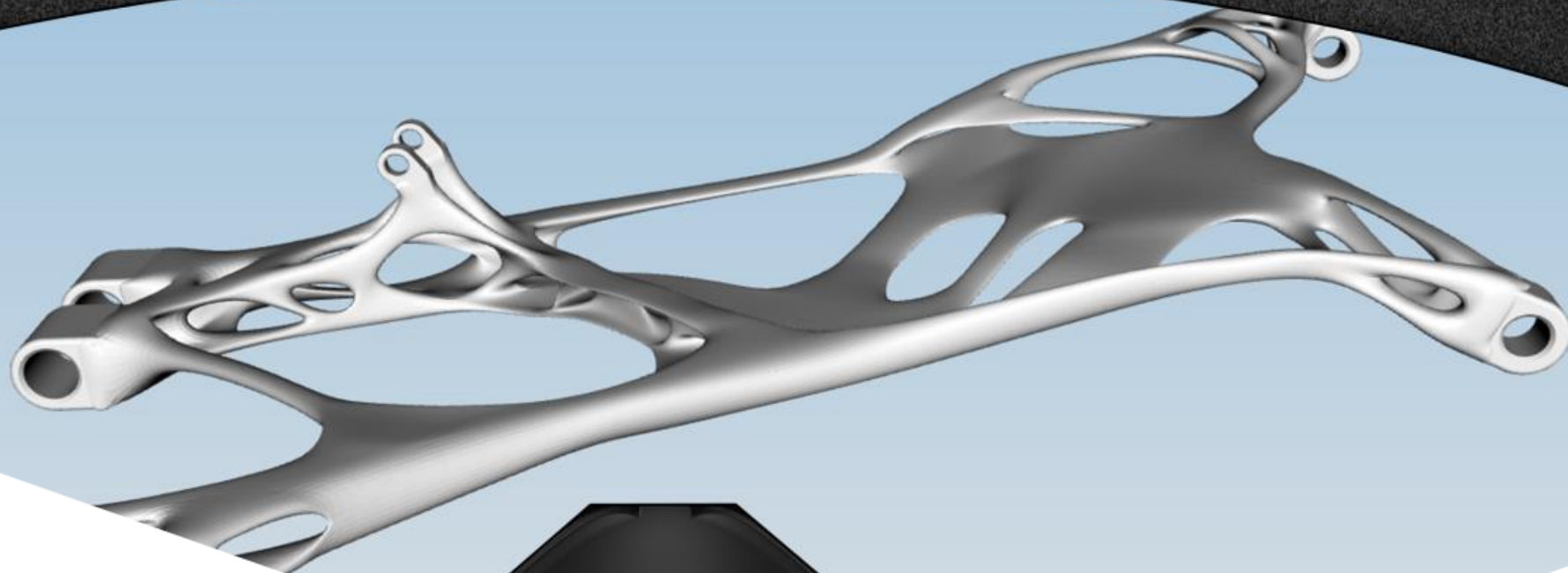# VISUALIZATION AS A SERVICE (VAAS).
MOTIVATION AND EXAMPLES @BMW.

BMW GROUP

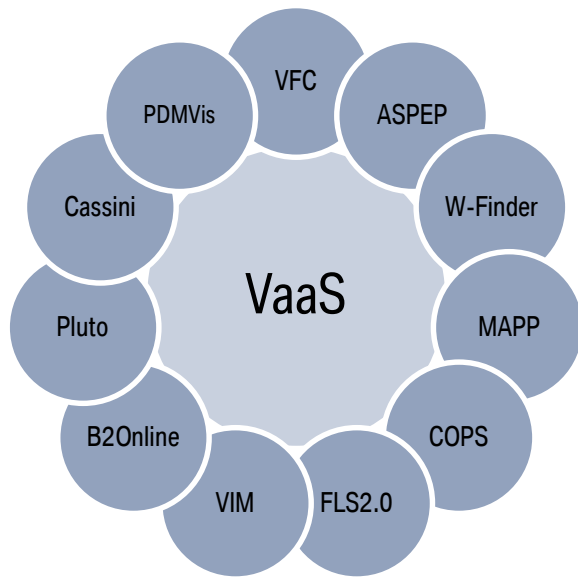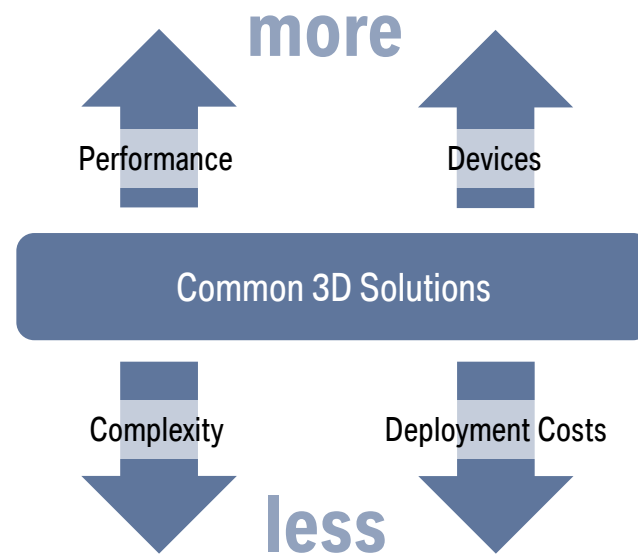THE NEXT 100 YEARS

BMW · MINI · Rolls-Royce Motor Cars Limited

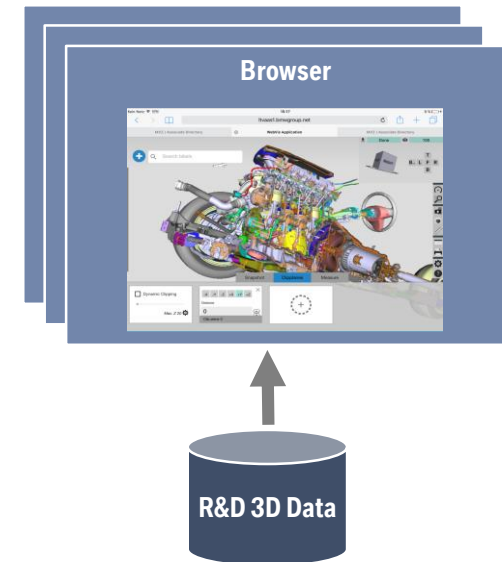# USER DEMANDS AND MOTIVATION.
ANOTHER KIND OF 3D USAGE.

Global

VFC, PDMVis, ASPEP, Cassini, W-Finder, **VaaS**, Pluto, MAPP, B2Online, COPS, VIM, FLS2.0

Smart

more

Performance · Devices

Common 3D Solutions

Complexity · Deployment Costs

less

Real Time

Browser

R&D 3D Data

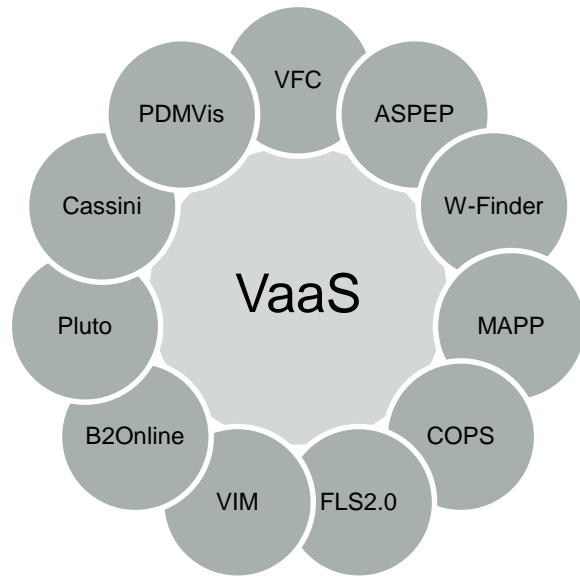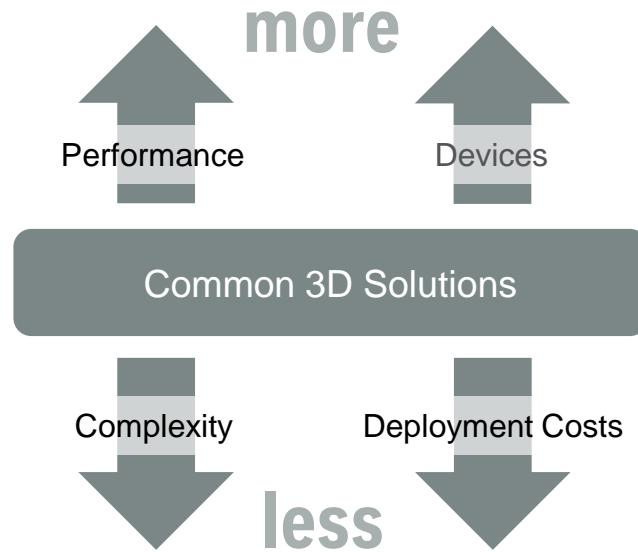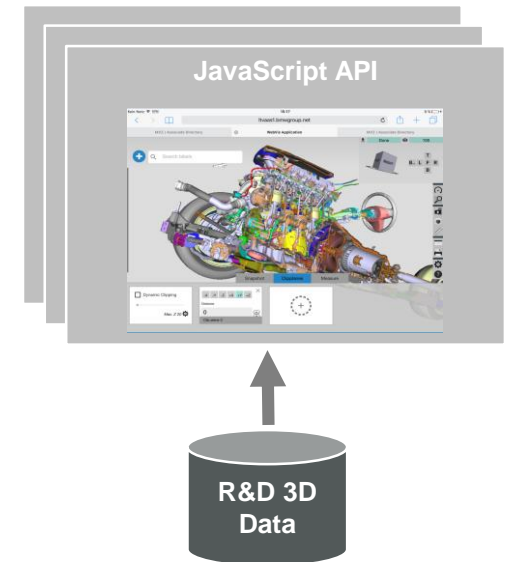# BMW-Requirement: Web, Smart and Real-Time connection

Web

Smart

Real Time

BMW-Requirement: **Web**, Smart and Real-Time connection

Web

VaaS — VFC, ASPEP, W-Finder, MAPP, COPS, FLS2.0, VIM, B2Online, Pluto, Cassini, PDMVis

Smart

more

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R&D 3D Data

Fraunhofer
IGD
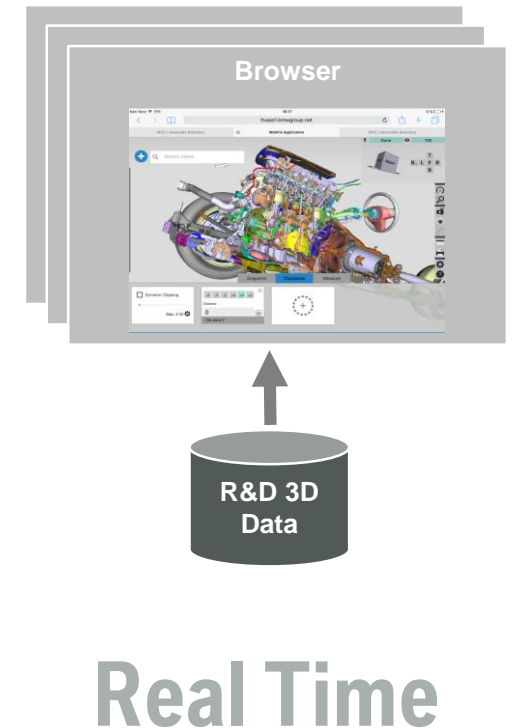
Web: Global related trends

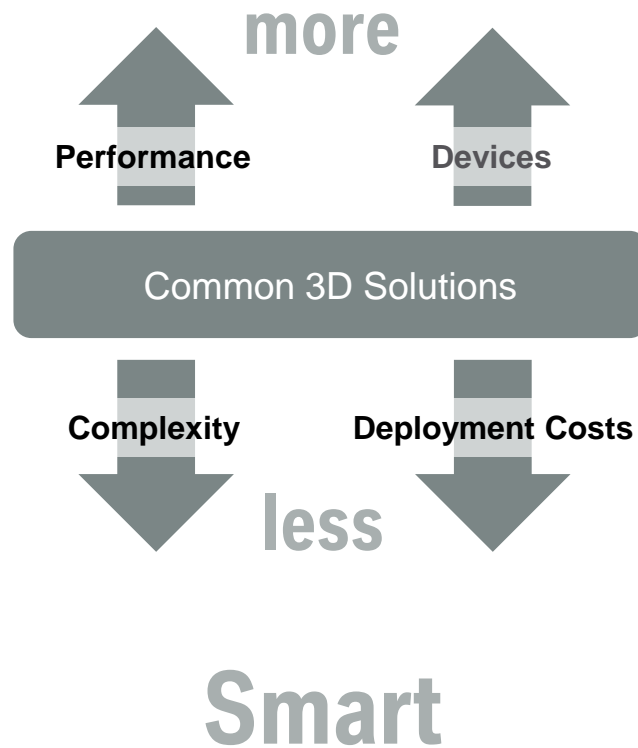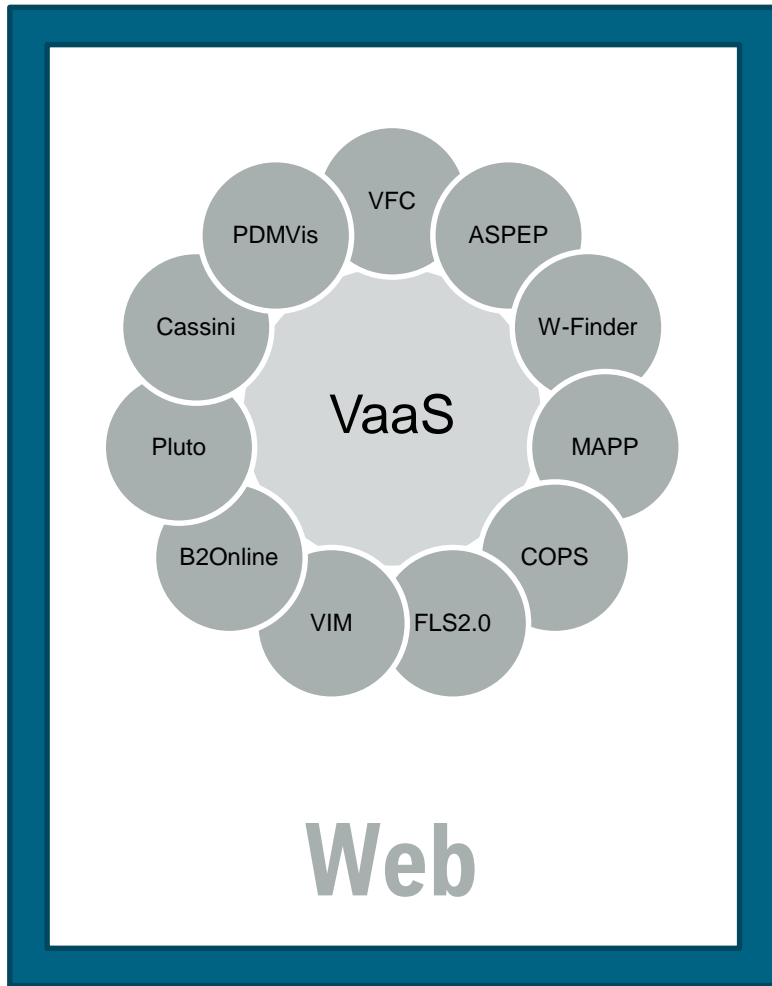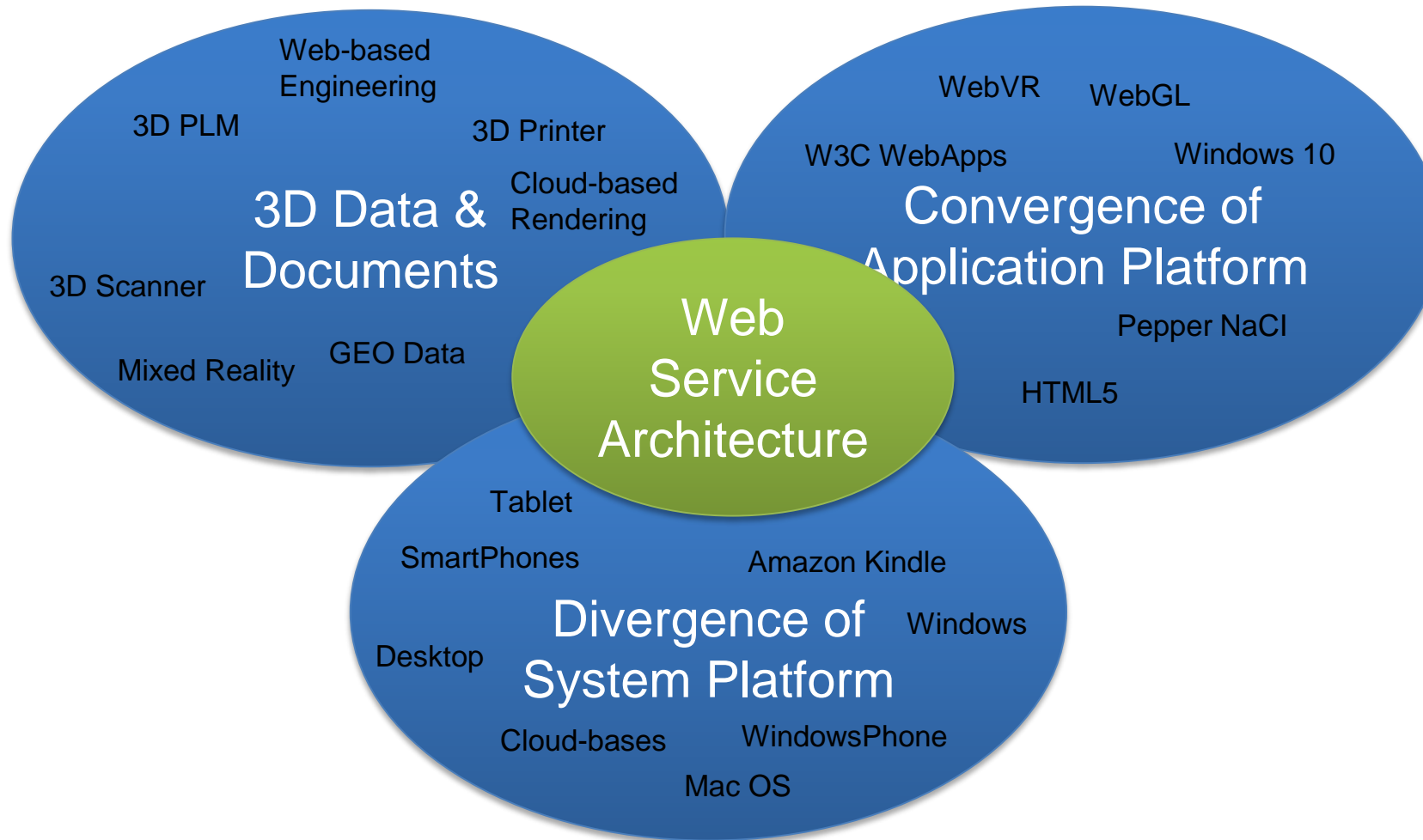**3D Data & Documents**
- Web-based Engineering
- 3D PLM
- 3D Printer
- Cloud-based Rendering
- 3D Scanner
- Mixed Reality
- GEO Data

Web Service Architecture

Convergence of Application Platform
- WebVR
- WebGL
- W3C WebApps
- Windows 10
- Pepper NaCI
- HTML5

Divergence of System Platform
- Tablet
- SmartPhones
- Amazon Kindle
- Windows
- Desktop
- Cloud-bases
- WindowsPhone
- Mac OS

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Application Pattern: Individual "Web Application" with interactive "3D Views"

Visualization as a Service - ProSTEP iViP Symposium 2017
© Fraunhofer IGD
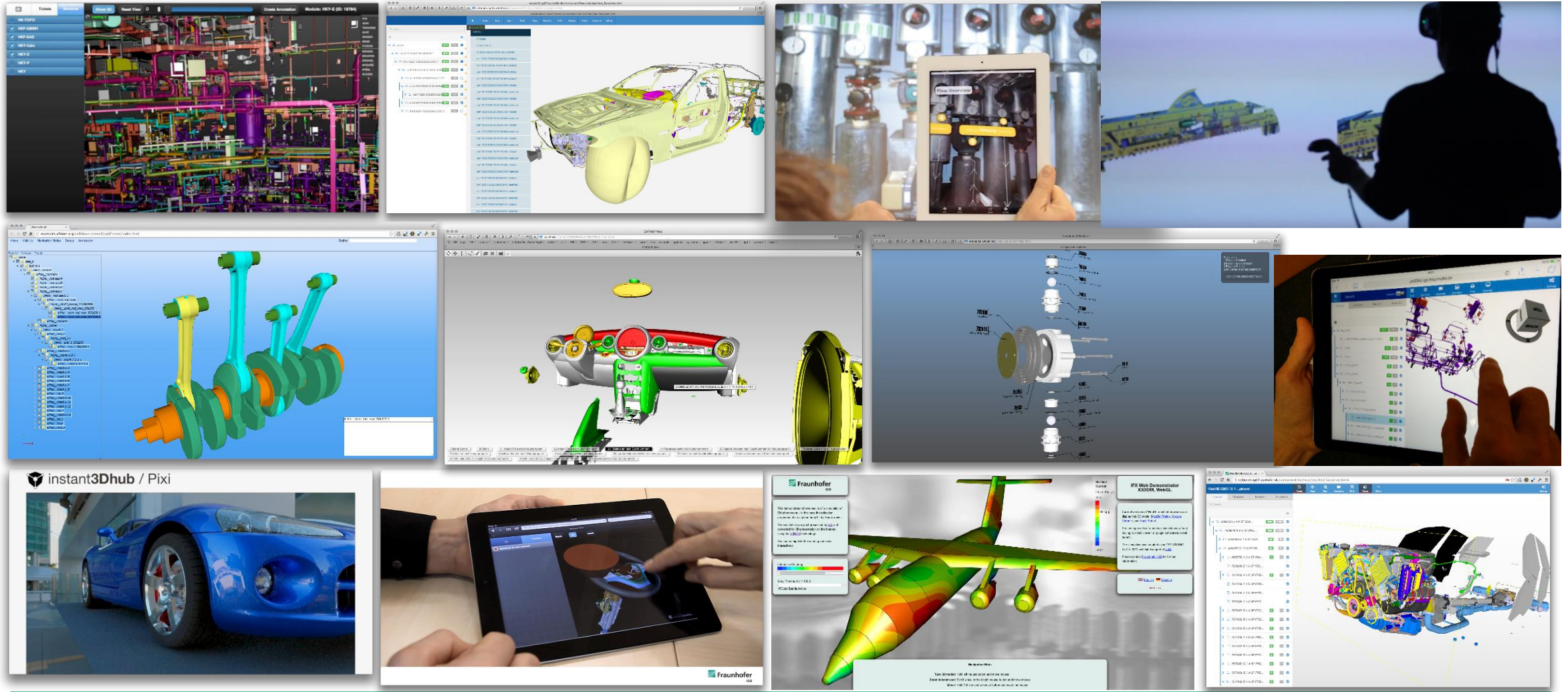
Application Pattern: Aggregates domain and 3D data relation
example: Shapeways "Printability Tool" with 3D Data View

(1) Shapeways Web-Portal (HTML5 web application)

(2) Domain Data

(3) 3D Data View

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Application Pattern: Aggregates domain and 3D data relation
Current approaches: Web-Portal with "3D Document" Viewer
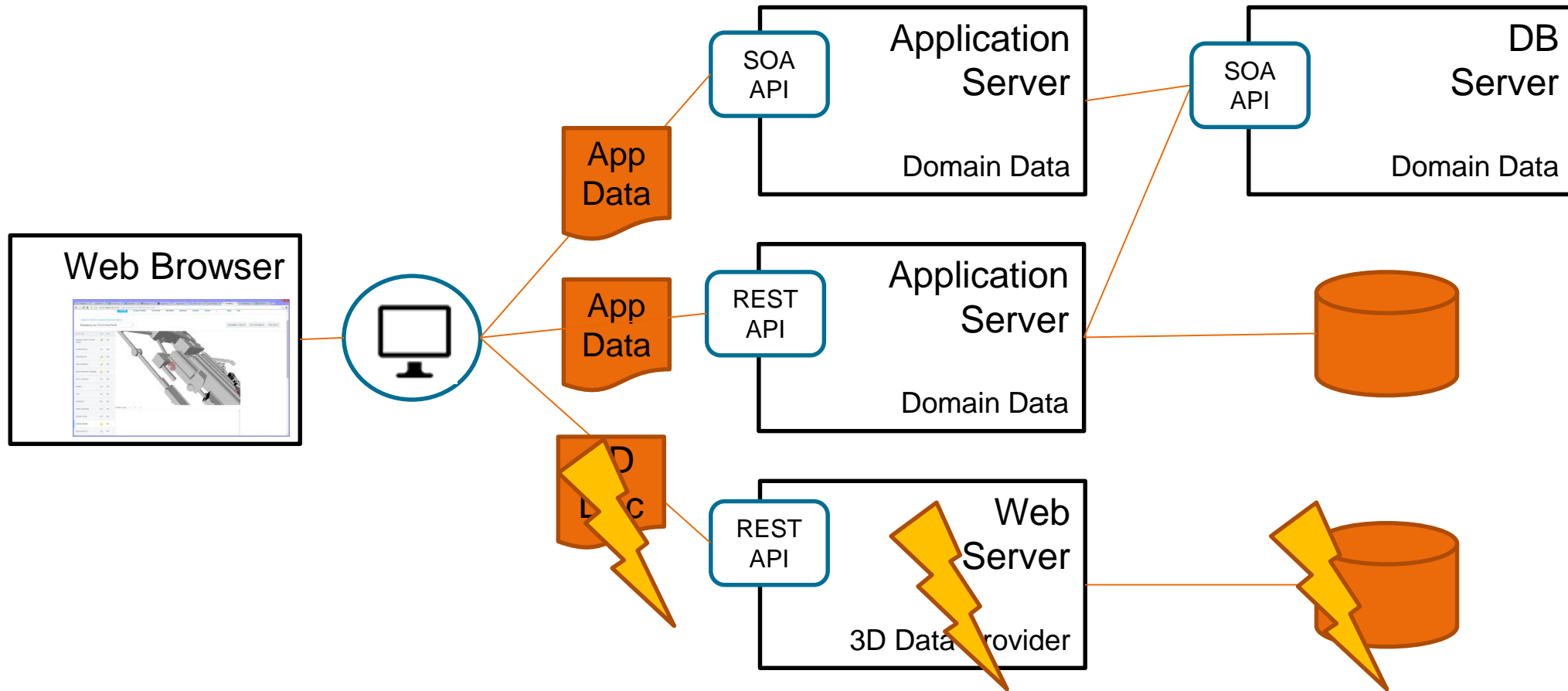
Application Pattern: Aggregates domain and 3D data relation
VaaS Solution: Smart Web-Services manages domain and spatial data relation

BMW-Requirement: Web, **Smart** and Real-Time connection

VFC
ASPEP
PDMVis
W-Finder
Cassini
VaaS
MAPP
Pluto
COPS
B2Online
VIM
FLS2.0

Web

more

Performance
Devices

Common 3D Solutions

Complexity
Deployment Costs

less

Smart

JavaScript API

R&D 3D Data
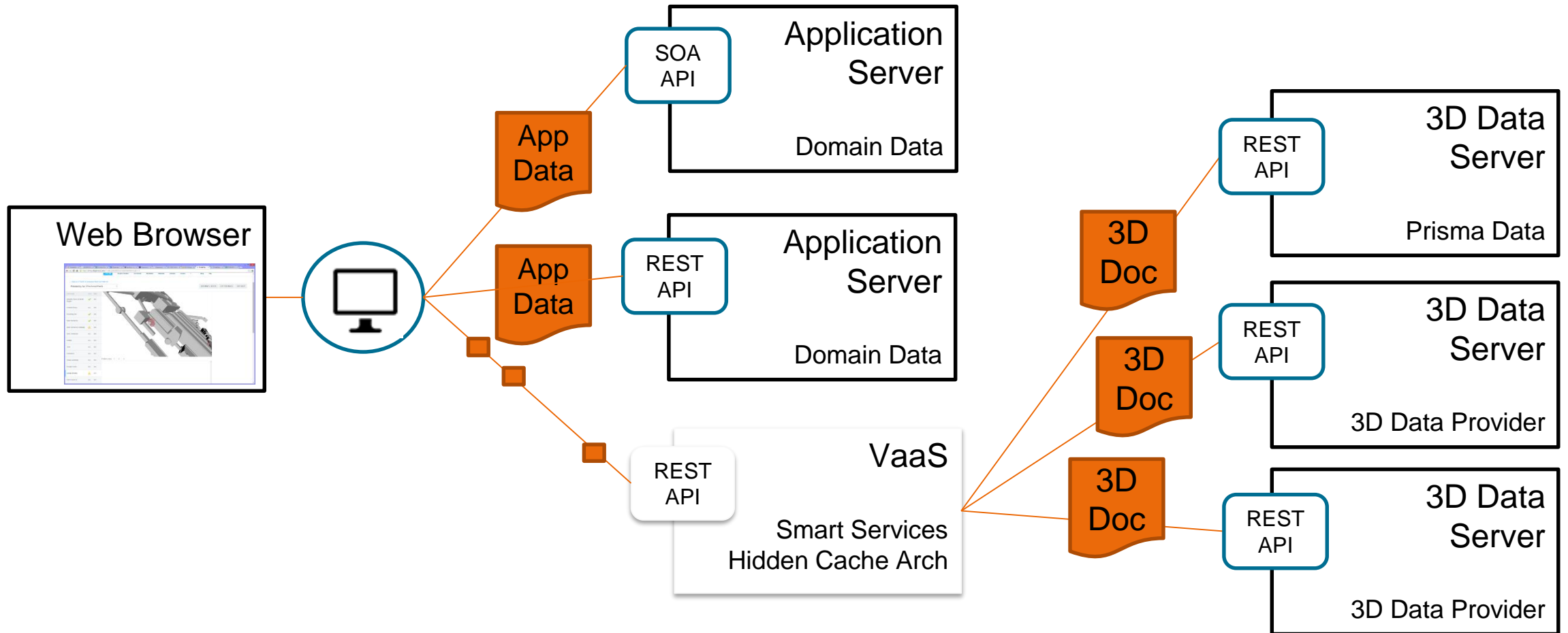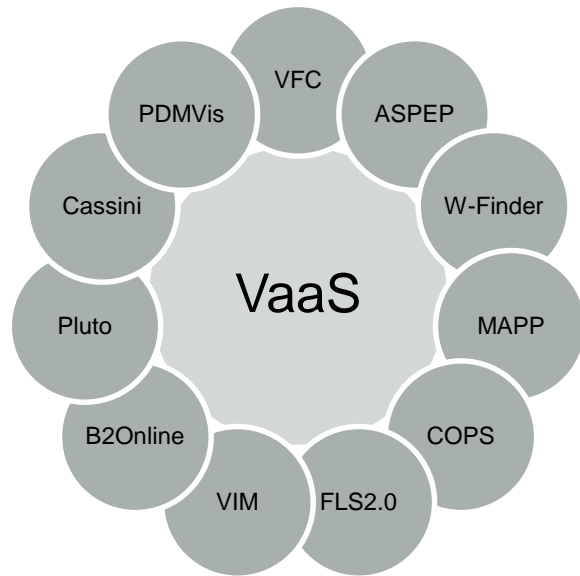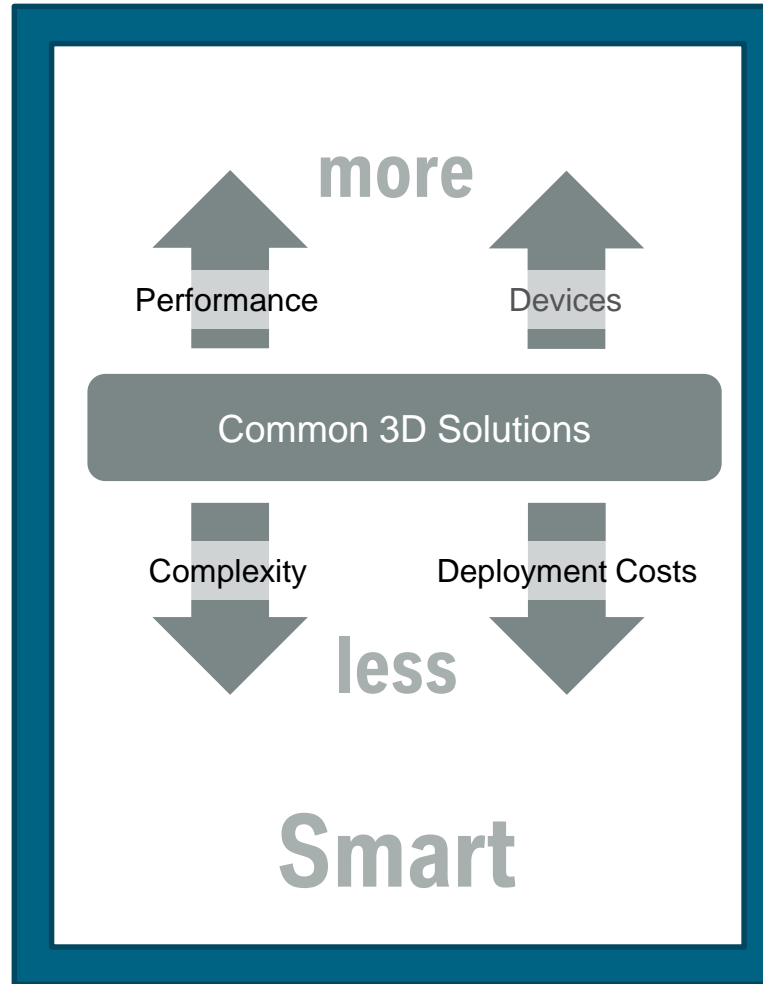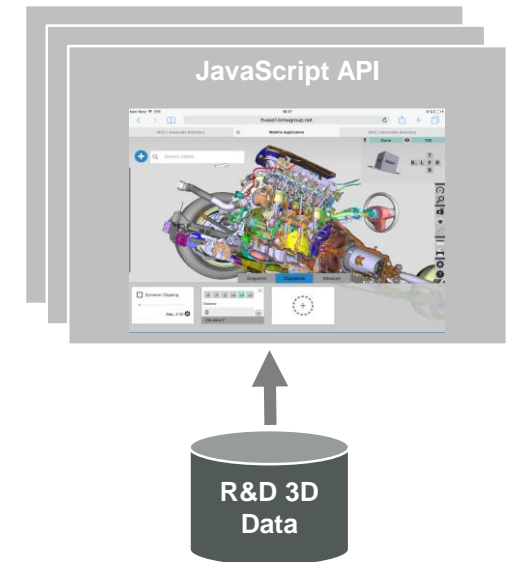
Real Time

Fraunhofer
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25 years visualization solution at Fraunhofer IGD/VCST

Scene Graph Tool Marked

1992: Y/VRCOM

Immersive VR
6D Interaction
Industrial App

2001: OpenSG (OS)

Scene Graph
Distributed Vis.
Multithread save

2005: instantReality

VR/AR Platform
X3D App Layer
Rapid App Devel.

2009: x3dom (OS) / transcoder

X3D in HTML
Mesh Streaming
On-the-fly Transcoder

2015: webVis/instant3DHUB

End user experience
Massive Data
VaaS platform

Document Size Sensitive

Smart Spatial Service (S³)
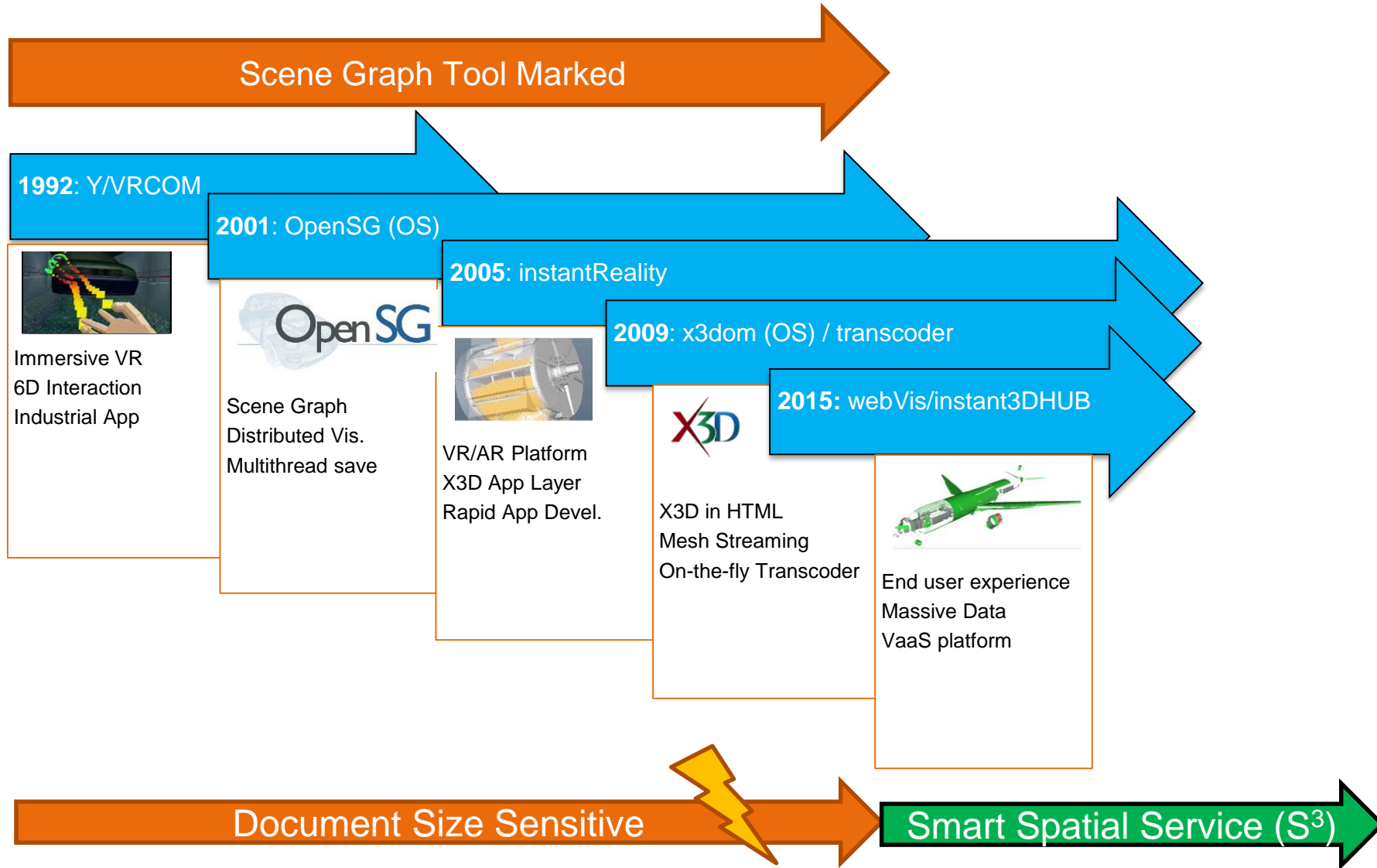
Disruptive Approach: From blocking Documents to Smart Spatial Services (S³)

- Blocking (Web) Document download/draw
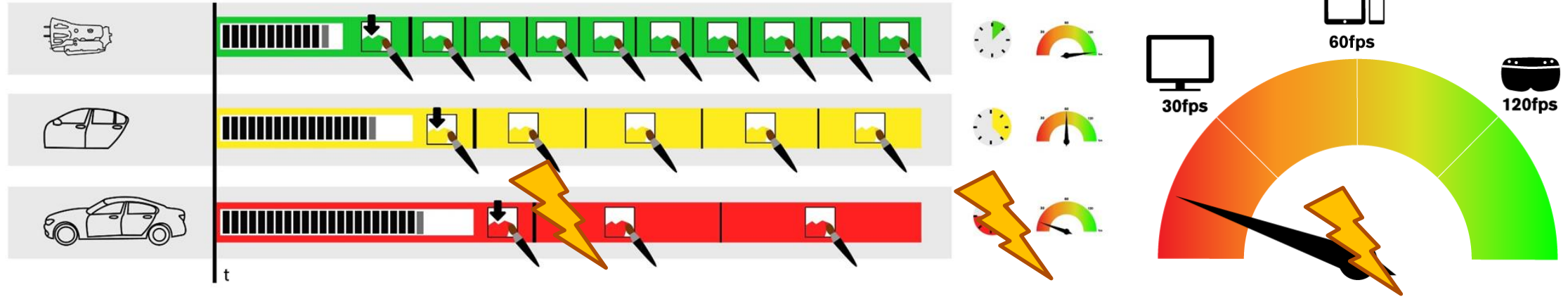
- Smart Spatial Service (S³): Constant and adaptive stream of data and redraws

Disruptive Approach: From blocking Documents to Smart Spatial Services (S³)

- Only most "**relevant**" parts streamed for fixed **time/memory budget**
  - **Builds on modern game system approaches**

- **"Relevance"** defined by **visibility, domain priority** and **target error**

- **user-experience** comparable to **movie-streaming** (e.g. netflix)
  - **Zero startup and unlimited size**
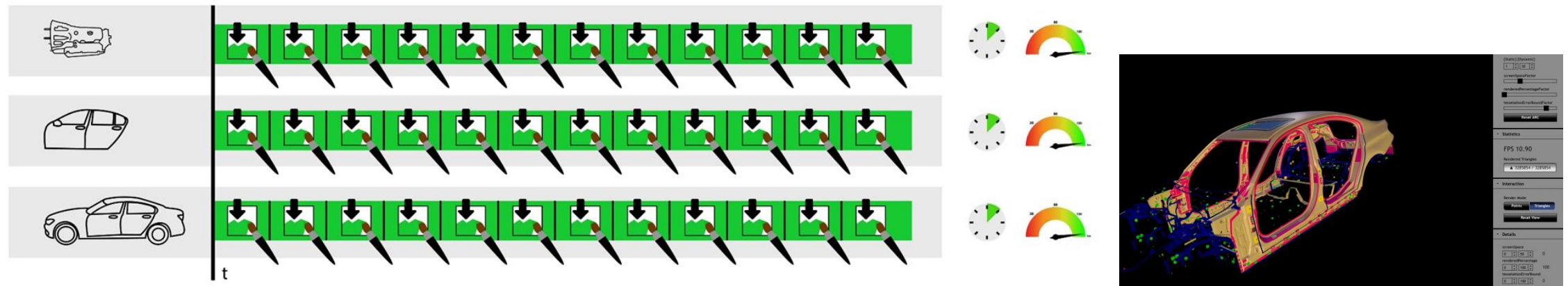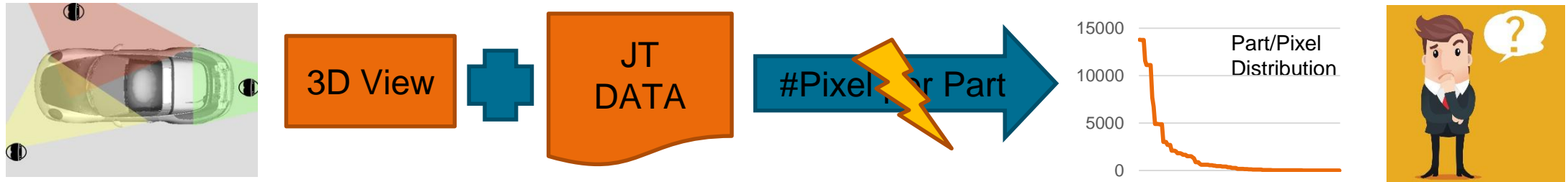 - **Dynamic** error adapts to **bandwidth/compute** limits

➢ **Makes 3D Graphics Great Again!** ☺

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Disruptive Approach: From blocking Documents to Smart Spatial Services (S³)

■ Challenge: Standard 3D Containers (e.g. JT, STEP) are not optimized for view-dependent access

    ■ **"How to download only parts which produce significant pixels for a given view ?!?"**

■ Solution: Build **Spatial Index Acceleration Structure** (e.g. comparable to GoogleMaps for 2D)

    ■ **Novel approach** provides **fast calculation** and **lossy compressed** surface data
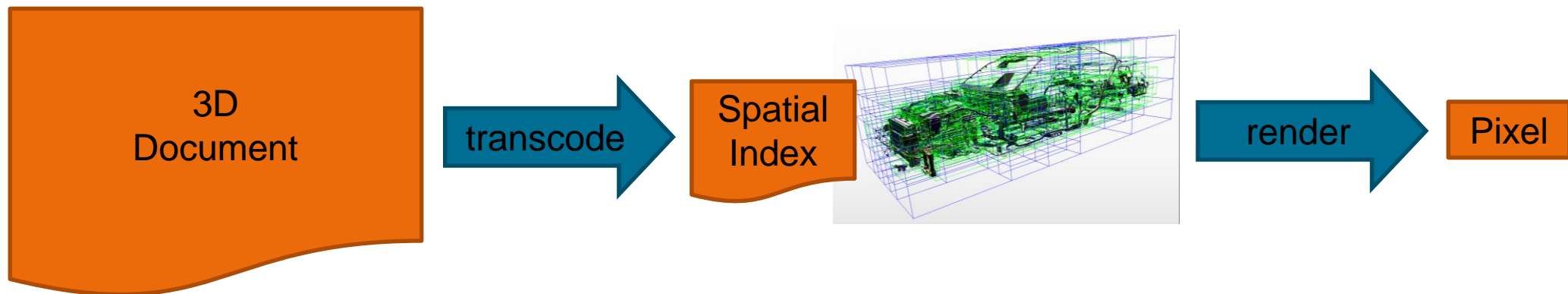
    ■ **Performance and size criteria** lead to a overall time reduction for **on-the-fly builds** ☺

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Smart Compute: Dynamic and adaptive client/server/hybrid Rendering

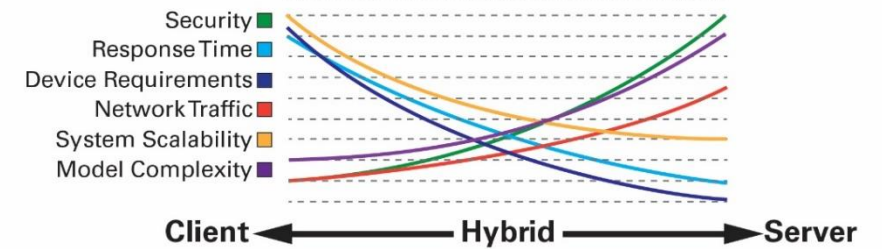- Most available solutions are **limited to client/API or server/API**

  - Application developers are **bound to single model**
  - **Costly adoption** to changing **scalability requirements**

- Dynamic **Client/server and hybrid pipeline orchestration**

  - Automatic **client class matching** and resource budgeting
  - Single **CRUD API** and interface setup (**VR, touch, desktop**)
  - Automatic render **pipeline service orchestration**

instant3Dhub.com/clientCap

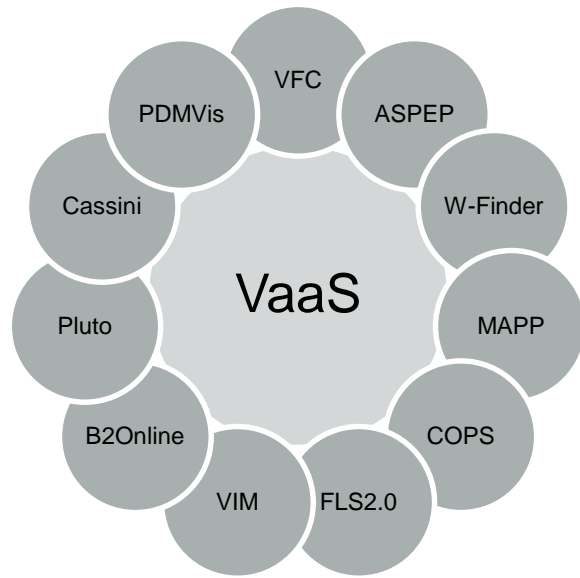- Goal: Any Device, Any Data, Any Size ☺

  - "**Simple and Smart**" enables large number of novel solutions and use-cases

    - **Current "Simple" solutions do not scale**
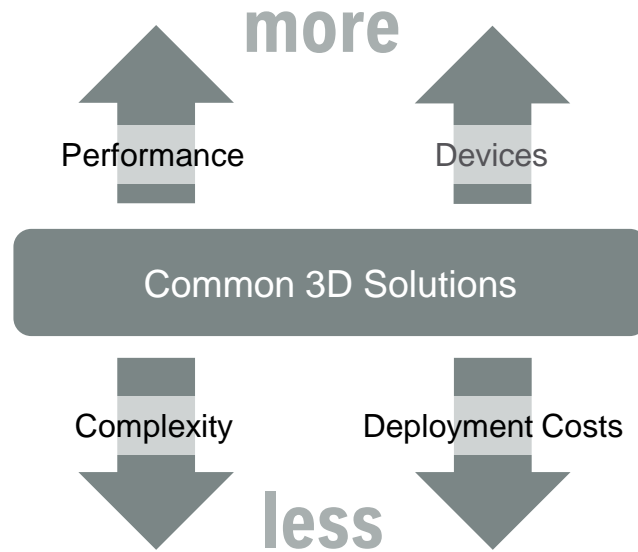   - **Current "Scalable" solutions are not simple to use**

BMW-Requirement: Web, Smart and **Real-Time connection**

Web

VaaS

VFC, ASPEP, W-Finder, MAPP, COPS, FLS2.0, VIM, B2Online, Pluto, Cassini, PDMVis

Smart

more

Performance — Devices

Common 3D Solutions

Complexity — Deployment Costs

less

Real Time
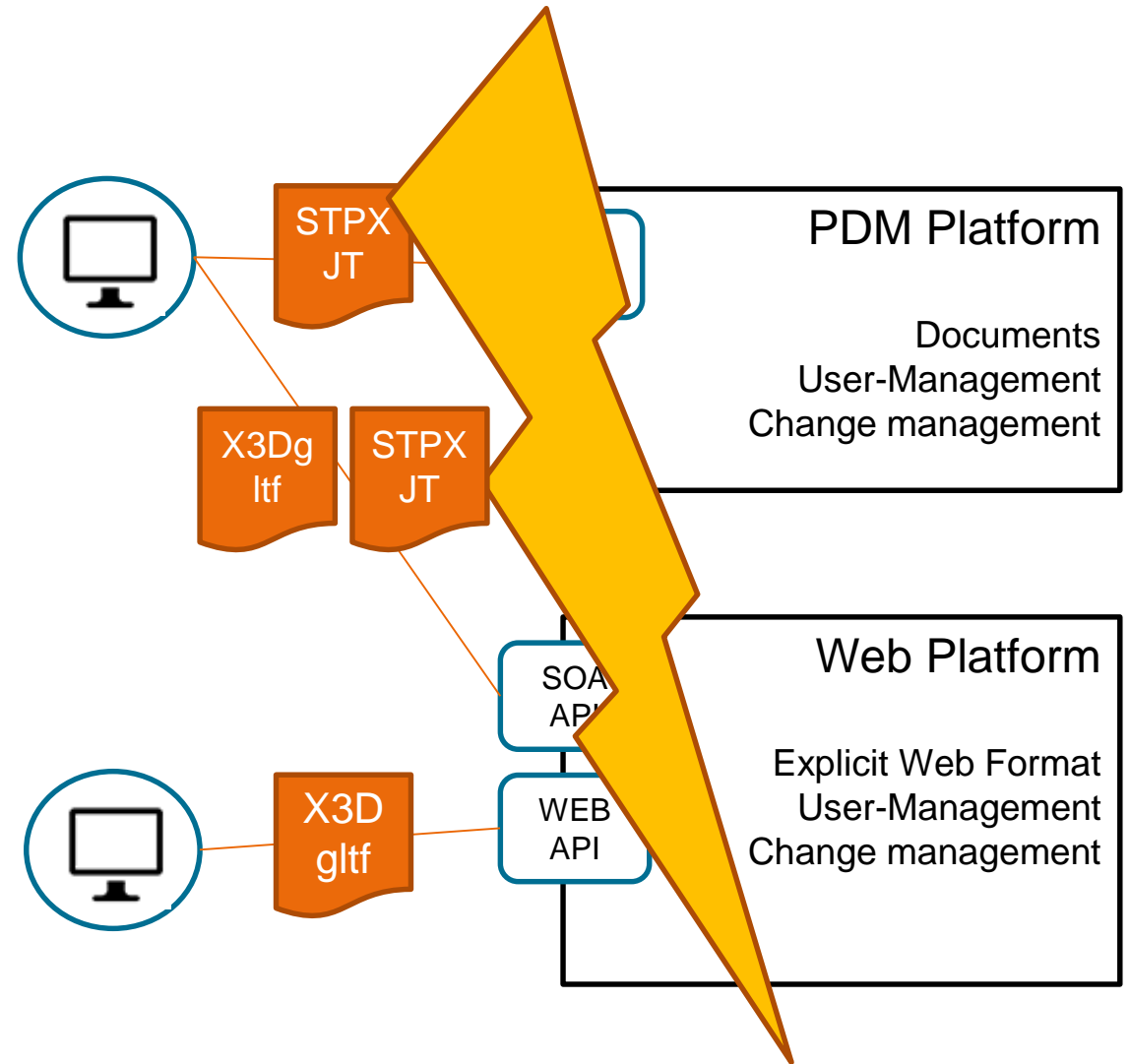
Browser

R&D 3D Data
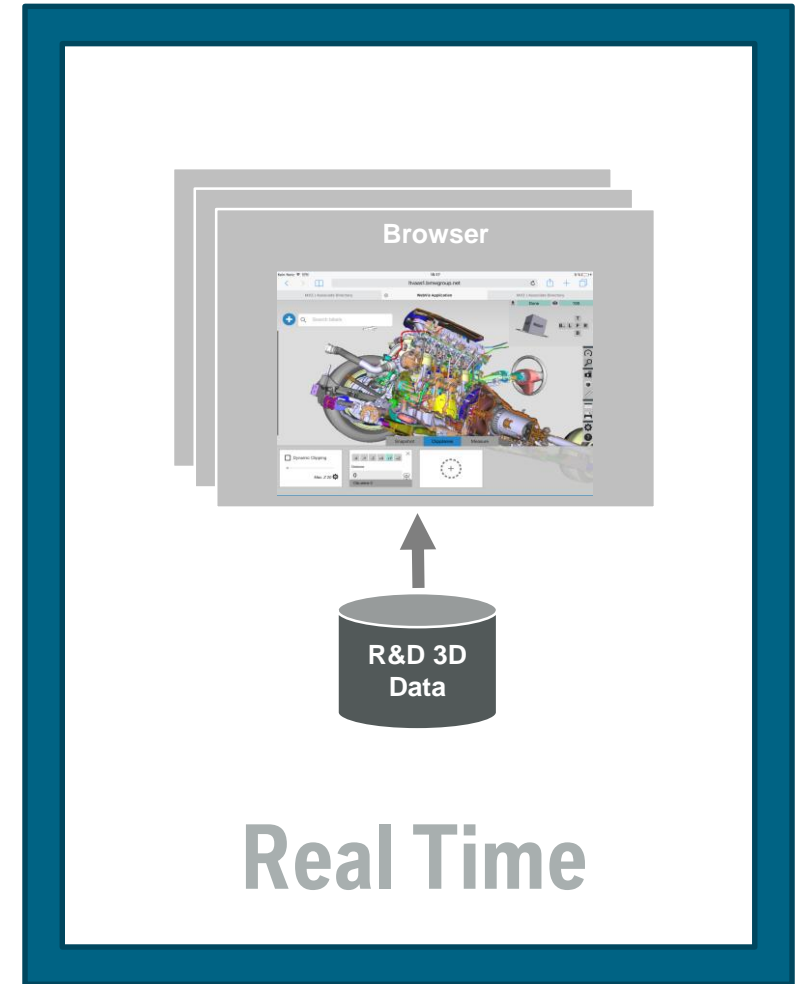
Real Time Integration vs "Down Stream" pipelines and portals

- Application developer has to manage "pipeline"
- Explicit data transport and conversion
  1. Authorize PDM User
  2. Download PDM Format
  3. Data validation
  4. Optional External conversion
  5. Authorize Web-Platform
  6. Upload PDM/Web Format
  7. Authorize Web User
  8. Download Web Format
- Exposed 3D-Format bound to specific client class
- Explicit Silo-to-Silo synchronization

STPX JT

X3Dg ltf

STPX JT

PDM Platform

Documents
User-Management
Change management

SOA API

WEB API

X3D gltf

Web Platform

Explicit Web Format
User-Management
Change management

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Micro Service Architecture (MSA) principles

■ IT Trend to manage complexity: From monolithic platforms to micro-service architectures
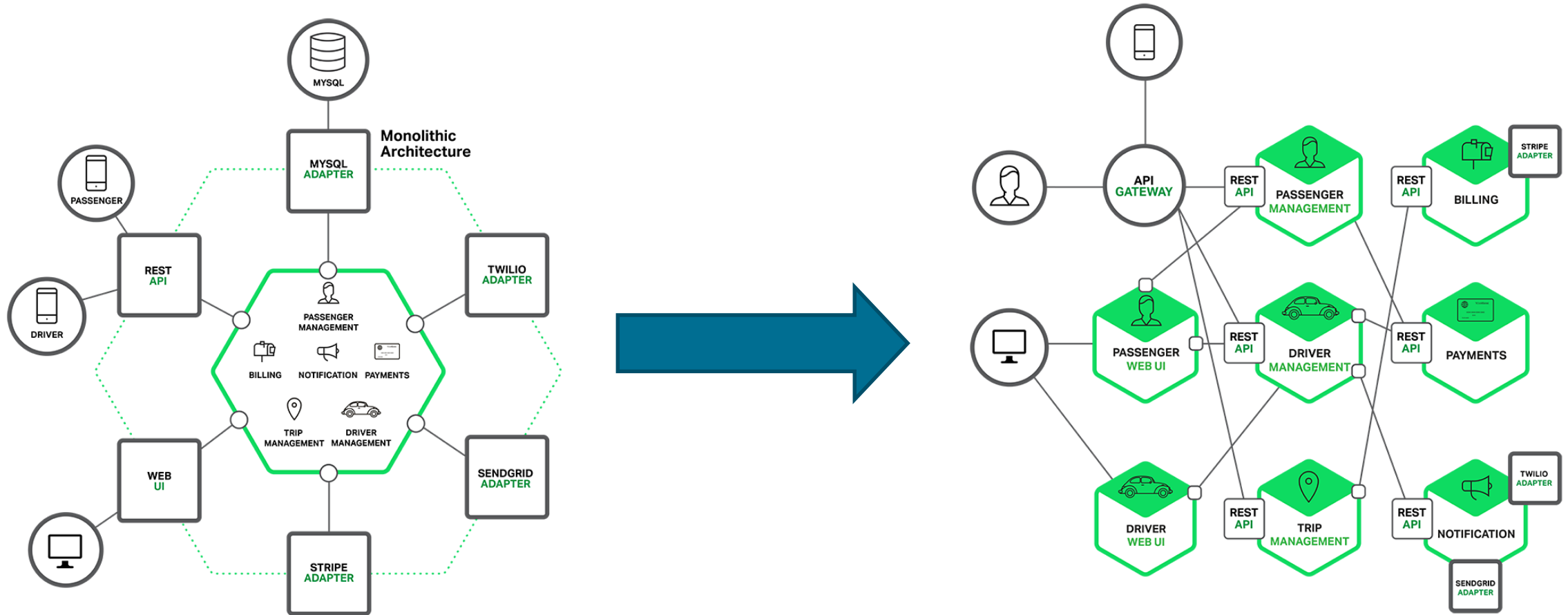
Introduction to Microservices, Chris Richardson, 2015

MSA data decoupling: Resource "Network" provides "Documents"

- **Document Container as Linked Data Prim Container Formats**
  - Current solution push/pull data through a given **front or backend API**
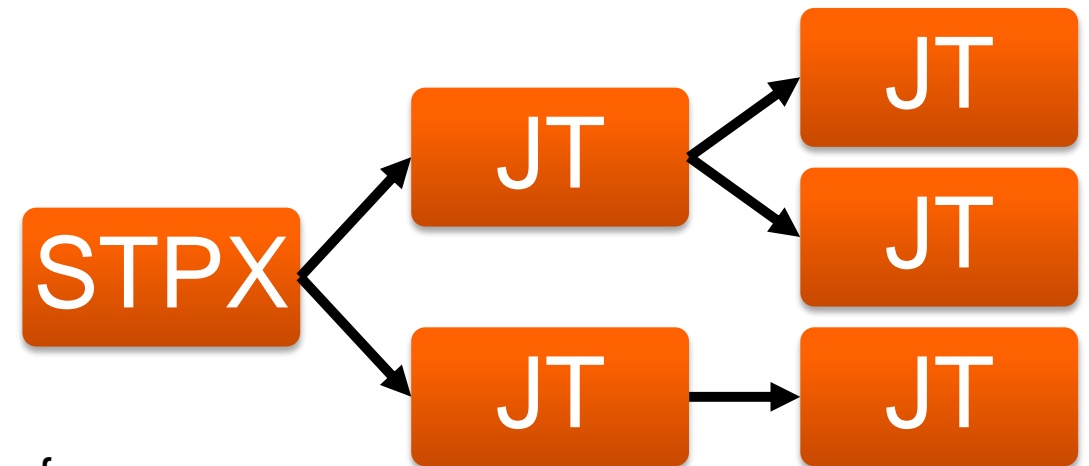 - Growing integration dependencies **increase costs and limit scalability**

- **Solution: Linked Resource Network (HATEOAS)**
  - **Resource Description Framework (RDF)**
    - **E.g. ARVIDA SceneGraph vocab**
  - **Link in Domain Container**
    - Issue: Minimal Support for full URI
      - STEP242/JT: Local Ref
      - Solution: Add URI (URN + URL) to STEP242/JT references
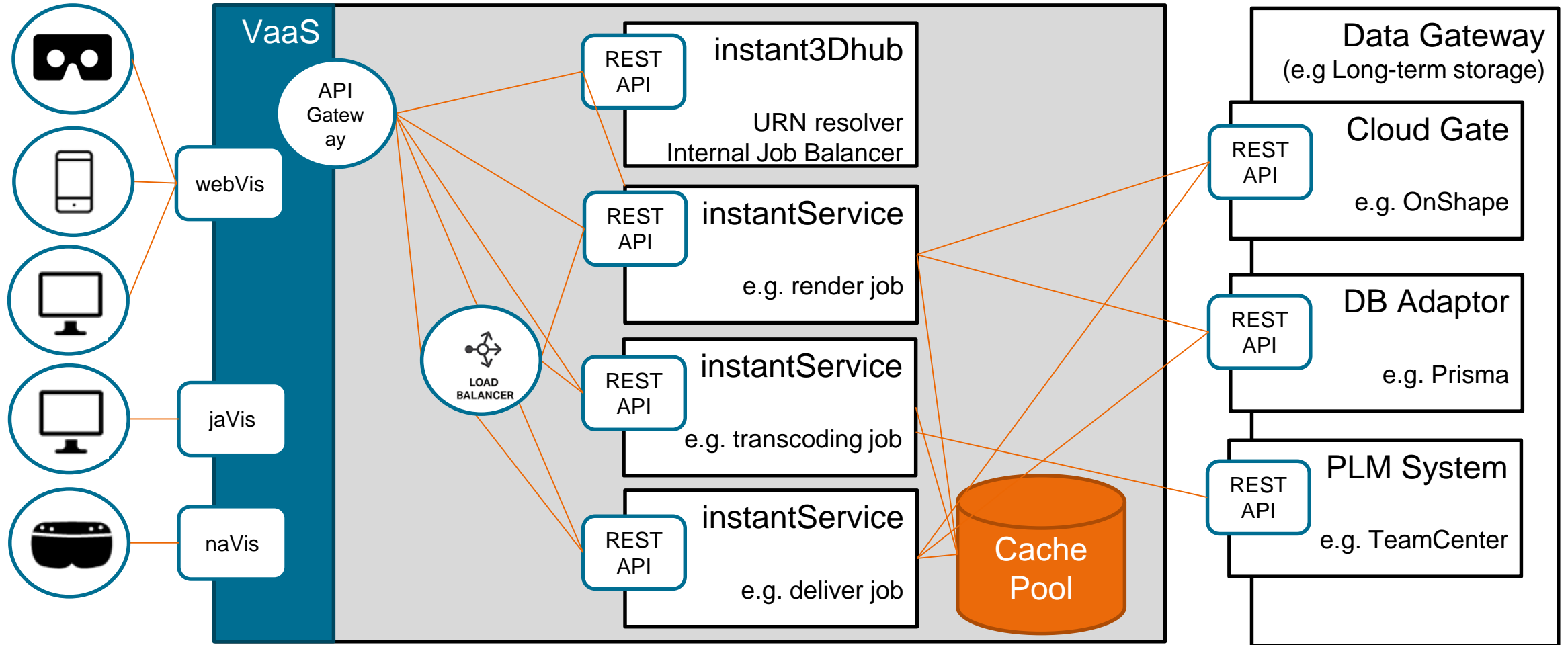   - **E.g. "urn:bmw:prisma:docuid:34529777"**

MSA data decoupling: Mature Standards provide trusted interfaces

- **Efficient and automated** content negation/processing builds on **mature container standards**
  - Service2Service communication: Services **must trust formats** with minimal validation efforts

- **JT/Step-AP242-XML: Premier VaaS gateway formats**
  - ISO Specification
  - Free/open implementation
  - Royalty free
  - Rich domain container
    - Tesselation/Brep
    - PMI
    - Attributes/ULP
    - Kinematic
    - External Container References

Maximum maturity

ensured by

Guidelines for ISO

Worldwide recognized

ISO 14306:2012

Investment Protection

✓ Vendor-neutral   ✓ Royalty free   ✓ Patent free

✓ Independent from specific CAD system   ✓ Independent from specific CAD release

Fraunhofer IGD

VaaS: Micro service architecture to access micro document data

Starting with a single line of HTML code for application development
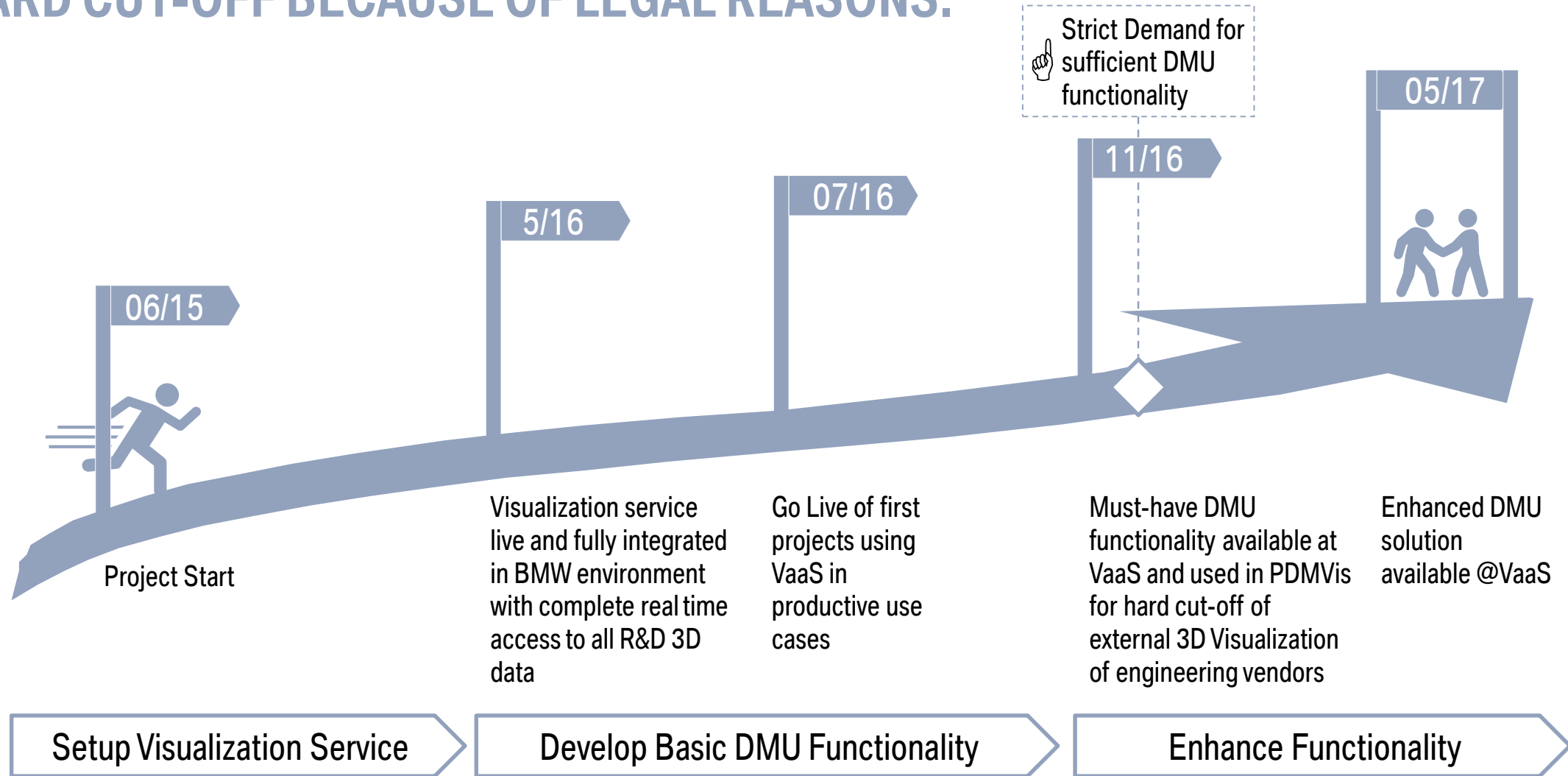## Build for agile prototyping process

fh-igd.de/rvsc


```html
1   <!DOCTYPE html>
2   <html>
3       <head>
4           <title>WebVis Application</title>
5
6           <script src="http://test.instant3dhub.org/repo/webvis/webvis.js"></script>
7           <link rel="stylesheet" type="text/css" href="http://test.instant3dhub.org/repo/webvis/webvis.css">
8
9       </head>
10      <body>
11          <webvis-full src="http://data.instant3dhub.org/repo/step/bloodhound/Bloodhound_SSC.stpx"></webvis-full>
12      </body>
13  </html>
14
```
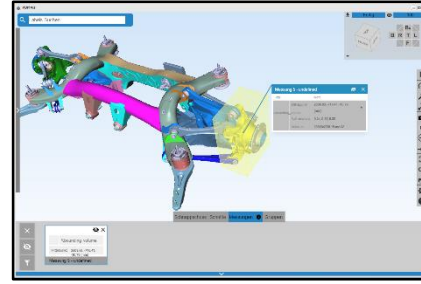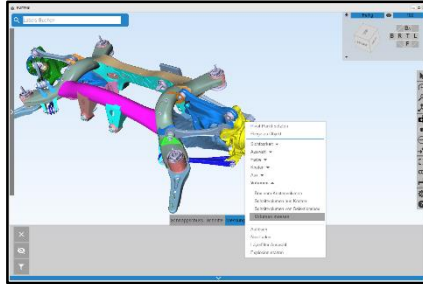
Fraunhofer IGD

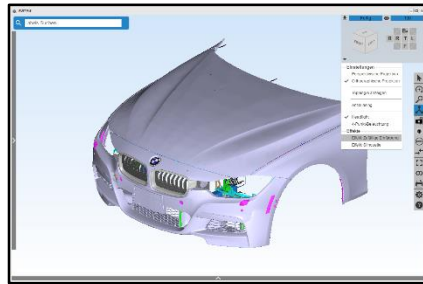# TOUGH TIME SCHEDULE.
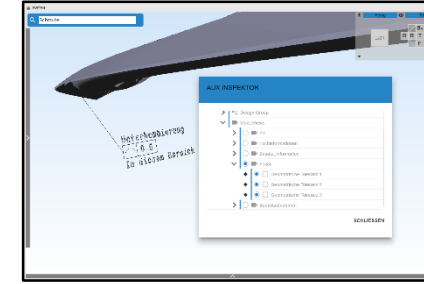# HARD CUT-OFF BECAUSE OF LEGAL REASONS.

Strict Demand for sufficient DMU functionality

05/17

11/16

07/16

5/16

06/15

Project Start

Visualization service live and fully integrated in BMW environment with complete real time access to all R&D 3D data

Go Live of first projects using VaaS in productive use cases

Must-have DMU functionality available at VaaS and used in PDMVis for hard cut-off of external 3D Visualization of engineering vendors

Enhanced DMU solution available @VaaS

Setup Visualization Service > Develop Basic DMU Functionality > Enhance Functionality

DMU USE CASES (EXAMPLES).

Volume Analysis

PMI

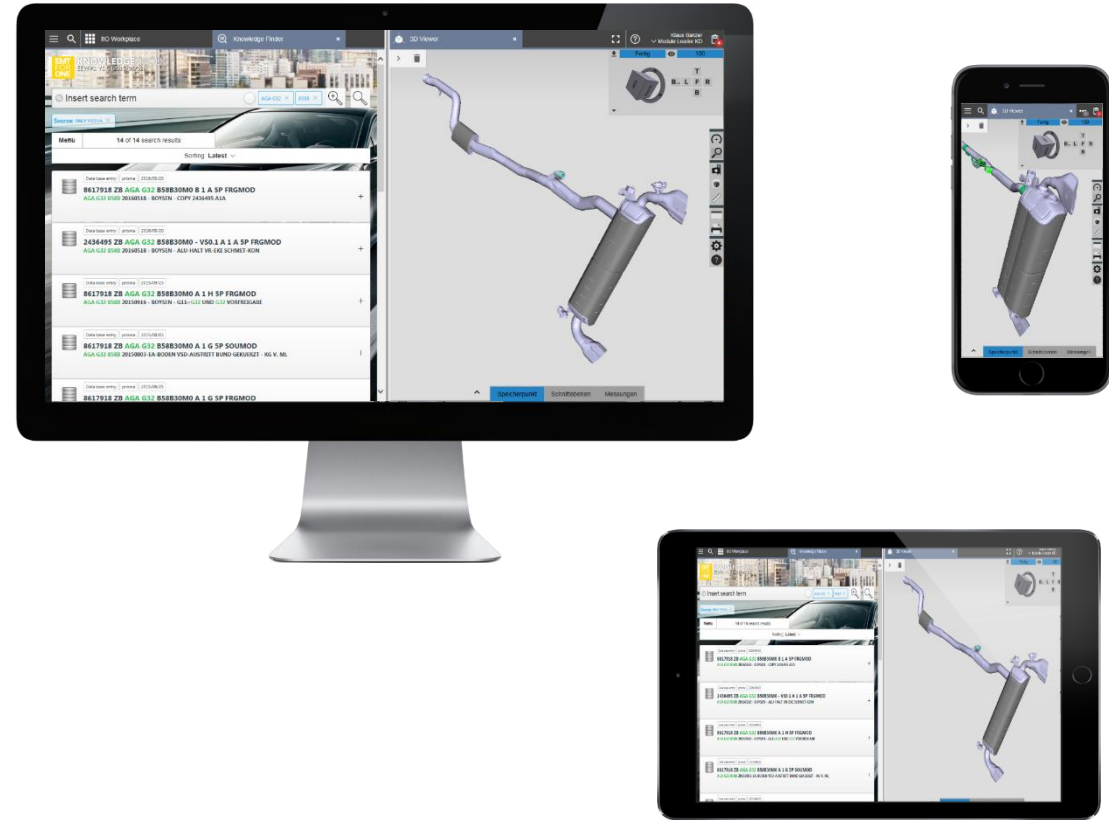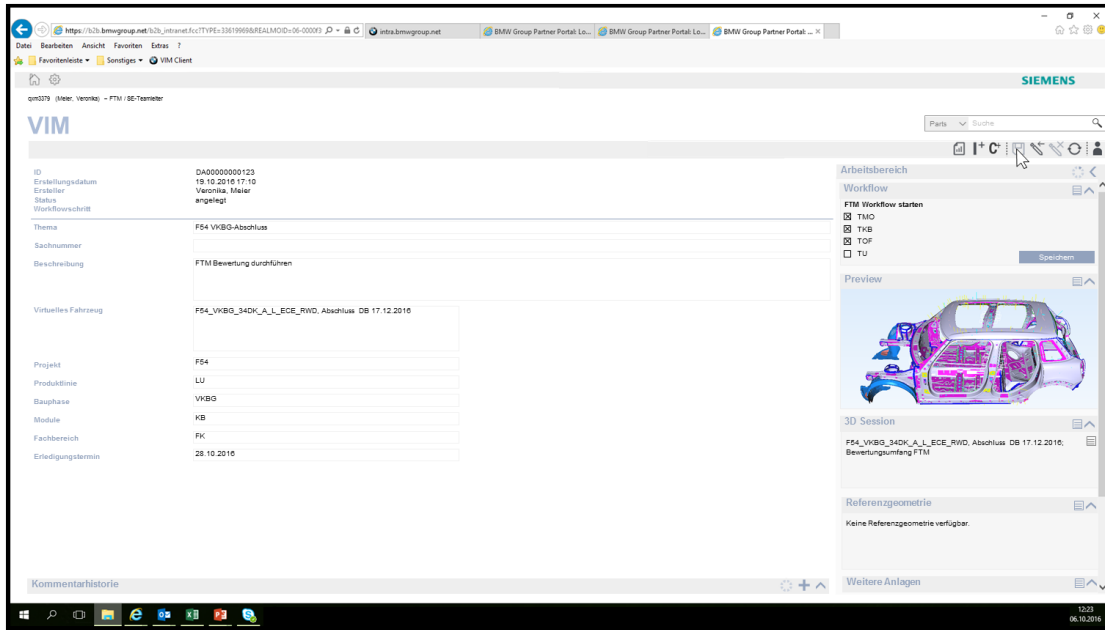

Comparison

Colouring
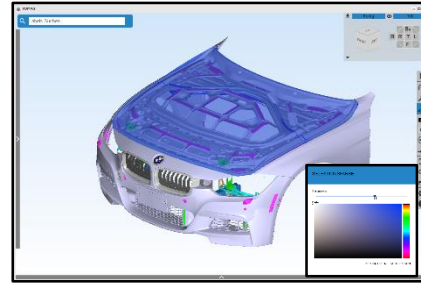
Explosion

Search

Measuring
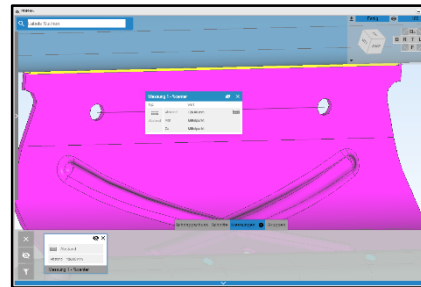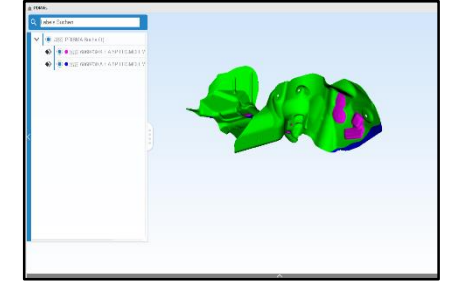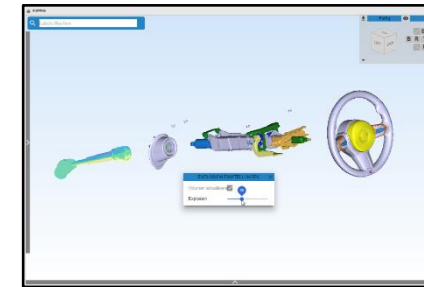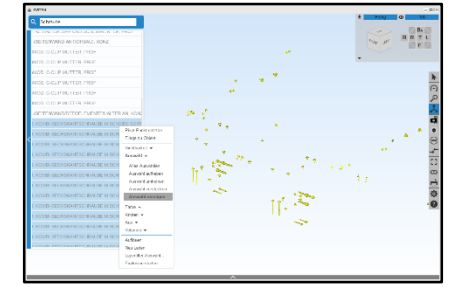
PROJECT: „WORKPLACE" INTEGRATION.
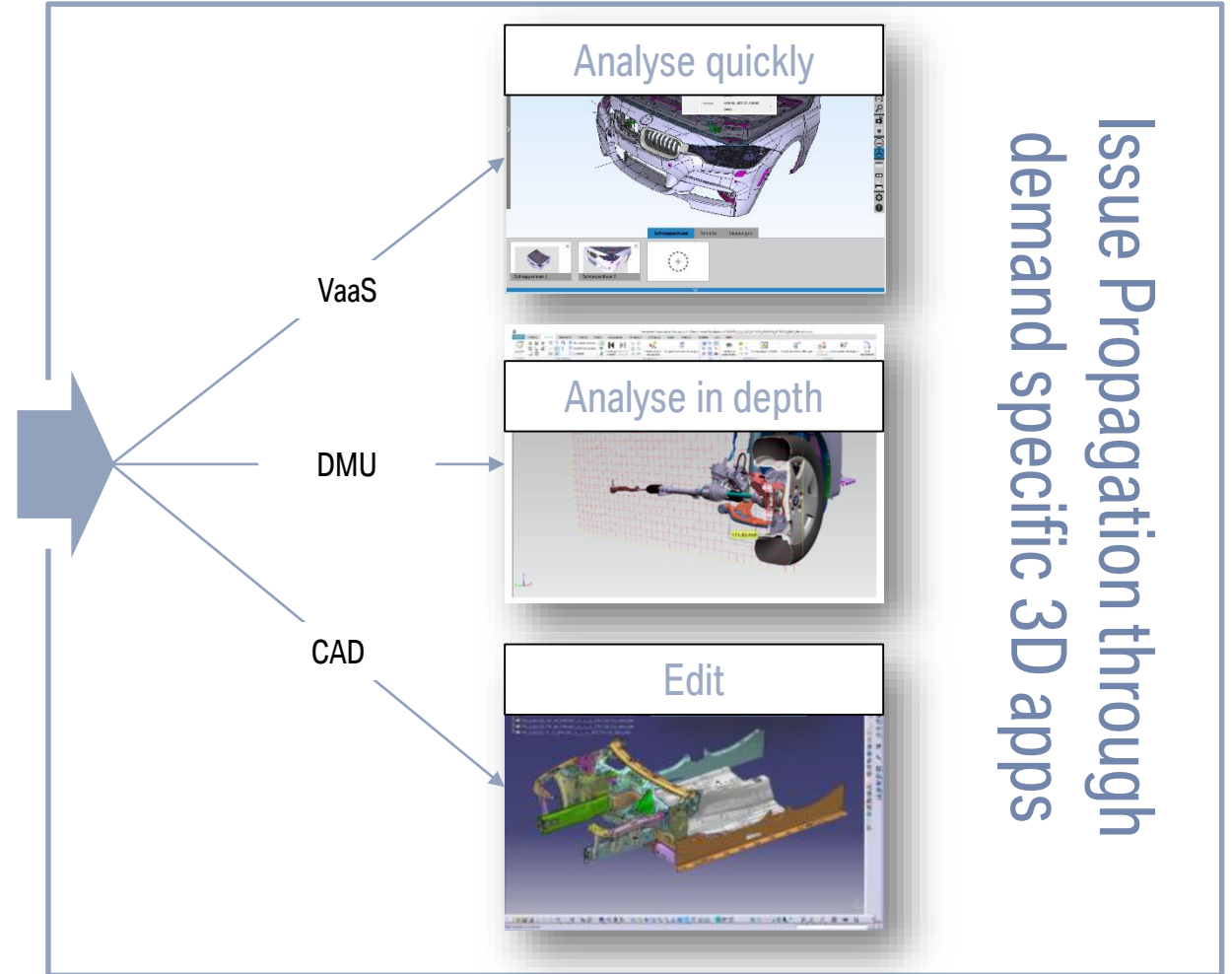# CLIENT PLATTFORM FOR FRONT-END INTEGRATION.

Key Features:

– Supports several business domains

– Supports multiple devices and OS (html5)

– 3D integration layer based on **VaaS for full 3D support**

– Full support of touch-capable devices

– Currently implemented in two modules

   – Knowledge Finder

   – Approval Control Center

PROJECT: VISUAL ISSUE MANAGEMENT (VIM).
INTEGRATION VIM & CONSISTENT 3D GEOMETRIC VISUALIZATION.

VaaS — Analyse quickly

DMU — Analyse in depth

CAD — Edit

Issue Propagation through demand specific 3D apps

VIM: seamless information distribution & visualization capabilities

PROJECT: B2ONLINE.
STANDARD SPECIFICATIONS FOR VENDORS.

Key Features:

- Platform, based on Liferay CMS

- Extension of standards / specifications through text, tables, pictures / films, CA-models and computation automatisms

- **VaaS facilitates understanding Drawings / Specifications** for design engineers and mechanics on-site

PROJECT: MULTIPLE ASSEMBLY PLANNING & PROCESS SYSTEM (MAPP) PRODUCT-PROCESS LINKAGE

Key Features:

- Identification and sequence checking for manufacturing equipment in the assembly planning process

- VaaS **facilitates visualization of constructed space** for manufacturing equipment designers

Visualization:
- in assembly sequence (virtual car)
- by product cluster
- by organizational units
- with individual filters

Product Data — **Process Data**

Bolting case data in the process

Product data in the process

Completeness check

assembly location at part number level
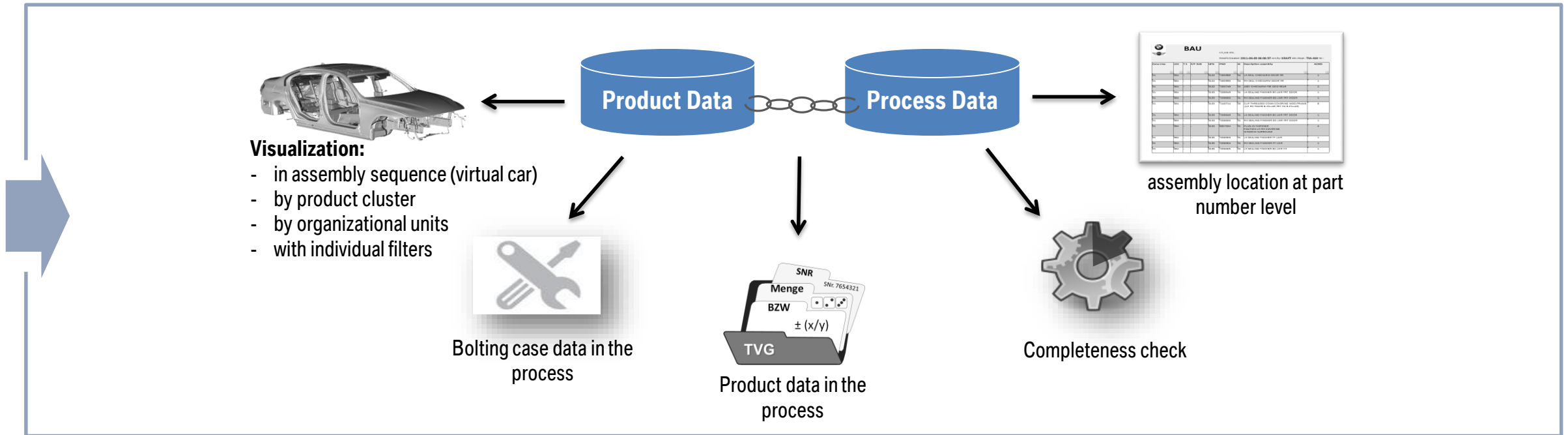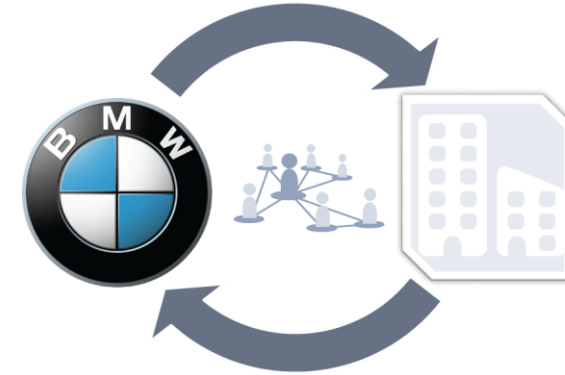
PROJECT: PDMVIS.
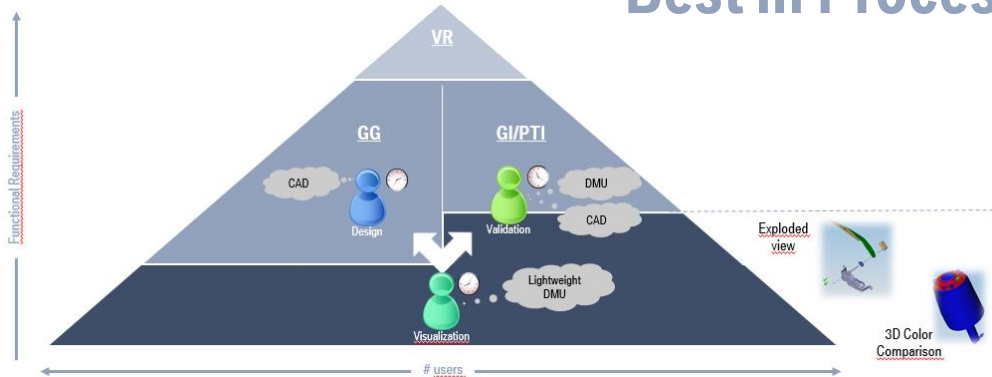# DMU FOR VENDORS AND DEMAND ORIENTATED VIS/DMU PACKAGE @BMW.

Key Features:

- Feature complete Vis/DMU solution for vendors within B2B portal („Web Desktop")
- Fully integrated in several modules for TDM or PDM Data access
- Demand-orientated best in process tool for quick 3D access and lightweight DMU
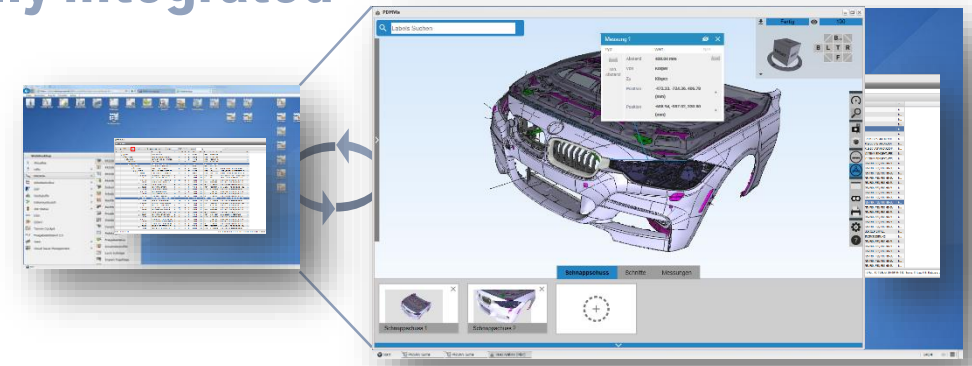
B2B

Best in Process

Fully integrated

EXPERIENCES SO FAR.

Challenges

– At project start a massive lack of functionality besides pure visualization

– Performance and stability of legacy browsers

– Acknowledgement of users for new solutions with access to common software (internal processes)

– Web Technology unusual for common 3D-software-vendors

Opportunities

– Win-win collaboration to implement features with maximum usability in focus (and not number of functions)

– Performance of state-of-the-art browsers is outstanding

– No negative feedback after hard cut-off of legacy 3D applications (external vendor access)

– Web Technology as a silver bullet for business-software-vendors

– Continuous deployment as succes factor for agile process initiatives (according to BMW 100% agile initiative)
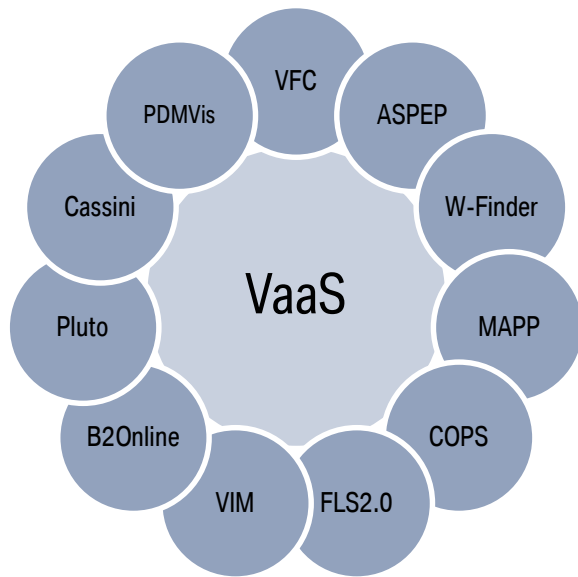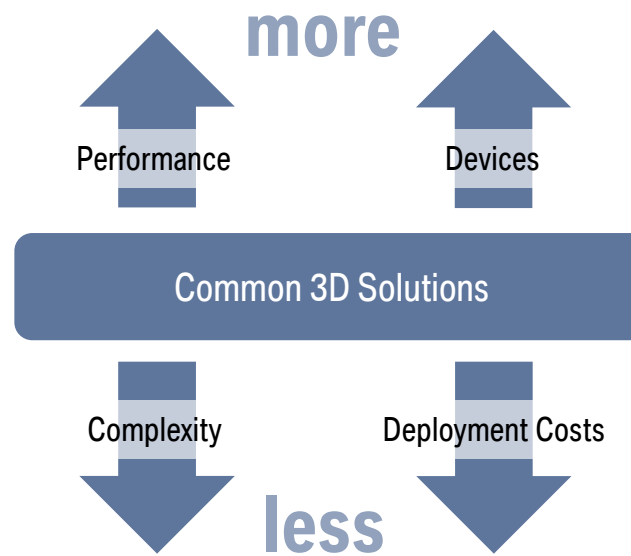
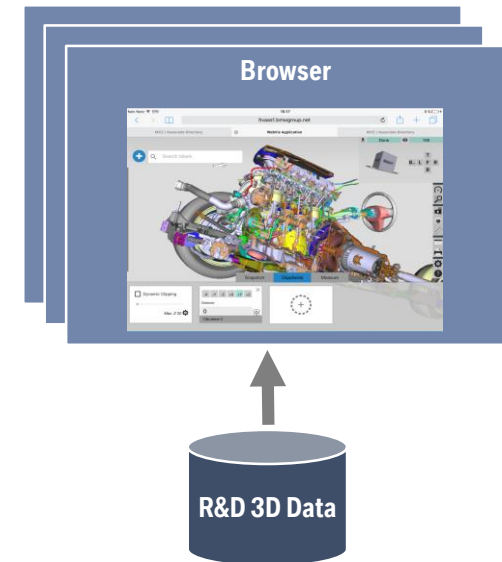Project completely in: Time 👍   Budget 👍   Quality 👍

USER DEMANDS AND MOTIVATION.
ANOTHER KIND OF 3D USAGE.

VaaS

VFC · ASPEP · W-Finder · MAPP · COPS · FLS2.0 · VIM · B2Online · Pluto · Cassini · PDMVis

more

Performance

Devices

Common 3D Solutions

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Deployment Costs

less

Browser

R&D 3D Data

Global ✓

Smart ✓

Real Time ✓

OUTLOOK.

Future fields of interest @BMW for Web Visualization:

- **High-End Rendering** on real-time data (no data preprocessing necessary) – Evaluation
- Support of **WebVR Technology** to offer VR to an engineer's world –available with productive environment for pilot projects

FEEDBACK.

Feedback & Anregungen?

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Dr. Johannes Behr | Fraunhofer IGD | +49-6151-155-510 | Johannes.Behr@igd.fraunhofer.de