



Dr.-Ing. Rainer Drath, ABB Forschungszentrum, AutomationML Plugfest 13.+14.10.2015

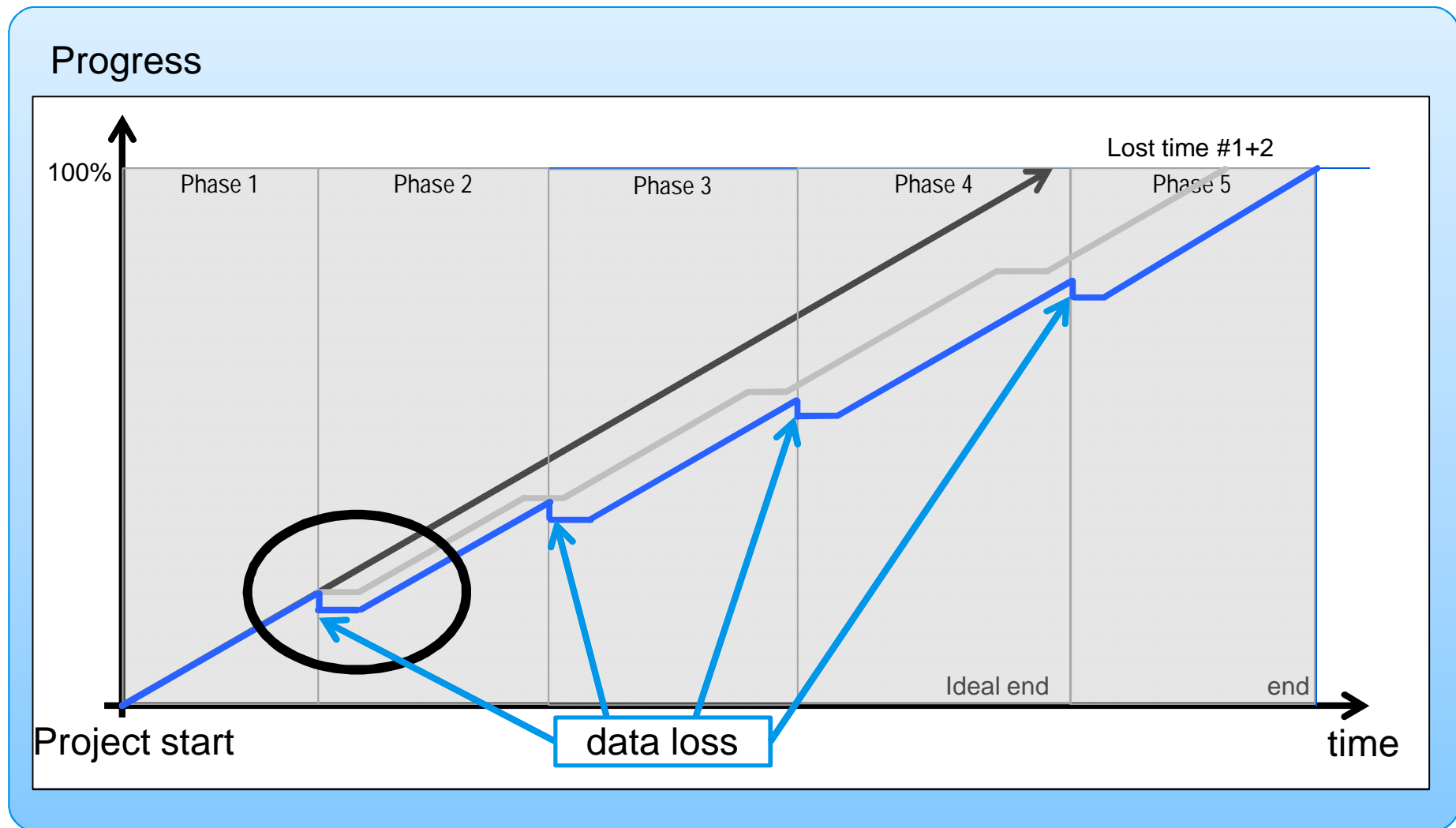
# Is your Engineering Tool open?

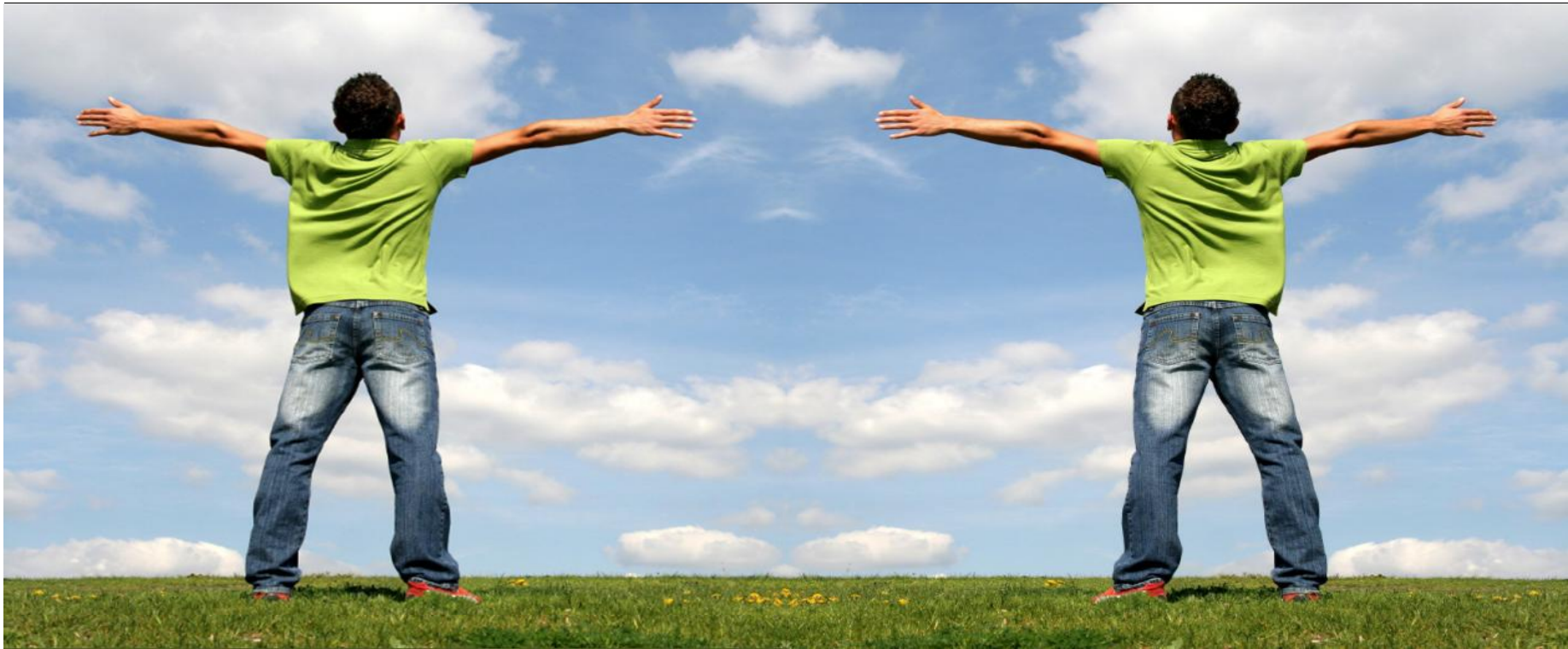
## The openness metric



# The engineering process of automation systems

## Real world engineering projects





Dr.-Ing. Rainer Drath, ABB Corporate Research Center Ladenburg, AutomationML Plugfest 14.-15.10.2015

# What makes a tool open?



# What makes a tool open



## **Provide export functions**

- Good: a proprietary file format
- Better: an open file format
- Better: a Software API

# What makes a tool open



## Provide unique identifiers

- Basic: an ID for each object
- Better: a stable ID for each object

# What makes a tool open



## **Provide formal functions**

- needed: version information
- needed: integrity checks

# What makes a tool open



## Provide type informationen

- Good: a reference to the object type
- Better: a library of all used types



# What makes a tool open



## **Provide import functions**

- Good: a proprietary file format
- Better: an open file format
- Better: a Software API

# What makes a tool open



## **Provide manipulation functions**

- needed: functions to change or add data
- needed: feedback about the success of changes

# What makes a tool open



## **Completeness of signal data**

- + signal names
- + signal direction
- + signal type
- + IEC data type
- + physical address

# What makes a tool open



## **Completeness of HW data**

- + type of component
- + hardware address
- + allocation between signal and hardware

# What makes a tool open



## Project data

- + project name
- + structure information
- + project status

# What makes a tool open




## **Provide Documentation**

- + for export actions
- + for the export/import data format
- + for import actions



# The evaluation metric

# The metric Implementation as an Excel sheet

| Openness Metric V 5.0  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
|--|----------------------|----------------------|--|--------------------------------------|----------------------|---|----------------------|--|---|--|----------------------|
| 11.09.2012   |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| <div></div>                                   |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| I. Export Functionality  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| 1.) Export Format  |                      |                      | 2.) Identifier   |                                      |                      | 3.) Formal requirements   |                      |  | 4.) Library   |  |                      |
| a) Export of Open format (PLCOpen, AutomationML, ...)  |                      |                      | b) Export of Proprietary data format (XML, Private: <Scheme, binary code, ...)             |                                      |                      | c) API for remote tool control                                    |                      |  | d) ID available for all objects   |  |                      |
|  |                      |                      |  |                                      |                      | e) Data integrity / authentication check                          |                      |  | f) Version control: timestamp   |  |                      |
|  |                      |                      |  |                                      |                      | g) Unique Reference Element to library class                      |                      |  | h) Export of related library class  |  |                      |
| 0  | 1                    | 0                    | 1  | 0                                    | 0                    | 0   | 1                    | 0  |   |  |                      |
| true/false   | true/false           | true/false           | green/yellow   | green/yellow                         | green/yellow         | green/red for safety  | green/red            | green/yellow                                       |   |  |                      |
| 0,5  |                      |                      | 0,5  |                                      |                      | 0   |                      |  | 0,5   |  |                      |
| Rule (EF = ExportFormat = Red/Yellow/Green)<br>"If (a or c) THEN EF = GREEN;<br>ELSE IF (b) THEN EF=YELLOW;<br>ELSE EF = RED"  |                      |                      | Rule (ID = Identifier)<br>"If (a AND b)<br>then ID=green<br>else ID=red<br>else ID=yellow" |                                      |                      | Rule (V=Version)<br>"If (a) Then<br>ID=green<br>else ID=yellow"   |                      |  | Rule (Lib = Library)<br>"If (a AND b)<br>then Lib = green<br>else If (a AND NOT b) then Lib = yellow<br>else Lib = red" |  |                      |
| EX = (EF==RED) * (ID==RED) * (Lib==RED) * (0,5 + 0,3*ID0 + (EF + V + DI + Lib)/20)   |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| 55%  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| II. Import Aspects   |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| 1.) Import Format  |                      |                      | 2.) Manipulations  |                                      |                      |   |                      |  |   |  |                      |
| a) Import of Open format (PLCOpen, AutomationML, ...)  |                      |                      | b) Import of Proprietary data format (XML, Private: <Scheme, binary code, ...)             |                                      |                      | c) API for remote tool control                                    |                      |  | d) Change or Add Data   |  |                      |
|  |                      |                      |  |                                      |                      | e) Feedback about validity of manipulations                       |                      |  |   |  |                      |
| 0  | 1                    | 0                    | 1  | 0                                    |                      |   |                      |  |   |  |                      |
| true/false   | true/false           | true/false           | true/false   | true/false                           | green/yellow         |   |                      |  |   |  |                      |
| 0,5  |                      |                      | 1  |                                      |                      |   |                      |  |   |  |                      |
| Rule (IF = ExportFormat = Red/Yellow/Green)<br>"If (a or c) THEN IF = GREEN;<br>ELSE IF (b) THEN IF=YELLOW;<br>ELSE IF = RED;" |                      |                      | Rule (CH=Change)<br>"If (a) Then<br>CH=green<br>else CH=red"                               |                                      |                      | Rule (FE=Feedback)<br>"If (a) Then<br>FE=green<br>else FE=yellow" |                      |  |   |  |                      |
| EX = (IF==RED) * (CH==RED) * (0,7 + ((IF+FE)/6,66)*CO  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| 85%  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| III. Completeness  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| 1.) Signals  |                      |                      |  | 2.) Hardware                         |                      |   |                      | 3) Engineering Project Data                        |   |  |                      |
| a) Tag name  |                      |                      |  | b) Signal direction (in/out)         |                      | c) Signal type (analog / digital)                                 |                      | d) IEC data type (bool / byte / int / ...)         |   | e) Physical address                      |                      |
|  |                      |                      |  |                                      |                      |   |                      | f) HW components (e.g. controllers, slave devices) |   | g) Hardware addresses (e.g. bus address) |                      |
|  |                      |                      |  |                                      |                      |   |                      | h) Signals can be allocated to HW devices          |   | i) Project name                          |                      |
|  |                      |                      |  |                                      |                      |   |                      |  |   | j) Structural information                |                      |
|  |                      |                      |  |                                      |                      |   |                      |  |   | k) Project status                        |                      |
| 1,0  | 1,0                  | 1,0                  | 1,0  | 1,0                                  | 1,0                  | 1,0   | 1,0                  | 1,0  | 1,0   | 1,0                                      | 1,0                  |
| green / yellow / red   | green / yellow / red | green / yellow / red | green / yellow / red   | green / yellow / red                 | green / yellow / red | green / yellow / red  | green / yellow / red | green / yellow / red                               | green / yellow / red  | green / yellow / red                     | green / yellow / red |
| 1,0  | 1,0                  | 1,0                  | 1,0  | 1,0                                  | 1,0                  | 1,0   | 1,0                  | 1,0  | 1,0   | 1,0                                      | 1,0                  |
| n.a.   | n.a.                 | n.a.                 | n.a.   | n.a.                                 | n.a.                 | n.a.  | n.a.                 | n.a.   | n.a.  | n.a.                                     | n.a.                 |
| n.a.   | n.a.                 | n.a.                 | n.a.   | n.a.                                 | n.a.                 | n.a.  | n.a.                 | n.a.   | n.a.  | n.a.                                     | n.a.                 |
| 1,0  | 1,0                  | 1,0                  | 1,0  | 1,0                                  | 1,0                  | 1,0   | 1,0                  | 1,0  | 1,0   | 1,0                                      | 1,0                  |
| Rule (EA = Export/Import Format Documented)<br>"EA = 1"  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| Rule (ID = Export/Import Format Documented)<br>"ID = 1"  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| Rule (IA = Import Actions Documented)<br>"IA = 1"  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| Doc = (EA+ID+IA)/3   |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| 100%   |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| IV. Documentation  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| 1.) Documentation  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| a) Export actions documented   |                      |                      |  | b) Export / Import format documented |                      |   |                      | c) Import actions documented                       |   |  |                      |
|  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| V. Comments  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
| Recommendations  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |
|  |                      |                      |  |                                      |                      |   |                      |  |   |  |                      |

# Application of the metric

| I. Export Functionality   |   |                                |                                 |                                     |                               |  |   |                                    |
|---|---|--------------------------------|---------------------------------|-------------------------------------|-------------------------------|--|---|------------------------------------|
| 1.) Export Format   |   |                                | 2.) Identifier                  |                                     | 3.) Formal requirements       |  | 4.) Library                                   |                                    |
| a) Export of Open format (PLCOpen, AutomationML, ...)   | b) Export of Proprietary data format (XML-Proprietary-Scheme, binary code, ...) | c) API for remote tool control | a) ID available for all objects | b) ID is stable for multiple export | a) Version control: timestamp | b) Data integrity / authentication check | a) unique Reference: Element to library class | b) Export of related library class |
| 0   | 1   | 0                              | 1                               | 0                                   | 0                             | 0  | 1   | 0                                  |
| true/false  | true/false  | true/false                     | yellow                          | green/yellow                        | green/yellow                  | green<br>red for safety                  | green/red                                     | green/yellow                       |
| Rule (EF = ExportForm<br>"IF (a or c) THEN EF = G<br>ELSE IF(b) THEN EF=YEL<br>else EF = RED" |   |                                | else ID=yellow"                 |                                     | else DI=yellow"               |  | else Lib = red"                               |                                    |
| EX = (EF==RED) * (ID==RED) * (LIB==RED) * (0,5 + 0,3*010 + (EF + V + DI + Lib)/20)            |   |                                |                                 |                                     |                               |  |   |                                    |
| 55%   |   |                                |                                 |                                     |                               |  |   |                                    |

Evaluation line  
enter 1 or 0 here

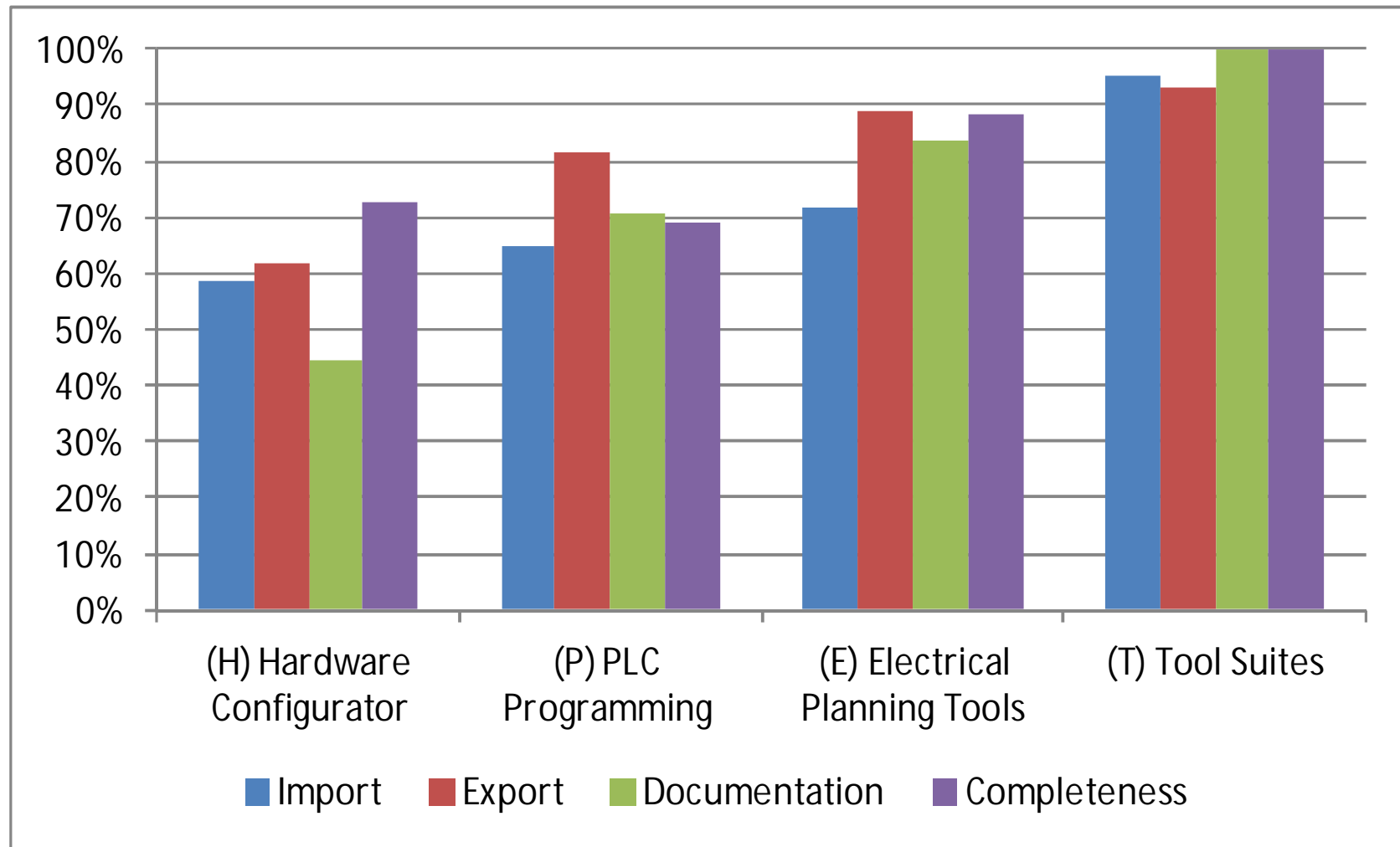
# Application of the metric

| I. Export Functionality   |   |                                |  |                                     |  |  |   |                                    |
|---|---|--------------------------------|--|-------------------------------------|--|--|---|------------------------------------|
| 1.) Export Format   |   |                                | 2.) Identifier                                 |                                     | 3.) Formal requirements                              |  | 4.) Library   |                                    |
| a) Export of Open format (PLCOpen, AutomationML, ...)                               | b) Export of Proprietary data format (XML-Proprietary-Scheme, binary code, ...) | c) API for remote tool control | a) ID available for all objects                | b) ID is stable for multiple export | a) Version control: timestamp                        | b) Data integrity / authentication check | a) unique Reference: Element to library class   | b) Export of related library class |
| 0   | 1   | 0                              | 1  | 0                                   | 0  | 0  | 1   | 0                                  |
| true/false  | true/false  | true/false                     | green/yellow                                   | green/yellow                        | green/yellow   | green<br>red for safety                  | green/red   | green/yellow                       |
| <div>This formular combines all block results</div>                                 |   |                                |  |                                     |  |  | 0,5   |                                    |
|   |   |                                |  |                                     |  |  | Rule (Lib = Library)<br>"if(a AND b)<br>then Lib = green<br>else if(a AND NOT b) then Lib = yellow<br>else Lib = red" |                                    |
| Rule<br>"IF (a AND b) THEN EF=green<br>ELSE IF (b) THEN EF=yellow<br>else EF = RED" |   |                                | Rule (not a)<br>then ID=red<br>else ID=yellow" |                                     | Rule<br>"if (a AND b) THEN V=green<br>else V=yellow" |  | Rule (b) then<br>DI=Green<br>else DI=yellow"  |                                    |
| EX = (EF==RED) * (ID==RED) * (LIB==RED) * (0,5 + 0,3*010 + (EF + V + DI + Lib)/20)  |   |                                |  |                                     |  |  |   |                                    |
| 55%   |   |                                |  |                                     |  |  |   |                                    |

# 15 Engineering tools under test

Contributions from ABB, HSU Hamburg, Vienna University of Technology and Christian Doppler Forschungsgesellschaft and the BMWFJ, Austria

# Evaluation of 15 tools (averages per category)





# Top 4 openness features

## **An open engineering tool should ...**

- support export and import of engineering data, however
- support stable identifiers for all objects
- deliver class/type information for all objects
- deliver feedback about the success of import actions

# References

- <http://aut.hsu-hh.de/openess>
- M. Barth, R. Drath, A. Fay, F. Zimmer, K. Eckert:  
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interoperability in engineering tool chains.  
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