

Online Appendix of the Paper: Managing Temporal and Versioning Aspects of JSON-based Big Data via the τ JSchema Framework

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A1 TCSchema: JSON Schema for Temporal Logical and Temporal Physical Characteristics

In this appendix, we provide TCSchema, the JSON Schema for temporal logical and temporal physical characteristics (cf. Fig. A1.1).

```
{
  "$schema": "http://json-schema.org/draft-04/schema#",
  "$id": "http://jsonschema.net",
  "type": "object",
  "title": "TCSchema",
  "required": [
    "temporalCharacteristicSet"
  ],
  "properties": {
    "temporalCharacteristicSet": {
      "$id": "#/properties/temporalCharacteristicSet",
      "type": "object",
      "properties": {
        "logical": {
          "$id":
            "#/properties/temporalCharacteristicSet/properties/logical",
          "type": "object",
          "properties": {
            "include": {
              "$id":
                "#/properties/temporalCharacteristicSet/properties/logical/properties/in
                clude",
              "type": "array",
              "items": {
                "type": "object",
                "required": [
                  "temporalCharacteristicLocation"
                ],
                "properties": {
                  "temporalCharacteristicLocation": {
                    "$id":
                      "#/properties/temporalCharacteristicSet/properties/logical/properties/in
                      clude/properties/temporalCharacteristicLocation",
```

```

        "type": "string"
      }
    }
  },
  "defaultTimeFormat": {
    "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/de
faultTimeFormat",
    "type": "object",
    "properties": {
      "format": {
        "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/de
faultTimeFormat/properties/format",
        "type": "object",
        "properties": {
          "plugin": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/de
faultTimeFormat/properties/format/properties/plugin",
            "type": "string"
          },
          "granularity": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/de
faultTimeFormat/properties/format/properties/granularity",
            "type": "string"
          },
          "calendar": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/de
faultTimeFormat/properties/format/properties/calendar",
            "type": "string"
          },
          "properties": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/de
faultTimeFormat/properties/format/properties/properties",
            "type": "string"
          },
          "valueSchema": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/de
faultTimeFormat/properties/format/properties/valueSchema",
            "type": "string"
          }
        }
      }
    }
  },
  "logicalItems": {
    "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems",
    "type": "array",
    "items": {
      "type": "object",
      "required": [
        "target"
      ],
      "properties": {
        "target": {
          "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/target",
          "type": "string"
        },
        "validTime": {
          "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/validTime",
          "type": "object",
          "properties": {
            "kind": {
              "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo

```

```

gicalItems/properties/validTime/properties/kind",
    "type": "string",
    "enum": [
        "state",
        "event"
    ]
},
"content": {
    "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/validTime/properties/content",
    "type": "string",
    "enum": [
        "constant",
        "varying"
    ]
},
"existence": {
    "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/validTime/properties/existence",
    "type": "string",
    "enum": [
        "constant",
        "varyingWithGaps",
        "varyingWithoutGaps"
    ]
},
"contentVaryingApplicabilities": {
    "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/validTime/properties/contentVaryingApplicabilities
",
    "type": "array",
    "items": {
        "type": "object",
        "properties": {
            "begin": {
                "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/validTime/properties/contentVaryingApplicabilities
/properties/begin",
                "type": "string"
            },
            "end": {
                "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/validTime/properties/contentVaryingApplicabilities
/properties/end",
                "type": "string"
            }
        }
    }
},
"maximalExistence": {
    "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/validTime/properties/maximalExistence",
    "type": "object",
    "properties": {
        "begin": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/validTime/properties/maximalExistence/properties/b
egin",
            "type": "string"
        },
        "end": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/validTime/properties/maximalExistence/properties/e
nd",
            "type": "string"
        }
    }
},
"frequency": {

```

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```
        "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/validTime/properties/frequency",
        "type": "string"
    }
},
    "transactionTime": {
        "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/transactionTime",
        "type": "object",
        "properties": {
            "kind": {
                "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/transactionTime/properties/kind",
                "type": "string",
                "enum": [
                    "state",
                    "event"
                ]
            },
            "content": {
                "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/transactionTime/properties/content",
                "type": "string",
                "enum": [
                    "constant",
                    "varying"
                ]
            },
            "existence": {
                "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/transactionTime/properties/existence",
                "type": "string",
                "enum": [
                    "constant",
                    "varyingWithGaps",
                    "varyingWithoutGaps"
                ]
            },
            "frequency": {
                "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/transactionTime/properties/frequency",
                "type": "string"
            }
        }
    },
    "itemIdentifier": {
        "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/itemIdentifier",
        "type": "object",
        "properties": {
            "name": {
                "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/itemIdentifier/properties/name",
                "type": "string"
            },
            "timeDimension": {
                "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/itemIdentifier/properties/timeDimension",
                "type": "string",
                "enum": [
                    "validTime",
                    "transactionTime",
                    "bitemporal"
                ],
                "default": "validTime"
            },
            "keyrefs": {
```

```

        "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/itemIdentifier/properties/keyrefs",
        "type": "array",
        "items": {
            "type": "object",
            "required": [
                "refName"
            ],
            "properties": {
                "refName": {
                    "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/itemIdentifier/properties/keyrefs/properties/refNa
me",
                    "type": "string"
                },
                "refType": {
                    "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/itemIdentifier/properties/keyrefs/properties/refTy
pe",
                    "type": "string",
                    "enum": [
                        "snapshot",
                        "itemIdentifier"
                    ]
                }
            }
        },
        "fields": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/itemIdentifier/properties/fields",
            "type": "array",
            "items": {
                "type": "object",
                "required": [
                    "path"
                ],
                "properties": {
                    "path": {
                        "$id":
"#/properties/temporalCharacteristicSet/properties/logical/properties/lo
gicalItems/properties/itemIdentifier/properties/fields/properties/path",
                        "type": "string"
                    }
                }
            }
        },
        "physical": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/physical",
            "type": "object",
            "properties": {
                "include": {
                    "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/i
nclude",
                    "type": "array",
                    "items": {
                        "type": "object",
                        "required": [
                            "temporalCharacteristicLocation"
                        ],
                        "properties": {
                            "temporalCharacteristicLocation": {
                                "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/i

```

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```
include/properties/temporalCharacteristicLocation",
    "type": "string"
  }
}
},
"defaultTimeFormat": {
  "$id":
  "#/properties/temporalCharacteristicSet/properties/physical/properties/d
efaultTimeFormat",
  "type": "object",
  "properties": {
    "format": {
      "$id":
      "#/properties/temporalCharacteristicSet/properties/physical/properties/d
efaultTimeFormat/properties/format",
      "type": "object",
      "properties": {
        "plugin": {
          "$id":
          "#/properties/temporalCharacteristicSet/properties/physical/properties/d
efaultTimeFormat/properties/format/properties/plugin",
          "type": "string"
        },
        "granularity": {
          "$id":
          "#/properties/temporalCharacteristicSet/properties/physical/properties/d
efaultTimeFormat/properties/format/properties/granularity",
          "type": "string"
        },
        "calendar": {
          "$id":
          "#/properties/temporalCharacteristicSet/properties/physical/properties/d
efaultTimeFormat/properties/format/properties/calendar",
          "type": "string"
        },
        "properties": {
          "$id":
          "#/properties/temporalCharacteristicSet/properties/physical/properties/d
efaultTimeFormat/properties/format/properties/properties",
          "type": "string"
        },
        "valueSchema": {
          "$id":
          "#/properties/temporalCharacteristicSet/properties/physical/properties/d
efaultTimeFormat/properties/format/properties/valueSchema",
          "type": "string"
        }
      }
    }
  },
  "stamps": {
    "$id":
    "#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps",
    "type": "array",
    "items": {
      "type": "object",
      "required": [
        "target",
        "stampKind"
      ],
      "properties": {
        "target": {
          "$id":
          "#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/target",
          "type": "string"
        },
        "dataInclusion": {
          "$id":
          "#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/dataInclusion",
          "type": "string",
          "enum": [
            "expandedEntity",
```

```

        "referencedEntity",
        "expandedVersion",
        "referencedVersion"
    ]
},
"stampKind": {
    "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/stampKind",
    "type": "object",
    "properties": {
        "timeDimension": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/stampKind/properties/timeDimension",
            "type": "string",
            "enum": [
                "validTime",
                "transactionTime",
                "bitemporal"
            ]
        },
        "stampBounds": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/stampKind/properties/stampBounds",
            "type": "string",
            "enum": [
                "step",
                "extent"
            ]
        },
        "format": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/stampKind/properties/format",
            "type": "object",
            "properties": {
                "plugin": {
                    "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/stampKind/properties/format/properties/plugin",
                    "type": "string"
                },
                "granularity": {
                    "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/stampKind/properties/format/properties/granularity",
                    "type": "string"
                },
                "calendar": {
                    "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/stampKind/properties/format/properties/calendar",
                    "type": "string"
                },
                "properties": {
                    "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/stampKind/properties/format/properties/properties",
                    "type": "string"
                },
                "valueSchema": {
                    "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/stampKind/properties/format/properties/valueSchema",
                    "type": "string"
                }
            }
        }
    }
},
"orderBy": {
    "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/orderBy",
    "type": "object",

```

```

      "properties": {
        "fields": {
          "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/orderBy/properties/fields",
          "type": "array",
          "items": {
            "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/orderBy/properties/fields/items",
            "type": "object",
            "oneOf": [
              {
                "properties": {
                  "target": {
                    "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/orderBy/properties/fields/items/properties/target",
                    "type": "string"
                  }
                }
              },
              {
                "properties": {
                  "time": {
                    "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/orderBy/properties/fields/items/properties/time",
                    "type": "object",
                    "required": [
                      "dimension"
                    ],
                    "properties": {
                      "dimension": {
                        "$id":
"#/properties/temporalCharacteristicSet/properties/physical/properties/s
tamps/properties/orderBy/properties/fields/items/properties/time/propert
ies/dimension",
                        "type": "string",
                        "enum": [
                          "validTime",
                          "transactionTime",
                          "bitemporal"
                        ]
                      }
                    }
                  }
                }
              }
            ]
          }
        }
      }
    }
  }
}

```

Fig. A1.1. TCSchema: The JSON Schema for temporal logical and physical characteristics

A2 Low-level Operations for Changing a Temporal Characteristics Document

In this appendix section, we propose the full set of the forty-one low-level operations that we have defined for changing temporal logical and physical characteristics in τ JSchema. For each one of these operations, we provide a description of its arguments

and its operational semantics. Moreover, for readability reasons, we have organized them into four subsets: operations acting on the entire temporal characteristics document (see Sec. A2.1), operations that are common to the logical and to the physical characteristics (see Sec. A2.2), operations that are specific to the logical characteristics (see Sec. A2.3), and operations that are specific to the physical characteristics (see Sec. A2.4).

A2.1. Operations Acting on the Whole Temporal Characteristics Document

We have defined only two change operations; we list them in Table A2.1.

Table A2.1. Change operations acting on the whole temporal characteristic document.

<i>Change operation</i>	<i>Description</i>
CreateTemporalCharacteristicDocument (TCD.json)	It creates a valid empty TCD. The argument is the name of the JSON file where the new TCD is stored.
DropTemporalCharacteristicDocument (TCD.json)	It removes the TCD.json file from the disk, with the constraint that the argument represents an empty TCD (i.e. like the one above initially created by CreateTemporalCharacteristicDocument). Any other contents must have been removed before.

A2.2. Operations Common to the Temporal Logical and Physical Characteristics

These change operations can be applied either to the “logical” or to the “physical” container. We have defined six change operations; we provide them in Table A2.2.

Table A2.2. Change operations common to the temporal logical and physical characteristics.

<i>Change operation</i>	<i>Description</i>
AddInclude (TCD.json, inWhat, temporalCharacteristicLocation)	It adds a new object as a new item, with specified “temporalCharacteristicLocation”, to the “include” array in the inWhat (i.e., “logical” or “physical”) container.
DeleteItemFromInclude (TCD.json, inWhat, temporalCharacteristicLocation)	It removes the item with specified “temporalCharacteristicLocation” from the “include” array in the inWhat (i.e., “logical” or “physical”) container.
ChangeItemInInclude (TCD.json, inWhat, oldTemporalCharacteristicLocation, newTemporalCharacteristicLocation)	It changes the value of the property “temporalCharacteristicLocation” of the item with specified “oldTemporalCharacteristicLocation” to the value “newTemporalCharacteristicLocation”, in the “include” array in the inWhat (i.e., “logical” or “physical”) container.
AddDefaultTimeFormat (TCD.json, toWhat, plugin, granularity, calendar, properties, valueSchema)	It adds the “defaultTimeFormat” property with specified plugin, granularity, calendar, properties, and valueSchema to the toWhat (i.e., “logical” or “physical”) container.
DeleteDefaultTimeFormat (TCD.json, fromWhat)	It removes the “defaultTimeFormat” property from the fromWhat (i.e., “logical” or “physical”) container.
SetDefaultTimeFormat (TCD.json, inWhat, plugin, granularity, calendar, properties, valueSchema)	It changes the plugin, granularity, calendar, properties, or valueSchema of the “defaultTimeFormat” property in the inWhat (i.e., “logical” or “physical”) container.

A2.3. Operations Specific to the Temporal Logical Characteristics

These change operations can be applied only to the “logical” container. We have

identified twenty-three change operations; we provide them in Table A2.3.

Table A2.3. Change operations specific to the temporal logical characteristics.

<i>Change operation</i>	<i>Description</i>
AddLogicalItem (TCD.json, logicalItemTarget)	It adds a new item with specified “logicalItemTarget” to the “logicalItems” array in the “logical” container.
DeleteLogicalItem (TCD.json, logicalItemTarget)	It removes the item with specified “logicalItemTarget” from the “logicalItems” array in the “logical” container.
AddValidTimeToLogicalItem (TCD.json, logicalItemTarget, validTimeKind, validTimeContent, validTimeExistence, validTimeFrequency)	It adds the “validTime” property with specified “validTimeKind”, “validTimeContent”, “validTimeExistence” and “validTimeFrequency” to the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container. Notice that possible values of the three last arguments are as follows: <ul style="list-style-type: none"> • validTimeKind: either “state” or “event”. • validTimeContent: either “constant” or “varying”. • validTimeExistence: one of “constant”, “varyingWithGaps”, “varyingWithoutGaps”.
DeleteValidTimeFromLogicalItem (TCD.json, logicalItemTarget)	It removes the “validTime” property from the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container.
SetValidTimeInLogicalItem (TCD.json, logicalItemTarget, validTimeKind, validTimeContent, validTimeExistence, validTimeFrequency)	It changes the “kind”, “content”, “existence” and/or “frequency” properties of the “validTime” property of the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container.
AddContentVaryingApplicabilityToValidTimeInLogicalItem (TCD.json, logicalItemTarget, contentVaryingApplicabilityBegin, contentVaryingApplicabilityEnd)	It adds a new object as a new item with specified “contentVaryingApplicabilityBegin” and “contentVaryingApplicabilityEnd” to the “contentVaryingApplicabilities” array, in the “validTime” property of the item specified with “logicalItemTarget” in the “logicalItems” array in the “logical” container.
DeleteContentVaryingApplicabilityFromValidTimeInLogicalItem (TCD.json, logicalItemTarget, contentVaryingApplicabilityBegin, contentVaryingApplicabilityEnd)	It removes the item with specified “contentVaryingApplicabilityBegin” and “contentVaryingApplicabilityEnd” from the “contentVaryingApplicabilities” array, in the “validTime” property of the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container.
ChangeContentVaryingApplicabilityInValidTimeInLogicalItem (TCD.json, logicalItemTarget, oldContentVaryingApplicabilityBegin, oldContentVaryingApplicabilityEnd, newContentVaryingApplicabilityBegin, newContentVaryingApplicabilityEnd)	It changes the value of the “begin” and/or the “end” property of the item with specified “oldContentVaryingApplicabilityBegin” and “oldContentVaryingApplicabilityEnd” in the “contentVaryingApplicabilities” array in the “validTime” property of the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container.
SetMaximalExistenceInValidTimeInLogicalItem (TCD.json, logicalItemTarget, maximalExistenceBegin, maximalExistenceEnd)	It adds or changes the “maximalExistence” property, with specified “maximalExistenceBegin” and “maximalExistenceEnd”, to the “validTime” property of the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container.
DeleteMaximalExistenceFromValidTimeInLogicalItem (TCD.json, logicalItemTarget, maximalExistenceBegin, maximalExistenceEnd)	It removes the “maximalExistence” property, with specified “maximalExistenceBegin” and “maximalExistenceEnd”, from the “validTime” property of the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container.
AddTransactionTimeToLogicalItem (TCD.json, logicalItemTarget, transactionTimeKind, transactionTimeContent, transactionTimeExistence)	It adds the “transactionTime” property, with specified “transactionTimeKind”, “transactionTimeContent”, and “transactionTimeExistence”, to the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container. Notice here that the four last arguments are optional.
DeleteTransactionTimeFromLogicalItem (TCD.json, logicalItemTarget)	It removes the “transactionTime” property from the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container.

<i>Change operation</i>	<i>Description</i>
SetTransactionTimeInLogicalItem (TCD.json, logicalItemTarget, transactionTimeKind, transactionTimeContent, transactionTimeExistence)	It changes the “kind”, “content”, and/or “existence” of the “transactionTime” property of the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container.
AddItemIdentifierToLogicalItem (TCD.json, logicalItemTarget, itemIdentifierName, itemIdentifierTimeDimension)	It adds the “itemIdentifier” property with specified “itemIdentifierName” and “itemIdentifierTimeDimension” to the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container. Possible values of the “itemIdentifierTimeDimension” argument are: validTime, transactionTime, or bitemporal; default is validTime.
DeleteItemIdentifierFromLogicalItem (TCD.json, logicalItemTarget)	It removes the “itemIdentifier” property from the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container.
SetItemIdentifierInLogicalItem (TCD.json, logicalItemTarget, itemIdentifierName, itemIdentifierTimeDimension)	It changes the “name”, and/or “timeDimension” of the “itemIdentifier” property in the item with specified “logicalItemTarget” in the “logicalItems” array in the “logical” container.
AddKeyrefToItemIdentifier (TCD.json, logicalItemTarget, keyrefName, keyrefType)	It adds an object as a new item of the array “keyrefs”, with specified “keyrefName” and “keyrefType”, to the “itemIdentifier” property of the item with specified logicalItemTarget of the “logicalItems” array in the “logical” container.
DeleteKeyrefFromItemIdentifier (TCD.json, logicalItemTarget, keyrefName)	It removes the item with specified keyrefName in “keyrefs” array from the “itemIdentifier” property of the item with specified logicalItemTarget of the “logicalItems” array in the “logical” container
ChangeKeyrefInItemIdentifier (TCD.json, logicalItemTarget, oldkeyrefName, newkeyrefName, oldkeyrefType, newkeyrefType)	It changes the value of refName property and/or the value of the refType property of the item specified with oldkeyrefName, in the “keyrefs” array in the “itemIdentifier” property of the item with specified “logicalItemTarget” in the “logicalItem” array in the “logical” container.
AddFieldToItemIdentifier (TCD.json, logicalItemTarget, fieldPath)	It adds an object as a new item of the “fields” array, with specified “fieldPath”, to the “itemIdentifier” property of the item with specified “logicalItemTarget” in the “logicalItem” array in the “logical” container.
DeleteFieldFromItemIdentifier (TCD.json, logicalItemTarget, fieldPath)	It removes the item, with specified “fieldPath”, from the “fields” array in the “itemIdentifier” property of the item with specified “logicalItemTarget” in the “logicalItem” array, in the “logical” container.
ChangeFieldInItemIdentifier (TCD.json, logicalItemTarget, oldFieldPath, newFieldPath)	It changes the item, with specified “oldFieldPath”, to “newFiledpath”, in the “fields” array in the “itemIdentifier” property of the item with specified “logicalItemTarget” in the “logicalItem” array, in the “logical” container.

A2.4. Operations Specific to the Temporal Physical Characteristics

These change operations can be applied only to the “physical” container. We have defined ten change operations; we provide them in Table A2.4.

Table A2.4. Change operations specific to the temporal physical characteristics.

<i>Change operation</i>	<i>Description</i>
AddStamp (TCD.json, stampTarget, stampDataInclusion, stampKindTimeDimension, stampKindStampBounds)	It adds an object as a new item of the “stamps” array, with specified “stampTarget” and “stampDataInclusion”, to the “physical” container. Moreover, it adds to this item the “stampKind” property with specified “stampKindTimeDimension”, and

<i>Change operation</i>	<i>Description</i>
	<p>“stampKindStampBounds”.</p> <p>Possible values of some arguments are as follows:</p> <ul style="list-style-type: none"> • “stampDataInclusion”: one of expandedEntity, referencedEntity, expandedVersion, or referencedVersion. • “stampKindTimeDimension”: one of validTime, transactionTime, or bitemporal. • “stampKindStampBounds”: either step or extent.
DeleteStamp (TCD.json,stampTarget)	It removes the item with specified “stampTarget” from the “stamps” array in the “physical” container.
SetDataInclusionInStamp (TCD.json, stampTarget, stampDataInclusion)	It introduces or changes the “dataInclusion” property of the item, with specified “stampTarget”, in the “stamps” array in the “physical” container.
SetStampKindInStamp (TCD.json, stampTarget, stampKindTimeDimension, stampKindStampBounds)	It introduces or changes the “timeDimension” and/or “stampBounds” of the “stampKind” property of the item, with specified “stampTarget”, in the “stamps” array in the “physical” container.
SetFormatInStampKindInStamp (TCD.json, stampTarget, stampPlugin, stampGranularity, stampCalendar, stampProperties, stampValueSchema)	It adds or changes the “format” property, with specified “stampPlugin”, “stampGranularity”, “stampCalendar”, “stampProperties”, and “stampValueSchema”, to the “stampKind” property of the item, with specified “stampTarget”, in the “stamps” array in the “physical” container.
DeleteFormatFromStampKindInStamp (TCD.json, stampTarget)	It removes the “format” property from the “stampKind” property of the item, with specified stampTarget, in the “stamps” array in the “physical” container..
AddOrderByFieldToStamp (TCD.json, stampTarget, newOrderByField)	It adds a new item “newOrderByField” to the “fields” array of the “orderBy” property of the item, with specified “stampTarget”, in the “stamps” array in the “physical” container.
DeleteOrderByFieldFromStamp (TCD.json, stampTarget, orderByField)	<p>It removes the “field” property having the value “orderByField” from the “orderBy” property of the item, with specified “stampTarget”, in the “stamps” array in the “physical” container. When the last “field” is removed, also the “orderBy” property container is removed.</p> <p>Here, “orderByField” is either the value of the property “dimension” of a “time” property, or the value of a “target” property in a “field” property of the “orderBy” property.</p>
DeleteOrderByFieldFromStamp (TCD.json, stampTarget, orderByField)	It removes the item “orderByField” from the “fields” array of the “orderBy” property of the item, with specified “stampTarget”, in the “stamps” array in the “physical” container. When the last item of “fields” is removed, also the “orderBy” property container is removed.
ChangeOrderByFieldInStamp (TCD.json, stampTarget, oldOrderByField, newOrderByField)	It changes the item having the value “oldOrderByField” in the “fields” array to the value “newOrderByField”, in the “orderBy” property of the item, with specified “stampTarget”, in the “stamps” array in the “physical” container.