process data.

The exchange of reference data generally represents an alternative to the exchange of data at the level of data management. The implementation and use of a reference data service depends on the application case as well as the technical operational requirements. Each individual service can therefore consist of two separate technical services. Within the interface, the process data exchange and reference data exchange are implemented as two separate independent technical services.

These statements also refer to the timetable information service of VDV454. Here however, the reference data service (REF-SIS) also has an inherent quality. With the exchange of daily updated timetables, it refreshes the seasonal timetable information according to recent changes, which significantly improves the quality of information provided to the passenger.

3.1.3 Controlled subscription method

There is firstly the possibility of mutual control of the data traffic. The strengths of the subscription method are recognised in the transmission of large volumes of data (segmentation, limitation). Contrary to the transfer protection and dynamic passenger information services, the selection possibility offered by the subscription method, which allows the volume of data to be reduced to interesting data only, is of secondary importance in the timetable information system, as the operator of such systems is generally interested in all available data.

The interfaces can also be integrated into the existing configurations of technical systems. This allows a modular design and step-wise implementation of the given objectives. This represents a cost advantage for the AVLC operator, as the infrastructure already provided for the services of the AVLC coupling can also be used for REF-SIS and SIS. This means there is no need for any new installations or the need to learn new handling practices. However, the communication infrastructure does need to be newly installed at the timetable information system level. There are also cost benefits here, which arise due to simultaneous usability for many different data sources. The interface described here allows several AVLC to simultaneously exchange data with several timetable information systems and vice versa (m to n relationship).

The basic communication procedure, which is based on the subscription method, is explained in chapter 4.2 . In order to avoid any inconsistencies, this document simply references VDV453 in its explanations without repeating the description of the methodology.

3.2 SIS, timetable information data service

3.2.1 Overview

This paper describes an interface between automatic vehicle location and control systems (AVLC) and timetable information systems for the largely automated transmission of actual timetable and operational status information.

It is designed as a new service extension to the AVLC integration interface as outlined in VDV453 and consists of a set of two mutually coordinated part services:

REF-SIS: Timetable information planned data service (reference for the SIS service)
Up-to-date planned timetables for mid-term enquiries (service day)

SIS: Timetable information process data service
Actual data from the operational procedure for short-term enquiries

These two services are implemented as modules of the communication infrastructure in accordance with the subscription method and with regard to VDV453 represent supplementary services within the general basic infrastructure. They fit into the overall concept of the AVLC universal interface and with that have all the advantages of this new technology.

The common architecture of VDV453 and VDV454 is represented in Figure 1: Overall architecture. The timetable information service can be implemented independently of the VDV453 services. It therefore represents a stand-alone implementation module in the sense of the VDV interface architecture.

3.2.2 The REF-SIS and SIS services

The functionalities of the two services, REF-SIS and SIS, have been developed to ensure mutual compatibility. REF-SIS transports the timetable data (of the current service day) and SIS the actual data relating to the current operational situation. Both services can be used individually. However, the overall quality is much improved if both services are used between the two interface partners, so that the actual data can be related to the previously transmitted planning data for the current service day.

The reference data service (REF-SIS) communicates the data from the operational planning, the process data service (SIS) the actual data and dispatch actions from the current operational procedures of the AVLC control centre. The reference data service is deactivated after transmission of the scheduled timetable, whilst the process data service runs in parallel to daily operation.

Both services incorporate cancellations as well as additional trips and any changes to trips or their attributes. As the timetable information system usually only knows the trips that are relevant to the passenger, the AVLC should only transmit these productive trips to the timetable information system. Otherwise, the timetable information system would offer services that do not actually carry any passengers.

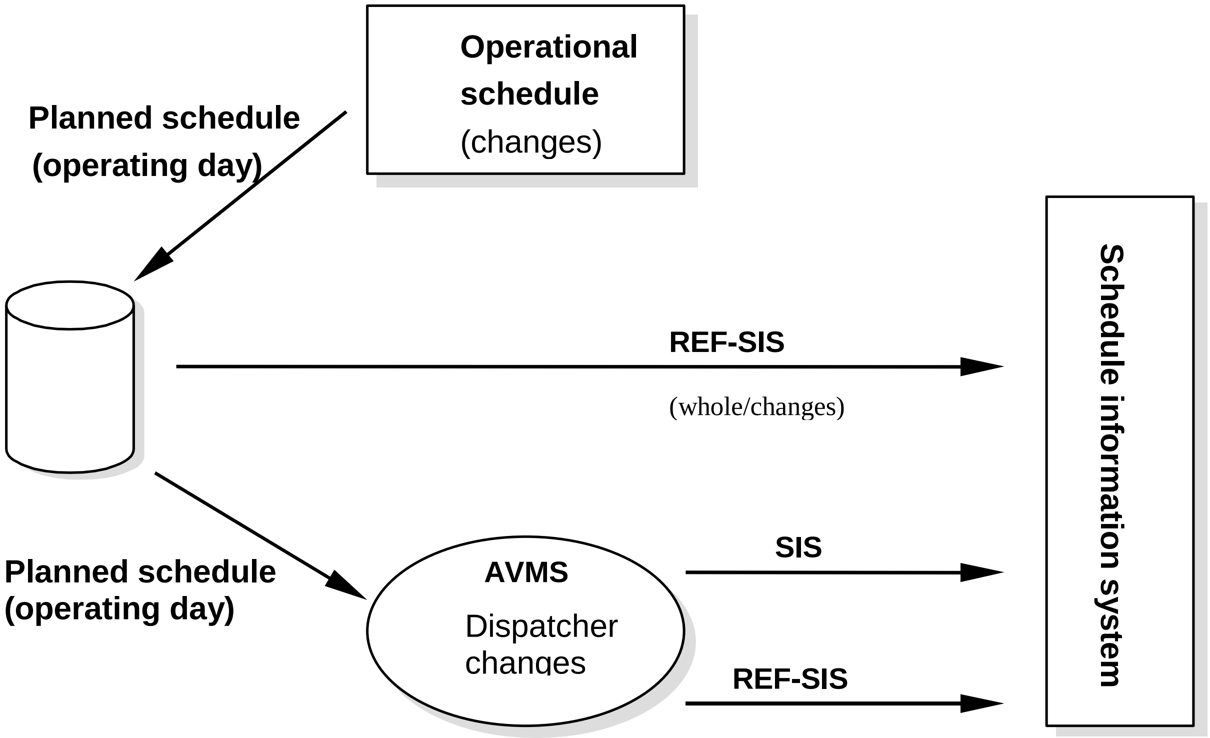


Figure 2: Application area of REF-SIS and SIS

Figure 2 represents the functional system architecture with the REF-SIS and SIS interfaces.

REF-SIS can be used on its own if the application partners accept the accuracy offered by daily updating of the data for the timetable information system.

The SIS service is also technically independent of REF-SIS, to allow for a situation with an ideal planning data supply or if there is only a need for real-time data relating to the daily operational conditions for short-term information, making REF-SIS superfluous to requirements.

Generally however, REF-SIS is used to improve the planning database for SIS service referencing and with that to guarantee the quality of the dynamic timetable information. The quality of the reference data supply of the timetable information system depends on the used systems and the organisational conditions and must be checked in each individual project. From the view of the system partner, the use of REF-SIS is strongly recommended.

The data that is exchanged in these services is always related to the timetable. The general message service of VDV453 is used to transfer text messages.

Overall, the design of the REF-SIS and SIS service pair takes into full account the variety of practical limitations imposed on and by the application partners. This satisfies the technical prerequisites for wide distribution.

3.2.3 Functional scope of REF-SIS

The REF-SIS service communicates updates to the daily AVLC timetables compared with the seasonal timetable that is provided in the timetable information system.

It is possible to transmit the following information:

- Cancellation or addition of trips
- Change to pattern, stop out of use
- Change to mode of transport / vehicle equipment
- Bay / platform change
- Changes to attributes (PassThru (Durchfahrt), NoAlighting (Ausstiegsverbot), NoBoarding (Einsteigeverbot), CyclesPermitted (Fahrradmitnahme), ExtraTrip (Zusatzfahrt), ExtraStop (Zusatzhalt), InfoText (Hinweistext)
- Trip formations (vehicle grouping, vehicle occupancy, vehicle equipment and statuses, vehicle position at the stop)

Note: As a consequence of deleting the TimetableVersionID the REF-SIS data cannot be viewed as a supply of differential data. This is due to the fact that the timetable information system is unable to establish whether the data supplies from the AVLC systems are based on the same version of the seasonal timetable as that of the timetable information system. Without a unique ReferenceVersion and common timetable basis any transmitted changes to the seasonal timetable cannot be relied upon and may lead to faulty and inconsistent customer information.

For this reason, the reference data is always exchanged completely within the framework of the subscription definition and on the basis of the line schedule.

During data exchange (in the framework of a subscription definition), the full daily timetable is transmitted to the timetable information system in the form of line schedules. This line schedule replaces the planning data from the seasonal timetable.

If a line schedule is not transmitted for a specific route, this means it does not have a daily timetable within the given time frame and the seasonal (annual) timetable remains valid for the relevant trips.

The REF-SIS planning data service therefore not only updates the data of the timetable information system but also provides a referencing system, by which the subsequent actual data can be more easily and quickly incorporated into the complete database of the timetable information system.

3.2.4 Functional scope of SIS

The actual data exchange updates the timetables with up-to-the-minute information that arises from the current traffic-related or operational situation. This is trip-related information. It may be caused by traffic problems (delays, congestion) or dispatch actions (diversions, reinforcement trips, turnarounds). On an operational level, the results of dispatch actions are understood as short-term planning data but are transmitted within the process data interface.

The sovereignty of the information remains with the AVLC. For example, it is not the actual delays that are exchanged but the prognosis profiles.

In general, the validity sequence in evaluating the available information is as follows:

- Process data
- Reference data
- Seasonal timetable data

Aside from the addition of pure actual data (e.g. timetable status), the process data service 'overwrites' the planning data (e.g. path changes) from the reference data service or the seasonal timetable if there has been no exchange of reference data.

Fundamentally, this deals with:

- First trip (inclusive of new planning and predicted times)
- Cancellation or addition of trips
- Change to pattern, stop out of use
- Change to mode of transport / vehicle equipment
- Bay / platform change
- Timetable deviations (delayed/early) upon violation of a threshold value; stop specific
- Traffic jams
- Vehicle capacities / passenger loads
- Changes to attributes (PassThru (Durchfahrt), NoAlighting (Ausstiegsverbot), NoBoarding (Einsteigeverbot), CyclesPermitted (Fahrradmitnahme), ExtraTrip (Zusatzfahrt), ExtraStop (Zusatzhalt), InfoText (Hinweistext)
- Trip formations (vehicle grouping, vehicle occupancy, vehicle equipment and statuses, vehicle position at the stop)

3.2.5 Limitation to the DPI service

It is important that timetable information systems have access to actual data concerning not only individual stops, connection or display areas but for as many of the routes and stops as possible within the AVLC network. This is the only way a timetable information system can calculate connections in the route network that take into consideration the real-time data. Some of these requirements can also be covered by the REF-DPI and DPI services that exist in VDV453. To ensure the efficient processing of the data in timetable information systems it is essential that it is provided in an adequate structure on the basis of trips and transferred as such rather than as a sum of the DPI signs at individual stops. The handling of this volume of data with the dynamic passenger information would be extremely inconvenient for both interface partners. The DPI service considers the transmission of real-time information from the point of view of the stop, the SIS service takes a network wide view.

3.3 Meta data, matching the stops and routes

As a timetable information system has to integrate data from several different operations and even various agencies into a single compound database, it cannot be assumed that the same codes are used to represent the same stops and routes in the AVLC and the timetable information system.

Stops, routes and other data are therefore formed into meta data. The IDs used here must be agreed bilaterally. This then demands the creation of assignment tables between the meta data IDs and the local IDs. The meta data must be agreed between the two communication partners in each case.

For heavily interlinked system landscapes (where there are multiple AVLC, DDS and timetable information systems) we recommend common operating practices and usage of the meta data in all relevant systems. This minimises the management needs and possible sources of error in the compound system. The DHID can be used for the unique identification of stops in accordance with VDV Recommendation 432 (IFOPT, Global ID). Furthermore, the aim is to make trips and (partial) routes uniquely identifiable (DFID, DTID, DLID).

The meta data types are as follows:

- **StopID (stops):**

  The level of division of the stops (stop or stopping point) need not agree on the two different sides. It is only important to ensure the meta stop can be matched to a locally known object on both sides.

  Example:

  Under meta ID 4712 the AVLC interprets the "Central Station Tram Platform 2" stopping point. The timetable information system on the other hand matches it to tram stop area 5, of stop 2011, 'Central Station'.

- **LineID (route):**

  The meta route must be matched to the locally known route on both sides.
  The LineIDs used by the systems participating in the data exchange must be globally unique. If this is not the case, the transport agency must be specified in the OperatorID element.

- **DirectionID:**

  For every route, the trips are arranged in one or more directions (e.g. outward and return). The DirectionID allows matching with the locally known directions.

- **ProductID:**

  The product allows a classification of the transport vehicle. The meta product must be matched to the local product.

  Examples of product classes are: train, bus, tram, boat, cable car etc.

  The TransportModeText element of a route comprises the local name of the mode of transport used on the route. The TransportModeText should not be confused with the product. Two routes of different operators can belong to the same product class (e.g. 'tram'), but carry different TransportModeTexts (e.g. tram train or light rail).

- **VehicleTypeID:**

  The vehicle type is used to describe the level of equipment in the vehicle. Within a city bus route for example, the individual trips can be served by buses with very different features. For people in wheelchairs or mothers with prams it is important to know whether there is a ramp or lift, or whether the bus is a low-floor bus offering easy access.

- **OperatorID:**
  The OperatorID (BetreiberID) is a code describing the managing transport agency. This

code allows routes from specific operators to be filtered out. With the OperatorID (BetreiberID) it is also possible to assign responsibilities for additional functions such as, for example, bookings and seat reservations.

3.4 Estimation of the data volumes

Limitation of the exchanged volumes of data by the XML parser and connecting lines can represent a challenge for the suggested specification. For this reason, definitions have been made to restrict the volume of data on which the limiting estimations are based.

3.4.1 General estimation of the data volumes

3.4.1.1 Assumptions

The generic 'LineSchedule' structure consists of n 'ScheduleTrip' structures, which in turn consist of m 'ScheduleStop' structures. In the sub-structures, it is possible to overwrite the details of the above lying category. The agreement is as follows: The fields in the sub-structures are optional and need only be completed and sent in the case of deviation. This avoids the transmission of redundant information. Information, which relates to the entire trip or even route, should be transmitted at the highest possible level.

The minimum data for transmission includes (see section 5 : Technical services):

ScheduleTrip
- TripID (FahrtID)
    - TripName
    - OperationalDay
- Possibly also ProductID or VehicleTypeID

ScheduleStop
- StopID (HaltID)
- DepartureTime (Abfahrtszeit)
- DeparturePlatformText (AbfahrtssteigText)

RealTrip (IstFahrt)
- TripRef (FahrtRef)
    - TripID (FahrtID)
        - TripName (Fahrtbezeichner)
        - OperationalDay
- LineID
- DirectionID

RealStop
- StopID (HaltID)
- DepartureTime (Abfahrtszeit)

- RealDeparturePrediction (IstAbfahrtszeitPrognose)

In the model calculation it has been assumed that the timetable information system is informed with a change in delay of more than 2 minutes. With a pure change to the delay, then in accordance with the progression rule only the stops at which the timetable status changes are reported (assumption: every 10th stop). The timetable information system extrapolates the value of the last reported delay along the route until the next delay value is reported. In the case of dispatch actions the complete timetable is transmitted.

Using figures based on experience, the percentage share of delayed trips has been calculated for discrete delay stages under 'normal' conditions and for the extreme case of 'heavy snow'. These discrete stages represent the times at which the AVLC sends a message to the timetable information system in accordance with the hysteresis setting of 2 minutes.

Change messages with x min delay (SIS) as a % of all trips

Trips with	Normal conditions	Heavy snow
< -2 min early time	5%	5%
> 2 min delay	50%	80%
> 4 min delay	20%	55%
> 6 min delay	10%	40%
> 8 min delay	5%	30%
> 10 min delay	1%	25%
> 20 min delay	0%	20%
> 30 min delay	0%	15%
> 40 min delay	0%	10%
Dispatch actions	5%	25%

It has been assumed for the calculation that under normal conditions delays are completely compensated, i.e. every trip is started and ended punctually. A trip delayed more than 10 minutes under regular conditions therefore, results in two entries in each delay row of the table However, when calculating the data volumes in cases of heavy snow, it is assumed that although trips can be started on time it would not be possible to compensate the delays. Neither method corresponds exactly to the actual operating conditions, but can be accepted as a good enough approximation for the purpose of our calculations concerning data volumes. Characteristic for the behaviour of a system under extreme conditions is firstly that significantly more (almost all) vehicles are delayed and secondly that many are severely delayed which means that the necessary message exchange increases per trip as the delay continues to increase.

Not taken into consideration:

- Transfer of connections (REF-SIS)
- Additional trip-specific or stop-specific information (see comments on optional fields)

- Additional attributes of the individual XML tags (30 byte / data element assumed)
- http protocol overhead

3.4.1.2 Estimation of the data volumes

For large-scale operations (60,000 trips/day, 40 stops/trip) this yields:

Total daily volume for REF-SIS:	300 MB	
Total daily volume for SIS:	90 MB	(normal conditions)
	270 MB	(heavy snow)

For a mid-sized transport authority (10,000 trips/day, 30 stops/trip) this yields:

Total daily volume for REF-SIS:	38 MB	
Total daily volume for SIS:	12 MB	(normal conditions)
	36 MB	(heavy snow)

3.4.1.3 Transmission capacities

If we assume that data exchange is distributed evenly throughout an 8-hour day in the SIS process data service, then a mid to large-scale operation requires a connection with a minimum net transmission rate of 1.4 kB/s or 9.4 kB/s respectively for the purpose of exchanging process data. When operating under severe traffic conditions, delayed updating of the timetable information system must be considered due to the uneven distribution of messages at peak times. However, using data compression it is possible to reduce the large XML files to around 10-20% of their original size and with that to save on line capacity. This has not been taken into consideration in the data volumes listed above. When using data compression all relevant parties must have sufficient computing power to carry out data compression and decompression without significant time delays.

The REF-SIS reference data service generally exchanges the entire schedule once or twice a day. Although this takes place outside the peak times, in the worst cases, transmission to the timetable information system can take up to 1 hour. Data compression is also advised here. With data compression, the minimum requirement on the link for a mid / large-scale operation is a net transmission rate of approximately 2.2 kB/h or 16.7 kB/h for the reference data exchange. As this service deals with the transmission of large volumes of related data and the transmission times have a significant role to play, the bandwidth of the available transmission path has a direct influence on the time required for data matching in the timetable information system.

3.4.2 Estimating the data volumes for formation data

In a large operation with 60,000 trips a day and 40 stops per trip, we would assume the following:

Total daily volume for REF-SIS:	11.1 GB	
Total daily volume for SIS:	5 GB	(normal conditions)
	8 GB	(heavy snow)

In a mid-sized operation with 10,000 trips a day and 10 stops per trip, we would assume the following:

Total daily volume for REF-SIS:	980 MB	
Total daily volume for SIS:	450 MB	(normal conditions)
	500 MB	(heavy snow)

3.5 Assessment of data actuality

The process information with which a system creates timetable information is fundamentally aged by the step-wise processing through various different systems.

Position messages from a vehicle are generally processed by the AVLC in cycles, formed into predictions and then passed on to the timetable information service.

Particularly for the SIS process data service, we must ask how old the data actually is and to what extent this age must be considered in the context of issuing timetable information.

The individual processing stages must be analysed and the resulting times accumulated.

The following figures are estimations based on the experiences of AVLC and timetable information system manufacturers.

The following stages and times are to be expected as delays:

- **Recording and transmitting the vehicle location (AVLC)**

  Vehicles are usually recorded in so-called polling cycles. The vehicles are polled in series and their data processed. There is a minimum polling cycle that is determined by the network capacity and the number of vehicles. In the systems of today, this is generally between 15-90 seconds.

  As an alternative to this method, some AVLC systems communicate with their vehicles on an event-triggered basis. Here the vehicle determines its own timetable deviation and reports it to the AVLC after reaching a set threshold. Here the delays are typically between 5-15 seconds.

- **Transmission to the timetable information service (transfer via VDV454)**

  This concerns the time that is required to transmit a message from the AVLC to the timetable information system. This includes the packaging of the information into the structures of VDV454, transmission via a data line as well as the unpacking from XML back into binary data. Exact estimations are difficult here as the composition of the systems as well as the amount of data permit a lot of leeway.

  Single figure second values are to be expected.

- **Entry into the database (timetable information system)**

  If the data is available on the side of the timetable information system interface, then it must be entered into the global database. The necessary reference data must be located and extended or changed accordingly. Estimations from the manufacturer are in the range of 3-10 seconds depending on the extent of the changes.

  This yields a complete delay within the information chain in the region of 2 minutes. To this must be added further delays on the side of the timetable information service, e.g. the transmission of an SMS. Overall, the delays are small enough to be able to issue short-term information.

3.6 Time formatting

As the ISO Format 8601 supports several representations, the same solution as that used in VDV453 is applied for the REF-SIS and SIS services:

Every piece of time information is related to UTC (Universal Time Coordinated). Deviations from this time zone are coded in accordance with ISO 8601 (e.g.: 2000-04-07T18:39:00+01:00).

Without a specification of time difference, the time is already in UTC. In this situation there may also be a subsequent Z (2002-04-30T12:00:00 corresponds to 2002-04-30T12:00:00Z). In other words, the first 19 characters are obligatory and correspond to local time or UTC.

This method of time representation avoids any problems with summer/winter changeover.

4 'Basic infrastructure' interface description

4.1 Foreword

The specification described in this document extends VDV453 with a further technical service. The following chapter describes the basic principle as well as the necessary extensions and modifications. In addition, the definitions made in VDV453 concerning the areas of 'architecture' and 'basic infrastructure' are also valid within VDV454.

4.2 Subscription method

The so-called subscription method defines a common basic communication structure, on which all technical services are based. The subscription method consists of a set of request and reply messages, which define an asynchronous communication structure.

The concept follows the client-server model. System A (server) can make data available to another system B (client).

The concept is event-based. The data changes on the basis of an action in the server system (A), which is then communicated to the client system (B) (see Figure 3).

The client and server first agree which information is to be exchanged. This is achieved by so-called subscriptions. Subscriptions are defined on the client side. The client sends a subscription request to the server and with that registers interest for specific data (step 1). The data concerned is defined within the actual subscription request. After confirmation from the server, the client can expect a subsequent supply of data.

The server (A) then informs the client (B) about new or modified data by means of a corresponding message (step 2). The client (B) can then retrieve the corresponding data from the server (A) (step 3).

In order to detect a server breakdown, status requests can be periodically sent to the server. With a status reply, the server confirms its functionality (step 4).

In order to detect the breakdown of a client, it is possible to send ClientStatusRequests on a periodic basis. With a ClientStatusReply, the client confirms its functionality (step 5).

Subscriptions have a life span as defined by the client and once expired are automatically deleted by the server. Deletion can also be achieved prior to this by the client (step 6).

An exception to this definition is given by the REF-SIS subscription. This is quit immediately once all requested timetables have been transmitted (see 5.1). It must be re-initiated by the timetable information system (client) for the transmission of additional data.

Step	Control System 1 (server)	Requests / Replies	Information System (client)
①	Enter subscription in management	Subscribe data (SubscriptionXYZ)	There is (foreign) data that is required in the schedule information system
		Acknowledgement or error message (SubscriptionReply)	
②	Suitable data found	Data available (DataReadyRequest)	Data polled at next opportunity
		Acknowledgement or error message (DataReadyAnswer)	
③	Transmit actual data	Transmit data (DataSupplyRequest)	Poll data
		Data (DataSupplyAnswer)	Process data
	New data exists for subscription	Data ready	Data polled at next opportunity
		Acknowledgement or error message	
	Transmit actual data	Transmit data	Poll data
		Data	Process data
④	Life sign	Status (StatusRequest)	Connection monitoring timeout expired
		Acknowledgement or error message (StatusReply)	
⑤	Remove subscription from management	Delete subscription (SubscriptionXYZ)	Subscribed data no longer required
		Acknowledgement or error message (SubscriptionReply)	

Figure 3: Communication procedure for the subscriptions

The services are managed separately, according to service type. Subscriptions are referenced via so-called SubscriptionIDs. A SubscriptionID is unique within a service. The client is responsible for assigning the SubscriptionID.

A detailed description of the subscription method is given in VDV Recommendation 453 along with the procedures following a break in connection or in case of error.

4.3 Protocols

Two protocols are used in the interface:

HTTP/1.1 as the transport protocol

XML 1.0 for recording the technical data

4.4 Service codes / request URL

Every service in VDV453 has a unique code (see VDV453, chapter 5.2.3). The additional codes for the timetable information service are as follows:

- 'sisref' for the reference data service of the timetable information interface
- 'sis' for the process data service

In accordance with the conventions for target addresses (request-URL, VDV453, chapter 5.2.4) a status request to the process data service of the timetable information interface, for example, would read:

```
http://serverhost:8080/fremdbetriebskennung/aus/status.xml
```

4.5 Common data types

The majority of data types in VDV453 is also used within VDV454. The data types of VDV454 are therefore integrated into the schema of VDV453.

The following data types are reused in VDV454 and for this reason are not described again here. If the data types contain sub-types, these too are used again.

The English aliases (see chapter 8) also remain valid.

Element	Type	Described in (VDV453)
SubscriptionRequest (Abo-Anfrage)	SubscriptionRequestType (AboAnfrageType)	Chapter 5.1.2
SubscriptionReply (Abo-Antwort)	SubscriptionReplyType (Abo-AntwortType)	Chapter 5.1.2

Element	Type	Described in (VDV453)
DeleteSubscription (Abo-Loeschen)	DeleteSubscriptionType (Ab-oLoeschenType)	Chapter 5.1.5
Confirmation (Bestae-tigung)	ConfirmationType (Bestae-tigungType)	Chapter 5.1.2
DataSupplyRequest (DatenAbrufenAnfrage)	DataSupplyRequestType (DatenAbrufenAnfrageType)	Chapter 5.1.4
DataSupplyAnswer (DatenAbrufenAntwort)	DataSupplyAnswerType (DatenAbrufenAntwortType)	Chapter 5.1.4
DataReadyRequest (DatenBereitAnfrage)	DataReadyRequestType (DatenBereitAnfrageType)	Chapter 5.1.3
DataReadyAnswer (Daten-BereitAntwort)	DataReadyAnswerType (DatenBereitAntwortType)	Chapter 5.1.3
TripID (FahrtID)	TripIDType (FahrtIDType)	Chapter 6.1.5
TripIDExt (FahrtIDExt)	TripIDExtType (FahrtIDExtType)	Chapter 6.2.4.4.1
TripInfo (FahrtInfo)	TripInfoType (FahrtInfoType)	Chapter 6.2.3.3.1
LineID (LinienID)	LineIDType (LinienIDType)	Chapter 6.1.6
Product ID (ProduktID)	ProductIDType (Produk-tIDType)	Chapter 6.1.7
DirectionID (RichtungsID)	DirectionIDType (Richtung-sIDType)	Chapter 6.1.6
StatusRequest (Sta-tusAnfrage)	StatusRequestType (Sta-tusAnfrageType)	Chapter 5.1.8
StatusReply (StatusAnt-wort)	StatusReplyType (StatusAnt-wortType)	Chapter 5.1.8

4.6 Use of the optional fields

The volume of data that needs to be transported within the scope of a timetable information interface significantly exceeds those of the services in VDV453.

The use of optional fields is therefore more predominant to reduce the data volumes.

Whilst the presence of optional fields in a message within the technical services of VDV453 indicates the technical support of a functional characteristic (e.g. quick cleardown), optional fields within VDV454 are primarily used to reduce the data volume.

This means that the optional fields are sent (where possible), when changes to the known information are to be communicated. In the case of initial messages this is generally the changes with regard to the scheduled timetable (reference data service) or seasonal timetable respectively. In terms of a follow-up message, these are changes with regard to the previous message. If there are no changes to the values, these optional fields can be omitted with a renewed sending of the message. In this case, any previously transmitted values retain their validity. Where provided, the scheduled timetable data (from the reference data service or the seasonal timetable) remains valid until the first occurrence of a message with optional elements.

If the SIS service is used without the REF-SIS service and the initial message does not have any optional elements, the relevant seasonal timetable information, where provided, is valid (irrespective of whether the AVLC and timetable information systems are using the same timetable base).

It is therefore advisable to include all information held by the AVLC in relation to a specific trip in any initial message to the recipient system. This guarantees that the most complete version of a trip is available from the off whilst protecting the independence of the SIS service (data recipients do not require any knowledge of the seasonal or daily timetables).

In the majority of cases, this special use of optional fields excludes the use of XML default values.

5 Technical services

5.1 REF-SIS planning data service

This service has the task of transmitting daily updated timetables for all known routes within the AVLC to the timetable information system. This improves the quality of mid-term information and eases the referencing between real-time messages in the SIS service and the scheduled timetable. However, it is not absolutely essential for the functioning of the actual data service.

As the timetable information system usually only knows the trips that are relevant to the passenger, the AVLC should only transmit these productive trips to the timetable information system.

The REF-SIS service is also used to transmit information concerning the planned connections and the linking of trips, in which the passenger is able to remain seated in the vehicle.

Due to the many advantages, systems that are able to host the REF-SIS service should always use it. The cooperation between new, more powerful AVLC and timetable information systems will profit in particular.

A REF-SIS subscription is usually ended immediately after all timetables have been transmitted. If the data supplier sends PendingData='true', this signals it still has additional data for the given subscription.

If agreed unilaterally between all partners, the subscription can remain active until the ValidUntilTimeStamp is reached. As long as the subscription is active, the data supplier can continue to send the line schedules that have not yet been transferred.

If the client terminates the subscription, it must be reset by the timetable information system (client) before any more data can be transferred. This usually occurs in daily cycles.

5.1.1 Timetable data request (SISRefSubscription)

The subscription request for planning data is represented by the SISRefSubscription structure and contains the following elements:

Definition of SISRefSubscription (AboAUSRef)

SubscriptionID (AboID):	(attribute) The SubscriptionID (AboID) references the subscription of planned schedules.
ValidUntilTimeStamp (VerfallZst):	(attribute) Specifies the time to which the subscription is valid

TimeWindow (Zeitfenster):	Two time points ('valid from' and 'valid to'), which establish the time window for the validity of the planning data. The times relate to the departure time at the departure stop. Even if the departure time lies within the time window but the trip leaves at a later point, the entire trip is still transmitted in one piece (see 5.1.1.1).
LineFilter (LinienFilter):	(sub-element, optional, multiple) filter stating the route for which route planning data is to be transmitted. This element contains the IDs of all routes as well as optionally the associated DirectionIDs, for which data is requested (see 5.1.1.2). No specification: Planning data is to be reported for all routes
OperatorFilter (BetreiberFilter):	(sub-element, optional, multiple) filter stating the transport authority (operator) for which scheduled timetables are to be transmitted. This element contains the OperatorID providing the subscription data (see 5.1.1.3). No specification: All planning data known to the AVLC is to be transmitted (subject to other filters or restrictions).
ProductFilter (ProduktFilter):	(sub-element, optional, multiple) filter stating the ProductID for which scheduled timetables are to be transmitted. This element contains the ProductIDs of the trips providing the subscription data (see 5.1.1.4). No specification: All planning data known to the AVLC is to be transmitted (subject to other filters or restrictions).
TransportModeTextFilter (VerkehrsmittelTextFilter):	(sub-element, optional, multiple) filter stating the transport modes for which route planning data is to be transmitted. This element contains the transport mode texts of the trips providing the subscription data (see 5.1.1.5). No specification: All planning data known to the AVLC is to be transmitted (subject to other filters or restrictions).
StopFilter (HaltFilter):	(sub-element, optional, multiple) filter stating the stops for which route planning data is to be transmitted. This element contains the stop IDs of the trips providing the subscription data (see 5.1.1.6). No specification: No StopFilter: All planning data known to the AVLC is to be transmitted (subject to other filters or restrictions).
BlockFilter (UmlaufFilter):	(sub-element, optional, multiple) filter stating the block for which scheduled timetable data is to be transmitted. This element contains the BlockID (UmlaufID) of the trips providing the subscription data (see 5.1.1.7). No specification: All scheduled timetables known to the AVLC are to be transmitted (subject to other filters or restrictions).
~~BlockID:~~	(optional, multiple) No longer in use. Do not use. ~~Filter restricting the block numbers for which the planned timetables are to be requested.~~ ~~No specification: All scheduled timetables known to the AVLC are to be transmitted (subject to other filters or restrictions).~~

TimetableVersionID:	(optional) No longer in use. Do not use. ~~This only includes changes with regard to the previously reported seasonal timetable with the specified VersionID. (meta-data, see 3.3).~~ ~~No specification: No ScheduleVersionID. The AVLC transmits the entire scheduled timetable.~~
DataAvailableUntil:	(optional) no longer in use. Do not use. ~~Specifies the time to which the data is available, with regard to the status of the seasonal timetable with the given TimetableVersionID.~~
WithProtectedConnection (MitGesAnschluss):	(optional) specifies whether the transfer information, for which transfer protection is active, is also to be transmitted. No specification: Transmission without connection information
WithCurrentlyActiveTrips (MitBereitsAktivenFahrten):	(optional) specifies whether the trips that are already active at the ValidFrom time point of the TimeWindow are also to be transmitted. This is most useful when the ValidFrom value matches the current time. No specification: Any currently active trips are not to be transmitted.[1]
WithFormation (MitFormation):	(optional, default "false") specifies whether formation data is to be transmitted for the subscribed trips. If this element is used, it must be assigned a valid value - either 'true' or 'false'. No specification: Transmission without formation data.

Combination of subscription filter and criteria

Filter criteria can be specified and combined as necessary in order to establish the scope of data for the given subscription.
The rules are as follows:

- If several filters of the same type are in place (e.g. LineFilters), this reflects an OR connection. In other words, at least one of the specified criteria must be included in the timetable data.
- Combinations of different filters (e.g. LineFilters and OperatorFilters) reflect an AND connection.
- Filter specifications within a single filter also specify an AND connection (e.g. specification of several StopIDs within a StopFilter).

Example:

```
<AboAUSRef AboID="2">
      <LinienFilter>
           <LinienID>10</LinienID>
      </LinienFilter>
      <LinienFilter>
           <LinienID>15</LinienID>
           <RichtungsID>A</RichtungsID>
      </LinienFilter>
```

[1] This means that the clients no longer receive the currently active trips from the data suppliers if the ‘WithCurrentlyActiveTrips’ (MitBereitsAktivenFahrten) element is not contained within the subscription. Until now however, these trips were actually sent in many system set-ups even though this contradicts the VDV454 standard.

```
        <BetreiberFilter>
              <BetreiberID>85:11</BetreiberID>
        </BetreiberFilter>
        <BetreiberFilter>
              <BetreiberID>80:A____9Z</BetreiberID>
        </BetreiberFilter>
        <HaltFilter>
              <HaltID>8550000</HaltID>
              <HaltID>8050000</HaltID>
        </HaltFilter>
        <HaltFilter>
              <HaltID>8530033</HaltID>
        </HaltFilter>
</AboAUSRef>
```

Using wildcards for the subscription filter

Use of wildcards (e.g. "%", "*", "?", "#"), must be agreed by all partners.

5.1.1.1 Restricting the data by time period

The time points in the TimeWindow structure refer to the respective departure times from the start stop.

Definition of TimeWindow	
ValidFrom (GueltigVon):	Start of the time window for the transmission of planned data.
ValidUntil (GueltigBis):	End of the time window for the transmission of planned data. Even if the end of a trip lies beyond the specified time window, the information about the whole trip is still transmitted.

Other trips that are viewed as belonging to the time frame include those that lie outside of the specified time frame but have a direct traffic-related connection to other trips within the time period. An example of this is the coupled trip, which splits off from a train. The train journey itself lies within the time period, which means that all coupled trips also belong, even if they are actually outside the specified time period. This avoids any inconsistencies between the individual train parts. Another example is offered by trains whose generic or product name changes mid route, which means they are often represented as two individual trips. From a passenger or traffic planning point of view however, it is one continuous trip.

5.1.1.2 Restricting the data by route (LineFilter)

The LineFilter structure allows the timetable information system to select individual routes of the AVLC system. If there is no LineFilter specified for the subscription, this implicitly implies transmission of data for all routes known to the AVLC. In other words, the AVLC can decide the routes for which it wishes to send data.

Definition of LineFilter	
LineID (LinienID):	Identifies the route; meta datum (see 3.3).
DirectionID (Rich-tungsID):	(optional) this value is a meta datum (see 3.3). It typically identifies the outbound and inbound journey of a route. No specification: No direction specified. The AVLC transmits the scheduled timetable of the entire route, independent of the direction of the trip.

In place of an identification via the route or LineID (LinienID) it is possible to use an inter-operational referencing via the BlockFilter (UmlaufFilter) for a block-based representation of the timetable. It is not automatically possible with meta data in the sense of the VDV453/454 recommendations, as block numbers are assigned dynamically by the timetable and duty planning systems and change on a daily basis, contrary to the route numbers. Even the internal block numbers of the timetable planning system may not be known to the AVLC personnel. It is therefore necessary to use a different code to select a subscribed block. In the example of the graphical schedule for a single agency the following procedure has proven useful: After selecting one or more (or all) routes, references to the corresponding blocks of the current operational day are reported by the AVLC to the visualisation system in the form of route/run numbers. On the basis of these references the user can select the desired blocks for display. It is not clear how this referencing can be extended to systems with several AVLC, which in the case of commonly served routes even describe the same physical blocks.

In the following example the timetable information system polls planned timetable data from the AVLC for route '10' in all directions. Data is to be sent for 24 hours starting at 9.30am on 21.7.2001.

Example:

```
<AboAUSRef AboID="2" VerfallZst="2001-07-22T09:30:47">
          <Zeitfenster    GueltigVon="2001-07-21T09:30:47"
                          GueltigBis="2001-07-22T09:30:47"/>
          <LinienFilter>
               <LinienID>10</LinienID>
          </LinienFilter>
</AboAUSRef>
```

A further method of breaking up the XML messages into smaller individual packets is offered by using the PendingData attribute in the DataSupplyAnswer element in the basic communication service.

5.1.1.3 Restricting the data by operator (OperatorFilter)

Definition of the OperatorFilter	
OperatorID:	Specification of the OperatorID (transport authority), which must be taken into consideration when using this filter.

Example:

```
<AboAUSRef AboID="3">
      <BetreiberFilter>
            <BetreiberID>85:11</BetreiberID>
      </BetreiberFilter>
      <BetreiberFilter>
            <BetreiberID>80:A____9Z</BetreiberID>
      </BetreiberFilter>
</AboAUSRef>
```

5.1.1.4 Restricting the data by product (ProductFilter)

Definition of the ProductFilter	
ProductID:	Specification of the ProductID, which must be taken into consideration when using this filter.

Example:

```
<AboAUSRef AboID="4">
      <ProduktFilter>
            <ProduktID>Train</ProduktID>
      </ProduktFilter>
      <ProduktFilter>
            <ProduktID>Bus</ProduktID>
      </ProduktFilter>
</AboAUSRef>
```

5.1.1.5 Restricting the data by transport mode text (TransportModeTextFilter)

Definition of the *TransportModeTextFilter (VerkehrsmittelTextFilter)*	
TransportModeText (VerkehrsmittelText):	Specification of the transport mode text, which must be taken into consideration when using this filter.

Example:

```
<AboAUSRef AboID="5">
     <VerkehrsmittelTextFilter>
           <VerkehrsmittelText>ICE</VerkehrsmittelText>
     </VerkehrsmittelTextFilter>
     <VerkehrsmittelTextFilter>
           <VerkehrsmittelText>EC</VerkehrsmittelText>
     </VerkehrsmittelTextFilter>
     <VerkehrsmittelTextFilter>
           <VerkehrsmittelText>NFB</VerkehrsmittelText>
     </VerkehrsmittelTextFilter>
</AboAUSRef>
```

5.1.1.6 Restricting the data by StopID (StopFilter)

Definition of StopFilter (HaltFilter)	
StopID (HaltID):	(multiple) specification of the StopID, which must be taken into consideration when using this filter.

Example:

AND link (all specified stops must be included in the route, including those across regional borders)

```
<AboAUSRef AboID="6">
     <HaltFilter>
        <HaltID>8509000</HaltID>
        <HaltID>8507000</HaltID>
     </HaltFilter>
</AboAUSRef>
```

OR link (at least one of the specified stops must be included in the route)

```
<AboAUSRef AboID="7">
     <HaltFilter>
        <HaltID>8500010</HaltID>
     </HaltFilter>
     <HaltFilter>
        <HaltID>8000026</HaltID>
     </HaltFilter>
</AboAUSRef>
```

5.1.1.7 Restricting the data by BlockID (BlockFilter)

Definition of BlockFilter (UmlaufFilter)	
BlockID (UmlaufID):	Specification of the BlockID that is taken into consideration when using this filter.

Example:

```
<AboAUSRef AboID="8">
     <UmlaufFilter>
          <UmlaufID>1234</UmlaufID>
     </UmlaufFilter>
</AboAUSRef>
```

5.1.2 Transferring data (SISMessage (AUSNachricht))

All data transmissions for a subscription (planning data, real-time data and connection information) are conveyed in the SISMessage (AUSNachricht) element.

Definition of SISMessage (AUSNachricht)	
SubscriptionID (AboID):	(attribute) The SubscriptionID (AboID) references the subscription created by the request.
LineSchedule (Linienfahrplan):	(optional, multiple) contains the timetable (of a part) of a route. Compulsory in the REF-SIS service. Element used by the timetable information system to update the seasonal timetable.
ScheduleBlock (SollUmlauf):	(optional, multiple) used for the block oriented transfer of the dated trips.
RealTrip (IstFahrt):	(optional, multiple) Contains current information on a trip. Used in the SIS process data service.
RealBlock (IstUmlauf):	(optional, multiple) contains up-to-date real-time (estimated) information about a block
ProtectedConnection (GesAnschluss):	(optional, multiple) contains information about a planned connection in 'ConnectionPlan' or the actual information about a (previously planned) transfer relationship in 'ConnectionStatus'
TripAssembly (FahrtVerband):	(optional, multiple) contains the details of trips with common sections (see 5.5)

With a route-based subscription the information in the LineSchedule (Linienfahrplahn) reply structure is route-specific and for a block-based subscription it is packaged in the ScheduleBlock (SollUmlauf) reply structure.

If a data supplier receives a DataSupplyRequest (DatenAbrufenAnfrage) but has not yet prepared the data, it sends an empty DataSupplyAnswer (DatenAbrufenAntwort) (contains the compulsory Acknowledge (Bestaetigung) element but not the optional SISMessage (AUSNachricht) element). In this situation, the data consumer cannot draw any conclusions about the timetables as the response does not contain any useful information.

5.1.2.1 Using AllData (DatensatzAlle)

The general use of AllData (DatensatzAlle) is described in VDV453, Chapter 5.1.4.2.1 ‘Using AllData (DatensatzAlle)”. This chapter contains additional information relevant to REFSIS.

If a data provider receives a ‘DataSupplyRequest’ (DatenAbrufenAnfrage):

- But does not have the data ready (AllData (DatensatzAlle) irrelevant) or
- Has already sent the data (next to AllData (DatensatzAlle) = ‘false’),

an empty DataSupplyAnswer (DatenAbrufenAntwort) (the mandatory element ‘Acknowledge’ (Bestaetigung) is included, but the optional element ‘SISMessage’ (AUSNachricht) is missing) shall be sent. In this situation, the data consumer cannot draw any conclusions about the line schedules as the response does not contain any useful information.

If, after all of the present scheduled timetables are sent, the client sends another DataSupplyRequest (DatenAbrufenAnfrage) (AllData (DatensatzAlle) irrelevant), and the server already deleted the SISRefSubscription (AboAUSRef), the server must send a confirmation with the result =’notok’ and an ErrorNumber (Fehlernummer) from the range 300-399.

If, after all of the present scheduled timetables are sent, the client sends another DataSupplyRequest (DatenAbrufenAnfrage) with AllData (DatensatzAlle) = ‘true’, and the server still has an active SISRefSubscription (AboAUSRef), the server must send all data corresponding to the confirmed time period in SISRefSubscription (AboAUSRef) again. If the data provider is no longer able to do this because the system has already deleted trips which start after the confirmed DataValidFrom (DatenGueltigAb) from the memory, an error message must be returned, after which the client must subscribe to the data again.

5.1.3 Line-based schedule data transmission (LineSchedule)

A SISMessage (AUSNachricht) element can contain several LineSchedule (Linienfahrplan) elements:

A line schedule always contains all trips of a route of a specific operator in a given direction from a data supplier (AVLC) in the corresponding validity time period.

The rules are as follows:

- The line schedule replaces the seasonal timetable on the basis of 'LineID', 'OperatorID' and 'DirectionID'.
- If a line schedule excludes specific planned trips, the relevant trips are not implemented.
- If a line schedule does not include any trips, there are no trips along this route in the given time period.

Definition of LineSchedule (LinienFahrplan)

LineID (LinienID):	The LineID is used to match the AVLC route with the route of the seasonal timetable in the timetable information system (see 3.3). Denotes the routes for which the seasonal timetable will be replaced by the daily timetable. The route IDs used by the AVLC must be completely unique across all transport authorities. If this is not the case, it is essential that the transport agency is specified in the OperatorID element. Note: Because route definitions are not defined universally within public transport systems, an alternative to the LineID is required to allow the timetable information system to accurately identify the origin and extent of a daily timetable supply.
DirectionID (RichtungsID):	This value is a meta datum (see chapter 3.3). It typically identifies the outbound and inbound journey of a route. Denotes the directions for which the seasonal timetable will be replaced by the daily timetable.
~~*ScheduleVersionID (FahrplanVersionID):*~~	(optional) No longer in use. Do not use. ~~Transmitted data relates to the specified version of the seasonal timetable.~~ No specification: Schedule version unknown
ScheduleTrip (SollFahrt):	(0 to multiple) Structure with details on the trip.
ProductID (ProduktID):	(optional) Product that is used on this route. Can be adjusted for each individual trip. The ProductID belongs to the meta data (see chapter 3.3). The product is used to classify the mode of transport. This allows sub-division into fare groups, interchange times, logos, etc. No specification: The product is derived from the annual (seasonal) timetable.
OperatorID (BetreiberID):	(optional, for reasons of upwards compatibility) this value is a meta datum (see 3.3). It specifies which transport authority carries out the planned trips. Every specified trip in the line schedule is conducted under the given OperatorID (BetreiberID). Denotes the transport authority for which the seasonal timetable will be replaced by the daily timetable. This element should be included whenever possible. If it is not possible to supply the OperatorID (BetreiberID), the data supplier must ensure that the LineID (LinienID) is universally unique and only the routes of a single transport authority are transferred within a line schedule.
LineText (LinienText):	(optional) Route text if different from published schedule. Can be overwritten per 'ScheduleTrip' (SollFahrt) structure. No specification: The route text is derived from the annual (seasonal) schedule.

DirectionText (RichtungsText):	(optional) destination text for the passenger (vehicle signage). We recommend that in the LineSchedule (Linienfahrplan) each destination text is used as a DirectionText (RichtungsText), as used by most ScheduleTrips (SollFahrten) within that LineSchedule (Linienfahrplan)[2]. Can be overridden according to the 'ScheduleTrip' element. No specification: Where the individual ScheduleTrip elements are without a 'DirectionText', it is taken from the seasonal (or annual) timetable according to LineID (LinienID) and DirectionID (RichtungsID). VDV recommends however, that the line schedule always includes the specification of a DirectionText.
FromDirectionText (VonRichtungsText):	(optional) text for the passenger informing them where the trip originated. We recommend that in the line schedule each origin text is used as a FromDirectionText (VonRichtungsText), as used by most ScheduleTrips within the line schedule2. Can be overwritten per 'ScheduleTrip' structure. No specification: Where the individual ScheduleTrip (SollFahrten) elements are without a 'FromDirectionText' (VonRichtungsText), it is taken from the seasonal (or annual) timetable according to LineID (LinienID) and DirectionID (RichtungsID). VDV recommends however, that the line schedule always includes the specification of a FromDirectionText (VonRichtungsText) (if used in the system).
TransportModeText (VerkehrsmittelText):	(optional) description of the mode of transport used by the operation or multi-agency, (e.g. „NFB", „S", „ICE") Can be adjusted for each individual trip. No specification: The transport mode text is derived from the annual (seasonal) schedule.
CyclesPermitted (FahrradMitnahme):	(optional) CyclesPermitted (FahrradMitnahme) is generally possible on this route. Can be adjusted for each individual trip. No specification: Information from the published annual (seasonal) timetable remains valid.
InfoText (HinweisText):	(optional, multiple) Information on the route. No specification: No information available for this route.

All optional elements in the line schedule can be overwritten by the corresponding entries in the 'ScheduleTrip' structure (with the exception of OperatorID (BetreiberID)).

<u>Pooling REF-SIS data using a data distributor (DDS):</u>

Trips of different AVLC systems (data suppliers) cannot be pooled into one line schedule and must be reproduced in different line schedules.

> Reason: If one data supplier fails, the associated line schedules are not supplied but those of the other data suppliers are provided as expected.

[2] Transmission of a LineSchedule (Linienfahrplan) includes all trips, for example of route 1 in direction A. The situation can arise in which 100 trips have the (from) direction text A and 5 have the (from) direction text B, as they follow slightly different paths. In this case, the (from) direction text A should be used in the line schedule instead of (from) direction text B and the different (from) direction text should be transmitted in the ScheduleTrip element.

Trips of different transport authorities cannot be pooled into one line schedule and must be reproduced in different line schedules.

> Reason: Even if one transport authority (operator) is unable to supply the associated line schedules, the others can supply the data as required.

Recommendation: The LineID and OperatorID should be unique across all systems involved with data exchange (AVLC, DDS, timetable information systems).

5.1.3.1 Single trip data (ScheduleTrip)

In every LineSchedule (Linienfahrplan) or ScheduleBlock (SollUmlauf) structure there are none, one or several ScheduleTrip (SollFahrt) p structures with the following content:

Definition of ScheduleTrip (SollFahrt)	
TimeStamp (Zst):	(attribute, optional) time stamp of the creation of the request.
TripID (FahrtID):	The TripID (FahrtID) is used to match the real-time messages from the SIS service with the scheduled timetable.
TripRelationship (FahrtBeziehung):	(Sub-element, optional) This element is used to reference other trips which are related to this trip, e.g. if an originally scheduled trip is divided into several trip sections executed by different vehicles (e.g. route closure / vehicle substitute). For more details, see the chapter 5.2.2.8 . No specification: The transmitted TripRelationships (FahrtBeziehungen) are deleted, and the planned data is taken into consideration. If the element is supplied, all TripRelationships (FahrtBeziehungen) need to be re-transmitted. TripRelationships (FahrtBeziehungen) which have already been transmitted no longer need to be taken into consideration.
ScheduleStop (SollHalt):	(optional, multiple) Structure with details on the stops in the pattern. To avoid (incorrect) interpretations on the fetcher side, the ScheduleStops (SollHalte) shall be provided in the sequence in which they were serviced in terms of time and location for data supply with CompleteTrip (Komplettfahrt) = 'true'. The scheduled times must increase in value chronologically in accordance with the sequence of the stops. In particular, when it comes to dispatched trips, the currently valid scheduled times must be supplied.
BlockID (UmlaufID):	(optional) BlockID (UmlaufID) is used to identify the block.
RunNumber (KursNr):	(optional) Internal AVLC run number of the trip. This number corresponds to the element LI_KU_NR in the VDV452.
TripNameText (FahrtBezeichnerText)	(optional, multiple) Indication of the publication-relevant TripName (FahrtBezeichner)(alphanumerical). For publication purposes, several TripNames (FahrtBezeichner) can be indicated, although the first takes priority.

TransportModeNumber (VerkehrsmittelNummer)	(optional) In this element, the planned trip number from the seasonal timetable can be copied for the transmitted trip. This trip number (train number for trains) is used, together with the other criteria, by the trip in the real-time data in VDV454 (SIS, REF SIS) to reference the trip in the seasonal timetable (also refer to VDV Recommendation 454, Chapters 2 and 3 as well as the glossary in Chapter 7). If the element is copied, the same transport mode number/train number as in the seasonal timetable must be used.
LineText (LinienText):	(optional) Route text if different from published schedule. No specification: LineText taken from 'LineSchedule'.
ProductID (ProduktID):	(optional) Product that is used for this trip. No specification: ProductID taken from 'LineSchedule'.
DirectionText (RichtungsText):	(optional) destination text for the passenger (vehicle signage). Within the ScheduleTrip, the destination text that is shown on the last section up to the terminal stop should be used as the DirectionText. (This is also valid for trips with intermediate destinations, such as circular routes.) Note: The DirectionText can also be used for the ScheduleStop (e.g. for the specification of intermediate destinations). No specification: DirectionText taken from 'LineSchedule' (Linienfahrplan).
FromDirectionText (VonRichtungsText):	(optional) text for the passenger informing them where the trip originated. The origin text of the start of the trip is used in ScheduleTrip. Note: The FromDirectionText can also be used on the ScheduleStop (e.g. for the specification of intermediate destinations). No specification: FromDirectionText (VonRichtungsText) taken from 'LineSchedule' (Linienfahrplan).
InfoText (HinweisText):	(optional, multiple) Information on the trip. No specification: No information on this trip.
PatternID (LinienfahrwegID):	(optional) unique code of the pattern in accordance with the given route for the vehicle on-board computer, corresponds to the "ROUTE_NO (ROUTEN_NR)" element of the "LINE (LINE (REC_LID))" table in the VDV452 standard. If there are any dispatch trips to be sent, which are known to the control system at the time of transferring the reference data, this code can also be partially overwritten by the entry in the 'ScheduleStop' (SollHalt) structure.
TrainName (Zugname):	(optional, for train services) train name, e.g. 'West Coast Express'. No specification: No train name
TransportModeText (VerkehrsmittelText):	(optional) name of the mode of transport, e.g. Reg, Express, ICE No specification: TransportModeText taken from 'LineSchedule'.
ExtraTrip (Zusatzfahrt):	(optional) indicates that this trip is transmitted as an addition to the planning data already sent (informal). No specification: The data supplier does not have any information regarding extra trip status.
Deleted (FaelltAus):	(optional) indicates that this trip has been cancelled and is therefore no longer valid within the daily timetable. No specification: Trip not represented as 'deleted'.

CyclesPermitted (FahrradMitnahme):	(optional) CyclesPermitted (FahrradMitnahme) is possible on this trip. No specification: CyclesPermitted (Fahrradmitnahme) taken from 'LineSchedule' (Linienfahrplan).
VehicleTypeID (FahrzeugTypID):	(optional) vehicle type; meta data (see 3.3). No specification: Vehicle type is unknown
ServiceAttribute (ServiceAttribut):	(sub-element, optional, multiple) structure that contains a description of the vehicle or trip attributes.
ScheduleFormation (SollFormation):	(sub-element, optional) structure to transmit formation relevant information relating to the ScheduleTrip (vehicles, vehicle groups, trip sections, vehicle equipment, vehicle statuses, vehicle occupancy, stopping position of the vehicles at the stops along the route).

Implementation notes:

ScheduleTrip (SollFahrt) can be used without ScheduleStop (SollHalt) to change the trip parameters if the trip has been made known previously. As soon as a ScheduleTrip has been transmitted with REF-SIS for the first time, the ScheduleStops specified in the ScheduleTrip are valid as the new journey path. The AVLC cannot be forced to send the 'Deleted' or 'ExtraTrip' element should a trip be cancelled or added (compared with the seasonal timetable) as there may be different versions of the timetable in the different systems, i.e. AVLC, DDS and the timetable information system.

The cancellation of a trip can be detected by the timetable information system in one of two ways:

- The cancelled ScheduleTrip is not transmitted in the line schedule.
- The cancelled ScheduleTrip is transmitted in the line schedule and labelled with 'Deleted'.

The 'Deleted' element has a controlling character in relation to the timetable information system. The timetable information system can then decide whether the cancelled trip is removed from the timetable or the passengers are informed of the cancellation in real time. Any cancelled seasonal timetable trips should, wherever possible, be declared via the 'Deleted' element. In this way it is possible to differentiate cancellations from time shifts which could lead to a situation, for example, in which a trip is pushed past the end of the time window of a REF-SIS supply and therefore registered incorrectly as a cancellation.

An extra trip can be labelled by the supplier system in one of two ways:

- The additional ScheduleTrip is transmitted in the line schedule.
- The additional ScheduleTrip is transmitted in the line schedule and the 'ExtraTrip' element is indicated.

In both cases the ScheduleTrip is added as an extra trip in the timetable. Specification of the ExtraTrip element is purely informative for the timetable information system.

5.1.3.2 Information on the trip service (ServiceAttribute)

The ServiceAttribute structure denotes the service attributes for the corresponding trip:

Definition of ServiceAttribute (ServiceAttribut)	
Name:	Describes the service attribute of the trip or the vehicle, e.g. low-floor vehicle.
Value (Wert):	Specifies whether the attribute is provided (value = 1) or not (value = 0).

5.1.3.3 Information on the Stop (ScheduleStop)

The ScheduleStop (SollHalt) structure can occur more than once within a ScheduleTrip.

Definition of ScheduleStop (SollHalt)	
StopID (HaltID):	The StopID is used to match the AVLC stop with the stop in the timetable information system (see chapter 3.3).
StopName (Haltestel-lenName):	(optional) Name of the stop (used for timetable information systems without separate data import)
DepartureTime (Ab-fahrtszeit):	(optional) This can be omitted for the terminal stop.
ArrivalTime (Ankun-ftszeit):	(optional) can be omitted if equal to the departure time or if related to the start stop.
DeparturePlat-formText (Ab-fahrtssteigText):	(optional) bay or stand name.
ArrivalPlatformText (AnkunftssteigText):	(optional) bay or stand name. Can be omitted if equal to Depar-turePlatformText.
DepartureSectorText (AbfahrtsSektoren-Text):	(optional) Publication-relevant indication of the sectors for depar-ture from a platform/track.
ArrivalSectorText (AnkunftsSektoren-Text)	(optional) Publication-relevant indication of the sectors for arrival at a platform/track
NoBoarding (Ein-steigeverbot):	(optional) Vehicle only stops for alighting. No specification: No boarding restrictions.
NoAlighting (Aus-steigeverbot):	(optional) Vehicle only stops for boarding. No specification: No alighting restrictions.
Passage (Durchfahrt):	(optional) Vehicle does not stop here. No specification: Vehicle does stop here.

DirectionText (Rich-tungsText):	(optional) destination text for the passenger (vehicle signage) of the upcoming intermediate destination (e.g. for circular routes) if different from the DirectionText (RichtungsText) in the ScheduleTrip (SollFahrt). No specification: DirectionText taken from 'ScheduleTrip'.
FromDirectionText (VonRichtungsText):	(optional) point of origin information for the passenger relating to the last intermediate destination (e.g. for circular routes), if different from the FromDirectionText (VonRichtungsText) in ScheduleTrip (SollFahrt) (corresponds to the vehicle signage prior to the last intermediate destination). No specification: FromDirectionText (VonRichtungsText) taken from 'ScheduleTrip' (SollFahrt).
InfoText (HinweisT-ext):	(optional, multiple) information on the trip that only applies at this stop. No specification: No special information for this stop.
PatternID (Linien-fahrwegID):	(optional) the unique pattern code of the current pattern sequence (in association with a given route) stored in the on-board computer of a vehicle corresponds to the "ROUTE_NO (ROUTEN_NR)" element of the "LINE (REC_LID)" table in the VDV452 standard or a generated code in the case of a trip section that has been created spontaneously in the control centre. This can be used in order to take into consideration any trip sections that have been modified as a result of dispatch action that are known at the time of transferring the reference data.
PlannedConnection (SollAnschluss):	(optional, multiple) information on planned connections (transfers). No specification: No connections.

5.1.3.4 Information of the formation of the ScheduleTrip (ScheduleFormation)

The *ScheduleFormation (SollFormation)* structure within the *ScheduleTrip (SollFahrt)* comprises all known formation information for the daily timetable.

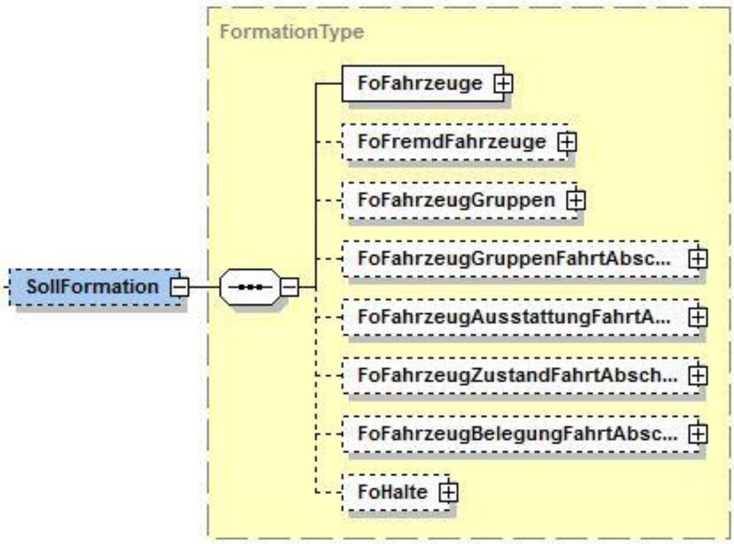


Figure 4 The "ScheduleFormation" element

All formation information that depends on the ScheduleTrip is assigned to the 'ScheduleFormation' (SollFormation) element.

Definition of ScheduleFormation (SollFormation)

The following sub-elements are used within 'ScheduleTrip' (SollFahrt) in a similar way to that described in 'RealTrip' (IstFahrt). Details are provided in chapters 5.2.2.4.1 to 5.2.2.4.8 .

FoVehicles (FoFahrzeuge):	Specification of all vehicles that travel within the ScheduleTrip on at least one trip section (FoVehicleGroupTripSection (FoFahrzeugGruppenFahrtAbschnitt)), see 5.2.2.4.1).
FoThirdPartyVehicles (FoFremdFahrzeuge):	(optional) Specification of all third-party vehicles that are not assigned to ScheduleTrip (i.e. not covering any of the trip sections), but have a direction connection to the trip (e.g. parked vehicles at a stop) (see 5.2.2.4.2).
FoVehicleGroups (FoFahrzeugGruppen):	(optional) this element describes the ordered series of vehicles that are connected as a VehicleGroup in the ScheduleTrip (see 5.2.2.4.3).
FoVehicleGroupTripSections (FoFahrzeugGruppenFahrtAbschnitte):	(optional) trip sections that arise for the ScheduleTrip as a result of status changes to the vehicle groups as well as the order of the individual vehicle cars (see 5.2.2.4.3).
FoVehicleEquipmentTripSections (FoFahrzeugAusstattungFahrtAbschnitte):	(optional) trip sections that arise for the ScheduleTrip as a result of status changes to the vehicle equipment (see 5.2.2.4.5).
FoVehicleStatusTripSections (FoFahrzeugZustandFahrtAbschnitte):	(optional) trip sections that arise for the ScheduleTrip as a result of status changes to the individual vehicles (see 5.2.2.4.6).
FoVehicleOccupancyTripSections (FoFahrzeugBelegung-FahrtAbschnitte):	(optional) trip sections that arise for the ScheduleTrip as a result of status changes to the individual vehicle occupancies (see 5.2.2.4.7).
FoStops (FoHalte):	(optional) formation relevant stop information, which is assigned to a ScheduleTrip for the arrival/departure at a stop (e.g. the stopping position of the individual vehicles) (see 5.2.2.4.8).

5.1.3.5 Planned transfers (PlannedConnection)

Information concerning which connections are possible through the course of the operational day under normal conditions is of great interest to the timetable information system. For this reason, these trip pairs, along with the associated planned data, should be transferred to the timetable information system. The timetable information system represents these transfers to the customer with texts such as "waiting for connection".

The planned transfers are transmitted in the PlannedConnection (SollAnschluss) structure:

Definition of PlannedConnection (SollAnschluss)	
TripID (FahrtID):	References the fetcher trip
StopID (HaltID):	(optional) Stop where the fetcher trip departs. No specification: The fetcher trip stop is the same as the feeder trip stop (ScheduleStop).
InterchangePathTime (Umsteigewegezeit):	In seconds.
StaySeated (Sitzenbleiben):	(optional) Flag to denote block linking. No specification: The passenger must change vehicles for this connection.

The PlannedConnection (SollAnschluss) structure can occur (possibly more than once) as a sub-element of the ScheduleStop (SollHalt) structure. The details in ScheduleStop specify the feeder data of the connection whilst the data relating to the fetcher trip is provided in PlannedConnection (SollAnschluss).

<u>Implementation notes:</u>

If both planning and real-time data are transmitted for the connection information, then the *ConnectionPlan* (for the planning data) and *ConnectionStatus (AnschlussPlan)* (for the process data) elements should be used exclusively (see 5.3).

With the exclusive transmission of planning information, the PlannedConnection (SollAnschluss) element can continue to be used.

The following example shows the timetable for route 10, consisting of one trip only with six stopping points and a planned connection at the second stopping point.

```
<AUSNachricht AboID = "25>
      <Linienfahrplan>
            <LinienID>10</LinienID>
            <RichtungsID>HIN</RichtungsID>
            <SollFahrt>
                  <FahrtID>
                        <FahrtBezeichner>2210</FahrtBezeichner>
                        <Betriebstag>21/07/2001</Betriebstag>
                  </FahrtID>
                  <SollHalt>
                        <HaltID>235</HaltID>
                        <Abfahrtszeit>2001-07-21T09:30:00</Abfahrtszeit>
                  </SollHalt>
                  <SollHalt>
                        <HaltID>236</HaltID>
                        <Ankunftszeit>2001-07-21T09:35:00</Ankunftszeit>
                        <Abfahrtszeit>2001-07-21T09:36:00</Abfahrtszeit>
                        <AbfahrtssteigText>2A</AbfahrtssteigText>
                        <SollAnschluss>
                        <FahrtID>
```

```
                              <FahrtBezeichner>3330</FahrtBezeichner>
                              <Betriebstag>21/07/2001</Betriebstag>
                        </FahrtID>
                        </SollAnschluss>
                  </SollHalt>
                  <SollHalt>
                        <HaltID>237</HaltID>
                        <Ankunftszeit>2001-07-21T09:50:00</Ankunftszeit>
                        <Abfahrtszeit>2001-07-21T09:51:00</Abfahrtszeit>
                        <AnkunftssteigText>5B</AnkunftssteigText>
                  </SollHalt>
                  <SollHalt>
                        <HaltID>238</HaltID>
                        <Ankunftszeit>2001-07-21T09:55:00</Ankunftszeit>
                        <Abfahrtszeit>2001-07-21T09:56:00</Abfahrtszeit>
                  </SollHalt>
                  <SollHalt>
                        <HaltID>239</HaltID>
                        <Ankunftszeit>2001-07-21T09:57:00</Ankunftszeit>
                        <Abfahrtszeit>2001-07-21T09:58:00</Abfahrtszeit>
                  </SollHalt>
                  <SollHalt>
                        <HaltID>240</HaltID>
                        <Ankunftszeit>2001-07-21T09:59:00</Ankunftszeit>
                  </SollHalt>
            </SollFahrt>
            <PrognoseMoeglich>true</PrognoseMoeglich>
            <FahrradMitnahme>true</FahrradMitnahme>
      </Linienfahrplan>
</AUSNachricht>
```

5.1.4 Block-specific timetable data transmission (ScheduleBlock)

For the block oriented transfer of data, the SISMessage (AUSNachricht) can contain one or more ScheduleBlock (SollUmlauf) elements:

Definition of ScheduleBlock (SollUmlauf)	
BlockID (UmlaufID):	BlockID (UmlaufID) is used to identify the block.
ScheduleTrip (SollFahrt):	(alternative, multiple) Structure with details on the trip.
ScheduleBlockTrip (SollUmlaufFahrt):	(structure, alternative, multiple) The ScheduleBlockTrip uniquely identifies the trips within a block on the basis of the long-term schedule.

5.1.4.1 ScheduleBlock - single trip (ScheduleBlockTrip)

A ScheduleBlock can comprise several DatedBlockTrip (SollUmlaufFahrt) individual trips.

Definition of ScheduleBlockTrip (SollUmlaufFahrt)	
LineID (LinienID):	The LineID (LinienID) is used to match the AVLC route with the route of the seasonal timetable known within the timetable information system.
ScheduleTrip (SollFahrt):	Structure with details on the trip

Implementation notes:

The ScheduleTrip (SollFahrt) element in ScheduleBlock (SollUmlauf) is retained for reasons of compatibility, however only ScheduleBlockTrip (SollUmlaufFahrt) should be used for new implementations.

5.2 SIS real-time data service

With this service the AVLC informs the timetable information system of the current status of all known trips. This enables the timetable information system to provide up-to-the-minute information for short-term journey planning.

As with the planned data service, the AVLC must only transmit the productive trips to the timetable information system, i.e. the trips that carry passengers.

5.2.1 Request for real-time data (SISSubscription)

With the SISSubscription (AboAUS) the timetable information system requests the real-time data for all or specific routes or individual trips (without route definitions) from the AVLC or a DDS.

SISSubscription (AboAUS) contains the following elements:

Definition of SISSubscription (AboAUS)	
SubscriptionID (AboID):	(attribute) the SubscriptionID (AboID) references the subscription for real-time data.
ValidUntilTimeStamp (VerfallZst):	(attribute) specifies the time to which the real-time data is to be transmitted.
LineFilter (LinienFilter):	(optional, multiple) filter stating the route for which real-time data is transmitted. This element contains the IDs of all routes as well as optionally the associated DirectionIDs, for which data is requested (see 5.1.1.2). No specification: Real-time data is to be reported for all routes

OperatorFilter (BetreiberFilter):	(sub-element, optional, multiple) filter stating the transport authorities for which real-time timetable data is to be transmitted. This element contains the OperatorID providing the subscription data (see 5.1.1.3). No specification: All real-time data known to the AVLC is to be transmitted (subject to other filters or restrictions).
ProductFilter (ProduktFilter):	(sub-element, optional, multiple) filter stating the ProductID for which real-time timetable data is to be transmitted. This element contains the ProductIDs of the trips providing the subscription data (see 5.1.1.4). No specification: All real-time data known to the AVLC is to be transmitted (subject to other filters or restrictions).
TransportModeTextFilter (VerkehrsmittelTextFilter):	(sub-element, optional, multiple) filter stating the transport mode texts for which real-time timetables are to be transmitted. This element contains the transport mode texts of the trips providing the subscription data (see 5.1.1.5). No specification: All real-time data known to the AVLC is to be transmitted (subject to other filters or restrictions).
StopFilter (HaltFilter):	(sub-element, optional, multiple) filter stating the StopID for which real-time timetable data is to be transmitted. This element contains the stop IDs of the trips providing the subscription data (see 5.1.1.6). No specification: No StopFilter: All real-time data known to the AVLC is to be transmitted (subject to other filters or restrictions).
BlockFilter (UmlaufFilter):	(sub-element, optional, multiple) filter stating the BlockID for which real-time timetable data is to be transmitted. This element contains the BlockID (UmlaufID) of the trips providing the subscription data (see 5.1.1.7). No specification: All real-time timetables known to the AVLC are to be transmitted (subject to other filters or restrictions).
~~*BlockID (UmlaufID):*~~	(optional, multiple) no longer in use. Do not use. ~~Specifies the real-time data to be transmitted per block.~~
Hysteresis (Hysterese):	Threshold value in seconds after which the deviations from the timetable or the last message are to be transmitted (see chapter 6.1.8). The deviation must be greater than or equal to the specified value before deviations are transferred.
PreviewTime (Vorschauzeit):	Maximum preview time in minutes requested by the timetable information system (see chapter 6.1.7).
WithProtectedConnection (MitGesAnschluss):	(optional) specifies whether the transfer information, for which transfer protection is active, is also to be transmitted. No specification: Transmission without connection information
WithRealTimes (MitRealZeiten):	(optional) specifies whether the AVLC should also transmit the real-time arrival and departure times (see 6.1.11). No specification: No transmission of actual arrival and departure times.

WithFormation (Mit-Formation):	(optional, default "false") specifies whether formation data is to be transmitted for the subscribed trips. No specification: Transmission without formation data.
OnlyUpdate (Nu-rAktualisierung):	(optional) When this element is set, the subscription informs the data provider that the ValidUntilTimeStamp (VerfallZst) is merely being extended. For this reason, it is not necessary for all trips corresponding to the subscription to be sent again in the next message. Only the trips with a new trigger (e.g. hysteresis, entry into preview time need to be sent. If the same subscription as the previous one is not available on the data provider side, or if this element is missing in the SubscriptionRequest (AboAnfrage), or if the client did not implement the element, all data corresponding to the subscription must sent in the initialising message after the SubscriptionRequest (Abo-Anfrage) (or a portion of the data if PendingData (WeitereDaten) = true is used).

Without a LineFilter (Linienfilter) or a BlockFilter (UmlaufFilter) this implicitly requests the transmission of data for all trips known to the AVLC (subject to other filters or restrictions).

5.2.2 Transferring real-time data

With a route-specific subscription, the real-time data is packaged in the RealTrip reply structure according to route and with a block-specific subscription in the RealBlock (IstUmlauf) reply structure. These elements are embedded within a *SISMessage (AUSNachricht)* element, which combines all replies of the timetable information service (see chapter 5.1.1.7).

At the start of the subscription the AVLC is responsible for transmitting the current overall status to the timetable information system.

In order to guarantee the mutual independence of the SIS and REF-SIS services, we recommend that the information for the complete trip including any new planning and predicted times is resent at least once.

When used together, the AVLC is able to transmit only the real-time data that differs from the daily timetable when the subscription starts.

Messages relating to the actual data status can contain the following content:

1. Timetable deviations with a prediction for the future sections (including the departure from the current stop),
2. Failure of a trip,
3. Change to the vehicle capacity (passenger load),
4. Change to mode of transport / vehicle equipment,
5. Platform change,
6. Stop obstruction,
7. Path changes.
8. Trip formations (vehicle grouping, vehicle load, vehicle equipment and statuses, vehicle positions at the stop)

In short: Every change with regard to the transmitted timetable can be represented and made known to the timetable information system.

5.2.2.1 Real-time data of a trip (RealTrip)

A change message is communicated in the RealTrip (IstFahrt) structure within SISMessage (AUSNachricht). It is possible to specify several trips.

Definition of RealTrip (IstFahrt)

TimeStamp (Zst):	(attribute, optional) time stamp of the creation of the request.
LineID (LinienID):	The LineID (LinienID) is used to match the AVLC route with the route of the long-term timetable specified in the timetable information system (see chapter 3.3).
DirectionID (Rich-tungsID):	This value is a meta datum (see chapter 3.3). It typically identifies the outbound and inbound journey of a route.
TripRef (FahrtRef):	(sub-element) the TripRef can be used to reference the real-time messages from the SIS service within the scheduled timetable.
TripRelationship (FahrtBeziehung):	(Sub-element, optional) This element is used to reference other trips which are related to this trip, e.g. if an originally scheduled trip is divided into several trip sections executed by different vehicles (e.g. route closure / vehicle substitute). For more details, see the 5.2.2.8 chapter No information in a partial trip (CompleteTrip (Komplettfahrt) = false): No change with regard to the planned schedule or last message. No information in a CompleteTrip (Komplettfahrt): The transmitted TripRelationships (FahrtBeziehungen) are deleted, and the planned data is taken into consideration. If the element is supplied, all TripRelationships (FahrtBeziehungen) need to be re-transmitted. TripRelationships (FahrtBeziehungen) which have already been transmitted no longer need to be taken into consideration.
CompleteTrip (Komp-dlettfahrt):	Specifies whether all information on the trip that is available in the data supplier is transmitted (e.g. all stops are transmitted in the RealStop structure as a result of dispatch actions, see 6.1.6).

BlockID (UmlaufID):	(optional) the BlockID (UmlaufID) is used to identify the block (see 3.3).
RunNumber (KursNr):	(optional) Internal AVLC run number of the trip. For planned trips, this number corresponds to the LI_KU_NR in the VDV452.
OperatorID (BetreiberID):	(optional) this value is a meta datum (see 3.3). It specifies which transport authority carries out this trip.
RealStop (IstHalt):	(sub-element, optional, multiple) Structure with details on the stops in the pattern. Can be omitted if all transmitted information is independent of path. To avoid (incorrect) interpretations on the fetcher side, the RealStops (IstHalt) shall be provided in the sequence in which they were serviced in terms of time and location for data supply with CompleteTrip (Komplettfahrt) = 'true'. The scheduled times must increase in value chronologically in accordance with the sequence of the stops. In particular, when it comes to dispatched trips, the currently valid scheduled times must be supplied.
TripNameText (FahrtbezeichnerText)	(optional, multiple) Indication of the publication-relevant TripName (FahrtBezeichner) (alphanumerical). For publication purposes, several TripNames (FahrtBezeichner) can be indicated, although the first takes priority.
TransportModeNumber (VerkehrsmittelNummer)	(optional) In this element, the planned trip number from the seasonal timetable can be copied for the transmitted trip. This trip number (train number for trains) is used, together with the other criteria, by the trip in the real-time data in VDV454 (SIS, REF SIS) to reference the trip in the seasonal timetable (also refer to VDV Recommendation 454, Chapters 2 and 3 as well as the glossary in Chapter 7). If the element is copied, the same VM/train number as in the seasonal timetable must be used.
LineText (LinienText):	(optional) Route text if different from published schedule. No specification: No change with regard to the planned schedule or last message.
ProductID (ProduktID):	(optional) product used for this trip; meta datum (see 3.3). No specification: No change with regard to the planned timetable or the last message.
DirectionText (RichtungsText):	(optional) destination text for the passenger (vehicle signage). Within the RealTrip (IstFahrt), the destination text that is shown on the last section up to the terminal stop should be used as the DirectionText (RichtungsText). (This is also valid for trips with intermediate destinations, such as circular routes.) Note: the DirectionText (RichtungsText) can also be used on the ScheduleStop (e.g. for the specification of intermediate destinations). No specification: No change with regard to the planned schedule or last message. VDV recommends that a DirectionText (RichtungsText) is always included in the first message.

FromDirectionText (VonRichtungsText):	(optional) point of origin text for the passenger. The point of origin text of the trip start should be used in RealTrip. Note: The FromDirectionText (VonRichtungsText) can also be used on the RealStop (e.g. for the specification of intermediate destinations). No specification: No change with regard to the planned schedule or last message. VDV recommends that a FromDirectionText (VonRichtungsText) is always included in the first message, if at all possible.
InfoText (HinweisText):	(optional, possibly multiple) information on the trip. No specification: No change with regard to the planned schedule or last message.
PatternID (LinienfahrwegID):	(optional) The unique pattern code of the current pattern sequence (in association with a given route) stored in the on-board computer of a vehicle corresponds to the "ROUTE_NO (ROUTEN_NR)" element of the "LINE (REC_LID)" table in the VDV452 standard or a generated code in the case of a pattern that has been created spontaneously in the control centre. In the case of dispatch actions this can be overwritten section by section by the entry in the 'RealStop' structure.
TrainName (Zugname):	(optional, for train services) train name, e.g. 'West Coast Express'. No specification: No change with regard to the planned schedule or last message.
TransportModeText (VerkehrsmittelText):	(optional) name of the mode of transport, e.g. Reg, Express, ICE No specification: No change with regard to the planned schedule or last message.
PredictionPossible (PrognoseMoeglich)	(optional) Indicates whether there is real-time delay information for the trip on arrivals and departures which have not yet occurred. No information: In the initial message, prediction is possible, otherwise there is not change in comparison with the previous message.
PredictionInaccurate (PrognoseUngenau):	(optional) quality status of the prediction (see 6.1.9). No specification: Vehicle is not in a traffic jam.
ExtraTrip (Zusatzfahrt):	(optional) Indicates that this trip is transmitted as an addition to the planning data already sent. No specification: Not an additional trip. Note: It is only in the case of CompleteTrip messages (which are compulsory as the first message for extra trips) that the absence of the 'ExtraTrip' attribute is interpreted as 'ExtraTrip=false'. With updates however, a missing 'ExtraTrip' attribute does not trigger a change.
Deleted (FaelltAus):	(optional) Indicates that this trip is deleted. No specification: This is not a trip that has been deleted.
ResetTrip (FahrtZuruecksetzen)	(optional): If this element is set, this trip is considered non-communicated. For more details refer to chapter 6.1.10 No specification: The trip is not reset.
CongestionInfo (StoerungsInfo):	(sub-element, optional) Explains the reason for the deletion of the trip or other error.

CyclesPermitted (FahrradMitnahme):	(optional) CyclesPermitted (FahrradMitnahme) is possible on this trip. No specification: No change with regard to the planned timetable or the last message.
VehicleTypeID (FahrzeugTypID):	(optional) transport vehicle type, for information on disabled access; meta datum (see 3.3). No specification: No change with regard to the planned schedule or last message.
PassengerLoad (Besetzgrad):	(optional) possible values: 'Light load', 'Heavy load', 'Overloaded', 'Unknown'. No specification: Passenger load is unknown.
ServiceAttribute (ServiceAttribut):	(sub-element, optional, multiple) Structure that contains a description of the vehicle or trip attributes.
RealFormation (IstFormation):	(sub-element, optional) structure to transmit formation relevant information relating to the RealTrip (IstFahrt) (vehicles, vehicle groups, trip sections, vehicle equipment, vehicle statuses, vehicle occupancy, stopping position of the vehicles at the stops along the route).

Implementation notes: The mid section of a trip is prolonged with a dispatch action, which results in overlapping planned times at the entry stop. How should the complete RealTrip (IstFahrt) now be transmitted?

If the alternative path takes longer than the original path, the travel time for this section is artificially streamlined to ensure that chronologically increasing values are consistently transmitted to the timetable information system.

5.2.2.2 Referencing the trip data (TripRef)

To allow the actual data messages in the timetable information system to be matched to the planned timetable, it is possible to use the *TripID (FahrtID)* of the *LineSchedule (Linienfahrplan)* structure from chapter 5.1.3 to identify the trip within a route when setting up the REF-SIS reference data service.

For installations in which there is no exchange of planned data using the REF-SIS service, the key details of the trip, i.e. the start and terminal stops and scheduled times at these stops, can be used in order to create a reference to the timetable. This means that use of the REF-SIS is not obligatory.

This information is combined in the TripRef structure:

Definition of TripRef (FahrtRef)	
TripID (FahrtID):	(optional) unique reference to the trip.
TripStartEnd (FahrtStartEnde):	(sub-element, optional) Defining data of the planned trip: First and last stop.

Both elements are optional, as some companies are not yet able to supply both the TripID (FahrtID) und TripStartEnd (FahrtStartEnde) elements. One of these two pieces of information, however, must be specified, either TripID or TripStartEnd.

VDV strongly recommends that both TripStartEnd and TripID are always transmitted.

5.2.2.2.1 Alternative referencing information (TripStartEnd)

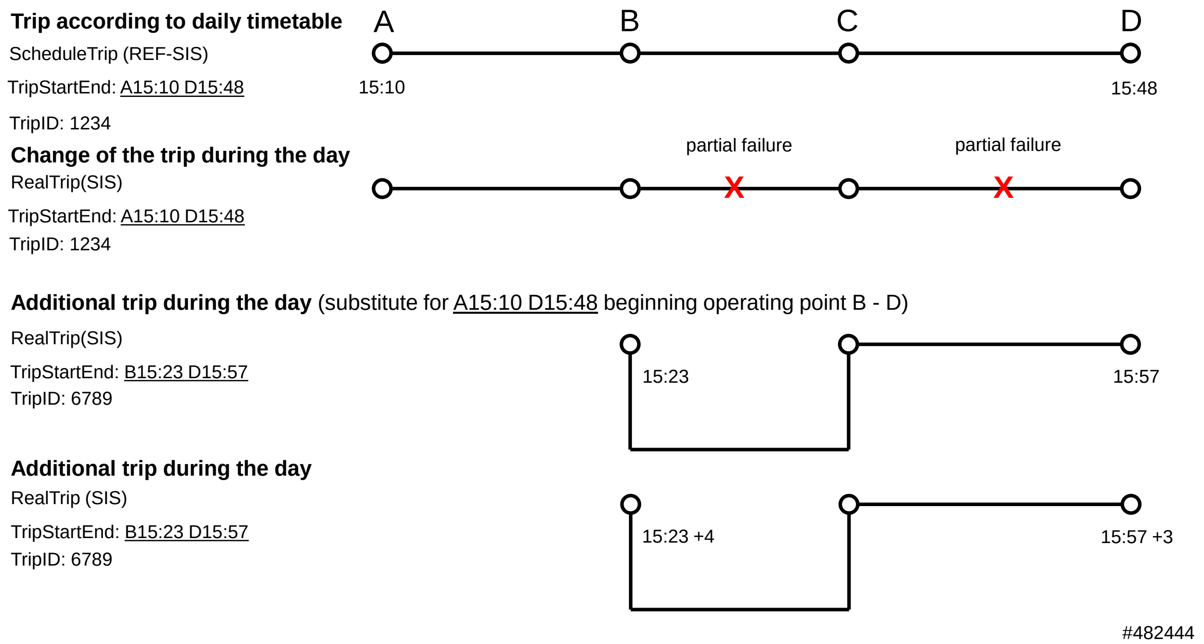
The defining data of a trip - first and last stops of the trip with the planned times at these stops - is combined in the TripStartEnd (FahrtStartEnde) structure:

Definition of TripStartEnd (FahrtStartEnde)	
StartStopID (StartHal-tID)	Start stop
StartTime (Startzeit)	Planned departure time at the start stop
EndStopID (EndHal-tID)	Terminal stop
EndTime (Endzeit):	Planned arrival time at the terminal stop

Both TripStartEnd (FahrtStartEnde) of the relevant ScheduleTrip (SollFahrt) as well as the referencing RealTrip (IstFahrt) must not be changed after the first recording of the ScheduleTrip (SollFahrt), as it would no longer be possible to use the TripStartEnd (FahrtStartEnde) element as referencing.

<u>There can only be one referencing RealTrip for every ScheduleTrip.</u>

Example:



In the case of extra trips, the specifications relating to the first recording of this extra trip are valid for the TripStartEnd (FahrtStartEnde).

Example:

If, for example, the path of the RealTrip (IstFahrt) has been shortened when compared with the original ScheduleTrip (SollFahrt), the modified RealTrip (IstFahrt) is given the values of the TripStartEnd (FahrtStartEnde) element of the ScheduleTrip (SollFahrt). Any added extra trip to cover the remaining path must be supplied with a new TripStartEnd (FahrtStartEnde) (remaining path).

Note: This trip identification cannot be used to represent several trips which start and end at the same time in the same place. Such trips cannot be distinguished with the TripStartEnd (FahrtStartEnde) identification but they can be managed in an AVLC with different TripIDs (FahrtID) and have different predictions.

5.2.2.3 Information on the stop (RealStop)

The RealStop (IstHalt) structure comprises possible changes with regard to the planned ScheduleStop (SollHalt):

Definition of RealStop (IstHalt)	
StopID (HaltID):	The StopID is used to match the AVLC stop with the stop in the timetable information system (see chapter 3.3).
StopName (HaltestellenName):	(optional) Name of the stop (used for timetable information systems without separate data import)
DepartureTime (Abfahrtszeit):	(optional) Planned departure time. Not entered or omitted for the terminal (end) stop.
ArrivalTime (Ankunftszeit):	(optional) can be omitted if identical to the departure time. Obligatory at the terminal stop.
RealDeparturePrediction (IstAbfahrtPrognose):	(optional) Prognosis for the departure time. No specification: planned departure time (except for RealDeparturePredictionStatus=Unknown)
RealArrivalPrediction (IstAnkunftPrognose):	(optional) prediction for the arrival time. No specification: planned arrival time (except for RealArrivalPredictionStatus=Unknown)

RealDeparturePredictionStatus (IstAbfahrtPrognoseStatus):	(optional) more detailed specification of the meaning of RealDeparturePrediction. The possible values are as follows: *Prediction (Prognose):* (default) the time specification is a prediction time for the (usually future) stop; *Real (Real):* This is the actual, real-time departure time (in the past); *Estimated (Geschaetzt):* This value is used if there is no information on the actual departure time, which needs to be replaced by a plausible estimation; *Unknown (Unbekannt):* This value is used if the AVLC does not have any information on the predicted or actual departure times at this or any of the earlier stops. In this case RealDeparturePrediction must NOT be sent.
RealArrivalPredictionStatus (IstAnkunftPrognoseStatus):	(optional) more detailed specification of the meaning of RealArrivalPrediction. The possible values are as follows: *Prediction (Prognose):* (default) the time specification is a prediction time for the (usually future) stop; *Real (Real):* This is the actual, real-time arrival time at the stop (in the past); Estimated (Geschaetzt): This value is used if there is no information on the actual arrival time, and therefore needs to be replaced by a plausible estimation; *Unknown (Unbekannt):* This value is used if the AVLC does not have any information on the predicted or actual arrival times at this or any of the earlier stops of this trip. In this case RealArrivalPrediction (IstAnkunftPrognose) must NOT be sent.
RealDeparturePredictionQuality (IstAbfahrtPrognoseQualitaet)	(optional) specification of a prediction quality level for RealDeparturePrediction /IstAbfahrtPrognose)
RealArrivalPredictionQuality (IstAnkunftPrognoseQualitaet)	(optional) Specification of a prediction quality level for the RealArrivalPrediction (IstAnkunftPrognose)
RealDepartureDispatch (IstAbfahrtDisposition):	(optional) Predicted departure time on the basis of an active dispatch action that differs from the scheduled departure time
RealArrivalDispatch (IstAnkunftDisposition):	(optional) Predicted arrival time on the basis of an active dispatch action that differs from the scheduled arrival time
PredictionInaccurate (PrognoseUngenau):	(optional) quality status of the prediction (see 6.1.9). No specification: Vehicle is not in a traffic jam.
DeparturePlatformText (AbfahrtssteigText):	(optional) bay or stand name. No specification: No change with regard to the planned timetable or the last message.
ArrivalPlatformText (AnkunftssteigText):	(optional) bay or stand name. Can be omitted if equal to DeparturePlatformText (AbfahrtssteigText). No specification: DeparturePlatformText (AbfahrtssteigText).

DepartureSectorText (AbfahrtsSektoren-Text):	(optional) Publication-relevant indication of the sectors for departure from a platform/track.
ArrivalSectorText (AnkunftsSektoren-Text)	(optional) Publication-relevant indication of the sectors for arrival at a platform/track
NoBoarding (Einsteige-verbot):	(optional) Vehicle only stops for alighting. No specification: No change with regard to the planned timetable or the last message.
NoAlighting (Aussteige-verbot):	(optional) Vehicle only stops for boarding. No specification: No change with regard to the planned timetable or the last message.
PassThru (Durchfahrt):	(optional) vehicle does not stop here but travels straight through. No specification: No change with regard to the planned timetable or the last message.
ExtraStop (Zusatzhalt):	(optional) This stop is additional and unplanned. No specification: Stop is planned.
DirectionText (Rich-tungsText):	(optional) destination text for the passenger (vehicle signage) of the upcoming intermediate destination (e.g. for circular routes) if different from the DirectionText (RichtungsText) in the RealTrip (IstFahrt). No specification: No change with regard to the planned timetable or the last message.
FromDirectionText (VonRichtungsText):	(optional) point of origin information for the passenger relating to the last intermediate destination (e.g. for circular routes), if different from the FromDirectionText (VonRichtungsText) in RealTrip (IstFahrt) (corresponds to the vehicle signage prior to the last intermediate destination). No specification: No change with regard to the planned timetable or the last message.
InfoText (HinweisText):	(optional, multiple) information on the trip that only applies at this stop. No specification: No change with regard to the planned timetable or the last message.
PatternID (Linien-fahrwegID):	(optional) the unique pattern code of the current pattern sequence (in association with a given route) stored in the on-board computer of a vehicle corresponds to the "ROUTE_NO (ROUTEN_NR)" element of the "LINE (REC_LID)" table in the VDV452 standard or a generated code in the case of a pattern section that has been created spontaneously in the control centre. Required in RealStop (IstHalt) in order to be able to take into account trip sections that have been changed by dispatch actions.
CongestionInfo (Stoer-ungsInfo):	(sub-element, optional) Explains the reason for the deviation from schedule, e.g. vehicle waiting for a connection.
PassengerLoad (Be-setzgrad):	(optional) Possible values: 'Light load', 'Heavy load', 'Overloaded', 'Unknown'. No specification: Passenger load is unknown.

If the PassengerLoad (Besetztgrad) field in the RealStop (IstHalt) structure is filled, this represents a predicted passenger load. If the corresponding field of RealTrip (IstHalt) is completed, this overwrites the last current passenger load message.

Note: VDV Recommendation 454 is to be interpreted such that transmission of the planned departure time is always compulsory, unless dealing with a terminal stop. From this specification it is possible to derive the sequence of stopping points.

The transmission of planned arrival times may be omitted if equal to the planned departure times. Transmission of the planned arrival time is compulsory for the terminal stop.

Caution: This is a business rule to be reproduced in the system logistics but for technical reasons cannot be defined in the associated XSD structure.

5.2.2.4 Formation of the RealTrip (*RealFormation*)

The *RealFormation* structure of the *RealTrip* comprises possible changes compared with the planned *ScheduleFormation* of the *ScheduleTrip*.

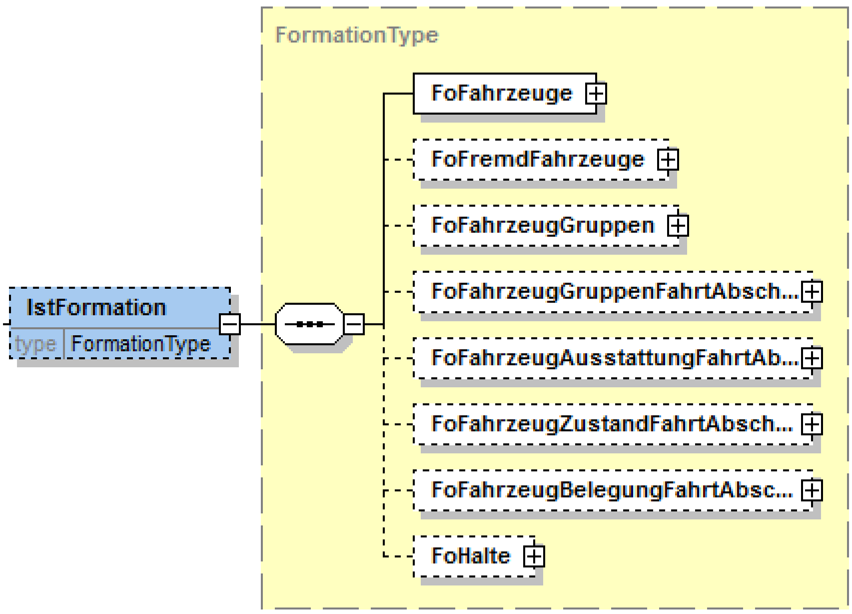


Figure 5 The 'RealFormation' element

All formation information that depends on the RealTrip is assigned to the 'RealFormation' element:

Definition of *RealFormation (IstFormation)*	
FoVehicles (FoFahrzeuge):	Specification of all vehicles that travel within the actual real-time trip (see 5.2.2.4.1).

FoThirdPartyVehicles (FoFremdFahrzeuge):	(optional) specification of all third-party vehicles that are not assigned to the RealTrip (i.e. do not cover any of the trip sections), but have a direct connection to it (e.g. parked vehicles at a stop) (see 5.2.2.4.2)
FoVehicleGroups (FoFahrzeugGruppen):	(optional) ordered sequence of vehicles that are connected as a VehicleGroup in the RealTrip (see 5.2.2.4.3).
FoVehicleGroupTripSections (FoFahrzeugGruppenFahrtAbschnitte):	(optional) trip sections that arise for the RealTrip as a result of status changes to the vehicle groups (see 5.2.2.4.4).
FoVehicleEquipmentTripSections (FoFahrzeugAusstattungFahrtAbschnitte):	(optional) trip sections that arise for the RealTrip as a result of status changes to the vehicle features (see 5.2.2.4.5).
FoVehicleStatusTripSections (FoFahrzeugZustandFahrtAbschnitte):	(optional) trip sections that arise for the RealTrip as a result of status changes to the individual vehicles (see 5.2.2.4.6).
FoVehicleOccupancyTripSections (FoFahrzeugBelegungFahrtAbschnitte):	(optional) trip sections that arise for the RealTrip as a result of status changes to the individual vehicle occupancies (see 5.2.2.4.7).
FoStops (FoHalte):	(optional) formation relevant stop information, which is assigned for the arrival/departure at a stop (e.g. the stopping positions of the individual vehicles) (see 5.2.2.4.8).

5.2.2.4.1 Vehicles in the formation (FoVehicles)

This element can be used in RealFormation (IstFormation) and ScheduleFormation (SollFormation).

Definition of *FoVehicles (FoFahrzeuge)*	
FoVehicle (FoFahrzeug):	(multiple) the formation of a trip consists of several vehicles that are combined within the '**FoVehicles**' (FoFahrzeuge) element.

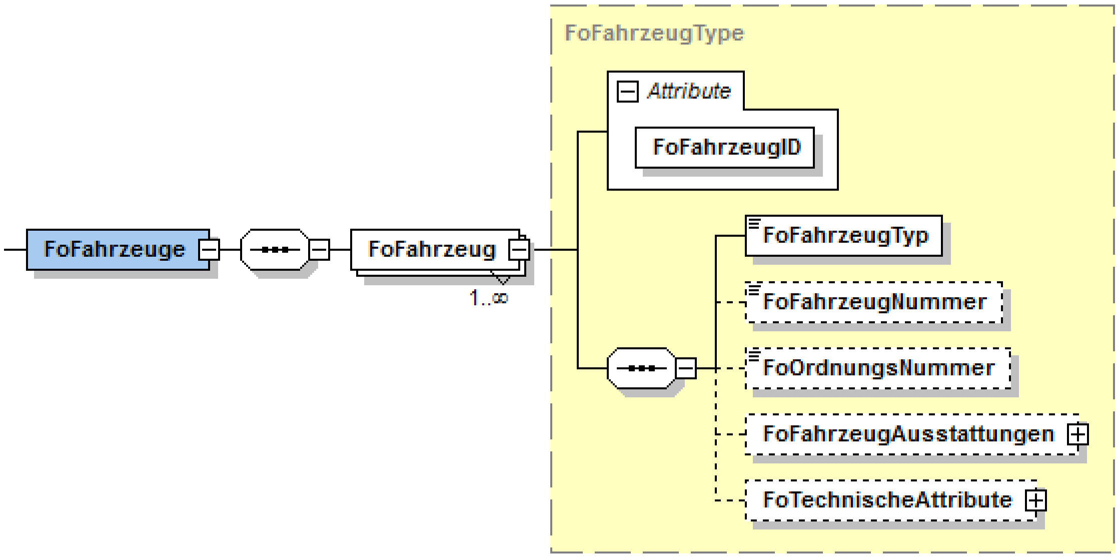


Figure 6 The 'FoVehicles' element

Both the 'FoVehicles' (FoFahrzeuge) and 'FoVehicle' (FoFahrzeug) elements must be specified as soon as formation elements are transferred via the VDV454 interface.

Definition of *FoVehicle (FoFahrzeug)*

FoVehicleID (FoFahrzeugID):	A vehicle is uniquely identified via an ID, in order to provide a means of reference from other formation elements. The VehicleID must be unique for the whole trip.
FoVehicleType (FoFahrzeugTyp): *[VL] (see Chapter 10.1)*	A vehicle is always of a specific type which describes its purpose (e.g. 'VL' for sleeper car, '1' for first class etc.)
FoVehicleNumber (FoFahrzeugNummer):	(optional) a vehicle can have a vehicle number. This denotes the official 'registration number' of the vehicle.
FoSerialNumber (FoOrdnungsNummer):	(optional) a vehicle can be assigned a serial number, e.g. for seat reservations and passenger orientation
FoVehicleEquipments (FoFahrzeugAusstattungen):	(optional) vehicles can have different levels of equipment and features (see chapter 5.2.2.4.1.1).
FoTechnicalAttributes (FoTechnischeAttribute):	(optional) a vehicle can have several technical attributes, e.g. the physical dimensions (see 5.2.2.4.1.2).

5.2.2.4.1.1 Vehicle equipment and features (FoVehicleEquipments)

Definition of *FoVehicleEquipments (FoFahrzeugAusstattungen)*	
FoVehicleEquipment (FoFahrzeugAusstat-tung):	(multiple) a vehicle can have different levels of equipment and features, which are combined within the higher-order 'FoVehicleEquipments' (FoFahrzeugAusstattungen) element.

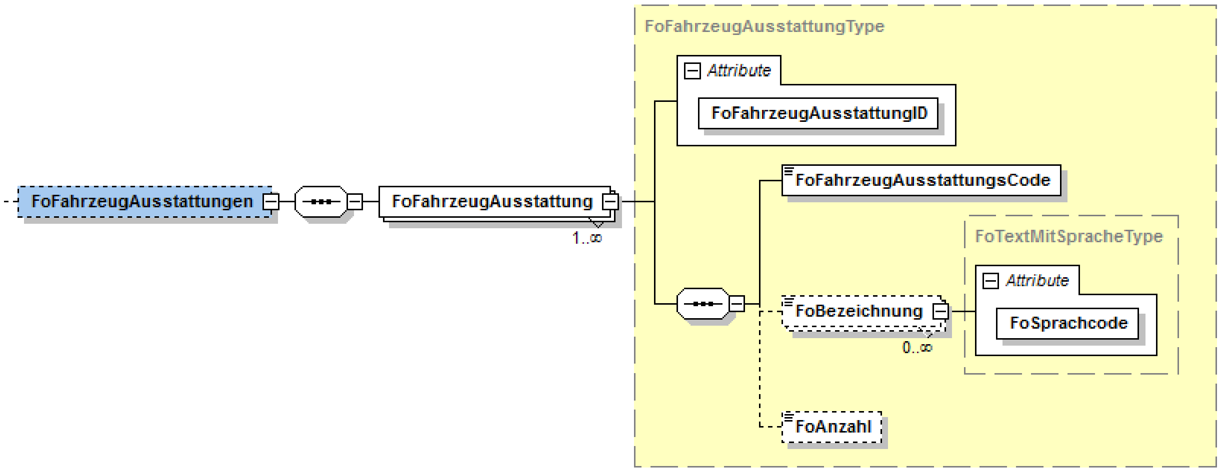


Figure 7 The 'FoVehicleEquipments' element

The 'FoVehicleEquipments' (FoFahrzeugAusstattungen) higher-order element is optional. As soon as it is used however, the associated sub-element ('FoVehicleEquipment') must be specified.

Definition of *FoVehicleEquipment (FoFahrzeugAusstattung)*	
FoVehicleEquipmentID (FoFahrzeugAusstattungID):	A particular set of equipment or features is identifiable via a unique ID. This allows it to be referenced from other formation elements, e.g. the 'FoStatus' (FoZustand) element.
FoVehicleEquipmentCode (FoFahrzeugAusstattungsCode): *[VL] (see Chapter 10.2)*	A classification code must be specified for each level of equipment.
FoName (FoBezeichnung):	(optional) name of the vehicle equipment, e.g. bicycle racks, buffet car, Wi-Fi, etc.
FoLanguageCode (FoSprachcode): *[VL] (see Chapter 10.3)*	(optional, sub-element of FoName (FoBezeichnung), default value: 'de'). Internationally recognised language code (e.g. 'de', 'fr', 'en', …). If the element is not specified, the default value is taken: 'de'
FoQuantity (FoAnzahl):	(optional) if a specific piece of equipment or set-up occurs more than once within a vehicle, it is possible to state exactly how many times here.

5.2.2.4.1.2 **Technical attributes of the vehicles (FoTechnicalAttributes)**

Definition of *FoTechnicalAttributes (FoTechnischeAttribute)*	
FoTechnicalAttribute (FoTechnischesAt-tribut):	(multiple) a vehicle can have several technical attributes, which are combined within the higher-order 'FoVehicleAttributes' (FoTech-nischeAttribute) element.

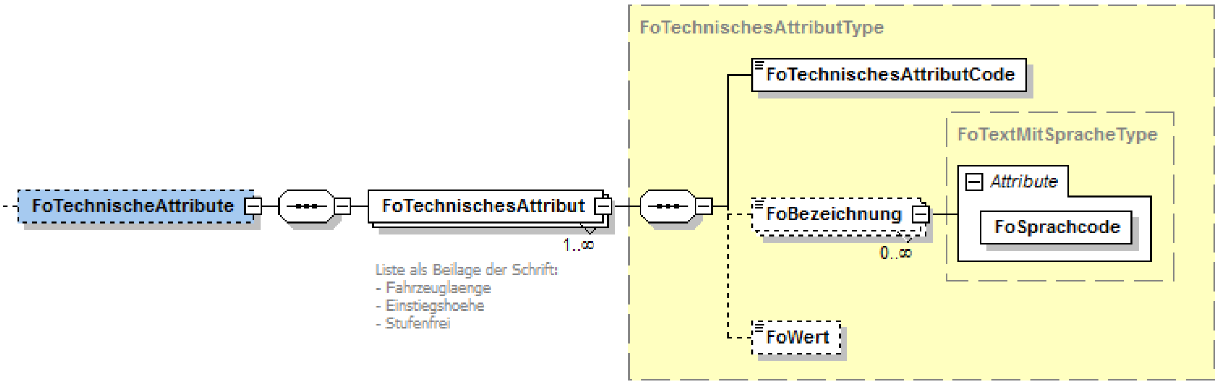


Figure 8 The 'FoTechnicalAttributes' element

The 'FoTechnicalAttributes' (FoTechnischeAttribute) higher-order element is optional. As soon as it is used however, at least one associated 'FoTechnicalAttribute' (FoTechnischesAt-tribut) sub-element must be specified.

Definition of *FoTechnicalAttribute (FoTechnischesAttribut)*	
FoTechnicalAttribute-Code (FoTechnischesAt-tributCode):	A code must be defined for each technical attribute, which is subsequently used for classification.
[VL] (see Chapter 10.4)	
FoName (FoBezeich-nung):	(optional) name of the technical attribute of the vehicle (e.g. ve-hicle height, vehicle length, empty weight, double decker, step height, etc.)
FoLanguageCode (FoS-prachcode):	(optional, sub-element of FoName (FoBezeichnung), default value: 'de'). International language code (e.g. 'de', 'ch', 'en'...). If this element is missing the default value is used: 'de'.
FoValue (FoWert):	(optional) every technical attribute can be given an alphanumeric value (e.g. '4.5', '26.0', '35', electric')

5.2.2.4.2 Third party vehicles of the formation (FoThirdPartyVehicles)

This element can be used in RealFormation (IstFormation) and ScheduleFormation (SollFor-mation).

Third-party vehicles can be specified for a particular trip (optional).
The third-party vehicles themselves are not part of the trip (i.e. the vehicles do not travel on any of the trip sections), but they do have a certain relevance in terms of customer infor-mation, for example 'parked vehicle' of a different trip is standing at the same platform as the trip vehicles.

The 'FoThirdPartyVehicles' element is provided in order to identify relevant vehicles that are not included in the trip but which are significant, particularly in relation to information regarding arrivals and departures at the respective stops.

The structure of the 'FoThirdPartyVehicles' (FoFremdFahrzeuge) element is similar to that of 'FoVehicles' (FoFahrzeuge).

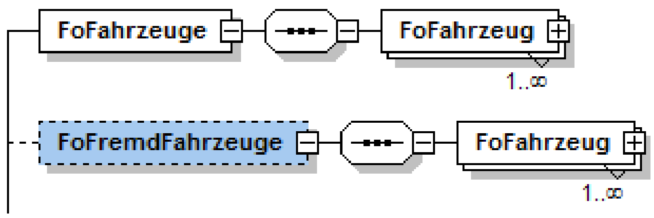


Figure 9 The 'FoThirdPartyVehicles' element

The 'FoThirdPartyVehicles' (FoFremdFahrzeuge) element is optional. As soon as it is used however, an associated sub-element ('FoThirdPartyVehicle') must be specified.

5.2.2.4.3 Vehicle groups in the formation (FoVehicleGroups)

This element can be used in the RealFormation and the ScheduleFormation

Definition of *FoVehicleGroups (FoFahrzeugGruppen)*	
FoVehicleGroup (FoFahrzeug-Gruppe):	(multiple) the formation consists of several vehicle groups that are combined within the 'FoVehicleGroups' (FoFahrzeugeGruppen) element.

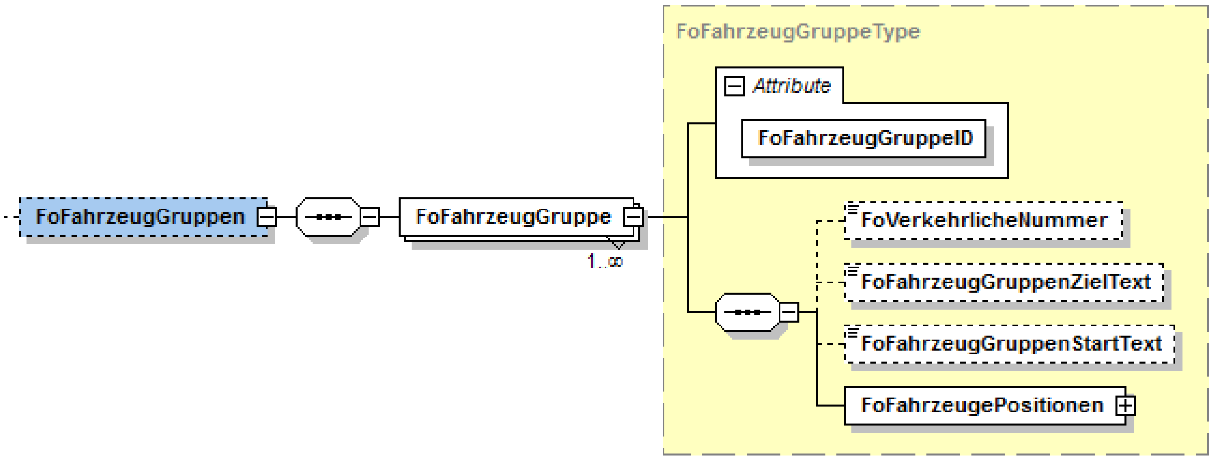


Figure 10 The 'FoVehicleGroups' element

The 'FoVehicleGroups' (FoFahrzeugGruppen) higher-order element is optional. As soon as it is used however, an associated sub-element ('FoVehicleGroup') must be specified.

The vehicle group combines all vehicles for which the following information is the same for a particular trip section:

- Common destination (FoVehicleGroupDestinationText)
- Common starting point (FoVehicleGroupStartText)

- Common traffic number (FoTrafficNumber)

The following diagrams illustrates the intention of these concepts:

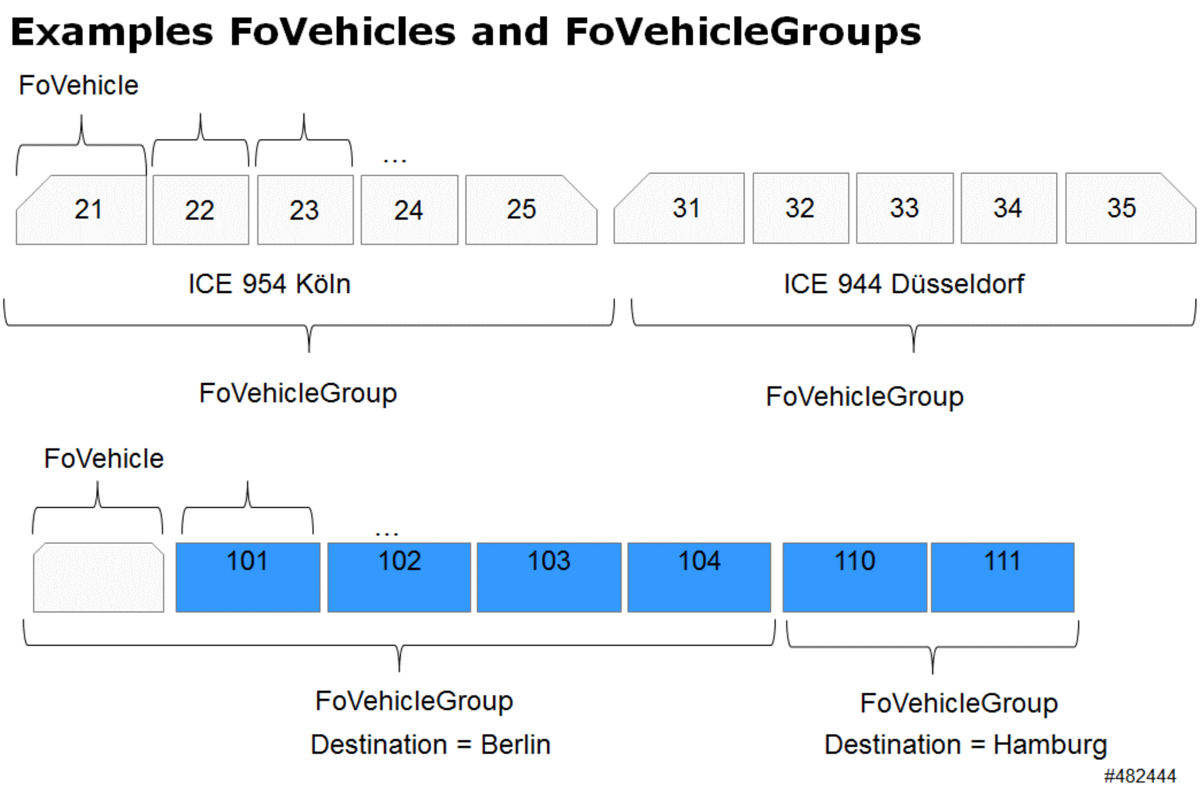


Figure 11 Examples of FoVehicles and FoVehicleGroups

The above example shows two coupled ICE trains, that are split further along the trip progression. Each ICE train (vehicle group) has a separate destination.
Each train consists of a number of vehicles (cars), each with their own characteristics (e.g. class, series number, equipment set, etc.). The vehicles of a vehicle group are not split during the trip.
In this situation, each ICE train is modelled as a VehicleGroup, as the composition of this group does not change during the trip.

The example below shows a locomotive driven train with additional cars. Each car is a vehicle. The vehicles with a common destination are each modelled as a vehicle group.

Definition of *FoVehicleGroup (FoFahrzeugGruppe)*

FoVehicleGroupID (FoFahrzeug-GruppeID):	A vehicle group is uniquely identified within the RealTrip via an ID. This allows it to be referenced from other formation elements.
FoVehiclePositions (FoFahrzeugPositionen):	A vehicle group references individual vehicles by the specification of their respective positions (ordered sequence) within the group.
FoTrafficNumber (FoVerkehrlicheNummer):	(optional) a single traffic number can be specified for a vehicle group. This is valid for all trip sections covered by the vehicle group.

FoVehicle-GroupDestination-Text (FoFahrzeug-GruppenZielText):	(optional) a destination text can be specified for a vehicle group. The destination text is valid for all trip sections covered by the vehicle group.
FoVehicleGroup-StartText (FoFahr-zeugGruppenStart-Text):	(optional) a start text can be specified for a vehicle group. The start text is valid for all trip sections covered by the vehicle group.

5.2.2.4.3.1 **Vehicles with position in the vehicle group (FoVehiclePositions)**

Definition of *FoVehiclePositions (FoFahrzeugePositionen)*

FoVehiclePosition (FoFahrzeugPosition):	(multiple) the 'FoVehiclePosition' (FoFahrzeugPosition) element describes a vehicle with its position and orientation within the vehicle group 'FoVehicleGroup' (FoFahrzeugGruppe). Several vehicles are combined within the 'FoVehiclePositions' (FoFahrzeugePositionen) element together with their respective positions.

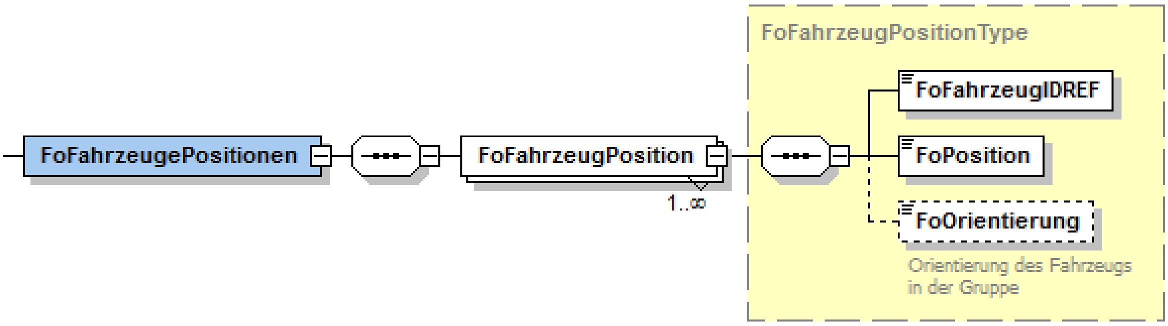


Figure 12 The 'FoVehiclePositions' element

Both the 'FoVehiclePositions' (FoFahrzeugePositionen) and 'FoVehiclePosition' (FoFahrzeugPosition) elements must be specified as soon as formation elements are transferred via the VDV454 interface.

Definition of *FoVehiclePosition (FoFahrzeugPosition)*

FoVehicleIDREF (FoFahr-zeugIDREF):	This element references a single vehicle of the RealTrip.
FoPosition (FoPosi-tion):	The position within the VehicleGroup must be specified for each vehicle.
FoOrientation (FoOrientierung):	(optional) if known, it is possible to specify the orientation of a referenced vehicle (alignment in the vehicle group, 'forwards', 'backwards')

5.2.2.4.4 Trip sections for vehicle groups (FoVehicleGroupTripSections)

This element can be used in RealFormation (IstFormation) and ScheduleFormation (SollFormation).

Definition of *FoVehicleGroupTripSections (FoFahrzeugGruppenFahrtAbschnitte)*

FoVehicleGroupTripSection (FoFahrzeugGruppenFahrtAbschnitt)	(multiple) there are one or more trip sections within a trip for which the vehicle groups travel unchanged. The individual trip sections are combined within the 'FoVehicleGroupTripSections' (FoFahrzeugGruppenFahrtAbschnitte) element.

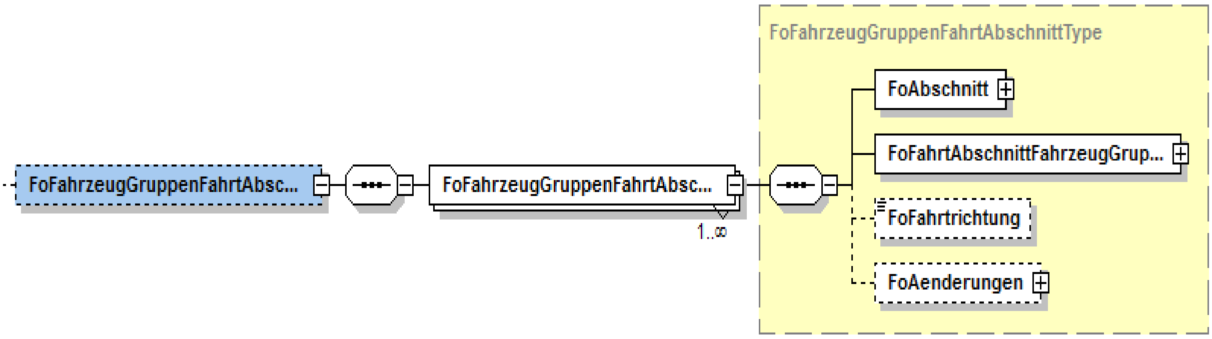


Figure 13The 'FoVehicleGroupTripSections' element

The 'FoVehicleGroupTripSections' (FoFahrzeugGruppenFahrtAbschnitte) higher-order element is optional. As soon as it is used however, an associated sub-element 'FoVehicleGroupTripSection' (FoFahrzeugGruppeFahrtAbschnitt) must be specified.

The following diagram illustrates usage with a corresponding example:

Examples Trip Sections

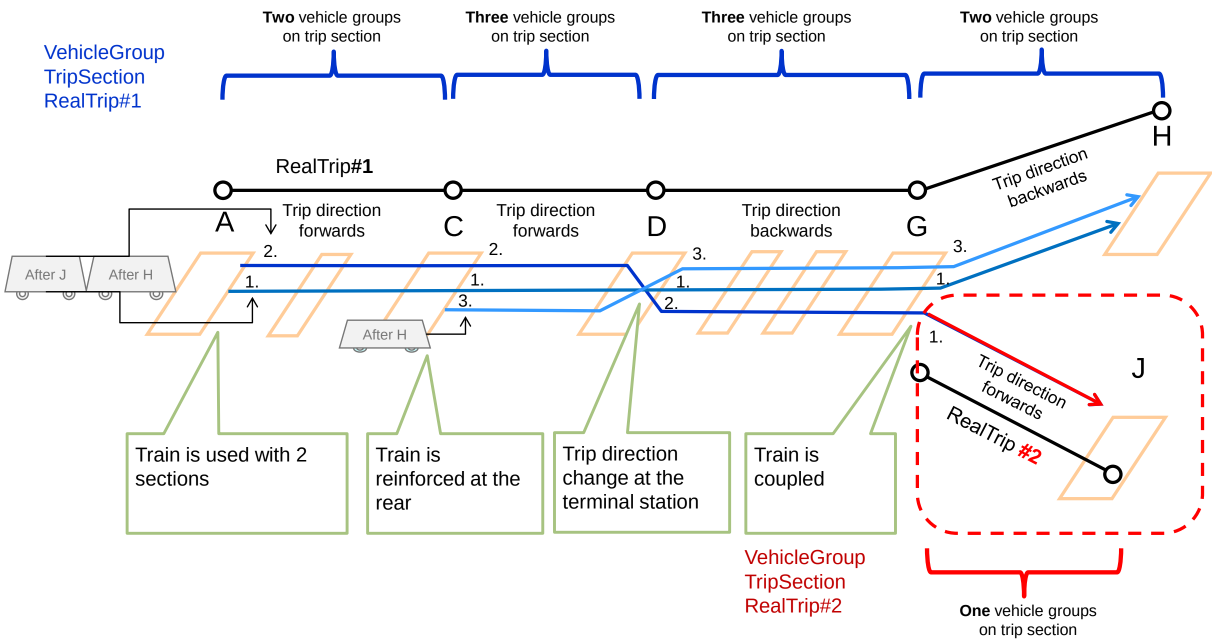


Figure 14 Typical trip sections

The VehicleGroupTripSections (FahrzeugGruppenFahrtAbschnitte) element always refers to one section of the trip, in which the group specific formations do not change (positioning of the vehicles, traffic numbers as well as origin and destination texts) and are shown as brackets in the diagram. At the marked stations there is always a specific action ('reinforcement', 'direction switch', 'decoupling', etc.), which affects the formation causing the creation of new VehicleGroupTripSections.

In the example, the individual vehicle groups are represented by a train symbol. Changes to the number of vehicles in the group or to the sequence, for example when changing direction in the station, result in a new VehicleGroupTripSection.

Vehicle groups 1 and 2 travel together on trip section 'A-C' within trip #1.

At station 'C' trip #1 is reinforced with an additional vehicle group '3'. The three vehicle groups then travel together to station 'G'.

As the trip direction of vehicle groups '1-3' changes at station 'D' (trip direction change from 'forwards' to 'backwards') two separate VehicleGroupTripSections are created for the 'C-D' and 'D-G' links for trip #1.

The train is decoupled at station 'G', i.e. the vehicle groups are split and and continue to different destinations.

Vehicle groups '1' and '3' travel on trip #1 to station 'H'. An additional VehicleGroupTripSection (FahrzeugGruppenFahrtAbschnitt) is created for this.

The former vehicle group '2' travels from station 'G' to station 'J' with a new trip, #2. This means that the vehicle group itself must be redefined for trip #2 (now vehicle group '1') and a separate VehicleGroupTripSection ('red') created.

Definition of *FoVehicleGroupTripSection (FoFahrzeugGruppenFahrtAbschnitt)*	
FoSection (FoAbschnitt):	This compulsory element describes the path on which the respective VehicleGroups travel unchanged (see 5.2.2.5.1).
FoTripSectionVehicleGroups (FoFahrtAbschnittFahrzeugGruppen):	This element describes the individual vehicle groups with their respective positions (arrangement) on the trip section (see 5.2.2.4.4.1).
FoTripDirection (FoFahrtrichtung):	(optional) it is possible to specify the trip direction of the respective vehicle groups on the relevant trip section ('forwards', 'backwards'). This denotes whether the groups and their vehicles are travelling in the opposite direction (see 5.2.2.4.4.2). If the element is not specified, the default value is taken: 'forwards'
FoChanges (FoAenderungen):	(optional) it is possible to specify relevant change information for the passenger information systems when compared with the original planned timetable information (see 5.2.2.5.2).

5.2.2.4.4.1 **Vehicle groups with position on the trip section (FoTripSectionVehicleGroups)**

Definition of *FoTripSectionVehicleGroups (FoFahrtAbschnittFahrzeugGruppen)*	
FoTripSectionVehicleGroup (FoFahrtAbschnittFahrzeugGruppe):	(multiple) one or more vehicle groups can travel within a trip section ('FoVehicleGroupTripSection'). These are then combined in the 'FoTripSectionVehicleGroups' (FoFahrtAbschnittFahrzeugGruppen) element.

Figure 15 The 'FoTripSectionVehicleGroups' element

Both elements must be specified if the formation elements are transferred via the VDV454 interface.

Definition of *FoTripSectionVehicleGroup (FoFahrtAbschnittFahrzeugGruppe)*	
FoVehicleGroupIDREF (FoFahrzeugGruppeIDREF):	Specifies the reference to the respective vehicle group and must be transmitted.

FoPosition (FoPosition):	Specifies the position of the referenced vehicle group on the relevant trip section (arrangement of the vehicle groups) and must be transmitted
FoPassages (FoDurchgaenge):	(optional) specifies whether there is an accessible passage way from the referenced vehicle group to an attached vehicle group for the passengers (see 5.2.2.4.4.1.1).
FoChanges (FoAenderungen):	(optional) it is possible to specify relevant change information for the passenger information systems when compared with the original planned timetable information (see 5.2.2.5.2).

5.2.2.4.4.1.1 Accessible passage way to an attached vehicle group

Definition of *FoPassages (FoDurchgaenge)*	
FoPassage (FoDurchgang):	(multiple) starting from one vehicle group it is possible to share information concerning accessible passageways for a maximum of two attached vehicle groups. The passage way possibilities are combined within the 'FoPassages' (FoDurchgaenge) element

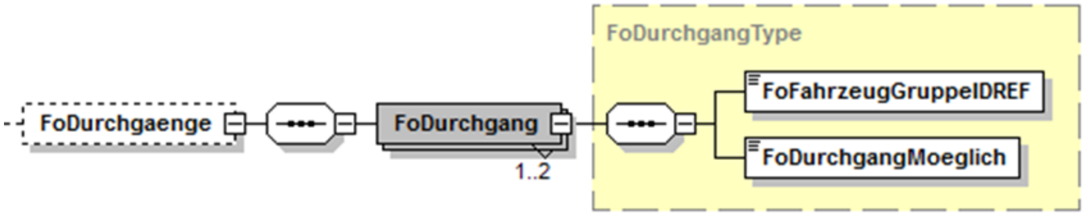


Figure 16 The 'FoPassages' element

Reference to the respective vehicle group is specified for each defined passage way (FoVehicleGroupIDREF).
Using the 'FoPassagePossible' (FoDurchgangMoeglich) element it is possible to specify whether passage to the referenced vehicle group is authorised for passenger use.

If neither 'FoPassages' (FoDurchgaenge) nor 'FoPassage' (FoDurchgang) is specified, it can be assumed that the source system does not know whether or not passage is possible for the passengers.

5.2.2.4.4.2 **Direction change within a trip**

The 'FoTripDirection' element can be used in order to specify the direction in which the specified vehicle groups travel along the trip section - either 'forwards' or 'backwards'. If the element is not specified, the default value is taken: 'forwards'

5.2.2.4.4.2.1 Processing without transmitting 'FoTripDirection'

If the element is not specified, the default value 'forwards' is taken.

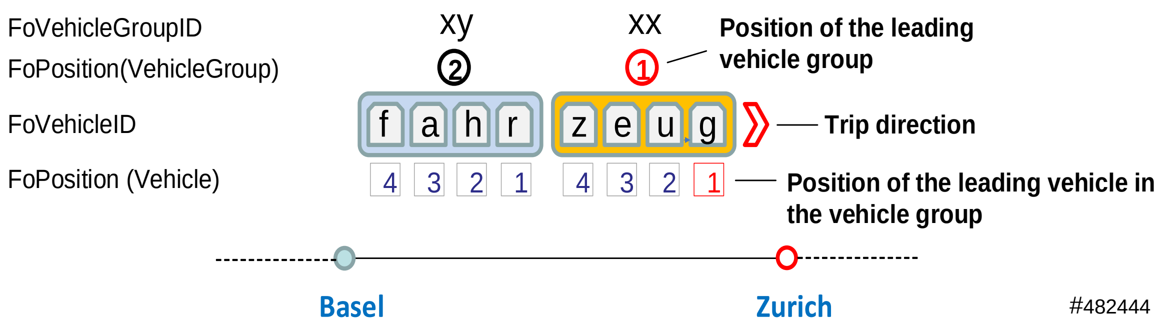


Figure 17 Establishing the trip direction

The trip direction is given by the identification of the leading vehicle. As illustrated in the example above, this can be established from the lowest position number of the vehicle groups or vehicles.

Implementation notes for the source systems:
When specifying the positions of the vehicle groups as well as the individual vehicles for a trip section, it should be remembered that the position numbers are always assigned in ascending order from the leading vehicle or vehicle group. If the 'FoTripDirection' element is not used, then in the case of a change in trip direction additional vehicle groups are compulsory due to the reassignment of the position numbers of the individual vehicles (illustrated in the diagram below).

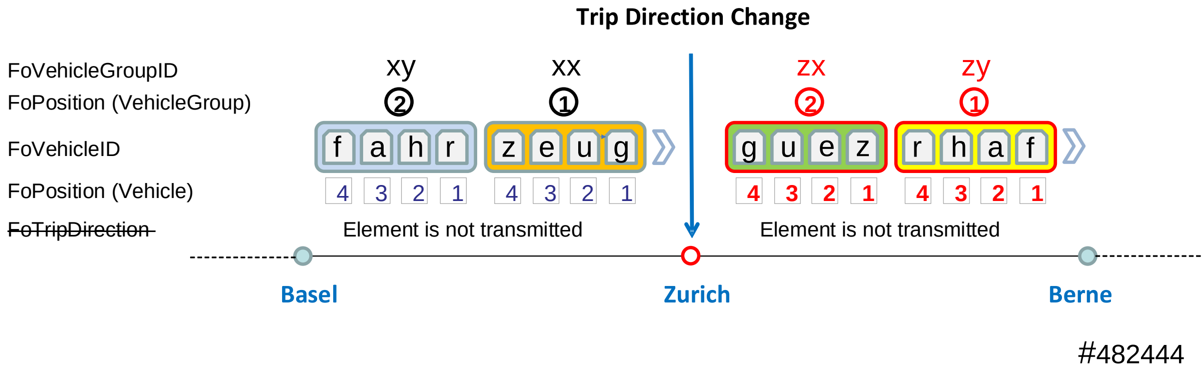


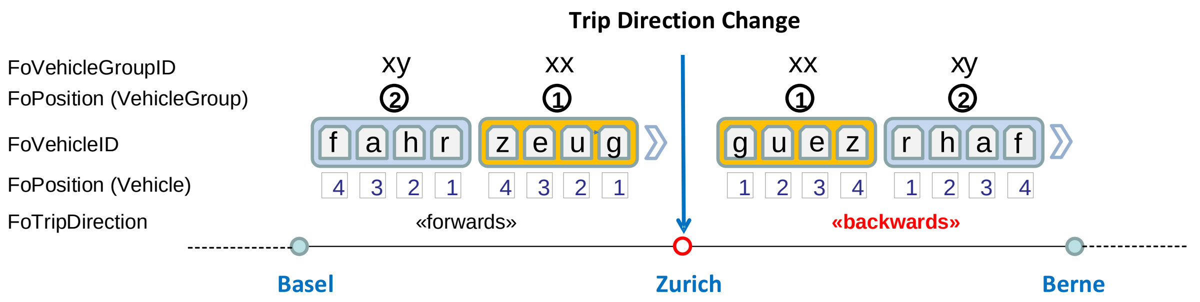
Figure 18 Trip direction change without transmitting 'FoTripDirection'

In the situation depicted here, vehicle groups '**xy**' and '**xx**' (without specification of 'FoTripDirection') cannot be used after the direction change in Zurich, as the positions of the vehicles in the groups and the positions of the groups themselves must be reassigned accordingly. It is necessary to define two additional groups, '**zx**' and '**zy**', in order to ensure the receiving system can later deduce the correct direction of travel.

5.2.2.4.4.2.2 Processing with transmission of 'FoTripDirection'

By specifying and transferring the trip direction, the procedure described in 5.2.2.4.4.2.1 is simplified.

The optional 'FoTripDirection' element allows the existing vehicle groups and vehicle positions to be used even after a change in direction as they remain constant.



#482444

Figure 19 Trip direction change with transmission of 'FoTripDirection' (FoFahrtrichtung)

The fact that the direction of travel has changed for the relevant trip section can be established by means of the 'FoTripDirection' (FoFahrtrichtung) element.

If this is set to the value 'forwards', this means that the trip direction or the leading vehicle is on the end that equates to the lowest position number of the vehicle group as well as the vehicles contained within it.

If the value is 'backwards', the leading vehicle is at the end with the highest position number of the vehicle groups and the vehicles contained within it.

As shown in Figure 19, reproduction of the change of direction by specifying the trip direction eliminates the need for two additional vehicle group definitions. The transmitted data volume is thereby reduced when compared to transmission without specification of the 'FoTripDirection' element.

5.2.2.4.5 Trip sections for vehicle equipments (FoVehicleEquipmentTripSections)

This element can be used in RealFormation (IstFormation) and ScheduleFormation (SollFormation).

Definition of *FoVehicleEquipmentTripSections (FoFahrzeugAusstattung-FahrtAbschnitte)*	
FoVehicleEquipmentTripSection (FoFahrzeugAusstattung-FahrtAbschnitt):	(multiple) there are one or more trip sections within a trip for which the vehicle equipments remains unchanged. The individual trip sections are combined within the 'FoVehicleEquipmentTripSections' (FoFahrzeugAusstattungFahrtAbschnitte) element.

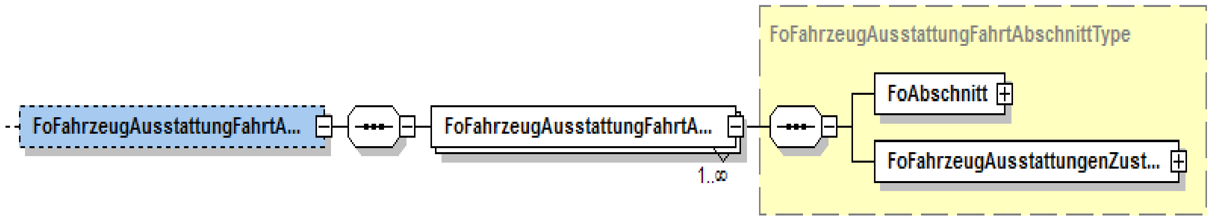


Figure 20 The 'FoVehicleEquipmentTripSections' element

The 'FoVehicleEquipmentTripSections' (FoFahrzeugAusstattungFahrtAbschnitte) element is optional. The vehicle equipments or statuses are not always known or transmitted via the VDV interfaces. However, as soon as a vehicle equipment on a trip section needs to be transmitted, the 'FoVehicleEquipmentTripSections' (FoFahrzeugAusstattungFahrtAbschnitte) and 'FoVehicleEquipmentTripSection' (FoFahrzeugAusstattungFahrtAbschnitt) elements is compulsory.

Definition of *FoVehicleEquipmentTripSection (FoFahrzeugAusstattung-FahrtAbschnitt)*

FoSection (FoAbschnitt):	This element describes the path on which the respective VehicleEquipments travel unchanged (see 5.2.2.5.1).
FoVehicleEquipmentStates (FoFahrzeugAusstattungenZustaende):	This element describes the corresponding statuses of the individual vehicle equipments on the trip section (see 5.2.2.4.5.1).

5.2.2.4.5.1 **Statuses of the vehicle equipments on a trip section (FoVehicleEquipmentTripSections (FoFahrzeugeAusstattungFahrtAbschnitte))**

Definition of *FoVehicleEquipmentTripSections (FoFahrzeugeAusstattung-FahrtAbschnitte)*

FoVehicleEquipmentTripSection (FoFahrzeugAusstattung-FahrtAbschnitt):	(multiple) one or more vehicle equipments with the corresponding statuses can travel within a 'FoVehicleEquipmentTripSection' (FoFahrzeugAusstattungFahrtAbschnitt). These are then combined in the 'FoVehicleEquipmentStatuses' (FoFahrzeugeAusstattungZustaende) element

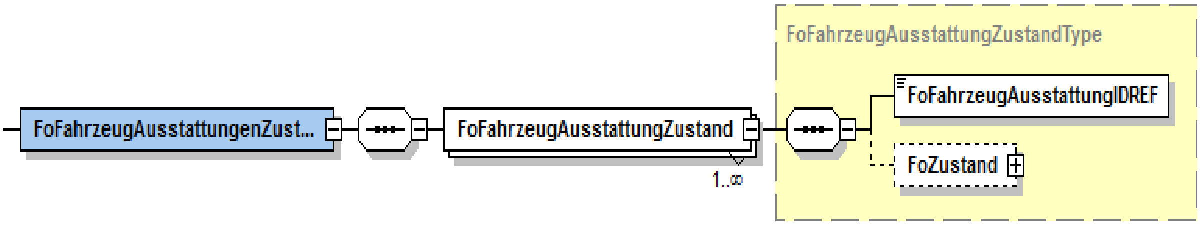


Figure 21 The 'FoVehicleEquipmentStatuses' element

Both elements must be specified as soon as 'FoVehicleEquipmentTripSections' (FoFahrzeugAusstattungFahrtAbschnitte) is used.

Definition of *FoVehicleEquipmentStatuses (FoFahrzeugAusstattungZustaende)*

FoVehicleEquipmentIDREF (FoFahrzeugAusstattungIDREF):	Reference to the respective vehicle equipment of a vehicle on the trip section.
FoStatus (FoZustand):	(optional) it is also possible to specify the status of the referenced vehicle equipment on the relevant trip section (see 5.2.2.5.3).

5.2.2.4.6 Trip Sections for VehicleStatuses (*FoVehicleStatusTripSections)*

This element can be used in RealFormation (IstFormation) and ScheduleFormation (SollFormation).

Definition of *FoVehicleStatusTripSections (FoFahrzeugZustandFahrtAbschnitte)*	
FoVehicleStatusTripSection (FoFahrzeugZustandFahrtAbschnitt):	(multiple) there are one or more trip sections within a trip for which the vehicles travel with unchanged statuses. The individual trip sections are combined within the 'FoVehicleStatusTripSections' (FoFahrzeugZustandFahrtAbschnitte) element.

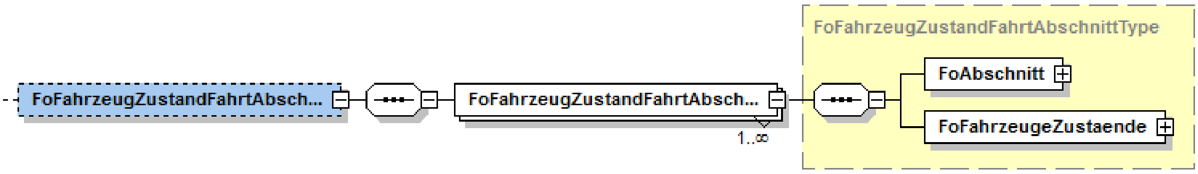


Figure 22 The 'FoVehicleStatusTripSections' element

The 'FoVehicleStatusTripSections' element is optional. The vehicle statuses are not always known or transmitted via the VDV interfaces. However, as soon as a vehicle status on a trip section needs to be transmitted, specification of the 'FoVehicleStatusTripSections' (FoFahrzeugZustandFahrtAbschnitte) and 'FoVehicleStatusTripSection' (FoFahrzeugZustandFahrtAbschnitt) elements is compulsory.

Definition of *FoVehicleStatusTripSection (FoFahrzeugZustandFahrtAbschnitt)*	
FoSection (FoAbschnitt):	This compulsory element describes the path on which the respective vehicle statuses remain unchanged (see 5.2.2.5.1).
FoVehicleStatuses (FoFahrzeugeZustaende):	This element describes the corresponding statuses of the individual vehicles on the trip section. This element must be specified (see 5.2.2.4.6.1).

5.2.2.4.6.1 **Statuses of the vehicles on the trip section (FoVehicleStatuses (FoFahrzeugeZustaende))**

Definition of *FoVehicleStatuses (FoFahrzeugeZustaende)*	
FoVehicleStatus (FoFahrzeugZustand):	(multiple) one or more vehicles with the corresponding statuses can travel within a trip section ('FoVehicleStatus'). These are then combined in the 'FoVehicleStatuses' (FoFahrzeugeZustaende) element.

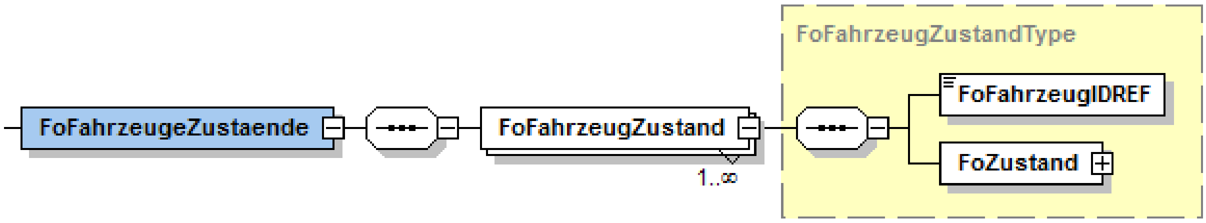


Figure 23 The 'FoVehicleStatuses' (FoFahrzeugeZustaende) element

Both elements must be specified as soon as 'FoVehicleStatusTripSections' (FoFahrzeugZustandFahrtAbschnitte) is used.

Definition of *FoVehicleStatus (FoFahrzeugZustand)*	
FoVehicleStatusIDREF (FoFahrzeugZustandIDREF):	Reference to the corresponding vehicle on the trip section.
FoStatus (FoZustand):	Specification of the status of the referenced vehicle on the relevant trip section (see 5.2.2.5.3).

5.2.2.4.7 Trip sections for vehicle occupancy (FoVehicleOccupancyTripSections)

This element can be used in RealFormation (IstFormation) and ScheduleFormation (SollFormation).

Definition of *FoVehicleOccupancyTripSections (FoFahrzeugBelegungFahrtAbschnitte)*	
FoVehicleOccupancyTripSection (FoFahrzeugBelegungFahrtAbschnitt):	(multiple) there are one or more trip sections within a trip for which the occupancy of the travelling vehicles remains unchanged. The individual trip sections are combined within the 'FoVehicleOccupancyTripSections' (FoFahrzeugBelegungFahrtAbschnitte) element.

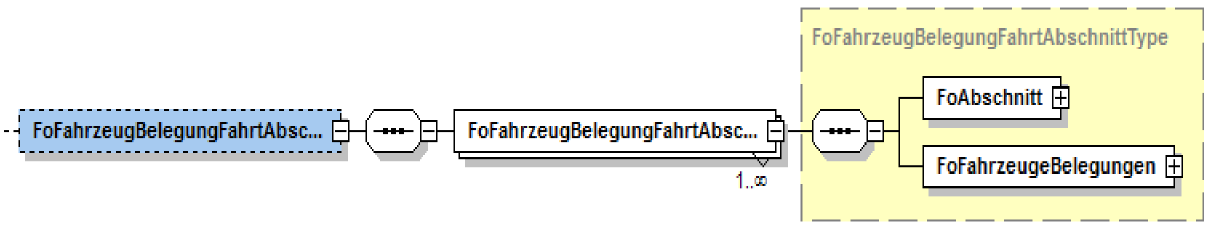


Figure 24 The 'FoVehicleOccupancyTripSections' element

The 'FoVehicleOccupancyTripSections' (FoFahrzeugBelegungFahrtAbschnitte) element is optional. The occupancy information is not always known or transmitted via the VDV interfaces. However, as soon as it becomes necessary to transmit a vehicle occupancy level, specification of the 'FoVehicleOccupancyTripSections' FoFahrzeugBelegungFahrtAbschnitte) and 'FoVehicleOccupancyTripSection' (FoFahrzeugBelegungFahrtAbschnitt) elements is compulsory.

Definition of *FoVehicleOccupancyTripSection (FoFahrzeugBelegungFahrtAbschnitt)*	
FoSection (FoAbschnitt):	This compulsory element describes the path on which the respective vehicles travel with an unchanged occupancy (see 5.2.2.5.1).
FoVehicleOccupancies (FoFahrzeugBelegungen):	This element describes the corresponding occupancy information of the individual vehicles on the trip section. This element must be specified (see 5.2.2.4.7.1).

5.2.2.4.7.1 **Occupancy of the vehicles on the trip section (FoVehicleOccupancy)**

Definition of *FoVehicleOccupancies (FoFahrzeugeBelegungen)*	
FoVehicleOccupancy (FoFahrzeugBelegung):	(multiple) one or more vehicles with the corresponding occupancy information ('FoVehicleOccupancy') can travel within a 'FoVehicleOccupancyTripSection' (FoFahrzeugBelegung). These are then combined in the 'FoVehicleOccupancies' (FoFahrzeugeBelegungen) element.

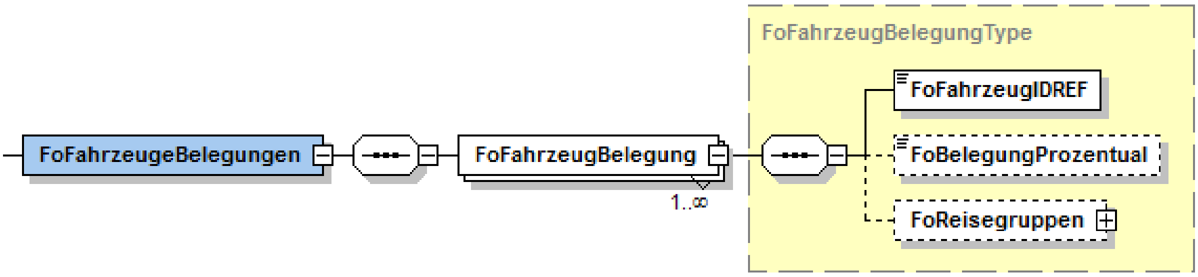


Figure 25 The 'FoVehicleOccupancies' element

Both elements ‘FoVehicleOccupancies’ (FoFahrzeugeBelegungen) and ‘FoVehicleOccupancy‘ (FoFahrzeugBelegung) must be specified as soon as 'FoVehicleOccupancyTripSections' is used.

Definition of *FoVehicleOccupancy (FoFahrzeugBelegung)*	
FoVehicleIDREF (FoFahrzeugIDREF):	Reference to the corresponding vehicle.
FoOccupancyPercentage (FoBelegungProzentual):	(optional) specification of the occupancy of the referenced vehicle on the relevant trip section as a percentage value.
FoTravelGroups (FoReisegruppen):	(optional) this element is used to specify whether travel groups have been booked on the vehicle for the relevant trip section and if so under what name (see 5.2.2.4.7.1.1)

If the 'FoVehicleOccupancy' (FoFahrzeugBelegung) element is transmitted, then in addition to 'FoVehicleIDREF' (FoFahrzeugIDREF) at least one of the sub-elements - 'FoOccupancyPercentage' (FoBelegungProzentual) and/or 'FoTravelGroups' (FoReisegruppen) - must also be transmitted.

5.2.2.4.7.1.1 Specifying travel groups in the vehicle

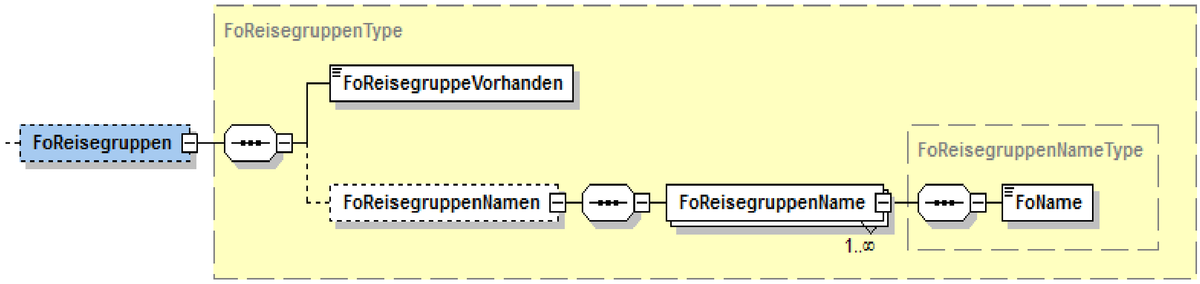


Figure 26 The 'FoTravelGroups' element

Definition of *FoTravelGroups (FoReisegruppen)*	
FoTravelGroupPresent (FoReisegruppeVorhanden):	Compulsory specification stating whether or not a group is booked onto the vehicle
FoTravelGroupName (FoReisegruppenNamen):	(optional) in addition, it is also possible to specify the names of the groups booked onto the vehicle.

5.2.2.4.8 Formations at the stop (FoStops)

This element can be used in RealFormation (IstFormation) and ScheduleFormation (SollFormation).

Definition of *FoStops (FoHalte)*	
FoStop (FoHalt):	(multiple) there are one or more stops to which the individual vehicles and the necessary stop information (stop position, sector name) has been assigned. The individual pieces of stop information are combined within the 'FoStops' element.

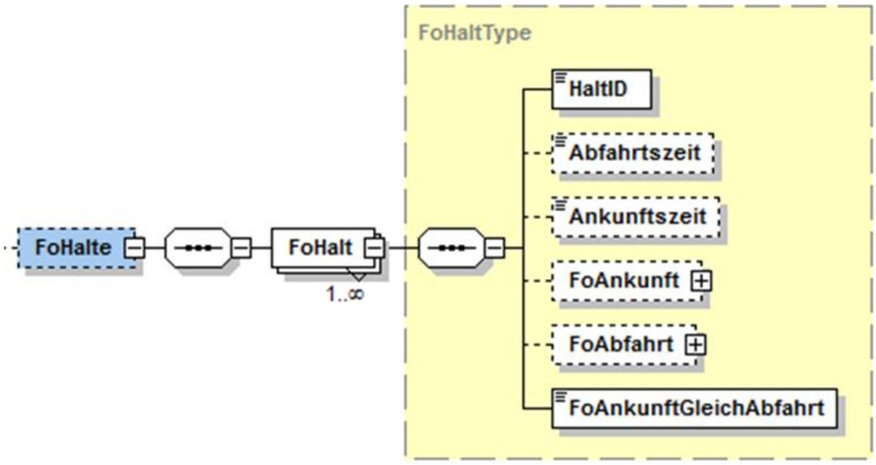


Figure 27 The 'FoStops' element

The 'FoStops' (FoHalte) element is denoted as optional as the information concerning the individual stops along the trip is not always transmitted. However, as soon as it becomes necessary to transmit stop information, specification of the 'FoStops' (FoHalte) and 'FoStop' (FoHalt) elements is compulsory.

Definition of *FoStop (FoHalt)*	
StopID (HaltID):	This element defines the ID of the respective stop and must match the ID of a RealStop of the Real/ScheduleTrip.
ArrivalTime (Ankunftszeit):	(optional) this element contains the exact arrival time at the relevant stop and must match the arrival time of the specified RealStop of the Real/ScheduleTrip
DepartureTime (Abfahrtszeit):	(optional) this element contains the exact departure time at the relevant stop and must match the departure time of the specified RealStop of the Real/ScheduleTrip
FoArrival (FoAnkunft):	(optional) this element combines the arrival-related information at the relevant stop (see 5.2.2.4.8.2).
FoDeparture (FoAbfahrt):	(optional) this element combines the departure-related information at the relevant stop (see 5.2.2.4.8.3).
FoArrivalEqualDeparture (FoAnkunftGleichAbfahrt):	If only one of the elements is transmitted, i.e. either 'FoArrival' (FoAnkunft) or 'FoDeparture' (FoAbfahrt), this element indicates that the transmitted information is valid for both the arrival and departure at the stop.

Note: The 'StopID' (HaltID), 'ArrivalTime' (Ankunftszeit) and 'DepartureTime' (Abfahrtszeit) elements are required in order to identify the corresponding RealStop of the RealTrip. These must match the corresponding fields of the relevant RealStop. At least one of the time elements - 'ArrivalTime' or 'DepartureTime' - must be specified.

5.2.2.4.8.1 **Description of the arrival at / departure from the stop**

The main purpose of the 'FoArrival' (FoAnkunft) and 'FoDeparture' (FoAbfahrt) elements is to transmit the information concerning the formation of a vehicle (especially trains) at a stop.

During a trip any given vehicle usually serves several stops.
The customer needs to know where exactly the individual vehicles stop at the respective platform. This information is used individually or in combined format for the stop signs along the platforms and depending on the situation may differ in terms of arrival or departure at the given stop. If both 'positioning of the vehicles at the platform' and 'positioning of the sectors on the platform' are resolved by the fetcher system, the assignment of vehicle positions to sector can be derived from this data for the passenger information.

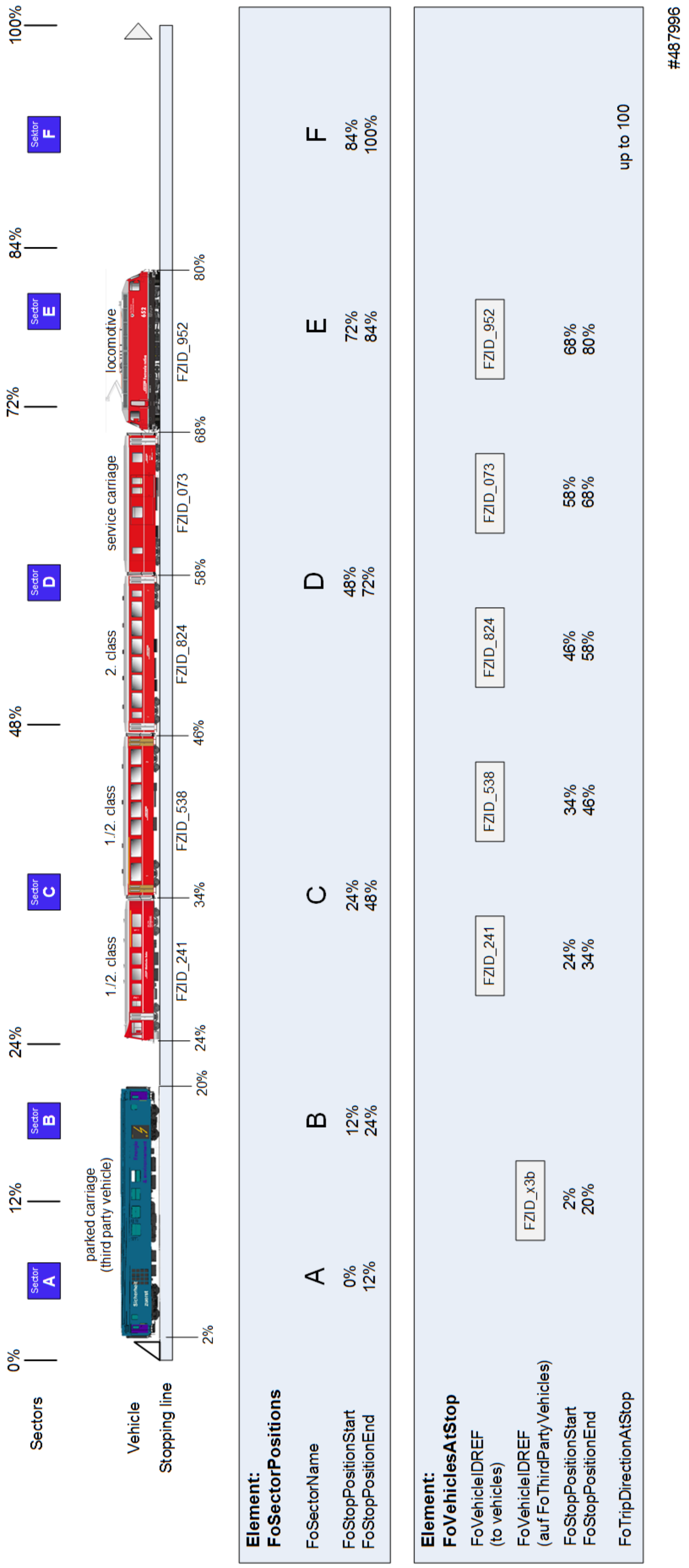


Figure 28 Stopping positions for vehicles and sectors of the platform

5.2.2.4.8.1.1 Sector positions along the platform:

The positions of the individual sectors at the respective platform are described accordingly (see 5.2.2.4.8.2.2 and 5.2.2.4.8.3.2).
The position of each sector on the platform is defined by a start and end position and given as a percentage. This allows rough sector positions to be specified, even if the exact length of the individual sectors in metres is not known.

The following data must be known:
- Length of the platform
- Origin (0-point), as the definitive start of the platform (reference point of the infrastructure)
- Length and positioning of the individual sectors in relation to the platform
- Sector names

5.2.2.4.8.1.2 Vehicle positions on the platform:

The positions of the individual and third-party vehicles at the respective platform are described accordingly (see 5.2.2.4.8.2.1 and 5.2.2.4.8.3.1).
The position of each vehicle always relates to the relevant platform and is denoted by a start and an end point, specified as a percentage value from the origin (0-point). This allows rough vehicle positions to be specified, even if the exact stopping positions of the individual vehicles in metres is not known.

The following data must be known:
- Length of the platform
- Origin (0-point), as the definitive start of the platform (reference point of the infrastructure)
- Knowledge about the vehicles and any possible third-party vehicles on the platform
- Absolute stopping position of at least one vehicle on the platform (this is generally the position of the leading vehicle)
- Length of the individual vehicles in relation to the platform

5.2.2.4.8.1.3 Trip direction upon arrival or departure from the platform

Describes the the trip direction at arrival (entry) or departure (exit) from the platform
(see 5.2.2.4.8.2 and 5.2.2.4.8.3).

5.2.2.4.8.1.4 Possible representations of the information at the stop

This model supports a wide spectrum for the transmission of information. Individual pieces of information can be reproduced and transmitted with varying levels of detail. This also takes into account the fact that the pages of the supplying system often provide a wide variety of information with differing levels of detail.

The following sketches show the spectrum of possible representations and information levels:

Comprehensive formation representation

Full representation with position on the platform, car numbers and vehicle features

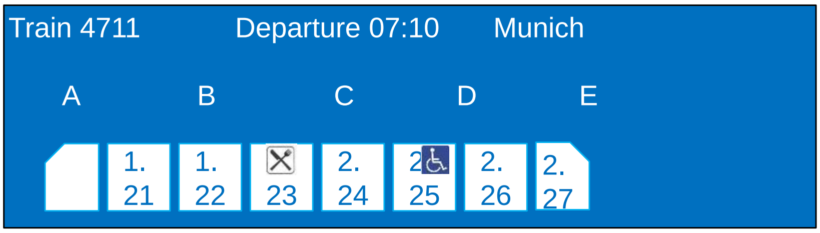


Figure 29 Comprehensive formation representation

The information can be used, for example, to supply the train formation signs along the platform with the specific information regarding the carriage characteristics.

Position of local trains on the platform

Position of a commuter train in relation to the platform

Figure 30 Position of local public transport trains on the platform

This model also allows the creation of simpler displays from the supplied information, such as those more commonly seen in connection with commuter trains and underground systems. These typically display the position and length of the train and its position relative to the platform.

Representation of different trip destinations

Full representation with position on the platform, destinations and car numbers

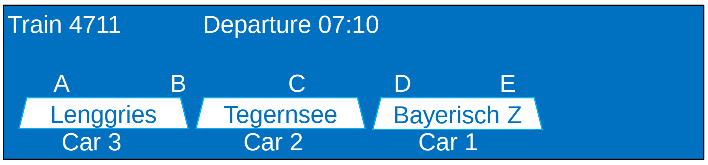


Figure 31 Representing different trip destinations

In addition, this model also allows the different destinations of the various vehicle groups within a coupled train to be represented as well as the position of the vehicles in the station. During the evaluation of this data on the fetcher system side, information such as 'FoVehicleGroupStartText' (FoFahrzeugGruppenStartText), 'FoVehicleGroupDestinationText' (FoFahrzeugGruppenZielText) and 'TrafficNumber' (VerkehrlicheNummer) can be established from the identification of the relevant vehicles in the defined vehicle groups and used on the display devices.

5.2.2.4.8.2 **Formations for the arrival at the stop (FoArrival (FoAnkunft))**

Stop information (e.g. allocation of vehicles to sectors) can be reproduced for the arrival of a trip ('FoArrival') at a stop ('FoStop').

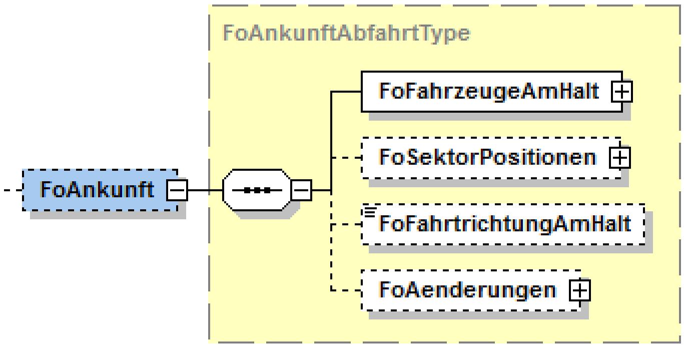


Figure 32 The 'FoArrival' element

Definition of *FoArrival (FoAnkunft)*	
FoVehiclesAtStop (FoFahrzeugeAmHalt):	Specification of the allocations and positioning of the individual vehicles and third-party vehicles at the platform designated for the arrival (see 5.2.2.4.8.2.1).
FoSectorPosition (Fo-SektorPosition):	(optional) specification of the allocations and positioning of the in-dividual sectors at the platform designated for the arrival (see 5.2.2.4.8.2.2).
FoTripDirectionAtStop (FoFahrtrichtungAm-Halt):	(optional) specification of the trip direction for the entry of the trip at the stop ('towards 0', 'towards 100').
FoChanges (FoAender-ungen):	(optional) specification of the change information that is relevant to the timetable information system (compared to the original timetabled info) concerning the arrival of the RealTrip at the stop (see 5.2.2.5.2).

5.2.2.4.8.2.1 Vehicles, statuses and stopping positions upon arrival at the stop (Fo-VehiclesAtStop (FoFahrzeugeAmHalt))

Definition of *FoVehiclesAtStop (FoFahrzeugeAmHalt)*	
FoVehicleAtStop (FoFahrzeugAmHalt):	(multiple) specification of the vehicle or third-party vehicle and its stopping position upon arrival at the respective stop. The individ-ual vehicles and their positions are combined within the 'FoVehi-clesAtStop' (FoFahrzeugeAmHalt) element.

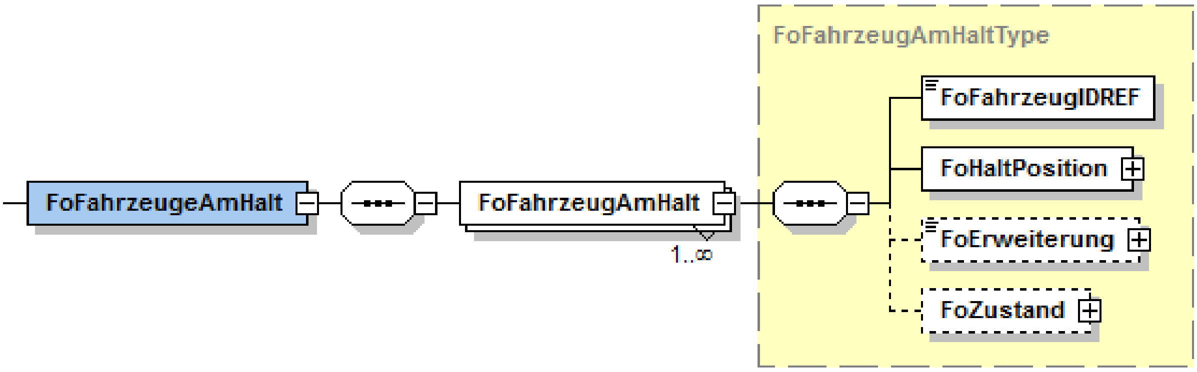


Figure 33 The 'FoVehiclesAtStop' element

Definition of *FoVehicleAtStop (FoFahrzeugAmHalt)*	
FoVehicleIDREF (FoFahrzeugIDREF):	Reference to the vehicle or third-party vehicle that is relevant to the arrival at the stop (see 5.2.2.4.1 and 5.2.2.4.2).
FoStopPosition (Fo-HaltPosition):	(optional) specification of the position of the referenced vehicle or third-party vehicle at the platform (see 5.2.2.4.8.2.1.1).
FoStatus (FoZustand):	(optional) specification of the status of the referenced vehicle or third-party vehicle upon arrival at the stop (see 5.2.2.5.3).
FoExtension (FoEr-weiterung):	(optional) structure to extend by project-specific structures, e.g. for the reproduction of barrier-free access paths to the stop (see 5.2.2.5.4).

5.2.2.4.8.2.1.1 Stopping position of the vehicle upon arrival at the stop (FoStopPosition (FoHaltPosition))

The 'FoStopPosition' (FoHaltPosition) element describes the start and end positions of a vehicle at the stop in relation to the total length of the platform

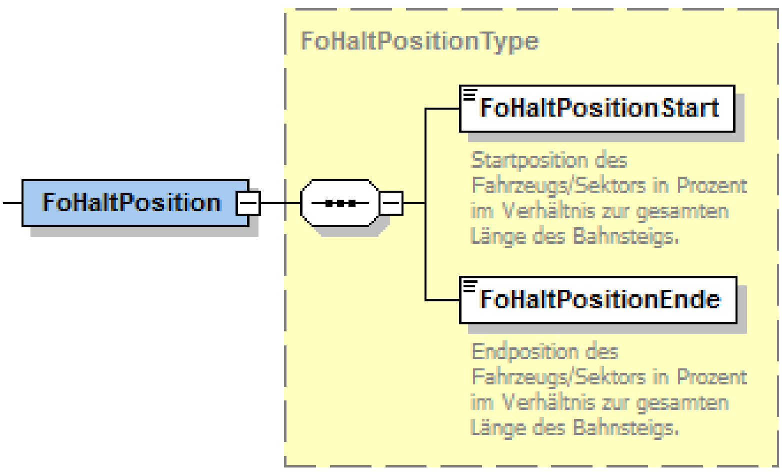


Figure 34 The 'FoStopPosition' element

Definition of *FoStopPosition (FoHaltPosition)*

FoStopPositionStart (FoHaltPositionStart):	Specification of the start position of the vehicle at the stop in relation to the total length of the platform as a percentage (e.g. 50).
FoStopPositionEnd (FoHaltPositionEnde):	Specification of the end position of the vehicle at the stop in relation to the total length of the platform as a percentage (e.g. 75).

5.2.2.4.8.2.2 Sector name and positioning upon arrival at the stop (FoSectorPositions (FoSektorPositionen))

Definition of *FoSectorPositions (FoSektorPositionen)*

FoSectorPosition (FoSektorPosition):	(multiple) this element is used to define the allocations and positioning of the individual sectors at the arrival platform. The individual sector positions are combined in the 'FoSectorPositions' ("FoSektorPositionen) element.

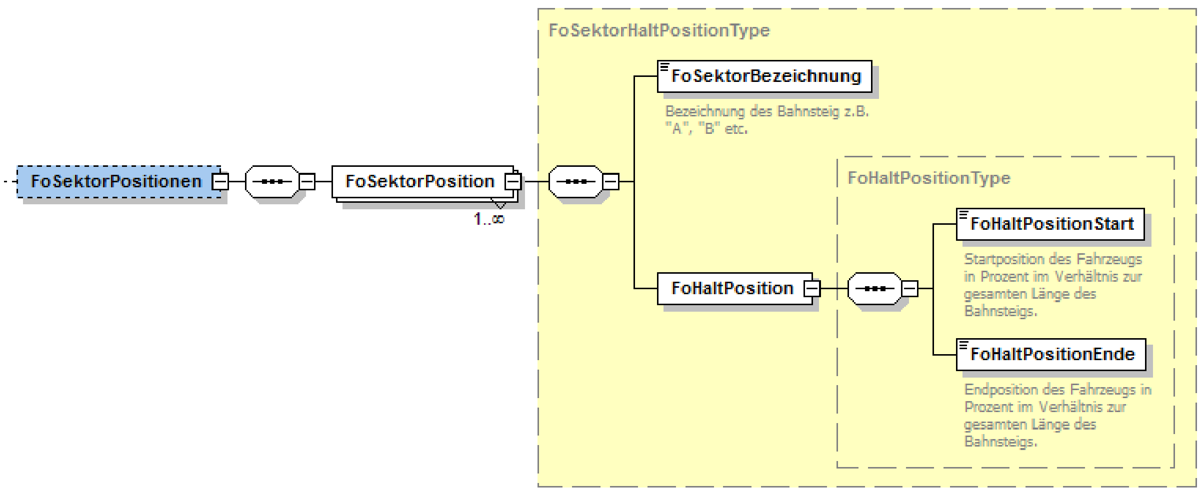


Figure 35 The 'FoSectorPositions' element

The 'FoSectorPositions' (FoSektorPositionen) element is denoted as optional as the information concerning the individual sector positions at the stop is not always transmitted. However, as soon as it becomes necessary to transmit a sector position at the stop, specification of the 'FoSectorPositions' (FoSektorPositionen) and 'FoSectorPosition' (FoSektorPosition) elements is compulsory.

Definition of *FoSectorPosition (FoSektorPosition)*

FoSectorName (FoSektorBezeichnung):	Specification of the name of the respective sector
FoStopPosition (FoHaltPosition):	Specification of the exact position of the sector on the platform

5.2.2.4.8.2.2.1 Sector position upon arrival at the stop (FoStopPosition)

This element describes the start and end positions of a sector at the stop in relation to the total length of the platform

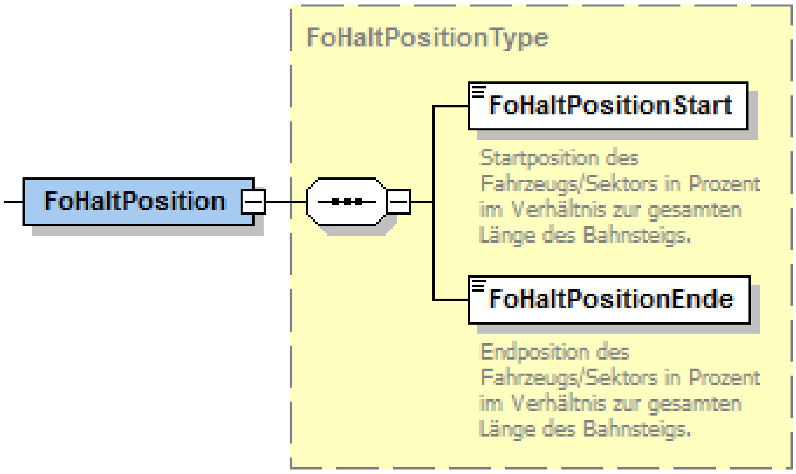


Figure 36 The 'FoStopPosition' element

Definition of *FoStopPosition (FoHaltPosition)*	
FoStopPositionStart (FoHaltPositionStart):	Specification of the start position of the sector upon arrival at the stop in relation to the total length of the platform as a percentage (e.g. 50).
FoStopPositionEnd (FoHaltPositionEnde):	Specification of the end position of the sector upon arrival at the stop in relation to the total length of the platform as a percentage (e.g. 75).

5.2.2.4.8.3 **Formations for departure from the stop (FoDeparture (FoAbfahrt))**

Stop information (e.g. allocation of vehicles to sectors) can be reproduced for the departure of a trip ('FoDeparture') at a stop ('FoStop').

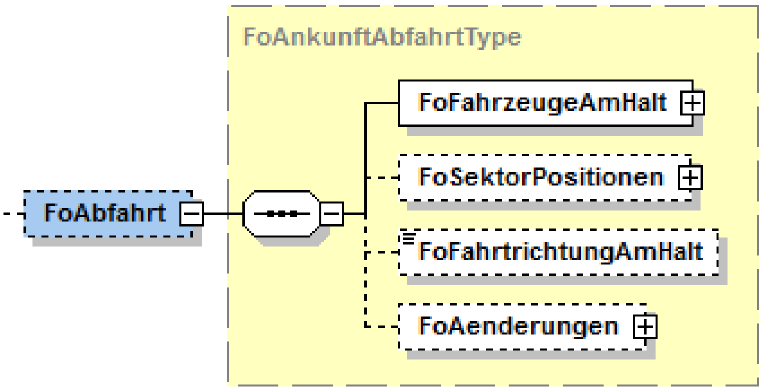


Figure 37 The 'FoDeparture' element

Definition of *FoDeparture (FoAbfahrt)*

FoVehiclesAtStop (FoFahrzeugeAmHalt):	Specification of the allocations and positioning of the individual vehicles and third-party vehicles at the platform designated for the departure (see 5.2.2.4.8.3.1).
FoSectorPositions (Fo-SektorPositionen):	(optional) specification of the allocations and positioning of the individual sectors at the platform designated for the departure (see 5.2.2.4.8.3.2).
FoTripDirectionAtStop (FoFahrtrichtungAm-Halt):	(optional) specification of the trip direction for the departure of the trip from the stop.
FoChanges (FoAender-ungen):	(optional) specification of the change information that is relevant to the timetable information system (compared to the original timetabled info) concerning the departure of the RealTrip from the stop (see 5.2.2.5.2).

5.2.2.4.8.3.1 Vehicles, statuses and stopping positions upon departure from the stop (FoVehiclesAtStop (FoFahrzeugeAmHalt))

Definition of *FoVehiclesAtStop (FoFahrzeugeAmHalt)*

FoVehicleAtStop (FoFahrzeugAmHalt):	(multiple) specification of the vehicle or third-party vehicle and its stopping position upon departure from the respective stop. The individual vehicles and their positions are combined within the 'Fo-VehiclesAtStop' (FoFahrzeugeAmHalt) element.

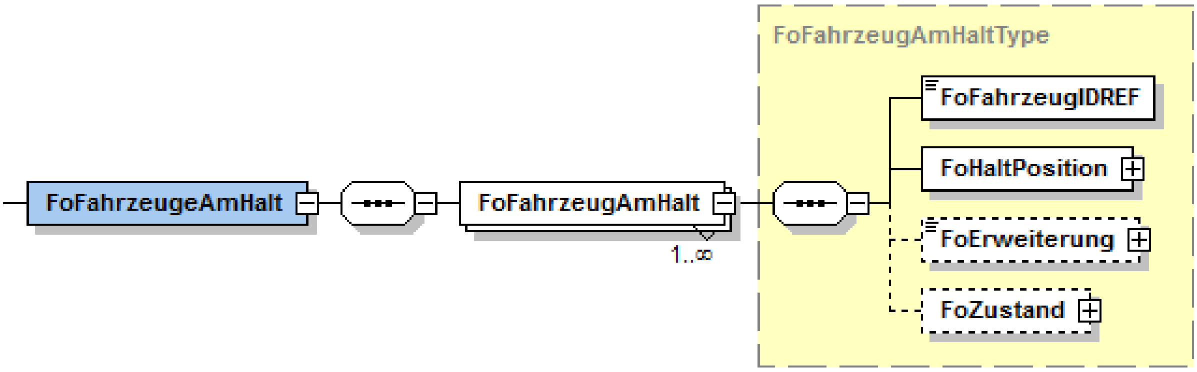


Figure 38 The 'FoVehiclesAtStop' element

Definition of *FoVehicleAtStop (FoFahrzeugAmHalt)*

FoVehicleIDREF (FoFahrzeugIDREF):	Reference to the vehicle or third-party vehicle that is relevant to the departure from the stop (see 5.2.2.4.1 and 5.2.2.4.2).
FoStopPosition (Fo-HaltPosition):	(optional) specification of the exact position of the referenced vehicle or third-party vehicle at departure from the platform (see 5.2.2.4.8.3.1.1).

FoStatus (FoZustand):	(optional) specification of the status of the referenced vehicle or third-party vehicle upon departure from the stop (see 5.2.2.5.3).
FoExtension (FoErweiterung):	(optional) structure to extend by project-specific structures, e.g. for the reproduction of barrier-free access paths to the stop (see 5.2.2.5.4).

5.2.2.4.8.3.1.1 Stopping position of the vehicle upon departure from the stop (FoStopPosition (FoHaltPosition))

This element describes the start and end positions of a vehicle upon departure from the stop in relation to the total length of the platform

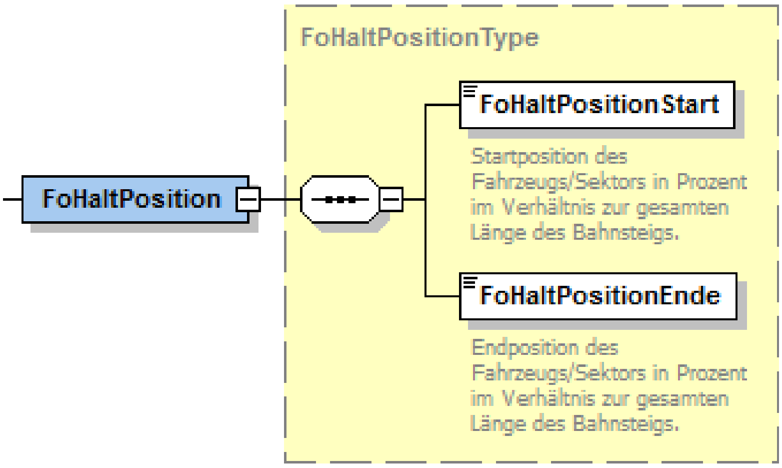


Figure 39 The 'FoStopPosition' element

Definition of *FoStopPosition (FoHaltPosition)*	
FoStopPositionStart (FoHaltPositionStart):	Specification of the start position of the vehicle upon departure from the stop in relation to the total length of the platform as a percentage (e.g. 50).
FoStopPositionEnd (FoHaltPositionEnde):	Specification of the end position of the vehicle upon departure from the stop in relation to the total length of the platform as a percentage (e.g. 75).

5.2.2.4.8.3.2 Sector name and positioning upon departure from the stop (FoSectorPositions (FoSektorPositionen))

Definition of *FoSectorPositions (FoSektorPositionen)*	
FoSectorPosition (FoSektorPosition):	(multiple) this element is used to define the allocations and positioning of the individual sectors at the departure platform. The individual sector positions are combined in the 'FoSectorPositions' ("FoSektorPositionen) element.

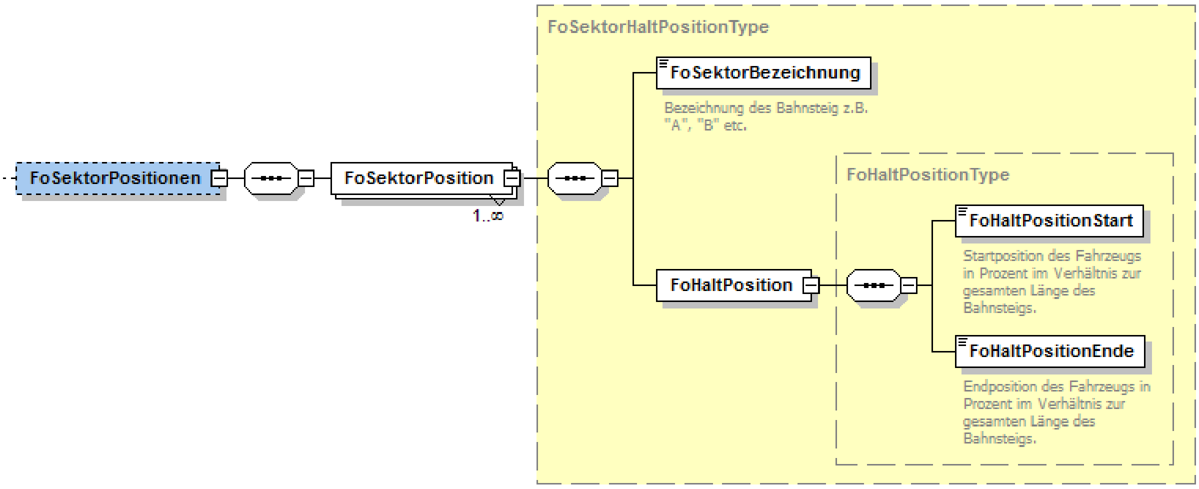


Figure 40 The 'FoSectorPositions' element

The 'FoSectorPositions' (FoSektorPositionen) element is denoted as optional as the information concerning the individual sector positions at the stop is not always transmitted. However, as soon as it becomes necessary to transmit a sector position at the stop, specification of the 'FoSectorPositions' (FoSektorPositionen) and 'FoSectorPosition' (FoSektorPosition) elements is compulsory.

Definition of *FoSectorPosition (FoSektorPosition)*

FoSectorName (FoSektorBezeichnung):	Specification of the name of the respective sector.
FoStopPosition (FoHaltPosition):	Specification of the exact position of the sector on the platform.

5.2.2.4.8.3.2.1 Sector position upon departure from the stop (FoStopPosition)

This element describes the start and end positions of a sector at the stop in relation to the total length of the platform

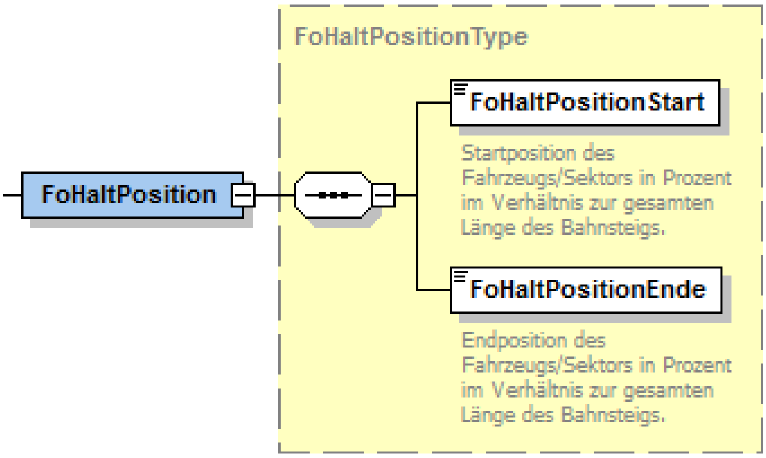


Figure 41 The 'FoStopPosition' element

Definition of *FoStopPosition (FoHaltPosition)*	
FoStopPositionStart (Fo-HaltPositionStart):	Specification of the start position of the sector upon departure from the stop in relation to the total length of the platform as a percentage (e.g. 50).
FoStopPositionEnd (Fo-HaltPositionEnde):	Specification of the end position of the sector upon departure from the stop in relation to the total length of the platform as a percentage (e.g. 75).

5.2.2.5 Multiple use element structures within RealFormation

5.2.2.5.1 Description of the section (FoSection)

This element describes a specific trip section.

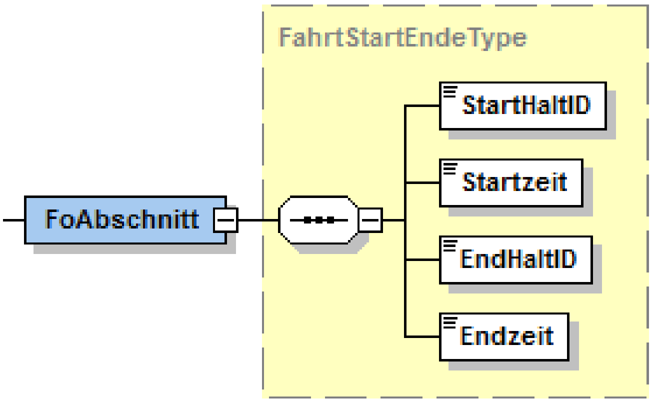


Figure 42 The 'FoSection' element

The StartStopID, StartTime, EndStopID and EndTime are required to be able to reference the corresponding RealStops (for the transmission of RealFormation) or ScheduleStops (for the transmission of ScheduleFormation).

Definition of *FoSection (FoAbschnitt)*	
StartStopID (Star-tHaltID):	ID of the respective starting point of the section, must match the ID of a Schedule or RealStop of the trip.
StartTime (Startzeit):	Start time at the StartStop of the section, must match the departure time of a Schedule or RealStop of the trip
EndStopID (EndHal-tID):	ID of the respective end point of the section, must match the ID of a Schedule or RealStop of the trip.
EndTime (Endzeit):	End time at the EndStop of the section, must match the arrival time of the specified Schedule or RealStop of the trip.

5.2.2.5.2 Description of changes with regard to the planning data (FoChanges)

Definition of *FoChanges (FoAenderungen)*

FoChange (FoAender-ung):	(multiple) this element can be used to share any changes from the originally transmitted scheduled values with the timetable information system. The individual changes are combined within the 'FoChanges' (FoAenderungen) element.

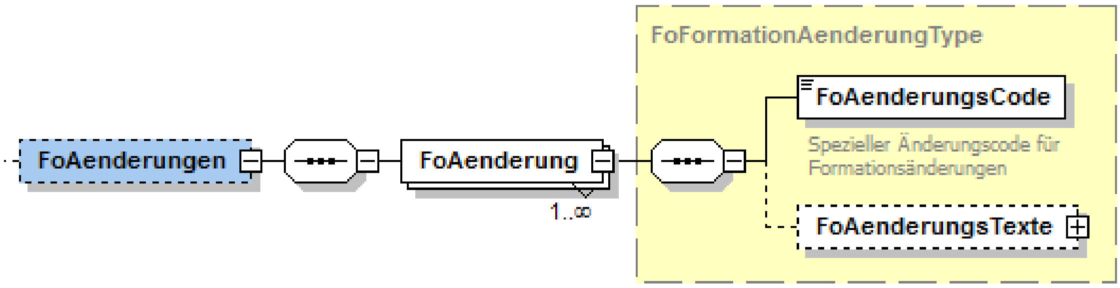


Figure 43 The 'FoChanges' element

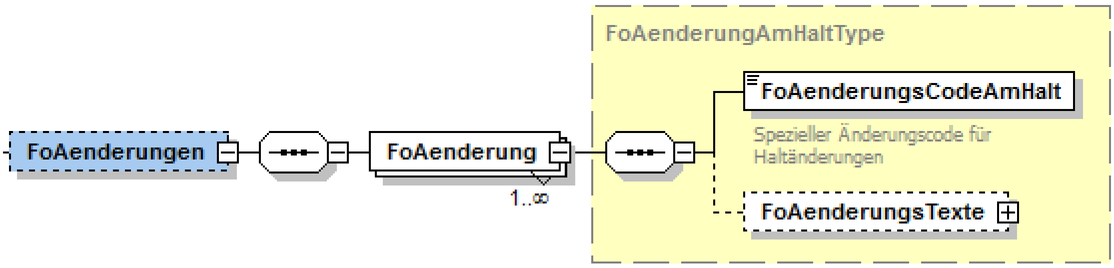


Figure 44 The 'FoChanges' element (at the stop)

Definition of *FoChange (FoAenderung)*

FoChangeCode (FoAenderungsCode) *or* *FoChan-geCodeAtStop (FoAen-derunsCodeAmHalt):* *[VL] (see Chapter 0)*	A change code must be specified for each piece of changed information (e.g. MissingCars, ExtraCars, ChangedSequence etc.). • The 'FoChangeCode' (FoAenderungsCode) element is used for changes regarding the vehicle groups on a trip section (see 5.2.2.4.4). • The 'FoChangeCodeAtStop' (FoAenderungsCodeAmHalt) element is used for change information at the relevant RealStop (IstHalt) (see Chapter 0)
FoChangeTexts (FoAender-ungsTexte):	(optional) the ChangeTexts are used to specify the desired change information in text format and to make corresponding suggestions for dealing with the changes.

5.2.2.5.2.1 **Description of the change texts (FoChangeTexts)**

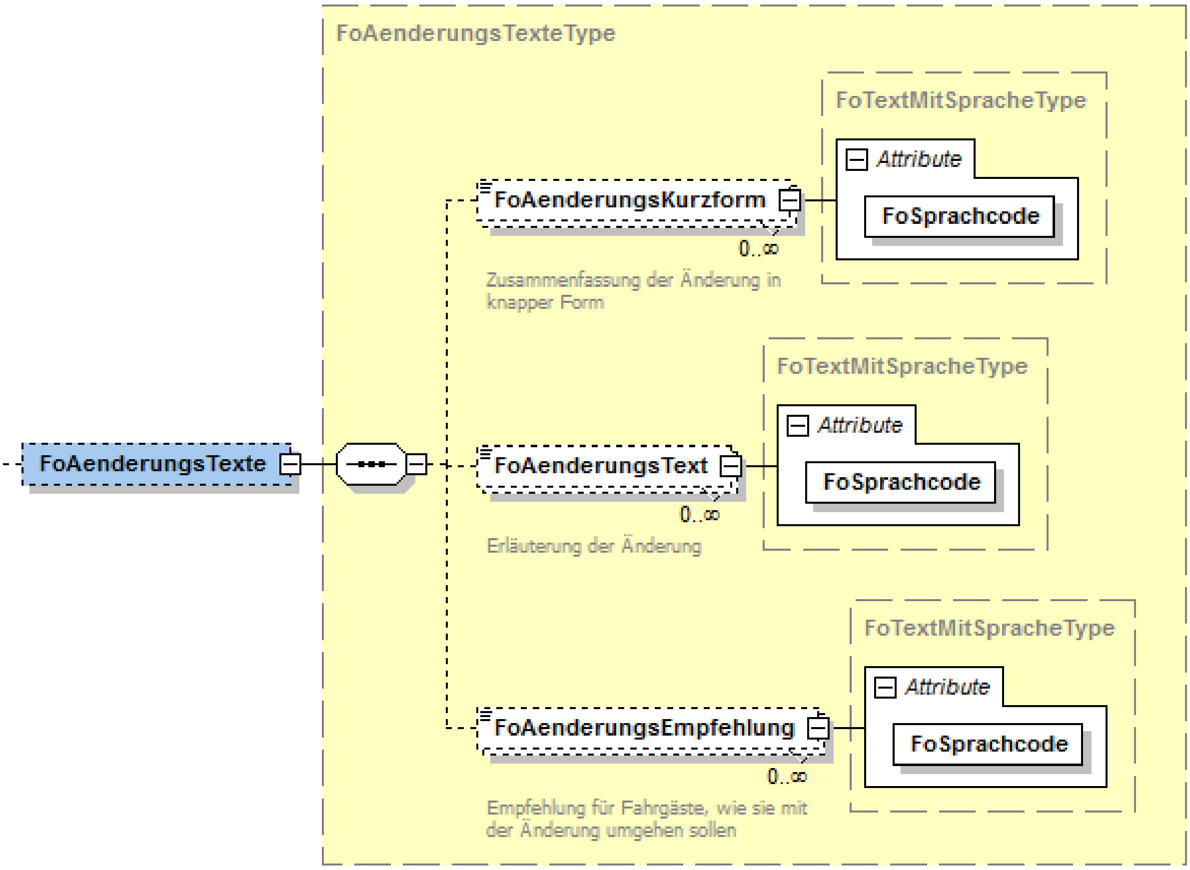


Abbildung 45 'FoChangeTexts'

Definition of *FoChangeTexts (FoAenderungsTexte)*	
FoChangeAbbreviation (FoAenderungsKurzform):	(optional, multiple) summary of the change information for publication in abbreviated format with specification of language ('FoLanguageCode').
FoChangeText (FoAenderungsText):	(optional, multiple) description of the change for publication with specification of language ('FoLanguageCode').
FoChangeSuggestion (FoAenderungsEmpfehlung):	(optional, multiple) information regarding suggestions for the passengers on how to deal with the changes. Specification of the corresponding language ('FoLanguageCode').

FoLanguageCode (FoSprachcode): [VL] (see 10.3 *)*

The 'FoChangeAbbreviation' (FoAenderungsKurzform), 'FoChangeText' (FoAenderungsText) and 'FoChangeSuggestion' (FoAenderungsEmpfehlung) sub-elements can be used in different languages (e.g. 'de', 'fr', 'en', ...) by specifying the internationally recognised language code according to **ISO 639-1**.

5.2.2.5.3 Description of statuses (FoStatus (FoZustand))

The 'FoStatus' (FoZustand) element is used to transmit the status of specific formation elements (e.g. for vehicles or vehicle equipments).

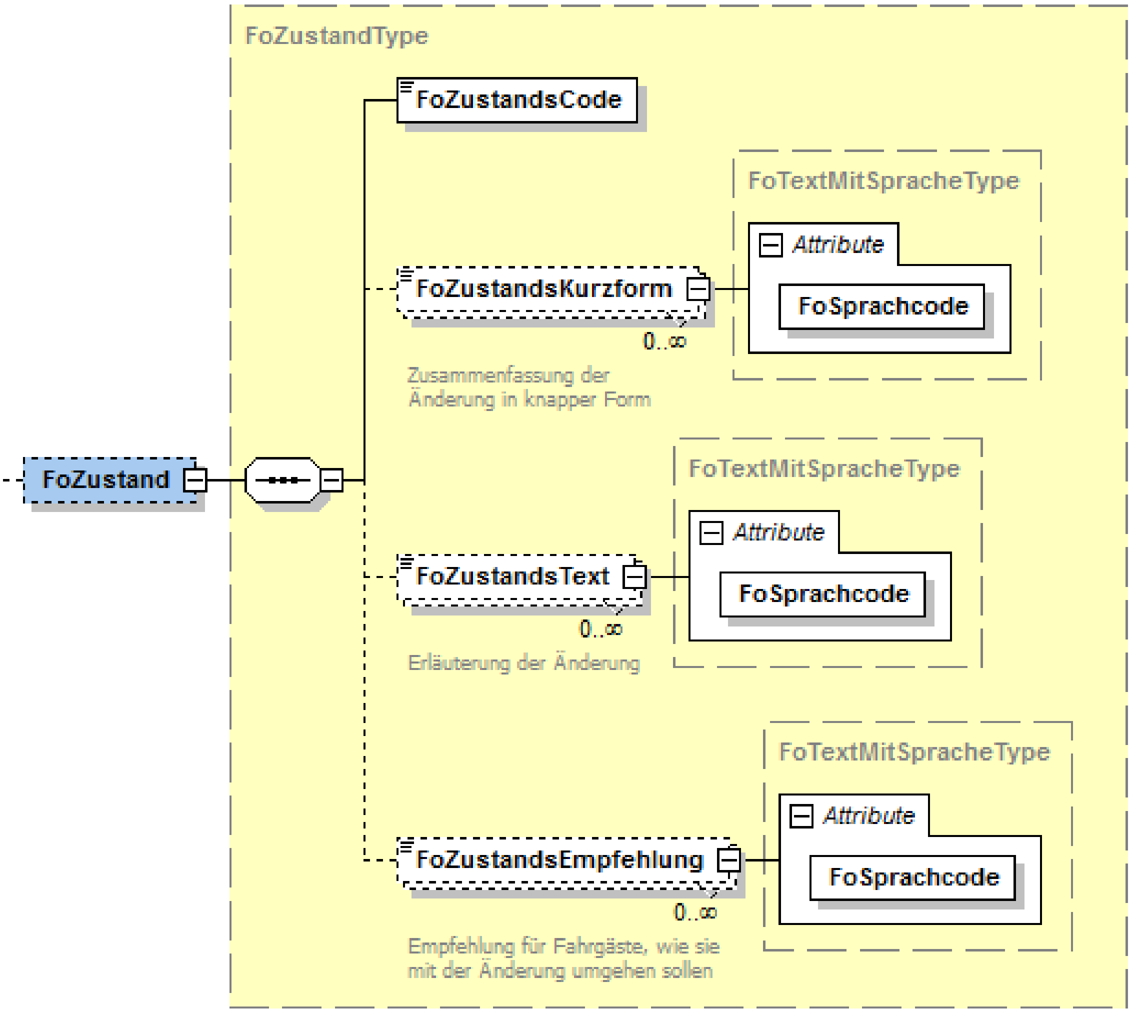


Figure 46 The 'FoStatus' element

Definition of *FoStatus (FoZustand)*	
FoStatusCode (FoZustandsCode): *[VL] (see Chapter 10.6)*	A status code must be specified for the transmission and identification of a status (e.g. 'closed', 'open, etc., ...).
FoStatusAbbreviation (FoZustandsKurzform):	(optional, multiple) summary of the status information for publication in abbreviated format with specification of language ('FoLanguageCode')
FoStatusText (FoZustandsText):	(optional, multiple) description of the status for publication with specification of language ('FoLanguageCode')
FoStatusSuggestion (FoZustandsEmpfehlung):	(optional, multiple) published advice for the passengers on how to deal with the relevant statuses, with specification of language ('FoLanguageCode')

FoLanguageCode (FoSprachcode): [VL] (see Chapter 10.3)

The 'FoStatusAbbreviation' (FoZustandsKurzform), 'FoStatusText' (FoZustandsText) and 'FoStatusSuggestion' (FoZustandsEmpfehlung) sub-elements can be used in different languages by specifying the internationally recognised language code (e.g. de, fr, en, ...) according to **ISO 639-1**.

5.2.2.5.4 Description of the structural entry points for extensions (FoExtension)

The 'FoExtension' (FoErweiterung) element can be used to convey additional project-specific information about a vehicle at the current stop.

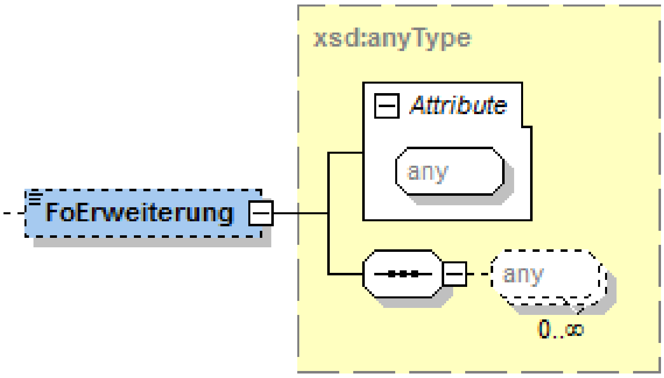


Figure 47 The 'FoExtension' element

Aspects of barrier-free access to a vehicle are particularly useful here.

This element can be used on a temporary basis until a corresponding structure is worked out by VDV for the purpose of 'barrier-free access'.

The 'anyType' data type is used in the XML schema so that the interface partners are free to use their own data structures without affecting the validity of the XML schema during validation.

5.2.2.6 Additional information (CongestionInfo)

The CongestionInfo (Stoerungsinfo) structure offers various possibilities for transferring additional information, e.g. concerning the cause of an error.

This information can be transmitted in the form of free texts as well as coded information, which can then be further processed automatically.

Definition of CongestionInfo (StoerungsInfo)

Reason:	(optional) Explains the reason for the deviation from schedule, e.g. vehicle waiting for a connection.
TpegReasonGroup (TpegReasonGroup):	(optional) facilitates the classification of the cause of error in accordance with the TPEG standards, see also SIRI Situation Exchange Service.
SituationBaseIdentityGroup (SituationBaseIdentityGroup):	(optional) references a situation in the SIRI SX service.

TpegReasonGroup and SituationBaseIdentityGroup are elements, which are specified in the SIRI Situation Exchange Service or which make reference to a message of the SIRI Situation Exchange Service.

Note: This structure is only included in the 'with SIRI' version of the XML schema definition.

5.2.2.7 Prediction quality (RealArrivalPredictionQuality and RealDeparturePrediction-Quality: (TimeQuality*)*

Definition of TimeQuality (ZeitQualitaet)

PredictionReliability (PrognoseVerlaesslichkeit):	Data type *PredictionReliabilityType (VerlaesslichkeitType)*, values 1 to 5 (see 9).
LowerTimeLimit (ZeitMin):	(optional) starting point of the time frame in which the prediction can lie.
HigherTimeLimit (ZeitMax):	(optional) end point of the time frame in which the prediction can lie.

5.2.2.8 Reference to the originally planned trip (TripRelationship)

The structure *TripRelationship (FahrtBeziehung)* is used to reference other trips which are related to this trip.

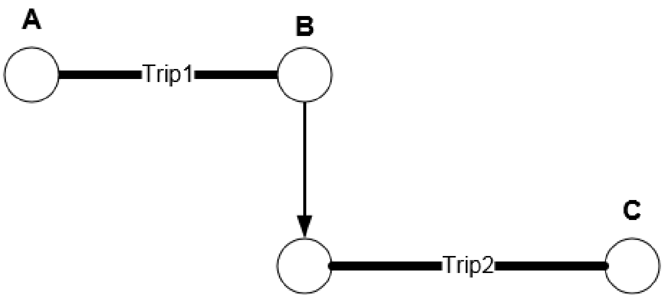
Definition of *TripRelationship (FahrtBeziehung)*

RelationshipType (BeziehungsTyp):	• **'ContinuationOfTrip' (FortfuehrungVonFahrt):** This trip trip continues the trip from RelationshipToTrip (BeziehungZuFahrt) at the stop (under RouteReference (StreckenBezug)). Passengers do not need to change. The new trip is not communicated as a transfer. • **'ContinuationByTrip' (FortfuehrungDurchFahrt):** This trip trip is continued by the trip from RelationshipToTrip (BeziehungZuFahrt) at the stop (under RouteReference (StreckenBezug)). Passengers do not need to change. The new trip is not communicated as a transfer. • **'SeparationOfTripIn' (TrennungVonFahrtIn):** This trip is continued as separated formations by the trips in RelationshipToTrip (BeziehungZuFahrt) at the RouteReference (StreckenBezug) (stop). • **'ContinuationOfSeparatedTrip' (FortfuehrungVonGetrennterFahrt):** This trip continues the separated trip in RelationshipToTrip (BeziehungZuFahrt) at the RouteReference (StreckenBezug) (stop). A relationship to other separated trips is not possible. • **'JoinOfTrip' (ZusammenfuehrungVonFahrt):** This trip is continued as separated formations by the trips in RelationshipToTrip (BeziehungZuFahrt) at the RouteReference (StreckenBezug) (stop). • **'ContinuationByJoinedTrip' (FortfuehrungDurchZusammengefuehrteFahrt):** This trip is continued by the joined trip in RelationshipToTrip (BeziehungZuFahrt) at the RouteReference (StreckenBezug) (stop). A relationship to a different trip which is joined is not possible. • **'ReplacementOfTrip' (ErsatzVonFahrt):** This RealTrip (IstFahrt) replaces a cancelled means of transport in part or in full. • **'ReplacementByTrip' (ErsatzDurchFahrt):** This cancelled RealTrip (IstFahrt) is replaced in part or in full by a different means of transport. • **'ReliefOfTrip' (EntlastungVonFahrt):** This RealTrip (IstFahrt) relieves means of transport in part or in whole. • **'ReliefByTrip' (EntlastungDurchFahrt):** This RealTrip (IstFahrt) is relieved in part or in full by a different means of transport. The individual types are explained in Chapter 5.2.2.8.1 .
RouteReference (StreckenBezug):	(Sub-element) The trip relationship (incl. relationship type) refers to this section or stop (see Chapter 5.2.2.8.2).
RelationshipToTrip (BeziehungZuFahrt):	(Sub-element, multiple) This element references a different trip (incl. TripSection (FahrtAbschnitt) or stop) which is related to this trip (see Chapters 5.2.2.8.1 and 5.2.2.8.3).

5.2.2.8.1 Relationships between trips (RelationshipTypes)

The following relationships or RelationshipTypes (BeziehungsTypen) (directional relationships) are generally differentiated:

Relationship	Description
Continuation	A means of transport continues it trip under a new code after a specific stop. Passengers do <u>not</u> need to change. The directional RelationshipTypes (BeziehungsTypen) for the continuation are: • 'ContinuationOfTrip' (FortfuehrungVonFahrt): This trip trip continues the trip from RelationshipToTrip (BeziehungZuFahrt) at the stop (under RouteReference (StreckenBezug)). • 'ContinuationByTrip' (FortfuehrungDurchFahrt): This trip trip is continued by the trip from RelationshipToTrip (BeziehungZuFahrt) at the stop (under RouteReference (StreckenBezug)). Example:

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      <BeziehungzuFahrt>
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</FahrtBeziehung>

Trip2 (Fahrt2):
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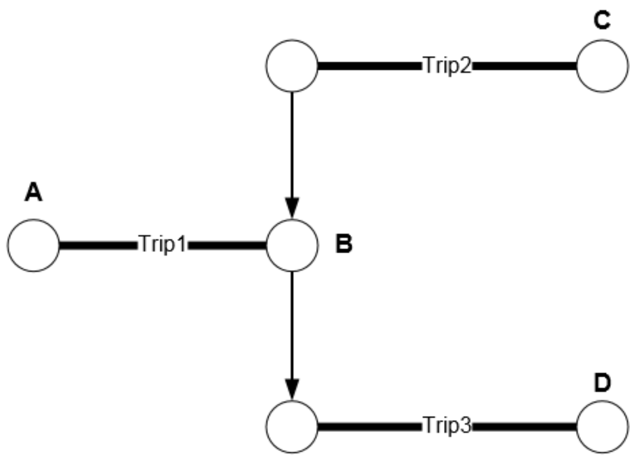
</FahrtBeziehung></td></tr>
<tr><td>Separation</td><td>The means of transport is separated at the indicated stop (generally the end depot point). The IDs of the follow-on trips with the stop in the RouteReference are in RelationshipToTrip (BeziehungZuFahrt).

The directional RelationshipTypes (BeziehungsTypen) for the continuation are:
• ‘SeparationOfTripIn’ (TrennungVonFahrtIn): This trip is continued as separated formations by the trips in RelationshipToTrip (BeziehungZuFahrt) at the RouteReference (StreckenBezug) (stop).
The back reference is ContinuationOfSeparatedTrip (FortfuehrungVonGetrennterFahrt) from the separated continuation of the trip to the exit trip.

Example:


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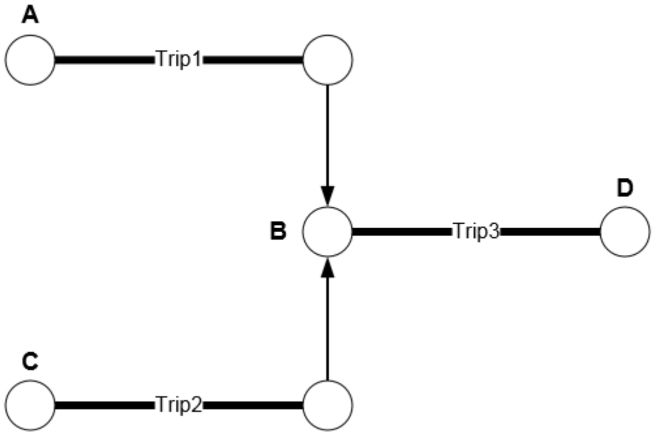
Joining	The means of transport is created by joining several other means of transport (listed in RelationshipToTrip (BeziehungZuFahrt)) at the indicated stop (generally at the start depot point). The directional RelationshipTypes (BeziehungsTypen) for the join are: • 'JoinOfTrip' (ZusammenfuehrungVonFahrt): This trip is continued with joined formations by the trips in RelationshipToTrip (BeziehungZuFahrt) at the RouteReference (StreckenBezug) (stop). The back reference is ContinuationByJoinedTrip (Fortfuehrung-DurchZusammengefuehrteFahrt) from the initial trip to the joined trip. Example:  Trip3 (Fahrt3): <FahrtBeziehung> <BeziehungsTyp>ZusammenfuehrungVonFahrt</BeziehungsTyp> <StreckenBezug> <Halt> <HaltID>B</Halt> <Abfahrtszeit>13:05</Abfahrtszeit> </Halt> </StreckenBezug> <BeziehungzuFahrt> <FahrtRef> <FahrtID> <FahrtBezeichner>Fahrt1</FahrtBezeichner>

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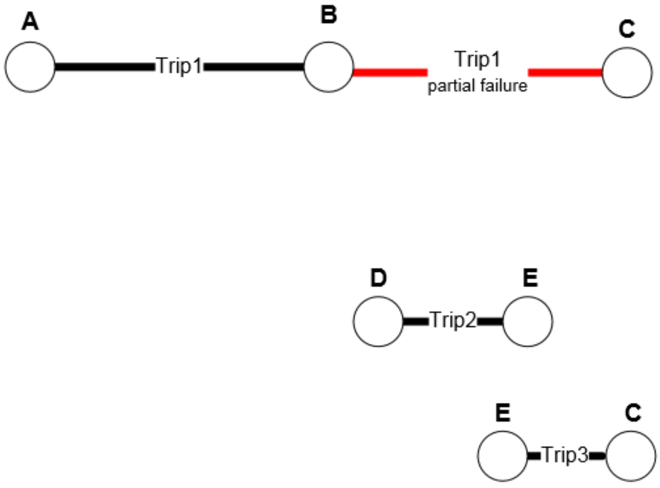
Replacement	The transmitted trip replaces a cancelled means of transport or is replaced by a different means of transport. The directional RelationshipTypes (BeziehungsTypen) for a replacement are: • 'ReplacementOfTrip' (ErsatzVonFahrt): This RealTrip (IstFahrt) replaces a cancelled means of transport. • 'ReplacementByTrip' (ErsatzDurchFahrt): This cancelled RealTrip (IstFahrt) is replaced by a different means of transport. Example:  Trip1 (Fahrt1) (Shortening of Trip1 (Fahrt1) from A to B is not modelled): <FahrtBeziehung> <BeziehungsTyp>ErsatztDurchFahrt</BeziehungsTyp> <StreckenBezug> <FahrtAbschnitt> <StartHaltID>B</StartHaltID> <StartZeit>13:00</StartZeit> <EndHaltID>C</EndHaltID> <EndZeit>13:10</EndZeit> </FahrtAbschnitt> </StreckenBezug> <BeziehungzuFahrt> <FahrtRef> <FahrtID>

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    <BeziehungzuFahrt>
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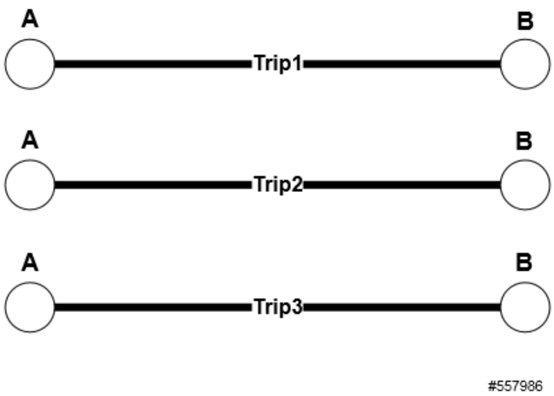
                <Betriebstag>01.01.2000</Betriebstag>
            </FahrtID>
            <FahrtStartEnde>
                <StartHaltID>A</StartHaltID>
                <StartZeit>12:40</StartZeit>
                <EndHaltID>C</EndHaltID>
                <EndZeit>13:10</EndZeit>
            </FahrtStartEnde>
        </FahrtRef>
        <StreckenBezug>
            <FahrtAbschnitt>
                <StartHaltID>B</StartHaltID>
                <StartZeit>13:00</StartZeit>
                <EndHaltID>C</EndHaltID>
                <EndZeit>13:10</EndZeit>
            </FahrtAbschnitt>
        </StreckenBezug>
```

	</BeziehungzuFahrt> </FahrtBeziehung> Trip3 (Fahrt3): <FahrtBeziehung> <BeziehungsTyp>ErsatztVonFahrt</BeziehungsTyp> <StreckenBezug> <FahrtAbschnitt> <StartHaltID>E</StartHaltID> <StartZeit>13:13</StartZeit> <EndHaltID>C</EndHaltID> <EndZeit>13:20</EndZeit> </FahrtAbschnitt> </StreckenBezug> <BeziehungzuFahrt> <FahrtRef> <FahrtID> <FahrtBezeichner>Fahrt1</FahrtBezeichner> <Betriebstag>01.01.2000</Betriebstag> </FahrtID> <FahrtStartEnde> <StartHaltID>A</StartHaltID> <StartZeit>12:40</StartZeit> <EndHaltID>C</EndHaltID> <EndZeit>13:10</EndZeit> </FahrtStartEnde> </FahrtRef> <StreckenBezug> <FahrtAbschnitt> <StartHaltID>B</StartHaltID> <StartZeit>13:00</StartZeit> <EndHaltID>C</EndHaltID> <EndZeit>13:10</EndZeit> </FahrtAbschnitt > </StreckenBezug> </BeziehungzuFahrt> </FahrtBeziehung>
Relief	A trip is relieved by a different trip. The directional RelationshipTypes (BeziehungsTypen) for the relief are: • 'ReliefOfTrip' (EntlastungVonFahrt): This RealTrip (IstFahrt) relieves a means of transport. • 'ReliefByTrip' (EntlastungDurchFahrt): This RealTrip (IstFahrt) is relieved by a different means of transport. Example:  Trip1 (Fahrt1): <FahrtBeziehung> <BeziehungsTyp>EntlastungDurchFahrt</BeziehungsTyp> <StreckenBezug> <FahrtAbschnitt>

```
                <StartHaltID>A</StartHaltID>
                <StartZeit>13:00</StartZeit>
                <EndHaltID>B</EndHaltID>
                <EndZeit>13:10</EndZeit>
            </FahrtAbschnitt >
    </StreckenBezug>
    <BeziehungzuFahrt>
        <FahrtRef>
            <FahrtID>
                <FahrtBezeichner>Fahrt2</FahrtBezeichner>
                <Betriebstag>01.01.2000</Betriebstag>
            </FahrtID>
            <FahrtStartEnde>
                <StartHaltID>A</StartHaltID>
                <StartZeit>13:04</StartZeit>
                <EndHaltID>B</EndHaltID>
                <EndZeit>13:20</EndZeit>
            </FahrtStartEnde>
        </FahrtRef>
        <StreckenBezug>
            <FahrtAbschnitt>
                <StartHaltID>A</StartHaltID>
                <StartZeit>13:04</StartZeit>
                <EndHaltID>B</EndHaltID>
                <EndZeit>13:20</EndZeit>
            </FahrtAbschnitt >
        </StreckenBezug>
    </BeziehungzuFahrt>
    <BeziehungzuFahrt>
        <FahrtRef>
            <FahrtID>
                <FahrtBezeichner>Fahrt3</FahrtBezeichner>
                <Betriebstag>01.01.2000</Betriebstag>
            </FahrtID>
            <FahrtStartEnde>
                <StartHaltID>A</StartHaltID>
                <StartZeit>13:08</StartZeit>
                <EndHaltID>B</EndHaltID>
                <EndZeit>13:25</EndZeit>
            </FahrtStartEnde>
        </FahrtRef>
        <StreckenBezug>
            <FahrtAbschnitt>
                <StartHaltID>A</StartHaltID>
                <StartZeit>13:08</StartZeit>
                <EndHaltID>B</EndHaltID>
                <EndZeit>13:25</EndZeit>
            </FahrtAbschnitt >
        </StreckenBezug>
    </BeziehungzuFahrt>
</FahrtBeziehung>

Trip2 (Fahrt2):
<FahrtBeziehung>
    <BeziehungsTyp>EntlastungVonFahrt</BeziehungsTyp>
    <StreckenBezug>
            <FahrtAbschnitt>
                <StartHaltID>A</StartHaltID>
                <StartZeit>13:04</StartZeit>
                <EndHaltID>B</EndHaltID>
                <EndZeit>13:20</EndZeit>
            </FahrtAbschnitt >
    </StreckenBezug>
    <BeziehungzuFahrt>
        <FahrtRef>
            <FahrtID>
                <FahrtBezeichner>Fahrt1</FahrtBezeichner>
                <Betriebstag>01.01.2000</Betriebstag>
            </FahrtID>
            <FahrtStartEnde>
                <StartHaltID>A</StartHaltID>
                <StartZeit>13:00</StartZeit>
                <EndHaltID>B</EndHaltID>
                <EndZeit>13:10</EndZeit>
            </FahrtStartEnde>
```

	</FahrtRef> <StreckenBezug> <FahrtAbschnitt> <StartHaltID>A</StartHaltID> <StartZeit>13:00</StartZeit> <EndHaltID>B</EndHaltID> <EndZeit>13:10</EndZeit> </FahrtAbschnitt > </StreckenBezug> </BeziehungzuFahrt> </FahrtBeziehung> Trip3 (Fahrt3): <FahrtBeziehung> <BeziehungsTyp>EntlastungVonFahrt</BeziehungsTyp> <StreckenBezug> <FahrtAbschnitt> <StartHaltID>A</StartHaltID> <StartZeit>13:08</StartZeit> <EndHaltID>B</EndHaltID> <EndZeit>13:25</EndZeit> </FahrtAbschnitt > </StreckenBezug> <BeziehungzuFahrt> <FahrtRef> <FahrtID> <FahrtBezeichner>Fahrt1</FahrtBezeichner> <Betriebstag>01.01.2000</Betriebstag> </FahrtID> <FahrtStartEnde> <StartHaltID>A</StartHaltID> <StartZeit>13:00</StartZeit> <EndHaltID>B</EndHaltID> <EndZeit>13:10</EndZeit> </FahrtStartEnde> </FahrtRef> <StreckenBezug> <FahrtAbschnitt> <StartHaltID>A</StartHaltID> <StartZeit>13:00</StartZeit> <EndHaltID>B</EndHaltID> <EndZeit>13:10</EndZeit> </FahrtAbschnitt > </StreckenBezug> </BeziehungzuFahrt> </FahrtBeziehung> •

5.2.2.8.2 Relationship to a route (RouteReference)

Definition of *RouteReference (StreckenBezug)*

Stop (Halt):	(sub-element) The trip relationship references this stop (see Relationship to a stop 5.2.2.8.2.1).
TripSection (FahrtAbschnitt):	(Sub-element) The trip relationship references this trip section (see TripStartEnd (FahrtStartEnde) in Chapter 5.2.2.2.1).
ControlCentreID:	(optional) code for the identification of the respective control centre in the case of an transfer relationship.

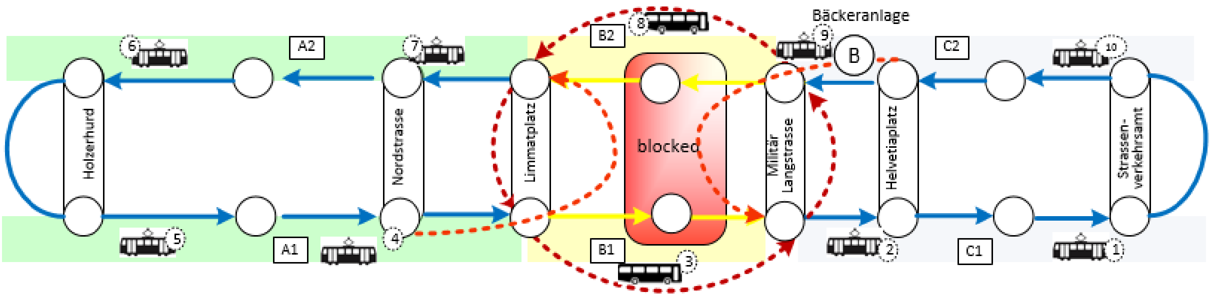
5.2.2.8.2.1 Relationship to a stop *(Stop (Halt))*

Definition of *Stop (Halt)*	
StopID (HaltID):	The StopID is used to match the AVLC stop with the stop in the timetable information system (see chapter 3.3).
DepartureTime (Abfahrtszeit):	(optional) Planned departure time, omitted at the terminal stop.
ArrivalTime (Ankunftszeit):	(optional) can be omitted if identical to the departure time. Obligatory at the terminal stop.

5.2.2.8.3 Relationship to trip *(RelationshipToTrip)*

Definition of *RelationshipToTrip (BeziehungZuFahrt))*	
TripRef (FahrtRef):	(sub-element) Unique reference to the trip (see Chapter 5.3.2.1)
RouteReference (StreckenBezug):	(Sub-element) The trip relationship (incl. relationship type) refers to this section or stop (see Chapter 5.2.2.8.2).

5.2.2.8.4 Example of a route closure



#419350

The *TripRelationship (FahrtBeziehung)* structure can, for example, be used in the case of a route closure, where an originally planned trip is now separated into several trip sections executed by different vehicles. The additional CompleteTrips (KomplettFahrten) with a created TripRef (FahrtRef) are transmitted to the originally planned trip with a *TripRelationship (FahrtBeziehung)*. This enables the timetable information system to re-join these segments into the original trip. The reference corresponds to the TripRef (FahrtRef) which is used in REFSIS and in the shortened segment. The trip segments are now sent via VDV454 as follows:

<u>Trip A1 (Fahrt A1) (Shortening of Trip A1 (Fahrt A1) to HOLZ10 to LIMM10 is not modelled, TripStartEnd (FahrtStartEnde) remains unchanged for TripA1 (Fahrt A1)):</u>

```
<FahrtBeziehung>
    <BeziehungsTyp>ErsatztDurchFahrt</BeziehungsTyp>
    <StreckenBezug>
        <FahrtAbschnitt>
            <StartHaltID>LIMM10</StartHaltID>
            <StartZeit>13:00</StartZeit>
            <EndHaltID>STRV10</EndHaltID>
            <EndZeit>13:30</EndZeit>
        </FahrtAbschnitt>
    </StreckenBezug>
    <BeziehungzuFahrt>
```

```
            <FahrtRef>
                <FahrtID>
                    <FahrtBezeichner>B1</FahrtBezeichner>
                    <Betriebstag>01.01.2000</Betriebstag>
                </FahrtID>
                <FahrtStartEnde>
                        <StartHaltID>LIMM20</StartHaltID>
                        <StartZeit>13:15</StartZeit>
                        <EndHaltID>MILA20</EndHaltID>
                        <EndZeit>13:20</EndZeit>
                </FahrtStartEnde>
            </FahrtRef>
            <StreckenBezug>
                <FahrtAbschnitt>
                    <StartHaltID>LIMM20</StartHaltID>
                    <StartZeit>13:15</StartZeit>
                    <EndHaltID>MILA20</EndHaltID>
                    <EndZeit>13:20</EndZeit>
                </FahrtAbschnitt>
            </StreckenBezug>
        </BeziehungzuFahrt>
        <BeziehungzuFahrt>
            <FahrtRef>
                <FahrtID>
                    <FahrtBezeichner>C1</FahrtBezeichner>
                    <Betriebstag>01.01.2000</Betriebstag>
                </FahrtID>
                <FahrtStartEnde>
                        <StartHaltID>MILA10</StartHaltID>
                        <StartZeit>13:25</StartZeit>
                        <EndHaltID>STRV10</EndHaltID>
                        <EndZeit>13:40</EndZeit>
                </FahrtStartEnde>
            </FahrtRef>
            <StreckenBezug>
                <FahrtAbschnitt>
                    <StartHaltID>MILA10</StartHaltID>
                    <StartZeit>13:25</StartZeit>
                    <EndHaltID>STRV10</EndHaltID>
                    <EndZeit>13:40</EndZeit>
                </FahrtAbschnitt>
            </StreckenBezug>
        </BeziehungzuFahrt>
</FahrtBeziehung>
```

<u>Trip B1 (Fahrt B1) (Bus replacement B1 from LIMM20 to MILA20):</u>

```
<FahrtBeziehung>
    <BeziehungsTyp>ErsatztVonFahrt</BeziehungsTyp>
    <StreckenBezug>
        <FahrtAbschnitt>
            <StartHaltID>LIMM10</StartHaltID>
            <StartZeit>13:15</StartZeit>
            <EndHaltID>MILA10</EndHaltID>
            <EndZeit>13:20</EndZeit>
        </FahrtAbschnitt>
    </StreckenBezug>
    <BeziehungzuFahrt>
        <FahrtRef>
            <FahrtID>
                <FahrtBezeichner>A1</FahrtBezeichner>
                <Betriebstag>01.01.2000</Betriebstag>
            </FahrtID>
            <FahrtStartEnde>
                    <StartHaltID>HOLZ10</StartHaltID>
                    <StartZeit>12:40</StartZeit>
                    <EndHaltID>STRV10</EndHaltID>
                    <EndZeit>13:30</EndZeit>
            </FahrtStartEnde>
        </FahrtRef>
        <StreckenBezug>
            <FahrtAbschnitt>
                <StartHaltID>LIMM10</StartHaltID>
                <StartZeit>13:00</StartZeit>
                <EndHaltID>STRV10</EndHaltID>
                <EndZeit>13:30</EndZeit>
            </FahrtAbschnitt>
```

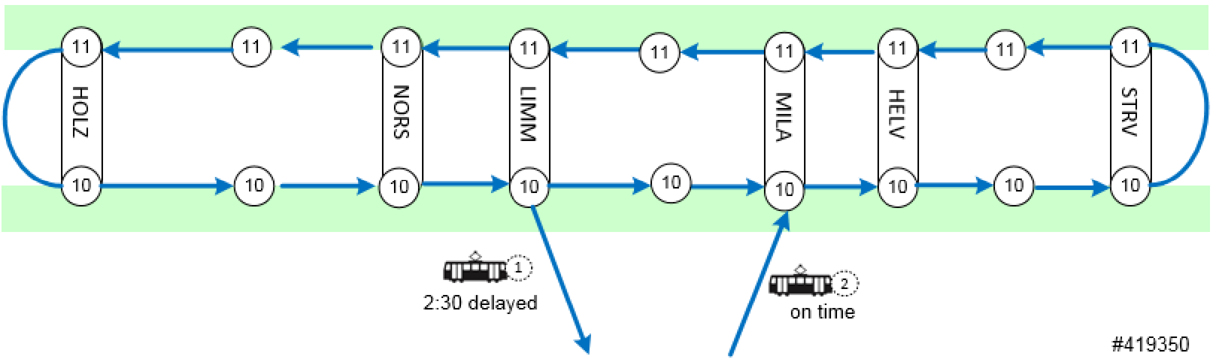
```
        </StreckenBezug>
    </BeziehungzuFahrt>
</FahrtBeziehung>
```

<u>Trip C1 (Fahrt C1) (tram replacement C1 from MILA10 to STRV10):</u>

```
<FahrtBeziehung>
    <BeziehungsTyp>ErsatztVonFahrt</BeziehungsTyp>
    <StreckenBezug>
        <FahrtAbschnitt>
            <StartHaltID>MILA10</StartHaltID>
            <StartZeit>13:25</ StartZeit >
            <EndHaltID>STRV10</EndHaltID>
            <EndZeit>13:40</ EndZeit >
        </FahrtAbschnitt>
    </StreckenBezug>
    <BeziehungzuFahrt>
        <FahrtRef>
            <FahrtID>
                <FahrtBezeichner>A1</FahrtBezeichner>
                <Betriebstag>01.01.2000</Betriebstag>
            </FahrtID>
            <FahrtStartEnde>
                <StartHaltID>HOLZ10</StartHaltID>
                <StartZeit>12:40</StartZeit>
                <EndHaltID>STRV10</EndHaltID>
                <EndZeit>13:30</EndZeit>
            </FahrtStartEnde>
        </FahrtRef>
        <StreckenBezug>
            <FahrtAbschnitt>
                <StartHaltID>MILA10</StartHaltID>
                <StartZeit>13:00</StartZeit>
                <EndHaltID>STRV10</EndHaltID>
                <EndZeit>13:30</EndZeit>
            </FahrtAbschnitt>
        </StreckenBezug>
    </BeziehungzuFahrt>
</FahrtBeziehung>
```

The timetable information system can use *Relationship (Beziehung)* and its own interchange relationships to detect that the passengers which arrive at LIMM10 should be directed to LIMM20 for the journey continuation to MILA20, where they can be directed to MILA10 for the journey continuation to STRV10.

5.2.2.8.5 Example of a vehicle replacement



The trip segments are now transmitted via VDV454 as follows:

<u>Trip A1 (Fahrt A1) (Shortening of Trip A1 (Fahrt A1) to HOLZ10 to LIMM10 is not modelled, TripStartEnd (FahrtStartEnde) remains unchanged for TripA1 (Fahrt A1)):</u>

```
<FahrtBeziehung>
    <BeziehungsTyp>ErsatztDurchFahrt</BeziehungsTyp>
    <StreckenBezug>
        <FahrtAbschnitt>
```

```
                <StartHaltID>LIMM10</StartHaltID>
                <StartZeit>13:00</ StartZeit >
                <EndHaltID>STRV10</EndHaltID>
                <EndZeit>13:30</ EndZeit >
            </FahrtAbschnitt>
    </StreckenBezug>
    <BeziehungzuFahrt>
        <FahrtRef>
            <FahrtID>
                <FahrtBezeichner>B1</FahrtBezeichner>
                <Betriebstag>01.01.2000</Betriebstag>
            </FahrtID>
            <FahrtStartEnde>
                <StartHaltID>MILA10</StartHaltID>
                <StartZeit>13:10</ StartZeit >
                <EndHaltID>STRV10</EndHaltID>
                <EndZeit>13:30</ EndZeit >
            </FahrtStartEnde>
        </FahrtRef>
        <StreckenBezug>
            <FahrtAbschnitt>
                <StartHaltID>MILA10</StartHaltID>
                <StartZeit>13:10</ StartZeit >
                <EndHaltID>STRV10</EndHaltID>
                <EndZeit>13:30</ EndZeit >
            </FahrtAbschnitt>
        </StreckenBezug>
    </BeziehungzuFahrt>
</FahrtBeziehung>
```

<u>Trip B1 (Fahrt B1) (Tram replacement B1 from MILA10 to STRV10):</u>

```
<FahrtBeziehung>
    <BeziehungsTyp>ErsatztVonFahrt</BeziehungsTyp>
    <StreckenBezug>
        <FahrtAbschnitt>
            <StartHaltID>MILA10</StartHaltID>
            <StartZeit>13:10</StartZeit>
            <EndHaltID>STRV10</EndHaltID>
            <EndZeit>13:30</EndZeit>
        </FahrtAbschnitt>
    </StreckenBezug>
    <BeziehungzuFahrt>
        <FahrtRef>
            <FahrtID>
                <FahrtBezeichner>A1</FahrtBezeichner>
                <Betriebstag>01.01.2000</Betriebstag>
            </FahrtID>
            <FahrtStartEnde>
                <StartHaltID>HOLZ10</StartHaltID>
                <StartZeit>12:40</StartZeit>
                <EndHaltID>STRV10</EndHaltID>
                <EndZeit>13:30</EndZeit>
            </FahrtStartEnde>
        </FahrtRef>
        <StreckenBezug>
            <FahrtAbschnitt>
                <StartHaltID>LIMM10</StartHaltID>
                <StartZeit>13:00</StartZeit>
                <EndHaltID>STRV10</EndHaltID>
                <EndZeit>13:30</EndZeit>
            </FahrtAbschnitt>
        </StreckenBezug>
    </BeziehungzuFahrt>
</FahrtBeziehung>
```

After vehicle 1 signs off, the created TripRef (FahrtRef) is retained for the trip already started by vehicle 2 so that the measured times can be retained for both partial trips. The route from LIMM10 to MILA10 is not replaced.

5.2.3 Block-based real-time data transmission (RealBlock)

As an alternative to the transmission of trip related information, real-time block-related information can also be transmitted with the SISMessage (AUSNachricht) element. The RealBlock (IstUmlauf) element is based on the RealBlockTrip (IstUmlaufFahrt) element, which contains the RealTrip (IstFahrt) and associated LineID (LinienID).

Definition of RealBlock (IstUmlauf)	
BlockID (UmlaufID):	BlockID (UmlaufID) is used to identify the block.
RealTrip (IstFahrt):	(alternative, multiple) Structure with details on the trip.
RealBlockTrip (IstUmlaufFahrt):	(structure, alternative, multiple) the RealBlockTrip uniquely identifies the trips within a block on the basis of the seasonal timetable.

5.2.3.1 RealBlock - individual trip (RealBlockTrip)

A RealBlock can comprise several individual RealBlockTrips (IstUmlaufFahrt).

Definition of RealBlockTrip (IstUmlaufFahrt)	
LineID (LinienID):	The LineID (LinienID) is used to match the AVLC route with the route of the long-term (seasonal) timetable known within the timetable information system.
RealTrip (IstFahrt):	Structure with details on the trip

Implementation notes:

The RealTrip (IstFahrt) element in RealBlock (IstUmlauf) is retained for reasons of compatibility, however only RealBlockTrip (IstUmlaufFahrt) should be used for new implementations.

As with the trip related transfer of information more then one RealBlock (IstUmlauf) element can be embedded in SISMessage (AUSNachricht).

5.3 Protected transfer relationships

5.3.1 Transferring connection data (ProtectedConnection)

If both planning and real-time data is to be transmitted for the transfer relationships, this is achieved with the ProtectedConnection (GesAnschluss) structure. This structure either transmits the planning data (ConnectionPlan) or the real-time data (ConnectionStatus) for a transfer relationship.

Definition of ProtectedConnection (GesAnschluss)

ConnectionPlan (AnschlussPlan):	(optional, alternative) Structure with the planning data of a transfer relationship to be protected.
ConnectionStatus (AnschlussStatus):	(optional, alternative) Structure with the real-time data of a previously planned transfer relationship to be protected.

5.3.2 Planning data of a transfer relationship (ConnectionPlan)

The ConnectionPlan (AnschlussPlan) element is used to transmit the information for a planned transfer relationship to be included in the transfer protection. This provides the timetable information system with advance information on which feeder-fetcher pairs are to be monitored by the transfer protection.

Definition of ConnectionPlan (AnschlussPlan)

ConnectionID (AnschlussID):	(attribute) The ConnectionID identifies the connection.
Feeder:	Structure that specifies the feeder trip of a transfer relationship.
StopIDFeeder (HaltIDZubringer):	Element that denotes the stopping point of the feeder in the connection area.
Fetcher (Abbringer):	Structure that specifies the fetcher trip of a transfer relationship.
StopIDFetcher (HaltIDAbbringer):	Element that denotes the stopping point of the fetcher in the connection area.
InterchangePathTime (Umsteigewegezeit):	(optional) Specifies the time normally required (in seconds) to get from the feeder stopping point to the fetcher stopping point.
MaxAutoDelay (MaxAutoVerzoegerung):	(optional) specifies the maximum delay (in seconds) that can be imposed automatically by the control system on the fetcher vehicle if the feeder is delayed. If this time period is exceeded a dispatcher decision becomes necessary.
Priority (Prioritaet):	(optional) this element can be used to classify the priority / importance of an individual transfer relationship. Value range: 1 to 3 where 1 is the highest value

5.3.2.1 Feeder and fetcher trip information (Feeder, Fetcher)

The feeder (Zubringer) and fetcher (Abbringer) elements use the TripIDGlobal (FahrtIDGlobal) element, which contains all information on the relevant trips inclusive of the ControlCentreID (LeitstellenID). This means it is also possible to uniquely identify the trips across several control systems.

Definition of TripIDGlobal (FahrtIDGlobal)

TripIDExt (FahrtIDExt):	Structure for the unique identification of the feeder or fetcher trip

LineID (LinienID):	(optional) Route identifier of the feeder or fetcher trip
ControlCentreID (Leit-stellenID):	(optional) code for the identification of the respective control centre in the case of an transfer relationship.

5.3.3 Status data of a transfer relationship (ConnectionStatus)

The ConnectionStatus (AnschlussStatus) structure is used to transmit the information concerning the current status of a previously planned transfer relationship designated for protection. This means that the planning data is updated in the timetable information system in advance.

Definition of ConnectionStatus (AnschlussStatus)	
ConnectionID (An-schlussID):	(attribute) The ConnectionID identifies the connection.
WaitInfo (WarteInfo):	Structure that provides information about the current status of the transfer relationship (NotWaiting or HoldBackUntil).
DepTimeFetcherProg (AbfahrtszeitAbbring-erPrognose):	(optional) Gives a prediction of the new departure time taking into consideration all feeders and interchange times.
ProtectionOff (Sicher-ungAufgehoben):	(optional) Indicates that a planned or an active transfer protection that has already begun, has been cancelled. It is not possible to make a statement about the success of a corresponding transfer relationship.

5.3.3.1 Information on holding back the fetcher vehicle (WaitInfo)

The WaitInfo structure specifies the status of the instructions to the fetcher vehicle. It is used to transmit the information concerning the current status of a previously planned transfer relationship designated for protection.

Definition of WaitInfo (WarteInfo)	
NotWaiting (Wartet-Nicht):	(optional, alternative) This element denotes that the fetcher has not received an instruction to wait beyond the scheduled departure time.
HoldBackUntil (ZurueckhaltungBis):	(optional, alternative) This denotes that the fetcher vehicle will wait for the arrival of the feeder up to a maximum defined by the given time. The *HoldBackUntil* element contains an optional *VehicleAcknowledgement (FahrzeugQuittung)* element, which indicates that the wait instruction has been acknowledged by the fetcher vehicle (see 6.2.5).

5.4 Transmitting formation information

Trips generally consist of several coupled vehicles or cars (especially in rail bound systems). This raises a number of issues that can be of interest to the passenger. The REF-SIS and SIS interface services comprise elements in order to be able to transmit the following information:

- Formations of a trip by combining individual vehicle groups. The vehicle groups can be separated or merged to form trip assemblies. These processes are called 'joining', 'splitting', 'coupling' or 'decoupling'. These vehicle assemblies sometimes have different terminal destination specifications and different 'traffic numbers' (e.g. in the case of run vehicles, see 5.2.2.4.3 ff).
- Individual vehicles (cars) have different technical properties and diverse equipment levels (see 5.2.2.4.1 f).
- The vehicles of a train pull up at a platform in different sectors. The platform sectors are often marked by the letters A to G. Passengers with seat reservations look for their car using the car allocation numbers in the respective platform sector. The car order may change at very short notice on occasion depending on the operational conditions (see chapter 5.2.2.4.8).
- In certain situations, a train only offers certain service characteristics in specific vehicles or on specific trip sections.
- Should changes occur in the above mentioned characteristics with regard to the planning status, the passengers should receive consistent information (possibly with recommendations, see 5.2.2.5.2).

Note: The transmission of formation data usually comes into play in connection with rail operators.

5.5 Transmitting trip assemblies (connecting trips)

TripAssembly elements describe how the individual trips are combined into grouped trips. The most common applications are train sections that separate or come together during the course of a journey. A TripAssembly element is a sub-element of SISMessage and can be used in both the REF-SIS and SIS services.

This section describes the combination of a vehicle (e.g. a train) at the trip level. Merging at the level of the individual vehicles (cars) is described in later sections of this document.

At the uppermost level, a trip assembly describes a combination of planned or actual trips that comprise several section-by-section trips. *A trip assembly typically models that which represents a traction unit trip in the sense of rail infrastructure operations. A train journey is typically denoted by a unique operational train number and a common train path.*

Definition of the TripAssembly (FahrtVerband)	
OperationalTrip-Number (BetrieblicheFahrtnummer):	(optional) operational trip number of the entire trip assembly.

TripAssemblySection (FahrtVerbandsAbschnitt):	(multiple) describes sections (from-stop, to-stop) on which a trip travels in connection with one or more other trips within a trip assembly.

A trip assembly section is defined as a path section of a trip assembly and contains all trips that travel this section together. A new TripAssemblySection (FahrtVerbandsAbschnitt) starts at every position in the sequence of the trip assembly, at which the composition of the trips changes.

Definition of TripAssemblySection (FahrtVerbandsAbschnitt)

TripSection (FahrtAbschnitt):	Structure to define the trip section ('from' stop including planned time, 'to' stop including planned time).
TripInSection (FahrtInAbschnitt):	(multiple, at least 2 elements) structure that references the respective trips in the assembly including the position of each trip within the group.

The TripInSection (FahrtInAbschnitt) structure is used to list the trips in a TripAssembly (on a section).

Definition of TripInSection (FahrtInAbschnitt)

TripID (FahrtId):	Structure for referencing a ScheduleTrip (SollFahrt) or RealTrip (IstFahrt).
Position (Position):	(optional) positive number to indicate the position of the trip in the composite on this section. Position 1 indicates the first position at the front of the trip assembly.

5.5.1 Examples of use

5.5.1.1 "Split operation

The following example illustrates this modelling with the example of 'coupled' operation. A three-part train assembly travels into Munich. The train assembly is split during the course of the trip (in the example at Holzkirchen and Schaftlach) so that each train section has a separate destination. This operating concept is typically used to offer passengers continuous connections - without having to change vehicles.

In the timetable planning (VDV452) as well as in REF-SIS and SIS, a separate trip is provided for each multiple unit. Each has its own trip code and a separate timetable, ensuring a simple method of representing the continuous journey possibility for the passengers. (From the point of view of the AVLC, separate passenger information as well as separate block planning can also be provided for each vehicle).

This modelling is represented in the lower section of the picture (often referred to as the traffic point of view) and primarily reflects the passenger point of view.

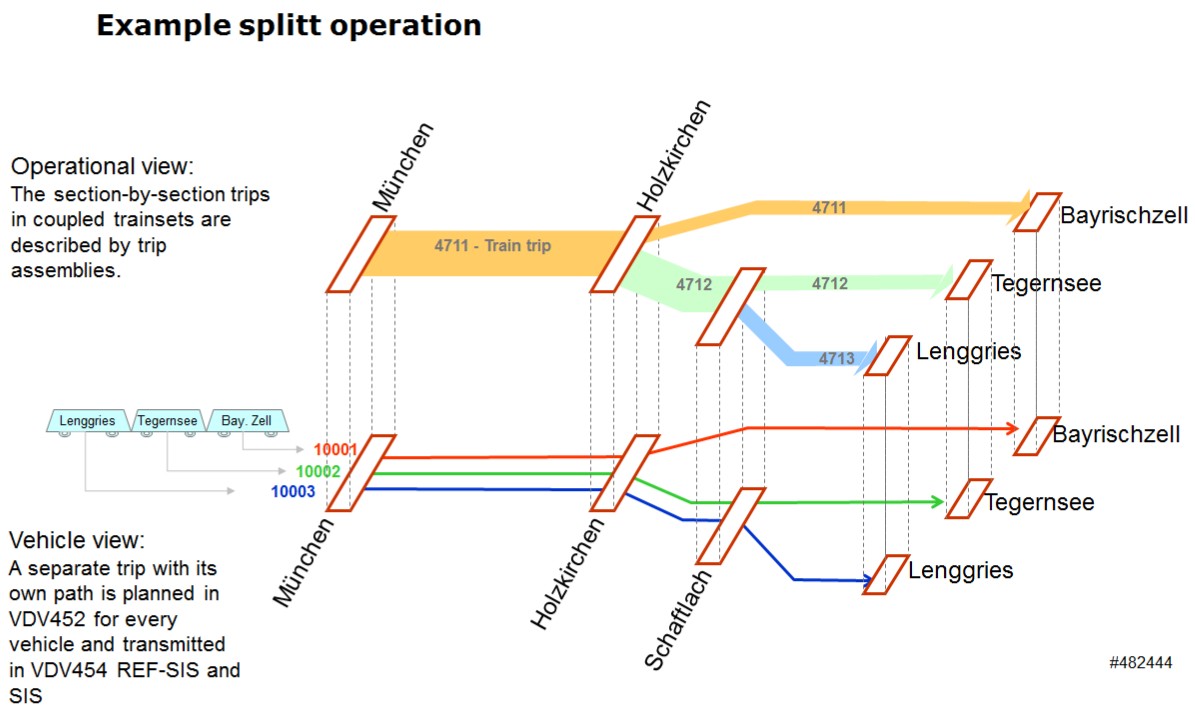


Figure 48 Example of coupled operation

The upper level of the picture describes the view of the trip assemblies - i.e. the units that travel together as a coupled train. This modelling typically reflects the view of the train infrastructure operator, for which a train represents a unit with a train number that is unique for a given operating day.

In this picture, the TripAssembly objects are denoted with a common colour.

5.5.1.2 TripAssembly, TripAssemblySection and TripInSection

In the following diagram, the same example is used to illustrate the relationship between the TripAssembly (FahrtVerband), TripAssemblySection (FahrtVerbandsAbschnitt) and TripInSection (FahrtInAbschnitt) for trip assembly 4711.

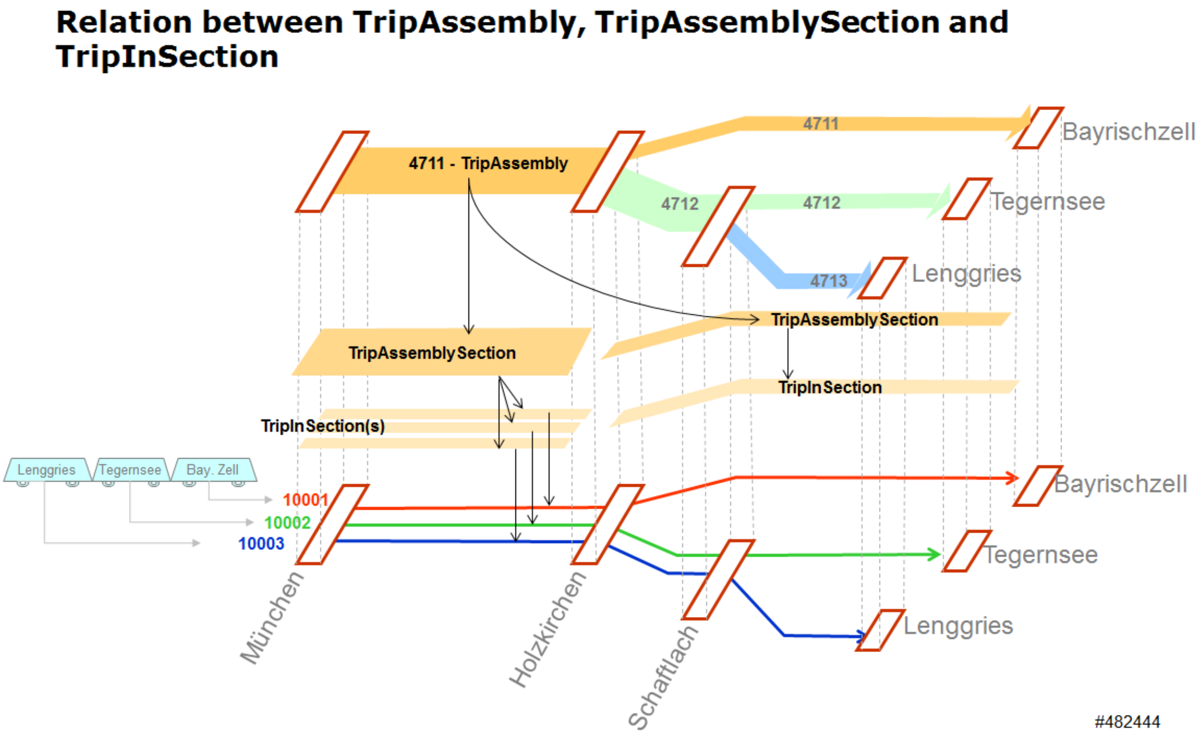


Figure 49 Relationship between TripAssembly (Fahrtverband), TripAssemblySection (FahrtVerbandsAbschnitt), TripInSection (FahrtInAbschnitt) and (Real) Trip ((Ist-)Fahrt)

This modelling can also be used to represent the splitting and joining of train trips. With this operating concept, additional cars are added to a train along sections with high passenger volumes. These additional vehicles do not cover the entire path of the associated train trip.

5.5.1.3 'Joining' and 'splitting'

The following picture illustrates modelling for an example with train splitting and joining

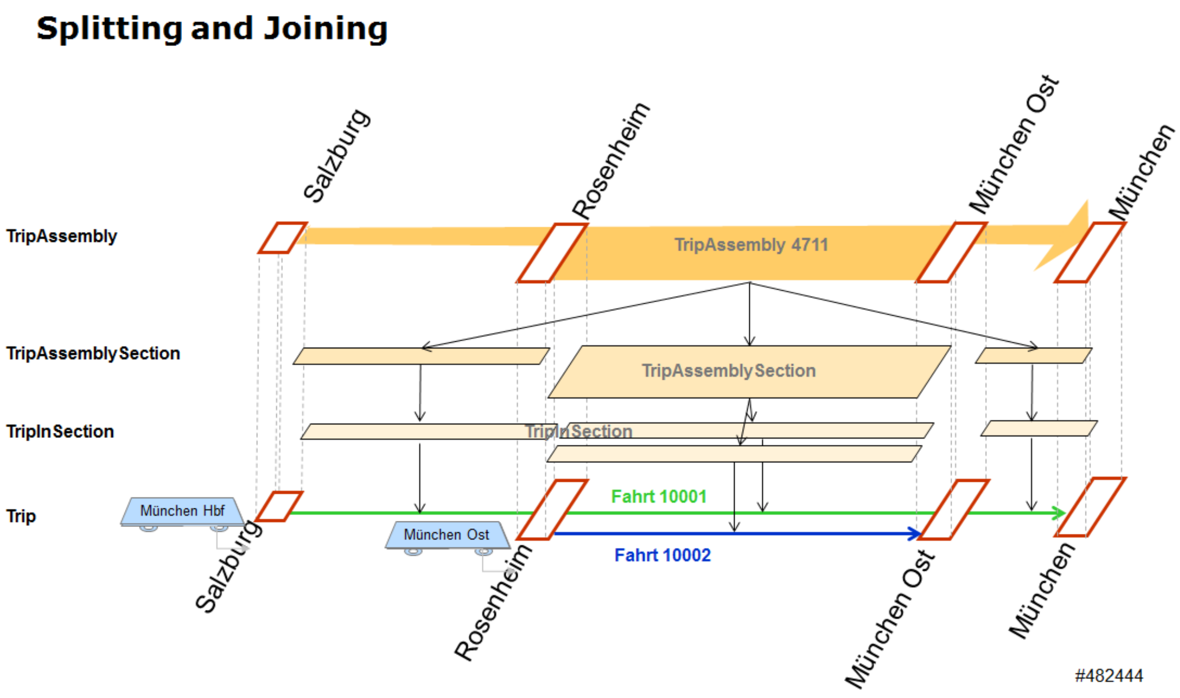


Figure 50 Trip assembly with splitting and joining

6 Handling the SIS real-time data service

6.1 Implementation notes and guidelines

Having dealt with the structure of the interfaces for the REF-SIS and SIS services in the previous chapter, this section covers important rules for their implementation and handling. Chapter 6.1.1 deals with the authority of the AVLC for establishing predictions. The exceptions are listed in the form of supplementary rules for the timetable information system in 6.1.2 .

The following sections then specify the time-based reporting behaviour for subscribed trips. This begins with the necessity of an active first message of all trips that fall within a prediction horizon (see 6.1.7). Then in chapter 6.1.8 we describe the regular reporting behaviour in accordance with the hysteresis functionality. The remaining chapters are concerned with special situations following a traffic jam or an unscheduled log-off.

After that the document outlines the handling of deleted and additional trips as well as the implementation for applications in the train field with different referencing.

6.1.1 Prediction ability of the AVLC

In accordance with the approach of this interface, the authority to predict arrival and departure times lies completely with the automatic vehicle location and control system (AVLC). This has access to all the latest operating data and dispatch actions. At the operational management level, local know-how is available ensuring higher quality predictions, which take into account a variety of influencing factors and which build on existing statistical material.

As a consequence, this means that the timetable information system – disregarding error checks and exceptions – is unable to independently correct the transmitted arrival and departure times. The specific ability of the timetable information system lies in the combination of knowledge. The timetable information system combines current individual trips to form complete connections with, under certain conditions, transfer times that are adapted to the current operational situation. With this comprehensive and up-to-date network knowledge, it is able to advise the passenger accordingly. This means that the timetable information system is interested in as much departure time and arrival time information as possible concerning pending mid-term trips (see 6.1.7).

Example: 'DelayPredictions'

The following example indicates the transmission of a delay prediction of a vehicle of route 10 corresponding to the example in 5.1.3.5 . The vehicle leaves the start stop with a delay and is located between the first and second stop with a delay of 2 minutes. On the basis of the long running time between stops 2 and 3, the prediction algorithm of the AVLC detects the potential to make up one minute. The prediction profile is as follows.

Stop	Scheduled arrival	Predicted arrival	Scheduled departure	Predicted departure	Delay
235	-	-	09:30	Passed	2
236	9.35	09:37	09:36	09:38	2
237	09:50	09:51	09:51	09:52	1
238	09:55	09:56	09:56	09:57	1
239	09:57	09:58	09:58	09:59	1
240	09:59	10:00	-	-	1

Transmission of the delay profile

The AVLC must not only provide the timetable information system with data concerning the departure and arrival times at one or more stops of a trip, but it must also report the predicted times (departure/arrival) for all future stops of a trip. It must inform the timetable information system of the entire stop-time function, the so-called delay profile of a trip.

6.1.2 Supplementary rule for the delay profile

To prevent unnecessary data traffic, measures are introduced to avoid the transmission of redundant information. These represent exceptions to the agreed rules, which allow the timetable information system to independently supplement the transmitted data. This is of particular importance to the delay information.

To reduce the transmitted data volume, the AVLC only transmits the stops at which the delay has changed (extrapolation rule). The timetable information system assigns the last reported delay to all stops along the pattern until the next reported delay is received.

This supplementary rule also applies to timetable deviations in which the vehicles are running early.

Using this rule, the timetable information system can then complete the remaining fields from a single message without additional information from subsequent or previous messages – there is neither need nor authorization for independent interpretation.

The following rules must be observed within the context of a change message (*CompleteTrip (Komplettfahrt) = false*).

The omission of leading stops (before the first transmitted stop) are differentiated from subsequent stops (after an initial transmitted stop) of the “projection”.

<u>Omission of leading stops without changes:</u>

- The first stop to be transmitted is the one which has a deviation (attribute and/or prediction time) from the last published RealTrip (IstFahrt). All stops before that stop can be omitted. All omitted leading stops remain unchanged. This rule must be applied independent of the prediction status (even *Unknown*).
- The “projection” starts with a change message after the first transmitted stop.

Omission of subsequent stops (projection):
After the first transmitted stop, stops can be omitted is they fulfil the following criteria:

- If the departure delay (difference between the predicted and scheduled time of the departure) of the last transmitted stop can be transferred to the arrival and departure delay of subsequent omitted stops, and there is no attribute change (with the exception of the prediction times).
- If the stop has the prediction status *Prediction*. Omitted stops always explicitly receive the prediction status = *Prediction*. (Because the prediction times are projected and for reasons of upwards compatibility)
- The projection ends as soon as a stop is transmitted again. The projection can be restarted after every transmitted stop if the necessary criteria are fulfilled.
- Note: In cases of doubt, it is better to transmit one stop too many than one stop too few. The projection is also adhered to is all subsequent stops are transmitted after the initial transmitted stop.

The following elements are projected in the case of omitted stops:

- The elements *RealArrivalPrediction (IstAnkunftPrognose)* and *RealDeparturePrediction (IstAbfahrtPrognose)*
- The departure delay of the previous stop (relative to the scheduled departure time) is transferred to the elements *RealArrivalPrediction (IstAnkunftPrognose)* and *RealDeparturePrediction (IstAbfahrtPrognose)* of the subsequent omitted stops.
- Special case: If the last transmitted stop has the prediction status = *Unknown*, a departure delay of ‘0’ is projected for omitted stops. This is more of a theoretical case and will rarely occur in real scenarios.

All other changes to elements must always be transmitted as attribute changes and and the stop indicated (stops with attribute changes must always be indicated).

Details for indicated stops:
The following stops must always be transmitted:

- All stops with attribute changes (this allow applies to the prediction status = *Unknown, Real, Estimated*)
- All stop for which the delay profile for *RealArrivalPrediction (IstAnkunftPrognose)* and *RealDeparturePrediction (IstAbfahrtPrognose)* changes in relation to the previous stop.

Indicated stops shall always be transmitted in full (including all available information on the stop).

The projection rule is not applied on all supplied stops.

Furthermore, the rules in Chapter 5.2.2.3 apply and are always used in this case.

Details for all stops:
According to Chapter 6.1.9, values for the element *PredictionInaccurate (PrognoseUngenau)* must always be transmitted again will every message. Otherwise the values are deleted. This rule also applies to non-transmitted stops (leading and subsequent).

Example 1: Standard example without an attribute change

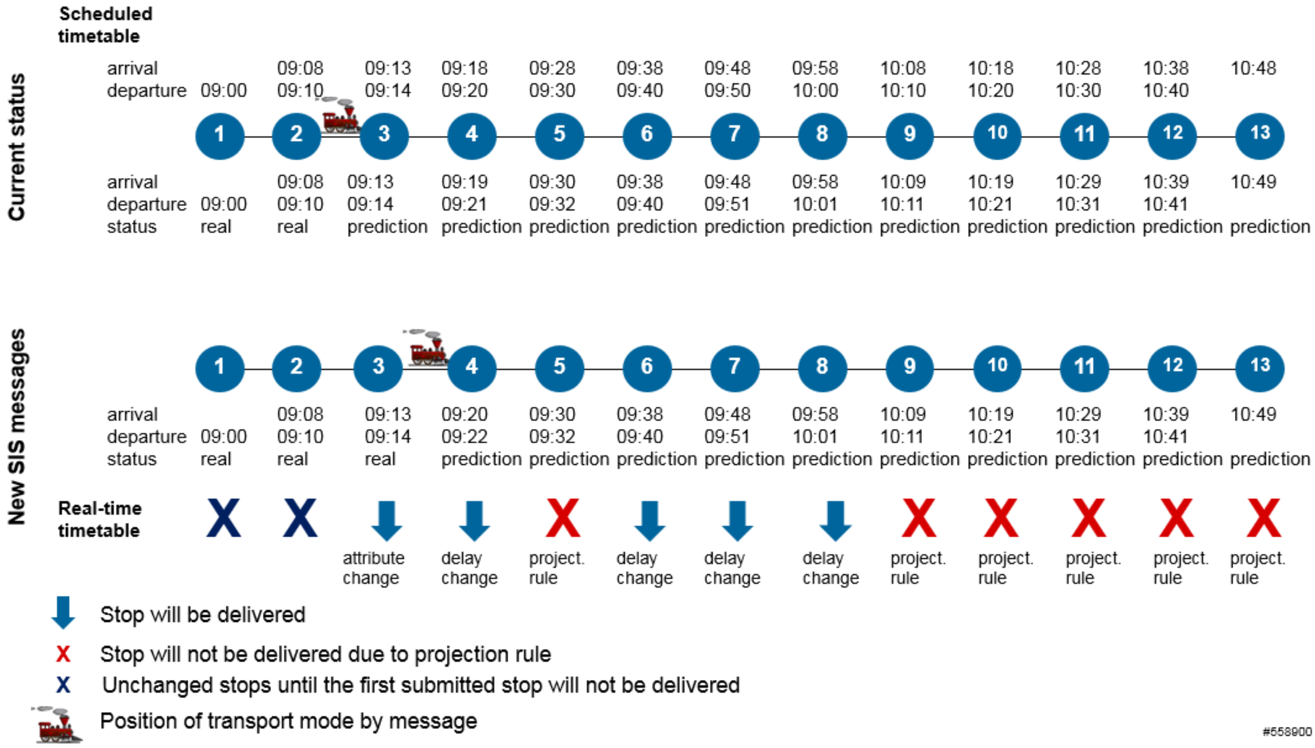


Figure 51 Completion rule: Standard example without an attribute change

Legend for Example 1:

- Stops 1 and 2 are leading stops without changes and can be omitted.
- The exit delay of 2 minutes from stop 4 is transferred to the arrival and departure prediction at stop 5.
- The exit delay of 1 minute from stop 8 is transferred to the arrival and departure prediction at stops 9 to 13.

Example 2: With attribute change, projection despite prediction status change

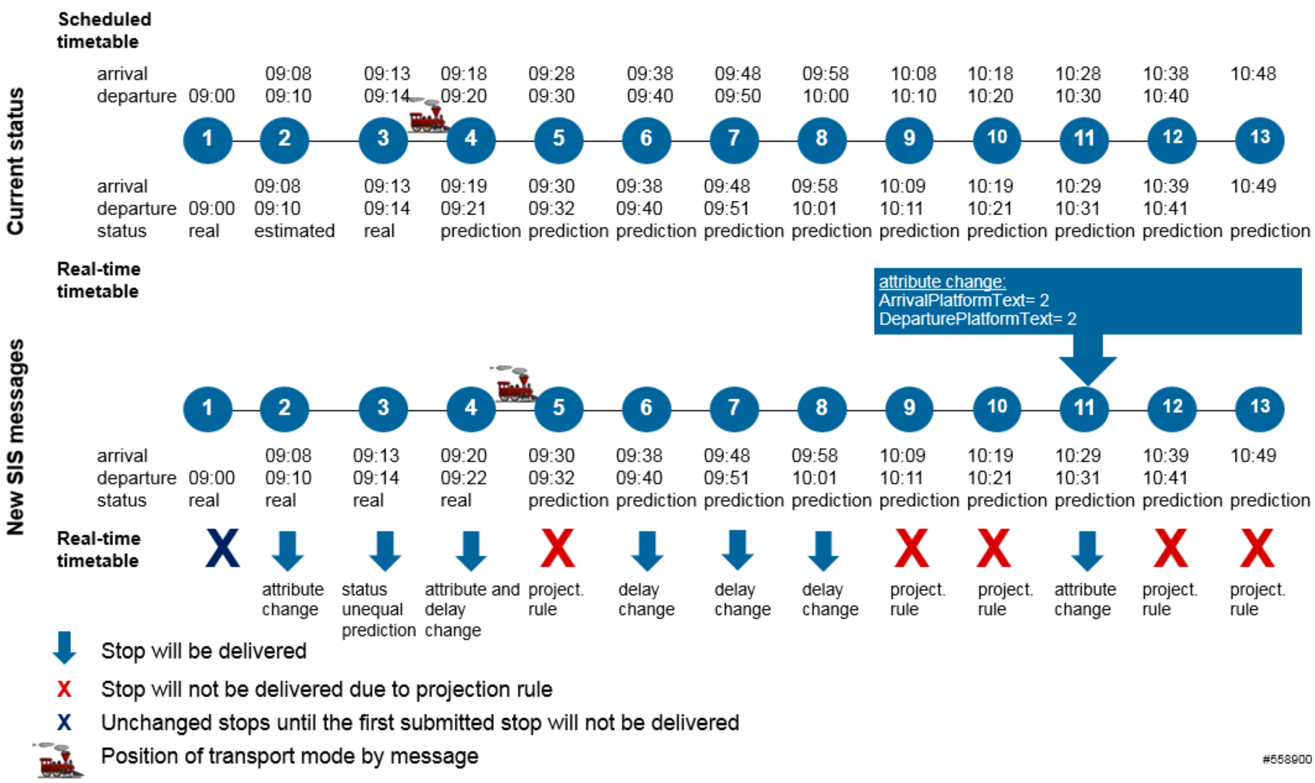


Figure 52 Completion rule: Example with attribute change, projection despite prediction status change

Legend for Example 2:

- Stop 1 is a leading stop without changes and can be omitted.
- Stop 2 cannot be omitted or projected, as the prediction status change to *Real* requires that an attribute change be transmitted.
- Stops 3 and 4 cannot be projected, as the prediction status is not *Prediction* (attribute change).
- For stop 5, the exit delay of 2 minutes from stop 4 is transferred to the arrival and departure prediction. Projected stops already receive the prediction status = Prediction. This is why the prediction status from stop 4 is not relevant to the projection.
- For stops 9 and 10, the exit delay of 1 minute from stop 8 is transferred to the arrival and departure prediction.
- Stop 11 cannot be projected, as the arrival and departure platform change requires that an attribute change be transmitted.
- For stops 12 and 13, the exit delay of 1 minute from stop 11 is transferred to the arrival and departure prediction.

Example 3: With attribute change, projection despite prediction status change

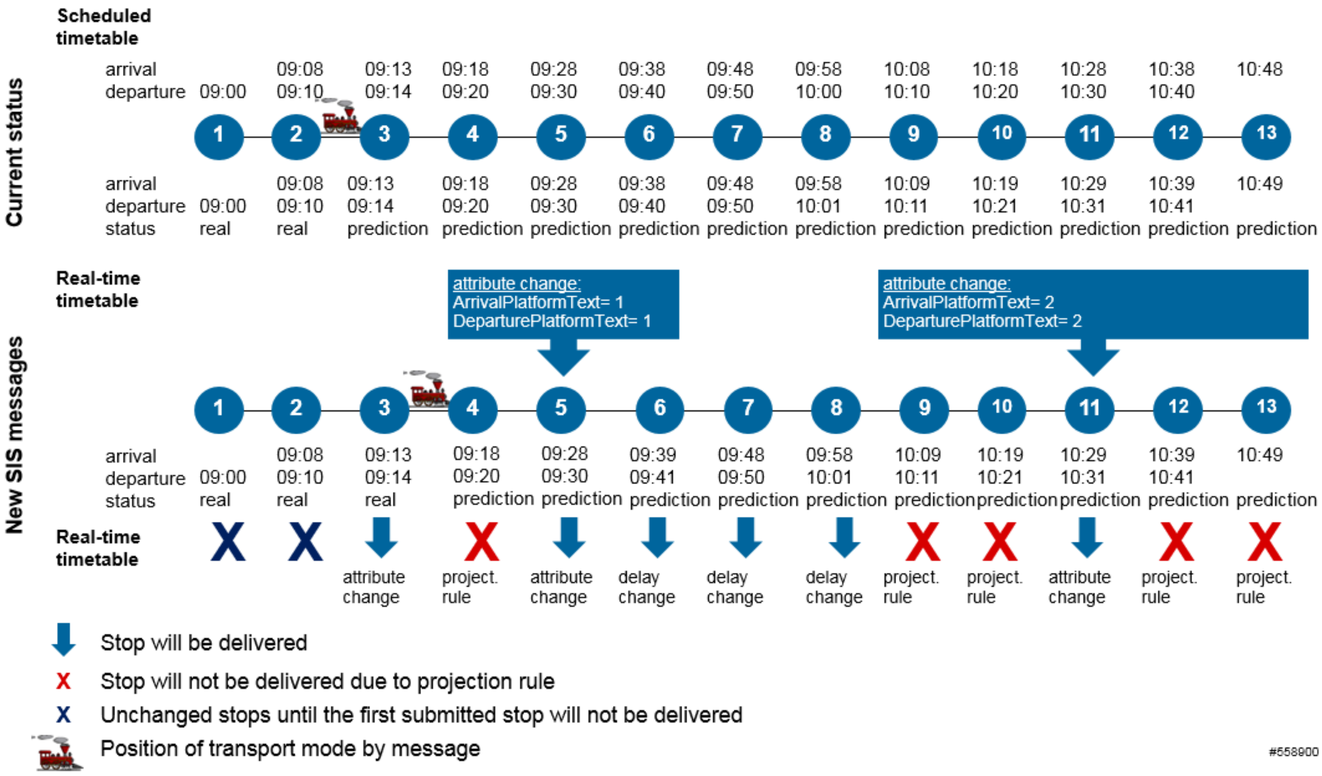


Figure 53 Completion rule: Example with attribute change, projection despite prediction status change

Legend for Example 3:

- Stops 1 and 2 are leading stops without changes and can be omitted.
- Stop 3 cannot be omitted or projected, as the prediction status change to *Real* requires that an attribute change be transmitted.
- For stop 4, the exit delay of 0 minutes from stop 3 is transferred to the arrival and departure prediction. Projected stops already receive the prediction status = *Prediction*. This is why the prediction status from stop 3 is not relevant to the projection.
- Stop 5 cannot be projected, as the arrival and departure platform change requires that an attribute change be transmitted.
- For stops 9 and 10, the exit delay of 1 minute from stop 8 is transferred to the arrival and departure prediction.
- Stop 11 cannot be projected, as the arrival platform change requires that an attribute change be transmitted.
- For stops 12 and 13, the exit delay of 1 minute from stop 11 is transferred to the arrival and departure prediction.

Example 4: With PredictionPossible (PrognoseMoeglich), prediction status change and *Unknown*

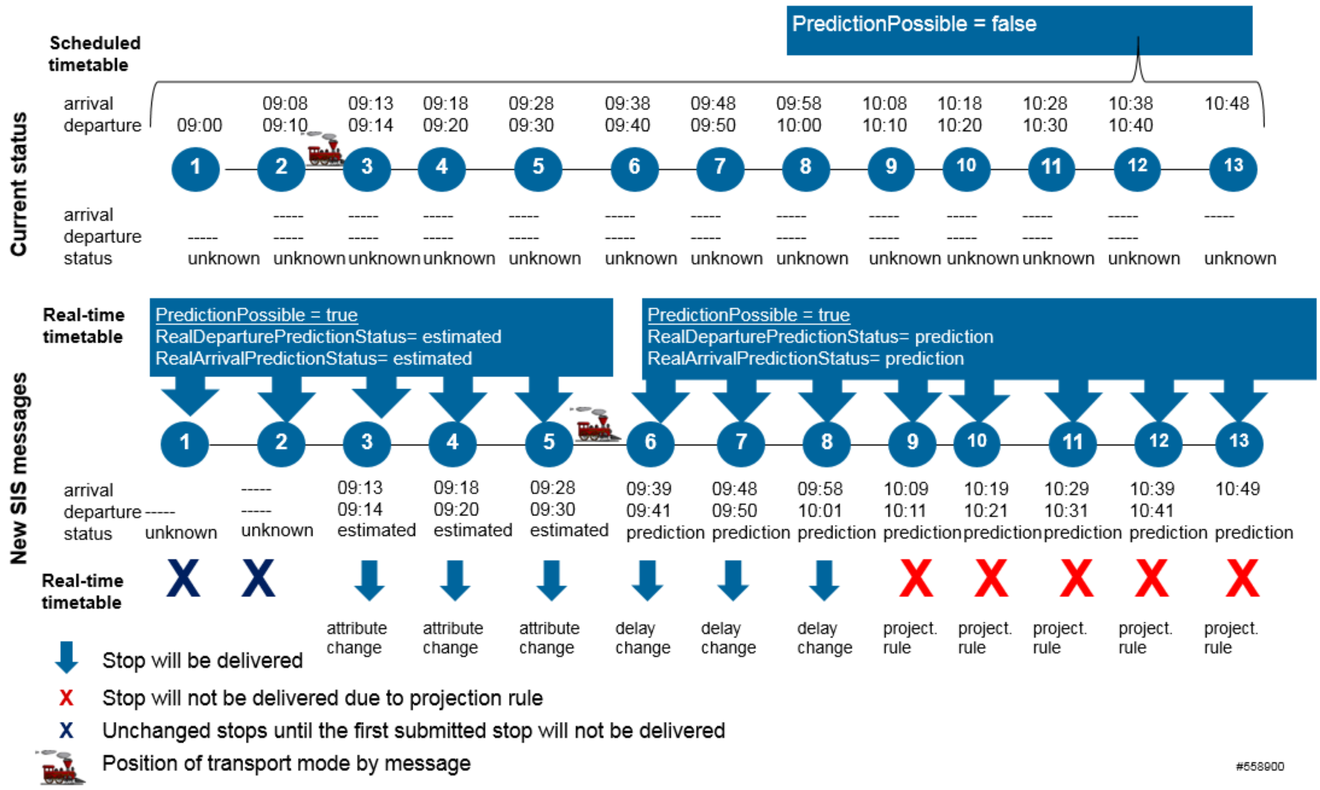


Figure 54 Completion rule: Example with PredictionPossible (PrognoseMoeglich), prediction status change and *Unknown*

Legend for Example 4:

- Stops 1 and 2 do not need to be transmitted, as they do not have any changes in relation to the last transmitted status and are at the start of the message.
- Stop 3 and 5 contain a status change to *Estimated* in relation to the last transmitted status and therefore have an attribute change. This means that these stops need to be transmitted.
- For stops 9 to 13, the exit delay of 1 minute from stop 8 is transferred to the arrival and departure prediction. For all projected stops, the prediction status is set to *Prediction*.

Example 5: Special case: projection with the prediction status = *Unknown*
A rather theoretical example which is, however, technically possible.

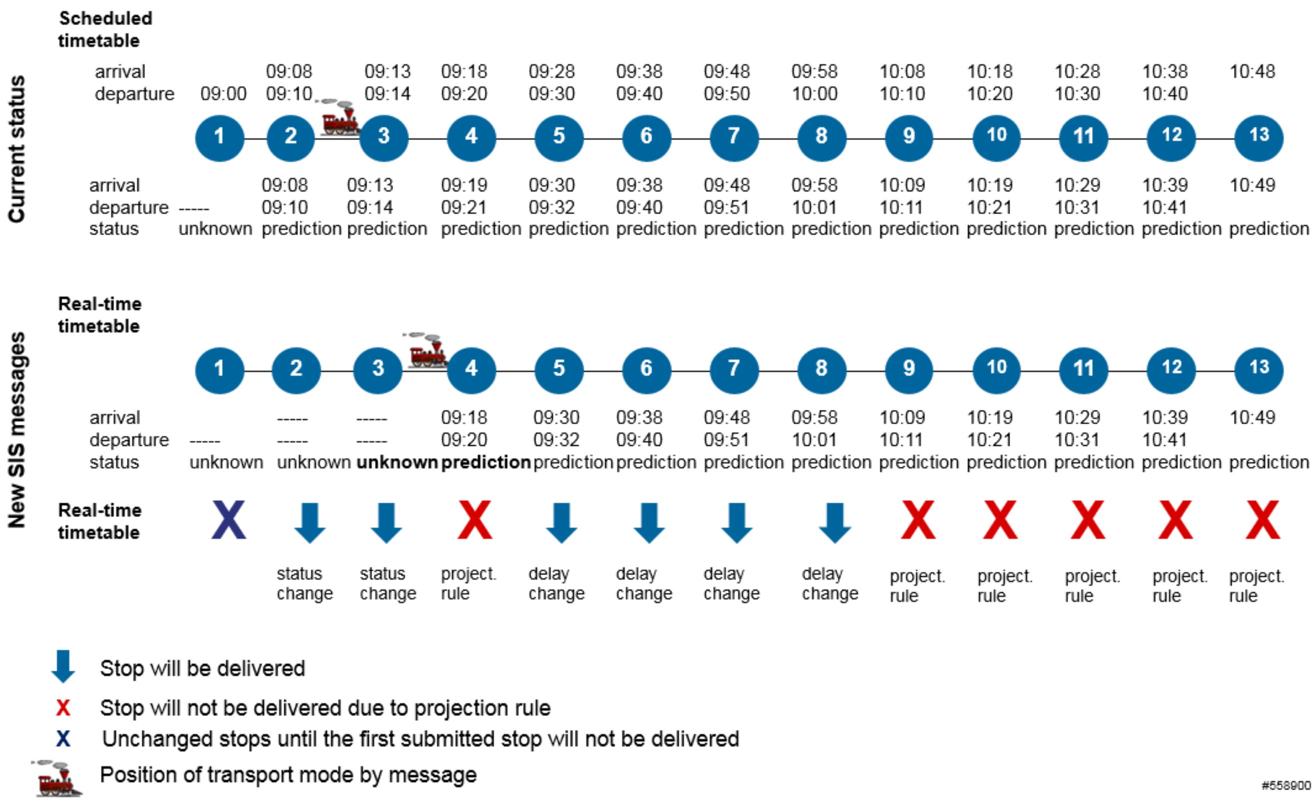


Figure 55 Completion rule: Example of a special case: projection with the prediction status = *Unknown*

Legend for Example 5:

- Leading, unchanged stops can be omitted. For this reason, stop 1 does not need to be transmitted.
- Stop 4 can be projected, as with the prediction status = *Unknown*, a delay of 0 minutes is projected in stop 3.
- For stops 9 to 13, the exit delay of 1 minute from stop 8 is transferred to the arrival and departure prediction. For all projected stops, the prediction status is set to *Prediction*.

6.1.3 Summation of messages for a trip

Subsequent SIS messages for a trip update the status according to the reported RealStops (and the subsequent stops in accordance with the projection rule). Updating is not carried out for the stops that lie before the first reported RealStop of the current message. The statuses from earlier messages remain valid here. A CompleteTrip (the RealTrip element with sub-element CompleteTrip=true) establishes a new basic status of a trip, from which the updates can start again in the recipient. The CompleteTrip (Komplettfahrt) should contain all information available on the RealTrip (IstFahrt), including new scheduled and prediction times. This guarantees that the most complete version of a trip is available from the off whilst protecting the independence of the SIS service (data recipients do not require any knowledge of the seasonal or daily timetables).

If the REF-SIS service is also used, it is possible that the CompleteTrip only contains the comparable changes.

The summing of subsequent messages for a trip entails a consideration of the individual sub-elements, and how an update is to be carried out and interpreted in each individual case.
The properties of the individual elements are as follows:

- ExtraTrip (Zusatzfahrt):
  This element is only used in connection with a CompleteTrip.
  It is not required in subsequent messages.
- Deleted (FaelltAus):
  This element has the following options - with the corresponding meanings:
  - Supplied with the value true: Trip is cancelled
  - Not supplied in CompleteTrip: Active
  - Not supplied in a non-complete trip: No change with regard to the previous message
  - Provided in a non-complete trip with the value false: Try not to use this to reset a cancellation message.
    Means: Travelling; the delay status cannot be reconstructed from earlier messages. Send a new prediction or use CompleteTrip.
- PassengerLoad (Besetztgrad):
  This element can be updated by specifying a new value or reset with the 'Unknown' value.
- ServiceAttribute (ServiceAttribut):
  Individual name-value pairs can be updated. Reset with an empty value.
- ExtraStop (Zusatzhalt):
  This element is only used in connection with a CompleteTrip.
  It is not required in subsequent messages.

This is also valid for the (From)DirectionText element. If the (From)DirectionText in the RealStop is different to that in the RealTrip, it can only be omitted if left out of both RealStop and RealTrip.

6.1.4 Example of 'passing through a stop' (attribute change)

Changes to stop-related attributes such as NoBoarding (Einsteigeverbote) / NoAlighting (Aussteigeverbote), CyclesPermitted (FahrradMitnahme), InfoText (Hinweistext) or PassThru (Durchfahrt) must be sent as special information in the ‘RealStop’ (IstHalt) structure for each relevant stop for which there is change in relation to the scheduled data status. The completion rule for the delay profile may not be used for these stops which have changes to attributes which do not affect the prediction times.

In the following example, the vehicle passes through the third stop and indicates 'no boarding' at the last two stops.

```
<AUSNachricht AboID="25">
      <IstFahrt>
            <LinienID>10</LinienID>
            <RichtungsID>HIN</RichtungsID>
            <FahrtRef>
                  <FahrtID>
                        <FahrtBezeichner>2210</FahrtBezeichner>
                        <Betriebstag>21/07/2001</Betriebstag>
                  </FahrtID>
                  <FahrtStartEnde>
                        <StartHaltID>235</StartHaltID>
                        <Startzeit>2001-07-21T09:30:00</Startzeit>
                        <EndHaltID>240</EndHaltID>
                        <Endzeit>2001-07-21T9:59:00</Endzeit>
                  </FahrtStartEnde>
            </FahrtRef>
            <Komplettfahrt>false</Komplettfahrt>
            <IstHalt>
                  <HaltID>237</HaltID>
                  <Abfahrtszeit>
                        2001-07-21T09:51:00
                  </Abfahrtszeit>
                  <Ankunftszeit>
                        2001-07-21T09:50:00
                  </Ankunftszeit>
                  <Durchfahrt>true</Durchfahrt>
            </IstHalt>
            <IstHalt>
                  <HaltID>239</HaltID>
                  <Abfahrtszeit>
                        2001-07-21T09:58:00
                  </Abfahrtszeit>
                  <Ankunftszeit>
                        2001-07-21T09:57:00
                  </Ankunftszeit>
                  <Einsteigeverbot>true</Einsteigeverbot>
            </IstHalt>
            <IstHalt>
                  <HaltID>240</HaltID>
                  <Ankunftszeit>
                        2001-07-21T09:59:00
                  </Ankunftszeit>
                  <Einsteigeverbot>true</Einsteigeverbot>
            </IstHalt>
      </IstFahrt>
</AUSNachricht>
```

Changes to the vehicle type are transmitted for the route.

6.1.5 Example of 'serving a request stop'

Stops that are only served as a result of a previous request are viewed in the timetable as demand response stops and specified as 'false' for the 'pass through' element.

If there is no stop request within the registration time for the respective stop, there is a correction in RealStop with PassThru = true. Afterwards, these stops are no longer displayed in the timetable information system and the vehicle can either pass through, or in the case of branch trips for example, miss out these stops.

6.1.6 Example of a 'path change'

In the case of major dispatch actions, it is necessary to re-transmit one-off information for the entire trip, including new scheduled and predicted times. This is the case for any additional trips, not included in the planning data, as well as any path changes. The CompleteTrip (Komplettfahrt) field in RealTrip (IstFahrt) must be set to 'true' to inform the timetable information system that an entire trip is being transferred. In this situation, the old trip is deleted and replaced by the new information. The information on the original ScheduleTrip (SollFahrt) used in TripRef (FahrtRef) remains – especially the TripStartEnd (FahrtStartEnde) elements (c.f. Chapter 5.2.2.2).

It should also be noted that all attributes need specifying, as there is no possibility of any reference to existing data. The timetable information system must be able to deal with this so that predictions are sent for all stops of the relevant trip after dispatch actions.

If a path change involves the omission of stops when compared with the original status, they no longer appear in the message. If new stops are inserted, the ExtraStop (Zusatzhalt) field must be set to 'true'.

The following example shows the RealTrip (IstFahrt) structure for the situation in which a different path is followed to the trip destination. The new stops are marked with the ExtraStop (Zusatzhalt) attribute.

```
<AUSNachricht AboID="25">
      <IstFahrt>
            <LinienID>10</LinienID>
            <RichtungsID>OUT</RichtungsID>
            <FahrtRef>
                  <FahrtID>
                        <FahrtBezeichner>2210</FahrtBezeichner>
                        <Betriebstag>21/07/2001</Betriebstag>
                  </FahrtID>
                  <FahrtStartEnde>
                        <StartHaltID>235</StartHaltID>
                        <Startzeit>2001-07-21T09:30:00</Startzeit>
                        <EndHaltID>240</EndHaltID>
                        <Endzeit>2001-07-21T10:02:00</Endzeit>
                  </FahrtStartEnde>
            </FahrtRef>
            <Komplettfahrt>true</Komplettfahrt>
            <IstHalt>
                  <HaltID>253</HaltID>
                  <Abfahrtszeit>
                        2001-07-21T09:36:00
                  </Abfahrtszeit>
                  <Ankunftszeit>
                        2001-07-21T09:35:00
```

```
                </Ankunftszeit>
                <IstAnkunftPrognose>
                      2001-07-21T09:37:00
                </IstAnkunftPrognose>
                <IstAbfahrtPrognose>
                      2001-07-21T09:38:00
                </IstAbfahrtPrognose>
                <Zusatzhalt>true</Zusatzhalt>
          </IstHalt>
          <IstHalt>
                <HaltID>254</HaltID>
                <Abfahrtszeit>
                      2001-07-21T09:44:00
                </Abfahrtszeit>
                <Ankunftszeit>
                      2001-07-21T09:43:00
                </Ankunftszeit>
                <IstAnkunftPrognose>
                      2001-07-21T09:45:00
                </IstAnkunftPrognose>
                <IstAbfahrtPrognose>
                      2001-07-21T09:46:00
                </IstAbfahrtPrognose>
                <Zusatzhalt>true</Zusatzhalt>
          </IstHalt>
          <IstHalt>
                <HaltID>255</HaltID>
                <Abfahrtszeit>
                      2001-07-21T09:54:00
                </Abfahrtszeit>
                <Ankunftszeit>
                      2001-07-21T09:53:00
                </Ankunftszeit>
                <IstAnkunftPrognose>
                      2001-07-21T09:54:00
                </IstAnkunftPrognose>
                <IstAbfahrtPrognose>
                      2001-07-21T09:55:00
                </IstAbfahrtPrognose>
                <Zusatzhalt>true</Zusatzhalt>
          </IstHalt>
          <IstHalt>
                <HaltID>240</HaltID>
                <Ankunftszeit>
                      2001-07-21T09:59:00
                </Ankunftszeit>
                <IstAnkunftPrognose>
                      2001-07-21T10:02:00
                </IstAnkunftPrognose>
          </IstHalt>
    </IstFahrt>
</AUSNachricht>
```

If an additional trip is to be transmitted and not just a path change to a known trip, then the ExtraTrip attribute in the RealTrip (IstFahrt) structure must be set to 'true'. This eliminates the marking of additional stops.

6.1.7 First message and preview time

First message (Erstmeldung)

With the help of the SIS service the timetable information system can, for example, mark trips as 'delayed x min', 'punctual' or 'cancelled'. The customer therefore expects, irrespective of the marketing strategy of the operator, trip information that is of a higher quality than the timetable with regard to actuality, accuracy and reliability.

The basic problem for the timetable information system when it comes to reliability is that in the case of trips for which it has not yet received any real-time messages, it is unable to decide whether it has no significant delay or whether the AVLC is unable to generate messages for this vehicle, if for example, it has no radio equipment. In the first case the trip should be marked as punctual in the timetable information system and in the latter case as having unknown accuracy.

In order to support highly reliable information when constructing the interface, the handling of the interface has been agreed so that the timetable information system bases its trip information on concrete message events and not on conclusions regarding non-events.

To ensure the data consumer has the most complete status of the trip after the initial transmission in the SIS service, the initial message should always be sent as a CompleteTrip. (The data consumer does not need any knowledge of the seasonal or daily timetable).

PreviewTime (Vorschauzeit)

The further one reaches into the future with a prognosis on the basis of scientific methods, the more unclear the influencing factors, which in turn increases the inaccuracy. This finding also corresponds to intuitive expectation.

It also applies to the prediction of traffic situations. Basically speaking, predictions are only reliable for near future trips. To avoid the danger of the misrepresentation of apparent prognosis accuracy, every automatic vehicle location and control system (AVLC) has a restricted preview time. The preview time is specific to each project and lies in the region of 20-60 min. This means it is impossible to make predictions about the punctuality of trips that lie too far in the future.

From the other point of view, the passenger does not expect an exact long-term prognosis. It makes little sense within a timetable information system to mark the evening's trips as punctual in response to a morning enquiry.

When setting up a SIS subscription, the timetable information system requests a desired preview time from the AVLC.

Reporting rules (Melderegeln)

The AVLC must report every trip for which there are predictions or other known changes, e.g. route path changes, at least once.

The AVLC transmits predictions for the trips that begin within the preview time or that are already active at the start of the subscription time period. A future trip lies within the preview time if the departure time of the trip at the start stop lies in the time window from the current time given by the preview time.

Trips that lie beyond the preview time are not usually reported by the AVLC. If, however, it has already been possible to draw earlier and reliable conclusions (e.g. as a result of pattern changes or trip cancellations), the AVLC is able to inform the timetable information system about the status of the trips before they fall within the preview time. This is particularly useful in the case of major disruptions or ongoing road works, where it is obvious in advance that the reference timetable can no longer be upheld or that the trip may have to be cancelled altogether. If the AVLC has informed the timetable information system of a trip before it has entered the preview time then it is necessary - in the case of status changes - to send further updates before reaching the preview time period. Despite any messages that may have been sent prior to reaching the preview time window, the AVLC must report the trip once it has entered the preview time period, even if this is a repetition of an earlier message.

Other trips that are viewed as belonging to the time frame include those that lie outside of the specified time frame but have a direct traffic-related connection to other trips within the time period. An example of this is the coupled trip, which splits off from a train. The train journey itself lies within the time period, which means that all coupled trips also belong, even if they are actually outside the specified time period. This avoids any inconsistencies between the individual train parts. Another example is offered by trains whose generic or product name changes mid route, which means they are often represented as two individual trips. From a passenger or traffic planning point of view however, it is one continuous train. In the case of an earlier message relating to a modified pattern, where there are no predictions regarding the departure or arrival times, we recommend setting the prediction status to Unknown (Unbekannt). This method is better than setting the PredictionPossible (PrognoseMoeglich) element to false, as predictions will become possible at a later time.

The message should be sent as early as possible within the PreviewTime (Vorschauzeit). If this is not possible, a message is generated for the trip after the first planned/real-time comparison (after log-on, after first radio contact, before/at/after the start stop).

As soon as a follow-on trip falls into the preview time, this too should be reported with the entire delay profile as soon as possible (i.e. with the prediction for the start stop and all subsequent stops).

For every transmitted trip, its predicted delay profile is reported (see chapter 0) up to the end of the trip, even if the trip finishes after the prediction horizon.

A trip that has been reported once must continue to be reported to its end or until predictions become impossible.

The timetable information system can therefore assume a trip to be punctual if it has received a FirstMessage (Erstmeldung) from the AVLC and PredictionPossible (PrognoseMoeglich) has not been set to false. Without any active transmission of this information via the interface, the timetable information system offers scheduled timetable information on this trip. If a trip is not being monitored by the AVLC, only the scheduled timetable can be offered to the customer.

This procedure guarantees that the timetable information system only marks trips as punctual when they are actually monitored by the AVLC and have been transmitted without error.

The disadvantage is the slightly greater volume of data that needs to be transmitted. The re-initialisation of a real-time data subscription (e.g. after a restart) in particular would generate a new message to the timetable information system from every vehicle affected by the subscription currently in operation.

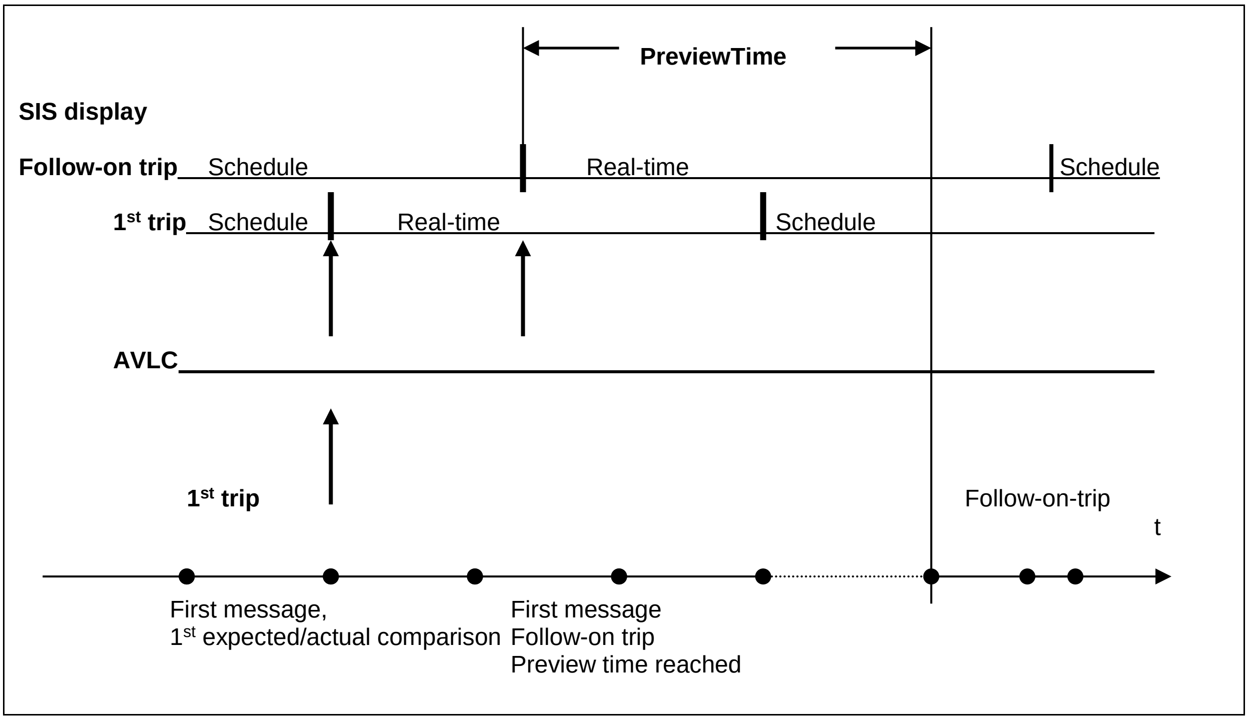


Figure 56: Prediction period and active first message

6.1.8 Temporal Reporting Behaviour - Hysteresis

The SIS service reports the current absolute arrival and departure times. The content of the delay message therefore does not represent information that is relevant to the preceding message, e.g. '+5 min', or to the timetable. Every individual SIS message can be interpreted on its own. It can be made available in the timetable information system if there is a corresponding reference to the planned data.

The temporal reporting behaviour in the case of trip delays however is relative to the last message, and takes the form of a hysteresis function: As soon as a delay prediction for a stop exceeds the last transmitted value by the specified hysteresis (threshold) value either positively or negatively, the AVLC triggers a real-time message to the timetable information system which overwrites the old value.
Here, it must be insured that all changes in relation to the last message are communicated: If the change to the predictions reaches the hysteresis at any stop on a trip, all other changes to the trip are also transmitted in addition to this stop – independent of the hysteresis. This ensures that the data fetcher always receives a complete and consistent image.

It is recommended that a single hysteresis value be globally defined for the entire real-time data subscription in the range of 1-2 min. Defining the threshold values per route or even per trip or interval cannot be recommended due to the resulting complexity. Instead, the global hysteresis should be interpreted as indicating that the timetable information system does not wish to receive any messages that lie below this threshold value. In other words, the deviation must be equal to or greater than the specified value before any deviations are transmitted. In the opposite direction however, the AVLC reserves the right to suppress messages that lie above the threshold as it is able to determine the meaningfulness of transmission. For example, the messages could be suppressed when the headways are short, i.e. the vehicles run in rapid succession. In this way, the AVLC retains the possibility of dynamically deciding on meaningful threshold values.

6.1.9 The PredictionInaccurate Element

If the automatic vehicle location & control system (AVLC) detects that it is no longer able to make a reliable prediction for a trip, it can activate the PredictionInaccurate (PrognoseUngenau) field in the RealTrip (IstFahrt) structure for the relevant trip and transmit a reason. As a result, the data fetcher must assume an imprecise delay, as no new valid prediction can be provided until further notice and further delays must be expected.

At the same time, the hysteresis mechanism described above is suspended, i.e. the AVLC refrains from sending any more messages as long as PredictionInaccurate (PrognoseUngenau) is active. This limits the rapidly increasing exchange of messages as the delay increases. The system avoids sending delay messages, when it must be assumed they will only increase further after another 2 minutes.

The following values can be given as reasons for PredictionInaccurate (PrognoseUngenau):

- 'Vehicle in jam' means that the vehicle is proceeding slowly or not at all.
- 'Technical problem' states that there is a problem with transmitting the vehicle data, which means there is no current, up-to-date information.
- 'Dispatch action' indicates that manual interaction has taken place, for example to protect a transfer, which means that accurate predictions are not possible.

- 'Missing update' means that although a prediction exists, communication errors have prevented any updates.
- "Unknown" means that the reason for an imprecise delay (inaccurate prediction) is unknown.

Implementation notes:

In the case of an inaccurate prediction, the AVLC should transmit the last prediction time it received together with the element "PredictionInaccurate" (PrognoseUngenau) and the respective value for the reason (e.g. 'Missing data updating").

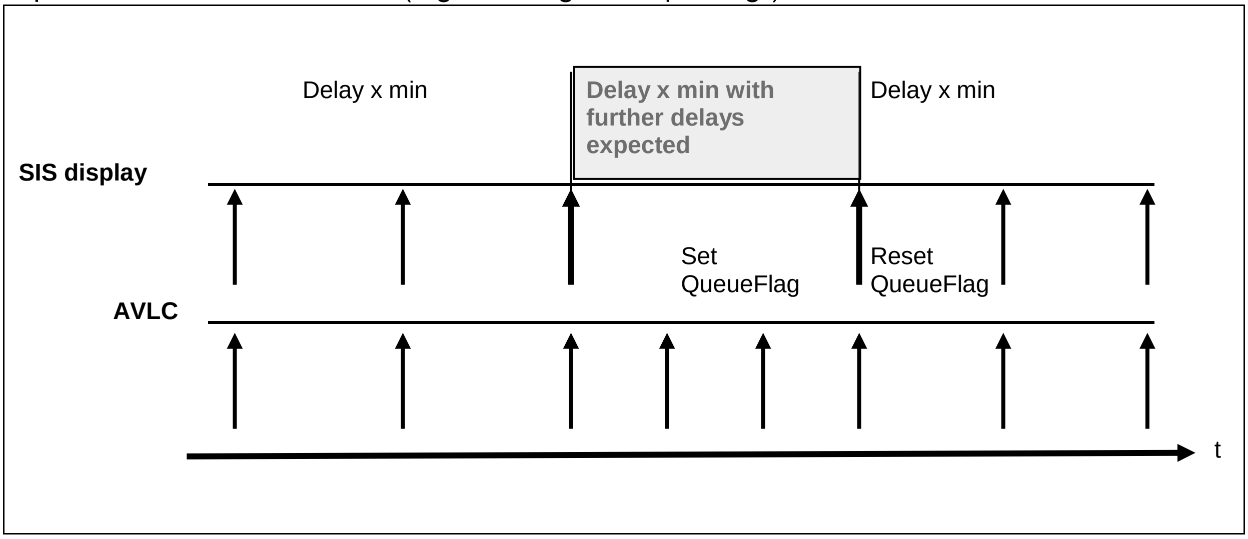


Figure 57: Reporting behaviour in the case of PredictionInaccurate

The last prediction time value together with PredictionInaccurate (PrognoseUngenau) can be used in the timetable information system to communicate an imprecise delay to passenger, e.g. "Imprecise delay" or "Delay of X minutes - Further delays can be expected".

In contrast to a communication failure, the timetable information system does not return to the fallback level of the scheduled data in the case of PredictionInaccurate (PrognoseUngenau) but, rather, the last transmitted prediction time is used. *(It is assumed that the last known prediction time is "in cases of doubt" more precise than, e.g., resetting the times to the scheduled value, especially if the trip already has a delay.)*

With the transmission of a new up-to-date prediction the AVLC lifts the PredictionInaccurate (PrognoseUngenau) status and signals to the fetcher that the hysteresis is running again.

Description of 'Imprecise delay':

An 'imprecise delay' is generally a prediction whose reliability can only be defined very poorly or for which a concrete prediction time cannot be precisely defined because of an event (e.g. incident). This can result in significant fluctuations in relation to the arrival/departure time communicated to the passengers. In this case, the last transmitted prediction time can deviate "imprecisely".

Definition of the prediction status ='Unknown':

The prediction status 'Unknown' is not suitable for the transmission of an inaccurate delay and may not be used in this case. This is because, in the case of a prediction status = 'Unknown', scheduled data is generally used as a fallback level, resulting in the loss of the last known predictions. This also resets all previous stops to the scheduled times. In the case of an imprecise delay from a specific stop onward, there are generally prediction, estimated and real times available.

<u>Reference of element 'PredictionQuality' (PrognoseQualität) (c.f. Chapter 9):</u>

If possible, the new PredictionQuality (PrognoseQualität) structure should be used for transmissions. (see Chapter 9 Appendix: Transmission of the prediction quality).

If the two elements 'PredictionInaccurate' (PrognoseUngenau) and 'PredictionQuality' (PrognoseQualität) are used simultaneously, the information on prediction quality shall be viewed as higher quality information, as it enables a finer differentiation in terms of the expected quality of the time predictions (*With PredictionInaccurate (PrognoseUngenau), practically only PredictionQuality (PrognoseQualität) level 5 can be represented, but not levels 1-4*).

The two elements are differentiated from one another in that, when PredictionInaccurate (PrognoseUngenau) is used, the data fetcher cannot be supplied with new time predictions until further notice, whereas this is only the case with quality level 5 when PredictionQuality (PrognoseQualität) is used. With the quality levels 1-4, the provision of time predictions remains possible.

The following rules apply to the simultaneous use of PredictionInaccurate (PrognoseUngenau) and PredictionQuality (PrognoseQualität):

- The indication of PredictionInaccurate (PrognoseUngenau) corresponds to PredictionQuality (PrognoseQualität) level 5. If this level is indicated using PredictionQuality (PrognoseQualität), PredictionInaccurate (PrognoseUngenau) could be used to transmit a reason for the imprecise prediction.
- If the quality levels 1-4 are used with PredictionQuality (PrognoseQualität), the element PredictionInaccurate (PrognoseUngenau) may not be set simultaneously, as this would represent a contradiction and result in inconsistent information.
- If both elements are used simultaneously, it must be insured that the PredictionQuality (PrognoseQualität) information in comparison to PredictionInaccurate (PrognoseUngenau) is projected on the next stops. The values for PredictionInaccurate (PrognoseUngenau), on the other hand, must be explicitly set for each stop individually.

6.1.10 Resetting the predictions / resetting the trip

If AVLC detects that, for the trip, no delay predictions for arrivals and departures at the stops which have not yet been serviced can be indicated, AVLC can withdraw a previously reported prediction. In this case, the AVLC must send the timetable information system a timetable deviation message with the *PredictionPossible (PrognoseMoeglich) = false* attribute for every trip already reported. With that, the timetable information system is aware of the inaccurate status of these trips and can pass on this information to the customers. See Chapter 6.1.9 The PredictionInaccurate Element. After a message with the attribute *PredictionPossible (PrognoseMoeglich) = false*, all predicted times for all stops are reset to the last reported scheduled times.

If the AVLC resets all changes, e.g. path, InfoTexts (Hinweistexte) etc., for a trip which was already reported, AVLC sends the trip with the 'ResetTrip' (FahrtZuruecksetzten) = true field. In this case, the destination system uses a trip version from VDV 454 REFSIS or the available scheduled data as a fallback level. The ExtraTrips (Zusatzfahrten) which were already reported, are viewed as unreported. If the destination system does not have any scheduled data, the reset trips are viewed as unreported. In the same way, the already reported ExtraTrips (Zusatzfahrten) are also viewed as unreported.

Attention: In some circumstances, resetting the trips may compromise the quality of the passenger information and should only be done in exceptional cases. Instead of resetting the trips, a new transmission of the trip as a CompleteTrip (Komplettfahrt) is preferred.

6.1.11 Actual arrival and departure times

For a complete representation of trip sequences, it is not only the predictions for the upcoming stopping points that are important but also the actual arrival and departure times at the stops already served. A parameter in the SubscriptionRequest can be used to inform the AVLC that it is also to send the actual arrival and departure times (see 5.2.1).

The actual times are reported in the RealStop element in the RealDeparturePrediction or RealArrivalPrediction sub-element respectively and denoted by the status values *RealDeparturePredictionStatus=Real* or*RealArrivalPredictionStatus=Real* (see Chapter 5.2.2.3 5.2.2.3).

The AVLC transmits an actual time as soon as the event occurs (arrival or departure at the stop). The CompleteTripMessages contain the actual times for stops that have already been served. Actual times are not updated. The actual time is only transmitted once per stop and event (arrival or departure), or possibly again within the context of CompleteTripMessages.

If the actual arrival or departure time cannot be established, e.g. in the absence of radio contact, the AVLC must send a plausible time to the fetchers with a label to indicate it is only an estimated time (RealDeparturePredictionPrognoseStatus = Estimated or RealArrivalPredictionStatus = Estimated).

If a new subscription transmits all currently active trips at the start of the subscription life cycle, the AVLC must add the actual times for all previously served stops in each of these trips.

6.1.12 Trip cancellations

There are three different starting situations for an AVLC message regarding missing trips:

a) The data sender and the timetable information system have the same timetable version, however, in the control centre and in contrast to the planning status, a trip is cancelled before transmission of the timetables in the REF-SIS service.

b) After completion of the REF-SIS transmission, a trip is deleted in the control centre.

c) The data sender and timetable information system do not have the same timetable version. The trip has been removed from the seasonal timetable before transmission to the control system (planned cancellation). The timetable information system however still has an old version of the timetable which contains the now missing trip. In this situation, the control system is unable to specify 'Deleted' as the trip itself is no longer listed. The trip is therefore no longer transmitted in the REF-SIS service.

In case a) the trip to be deleted is communicated in the ScheduleTrip (SollFahrt) structure in LineSchedule (Linienfahrplan) and denoted by the Deleted attribute.

In case b) the trip to be deleted is communicated in the *RealTrip (IstFahrt)* structure via the SIS service and denoted by the *Deleted (FaelltAus)* attribute.

In both cases, at least the start and destination stops of the trip must be transmitted in the ScheduleTrip (SollFahrt) or RealTrip (IstFahrt) structure, as these identify the trip.

In case c) the trip to be deleted is omitted from the ScheduleTrip structure in the line schedule and with that noted by the timetable information system as cancelled (i.e. if the corresponding ScheduleTrip does not exist in the line schedule, it is seen as cancelled).

6.1.13 Additional trips

There are also three different starting situations for an AVLC message regarding extra trips:

a) The data sender and the timetable information system have the same timetable version, however, in the control centre and in contrast to the planning status, an additional trip is added before transmission of the timetables in the REF-SIS service.

b) After completion of the REF-SIS transmission, an additional trip is added by the dispatcher.

c) The data sender and the timetable information system do not have the same timetable version. The trip has been added to the seasonal timetable before transmission to the control system (extra trip).

In case a) the additional trip is communicated in the ScheduleTrip (SollFahrt) structure in LineSchedule (Linienfahrplan) and denoted by the ExtraTrip (Zusatzfahrt) attribute.

In case b) the additional trip is communicated in the RealTrip (IstFahrt) structure and denoted by the ExtraTrip (Zusatzfahrt) attribute.

In case c) the additional trip is communicated in the ScheduleTrip (SollFahrt) structure in LineSchedule (Linienfahrplan) and in accordance with the possibilities of the control system denoted by the ExtraTrip (Zusatzfahrt) attribute - or not, as the case may be.

If the additional trip follows a path that deviates from the other paths of the route, it must be guaranteed that this path has been previously supplied in the planning system. This means it may not be possible to represent this extra trip in the network topology of the timetable information system. In the case of an unknown path, there must be a suitable reaction in the timetable information system.

6.1.14 Implementation for rail applications

With train travel, it is often not possible to apply the regular route modelling as used in local public transport. However, in order to be able to apply the same data model for the train schedules, it is recommended that one uses the timetable links for a corresponding route definition. In this case, the TripID would be the (unique) train number and the LineText would be composed of train type and train number (e.g. IC 18). This allows a train journey to be broken down into several 'routes' on the basis of the timetable links.

6.1.15 Ensuring plausible predictions

Inconsistencies in the data supply must be avoided. If an arrival prediction which is earlier the prediction of a leading stop is transmitted for a stop on the trip progression, the predictions of the leading stop must be adapted by the data provider such that plausible predictions without negative time jumps are set for the entire trip progression. Furthermore, the arrival prediction at a stop must always be earlier or equal to the departure prediction. If, for example, for a trip with the stops ‘A, B, C’, a newly transmitted arrival prediction for C is earlier than the last transmitted prediction for B (or even A), the data provider must adjust the predictions for B (and possibly A) as well.

Example in which the departure from A needs to be transmitted again:

- Last prediction: Departure A = 12:05 / Arrival B = 12:07
- The vehicle departs from A at 12:02
- New prediction: Departure A = 12:02 / Arrival B = 12:04, because the trip progression would otherwise be implausible (Departure A = 12:05 / Arrival B = 12:04)

6.2 Connection information

6.2.1 The Situation

Passengers using public transport are often reliant on connections with other routes. The term 'connection' in timetable information systems is wider comprehended than in a AVLC system. For a timetable information system, a connection exists between two trips when a passenger can sensibly transfer between them in order to continue a meaningful journey.

Connections at important junctions are planned by the transport authority in advance in order to guarantee the most comfortable journey for the passenger. Connections should not be too tight in order to ensure they can still be protected even in the case of a minor delay. However, the wait for the connecting vehicle should not be so great as to be considered annoying by the passengers.

As the operational process is prone to disturbances and delays, the transport authority often applies the transfer protection function. In this context the AVLC exchanges messages with the participating feeder and fetcher vehicles in order to allow a sensible wait decision to be made regarding the fetcher vehicle for the given connection. Wait decisions during the transfer protection procedure should also be made available to the timetable information system in order to publish this information for the passenger and to keep those travelling fully up-to-date of the current situation, for example, by means of a central timetable information system.

6.2.2 Applications

The applications for passenger information and interaction are as follows (see Figure 58)

Pre-trip connection information:

The pre-trip connection information provides advance information about all connections that are to be protected within the operation. This information has additional benefits for the passenger as connections that are to be protected are generally more reliable that those that are not actively monitored. With the availability of this information an electronic timetable information system is able to calculate connections with a higher level of reliability.

Collective on-trip connection information:

With the collective on-trip connection information a passenger can get information about all the connection possibilities of his current trip. In this context the most current data can be derived from the transfer protection procedures. The collective information does not know the travel plans of individuals so does not take this into account.

Personalised on-trip connection information:

As a travelling companion service, the personalised on-trip information monitors the travel plans of the registered passengers and actively informs them when the connections become endangered.

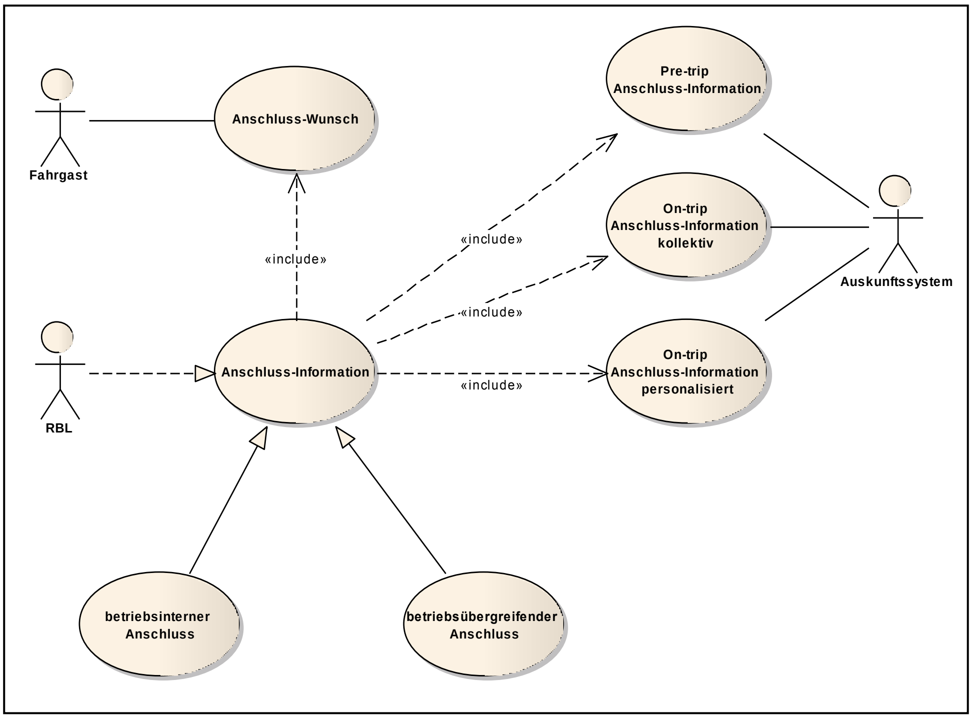


Figure 58: Application cases of the connection information

A transfer protection action can either be initiated within a specific transport authority or as an inter-operational action. In the first situation only one AVLC system is involved and in the second messages are exchanged between two AVLC systems.

6.2.3 Connection information in the timetable information system

In order to have access to advance information on planned connections, they must be transmitted as feeder-fetcher trip pairs to a timetable information system. These trip pairs are made known to the timetable information system within the context of the planned data transmission (see 5.1.3.3 and 5.3.2)

When a feeder nears a transfer point during operation, the fetcher system is informed of the predicted arrival time of this vehicle thanks to the information received from the participating AVLC systems. This allows the fetcher system to make an informed decision regarding whether or not to wait for a delayed feeder. Corresponding information must then be transmitted from the fetcher AVLC to the timetable information system within the context of actual data transmission (see 5.3.3).

6.2.4 Message content

Identifiers must be used for the transmission of the planned transfer protection data, which can be understood globally by all participant systems. The information relating to a connection to be protected comprises the following data elements:

- ID of the connection
- TripID of the feeder

- Feeder StopID at the connection location
- TripID of the fetcher
- Fetcher StopID at the connection location
- Control centre code of the feeder (agency code)
- (The control centre code of the fetcher is implicit when the fetcher is reporting the data)
- Necessary interchange time
- Maximum automatic delay

The necessary interchange time describes the time that is typically required by a passenger to change from the feeder into the fetcher vehicle.

The maximum automatic delay denotes the time period for which the fetcher vehicle can be automatically held back by its control centre if the feeder is delayed. A decision by the dispatcher in the fetcher AVLC system is only requested when this delay value is exceeded.

In order to keep the message volume to a minimum during operation, a timetable information system can evaluate a protected connection as viable as long as the feeder delay remains below the threshold value of the maximum automatic delay. For larger delays, the connection is considered cancelled unless a message is received from the fetcher AVLC system indicating that the dispatcher has authorised a longer wait for the fetcher vehicle. The dispatcher can of course also initiate the transfer failure below the maximum automatic delay threshold.

The fetcher AVLC sends messages in the following situations:

- Transfer failure,
- In case of wait decisions that exceed the maximum automatic delay,
- In the case of new, dynamically created connection pairs and
- Upon surrender of the transfer protection (transfer protection has been withdrawn but there is no statement regarding the realization of this transfer).

6.2.5 Quality Statements

It is essential to be able to assess the reliability of the predictions in order to be able to provide the passenger with reliable and meaningful statements. It would be fatal to recommend an alternative to the passenger if his originally planned connection proved successful. On the one hand, it is important to be able to inform the passengers about critical connections and possible alternatives in good time, but on the other the quality and reliability of the predictions increase the closer the feeder is to the connection point.

It is necessary to find quality features that resolve this dilemma.

In accordance with the information status, which is implicit (for the first three stages) and explicit (with acknowledgement) within the timetable information system, it is possible to differentiate between the following quality levels when providing the passenger with connection information:

- Planning level
- Prediction level
- Dispatcher level
- Vehicle acknowledgement level

The 'planning' level is the preliminary stage for dynamic timetable information. Here, the protected connections are only considered on the basis of the planned data.

In the 'prediction' level the predicted arrival times received from the AVLC are used to determine whether a connection will take place. This is the lowest quality level when using dynamic data.

In the 'dispatcher' level there is a dispatcher decision and instruction to the fetcher vehicle. This level can be regarded as very reliable.

In the 'vehicle acknowledgement' level there is also confirmation from the fetcher vehicle, so that one can be certain that the connection decision has arrived in the fetcher vehicle. This level represents the highest degree of reliability.

6.2.6 Stay-seated connection

The situation where the passengers remain seated, the so-called 'stay seated' connection, represents a special case. This represents a virtual connection in the same vehicle. This situation arises when the vehicle in question transfers to a different route at the end of the current trip, where it begins a new trip (route reassignment within a block). For the passenger, the change between these two individual trips represents a connection. However, the passenger can remain seated in the same vehicle (assuming this is permitted). In this situation, the information that he need not get off the vehicle is very useful.

7 Glossary

Term	Description
Actual timetable	Timetable generated from the scheduled timetable, which is supplemented with up-to-date information.
AVLC	Automatic vehicle location and control system, AVLC
Control centre	Set-up to control and regulate the traffic-based and operational processes of a transport authority.
CP	Transfer protection: Service for the operational exchange of transfer protection data
DDS	Data hub
Delay	Positive deviation from the scheduled timetable
Dispatch	Operative management for controlling the traffic and the operation
DPI	Dynamic passenger information: Service for the operational exchange of passenger information data.
Early time	Negative deviation from the scheduled timetable
GMS	General message service: Service for the exchange of operational messages between two control centres
HTML	Hyper Text Markup Language
http	Hyper Text Transfer Protocol
Interchange time	Time required to change between vehicles at a connection point.
Meta data	The definitions and stipulations agreed between two transport authorities as a basis for data exchange.
OFF	Real-time timetable information system service, real-time data from the operational procedure for short-term enquiries
OperationalDay	Time frame for the validity of timetables within an AVLC (can be different in different AVLC systems).
Planned timetable	The scheduled timetable.
Process data exchange	Exchange of real-time information between the AVLC and timetable information system
Reference data exchange	Exchange of planned timetables between the AVLC and timetable information system
REF-SIS (REF-AUS)	Timetable information system planned data service for the days timetables for mid-term information
Registration number	Unique, fixed identification number of a vehicle which has been used to officially register the vehicle.
Route trip	Trip on a route
Seasonal timetable	Timetable that is valid for a defined period of time (season) and which is published in various media (timetable booklet, electronic timetable information).
Stay-seated connection	Virtual connection in the same vehicle (see section 6.2.6)
Subscription method	Communication method in the interface for the purpose of data exchange.
Timetable prediction	Preview of the actual timetable of a subsequent time section
Transfer planning	Determination of the connections to be monitored (on the basis of the daily

Term	Description
	timetable).
Validity time frame of timetables	Fixed time frame for which a timetable is valid, e.g. a timetable period. Different transport authorities do not generally have matching validity time frames for timetables.
VIS	Visualisation: Service for exchanging process data for visualising third-party vehicles in a control centre
XML	Extended Markup Language

8 English Aliases

The following tables contain the German names of the elements used in the XML-file (XSD), the English translation used in this recommendation and the name used in the CEN-standard 'SIRI'.

Please refer to the SIRI documentation for the equivalents of the additional elements.

8.1 Services

VDV454 name		**SIRI equivalent**	
Full name	Abbr.	Full name	Abbr.
Timetable Information Reference Data Service	REF-SIS	Production Timetable Service	PT
Timetable Information Process Data Service	SIS	Estimated Timetable Service	ET

8.2 Root elements and complex sub-elements

VDV454 name	**SIRI equivalent**
SISSubscription (AboAUS)	EstimatedTimetableSubscriptionRequest with EstimatedTimetableRequest
SISRefSubscription (AboAUSRef)	ProductionTimetableSubscriptionRequest with ProductionTimetableRequest
SISMessage (AUSNachricht)	ProductionTimetableDelivery (PT service) EstimatedTimetableDelivery (ET service)
TripStartEnd	DatedVehicleJourneyIndirectRef
RealStop	EstimatedCall
RealTrip	EstimatedTimetableVersionFrame with EstimatedVehicleJourney
LineSchedule (LinienFahrplan)	DatedTimetableVersionFrame
PlannedConnection	TargetedInterchange
ScheduleTrip	DatedVehicleJourney
ScheduleStop	DatedCall
TimeWindow (Zeitfenster)	ValidityPeriod

8.3 Additional Elements

The following table contains other English aliases which are used for the SIRI implementation.

VDV454 name	SIRI equivalent
ArrivalPlatformText (AnkunftssteigText)	ArrivalPlatformName
ArrivalTime (Ankunftszeit)	AimedArrivalTime
CompleteTrip (Komplettfahrt)	IsCompleteStopSequence
CyclesPermitted (FahrradMitnahme)	(VehicleFeatureRef)
Deleted (FaelltAus)	Cancellation
DeparturePlatformText (AbfahrtssteigText)	DeparturePlatformName
DepartureTime (Abfahrtszeit)	AimedDepartureTime
DirectionID (RichtungsID)	DirectionRef
DirectionText (RichtungsText)	DestinationName
EndStopID (EndHaltID)	DestinationRef
EndTime (Endzeit)	AimedArrivalTime
ExtraStop (Zusatzhalt)	ExtraCall
ExtraTrip (Zusatzfahrt)	ExtraJourney
FromDirectionText (VonRichtungsText)	OriginName
Hysteresis (Hysterese)	ChangeBeforeUpdate
InfoText (HinweisText)	JourneyNote / LineNote
InterchangePathTime (Umsteigewegezeit)	InterchangeDuration
LineFilter (LinienFilter)	LineRef
LineID (LinienID)	LineRef
LineText (LinienText)	LineNote / PublishedLineName
NoAlighting (Aussteigeverbot)	(ArrivalBoardingActivity)
NoBoarding (Einsteigeverbot)	(DepartureBoardingActivity)
Passage(Durchfahrt)	(DepartureBoardingActivity) / (ArrivalBoardingActivity)
PassengerLoad (Besetztgrad)	Occupancy
PredictionInaccurate (PrognoseUngenau)	PredictionInaccurate
PredictionPossible (PrognoseMöglich)	Monitored
PreviewTime (Vorschauzeit)	PreviewIntervall
Product ID (ProduktID)	ProductRef
RealArrivalDispatch (IstAnkunftDisposition)	ExpectedArrivalTime
RealArrivalPrediction (IstAnkunftPrognose)	AimedArrivalTime
RealDepartureDispatch (IstAbfahrtDisposition)	ExpectedDepartureTime
RealDeparturePrediction (IstAbfahrtPrognose)	AimedDepartureTime
ScheduleVersionID (FahrplanVersionsID)	VersionRef
ServiceAttribute (ServiceAttribut)	VehicleFeatureRef
StartStopID (StartHaltID)	OriginRef
StartTime (Startzeit)	AimedDepartureTime
StaySeated (Sitzenbleiben)	StaySeated
StopID (HaltID)	StopPointRef
StopName (HaltestellenName)	StopPointName
StopSeqCounter (HstSeqZaehler)	VisitNumber
TimeWindow (Zeitfenster)	ValidityPeriod

VDV454 name	SIRI equivalent
TrainName (Zugname)	VehicleJourneyName
TransportModeText (VerkehrsmittelText)	VehicleMode
TripID (FahrtID)	DatedVehicleJourneyRef
TripRef (FahrtRef)	DatedVehicleJourneyRef
ValidUntilTimeStamp (VerfallZst)	InitialTerminationTime

9 Appendix: Transmission of the prediction quality

The following are extracts from the "Transmission of Prediction Quality using the VDV453/454 Interfaces" document, the current version of which can be found at the VDV website under Technology – Projects – Real-time data interfaces (www.vdv.de/i-d-s-downloads.aspx).

9.1 Terms and definitions

Timetable deviation / punctuality	Difference between the planned and actual arrival, departure or passage times of a trip at a specific location; can only be calculated after the relevant real-time message has been received.
Prediction value	This is provided by the source system operator in the context of it's ownership of the predictions; it is the communicated predicted arrival or departure time (according to the definition) of a particular mode of transport at a particular stopping point; it can change several times during the course of the trip (with block-based predictions even before the trip starts).
Prediction period	The difference between the time of creation of the prediction and the time of the actual arrival or departure of the corresponding trip at the specified stopping point.
Prediction deviation	Difference between the actual and the predicted arrival or departure time.
Prediction quality	This is a measurement provided by the source system together with the prediction value indicating the expected prediction error in accordance with the definition. When PredictionQuality (PrognoseQualität) is indicated in VDV454, its interaction with PredictionInaccurate (PrognoseUngenau) must also be taken into consideration (see Chapter 6.1.9)
Source system	System that generates trip and prediction data and makes it available to external target systems via the VDV interfaces (e.g. AVLC, Regio-AVLC, ISTP/RIS, ...)
Target system	System that receives or processes trip and prediction data via the VDV interfaces (e.g. to create the journey chains) and passes it on to the end user (usually passengers) - for example via stationary DPI signs, schedule information on the web, mobile media platforms etc.

9.2 Level definitions, threshold values

As limiting values for the confidence intervals of levels 1 - 4 we would suggest the following:

Prediction quality level	**Lower threshold value (earliest arrival / departure time)**	**Upper threshold value (latest arrival / departure time)**	**Interval width**
1: very certain	- 1 min	+ 2 min	3 mins
2: Quite certain	- 3 min	+ 6 min	9 min
3: Uncertain	- 8 min	+ 16 min	24 min

Prediction quality level	**Lower threshold value (earliest arrival / departure time)**	**Upper threshold value (latest arrival / departure time)**	**Interval width**
4: Very uncertain	- 20 min	+ 40 min	60 min
5: No prediction possible	Undetermined	Undetermined	> 60 min

Level 5 has no temporal limitation. This is always used if it is not possible to make a reliable statement about the prediction accuracy, i.e. the prediction stretches more than 60 minutes (-20/+40).

Transmission of a particular level means that from the point of view of the source system, the prediction errors are highly likely to lie within the specified interval. Although the source system is not offering a 'guarantee', it is subsequently possible using relatively simple statistical tests to establish which confidence level was actually achieved. In addition, this definition in the VDV interface allows the participating parties to agree different assured confidence levels depending on their respective constellations and technical possibilities, which can then be used accordingly by the target system. In an initial stage, the creation and use of these levels is also possible without such assurances (e.g. 95%).

In each case it is the responsibility of the target system operator to agree comparable quality assurances with the various supplier systems on the basis of this quality level definition, in order to ensure common usage of the data in the target system.

Prediction level 1 for example, is therefore defined so that the deviation from the predicted time P has a high probability to lie within the interval [P – 1 min - P + 2 min]. In the absence of any additionally supplied interval limits, the confidence interval limits are given by the above table in connection with the respective predicted value.

Furthermore, it is optionally possible to transmit specific interval limits which differ from those defined by the rules implied above.

If the supplying system still specifies a time interval for the quality level, then the level and the interval width must be consistent, i.e. it is not possible to specify a quality level whose interval width according to the above definition is smaller than the explicitly specified interval (for example, the explicitly defined interval [-5, +5] can only be supplied with quality level 3, 4 or 5 and not with level 1 or 2). If this condition is not upheld, the target system is free to select a correspondingly lower level for any further processing (in the example level 3).

An important consequence of this definition is that the prediction quality is not a property that relates to the entire trip (or the remaining part of the trip), instead it is only valid for a specific time and a specific event in the future (arrival/departure at a specific stop). Particularly in the case of long trips with large distances between stops, e.g. in the case of long-distance rail travel, the prediction quality can differ quite significantly at the various stops due to the varying prediction periods.

9.3 Projection rule

It would seem sensible to define a projection rule for the prediction quality level, similar to that which is already used in VDV454 to communicate the current timetable adherence of a trip. As long as there is no additional knowledge of further problems along the trip progression, the level for the next stop should be used for all additional stops. If however due to congestion messages or existing disturbances it can be assumed that the vehicle will run into trouble further along the route, the situation will worsen from that point compared to the current level and possibly also the calculated limits. From this point therefore, the values should be projected along the remainder of the trip progression.

The focus group found that it would be unrealistic to accurately project the prediction quality of future events. The purely theoretical possibility that a vehicle can remain stationary at any time does not mean that mobility in local public transport cannot be planned reliably. To the contrary, there are good empirical values for most types of traffic, where it is necessary to consider deviations from the scheduled operation. A prediction for a departure or an arrival that lies in the future, should not be classified within the quality levels as worse than the usual empirical value for the deviation of this type of traffic. If, for example, it is known that for a specific trip, the usual delay is no more than 2 minutes and there are currently no known problems, it is acceptable to assign this trip to quality level 1, even if the end of the trip is hours away.

These empirical values must be agreed between the timetable suppliers, the AVLC operators and the timetable information system operators. Their definition requires the knowledge and experience of the respective transport operator. This experience-based quality classification can occur at the level of transportation type, route, individual trip or weekday and time.

In the same way, it is also possible to classify the traffic, which is not subject to any monitoring by the AVLC, for example, as it is only executed on a day in the future as the necessary vehicle equipment is missing or it is not recorded by an AVLC system.

A further possibility - which is not included in this proposal - is for these empirical values for the reliability to be transmitted via a suitably extended VDV interface from the trip operator (en route via the corresponding AVLC) to the timetable information system. As this deals with values that refer to the planned schedules, an extension of the REF-SIS syntax would be conceivable, which would be analogous to the extension of the SIS syntax outlined here. The meaning of the values would no longer represent an assessment of the reliability of the supplied prediction values but an assessment of the reliability of the planned trips as described above. The data for the prediction qualities with punctual traffic supplies an initial, already very accurate, estimation of the reliability assessments. If necessary, they can be further refined into starting delays by an assessment of the historical data.

Example of the projection rule:

Stop sequence of a trip	Stop A	Stop B	Stop C	Stop D	Stop E
Scheduled time-table time	06:47	07:24	07:53	08:18	08:49
Prediction times and levels					
Example 1:		07:29 Level 1			
Example 2:		07:29 Level 3		08:23 Level 2	
Example 3:		07:24 Level 1	07:53 Level 2		

Table 1: Three examples for the transmission of prediction quality levels with the help of the projection rule, the missing values are projected by definition.

Table 1 shows three examples of how to represent the prediction levels for the future stops of a trip with the help of the projection rule. The trip in the example travels along the five stops from A to E. The scheduled timetable times are given in the first table row. The trip is currently located between A and B at 6:50 a.m.

In example 1, the predicted time for stop B is 7:29 a.m. This would indicate that the trip is currently running 5 minutes behind timetable. Prediction level 1 indicates that the expected fluctuation around the predicted value lies within the tolerance values of level 1. On the basis of the projection rule, it is possible in the same way to assume a delay of 5 minutes with prediction level 1 for the subsequent stops C, D and E.

In the second example there is also a predicted delay of 5 minutes for stop B. This time however there is a greater level of uncertainty. For this reason only prediction level 3 is assigned. As it can be assumed there is a certain travel time reserve in this situation between stops C and D, an improved prediction quality of level 2 is signalled for stop D (with an unchanged delay prediction of 5 minutes).

in the third example, a punctual departure with prediction level 1 is indicated for stop B. In this example it is assumed that the subsequent prediction for the trip after violation of a prediction period of more than one hour will comprise greater fluctuations. This means that worse prediction levels are indicated for the stops after 7:50 a.m. Due to the projection rule it is sufficient to transmit this exclusively for stop C (level 2).

The values that are implied implicitly by the projection rule, without the express need for transmission, are entered in grey in Table 2.

Stop sequence of a trip	Stop A	Stop B	Stop C	Stop D	Stop E
Scheduled time-table time	06:47	07:24	07:53	08:18	08:49
Prediction times and levels					
Example 1:		07:29 Level 1	07:58 Level 1	08:23 Level 1	08:54 Level 1
Example 2:		07:29 Level 3	07:58 Level 3	08:23 Level 2	08:54 Level 2
Example 3:		07:24 Level 1	07:53 Level 2	08:18 Level 2	08:49 Level 2

Table 2: The same table with the above examples. The values that are derived from the projection rule are shown in grey.

10 Appendix: Value lists (ENUM)

10.1 FoVehicleType

It remains to be clarified whether the ENUM follows the UIC Standard (UIC Leaflet 580, excerpts at wikipedia), or ENUM defines or in fact whether the VDV454 Recommendation is submitted without any value lists for the possible vehicle types.

10.2 FoVehicleEquipmentCode

The 'FoVehicleEquipment' (FoFahrzeugAusstattung) entity is defined via the compulsory 'FoVehicleEquipmentCode' (FoFahrzeugAusstattungsCode) attribute. Alternatively, the entities have a corresponding name, the 'FoName' (FoBezeichnung) attribute, for every code.
In XSD the codes are listed as ENUM values, whereas the language-specific names are not.

FoVehicleEquipmentCode (FoFahrzeugAusstattungsCode) (ENUM)	Optional[3] (examples)		
	FoName (FoBezeichnung)	Language code	FoQuantity[4]
AirCon	Air conditioning / heating system installed	de	N/A
BabyCarriageCar (AbteilKinderwagen)	Vehicle with an area for baby carriages	de	
BusinessCar (AbteilBusiness)	Vehicle with a business (office) area	de	N/A
CrecheCar	Vehicle with crèche facilities	de	N/A
CycleRack	Cycle rack installed	de	N/A
CycleRackResRec (AbteilFahrradResPflicht)	Cycle rack installed; reservation required	de	N/A
CycleRacks	Number of cycle racks	de	3
DisabledToilet	Provision of a disabled toilet	de	N/A
FamilyCar (AbteilFamilien)	Vehicle with a family area	de	
NumberCycleRacksResRec (PlaetzeFahrradResPflicht)	Number of bicycle spaces with reservation requirement	de	3
Quiet	Quiet coach	de	N/A
Seats1	Number of seats in 1st class	de	20
Seats2	Number of seats in 2nd class	de	32
SeatsCC	Number of reclining seats	de	22
SeatsWL	Number of beds	de	11

[3] The meaning of the ENUM values are listed in this table as values of 'FoName' (FoBezeichnung), which simultaneously highlights the completion of further optional elements.

[4] If this optional element is not used in the examples, 'N/A' is listed.

SeatsWR	Number of seats in the restaurant	de	18
StandingSpace	Number of standing places	de	45
Toilet	Provision of a toilet	de	N/A
WheelchairArea	Vehicle with a section for wheelchairs	de	N/A
WheelchairSpaces	Number of wheelchair spaces	de	1
Wi-Fi	Wi-Fi access	de	N/A

10.3 FoLanguageCode

The language code follows ISO 639-1:2002 (http://www.iso.org/iso/home/standards/language_codes.htm and current list of language codes at http://en.wikipedia.org/wiki/List_of_ISO_639-1_codes). The language code consists of two lowercase characters, which corresponds exactly to ISO 639-1.

Examples:

Language code = ISO 639-1	Language name, English	Language name, native
de	German	German
fr	French	français, langue française
en	English	English
it	Italian	italiano
rm	Romansh	rumantsch grischun

The default value of FoLanguageCode (FoSprachCode) is 'de'.

10.4 FoTechnicalAttributeCode

The 'FoTechnicalAttribute' (FoTechnischesAttribut) entity is defined via the compulsory 'FoTechnicalAttributeCode' attribute. Alternatively, the entities have a corresponding name, the 'FoName' (FoBezeichnung) attribute, for every code.
In XSD the codes are listed as ENUM values, whereas the language-specific names are not.

FoTechnicalAttributeCode (ENUM)	**Optional[5] (examples)**		
	FoName (FoBezeichnung)	Language code	FoValue
EmptyWeight	Weight of empty vehicle in tonnes	de	40
LowFloorEntrance (NiederflurEinstieg)	Vehicle with a low-floor entrance	de	TRUE
NoOfAxes	# of axles	de	4

[5] The meaning of the ENUM values are managed in this table as values of 'FoName' (FoBezeichnung) - in order, for example, to highlight the completion of additional optional elements.

FoTechnicalAttributeCode (ENUM)	Optional[5] (examples)		
	FoName (FoBezeichnung)	Language code	FoValue
StepFree	Vehicle without a step between the footboard and passenger area	de	TRUE
StepHeight	Height of the entry step in centimetres above the platform height	de	55
VehTotalLength	Total length of the vehicle, length from buffer to buffer in metres	de	24.7
VehUICCheckDigit (FzUICPruefziffer)5	Digit 12 of the UIC car number: Check digit	de	8
VehUICManagement (FzUICVerwaltung)5	Digits 3 and 4 of the UIC car number: Country	de	85
VehUICNumber (FzUIC-Nummer)[5]	Full UIC number (12 digits)	de	61 85 10-90 267 8
VehUICSerialNumber (FzUICOrdnungsnummer)5	Digits 9 to 11 of the UIC car number: Serial number	de	267
VehUICType (FzUICTyp)5	Digits 5 to 8 of the UIC car number: Class ID and heating system	de	10 90

10.5 FoChangeCode & FoChangeCodeAtStop

The ENUMs are identical for the 'FoChangeCodeAtStop' (FoAenderunsCodeAmHalt) and 'FoChangeCode' (FoAenderungsCode) and are therefore listed in the following table.

FoChangeCode (FoAenderungsCode) (ENUM)	Optional: FoChangeTexts[6] (example)
ChangedCarSequence	Vehicle is travelling with a different formation (general formation change without an exact explanation of the change)
ExtraCars (ZusaetzlicheWagen)	The vehicle has extra cars
ExtraVehGroup	The vehicle has an extra vehicle group
MIssingCars	The vehicle has fewer cars than scheduled
MissingFamilyCar (FehlendeFamilienwagen)	Means of transport is travelling without a family car
MissingRestaurantCar	Vehicle is travelling without a restaurant car
MissingTimetableCar	Scheduled cars are missing from the means of transport
MissingVehGroup	Missing vehicle group
OppositeCarSequence	The formation of the vehicle has been inverted (but without any additional or missing cars)

[6] The meaning of the ENUM values are listed in this table as values of the optional 'FoChangeTexts' (FoAenderungsTexte) element.

10.6 FoStatusCode

The following ENUM list is defined for specification of the statuses of the vehicles and vehicle features.

FoStatusCode (ENUM)	Optional[7] [8] (examples)					
	FoStatusAbbreviation	Language code	FoStatusText	Language code	FoStatusSuggestion	Language code
available	Equipment available	de	N/A	N/A	N/A	N/A
closed	Equipment/vehi-cle closed	de	car closed	de	N/A	N/A
defective	Equipment faulty	de	N/A	N/A	N/A	N/A
not_available	Equipment not available	de	N/A	N/A	N/A	N/A
not_staffed	Car is open but the restaurant is not staffed	de	N/A	N/A	N/A	N/A
open	Equipment/vehi-cle open	de	N/A	N/A	N/A	N/A
reserved	Equipment re-served	de	N/A	N/A	N/A	N/A

10.7 FoOrientation

An ENUM with the following 'restriction' is defined for the orientation.

ENUM value
forwards
backwards

[7] The meaning of the ENUM values are managed in this table as values of 'FoStatusAbbreviation' (FoZustandsKurzform) - in order, for example, to simultaneously highlight the completion of additional optional elements.

[8] If optional elements are not used in the examples, 'N/A' is listed.

10.8 FoTripDirection

An ENUM with the following 'restriction' is defined for the trip direction.

ENUM value
forwards
backwards

10.9 ProductID

The following ENUM list has been defined in order to specify product type.

ENUM value	Meaning of the value
Train	A single vehicle operating individually or within a train assembly
Tram	Rail bound vehicle serving within the local public transport sector and powered electrically.
Bus	An abbreviated name for omnibus
Ship	A larger seafaring vessel
Cable car	Cars, chairs or a transport system with which hanging cars are pulled along by a rotating cable system

10.10 TransportModeText

The following ENUM list has been defined in order to specify transport type.

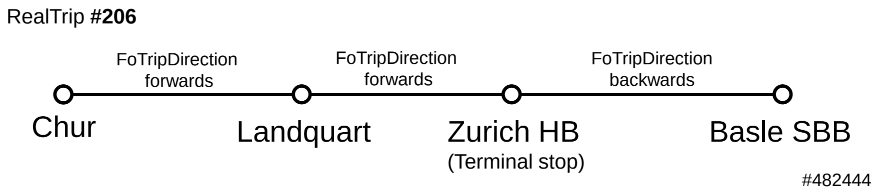
ENUM value	Meaning of the value
AG	Agency Train
ALS	Alaris
ARC	Arco
ART	Car Tunnel Train
ARZ	Car Travel Train
ATR	Altaria
AVE	Alta Velocidad ES
BAT	Ship
BAV	Steamboat
BEX	Bernina Express
BUS	Bus
CAT	City Airport Train
CNL	CitynightLine
D	Fast train
E	Express train
EB	Express bus
EC	EuroCity
EM	Euromed
EN	EuroNight
ES	Eurostar Italia
EST	Eurostar
EXT	Extra train
FAE	Ferry
FUN	Funicular
GEX	Glacier Express

ENUM value	Meaning of the value
IC	InterCity
ICB	InterCity-Bus
ICE	Intercity-Express
ICN	InterCity tilting train
IN	InterCityNacht
IR	InterRegio
IRE	Interregio-Express
JAT	Jail Train
KAT	Catamaran
KB	Minibus
L	Engine Train
LB	Cable car
M	Metro
MAT	Service train
NB	Night bus
NFB	Low-floor bus
NFO	Low-floor trolley bus
NFT	Low-floor tram
NZ	Night train
OEC	ÖBB EuroCity
OIC	ÖBB InterCity
R	Regio
RB	Regional train
RE	RegioExpress
RJ	Railjet
RSB	Regio commuter train
S	Commuter train
SB	School bus
SN	Night commuter train
STB	Lightrail
STR	Tram
T	Tram
TAL	Talgo
TER	TER200
TGV	Tran à grande vitesse
THA	Thalys
TLK	Twoje Linie Kolejowe
TRO	Trolleybus
TX	Taxi
U	Underground train / subway
UEX	Holiday Express
VAE	Voralpen-Express
VIA	InterCity
WB	Westbahn
X	InterConnex
X2	X2000 tilting train
TRAIN	Train category unknown

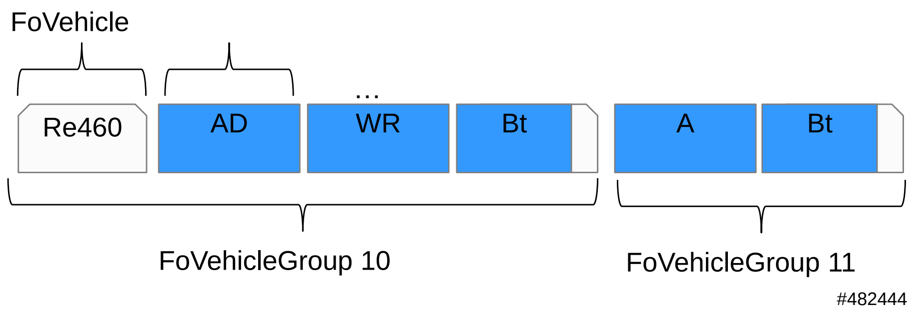
11 Appendix: XML examples

11.1 Example of transmitting the formations (RealTrip)

The separate **FormationsBeispiel_fuer_VDV454.xml** file shows an example of a train with formation data. The example shows a train with TripName 206, travelling from Chur to Basel SBB with stops in Landquart and Zurich HB (head station).



The train is composed as follows:



VehicleGhroup_10
1. (Re460) = Locomotive
2. (AD) = Car with 1st class seating and a baggage area
3. (WR) = Buffet car
4. (Bt) = Car with 2nd class seating and an engine cab

FahrzeugGruppe_11
5. (A) = Car with 1st class seating
6. (Bt) = Car with 2nd class seating and an engine cab

The passengers are not able to transfer between the two vehicle groups 10 and 11.

The third-party vehicle (D) stands at the head platform in Zurich HB in sector A with status code 'closed'.