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ARCHITECTURE CONSIDERATIONS FOR INTEGRATED DIGITAL SERVICES

Digital Omnichannel Transformation in Action

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// Agenda

01 About the Speaker

02 Digital Omnichannel Transformation (DOT)

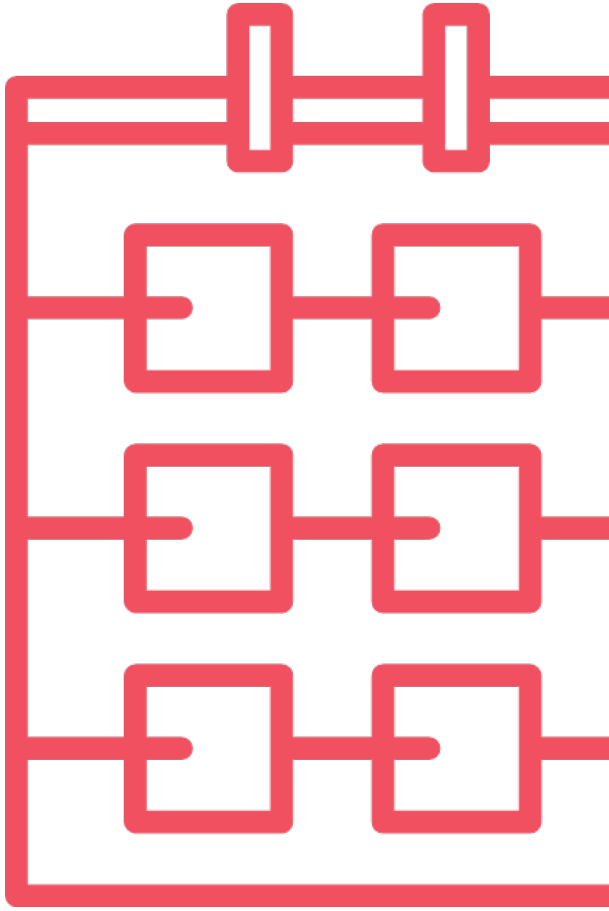
03 DOT Systems Landscape

04 DOT Systems Integration

05 DOT Solution Architecture

06 Coherence of DOT Processes in Heterogeneous Systems

07 Summary and Outlook



// DR. HANS-WERNER SEHRING

50% Professional

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Merkle (Namics)

T-Systems MMS

Clients from media // insurance // automotive // telco // retail // finance // travel // industry

Architecture // CMS // DAM // PIM // Commerce // App

50% Science

TUHH

TuTech

IARIA

Fellow of the International Academy, Research, and Industry Association (IARIA) // editor-in-chief of the International Journal on Advances in Intelligent Systems // Steering of the International Conference on Creative Content Technologies

Content management // knowledge representation // personalization // software architecture // Software engineering // model-driven software development // ddaptive systems // Cloud // e-learning

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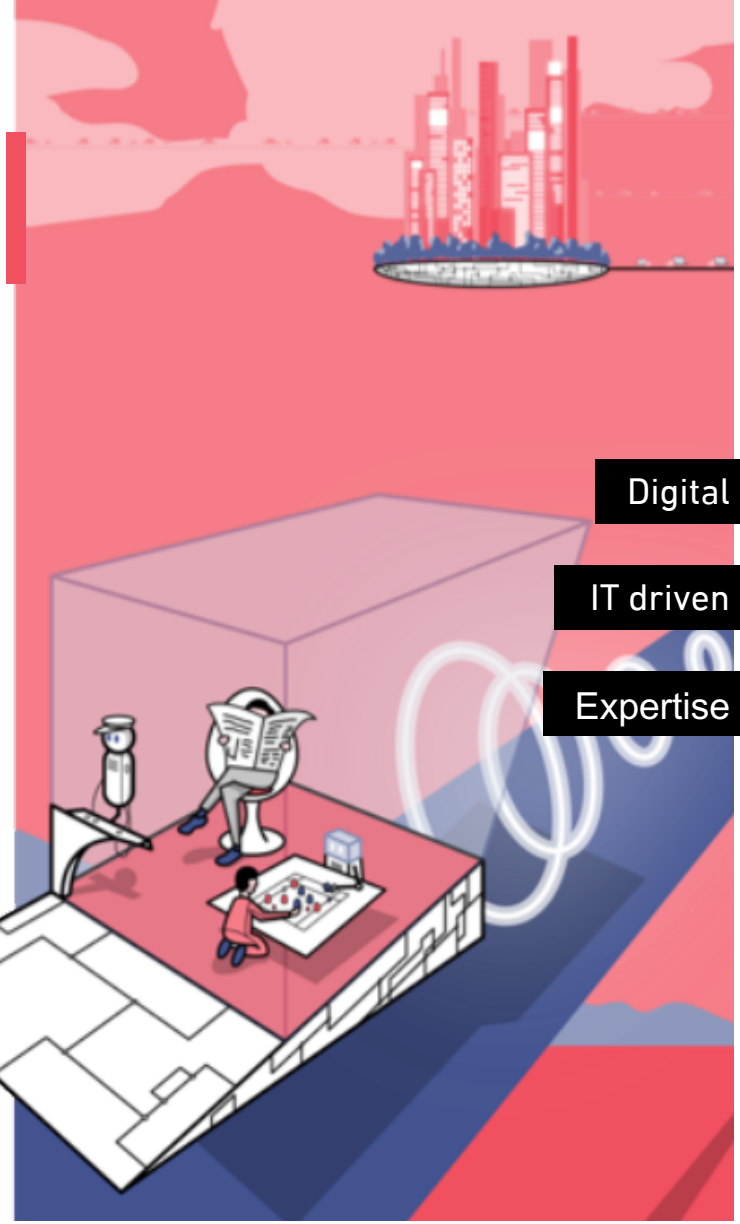


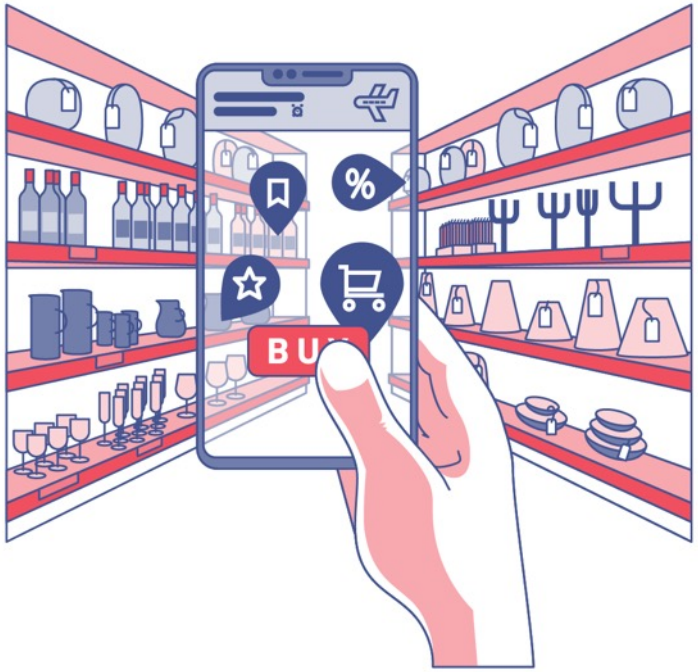
02

DIGITAL OMNICHANNEL TRANSFORMATION (DOT)

// Introduction

- The digital transformation is happing for some time now
  Changing the process tooling, communication behavior, … of an organization to the work in the digital domain
- Digital transformation is not only about the introduction of IT tools
  It allows to explore new business models, rethink processes, intensify communication, increase the reach of services, etc.
- There are many aspects of digital transformation
  Two (commercially) important aspects are
  - digitization of value-adding processes (e.g., Industry 4.0) and
  - digitization of communication and customer engagement (e.g., web- and app-based services)
- Based on my personal experience, I concentrate on the latter: digital omnichannel transformation (DOT)

// Digital Transformation of Communication



- In particular, we consider digital communication of organizations (companies, institutions, ...) with users of their services
- Due to the professional focus on commercial applications, ...
  - we concentrate on companies as service providers, though many aspects also apply to public institutions and others
  - we use the term customer for end users with whom to communicate. This is to distinguish them from internal users like marketers, sales personnel, editors, curators, etc.
- Customers interact with companies at touchpoints
  - They use digital or digitized services: information, online shopping, etc.
  - They communicate with representatives of companies: support, etc.
  - They communicate with each other: messaging, forums, etc.

// Digital Omnichannel Transformation Requirements

- Communication should be easy and enjoyable for customers
  Therefore, user experience / customer experience is important for successful communication
- Communication between customers and companies takes place …
  - Omnichannel: alternately on all communication channels used, and customers expect companies to use the communication channels they use in daily live: the WWW, mobile apps, social media platforms, chats (one-to-one or group communication), voice, and also personal communication with agents
  - Cross-channel: customers change communication channels in the course of an interaction to use the medium and device that is most appropriate and convenient in a specific situation
- In order to provide a suitable experience, the context of customers needs to be considered
  - Mobile device or stationary computer depending on current location
  - Searching and browsing or dialogs (chat/speech) depending on device
- Customers can be addressed individually when they (or at least their demands) are known

// Dialogical Communication

The Digital Omnichannel Transformation is based on systems integration.

- Communication with customers should take place in the form of a dialog
  - as opposed to one-way communication of sending messages
  - dialog means that responses from the user are taken into account
  - customers expect service providers to act accordingly
- Example: different perspectives on a customer that are combined in a common view on a customer
- Perspectives cover those aspects that are relevant in a communication situation / at a touchpoint

// Example of DOT Communication

> Before buying a car, a potential customer first gets some inspiration on driving experiences on social media.

> When using a smartphone for first research on cars, the car manufacturers' apps utilize information on previous social media activities.

> After deciding for one car model, the user changes to a desktop computer for larger product images and a more convenient use of the car configurator on the manufacturer's website. When stuck with configuring, a chat dialog offered by the manufacturer is used to receive help from a sales agent. Finally, the customer books a test drive.

> The sales representative of a car dealer is provided with the information of the preferred car configuration of the customer.

> After the test drive, the car dealer can follow up on the test drive by mail or phone. Alternatively, the customer can automatically be approached on the digital channels by mail, text messages, banner ads, etc.

> Etc.

// Omnichannel Communication Requires Integrated Systems Support

The Digital Omnichannel Transformation is based on systems integration.

- Customers expect context-dependent communication

  ⇒ There need to be different user interfaces to the provided services

- Customers use communication channels at their convenience, not for the service they are going to use

  ⇒ User interfaces on the communication channels interact with all components

- Customers use different communication channels interchangeably

  ⇒ Dialog state needs to be transferred from one channel to another, and the need to be preserved over time

- Typically, various technical components work in concert in a digital solution
  - At different points on the customer journey, customers interact with different components
  - For dialogical communication, information needs to be passed between components, and these need to share the same notion of customers, entities, etc.

  ⇒ Processes spanning multiple component, data exchange between components according to the processes

03

DOT SYSTEMS LANDSCAPE

// The DOT System Landscape

Digital solutions are composed of multiple components.

- An overall DOT system incorporates many functionalities
  - Primary functionality for customer interaction and service fulfilment — e.g., website publication and handling of commerce transactions
  - Secondary functionality for business operations — e.g., aggregating data gathered through customer interactions
  - Supporting functionality that enables primary and secondary functionalities — e.g, tracking to explore customer behavior
- Since many specialized functionalities are incorporated, there is no single system that implements them all
- Since highly specialized functionalities are required, typical solutions are built from readily available COTS and services
  We call these components
- We are typically facing a landscape of specialized DOT components that together form a digital solution

// Technology Considerations

Software components that build the foundation of digital solutions

> There are many classes of components that are currently used as the foundation of digital solutions.

> They operate on different layers of digital solutions, and they provide different functionality, like

  > Content Management

  > Presentation of content as documents and of applications

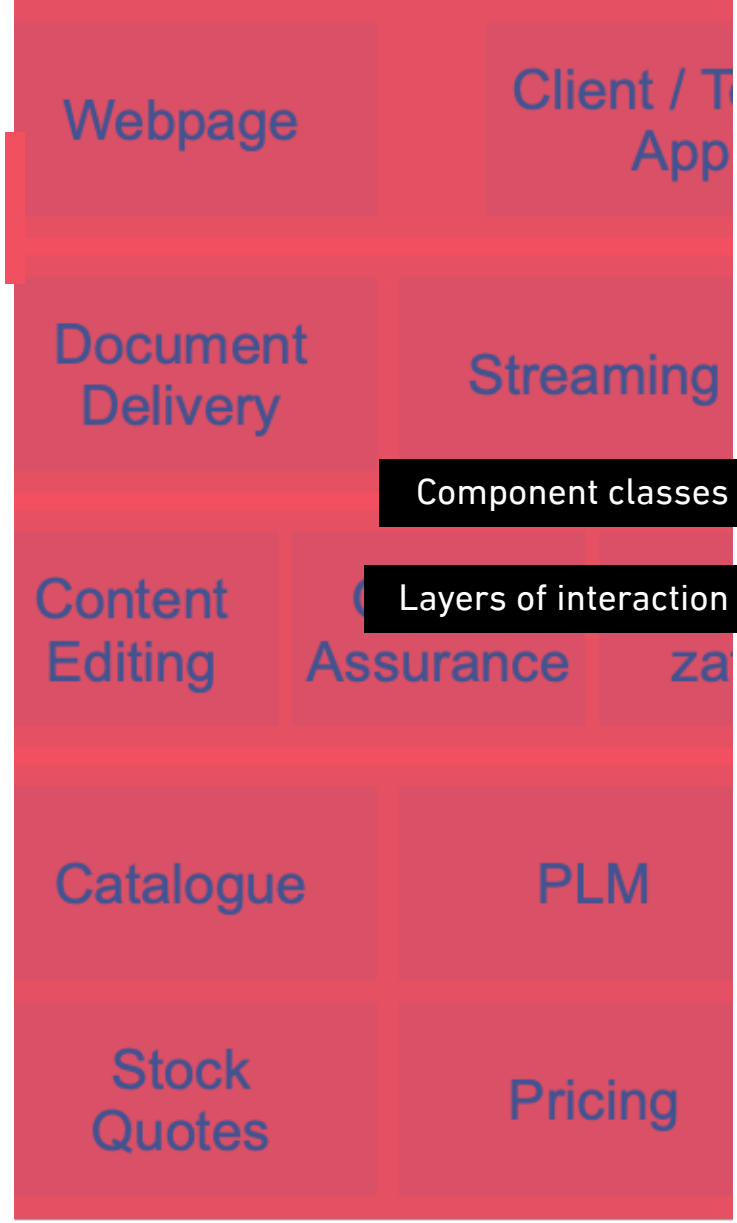
  > Document processing, e.g., to adapt presentations for specific uses

  > Playout, i.e., the delivery of documents to viewers

  > Transaction management, e.g., online purchases

  > User interaction, e.g., handling user input in the course of a dialog

  > Backend systems and data, e.g., product catalogs or warehouse mgmt.



// Examples of Components of a Digital Solution

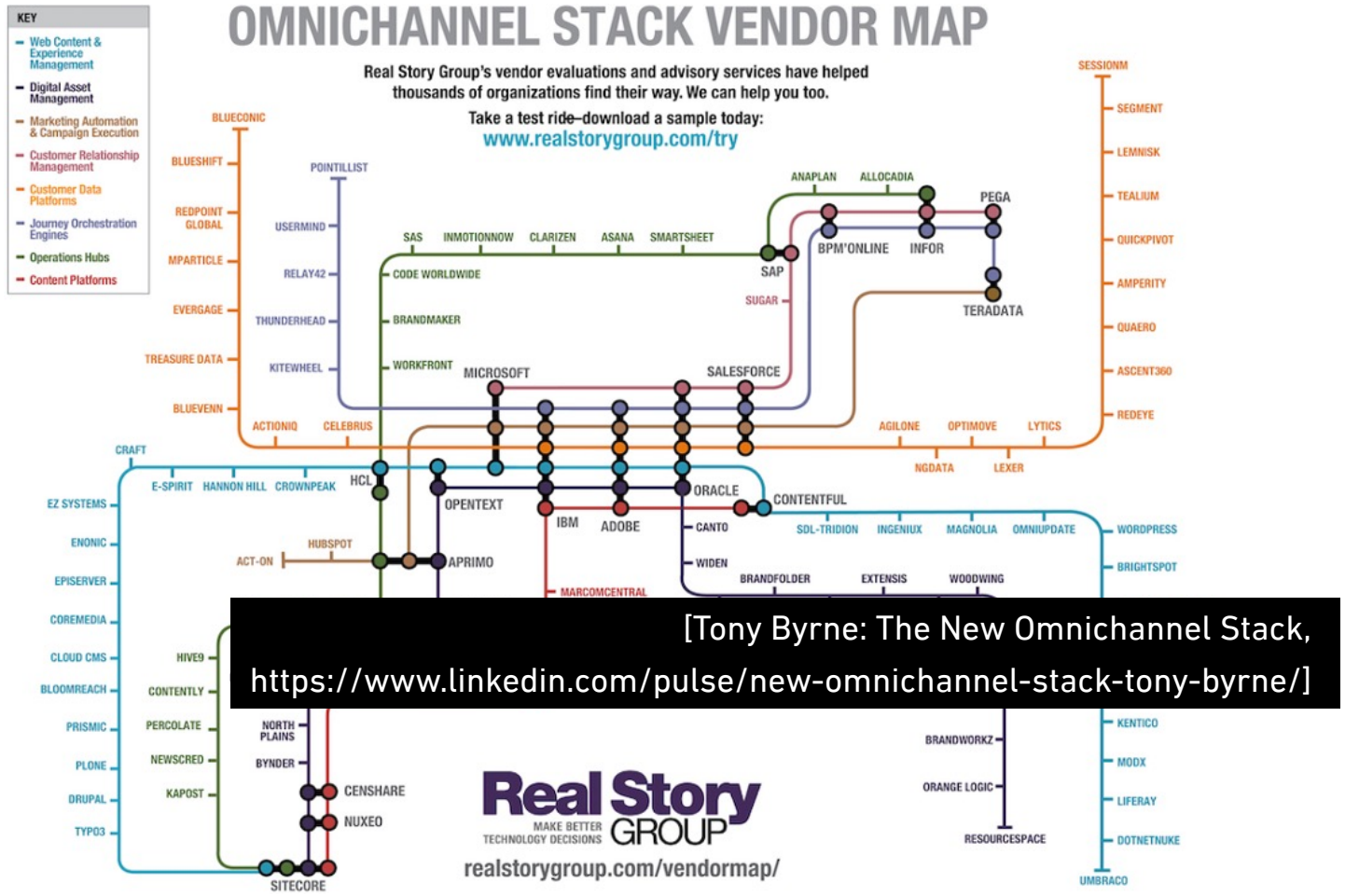
- Functionality is provided by a multitude of components, e.g.,
  - Content Management by a CMS, a DAM system, and content planning tools
  - Presentation by a CMS, a static site generator, and document generators
  - Document processing by A/B testing tools and personalization engines
  - Playout by (web) servers
  - Transaction management by a commerce plattform, CPQ tools, and payment and logistics gateways
  - User interaction, by tracking/analytics, retargeting, a customer journey orchestration engine, and CIAM
  - Backend systems and data, like a PIM, CRM, CDP, DMP

// RSG Product Map

Analyst's selection of technologies

> For every class of component, there is a range of software products and services filling that role.

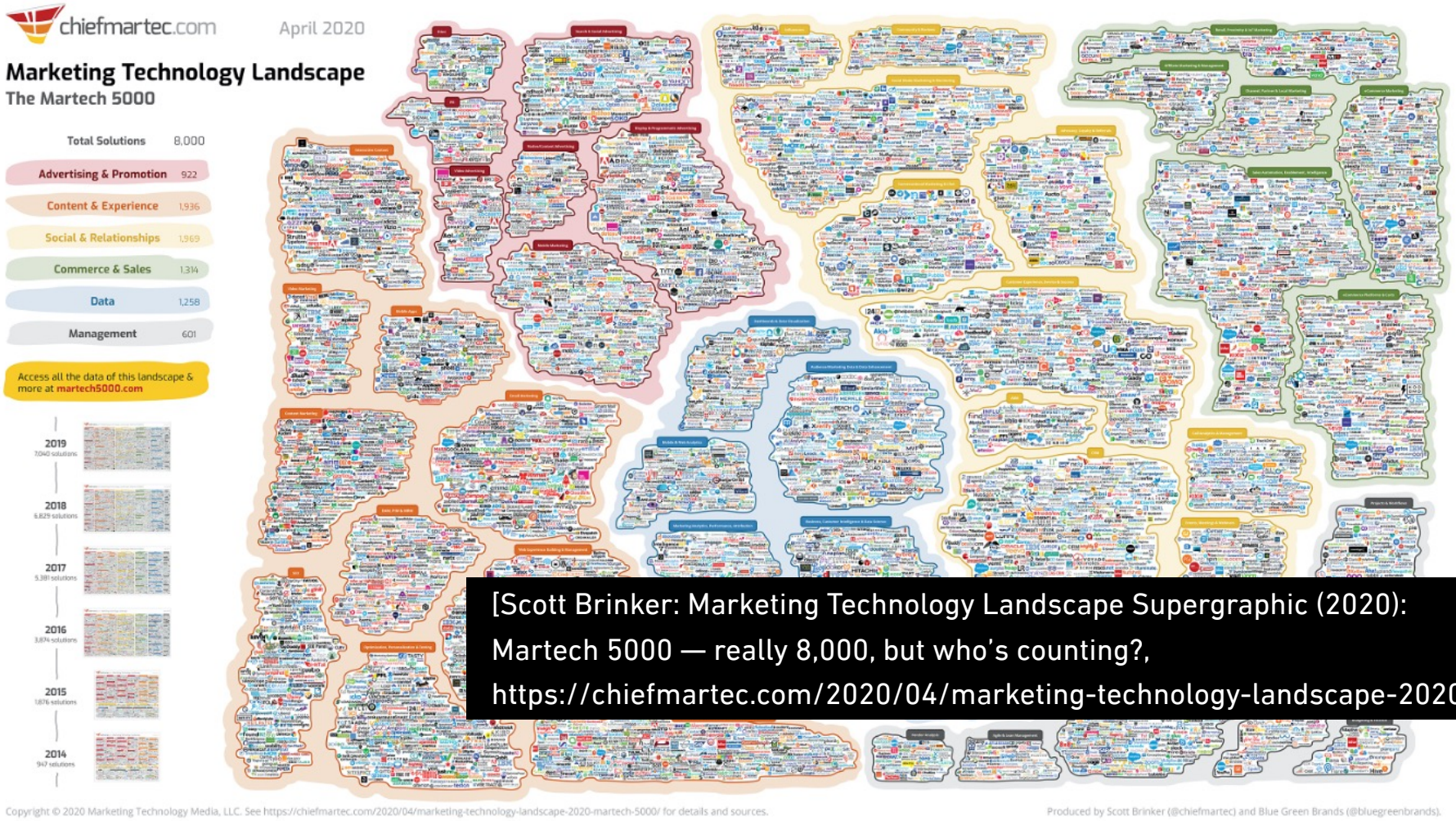
> The Real Story Group (RSG), for example, names quite a few.



[Tony Byrne: The New Omnichannel Stack, https://www.linkedin.com/pulse/new-omnichannel-stack-tony-byrne/]

// Or, More Complete: the “Supergraphic”

There is a plethora of components available – and the number is constantly growing



[Scott Brinker: Marketing Technology Landscape Supergraphic (2020): Martech 5000 — really 8,000, but who’s counting?, https://chiefmartec.com/2020/04/marketing-technology-landscape-2020-martech-5000/]

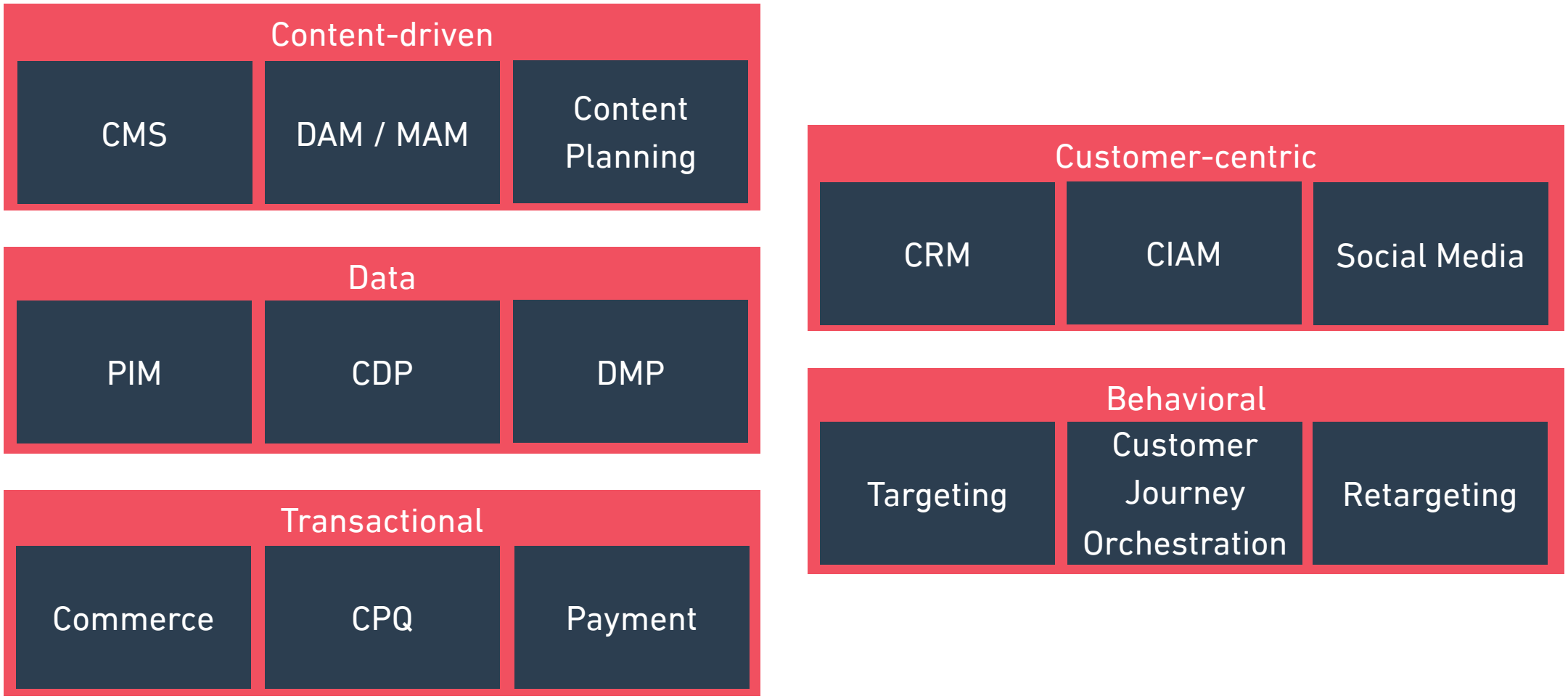
// Classification of Digitization Components

The enumerations of known digitization products also aim to provide component classes in order to be able to abstract from single products.

- Although there is an understanding of the functionalities and components that supply them, there is no universal definition of component classes
- Component classes are often defined after the application areas that single components are built for
  - Many existing products and services do not address one functionality only
  - They fulfill multiple requirements to a certain degree
  - Classifications reflect subjective definitions based on typical products, and they are not free of intersections
- Here we use a different approach by main content / main use of a component as part of an overall solution
  - Content, data, or customer
  - Transactions
  - Behavior
- As any classification, it is ambiguous because of overlapping functionalities

// Classes of Customer-facing Components

From the vast range of DOT components, we focus on the customer-facing ones – components the customer communicates with and components that support these.

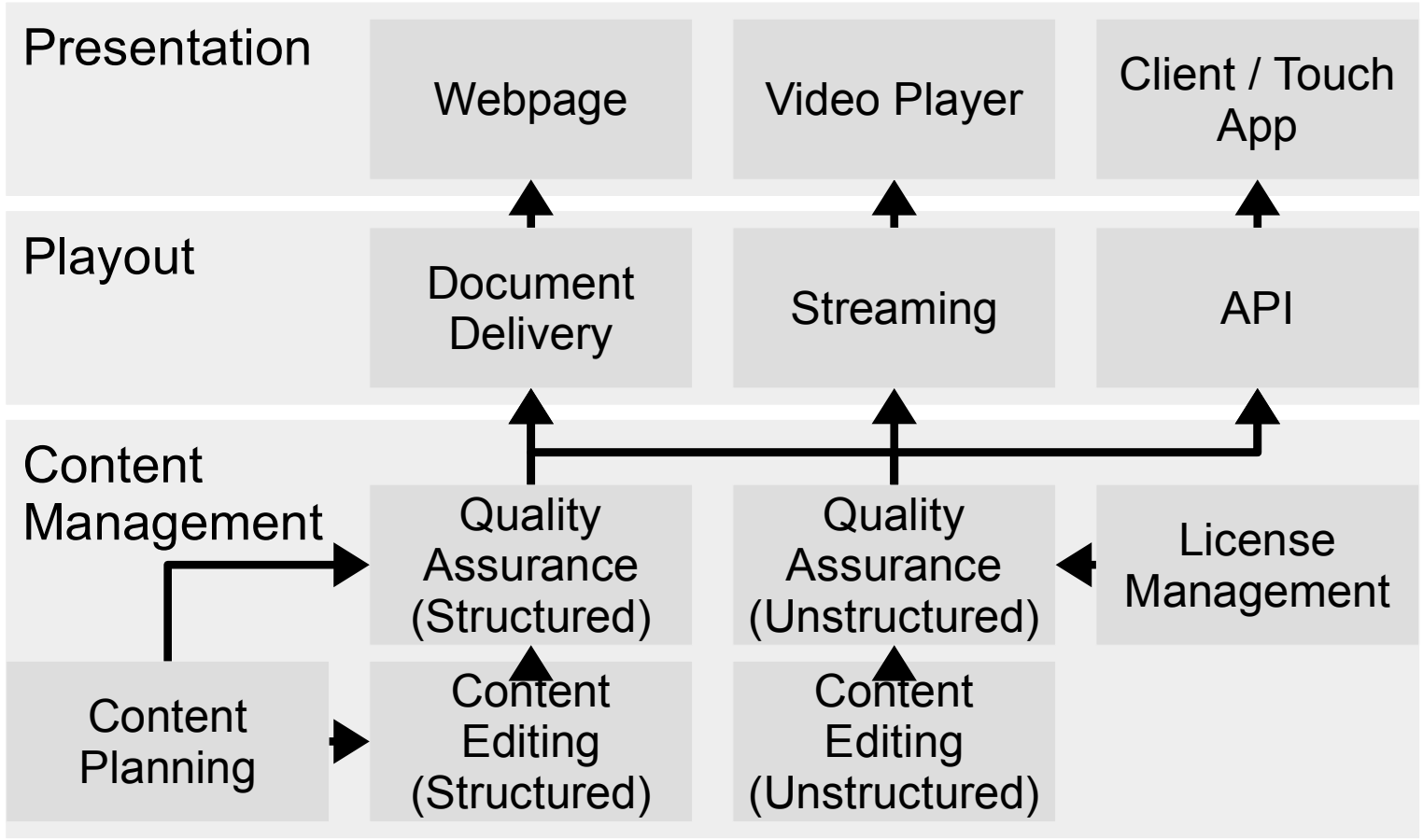


// Example: Content-driven Components

Everything that is required to manage content, produce media files, and to distribute them

- Content is an important ingredient to every digital solution (“content is king”). Consequently, several component classes deal with content.
- Content management:
  - Content Management Systems (CMSs) for structured content
  - Digital Asset Management (DAM) systems for unstructured content
  - Content planning and campaign management tools give direction to content production.
- Other sources of data also provide content, including product information management (PIM), and enterprise resource planning (ERP) systems.
- Content is distributed by playout components like rendering engines, web servers, application servers, etc.
- Document processing is employed to adjust presentations, e.g., to adapt images to different devices.

// Content-driven Component Integrations



Examples:

> Different content management systems need to be integrated with respect to the lifecycles of the content the manage.

> APIs used for applications include the utilization of content.

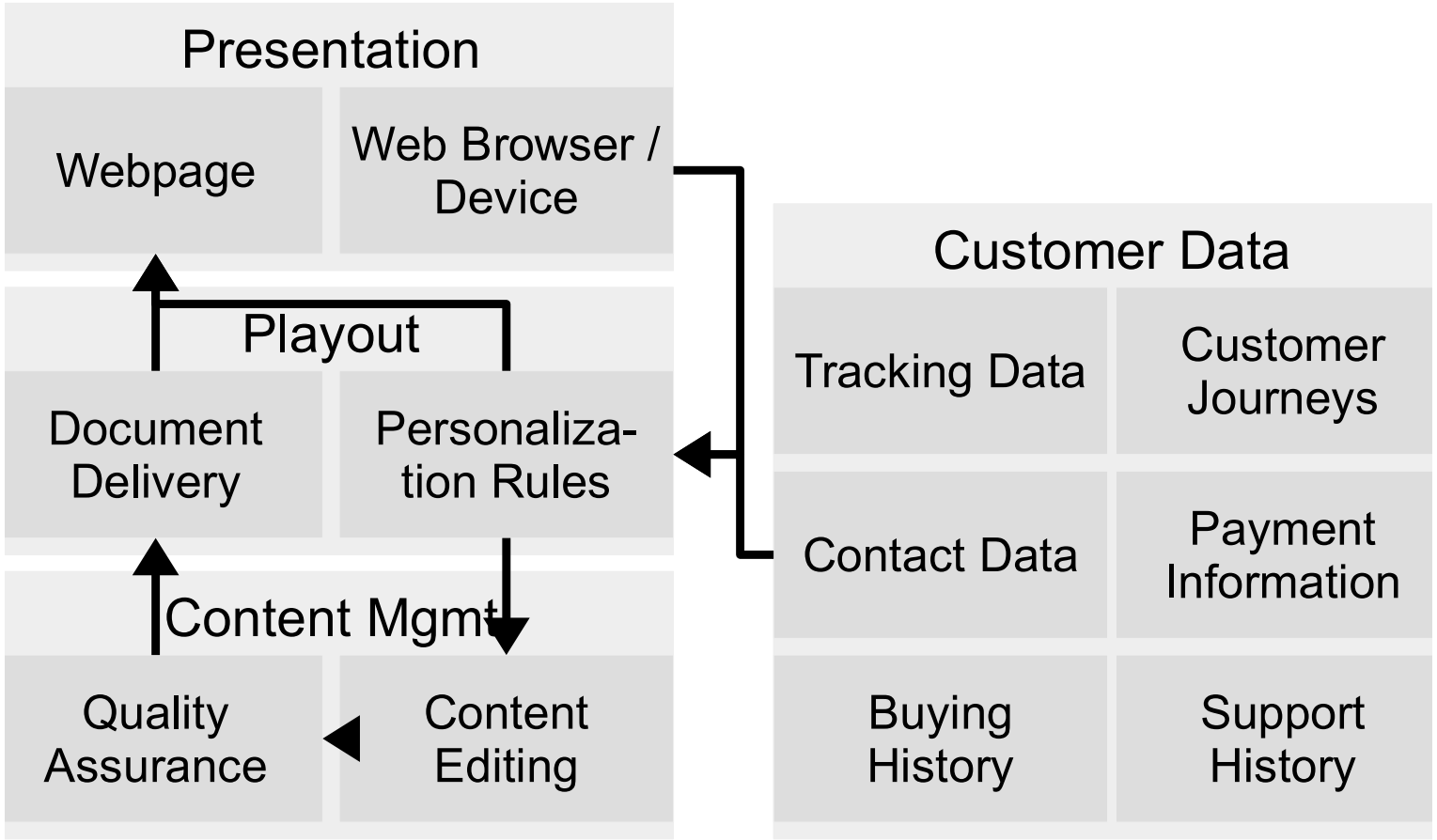
> The throughput from streaming servers is measured and fed back by video players.

// Example: Behavioral Components

Targeting content and content representations to Contexts, Audiences, and Single Users

- Personalization technology is used to adapt content and content presentations for
  - target groups / audiences
  - specific user groups (e.g., employees of one company that is a customer)
  - individual users
- Personalization has to be applied dynamically because it takes the requester and context into account.
- Personalized presentations can be explicit (defined by user) and implicit (based on behavior and context).
- Other behavioral components direct the customer along the customer journey
  - Retargeting
  - Customer journey orchestration
- Behavior is recognized by, e.g., tracking, A/B testing, transactions, and customer feedback

// Behavioral Component Integration – Personalization



Examples:

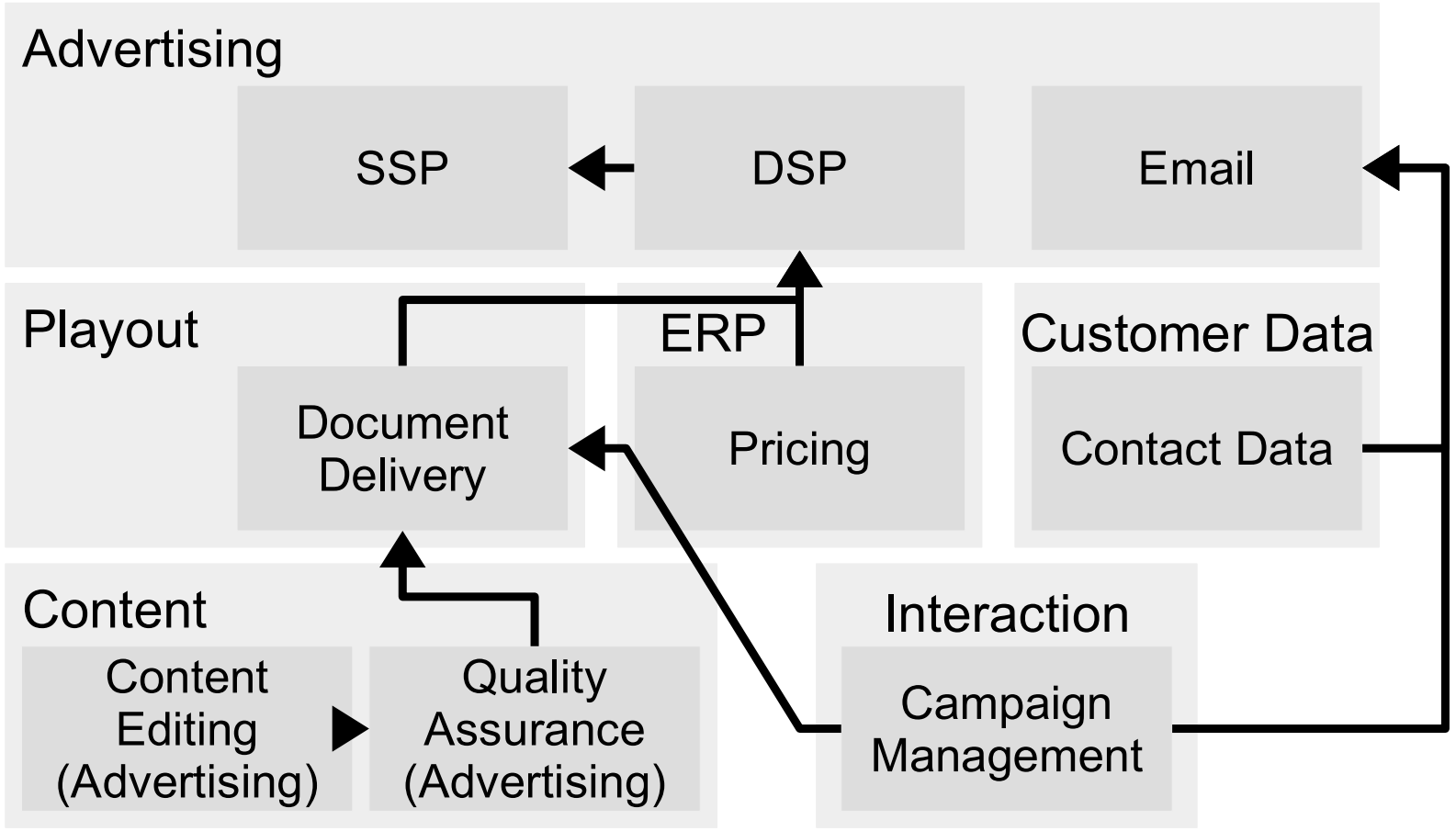
> Personalization rules are evaluated on content.

> Personalization rules can take bevahioral data into account.

> Personalization rules can take customer data into account.

// Example: Behavioral Component Integration – Retargeting

Focusing users on critical customer journeys



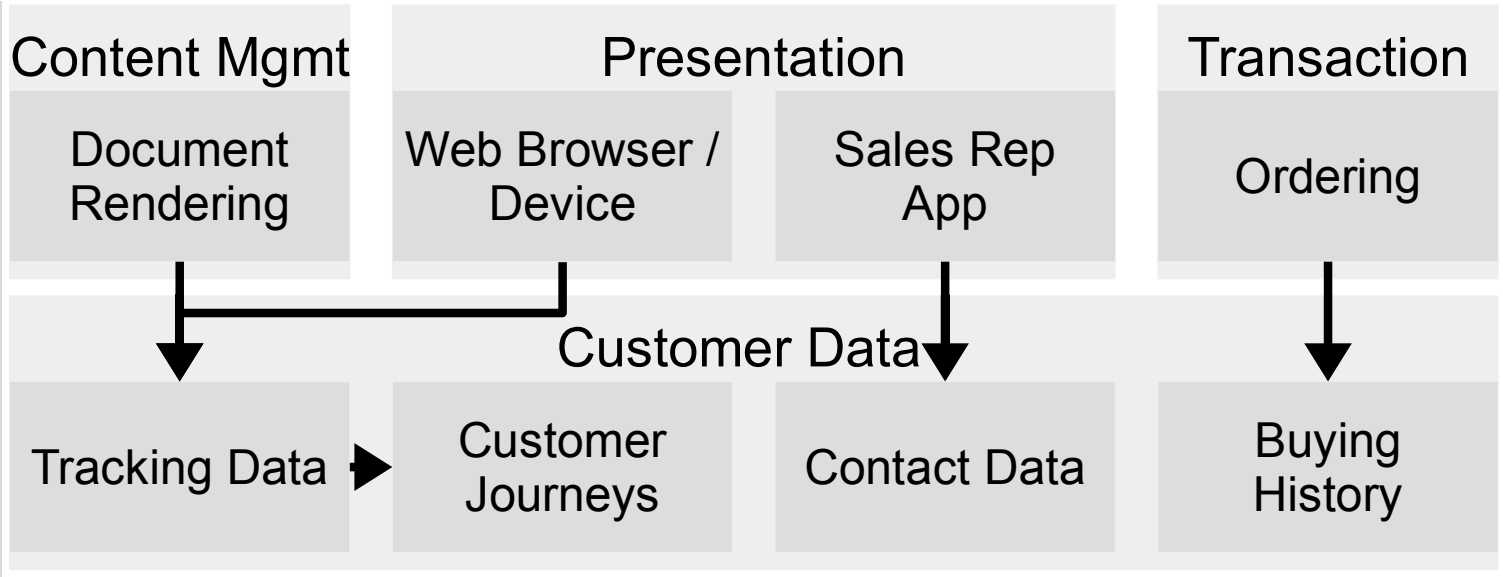
> Institutions want users to complete critical customer journeys. I.e., those which constitute the main business processes.

> When users deviate from such customer journeys, they shall be brought back on track by means of retargeting.

> Typical means of retargeting are email reminders and banner ads.

// Example: Customer-centric Component Integration

Collecting data about customers and interactions supports communication and all processes.



> Customer data has an impact on many operations of the digital platform.

> Traditionally, customer relationship management (CRM) systems maintain customer information.

> Customer data platforms (CDPs) extend the view on a customer by incorporating information coming from all channels.

// Varying Applications of Components

There may be a more universal use of basic functionality above that of a component's main purpose.

- Considering base functionality provided by components in a more basic way opens a perspective on different applications and combinations.
- Sample applications of a personalization engine
  - Some campaigns may by implemented by personalization
    - A customer is assigned to a campaign by being placed in a user segment
    - Content is prepared in a way that suits the campaign, e.g., to point out a service that is promoted by the campaign
  - A/B testing may be implemented by personalization
    - The variants of a dialog are prepared as "personalized" presentations
    - Customers are randomly assigned to one of the test groups
    - The test groups are used as user segments to present one of the dialog alternatives
    - Tracking is used to measure the performance of the respective alternative

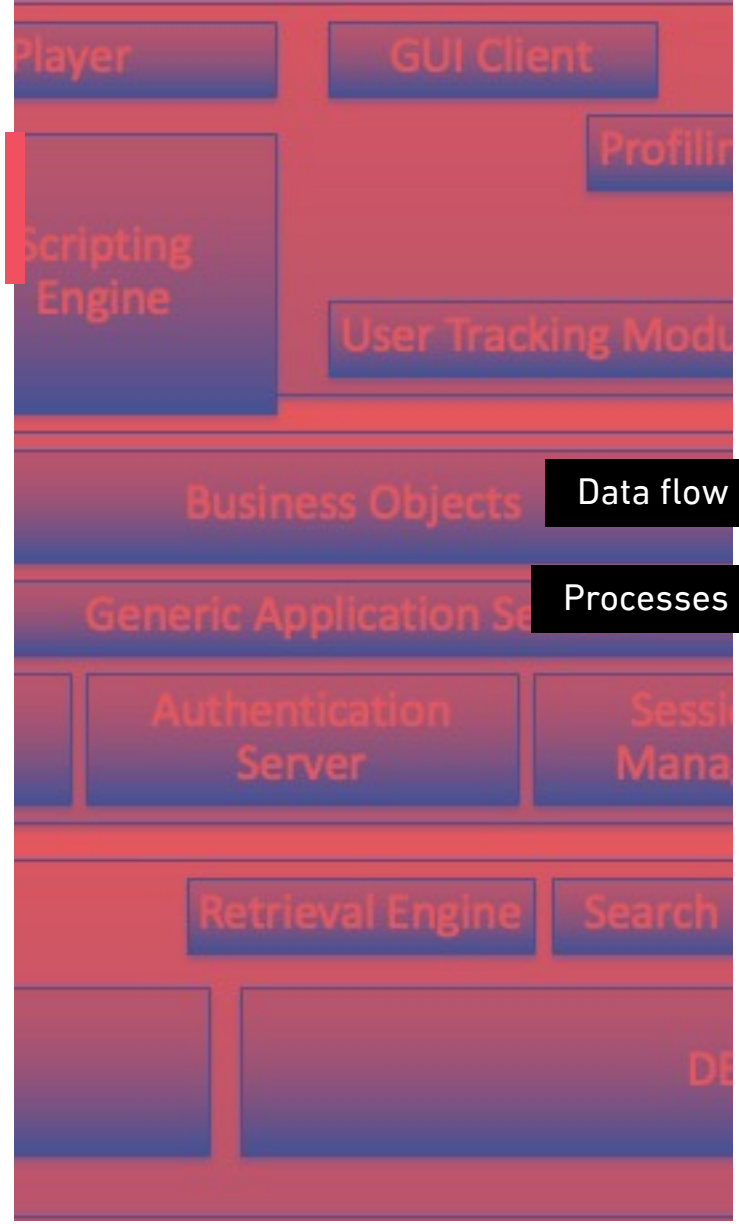
04

DOT SYSTEMS INTEGRATION

// Integration of DOT Components

Systems integration requires consistent data handling for coherence in communication and processes.

- > Since digital solutions are assembled from components, their components need to be integrated
- > Aspects of component integration
  - > Architecture – e.g., service-side integration, client-side integration with headless services in backend, etc.
  - > Processes – cross-system processes that enable a customer journey
  - > Data flows – determined by information demand in each process step
- > Two principal integration approaches
  - > Readily available integration tools and integrated solutions
  - > Custom component integrations



// Readily Available Integration Solutions

- Of-the-shelves component integrations basically come in two ways
  - Point-to-point integration by bridge solutions
  - Integrated DOT platforms
- They offer varying degrees of
  - Minimal: technical integration
  - Optimal: support whole use cases / customer journeys

Bridge solutions

- Point-to-point integrations between two components
- Provided by the vendor of one of the integrated software vendors or by a third party

Integrated DOT platforms

- SaaS offerings provide digital solutions that can be customized with comparably small effort
- Companies acquire knowledge on state-of-the-art communication patterns

// Integrated „Clouds“

> Prominent examples are the
  > Marketing Clouds and
  > Sales Clouds

of vendors like Adobe, Salesforce, and SAP

https://www.forcetalks.com/blog/key-features-of-salesforce-marketing-cloud-connect/

> Vendors allow integrating their “clouds” in order to integrate the provided services further

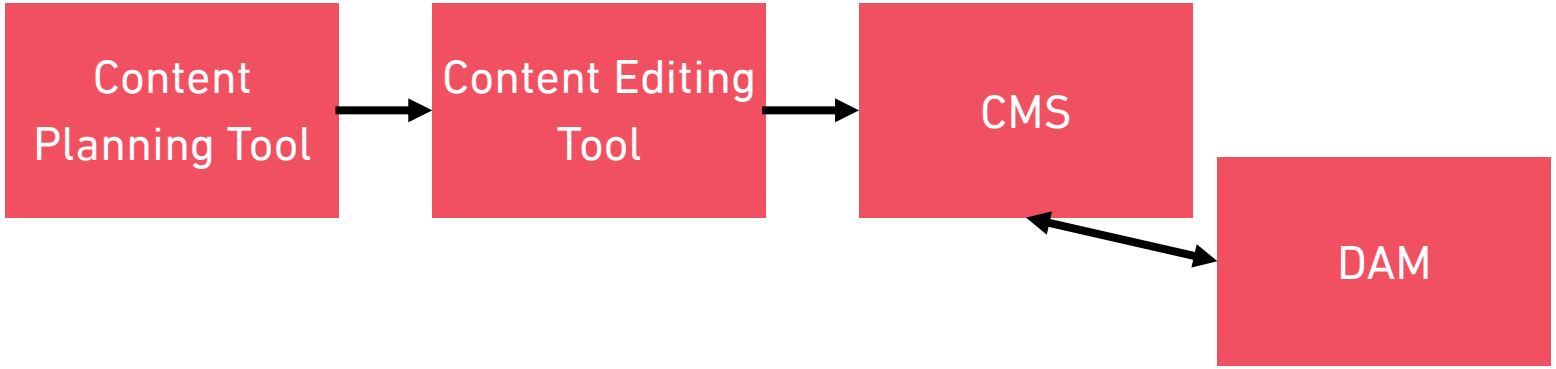
// Custom Components Integrations

- Prefabricated integrations provide one way of integrating components and, thus, one way of employing them
- Therefore, good reasons exist for a custom integration of selected components
- Examples are
  - Components are employed differently for specific tasks
  - Application-specific use cases may require different cooperation
  - Integration for a „best of breed“ approach of selected components
  - Integration of existing components that where operated as standalone systems before
- Prefabricated component integration and custom integration allow companies to …
  - either plan communication with their customers following the possibilities offered by the software solution
  - or shape their digital landscape after their plans for customer interactions

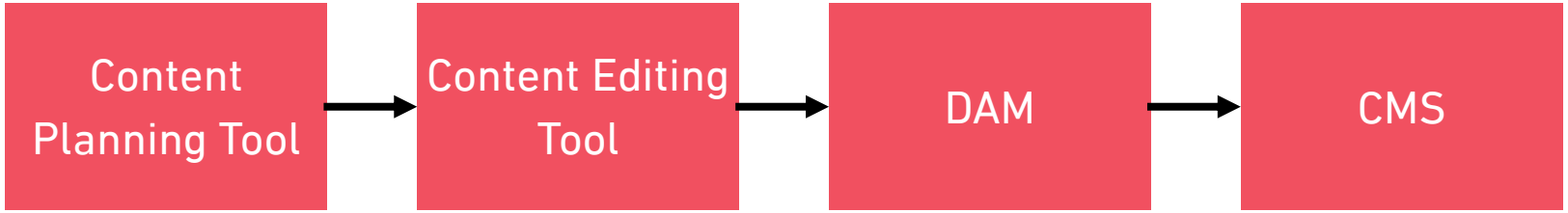
// Different Ways to Utilize and Integrate Systems for Specific Tasks

> Example: content production and the two possible roles of a DAM system

> Variant A CMS to manage structured content and text, DAM to manage unstructured content (images etc.)



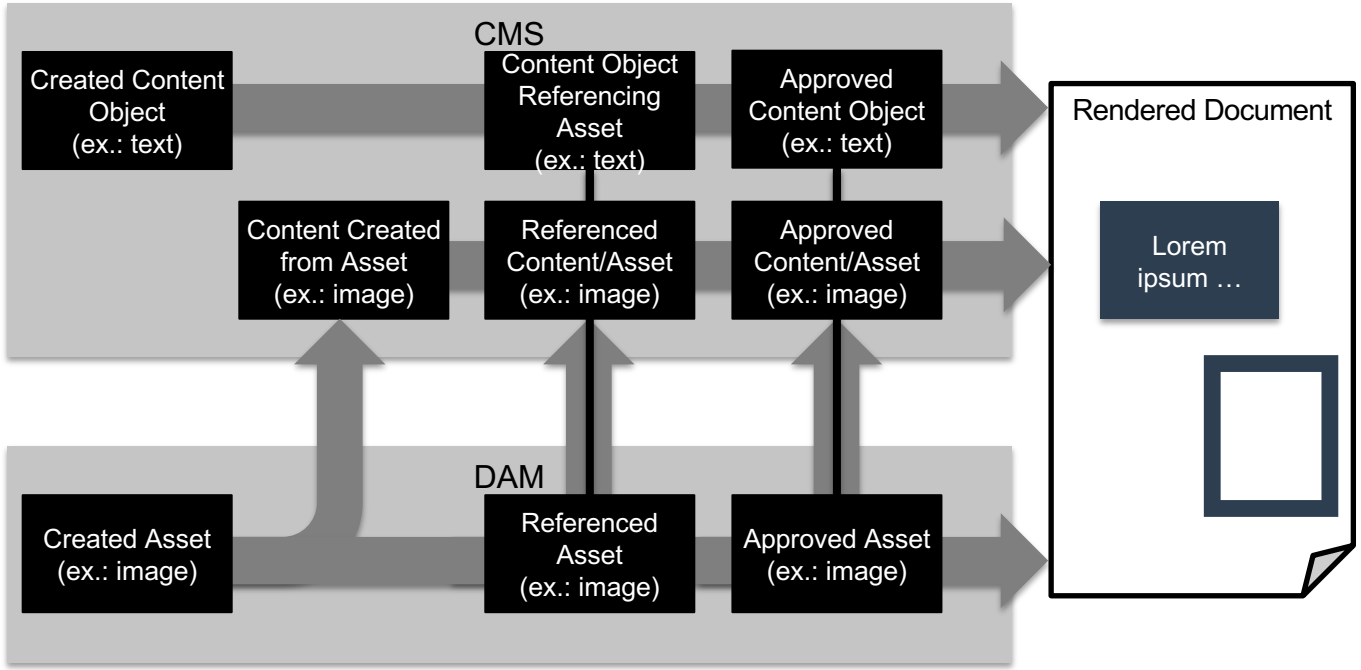
> Variant B DAM stores content items, CMS aggregates them to compound content and adds layout



// Component Integration is Application-Specific

As an example, consider the integration of a CMS for structured content and document generation and a DAM for unstructured content and media production.

- Lifecycles of content in CMS and DAM
  - Similar (created, QA'ed, published, deleted)
  - Not synchronized between components
- Integration forms depending on …
  - Point in lifecycle
  - Kind of integration (copies or references)
- Advantages depend on application
  - Content authoring: selection of media in CMS or in DAM
  - Quality assurance: performed in DAM or in CMS; possibility of broken links vs. possibility of outdated content
  - Media production: specialized functionality of DAM vs. context-specific production by CMS
  - Etc.



05

DOT SOLUTION ARCHITECTURE

// Architecture of Digital Solutions

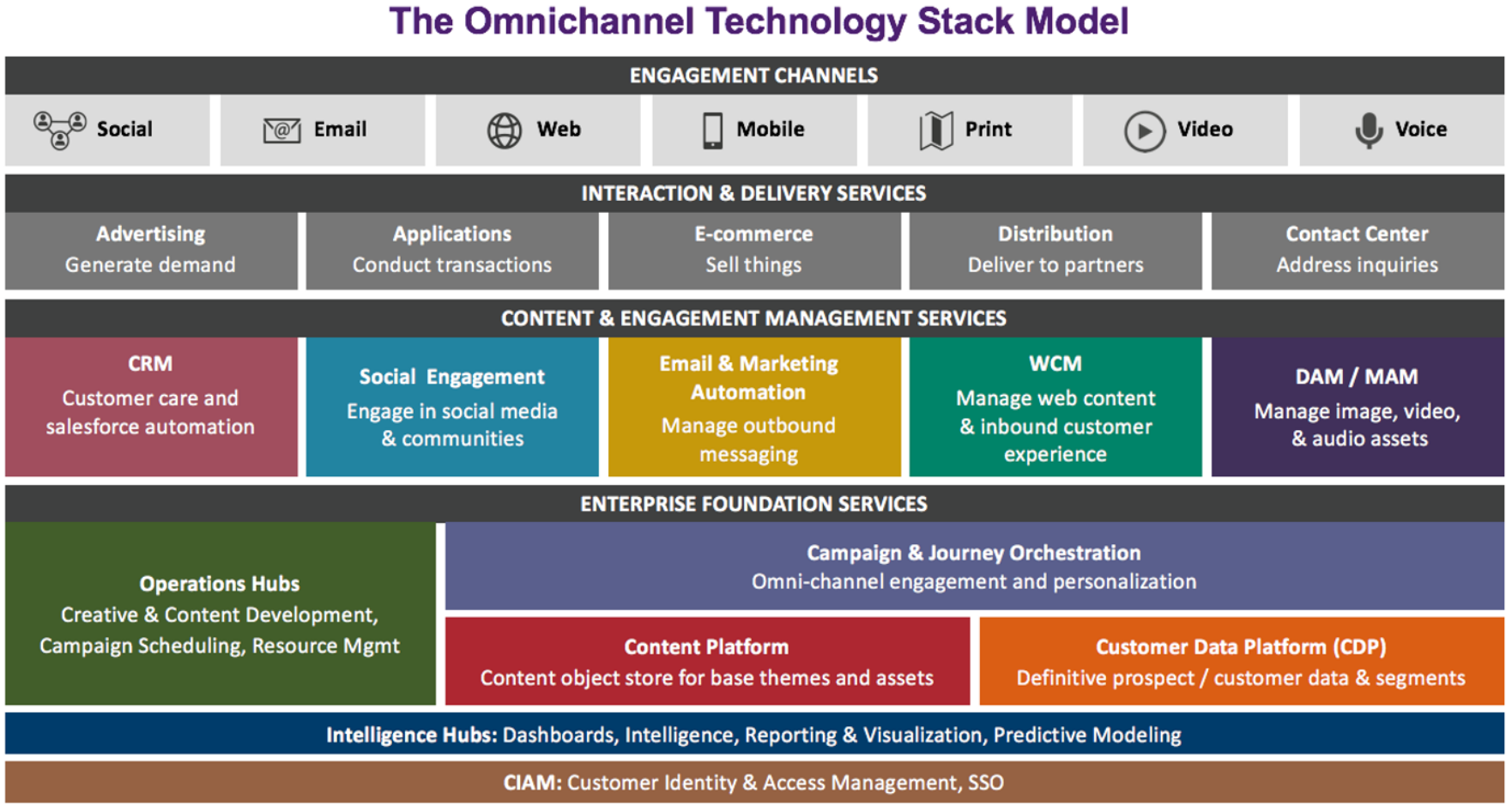
> With the multitude of specialized components that are utilized in a solution come many integration tasks
> To this end, there need to be architectures that tie together the whole landscape of the digital transformation

> When companies start their digital transformation, they will not cover all aspects of digital communication
> They start with some components and probably a roadmap of a potential evolution of their DOT landscape

> There are reference architectures for DOT solutions
  > They demonstrate how DOT components are typically combined
  > They provide a starting point when planning
  > They furthermore give a more complete picture to indicate in which directions a DOT solution may evolve

// Reference Architecture

Some organizations and analysts publish reference architectures.



[Tony Byrne: The New Omnichannel Stack, https://www.linkedin.com/pulse/new-omnichannel-stack-tony-byrne/]

// Architecture of Digital Solutions

In practice, it is often the case that digitalized systems are created from what is available and can be combined rather that as a solution for concrete requirements.

Instead, the technological solution that drives the digitization of an enterprise should be based on clients needs and on business goals.

Architecture work needs to be done carefully in order build adequate digital solutions.

We favor a customer-specific architecture for its digital landscape. Therefore, just applying a reference architecture as-is does not suffice.

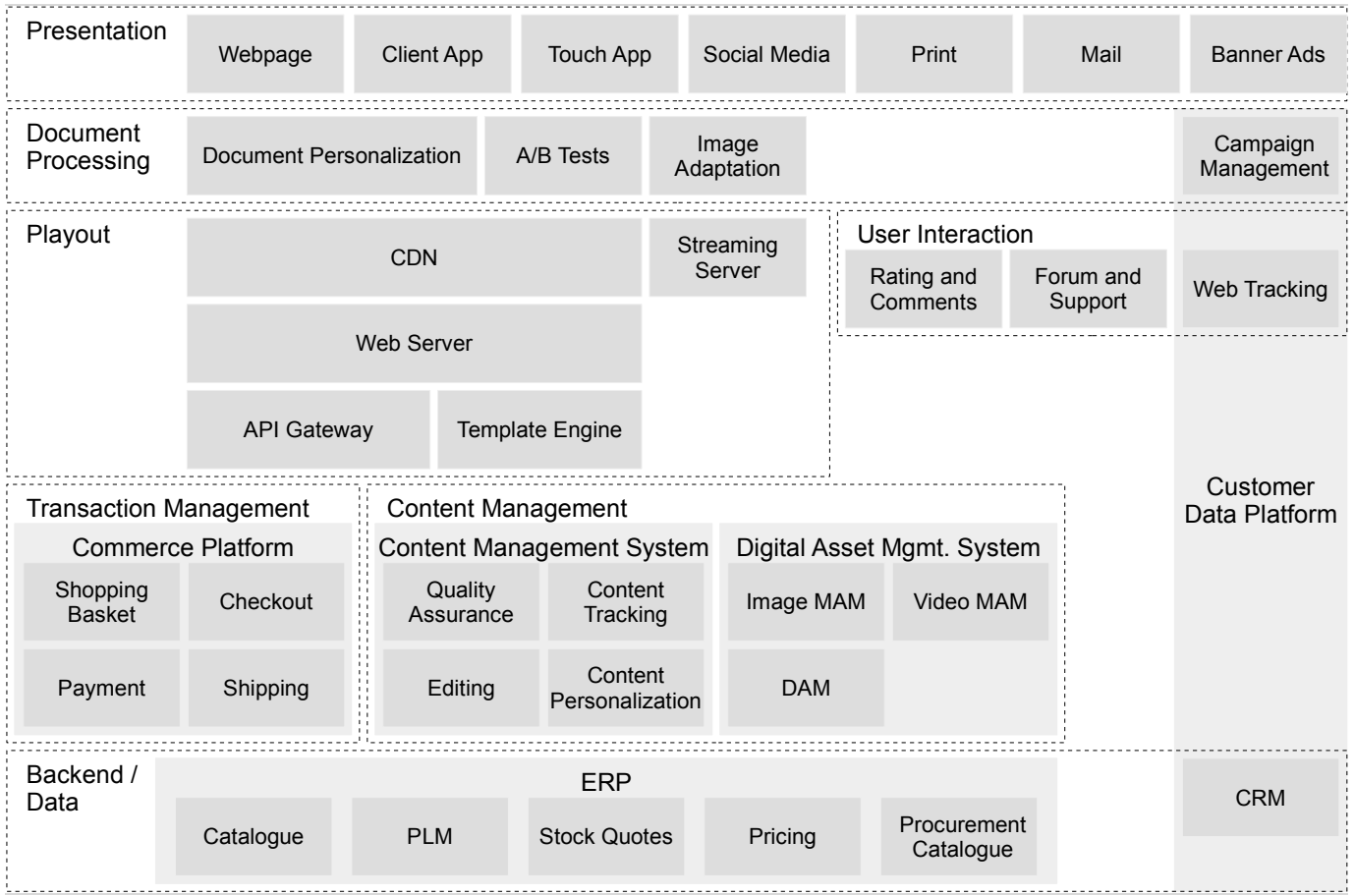
But knowledge and experience about the digital landscape must be documented on architecture level.

We do so by collecting recurring integration patterns with variants for different applications. On architecture level, this patterns are defined based on component classes that are defined after contributions of components.

// Functional Building Blocks of a Digital Solution Architecture

Presentation	Webpage	Client / Touch App	Social Media	Print	Email	Banner Ads	
Playout	Document Delivery	Streaming	API	Interaction	User-generated Content	Product Configuration	Shopping Basket
Content Management	Content Editing	Quality Assurance	Personali-zation	Content Planning	Transaction Management	Ordering	Logistics Interface	Support Functions
Enterprise Ressource Planning	Catalogue	PLM	PIM	Customer Data	Tracking Data	Customer Journeys	Contact Data
	Stock Quotes	Pricing	Procurement Catalogue		Buying History	Support History	Payment Information

// Functional Building Blocks Combined in System Configurations



Examples:

> Content management is provided by a CMS and a DAM.

> User interactions consist of ratings, comments, forums, and a support database, and they are measured by web tracking.

> CDP is built from campaign management, web tracking, and CRM components.

06

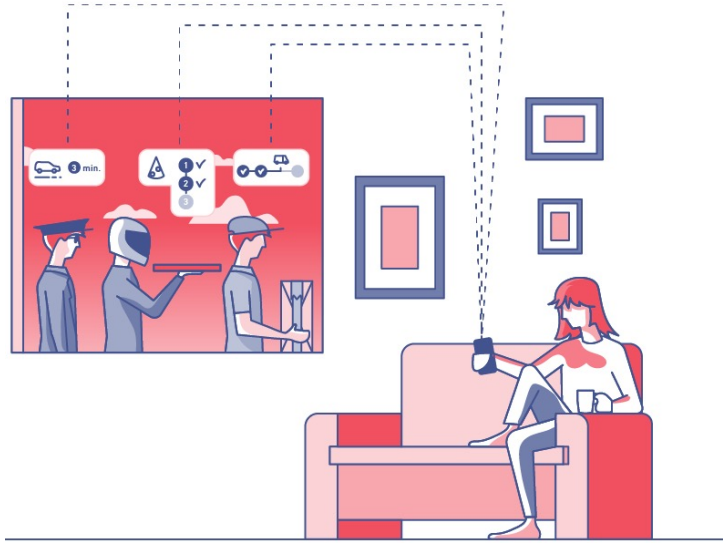
COHERENCE OF DOT PROCESSES IN HETEROGENEOUS SYSTEMS

// Relationship of Customer Interaction and DOT Solution Architecture

> We consider DOT systems that allow companies to communicate and to interact with their customers.

> Communication and interactions span multiple single interactions of a customer on one channel and in one context. The overall goals of a company – informing customers, sell their products or services to customers, maintain the loyalty of customers, etc. – are reached at the end of a customer journey.

> In the course of a customer journey, a customer interacts with multiple components of a company's DOT solution



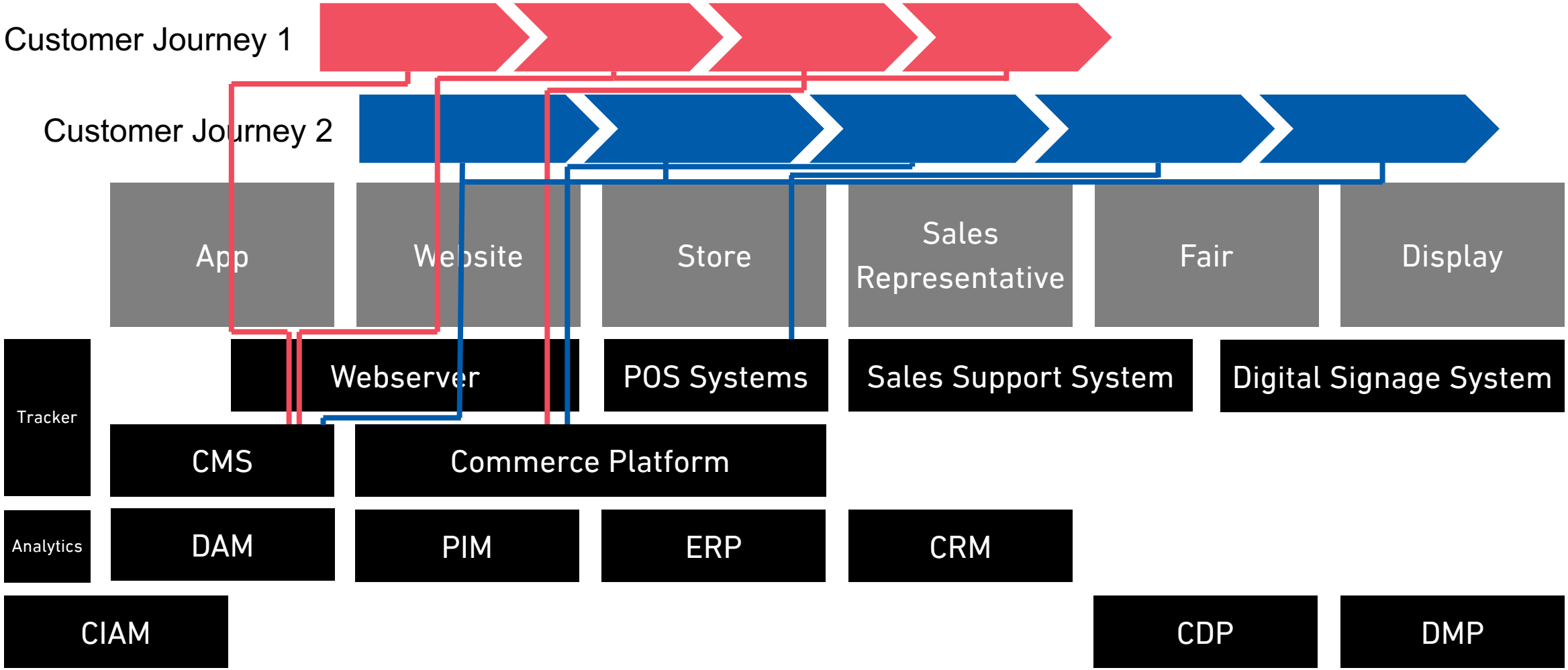
// Customer Journey and Touchpoints, Processes and Dataflows

This reference architecture outlines some prominent systems of the digital landscape. Customers interact with it through various channels.

DSP
SSP
App
Website
Store
Sales Representative
Fair
Display
Tracker
Webserver
POS Systems
Sales Support System
Digital Signage System
CMS
Commerce Platform
Analytics
DAM
PIM
ERP
CRM
CIAM
CDP
DMP

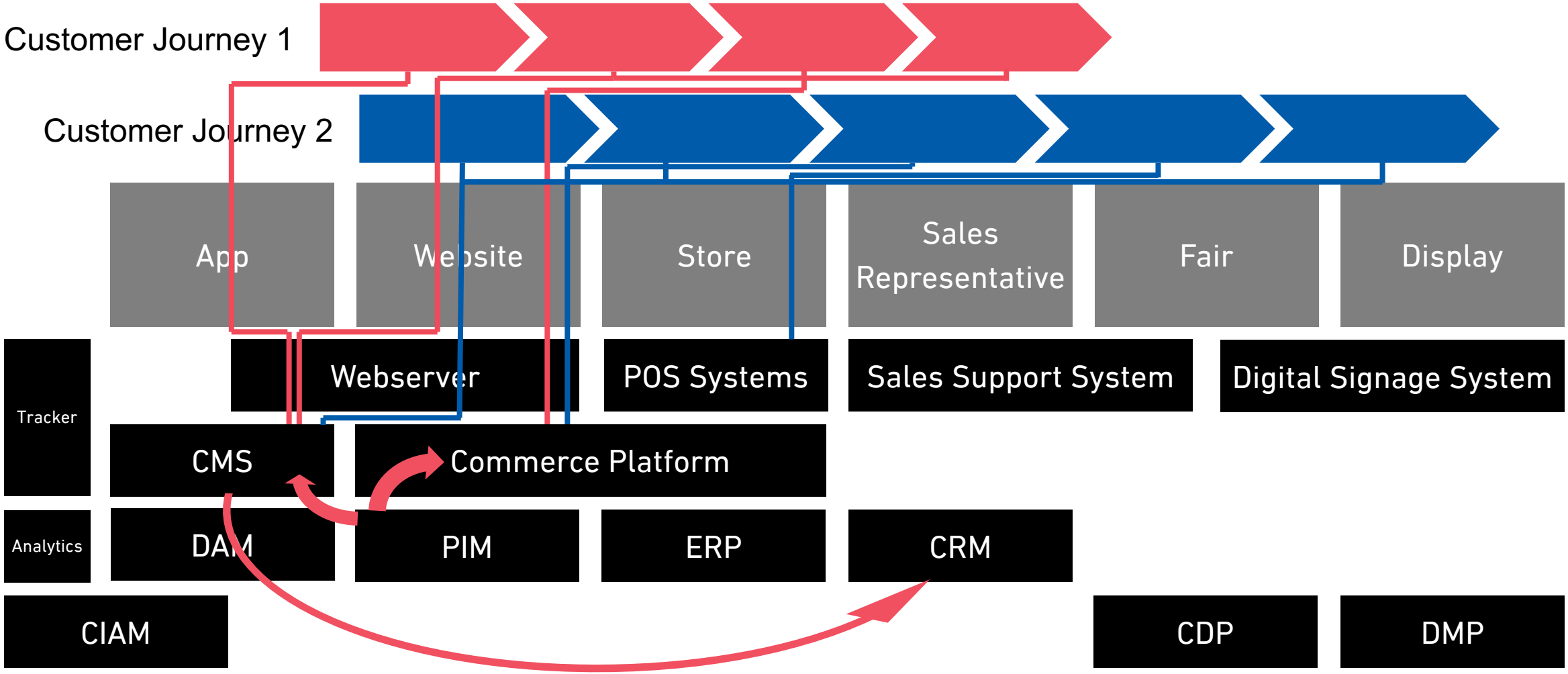
// Customer Journey and Touchpoints

On a customer journey, a customer interacts with several DOT components.

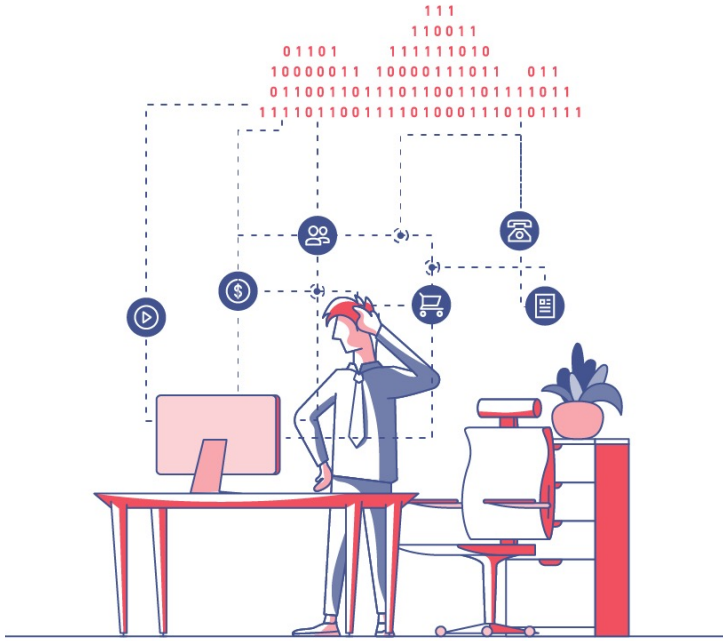


// Data Flows Required for a Customer Journey

The components that operate the touchpoints have to exchange data that is required during the communication with a customer.



// Coherence of Customer Interactions



- For such communication to work, it needs to be coherent
  - The system needs to understand whether a new communication is established, or an ongoing dialog is continued (possibly on a different channel)
  - The system needs to react consistently in all communication steps
- To establish coherence, single communication steps need to
  - Operate on consistent datasets and content
  - Share information in the communication history so that communication forms a dialog
  - Work a on consistent, company-wide model of the customer so that all information gathered about one customer reveals a consistent, multi-faceted view on the customer

// Technical Foundation of Coherence

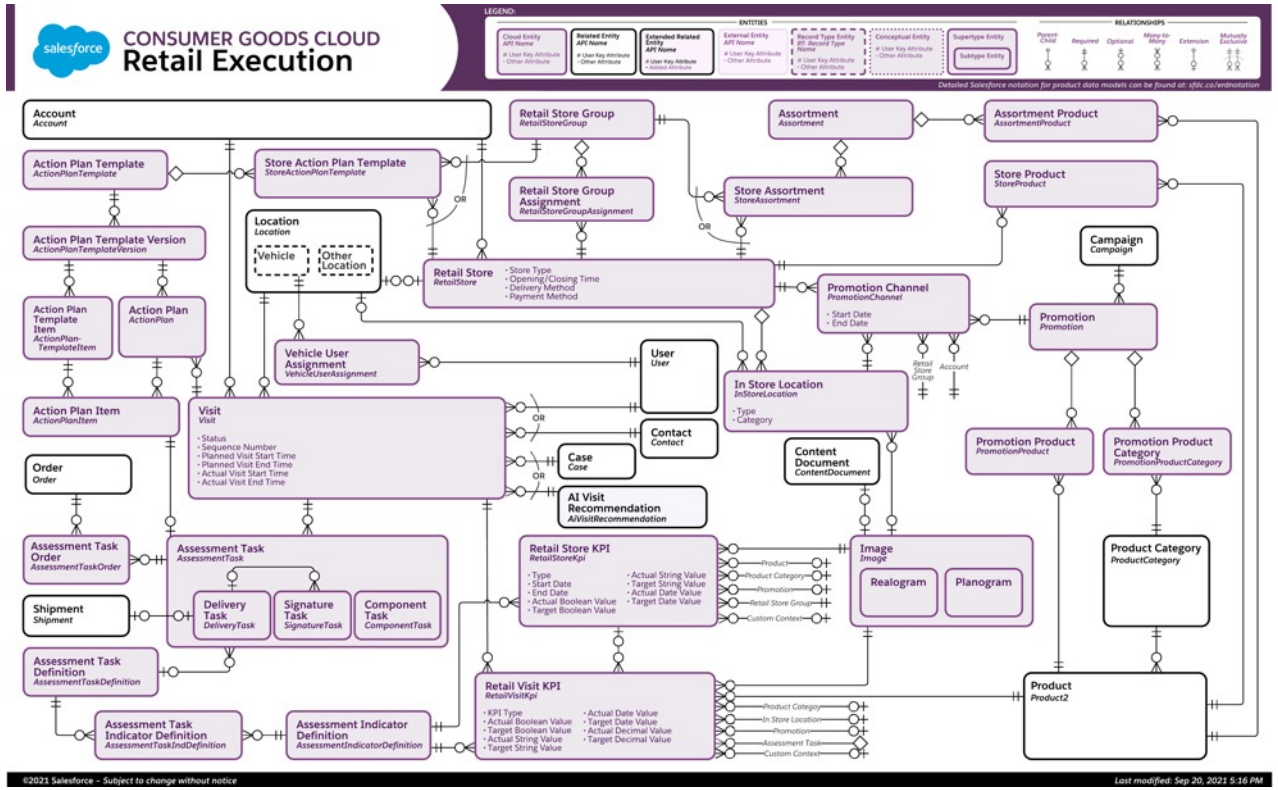
- How to establish coherence
  - For dialogical communication, we need to pass data and interpret it consistently throughout the system
  - To this end, there need to be mutual agreements at the integration points, or there needs to be a system-wide model of the entities dealt with
- Such a system-wide model about the entities can be …
  - predefined and used as the foundation of all components when they are developed;
    this is typically the case in integrated platforms
  - defined for the application at hand and be used for the definition of all components when they are integrated;
    this is typically the case when customly integrating components

// Common Model of an Integrated Platform

Integrated Platforms have a metamodel, and they allow aggregating and adding entities to that model.

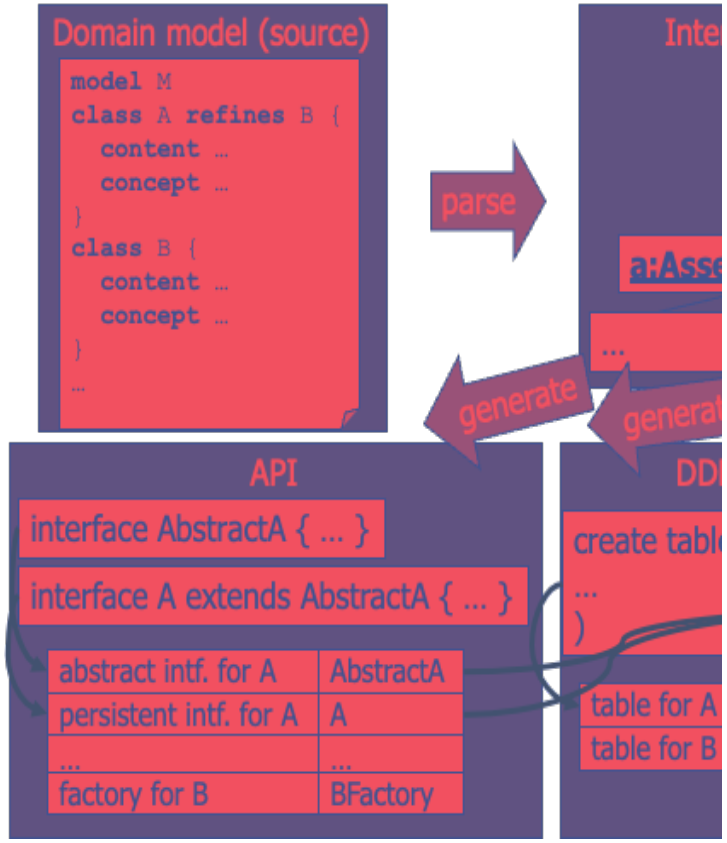
- Typically, integrated platforms come with vast, universal models that
  - are used throughout the whole system
  - are composed of singular models maintained by one component
  - are used by all components for the interpretation of data
- E.g., typical Cloud solutions allow selecting single services whose models are compatible

Some example:



https://architect.salesforce.com/design/architecture-gallery/consumer-goods-cloud-retail-execution-data-model

// Custom Model of an Integrated Components



- A model of all entities that is shared by all components is established in different ways, depending on the integration approach
  - When using COTS components with built-in models of the entities they manage, there need to be adapters that map the custom model to the generic model of the COTS
  - When using COTS components that can be parameterized with individual models for the entities they manage, then the individual models have to be set up in accordance with a system-wide model
  - When using an application-specific system-wide model of all entities, then the DOT system needs to be custom developed or be generated from the model.
- In previous and ongoing research, we study the latter.

// Approaches to Custom Digital Solutions – Concept-Oriented Content Management

- We developed two approaches to create consistent and coherent digital landscapes.
- The first approach is Concept-Oriented Content Management (COCoMa)
- With COCoMa, systems are generated from a domain model
- It is based on the observation that the functionality of each component is quite standard, and that the focus is on a model of the entities handled by a component
- It is based on …
  - A modeling language that allows combining models along different dimensions
  - The generation of components
  - An architecture that allows to define functionality by means of component composition, and that supports systems evolution

// A Multi-domain Model in COCoMa

```
model ArtHistory
from Documents import Document
class ArtHistoryDocument refines Document{
  content scan : byte[]
  concept
    relationship placement:Librar
}
```

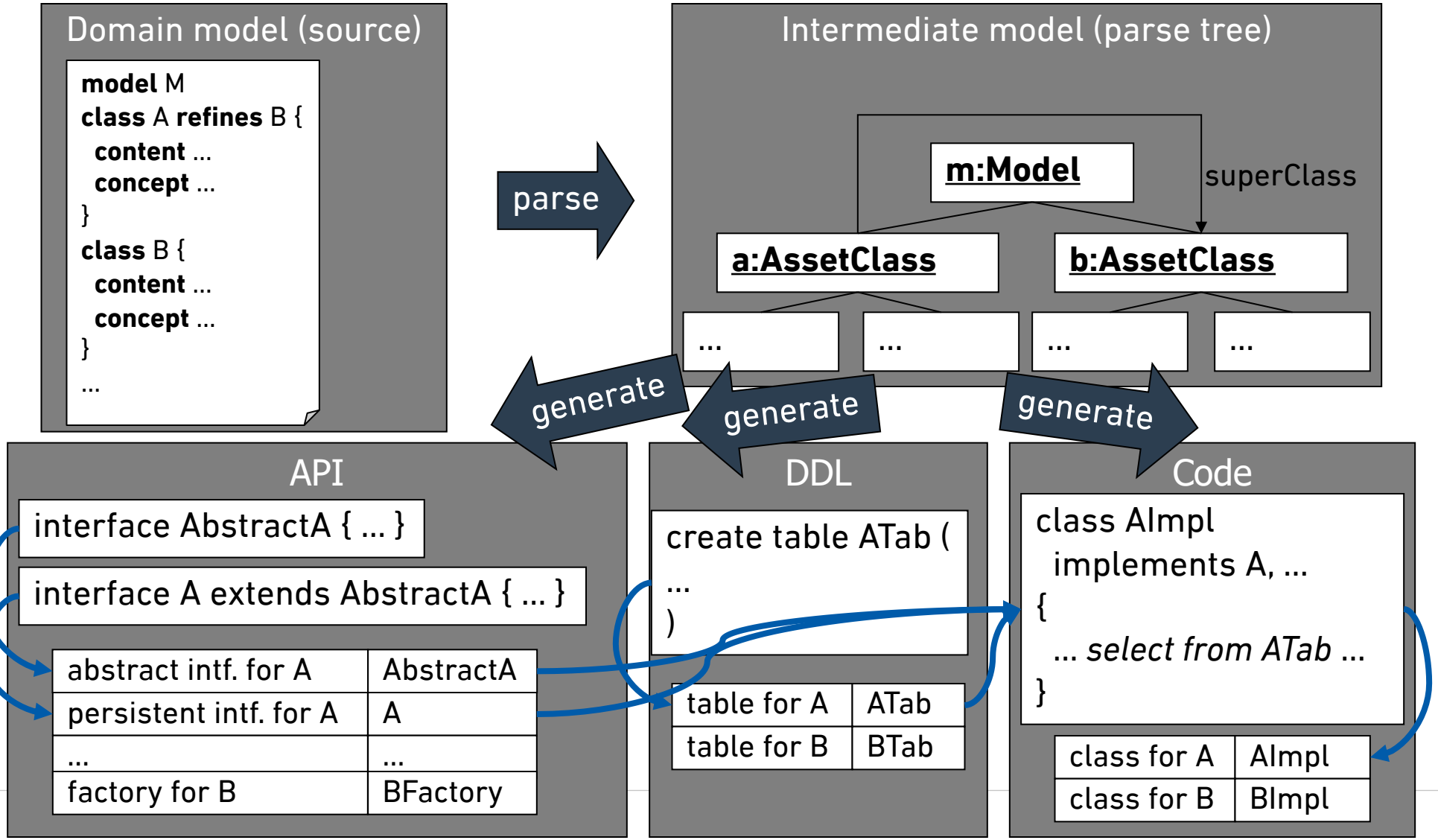
```
model Biography
class Person
```

```
model Documents
from Biography import Person
class Document {
  concept
    relationship author:Person
}
```

```
model CivilLaw
from Documents import Document
from Temporal import Date
class PersonalRightsProtection refines Bill {
  content paragraphs : LegalText*
  concept characteristic restrictionPeriod : Years
          relationship  protectedDocument  : Document
          constraint protectedDocument.author.deathDate
                     + restrictionPeriod <= create Date
}
```

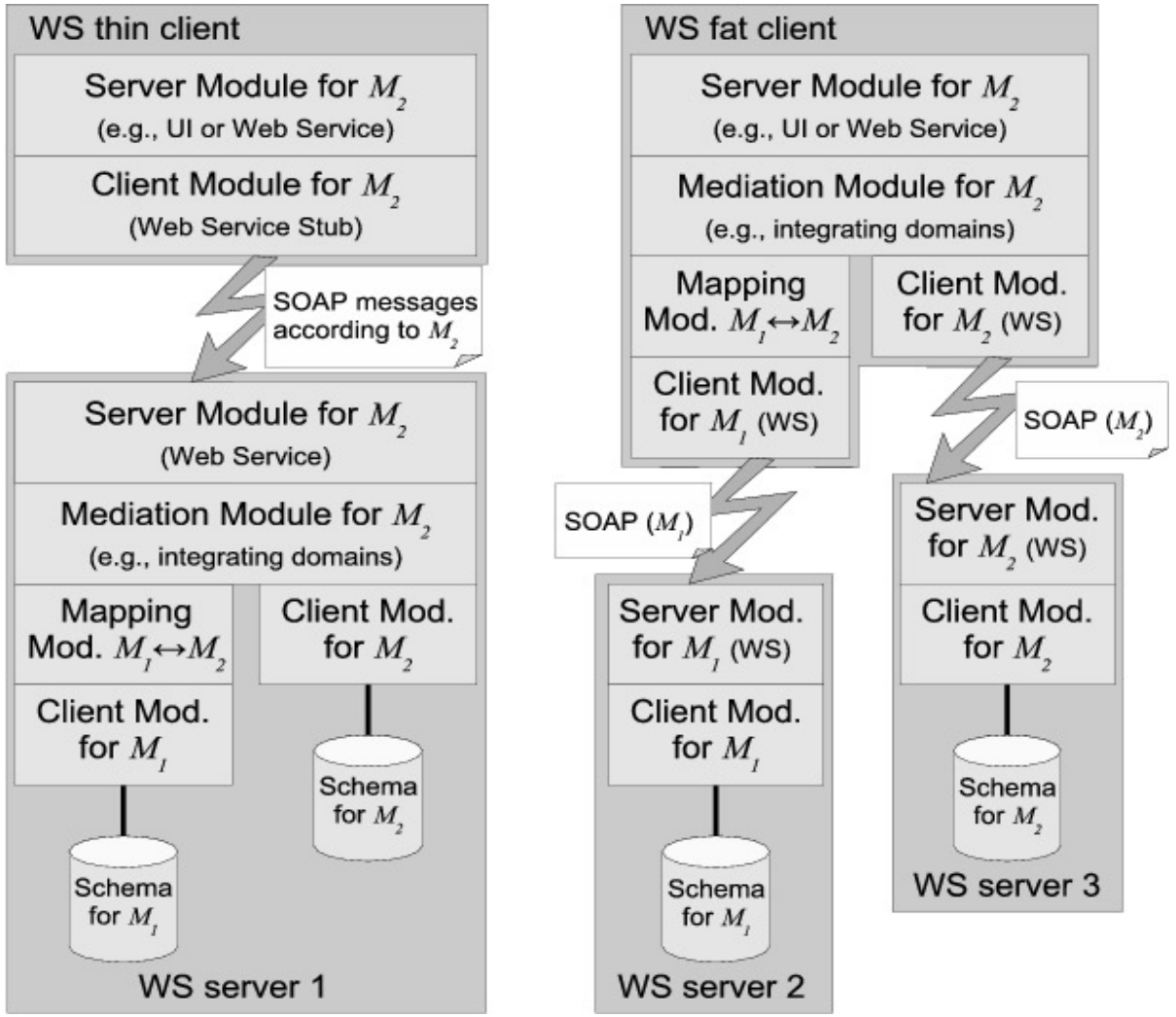
```
model Temporal
class Date
```

// Overview Over the COCoMa Compilation Process



// COCoMa Architecture Sketch

- > Scenarios …
  - > integration
  - > personalization
  - > revision
- > … of two models M_1 and M_2



// Approaches to Custom Digital Solutions – Minimalistic Meta Modeling Language

- > We us the Minimalistic Meta Modeling Language (M^3L) to study coherent system interaction
- > M^3L allows defining concepts in contexts, where each concept has relationships with other concepts and contains content
  - > M^3L was designed with Model-driven Software Development tasks in mind
  - > M^3L proved useful for content modeling and management
- > We are currently investigating the benefits of using M^3L throughout the whole digital landscape
- > Advantages are, amongst others,
  - > Coherent modeling of content, business rules, transmission protocols, support services, etc.
  - > Extendibility and evolvability of models

// Modeling Digital Solutions with the M³L

M³L's way of defining Concepts in Contexts is well suited to create model the digital landscape of a company component-wise.

M³L

Using the M³L, we model DOT components together with the entities they handle

Integration is reflected by importing and amending models
e.g., a system-wide Customer is created from CRM {Customer}, Targeting{Customer}, Account{Customer}, etc.

Customization is achieved by refining entities in the models of the respective components

CMS

MyContent {
Keynote2019 is an **Article** {
"Solution Landscape" is the **Title**
"In this talk I will present you..." is the **Text** } }

MySite {
Keynote2019Page is a **Page** {
MyContent { **Keynote2019** } is the **Content** } }

DAM

Image is an **Asset** {
ColorDepth is a **Number**
FileName is a **String** }
Picture0815 is an **Image** {
"img0815.png" is the **FileName** }

PIM

MyCatalog is a **Catalog** {
Photo is an **Image** |- **DAM** { **Asset** { **ID** is the **UPC** } }
Electronics is a **Category** {
"TV and Video" is a **Category** {
"TV Sets" is a **Category** {
VX_389_ABC is a **ProductFamily** {
VX_389_ABC_00 is a **Product** {
VX_389_ABC_00_b is an **Article** { ... }}}}}}}

Component Integration

MySite {
ProductDetailPagePage4711 {
DAM { **Image** { **12345** is the **ImageID**
Left is the **Position** } } is a **Picture**
"Welcome to the Page" is the **Title**
Product { 789 is the **UPC** } is the **Content**
Shop { **Basket** { **Session** {**User**} is the **Customer** }}
} }

08

SUMMARY AND OUTLOOK

// Summary

> Digital transformation is not achieved through single systems. The DOT solution of a company is a composition of multiple components that work in concert.

> We have a look at the established DOT systems that may be used for single interaction tasks or in concert. These systems form the DOT landscape in which they act as components.

> Manifold forms of DOT system integration are used to implement a DOT solution. Software vendors meet this demand by providing integrated DOT platforms or services. But there also are strong points for custom solutions created by an application-specific integration of components.

> In any case, the overall DOT solution architecture is key to use components in a way that meets the digital transformation goals of a company.

> DOT solutions as discussed in this talk allow companies to communicate and interact with their customers. Since DOT solutions consist of multiple components, coherence of communication has to be reflected by coherence of DOT processes.

// Conclusion and Outlook

- To conclude, the digital transformation is driven by technology, and there is an increasing wealth of technology for digitalized institutions.
- Solutions for digitalized institutions must not be designed by looking at the functionality of available software components only.
- Instead, solutions are built for business goals at hand in order to achieve competitive advantages.
- An adequate combination of components can be achieved by means of architecture that follows proven principles but allows designs that are targeted at the business goals.
- An outlook on the future of the digital transformation is hardly possible. New requirements, and thus products and services emerge constantly.
- One constant is convergence: E.g., sales, marketing, and aftersales support functions are no longer separated, as are communication channels, no to mention the “real world” and the digital realm.
- Consequently, future work will continue to not define reference architectures, but to collect patterns for integration tasks.

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THANKS.

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