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Chapter 5: Service and Related Data Concepts

In This Chapter

- Understand the requirements related to the Service Branch.
- Discover how Service branch and related data concepts are used.
- Learn how to apply the elements in the Service branch.
- Understand how to convert Standard Daily Time to Schedule Time for the SDP.

Service

The service branch describes the provision of (revenue) service. It includes the following elements:

- Trip
- Note
- Block (bus assignment)
- Event Connection (discussed in Chapter 10)

Purpose of a Service Branch Model

The Service Branch of the SDP XML Schema provides needed information on the transit service provided by an agency or organization unit of an agency. The Service Branch elements include information on trips and trip times, scheduling notes, bus assignment schedules (i.e., Block) and coordinated transfers (i.e., Event Connection). The Block and Event Connection requirements and guidance are described in Chapter 10: Advanced Topics.

Conceptual Data Reference Model (CDRM) Description for Service

The CDRM, shown in Figure 5-1, describes the data concepts that are incorporated in Service and how they are related. Trip is the primary building block of Service. The key portions of the Service CDRM are described as follows:

- A Trip is a one way scheduled movement of a transit vehicle between starting and ending locations (typically timepoints) which operates on certain days. A Trip is classified as revenue, non-revenue, and sometimes by agency defined types. Each Trip is an instance of a Pattern.
- A Trip may be associated with zero or more Notes. A Note may further describe the trip, for example, such as: "Connecting Service" or "Friday Only."
- The Trip is demarcated by an ordered sequence of Trip Time event times and locations. A trip time location may be a timepoint, transit stop, or both, as well as a location used to trigger an operational event.
- A Trip is composed of two or more ordered 'times' (tripTime) of Trip Time. Each tripTime in the sequence becomes a temporal event of the Trip describing events that occur at that location. A TRIP TIME may occur at a specific location more than once in a single TRIP, however, each occurrence is a unique temporal event (tripTime). (For example, a revenue vehicle may loop to the same stop more than once during a single trip. Another example may involve a train that arrives at a station at 10:30 a.m. and departs the station at 10:40 a.m. These may be described as two separate events at the same location. Each is described as a separate Trip Time.) Trip Time includes:
  - tripTime (mandatory) in the form of a signed integer that represents seconds past midnight. (The value may exceed a 24 hour clock.)
  - locationID (mandatory) of the event (should match a point on the associated Pattern).
  - timeType (mandatory) which describes whether this is an arrival, departure, passing, begin trip or end trip time.
  - platformNo (optional) for trains that include a boarding area in the Trip Time element.

  - seqNo (optional) or sequence number that defines the order in which the trip times occur. Alternatively, the tripTime, since it is an integer, may be used to sort the Trip Times.
- A Trip Time may be composed of zero or more Trip Event Types.
- The Trip Event Type is a classification of the event that occurs at the Trip Time. The Trip Event Type includes a designation that the event is included in the timetable header, short turn occurs, and alighting, boarding or both. Additional values and descriptions may be inserted as needed.

Additionally, a Trip Time may be associated with a scheduled connection to a different Trip. The Event Connection should include the time of the arriving Trip Time event and the departing Trip Time event. (A more detailed discussion of the coordinated transfers is discussed in Chapter 10: Advanced Topics. The discussion describes the associations among Event Connection, Connection Segment and Transfer Cluster.)

A Trip Time may be associated with zero or more Notes. A Note may further describe the event, for example, Metro North Railroad includes notes such as: "Discharge may depart 5 minutes early," or "Connecting Service."

A Note Library exists which is composed of Note_Entry(ies). Each entry contains a note identifier (noteID) and noteText that is shown to the public.

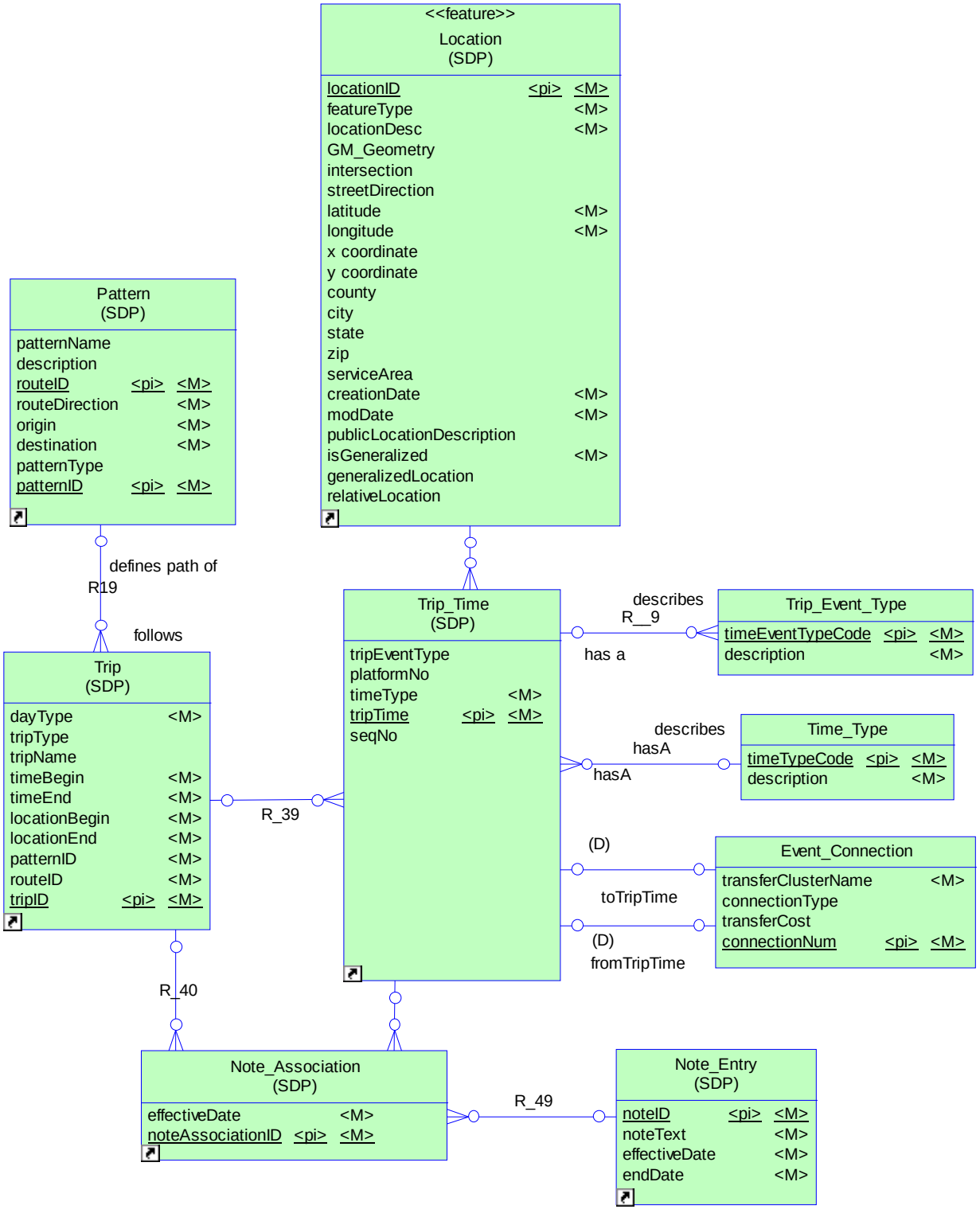

Figure 5-1: Service Data Model (Without Block)

Each data concept depicted in the Service CDRM will be discussed in more detail later in this chapter.

SDP XML Schema Description for the Service Branch

The rules applied to implement the CDRM as an XML Schema "flattens" the relationship among the entities in the Service Provision layer. Figure 5-2 depicts the top level of the Service branch from the SDP XML Schema.

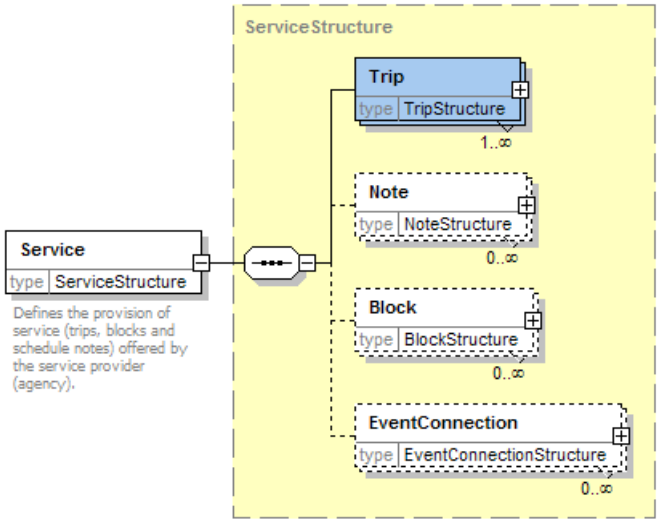

Figure 5-2: Service Model Implemented in the SDP XML Schema

Detailed descriptions of embedded elements in the Trip and Note elements may be found in Sections 5.1 and 5.2, respectively. (The Block and Event Connection requirements are described in Chapter 10: Advanced Topics.)

Section 5.1: Trip and Related Data Concepts

Purpose of the Trip Data Concept

Trip and its related entities, Note_Association, Trip_Time and Pattern, describe key elements of the transit service referenced by a schedule. Agencies typically have both revenue and non-revenue trips. Currently, non-revenue trips are not used by regional downstream applications, but they may be needed by internal applications that use the SDP format.

Requirements for the Trip Data Concept

The requirements that drive the Trip Data Concept are described in Table 5.1-1.

Table 5.1-1: Trip Requirements

#	Category	Requirements
1	Unique/Identity	• A trip is unique for a schedule version developed by a Transit Agency. • A trip is the temporal component of a pattern of a route in a given direction on a given type of day. • Each trip is fully defined by the set of scheduled times that a vehicle passes (arrives at or departs from a point) along an associated pattern. Specifically, a trip is composed of two or more ordered times. The times are typically described with respect to a schedule day (e.g., 24 or 36 hour day). • *Identity:* A unique identifier may be used to define a trip. The identifier should not be reused within a schedule version. Although not recommended, a trip may be identified by the first "trip time," i.e. passing time at the first timepoint. • A trip may be described as a temporal instance of a pattern. • Elements (scheduled trip times) of a trip correspond to selected points along a physical path described by a pattern. • Rail transit may identify a customer's "service trip" by the primary train number or name. (See Appendix A for more information on Special Considerations for Rail Transit).
2	Composition	• A trip is described by a starting location and departure time, and by an ending location and arrival time. The starting and ending locations should correspond to the origin and destination locations of the referenced pattern. • A trip may only operate on specific, non-overlapping days (e.g., weekday, Monday only, holiday) called Day Types.

Table 5.1-1: Trip Requirements

#	Category	Requirements
3	Trip Collections	• A set of abridged trip descriptions, aggregated by route direction and day type may be published for customer use as a timetable. • The set of trips, each associated with a pattern, and each pattern belonging to a route in a given direction, constitutes the scheduled service for a route. • A set of trips from one or more routes may be scheduled together in order to operate frequent service along a corridor. These are sometimes called lines or route groupings. • A set of trips may be chained together to describe the vehicle assignment or work for a day (block). The ordered set of trips may be characterized as revenue and non-revenue. The first and last trips (usually non-revenue) typically detail the vehicle's pull out from, and pull in to the garage or depot.
4	Exceptions	• As an operational exception, a trip may follow only part of a pattern if it was developed as a "short turn" trip. The point at which it turns around should be described as a ***time event type*** in the trip time description.
5	Subtype	• A trip may be revenue generating. • A trip may be non-revenue generating such as a deadhead, pull in or pull out. • A trip may be characterized by the type of service provided including regular, express, limited, scenic, etc.
6	Attributes	• Schedulers may sometimes attach one or more notes to a trip or trip time to convey information about the scheduled service. • Other attributes may sometimes be associated with a trip such as amenities that should be offered by the operating vehicle (e.g., bicycles rack/allowed), accessibility, mobile WiFi, etc.

Conceptual Data Reference Data Model Description

The Trip requirements are modeled in the CDRM as previously shown in Figure 5-2. The Trip and associated entities are used by Route, Route Grouping and Block as components of the transit service description.

SDP XML Schema Model Description for TRIP and TRIP TIME

In the course of implementing the SDP XML Schema for Trip from the CDRM, a number of translations were used. The XML Schema excerpt of the Trip data concept is illustrated in Figure 5-3. (Note: Figure 5-4 expands tripTimeList to show the elements of the embedded Trip Time element.)

The rules and assumptions associated with the Trip element include:

- Implemented *type* entities as enumerated type structures embedded in Trip element. The entities changed include: tripType, dayType.
- noteList embeds the set of related noteIDs into the Trip element.
- timeBegin and timeEnd should correspond to the first and last tripTime child element of tripTimeList elements.

- Likewise, locationBegin and locationEnd should correspond to the first and last locationID child element of the tripTimeList elements.
- timeBegin and timeEnd use schedule time, that is the number of seconds past midnight (a signed integer).

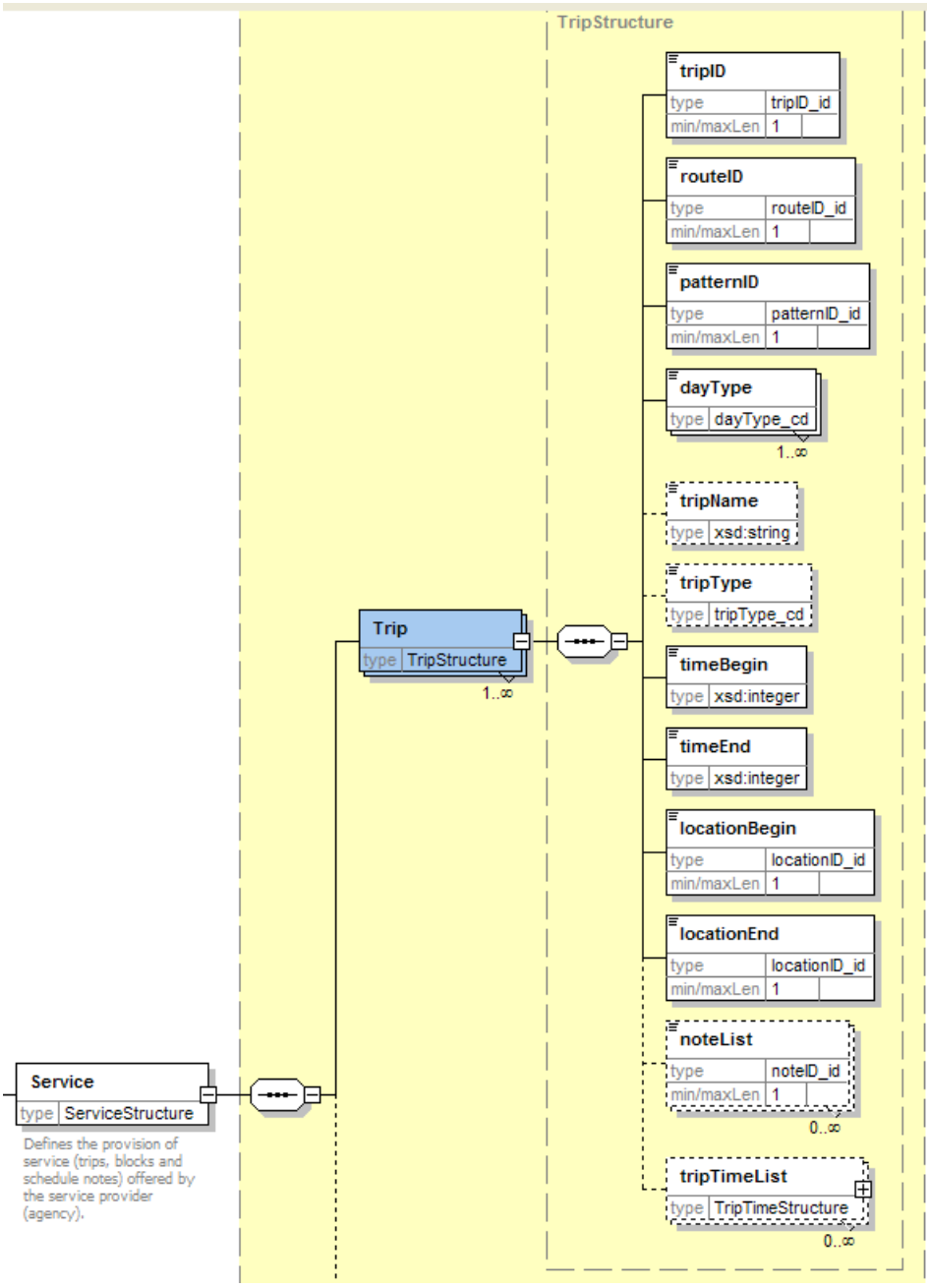

Figure 5-3: SDP XML Schema Excerpt of Trip

Figure 5-4 shows the SDP XML Schema for TripTime (this embedded element is tagged with tripTimeList in the Trip element). The rules and assumptions associated with the Trip Time element are similar to Trip. They include:

- Implemented *type* entities as enumerated type structures embedded in Trip Time element. The entities changed include: tripEventType, timeType.
- notes embeds the set of related noteIDs into the Trip Time element.
- tripTime, seconds past midnight, uses a signed integer, and thus may be used to sort the elements within the Trip, however, seqNo is added for those applications that prefer a set of sequential non-negative integers.
- Some agencies may wish to relate this element to a specific stop. The platformNo is equivalent to a stopID, therefore, it may be considered a stop.
- A rail operator may also associate an event with the trackNo. See the discussion on extensions to the SDP XML Schema (Appendix A).

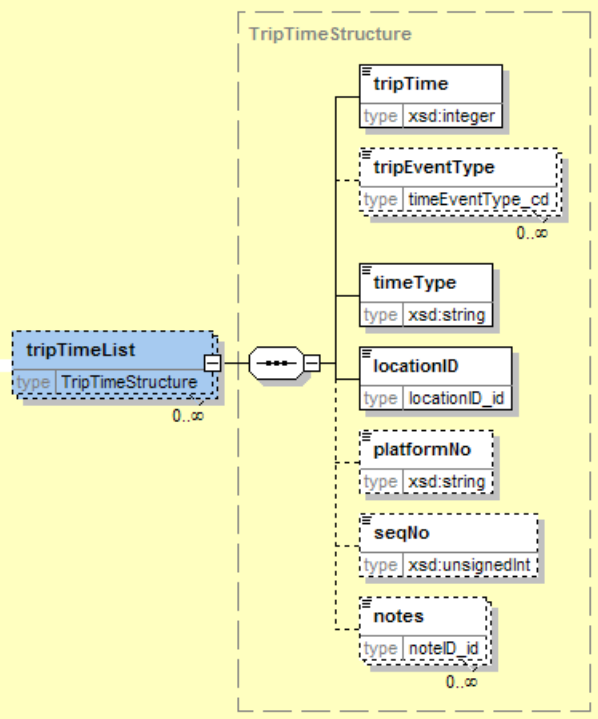

Figure 5-4: SDP XML Schema Excerpt of Trip Time

Detailed Data Formats and Guidance

This section describes the format and guidance associated with Trip in Table 5.1-2 and with TripTime in Table 5.1-3. The guidance is consolidated into tables that include a list of baseline requirements (M for mandatory and O for optional), the element name, the data type and guidance related to element. The first column of each table designates the baseline requirements based on the SDP XML Schema version 1.0. A downstream application may further restrict these requirements in order for the data set to meet its data needs. The element name corresponds to the related conceptual data model entities and attributes. The type may refer to a native XML type, or declared type in the XML schema. The Guidance column is called

"Questions to Ask." These questions direct the analyst to a similar or equivalent concept in their own schedule data set. In addition, some comments describe the impact of the data structures on the SDP XML Document deployment.

Table 5.1-2: Trip Guidance

Required	Element Name	Type	Questions to Ask
M	tripID	tripID_id UNIQUE	What field uniquely designates the trip? If there is no field, can you generate a unique set of identifiers per Route or across the schedule version data set?
M	routeID	routeID_id	How is a trip associated with a route?
M	patternID	patternID_id	Is a trip associated with a pattern? How?
M	dayType	dayType_cd [1..*]	How is day type defined and assigned to trips? (See Chapter 9 guidance on assigning day types). Notice that many day type codes may be used so that the trip definition may be used as a building block to develop sets of trips that may be used for different types of service. A special, locally defined day type may be defined using the DayType element in the AgencyRegistration branch.
O	tripType	tripType_cd	What field corresponds to tripType? Only revenue trips are needed for regional applications.
O	tripName	string	This field may be used by a named trip. Many rail operators may name a "train," for example, the field may be used as the primary train number for a service trip.
M	timeBegin	time	Time trip begins (timeBegin should correspond to first TripTime.tripTime value).
M	timeEnd	time	Time trip ends (last timeEnd should correspond to last TripTime.tripTime value).
M	locationBegin	locationID_id	Location begins (locationBegin should correspond to first TripTime.locationID value).
M	locationEnd	locationID_id	Location ends (locationEnd should correspond to last TripTime.locationID value).
O	noteList	list of noteID_id*	If there are notes, then complete the Note library and assign appropriate noteID to this list.
M	tripTimeList	ordered list of TripTime*	This is the list of trip times in the trip. Typically this is stored in sequential order, first time to last time of the trip.

Table 5.1-3: Trip Time Guidance

Required	Element Name	Type	Questions to Ask
M	tripTime	integer	The trip time is defined as an integer representing seconds past midnight. See Algorithm 1 below for technique to translate from clock time to seconds past midnight.
O	tripEventType	tripEventType [0..*]	Are there points or times along the trip that are designated for events (e.g., fare set change, headsign change, interior sign/annunciator message)? If true, then check code list for all the events represented in your data. This field may be listed more than once.
M	timeType	timeType_cd	Is the type of timing described in the table: arrival, departure, passing? Typically, if the tripTime is the first, then the default field is departing. If the field is the last, then the default is arrival. The default for all other occurrences depends on scheduling policy.
M	locationID	locationID_id	This locationID corresponds to the point along the trip where the time occurs. It may be any feature where time is measured.
O	platformNo	string	The platform where boarding or alighting occurs; check if mode is a Ferry or rail (commuter or subway). If true: How is the platform associated with the train or ferry's arrival at a station?
O	seqNo	integer	The order of this tripTime in the trip sequence. This field is not mandatory since the tripTime may be used to order the events.
O	notes	list of noteID_id	If there are notes, then complete the Note library and assign appropriate noteID to this list.

Usage and Examples of Trip and Trip Time Elements

Similar to a database, the SDP XML Schema allows an unlimited number of TRIP elements to be inserted between the Service tags. Additionally, an unlimited number of tripTimeList (TripTime) elements may also be embedded in each Trip element. Furthermore, the example below shows that optional elements may appear in one child element, yet not be present in another. This may be seen with the child element noteList in Trip, and again in tripTimeList with the tripEventType and notes child elements.

[Note: noteList and notes content were inserted to illustrate how the note association concepts work. They were not part of the native data.]

```
<Service>
  <Trip>
    <tripID>1</tripID>
    <routeID>3210</routeID>
    <patternID>119</patternID>
    <dayType>sat</dayType>
    <tripType>revenue</tripType>
```

```
      <timeBegin>22380</timeBegin>
      <timeEnd>22980</timeEnd>
      <locationBegin>7</locationBegin>
      <locationEnd>4918</locationEnd>
      <noteList>Express</noteList>
      <noteList>Friday Only</noteList>
      <tripTimeList>
        <tripTime>22380</tripTime>
        <tripEventType>ChgHeadsign</tripEventType>
        <timeType>beginTrip</timeType>
        <locationID>7</locationID>
        <seqNo>1</seqNo>
      </tripTimeList>
      <tripTimeList>
        <tripTime>22980</tripTime>
        <timeType>passing</timeType>
        <locationID>4918</locationID>
        <seqNo>2</seqNo>
        <notes>Alighting Only</notes>
      </tripTimeList>
    </Trip>
<!-- more trips here -->
  </Service>
```

Converting Standard Daily Time to Schedule Time

Different transit agencies in the United States use different methods for describing time when a transit trip operates over midnight, existing, in part, on two different days. Standard daily time may not be used for some systems and reports. Instead a day may be extended from 24 hours to some other number of hours, such as 30 hours in "schedule time." Also, some transit agencies may use either a 12 hour or a 24 hour clock for "schedule time."

This section describes an algorithm to convert standard time, i.e., hh:mm:ssss to Schedule Time. The schedule time was converted from minutes past midnight to seconds past midnight. To convert from standard time to seconds-past-midnight, use the following algorithm:

Algorithm for a 24 hour clock

tripTime = hh*3600+mm*60+ss

Algorithm for a 12 hour clock using a.m. and p.m.

If a 12 hour clock is used, then PM implies 12 hours from midnight, so add 12*3600 to the tripTime.

Trip time (also timeBegin/timeEnd) is a signed integer to represent times that occur prior to midnight (when a trip begins before midnight but is part of the next day's schedule, e.g., New Year's Day). Trip time may extend past 24 hours when a trip extends into the next day (after midnight) but belongs to the previous day, e.g., New Year's Eve day.

Section 5.2: Note and Note Association Data Concepts

Purpose of a Note in a Schedule

Notes are a key source of information on scheduled trips and trip times. A note may be targeted for the public, an operator, scheduler or other user of the schedule. The SDP focuses on those notes that are used by the public. An agency may not have notes or may not choose to include any notes in its schedule, therefore the Note data concept is optional.

Some examples of possible Notes are shown below.

- Indicates specially-designated weekend train allowing more than the regular eight bikes per train limit.
- Change at Jamaica. The track of your connecting train will be announced.
- Stops only to discharge (receive) customers.
- These buses continue to Walt Whitman Mall.
- Exit from first two cars.
- Trip operates via Union City upon request at time of boarding.
- Trip operates express via I-280 between Newark and Orange. Westbound trips to Livingston Mall operate to Park-Ride upon request.

Requirements for Note Data Concept

The requirements related to describing and populating a note is described Table 5.2-1.

Table 5.2-1: Note Requirements

#	Category	Requirements
1	Purpose and Identity	• The noteID must be a unique identifier within a schedule version. • A noteID may be defined as an alphanumeric character. • The noteText is typically developed as part of a schedule version. It conveys information about the schedule trip or trip time to the customer in a publication format.
2	Note Text	• A noteText is associated with a unique noteID. • The noteText is a concise message to explain a part of a schedule. It is displayed to the public. As such, the style should conform to agency print and web style policies. • A note text should be terse; it is recommended that the text not exceed 256 characters. • The note text is added for public dissemination only; it should not be used to replace assignment of day type, trip type, time event type, time type or connection type of any its associated entities.
3	Associations	• There is a many to many relationship between trips and notes, and trip times and notes. As such there should is an association table ascribing the occurrence of a note to a trip or trip time.
4	Note Library	• The note library is a collection of notes that may be used by Trip and Trip Time descriptions. • Each entry will allow an unlimited number of characters.

Conceptual Data Model Description for Note

The requirements for Note are modeled in the CDRM shown in Figure 5-5. The Note data concept includes the Note entity, and its associated entity, Note Association.

SDP XML Schema Model Description for Note

The SDP XML Schema for Note was implemented from the conceptual model without any issues. As a result, there was no need to modify requirements or create special requirements. The SDP XML Schema excerpt of the Note data concept is illustrated in Figure 5-5.

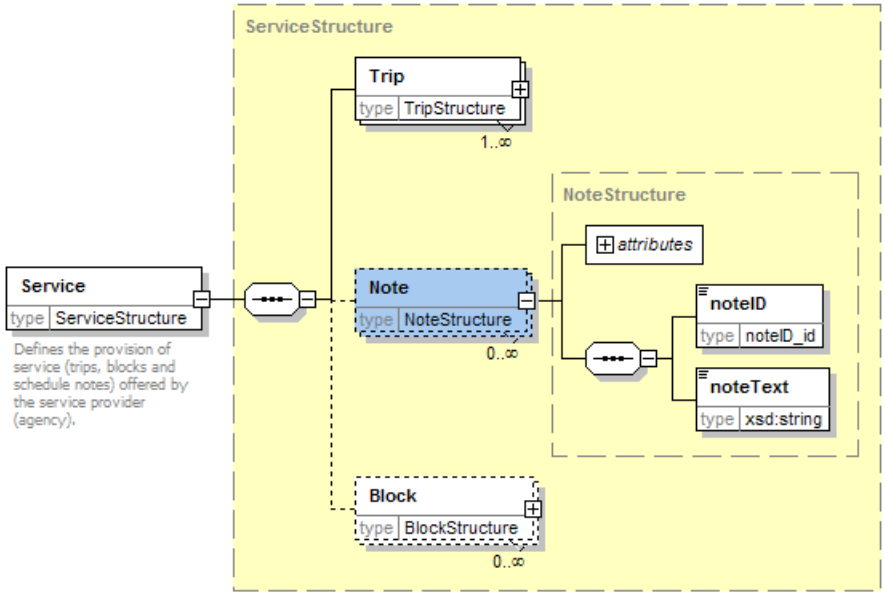

Figure 5-5: SDP XML Schema Excerpt for Note

Data Formats and Guidance for Note

This section describes the format and guidance for each element in the Note data concept described above. The guidance is consolidated into Table 5.2-2, which includes a list of baseline requirements (M for mandatory and O for optional), the element name, the data type and guidance related to element. The guidance provides clarity to the data definition. The first column of each table designates the baseline requirements based on the SDP XML Schema version 1.0. A downstream application may further restrict these requirements in order for the data set to meet its data needs. The element name corresponds to the related conceptual data model entities and attributes. The type may refer to a native XML type, or declared type in the XML schema. The Guidance column is called "Questions to Ask." These questions direct the analyst to a similar or equivalent concept in their own schedule data set. In addition, some comments describe the impact of the data structures on the SDP XML Document deployment.

Table 5.2-2: Note Guidance

Required	Element Name	Type	Questions to Ask
M	noteID	noteID_id UNIQUE	A unique identifier to designate the note.
M	noteText	String	The text of the note. This may be used by an application as content for public dissemination.
	effectiveDate	Date	[attribute] The first date on which the note record is valid.
	endDate	Date	[attribute] The last date on which the note record is valid. If the record does not have a specific end date, then use default end date [9999-12-31].

Example of Note Implementation

Notes can be a key source of important information on scheduled trips and trip times. In the example below, Table 5.2-3 lists some of Metro-North Railroad (MNR) Notes (extracted from their timetables).

Table 5.2-3: Example of Notes from Metro-North Railroad

noteID	noteText	Relationship to other SDP elements
A	Amtrak connections	
C	Connecting service	
D	Discharge passengers	maps to TripTime:tripEventType (AlightingOnly)
H	Discharge may depart 5 minutes early	
R	Receive only	maps to TripTime:tripEventType (BoardOnly)
G	Guaranteed ride home	
Bicycle	Bicycle train [includes additional text citing rules related to boarding with a bike…]	
Bus	Bus service connection	

Two of the notes—C and H—are further selected as examples and used to populate the SDP XML Note element, in the fragment of a SDP XML Document shown below.
The two notes excerpted from the table may be rendered to XML as follows:

```
<Service>
<!--Trip elements go here -->

        <Note>
                <noteID> C </noteID>
                <noteText> Connecting service </noteText>
        </Note>
        <Note>
                <noteID>H</noteID>
                <noteText> Discharge may depart 5 minutes early </noteText>
        </Note>
```

</Service>

When Should an Agency Use Notes as Opposed to Other Flags and Codes?

Notes are always acceptable. They are often used to explain special instructions to the public. The drawback of using notes is that they must be manually inserted and may not be well maintained over a long period of time. In contrast, codes and flags are frequently necessary to aid logical processing and implement automated algorithms. They are easier to maintain, and they provide information to downstream applications. So whenever possible, use codes and flags. Definitely add notes when the codes do not convey all the information to the public as well to highlight the information for the downstream user.

Validation Check

Retaining the relationship between the codes and notes is essential. For example, in the third column of Table 5.2-2, several notes relate directly to the code values, e.g., tripEventType (alight and board only). A validation check may be inserted in a native to SDP translator to ensure the data are consistent.