Standard machine interface for the flat glass industry (OPC/UA CS)

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Abstract

At GPD2019, we announced the constitution of our VDMA-OPC Foundation joint working-group for defining an OPC-UA Companion Specification (CS) for flat glass processing machinery. Now, two years later, the Companion Specification was published as "OPC 40301 - OPC UA for Flat Glass" by the OPC foundation. This standardization of communication can be considered a milestone for the flat glass processing industry! The article will give a brief overview of the CS addressing the most important painpoints of our customers and the machine manufacturers and describes the forthcoming actions considering glass processing and machinery in general.

Introduction

Todays´ highly automated flat glass processing requires expertise and equipment of various international premium suppliers. As these suppliers speak different languages, so do the machines. Connecting those machinery into automated lines and integrating production control nowadays requires a multitude of interfaces, most of the time individually implemented for the specific application. As machines and in particular the controlling software evolves in ever increasing pace, those individual interface result in the challenge to be maintained by suppliers and operators. Taking on this challenge with the vision of creating "plug and produce" machinery, VDMA could assemble numerous prestigious machinery and software suppliers to establish a joint futureoriented standard for communication.

How we started

Within this initiative it became rapidly clear that as base for such interface OPC-UA is a viable standard, being used in wide areas of machinery communication. Just for reference OPC UA, stands for Open Platform Communication – Unified Architecture, a worldwide respected standard for machine-to-machine communication, allowing transmission of customer defined parameters (e.g., "pressure: 6,35 bar" instead of 6,35 only) as well as the application of method and structured objects. In a joint effort we harmonized the understanding between the participants of different processing's and their respective particularities and requirements.

Figure 1: Companies establishing the harmonized Interface.

Attribute	Value				
BrowseName	GlassType				
IsAbstract	false				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the BaseMaterialType defined in this Companion Specification, i.e., inheriting the InstanceDeclarations of that Node.					
0:HasComponent	Variable	Absorption	0:Number	0:AnalogUnitType	Optional
0:HasProperty	Variable	CoatingClass	CoatingClassEnumeration	0:PropertyType	Mandatory
0:HasComponent	Variable	CoatingEmessivity	0:Number	0:AnalogUnitType	Optional
0:HasProperty	Variable	CoatingSubClass	LimitedString64	0:PropertyType	Optional
0:HasComponent	Variable	ElectricalConductivity	0:Number	0:AnalogUnitType	Optional
0:HasProperty	Variable	Orientation	0:Number	0:PropertyType	Mandatory
0:HasComponent	Variable	Reflection	0:Number	0:AnalogUnitType	Optional
0:HasProperty	Variable	SignificantSide	SignificantSideEnumeration	0:PropertyType	Mandatory
0:HasProperty	Variable	StructureClass	LimitedString64	0:PropertyType	Mandatory
0:HasProperty	Variable	StructureAlignment	StructureAlignmentEnumeration	0:PropertyType	Mandatory
0:HasComponent	Variable	Transmission	0:Number	0:AnalogUnitType	Optional
The following nodes are override from BaseMaterialType and the Modelling Rules change to Mandatory					
0:HasComponent	Variable	X	0:Double	0:AnalogUnitType	Mandatory
0:HasComponent	Variable	Y	0:Double	0:AnalogUnitType	Mandatory

Table 1: Model description of glass for machine-to-machine communication

Establishing the CS

As OPC UA is an international standard for communication, however it does not define domain specific meaning and processes. Such definitions are subject to so called Companion Specifications (CS), which determine parameter definitions from meaning to naming to units to be used (as shown in table 1 below), as well as processes and methods relevant for a specific industry. Considering the complexity of the task, the challenge of harmonizing requirement of companies with individual philosophies, and knowing how long it took in other industries, we consider our pace record breaking.

OPC 40301 OPC UA for Flat Glass: The new standard

For establishing the Companion Specification, the group consolidated around individual use cases and focused on prioritizing with respect to importance to the flat glass processing industry. Rapidly, the themes consolidated to

- Machine Identification (who am I)
- Transfer of work jobs from

superposed production systems to machines (what shall I do), including production status (How I performed),
of which the transfer of job holds the most significant benefit for integrated flat glass processing lines and equipment.
Diving deeper into the use cases, the requirements on the semantics to be used and production methods to be respected were agreed. As example for such consolidation, different production steps (as shown in Figure 2 below) were analyzed. As result abstract working principles like in that case at cutting an incoming material may become many, in grinding may stay the same or in IG production multiple material may become one were deducted and form the basis for universal description for the transfer of jobs (work orders) to individual machines.

"Panta Rhei": The core of the specification: Having set the jobs in the focus of works the questions about how such jobs shall be handled in terms of workflow became obvious. Taking the analogy of classical workorders received in private from your partner or superior in your professional life we structure into

1. General rules of job management, meaning what shall be the content, how can it be interpreted, what is mandatory to know and what is optional.

Next the processes required for execution of jobs such as

2. Generating a job
3. Holding a list of jobs (dishwasher clearing, lawn mowing, balustrade painting)
4. Requesting jobs (I am boared, give me a duty)
5. Sending jobs (ordering a job like "mow the lawn!")
6. And obtaining information about the execution of the job ("Darling I finished painting"),

were determined and put in relation to each other as picture in Figure 3below.
Importance was drawn to divide the processes strictly between ordering system (production planning system) and machines.

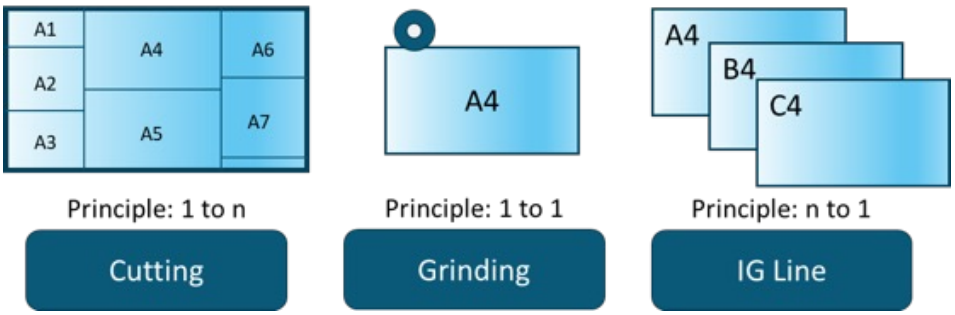

Figure 2: Example of different working principles at different production processes, base for harmonization.

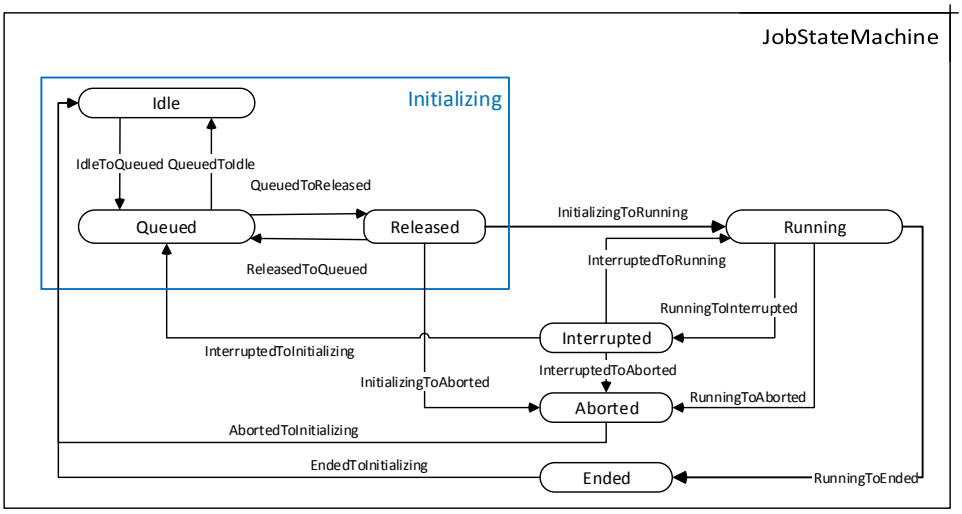

Figure 3: State machine overview

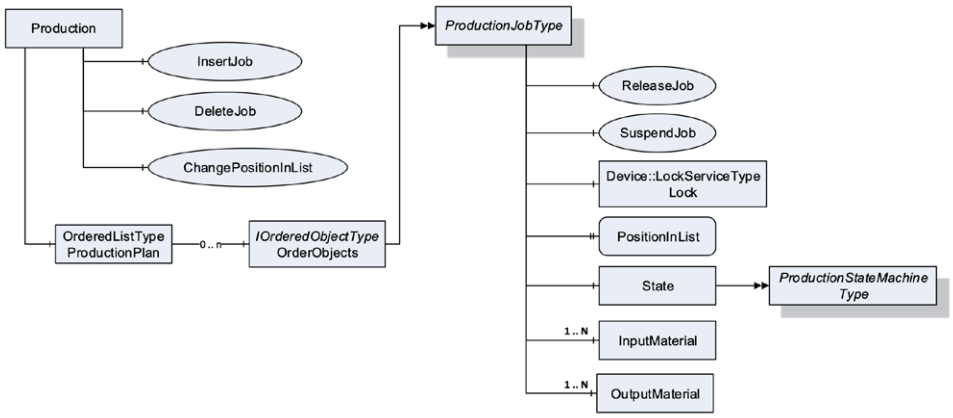

Figure 4: Excerpt of core definition of Job Type for flat glass processing

Bases on those workflow and job requirements the semantics were detailed in such a way that they are compliant to applications from raw material warehouse via cutting, edge and surface processing, tempering, lamination up to IG production.
Based on definition on parameters and workflow the generalized standardized communication protocols could emerge of which the prime one is displayed in figure Displaying a bit of detailed how such communication protocols are built up is shown in Figure 4 above.

Such standard was not in even at far sight a few years ago and represents an important milestone for simplification of built and start-up of automated production lines constituted of equipment from different prime suppliers. For anybody who has got now real hunger for reading the details please refer to our specification on the OPC foundation or VDMA homepage.

If we are already on the Moon, why not target Mars?

As this achievement is already groundbreaking why not dive in further and nail down the very details of production information required from cutting to tempering to IG production. This implies that not only the method and general information of jobs shall be standardized but also in detail how the processing (e.g., cutting pattern) shall be communicated. For that, dedicated subwork groups established already promising definitions closing to the target of "plug & produce".
Such standardization on the example of the cutting pattern holds standardized information about geometric description of panes as well as the standardized definition of the processings (cutting, edge deleting, marking) in recursive manner of which excerpts are displayed in Figure 5 beside.
Having a view on the present situa-tion, where even the naming of glass pane shapes is different for each software supplier, this harmonization is like a flight to mars for glass processing.

From definition to reality: the demonstrator

In the sense of test and show what you specify we invested in implementing sample OPC-UA servers and OPC-UA clients based on the CS. These servers and clients will represent different machinery and ERP-Systems all connected in a visible way using the UMATI organization (body for harmonizing machine communication across industries). The aim is to show interoperability between independent manufacturers in a visible example. The group aims to showcase the demonstrator during glasstec!

Summary: from the tower of Babylon to Machine Esperanto

The OPC-UA CS 40301 is the result of a joint open-minded effort of numerous prime glass machinery and software supplier, standardizing the for the time being the communication of jobs (work orders) and respective feedback. Such standardization is of prime importance on the path towards "plug and produce" reducing time and effort with respect to interfaces for machine 2 machine communication. The actual status is only the beginning of a continuous way of standardization on which we are working at the moment.

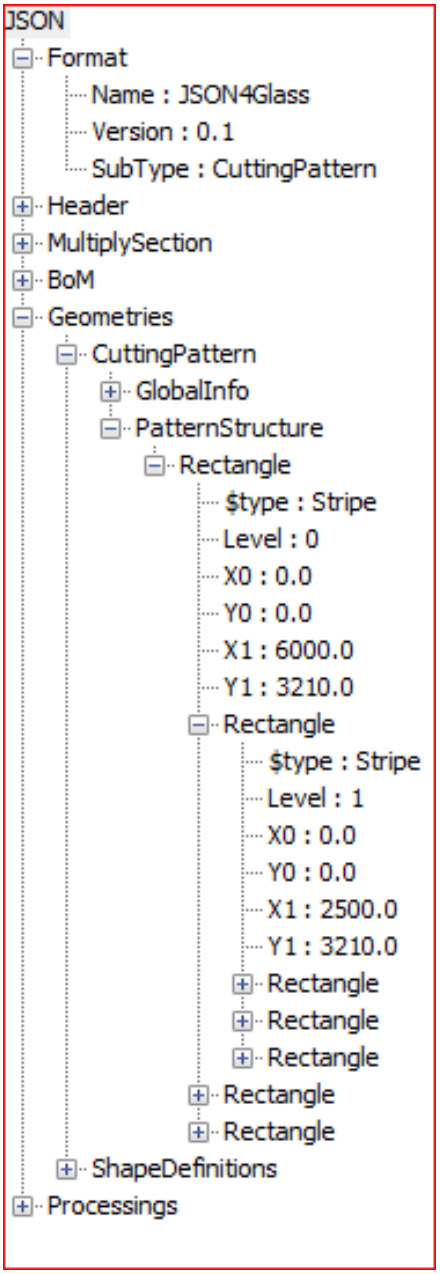

Figure 5: Json description of cutting pattern