

Data Model for the NWAf Production App Base

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1 Objective

This model is intended for importing data to and exporting data from the Production App Base of the NETRONIC Web Application Framework (NWAf for short). The Production App Base is the base for developing new applications specific to the customers' needs in the field of production planning and control. In this context the model also serves as a first reference for NETRONIC's prospects to display their data in a prototype based on the Production App Base or in the Production Demo App that is based on the Production App Base.

The data model is not only restricted to the Production App Base, but is thought to be extensible for many other purposes like usage of the scheduling engine. It offers an extensible minimum of semantics for production scheduling.

For applications that are built on top of the Production App Base, the data model is extensible on every object. When created within JavaScript, the objects do not require a special constructor, so they can be created easily with or without using the new keyword. If upward compatibility is taken into account, then use a prefix like the underscore in order to prevent false usage within the Production App Base.

2 Import/Export Data Model

2.1 ProductionData

The ProductionData object is the root object for defining a full data set for initializing a session of the Production Base App. It contains all definitions of calendars, resources and production orders that will be graphically displayed and handled after loading.

Property Name	Type	Description
Settings	Object	Required – Set of settings
Resources	Array< Resource >	Required – Array of Resource objects
Projects	Array< Project >	Optional, default: undefined – Array of Project objects, required if Settings.ContainsProjects is set to true
ProductionOrders	Array< ProductionOrder >	Optional, default: undefined – Array of ProductionOrder objects, required if Settings.ContainsProjects is set to false
Links	Array< Link >	Optional, default: undefined – Array of Link objects
[For future use: Skills]	Array<Skill>	Optional, default: undefined – Array of Skill objects
[For future use: Departments]	Array<Department>	Optional, default: undefined – Array of Department objects

2.2 Settings

This object defines all general settings for handling the data. It has to be defined in the Settings property of the ProductionData object.

Property Name	Type	Description
Version	String ("2.1"/"2.0"/"1.0.4")	Optional, default: "2.1" – Version of the data model. This is useful for providing compatibility with data for older data models as long as these are supported by the current ProductionAppBase.
ContainsProjects	Boolean	Optional, default: false – If set to false, then ProductionData.ProductionOrders has to be set and filled. If set to true, then ProductionData.Projects has to be set and filled. This setting allows to further group production orders into

		several projects.
Start	Date or String	Required – Start of the visible time area. Concerning the type of value that is required here, please see Settings.DatesAreStrings and Settings.DatesAreLocal.
End	Date or String	Required – End of the visible time area. Concerning the type of value that is required here, please see Settings.DatesAreStrings and Settings.DatesAreLocal.
TimeStepUnit	String ("second"/"minute"/ "hour"/"day")	Optional, default: "second" – This is needed for dragging operations. Operations will be moved only in steps that are defined here together with Settings.TimeStepUnitFactor
TimeStepUnitFactor	Number (integer; > 0)	Optional, default: 1 – see Settings.TimeStepUnit
TimeAxisResolutionUnit	String ("second"/"minute"/ "hour"/"day")	Optional, default: "day" – Initial resolution of the time axis together with Settings.TimeAxisPixelsPerResolutionUnit
TimeAxisPixelsPerResolutionUnit	Number (integer; > 0)	Optional, default: 40 – see Settings.TimeAxisResolutionUnit
WorkDate	Date or String	Optional, default: undefined – If defined, then this date is shown as a special date line in the chart. E.g. it can mark the current day. Concerning the type of value that is required here please see Settings.DatesAreStrings and Settings.DatesAreLocal.
DatesAreLocal	Boolean	Optional, default: true – If set to true, then all dates are expected to be in local time. If set to false, they are expected to be in UTC. This setting is respected only when Settings.DatePropertiesAreStrings is true.
DatesAreStrings	Boolean	Optional, default: true – If set to true, then all date properties in the data are required in strings formatted "%d-%m-%y %H:%M:%S". Is set to false, then all date properties in the data are required to be Date objects. Remark: For objects parsed from a JSON stream, a value of true is obligatory. For objects set within the application, it is possible to use a value of false.
Editable	Boolean	Optional, default: false – If set to true, then the graphical representation can be modified interactively. In the moment only operation interaction is implemented. So, if set to true, then

		operations are generally draggable. Exception: An operation is not allowed to be dragged by other properties (see ProductionOrder.Editable and Operation.Editable).
PrecalculatedResourceLoads	Boolean	Optional, default: false – If set to true, then resource loads are set on input within the calendar entries of the resource calendar (see property Load of CalendarEntry object). This can be useful, when not all production orders are defined in the data, but the resources should show the real load based on all production orders. If set to false, the loads are calculated inside the application by looking at the property CapacityNeed of Operation objects.
DefaultProductionOrder-PlanningStatus	Number (integer; Demo App: values 0 to 4)	Optional, default: 0 – Status number, that is used when ProductionOrder.PlanningStatus is not defined
PlanningStatusTexts	Object	Optional, default: { 0: "Simulated", 1: "Planned", 2: "Firm Planned", 3: "Released", 4: "Finished" } – Texts for the status values. These texts will be displayed as titles of the status groups in the production orders view. Remark for the Demo App: Other values than 0 to 4 are not recognized, because these values are used for coloring several graphical items.
LinksByOperationSuccessorNos	Boolean	Optional, default: true – If set to false, then links are solely defined explicitly by Link objects. If set to true, then there will be links defined implicitly by operation sequence within production orders.
[deprecated: DateTimeFormat]	String	Optional, default: "%d-%m-%y %H:%M:%S" – This format is used to parse all date strings inside this model. It is used accordingly to the specification in the class d3.time.format of the framework D3.js. See also http://d3js.org/ and https://github.com/mbostock/d3/wiki/Time-Formatting .
[deprecated: DateFormat]	D3 format string	Optional, default: "%d-%m-%y"
[for future use: OwnCapacityForParent-Resources]	Boolean	Optional, default: true – Only respected, when Settings.Precalculated-ResourceLoads is false: If this property is set to false, then the capacity of resources, that have child resources, is

		calculated as the sum of capacity of the child resources. If set to true, then this is own capacity.
[for future use: OperationSequenceBy-AscendingNos]	Boolean	Optional, default: false – If set to true, then the operation sequence is automatically defined by the operation numbers (useful for showing implicit links between operations and for scheduling)
[for future use for scheduling:.AutoSchedule-Forward]	Boolean	Optional –
[for future use for scheduling:.AutoSchedule-Backward]	Boolean	Optional –

2.3 Resource

A Resource object defines the properties of a single resource. It has to be defined in the Resources array of the ProductionData object.

Property Name	Type	Description
ID	String	Required – Identifier of the resource
Name	String	Required – Name of the resource
Capacity	Number (floating point; ≥ 0)	Required – Default capacity, constant all along the working time. Used for displaying capacity curves. See also properties Capacity of the CalendarEntry object and CapacityNeed of the Operation object.
Calendar	Calendar	Optional, default: undefined – Corresponding calendar. If undefined, then the calendar has constantly non-working time.
ChildIDs	Array<Resource.ID : String>	Optional, default: undefined – Identifiers of sub-resources that are assigned to this resource. Using this option will turn the current resource into a resource group, while the resource keeps its role as a resource with own capacity. Currently only one level of children is allowed.
[for future use: .Skills : Array<Skill.ID : String>]		Optional
[for future use: .DepartmentID : String]		Optional
[for future use for scheduling: .Efficiency : Number]		Optional

2.4 Calendar

A Calendar object defines a simple working time calendar to be used with resource availability. It has to be defined in the Calendar property of Resource objects. A Calendar object merely contains an array of CalendarEntry objects, which define single time periods of working time.

Property Name	Type	Description
Start	Date or String	Optional, default: undefined – Start date of the time range, within which the calendar is actually well-defined. If set, then operations cannot be moved interactively before the date. If not set, then operations cannot be moved interactively before the value in Settings.Start. Concerning the type of value that is required here please see Settings.DatesAreStrings and Settings.DatesAreLocal.
End	Date or String	Optional, default: undefined – End date of the time range, within which the calendar is actually well-defined. If set, then operations cannot be moved interactively after the date. If not set, then operations cannot be moved interactively after the value in Settings.End. Concerning the type of value that is required here please see Settings.DatesAreStrings and Settings.DatesAreLocal.
Entries	Array< CalendarEntry >	Required – Array of CalendarEntry objects.

Remark: There is no ID needed, because the object is only used inside the Calendar property of Resource objects.

2.5 CalendarEntry

A CalendarEntry object defines a single time period. It has to be defined in the Entries array of a Calendar object. If several objects describe the same time period, then the last object wins. If a capacity of zero is set in an object, then non-working time is described.

Property Name	Type	Description
Start	Date or String	Required – Start of the working time period. Concerning the type of value that is required here please see Settings.DatesAreStrings and Settings.DatesAreLocal.
End	Date or String	Required – End of the working time period. Concerning the type of value that is required here please see Settings.DatesAreStrings and Settings.DatesAreLocal.
Capacity	Number (floating point; ≥ 0)	Optional, default: value of corresponding Resource.Capacity – Capacity within this time interval. Used for displaying capacity curves, when the resource needs individual capacities per time period. See also properties Capacity of

		the Resource object and CapacityNeed of the Operation object.
Load	Number (floating point; ≥ 0)	Optional, default: undefined – Load within this time interval. This setting is only used, when the property PrecalculatedResourceLoads of the Settings object is set to true. Used for displaying load curves.

Remark: There is no ID needed, because the object is only used inside the Entries property of Calendar object.

2.6 Project

A Project object offers a grouping possibility for ProductionOrder objects. Only if Settings.ContainsProjects is set to true, then it is possible and required to put all production orders to the ProductionOrders property of Project objects.

Property Name	Type	Description
ID	String	Required – Identifier of the Project object
Name	String	Required – Name of the project
Start	Date or String	Required – Start date of the project. Concerning the type of value that is required here please see Settings.DatesAreStrings and Settings.DatesAreLocal.
End	Date or String	Required – End date of the project. Concerning the type of value that is required here please see Settings.DatesAreStrings Settings.DatesAreLocal.
ProductionOrders	Array< ProductionOrder >	Required – Array of ProductionOrder objects
PlanningStatus	Number (integer; ≥ 0)	Optional, default: 0 –

2.7 ProductionOrder

A ProductionOrder object defines the properties of a single production order and contains all operations. If Settings.ContainsProjects is set to false (which is the default), then objects of this type have to be defined in the ProductionOrders array of the ProductionData object. Otherwise they have to be defined in the ProductionOrders arrays of Project objects.

Property Name	Type	Description
ID	String	Required – Identifier of this production order
Name	String	Required – Name of this production order
Operations	Array< Operation >	Required – Array of operation objects that are assigned to this production order.
ReleaseDate	Date or String	Optional, default: undefined – Used to mark the release date of the production order. Concerning the type of value that is required

		here please see Settings.DatesAreStrings and Settings.DatesAreLocal.
DueDate	Date or String	Optional, default: undefined – Used to mark overdue operations. Concerning the type of value that is required here please see Settings.DatesAreStrings and Settings.DatesAreLocal.
PlanningStatus	Number (integer; Demo App: values 0 to 4)	Optional, default: Settings.DefaultProductionOrderPlanningStatus – Used for grouping production orders according to planning states (for mapping to long texts see Settings.PlanningStatusTexts). In the production order view the status groups are sorted ascending by this number.
Editable	Boolean	Optional, default: true – When set to false, then the contained operations are not movable or resizable. See also Operation.Editable and Settings.Editable.
Start	Date or String	Optional, default: undefined – Start date of the production order. Concerning the type of value that is required here please see Settings.DatesAreStrings and Settings.DatesAreLocal.
End	Date or String	Optional, default: undefined – End date of the production order. Concerning the type of value that is required here please see Settings.DatesAreStrings and Settings.DatesAreLocal.
[for future use for scheduling: .Quantity : Number]		Optional

2.8 Operation

An Operation object defines the properties of a single operation in a production order. It has to be defined in the Operations array of a ProductionOrder object.

Property Name	Type	Description
No	Number (integer; ≥ 0)	Required – Number of the operation. Within one production order, these numbers have to be unique, since they either define the sequence of the operations within the production order or are used for build a net by taking the property SuccessorNos into account.
Name	String	Required – Name of the operation
Start	Date or String	Required – Start date of the operation. Concerning the type of value that is required here please see Settings.DatesAreStrings and Settings.DatesAreLocal.

End	Date or String	Required – End date of the operation. Concerning the type of value that is required here please see Settings.DatesAreStrings Settings.DatesAreLocal.
Duration	Number (integer; ≥ 0) (in milliseconds)	Optional, default: undefined – Duration (only working time) of the operation (if defined: will be recalculated when resizing or dragging operations). Remark: In the Production App Base this property is ignored on input. It is only maintained on interactions.
ResourceID	String	Required, if the property ResourceAssignments is undefined, default: undefined – Identifier of the resource that is assigned to this operation.
ResourceAssignments (not yet implemented)	Array<Resource Assignment>	Required with at least one entry, if the property ResourceID is undefined, default: undefined – Assignments to resources for this operation
SuccessorNos	Array<Operation.No : Number>	Optional, default: undefined – List of number of operations within the same production order. When the property LinksByOperation-SuccessorNos of the Settings object is set to true, then also links are generated, which are displayed when marking one operation. This is an alternative to links that are defined in the ProductionData.Links array.
Progress	Number (floating point; in percent)	Optional, default: 0.0 – Used to display a completion layer.
CapacityNeed	Number (floating point; ≥ 0)	Required, if the property ResourceAssignments is undefined, default: undefined – Used to display load curves. See also property Capacity of the Resource object. If ResourceAssignments are defined, then the property CapacityNeed of the ResourceAssignment object has to be used instead.
Editable	Boolean	Optional, default: true – When set to false, then this operation is not movable or resizable. See also ProductionOrder.Editable and Settings.Editable.
MaterialAvailability	Date or String	Optional, default: undefined – Date, when all needed material is available.
PlanningStatus	Number (integer; Demo App: values 0 to 4)	Optional, default: undefined – If not set, then the property ProductionOrder.PlanningStatus is used.
[for future use: .SkillID]	String	Optional
[for future use for scheduling: .SetupTime, .RunTime, .WaitTime, .LotSize]		Optional

Remark: There is no ID needed, because it is only used inside the Operations property of ProductionOrder objects.

2.9 ResourceAssignment

(Not yet implemented!)

A ResourceAssignment object defines one assignment of an operation to one resource (see property ResourceAssignments of the Operation object).

Property Name	Type	Description
ResourceID	String	Required – Identifier of a resource
CapacityNeed	Number (floating point; ≥ 0)	Required – Used to display load curves. See also property Capacity of the Resource object and property CapacityNeed of the Operation object.

2.10 Link

A Link object defines the properties of a single link between operations. It has to be defined in the Links array of the ProductionData object. For implicit links between operations of the same production order see property LinksByOperationSuccessors in the Settings object.

Property Name	Type	Description
ID	String	Required – Identifier of this link
SourceProductionOrderID	String	Required – Identifier of the source production order
SourceOperationNo	Number	Required – Identifier of the operation number within the source production order
TargetProductionOrderID	String	Required – Identifier of the target production order
TargetOperationNo	Number	Required – Identifier of the operation number within the target production order
RelationType	Number (0: Finish-Start, 1: Start-Start, 2: Finish-Finish, 3: Start-Finish)	Optional, default: 0 – The relation type is used for drawing and for scheduling.

2.11 Skill

Not yet implemented.

Property Name	Type	Description
[for future use: ID]	String	Required
[for future use: Name]	String	Required

2.12 Department

Not yet implemented.

Property Name	Type	Description
[for future use: ID]	String	Required
[for future use: Name]	String	Required

3 Changelog

2.1 (not implemented yet):

- NEW ResourceAssignment
- NEW Operation.ResourceAssignments

2.0.1:

- NEW ProductionOrder.ReleaseDate

2.0:

- CHANGED Settings.Calendars -> Resource.Calendar
- NEW Settings.ContainsProjects
- NEW Settings.PrecalculatedResourceLoads
- NEW Settings.LinksByOperationSuccessorNos
- NEW ProductionData.Projects
- NEW ProductionData.Links
- NEW Project
- NEW Link
- NEW CalendarEntry.Capacity
- NEW CalendarEntry.Load
- NEW Operation.MaterialAvailability
- NEW Operation.PlanningStatus
- REMOVED Resource.CalendarID
- CHANGED Settings.ProductionOrderStatusTexts -> Settings.PlanningStatusTexts
- CHANGED ProductionOrder.Status -> ProductionOrder.PlanningStatus

1.0.4:

- CHANGED Data -> ProductionData
- CHANGED Jobs -> ProductionOrders
- DEPRECATED Settings.DateTimeFormat

1.0.3:

- Clarification of required and optional properties
- More explanations
- NEW Job.Editable, Operation.Editable
- NEW Settings.JobStatusTexts
- NEW Settings.DefaultJobStatus
- NEW Calendar.Start, Calendar.End
- DEPRECATED Settings.DateFormat
- DEPRECATED Settings.OperationDurationMaximumInMilliseconds

1.0.2:

- CHANGED Settings.ProjectStart -> Settings.Start
- CHANGED Settings.ProjectEnd -> Settings.End
- NEW Settings.TimeResolutionUnit and Settings.TimeResolutionUnitsPerStep
- NEW Settings.DateIsLocal
- More explanations in Settings

Appendix: JSON-formatted Sample Data

The easiest way to import own data into the Production Base App is to provide JSON-formatted data that follows the data model described above. In the following a rough sketch of how data should look like is given. For testing, you can copy the following lines, save them to a *.json file and load it into the Base App by using the "Open JSON file" button:

```
{
  "Resources": [{
    "ID": "0100",
    "Name": "Assembly department",
    "Calendar": {
      "Entries": [{
        "Start": "28-01-16 08:00:00",
        "End": "28-01-16 16:00:00"
      },
      {
        "Start": "29-01-16 08:00:00",
        "End": "02-02-16 16:00:00"
      },
      {
        "Start": "04-02-16 08:00:00",
        "End": "12-02-16 16:00:00"
      }
    ]
  },
  "Capacity": 3,
  "ChildIDs": ["1110", "1140"]
},
  {
    "ID": "1110",
    "Name": "Mike Seamans",
    "Calendar": {
      "Entries": [{
        "Start": "28-01-16 08:00:00",
        "End": "28-01-16 16:00:00"
      },
      {
        "Start": "29-01-16 08:00:00",
        "End": "02-02-16 16:00:00"
      },
      {
        "Start": "05-02-16 08:00:00",
        "End": "08-02-16 16:00:00"
      }
    ]
  },
  "Capacity": 1
},
  {
    "ID": "1140",
    "Name": "Machine inspection",
    "Calendar": {
      "Entries": [{
        "Start": "28-01-16 08:00:00",
        "End": "28-01-16 16:00:00"
      },
      {
        "Start": "29-01-16 08:00:00",
        "End": "02-02-16 16:00:00"
      },
      {
        "Start": "05-02-16 08:00:00",
        "End": "08-02-16 16:00:00"
      }
    ]
  },
  "Capacity": 1
}],
  "ProductionOrders": [{
    "ID": "1-101007-10000-R00020",
    "Name": "Touring Bicycle",
    "DueDate": "03-02-16 00:00:00",
    "Status": "1",
    "Operations": [{
      "No": 10,
      "Name": "Assembly department",
      "Start": "28-01-16 09:07:15",
      "End": "29-01-16 00:00:00",
    }
  ]
}
```

```
    "ResourceID": "1140",
    "CapacityNeed": 1,
    "Progress": 0.0,
    "SuccessorNos": [20]
  },
  {
    "No": 20,
    "Name": "Packing table 2",
    "Start": "01-02-16 11:20:00",
    "End": "02-02-16 10:00:00",
    "ResourceID": "1110",
    "CapacityNeed": 1,
    "Progress": 0.0
  }
}],
{
  "ID": "1-101008-10000-R00020",
  "Name": "Touring Bicycle",
  "DueDate": "04-02-16 00:00:00",
  "Status": "1",
  "Operations": [{
    "No": 10,
    "Name": "Assembly department",
    "Start": "28-01-16 13:58:41",
    "End": "29-01-16 08:28:41",
    "ResourceID": "0100",
    "CapacityNeed": 1,
    "Progress": 0.0,
    "SuccessorNos": [20]
  }],
  {
    "No": 20,
    "Name": "Control",
    "Start": "29-01-16 15:16:32",
    "End": "01-02-16 08:46:32",
    "ResourceID": "1110",
    "CapacityNeed": 1,
    "Progress": 0.0
  }
}],
"Settings": {
  "Version": "2.0",
  "Start": "25-01-16 00:00:00",
  "End": "25-02-16 00:00:00",
  "TimeResolutionUnit": "minute",
  "TimeResolutionUnitsPerStep": 1,
  "WorkDate": "28-01-16 00:00:00",
  "Editable": true
}
}
```