Technische Universität München

TUM School of Life Sciences Weihenstephan

Lehrstuhl für Brau- und Getränketechnologie
Univ.-Prof. Dr.-Ing. Thomas Becker

TUM

WS Bake Version 11
From data points to an
OPC UA information model

Romy Ries
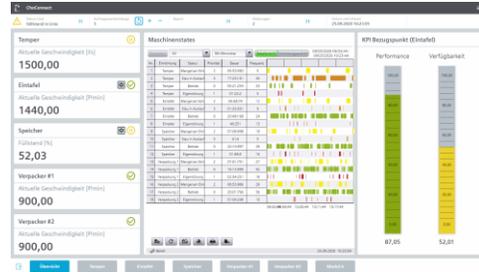
Online information event
Freising, 21.06.2023

Agenda

- Overview on the Weihenstephan Standards Version 10

- Explanation of the working method in the WS Sweets project and presentation of the results (Version 11)

- Introduction of the project proposal for WS Bake 11
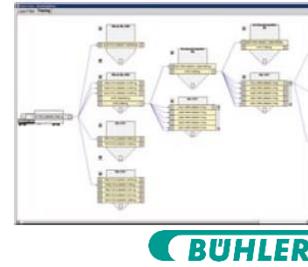
- Discussion and questions

Overview Weihenstephan Standards
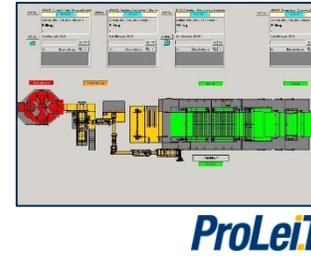
Efficiency analysis/ reporting

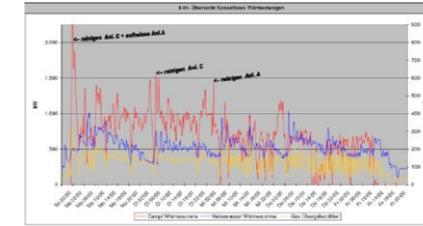SIEMENS

Batch/article tracing

BÜHLER

Visualization

ProLeiT

Quality/energy management

ProLeiT

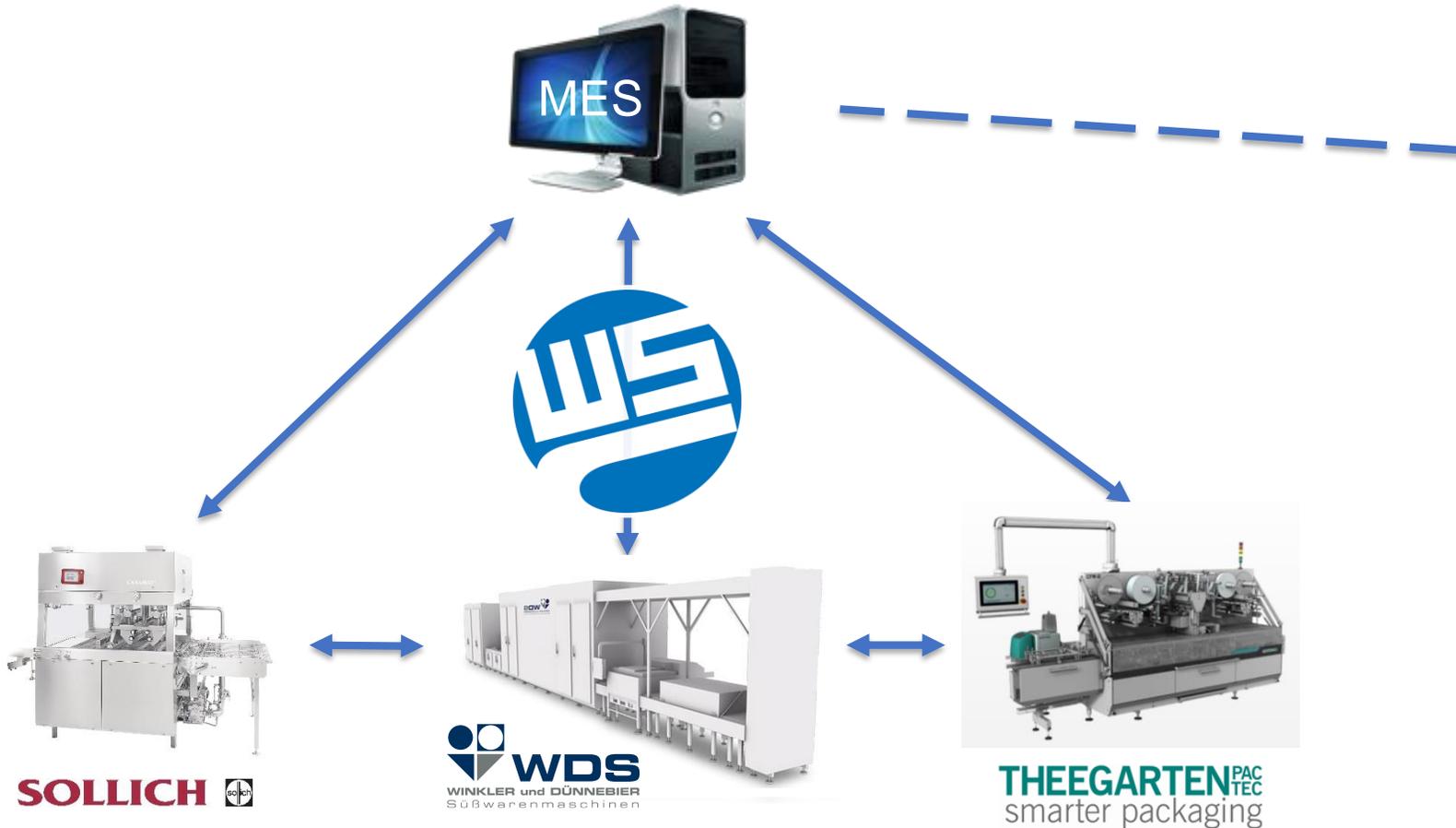MES
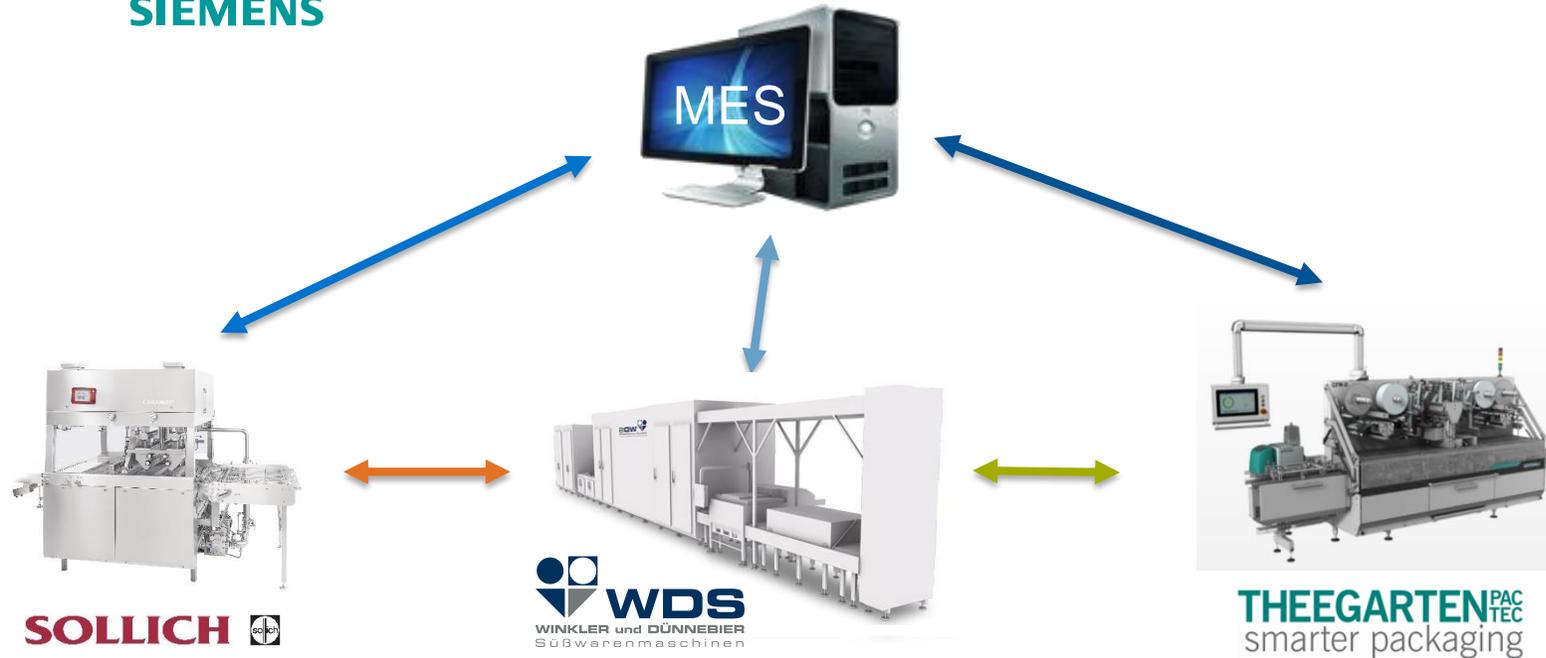
SOLLICH

WDS
WINKLER und DÜNNEBIER
Süßwarenmaschinen

THEEGARTEN PAC TEC
smarter packaging
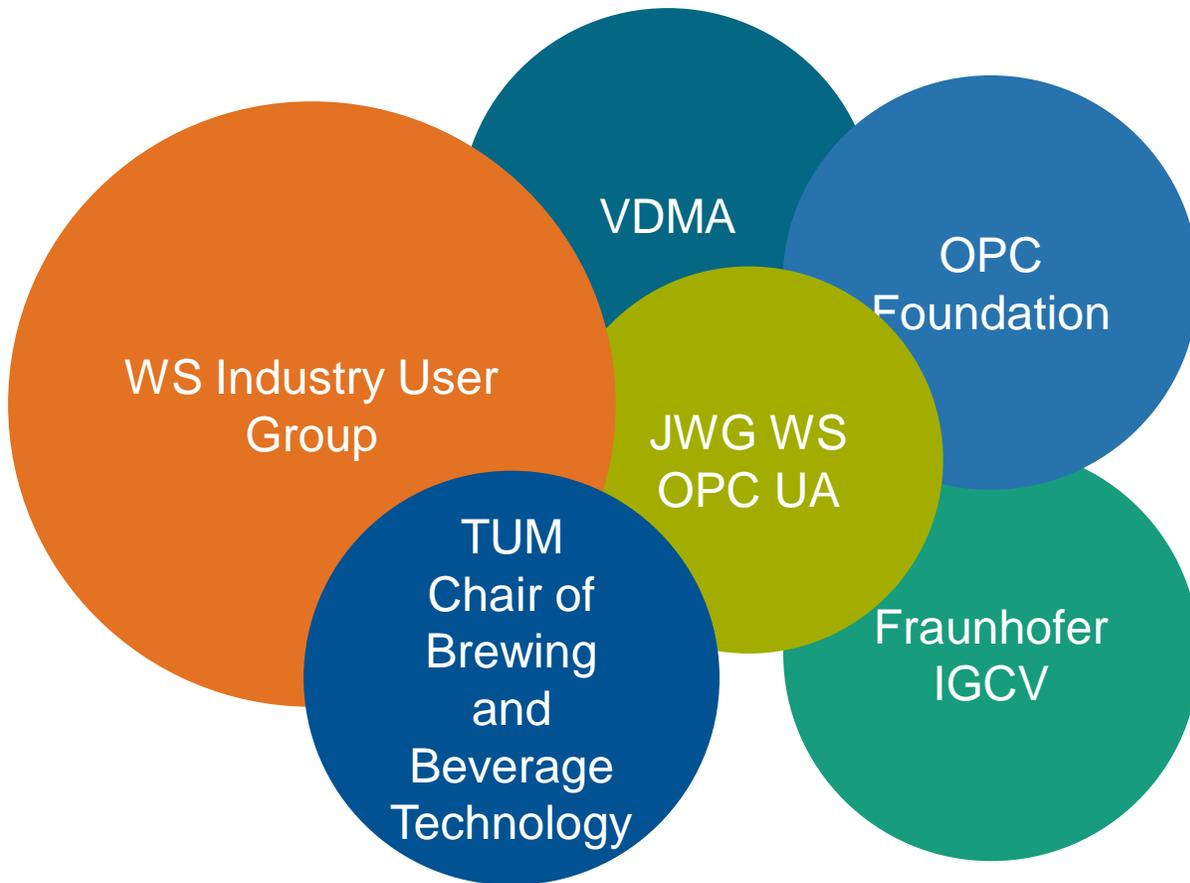
Food and beverage production and packaging line

The Weihenstephan Standards provide

- standardized data content for machines in the F&B industry
- communication protocol based on WS OPC UA CS ...

- domain specific recommendations for evaluation and reporting
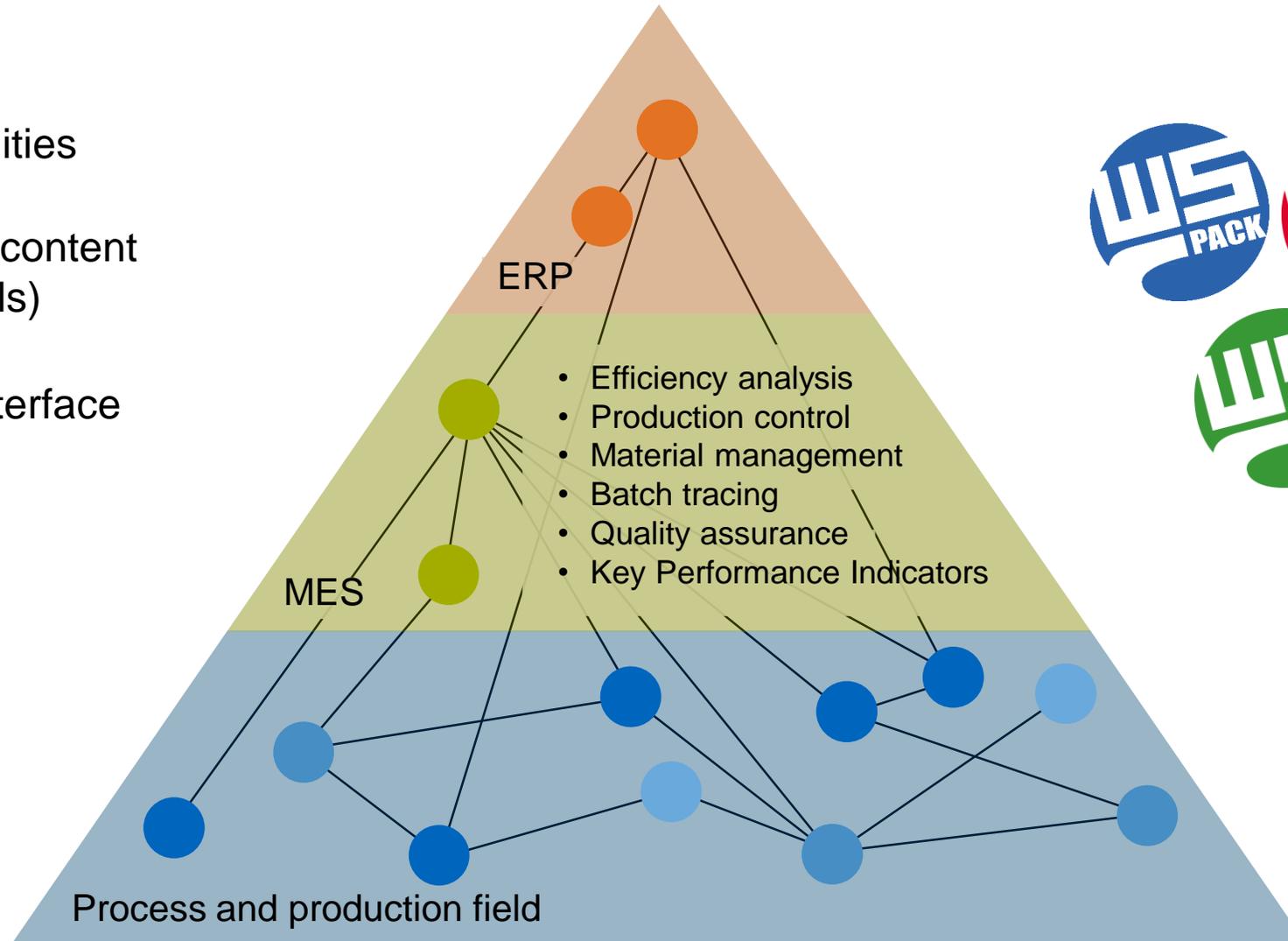
e.g. Efficiency analysis/ reporting

Who we are

- **WS Industrial User Group:**

  The Weihenstephan standards are discussed and decided independently and pre-competitively in the WS Industry User Group.

- **TUM (https://lbgt.wzw.tum.de):**

  The Chair of Brewing and Beverage Technology at the Technical University of Munich accompanies the WS from a scientific point of view and is responsible for the operational development.

- **VDMA (https://vdma.org):**

  The German Machinery and Equipment Manufacturers Association supports the development of the Weihenstephan Standards.

- **JWG WS OPC UA:**

  Joint Working Group which is responsible for the development of the companion specifications OPC UA for Weihenstephan Standards

- **Fraunhofer IGCV (https://www.igcv.fraunhofer.de):**

  Co-author of the CS UA for Weihenstephan Standards

- **OPC Foundation (https://opcfoundation.org/):**

  The OPC Foundation has the task of creating data transmission standards for secure and reliable interoperability in industrial automation.

WS Industrial User Group

Weihenstephan Standards

1. IT/MES-Functionalities

2. standardized data content
   (information models)

3. Communication Interface

ERP

MES

- Efficiency analysis
- Production control
- Material management
- Batch tracing
- Quality assurance
- Key Performance Indicators

Process and production field

WS PACK
WS FOOD
WS BAKE
WS BREW
WS SWEETS

1. IT/MES-Functionalities

The WS define domain-specific evaluation recommendations for IT/MES functionalities. These can be found in the respective documents "Data Evaluation and Reporting".
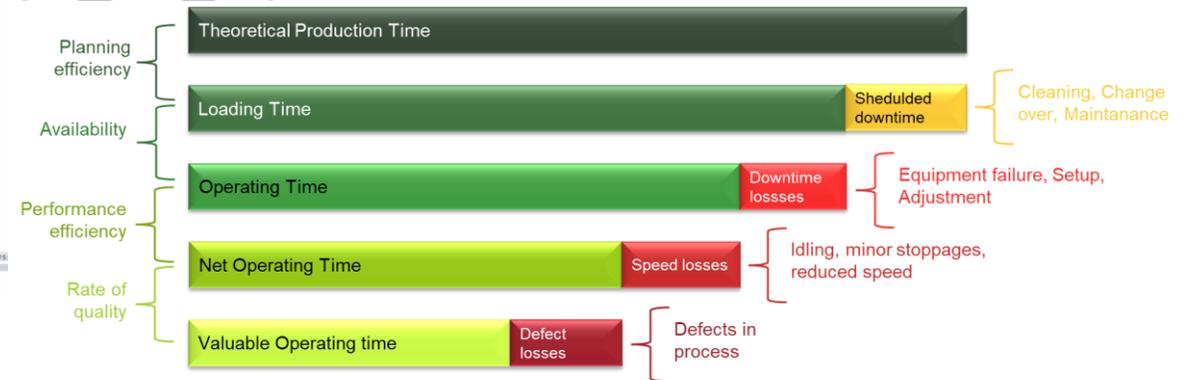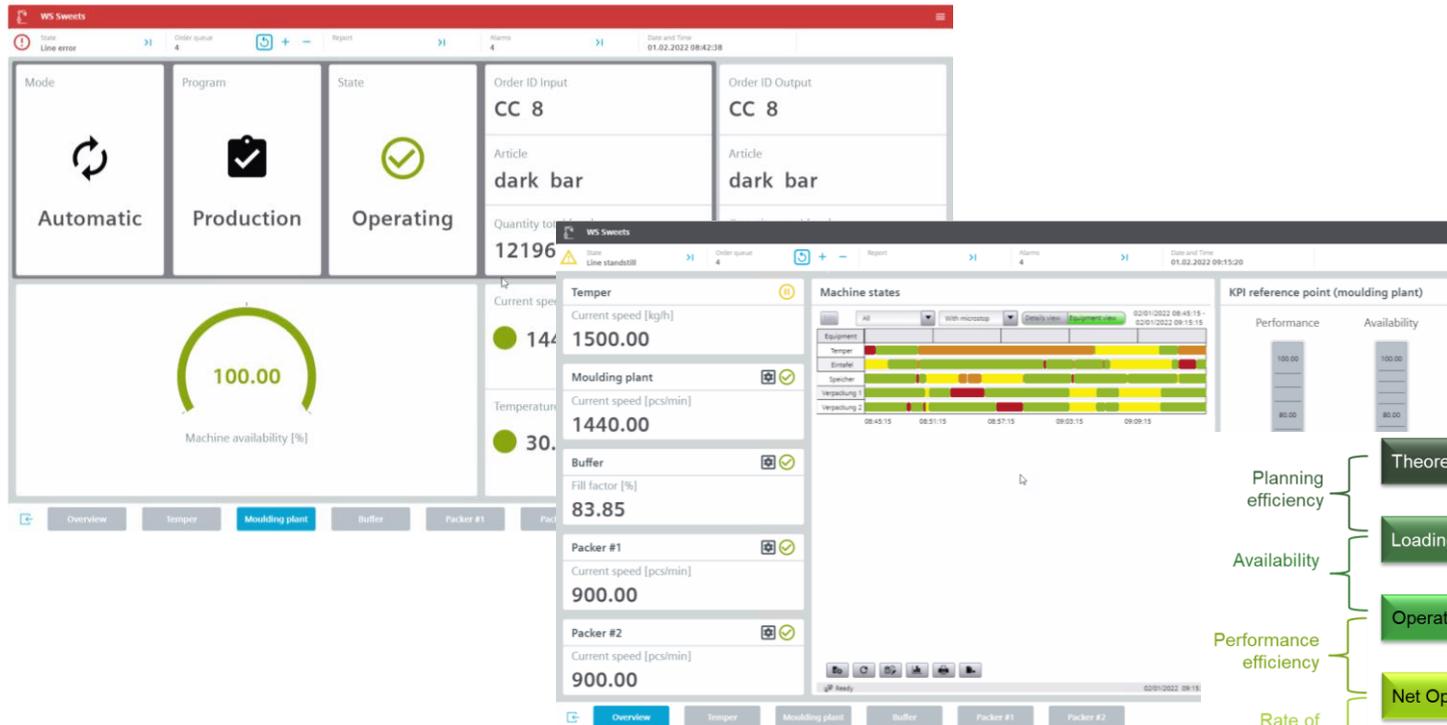
2. Standardized data content (information models)

- Based on the required IT/MES functionalities, domain-specific information models are defined for over 160 different machine classes

WS BrowseName: ActualTemperature
WS DisplayName: Actual Temperature
Description: This data point gives the actual temperature.
Details: This data point is only be used if it is clear which temperature is meant.
TypeDefinition: WSAnalogUnitType:
DataType: Float
Access permission: R

3. Communication Interface(s)

- Communication interfaces define how the WS data is transferred to higher-level IT systems (e.g. MES)
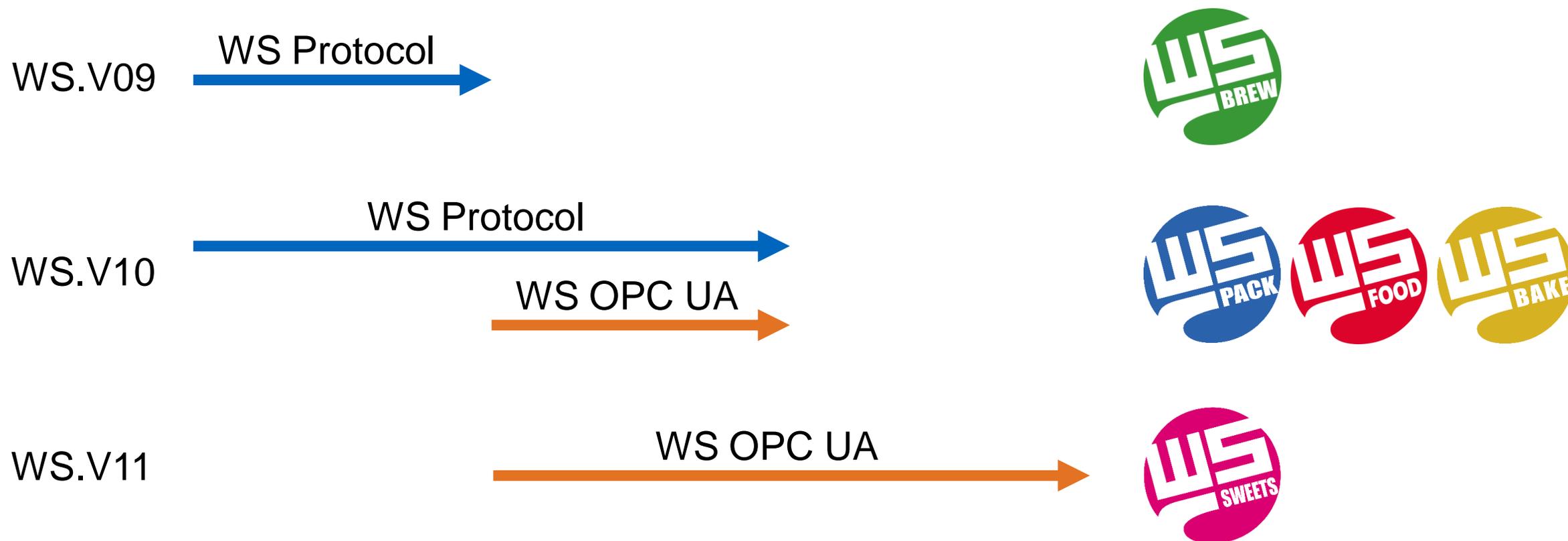
3. Communication via OPC UA
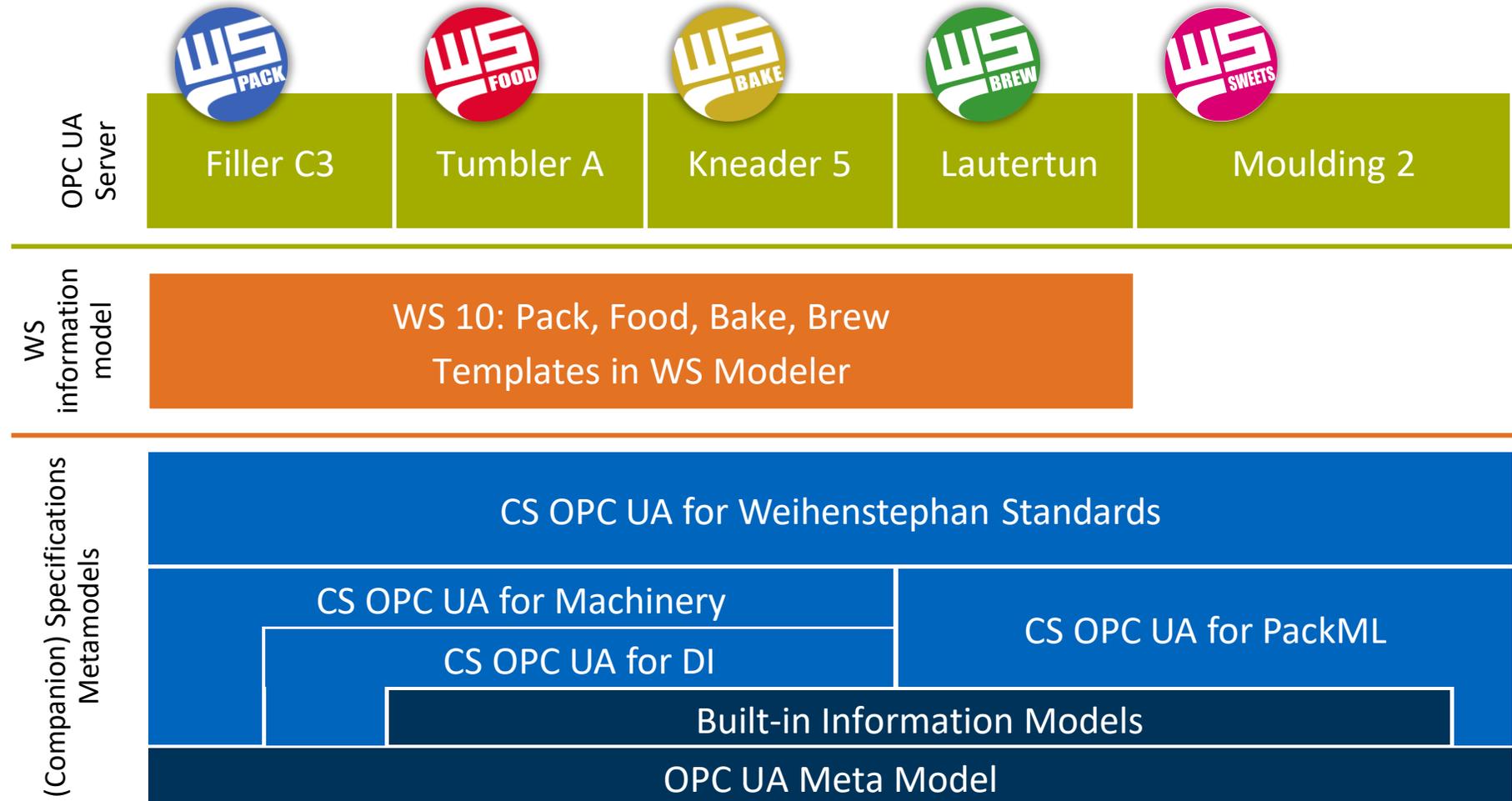
Layered model for WS via OPC UA: Illustration according to Christoph Nophut

| Category	WS BrowseName	WS Pack Pasteurising machines	WS Pack Fill and seal machines	WS Pack Inspection machines	WS Pack Inspection machines for packages	WS Pack Empty bottle inspection machine	WS Pack Full bottle inspection machine
Measured values	WS_Vol_Flow_Det						
Operating modes	WS_Cur_Mode	Mandatory	Mandatory	Mandatory	Mandatory	Mandatory	Mandatory
Operating modes	WS_Cur_Modes	Optional	Optional	Optional	Optional	Optional	Optional
Operating states	WS_Cur_State	Mandatory	Mandatory	Mandatory	Mandatory	Mandatory	Mandatory
Operating states	WS_Cur_States						
Operating states	WS_S88_State						
Operating states	WS_S88_States						
Parameters	WS_Beer_Type		Optional				
Parameters	WS_Bot_Tank_No		Optional				
Parameters	WS_Bottle_Type		Optional	Optional	Optional	Optional	Optional
Parameters	WS_Crate_Type						
Parameters	WS_Date_Coding						
Parameters	WS_Mach_Design_Spd	Mandatory	Mandatory	Mandatory	Mandatory	Mandatory	Mandatory
Parameters	WS_Outfit_Type						Optional
Parameters	WS_Pack_Aids_Type		Optional				
Parameters	WS_Pack_Cont_Type		Optional				Optional
Parameters	WS_Pack_Media_Type		Optional				
Parameters	WS_Package_Type			Mandatory	Mandatory	Mandatory	Mandatory
Parameters	WS_Pallet_Pattern						
Parameters	WS_Pallet_Type						
Parameters	WS_Prod_Ratio						
Parameters	WS_Set_Mach_Spd	Optional	Optional	Optional	Optional	Optional	
Programs	WS_Cur_Prog	Mandatory	Mandatory	Mandatory	Mandatory	Mandatory	
Programs	WS_Cur_Progs	Optional	Optional	Optional	Optional	Optional	Optional
Programs	WS_Prog_Step	Optional	Optional	Optional	Optional	Optional	Optional

WS Version 10

Information model of a tunnel oven in WS 10
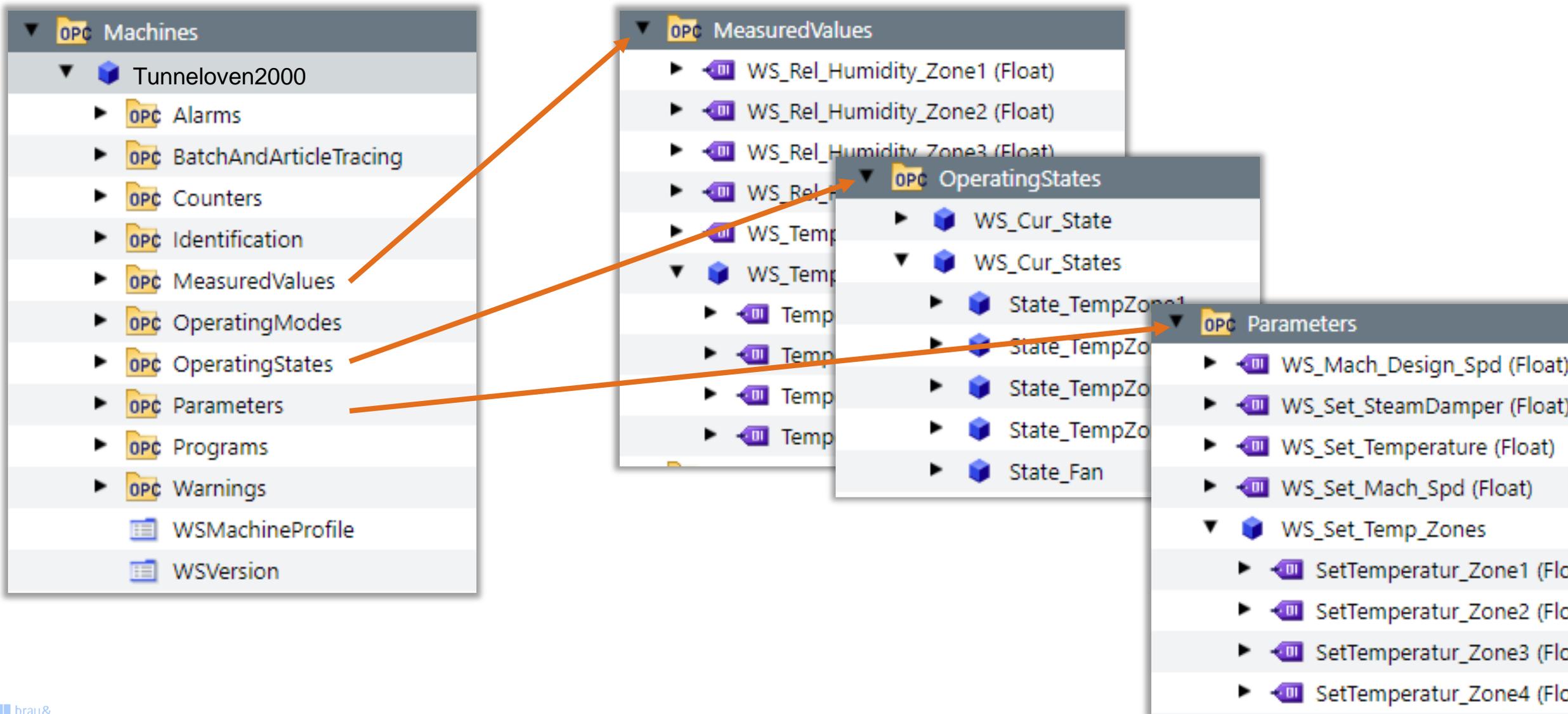
Limitations in version WS 10

- Naming of data points (BrowseNames)
  - Cryptic designations (e.g. WS_Mach_Spd, WS_Tot_Prod_U_L)
  - Often definition of new customer/manufacturer specific data points necessary
- no component-based modeling approach, but "flat" data point list
- No proper type system in the sense of object-oriented modeling
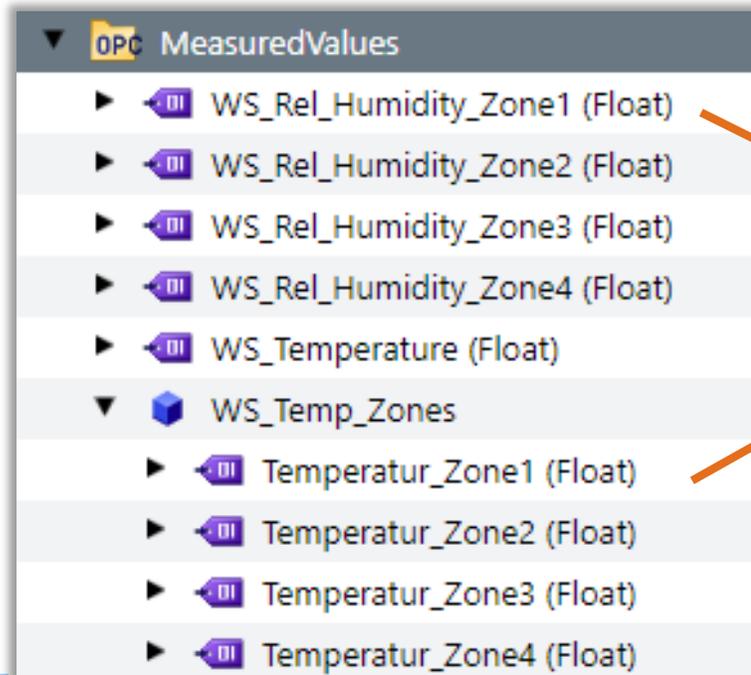
Informationen on TemperatureZone1
- WS_Cur_State_Zone1
- WS_Rel_Humidity_Zone1
- Temperature_Zone1
- SetTemperature_Zone1
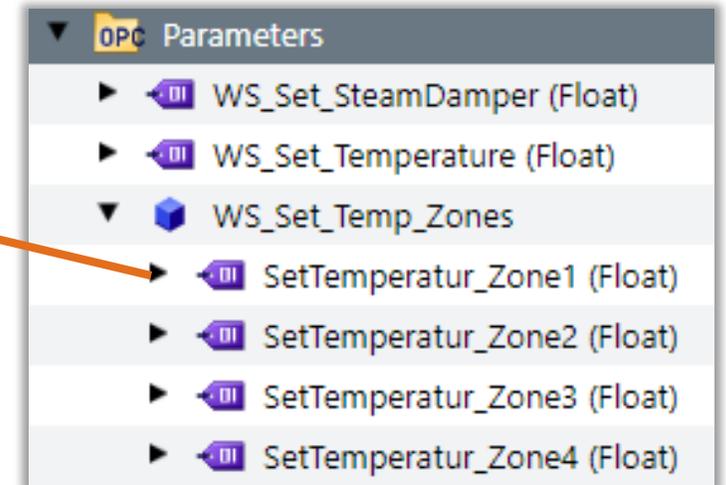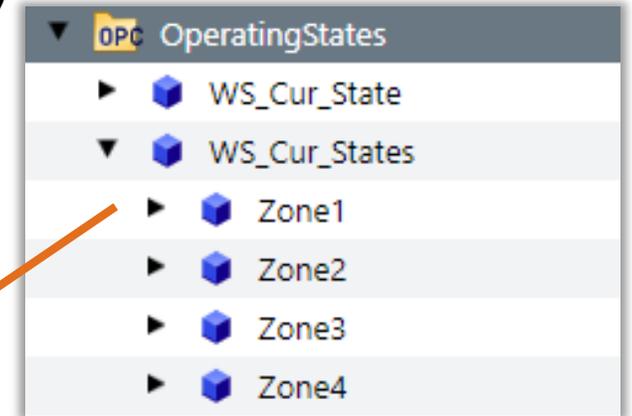
3. Communication via OPC UA
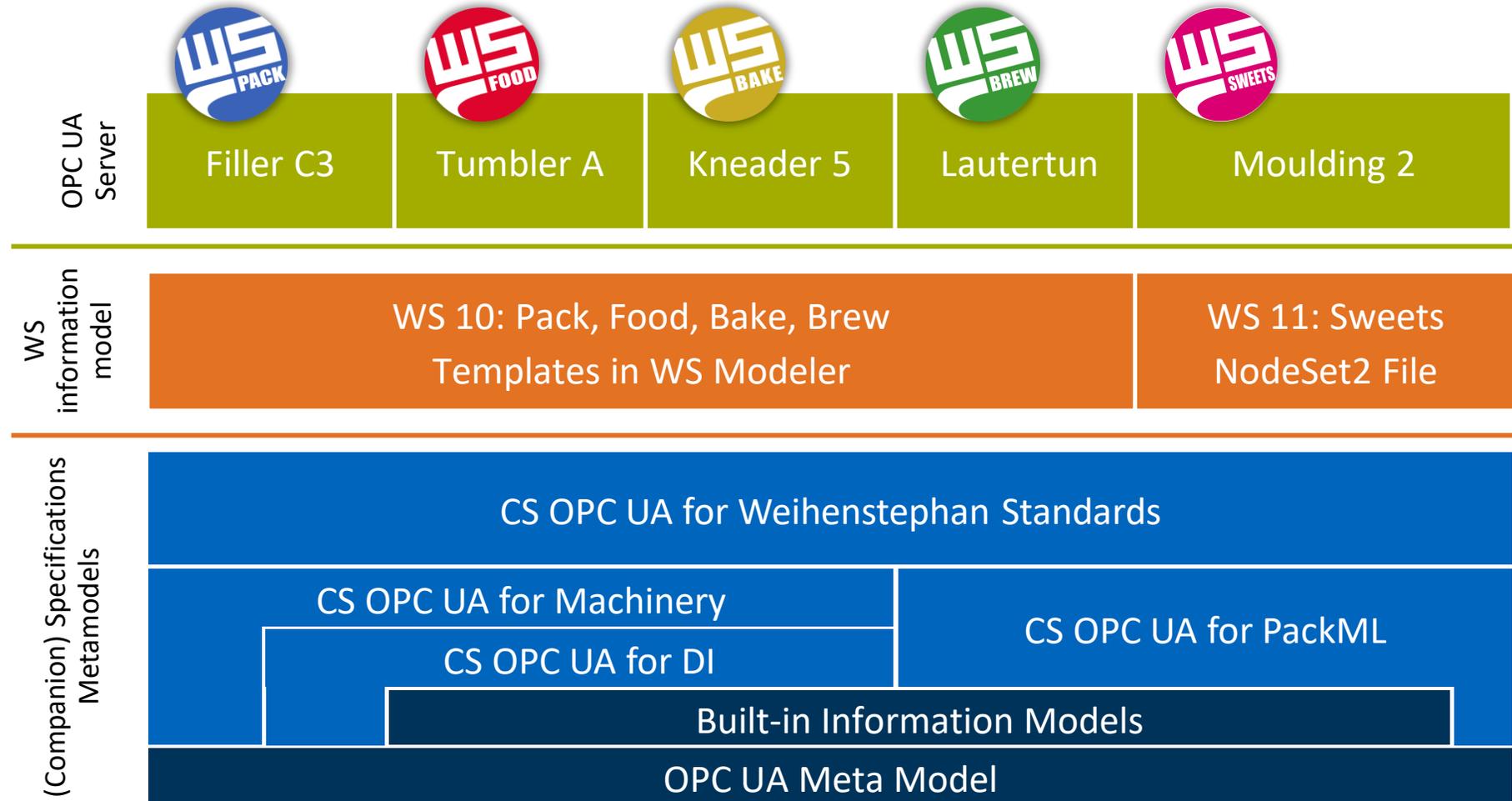
Layered model for WS via OPC UA: Illustration according to Christoph Nophut

WS Sweets Project

Machines considered in WS Sweets

- Initial question: Which machines should be considered for the WS Sweets project?

- Machines for selected reference processes
    - Chocolate tablet production   → Moulding plants
    - Fruit gum production   → Mogul plants
    - Bar production   → Bar production lines
    - Production of jelly and bar masses   → Cooking plants

Project steps in WS Sweets

1 **Machine classes**

Which machines should be considered in the WS Sweet project?

- Machines for selected reference processes
  - Chocolate tablet production
  - Fruit gum production
  - Bar production
    - …

2 **IT functionalities**

Which functionalities of which systems should be served?

- Process visualization
- Key figure calculation
- Order management
- ….

3 **Data points**

incl. data point machine assignment

- WS_Cur_State
- WS_Temperatur
- WS_Temperindex
- ….

4 **Evaluation recommendation**

- domain-specific evaluation recommendations for WS Sweets as PDF documents
- how to generate and display information based on WS data points

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Component based modeling approach

- Initial project plan: Flat data point list for individual machines analogous to the existing WS
- Not suitable for machines of the reference processes, as these are modular and individually configured
→ Information model for machines consisting of components with data on component level

WS Version 10: „flat" List

Cooling Station

- State
- Set_Temperature_01
- Set_Temperature_02
- Temperature_01
- Temperature_02
- Set_Spd_Fan_01
- Set_Spd_Fan_02
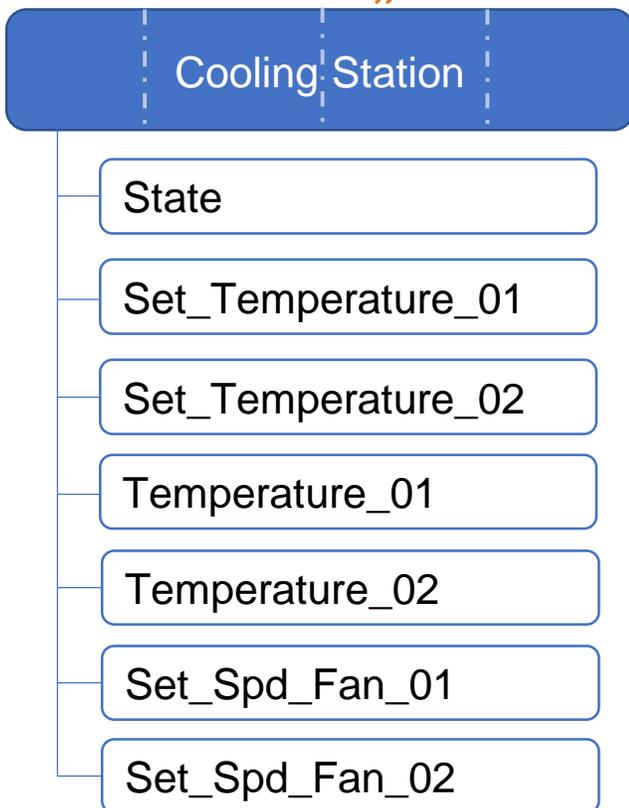
WS Version 11: Component approach
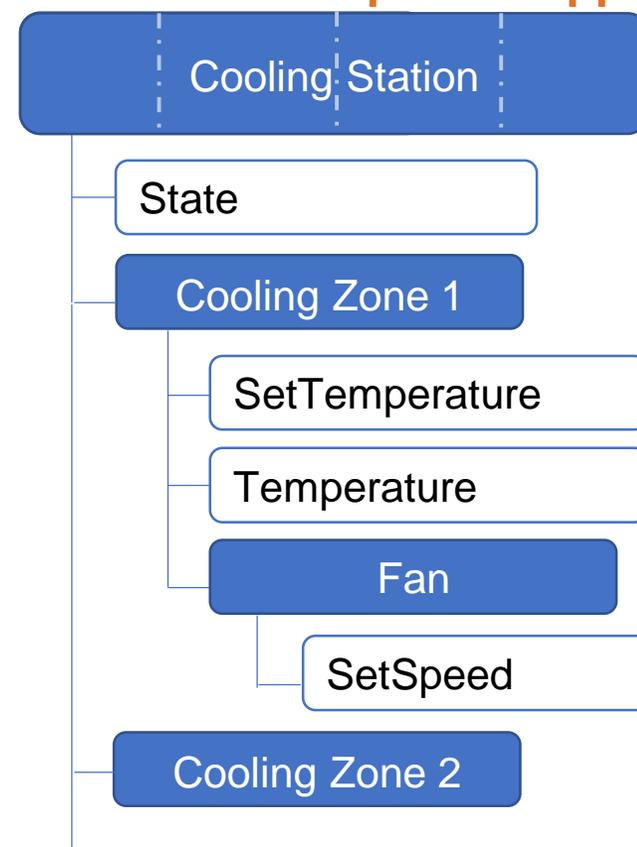
Cooling Station

- State
- Cooling Zone 1
  - SetTemperature
  - Temperature
  - Fan
    - SetSpeed
- Cooling Zone 2

* The models are simplified, e.g. no folders are displayed for grouping categories!

Working method in the WS Sweets project

- Workshops for the harmonized description of machines and their components

- Four different working groups for: Mogul plants, moulding plants, bar production lines, cooking plants

- Definition of the machines: Designation and data points at machine level

- Definitions of their components: Designation, modeling rule (can/must exist (possibly multiple times)) and data points on component level

- Harmonization of components between the different processes and machines e.g. a dosing unit or hopper

Working method in the WS Sweets project

- Workshops for the harmonized description of machines and their components

2	L1	L2	L3	L4	L5	L6	L7	L8	L9	TypeDefinition	BroweName	BrowseName Example	Modeling Rule
3	X									WSMachineType	Frei Wählbar / "WS Sweets Forming"		
4		X								WSDosingUnitType	Frei Wählbar		0,1,n
5		X								WSContinuousMixingType	Frei Wählbar	"Contimix1"	0,1,n
6			X							WSHopperType	"Hopper"		0,1
7				X						WSLevelControlType	LevelControl		1
8				X						WSTemperingDeviceType	TemperingDevice		0,1
9					X					WSElectricalHeaterType	ElectricalHeater		0,1
10					X					WSTempClosedLoopControlType	TemperaturControl		1
11						X				AnalogUnitType	ActualValue		1
12						X				AnalogUnitType	SetPoint		0,1
13					X					WSPumpFCMotorType	Pump		0,1
14			X							WSMotorType	SlewDrive (Schwenkantrieb)		0,1
15			X							WSMotorType	WormDrive (Schneckenantrieb)		1
16			X							WSTemperingDeviceType	TemperingDevice		0,1
17		X								WSRollerType	Frei Wählbar	"Vorkühlwalze", "Kompess	0,1,n
18			X							WSRollerFCMotorType	"Motor"		1
19			X							WSTemperingDeviceType	"TemperingDevice"		0,1
20		X								WSSlabFormerType	Frei Wählbar	"Schicht 1"	0,1,n
21			X							WSRollerType	TopRoller		1
22				X						WSMotorType	Motor		1
23				X						WSTemperingDeviceType	TemperingDevice		0,1
24			X							WSRollerType	BottomRoller		1
25				X						WSRollerFCMotorType	Motor		1

Results WS Sweets information model

With WS Version 11, the Weihenstephan standard takes two new approaches:

- **Modelling of components:**

  A machine can consist of components. Components themselves can also consist of other components.

- **Modelling a proper OPC UA Information model:**

  All relevant WS machines and components are modelled as types.

Types for WS Sweets Machines
- for stand-alone machines only
  e.g. WSSweetsMogulPlantType
- Incl. components and data points at machine level
- Subtypes of the WSMachineType
- Objects/Variables/Properties are inherited

Types for Components
- for not stand-alone components e.g. WSMotorType
- Incl. components and data points at component level
- Definition of a generic WSComponentType with information that are relevant for all components
- Most components are subtypes of this WSComponentType
- Components were harmonized across processes if possible (motor, hopper, ..)

Summary WS Versions

WS.V09:

WS Protocol

- Permutation table defines data points via machine profiles
- Flat list of data points addressed by TAG numbers
- TAG number range divided into categories, e.g. counters, measured values

WS.V10:

OPC UA

+ WS Protocol

- Permutation table defines data points over machine profiles
- Data points addressed by (partly cryptic) BrowseNames
- Data points grouped in FunctionalGroupFolders, e.g. counters, measured values
- No underlying type system
- Backward compatibility exists

WS.V11:

OPC UA

- Object-oriented modeling
- Modeling of machine profiles by underlying type system
- Component-based modeling
- Event-driven data acquisition
- No backward compatibility, no TagNr, new self-speaking BrowseNames

Project goal WS Bake Version 11

Based on the Weihenstephan Standards Bake Version 10, the „flat" machine profiles of the machines defined in WS Bake 10 are to be converted in a standardized and component-built WS Bake OPC UA information model.

WS Bake Version 11 – Project steps

WP 1:   Reference processes,
        Definition of project scope

- Is the scope of the reference processes/machines of WS Bake version 10 suitable for all project partners?
- If necessary, definition of additional reference processes or machines to be considered in the WS Bake 11
- Definition Project scope

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WS Bake Version 11 – Project steps

WP 2: Summary IT functionalities WS Bake 10, update and extension if required

- Requirement analysis: Are the served IT functionalities from WS Bake 10 sufficient or do they need to be extended?
- If necessary, define additional IT functionalities and derive the required data content per machine

→ Should further (not necessarily Bake specific) functionalities be considered, e.g. OPC UA Alarms & Conditions, Events, OPC UA Methods, Batch & Article Tracing?

→ extended project scope

WS Bake Version 11 – Project steps

WP 3:   Definition of the WS Bake OPC UA information model

- Working in small machine specific working groups:
  e.g. WP 3.1 regarding kneaders

  - Work meeting kneader group + individual queries
  - Follow-up and harmonization:
    which components are already defined (in WS Sweets)
    relevant data points from WS Bake 10
  - Requirements IT:
    Which data points are also of interest?
    Interviews with/feedback from production plants
  - TypeSystem WS Bake kneader:
    Create TypeSystem,
    Definition of all ObjectTypes, Objects, Variables
  - Validation, improvement, bug fix

Analogous procedure is used in:
WP 3.2 - Dough processing plant
WP 3.3 - Fermentation plants,
WP 3.4 - Baking plants
WP 3.5 - Cooling and freezing equipment
WP 3.6 - …?

WS Bake Version 11 – Project steps

WP 4: Validation and documentation,
update of evaluation recommendation

- Validation of the WS Bake type system:
  Feedback loop, improvement, bug fix
- Create documentation and tutorials, how to use WS Bake
- Update WS Bake evaluation recommendation

WS Bake Version 11 – Project steps

WP 0:   Project management

- Kickoff meeting, intermediate and final meeting
- Forming of machine specific working groups
- Public Relations: promote WS Bake through lectures at conferences and articles

Workplan WS Bake Version 11 – Minimal project scope

Work packages		Weeks																PW
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	**17**
0	Project management																		**2**
1	Requirements for reference processes/ machine classes																		**1**
2	Requirements IT functionalities																		**2**
3	Definition of the WS Bake OPC UA information model																		**9**
3.1	Kneaders																		1,5
3.2	Dough processing plant																		3
3.3	Fermentation plants																		1,5
3.4	Baking plants																		1,5
3.5	Cooling / freezing equipment																		1,5
3.6	…?																		?
4	Validation and documentation																		3

Financing plan

The project work will be carried out by two research assistants (Dipl.-Ing. or M.Sc.) of the Technical University of Munich at the Chair of Brewing and Beverage Technology.

On the minimal project scope at least 17 weeks of full-time work are required to complete the described work packages. At the kickoff meeting, the interested project partners can bring in their requirements and together we will define the project scope. After that we can agree on an updated project cost proposal.
Estimated costs are between 40.000 – 60.000 € depending on the project scope.

The project costs will be distributed among the project partners and also covered by the purchase of WS company packages. For example, with 10 project partners, the costs per partner are about 5.000 €.

Possible project start: 1. September 2023

Information model of a tunnel oven in WS Version 10
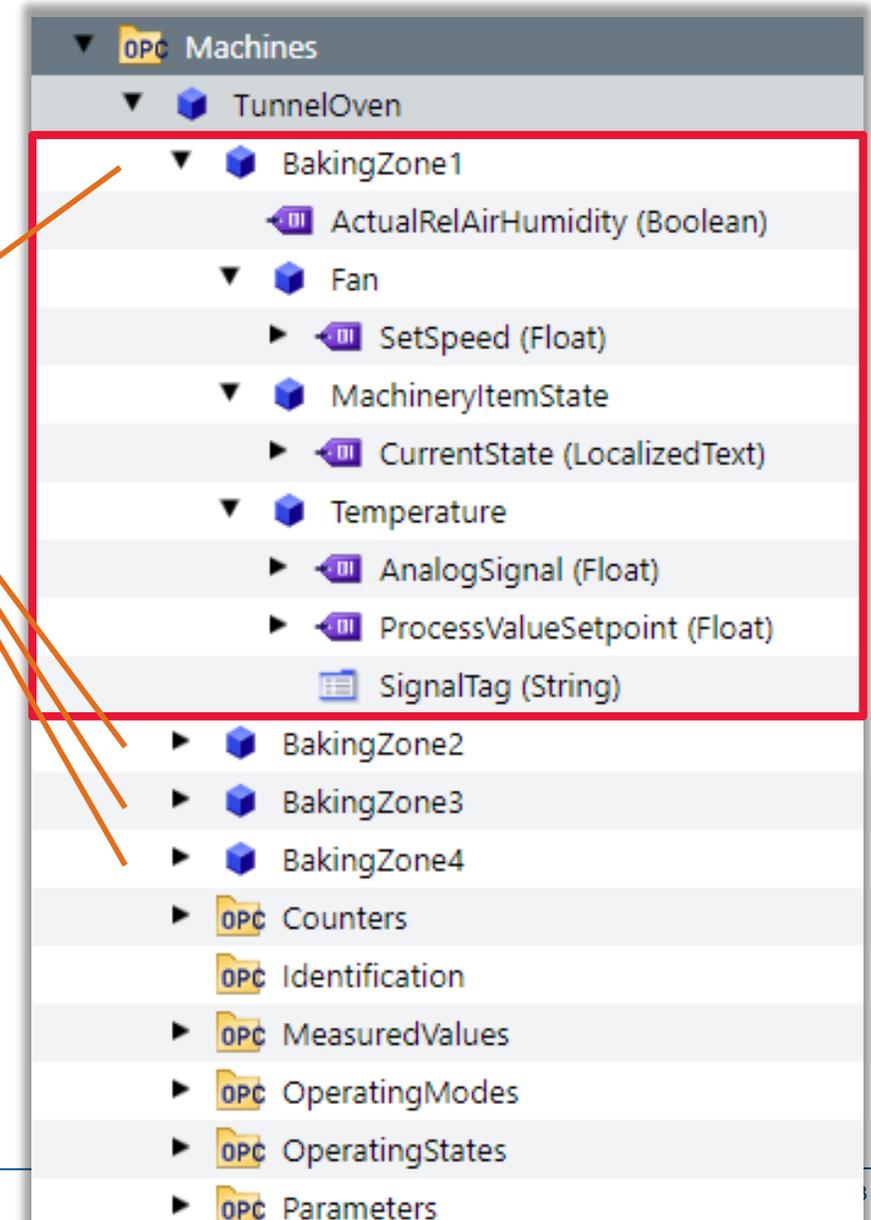
Outlook: Information model of a tunnel oven in WS Version 11

freely nameable instances of the WSTemperingZoneType
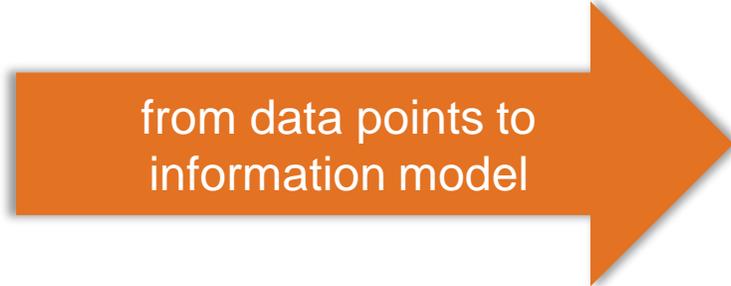
from data points to information model

https://www.weihenstephan-standards.com

- Video tutorials
- Implementation guide
- WS Packages
- More information to WS industry user group

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