

1 xAPI Formal Specification

The current formal specification only defines xAPI statements abstractly within the context of Z. A concrete definition for xAPI statements is outside the scope of this document.

1.1 Basic and Free Types

[*MBOX*, *MBOX_SHA1SUM*, *OPENID*, *ACCOUNT*]

- Basic Types for the abstract representation of the different forms of Inverse Functional Identifiers found in xAPI

[*CHOICES*, *SCALE*, *SOURCE*, *TARGET*, *STEPS*]

- Basic Types for the abstract representation of the different forms of Interaction Components found in xAPI

IFI ::= *MBOX* | *MBOX_SHA1SUM* | *OPENID* | *ACCOUNT*

- Free Type unique to Agents and Groups, The concrete definition of the listed Basic Types is outside the scope of this specification

OBJECTTYPE ::= *Agent* | *Group* | *SubStatement* | *StatementRef* | *Activity*

- A type which can be present in all activities as defined by the xAPI specification

INTERACTIONTYPE ::= *true-false* | *choice* | *fill-in* | *long-fill-in* | *matching* | *performance* | *sequencing* | *likert* | *numeric* | *other*

- A type which represents the possible interactionTypes as defined within the xAPI specification

INTERACTIONCOMPONENT ::= *CHOICES* | *SCALE* | *SOURCE* | *TARGET* | *STEPS*

- A type which represents the possible interaction components as defined within the xAPI specification
- the concrete definition of the listed Basic Types is outside the scope of this specification

CONTEXTTYPES ::= *parent* | *grouping* | *category* | *other*

- A type which represents the possible context types as defined within the xAPI specification

[*STATEMENT*]

- Basic type for an xAPI data point

[*AGENT*, *GROUP*]

- Basic types for Agents and collections of Agents

1.2 Id Schema

<i>Id</i>
$id : \mathbb{F}_1 \#1$

- the schema *Id* introduces the component *id* which is a non-empty, finite set of 1 value

1.3 Schemas for Agents, Groups and Actors

<i>Agent</i>
$agent : AGENT$
$objectType : OBJECTTYPE$
$name : \mathbb{F}_1 \#1$
$ifi : IFI$
$objectType = Agent$
$agent = \{ifi\} \cup \mathbb{P}\{name, objectType\}$

- The schema *Agent* introduces the component *agent* which is a set consisting of an *ifi* and optionally an *objectType* and/or *name*

<i>Member</i>
<i>Agent</i>
$member : \mathbb{F}_1$
$member = \{a : AGENT \mid \forall a_n : a_i..a_j \bullet i \leq n \leq j \bullet a = agent\}$

- The schema *Member* introduces the component *member* which is a set of objects *a*, where for every *a* within $a_0..a_n$, *a* is an *agent*

<i>Group</i>
<i>Member</i>
$group : GROUP$
$objectType : OBJECTTYPE$
$ifi : IFI$
$name : \mathbb{F}_1 \#1$
$objectType = Group$
$group = \{objectType, name, member\} \vee \{objectType, member\} \vee \{objectType, ifi\} \cup \mathbb{P}\{name, member\}$

- The schema *Group* introduces the component *group* which is of type *GROUP* and is a set of either *objectType* and *member* with optionally *name* or *objectType* and *ifi* with optionally *name* and/or *member*

<i>Actor</i>
<i>Agent</i>
<i>Group</i>
$actor : AGENT \vee GROUP$
$actor = agent \vee group$

- The schema *Actor* introduces the component *actor* which is either an *agent* or *group*

1.4 Verb Schema

<i>Verb</i>
<i>Id</i>
$display, verb : \mathbb{F}_1$
$verb = \{id, display\} \vee \{id\}$

- The schema *Verb* introduces the component *verb* which is a set that consists of either *id* and the non-empty, finite set *display* or just *id*

1.5 Object Schema

<i>Extensions</i>
$extensions, extensionVal : \mathbb{F}_1$
$extensionId : \mathbb{F}_1 \#1$
$extensions = \{e : (extensionId, extensionVal) \mid \forall e_n : e_i..e_j \bullet i \leq n \leq j \bullet$ $(extensionId_i, extensionVal_i) \vee (extensionId_i, extensionVal_j) \wedge$ $(extensionId_j, extensionVal_i) \vee (extensionId_j, extensionVal_j) \wedge$ $extensionId_i \neq extensionId_j\}$

- The schema *Extensions* introduces the component *extensions* which is a non-empty, finite set that consists of ordered pairs of *extensionId* and *extensionVal*. Different *extensionIds* can have the same *extensionVal* but there can not be two identical *extensionId* values
- *extensionId* is a non-empty, finite set with one value
- *extensionVal* is a non-empty, finite set

<i>InteractionActivity</i>
$interactionType : INTERACTIONTYPE$
$correctResponsePattern : seq_1$
$interactionComponent : INTERACTIONCOMPONENT$
$interactionActivity = \{interactionType, correctReponsePattern, interactionComponent\} \vee$ $\{interactionType, correctResponsePattern\}$

- The schema *InteractionActivity* introduces the component *interactionActivity* which is a set of either *interactionType* and *correctResponsePattern* or *interactionType* and *correctResponsePattern* and *interactionComponent*

<i>Definition</i>
<i>InteractionActivity</i>
<i>Extensions</i>
$definition, name, description : \mathbb{F}_1$
$type, moreInfo : \mathbb{F}_1 \#1$
$definition = \mathbb{P}_1\{name, description, type, moreInfo, extensions, interactionActivity\}$

- The schema *Definition* introduces the component *definition* which is the non-empty, finite power set of *name*, *description*, *type*, *moreInfo* and *extensions*

<i>Object</i>
<i>Id</i>
<i>Definition</i>
<i>Agent</i>
<i>Group</i>
<i>Statement</i>
$objectTypeA, objectTypeS, objectTypeSub, objectType : OBJECTTYPE$
$substatement : STATEMENT$
$object : \mathbb{F}_1$
$substatement = statement$
$objectTypeA = Activity$
$objectTypeS = StatementRef$
$objectTypeSub = SubStatement$
$objectType = objectTypeA \vee objectTypeS$
$object = \{id\} \vee \{id, objectType\} \vee \{id, objectTypeA, definition\}$
$\vee \{id, definition\} \vee \{agent\} \vee \{group\} \vee \{objectTypeSub, substatement\}$
$\vee \{id, objectTypeA\}$

- The schema *Object* introduces the component *object* which is a non-empty, finite set of either *id*, *id* and *objectType*, *id* and *objectTypeA*, *id* and *objectTypeA* and *definition*, *agent*, *group*, or *substatement*
- The schema *Statement* and the corresponding component *statement* will be defined later on in this specification

1.6 Result Schema

<i>Score</i>
$score : \mathbb{F}_1$ $scaled, min, max, raw : \mathbb{Z}$
$scaled = \{n : \mathbb{Z} \mid -1.0 \leq n \leq 1.0\}$ $min = n < max$ $max = n > min$ $raw = \{n : \mathbb{Z} \mid min \leq n \leq max\}$ $score = \mathbb{P}_1\{scaled, raw, min, max\}$

- The schema *Score* introduces the component *score* which is the non-empty powerset of *min*, *max*, *raw* and *scaled*

<i>Result</i>
<i>Score</i> <i>Extensions</i> $success, completion, response, duration : \mathbb{F}_1 \#1$ $result : \mathbb{F}_1$
$success = \{true\} \vee \{false\}$ $completion = \{true\} \vee \{false\}$ $result = \mathbb{P}_1\{score, success, completion, response, duration, extensions\}$

- The schema *Result* introduces the component *result* which is the non-empty power set of *score*, *success*, *completion*, *response*, *duration* and *extensions*

1.7 Context Schema

<i>Instructor</i>
<i>Agent</i> <i>Group</i> $instructor : AGENT \vee GROUP$
$instructor = agent \vee group$

- The schema *Instructor* introduces the component *instructor* which can be ether an *agent* or a *group*

<i>Team</i>
<i>Group</i>
<i>team</i> : <i>GROUP</i>
<i>team</i> = <i>group</i>

- The schema *Team* introduces the component *team* which is a *group*

<i>Context</i>
<i>Instructor</i>
<i>Team</i>
<i>Object</i>
<i>Extensions</i>
<i>registration, revision, platform, language</i> : $\mathbb{F}_1 \#1$
<i>parentT, groupingT, categoryT, otherT</i> : <i>CONTEXTTYPES</i>
<i>contextActivities, statement</i> : \mathbb{F}_1
<i>statement</i> = <i>object</i> \ (<i>id, objectType, agent, group, definition</i>)
<i>parentT</i> = <i>parent</i>
<i>groupingT</i> = <i>grouping</i>
<i>categoryT</i> = <i>category</i>
<i>otherT</i> = <i>other</i>
<i>contextActivity</i> = { <i>ca</i> : <i>object</i> \ (<i>agent, group, objectType, objectTypeSub, substatement</i>)}
<i>contextActivityParent</i> = (<i>parentT, contextActivity</i>)
<i>contextActivityCategory</i> = (<i>categoryT, contextActivity</i>)
<i>contextActivityGrouping</i> = (<i>groupingT, contextActivity</i>)
<i>contextActivityOther</i> = (<i>otherT, contextActivity</i>)
<i>contextActivities</i> = \mathbb{P}_1 { <i>contextActivityParent, contextActivityCategory,</i> <i>contextActivityGrouping, contextActivityOther</i> }
<i>context</i> = \mathbb{P}_1 { <i>registration, instructor, team, contextActivities, revision,</i> <i>platform, language, statement, extensions</i> }

- The schema *Context* introduces the component *context* which is the non-empty powerset of *registration, instructor, team, contextActivities, revision, platform, language, statement* and *extensions*
- The notation *object* \ *agent* represents the component *object* except for its subcomponent *agent*

1.8 Timestamp and Stored Schema

<i>Timestamp</i>
<i>timestamp</i> : $\mathbb{F}_1 \#1$

<i>Stored</i>
<i>stored</i> : $\mathbb{F}_1 \#1$

- The schema *Timestamp* and *stored* introduce the components *timestamp* and *stored* respectively. Each are non-empty, finite sets containing one value

1.9 Attachements Schema

<i>Attachments</i>	
<i>display, description, attachment, attachments</i> : \mathbb{F}_1	
<i>usageType, sha2, fileUrl, contextType</i> : $\mathbb{F}_1 \#1$	
<i>length</i> : \mathbb{N}	
<i>attachment</i> = { <i>usageType, display, contentType, length, sha2</i> } $\cup \mathbb{P}\{description, fileUrl\}$	
<i>attachments</i> = { <i>a</i> : <i>attachment</i> }	

- The schema *Attachements* introduces the componenet *attachements* which is a non-empty, finite set of the component *attachment*
- The component *attachment* is a non-empty, finite set of the componenets *usageType, display, contentType, length, sha2* with optionally *description* and/or *fileUrl*

1.10 Statement and Statements Schema

<i>Statement</i>	
<i>Id</i>	
<i>Actor</i>	
<i>Verb</i>	
<i>Object</i>	
<i>Result</i>	
<i>Context</i>	
<i>Timestamp</i>	
<i>Stored</i>	
<i>Attachements</i>	
<i>statement</i> : <i>STATEMENT</i>	
<i>statement</i> = { <i>actor, verb, object, stored</i> } $\cup \mathbb{P}\{id, result, context, timestamp, attachments\}$	

- The schema *Statement* introduces the component *statement* which consists of the components *actor, verb, object* and *stored* and the optional components *id, result, context, timestamp*, and/or *attachments*
- The schema *Statement* allows for subcomponent of *statement* to refrenced via the . (selection) operator

<i>Statements</i>	
<i>Statement</i>	
<i>IsoToUnix</i>	
<i>statements</i> : \mathbb{F}_1	
$statements = \{s : statement \mid \forall s_n : s_i..s_j \bullet i \leq n \leq j$ $\bullet convert(s_i.timestamp) \leq convert(s_j.timestamp)\}$	

- The schema *Statements* introduces the component *statements* which is a non-empty, finite set of the component *statement* which are in chronological order.