I.1 Introduction

While a monolithic implementation could create a complete sequencing system or a single monolithic sequencing service, an implementation can be built from a collection of lower-level sequencing services. Each of the services implement a part of the sequencing behavior defined in the Simple Sequencing Specification in conjunction with a set of external services. A conceptual view of such a collection of services combined into a single sequencing tool or overall service is illustrated in the diagram.

Services that comprise a sequencing system include:

- **Overall Sequencing Process Service** [OP] – controls the overall sequencing process (denoted as Sequencing Control Service in the diagram).
- **Navigation Service** [NB] – processes sequencing requests.
- **Exit Service** [EB] – processes exit requests.
- **Rollup Service** [RB] – performs the rollup process.
- **Selection and Ordering Service** [OB] – performs the selection and ordering process (not shown in the diagram).
- **Sequencing Service** [SB] – processes sequencing requests.
- **Delivery Service** [DB] – processes delivery requests.
I.1.1 Service Descriptions

Each of these services has one or more service access points (SAP) that are characterized by:

- **Description** – a brief overall description of the service.
- **Request** – the information passed to the service in a service call. The information may be data items or descriptions of data components and objects. For data components and objects, the representation is not specified.
- **Process** – the process used by the service. Processes implement behavior as described in the Simple Sequencing Specification.
- **Results** – the results returned from the service call.
- **Related Services** – other key services used by the service.
- **Bindings** – the service access point binding, e.g., the WSDL for the service as a web service.

I.1.2. General Assumptions

Each service works as a request-response process. The request maps directly to the different types of requests in Simple Sequencing (e.g., navigation request, sequencing request) described in the Simple Sequencing Specification. The service access points are based on a stateless model – each request is fully specified in terms of the sequencing activity tree and learner. The processes themselves are responsible for maintaining all state, such as the dynamic tracking data and where the individual learner is within the activity tree. There is no notion of transactions or coordination of multiple calls to services. There are similarly no assumptions about multi-threading or simultaneous processing of requests.

Data items passed to the request are only described conceptually. For example, each request includes the designation of the learner. How the data items are actually specified, e.g., is it a learner name or id, does it include authentication and authorization credentials, is not described.

Error conditions are not fully specified. In particular, general service failures, communications failures, etc., are not described. The results description does not indicate how error content or error indicators are defined, encoded or bound to a data type.

Note, any given process need not implement any of the subprocesses described herein or presented in the Simple Sequencing Specification. The corresponding subprocess behavior must be provided, but how that behavior is provided is left to an implementation. As a result, the structure and set of processing error returns may not be the same across implementations.
OP.1 Overall Sequencing Process Service

The overall sequencing process is just a workflow process. In controls the overall sequencing and is the direct interface to applications. Applications pass navigation requests to the Sequencing Loop Process that in turn invokes the other processes and delivers content activities to the learner.

The overall sequencing process has three service access points (SAP):
- **Sequencing Initialization Process** – Initialize the sequencing process.
- **Sequencing Loop Process** – Process one navigation request and deliver one activity.
- **Sequencing Termination Process** – Terminate the sequencing process.

OP.1.1 Sequencing Initialization Process SAP

**Description:**
Initialize the sequencing process. Initialize the sequencing system so it is ready to accept navigation requests.

**Request:**
The Sequencing Initialization Process requires data items that specify:
- The designation of the activity tree.
- The root activity of the tree for sequencing. An Xpath expression specifying the root node as a part of a larger tree. Specifying a root permits sequencing to be applied to part of a larger tree structure. The root for sequencing may be the same as the root of the activity tree.
- The learner.

**Process:**
The Sequencing Initialization Process behavior is defined in SS.OP.1. The process performs all actions to initialize sequencing. It leaves the sequencing system ready to accept a navigation request. The process does not include an initial navigation request.

**Results:**
The Sequencing Initialization Process returns the following upon completion:
- A Boolean indication if the Sequencing Initialization Process was successful.
- An error indication if the process was not successful. Possible errors include:
  - Data errors:
    - The activity tree was not properly specified.
    - The root of the tree was not properly specified.
    - The learner was not properly specified.
  - Processing Errors:
    - Error in the Sequencing Initialization Process.

The service process description does not define how to return multiple error indicators.

**Related Services:**
The Sequencing Initialization Process relies on the following other external services:
- Not specified.

**Bindings:**
Not specified.
OP.1.2 Sequencing Loop Process SAP

Description:
Process one navigation request and delivery an activity (and its associated content resources) to the learner.

Request:
The Sequencing Loop Process requires data items that specify:
- The designation of the activity tree.
- The root activity of the tree for sequencing. An Xpath expression specifying the root node as a part of a larger tree. Specifying a root permits sequencing to be applied to part of a larger tree structure. The root for sequencing may be the same as the root of the activity tree.
- The navigation request (from the Navigation Request vocabulary).
- A navigation location. An Xpath expression specifying a node in the activity tree. Ignored except for Choice navigation requests.
- The learner.

Process:
The Sequencing Loop Process behavior is defined in SS.OP.1. It processes one navigation request and may result in the delivery of content resources for an activity to the learner.

Results:
The Sequencing Loop Process returns the following upon completion:
- A Boolean indication if the Sequencing Loop Process was successful.
- An error indication if the process was not successful. Possible errors include:
  - Data errors:
    - The activity tree was not properly specified.
    - The root of the tree was not properly specified.
    - The navigation request was not properly specified.
    - The navigation location was not properly specified.
    - The learner was not properly specified.
  - Processing Errors:
    - Error in the Sequencing Loop Process (SS.OP.1).

The service process description does not define how to return multiple error indicators.

Related Services:
The Sequencing Loop Process relies on the following sequencing services:
- Navigation Request Service (see Section NB.1).
- Exit Request Service (see Section EB.1).
- Rollup Process Service (see Section RB.1).
- Selection and Ordering Service (see Section OB.1).
- Sequencing Request Service (see Section SB.1).
- Delivery Request Service (see Section DB.1).
- Delivery Environment Service (see Section DB.1).

Bindings:
Not specified.
OP.1.3 Sequencing Termination Process SAP

Description:
Terminate the sequencing process. Stop sequencing. Any further navigation requests will fail with a “not initialize” error.

Request:
The Sequencing Termination Process requires data items that specify:
- The designation of the activity tree.
- The root activity of the tree for sequencing. An XPath expression specifying the root node as a part of a larger tree. Specifying a root permits sequencing to be applied to part of a larger tree structure. The root for sequencing may be the same as the root of the activity tree.
- The learner.

Process:
The Sequencing Termination Process behavior is defined in SS.OP.1. The process performs all actions to terminate sequencing. It begins by identifying the current activity for the learner. It issues an Exit All navigation request. Once the navigation request has been completed, sequencing terminates.

Results:
The Sequencing Termination Process returns the following upon completion:
- A Boolean indication if the Sequencing Termination Process was successful.
- An error indication if the process was not successful. Possible errors include:
  - Data errors:
    - The activity tree was not properly specified.
    - The root of the tree was not properly specified.
    - The learner was not properly specified.
  - Processing Errors:
    - Error in the Sequencing Termination Process.

The service process description does not define how to return multiple error indicators. The process does not define how to terminate the content activity being presented to the learner.

Related Services:
The Sequencing Termination Process relies on the following other sequencing services:
- Sequencing Loop Process.

Bindings:
Not specified.
NB.1 Navigation Process Service

The navigation process service handles navigation requests. Requests are validated and corresponding exit and sequencing requests are generated.

The navigation process service has one service access point (SAP) for the Navigation Request Process.

NB.1.1 Navigation Request Process SAP

Description:
Process a navigation request and return an exit request and a sequencing request for further processing.

Request:
The Navigation Request Process requires data items that specify:
- The designation of the activity tree.
- The root activity of the tree for navigation. An Xpath expression specifying the root node as a part of a larger tree. Specifying a root permits navigation to be applied to part of a larger tree structure. The root for navigation may be the same as the root of the activity tree.
- The navigation request (from the Navigation Request vocabulary).
- A navigation location. An Xpath expression specifying a node in the activity tree. Ignored except for Choice navigation requests.
- The learner.

Process:
The Navigation Request Process behavior is defined in SS.NB.2.1 (Navigation Request Process).

Results:
The Navigation Request Process returns the following upon completion:
- A Boolean indication if the Navigation Request Process was successful.
- An indication of the corresponding exit request to process if the process was successful (from the Exit Request vocabulary).
- An indication of the corresponding sequencing request to process if the process was successful (from the Sequencing Request vocabulary).
- An error indication if the process was not successful. Possible errors include:
  - Data errors:
    - The activity tree was not properly specified.
    - The root of the tree was not properly specified.
    - The Navigation Request was not properly specified.
    - The navigation location was not properly specified.
    - The learner was not properly specified.
  - Processing Errors:
    - Error in the Navigation Request Process (SS.NB.2.1).

The service process description does not define how to return multiple error indicators.

Related Services:
The Navigation Request Process relies on the following other external services:
- Not specified.

Bindings:
Not specified.
EB.1 Exit Process Service

The exit process service handles exit requests. Exit processing controls the behavior when a content activity terminates.

The exit process service has one service access point (SAP) for the Exit Request Process.

EB.1.1 Exit Request Process SAP

Description:
Process an exit request and return a sequencing request for further processing.

Request:
The Exit Request Process requires data items that specify:
- The designation of the activity tree.
- The root activity of the tree for exit processing. An Xpath expression specifying the root node as a part of a larger tree. Specifying a root permits exit processing to be applied to part of a larger tree structure. The root for exit processing may be the same as the root of the activity tree.
- The exit request (from the Exit Request vocabulary).
- A current activity. An Xpath expression specifying a node in the activity tree.
- The target activity. An Xpath expression specifying a node in the activity tree. Ignored except for Exit Target exit requests.
- The learner.

Process:
The Exit Request Process behavior is defined in SS.EB.2.4 (Exit Request Process).

Results:
The Exit Request Process returns the following upon completion:
- A Boolean indication if the Exit Request Process was successful.
- An indication of the overriding sequencing request, optional (from the Sequencing Request vocabulary).
- An error indication if the process was not successful. Possible errors include:
  - Data errors:
    - The activity tree was not properly specified.
    - The root of the tree was not properly specified.
    - The current activity was not properly specified.
    - The target activity was not properly specified.
    - The Exit Request was not properly specified.
    - The learner was not properly specified.
  - Processing Errors:
    - Error in the Exit Request Process (SS.EB.2.4).
    - Error in the Sequencing Exit Condition Rules Subprocess (SS.EB.2.1).
    - Error in the Sequencing Post Condition Rules Subprocess (SS.EB.2.2).
    - Error in the Completion Subprocess (SS.EB.2.3).

The service process description does not define how to return multiple error indicators.

Related Services:
The Exit Request Process relies on the following other external services:
- Tracking Model Services (used to access and set values in the Tracking Model, see SS.TM).
- Activity State Model Services (used to access and set values in the Activity State Model, see SS.AM).

Bindings:
Not specified.
RB.1 Rollup Process Service

The rollup process service performs rollup processing – the results from an activity are used to determine the results for parent activities.

The rollup process service has one service access point (SAP) for the Rollup Process.

RB.1.1 Rollup Process SAP

Description:
Perform the rollup process and update the tracking model for the learner.

Request:
The Rollup Process requires data items that specify:
- The designation of the activity tree.
- The root activity of the tree for rollup. An Xpath expression specifying the root node as a part of a larger tree. Specifying a root permits rollup to be applied to part of a larger tree structure. The root for rollup may be the same as the root of the activity tree.
- The activity at the end of the rollup path. An Xpath expression specifying a node within the activity tree.
- The learner.

Process:
The Rollup Process is behavior defined in SS.RB.1.5 (Overall Rollup Process).

Results:
The Rollup Process returns the following upon completion:
- A Boolean indication if the Rollup Process was successful.
- An error indication if the process was not successful. Possible errors include:
  - Data errors:
    - The activity tree was not properly specified.
    - The root of the tree was not properly specified.
    - The end of the rollup path was not properly specified.
    - The learner was not properly specified.
  - Processing Errors:
    - Error in the Overall Rollup Process (SS.RB.1.5).
    - Error in the Measure Rollup Process (SS.RB.1.1).
    - Error in the Objective Rollup Process (SS.RB.1.2).
    - Error in the Activity Progress Rollup Process (SS.RB.1.3).
    - Error in the Objective Mapping Process (SS.RB.1.4).
    - Error in the Duration Rollup Process.

The service process description does not define how to return multiple error indicators.

Related Services:
The Rollup Process relies on the following other external services:
- Tracking Model Services (used to access and set values in the Tracking Model, see SS.TM).

Bindings:
Not specified.
OB.1 Selection and Ordering Process Service

The selection and ordering process service selects learning activities and orders (randomly) the activities. Only activities from the selected, ordered set are sequenced.

The selection and ordering process service has one service access point (SAP) for the Selection and Ordering Process.

OB.1.1 Selection and Ordering Process SAP

Description:
Perform the selection and ordering process to determine the candidate activities for sequencing.

Request:
The Selection and Ordering Process requires data items that specify:
- The designation of the activity tree.
- The root activity of the tree for selection and ordering. An Xpath expression specifying the root node as a part of a larger tree. Specifying a root permits the selection and ordering process to be applied to part of a larger tree structure. The root for selection and ordering may be the same as the root of the activity tree.
- The learner.

Process:
The Selection and Ordering is behavior defined in SS.OB.1.5 (Selection and Ordering Process).

Results:
The Selection and Ordering Process returns the following upon completion:
- A Boolean indication if the Selection and Ordering Process was successful.
- An error indication if the process was not successful. Possible errors include:
  - Data errors:
    - The activity tree was not properly specified.
    - The root of the tree was not properly specified.
    - The learner was not properly specified.
  - Processing Errors:
    - Error in the Selection and Ordering Process (SS.OB.1.3).
    - Error in the Select Children Subprocess (SS.OB.1.1).
    - Error in the Randomize Children Subprocess (SS.OB.1.2).

The service process description does not define how to return multiple error indicators.

Related Services:
The Selection and Ordering Process relies on the following other external services:
- Not specified.

Bindings:
Not specified.
SB.1 Sequencing Process Service

The sequencing process service handles sequencing requests. Processing a sequencing request determines the next content activity that is targeted for delivery to the learner.

The sequencing process service has one service access point (SAP) for the Sequencing Request Process.

SB.1.1 Sequencing Request Process SAP

Description:
Process a sequencing request and return a delivery request.

Request:
The *Sequencing Request Process* requires data items that specify:
- The designation of the activity tree.
- The root activity of the tree for sequencing. An Xpath expression specifying the root node as a part of a larger tree. Specifying a root permits sequencing to be applied to part of a larger tree structure. The root for sequencing may be the same as the root of the activity tree.
- The sequencing request (from the *Sequencing Request* vocabulary).
- The target sequencing request. An Xpath expression specifying a node within the activity tree. Ignored except for *Choice* sequencing requests.
- The last activity identified for sequencing. An Xpath expression specifying a node within the activity tree. Ignored for some types of sequencing requests.
- The learner.

Process:
The *Sequencing Request Process* behavior is defined in SS.SB.2.14 (*Sequencing Request Process*).

Results:
The *Sequencing Request Process* returns the following upon completion:
- A Boolean indication if the *Sequencing Request Process* was successful.
- An Boolean indication to Exit Sequencing (i.e., exit the sequencing process).
- The activity to deliver if the process was successful. An Xpath expression specifying a node within the activity tree. None will be returned if the *Sequencing Request Process* was not successful or if sequencing is to terminate.
- An error indication if the process was not successful. Possible errors include:
  - Data errors:
    - The activity tree was not properly specified.
    - The root of the tree was not properly specified.
    - The sequencing request was not properly specified.
    - The last activity identified for sequencing was not properly specified.
    - The learner was not properly specified.
  - Processing Errors:
    - Error in the *Sequencing Request Process* (SS.SB.2.14).
    - Error in the *Sequencing Rules Check Subprocess* (SS.SB.2.1).
    - Error in the *Limit Conditions Check Subprocess* (SS.SB.2.2).
    - Error in the *Flow Tree Traversal Subprocess* (SS.SB.2.3).
    - Error in the *Flow Activity Sequencing Subprocess* (SS.SB.2.4).
    - Error in the *Check Activity Subprocess* (SS.SB.2.5).
    - Error in the *Choice Activity Sequence Subprocess* (SS.SB.2.6).
    - Error in the *Start Sequencing Request Process* (SS.SB.2.7).
    - Error in the *Resume All Sequencing Request Process* (SS.SB.2.8).
    - Error in the *Continue Sequencing Request Process* (SS.SB.2.9).
    - Error in the *Previous Sequencing Request Process* (SS.SB.2.10).
    - Error in the *Choice Sequencing Request Process* (SS.SB.2.11).
    - Error in the *Retry Sequencing Request Process* (SS.SB.2.12).
Error in the Exit Sequencing Request Process (SS.SB.2.13).

The service process description does not define how to return multiple error indicators.

**Related Services:**
The Sequencing Request Process relies on the following other external services:
- Time Service (return current time point).

**Bindings:**
Not specified.
DB.1 Delivery Process Service

The delivery process service handles delivery requests. Delivery requests are validated and the corresponding content resources for the identified activity are delivered to the learner.

The delivery process service has two service access points (SAP):
- Delivery Request Process – Process a delivery request.
- Content Delivery Environment Process – Deliver an activity.

DB.1.1 Delivery Request Process SAP

Description:
Process a delivery request and identify the content to deliver to the learner.

Request:
The Delivery Request Process requires data items that specify:
- The designation of the activity tree.
- The root activity of the tree for delivery. An Xpath expression specifying the root node as a part of a larger tree. Specifying a root permits delivery to be applied to part of a larger tree structure. The root for delivery may be the same as the root of the activity tree.
- The activity for delivery. An Xpath expression specifying a node within the activity tree.
- The learner.

Process:
The Delivery Request Process behavior is defined in SS.DB.1.3 (Overall Delivery Process).

Results:
The Delivery Request Process returns the following upon completion:
- A Boolean indication if the Delivery Request Process was successful.
- An indication of the content resource to deliver if the process was successful.
  - The content if the Delivery Request Process successfully identified the activity from the resource GUID in the content package.
  - Error content if the Delivery Request Process was not successful.
- An error indication if the process was not successful. Possible errors include:
  - Data errors
    - The activity tree was not properly specified.
    - The root of the tree was not properly specified.
    - The end of the delivery path was not properly specified.
    - The learner was not properly specified.
  - Processing Errors
    - Error in the Overall Delivery Process (SS.DB.1.3).
    - Error in the Sequencing Rules Process (SS.DB.1.1).
    - Error in the Limit Conditions Process (SS.DB.1.2).

The service process description does not define how to return multiple error indicators.

Related Services:
The Delivery Request Process relies on the following other external services:
- Time Service (return current time point).

Bindings:
Not specified.
DB.1.2 Content Delivery Environment Process SAP

Description:
Deliver the resources for an activity to the learner.

Request:
The **Content Delivery Environment Process** requires data items that specify:
- The designation of the activity tree.
- The root activity of the tree for delivery. An Xpath expression specifying the root node as a part of a larger tree. Specifying a root permits delivery to be applied to part of a larger tree structure. The root for delivery may be the same as the root of the activity tree.
- The activity for delivery. An Xpath expression specifying a node within the activity tree.
- The learner.

Process:
The **Content Delivery Environment Process** behavior is defined in SS.DB.2.

Results:
The **Content Delivery Environment Process** returns the following upon completion:
- A Boolean indication if the **Content Delivery Environment Process** was successful.
- An error indication if the process was not successful. Possible errors include:
  - Data errors:
    - The activity tree was not properly specified.
    - The root of the tree was not properly specified.
    - The end of the delivery path was not properly specified.
    - The learner was not properly specified.
  - Processing Error:
    - Error in the **Content Delivery Environment Process**.

The service process description does not define how to return multiple error indicators.

Related Services:
The delivery process relies on the following other external services:
- Time Service (return current time point).
- Tracking Model Services (used to access and set values in the Tracking Model, see SS.TM).

Bindings:
Not specified.