χMCF v3.1.1 (ISO/DPAS 8329 to be)

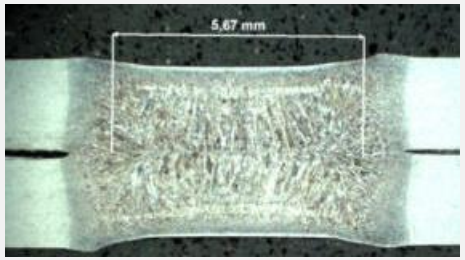
Description of mechanical connections and joints in structural systems

Agenda

1	Joining Technologies & Processes are challenging …
2	χMCF – the Enabler for Smooth Processes
3	Use Cases
4	History, Status, Outlook & Supporting Organizations
5	Status of ISO Standardization
6	Federated use of STEP AP242 with χMCF
7	Technical Details of χMCF

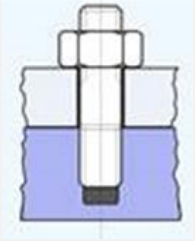
Challenges wrt. Connection Information
Big Variety & Complexity

- > 60 known connection techniques.
- Up to 25 quality criteria per connection technique.

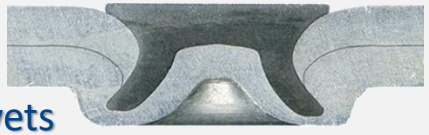


Spot Weld (Section)

All kinds of screws

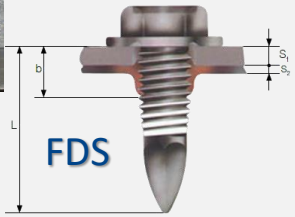


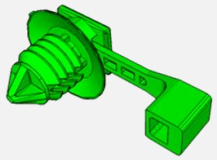
Rivets

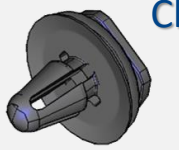



Nails


ROTAV

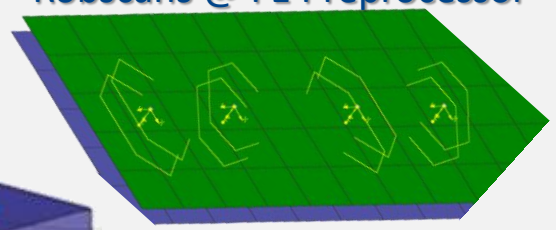

FDS

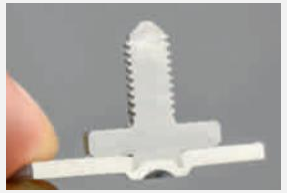




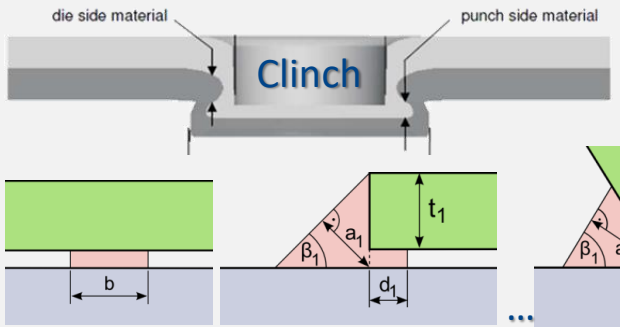
Clips

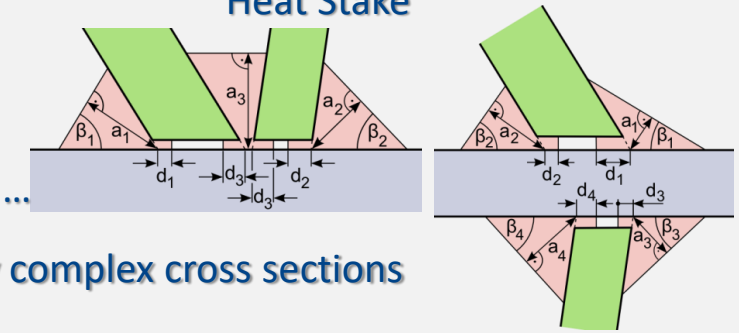
Robscans @ FE Preprocessor




Clinch Rivet Stud

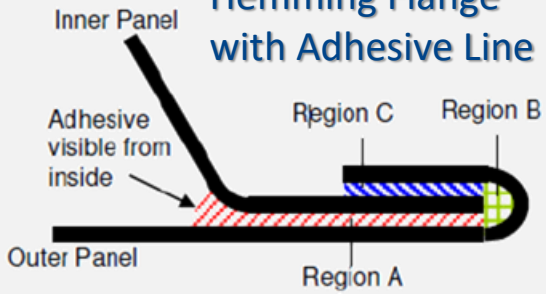

Heat Stake



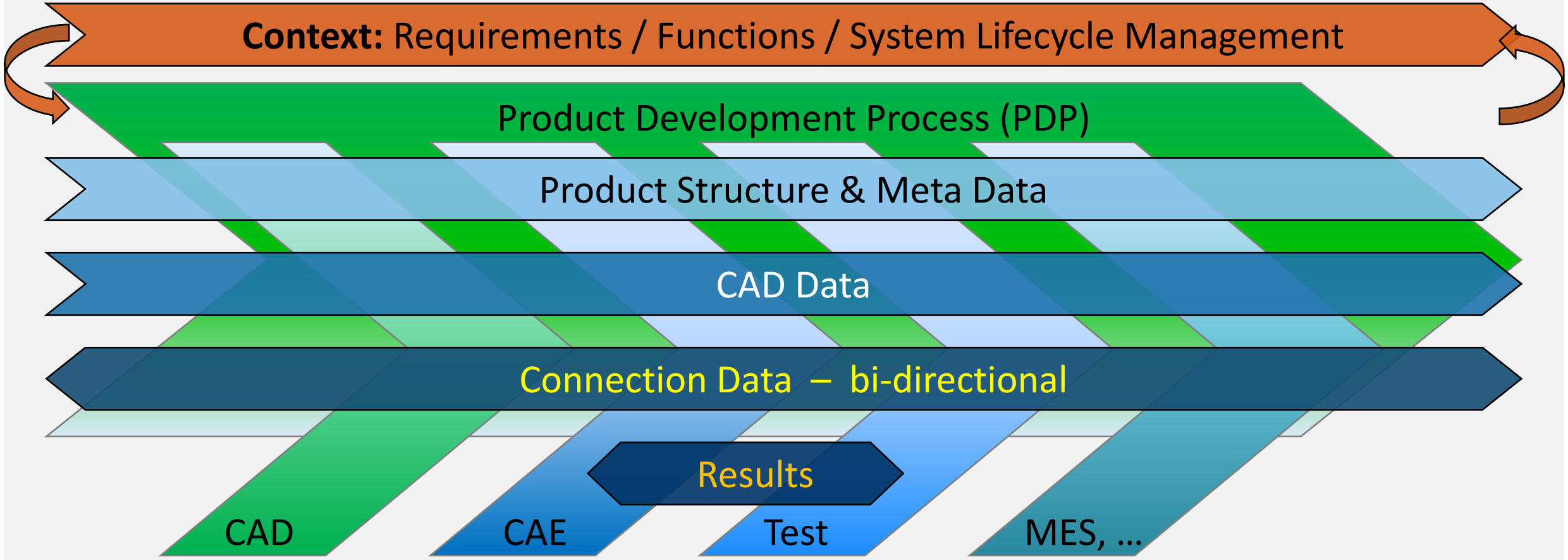


Weld lines with increasingly complex cross sections

Hemming Flange with Adhesive Line



Challenges wrt. Product Development Process



Connections are the mandatory ***3rd cross-sectional data track*** of PDP!

What is so Special about Connection Data?

Connections differ from product structure, meta data and CAD data, since e. g.:

function dominates over their shape	need more *PLM upstream data propagation* than CAD	work needs different *tools & plugins*, special *process steps* and expert *knowledge*
belong to *inner nodes* of product tree, not to its leaves	*data size* is much smaller than CAD data	CAD and connections *complement each other*. Each is *useless without the other*.

What are the Frequent Problems?

- Every OEM creates *own CATIA/NX macros* or buys *proprietary software*.
- Common suppliers *need to be familiar with all those* tools.
- Data exchange along process chain needs *additional tools*, frequently “home-brewed”.
  ➔ Expensive and error-prone.
- However, in reality only *few techniques* are supported with only a *fraction of their data*.
- Inventing new techniques or adding new parameters
  results in *excessive costs* and *process threats*.
- Changing software vendors implies *high investments*.

➔Resulting “*vendor lock-in-effect*” impedes competition
and hence *hinders progress*.

χMCF – the Enabler for Smooth Processes

χMCF: *The* Standard for Connection Information

VDA FAT | Forschungsvereinigung Automobiltechnik **AK 25** | **Fügetechnik** defines and maintains χMCF.

XML-based χMCF meets all "usual" requirements to a standard **(incl. long-time ability!)**, plus:

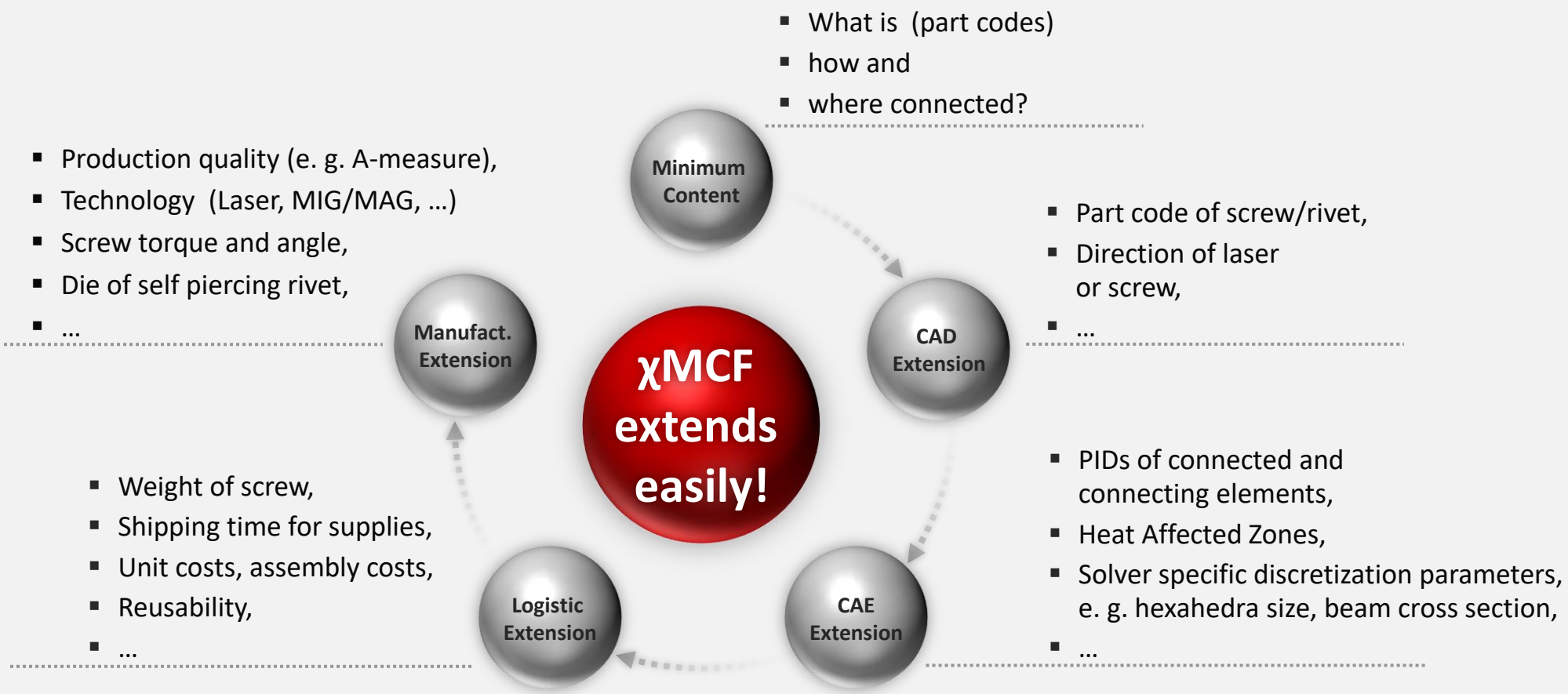
- All connection types & techniques can be represented.
  – Unambiguous, completely, exact, and to the current design maturity.
- All PLM processes are supported – CAD, CAE, CAT, Manufacturing Planning & Execution, including special sub processes, e. g.:
  - Durability simulation,
  - Robot programming,
  - Supplier integration, …
- One χMCF-file contains either data of one *assembly*, one *car* or all *variants* of a series.
  ➔ χMCF meets any kind of *OEM specific process* design.
- χMCF allows imbedding *custom data* specific to *OEM, process* and *tool*.

➔ All existing proprietary formats can be replaced sustainably.

- VDA: German Association of the Automotive Industry
- FAT: Research Association for Automotive Technology; department of VDA
- AK 25: Working Group 25; focus on joining technologies

Download χMCF 3.1 Standard at VDA web site: https://www.vda.de/en/news/publications/publication/xmcf---a-standard-for-describing-connections---joints-in-mechanical-structures--version-3.1-

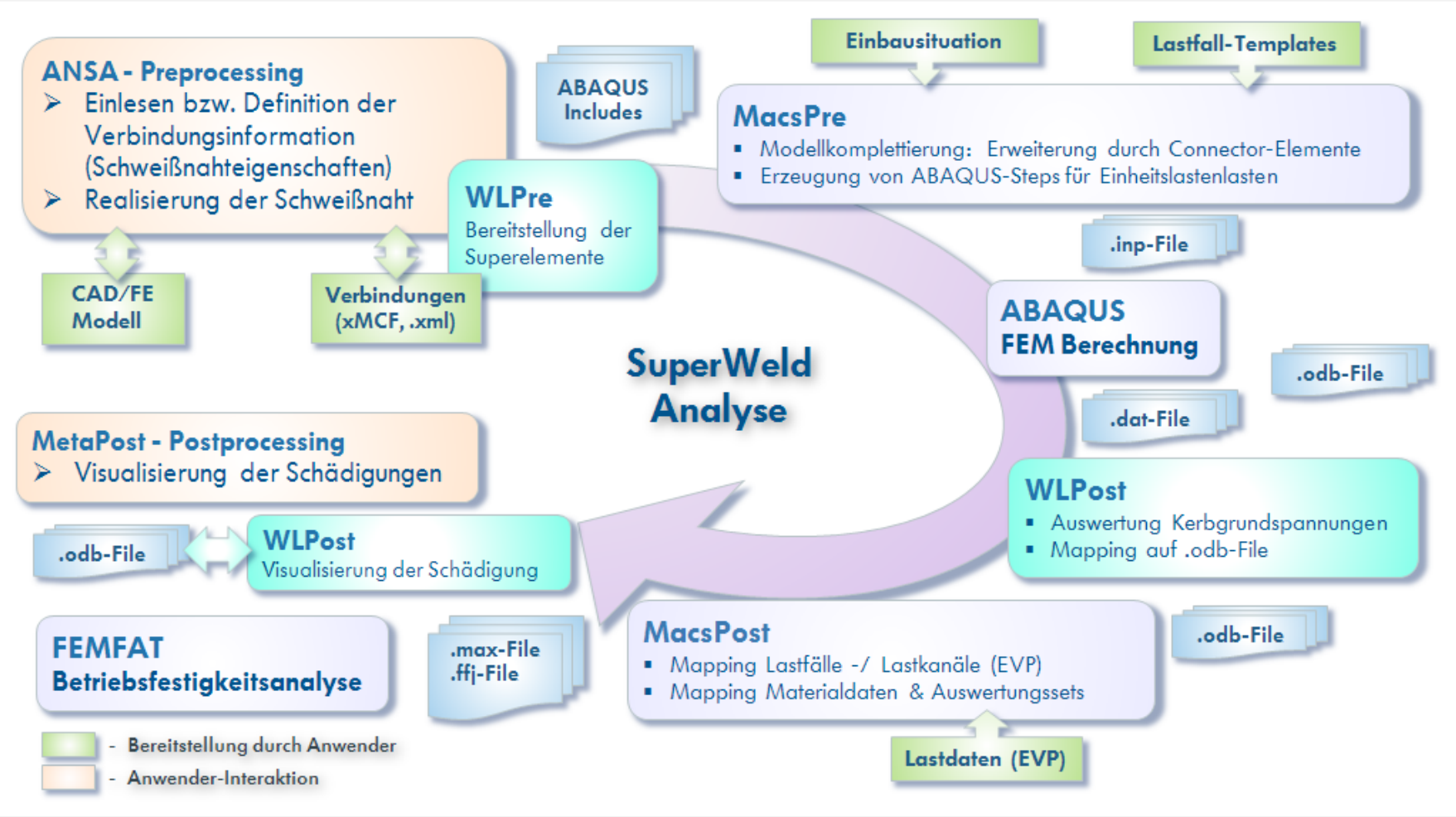
χMCF Accumulates Data along the Process Chain



χMCF Use Cases

Use Case 0: CAE Integration

Variant of a fatigue process at Volkswagen, 2014

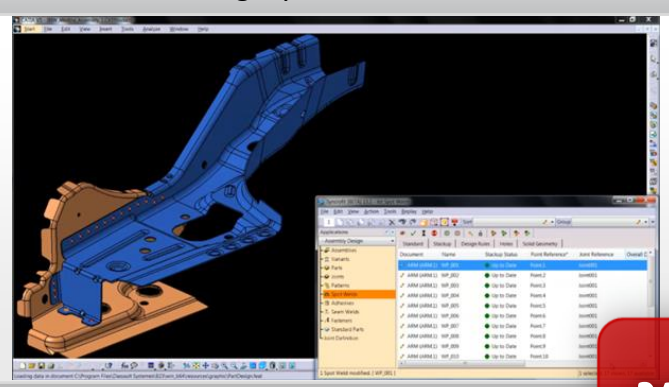


Many different tools.
Many different formats.

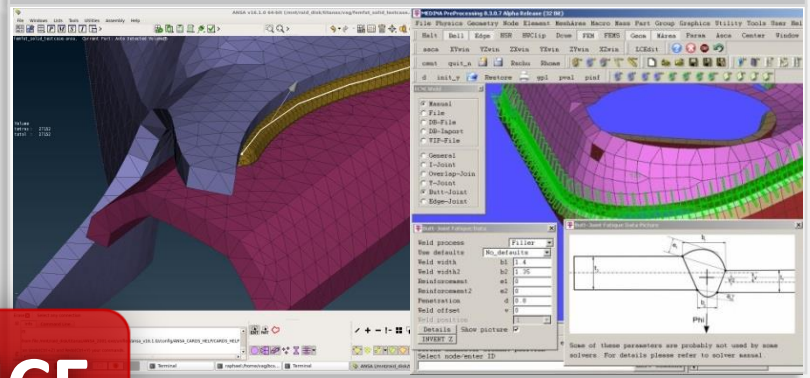
Source of image: Dr. Tröndle, Volkswagen AG, 2014

χMCF-based Tool-Integration (as of 2017)

CAD e.g. SyncroFIT for CATIA & NX

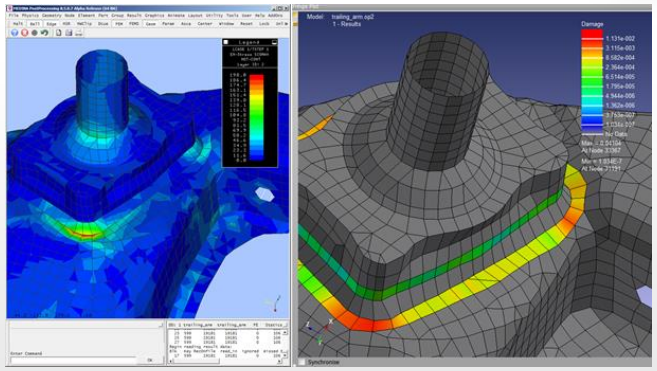


CAE Pre e.g. ANSA, MEDINA

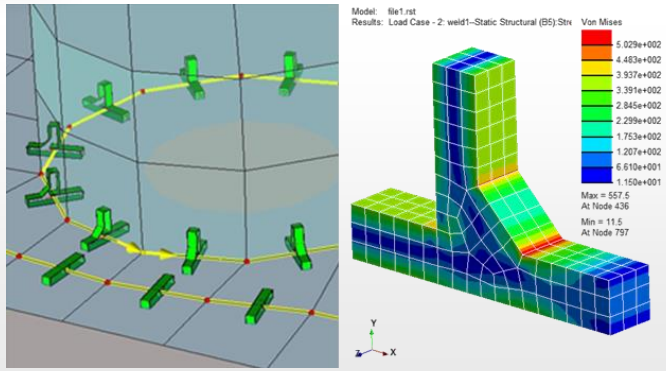


χMCF

CAE Post e.g. MEDINA, nCode



CAE Solve e.g. LMS, nCode, FEMFAT



Strategy & Example Use Cases at **BMW**

Use Case @ BMW (2018): χMCF Data Exchange between PDM & **Production Planning**

SAP IPPE

- Product structure data
  - metadata (PPXML)

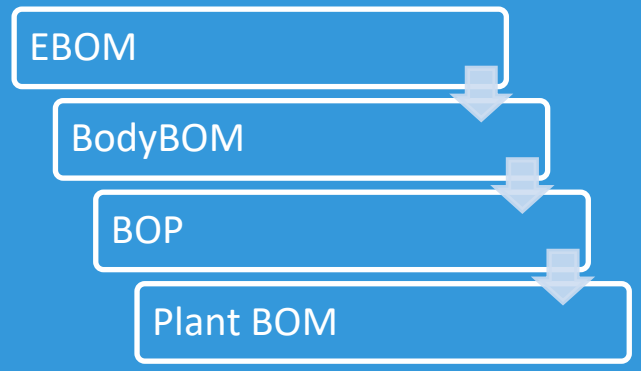
PRISMA (TDM)

- Part information
  - metadata
  - geometrical data (JT)

VIP (Verbindungstechnisches Informations- und Produktionssystem)

- Manufacturing features data
  - metadata (**χMCF 3.0**)
  - geometrical data (JT)

Teamcenter **Manufacturing**

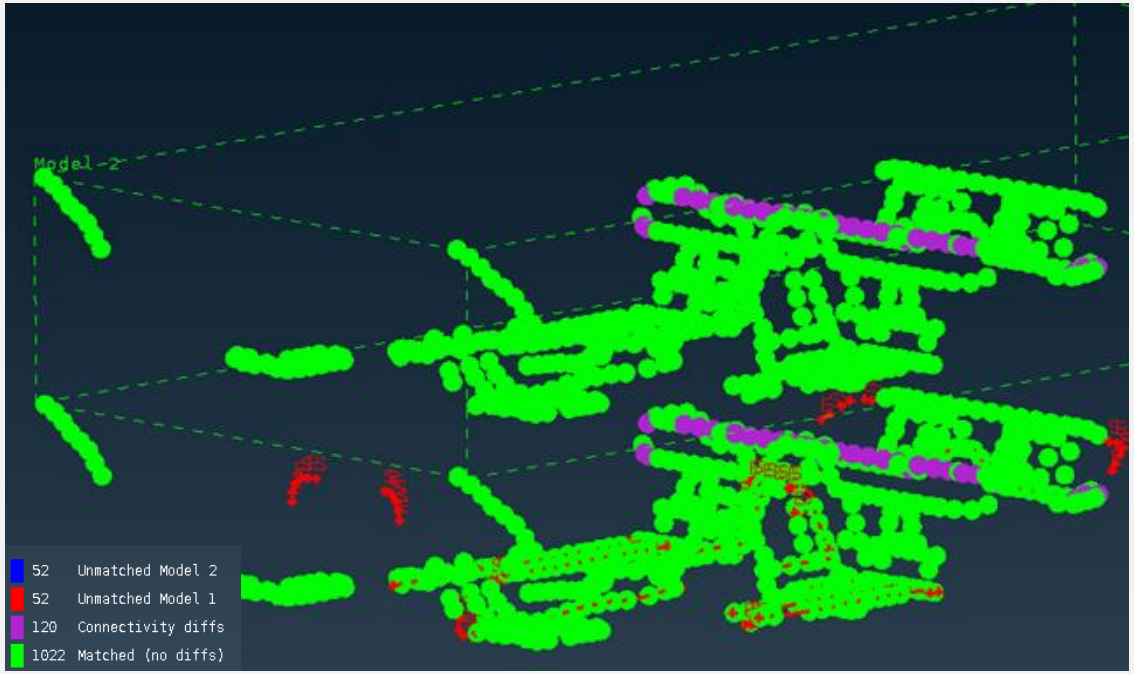


BMW χMCF Strategy

- **Production Planning** (Teamcenter Manufacturing) was addressed 2018.

- **CAE** was addressed 2019. Data for CAE contains technology parameters, e.g. weld shape.

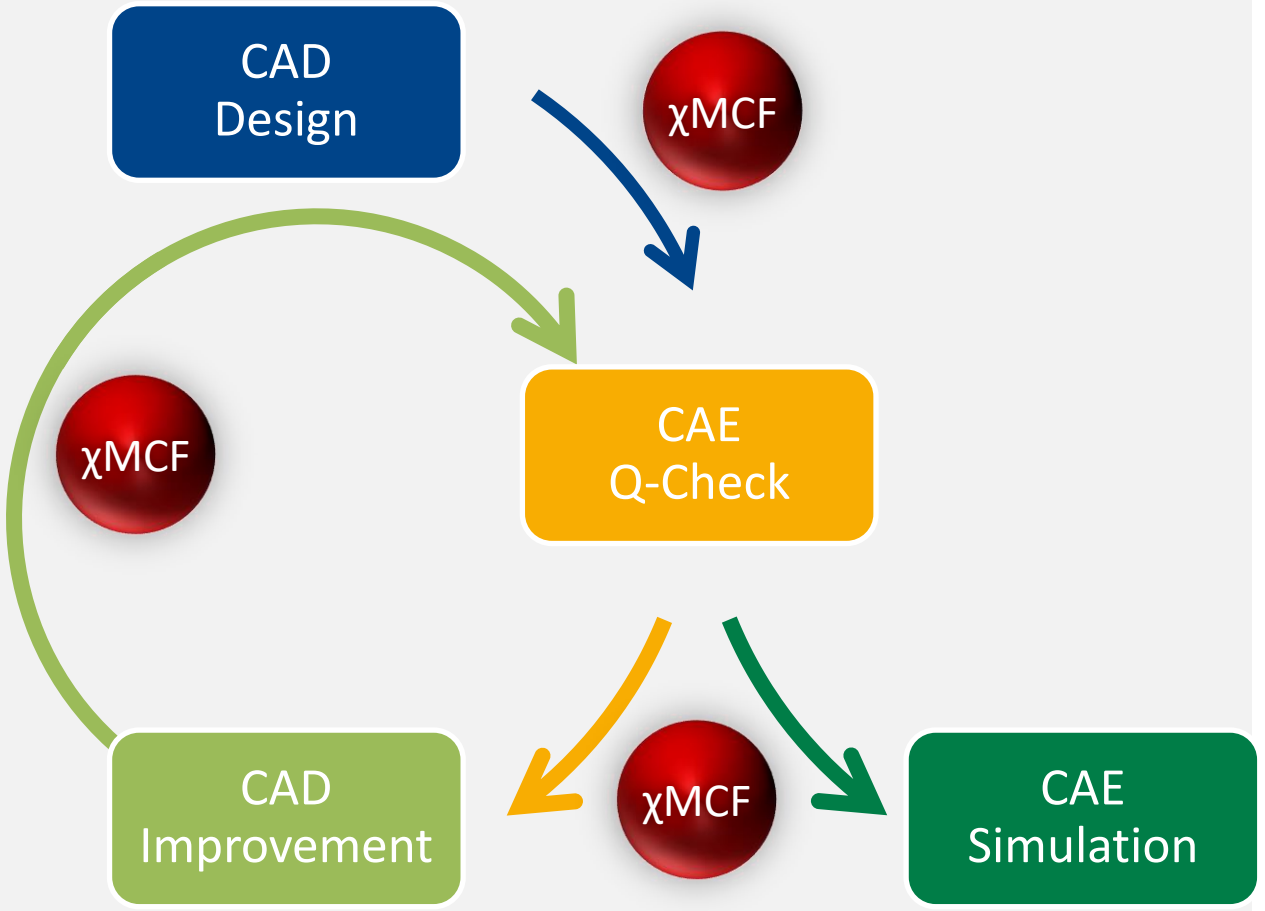
FEM preprocessor acted as a *verification tool*, comparing VIP & χMCF data during prototype phase:



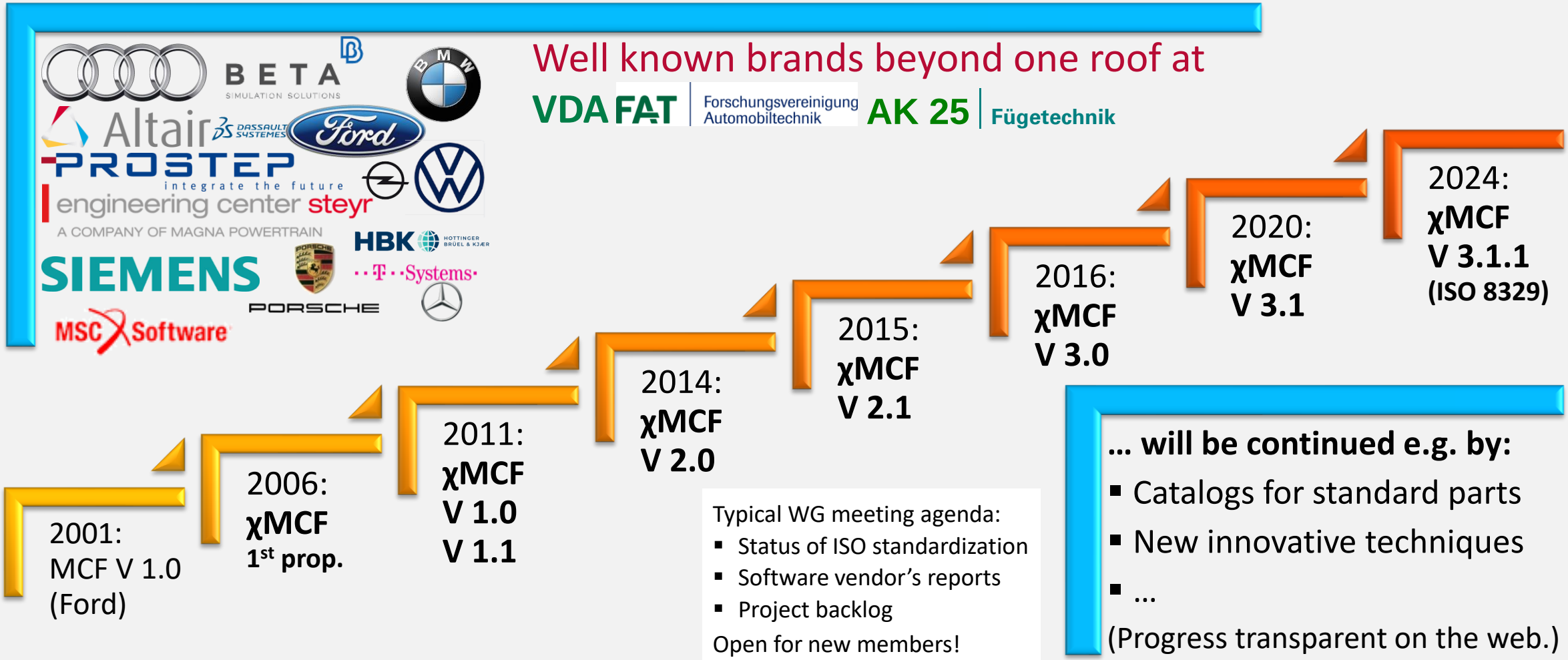
χMCF Example Use Case at **Volkswagen** 2019

Use Case @ at Volkswagen:
Quality-Gate between CAD and CAE – Enabled by χMCF

- Frequently, a complete digital vehicle is assembled *in CAE for the first time* in product development process.
- Using χMCF, connection data can be provided to CAE in the most *automated and low-error fashion*.
- Powerful features of FEM a preprocessor allow for *automated, fast and reliable quality checks*.
- Custom scripts provide *custom error categorization*.
- Via χMCF, categorized quality issues can be *sent back to design*.
- Categories allow CAD to fix the issues by a defined and *plannable process*.



χMCF – A Standard with History and Broad Support



Summary

- Connection processes are *rich and manifold* – so are the data.
- χMCF is *the* powerful and mature standard for piping connection data forward and backward through the product development process.
- It is able to *bridge any gap* between process steps or tools.
  – As has been shown by applications at BMW & Volkswagen.
- Many *important tools already support* χMCF – more to come.

➔ AK 25 provides support when *optimizing processes to benefit* from χMCF.

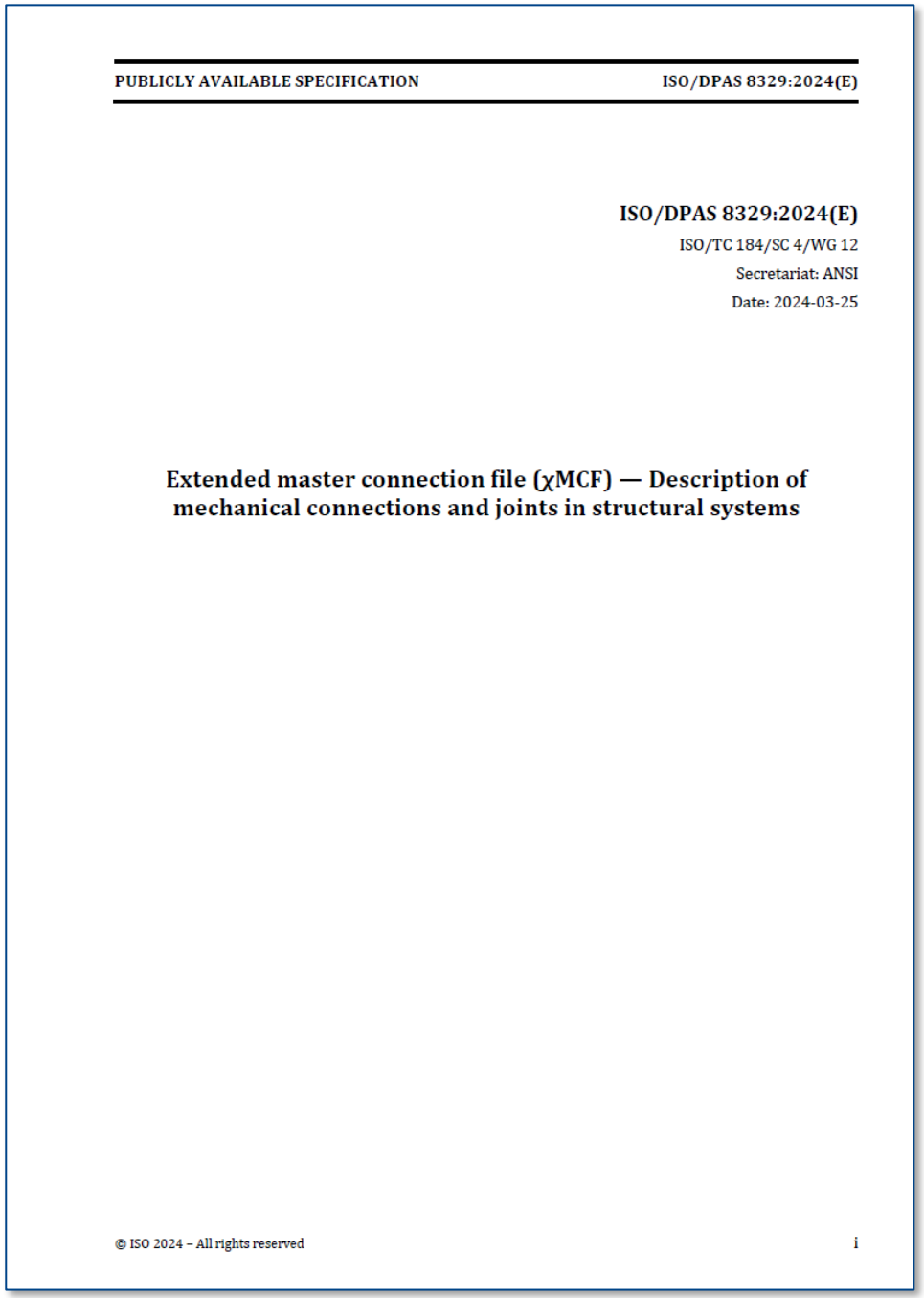
➔ More *demand placed at software vendors* will lead to even wider support of χMCF.

Current Status of ISO Standardization (ISO 8329)

- Based on χMCF 3.1, the document for ISO 8329 was developed.
  Due to some minor improvements, it carries the version code 3.1.1.

- Latest revision has been submitted to ISO on March 25th, 2024.

- We assume that the ISO 8329 standard will be published this year.



PUBLICLY AVAILABLE SPECIFICATION ISO/DPAS 8329:2024(E)

ISO/DPAS 8329:2024(E)

ISO/TC 184/SC 4/WG 12

Secretariat: ANSI

Date: 2024-03-25

Extended master connection file (χMCF) — Description of mechanical connections and joints in structural systems

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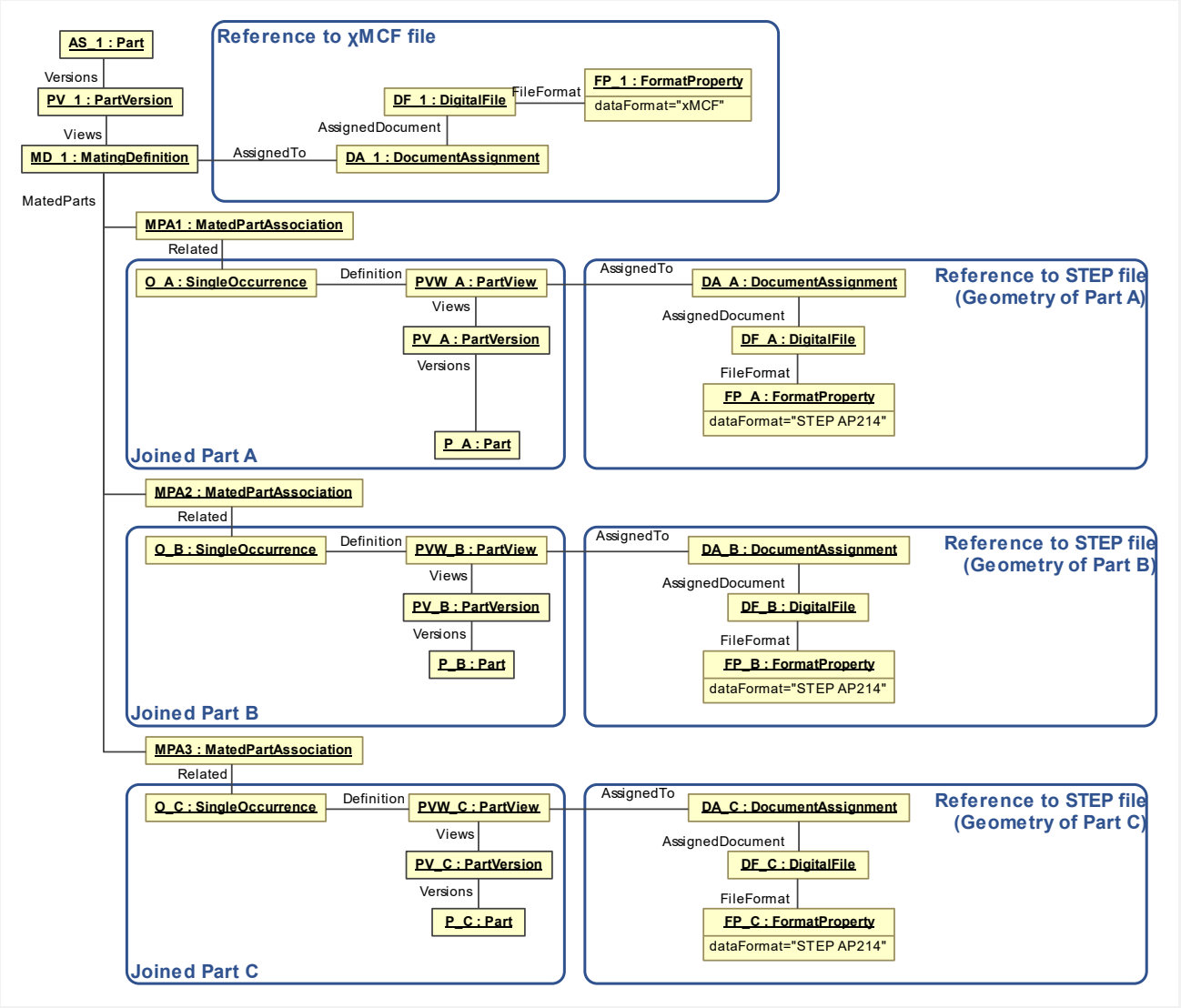
Federated use of STEP AP242 with χMCF

Federating the Standards

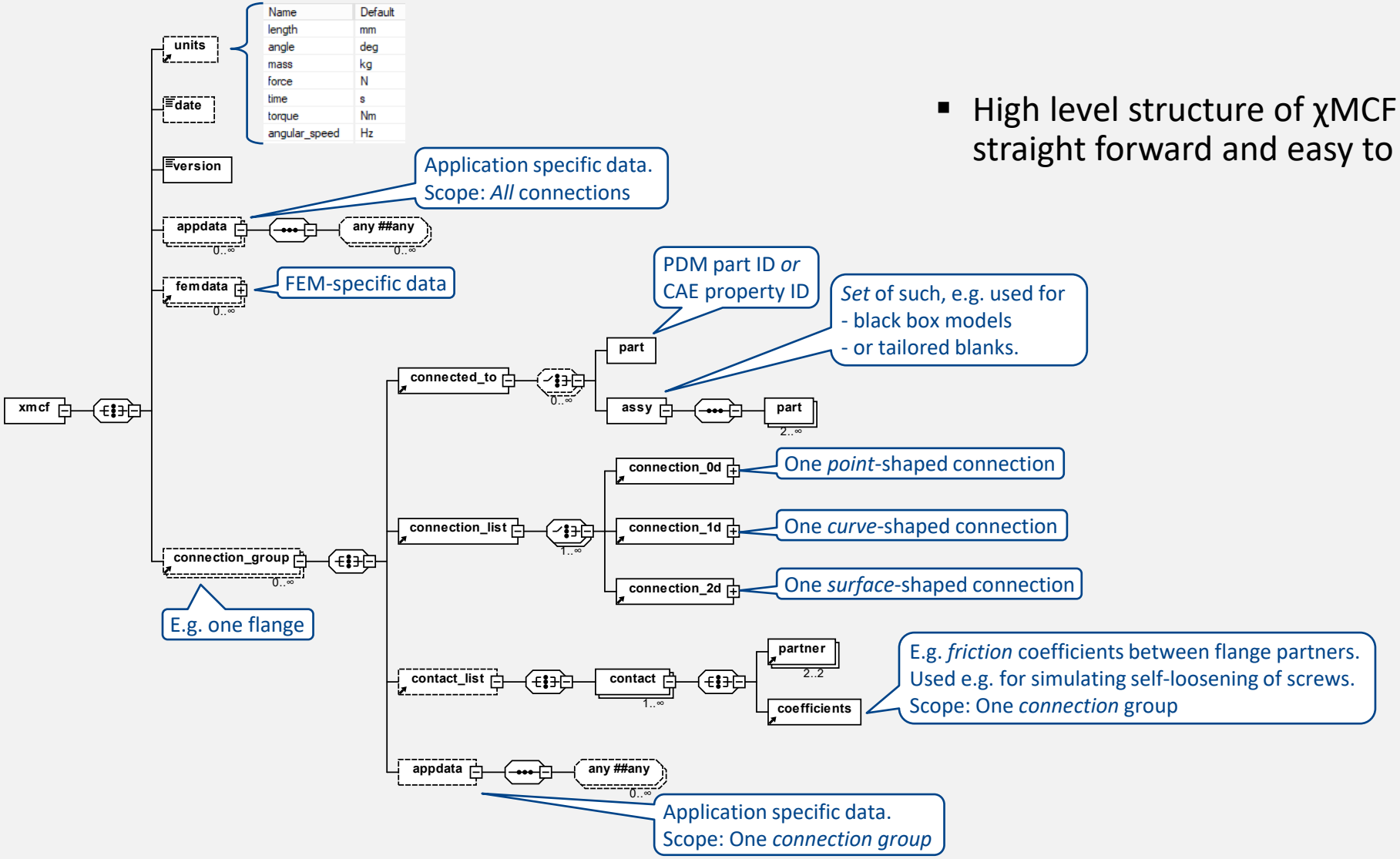
Approach:

- Include *basic* mating information in AP 242 (existing capabilities)
- with linking to χMCF, where χMCF has a high level of details of the connection.



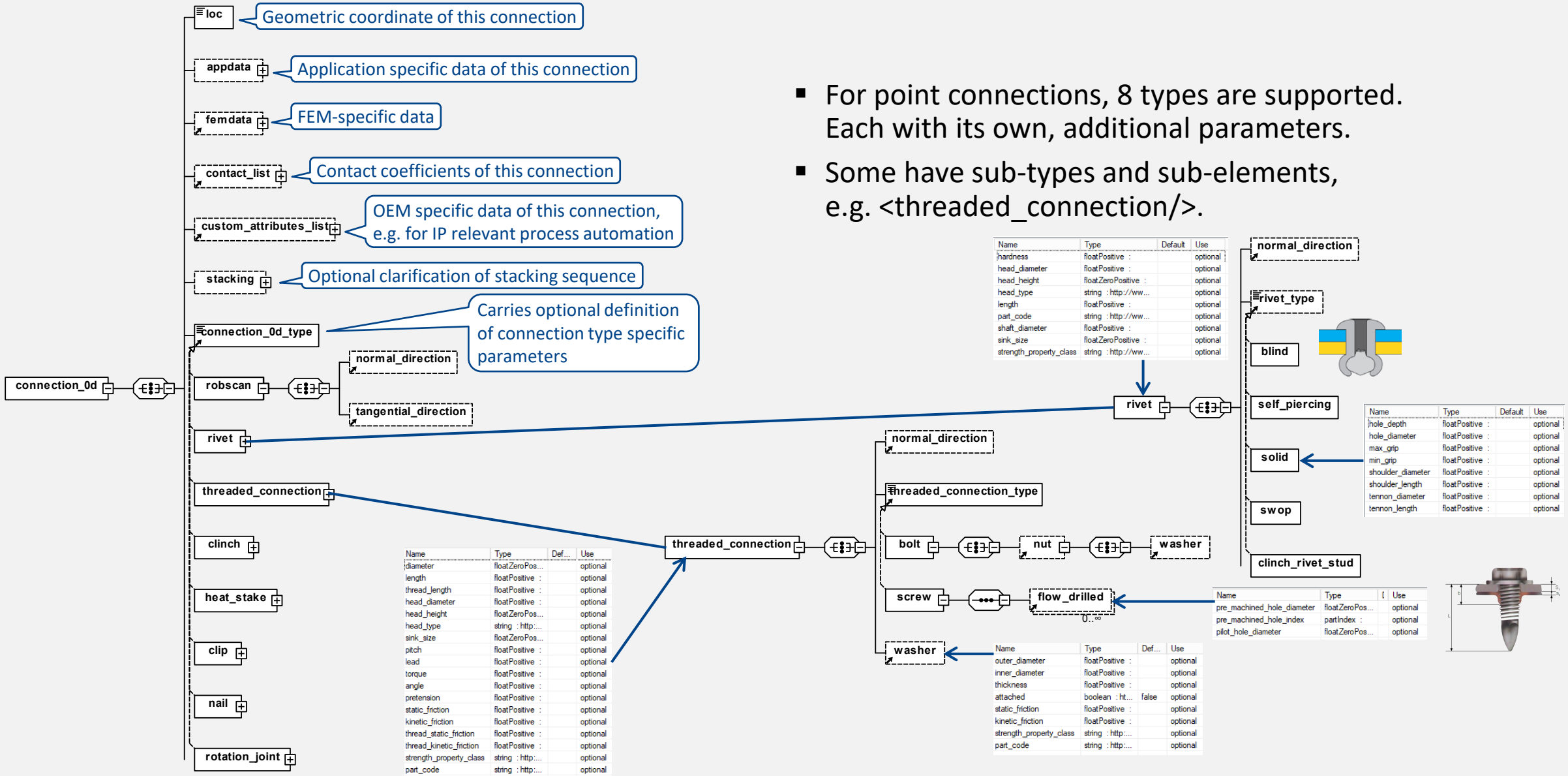
Technical Details of χMCF

Structure of χMCF 3.1 XSD – High Level



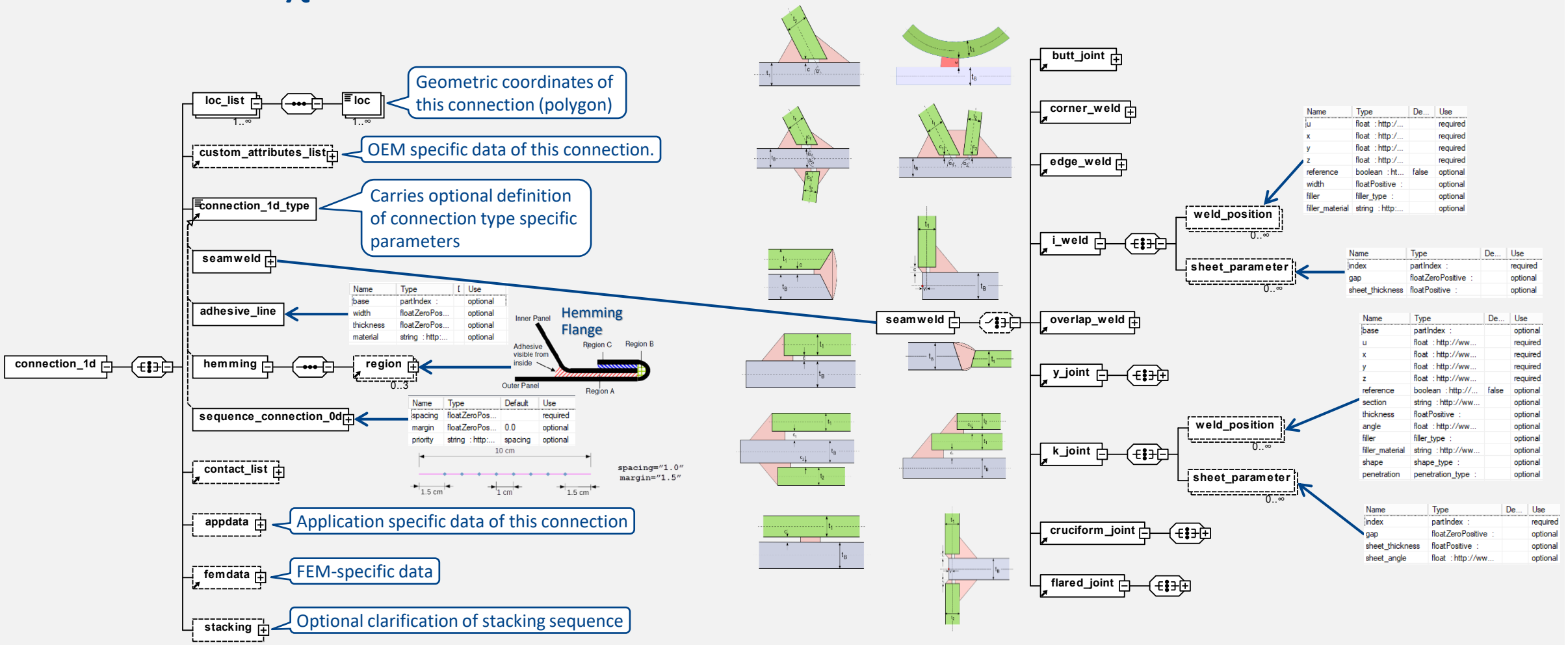
- High level structure of χMCF is straight forward and easy to understand.

Structure of χMCF 3.1 XSD – Point Connections

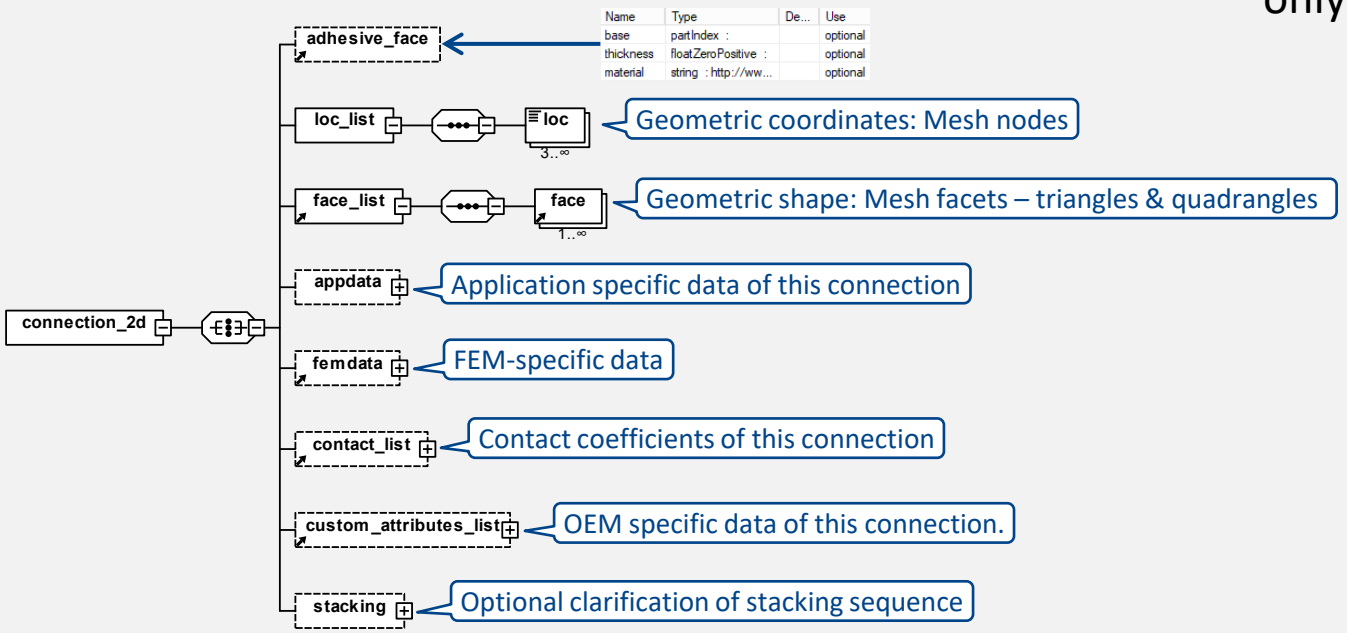


- For point connections, 8 types are supported. Each with its own, additional parameters.
- Some have sub-types and sub-elements, e.g. <threaded_connection/>.

Structure of χMCF 3.1 XSD – Curve Connections



Structure of χMCF 3.1 XSD – Surface Connections



- For surface connections,
  only one type is defined: adhesive gluing.